ORIGIN OF FOUR UPPER PENNSYLVANIAN (MISSOURIAN) CYCLOTHEMS IN THE SUBSURFACE OF WESTERN KANSAS: APPLICATION TO SEARCH FOR ACCUMULATION OF PETROLEUM

by

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ABSTRACT

Thin, widespread, carbonate-dominated cyclothems of the Lansing and Kansas City groups were deposited across Kansas during the Missourian on a gently tilted shelf bordering the rapidly subsiding Anadarko basin. Similar cyclothemic deposits of Late Pennsylvanian age are found throughout the Midcontinent and in many parts of the world. The possible causes of this cyclothemic sedimentation are re-evaluated based upon a comparison of the stratigraphy, sedimentology, and diagenesis of four, similar, successive cyclothems over a wide area in the subsurface of western Kansas using cores, cuttings, and wireline logs. The observations and interpretations are used to evaluate the distribution of petroleum reservoirs in these cyclothems.

The four cyclothems are characterized by a rapid transgression and relatively slow regression of the sea across a gently tilting shelf. A thin, basal transgressive carbonate is overlain by the marine shale, representing maximum inundation by the sea. The marine shale completely covered the study area but for local areas over the more significant positive areas of the shelf and in one of the cyclothems, the I-Zone. The black organic-rich facies in the marine shale covers much of the southern two-thirds of the shelf excluding portions of the structurally positive areas and again in the I-Zone. The anoxic bottom conditions that brought on the deposition of black shale resulted primarily from the combination of stagnant bottom waters due to a thermocline and scavenging of oxygen by large amounts

of terrestrial organic matter. A positive water balance due to large amounts of freshwater runoff across a nearly landlocked cratonic sea together with minor coastal upwelling encouraged stratification of the water and dispersal of the organic matter.

The shoreline retreated across the shelf during each cyclothem depositing a veneer of shallow-water, restricted-marine regressive carbonates and eventually exposing this carbonate to subaerial processes and meteoric freshwater diagenesis. The regressive shale capping the cycle is generally very thin or absent and commonly contains soil structures.

Progressive, contemporaneous, epeirogenic deformation of the shelf significantly affected sedimentation and diagenesis in these cyclothems. These changes included firstly, varying but generally less subsidence over previously active structures such as the Central Kansas and Cambridge uplifts resulting in condensation of lithofacies, loss of black marine shale, early onset of shallow-water facies, and more intense early freshwater diagenesis. Secondly, increased subsidence occurred along portions of the shelf closest to the Anadarko basin, most active during deposition of the earliest two cyclothems which resulted in a steepened depositional slope and a more favorable setting for extensive development of high energy carbonate facies during late regression. These epeirogenic adjustments were however secondary in importance to a rapidly fluctuating sea level in controlling the formation of the cyclothems. Periodic changes in eustatic sea level due to continental Gondwana glaciation are deemed most plausible for producing the rhythmic flooding and subaerial exposure of the broad, gently-dipping shelf.

The characteristics of contemporaneous structural elements that affected sedimentation are closely related to inhomogenieties in the Precambrian basement terrane suggested by variations in the magnetic field intensity. Detailed, high-level interpretation of potential field geophysics may eventually be very useful in analyzing depositional and structural trends and patterns in the sedimentary layers.

DEDICATION

This volume is dedicated to my wife Karen and daughter Chris whose patience and understanding have persevered through the completion of this project during vital years of our relationships.

ACKNOWLEDGMENTS

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W. LYNN WATNEY

CHAPTER ONE

INTRODUCTION

General Problems Specific to Study Area

Cyclothems characterize the Chesterian through Wolfcampian stratigraphic succession in the Midcontinent of North America and other Late Paleozoic successions worldwide. This sequence of terrigenous clastic and carbonate rocks comprises repetitive lithofacies that are widespread and constant in thickness. It is not unusual to be able to trace beds less than 10 feet (3.3 m) thick for more than 300 miles (450 km) along the outcrop. The obvious repetitions of the sequence led to the pioneering work on cyclothems of R. C. Moore, Marvin Weller, and H. R. Wanless.

The origins proposed for these and similar cyclothems are contradictory (Moore, 1929; Weller, 1930; Branson, 1962; Brown, 1972; Heckel, 1977, 1980). An objective of this study is to address this problem with new insight provided by careful description of four Missourian cyclothems based upon an extensive, three-dimensional network of subsurface data for rocks of the Kansas City Group of western Kansas. The cyclothems are informally referred to by letters

H, I, J, and K (Morgan, 1952). The specific objectives of the study are to examine the effects of the configuration of the shelf on the nature of the four cyclothems, to evaluate evidence for sea-level change, and to deduce the amount of any change. The study attempts to estimate the contribution of the potential causes of cyclicity: sea-level change, tectonism, and the sedimentation process itself.

Western Kansas was a broad shelf bordering the Anadarko basin during much of the late Paleozoic, including the Missourian. Sampling detail is sufficient to describe the activity of subtle tectonic elements on this shelf and the varying depositional setting of each cyclothem. Flexure and subsidence of the Missourian shelf in western Kansas was a response to rapid subsidence in the Anadarko basin to the south. Subsidence of the shelf, however, was not uniform, and local episodic movement certainly influenced the lithofacies distribution in each cyclothem. However the local tectonism does not account for the shelf-wide repeating pattern. Here the cause must be a result of source-area tectonics, sea-level oscillation, or shifting of sedimentary environments.

Another objective of this thesis is understanding the factors responsible for accumulation of hydrocarbons. This information along with structural setting, should be a useful component in evaluating areas for exploratory drilling or extending productive trends. Favorable reservoirs for petroleum vary in distribution among each of the cyclothems. Not all zones produce at any location.

The study area in western Kansas covers 47 counties and 30,000 square miles (77,000 sq. km) (Fig. 1.1). The northwest-trending

Central Kansas uplift (CKU) and Cambridge arch (CA) cross the eastern and northern portions of the study area. These broad uplifts are separated by only an unnamed, narrow, shallow depression. Together they constitute a major portion of the study area and form a province that contrasts with the less deformed area to the west. Although the major tectonic activity along the CKU-CA was only a brief event during the Late Mississippian and Early Pennsylvanian, the location was also the site of an earlier uplift, the ancestral CKU (Merriam, 1963), during the early Paleozoic. The amount of vertical movement (hundreds of feet) was considerably less than the thousands of feet that occurred in the Early Pennsylvanian in the neighboring uplifts. Perhaps 6 to 12 miles (10 to 20 kilometers) of thrusting occurred in the Wichita Mountains (Brewer et al, 1983). Movement of the CKU and CA during deposition of the H, I, J, and K intervals influenced the distribution of lithofacies and potential reservoirs.

Materials and Methods

Good quality wireline logs from 2300 wells penetrating the entire Kansas City Group provide the control for subsurface stratigraphic and structural mapping, including isopach maps and subsea structure maps for interpreting structural development. The well density averages one per 13 square miles (34 km^2) or one well every 3.6 miles (5.8 km) (Fig. 1.2). Maps include thickness of the cyclothems, thickness of the regressive shale, thickness of porous regressive carbonate (upper and lower intervals), and maximum gamma radia-

Figure 1.1. Map of the state of Kansas showing the area studied in this investigation (light dotted pattern in mapped area and heavier dotted pattern in area with core only) and that of Watney (1980) in western Kansas (double cross hatched in area mapped and cross hatured in areas studied with core only). The surface outcrop of the Lansing and Kansas City groups is identified in eastern Kansas. The Central Kansas uplift (CKU), Cambridge arch (CA), and the Nemaha uplift in eastern Kansas are recognized on this map as the outlined areas where the Mississippian strata are now missing due to erosional truncation along the edges of the uplifts (Merriam, 1963). After Watney (1984).

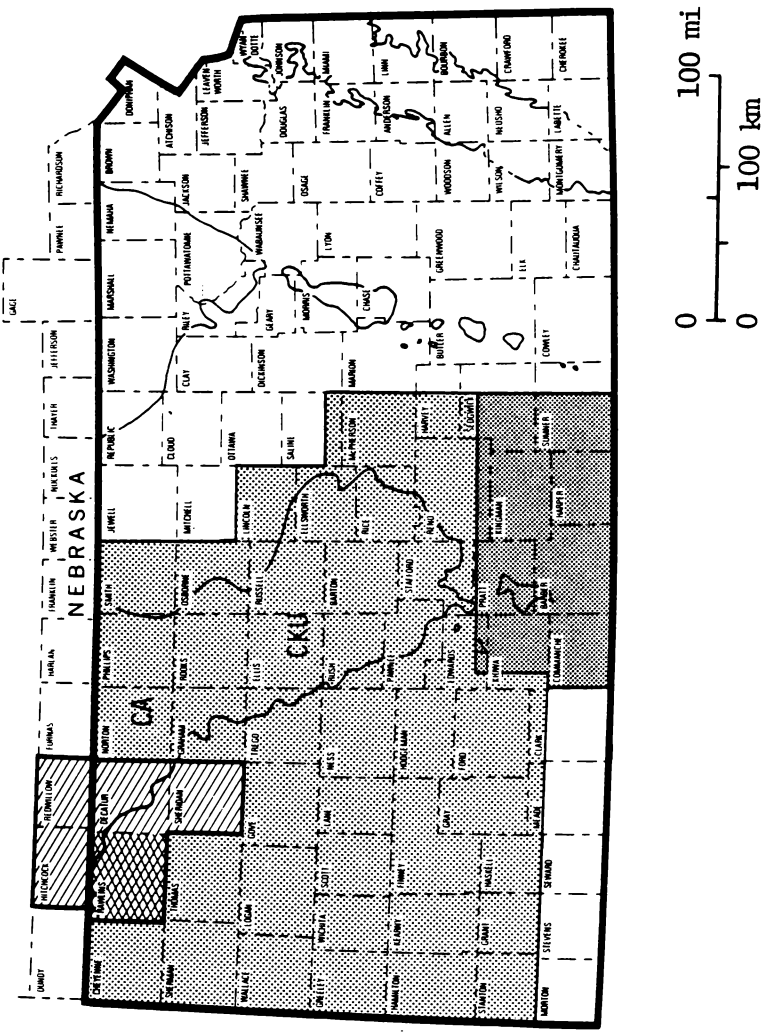
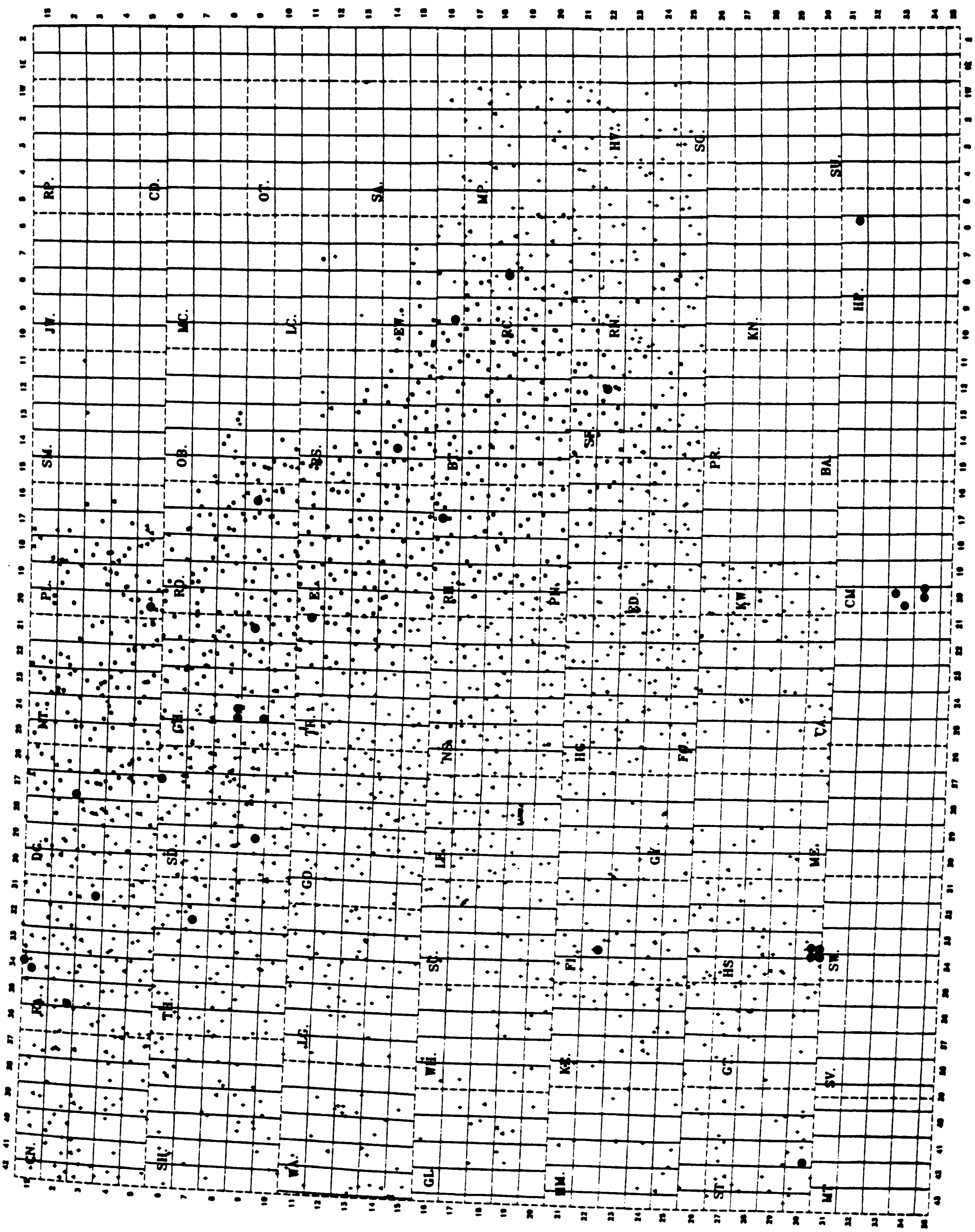

NEBRASKA
CA
CKU
0
100 mi
0
100 km

Figure 1.2. Township map of western Kansas showing locations of wireline logs and cores used in the study area. Plus (+) symbol indicates those wells with Mississippian strata below the Pennsylvanian and circles (o) or triangles (Δ) indicate those wells that do not have Mississippian strata beneath the basal Pennsylvanian unconformity. Cores are identified by larger solid dots. Three cores are from Red Willow and Hitchock counties, Nebraska. Spacing between township boundaries is 6 miles (10 Km). County names are abbreviated (see Fig. 1.1).



tion of the marine shale. These various maps were prepared for each of the four cyclothems. Trend surface and residual mapping of structure and isopach information and ratio mapping were also done. The detailed stratigraphic mapping is discussed in a later section.

The study materials included 37 cores that sampled at least portions of the four cyclothems identified for study (cyclothems H, I, J, K) in the Missourian Kansas City Group (Fig. 1.3, Table 1). Comparison of cores and logs from the same wells permits recognition of characteristic log response of lithofacies. Interpretation of other logs leads to interpretive maps showing the distribution of lithofacies in each of the four cyclothems. Cores and thin sections of carbonates are described according to classification of Dunham (1962) and stained as recommended by Dickinson (1965, 1966). Recognition of invertebrate fossil fragments was assisted with the use of descriptions of Majewske (1969) and Horowitz and Potter (1971).

The data base included well name, location (spot, section, township, range) and surface elevation and 26 stratigraphic variables. Variables other than those in the H- through K-Zones were: top of Stone Corral, Heebner, Lansing Group, base of G-Zone, base of Pennsylvanian, and formations below the basal Pennsylvanian unconformity. Variables recorded for each cyclothem of interest were top of cyclothem, top of regressive carbonate, thickness of porous carbonate in upper and lower divisions of regressive carbonate, and maximum gamma radiation in the marine shale. Initial data processing was done at the Kansas University's Academic Computer Center's mainframe Honeywell 66/60 computer using custom FORTRAN programs and SURFACE II

Table 1. Cores Used in This Investigation

	WELL NAME	LOCATION	COUNTY	CORED INTERVAL (FEET)	ZONE
1.	Farmer 1 Nicholson	NE NE SW 12-1N-27W	Red Willow, NE	3160-3174	H
2.	Farmer 3 Nicholson	C NE NE	Red Willow, NE	3153-3168	H
3.	Empire 1 Rathe	C NW SW 9-3N-30W	Hitchcock, NE	3618-3642	D,E,G*
				3653-3674	
				3737-3770	I,J
4.	Empire 10 Palmer	NE NE SE 6-1S-33W	Rawlins	4055-4073	J
5.	Murfin 1 Souchek	C SE NE 2-1S-34W	Rawlins	3959-3972	A
				4004-4037	DE*
				4100-4125	H
				4140-4154	J
6.	Skelly 1 Bartosovsky	SE SW SW 9-1S-34W	Rawlins	3960-4250	All LKC*
				4114-4223	H,I,J,K
7.	Cities Service Z-1 Miller	SE NE SE 31-2S-27W	Decatur	3680-3689	D
				3695-3722	EF
				3732-3744	G*
				3744-3762	H
8.	Murfin 1 Prentice	C NE NE 30-2S-35W	Rawlins	4238-4278	
				4297-4323	D,E,G*
9.	Cities Service A-1 Holmdahl	NE SW SW 29-3S-31W	Rawlins	3955-91.5	C,D,E*
				4082-4104.5	J
10.	Cities Service F-5 Reese	NE SW SE 22-5S-20W	Phillips	3361-3365	D
				3371-3389	F,G
				3391-3400	G*
				3455-3464	I
				3477-3480	J
				3486-3498	K
11.	Conoco 406 Adell Unit	SE SE SW 2-6S-27W	Sheridan	3604-3818	All LKC*
				3712-3805	H,I,J,K
12.	Cities Service A-1 Knudson	NE SE NW 16-7S-32W	Thomas	4253-4277	J

13.	Texaco 4-7 Holley Unit	NW SW NE 31-8S-24W	Graham	3914-3921	I
14.	Texaco 6-11 Holley Unit	SE NE NE 32-8S-24W	Graham	3946-55.5 3965-3975	I J
15.	Texaco 7-11 Holley Unit	SE SE NE 32-8S-24W	Graham	3918-3924	I
16.	Cities Service 506 Dorr Unit	C SE SW 16-9S-16W	Rooks	3332-3398 3392-3400 3298-3392	D,E,F,G,H L* H,I,J,K
17.	Conoco 9 Morel	NE NE NE 15-9S-21W	Graham	3543-3618.5	H,I,J
18.	Empire B-2 Reidel	S/2 SW 31-9S-24W	Graham	3952-3994	H,I
19.	Gulf 1-22 Hughes	C SW SW 22-9S-29W	Sheridan	4108-4223	H,I,J,K
20.	Gore 4 Findley	S/2 SE NE 23-11S-21W	Trego	3726-3758	I,J,K
21.	Pan American B-6 Ohlson	NE SE NE 28-14S-14W	Russell	3092.5-3219	H,I,J,K Pre.
22.	Springer 1 Oeser South	SE NW SW 30-16S-11W	Barton	3124-3161 3200-3225	F,G* J
23.	Clinton 2-D Stegman	SE NW NE 11-16S-17W	Rush	3393-3443	I,J,K
24.	Conoco 11 Ainsworth	SE SW NE 25-18-8W	Rice	3912-3996.2	H,I,J,K
25.	Stanolind 3 Denker	NE NW SW 10-22S-12W	Stafford	3419.7-3523.4	H,I,J,K
26.	Texaco 1 Becker	SE NE SE 29-22S-33W	Finney	4155-4178	K
27.	Cities Service C-2 Blair	C NW NW 29-30S-33W	Haskell	4118-4745 4390-4409 4555-4592	selected samples available approx. every 3 feet through LKC* H J,K

28.	Cities Service E-2 Thompson	C NW NW 30-30S-33W	Haskell	4354-4369 4533-4577	H,J,K
29.	Cities Service D-2 Conover	NW SE 31-30S-33W	Haskell	4130-4760 4398-4618	selected samples spaced approx. 3 feet through LKC* H,I,J,K
30.	Cities Service C-2 Conover	C SE SW 32-30-33W	Haskell	4120-4179	only selected samples available from Lansing Group*
31.	Tideway 1 Beauchamp	N/2 SW 19-30S-40W	Stanton	3930-3974	H,I
32.	Texaco 4 Litsey	NE NE NW 25-31S-6W	Harper	3744-3766	J,K
33.	KRM 1 Harman	C NW 11-33S-20W	Commanche	4759.5-73.5	K
34.	Sam Gary 21-5 Scheufler	SW NW 21-33S-20W	Commanche	4804-4830	J,K
35.	KRM 3 Rhoades	NW NE 14-34S-20W	Commanche	4767.5-4785	J base K
36.	KRM 2 Lemon	SW SW 13-34S-20W	Commanche	4788-4805.2	J base K
37.	KRM 2-X Lemon	NE SW 14-34S-20W	Commanche	4754-4777	K

Figure 1.3. Stratigraphic nomenclature, Pennsylvanian and Permian systems in western Kansas (from Rascoe, 1979).

SYSTEM	SERIES	STAGE	GROUP
PERMIAN	GUADALUPIAN		
	LEONARDIAN		Nippewalla
			Sumner
	WOLFCAMPIAN		Chase
			Council Grove
			Admire
PENNSYLVANIAN	UPPER	VIRGILIAN	Wabaunsee
			Shawnee
			Douglas
		MISSOURIAN	Lansing
			Kansas City
			Pleasanton
	MIDDLE	DES MOINESIAN	Marmaton
			Cherokee
		ATOKAN	
	LOWER	MORROWAN	

graphics (Sampson, 1978). Later, data were transferred to the Kansas Geological Survey's minicomputer, the Data General MV/8000, for continued analysis. After information was keypunched onto cards, a magnetic tape of the data was prepared. The township-range locations were converted to a Lambert conformal conic projection using a routine developed by Owen Spitz of the Kansas Geological Survey. Preliminary maps were created using data calculated with the Fortran program and the Surface II graphics system. Error analysis was conducted using both visual examination of the data file and maps and the use of a statistical routine that compared the spacial variation of the data. Editing was done and maps were re-created. Construction of maps was done using the MV8000, a Xynetics flatbed plotter, and printing terminals attached to the minicomputer. Appendix A provides details of input format and output files used in mapping as well as the FORTRAN program that created the output files. An elaborate data processing package, "STRATPLOT," was developed with the assistance of Richard Brownrigg to handle a CRT menu-driven update program to edit a master file and to create various plot files formatted for SURFACE II software.

Subsurface Nomenclature

The Lansing and Kansas City groups belong to the Missourian Stage of the Upper Pennsylvanian. They comprise a succession of a dozen repetitions of major carbonate units and thinner shale beds in western Kansas (Watney, 1980; Figures 1.3, 1.4, and 1.5). Each repetition includes a transgressive and regressive assemblage of lithofacies, in which the upper (regressive) carbonate is thickest and is the stratum most likely to be a petroleum reservoir. Component lithofacies are shown in Table 2.

Table 2. Equivalency Between Cyclothem and Formal Stratigraphic Nomenclature

Informal Cyclothem Nomenclature	Formation and Member
H-Zone	Chanute Shale Drum Limestone Quivera Shale Member of the Cherryvale Shale
I-Zone	mid portion of Cherryvale Shale including Westerville Limestone Member and Block Limestone Member
J-Zone	Fontana Shale Member of of the Cherryvale Shale Dennis Limestone
K-Zone	Galesburg Shale Swope Limestone

The lower (transgressive) carbonate and the lower (marine) shale are thin nearly everywhere in the cyclothems in western Kansas. The lower shale can be a strong emitter of natural gamma radiation and thus provide a striking response on a gamma ray log.

The four cyclothems are identified on a wireline log in Figure 1.4. The letter nomenclature was first used by Morgan (1952) to identify limestone units in the subsurface and is still in common use

Figure 1.4. Gamma ray-neutron wireline log display and interpretive lithologies of Veail #1 Peterson well from northern portion of the study area. Scale of gamma-ray curve is API units. Neutron curve is scaled in counts per second (cps). Four cyclothems are identified as the H-, I-, J-, and K-Zones. The top of each interval is the regressive (upper) shale and the base of the cyclothem is the transgressive unit (lower carbonate). Note that both the transgressive unit and the marine (lower) shale are not distinctive units in the log in the I-Zone. The marine portion of the cyclothem, the focus of the isopach mapping described later, includes all divisions of the cyclothem except the regressive (upper) shale.

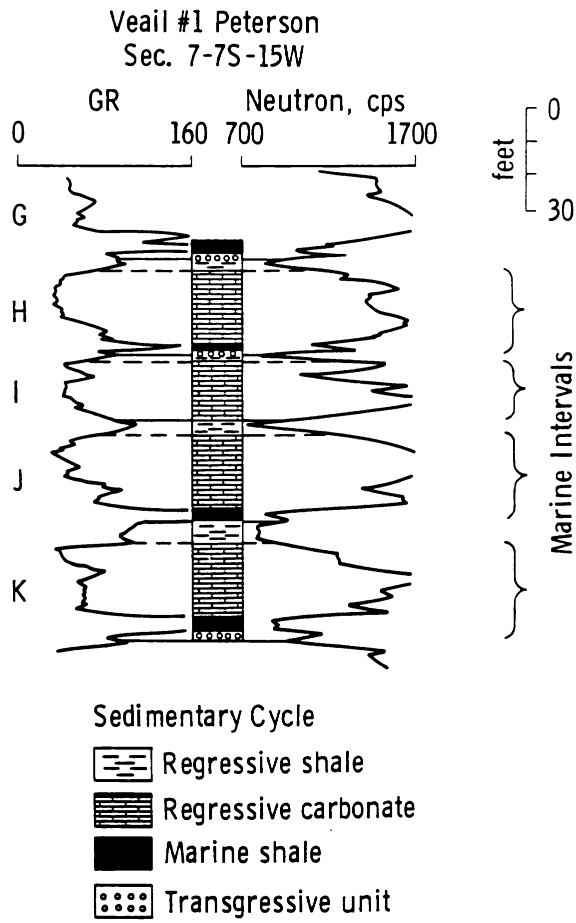
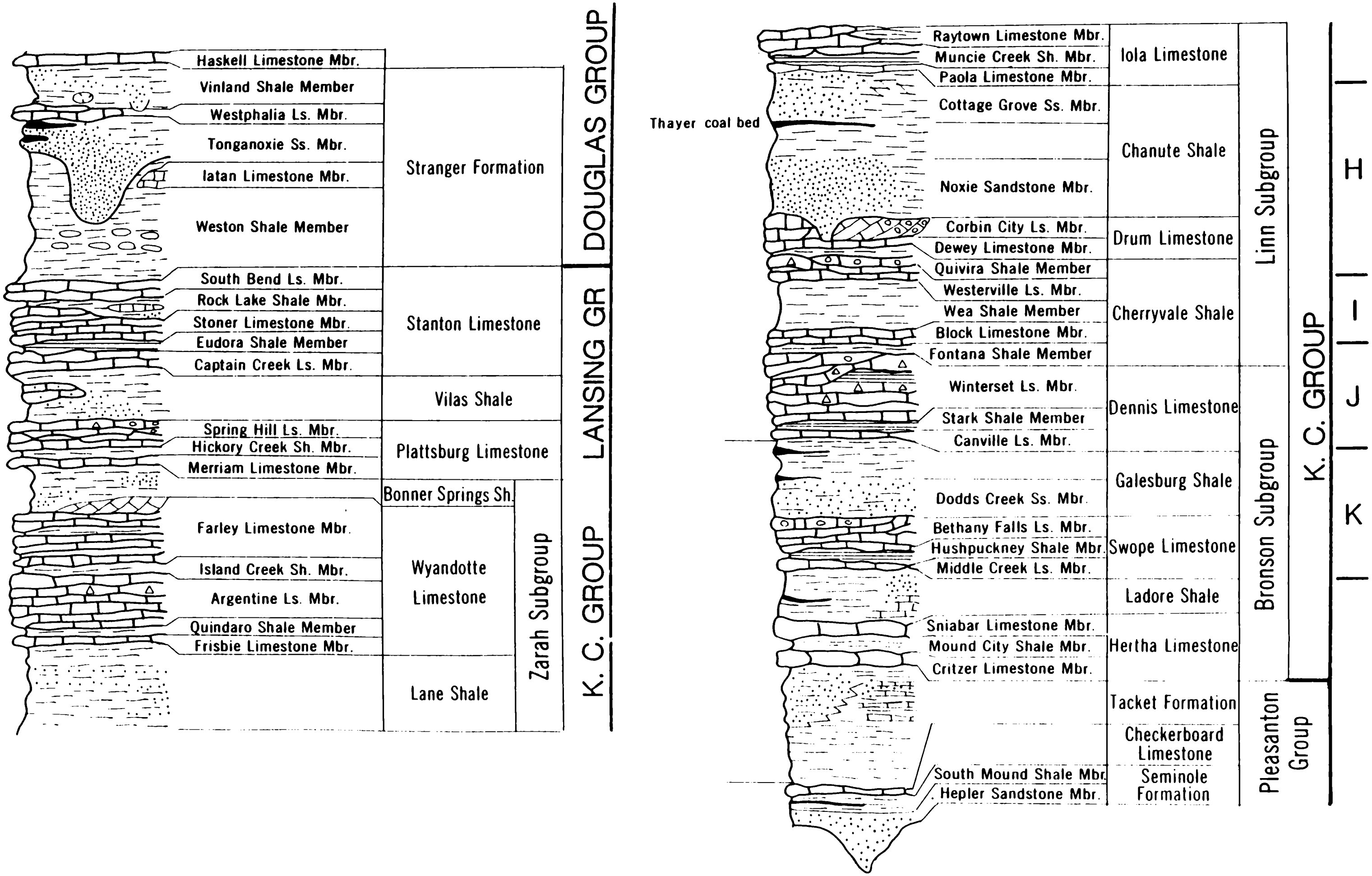

Veail #1 Peterson
Sec. 7-7S-15W
GR
0
160
Neutron, cps
700
1700
feet
0
30
G
H
I
J
K
Marine Intervals
Sedimentary Cycle
Regressive shale
Regressive carbonate
Marine shale
Transgressive unit

Figure 1.5. Formal member and formation nomenclature of the Lansing and Kansas City groups in eastern Kansas (from Zeller, 1968). Stranger Formation is in Douglas Group; Stanton Limestone through Plattsburg Limestone comprise the Lansing Group; and the Bonner Springs Shale through the Hertha Limestone make up the Kansas City Group.



Haskell Limestone Mbr.
Vinland Shale Member
Westphalia Ls. Mbr.
Tonganoxie Ss. Mbr.
Iatan Limestone Mbr.
Weston Shale Member
Stranger Formation
DOUGLAS GROUP
South Bend Ls. Mbr.
Rock Lake Shale Mbr.
Stoner Limestone Mbr.
Eudora Shale Member
Captain Creek Ls. Mbr.
Stanton Limestone
Vilas Shale
Spring Hill Ls. Mbr.
Hickory Creek Sh. Mbr.
Merriam Limestone Mbr.
Plattsburg Limestone
LANSING GR
Bonner Springs Sh.
Farley Limestone Mbr.
Island Creek Sh. Mbr.
Argentine Ls. Mbr.
Quindaro Shale Member
Frisbie Limestone Mbr.
Wyandotte Limestone
Lane Shale
Zarah Subgroup
K. C. GROUP
Raytown Limestone Mbr.
Muncie Creek Sh. Mbr.
Paola Limestone Mbr.
Iola Limestone
Thayer coal bed
Cottage Grove Ss. Mbr.
Noxie Sandstone Mbr.
Chanute Shale
Corbin City Ls. Mbr.
Dewey Limestone Mbr.
Drum Limestone
Linn Subgroup
Quivira Shale Member
Westerville Ls. Mbr.
Wea Shale Member
Block Limestone Mbr.
Fontana Shale Member
Cherryvale Shale
Winterset Ls. Mbr.
Stark Shale Member
Canville Ls. Mbr.
Dennis Limestone
Galesburg Shale
Dodds Creek Ss. Mbr.
Bethany Falls Ls. Mbr.
Hushpuckney Shale Mbr.
Middle Creek Ls. Mbr.
Swope Limestone
Ladore Shale
Sniabar Limestone Mbr.
Mound City Shale Mbr.
Critzer Limestone Mbr.
Hertha Limestone
Bronson Subgroup
K. C. GROUP
Tacket Formation
Checkerboard Limestone
South Mound Shale Mbr.
Hepler Sandstone Mbr.
Seminole Formation
Pleasanton Group
H
I
J
K

by those working in western Kansas. Parkhurst (1958) established a correlation between these subsurface units and the outcrop of the Missourian-age rocks in eastern Kansas. Table 2 shows the equivalence between the letter nomenclature used here and the formal outcrop names. The best correlations are between the K- and J-Zones and their outcrop equivalents: the Galesburg Shale-Swope Limestone and the Fontana Shale-Dennis Limestone. Each zone is dominated by a thick upper (regressive) carbonate rock.

Strata equivalent to the I-Zone are within the Cherryvale Shale; the exact correlation is still in question but correlation with the Westerville Limestone (lower or regressive limestone) is favored here. The Cherryvale Shale contains several shales and limestone members. The lowermost shale, the Fontana, is the topmost member of the J-Zone, the upper shale or regressive shale. The I-Zone in western Kansas is a carbonate-dominated succession that pinches out along the northern edge of the study area, unlike the other three persistent zones in the subsurface. This carbonate may be equivalent to the Westerville Limestone Member of the Cherryvale Shale. Both the Westerville and underlying Block Limestone members are thin, averaging only four (1.2 m) and eight feet (2.4 m) in thickness in the surface outcrops of eastern Kansas and western Missouri. The Westerville Limestone Member is the more persistent and can be traced for 250 miles (400 km) along the outcrop north of Kansas City to near Des Moines, Iowa. Not only is a black lower (marine) shale common to the other cyclothems generally missing from both the I-Zone and the Westerville section, but also the upper (regressive) shale is quite thin or absent in areas in both the outcrop and the subsurface.

The H-Zone correlates with a composite section including the Quivira Shale Member of the Cherryvale Shale, an unnamed dark marine shale, which is succeeded by the upper (regressive) Drum Limestone, and the overlying Chanute Shale (Zeller, 1968). A lower (transgressive) limestone is lacking in surface exposures but appears to be developed in most areas of the subsurface.

Problems Associated With the Concept of Cyclothems

Repetitive sedimentary sequences which have been described in the area of study are very similar to equivalent strata in the outcrop. This recognition provides an important basis for meaningful subdivision of these strata (Watney, 1980). The similarities go beyond stratigraphic definition, but include the detailed comparison of the members of cyclothems as defined by Moore (1931) and Heckel and Baesemann (1975) as previously discussed. This classification is the first step toward understanding the origin of the succession.

The interpretation of cyclothems is hampered by several problems including: 1) demonstrating true repetition of processes in time which led to accumulation of a succession of rock classified as a cyclothem; 2) complications in definition of a cyclothem when change in lithofacies occurs including problems in correlation of equivalent successions, and therefore 3) the controversy regarding whether processes that led to formation of cyclothems include intrabasinal controls such as eustatic change in sea level or tectonic deformation.

A basic problem with cyclothems is documenting that they are truly periodic. Cyclic sedimentation is the repetition of a predictable sequence of strata in time (Duff, Hallam, and Walton, 1967), but without the condition that cycles are of equal length beyond that implied by some similarities in thickness. The processes succeed in a predictable fashion. In contrast episodic sedimentation is simply a stochastic event. Both can involve repetitions of lithofacies, yet in the latter the episodes do not represent periods or rhythmns (Doveton, 1971; Schwarzacher, 1975). Because precise measurement of time is impossible in these old rocks, it is only the regularity of the repetitions of lithofacies that can be used to define them. The original definition of cyclothem was restricted to Pennsylvanian-aged sedimentary rocks by Weller (1930), but Duff and Walton (1962) extended the concept to include other strata.

Most of classifications of cyclothems and many interpretations were based on outcrops, many of which were small. Vertical successions were strongly emphasized at the expense of lateral variability. Initially the definitions did not allow any flexibility in the composition of cyclothems. Separate classifications resulted for cyclothems dominated by carbonate rocks, terrigenous clastics, and evaporites as well as numerous successions within each of these sediment end members. Wanless (1964), however, demonstrated with the aid of the black-shale facies common to many Pennsylvanian cyclothems in the Midcontinent that the terrigenous clastic cyclothems present in Illinois are equivalent to more marine-dominated successions in the western Midcontinent. He showed that regardless of the succession of sediments deposited, a sedimentary cyclothem could nevertheless be recognized. The different processes that generated the cyclothem were expressed with different types of sedimentary rocks. Yet, the repetition and correlation at least for restricted sequences had been established.

Heckel (1977) reemphasized the significance of this regional correlation of Wanless and provided an explanation for the lateral variation of the succession of lithofacies using sedimentologic concepts modified by eustatic change of sea level. He stressed that the continuity of the thin, black (lower) shale is evidence that this shale is the deepest water facies of the cyclothem, an idea originally introduced by Evans (1967) and Schenk (1967). Typically, the succession beneath this shale is a thin lower (transgressive) unit and above it is an upper limestone that is a regressive, shallowing-upward sequence, generally much thicker than the other members of the cyclothem. This interpretation is contrary to those of Moore (1929), Weller (1930) and subsequent workers, Zangerl and Richardson (1963) and Merrill (1973) who all considered the black (lower) shale to represent extremely shallow water. Moore (1929) originally pointed out that the relief of the depositional surface was very low, and only very slight changes in sea level would shift the shoreline over considerable distances. Thus, it was not necessary to vary water depth significantly. Now, with the deep-water concept of Heckel's model requiring quasi-estuarine circulation and the development of a thermocline, a greater range of sea-level change is called for. Heckel suggests a minimum of 100 m (300 ft). Very thin, widely distributed successions of contrasting lithologies separated by sharp contacts also suggest an origin involving more than simple aggradation of sediment over a shallow platform. In any case, the issue of the depth of water attributed to the black-shale facies is a key one and will be addressed in this study.

Very soon after cyclothems were recognized, Wanless and Shepherd (1936) proposed a climatic model for their generation calling upon repeated continental glaciation in Gondwana to produce global variations in sea level. Twenty years later this theory still was viewed with considerable doubt. Others argued that there was an insufficient record of glaciation in time and space to explain some 160 cyclothems recognized in the late Paleozoic strata (Moore, 1930; Weller, 1956). Oscillating tectonism affecting the provenance of terrigenous clastics was offered as an explanation by Weller (1956) in his diastrophic control theory to explain the development of terrigenous clastic cyclothems in the Illinois basin. Swann (1964) proposed a more subtle climate-control hypothesis invoking changing precipitation to explain more complex carbonate-terrigenous clastic cyclothems of the Chesterian, again in the Illinois basin. George (1978) proposed a combination of eustacy and tectonics to explain the sedimentary succession in the British Dinantian.

In general the causes proposed through the early 1960's in the U.S. to explain cyclicity were those that invoked mechanisms that operated independently of sedimentation, such as glaciation, the so-called allocyclic processes (Beerbower, 1964). Duff and Walton (1962) reviewed British literature on late Carboniferous terrigenous clastic cyclothems of Great Britain and concluded that, although there was a great variety of cyclothems in the Coal Measures, all were the result of processes that operated internally to sedimentation itself, the autocyclic processes. However, Woodland and Evans (1964), and more recently Ramsbottom (1979), concluded that some of these same Pennsylvanian successions were allocyclic and were affected by changes in eustatic sea level. Similarly, an important school of thought in the U.S. now emphasizes autocyclic causes for the Pennsylvanian cyclothems (Donaldson, 1974; Ferm 1967, 1970; Galloway and Brown, 1973). Nevertheless, the opposing school supporting broad sea-level changes is still strongly represented (Van Siclen, 1958, 1972; Wanless, 1964; Wilson, 1967b, 1975, 1977; Heckel, 1977, 1980; Toomey et al, 1977; Baird and Shabica, 1980). Duff and Walton (1962) admitted that more extensive sedimentological interpretations are needed to provide conclusive evidence for the causes of cyclothems.

Heckel (1977) revitalized the idea that continental glaciation was a cause for eustatic change in sea level. He concluded that this was necessary in order to explain the marked contrast in successive depositional environments over a wide region suggested by his lithofacies and paleontologic interpretation.

The evidence presented to support eustatic change in sea level as the major cause of these cyclothems is still ambiguous. Workers studying clastic-dominated successions in particular have not found it necessary to invoke a change in global sea level because the outstanding features of cyclicity in such rocks can be explained by processes of local sedimentation (Brown, 1972). Nevertheless, the demonstration of regionally correlative cycles that transcend depositional systems and represent regular periodic or episodic events is the evidence that must be sought to support an interregional mechanism to explain these events. The repetitive succession of widespread lithofacies of widely differing composition present worldwide in late Paleozoic strata has convinced many geologists of global changes in sea level. The debate continues.

Recent Advances in Understanding Causes of Eustatic Sea Level Change and the Response in the Sedimentary Record

Recent investigations of possible global mechanisms for sea-level change have provided a better understanding of the magnitude and periodicity of these processes and potential application to the explanation of the sedimentary records in both continental and oceanic settings. Global plate tectonism and continental glaciation have been most commonly addressed (Ronov et al, 1969; Johnson, 1971; Hallam, 1977, 1981). Sloss and Speed (1974) suggested oscillating tectonism on the cratons as causes for the major cratonic sedimentary sequences, but they judged that the frequency of Pennsylvanian cyclothems is too high to be explained by such tectonism. On the other hand, Wanless and Cannon (1966), Crowell and Frakes (1970, 1975), Crowell (1978, 1982), Hambrey and Harland (1981), and Gravenor and

Rocha-Campus (1983) have provided strong evidence for complex waxing and waning of late Paleozoic continental glaciers in Gondwana, adding support to the theory of glacial control to explain the origin of cyclothems. Crowell argued that sea level went through short-term fluctuations much like those of the Pleistocene. Such fluctuation could have been of sufficient frequency and magnitude to explain the cyclothems.

Donovan and Jones (1979) examined eustatic sea-level change and concluded that two major causes produce this phenomenon: 1) short-term change in volume of land ice and 2) longer term changes in the volume of ocean ridges. Studies of Pleistocene glaciation indicate that change of sea level ranged from 330 to 490 feet (100 to 150 meters) with a rate of change in water level of 1 cm/year (Donovan and Jones, 1979). Although Hays and Pittman (1973), for example, suggested that rapid sea-floor spreading during the Late Cretaceous increased the volume of the mid-ocean ridges making sea level rise world-wide some 980 feet (300 meters), the rate of change in sea level was only 1 cm/1000 years. This is considerably slower than the rate needed to accommodate the changes in water depth and periodicity ascribed to late Paleozoic cyclothems, e.g. 400,000 years duration and at least 100 meter changes in sea level (Heckel, 1977, 1980).

Crowell (1978) used plate tectonics to explain why continental ice accumulated in such abundance during the late Paleozoic. First, he suggested that plate motion moved the huge continent of Gondwana over the south-polar region allowing ice to accumulate. Second, an increased volume of the ocean basin due to motion and position of the global plates provided lower sea levels during the late Paleozoic exposing increased areas of the continents. Vail et al. (1977) detailed this changing sea level mentioning major evidence based directly on the distribution of seismic sequences along continental margins. This fall in sea level was necessary to allow ice to accumulate on land and thus draw water from the ocean basins, further lowering sea level. Fisher (1982) has referred to this low sea level as the "icehouse state", common to several periods of geologic time including the late Paleozoic and the present. In contrast, the greenhouse state during high sea level reduced latitudinal climatic differences and produced global heating, reduced circulation of the oceans, and contributed to the ocean-wide anoxic events such as occurred during the Early Devonian, Jurassic, and Cretaceous (Fisher and Arthur, 1977; Arthur and Schlanger, 1979; Parrish, 1982).

Recognition of Sea-Level Change in the Sedimentary Record

The nature of the periodicity of Pleistocene glaciation and resultant transgressions and regressions is well documented by analysis of oxygen- and carbon-isotope composition of nannoplankton obtained from deep-sea cores (Broecker and Van Donk, 1970; Hays et al, 1976). The 100,000-year, glacial-rhythm signals of the Pleistocene marine record have been attributed by Milankovitch (1941) to rhythmic eccentricity of the earth's orbit. Fisher (1982) suggested that the 400,000 year period of the Pennsylvanian cyclothems could be the result of glacial pulses also controlled by variations in eccentricity.

Study of the Pleistocene coastal sedimentary record itself provides additional evidence, albeit more subtle, of these changes in sea level. Moreover, the Pennsylvanian stratigraphic record of marginal and shallow-marine settings should be similar to the Pleistocene ones if both were modified by changes in sea level.

Evans (1979) nicely summarized the varying conditions on the continental shelves during the Quaternary fluctuations in sea level and so provided a useful guide to the type of observations of the ancient sedimentary record needed in order to recognize features that might be definitive evidence for establishing a marked change in sea level. Sea coasts distant from an appreciable source of terrigenous sediment commonly exhibit a succession of strata that start with a thin marine sequence suggesting rapid inundation of the shelf. This transgression is followed by condensed sequences, commonly marked by diastems or hardgrounds with accumulation of glauconite, phosphorite, or carbonate debris representing high sea-level stand. This sequence preceded thicker, more rapidly deposited sediment heralding the onset of regressive coastal sedimentation. Under such circumstances, the approach of a rapidly prograding delta would significantly change the depositional environment. Moreover, Evans suggested that stagnation could occur on the shelf during high sea-level stands if tidal circulation were eliminated. Anoxic bottom waters might result.

Transgression in an area of abundant local sediment supply could result in an almost static shoreline. Progradations of Quaternary deltas like the Mississippi River delta have occurred during episodic, near stillstands. The net effect has been that even during the very gradual rise of sea level in the last 4,000 to 5,000 years the shoreline of the Mississippi delta has advanced seaward at an average rate of 12 miles (20 km)/1000 years.

During Pleistocene cycles, sea level apparently began to fall each time soon after it had risen as is convincingly shown by deep-sea, oxygen-isotope data. The rate of fall was appreciably slower than the rise and was sometimes interrupted by minor fluctuations (Broecker and Van Donk, 1970). Offlapping sets of barrier-island, lagoonal, and delta-plain deposits are evidence of this staggered fall on the coast and shelves of the U.S. bordering the Gulf of Mexico and Atlantic Ocean. For example, eight cyclothems are recognized in the Quaternary on the Gulf Coast (Beard et al, 1982).

Evans (1979) observed in general that the Quaternary sediments, although usually loose and friable, were typically not eroded away during subaerial exposure and erosion at a time of lowering of sea level. Marine coastal sediment buildups became coastal hills and then were again inundated by the sea. Weathered, oxidized surfaces separate these sedimentary sequences. In fact, Evans concluded that such stratal contacts, the geometry of the sedimentary units, and the recognition of nearly synchronous bedding surfaces permit one to construct a comprehensive stratigraphic model. This is particularly true of cycles of sedimentation. The recognition of evidence for erosion, weathering, or simply nondeposition is very important in interpreting the sedimentary record. Description of small-scale hiatuses or diastems is a very necessary component in describing lithology. Such events might be expected to occur more frequently during the withdrawl of the sea, late in the cycle. The break in sedimentation may be regional in extent and may represent a substantial amount of time. Beard et al. (1982) have interpreted the geometry of the depositional sequences resulting from these eustatic cycles using seismic stratigraphy.

Detailed sedimentologic and stratigraphic information will most convincingly establish the origin of the cyclothems whether a glacial origin or whether autocyclic processes are causal. Ideally one would have available a number of complete, correlative, vertical stratigraphic sections in order to construct a three-dimensional view of the strata, incorporating details of the facies and their contacts. The scale of observation in this type of geologic study necessarily ranges from microscopic to distances of hundreds of kilometers. Examination of a succession of cyclothems on these scales is necessary in order to answer definitively the general question of origin. The remarkable repetition of strata over wide areas repeated worldwide during the late Paleozoic continues to beckon those who desire to enter into this debate.

Potential For Understanding Cyclothems in the Study Area

The Late Pennsylvanian Missourian strata examined in this study are unmistakably repetitive. Cyclic sedimentation has been described from many other places in sedimentary rocks of this age, e.g. Paradox basin (Choquette and Trout, 1963; Hite, 1970); Midland basin (Van Siclen, 1958; Ross, 1967; Galloway and Brown, 1973), Colorado Plateau (Brill, 1963), Nevada, Utah, and Idaho (Heath et al, 1967; Roberts et al, 1965), Appalachian coal basin (Morris, 1967), Yukon territory, Canada (Bamber and Waterhouse, 1971), Nova Scotia (Copland, 1959; Shenk, 1969), northwestern Europe (Trueman, 1946; Ramsbottom, 1979), Russian platform (Rauser-Chernovsova et al, 1979)]. Whether carbonates, terrigenous clastics, evaporites, or mixtures of these, a periodic sequence of lithofacies of comparable thickness and estimated duration has been described. Alternating carbonates and terrigenous clastics comprise a dozen formations of the Lansing and Kansas City groups that have been categorized by marine and nonmarine components of the cyclothem (Zeller, 1968).

Marine sedimentation was more widespread over most of the world's cratons during the Missourian than in the earlier Pennsylvanian. The mean sea level was slowly rising following a major episode of cratonic emergence and erosion during the Late Mississippian and earliest Pennsylvanian. Yet, this rise in sea level was only a second-order development during a much longer period of falling sea level that began in the mid Paleozoic (Vail et al, 1977).

The sediments of the Kansas City Group accumulated on a rather stable shelf in Kansas following a period of pronounced local tectonism during the Early Pennsylvanian with movement along the Central Kansas uplift (CKU), Cambridge arch (CA), and the Nemaha uplift. Subsurface information available from western Kansas offers a unique opportunity to study cyclothems correlative in three dimensions over long distances. The composition varies little laterally, permitting lithologic correlation and documentation of the distribution of facies. The carbonate rocks that dominate these cyclothems provide a sensitive record of the diagenesis and allow one to interpret the conditions developed in the waning stages of these cyclothems (Watney, 1980; Heckel, 1983).

The once-active tectonic elements that underlie the area of study provide an opportunity to evaluate in detail the nature of movement subsequent to the major tectonic activity and to assess its effects on sedimentation and diagenesis.

Successions of late Paleozoic rock strata deposited over the shelf in western Kansas noticably thin over locations of previous tectonic uplifts (e.g. CKU and CA). However, specific units, e.g. Missourian cyclothems may not thin or do so only with varying areal extent. Moreover, the facies that comprise the cyclothems are not considered significantly different between areas of previous uplift and subsidence. Later subdued, episodic differential movement apparently occurred on the shelf coinciding closely with patterns of previous, more pronounced structural movement.

CHAPTER TWO

TECTONICS

Regional Tectonics

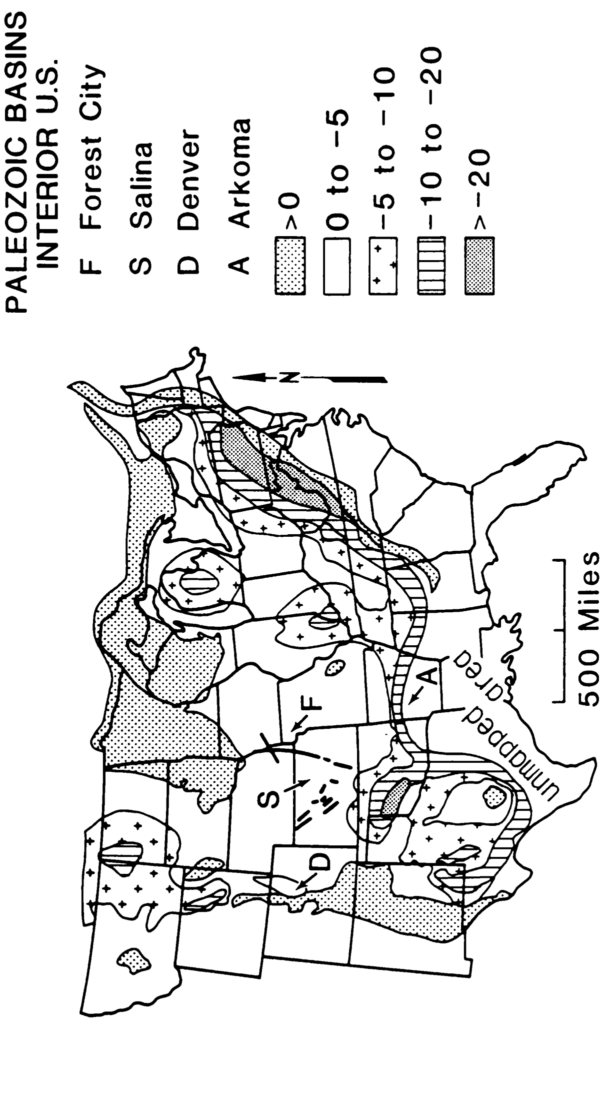
Uplifts

In the Midcontinent of the U.S., Phanerozoic sediments offlap exposures of the Canadian Shield. The Midcontinent is bordered by the Appalachian Mountains on the east, the Ouachita Mountains and the Arbuckle Mountains on the south, and the Rocky Mountains on the west. The mountains were active orogenic belts during the late Paleozoic. In fact, the Appalachian-Ouachita-Marathon orogenic system (Fig. 2.1; Lidiak, 1982) represents the tectonic suture formed by the collision of Laurasia and the northern, leading plate boundary of Gondwana.

Plate collision along the Ouachita segment of the suture climaxed in the Late Mississippian and Early Pennsylvanian with thrusting and uplifting to form highlands in the region of central Arkansas, southeastern Oklahoma, and eastern Texas (Ham and Wilson, 1967; Keller and Cebull, 1973) and downwarping of foreland basins to the north. Concurrent with deformation on the plate margin, intracratonic uplifts of much smaller magnitude formed in Kansas, e.g. the Cambridge arch (CA), the Central Kansas uplift (CKU), and the Nemaha uplift, with shallow basins subsiding between them.

Orogenic activity shifted to southwest Texas in the Marathon Mountains during the Early Permian as a result of a changing pattern of stress directed into the craton. Kluth and Coney (1981a and b) suggested that these changing stresses were responsible for reacti-

Figure 2.1. Paleozoic basins in the interior of the U.S. (after Lidiak, 1982) showing the depth to the Precambrian basement in thousands of feet. During the late Paleozoic the interior of the craton was bordered on south by the Appalachian-Ouachita-Marathon orogenic systems defining the southern margin of the basins illustrated here and on the north by the Canadian shield. To the west of the craton lie the Wyoming platform and the Ancestral Rocky Mountains.


PALEOZOIC BASINS
INTERIOR U.S.
F Forest City
S Salina
D Denver
A Arkoma
>0
0 to −5
−5 to −10
−10 to −20
>−20
N
500 Miles
unmapped area
F
S
D
A

vation of many zones of pre-existing weakness in the interior of the craton. Thomas (1983) elaborated on this subject, but urged caution in using this interpretation for all structural features on the craton. The actual location and extent of deformation was dependent on the trend and location of these zones of weakness and was a function of the major direction and sense of stress. Episodic structural deformation may have played an important role in the development of the cyclothems of this study.

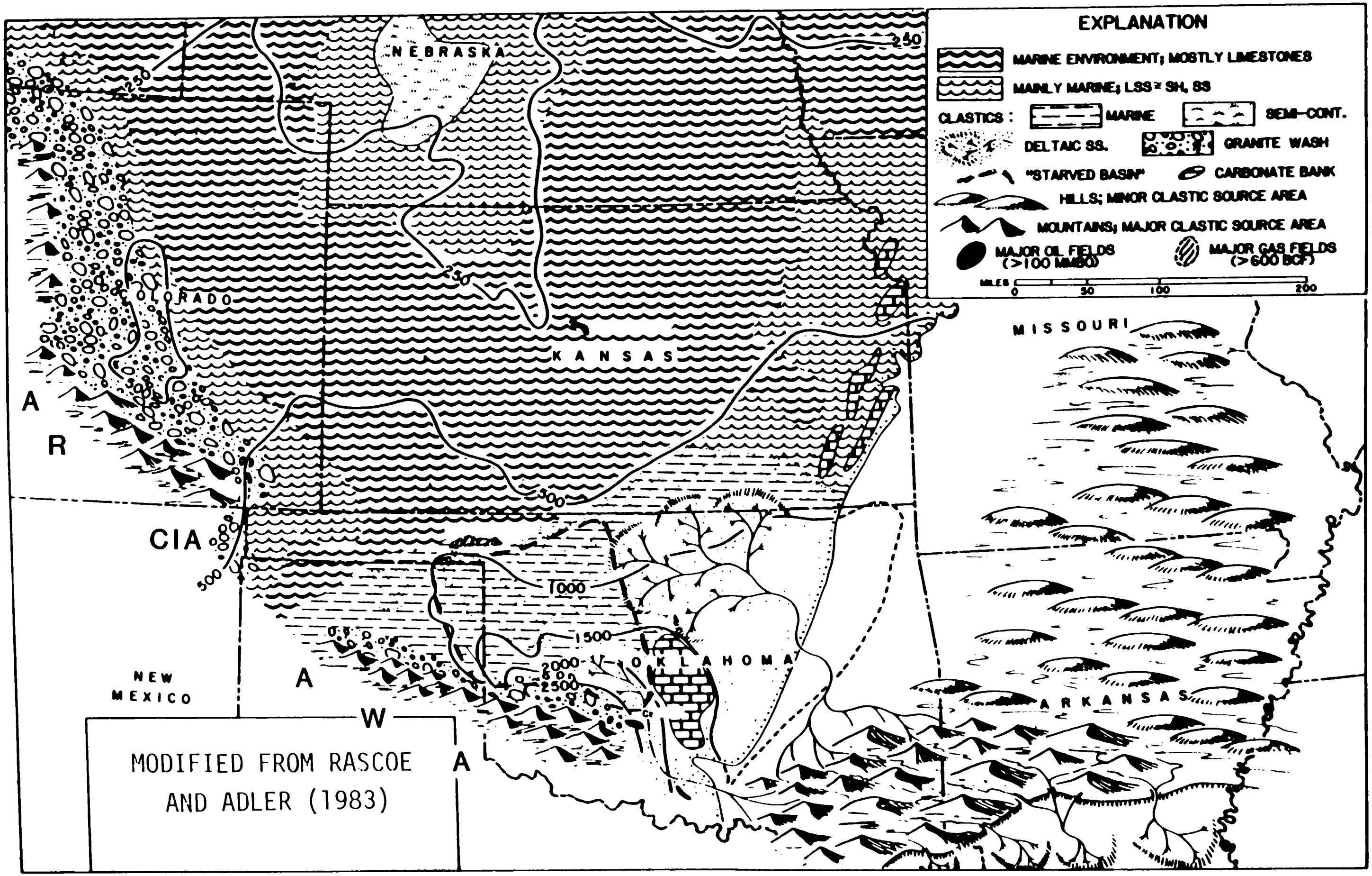
Cambridge and Chadron Arches

North of the area of study, the Chadron arch, a southeastward extension of the Transcontinental arch in west central Nebraska was emergent for most of the late Paleozoic. This area and the Transcontinental arch apparently were the only major sources of fine-grained terrigeous clastics in western Kansas. However, the ancestral Rockies may have also contributed fine-grained terrigenous clastics as suggested by lithofacies maps of McKee et al. (1975). The Transcontinental arch was not high in relief, but was quite extensive.

Amarillo-Wichita-Arbuckle Uplifts

The Amarillo-Wichita-Arbuckle uplifts (Fig. 2.2) extending from the Texas Panhandle to southeastern Oklahoma, immediately south of the study area, are thought also to represent reactivation beginning in the Middle Pennsylvanian of pre-existing zones of weakness in the

Figure 2.2. Generalized paleogeographic map of the western Midcontinent during the Missourian illustrating major depositional facies and provenance areas for the siliciclastic sediments (from Rascoe and Adler, 1983). Contours shown represent thickness of Missourian strata in feet. Dominant terrigenous clastic source is the uplifted Ouachitas mountains (OM) in southeastern Oklahoma and Arkansas. Amarillo-Wichita-Arbuckle uplifts (A-W-A), Ancestral Rocky mountains (AR), and Cimmaron arch (CIA) provided coarse-grained terrigenous debris only locally. The only seaway permitting easy access of open marine waters onto the craton during the Late Pennsylvanian was the approximately 100-mile-(160 km) wide pass between the Amarillo-Wichita-Arbuckle uplifts and the Ancestral Rocky mountains (Rascoe and Adler, 1983; Heckel, 1977). Carbonate bank along southeastern Anadarko basin margin is Belle City Limestone illustrated in Figure 2.4.



MODIFIED FROM RASCOE AND ADLER (1983)

basement. Orientation of the uplifts coincides with an underlying Precambrian and Cambrian rock assemblage that Hoffman et al. (1974) interpreted as an aulocogen. The north side of the Wichita uplift has been thrust some 5 to 5.6 miles (8 to 9 km) northward onto the craton (Brewer et al, 1983).

Ancestral Rockies

During the Pennsylvanian the Ancestral Rockies consisted of prominent blocks uplifted in the area now occupied by the Front Range in central Colorado. The uplift was initiated about the same time as the lesser uplifts in Kansas. Maximum tectonic activity occurred during the Middle Pennsylvanian. Coarse arkosic clastics were shed from the faulted front much the same as in the Arbuckle Mountains, but overthrusting did not occur (Wilson, 1975). The decrease in tectonic activity during the Late Pennsylvanian is also recognized in areas southwest of the Ancestral Rockies. Uplift along the northern end of the Ancestral Rockies in Wyoming, in contrast, persisted into the Missourian (Mallory, 1958, 1967).

Cimmaron and Los Animas Arches

The Cimmaron arch, a southeastern Colorado salient of the Ancestral Rockies that extends to the east (Fig. 2.2), influenced the extreme southwestern portion of the study area in western Kansas. This will be described in more detail later. The Los Animas arch, extending northeast-southwest across eastern Colorado from the Cimarron arch into northwestern Kansas, presented only subdued structual relief during the Late Pennsylvanian and affected sedimentation only locally (Rascoe and Baars, 1979).

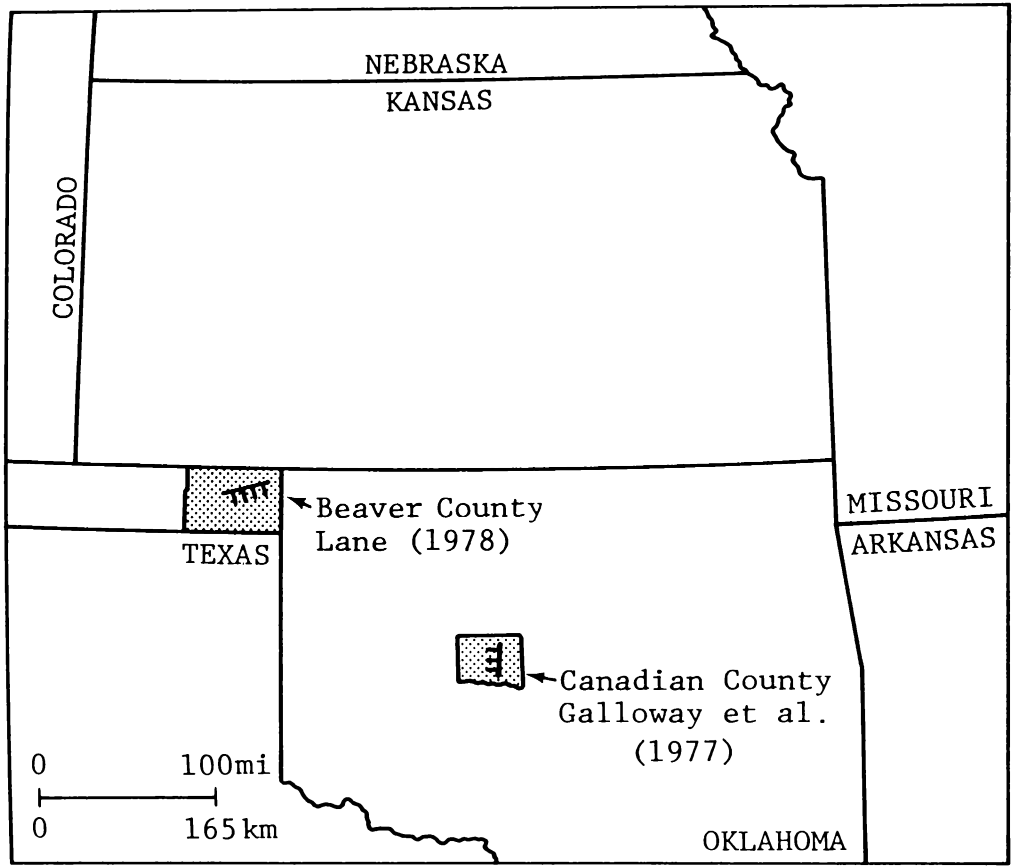
Basins

Anadarko Basin

The northward overthrusting of the Amarillo-Wichita Mountains apparently caused the rapid subsidence of the Anadarko basin immediately to the north of this uplift (Brewer et al, 1983). The Permo-Pennsylvanian section alone in the basin exceeds 16,000 feet (5 km)(Evans, 1979). Coarse-grained arkosic fan deposits spread away from the faulted margins of the uplifts into the Anadarko basin during the Middle Pennsylvanian and into the Early Permian (Evans, 1979). Their presence is a record of synsedimentary uplift to the south and consequent subsidence of the basin.

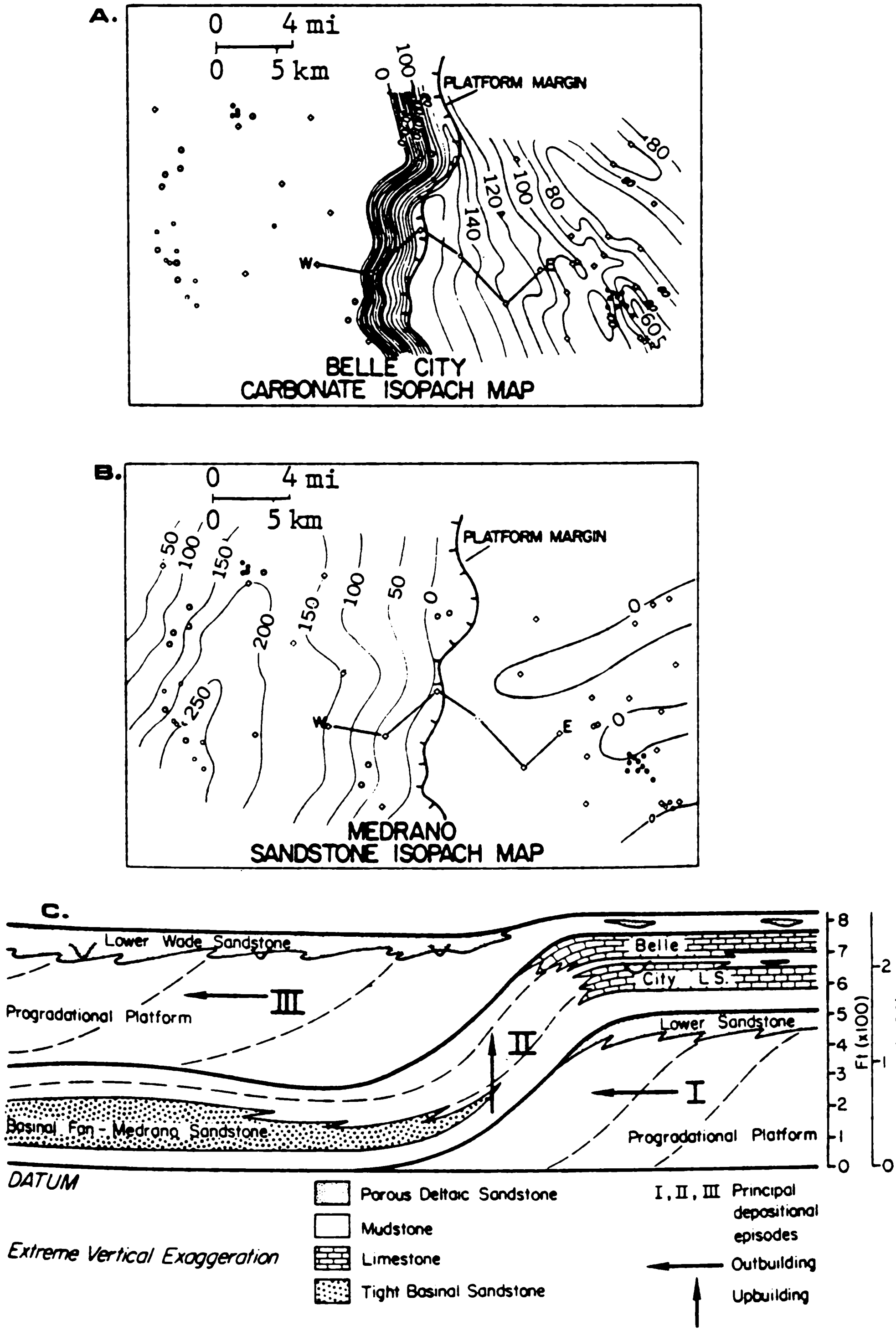
The Anadarko basin and the Arkoma basin, the more eastern Ouachita trough in northern Arkansas, prevented coarse terrigenous clastics originating in the southern Ouachita highlands from reaching the Kansas shelf during the Early Pennsylvanian. Early in the Late Pennsylvanian the Ouachita trough had been filled, and paralic sediments began to spread into eastern Oklahoma and southeastern Kansas (Morris, 1974; Moore, 1979). Detritus derived from the Ouachita Mountains was deposited along the eastern edge of the basin, crossing a mixed carbonate and terrigenous-clastic shelf during regressive episodes. The carbonate intervals typically thicken along this shelf margin. Terrigenous material periodically prograded across the shelf

Figure 2.3. Index map showing the study areas of Lane (1979) in Beaver County, Oklahoma and Galloway et al. (1977) in Canadian County. Each located the Missourian shelf (platform) margins of the Anadarko basin as shown by the hachured lines. Teeth of hachures point basinward.



Depositional Platform Margin

Figure 2.4. A) Isopach map of the Belle City Limestone (Missourian) shelf carbonate unit (10 ft. contour interval) and its equivalent basinal sandstone isopach map (50 ft. contour interval). B) of the Medrano Sandstone in Canadian County, Oklahoma (See Figure 2.3). C) West-to-east shelf to basin cross section of Galloway et al. (1977) interpreted from seismic profiles and borehole information. Note interval II and the location of the Belle City Limestone, a shelf deposit, with respect to the basinal Medrano Sandstone. Source of clastics is from east prograding across shelf reciprocally with carbonate. The Anadarko basin was a deep basin during the Late Pennsylvanian. The depth of water to the south and distance from a significant terrigenous clastic source minimized the importance of clastics in western Kansas.


A.
0 4 mi
0 5 km
PLATFORM MARGIN
100
120
140
80
60
W
E
BELLE CITY
CARBONATE ISOPACH MAP
B.
0 4 mi
0 5 km
PLATFORM MARGIN
50
100
150
200
250
0
W
E
MEDRANO
SANDSTONE ISOPACH MAP
C.
Lower Wade Sandstone
Progradational Platform
III
II
I
Belle
City L.S.
Lower Sandstone
Basinal Fan - Medrano Sandstone
Progradational Platform
DATUM
Ft (x100)
M (x100)
Extreme Vertical Exaggeration
Porous Deltaic Sandstone
Mudstone
Limestone
Tight Basinal Sandstone
I, II, III Principal depositional episodes
Outbuilding
Upbuilding

margin and into the deep basin to form extensive submarine aprons. Galloway et al. (1977) used seismic stratigraphy to define the geometry and the correlation of sedimentary strata along this eastern shelf margin. The economic potential of isolated basinal sandstones of Virgilian and Missourian age that lap against the toe of the shelf margins, such as the Cleveland, Cottage Grove, and Tonkawa sandstones, has yet to be fully developed (Rascoe, 1978a,b). Kumar and Slatt (1982, 1984) described a similar shelf configuration along the northern border of the Anadarko basin.

This northern edge of the Anadarko basin adjacent to the southern edge of the study area was a constructive carbonate shelf margin with considerably less terrigenous detritus than to the southeast (Fig. 2.3). Terrigenous clastics were a minor component of the Late Pennsylvanian sedimentary cycles along the southern portion of western Kansas, which was isolated from the Ouachitas by the Anadarko basin.

According to Lane (1979) carbonates along the northern shelf margin in Beaver County, Oklahoma (Fig. 2.3), are primarily oolitic or contain phylloid algae. The shelf break is quite apparent in the subsurface although the slope is only of one degree (Lane, 1979). Valleys and headlands with a total vertical relief estimated by Lane to be 400 feet (120 m) broke up the shelf margin. Allodapic skeletal and oolitic, shelf-carbonate debris were found at the foot of the valleys studied by Lane. The relief across the eastern margin of the Anadarko basin during the accumulation of the Missourian interval studied was approximately 450 feet (140 m) across the carbonate-terrigenous clastic shelf margin according to the data of Galloway et al. (1977) (Figs. 2.3 and 2.4). Kumar and Slatt (1984) used decompaction analysis to suggest that during the deposition of the lower portion of the Tonkowa Sandstone interval (Upper Missourian) that the maximum water depth was between 1,000 and 1,500 feet (300 to 460 m). Their minimum calculations were 400 to 625 feet (120 to 190 m).

The Anadarko basin continued to be a deep basin where subsidence exceeded the rate of sedimentation. The contribution of sediment from The Amarillo-Wichita-Arbuckle uplifts, despite their pronounced relief, was local and consisted of thick, coarse-grained, clastic-fan deposits formed only adjacent to the uplift.

Although no carbonate reef buildups have been described along the northern edge of the Anadarko basin, sedimentary and climatic conditions for local development may have been favorable. The eastern part of the Midcontinent lay in the humid tropical zone, and the western part was a semi-arid tropical region (Schopf, 1975). The equator crossed southwest to northeast passing across the Anadarko basin (Scotese et al, 1979). The break in slope along the northern margin and the lack of significant terrigenous detritus may also have provided favorable conditions for local development of carbonate reefs. Missourian-aged coral-algal reefs did grow in a coastal setting along steeply dipping edges of active fault blocks bordering the Wichita uplift on the north side in Wheeler County, Texas (Becker, 1977).

Basin Adjacent to Ancestral Rockies

The ancestral Denver basin at the eastern side of the Ancestral Rockies did not subside as deeply or over as large an area as the Anadarko basin. Arkosic sandstones and conglomerates of the Fountain Formation accumulated up to 2000 feet (600 m) thick along a depression against the Ancestral Rockies during the Middle Pennsylvanian. A thinner, more blanket-like deposit of finer clastics of the Fountain Formation ranging from 200 to 600 feet (60 to 180m) in thickness accumulated in the same area during the Missourian (Wilson, 1975). These clastic rocks prograded only a short distance from the uplifted region (Fig. 2.2) and did not significantly influence sedimentation in Kansas except in extreme southwestern Kansas.

Tectonic Activity in Western Kansas

Late Paleozoic Tectonism

The site of the study in western Kansas lies immediately north of the Anadarko basin. Actually, the western region of Kansas is considered to be the northern shelf of the Anadarko basin separated from the deep basin by a margin in northwestern Oklahoma. The shelf area of western Kansas is referred to as the Hugoton embayment. This region was generally stable; however, uplift in the Late Mississippian and Early Pennsylvanian in western Kansas and Nebraska formed the Cambridge arch (CA) and the Central Kansas uplift (CKU). This movement coincided with compressive movements in the Ouachitas. The entire Midcontinent was emergent then with considerable erosion of the pre-Pennsylvanian sedimentary rocks on the uplifts. The CKU and CA are now well defined by the truncated edge of upwarped Mississippian strata (Fig. 1.1; Merriam, 1963).

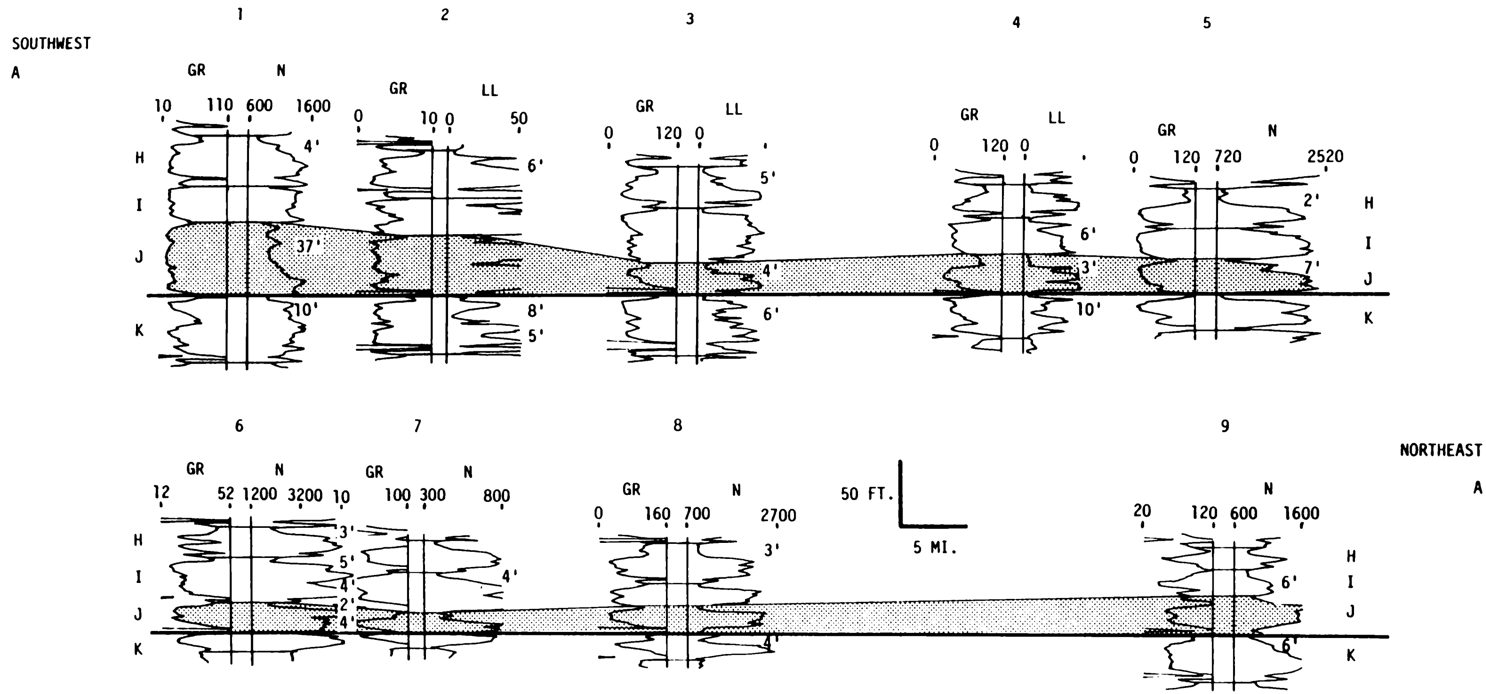
Following this rather brief period of tectonic deformation, the region began to subside more rapidly than at other times in its history. The Permo-Pennsylvanian represents only 23 percent of Paleozoic time, but this interval averages 5000 ft (1.5 km) in thickness or between 45 and 75 percent of the entire sedimentary column preserved in Kansas. The Pennsylvanian strata lap onto the eroded terrain; the entire state was covered in the early Missourian. Locally, the Missourian strata rest directly on Precambrian schist, granite, and quartzite (Walters, 1946).

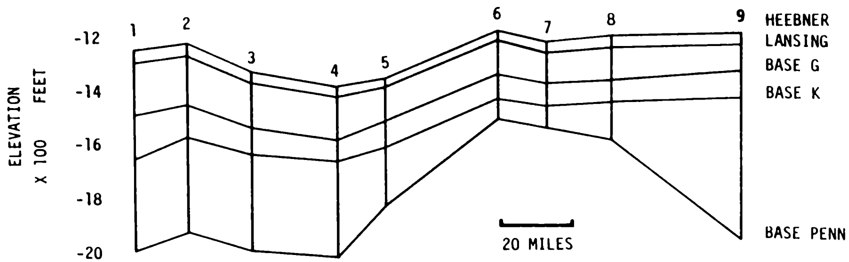
Three stratigraphic cross sections (Figs. 2.5, 2.6, and 2.7) illustrate the variation in wireline log signature of the four Missourian cyclothems from the Kansas City Group from southwest to northeast and across the study area. The thickness of each cyclothem and the percentages of terrigenous material and carbonates in each cyclothem vary notably.

Figure 2.8 is an isopach map of the interval from the base of the K-Zone of the Kansas City Group to the base of the Pennsylvanian. Thickness of this interval ranges from zero over the crest of the CKU to more than 1350 feet (410 m) in the extreme southwestern part of the study area. The lower surface is a regional unconformity that formed at the time of tectonic activity in western Kansas. Most of the craton was exposed to subaerial weathering and erosion at this

Figure 2.5. Southwest to northeast stratigraphic cross section A-A' of a portion of the Kansas City Group including the H, I, J, and K-Zones. Section extends 260 miles (410 km) northeastward from the southern part of the study area across the northern end of the Central Kansas uplift into the Salina basin. Logs used include gamma ray (GR), neutron (N), and Laterolog (LL). Scales for these logs are provided. Datum is the base of the J-Zone. Bases of H- and K-Zones are ruled in on each log but are not connected. A structural cross section of the same wells is included as an inset on this illustration. Measured depth from the ground surface to the top of the displayed log sections range from 4200 feet on the southwest to 3200 feet on the northeast. Top and bottom of zones are identified. Index to wells included on cross section:

Well	Well Name	Location
1	Thunderbird #1 Maxwell	NWSW 32-23-29W
2	Goff #1 Chennel	SWSW 21-21-28W
3	Kern-Landis #1 Ward	SWNE 4-19-26W
4	Hawley Tr. #2 Brungardt	SWNE 13-15-25W
5	Slawson #1-A Weedin Tr.	SWNW 1-14-22W
6	Conoco #9 Morel	NENENE 15- 9-21W
7	Imperial #1 Lesage	SESENE 18- 7-20W
8	Nat. Assoc. Pet. #1-A Lafferty	NWSWSE 19- 4-19W
9	Dreiling et al. #1 Conway	NESWSE 3- 3-13W


SOUTHWEST
A
NORTHEAST
A'
1
2
3
4
5
6
7
8
9
GR
N
LL
H
I
J
K
50 FT.
5 MI.


ELEVATION X 100 FEET
-12
-14
-16
-18
-20
HEEBNER
LANSING
BASE G
BASE K
BASE PENN
20 MILES

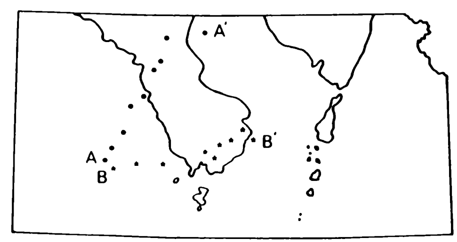

A
B
A'
B'

Figure 2.6. West to east stratigraphic cross section B-B' constructed as Figure 2.5 extending across the southern portion of the area of study including the southern end of the Central Kansas uplift. Bases of H- and K-Zones are ruled on logs. Measured depth to the top of displayed log-sections range from 4350 feet on the west to 2830 feet on the east. Index to wells included in the cross section shown in figure 2.5:

Well	Well Name	Location
1	Deep Rock #1 Schartz	NWNE 33-24-28w
2	Dunne and Gardner #1 Benish	W/2NWNE 9-24-24w
3	Markley #1 Brake	NWNE 6-24-20w
4	Knight #3 Ewing	NWSENE 4-23-17w
5	Sunray #1 Keenan	SESWNE 2-22-14w
6	Pan American #A-5 Teichman	NENWSE 10-22-12W
7	Veeder #4 Diets	SESESE 6-21-11W
8	Tomlinson #7 Bressler	SWNWNE 14-20-10w
9	Conoco #A-7 Warner	NWSWNW 36-18- 8W
10	Conoco #5 Carlson	SWNWNE 36-19- 6w
11	NCRA #1 LPG	NENWSE 29-19- 4w

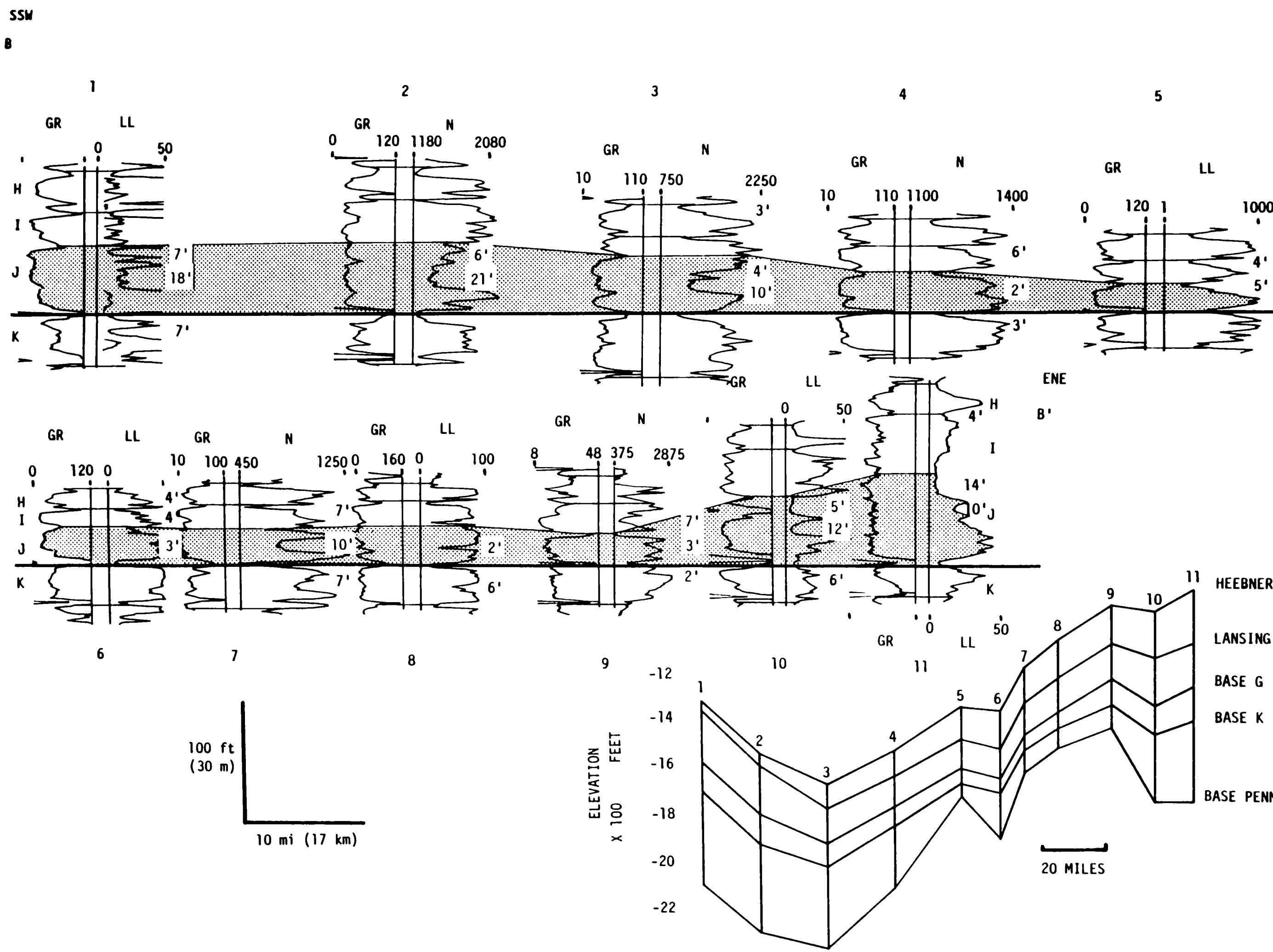
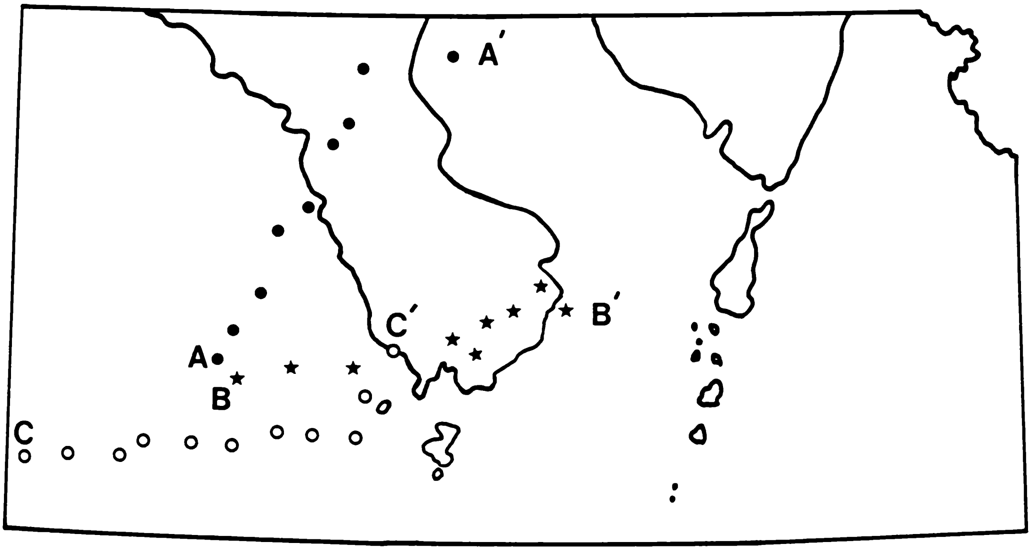
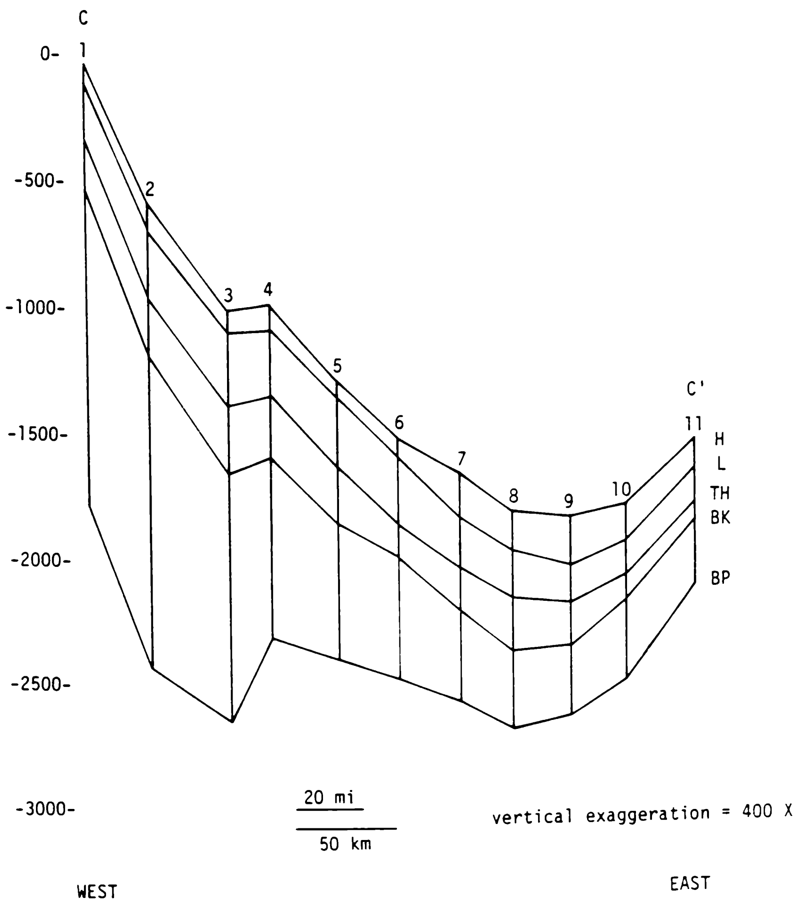
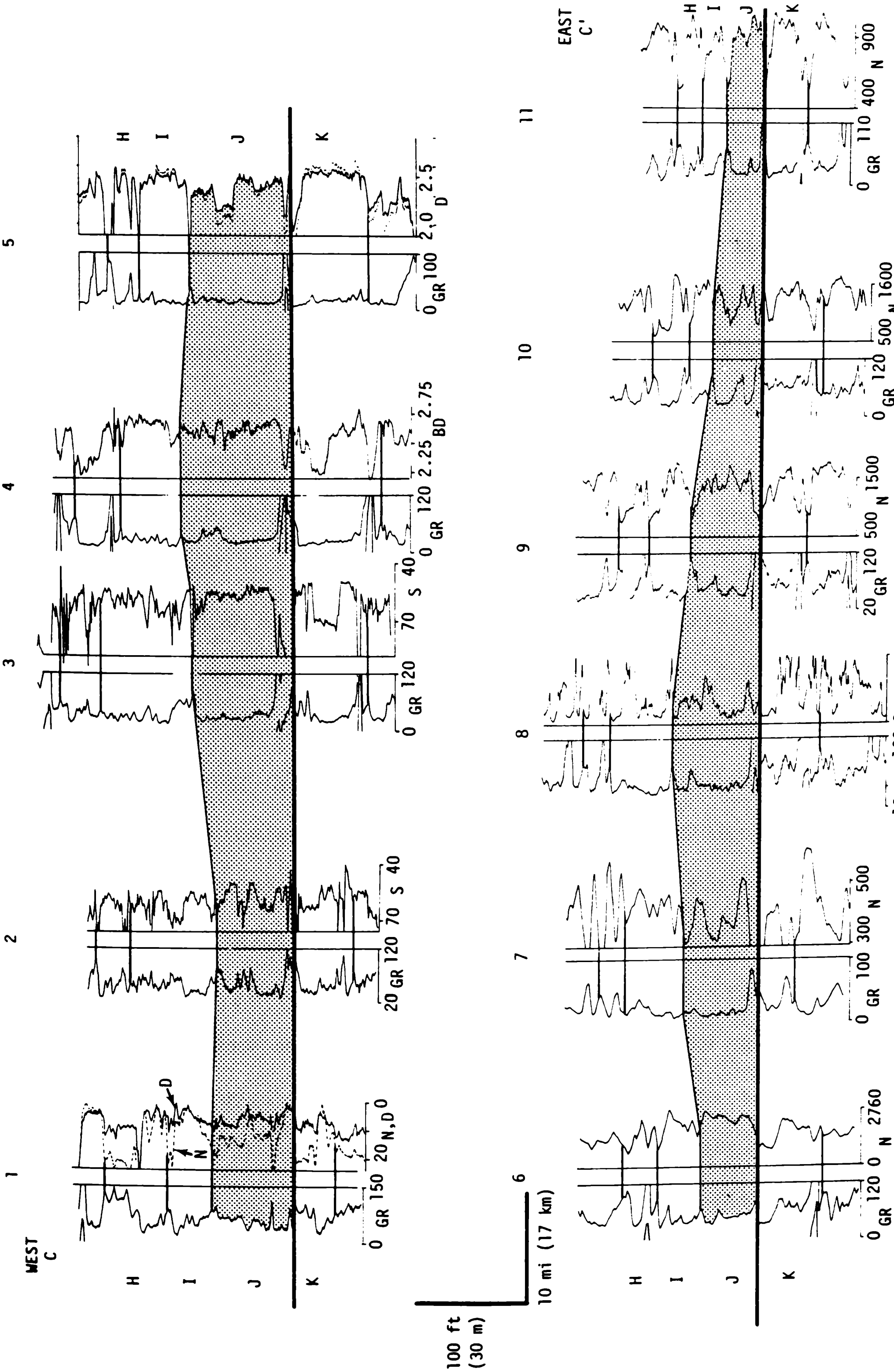

SSW
B
ENE
B'
GR
LL
N
H
I
J
K
100 ft
(30 m)
10 mi (17 km)
ELEVATION FEET
X 100
HEEBNER
LANSING
BASE G
BASE K
BASE PENN
20 MILES

Figure 2.7. (a) Index map for section A-A', B-B', and C-C' and structural cross section of C-C'. (b) West-southwest to east-northeast stratigraphic cross section C-C' across the extreme south-western portion of the study area intersecting with and including well #4 in section B-B'. Western portion of section begins on the southwest positive area, probably an extension of the Cimmaron arch in southeastern Colorado. Measured depth to the top of displayed log sections range from 3860 feet on the west to 3830 feet on east. Bases of H- and K-Zones are ruled on logs. The index of wells included in this cross section are:

Section #	Well Name	Location
1	TXO #1 Bierig	NWSESW 34-30-42w
2	Pan American #1 Dewell	SWNE 19-30-39w
3	La Cima Corp. #1 Jones	NWNE 21-29-34w
4	Ashland #5 Ray	NWSE 21-29-34w
5	Jones and Pellow #1 Wedel	NWNWNW 15-29-31w
6	Pan American #1 Gamble	SWSE 22-29-28w
7	Kewannee #1 Burnett	SWSESW 22-28-25w
8	Five Nations #1 Copeland	NWNWNW 25-28-23w
9	Rains and Williamson #1 Sloan	SESE 27-28-20w
10	Glen Rupe #1 Titus	SWSW 4-26-19w
11	Knight #3 Ewing	NWSENE 4-23-17w


A
A'
B
B'
C
C'


C
C'
0-
-500-
-1000-
-1500-
-2000-
-2500-
-3000-
1
2
3
4
5
6
7
8
9
10
11
H
L
TH
BK
BP
20 mi
50 km
vertical exaggeration = 400 X
WEST
EAST


WEST
C
EAST
C'
H
I
J
K
1
2
3
4
5
6
7
8
9
10
11
100 ft
(30 m)
10 mi (17 km)
0 GR 150 20 N,D 0
20 GR 120 70 S 40
0 GR 120 70 S 40
0 GR 120 2.25 BD 2.75
0 GR 100 2.0 D 2.5
0 GR 120 0 N 2760
0 GR 100 300 N 500
10 GR 100 0 G 50
20 GR 120 500 N 1500
0 GR 120 500 N 1600
0 GR 110 400 N 900

time marking the boundary between Sloss's Kaskaskia and Absaroka cratonic sedimentary sequences (Sloss, 1963; Ham and Wilson, 1967). The sedimentary rocks, isopached in Figure 2.8, onlap the CKU from the southwest where the basal Pennsylvanian becomes progressively younger (Morrowan to Missourian) to the northeast onto the crest of the uplift. During the Morrowan the area mapped with approximately less than 500 feet in thickness in Figure 2.8 was still exposed to the west while a transition between fluvial and deltaic sedimentation occurred across western Kansas and eastern Colorado and into the Anadarko basin in Oklahoma and northern Texas (Rascoe and Adler, 1983).

The Missourian Lansing and Kansas City groups were deposited some 20 million years after the major movement of the CKU-CA on an appreciably different configuration of the shelf in western Kansas than existed during the Early Pennsylvanian (Figs. 2.8 and 2.9). The preceding Pennsylvanian sediments had nearly covered the CKU and significantly reduced the relief produced by the initial uplift. The Missourian shelf was more gently inclined with more uniform depositional conditions (Rascoe and Adler, 1983). The four cyclothems, the H, I, J, and K-Zones in the Kansas City Group, vary in composite thickness from around 60 ft (18.3 m) over the Cambridge arch to more than 250 ft (76.2 m) in areas proximal to the shelf margin in the Hugoton embayment of southwestern Kansas (Fig. 2.9). This quadrupling of thickness in a distance of over 140 mi. (225 km) is less than 2 ft/mi. (0.38 m/km). The average rate of thickening divided

Figure 2.8. Shaded isopach map of the study area of the interval from the base of the K-Zone to the base of the Pennsylvanian. Lower surface is a major unconformity. Interval includes Morrowian, Atokan, Desmoinesian, and lower Missourian. Variable shading donotes intervals of 100 feet (30 m) with darker areas representing thicker strata. Heavy black line surrounds the location of the truncated margin of the Mississippian strata on the Central Kansas uplift (CKU) and Cambridge arch (CA). Hachured, segmented lines are Precambrian basement faults (from Cole (1976). Downthrown side of fault is hachured. Light dashed rectangles outline counties in western Kansas. Northern border is the the Kansas-Nebraska border. This structural information will be used for reference on most of the succeeding maps.

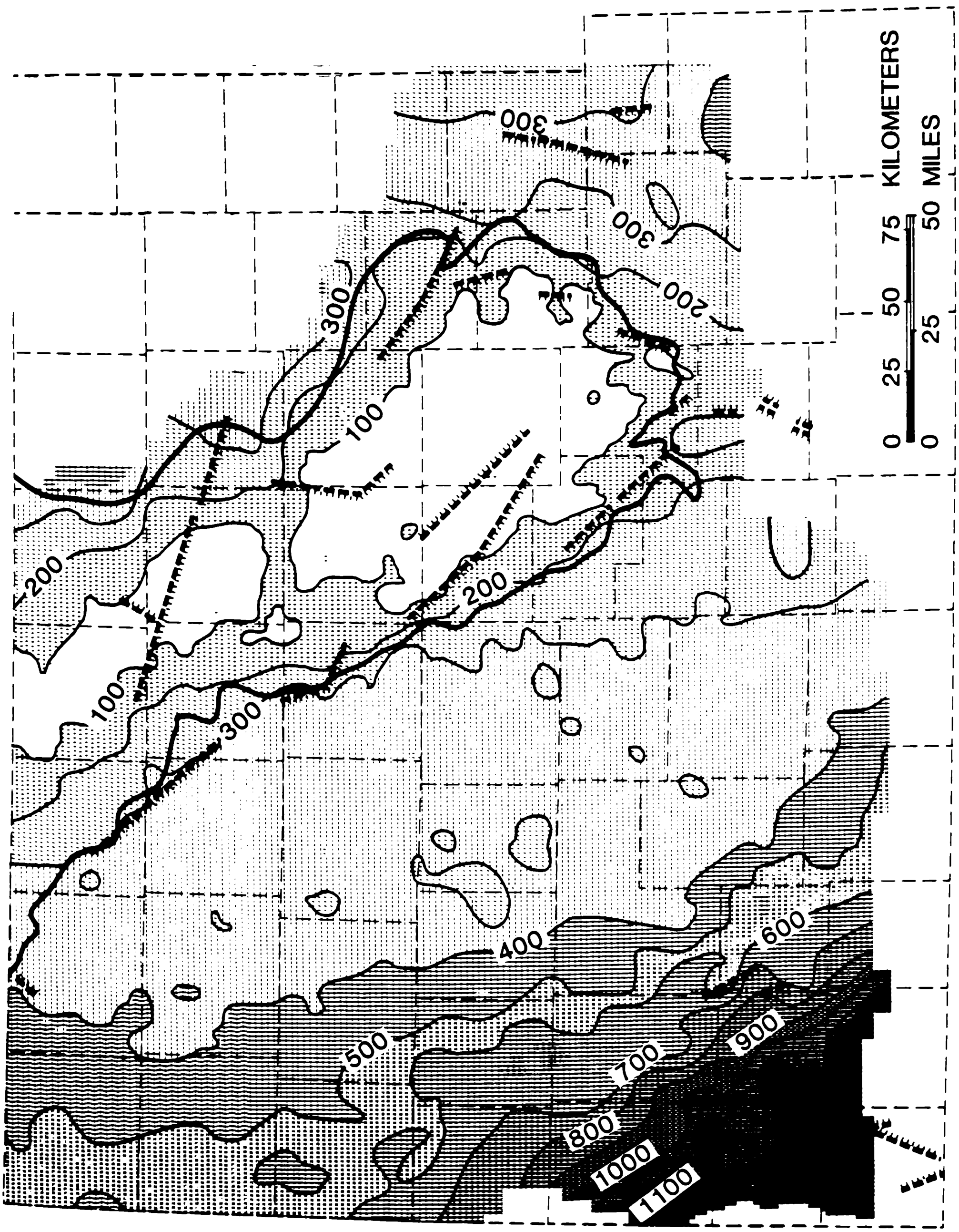
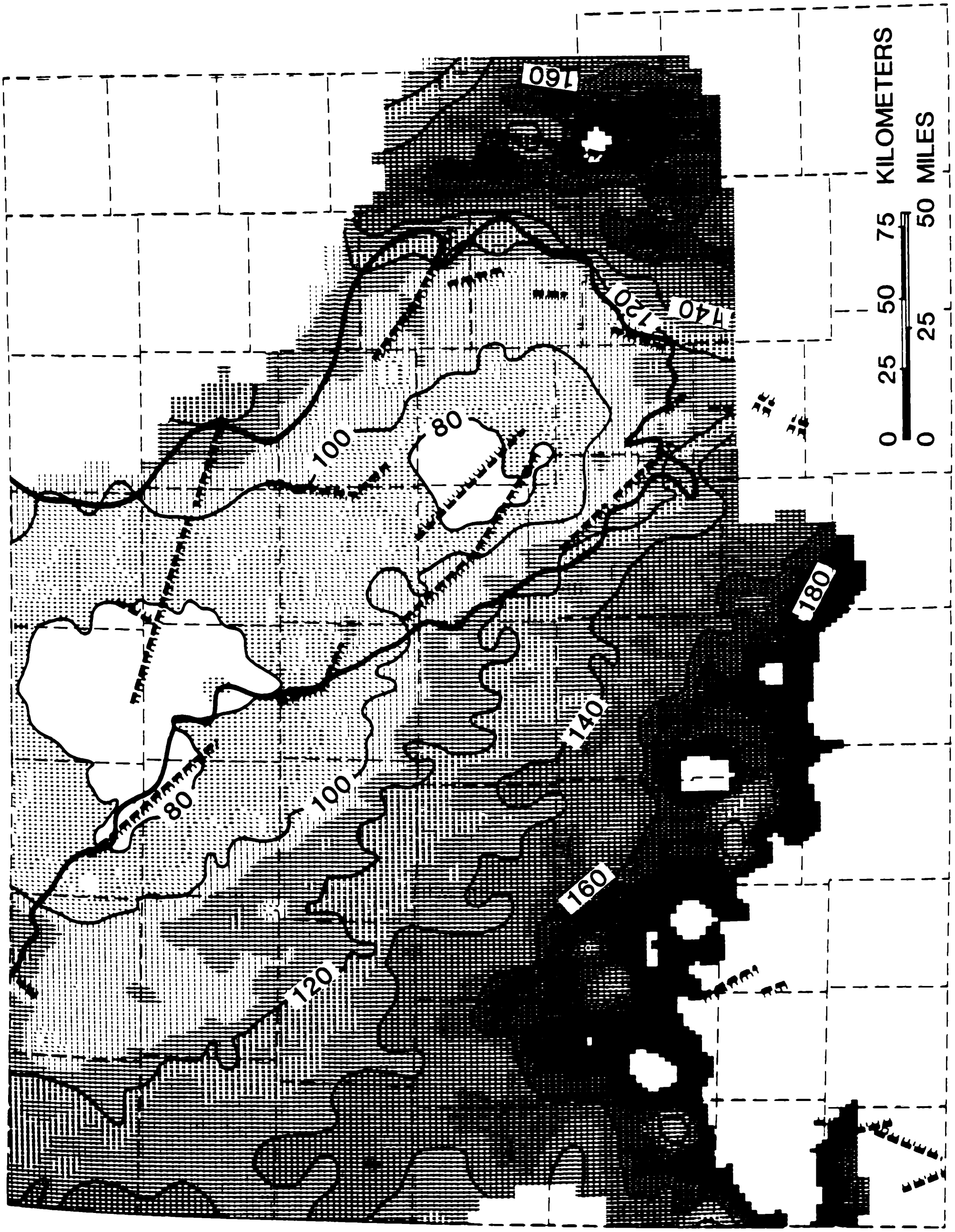

KILOMETERS
0 25 50 75
MILES
0 25 50
100
200
300
400
500
600
700
800
900
1000
1100

Figure 2.9. Shaded isopach map of the interval from the top of the H-Zone to the base of the K-Zone. Intervals are shaded in increments of 10 feet (3 m). Labeled contours represent 20 feet (6 m) intervals. Black areas along the southern margins of the study area exceed 180 feet (55 m) in thickness. County boundaries are lighter dashed lines. Noticeable thinning occurs over the crest of the CKU and CA. Minor thinning is noted over the southwest positive area.


80
100
120
140
160
180
0 25 50 75 KILOMETERS
0 25 50 MILES

equally among the four cyclothems is 0.5 ft/mi. to the south and southwest.

This thickening may approximate the amount of differential subsidence across the shelf during the deposition of these four cyclothems. The relief created by the initial tectonic movement of the CKU and adjacent shelf had been greatly diminished by the time of the Missourian due to concurrent regional subsidence and sediment accumulation. In contrast to the Morrowan, the lowermost Pennsylvanian which is an accumulation of a wedge-shaped complex of fluvial and deltaic sediments in this same area, the cyclothems in the Kansas City Group are less variable in thickness across the shelf typified by thin, widespread lithofacies (Figs. 2.5, 2.6, 2.7). Thus it is likely that the thickness of the Missourian cyclothems (Fig. 2.9) does not approximate the relief on the lower surface as does the isopach map of the earlier Pennsylvanian interval (Fig. 2.8). Rather the variation in thickness reflects more of the syndepositional structural movement of the shelf.

The minimum paleoslope that this thickening suggests is quite low indeed, 0.5 feet/mile. Yet, as will become apparent later, this depositional slope was probably not constant between cyclothems. The southwesterly dip is a shift from the more westerly dip of the earlier Pennsylvanian interval (Fig. 2.8). Thinning during the accumulation of the Kansas City Group occurred over two major centers: on the CA and on the CKU centered along the Rush rib (Merriam, 1963), located in Rush and Barton counties (Fig. 2.9). A broad area of regional thinning extends farther to the west than the CKU-CA as defined by the truncated margin of the Mississippian strata (Fig. 1.1) (Merriam, 1963).

Areas of more local thinning, such as the elongate feature in Thomas (TH) and southern Rawlins (RA) counties are also common. This thinning extends southward as a nose that coincides with the general location of the Oakley anticline, a structure noted for its rather prominent influence on deposition during the Early Permian (Merriam, 1963).

The H to K composite interval exhibits its greatest rates of thickening and greatest local variability in thickness in southwestern Kansas. In the southeastern part of the mapped area the H to K composite interval thickens rapidly southeastward into a saddle between the southern Salina and northern Sedgwick basins (Fig. 2.9).

While general thickening to the southwest is noted in the Lower Pennsylvanian interval off the CKU (isopach map - Figure 2.8 and cross section - Figure 2.7), moderate thinning occurred in the southwest during the deposition of the Kansas City Group in conjunction with a localized increase in the percentage of terrigenous clastics (Figs. 2.7 and 2.9) and accompanied by only minor attenuation of thickness of individual cyclothems. The area apparently underwent a reversal from subsidence during the Early Pennsylvanian to slightly positive in Late Pennsylvanian between the time represented by these two intervals. This is in keeping with the other observations of the westward shift in the uplifts during the later Pennsylvanian and Permian and the growth of the Los Animas arch and the Cimmaron arch in southeast Colorado (Fig. 2.2). Later uplift of this area is apparently much more substantial (structural cross section in Figure 2.7a).

Post-Missourian Tectonism

Bush (1977) also recognized a westward shift in Late Pennsylvanian movement on the CA toward the Oakley anticline and Los Animas arch. The actual motion in the Late Pennsylvanian was probably only less rapid subsidence than the other areas. This westward shift of activity of more positive elements on the shelf continued as indicated by thinning of younger intervals such as that between the Heebner Shale and the Kansas City Group. The isopach map of the interval between the Stone Corral Formation (Leonardian, Lower Permian) and the Lansing Group indicates that the entire northern shelf became relatively positive along with marked thinning associated with the northeastwardly trending Los Animas arch (Fig. 2.10). Figure 2.11 graphically summarizes the structural evolution of the western Kansas shelf during the Late Pennsylvanian and early Permian. Rascoe (1979) also illustrated the later period of pronounced growth of the Los Animas arch during the Early Permian. Meanwhile, by the time the Hutchinson Salt was deposited in the Leonardian, the CKU to the east had become a site of moderate subsidence with a shallow, bowl-shaped depression centered almost directly over the older positive structure (Watney and Paul, 1980).

Kluth and Coney (1981) argued that marginal lithospheric plate deformation affected the interior of the craton during the Late

Figure 2.10. Shaded isopach map of the interval from the top of the Stone Corral Formation (Leonardian, Lower Permian) to the top of the H-Zone. Intervals are shaded increments of 200 feet (60 m) and labeled contours are at 400-foot intervals (122 m). Outlines of the counties and the CKU and CA are shown.

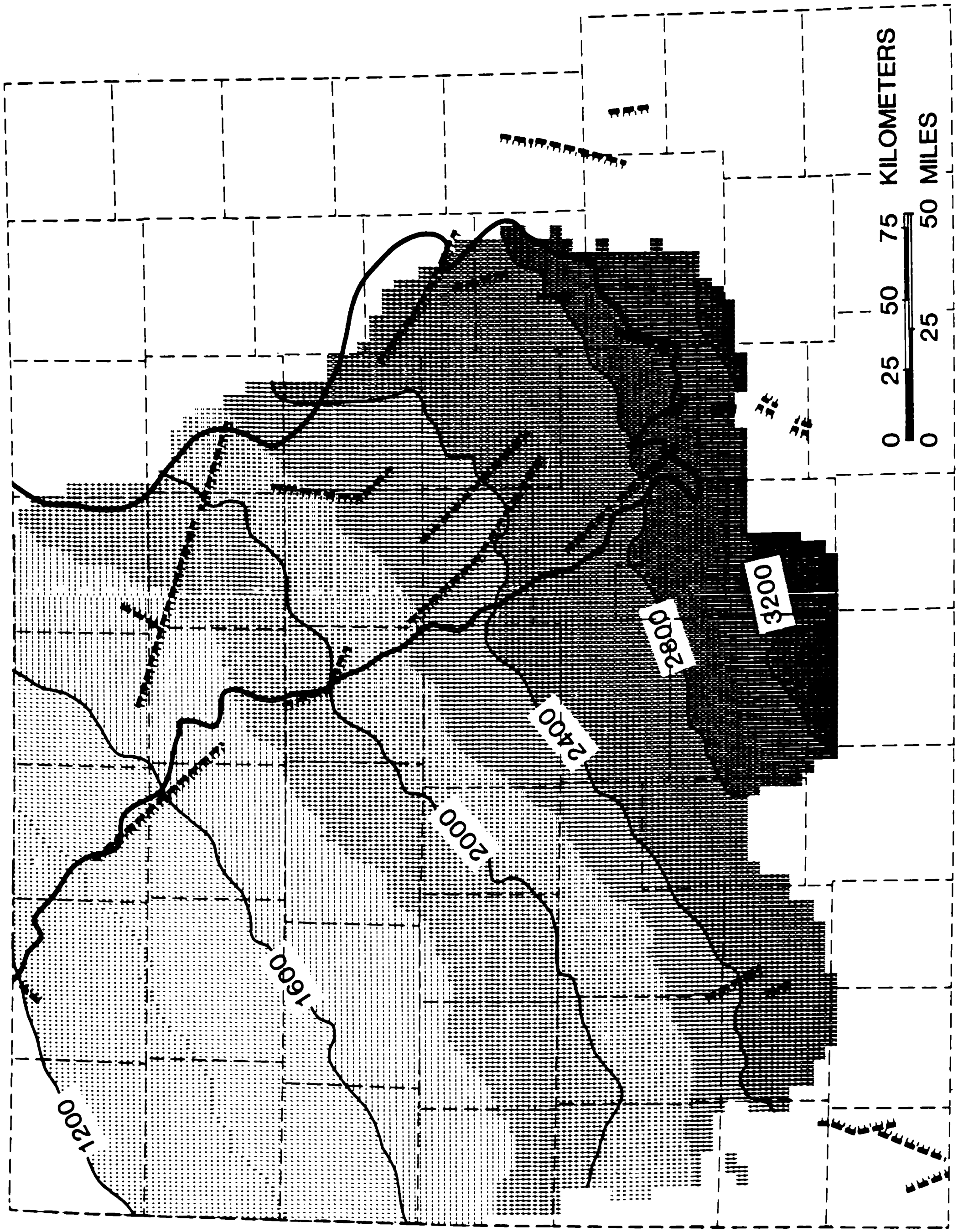
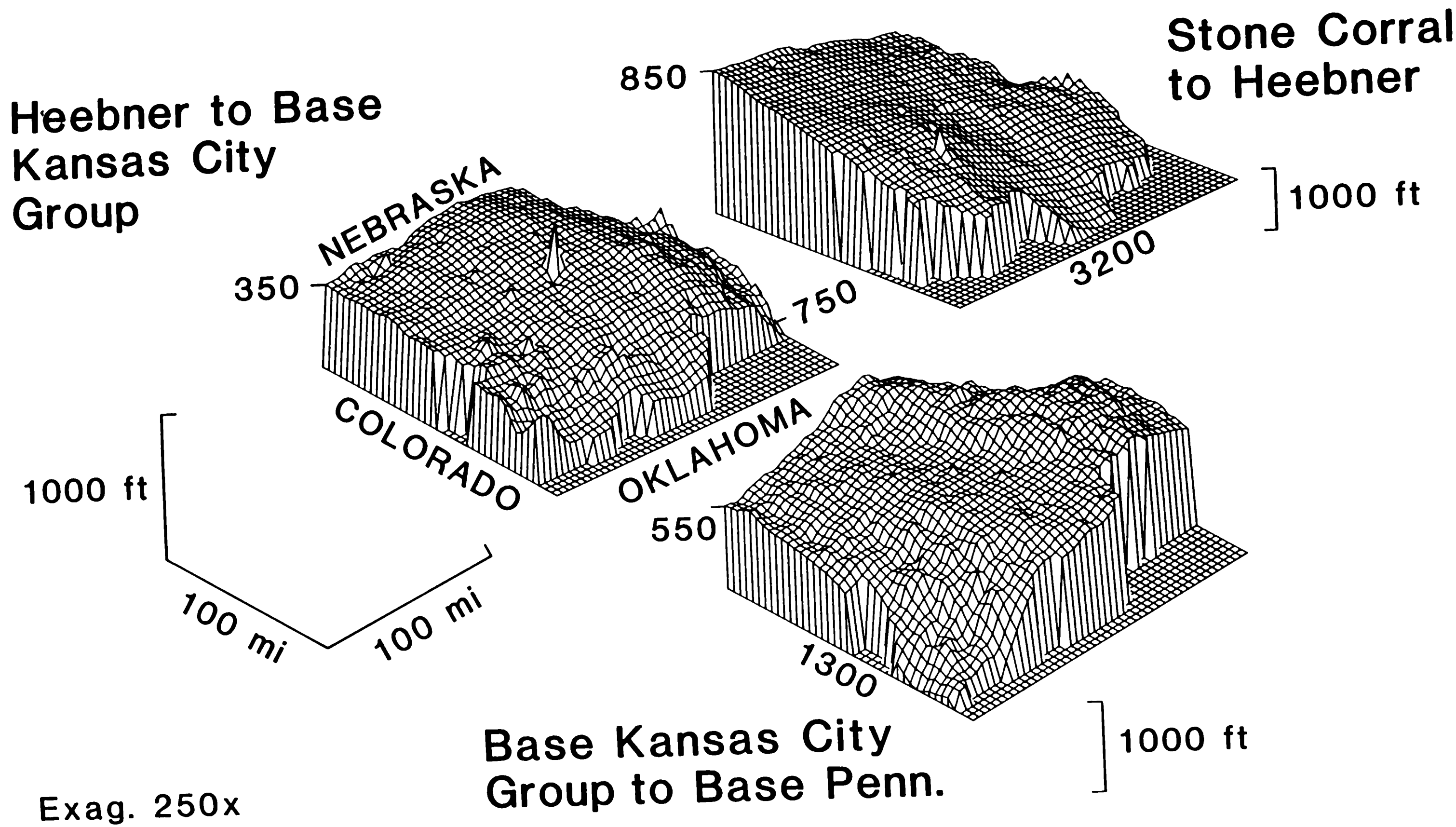

1200
1600
2000
2400
2800
3200
0 25 50 75 KILOMETERS
0 25 50 MILES

Figure 2.11. Structural evolution of western Kansas as indicated by perspective block diagrams illustrating thicknesses of successively younger intervals of Upper Pennsylvanian and Lower Permian strata. Upper datum of thickness interval is presumed to be horizontal. Surfaces shown on these diagrams represent the configuration of the lower datum with the upper datum as an immaginary plane. CKU and CA are most prominent on the base of Kansas City to base of Pennsylvanian interval, representing the first sediments deposited after the major uplift of these structures. During the time the Stone Corral to Heebner (Shawnee Group, Virgillian) interval was deposited, the subsidence (inferred from area of greatest thickening) on the shelf was dominated by the southerly plunge into the Anadarko basin. The uplifts on the shelf during the development of this youngest interval had only a very subtle expression. The lowest diagram is equivalent to the isopach map of Figure 2.8.


Heebner to Base
Kansas City
Group
Stone Corral
to Heebner
Base Kansas City
Group to Base Penn.
NEBRASKA
COLORADO
OKLAHOMA
350
750
850
3200
550
1300
1000 ft
1000 ft
1000 ft
100 mi
100 mi
Exag. 250x

Pennsylvanian and Early Permian as the result of plate convergence on the east and later on the south. Fath (1920) suggested very early that Late Mississippian to Early Pennsylvanian structural movement in Kansas developed along weaknesses in the Precambrian basement. Morgan (1932), who defined the CKU, suggested that this structure followed the Precambrian grain activated by folding in the Appalachians. Butcher (1933) suggested that orogeny and epeirogeny are two components caused by one and the same processes. Thomas (1983) elaborates on the laterally directed stress concept of Kluth and Coney (1981) and suggests that independent intraplate adjustment that is not related to plate convergence must be considered. A progressive westward shift of younger structural movement perhaps as a response to the change in regional stress pattern is suggested within the area of study by the previously mentioned isopach patterns. Regardless of their cause, slight episodic epeirogenic movement of these tectonic elements has significantly affected the distribution of the relatively thin sedimentary rocks on this portion of the craton.

Present-day subsea structural elevation on the top of the K-Zone regressive carbonate (Fig. 2.12) reveals the positive position of the CKU and CA. Deformation preceding K-Zone deposition was most pronounced, however, over the CA as illustrated by the closely-spaced contours over this structure. One set of structural lineaments parallels the trend of the CKU (N45W), and the other parallels the Las Animas arch and Nemaha uplift (N45E). The concentration of oil and gas fields on the CKU (Fig. 2.13) can be explained as accumula-

Figure 2.12. Structural contour map of the top of the K-Zone regressive (upper) carbonate. Sea level reference datum is used. Contour interval is 50 feet (15 m). Heavy dashed lines are structural lineaments identified by visual interpretation of the contours. Black areas are selected large L-KC oil fields lying off of the CKU and along prominent positive structural features. They are identified as follows: C - Cahoj, J - Jennings, PP - Pleasant Prairie, E - Eubanks, VI - Victory, VO - Voshell, and B - Burrton. Counties are indicated with dashed lines and names are abbreviated. Townships are shown using light solid lines that are labeled along the perimeters of the mapped area.

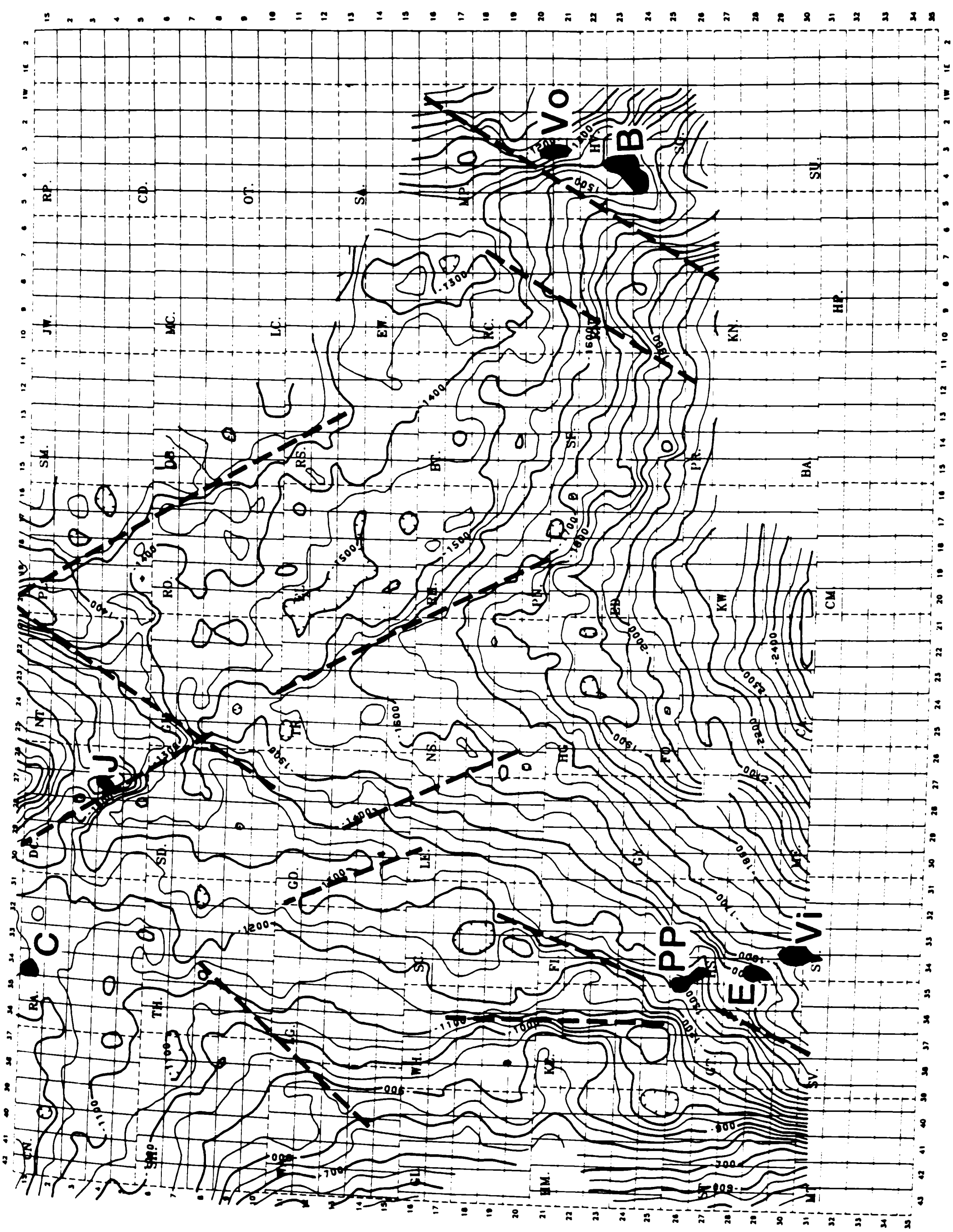
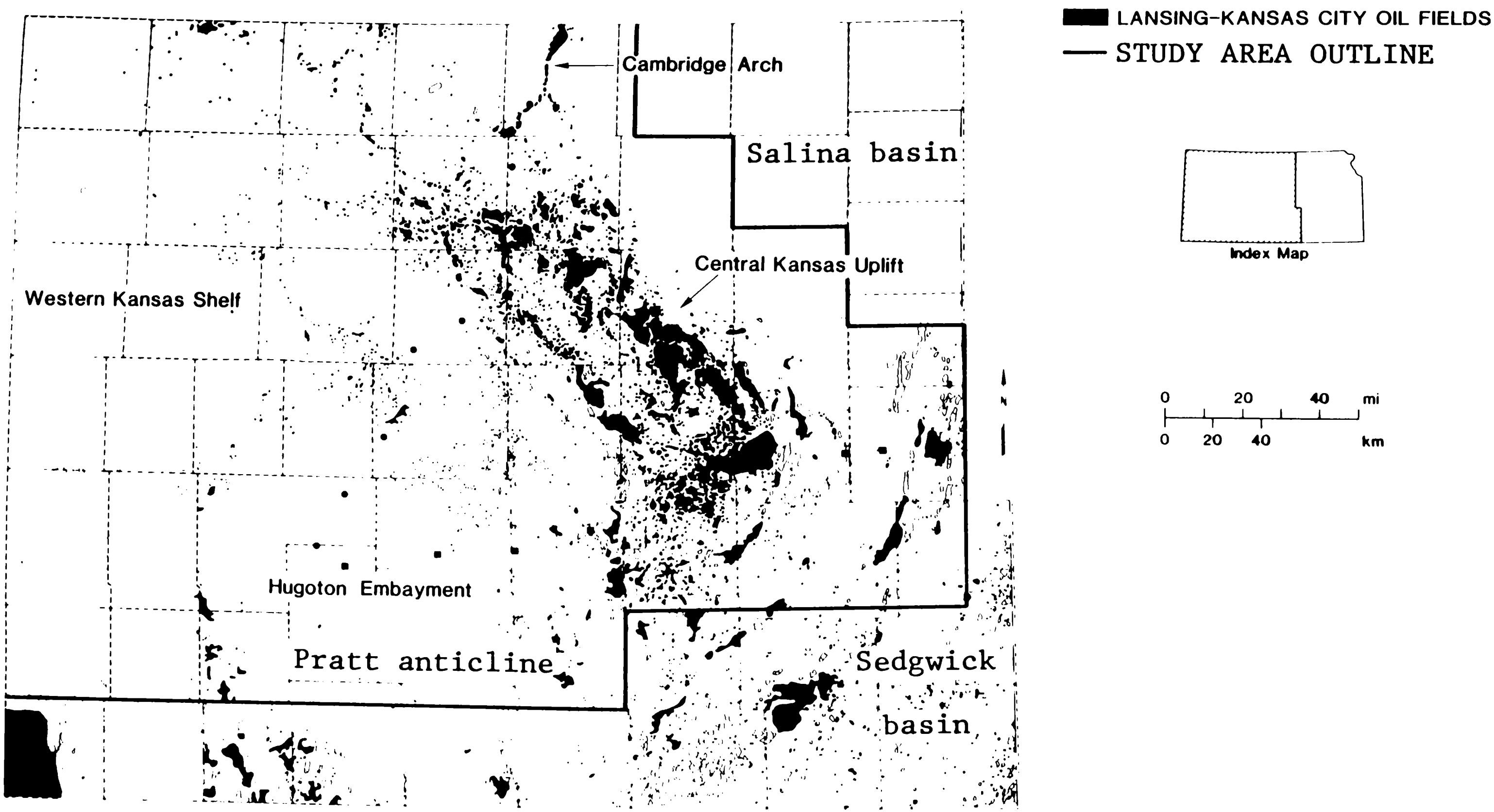

Vo
B
J
C
PP
E
Vi

Figure 2.13. Oil fields of western Kansas (see index map inset). Fields that are identified here as solid black areas produce oil from the Lansing and Kansas City groups. The heavy solid lines identify the area of study. Much of the production is from the northwest-trending CKU and more subtle subparallel trends in western Kansas. Northeasterly-trending narrow anticlines are sites of additional oil production from the Lansing and Kansas City groups in the southeastern area of the southern Salina and Sedgwick basins.


LANSING-KANSAS CITY OIL FIELDS
STUDY AREA OUTLINE
Cambridge Arch
Salina basin
Central Kansas Uplift
Western Kansas Shelf
Hugoton Embayment
Pratt anticline
Sedgwick basin
Index Map
0 20 40 mi
0 20 40 km
N

tions on the crest of an anticline, but the paucity of production over the CA, even more structurally prominent does not follow. Other accumulations of petroleum that are obviously structurally controlled in the Lansing and Kansas groups include the Burton-Voshell anticline (abbreviated B and VO on Fig. 2.12) and the Pleasant Prairie (PP), Eubank (E), and Victory (VI) fields. The Cahoj (C) field in northern Rawlins (RA) County also occupies a regional structural high. Subtle structural trends that are actively being explored and developed today include areas in northeastern Logan County (LG) extending NW-SE across Gove County (GO) and into Lane (LE) and Ness (NS) counties.

Trend Surfaces of K-Zone in Structural Interpretation

Trend surface mapping provides a means for partitioning the local and regional elements of a map (Merriam and Harbaugh, 1964). This may prove very important in removing regional dip to emphasize local structural anomalies of small relief. Slight changes in dip on the original map may actually be sites of structural closure and be sites of oil accumulation if favorable reservoir rocks are present.

The structure of the K-Zone provides an example for trend-surface mapping. A polynomial trend surface and its residual are used to resolve and illustrate the similarities between the original deformation and later periods of differential uplift that may have been important during sedimentation. In order to do this a good match between the statistical model and structural surface is desired. This match is usually selected on an empirical basis. The choice made here is based on optimizing the fit of the model surface using the lowest order polynomial equation to preserve both regional and local variation. The discussion of the statistics used is found in Appendix B.

The ratio of the sum of squares due to regression and the total sum of squares is the goodness of fit. The sum of squares due to regression represents the departure of the regression surface from the original data. The total sum of squares is the sum of variation of the data set. It is plotted against the order of the trend surface in Figure 2.14. No residuals would mean that the regression surface provided a perfect fit to the original data. A high enough order of trend surface equation would eventually provide a close match to an original surface that was not too complex. However, a map of the residual trend surface may represent significant geological events that otherwise might be masked by a dominant regional trend. The function of the trend-surface analysis here is to differentiate the local from the regional trends and patterns.

A third-order fit was chosen for presentation and analysis. This surface explains more than ninety percent of the original variation. The higher order trends contribute additional fit, but only by small increments. These increments, while improving the resolution of the fitting surface, do so at the expense of the residuals. Therefore the residual map becomes increasingly difficult to interpret geologically. The calculation of trend surface, residuals, and goodness of fit are described in Appendix B.

The trend surface of the top of K-Zone is a generalization of

Figure 2.14. A plot of the ratio of the goodness of fit of the trend surface to the original data, expressed as the ratio of the sum of squares due to regression to the total sum of squares times 100. This is plotted versus the order to the trend surface. These data are calculated for the structural elevation on top of the K-Zone regressive (upper) carbonate.

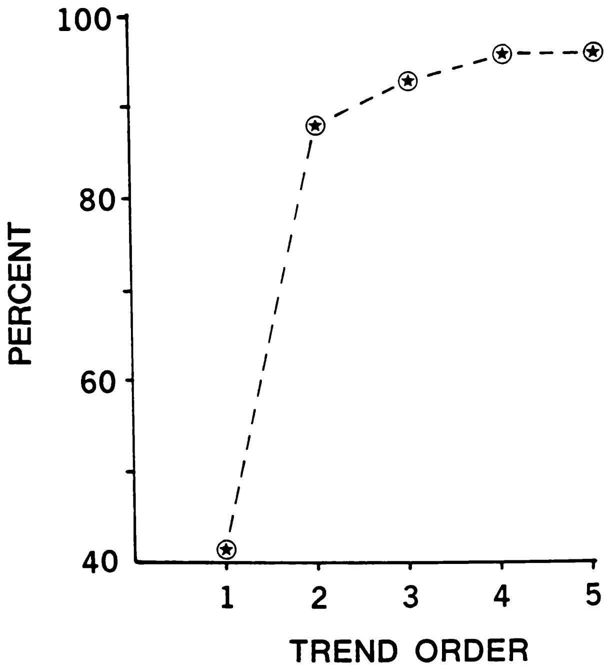
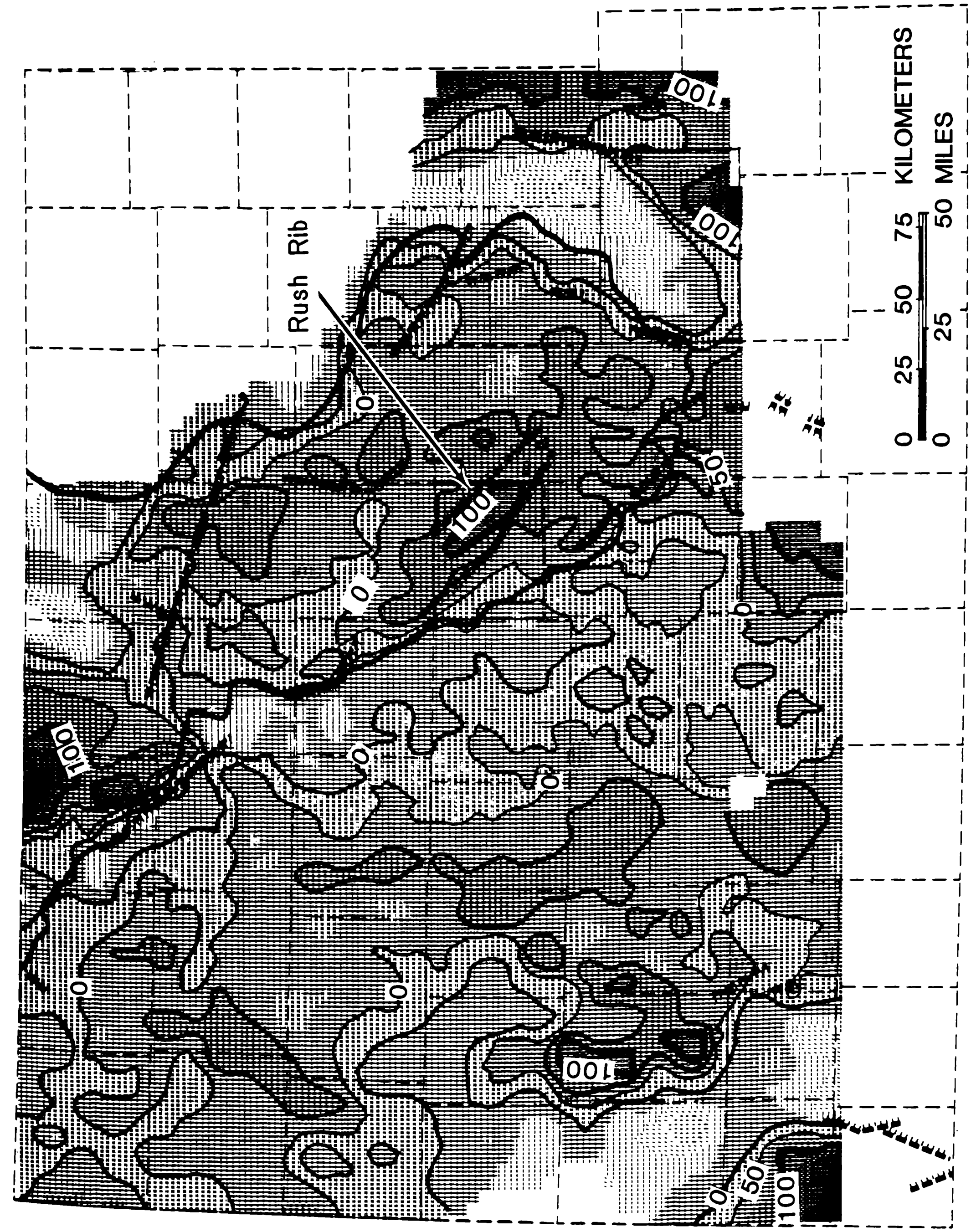

100
80
60
40
PERCENT
1
2
3
4
5
TREND ORDER

Figure 2.12, a broad, southward plunging syncline, the Hugoton embayment, with upturned edges extending over the CKU and over western Kansas along the flanks of the Los Animas arch. The difference between the smoothed surface and the original (Fig. 2.12) is the trend-surface residual (Fig. 2.15). Notice on the map of the residuals that the CKU is much more sharply defined than on either the original structural map (Fig. 2.12) or the trend surface residual (Fig. 2.15). The finer details of the residual map coincide very closely with the Precambrian surface. In particular, note the local northwest-southeast trending horst block on the Precambrian basement surface called the Rush rib (Merriam, 1963). This feature, called the Rush rib (Merriam, 1963), is identified in Figure 2.15 as a positive residual, and is also the site of a magnetic anomaly (Yarger, 1983). The deformation may be located along a weakness in the Precambrian basement (Watney, 1983).

The outline of the CKU noted in Figure 2.15 is defined by a line which follows the truncated margin of upwarped Mississippian strata surrounding the CKU. The edge of the broad area of positive residuals corresponds almost exactly to this line. The very close correlation in the outline of two structural anomalies, the very prominent tectonic upwarp of the CKU during the Early Pennsylvanian and this later post mid-Missourian, subdued, epeirogenic deformation strongly suggests possible recurrent movement along weaknesses in the basement. The northeastward dip off the northeastern edge of the CKU represents a significant reversal of regional dip, making it even more apparent why oil is trapped over the CKU.

Figure 2.15. Contour map of the third-order trend surface residual of top K-Zone. Contour interval is 50 feet (15 m). County lines are dashed and the outline of the CKU and CA is noted by the heaviest black line. The faults that offset the Precambrian basement are noted by the hachured dashed lines.


Rush Rib
100
0
50
0 25 50 75 KILOMETERS
0 25 50 MILES

The distribution of the structural residuals and the patterns of thinning on the isopach map of the four cyclothems in the L-KC (Fig. 2.9) are comparable. The differences observed in patterns between them probably represent more the considerably longer time required for structural development (Fig. 2.15) than for accumulation of the four cyclothems included in the isopach map (Fig. 2.9). Furthermore, local deviations in thickness of each cyclothem may result from local build-up of carbonate rocks or progradation of terrigenous clastics. In fact, individual cyclothems can exhibit distinctly different depositional patterns, limiting the amount of unambiguous information about the details of deposition of each cyclothem to be drawn from such a gross-interval isopach map.

The coincidence of positive residuals and thin areas on the isopach map may provide an important key to development of reservoirs. Active structural uplift or relatively less subsidence during the deposition of a cyclothem produced high areas that influenced the development of favorable reservoir facies (Watney and Ebanks, 1978; DuBois, 1979; Watney, 1980; Prather, 1981). The residual map of structural trends highlights areas of potential structural development. Comparing this map to those with stratigraphic data can provide an important means of assessing the presence of paleostructure and permit the interpolation of existing subsurface data to provide trends for development of petroleum prospects.

Recurrent Structural Activity and Basement Discontinuities

The similarity between structural contour and isopach maps of many intervals and the episodic activity along some structures suggest an evolving pattern of deformation on the shelf of western Kansas as if it were following a template defined in the underlying Precambrian basement. The Ouachita orogenic system resulting from plate convergence may have provided the driving force behind the extensive craton-wide deformation during the late Paleozoic. Weaknesses in the basement subject to reactivation could include faults, fractures, or simply discontinuities in rock types such as intrusions or terrane boundaries. Lidiak (1982), Dutch (1983), and Yarger (1983) have used gravity and magnetic patterns to interpret trends and discontinuities in the Precambrian crust of the Midcontinent.

Dutch (1983) identified major terranes in the Precambrian basement using potential-field geophysics (Fig. 2.16). Kansas is dominated by northwesterly and northeasterly geophysical trends. Yarger (1983) detailed these trends and integrated them with the Precambrian geology illustrated by Bickford et al. (1981; Figure 2.17). These geophysical trends correlate with the Precambrian geology and many are inferred to represent discontinuities in the basement rocks. Furthermore, these geophysical trends coincide with structural trends now expressed in the sedimentary rock column. Apparently some of the weaknesses in the basement became tectonically active and consequently were the locations of considerably younger structures.

Figure 2.16. Precambrian geology and geophysical trends in the northern Midcontinent (after Dutch, 1983). Map of simplified basement terrane and linear gravity and magnetic trends, paralleling elements of the Precambrian terrane. Prominent northeast trend of the 1.1-billion-year-old Midcontinent rift system CNARS or Central North American Rift System cuts the older accretionary terrane which is dominated by a northwesterly trend over the southern mapped area including Kansas. CKU parallels the northwesterly trends and the Nemaha uplift the northeasterly trends.

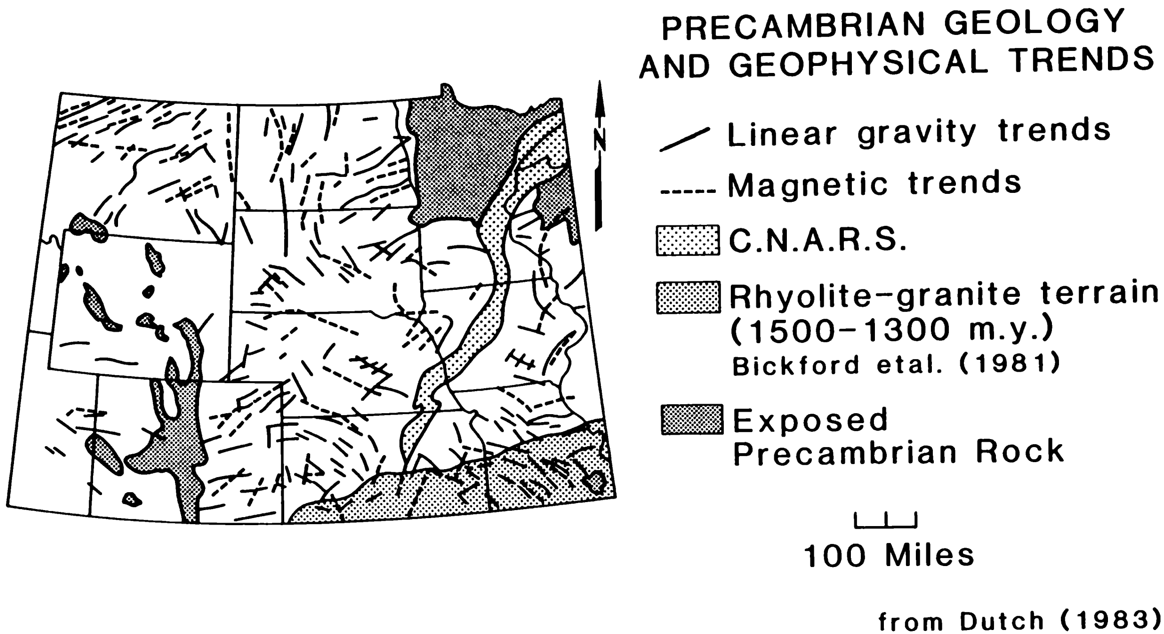
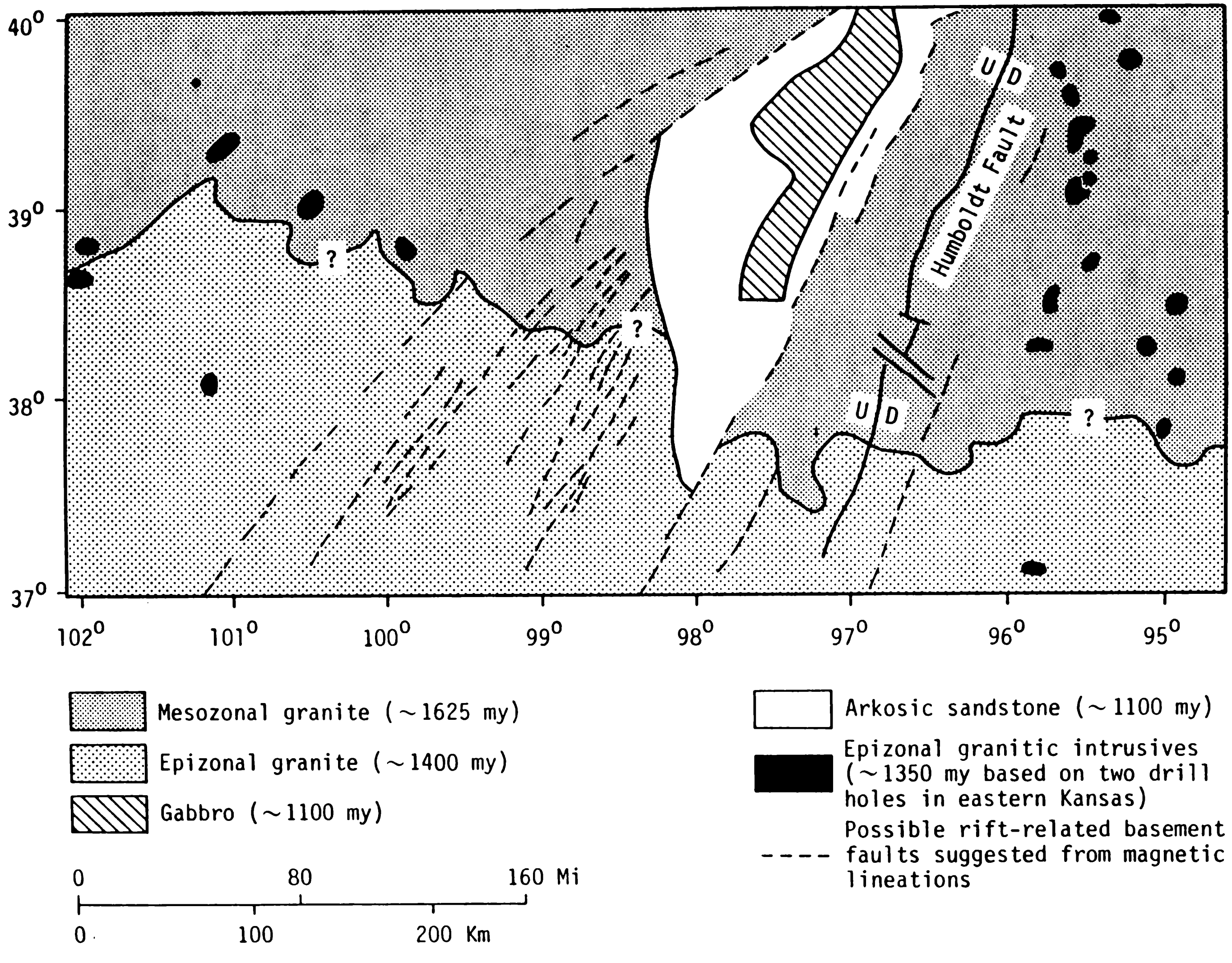

PRECAMBRIAN GEOLOGY AND GEOPHYSICAL TRENDS
N
Linear gravity trends
Magnetic trends
C.N.A.R.S.
Rhyolite-granite terrain (1500-1300 m.y.)
Bickford etal. (1981)
Exposed Precambrian Rock
100 Miles
from Dutch (1983)

Figure 2.17. Precambrian terranes in Kansas and immediate adjacent areas (after Yarger, 1983, modified from Bickford et al, 1981).


40°
39°
38°
37°
102°
101°
100°
99°
98°
97°
96°
95°
?
?
?
U
D
U
D
Humboldt Fault
Mesozonal granite (~1625 my)
Epizonal granite (~1400 my)
Gabbro (~1100 my)
Arkosic sandstone (~1100 my)
Epizonal granitic intrusives (~1350 my based on two drill holes in eastern Kansas)
Possible rift-related basement faults suggested from magnetic lineations
0
80
160 Mi
0
100
200 Km

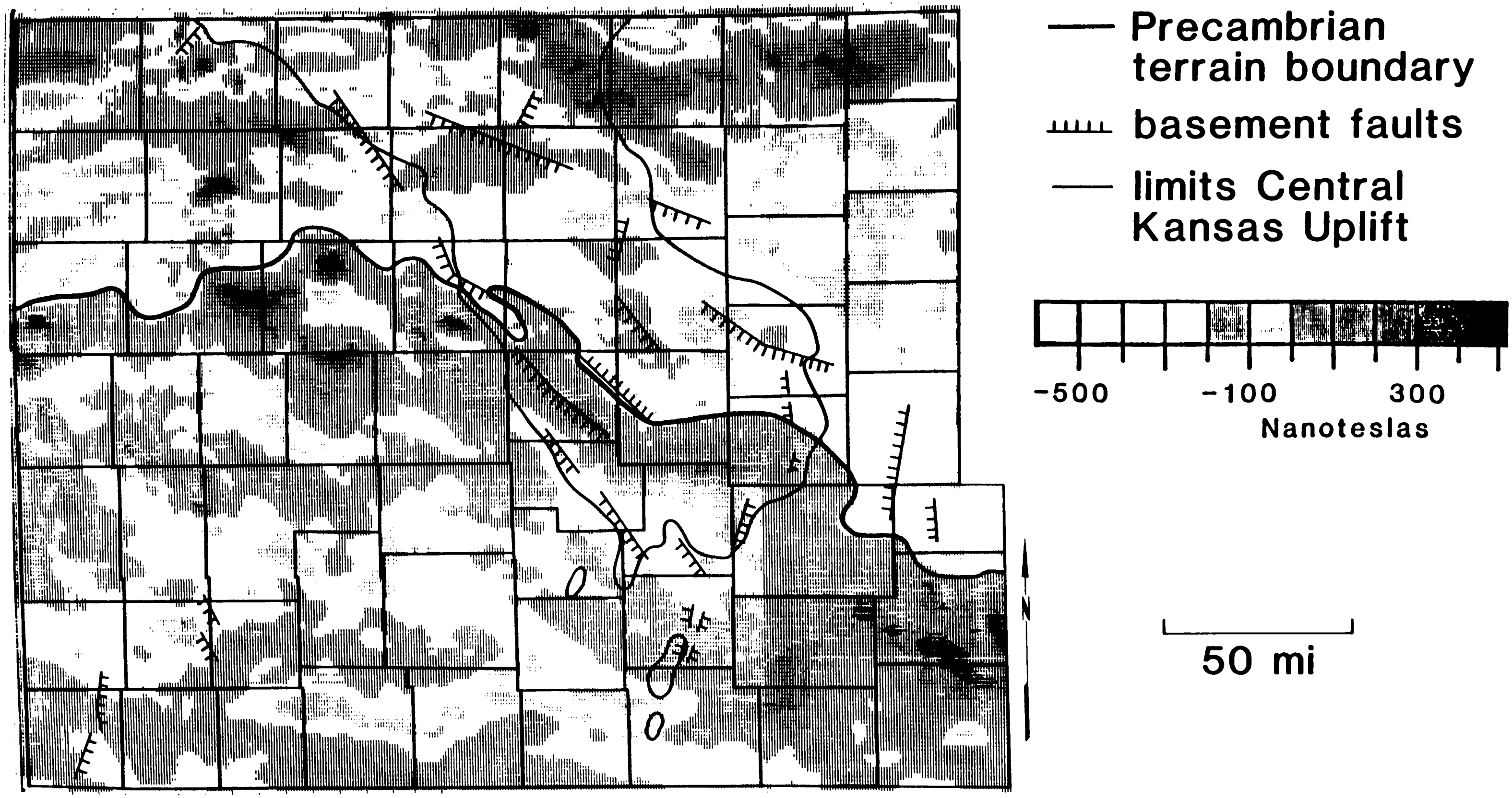
Yarger (1983) used digital filtering of the original total magnetic field measurements to highlight the magnetic trends. One such map is a pole correction map (Fig. 2.18). Yarger concluded that the dominant low-frequency, northwesterly trending pattern shown in Figure 2.18 probably represents the grain of the Precambrian. According to Dutch (1983) the bands of magnetic anomalies represent successive accretion of younger terrains that were tectonically welded to the protocontinent. Note that the CA-CKU trends nearly parallel to these anomalies as do many smaller structures both on the crests of these major structures and in areas farther west. Several of the magnetic anomalies directly coincide with recognized structural elements in western Kansas. The strike of the isopach map (repeating the assumption that structural development during this interval is represented by the thickness) of the Kansas City Group, for example, generally parallels the anomalies on the pole correction map.

The configuration of the Precambrian surface (Fig. 2.19, western sector and Fig. 2.20, eastern sector of study area) reveals the combined effects of long-term erosion and all of the subsequent deformation during the Phanerozoic. The CA-CKU, however, is prominently expressed on its surface. Basement faults notably have two prominent trends.

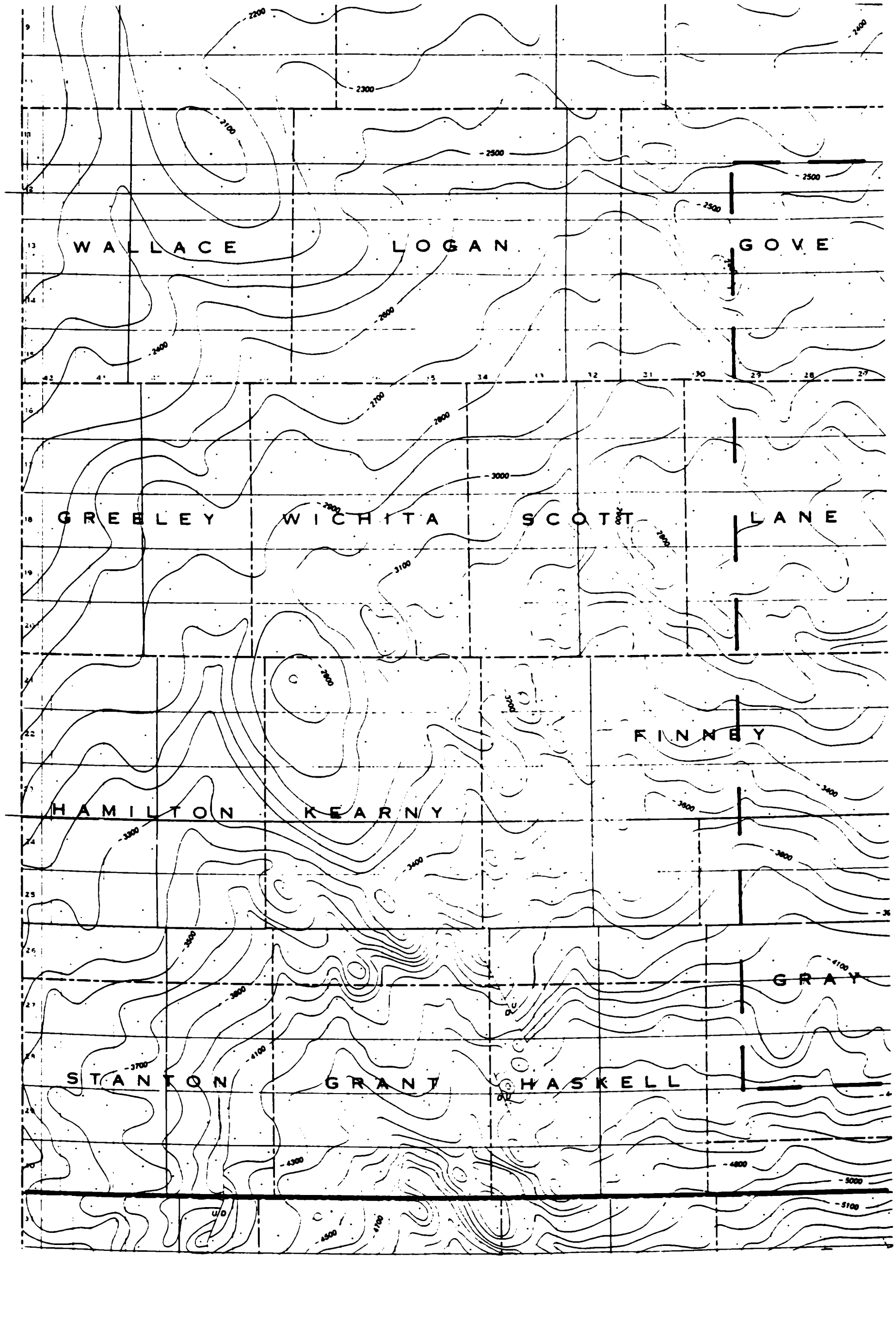
The second vertical derivative map of Yarger reveals better defined, sharper magnetic anomaly patterns that cut both northeasterly and northerly across the map (Fig. 2.21). The map highlights areas where the magnetic gradient is greatest emphasizing shallow

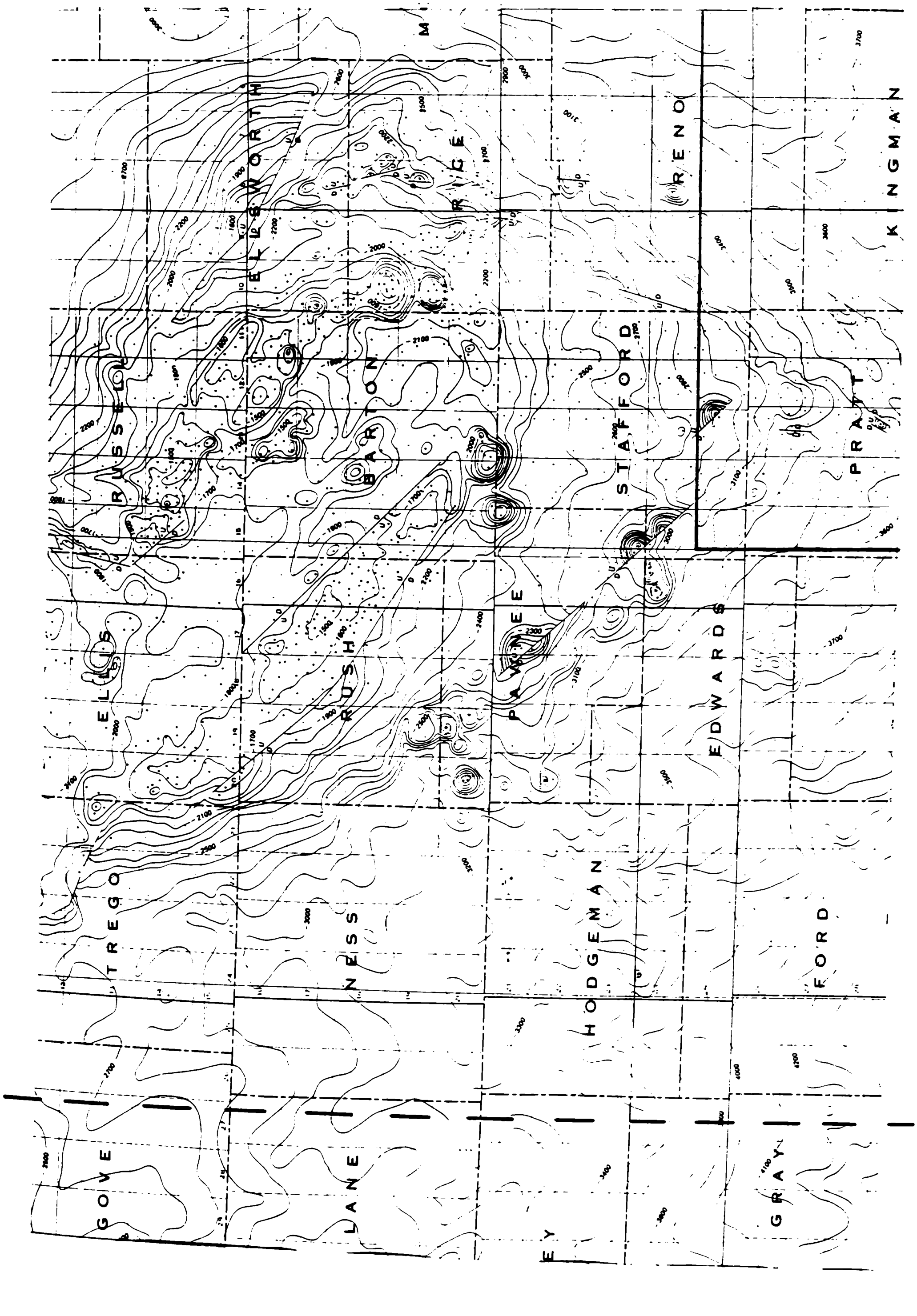
Figure 2.18. Filtered aeromagnetic map of western Kansas (modified from Yarger, 1983). Map is a pole correction of the total magnetic field. The distortion caused by the earth's inclined magnetic field is calculated and subtracted from the original map of the total magnetic field intensity. Yarger concluded that the low-frequency, generally northwesterly trending elements shown here probably represent deep-seated structure of the Precambrian. Yarger identified a prominent boundary between the two terranes of contrasting age shown on this map by the heavy line crossing the mapped area. CKU and CA with the basement faults are also shown on the map.

Pole Correction Map of Magnetic Field (Yarger, 1983)



Figures 2.19 and 2.20. Contour map of the configuration of the Precambrian surface for western Kansas from Cole (1976): (a) western study area and (b) southern study area. The map is divided in two parts in order to preserve detail. Contour interval equals 50 feet (15 m). Dots represent both depth estimates and actual penetrations of the Precambrian surface. Counties and townships are shown. Portions of southern border of this study is indicated by heavy line.


WALLACE
LOGAN
GOVE
GREELEY
WICHITA
SCOTT
LANE
FINNEY
HAMILTON
KEARNY
GRAY
STANTON
GRANT
HASKELL
2200
2300
2100
2500
2600
2400
2700
2800
3000
3100
3400
3300
3800
3500
4100
3700
4300
4500
4800
5000
5100


ELLSWORTH
RICE
RENO
KINGMAN
RUSSELL
BARTON
STAFFORD
PRATT
ELLIS
RUSH
PAWNEE
EDWARDS
TREGO
NESS
HODGEMAN
FORD
GOVE
LANE
GRAY

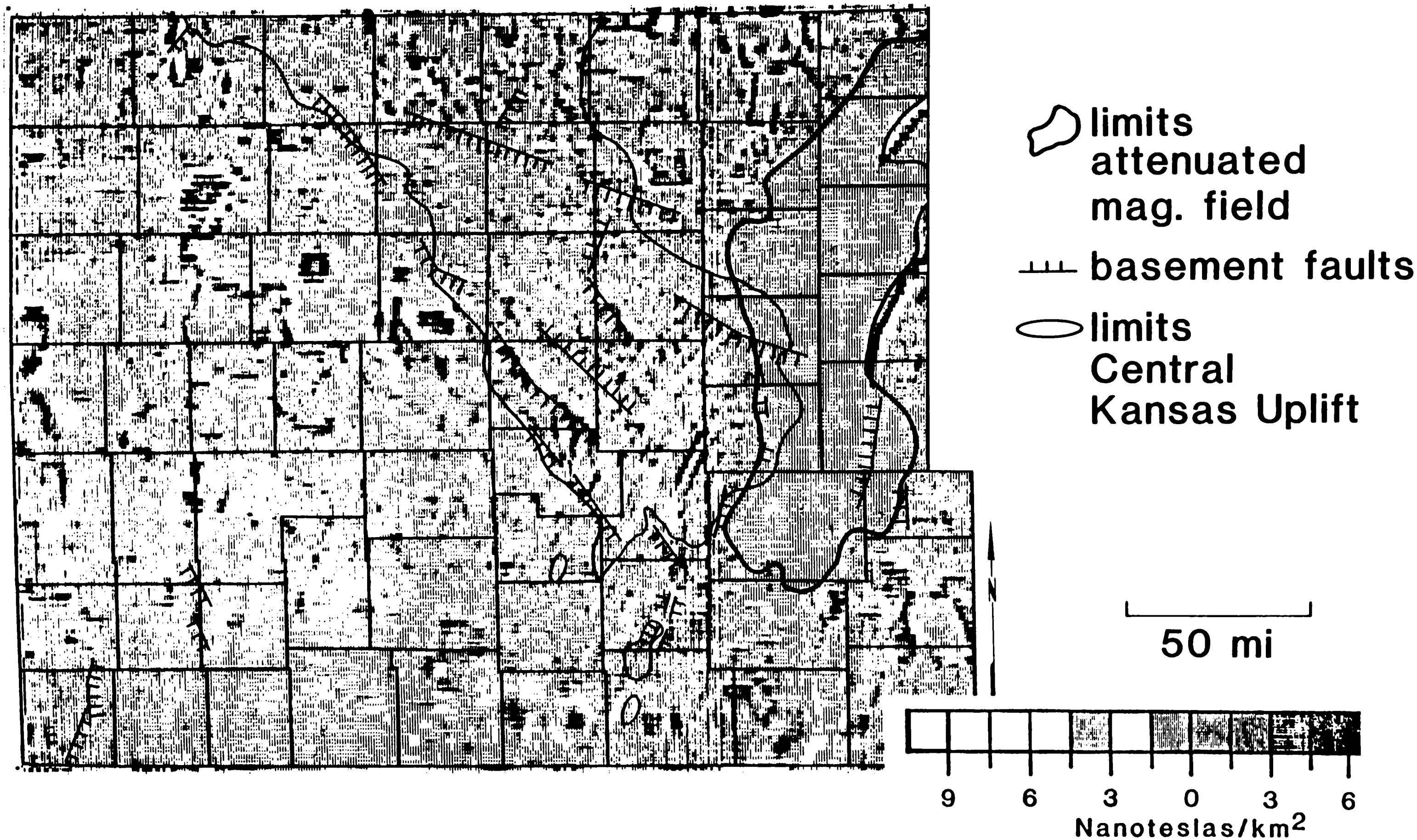
features such as steep contacts between rocks of contrasting magnetic susceptibility. In particular, the map enhances short, subparallel, northeastwardly trending linements that are thought to represent faulting and intrusion of mafic igneous rocks associated with the 1.1 billion year old Central North American Rift System (CNARS) (Ocola and Meyer, 1973, Yarger 1983).

In general the second vertical derivative map emphasizes the northeasterly trend of the CNARS that cross cuts the older accretionary terrane. The southeastern border of the CKU terminates at the west edge of the area of attenuated magnetic signature associated with the CNARS. This area of attenuated readings represents a thick wedge of Precambrian, graben-filling terrigenous sediments called the Rice Formation. The southern CKU is also sliced by northeast trending linear magnetic anomalies. The Pratt anticline (Fig. 2.13), a structure that will be important in later discussion, parallels these same northeastwardly trending lineaments. In fact, most of the late Paleozoic structures east of the CKU, including the Nemaha uplift, parallel the CNARS.

Kluth and Coney (1981) suggested that the constraints on deformation included the existence of a weakness, its location and trend. that was reactivated by orogenic activity along the plate margin. The implication here is that the episodic reactivation of these zones of weakness, albeit commonly subtle, would be expected to affect sedimentation during these periods of activity. Furthermore, the locations of these structural elements may be detected by analysis of the gravity and magnetic information.

Figure 2.21. Filtered map of the total aeromagnetic field of Yarger (1983) depicting the second vertical derivative of the magnetic field. Dark shaded lineaments and patterns illustrate where the gradient in the magnetic field is greatest. The map identifies probable steep contacts between rocks of contrasting magnetization in the shallow basement such as might be produced by faulting or intrusion of mafic igneous rocks (Yarger, 1983). Filtering enhances the short, subparallel, northeasterly-trending magnetic pattern of the CNARS. Line segments likely represent graben and horst system intruded by gabbros. The area of attenuated magnetic signature outlined on this map denotes thick clastic sedimentary strata of the Precambrian Rice Formation, sedimentary rock which filled the rift feature.

2nd Vertical Derivative of Mag. Field (Yarger, 1983)



CHAPTER THREE

STRATIGRAPHY

Middle and Upper Pennsylvanian Rocks

The Missourian Stage consists of the Pleasanton, Kansas City, and Lansing groups. The succession was illustrated in Figure 1.5. These strata comprise alternating limestone, shale, and more limited occurrences of sandstone and coal. Total thickness ranges from about 300 feet (90 m) in northern Kansas to nearly 500 feet (150 m) in southern Kansas. The Missourian overlies the Des Moinesian Stage. The Cherokee Group, which is part of the Des Moinesian, contains considerably more sandstone and coal in eastern Kansas than the Missourian strata. The net thicknesses of sandstone and the total thickness of the Cherokee Group increase toward a source area to the north on the Canadian Shield (Visher et al, 1971). However, Wright (1975) in interpreting the distribution of strata equivalent to the Cherokee Group in the Midcontinent concluded that the source area for them were primarily the Canadian Shield <u>and</u> the Appalachians and locally uplifts such as the CKU and Nemaha uplift. In Oklahoma the interval again thickens in a depocenter along the margins of the Anadarko and Arkoma basins. Thicknesses exceed 1000 feet (300 m) in northeastern Kansas in the center of the Forest City basin. The Marmaton Group lies above the Cherokee Group; and with it comprises the Des Moinesian. The Marmaton Group is less variable in thickness than the Cherokee averaging 250 feet (80 m). It contains alternating limestones and shales with minor sandstone (Zeller, 1968). In contrast in western Kansas the Cherokee and Marmaton groups are both predominantly carbonate strata much like the overlying Kansas City Group.

The Pleasanton Group, lowermost in the Missourian Stage, is dominated by terrigenous clastics in eastern and central Kansas where it ranges in thickness from 10 feet (3 m) to 150 feet (46 m), attaining its greatest thickness in extreme northeastern Kansas (Moore, 1949; Howe, 1982). It becomes progressively more marine to the south and west. In the study area the Pleasanton Group is predominately a terrigenous clastic unit generally less than 50 feet (15 m) thick. The Pleasanton is overlain by the Kansas City Group which comprises the middle portion of the Missourian strata. Its composition is one of alternating limestones and shales. The Lansing Group immediately overlies the Kansas City Group.

The Virgilian Stage, which succeeds the Missourian, begins with the terrigenous-clastic-dominated Douglas Group, which attains thicknesses in excess of 700 feet (210 m) in south-central and southeastern Kansas (Moore, 1949). The Douglas Group is less than 75 feet (23 m) thick over most of the area of study except in the southeastern portion. The southeasterly source of terrigenous clastics was the Ouachita highlands, where uplift culminated during the Late Pennsylvanian. Western Kansas was isolated from these sources from the Middle Pennsylvanian.

The Kansas City Group

The Kansas City Group strata examined in this study were first described from the exposures along the Missouri River at Kansas City, Missouri (Hinds, 1912). The term is applicable to the carbonate-dominated succession in Kansas, Missouri, Nebraska, and Iowa.

Outcrop and Eastern Kansas

The Kansas City Group ranges from 100 feet (30 m) in thickness along its outcrop south of Omaha to more than 300 feet (90 m) in southeastern Kansas, a distance of 300 miles (480 km). In the subsurface of western Kansas, the Kansas City Group ranges in thickness from 250 feet (76 m) to 400 feet (121 m).

The stratigraphy of the Kansas City Group that is the focus of this paper was summarized by Moore (1936, 1949) and Zeller (1968) (Table 2). The interval studied in the Kansas City Group extends from the Chanute Shale downward to the base of the Swope Limestone. The Galesburg, Fontana, and Chanute shales are thicker in southeastern Kansas where they contain more sandstone. These predominantly nonmarine intervals continue to thicken southward into Oklahoma, where the carbonate markers are missing or greatly reduced in thickness. Of the limestones involved, only the Drum and Dennis limestones have been formally recognized in Oklahoma. Their equivalent strata there are the Dewey and Hogshooter limestones, respectively. The Galesburg Shale, which rests on the Swope Limestone, varies from 10 feet to as much as 75 feet (23 m) in thickness in southeastern

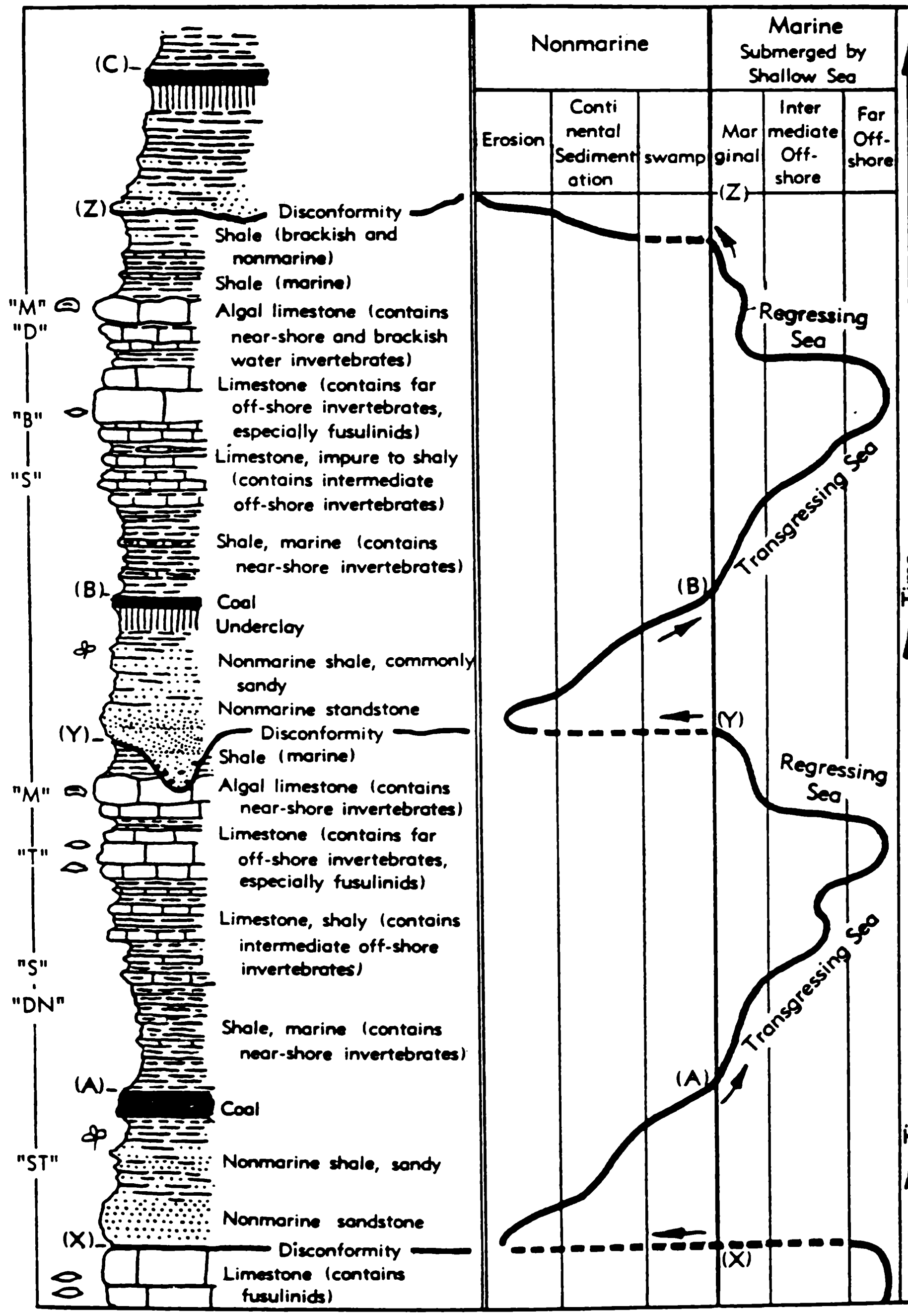
Kansas. Sandstones in this interval locally exceed 60 feet (18 m). Wanless and Wright (1978) depicted the Galesburg Shale in this region as a multilobed deltaic sandstone lithofacies with a southeastern source. Similarly, the Chanute Shale above the Drum Limestone exceeds 200 feet (61 m) in southeastern Kansas compared to only 12 feet (3.7 m) in northeastern Kansas (Zeller, 1968). The Thayer coal was mined from this fluvial-deltaic interval in southern Kansas. The regional stratigraphic variation from the terrigenous section of northeastern Oklahoma to the carbonate-dominated shelf of central Kansas was described by Lukert (1949). It is apparent that the study area is distant from the source of terrigenous detritus that in some regions predominates in the stratigraphic interval of the four cyclothems examined.

Strata of particular interest to this study were examined in the outcrop by Payton (1964, 1966; Swope Limestone), Mossler (1971, 1973; Dennis Limestone), Railsback (1984; Dennis Limestone), Frost (1975; Dennis Limestone), and Stone (1979, Drum Limestone).

Cyclothems and Stratigraphic Succession

Moore (1936) classified the Lansing and Kansas City groups into cyclothems and arranged successive cyclothems into megacyclothems (Fig. 3.1). He regarded a nonmarine sandstone as the base of a cyclothem much as Weller (1930) did in the classification of Middle Pennsylvanian terrigenous cyclothems in the Illinois basin. Moore's cyclothems are capped by a marine shale or limestone unit (Fig. 3.1).

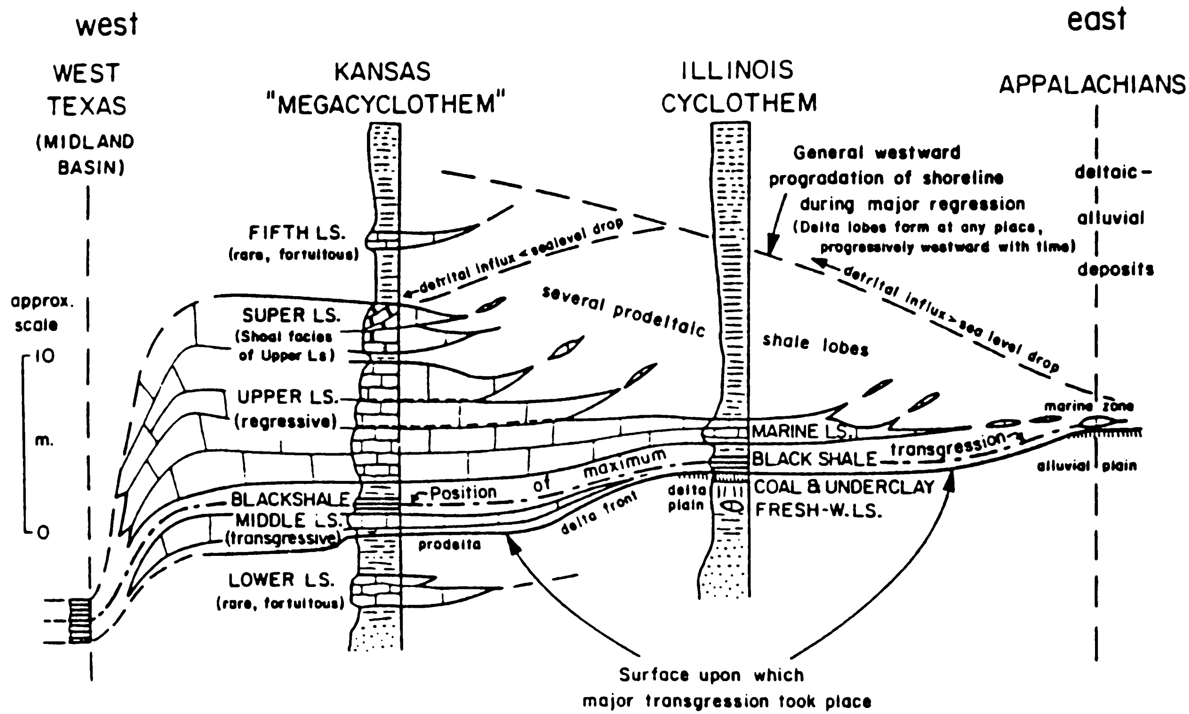
Figure 3.1. Megacyclothem model of Moore (1964) showing two nearly symmetrical cyclothems where maximum transgression is associated with the lower portion of the upper limestones (regressive carbonate).


Nonmarine
Marine Submerged by Shallow Sea
Erosion
Continental Sedimentation
swamp
Marginal
Intermediate Off-shore
Far Off-shore
(C)
(Z)
Disconformity
Shale (brackish and nonmarine)
Shale (marine)
"M"
"D"
Algal limestone (contains near-shore and brackish water invertebrates)
Limestone (contains far off-shore invertebrates, especially fusulinids)
"B"
Limestone, impure to shaly (contains intermediate off-shore invertebrates)
"S"
Shale, marine (contains near-shore invertebrates)
(B)
Coal
Underclay
Nonmarine shale, commonly sandy
Nonmarine standstone
(Y)
Disconformity
Shale (marine)
"M"
Algal limestone (contains near-shore invertebrates)
"T"
Limestone (contains far off-shore invertebrates, especially fusulinids)
Limestone, shaly (contains intermediate off-shore invertebrates)
"S"
"DN"
Shale, marine (contains near-shore invertebrates)
(A)
Coal
"ST"
Nonmarine shale, sandy
Nonmarine sandstone
(X)
Disconformity
Limestone (contains fusulinids)
Regressing Sea
Transgressing Sea
Regressing Sea
Transgressing Sea
Time
Time

Heckel (1977) reclassified the same stratigraphic succession into Kansas-type cyclothems that most commonly comprise a thin, transgressive limestone at the base, a marine core shale, a regressive limestone, and an outside regressive shale at the top. Heckel (1977) proposed that the black marine shale represents the deepest water facies, as had been suggested by Shenk (1967), Evans (1967), and Heckel and Baesemann (1975). Although such shales are thin, they are very continuous. By using the black shales, one can correlate the carbonate succession in Kansas to an equivalent, more terrigenous sequence in the Illinois basin (Fig. 3.2 after Heckel, 1977, modified from Wanless, 1964). The subsurface units were categorized using a modification of Morgan's (1952) classification where the lettered zone is defined primarily by another excellent marker, the lower carbonate. Both this unit and the black shale provide the key elements in correlation of these strata.

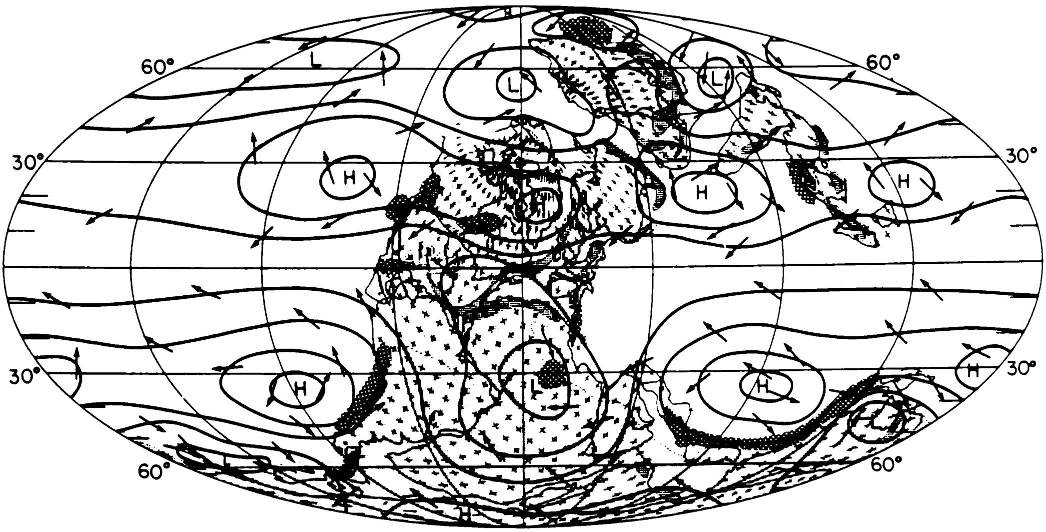
Heckel (1980) summarized the Upper Pennsylvanian stratigraphy of the region west and north of the study area. Evaporites, shallow-water carbonates, and red beds dominate equivalent strata of the Minnelusa Formation in eastern Wyoming and western portions of North and South Dakota. These areas were a cratonic shelf extending to another marine connection at the western margin of the craton. An arid climate to the northwest is indicated by these rocks. Reconstruction of the continent during the Late Pennsylvanian is shown in Figure 3.3 from Parrish (1982). Evaporites tend to form in the dry subtropics around 30 degrees North and South latitude. Equatorial air sinks along the 30 degree latitude producing stable, dry, high

Figure 3.2. Diagrammatic cross section of facies change of Missourian Kansas-type cyclothem approaching eastern detrital source and grading to the Illinois cyclothem (from Heckel, 1977, Figure 7). Illinois cyclothem is essentially equivalent to the Cherokee cyclothem of eastern Kansas.



west
east
WEST TEXAS (MIDLAND BASIN)
KANSAS "MEGACYCLOTHEM"
ILLINOIS CYCLOTHEM
APPALACHIANS
deltaic-alluvial deposits
General westward progradation of shoreline during major regression
(Delta lobes form at any place, progressively westward with time)
detrital influx > sea level drop
detrital influx < sealevel drop
several prodeltaic shale lobes
FIFTH LS. (rare, fortuitous)
SUPER LS. (Shoal facies of Upper Ls)
UPPER LS. (regressive)
BLACKSHALE
MIDDLE LS. (transgressive)
LOWER LS. (rare, fortuitous)
approx. scale
10
m.
0
Position of maximum transgression
prodelta
delta front
delta plain
MARINE LS.
BLACK SHALE
COAL & UNDERCLAY
FRESH-W. LS.
marine zone
alluvial plain
Surface upon which major transgression took place

Figure 3.3. Pattern of atmospheric circulation and upwelling for Westphalian (Late Carboniferous) (from Parrish, 1982). At the center of this hemispheric map is the Appalachian mountains in the eastern U.S. Base maps from Scotese et al. (1979). The upper map illustrates the locations of high and low atmospheric pressures and associated circulation pattern of surface winds during the northern winter. The lower map is the same area for the northern summer. Fine double diagonal-crossed (darkest) pattern are areas of potential upwelling. Areas with the fine dotted pattern are prominent positive areas.


60°
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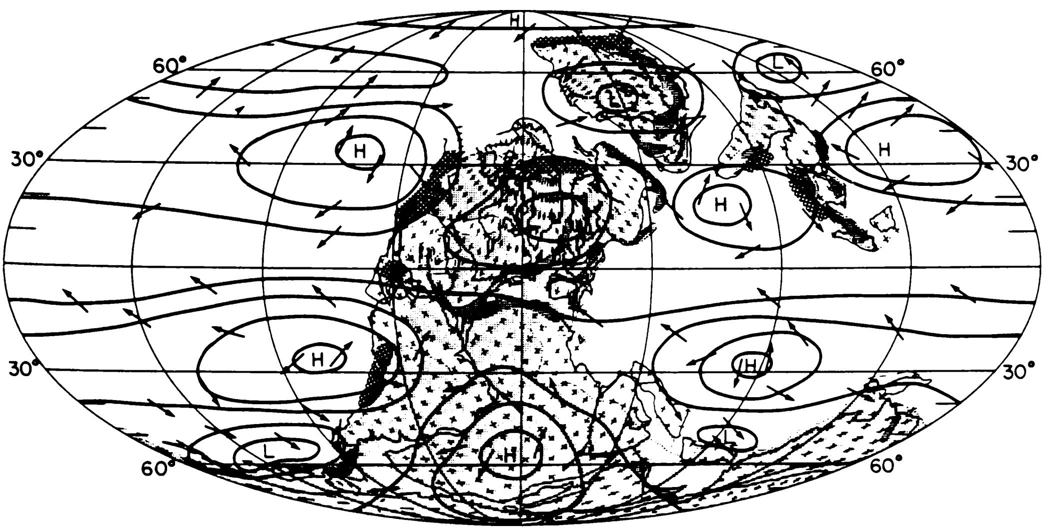
60°
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60°
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L
H

pressure cells. As seen in Figure 3.3 the continents perturb the high pressure cells. Their persistence along this latitude toward the northerly portion of Laurasia would however explain the evidence for arid and semiarid conditions during the Pennsylvanian (Schopf, 1975; Heckel, 1980).

The sources and abundance of terrigenous clastics vary considerably from the eastern to western Midcontinent, but the lateral persistence of most cyclothems has been documented in the subsurface by Parkhurst (1959). The cyclothems are not exact repetitions of one another (Watney 1980; Heckel, 1980) because specific units are not persistent or vary markedly in character, e.g. the black shale portion of marine shale.

Some 25 widespread cyclothems are recognized in the Upper Pennsylvanian of the Midcontinent. These sedimentary units were deposited over a period of 10 million years. This makes the average duration of each cyclothem 400,000 years. Many carbonate-dominated cyclothems are quite constant in thickness on the stable shelf; this suggests the repetition of similar processes causing their development.

Lithofacies

Cores reveal that all the cyclothems are asymmetrical and are dominated by regressive facies (Watney, 1980). Each cyclothem begins with a thin, lower (transgressive) carbonate followed by a lower (marine) shale, then a thick, upper (regressive) carbonate, and finally a upper (regressive) shale, which is quite variable in thickness (Table 3).

Table 3. Common Lithofacies Comprising Cycles in Upper Pennsylvanian

Genetic Nomenclature		Descriptive Nomenclature (used here)
1) regressive shale	------->	1) upper shale
2) regressive carbonate	------->	2) upper limestone
3) marine shale	------->	3) lower shale
4) transgressive unit	------->	4) lower limestone

Watney (1980) previously defined these lithofacies in the northern portion of the study area. His description of the vertical section and the genetic interpretations form the basis for interpretations of this study (Table 4). The lower carbonate unit overlies and is sharply separated from the underlying cyclothem. This unit grades upward into the lower shale. The upper shale generally overlies the upper carbonate with a sharp contact (Table 3 and 4). The four cyclothems reported on in this investigation vary little from this succession although there is some diversity of lithofacies in various divisions of the the study area: north, west central, southwest, and over the CKU (Table 5). Plate 1 illustrates the facies succession of selected cores from each of the four cyclothems.

The detailed variation within a lithofacies is of additional interest and includes differences in the skeletal composition and abundance, grain types, and nature of porosity development in the upper carbonates. The four lithofacies components of the cyclothem

Table 4. Description and Interpretation of Facies Comprising the Typical Sedimentary Cycle, which is the Basis for the Interpretation Presented in the Text.

Descriptive Facies	Thickness (Ft.)	Lithology	Diagenetic Alternation	Facies Contacts	Genetic Facies	Depositional Environment
Upper Shale	0-30, thicker to north	Red-brown, gray unbedded silty shale	intense		Regressive shale	Commonly oxidized, continental clastics
				S		
Upper (upper)	1-15	Lime-mudstone to grainstone common; occ. dolomitic; sparsely to very fossiliferous	moderate to intense		Regressive Carbonate	Shallow, clear-water carbonate; tidal flat, lagoon, and open marine; high and low energy
Carbonate (lower)	5-25	Lime-mudstone or wackestone argillaceous at bottom; fossiliferous				Subtidal, low-energy, clear-water, open-marine carbonate grading downward to alternately turbid and clear-water carbonate
				G		
Lower Shale	2-20, commonly 2-6, up to 20 in north	Fossiliferous, gray-green; black	minimal		Marine Shale	Subtidal, low energy, marine; restricted, anoxic conditions prevalent to south and to north locally shallow water
				G		
Lower Carbonate (upper)	0-15, commonly 0-5	Wackestone, occ. lime-mudstone, diversely fossiliferous	minimal to locally moderate		Transgressive Carbonate	Subtidal, low energy, open marine; clear to turbid water conditions
(lower)	0-8, commonly 0-1	Silty grainstone to packstone; occ. wackestone, occ. base rich in quartz sand or silt				Sandy or silty reworked shoal water, intermittent restricted to open marine
				S		

S = Sharp Contact
G = Gradational Contact

Table 5. General Lithofacies Components of the Kansas City Group Cyclothem in Kansas

LITHOFACIES	NORTH	CKU
Upper (Regressive) Shale	Red-brown (oxidized) siltstone with soil characteristics; greatest thickness along northwest boundary of study area	Unfossiliferous silty shale; gray, green (reduced) on south end of uplift; oxidized to reduced on north end (Cambridge Arch); thinner, locally missing over uplift.
	WEST CENTRAL	**SOUTHWEST**
	Reduced, oxidized on northern portion; unfossiliferous to locally restricted, shallow-water fauna to south commonly very thin to missing in southern reaches	reduced, sparsely fossiliferous to unfossilif., absent in many areas or extremely thin i.e., difficult to map using wireline logs; most cyclothems contain sparce indications of soil fm.
	NORTH	**CKU**
Upper (Regressive) Limestone	Regional thinning to north; lower interval commonly shalier and more silty to north; siltier in upper interval; top locally eroded and more heavily weathered northward, secondary porosity more important; limited coated grains and thin interval of grainstones; shaley intervals in lower portion are light color tones	Thin over uplift, areas of extreme thinning; evidence of weathering very apparent across uplift; secondary porosity important reservoir parameter; cleaner carbonate overall in southern area; light colored carbonates are rule; locally very thin or missing subtidal quiet-water carbonate with diverse fossils

LITHOFACIES	WEST CENTRAL	SOUTHWEST
Upper (Regressive) Carbonate	Gradual thickening to south; local thickening due to biohern or grainstone accumulation or combination; well-developed subtidal, open marine ls. with lt. colored micrite; shalier to north; oolitic shoal-water grainstones more significant to south; generally thicker, more extensive grainstones, but still isolated patches; E-W trend of shoal carbonate north, N-S trend south with E-W minor trend in oolite tract; more subtle effects of weathering to south	Relatively dark-colored lower interval of open-marine carbonates with more abundant organic-matter macerals preserved in this relatively thick subtidal portion; more chert replacement; extensive thick oolite developed as large sheet-like lobes that cover area, N-S lobes with E-W elongated fingers, major trends commonly consist of series of N-S lobes running NW-SE

	NORTH	CKU
Lower (Marine) Shale	Silty, calcareous, gray or green shale commonly oxidized to maroon color; brachiopods and crinoids common; restricted facies with pelecypods and ostracodes associated with limestone nodules including layers of silty grainstone; interval thickens northward to more than 20 feet (6 m)	Gray-green to black color; black shale is hard with concoidal and platey fractures; sparce fossils include conodonts, fish scales, orbiculoid brachiopods; gray-green shale contains predominately brachiopods; thickness varies from zero to several feet

LITHOFACIES	WEST CENTRAL	SOUTHWEST
Lower (Marine) Shale	As in area of CKU except is thicker; consistent thickness of several feet	Dark-gray to black shales are the rule outside of the extreme southwestern area of study where unit becomes abruptly thicker, siltier, and contains more diverse fossils
	NORTH	CKU
Lower (Transgressive) Limestone	Thin, laterally extensive, (good marker bed to denote lower boundary of cycle) coated (Osagia grainstone-packstone with diverse fossil assemblage; locally carbonate buildup as mud mound (phylloid algae) or oolitic shoal; moderate to very silty at the base with local sandstone and conglomerate development (localized reservoir play); base is erosional	Thin, extensive, silty to sandy grainstone to packstone commonly with Osagia at base; conglomeratic at base; persists even when marine shale is missing; base is erosional
	WEST CENTRAL	SOUTHWEST
	As in north	Generally slightly thicker than to north; darker gray-brown with diverse fossils in silty wackestone to packstone; preserved flecks organic matter; clean intervals with phylloid algae; base less distinctly erosional although hiatus is noted.

will be reviewed beginning with the lower carbonate at the bottom of the cyclothem DuBois (1979), Watney (1980), and Prather (1981) described the facies variation in these cyclothems in the northern portion of the present study area. First, observations will be provided with reference to specific zones and cores with the aid of four maps locating representative cores from each interval (Plate 1). Next, a summary of the interpretation of the depositional environments represented by each lithofacies and the diagenesis will be presented.

The wireline-log signature of each lithofacies is quite similar from cyclothem to cyclothem as illustrated by a gamma ray-neutron log (Fig. 1.4).

Lower (Transgressive) Carbonate

This basal lithofacies of the cyclothem is generally less than 5 feet (1.5 m) thick, and its lithologic succession is quite constant. This thin unit can be correlated over long distances on wireline logs. The lower contact is sharp and commonly is distinctly erosional, although erosional relief is insignificant and can only be identified in cores. The lowest portion is commonly slightly restricted to diversely fossiliferous packstone or grainstone or a thin layer of quartz sandstone or siltstone that grades upward to a diversely fossiliferous and increasingly argillaceous wackestone (Table 6, Fig. 3.4, Fig. 3.5, Fig. 3.6). The upper contact with the lower shale is gradational, but the gradation occurs over only a few centimeters. The lower carbonate progresses rapidly from a lagoonal (or shallow

Table 6. Examples of Lower Contact and Composition of Basal Portion of Lower Carbonate. (Cores identified in Figure 1.2 and Plate 1)

A. Lithoclastic grainstone with clasts of caliche and darkened, corroded clasts of micrite incorporated from underlying unit (on the CKU)

1. J-Zone Gore #4 Findley, Sec. 23-11s-21w
2. J-Zone Conoco #11 Ainsworth, Sec. 25-18s-8w

B. As in A with a basal calcareous sandstone facies (on the CKU)

1. H-Zone Empire #B-2 Reidel, Sec. 31-9s-24w
2. H-Zone Pan American #B-6 Ohlson, Sec. 28-14s-14w
3. J-Zone Clinton #D-2 Stegman, Sec. 11-16s-17w

C. Prominent basal conglomerate (on the CKU)

1. H-Zone Stanolind #3 Denker, Sec. 10-22s-12w

D. Chert, carbonate, quartz pebble or boulder conglomerate (on the CKU)

1. K-Zone Pan American #B-6 Ohlson, Sec. 28-14s-14w

E. Quartz-siltstone-rich carbonate grainstone and packstone with composite intraclasts of oolite grains and chips of wood (on the southwest shelf)

1. J-Zone Gary #21-5 Scheufler, Sec. 21-33s-20w

F. Limited reworking with burrows filled with quartz siltstone in an intraclastic packstone; sharp basal contact (on the southwest shelf)

1. J-Zone Cities Service #C-2 Blair, Sec. 29-30s-33w

G. Noticeable erosional scouring with lag conglomerate at the base of quartz siltstone and sandstone containing lithoclasts of mudstone and caliche (southwest positive area)

1. G- and H-Zones Tideway #1 Beachamp, Sec. 19-30s-40w

Note: H-Zone in southwestern Nebraska has a pronounced erosional base (DuBois, 1979).

Figure 3.4. Photomicrographs and slab photos of lithoclastic grainstones with clasts of caliche and darkened, corroded clasts of micrite (on the CKU).

A. Gore #4 Findley, 3742.5 feet. Slab photograph of sharp basal contact of J-Zone lower carbonate (tan lithoclastic, bioclastic, diversely fossiliferous, osagid (Henbest, 1963), oncoidal, silty packstone) resting on green to red-brown mottled unfossiliferous calcareous siltstone of the K-Zone. Contact with irregular centimeter-sized relief truncating microcrystalline calcite nodules in siltstone. Inch scale on right margin.

B. Photomicrograph of Gore #4 Findley, 3742.5 feet. Photo straddles sharp contact (a) that crosses core diagonally. Beneath is clotted, microcrystalline calcite which is cut by discontinuous, irregular, calcite-spar filled fractures. Some fractures surround areas of more dense or pure calcite and resemble circumgranular cracks of Wilson (1975). Silty fossiliferous packstone overlies this siltstone in erosional contact. Lithoclasts of carbonate rock have same microfabric as underlying calcareous nodules in siltstone. Bar scale represents one millimeter. Plane-polarized light.

C. Slab photograph of Clinton #2-D Stegman, 3425 feet. Dark green fossiliferous shale of basal portion of the lower unit of J-Zone sharply overlying light-green, unfossiliferous soft regressive shale of the upper shale of the K-Zone. Lower portion of the shale contains embayed, darkened carbonate clasts as seen in photograph. This shale is only 4 centimeters thick resting on the surface of a subaerial crust of the upper carbonate. Lithoclasts are probably derived from this exposed carbonate rock. Darker fossiliferous upper shale is only a centimeter in thickness with a coquina of shell fragments at its base which form a packstone of the lower carbonate. Bar scale is in centimeters.

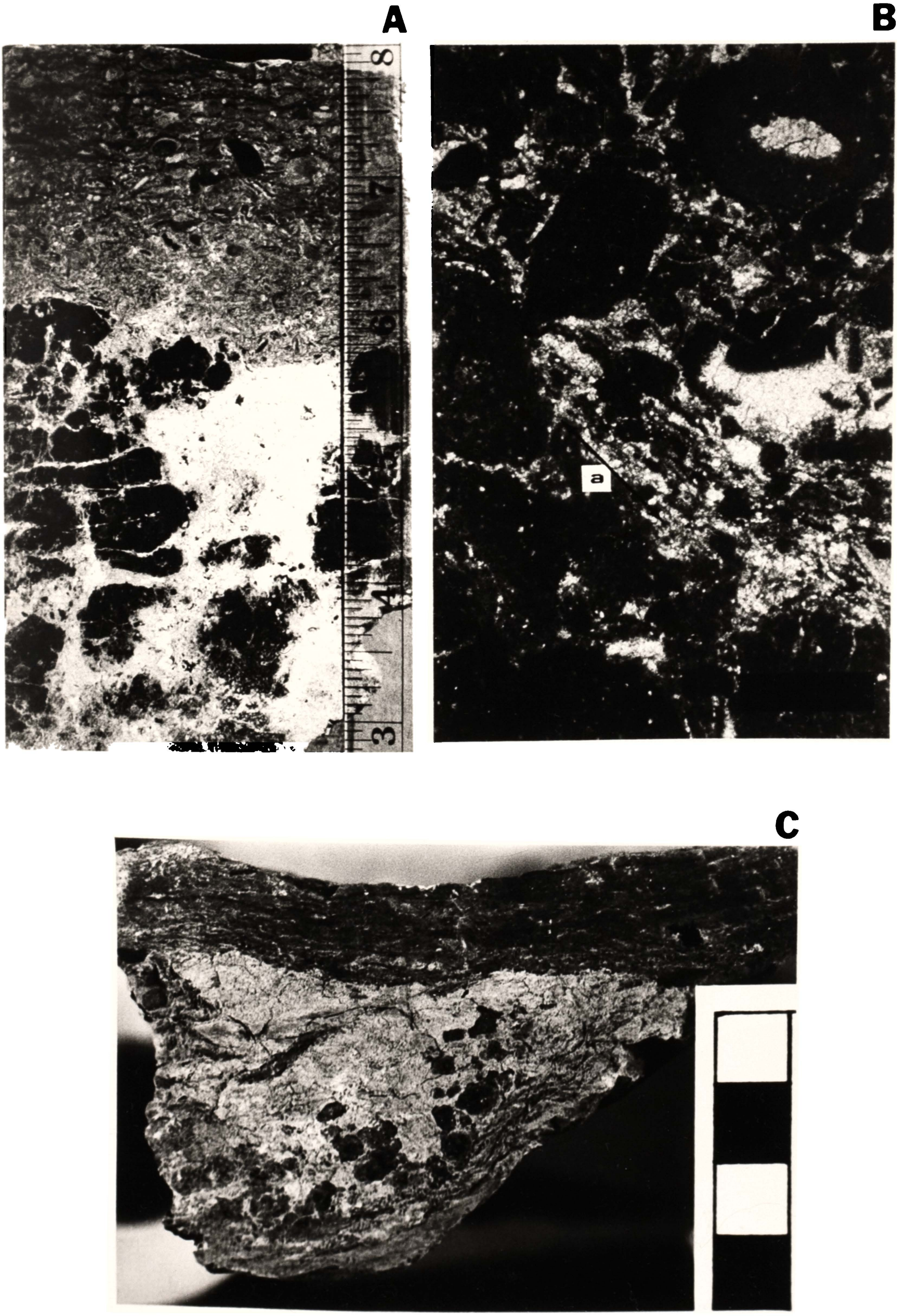

A
B
a
C

Figure 3.5. (Cont. from Figure 3.4).

A. Slab photograph from Clinton #2-D Stegman, 3742.5 feet. Base of the K-Zone contains corroded (fritted edges), darkened-carbonate lithoclasts in green silty shale rapidly grading downward to silty, burrowed, osagid (Henbest, 1963), bioclastic packstone of lower carbonate. Immediately under this unit is a subaerial crust of the L-Zone. Bar scale is in centimeters.

B. Slab photograph of Conoco #11 Ainsworth, 2986 feet. Base of J-Zone lower carbonate. Dark-gray, silty shale containing varied-sized lithoclasts of dense, gray, mottled unfossiliferous lime mudstone. Fossils increase upward for another centimeter in the darker shale of the J-Zone to where it grades rapidly into a diversely fossiliferous wackestone. Underlying upper shale containing larger, more abundant limestone clasts in lighter-colored matrix is assigned to the K-Zone. Lithoclastic conglomerate of K-Zone rests on five feet of oolitic grainstone of the underlying upper carbonate, a lithology not represented among the clasts. Bar scale is in centimeters.

C. Photomicrograph of Empire #B-2 Reidel, 3977.8 feet. Near base of lower carbonate of H-Zone. Silty, light brown wackestone that grades upward into a heavily-burrowed, green, silty fusulinid packstone to grainstone. A few lithoclasts of dense brown microcrystalline dolomite are slightly silty and contain circular voids surrounded by a halo of very dense, more pure carbonate (pedotubules). Particles resemble nodular carbonate bodies (caliche) in underlying regressive shale of I-Zone. Clasts were probably derived from erosion of this underlying shale. Bar scale is in millimeters. Plane-polarized light.

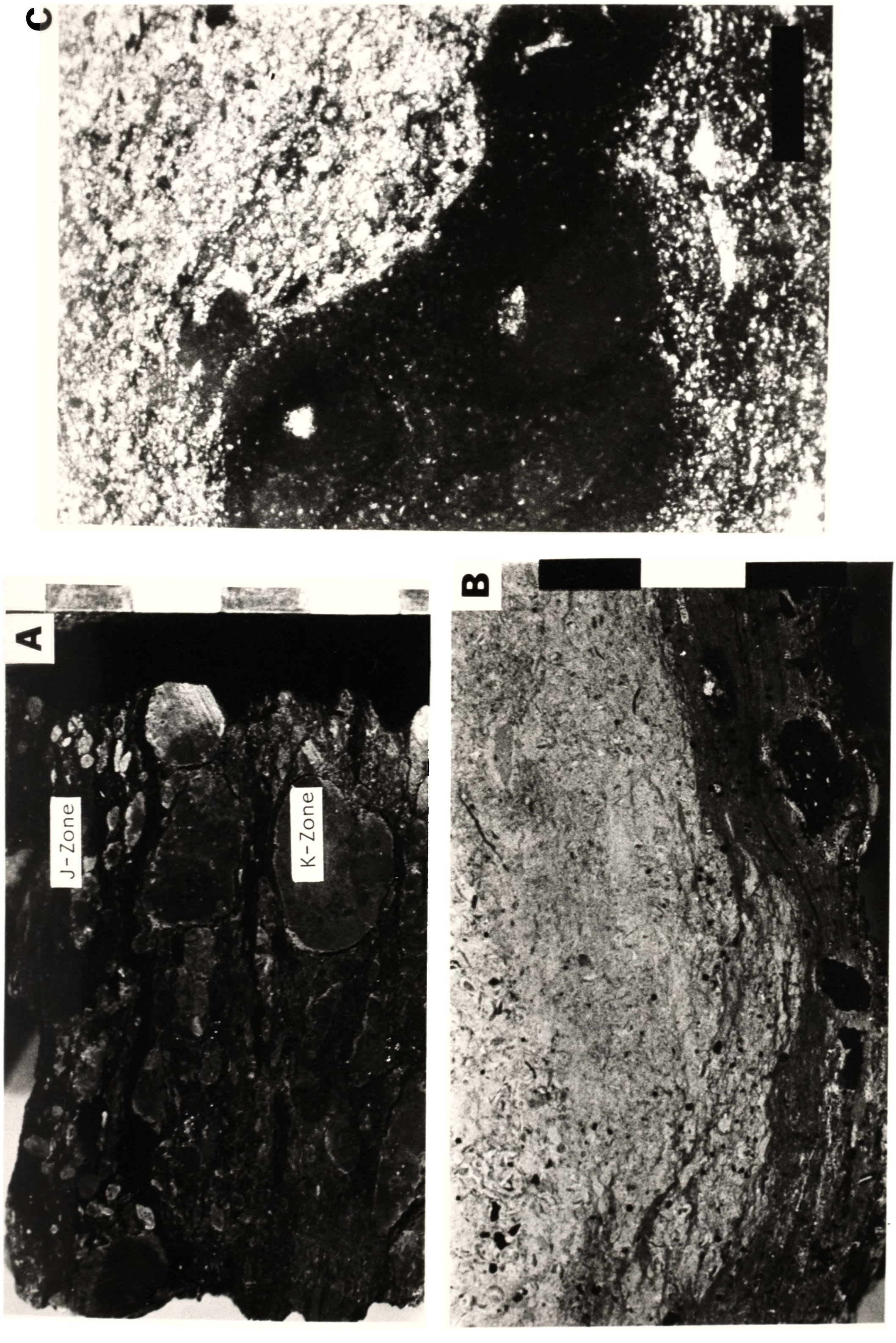

C
A
J-Zone
K-Zone
B

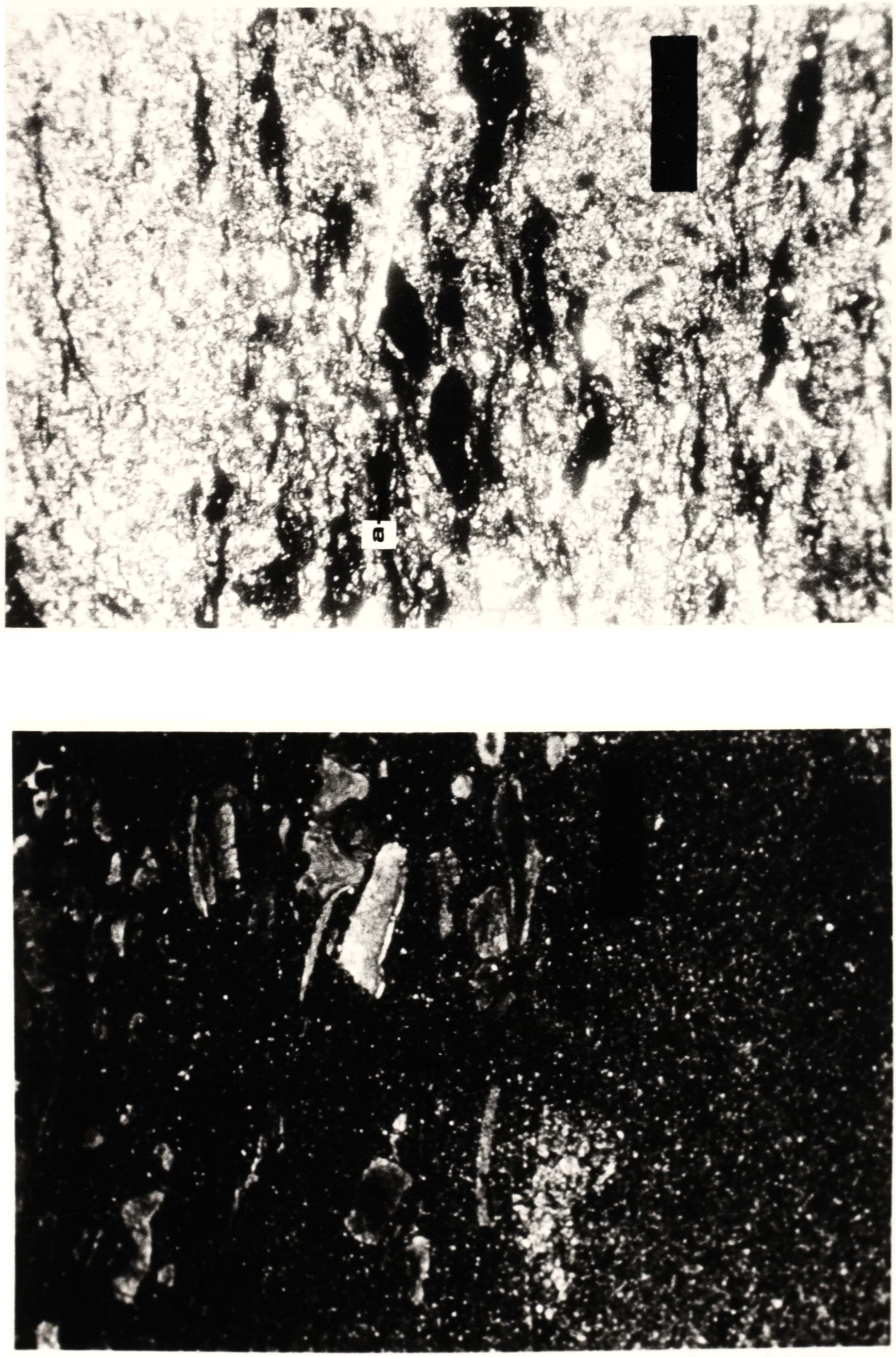
Figure 3.6. Photomicrographs of silty basal portion of the lower carbonate in southern area of investigation.

A. Photomicrograph from Cities Service #C-2 Blair, 4562 feet, base of J-Zone. Subtle but rapid transition upwards from unfossiliferous, dolomitic siltstone to bioclastic, crinoid, brachiopod-rich siltstone (a). Grades rapidly upwards into a pelmatozoan, molluscan, tubular-foraminiferal packstone (b) with silt-free, non-dolomitic micrite matrix. Evidence of erosion at base of zone is equivocal. Bar scale is one millimeter. Plane-polarized light.

B. Photomicrograph from KRM #2-X Lemon, 4779 feet, base of J-Zone. Quartz silt in argillaceous micrite containing small brachiopods and scattered bivalves. Lenticular wisps and stringers (a) are slightly translucent and deep red. Perhaps this material is organic matter. Bar scale is one millimeter. Plane-polarized light.

B

A



b a

subtidal to low intertidal) up into a subtidal deposit. Toomey (1969, 1972) described in detail the biota of a lower limestone (Leavenworth) from eastern Kansas.

Observations are similar among the four cyclothems described in this investigation. The bases of the lower carbonates of the cyclothems examined on the northern shelf and the positive areas including the CKU-CA and southwestern positive area all lie on an eroded surface. Individual cores that contain more than one cyclothem show evidence of this erosion. Minor thinning or truncation of underlying units is suggested; e.g. each of the lower carbonates of the four cyclothems in the Stanolind #3 Denker (Sec. 10-22s-12w) rests within inches of the underlying upper carbonate without intervening upper shale or with only a very thin shale.

Sandstones and conglomerates at the base of many cyclothems were derived from scouring and selective sorting of the underlying upper shale. Quartz sandstone locally exceeds five feet (1.5 m) in thickness at the base of the lower carbonates. The sandstone and siltstone in the G, H, and I-Zones, for example, are important components in these cyclothems in the extreme southwestern part of the study area. In Cheyenne County in northwestern Kansas, the basal portion of the J-Zone is locally a coarsening-upward silty sandstone exceeding 10 feet (3 m) in thickness. It serves as an oil reservoir in the Northrup field in Sec. 26-2s-42w. Core is available from a similar deposit at the base of the A-Zone in Cahoj field, Rawlins County in the #1 Bartosovsky well in Sec. 9-1s-34w. Quartz siltstone coarsens upward to silty sandstone capped by a thin coquina of brachiopods and crinoids. This succession of facies is commmon in marine bar deposits (Reading, 1978).

The basal portion of the lower carbonate is oolitic in the I-Zone in Cities Service #D-2 Conover in Sec. 31-30-33w. Hopkins (1977) described in detail a thick local accumulation of oolite at the base of the A-Zone in the Lansing Group in the Wilson Creek field, Ellsworth County. Thirty feet (9 m) of oolite accumulated over a paleohigh located on an upthrown block of the prominent Ellsworth fault.

Depositional Environment of the Lower Carbonate

The wide areal extent of this thin carbonate unit is striking. Its thickness:length ratio exceeds 5 x 10^5. Such thin but widespread marine deposits overlying a generally nonmarine clastic unit suggest a rapid inundation of the shelf. The transgression apparently was of short duration while affecting large areas of the shelf suggesting that either shelf-wide subsidence or eustatic sea level rise occurred bringing the sea back onto the shelf.

Thin basal deposits of quartz silt and sand, darkened carbonate grains and clasts, and locally very fine-grained, dark-gray to black, microcrystalline peloids suggest selective sorting in shallow water with limited sedimentation during the initial inundation of the shelf. With inundation of the coastline, terrigenous sediments would have been trapped in estuaries. Occasional storms could then rework sediment on the shelf. Some sediments were apparently eroded; rounded clasts of caliche similar to that found in the underlying unit are the most direct evidence.

The upper contact with the lower shale is nearly as sharp and in the outcrop is strikingly planar. Two explanations are possible for the rapid transition of the lower carbonate to the lower shale: 1) clastic influx that overwhelmed carbonate sedimentation, or 2) major deviations in the physical or chemical conditions such as modifications in salinity, water temperature, sunlight, or nutrients sufficient to sustain carbonate-producing biota.

The common occurrence of blue-green algally coated grains in the lower portion of this deposit suggest a shallow, sunlit seafloor affected by moderate current action. High-spired cerithid gastropods possibly denote a shallow, restricted lagoon. Oncolites common to the lower portion of the lower carbonate imply specifically low-intertidal and shallow-subtidal environments (Ginsburg et al, 1971) and possibly restricted-marine bay or lagoon (Wilson, 1975).

The transition within the lower carbonate to subtidal deposits with a diverse assemblage of fossils is abrupt. Whole brachiopods, crinoid ossicles, bryozoa, fusulinids, and other foraminifera are the dominant fauna in these wackestones. Phylloid algae are common, but buildups are unusual. Core and wireline logs from the E-Zone lower carbonate in the Lansing Group show evidence of a phylloid algal micritic bioherm that measures 20 miles (32 km) by 6 miles (10 km) (Watney, 1980, Figure 57).

Evidence for deepening water during deposition of the lower carbonate has resulted in its classification as the transgressive carbonate of the cyclothem (Table 3, 4)

<u>Diagenesis of Lower Carbonate</u>

Well-preserved depositional textures and skeletal grains are the rule. Generally this carbonate was protected from the invasion of fresher waters by a barrier to flow produced by the overlying marine shale (Heckel, 1983). Consequently, carbonate rock of the lower carbonate has generally undergone slow grain-to-grain compaction in the absence of early cementation. Moreover, unstable grains have undergone neomorphism in the absence of leaching as described by Heckel (1983). Railsback (1984) also observed that the lower carbonate in the Dennis Limestone was least affected by freshwater diagenesis.

Finely crystalline pyrite commonly replaces both micritic matrix and carbonate particles, particularly those that are encrusted by blue-green algal rinds in the lower carbonate. The darkening so produced can affect the entire unit even the lowest portions which were deposited in clear-water, oxidizing, turbid environments. The precipitation of pyrite may have occurred shortly after deposition. Other zones with dark, opaque flecks of organic matter also suggest that oxygen levels were low within the sediment during its accumulation (Fig. 3.6 B). Textural selectivity of the pyritization and preservation of organic matter suggest that reducing conditions prevailed just beneath the sediment-water interface. The organic matter associated with blue-green algal grain coatings, so common to the interval may have provided a favorable reducing substrate for precipitation of pyrite, perhaps assisted by sulfate-reducing bacteria (Berner, 1971). The very fine pore structure would tend to sustain microenvironments of low dissolved oxygen.

Other evidence of early diagenesis includes the patchy recrystallization of grains and micrite. Micrite is altered to brown, microcrystalline or microgranular calcite or dolomite spar. Collapse and fracturing of the matrix and skeletal grains is not unusual where dissolution occurs, particularly in phylloid-algae-bearing wackestones (Ebanks and Watney, in press). Void-filling cements of these secondary pores consist of irregularly distributed fine to coarse-sized, scalenohedral calcite spar. Early dissolution and recrystallization of the limestone is likely to have resulted from adjustment to circulating undersaturated waters. Such diagenesis, however, is not common in this unit.

Lower Shale

The thin lower shale that overlies the lower carbonate (Table 5) is a very important and rather controversial lithofacies of the cyclothem. In western Kansas the lower shales vary from green or olive to gray-green, massive, silty or clay-rich to gray and black, carbonaceous, fissle clay shales, very similar to rocks in the outcrop to the east. The black shale is most commonly separated from the adjacent carbonate rocks by at least a very thin gray shale. The gray and green facies are fossiliferous, containing predominately open marine, benthonic organisms. The black shales in contrast contain predominately nektonic and nektobenthonic organisms with few if any benthonic organisms and abundant pelagic forms according to Boardman et al. (1984). The unusual abundances of fauna such as conodonts and fish debris and lack of common marine invertebrates in most of these black shales has provoked numerous and contrasting explainations for this occurrence. Millimeter- to centimeter-sized horizontal burrows are commonly associated with green and gray facies. The abundance of macerated fossil debris in some backfilled burrows and commonly scattered benthic invertebrates indicative of a normal marine bottom in the gray shale contrasts with the sparse fauna in the darker gray or black shale. Furthermore, the presence of nonskeletal phosphorite, pyrite, large amounts of finely comminuted organic matter, and trace metals in elevated concentrations is well documented (Heckel, 1977; Cubitt, 1977; Watney, 1979; Malinky, 1982; Boardman etal, 1984).

Boardman et al. (1984) identified several faunal communities associated with specific lithotopes of the lower shale. The black fissile, clay-rich, phosphate-bearing shale contains *Caneyella* and *Dunbarella* bivalves, ammonoid and nautiloid cephalopods, sharks, conodonts, radiolarians, and conularids. Malinky (1980) has also identified less abundant hyoliths, rostroconchs, possible arthropods, and problematical fossils. Black shales also contain orbiculoid and linguloid brachiopods, and fish remains. Dark-gray to black, nonfissile shales contain the subcommunity Sinuitina-juvenile ammonoid-Anthraconeilo, dominated by juvenile ammonoid cephalopods, bactritoid cephalopods, and Sinuitina (Bellerophontid) gastropods. Dark gray to medium gray, clay-rich lower shales contain the subcommunity Treposspira-mature ammonoid-Anthraconeilo subcommunity.

The Caneyella-Dunbarella-ammonoid-radiolaria community represents pelagic, nektonic, and nektobenthonic organisms. Benthic organisms are absent according to Boardman et al.'s interpretation, because of an anoxic bottom. However, Schram (1984) described four species of benthic arthropods collected from three black shales including the Stark and Hushpuckney shales near Omaha, Nebraska. Also the diversity of the pelagic taxa is highest in this community which was considered by Boardman et al. (1984) to be essentially identical to the deep-water community of the Lamar Limestone of the Delaware basin as reported by Babcock (1977).

The Sinuitina-juvenile ammonoid-Anthraconeilo subcommunity is interpreted to represent dysaerobic bottom waters while the Trepospira-mature ammonoid-Anthraconeilo subcommunity represents more fully oxygenated, normal-salinity, low energy conditions. The maximum diversity of benthic and nektobenthic invertebrates occurs in higher taxonomic levels in the latter subcommunity. The immature taxa in the former subcommunity is explained by Boardman et al. (1984) as due to catastrophic kills caused by periodic depletion of oxygen in the water column. The good preservation of the juvenile ammonoids suggests lack of predation or turbulence, and they are considered autochthonous occurrences.

The green or olive to gray-green shales contain small productid brachiopods, echinoderms, and less commonly bryozoans, corals, molluscs, ostracods, and even fusulinids. The fauna is interpreted as benthonic and open marine.

Boardman et al. (1984) have observed in all cases a lateral succession from the black, fissile, clay-rich shale and its associated faunal community into the dark-gray and gray marine shales around the limits of the deposit in the outcrops examined in Oklahoma and Kansas. They also observed that the black shale, however thin, has the most extensive distribution of all the facies that comprise the cyclothem, even in areas of significant terrigenous influx.

Phosphate nodules are typical of the black shales and range in size from millimeters to centimeters (Kidder, 1982). The presence of this nonskeletal phosphate correlates with the high levels of preservation of organic matter and pyrite.

Phosphate nodules are composed of apatite and generally contain abundant and diverse radiolarians with occasional pelagic megafossils such as nautiloids and fish bones. Detrital material and terrestrial palynomorphs are absent. Kidder (1982) explained the origin of phosphate nodules by precipitation from interstitial water into radiolarian tests resulting in displacment of sediment below the sediment-water interface. He attributed the phosphorous to breakdown of planktonic organisms and fecal material. A terrestrial source for phosphate brought to a marine setting in solution and suspension by rivers may also be possible according to information from modern rivers (Baturin, 1983). Phosphate in modern sediments has also been attributed to dissolution of fish debris (Suess, 1981). The similarity of the Missourian phosphorites to modern ones suggests slow rates of sedimentation (Kidder, 1982; Nodine-Zeller et al, 1979).

Heckel (1977) argued that the phosphate is an indicator of stagnant, anoxic bottom conditions during deposition of black shale. This environment was probably responsible for the early pyritization and general darkening of the underlying transgressive limestone as previously described.

Lower shales thicken along the the northern or landward edge of the study area (Table 7). They commonly thicken northward at the expense of the upper carbonates (DuBois, 1979; Watney, 1979; Plate 1, Watney, 1980). The common dark-colored facies is replaced by generally silty, green calcareous lower shale in southern Nebraska. Similarly, limited information suggests that in extreme southwestern Kansas significant terrigenous clastic influx proceeded concurrently with deposition of the lower shale resulting in silty gray-green facies that replaces the black shale (Table 7).

Portions of the non-black shales may still represent dysaerobic conditions and perhaps deep water (Heckel and Baesemann, 1975; Boardman et al, 1984), but detailed palecological investigations of these shales has not been conducted.

The lower shale is generally on the order of two feet (0.6 m) thick, but in northern Kansas and southern Nebraska, the nonblack marine shale can exceed 20 feet (6 m) in thickness (Watney, 1980). Along the CA-CKU the cored wells reveal another facet of the lateral

Table 7. Facies Relationships of the Lower Shale.

A. Generally thick gray or green lower shale

1. G-Zone in Rawlins County in northwestern Kansas [cross section in Watney (1980), Plate 1] where marine shale thickens toward the north (landward) replacing the lower portion of the upper carbonate.

2. J-Zone in Hitchcock County, Nebraska, contains thick green and gray brachiopod-rich shale with maroon and brown mottling (secondary oxidation) (DuBois, 1979).

3. Tideway #1 Beachamp, Sec. 19-30s-40w (southwest shelf)

   a. H-Zone -- thick, dark gray to dark green fossiliferous argillaceous siltstone and shale with diverse fauna (fenestrate bryozoa, crinoids, brachiopods); unit is coarse grained and thicker than in other areas on southern shelf; basal deposit is caliche-clast carbonate conglomerate

   b. I-Zone -- thin upper carbonate rock underlain by thick gray-green siltstone to fine-grained quartose sandstone; lenses are micritic with abundant, diverse fossils; ripple cross lamination

B. Areas lacking lower shale or with unusually thin but open-marine facies (Central Kansas uplift)

1. H-Zone Pan American #B-6, Sec. 28-14s-14w
0.5 feet (15 cm) green shale with lenses of brachiopod, crinoid, tubular-foraminiferal coquina

2. H-Zone (Same well as in B.1)
0.3 feet (9 cm) of dark-gray shale; high diversity of fossils similar to the underlying limestone

3. H- and I-Zones Stanolind #3 Denker, Sec. 10-22s-12w
0.4 feet (12 cm) and 0.2 feet (6 cm) of soft green shale with lenses of limestone

4. I-Zone (Same well as in B.1)
   no distinct marine shale; basal regressive carbonate is very argillaceous and silty wackestone with diverse fauna (fusulinids, other foraminifera, brachiopods, and crinoids); abraded skeletal grains in silty quartz sandstone matrix at bottom of cyclothem

5. I-Zone Conoco #11 Ainsworth, Sec. 25-18s-8w
   no marine shale

6. K-Zone (Same well as in B.1)
   interlayered thin diversely fossiliferous gray and green shales and thin open-marine wackestones resting on conglomerate and eroded Precambrian surface

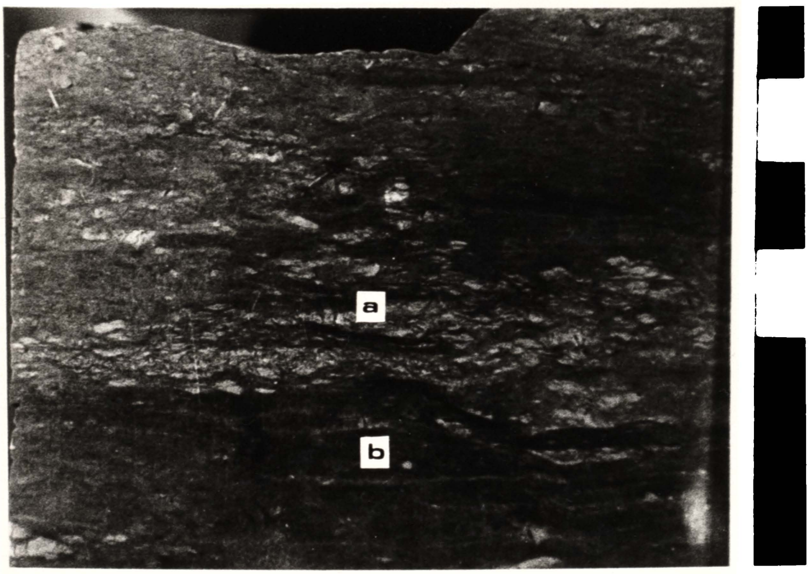
   (Note: marine shale of J-Zone in contrast is thin (0.6 feet or 18 cm), but is dense and black variability of the lower shales. These shales are not present in several areas of this positive feature of the shelf (Plate 1). Shales with thicknesses less than 2 feet (0.6 m) are sometimes not resolved by the wireline logs. The lower part of the upper carbonate can be difficult to discriminate from the lower carbonate in these situations. The lower shales were either eroded or not deposited at various locations on the CA-CKU in all of the four cyclothems. Where they are missing, either the upper carbonate unit lies directly on the lower carbonate or a thin zone of alternating layers and lenses of non-black silty shale and wackestone succeeds the transgressive unit. Several examples illustrating associated changes in the lower portion of the upper carbonate when the lower shale is missing or poorly developed are found in Figures 3.7 and 3.8.

Figure 3.7. Photomicrographs and slab photographs of lowermost portion of the upper carbonate and upper portion of the lower carbonate from areas lacking lower shale or with unusually thin but open-marine facies.

A. Gore #4 Findley, 3741 feet, base of J-Zone regressive carbonate. Slab photograph illustrates very silty, green brachiopod, crinoid, fusulinid, molluscan wackestone (a) resting on dark green, silty, brachiopod-bearing shale (b). Contact is gradational between lower marine shale and the regressive carbonate. Silty fossiliferous carbonate is common in this area of the shelf in all zones. Scale bar is divided into centimeters.

B. Conoco #11 Ainsworth, 2984 feet, base of the regressive carbonate of J-Zone. Photomicrograph of brown, burrowed, calcareous siltstone containing mollusc, bryozoan, tubular foraminifera, brachiopod, crinoid, and micritic argillacous matrix. Underlying shale (not shown) is only few centimeters thick without change in abundance of fossils. Lower carbonate rests on upper carbonate of K-Zone which is silty and is similarly composed of fossiliferous light brownish-gray wackestone. Bar scale represents one millimeter. Plane-polarized light.

A



B

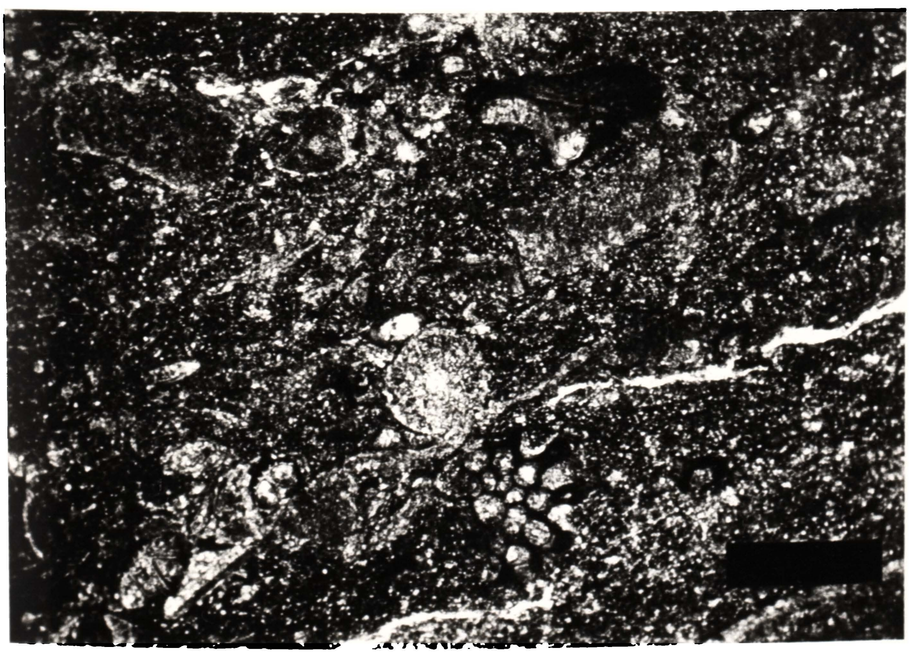
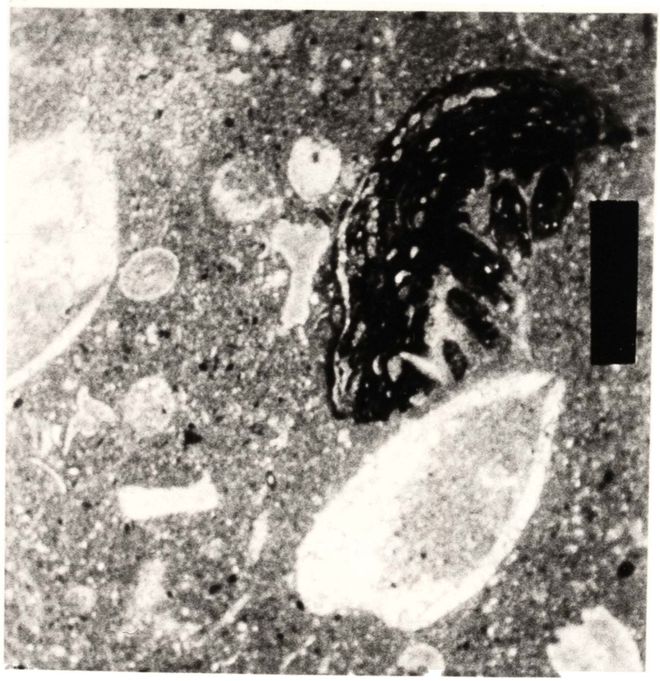


Figure 3.8. Lowermost portion of upper carbonate and upper portion of lower carbonate from areas lacking marine shale or with unusually thin but open marine facies continued from Figure 3.7. Photomicrographs in plane-polarized light, 1 mm scale.

A. Pan American #B-6 Ohlson, 3130.5 feet, base of I-Zone and base of upper carbonate. Photomicrograph of gray-green quartz siltstone containing a very calcareous, argillaceous matrix with scattered small bivalves and foraminifera. Intermittent layers contain more micrite matrix and fossils. Underlying or overlying fossiliferous marine shale is lacking. Unit rests sharply on gray-green, soft, unfossiliferous shale which grades downward to red-brown shale interpreted as upper shale of the K-Zone.

B. Tideway #1 Beauchamp, 3974 feet, lower I-Zone. Photomicrograph of green, silty, brachiopod, bryozoan, crinoid, mollusc, encrusting foraminifera (osagia) wackestone from limestone lens in interval of quartz siltstone which dominates middle portion of I-Zone.

B



A

Depositional Environment--Lower Shale

The lower shale, although normally thin, represents depositional conditions notably different from the adjacent transgressive and regressive carbonates. It represents the lowest energy and probably deepest water conditions of the cyclothems (Table 4). The shale commonly reflects restricted, anoxic conditions, distinctly different from those that controlled the deposition of the adjacent carbonates (Table 5). The lowest energy and most open-marine conditions represented by the adjacent carbonate rock units produce a nearly symmetrical facies distribution.

The open-marine, low-energy subtidal environment of the lower carbonate frequently became increasingly muddy during deposition of the top of the unit yet the onset of lower shale deposition was apparently rather rapid. The contact between these two units is sharp. The environment during the accumulation of lower shale was a low energy, subtidal setting over almost all of the area of study and throughout the area extending to the outcrop belt. The result was the slow accumulation of predominantly clay-sized particles of terrigenous detritus. Paleobathymetric highs along the CKU, the southwestern Kansas positive area, and southwestern Nebraska were exceptions. There mixed carbonate-clastic facies were deposited.

The gray or greenish-tinted shale facies of the lower shale rests on the lower carbonate. In many places on the shelf this facies is very thin and is succeeded by the dark gray to black facies. The question of the water depth during the accumulation of this very extensive black facies remains open. Elevated concentrations of trace elements, organic matter, and phosphorite with an unusual faunal assemblage suggest slow accumulation of the shale under anoxic conditions, perhaps in relatively deep water. This also suggests that the bottom was generally uninhabitable for invertebrates and higher forms of animal life. Schram (1984) concluded, for example, that the arthropods were deeper-water marine forms and were incorporated in this sediment as catrastrophic kills probably occurring during fluctuating anoxic bottom-water conditions. The diminished thickness of the shale and the frequent loss of the black shale facies over the CKU suggest that shallower water conditions may have prevailed in this localized area. Moreover, the black facies grades into thicker open-marine shales on the northern shelf (Table 7). Also on the extreme southwestern shelf the lower shale has a very silty matrix with diverse fossils including abundant benthic forms. These facies relationships support the hypothesis that the black shale represents the deeper water phase that accumulated more distant from sources of active terrigenous clastic influx and under slower rates of deposition.

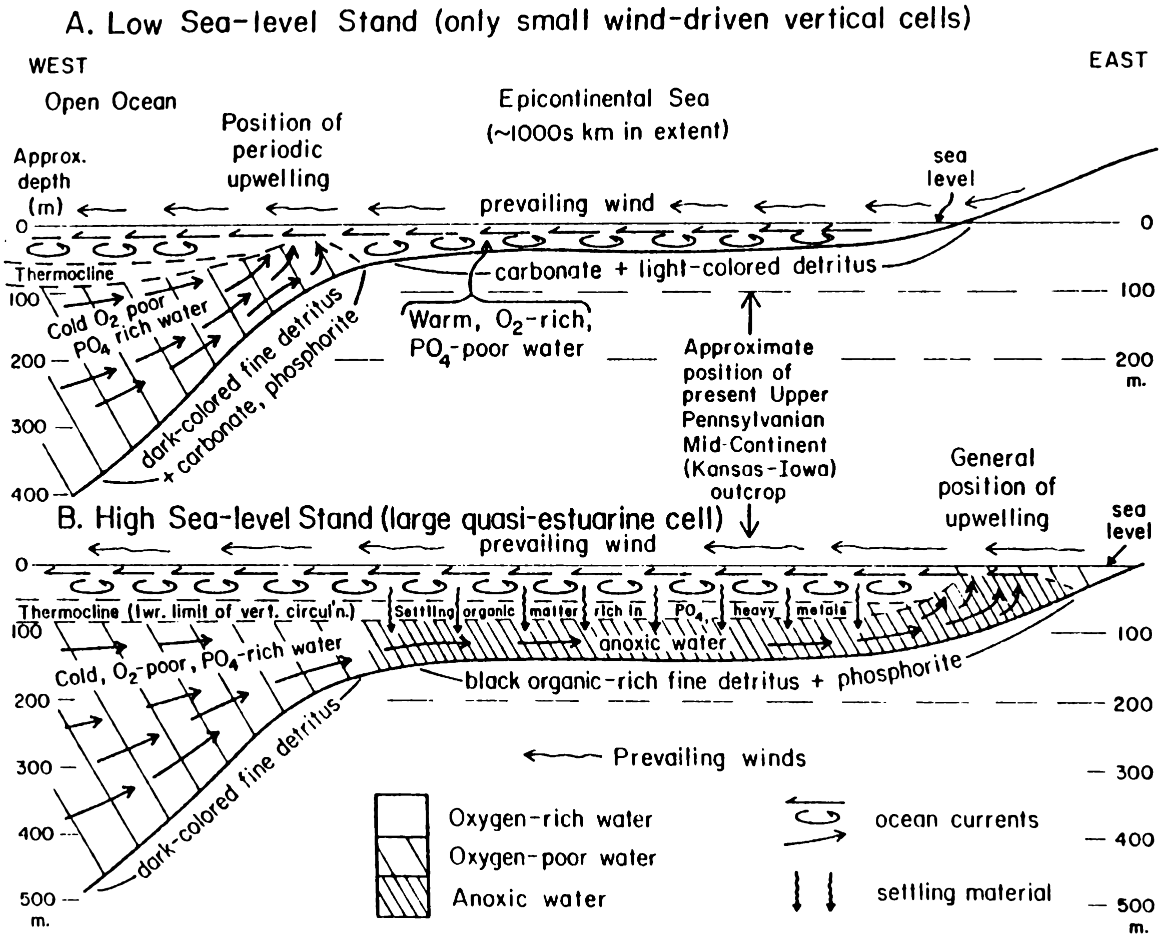
Evidence of slow sedimentation during the accumulation of Midcontinent black shales is abundant. The common abundance of phosphate in black shales, the concentrations of generally sparse fossils such as conodonts and fish debris, and the concentration of organic matter suggest that sedimentation rates were reduced (Heckel, 1977, 1980). Evans (1967) also suggested that the black shale represents a major diastem developed during high sea level. The Excello Shale, a widespread, black, fissile marker at the top of the Cherokee Group, is composed of horizontally oriented clay mineral plates lying in face-to-face contact (James, 1970). This unusually high degree of orientation is common to this facies and perhaps suggests slower rates of sedimentation. Potter, Maynard, and Pryor (1980) would classify this shale as having parallel horizontal bedding resulting from episodic suspension sedimentation in still water in the absence of bioturbation. Reineck and Singh (1975) attributed parallel orientation of clay minerals to single grain sedimentation. Commonly when the clay particles carried by rivers mix with sea water the particles are destabilized by the compression of the double water layer around each particle. If the concentration of particles is great enough they collide to produce flocs or aggregates of hundreds of essentially random-oriented particles (Gibbs, 1983). Low concentrations of particles or perhaps a film of organic matter could limit the formation of flocs resulting in a high degree of horizontal orientation. Compaction and post-depositional diagenesis including recrystallization of the clay minerals would be expected to affect the orientation observed. However, overburden pressure alone has not been found to be sufficient to orient clay flakes from an originally flocculated condition. There is no consistent correlation between fissility of shale and burial depth.

The upper, gray and green-tinted facies of the lower shale always grades, albeit rapidly, into the regressive carbonate. These nonblack shales represent a transition from anoxic bottom waters through dysaerobic to normal-marine conditions (Malinky, 1980).

Epeiric seas present problems in models for generating widespread black shale. The model proposed by Heckel (1977) requires upwelling of nutrient-rich cold waters from adjacent oceans onto the craton and transportation of these waters across the craton with wind-driven quasi-estuarine circulation (Figs. 3.9 and 3.10). Cook and McElhinny (1979), moreover, concluded that although upwelling can be a viable mechanism for black shales and phosphorite deposited at continental margins adjacent to deep oceans, it is not an appropriate mechanism for generating anoxia over extensive cratonic seas.

Parrish (1982) has suggested that there may be alternatives to Heckel's model because of variations of the surface winds not considered by Heckel. Parrish (1982) suggested that ancient atmospheric circulation controlled by the configuration and location of continents determines the location of upwelling. In the northern hemisphere oceanic upwelling can occur along a coast with a wind blowing parallel to the coast with the coast at the left. The Coriolis effect deflects the topmost layers of water to the right. The net transport of water is then offshore resulting in bottom waters moving shoreward (opposite) to replace the surface waters, a movement called Ekman transport. Parrish suggested that as sealevel rises upwelling and the oxygen-minimum zone may spread unto the craton. Furthermore, a shallow shelf gradient may result in upwelling removed from the geographic shoreline with an extensive anoxic

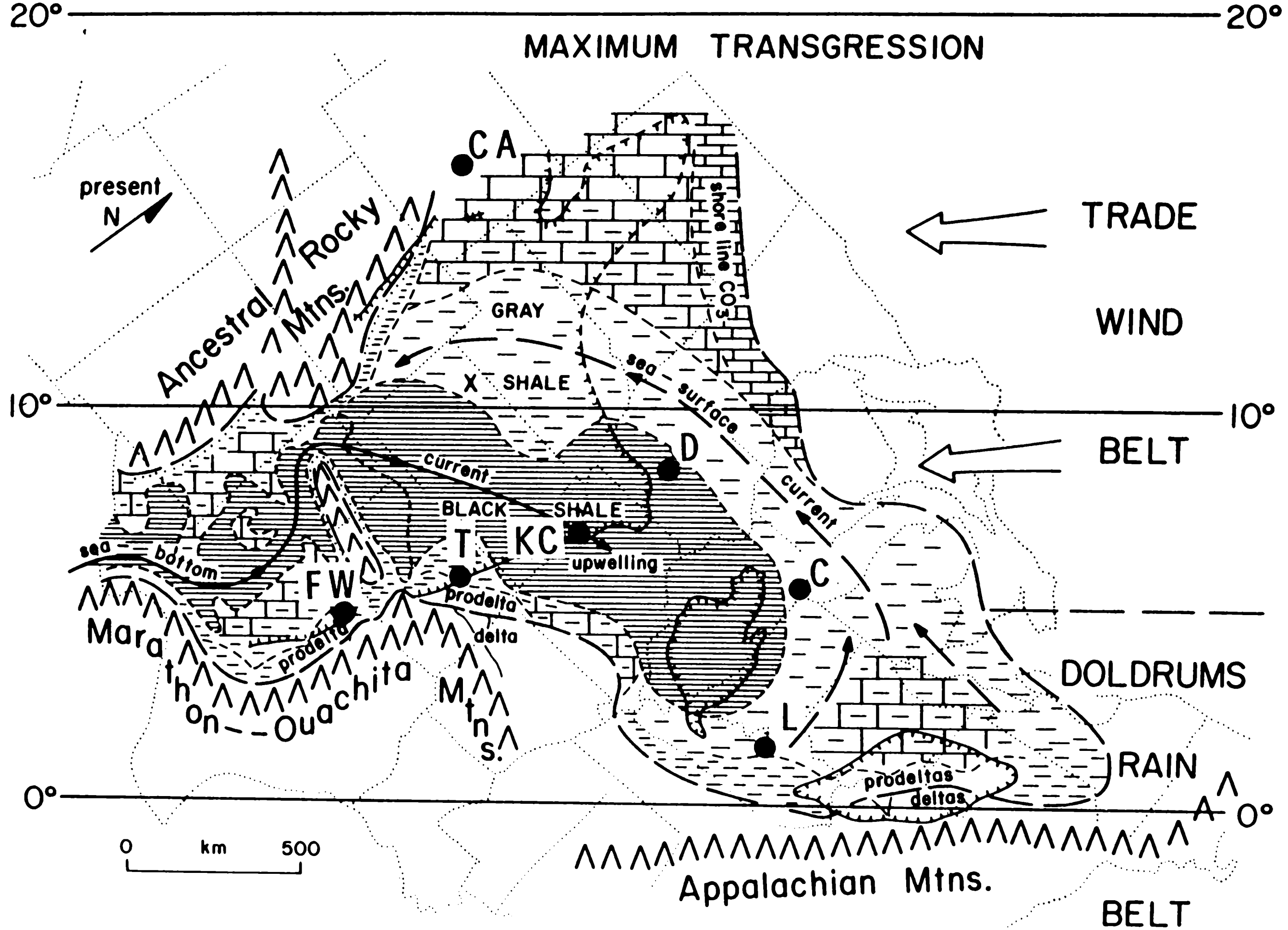
Figure 3.9. Heckel's (1977) model for generation of anoxic bottom waters on a west-facing tropical epicontinental sea during highstand of sea level (bottom) compared to that during low stand in sea level (top). Large quasi-estuarine circulation cells (Brongersma-Sanders, 1972) and resultant upwelling were established due to the prevailing westerly surface winds during high stand. A thermocline results in depletion of bottom oxygen and concentration of phosphate.



A. Low Sea-level Stand (only small wind-driven vertical cells)
WEST
EAST
Open Ocean
Epicontinental Sea
(~1000s km in extent)
Position of
periodic
upwelling
Approx.
depth
(m)
sea
level
prevailing wind
0
100
200
300
400
0
100
200
m.
Thermocline
Cold O_2 poor
PO_4 rich water
carbonate + light-colored detritus
Warm, O_2-rich,
PO_4-poor water
dark-colored fine detritus
+ carbonate, phosphorite
Approximate
position of
present Upper
Pennsylvanian
Mid-Continent
(Kansas-Iowa)
outcrop
General
position of
upwelling
B. High Sea-level Stand (large quasi-estuarine cell)
sea
level
prevailing wind
0
100
200
300
400
500
m.
Thermocline (lwr. limit of vert. circul'n.)
Settling organic matter rich in PO_4, heavy metals
anoxic water
Cold, O_2-poor, PO_4-rich water
black organic-rich fine detritus + phosphorite
dark-colored fine detritus
100
200
300
400
500
m.
Prevailing winds
Oxygen-rich water
Oxygen-poor water
Anoxic water
ocean currents
settling material

Figure 3.10. Paleogeographic map showing probable facies relations of Upper Pennsylvanian Midcontinent sea during deposition of marine (lower) shale along Midcontinent outcrop at phase of maximum transgression (from Heckel, 1980). Hachured lines show approximate location of outcrop (solid) and subcrop (broken) limits of Upper Pennsylvanian strata. Short dashes show facies boundaries and north limit of Anadarko basin. Long dashes show extent of sea. Lithologic symbols are standard, with some explaination or emphasis added. Key for abbreviations of U.S. cities for location are as follows: CA - Casper, Wyoming; FW - Fort Worth, Texas; T - Tulsa, Oklahoma; KC - Kansas City, Missouri; D - Des Moines, Iowa; C - Chicago, Illinois; L - Louisville, Kentucky.

UPPER PENNSYLVANIAN PALEOGEOGRAPHY, CENTRAL U.S.



zone perhaps developed on the craton provided the water is deep enough to permit significant water stratification. The distribution of the anoxic zone may be scattered across the shelf in part related to the dynamics of the upwelling phenomenon and the development of the Ekman layers (water masses with opposing currents, i.e. outward flow at surface and return flow at the bottom) (Parrish, 1982). As long as these layers are maintained the upwelling is possible. The limit of upwelling onto the craton is the bathymetric contour marking the depth where turbulence takes over, i.e. where the two layers disperse. This does not neccessarily parallel the shoreline. With very shallow gradients of the bottom the upwelling may be widely distributed. The minimum depth for upwelling (and Ekman transport) is 165 feet (50 m) according to Parrish (1982). Organic productivity due to upwelling of nutrient-rich water should decrease away from the site of upwelling according to Parrish. This pattern appears should be significant in evaluating the cause of the organic-rich sediment.

Parrish (1982) also supported Demaison and Moore's (1980) Black Sea model (Fig. 3.11), as an alternative to upwelling where anoxic, silled basins developed on the craton. This model requires a continuous influx of fresh water to create a persistent salinity stratification (halocline). The lack of circulation on the bottom eventually results in anoxic conditions as decomposition of primarily terrestrial particulate organic matter depletes the dissolved oxygen.

Figure 3.11. Model for semi-enclosed anoxic cratonic basin using criteria from Demaison and Moore (1980).

SEMI-ENCLOSED ANOXIC CRATONIC BASIN MODEL

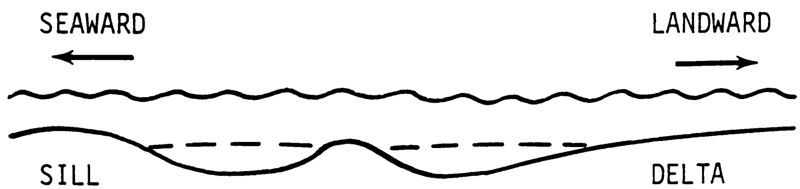
POSITIVE WATER BALANCE

(after Demaison and Moore, 1980)

inflow:
cool nutrient-rich oceanic water, normal salinity

outflow:
warm marine surface water

inflow:
nutrient-rich freshwater



elevated salinity, trap for organic matter

HALOCLINE POSITIVE

(from Demaison and Moore, 1980)

Sill: Restrict vertical mixing to enhance water stratification

Isolated positive bathymetry: Mid-basin relief above halocline with resultant dominant oxygenated or dysaerobic conditions (Hallum and Bradshaw, 1979).

Shelf basin (depression): Acts as nutrient trap, depleting dissolved oxygen leading toward preservation of organic matter.

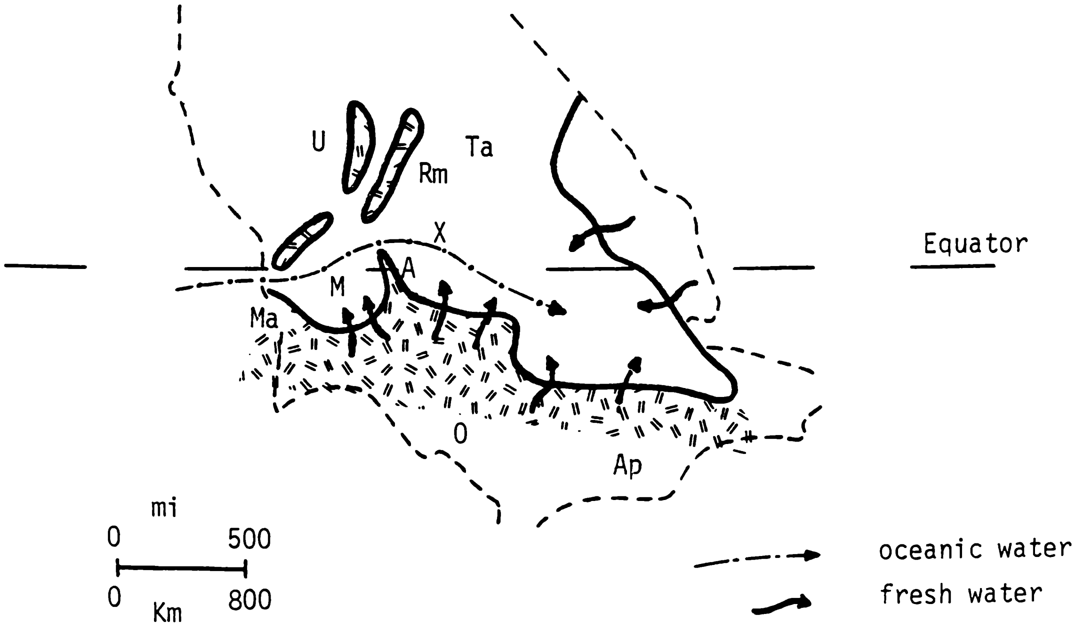
Favorable paleogeographic setting: Temperate to warm, moist intracratonic setting, also in pockets along continental shelf margin (Demaison and Moore, 1980).

The permanent halocline marking the boundary between the oxic and anoxic conditions in the Black Sea ranges from 820 to 500 feet (250 to 150 m) and coincides with the 20,000 milligram/liter isohalocline. The maximum water depth is nearly 5000 feet (1.5 km) while the sill is located at 90 feet (27 m) below the surface. Demaison and Moore (1980) considered that the Upper Jurassic black shales of western Siberia, southern England, and the North Sea and the Mowry Shale in the western U.S. are explained by anoxic silled basins analogous to the Black Sea.

Moist equatorial lands alongside the Appalachians and the Ouachitas could have provided significant freshwater runoff and organic matter during the Missourian. However, a thick continuous layer of fresh and brackish water covering the entire water mass of the Midcontinent sea was improbable during the development of these cyclothems. However, salinity in the surface waters may have been somewhat reduced. The varying pattern of precipitation and atmospheric circulation may have episodically allowed extensive coverage by fresher surface water. The runoff may have also contributed significant volumes of suspended organic matter to the cratonic sea. The salinity stratification due primarily to freshwater influx, albeit not continuous, and positive water balance of Demaison and Moore (1980) seems more probable than exclusive upwelling derived from oceanic processes. Surface water outflow would help to create estuarine circulation and assist wind-generated surface currents and may have encouraged upwelling of cold marine waters from the edge of the craton (Fig. 3.12).

Figure 3.12. Map is annotated to describe environmental conditions important in generating anoxic conditions on the cratonic sea as described in the present study. The following abbreviations are used: Rm - Ancestral Rocky mountains, U - Uncompaghre, Ma - Marathon mountains, O - Ouachita mountains, Ap - Appalachian mountains, Ta - Transcontinental arch, An - Anadarko basin, M - Midland basin.

LATE CARBONIFEROUS PALEOGEOGRAPHIC SETTING IN THE MIDCONTINENT DURING THE ACCUMULATION OF THE MARINE SHALE FACIES



[paleogeography from Heckel (1977) and equator from Parrish (1982); area of study is marked as a X] Partial outline of U.S. is dashed.

Easterly winds in winter off continent away from stabilized high pressure on continent's interior (winter monsoon, low precipitation); would promote upwelling from west unto craton (see Figure 3.3 for hemispheric map after Parrish, 1982).

Westerly varying to northwesterly winds in summer onto continent toward low pressure on continent's interior (summer monsoon, high precipitation); would promote runoff from surrounding landmass.

The actual amount of precipitation on the bounding exposed lands of the Appalachians and Ouachitas is open to debate. An eastward trend in moisture reduction is suggested by diminished coal resources in the west through increasingly younger Pennsylvanian-age sedimentary rocks. The trend toward increased dryness begins in the western Midcontinent and eventually reaches the Appalachians between latest Des Moinesian and earliest Missourian. Yet, the mean climate during the Missourian in the Midcontinent and to the east was moist, not arid or semi-arid (Phillips and Peppers, 1984). Restricted occurrences of paleosols, red beds, and caliche are more abundant in the Conemaugh Group (Missourian) in the Appalachians than older strata, but suggest short episodes of drier seasonal conditions followed by dominant moist conditions (Schutter, 1984).

Evans (1967), who examined the geochemistry of the Heebner Shale of the Virgilian Oread Formation, also invoked the Black Sea model for the origin of anoxic conditions. He proposed that a narrow pass around the western edge of the Wichita Mountains restricted access of open-marine waters to the Anadarko basin and interior of the craton, a paleogeographic reconstruction that appears valid today. Stagnation resulted from limited circulation. Evans' explanation would help to explain the greater abundance of black shales in the Middle and Upper Pennsylvanian strata throughout the Midcontinent than in equivalent sediments on the eastern shelf of the Midland basin unless this latter shelf was perhaps a shallower setting (Boardman et al, 1984). Black shales developed on this shelf or in basinal areas of the Midland basin would be more easily explained by upwelling and differences between the black shales might be anticipated. The isolated stratified model would also be applicable to deposits of sapropelic black dolomites deposited during the Middle Pennsylvanian in the Paradox basin (Hite, 1978). However, sulfate and halites associated with these dark dolomites would preclude a low salintiy layer due to freshwater runoff like the Black Sea. Semi-arid conditions are also suggested by other evidence (Schopf, 1975).

According to Demaison and Moore (1980) and Rossignol-Strick (1982) a warm, tropical climate would also induce thermal stratification of the water mass complementing any freshwater influx. The equatorial, cratonic setting of the sea would both encourage the development of elevated temperatures in the upper layers of the water column and perhaps promote a positive water balance due to the input of freshwater. Deeper sub-basins on the craton would tend to limit mixing of the water where the sea floor was below wave fetch. An abundant supply of organic matter could then deplete the oxygen in the lower portion of the water column at these locations. Given the significance of thermal stratification, variations in the bathymetry could provide for more local variation in the degree of stagnation or induce episodic fluctuation between anoxic, dysaerobic, and oxygenated bottom conditions. This would more closely match the widespread yet patchy distribution of anoxic sediments which appear to be dependent on local bathymetry. Evidence supporting the loss of black facies of the lower shale is provided in this study and others, e.g. James (1970) and Price (1982).

The development of a transient anoxic bottom layer during transgression was described in an example presented by Petters and Ekweozor (1982). They analyzed the distribution of foraminifera, total organic carbon, hydrocarbon biomarkers, and total sulfur in black and dark-gray laminated shales of Cretaceous age in the Benue trough of Nigeria. They demonstrated that much of the organic matter came from a terrigenous source. An estuarine circulation pattern driven by drainage of substantial volumes of freshwater off the humid, tropical landmass to the east introduced the large quantities of terrestrial organic matter that consumed much of the oxygen in the shallow cratonic sea. A positive water balance from fresh-water input in this confined inland sea resulted according to Petters and Ekweozor (1982) in density and perhaps thermal stratification and stagnation of the bottom waters without a recognized bathymetric sill between this depression and the deep ocean. Stronger anoxia is indicated in the more distal, landlocked parts of the Benue sea. Locally, stenohaline organisms such as ammonites were trapped in this marginal, landward setting and died _en mass_. Similar reasoning and comparable models are provided by Rossignol-Strick (1982) and Seibold and Berger (1982). (See Figure 3.11).

Petters and Ekweozor (1982) believed that anoxic conditions are induced by water stratification significantly affected by estuarine flow (positive water balance) developed during transgression with high organic productivity and oxygen loss due to the influx of large concentrations of terrestrial organic matter.

This setting has several important similarities to the Midcontinent epicontinental sea of the Pennsylvanian. Widespread inundation of the large deltas occurred in the eastern Midcontinent and the Appalachians during transgression, as described by Wanless (1964) and Baird and Shabica (1980). The rising sea then gradually covered broad freshwater coal swamps that the large delta systems to the east (Wanless, 1975). With the rise in base level during initial inundation of the delta, some of this organic matter was probably dispersed into the sea water. The combination of unfavorable substrate and turbid water containing high concentrations of organic debris apparently was enough to inhibit or eliminate the development of the transgressive carbonate (Heckel, 1977). Large volumes of freshwater carrying suspended organic matter could also have been dispersed over much of the deepening cratonic sea, also providing a positive water balance and outward surface flow and perhaps encouraging inflow of bottom oceanic water. Once water was sufficiently deep, thermal and density stratification may have resulted. The fraction of water volume contributed to the epeiric water body by the freshwater influx would be small and would be concluded to be inadequate to produce a thick surface layer of freshwater that would result in salinity stratification. The predominance of stenohaline fauna in the lower shale supports this conclusion (Boardman et al, 1984). Thermally stratified lakes such as those in East Africa have a perennial thermocline developed between 230 to 330 feet (70 to 100 m) below the surface, but seasonal change and variations in salinity and areal extent of the water body do not permit a precise generalization of depth of the thermocline (Degens and Stoffers, 1976).

The level of stagnation was perhaps greatest in the depressions on the shelf (Hallam and Bradshaw, 1979), a similar conclusion to that stated above. Anoxia could have resulted from the depletion of oxygen in these areas of stagnation due to the abundance of terrigenous organic matter brought in from the shore.

The setting described by Petters and Ekweozor (1982) also provides means of terminating the anoxic bottom conditions. This would happen when most of the exposed terrane was inundated during maximum transgression, leaving no means of concentrating surface runoff which created the positive water balance and also eliminating the major source of organic matter that could consume the oxygen. The termination of convective heating of the land surface during the summer (tropical summer monsoon, Miller and Thompson, 1975) could dramatically alter the rainfall pattern and similarly reduce the positive water balance (outflow) of the craton-dominated system. A gradual return to oxic, nontoxic bottom water would restore normal marine conditions to the sea floor.

The black shale is typically overlain by a thin, dark-gray to gray shale layer and is typically barren of aragonitic taxa. In particular, Boardman et al. (1984) note the loss of two ammonoid-bearing units overlying and underlying black shales in Kansas, Illinois, and Indiana. These areas are also locations of limited clastic sedimentation during the accumulation of this interval.

They propose that these aragonitic ammonoids and other molluscs were not preserved because of extremely reduced rates of sedimentation during the accumulation of the lower shale. The environment they ascribe to this interval is dysaerobic (low oxygen) based also on faunal attributes. These observations and conclusions are also supported by Heckel (1983). It appears that with dysaerobic conditions during the slow accumulation of the gray shales dissolution of carbonate dominated without any significant phosphatization. This period of very slow sedimentation may be related to water depth, perhaps representing a time when the sea floor was below the photic zone (Heckel, 1977). The accumulation of carbonate sediment would not begin until the water level lowered to where carbonate-secreting organisms could again flourish on the sea floor. This lowering would also be followed by a renewed progradation of the deltas and accumulation of terrigenous clastics. The inundation of the shoreline, the loss of both a positive water balance and organic matter may have initiated the return to oxygenated bottom conditions.

Anoxic bottom waters might be expected to be more prevalent in depressions proximal to the deltas, the major source of the organic matter. This would be opposite the anticipated increase of organic matter from simple oceanic upwelling. Moreover, the lateral change from predominately black to all dark-gray and gray shales in the area of study is significant and may be a function of paleobathymetry. At some isolated locations the lower shale is not even recognized as a distinctive unit. The faunal distribution of these non-black shales has not been examined in the detail that Boardman et al. (1984) have done elsewhere. Deep-water communities may be present within these intervals, albeit in thin deposits and only identified with detailed paleontologic examination.

Hallam and Bradshaw (1979) described a similar example of anoxic conditions on the northern European shelf during the early Toarcian where bathymetric lows on the sea floor were sites of anoxic bottom waters. The London-Brabant platform protruded above the anoxic water layer; here organic-poor, non-black argillaceous and oolitic limestones were deposited rather than black shale. These authors emphasized that while the black shales were deposited in water deeper than contemporary non-black shales, they may not necessarily differ significantly in depositional depth from non-black facies stratigraphically above or below them. What they suggested then is a change in physiochemical conditions of the water related to varying relief across the shelf that led to a change in lithofacies (Fig. 3.11).

Hallam and Bradshaw (1979) noted that black shales are not found near the tops of regressive sequences, nor are they fully developed in the thicker basinal sequences. This is similar to the observed lithofacies successions in the Missourian of the Midcontinent. The black, organic-rich shales were also deposited well onto the craton remote from the shelf margins.

Poor circulation in a water body such as in a cratonic sea with a very large ratio area to depth would be encouraged according to the calculations of Keulegan and Krumbein (1949). They also suggest that an abundant supply of vegetable matter associated with a humid, warm setting could lead to establishing anoxic conditions in the lower water column of the shallow cratonic sea. Only after the organic matter was eliminated or when the sea shallowed would normal marine conditions be established. This is quite compatible with the models of Demaison and Moore (1980) and Petters and Ekweozor (1982) except that in the later model, influx of freshwater and elevated temperatures further promoted stratification of the water mass and that terrestrial organic matter consumed the oxygen resulting in anoxia. Water depth in any model, however, had to be sufficient to allow stratification to occur, perhaps 230 feet (70 m) minimum for development of a thermocline (Degens and Stoffers, 1976) or the 165 feet (50 m) minimium for upwelling (Parrish, 1982).

Upper Pennsylvanian dark shales and limestones are found in the deeper basins such as the Anadarko (Rascoe, 1962) and the Midland basins (Wanless, 1958). Yet, thin, metal-rich, radioactive black shales are restricted to the interior cratonic setting. Furthermore, these cratonic shales do not increase systematically in content of organic matter, phosphate, or heavy metals including uranium, nearer to the margins of the shelf (southwestward) as mentioned below. The implication is that these anoxic conditions on the craton are controlled by processes primarily restricted to the craton as described.

Geochemical Trends in Lower Shale

The model can be tested using measurements of gamma radiation in the sedimentary rocks and geochemical analyses. Levels of natural gamma radiation correlate with concentrations of organic matter in the black-shale facies as previously recognized in strata of other ages (Johnson, 1975; Demaison and Moore, 1980). The recording of this radiation in the subsurface requires a calibrated natural gamma-radiation log and can provide a means of mapping the distribution of this facies.

Organic matter associated with upwelling should have higher concentrations of algal or sapropelic organic matter than humic or terrestial plant debris (Dow, 1978; Demaison and Moore, 1980), because activity of phytoplankton is highest in these areas of upwelling along continental shelves (Hallam, 1967). Therefore, knowledge of the source of the organic matter may provide a link to the origin of the anoxic conditions. The geochemical analysis of the organic matter could reveal its origin, but Demaison (1981) warned that anaerobic microbial reworking can transform terrestrial non-sapropelic organic matter into a lipid-rich fraction that looks much like organic matter derived from planktonic organisms. Nevertheless, the hydrogen richness, pyrolysis yield, and soluble lipid content, commonly analyzed indicators of potential petroleum source rocks, can be used as a measure amounts of biodegraded and sapropelic organic matter. These routine geochemical measurements may eventually assist in interpreting the origin of the black shales.

Available geochemical evidence does not unequivocally support upwelling as the cause of anoxia across the entire craton. Both Middle and Upper Pennsylvanian black shales from portions of the craton distant from suspected areas of upwelling to the southwest have high levels of total organic carbon, phosphate, and minor elements such as uranium (Mecca Quarry Shale, Middle Pennsylvanian of Illinois, Coveney and Martin, 1983; Excello Shale, James, 1970; Heebner Shale, Evans, 1967; Upper Pennsylvanian shales, Hatch, personal communication, 1983). Minor elements such as molybdenum and zinc are also at high concentrations in black shales from the interior of the Illinois basin in the Middle Pennsylvanian Mecca Quarry Shale (Coveney, 1980; Coveney and Martin, 1983).

A marine upwelling source for a majority of the organic carbon, minor elements, and even the phosphate is questionable. Coveney and Martin found generally greater concentrations of phosphate in samples from the Mecca Quarry black shale in western Illinois than equivalent stratum in southern Indiana. Molybdenum (Mo) concentration increases to values of up to 1,160 parts per million (ppm) in Indiana. Total organic matter did not change significantly along their same traverse. Phosphate and molybdenum are highest according to them nearer to the eastern, ancient shoreline. The average uranium concentration in the Excello Shale, a widespread black shale, in samples from the Illinois basin are nearly twice those averages from samples in the Midcontinent (45.4 ppm versus 23 ppm). Phosphate content was slightly lower in the Illinois basin samples (2.4 percent versus 3.0 percent). The phosphate concentrations moreover correlate with the uranium content when the uranium is below 50 ppm (James, 1970). The average content of total organic carbon in the Excello Shale was also greater in the Illinois basin compared to the Midcontinent (14.4 percent versus 10.9 percent) (James, 1970).

The restricted access of the upwelling waters in the southern portion of the craton, the irregularity of the bathymetry over the wide cratonic sea, and the long distances from the area of upwelling would expectedly limit the lateral distances over which the integrity of the upwelling layer would be maintained. Geochemical investigations of Recent areas of upwelling with anoxic bottom waters are providing some analogies that can be compared with these ancient black shales.

Recent sediments beneath oceanic upwelling areas such as along the Namibian and Peru-Chile shelves are greatly enriched in opaline silica (5-70 weight percent), organic matter (2-20 percent organic carbon), phosphorous (0.2-greater than 1 weight percent), and associated elements nickel (35-455 ppm), zinc (18-337 ppm), molybdenum (30-500 ppm), cadmium (20-30 ppm), and uranium (5-60 ppm) (Baturin, 1983). With the exception of opaline silica derived from primarily diatomaceous algae, restriced in abundance to Cretaceous and younger sedimentary rocks, enrichment in these biogenically concentrated components would be anticipated in rocks affected by upwelling. Bone breccias, coprogenic material, phosphorites, and pyrite are also common to these Recent deposits. Baturin (1983), furthermore, stated that the enrichment of biogenic components during upwelling is associated with an arid climate, absence of rivers, shallow water (not oceanic), low temperatures of surface waters, limited or entirely absent bottom fauna, and low oxygen conditions in bottom waters. The first two conditions apparently were not met during the development of the Pennsylvanian cratonic seas, in particular, in areas of the eastern craton where organic matter and metal concentrations are high as indicated in the above discussion. Analysis of uranium isotopes (excess of uranium-234), carbon isotopes and biomarkers using mass spectroscopy of lipid fractions, oxygen and surfur isotopes (compared to sea water) may also hold some potential in characterizing sediments associated with high marine organic productivity and perhaps provide further indicators of upwelling based on the study of Recent sediments (Baturin, 1983; Brassell and Eglinton, 1983).

Analysis of phosphate of Recent sediments suggests that it may eventually be a key component in establishing an upwelling system as the cause for organic-rich sediments. However, the comparison of average phosphate abundances of modern rivers and oceans suggest that either could be a source of phosphate to an inland sea. Phosphate which encourages high organic productivity could be derived in sufficient quantities from dissolved and suspended load from runoff entering the cratonic sea via rivers. To arrive at this conclusion compare some abundances of phosphate in modern rivers and the World ocean.

The dissolved phosphate is insignificant to that suspended in sea water in shallow marginal oceanic settings and areas of upwelling. For example, average dissolved inorganic and organic phosphate in the World ocean average 72 micrograms per liter (μ gm/l) and between 6 and 60 μ mg/l, respectively. Average dissolved inorganic and organic phosphate in river water by comparison are 15 and 30 μ mg/l. In contrast, phosphate in suspension averages 3 X 10^6 μ gm/l in sea water to 0.6- 0.7 X 10^6 in river waters, values which are quite similar. Suspended phosphate in marginal settings and areas of upwelling, in contrast, ranges from 1.0 X 10^6 up to 8.6 X 10^6 μ gm/l, up to an order of magnitude greater than suspended phosphate in average modern river water.

A tropical climate with moderate or high rates of precipitation on the surrounding landmasses feeding rivers draining into an inland cratonic sea could conceivably provide sufficient amounts of phosphate to produce elevated levels of organic productivity in the cratonic sea. Alternately, if upwelling were the origin of the phosphate it would be expected that a pronounced gradient or simply a regular pattern of phosphate concentration would be observed across the craton. This is not evident from anyone's work to date.

James (1970) found nearly twice the average hydrocarbon (soluble kerogen such as lipids) yields, defined as the ratio ppm hydrocarbon extractable:total percent organic carbon in two subset samples the western Midcontinent Excello Shale (Des Moinesian) (3.25 X 10^{-2} ppm and 2.22 X 10^{-2} ppm), than in the Illinois basin (1.4 X 10^{-2} ppm). The general pattern of hydrocarbon yield across the Midcontinent is a westward and southward increase. Furthermore, the hydrocarbon yield is inversely related to the uranium content, as also was indicated from the earlier discussion.

Let us assume that the terrestrial organic matter is Type III (Tissot and Welte, 1978), which generally does not yield significant hydrocarbons other than methane, and furthermore that no biodegradation of this has taken place to produce oil-prone organic matter. With these assumptions the results of James (1970) suggest that a greater amount of terrestial material was contributed to the organic matter in the Illinois basin area, suggesting that it was closer to the source of freshwater runoff. The study of the results of Rock-Eval pyrolysis and gas chromatography of extractable organic matter from marine-shale samples in the present study indicate that the organic matter is low in hydrogen and has low pristane: phytane ratios (<1.7) suggesting the predominance of terrestrial organic matter over marine even in the western Midcontinent during the Missourian (Hatch and Watney, in preparation).

James (1970) also recognized the change from black-shale facies to the greenish-gray facies in the Excello over structural highs such as the Mississippi River arch and the north flank of the Ozark dome. This change in facies was accompanied by a considerable decrease in average organic carbon to that of non-organic-rich shales. Although this black shale is one of the most extensive of the Pennsylvanian strata in the Midcontinent, these positive bathymetric features would likely have obstructed any upwelling currents from the western Midcontinent. James favored the Baltic Sea model of Manheim (1961) that invokes a simple thermocline with no associated upwelling. The distribution of total organic carbon, uranium, and phosphate do not corroborate a strictly oceanic upwelling model but suggest another means of creating stratification of the water mass in the interior of the craton.

Elevated salinities within bathymetrically lower and more isolated areas on the western, drier portion of the cratonic shelf (Schopf, 1975) may also have been a factor in producing anoxia perhaps influenced by the influx of low-oxygen bottom waters or particulate organic matter from marine upwelling not as distant from these regions. Physical and chemical changes associated with hypersaline waters could have encouraged the formation of anoxic conditions such as lowered limits of dissolved oxygen with increasing salt concentration, elevated metal concentrations, and easier phosphate replacement and precipitation (Hite, 1980). The precipitation of phosphate versus carbonate would be preferred below a ph of 7.8. This is the "limestone fence" of Krumbein and Garrels (1952). This would be controlled by the amount of dissolved carbon dioxide, where cooler, more saline water would contain more carbon dioxide and lower pH. Thus rising salinity would tend to promote the preservation of more organic matter, precipitation of phosphate, and perhaps the co-precipitation of minor elements. More direct evidence, however, of the development of a saline mass of water is lacking. No significant occurrences of evaporite minerals have been found in these sediments studied here. However, dolomitization in carbonate strata below the black shale, has been convincingly shown to have developed during a later stage of diagenesis (McHargue and Price, 1982).

Model Supported By This Study

An estuarine-thermocline model is preferred to explain development of anoxia during accumulation of the black shale. It employs the most available and likely components to result in an anoxic sea floor on the craton, namely abundant terrestrial organic matter produced in a humid, tropical climate, dispersed into the sea via abundant influx of freshwater creating an estuarine-like positive water balance. Influx of heavier, cooler marine waters (return flow) to the positive water balance of the estuarine system was probably important in the southwestern reaches of the craton. Tropical heating of surface waters, a net outflow of surface waters, and an inflow of cool oceanic bottom water led to stratification of the water mass after sufficient depth was reached during late transgression. Mixing would probably have reduced any significant salinity contrast of the surface waters due to freshwater influx, particularly over the western Midcontinent shelf. Oxygen was depleted by the organic matter during a time when the influx of terrigenous clastic detritus had been eliminated or greatly minimized except along the shorelines of the cratonic sea. The result was a thin, black, fissile, faunally restricted shale repeated in many Middle and Upper Pennsylvanian cyclothems across the Midcontinent. Favorable climate, high levels of organic matter productivity, and positive water balance were thus the crucial ingredients to the formation of these extensive black-shale units.

The depth of water during the deposition of this shale was probably near or at its maximum judging from its extensive lateral distribution and indications of slow rates of deposition (Heckel, 1977; Boardman et al, 1984). Once the supply of organic matter from the inundated coast was eliminated, the sea bottom, however deep, was restored to normal marine conditions. The lack of carbonate mud during and immediately before and after the accumulation of black shale (Heckel, 1977) indicates unfavorable conditions on the seafloor. Rather than the seafloor being below the photic zone, abnormal Eh or toxicity of the bottom waters may have prohibited carbonate accumulation. However, the observed lower limit of the green alga _Halimeda_ (but not a mud producer) is 260 feet (80 m). Depth ranges for _Penicillus_, a modern mud producer, is not known, but green algae in general are most abundant in waters less than 30 feet (20 m) Wilson (1965). The lower depth depth limit of Halimeda is similar to the required depth to initiate a thermocline as described above (230 feet, 70 m). Either deleterious water chemistry or lack of significant sunlight may have been important in severely limiting benthonic organisms, particularly carbonate producers.

Water very near the shoreline would be more oxygenated and would result in the deposition of dysaerobic or normal shallow-marine sediment (Boardman et al, 1984). Condensed sandy layers of shell hash at the base of the upper carbonate occurring at the stratigraphic level occupied by the lower shale observed in this study may reflect a lack of deposition or even slight erosion during the interval of lower-shale deposition elsewhere (Hallam and Bradshaw, 1979). The marine shale may have been removed or not deposited in deeper or mid-shelf areas over the intermediate-depth bathymetric highs that were isolated from influx of terrigenous clastics. Low areas on the shelf were sites of accumulation of organic matter and what little clay material was available (Fig. 3.11).

This model is different from previous explanations of the black shale facies. While the suggestion here is that the black shale was deposited in deep water, the water depth was not the only significant control and may not have been appreciably greater than during the accumulation of the adjacent sediments. The carbonate sediment may not have been deposited because of adverse physiochemical conditions, rather than lack of sunlight.

The depositional model in which the lower shale is deposited in deeper water near maximum transgression and is the turning point of the transgressive-regressive sequence is supported by the diagenetic alteration observed in the cyclothems (Watney, 1980; Heckel, 1983). The lower shale is therefore referred to as the marine shale (Table 3, 4). The early freshwater diagenesis (particularly oxidation) that affected the marine shale on the extreme northern shelf supports the depositional evidence that the northern shelf was at the most landward portion of the epeiric sea. Besides serving as a source of fine-grained terrigenous clastics, the extreme northern shoreline was the location of more extensive percolation of fresh waters that even penetrated the marine shales during later portions of each cyclothem. Fresh, phreatic groundwater flow was better developed along the northern region than to the south where evidence is lacking for any significant penetration of fresh water through the shale or the lower portion of the overlying limestone. Railsback (1983) observed a similar diagenetic overprint in the Dennis Limestone along the eastern outcrop belt. These conditions all suggest that the northern shelf was at a higher elevation than the south. Most areas on the CKU lack black shale in all cyclothems either because of erosion or nondeposition. The accumulation of phosphatized grains and skeletal lag deposits over areas on the CKU suggests perhaps a hiatus in deposition.

The marine shale of the I-Zone is very thin, and a significant black-shale facies is developed only in the extreme southern part of the study area. The I-Zone is least typical of the cyclothems studied because the entire cyclothem pinches out before reaching the northern edge of the study area. Generally, the marine shale is too thin even to be identified by wireline logs. The restricted distribution and thinness this of marine shale suggest a more limited transgression of the shelf during the accumulation of this cyclothem. Stratigraphic maps presented below provide more detail about the distribution of this unit and its stratigraphic pinchout.

Regardless of the model invoked, the physical processes utilized to explain the model need to be validated. The case supported here is anoxia generated internally in the craton with insignificant upwelling developed during rising sea level and with influx of abundant fresh water and terrestrial organic matter. In order to test this model one must consider controls on horizontal motion of the water due to freshwater and marine influx, Coriolis acceleration, wind stresses, and the effect of surface heating on generation of turbulence and formation of internal stratification (Officer, 1976). Detailed paleogeography and paleo-climatic modeling are major steps to simulation and testing of conditions specified in these models.

Diagenesis of Lower Shale

Along the northern shelf the lower shale is locally oxidized with maroon, red-brown, and yellow mottling superimposed on the typically gray-green to green color. Red-brown, partly silicified mottles are also common. Burrows or lenses rich in micritic carbonate and calcareous fossils are preferentially silicified. Locally, silicification is more pervasive and transects sedimentary structures. Associated with this oxidation and silicification are dissolution of calcareous fossils and small-scale (millimeter- and centimeter-sized) fracturing and fissuring of the shale. The small fissures anastomose and are patchily filled by more intensely oxidized, reddish shale that may have been carried into the fissure from within or the uppermost red-brown silty upper shale.

Also occurring with silicification, solution, and oxidation is the development of sharpened, almost microstylolitic boundaries between carbonate-rich and clay-rich areas in these same calcareous lower shales of the northern shelf. These contacts are typically accentuated by a thin rim of dark clay, possibly left as a residue following solution of the carbonate. Also wispy shale laminae can be discerned in the more calcareous shale intervals.

This rather pronounced diagenetic overprinting characterized by selective leaching or silicification of skeletal grains is restricted to the northern shelf. The silicification and leaching probably occurred early when oxidizing, fresh or undersaturated waters moved through the sediment while mineralogically less stable carbonate particles were present. The upper portion of lower shale shows more extensive overprinting than the lower, suggesting that the waters came from above. This pattern of early diagenesis is repeated in each cyclothem.

The microstylolitic boundaries between the carbonate rich and shaley areas and the wispy-shale laminae resembles a form of pressure solution called nonsutured seam solution by Wanless (1979). Wanless (1979) discounted compaction as a significant process in volume reduction of an argillaceous limestone or very calcareous shale. It is difficult at best to determine unambiguous evidence to support some form of early compaction. The convergence of shale wisps around skeletal grains upon microscopic examination typically indicates partial solution of the skeleltal grains. Burrows are commonly backfilled with more calcareous matrix which although slightly deformed is commonly surrounded by draping and converging wisps of shale. This in itself is perhaps indication of early lithification of the burrow surrounded by a compacting, muddy carbonate matrix. Concomitant dissolution due to percolation of undersaturated waters would tend to remove the carbonate and promote this compaction process. The northern shelf locations are the most frequent sites for the textures and may be related to the relative abundance of available percolating undersaturated water. These observations, although not conclusive, may indicate that early compaction and dissolution proceeded concurrently in order to generate these textures. Wispy shale laminae and microstylolites are also common in the upper carbonate across the western Kansas shelf and may reflect a more pervassive process, perhaps simply late-stage pressure solution.

On the southern shelf the lower shale is least affected by percolating fresh water. Diagenesis is limited to simple compaction and local pyritization of fossils.

Upper Carbonate

The upper carbonate (Table 4) has the greatest diversity in thickness and depositional and diagenetic facies of the cyclothem units. It is the primary reservoir lithofacies (Table 5). It represents a shallowing upward sequence of carbonate facies ranging from open-marine, quiet-water conditions to restricted, high- and low-energy environments. Its base is gradational with the marine shale, representing a transition from terrigenous clastic to carbonate sedimentation. Along the northern border of western Kansas, where the marine shale is thicker, the transition is commonly extended with shale intercalations, e.g. J-Zone, the Gore #1 Wertz, Hitchcock County, Nebraska, and in several zones in Rawlins County, Kansas, Plate 1 from Watney (1980). The carbonate and the marine shale along the northern two-thirds of the shelf in the study area are both lighter colored and very noticeably burrow mottled compared to the rocks in the southern shelf. The basal contact is increasingly gradational with the underlying shale to the north.

Lower Part of the Upper Carbonate

The lower part of the regressive carbonate in the north is a diversely fossiliferous, tan to light-gray, burrowed wackestone. Locally in the extreme northern part of the area the lower wackestone is interrupted by abraded, bioclastic packstone and grainstone (DuBois, 1979). Carbonate intervals also contain more quartz silt and shale than those to the south.

A very common feature of the lower part of the upper carbonate, particularly on the northern shelf, is centimeter-sized mottling found in argillaceous wackestone. The mottles are composed of micrite and probably represent horizontally oriented burrows now compressed to lenticular shape. The intervening argillaceous carbonate contains wispy shale laminations that commonly converge and wrap around the cleaner carbonate of the burrows.

Brachiopods, crinoids, fusulinids, corals, pelecypods, tubular and encrusting foraminifera, and occasional bryozoans are present in most sections of the wackestone that have been cored. Phylloid algae are locally abundant, forming broad buildups such as in the D, G, and H-Zones in Rawlins County (Watney, 1980). <u>Eugonophyllum</u> is the predominate alga in these buildups, but it can be identified only through ghosts of thalli preserved after inversion or void filling by coarse calcite spar. Abundant phylloid algae are limited to non-argillacous layers of micrite. The occurrence of the algal buildups is similar to those described in the outcrop by Harbaugh (1959) and Heckel and Cocke (1969).

Table 8 lists representative cores with variation in facies that comprise the lower part of the upper carbonate. The diverse organisms in a micrite-supported framework that typically comprise the lower part of the upper carbonate are interpreted to represent a subtidal, low-energy shelf facies with open circulation (Wilson, 1975). The phylloid-algal wackestone is interpreted to have accumulated in clear, shallow water. Abundant tubular foraminfera and

Table 8. Facies Variation in the Lower Part of the Upper Carbonate.

A. Thinning over the CKU-CA and local shallow water indicators

1. I, J, K zones Clinton 2-D Stegman, Sec. 11-16S-17W Located along crestal area of Rush rib (Merriam, 1963); no marine shale in I-Zone, 1-foot-thick fossiliferous, dark gray shales in J- and K-Zones.

--In all cases lower regressive micritic carbonate is punctuated by thin zones of abraded and coated bioclastic grainstone much like northern shelf; micritics are peloidal mudstone and poorly fossiliferous wackestones with shrinkage cracks; all three cyclothems at this location are thinnest in entire area under investigation.

2. Other examples previously mentioned in section on marine shales (Table 7 and Figures 3.7 and 3.8) where this shale is missing and transgressive unit is in contact with the lower regressive carbonate.

B. Dark micritic regressive carbonate facies on southern shelf

1. a.	K-Zone	Cities Service	#D-2	Conover	Sec 31-30S-33W
b.		Cities Service	#E-2	Thompson	Sec 30-30S-33W
c.		Texaco	#4	Litsey	Sec 25-31S-6W
d.		KRM	#7	Lemon	Sec 13-34S-20W

--Few but larger brachiopods, crinoids, fenestrate and ramose bryozoan; intervals silty with very evenly spaced, dark-gray, wavy shale laminations (burrowing is limited).

2. J-Zone, Cities Service #C-2 Blair, Sec 29-30S-33W Core taken six feet above bottom of regressive carbonate.

--Dark-gray to dark-brown micrite with scattered concentrations of broken brachiopods, crinoids, and tubular and encrusting foraminifera; many fossils replaced by pyrite; glauconite fills chambers of foraminifera.

3. H-Zone Cities Service #D-2 Conover, Sec 31-30S-33W

--Gray, brown, dense micrite with bryozoans, tubular forams, and bivalves; scattered silt laminae and disseminated quartz silt and pyrite; scattered glauconite.

4. J-Zone, study by Brown (1963) which encompasses southern study area.

--Recognized a dark gray, dense, and nonfossiliferous micrite covering extensive areas of the study from cuttings.

C. Pronounced shallowing character and eventual pinchout of I-Zone regressive carbonate (northern shelf)

1. Gulf #1-22 Hughes in Sec. 22-9s-29w

--Lower portion of regressive carbonate is silty, mudcracked, locally brecciated, poorly fossiliferous bioturbated wackestone.

2. Skelly #1 Bartosovsky, Sec. 9-1s-34w

--I-Zone interval is missing; only gray-green silty shale at position of I-Zone; unoxidized zone of shale interrupts a long interval of otherwise red-brown siltstone in the J-Zone regressive shale prominent paleosol is developed immediately beneath this gray-green shale (Watney, 1980).

peloidal micrite commonly occurring with most algal limestones suggest possibly slightly restricted marine conditions (Wilson, 1975). Marked deviations from this generally subtidal, low-energy wackestone facies include isolated occurrences of grain-supported fabrics which are interpreted as shallower water facies deposited in moderate- to higher energy marine environments in the lower regressive carbonate (Fig. 3.13). The lower part of the regressive carbonate of the southern shelf is noticeably darker brown or grayer than along the northern shelf (Figs. 3.14 and 3.15). Burrowing, pervasive on the northern shelf, is less common in the south, particularly within this darker facies. As Wilson (1975) and Enos (1983) suggested, abundant burrowing is commonly an indicator that marine conditions were at least slightly restricted. Fewer burrows in the carbonate rocks on the southern shelf probably reflect more open-marine conditions. The stenohaline, suspension-feeding macrofossils, such as crinoids and bryozoans, are larger in the more southern locations than in northern ones, suggesting more open-marine conditions with greater supply of nutrients. Occasional thin layers of broken but unabraded fossils on the southern shelf suggest either a lag concentrate perhaps resulting from storms which removed the lime mud matrix or transported these particles.

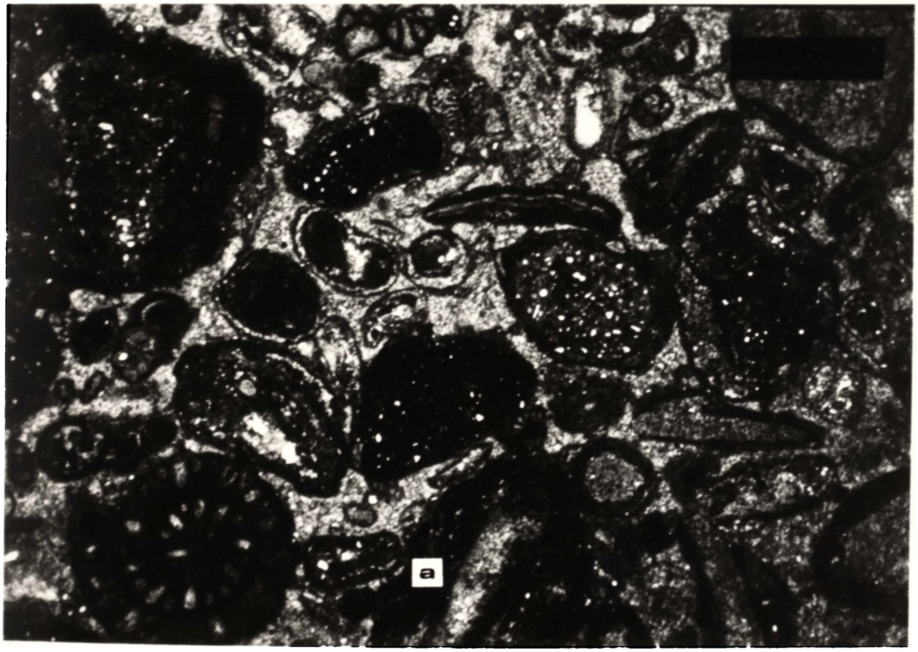
Petrographic evidence suggests more abundant organic matter in darker carbonates (Figs. 3.13 and 3.15). A higher natural gamma radiation level common to the lower portion of the upper carbonate cannot be explained simply by the argillaceous content. Elevated

Figure 3.13. Local shallow water indicators in the lower portion of upper carbonate. Photomicrograph and slab photo.

A. Conoco #9 Morel, 3585 feet, lower portion of I-Zone upper carbonate. Plane-polarized light and 1 mm scale. Photomicrograph of biclastic, intraclastic packstone. Blue-green algal and encrusting foraminifera form coated grains (a) on brachiopod and mollusc fragments and on intraclasts of silty, unfossiliferous dolomicrite and micrite. Some intraclasts contain irregular discontinuous fractures and are darkened. Particles are subrounded. Shallow water, perhaps with moderate turbulence, is suggested. Significantly, the interval is only 3.5 feet (1.1 m) above the base of the upper (regressive) carbonate and 17 feet (5.2 m) below the top. Underlying the regressive carbonate is a black, hard, marine shale containing phosphatic orbiculoid brachiopods. Although shallow water indicators occur low and early in the upper (regressive) carbonate of the I-Zone, the presence of the black shale, generally uncommon on the upper shelf in the I-Zone, could be interpreted to represent deeper water conditions.

B. Clinton #2-D Stegman, 3405 feet, base of I-Zone. Scale in centimeters. Slab photograph of burrowed, light green, silty, foraminferal-algal encrusted, brachiopod, bryozoan, crinoid wackestone. Wispy stylolitic argillaceous seams (a) form contacts between lenticular-shaped areas distinguished by widely varying abundances of skeletal debris and color of micrite. Scattered intraclasts are unfossiliferous mudstone (b). Compaction and possible solution of micrite results in convergence of wispy shale laminations (insipient stylolites) similar to that described by Shinn (1980) and Wanless (1979). Bar scale is in centimeters. No marine shale is present in the I-Zone at this location, only thin, green, argillaceous partings. This carbonate rock rests sharply on an unfossiliferous soft, green and red mottled shale at 3405.5 feet that contains caliche nodules and vertical fissures and tubular structures filled with softer shale. This shale is interpreted as to be the regressive shale of the J-Zone; it is 3 feet thick.

A



B

Figure 3.14. Dark mudstone and wackestone in lower portion of upper carbonate facies on the southern shelf. Photomicrographs in plane-polarized light.

A. Cities Service #E-2 Thompson 4577 feet, lower regressive carbonate, K-Zone. Bar scale is 1 mm. Very sparsely fossiliferous, slightly silty, gray lime mudstone with scattered, very finely disseminated pyrite cubes and irregular fine-grained opaque flecks (organic matter ?) and scattered small bivalve fragments.

B. Cities Service #D-2 Conover, 4416 feet, lower portion of H-Zone upper carbonate. Bar scale is 1 mm. Photomicrograph of crinoid, brachiopod, bryozoan wackestone to packstone. Matrix is slightly silty, argillaceous micrite. Abundant broken but unabraded and unmicritized, uncoated skeletal fragments. Finely disseminated pyrite is abundant. Pyrite also replaces portions of crinoid ossicles (a). Partial yellow-tinted silica replacement in interiors of brachiopod shells and crinoid ossicles. Features are analogous to Heckel's (1983) overcompacted texture and typical diagenesis for the lower regressive carbonate. Open-marine deposition and slow accumulation are indicated.

C. Cities Service #D-2 Conover, 4426 feet, lower portion of H-Zone upper carbonate. Bar scale is 0.5 mm. Photomicrograph of crinoid ossicles with subhedral rhombs of low-iron dolomite. Irregular blebs of fine-grained pyrite in interior of the ossicle separates dolomite (a) from anhedral crystals of low-Fe calcite (b) comprising better preserved outer portions of ossicles. Notice that edges of ossicle appear to be partly dissolved and recrystallized to finely crystalline calcite.

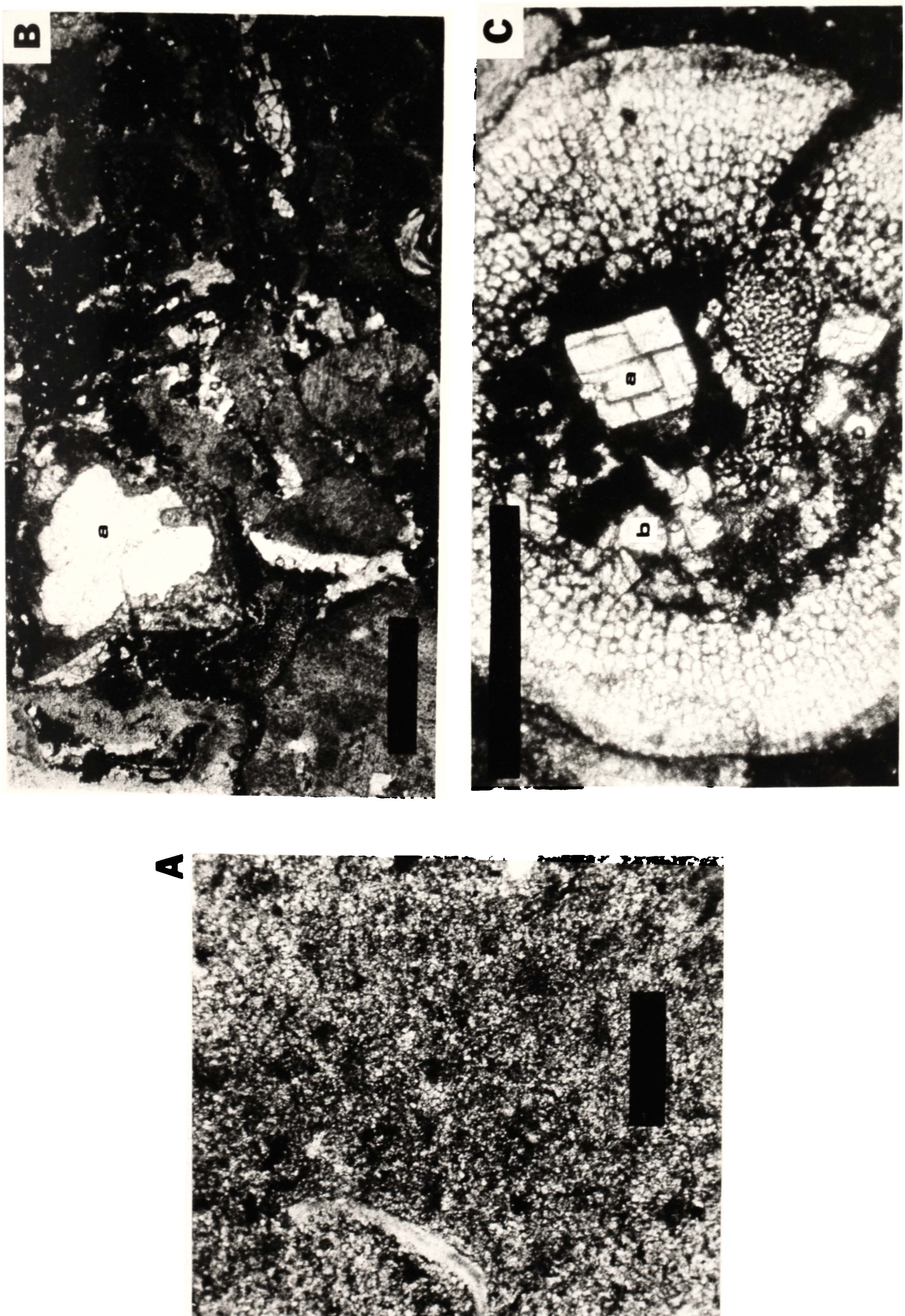

B
a
C
a
b
A

Figure 3.15. Dark mudstone and wackestone in lower portion of upper carbonate facies on the southern shelf. Photomicrographs in plane-polarized light.

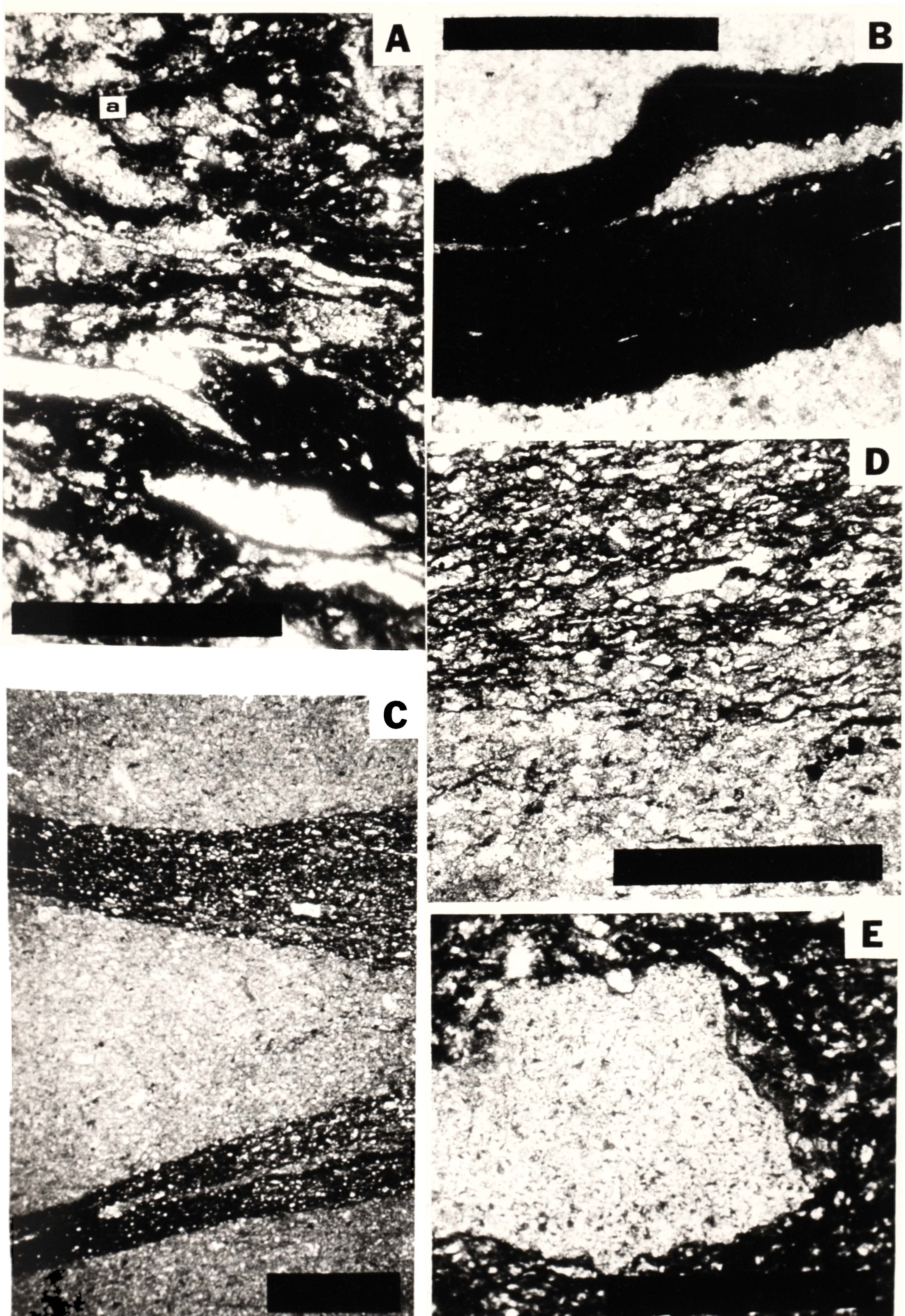
A. KRM #2-X Lemon, 4779 feet, lower portion of K-Zone upper carbonate. Bar scale equals 0.5 mm. Photomicrograph of very silty, argillaceous bivalve wackestone containing abundant opaque pyrite as finely disseminated crystals and replacement of bivalve shells. Bivalves are concentrated as intermittent layers of broken shells. Stringers of amber-red semiopaque organic matter (?) (a) are common. Crinoids, brachiopods, and bryozoan and rythmic dark gray shale layers are scattered throughout the interval from which thin section was taken.

B. Texaco #4 Litsey, 3762.3 feet, lower portion of upper carbonate of K-Zone. Bar scale equals 0.5 mm. Photomicrograph of dark gray shale laminae in gray lime mudstone interval. Scattered silt-sized quartz grains. Scattered red flecks and stringers, perhaps of organic matter, are oriented parallel to bedding. Thin section is from immediately below 0.5-feet thick, dark-gray to black mudstone containing rare crinoids and tubular foraminifera.

C. Texaco #4 Litsey, 3762.3 feet. Bar scale equals 1 mm. Two very shaley wackestone seams expanding laterally (to the right) into more carbonate-rich intervals with wispy shale laminations. See D below.

D. Texaco #4 Litsey, 3762.3 feet. Bar scale equals 0.5 mm. Top half of the photograph is comprised of carbonate matrix with abundant discontinuous wisps of shale. The irregularity of the shale and the etched bioclasts within these intervals suggest that some or all of these wisps of shale represent insoluble residue remaining after dissolution of the carbonate matrix (incipient stylolites).

E. Texaco #4 Litsey, 3762.3 feet. Bar scale equals 0.5 mm. Echinoid fragment in shaley carbonate matrix. Fritted edges of echinoid fragment attributed to dissolution.


A
a
B
C
D
E

uranium concentrations, confirmed by gamma ray spectral logs (J. H. Doveton, personal communication, 1984), in the lower interval are thought to be associated with more abundant organic matter analogous to uranium and organic-carbon concentrations in the marine black shales (Watney, 1979). The pyrite and glauconite suggest slow accumulation with little sedimentation of clay minerals and other fine detritus. Intervals of darker carbonate and disseminated pyrite on the southern one-third of the shelf suggest that fluctuating reducing conditions existed on the sea floor. Pyrite and glauconite may have been introduced after deposition as a result of the presence of the organic matter.

Heckel (1977) found no micritization of carbonate grains in the base of the lower portion of the upper carbonate. He concluded therefore, that the water was too deep for proliferation of blue-green or green algae. However, endolithic fungal borings of mollusc fragments is a form of micritization that has been found in modern sediments off the Carolina coast to depths of up to 2600 feet (780 m) (Perkins and Halsey, 1971). However, it is highly doubtful that water depths were ever this deep, but does not demonstrate that micritization can be a questionable indicator of the depth limit. Production of carbonate mud was also limited, and consequently grainstones containing unabraded and non-micritized bioclasts are common. However, these grainstones indicate deep water rather than high-energy conditions (Heckel, 1977). Oxygen levels may have been intermitently reduced during the early accumulation of the upper carbonate along the southern part of the study area due to somewhat deeper water conditions than on the northern shelf. Also the presence of abraded, micritized grainstones on the northern shelf suggests shallower water than on the southern shelf.

The darker micrite facies do not represent prolific carbonate production, but rather intermittent periods favoring carbonate accumulation with micrite and shell debris. The quartz silt and dark shale present as distinct layers and dark, more argillaceous and silty carbonates perhaps represent periods of slower accumulation of carbonate sediment or deposits of suspended particles from distant river systems. The thin layers of dark shale may also represent the return of dysaerobic conditions to the sea floor. Heckel (1983) and Boardman et al. (1984) stated that mollusc shells in particular have been noticeably etched or dissolved in the dark gray, dysaerobic facies of the marine shale, probably in response to cold water with higher concentrations of carbon dioxide during slow sedimentation associated with the low-oxygen environment. Intermittent dissolution of lime mud in the lower portion of the regressive carbonate would further limit the opportunity for accumulation and preservation of carbonate grains during these times of reduced dissolved oxygen. Rather, these low oxygen conditions would favor the accumulation of the dark shale layers observed in the lower part of the regressive carbonate. The pyrite and the glauconite also common to the darker facies probably precipitated at or near the sediment-water interface during times of slow accumulation of sediment.

The I-Zone presents an unusual facies distribution in the lower part of the upper carbonate. Unusually shallow-water facies are present throughout the cyclothem along the entire northern shelf. The regressive carbonate also pinches out into shale along the northern border of the study area. Rather than representing a prominent influx of terrigenous clastics, the Bartosovsky core along the northern area of the study, contains only a thin interval of shale where the entire I-Zone should occur. Furthermore, this same interval contains paleosols indicative of slow accumulation during emergence. As stratigraphic mapping will illustrate, the northern shelf was probably entirely emergent even during marine sedimentation of the I-Zone to the south and provided an extended period for soil formation and even considerable erosion of the underlying J-Zone in southern Nebraska (DuBois, 1979). A regional paleoslope is implied by this facies distribution. Moreover, the paleoslope appears to be an important property of this shelf affecting facies distribution in other cyclothems.

Upper Part of the Upper Carbonate

The upper part of the regressive carbonate is generally lighter colored than the lower part and represents continued shallowing-upward conditions. The variability of these facies is much greater than those below and, includes an upward, albeit irrregular, decrease in diversity of biota in a wider spectrum of textures. The mudstones in this interval contain cerithid gastropods, concentrations of ostracodes, small bivalves, and tubular foraminifera. Peloids, laminations, mudcracks, and fenestral fabric are also common. Algal stromatolites have also been recognized (H-Zone, Dorr 506, Sec. 16-9s-16w; Figure 3.18 C). Most of the grainstones on the upper shelf are lightly coated bioclasts; few true oolites are developed. With few exceptions the thickness of grainstones ranges from two to six feet (0.6 to 1.8 m). Bioclasts are commonly less well preserved higher in the upper carbonate than in the lower. Micrite and grains are partly dolomitized and occur as microgranular spar, where grains and matrix are still distinguishable due to variation in crystallinity and color.

In general the upper unit is much more variable laterally than the underlying division of the upper carbonate. On the northern shelf the upper interval varies in thickness from zero to 15 feet (4.6 m), but averages around 4 feet (Table 4). Variations of individual facies in the upper part of the upper carbonate are described in Table 9 and Figures 3.16, 3.17, 3.18, and 3.19.

These deposits are interpreted to have accumulated in a marginal-marine (shallow lagoonal or restricted, intertidal, supratidal) environment under high- and low-energy conditions. Diagenetic overprinting is more prominent in the upper portion of the upper carbonate than in the lower (Watney, 1980; Heckel, 1983). The upper part is usually thin in comparison to the total thickness of the upper carbonate. The presence of these wide-ranging, shoal-water facies covering the entire shelf suggests a diachronous relationship within this facies, particularly if any significant paleoslope was present. The recognition of diachronous units obviously affects the interpre-

Table 9. Facies Variation in the Upper Part of the Upper Carbonate.

A. Effect of paleohighs on development of high-energy facies

1. H, I, J-Zones in the Pan American #B-6 Ohlson, Sec. 28-14s-14w (Central Kansas uplift)
   Note: Core is located on Precambrian knob on CKU; Succession of thick grainstone deposits occur in three cored intervals; carbonates show effects of intense freshwater diagenesis.

2. I, J, K-Zones in the Clinton #D-2 Stegman, Sec. 11-16s-17w and Conoco #9 Morel, Sec. 15-9s-21w (Central Kansas uplift)
   Note: Stegman core is located on Rush Rib and Morel core on west side of CKU;
   Repetitive succession of grainstones occur at both cored locations; in addition all three regressive carbonate units in Stegman core are capped by subaerial crusts; J-Zone in Morel core is very heavily fractured; fractures are open and deformed suggesting possibly early formation.

3. J-Zone Murfin #1 Souchek, Sec. 2-1s-34w (northwest shelf)
   Note: Located near crest of Cahoj field; reported by Watney (1980);
   Over 90 percent of regressive carbonate is cross bedded representing moderate- to high-energy condition during accumulation of this interstratified bioclastic packstone and grainstone.

B. Extensive oolitic grainstone developed over southern shelf (Figures 3.16 and 3.17)

1. In general, J and K-Zones have prominent oolite facies on southern shelf; oolite is well-sorted, cross-stratified and associated with extremely high total porosity due to the frequent development of oomoldic porosity; thickness ranges from zero to in excess of 60 feet (18 m) with considerable local relief; appropriate wireline logs have unique signature (very low gamma ray and generally high porosity) which permits mapping of this facies; base of oolite is in sharp contact with open-marine wackestones; cores from interooid regions lack restricted lagoonal deposits (Gary #21-5 Scheulfer, Sec. 21-33s-20w).

C. Restricted, shallow-water, nonoolitic facies (Figures 3.18 and 3.19) (CA and CKU)

1. Shallow subtidal to intertidal and supratidal facies are generally thin compared to overall thickness of cyclothem; thicknesses range from only few inches to several feet; accumulations of grainstone or packstone are commonly not associated with restricted mudstone or wackestone. (H-Zone, Cities Service Dorr 506, Sec. 16-9s-16w; 2 feet algal stromatolite)

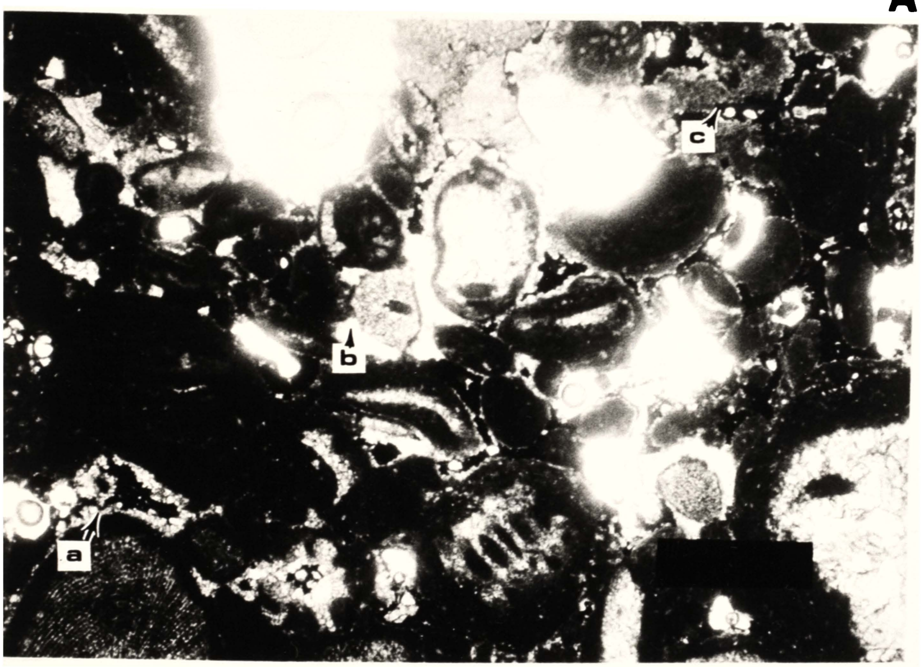
2. I-Zone has an exceptional development of very shallow-water carbonates covering most of the shelf, particularly over the CKU: Clinton #D-2 Stegman, Stanolind #3 Denker, Cities Service #506-w Dorr, Sec. 11-16s-17w, and Texaco #6-11 Holley, Sec. 32-8s-24w.

Figure 3.16. High-energy grainstone facies in the upper portion of upper carbonate.

A. Clinton #2-D Stegman, 3393 feet, top of the I-Zone upper carbonate. Photomicrograph in plane-polarized light, 1 mm scale. Heavily micritized bioclastic grainstone contains rounded fragments of foraminifera, crinoids, and molluscs. Some grains are rimmed with fine, blocky, pachous calcite spar (a). Some pores lack cement (bright intergranular areas). Coarser late-stage, Fe-calcite spar occupies some of the intergranular pore space. Syntaxial, coarse calcite spar forms overgrowths on echinoderms only visible within field of view (b). Much of the pore space is occupied by dark residual oil (c). This grainstone is typical of that on the northern shelf-lightly coated grains and heavily micritized, commonly these grainstones are also overcompacted. Other examples are shown in Watney (1980).

B. Cities Service #E-2 Thompson, 4554 feet, upper portion of upper carbonate of K-Zone. Slab photograph, bar scale in centimeters. This oolitic grainstone contains abundant oomolds (0.05 mm diam.), and dark oil stain is visible in some pores.

A



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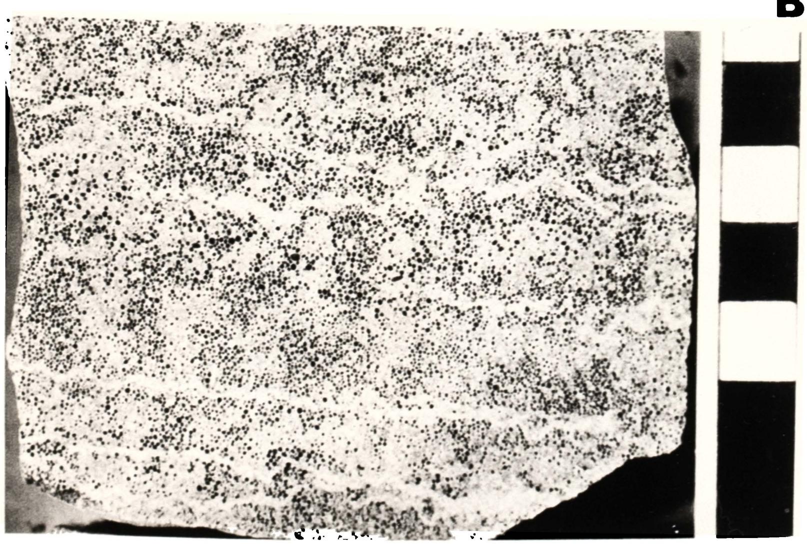
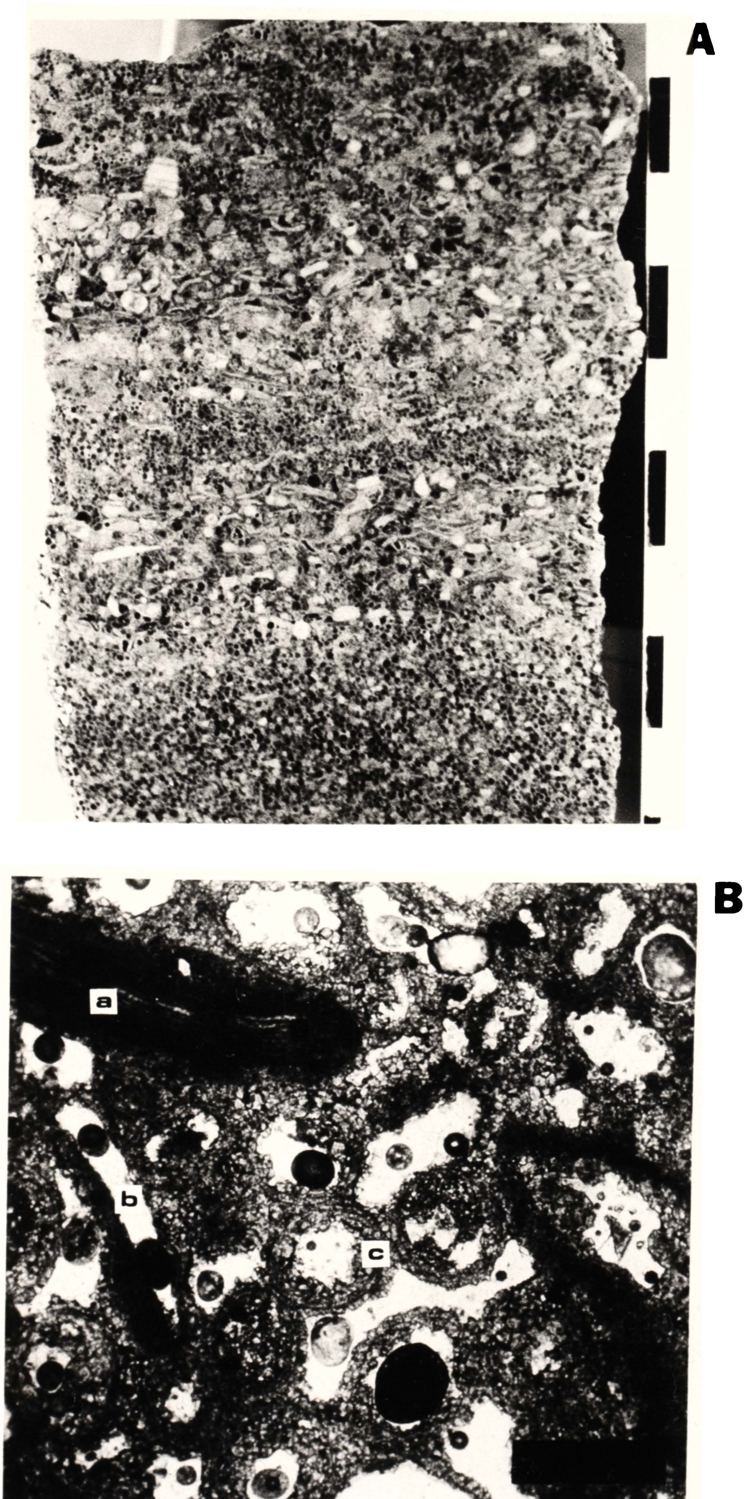


Figure 3.17. High-energy grainstone facies in the upper regressive carbonate.

A. Cities #E-2 Thompson, 4552.5 feet, slab photograph of upper portion of upper carbonate of K-Zone (Bar scale in centimeters). Oolitic grainstone alternates with intervals of abundant bioclastic grainstone consisting of primarily fragments of crinoids and bivalves. Most bioclasts have superficial oolitic coating. Molds of both ooids and bivalves are present. Scattered coarse dolomite fills some of the voids. Dogtooth calcite spar lines most pore space.

B. Cities Service #E-2 Thompson, 4554 feet, photomicrograph of top portion of the upper carbonate, K-Zone. Plane-polarized; bar scale is 1 mm. Neomorphosed and oomoldic grainstone contains well-preserved brachiopod fragment (a) and dissolved or recrystallized mollusc fragments recognizable only by outline (b). Intergranular porosity is common with some solution enhanced and rimmed by irregular, fine, blocky calicte spar. Concentric laminations in cortex of some ooids are still discernable as faint lines in fine calcite mozaic (c). Blue plastic impregnation of sample before thin sectioning did not contact these pores, suggesting that these do not represent effective porosity.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b
c

Figure 3.18. Restricted marine, shallow-water, facies faunal diversity. Slab photographs of cores; bar scale in centimeters.

A. Cities Service #F-5 Reese, 3455 to 3458 feet, slab photograph of the uppermost portion of the upper carbonate of the I-Zone. Top most portion of core is upper left and bottom is on lower right. Upper sample is mixed-clast carbonate conglomerate (a) with millimeter- to centimeter-sized particles of rounded, pitted carbonate pebbles and grains comprised of composite-pellet grainstone and unfossiliferous lime mudstone. Some grains have thin darkened rims. Matrix is vivid green shale. Underlying pieces are an _in situ_ breccia (b) of solution pitted, fitted clasts of lime mudstone with some darkened rim of brown microcrystalline calcite. Only fossils noted are scattered small bivalves at 3457 to 3457.5 feet. Vertical and horizontal fractures and solution channels (centimeter in diameter) cut the rock. Channels are filled with clasts of rock that border the void, green shale, and coarse clear calcite spar.

B. Cities Service #506W Dorr, 3347.8 feet, slab photograph of upper portion of upper carbonate of J-Zone. Upper 10 feet of this carbonate rock (3343 to 3353 feet) are unusually sparsely fossiliferous. Interval down to 3348 feet is dominated by pellet mudstone with rare gastropods. Slab is from bottom of dense brown lime mudstone cut by solution channels (a) that are filled by green shale or coarse clear calcite spar. Dark-gray intraclasts of mudstone in lighter mudstone (b) matrix forms lower half of slab.

C. Cities Service #506W Dorr, 3300.5 feet, slab photograph of uppermost portion of upper carbonate of H-Zone. Thin, uniformly laminated, tan to brown lime mudstone. Layers are disrupted by vertical, centimeter-sized cylinder (a) of mixed, more homogenous lime mudstone bounded by unturned edges of laminated mudstone. Laminations suggest algal stromatolite and cylinder resembles a fluid escape structure. Overlying laminations in adjacent slab are continuous over disrupted structure.

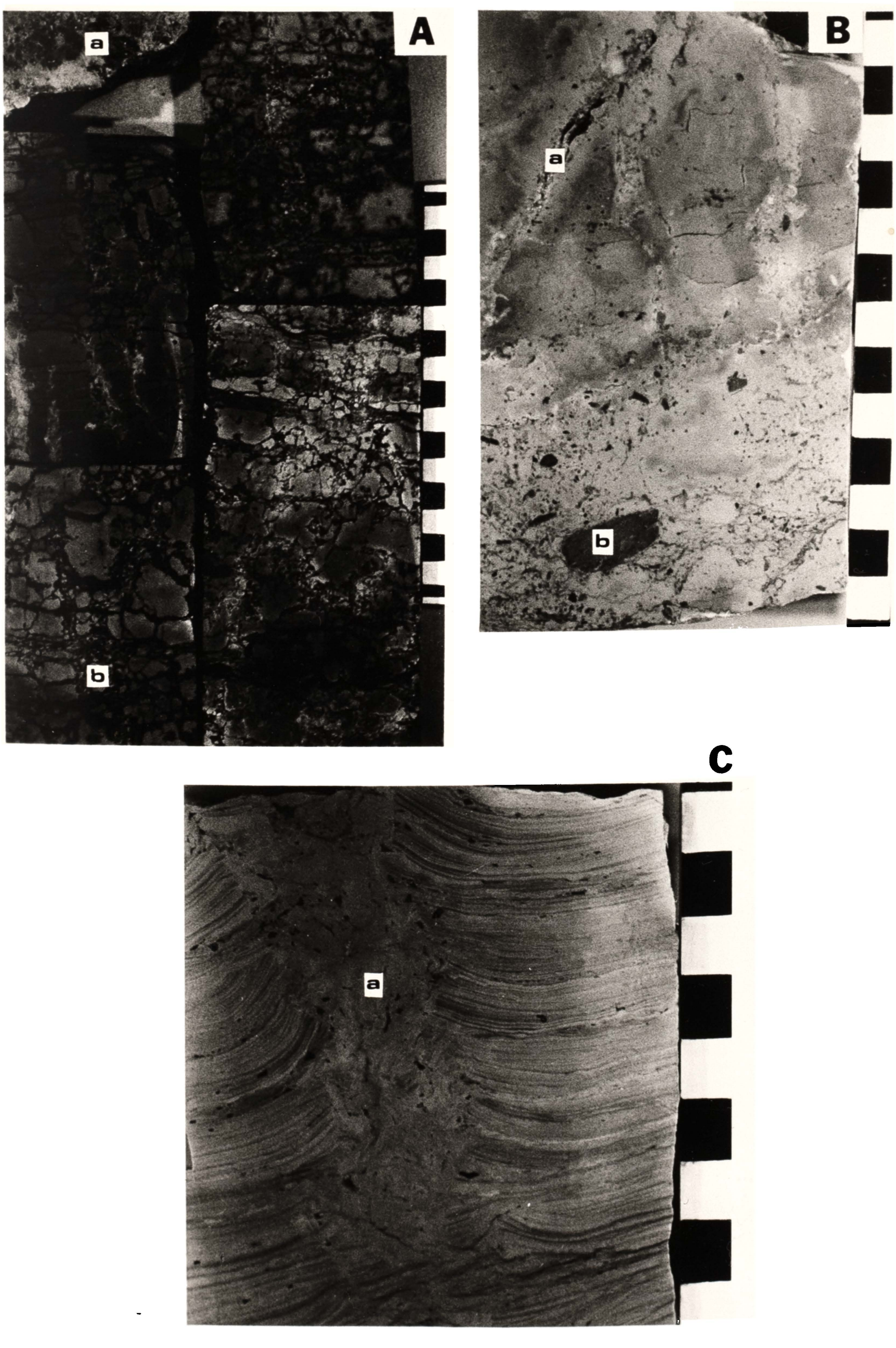
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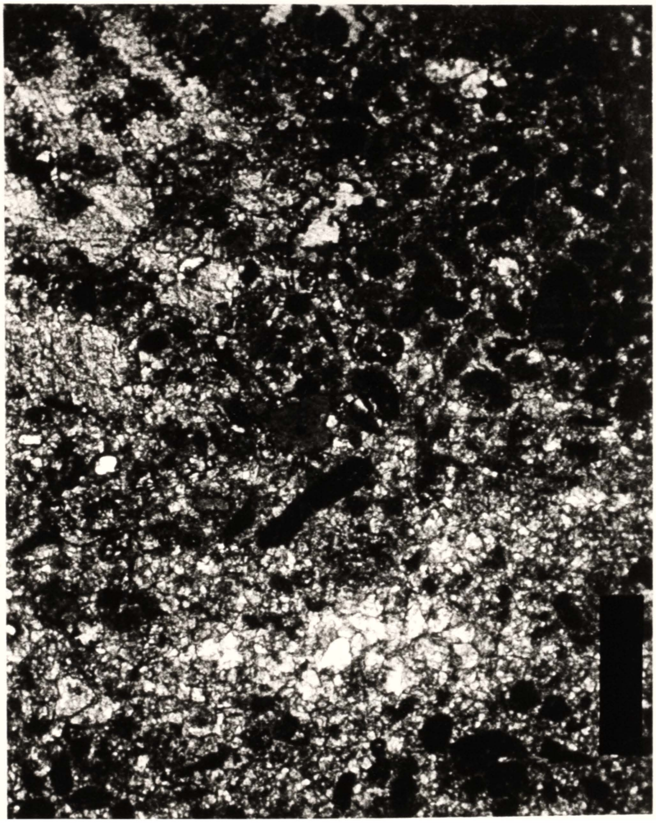
Figure 3.19. Low-faunal-diversity, restricted-marine, shallow-water, facies. Photomicrographs in plane-polarized light, 1 mm scale.

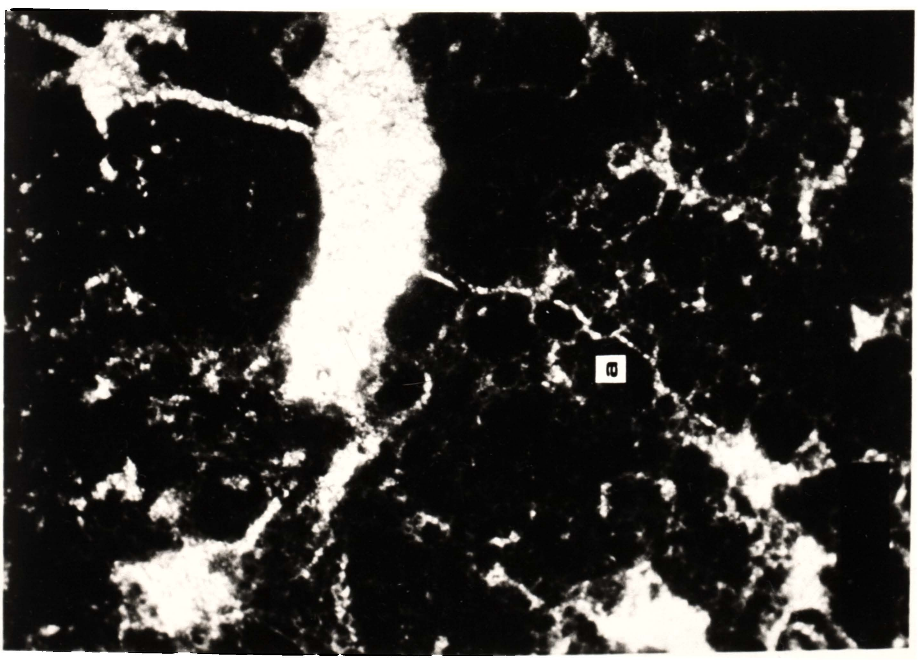
A. Conoco #11 Ainsworth, 2941 feet, uppermost portion of upper carbonate, I-Zone. Dolomitized mudstone breccia cut by solution channels. Matrix as seen here is clotted, granular, microcrytalline dolomite with fractures and vugs filled by sparry dolospar. Particulate matrix are delineated by variations in abundance of denser micritic dolomite (a) and fine dolospar. Fabric is similar to that described as circumgranular cracking by Wilson (1975).

B. KRM #2-X Lemon, 4763.2 feet. Upper portion of K-Zone upper carbonate. Peloidal grainstone contains medium crystalline calcite spar with patches of sparry Fe-dolomite replacement of grains and cement. Abundant sub-millimeter brown-yellow replacement chert are found in the unit.

B



A



tation of the distribution of favorable reservoir rock common to the upper part of the upper carbonate. The higher energy environments probably developed progressively across the shelf through time.

The CKU-CA structure was established earlier to have been a positive area on the shelf during the accumulation of these cyclothems. The Cahoj structure in Rawlins County is considerably smaller than the CKU-CA but was interpreted to have been an effective paleohigh with a marked influence on all facies of the upper part of the upper carbonate and on the extent of diagenetic overprinting (Watney, 1980). Although accumulations of skeletal grains are widespread over the shelf, it appears that the locations on the CKU-CA and positive areas like Cahoj offered the best opportunities for thicker accumulations involving more than one cyclothem.

Wave and current action on the upper portion of the shelf was limited (Watney, 1980, p.24). Locations most favorable for local accumulations of grains were on these local paleo highs that served to focus waves and currents. Highs may have resulted from carbonate buildups developed in the lower part of the regressive carbonate or from active structural uplift (see Watney, 1980, Figure 53).

Oolitic grainstone covered much of the southern shelf in the J and K-Zones. Oolitic grainstone is also present in the H- and I-Zones but is considerably more limited in areal distribution and thickness. If sediment aggradation and progradation were responsible for shallowing, it would be expected that the shallow-water intertidal and supratidal deposits would be thicker and the transition from open marine, subtidal facies to these facies would be more gradual.

The sediments that are commonly aggrading and locally prograding to fill the bays in south Florida are capped by a significant portion of supratidal island facies (Enos and Perkins, 1979) which resulted from shallow submergence of these carbonate platforms. In contrast, the proportionately thinner shallower-water sediments of the upper part of the upper carbonate relative to the entire thickness of the unit in these Pennsylvanian rocks suggest that perhaps the falling relative sea level may have been, in part, independent of processes related to sedimentation. The limited thickness but extreme areal extent of shallowest water deposits and rapid changes in the stratigraphic succession suggest that the rate of shallowing might have increased in the later portion of the cyclothem separately from any effects of sedimentation. These will be discussed in the next section. The upper carbonate is referred to as the regressive carbonate for reasons discussed above.

Diagenesis of Regressive (Upper) Carbonate

The diagenetic processes that affected these carbonate rocks are complex, and examples of almost all the common diagenetic realms have been recognized previously (Watney and Ebanks, 1978; Watney, 1980; Watney, 1984; and Heckel, 1984). Early freshwater diagenesis, in particular, has been recognized as a critical factor for the development of oil and gas reservoirs in the Lansing and Kansas City groups (Watney, 1980). Furthermore, knowledge of the diagenetic features may assist in resolving the environmental conditions that were active during the latest stages of accumulation of each zone.

Primary intergranular or possibly framework porosity produced by phylloid algae, albeit modified somewhat by diagenesis, provided the best opportunities for the development of permeability (Watney, 1980; Ebanks and Watney, in press; Hopkins, 1977; Pray and Wray, 1963). Understanding the distribution of grain-supported carbonates is also a key ingredient to locating oil and gas prospects in western Kansas (Brown, 1963; Watney, 1980).

Longman (1980) summarized petrographic criteria for recognizing various diagenetic conditions (Table 10). Heckel (1983) has proposed a model that relates the types and levels of diagenesis within the Pennsylvanian cyclic carbonates of the Midcontinent. Relevant features are cements, carbonate crusts of probable subaerial origin associated with root casts (pedotubles) and diagenetic overprinting, respectively (Figs. 3.20-3.25). Carbonate crusts are always at the top or very upper part of the regressive carbonate resting sharply on contrasting carbonate textures. The crusts are also associated with root casts, desiccation and weathering features, internal sediment, and an upper unfossiliferous shale that commonly contains paleosoil features like calichification (nodular microcrystalline calcite and dolomite) resting on top of the upper carbonate. This association plus the strong resemblance of the carbonate to caliche has resulted in its classification as a caliche crust as discussed further below.

Diagenetic overprinting includes irregular micritic, caliche-like cements, and irregular, meniscus, pendant, blocky, and sparry

Table 10. Carbonate Diagenesis: A Summary of Criteria Commonly Used to Interprete Diagenetic Environments

A. Diagenetic Realms

Include shallow, submarine diagenesis; meteoric diagenesis (vadose, phreatic); burial

B. Cement Fabric Recognition Criteria (Longman, 1980;

Heckel, 1983):

1. Marine diagenesis - a) isopachous fibrous aragonitic cement with long axes perpendicular to boundaries of pore wall (##)

2. Meteoric phreatic - equant calcite, isopachous bladed calcite, sparry calcite, syntaxial overgrowth calcite (#)

3. Meteoric vadose - (minor cementation) meniscus sparry to micritic calcite, pendant spar to equant calcite, irregularly distributed equant calcite cement (##).

4. Deep subsurface - generally Fe-rich, coarsely crystalline calcite or Fe saddle dolomite (#).

D. Changes in porosity in Missourian carbonates in western Kansas as a result of diagenesis:

1. Marine diagenesis - decline in primary porosity (##).

2. Meteoric phreatic diagenesis - variable effect on magnitude and distribution of porosity (##).

3. Meteoric vadose diagensis - as (2) with range from extensive dissolution to calcite precipitation; internal (vadose) sediment (#).

4. Deep subsurface - gradual porosity decline with cementation and compaction (#).

E. Acessary changes occurring during diagenesis:

1. Marine - prolonged exposure of grains on sea floor without significant cementation resulting in micritization of these grains by endolithic organisms; bioturbation - breaking grains, destroying stratification, as well as mixing mud-rich and grain-rich sediments; pyritization

of grains and precipitation of glauconite are common to periods of slow rates of deposition (*).

2. Meteoric phreatic - Neomorphism including frequent recrystallization of lime mud to microcrystalline calcite spar and locally dolomicrospar (probably through replace ment). Both varieties of microspar commonly increase porosity and enhance permeability relative to replaced micrite. Also discontinuous (anastomosing) yet discrete fractures appear to occur in part as the result of differential dissolution or compaction in this environment. Fractures are commonly facies specific and probably reflect zones which are lithified earlier than the surrounding units as the result of fabric. Solution channels are probably in part developed during this stage under physico-chemical conditions similar to that of cave formation. In situ breccias and conglomerates reflect even more intense processes of freshwater corrosion on the carbonates. Furthermore, red silicified grains or matrix are common in the carbonates and are thought to result from precipitation in shallow, oxidizing meteoric phreatic conditions.

3. Meteoric vadose - diagnostic cement types of this diagenetic environment are key elements to discerning early subaerial exposure and vadose conditions that affected these rocks. In particular, the documentation of subaerial crusts has recently been in vogue. Numerous articles have characterized a variety of subenvironments occurring during subaerial exposure that produce identifiable variations in the texture of the crusts. Associated plant-root structures are further evidence of prolonged exposure. Diagenetic breccias, conglomerates, and microkarst resulting from extended exposure are also key features.

   Diagenetic overprinting is a sensitive record of processes that developed late in the regressive portions of these cyclothems proceeding normal marine carbonate accumulation. The recognition of overprinting is important as diagnostic evidence such as fossils and sedimentary structures are consequently lacking.

Abundance (interpretations in accordance with Longman (1980):

(*) <u>COMMON</u> (**) <u>RARE</u> in rocks in the study area

Figure 3.20. Carbonate cements. Photomicrographs in plane-polarized light.

A. Clinton #2-D Stegman, 3393 feet, near top of upper carbonate of I-Zone. Bar scale equals 0.5 mm. Porous oil-stained grainstone contains with good inter-particle porosity with fine, blocky, irregularly distributed fringing cement followed by much coarser Fe-calcite spar shown here with euhedral crystal termination (bottom center). Black areas are oil in interstitial porosity.

B. Tideway #1 Beauchamp, 3933.7 feet, immediately below top surface of upper carbonate of the H-Zone (subaerial crust). Bar scale is 0.5 mm. Photo taken with cross-polarized light. Fibrous calcite cement forms a pendant beneath a crinoid fragment separated from crinoid by a thin micrite rim. Note that crinoid is at extinction and cement is not providing evidence that these are not in optical continuity. The edges of this pendant have been etched and coated with dark brown microcrystalline calcite cement (opaque rind) very similar to that in the overlying caliche subaerial crust. Pendant cement is perhaps a vadose cement developed during initial exposure of sediment in marine or freshwater conditions. During continued exposure partial solution of the existing carbonate sediment and cement occurred followed by precipitation of the micritic cement.

C. Tideway #1 Beauchamp, 3933.7 feet. Bar scale equals 1 mm. Oolitic grainstone lies immediately beneath subaerial crust. Photo shows pendants of faintly, irregularly laminated to dense, micritic calcite cement (a) beneath several coarse calcite spar-filled oolites and bioclasts. Note fibrous pendant calcite (b) cement beneath an optically extinct bioclast (crinoid?).

D. Conoco #9 Morel, 3612.5 feet, immediately below nodular caliche of upper carbonate of K-Zone. Bar scale is 1 mm. Photomicrograph illustrates dissolution of grains and micritic matrix preceded first cement forming large secondary pores. Clast-like nodular areas now consist of micritized recrystallized bioclasts (a) and clotted slightly silty micrite (b). Cementation consists of very thin light gray microcrystalline dolomite cement (d) irregularly distributed around particles. Dark, dense micrite rims (endolithic algal borings) partially surround some carbonate clasts (c). This is followed by a layer of isopachous drusy cement (e) which is followed by void-filling coarse crystalline Fe-calcite (f). Large pores now filled by calcite spar highlighted by dark microcrystalline cement resemble reticulate channels even in thin section. They do not resemble a typical intergranular pore system but rather solution enhanced pores associated with dissolution of grain and matrix. The development of the porosity and the later precipitation of the finely crystalline (dense, micritic) cement are concluded to be associated with the development of the overlying subaerial crust.

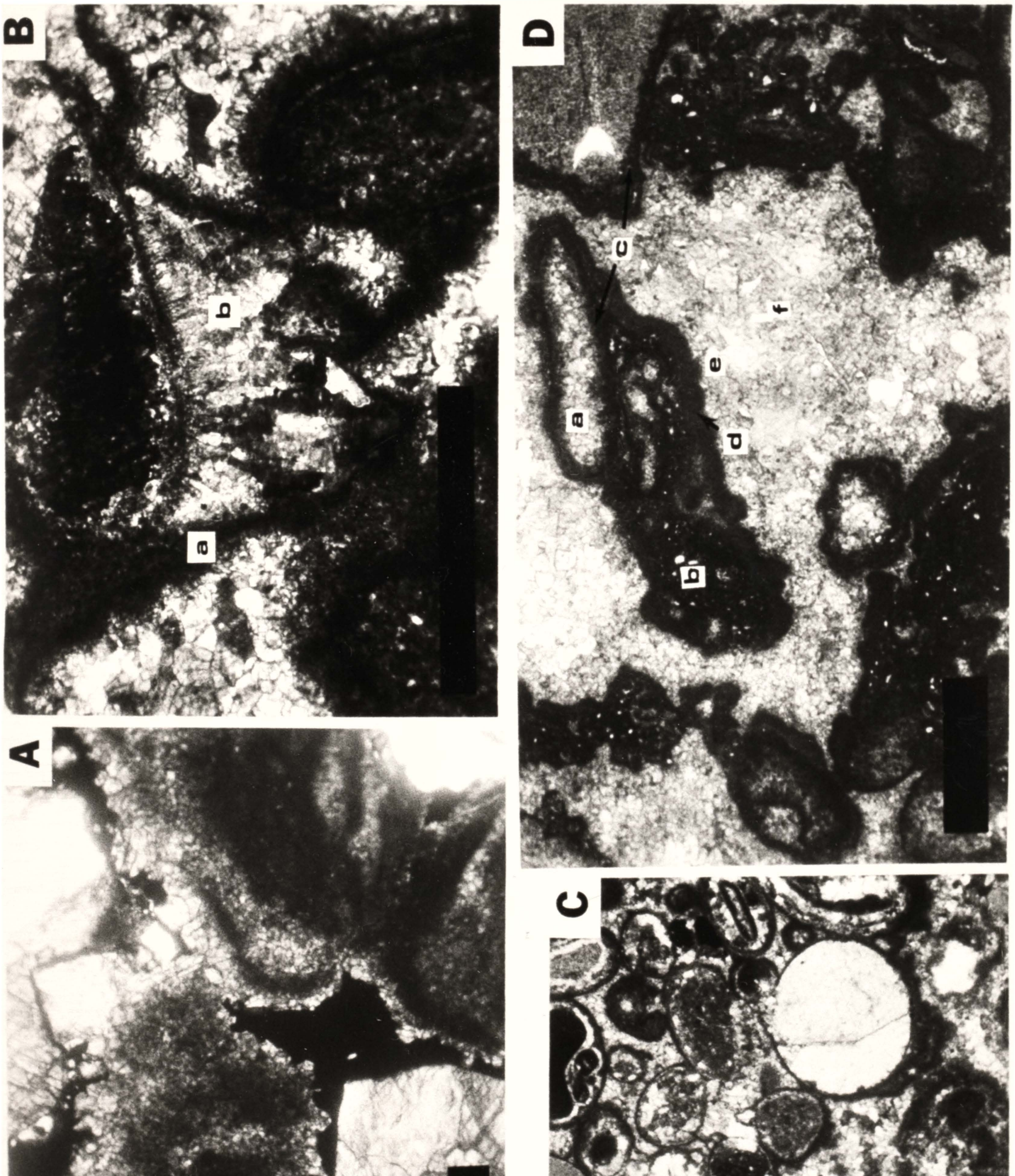

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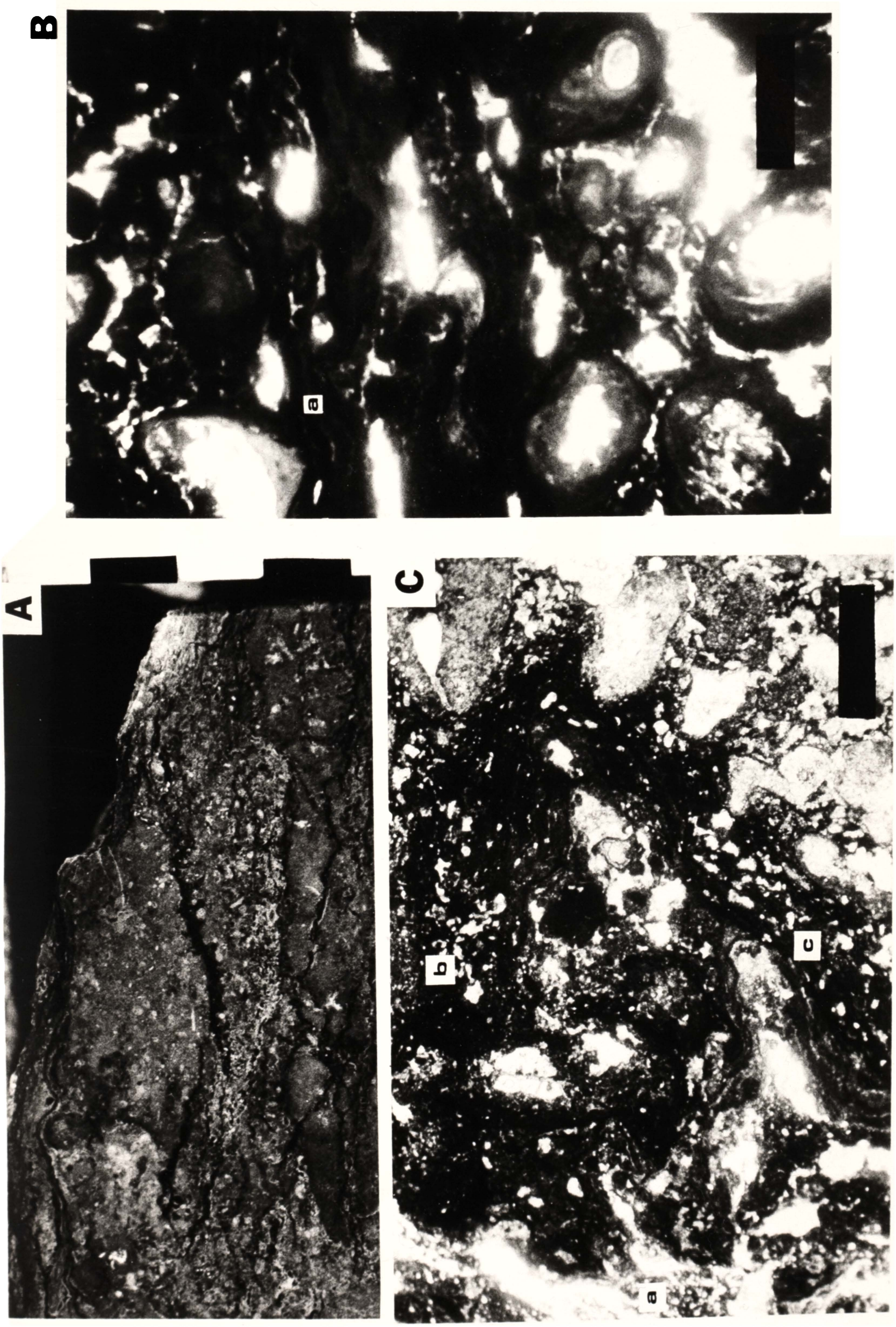
Figure 3.21. Caliche carbonate crusts and associated evidence for subaerial diagenesis.

A. Clinton #2-D Stegman, 3425 feet, upper contact of upper carbonate of K-Zone. Bar scale in centimeters. Slab photograph illustrates millimeter-thick, multiple laminated caliche crusts (top left) in pellet bioclast packstone. Particles are heavily overcompacted and cemented.

B. Clinton #2-D Stegman, 3425.1 feet, same position as in A. Photomicrograph (plane-polarized light) of dense brown crinkly laminated, pelleted microcrystalline calcite cement (a) comprising layer of caliche. Dense brown cement surrounds heavily micritized and solution-altered and rounded grains. Bottom of crust (not shown) is sharp. Scale is one millimeter.

C. Conoco #9 Morel, 3612 feet, photomicrograph (plane-polarized, 1 mm bar scale) of top portion of the upper carbonate, K-Zone. Underside of laminated to granular caliche layer exhibiting irregular, centimeter-sized relief. Vertically oriented caliche with horizontal extension on left quarter of photograph is composed of patchy brown microcrystalliine calcite. Pocket shown has roof and floor defined by dark laminated calcite in contact with a bioclastic grainstone. Notice tubular structure outlined by internal laminations in lower portion of the pocket of caliche.


B
a
A
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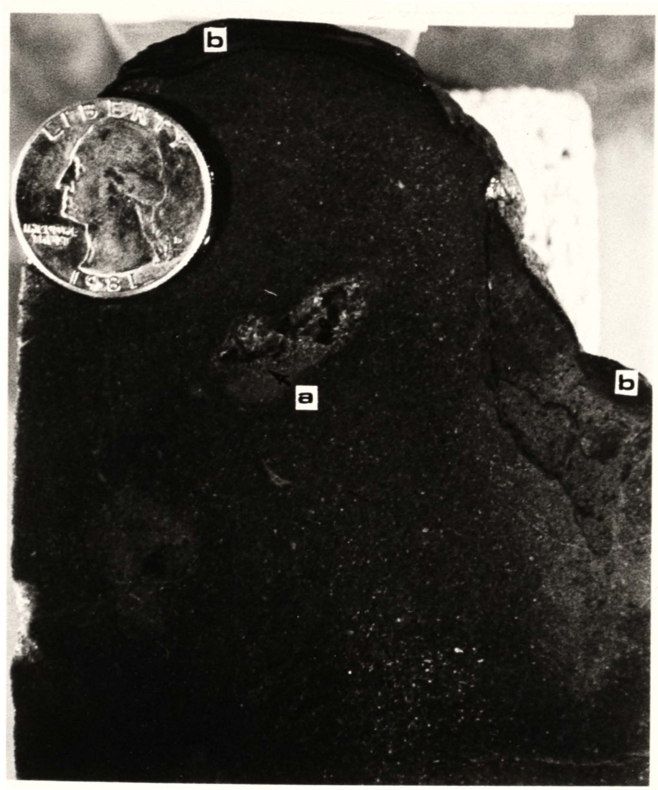
c
a

Figure 3.22. Caliche carbonate crusts (continued).

A. KRM #6 Lemon, 4780.5 feet, slab photograph of top contact of upper carbonate of K-Zone. Brown to dark-brown oolite, solidly cemented and cut by solution channels. Centimeter-sized cavity (center) is partly filled by layer of lighter-colored quartz siltstone and ooids (a). Upper surface is a laminated subaerial crust 2 to 3 millimeters thick, (b). Crust is found on all portions of the uneven upper surface and is overlain by a gray-green argillaceous, unfossiliferous siltstone. U.S. quarter is 2.4 centimeters in diameter.

B. Tideway #1 Beauchamp, 3933.7 feet. Near top of upper carbonate of H-Zone. Photomicrograph (plane-polarized, bar scale is 1 mm) of peloid, subaerial caliche crust comprised of dark-brown microcrystalline calcite resting sharply on an oolitic grainstone.



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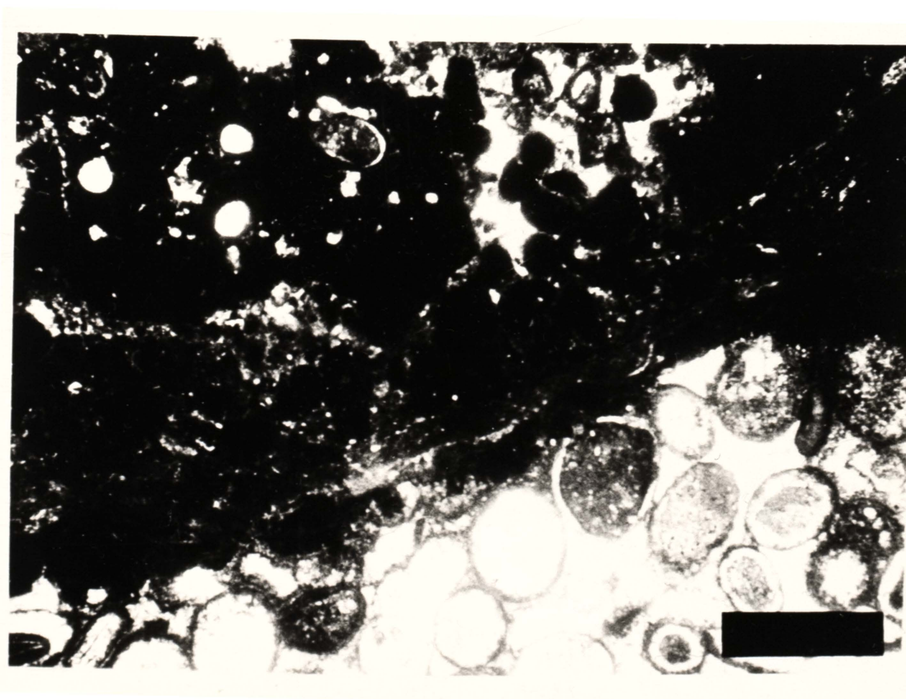


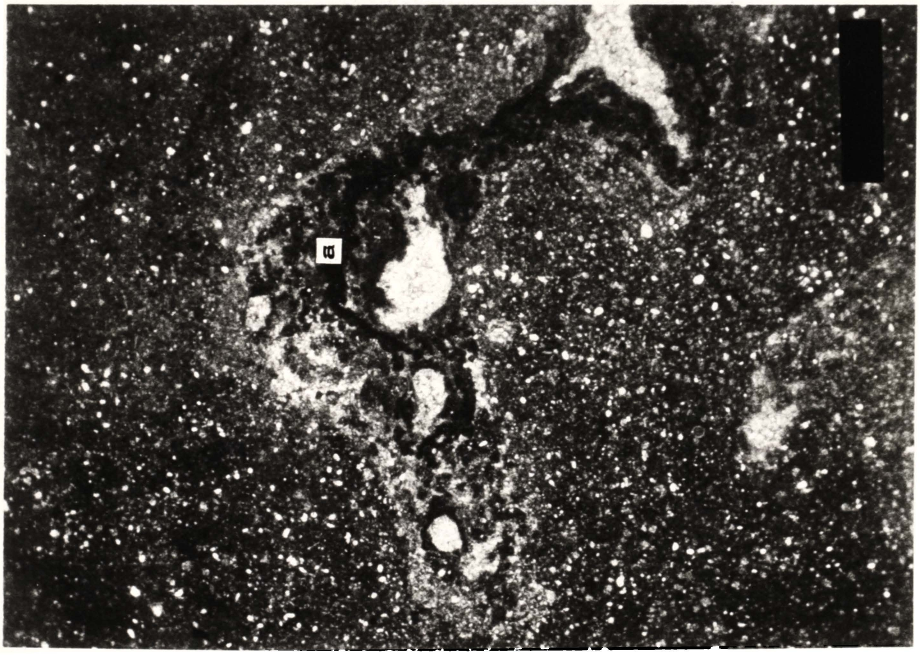
B

Figure 3.23. Pedotubules developed in association with paleosols. Photomicrographs, plane-polarized, bar scale equals 1 mm.

A. Tideway #1 Beauchamp, 3965.5 feet. Photomicrograph from uppermost portion of H-Zone. Pedotubule preserved in a dolomitized ostracod, bivalve, foraminiferal spiculitic packstone. Notice scalloped surface (a) of void conforming to particles around the wall as if they were pushed aside. Upper and lower surface of interior of void lined by plastered clay (b) interpreted as a oriented clay cutan commonly associated with root tubules. Void is filled by Fe-calcite. Rock is an _in situ_ breccia with fractures and solution channels filled by interval quartz silt, forming geopetal structures. Fenestral fabric is also common.

B. Pan American #B-6 Ohlson, 3134 feet. Photomicrograph of longitudinal cut along a pedotubule immediately below subaerial caliche crust capping upper carbonate of J-Zone. Tubules are surrounded by dense peloidal microcrystalline calcite (a). Matrix is unfossiliferous, silty peloid lime mudstone.

B



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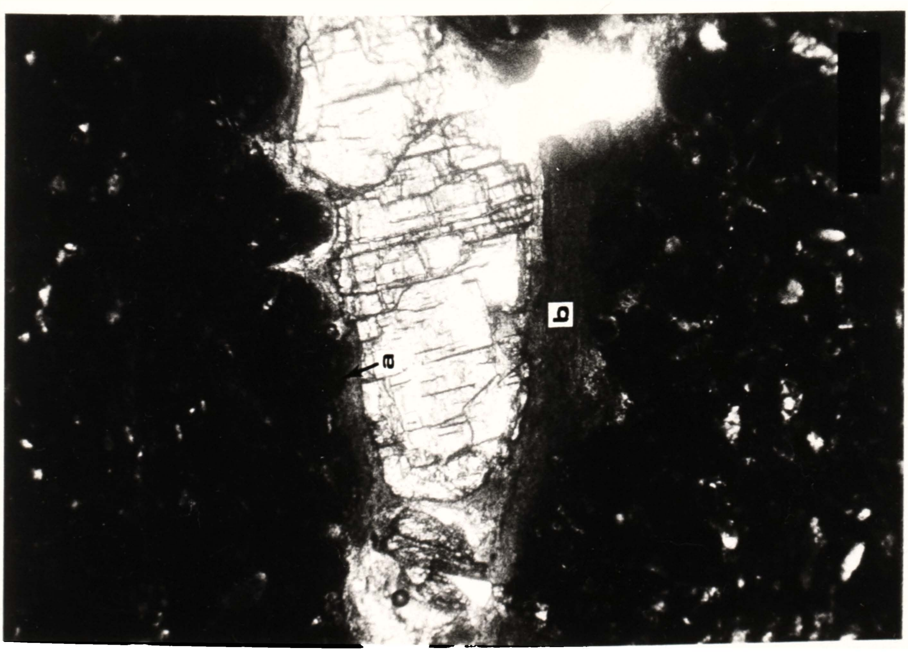


Figure 3.24. Pedotubules developed in association with paleosols.

A. KRM #3 Rhoades, 4769.5 feet. Photomicrograph (plane-polarized, 1 mm bar scale) from top portion of upper carbonate of K-Zone. Transverse sections of pedotubules in quartz silty argillaceous dolomicrite. Tubules surrounded by dense microcrystalline dolomite (A) and voids rimmed by fine crystalline non Fe-dolospar and then filled by Fe-calcite. Darkened rims interpreted as caliche cement precipitated during exposure of sediment. Irregular patches of medium crystalline Fe-calcite with rhombs of Fe-dolomite are also present. Diffuse boundaries of these patches against surrounding rock (B) and inclusions of matrix suggest that these are replacement features.

B. KRM #2-X Lemon, 4762.5 feet, slab photograph (bar scale in centimeters) from uppermost K-Zone. Irregularly bedded-mottled tan to light gray unfossiliferous dolomicrite with wispy and lenticular intervals of green silty shale. Millimeter-sized tubules surrounded by dark brown microcrystalline dolomite. Tubules filled by sparry carbonate. Carbonate sediment probably underwent solution compaction resulting from infiltration of undersaturated waters. During same period, sediment was exposed and cut by pedotubules that are preserved because of early cementation around tubules.

B

A

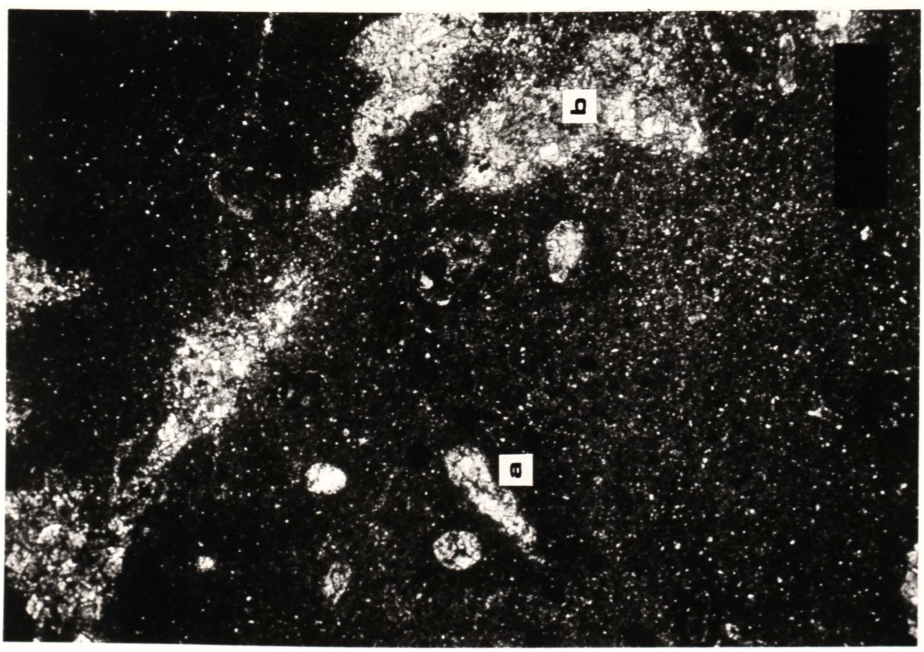
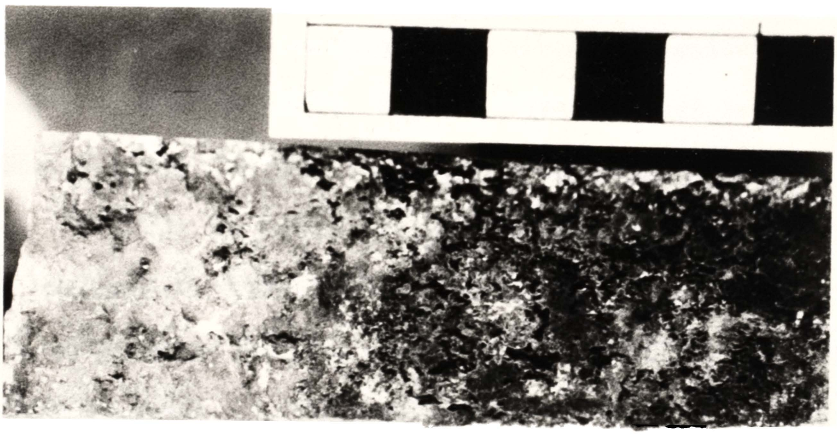


Figure 3.25. Other examples of carbonate diagenesis.

A. and B. Conoco #9 Morel, 3604 feet. Slab photograph (bar scale is in centimeters) of base of packstone in middle portion of upper carbonate, J-Zone. Three sets of vertical, open fractures cut the core approximately 2 centimeters apart including left side of core in A. A side view of core looking at surface of fracture is shown in B. Coarse crystalline calcite with corroded, Fe-oxide stained surfaces lines the fracture. Note curved and discontinous nature of fractures suggesting some minor-compressional deformation of the fractures after formation. Overlying I-Zone is similarly fractured.

B



A

crystalline calcite cements (Fig. 3.20). Vadose sediment in solution cavities is also common. Diagenetic breccias and conglomerates are restricted to the northern shelf and over the CA and portions of the CKU. Root casts, caliche mottling, and associated caliche crusts are also present across the shelf, but these features are less pronounced in carbonates along the southern part of the study area (Figs. 3.21 and 3.22). In fact, in the southern area the crusts and calichification are commonly restricted to millimeter-sized features and are difficult to identify in core, to say nothing of cuttings. Study in thin section is essential for confirmation of these thin, poorly developed crusts.

The dominant high-energy, grain-supported facies in the upper portion of the regressive carbonate in the southwestern part of the study area is oolite. Most oolitic zones were leached to form oomoldic porosity. The mobilized calcium carbonate apparently moved only far enough to be precipitated as freshwater cements in the immediately adjacent void space, eventually plugging the pores. Thus, an avenue commonly does not exist for fluid to flow through these rocks outside of limited fractures and vugs (Figs. 3.16 and 3.17). In this case, early diagenesis degraded the reservoir properties; locally further leaching and fracturing restored reservoir quality.

The carbonate reservoirs in the northernmost portion of the study area and southern Nebraska are characterized by early development of secondary porosity in both grain-supported carbonates and micritic units (Watney, 1981; DuBois, 1979; Prather, 1981). Subaerial exposure and concurrent freshwater diagnesis are clearly evident in these reservoirs. Striking evidence of early freshwater diagenesis includes red-brown, silty, shale-filled solution fissures cutting down to 20 feet (6 m) below the top of the carbonate; eroded tops of carbonates with thick, mixed-pebble carbonate conglomerates; and pervasive infiltration of quartz silt along solution cavities extending downward to several feet into the carbonates. Void-filling internal sediment terminates abruptly downward in one core leaving open pores below the level interpreted as a paleowater table (Ebanks and Watney, in press). DuBois (1979) described a persistent but thin layer of reddish chert near the middle of the regressive carbonate in the Republican River field in Hitchcock County, Nebraska. This chert may represent a previous water table where silica, mobilized from the calichification process, precipitated at the top of the phreatic zone, possibly as a result of an abrupt decrease in the pH of the water.

Locally anhydrite laths replace micrite or fill voids. The anhydrite may have resulted from elevated sulfate concentrations in meteoric waters during exposure. Calichification and extensive oxidation imply semi-arid climatic conditions (Reeves, 1970) during this time along the northern shelf. This would be consistent with the temporary existence of sulfate-rich surface waters to form anhydrite.

The net effect of subaerial exposure and freshwater percolation on the northern shelf was to leach matrix and grains, frequently greatly disturbing the original fabric and producing irregular solution cavities and zones with molds, vugs, and granular-crystalline porosity (Watney, 1980). Fractured, leached, and recrystallized micrites are common in reservoirs in this area. Although the entire interval of the upper carbonate is susceptible to leaching, the best and most common development of porosity occurs in association with grain-supported textures.

Intense early diagenesis also persisted over much of the CA and CKU in all of the cyclothems examined in the Kansas City Group. Intense freshwater diagenesis is indicated by the development of in situ breccias, solution channels, and early fracturing. Carbonates on the CA and CKU are commonly less shaley and regressive shales overlying each regressive carbonate are decidedly thinner, particularly to the south. These conditions are favorable for dissolution of carbonate rock and formation of porosity with less opportunity for percolation of shale into the voids. The persistence of the CA and CKU as positive areas on the shelf throughout the accumulation of the cyclothems is a significant factor in the development of large Lansing-Kansas City reservoirs over these areas.

Southwestward across the shelf, early diagenesis is less evident. Large solution cavities, breccias, and conglomerates are missing. Instead, subtle criteria indicating local subaerial exposure and active early diagenesis by waters undersaturated with respect to calcium carbonate include vugs, molds, and minor solution cavities, some with caliche-like calcite coatings containing internal quartz silt especially at the very tops of the carbonates. Thin, subaerial crusts and root casts are also found in this region. These are associated with various carbonate cements that resulted from this diagenetic environment--blocky and dogtooth, irregular and isopachous calcite cement, and occasionally bladed, blocky, or micritic pendant and meniscus cements (Fig. 3.20). The extent of diagenesis diminishes downward from the top of the upper carbonate. In contrast to the areas to the north, the micritic portions of this carbonate are not prospective reservoir rocks because the early diagenesis is less intense.

In addition to compaction some solution must have occurred along wispy shale (microstylolites) that commonly wraps around cleaner carbonate in what are interpreted as burrows. Shale wisps in the matrix have converged and wrap around the less argillaceous carbonate mottles. For example, crinoid fragments that have sutured contacts penetrate the edge of a burrow with a thin layer of clay pressed between them.

Calichification

The formation of caliche occurred here during early emergence in a marginal marine or continental setting analogous to that described by James (1972) and Esteban and Klappa (1983). Finely crystalline calcitic (micritc) cement episodically precipitated in existing voids as water chemistry changed in a vadose environment during weathering of the carbonate sediment. Supersaturation and undersaturation were recurrent as water evaporated or carbon dioxide was taken up by plants. In general, caliche or calcrete can be formed as a purely accretionary deposit on the surface of a carbonate (Multer and Hoffmeister, 1968) or internally in the sediment by precipitation or replacement as finely crystalline calcite. The processes can be associated strictly with soil formation (Gile et al, 1966) or may be a more direct product of biogenic activity, for example, from growth of lichen (Klappa, 1979) or calcification of algal mats (Krumbein and Giele, 1979). Their distinction from what would be called stromatolites is described by Read (1978).

Laminated crusts are especially common and are very similar to those described in Holocene and Pleistocene carbonates by Multer and Hoffmeister (1968) and Coniglio and Harrison (1983) as subaerial caliche crusts. The laminae consist of wavy to crinkly alternations of less than 0.5 millimeter brown and tan microcrystalline calcite. Nodular and irregular caliche cut by subhorizontal cracks filled by peloidal calcite is also commonly associated with the laminated zones, again very similar to examples previously described in Recent sediments (Hay and Wiggins, 1980) (Figs. 3.21 and 3.22).

The carbonate microfabric associated with the caliche cement itself provides evidence suggesting subaerial exposure. The association of the cement with molds and vugs, circumgranular and sheet cracks, intimate association with tubular voids interpreted as root casts, microkarst (Read and Grover, 1977), and internal sediment partly filling solution voids all suggest a near-surface, fluctuating, vadose and phreatic groundwater environment with meteoric water alternately undersaturated and supersaturated with respect to calcium carbonate. The lack of significant evaporites precludes any prolonged hypersaline conditions with the exception of an occurrence in southern Nebraska where nodular anhydrite is locally developed (H-Zone, Prather, 1981).

The typical overlying red silty upper shale that has been interpreted as a paleosol (Watney, 1980) suggests, at least during the time when upper shale was deposited in the cyclothem, that the shelf was emergent, probably with a semiarid climate similar to that existing today in west Texas (Reeves, 1970). Low-relief topography associated with the region to the north of the study area and semiarid climatic conditions help to explain the lack of significant clastic deposition in the study area. Rather, coarser clastics were deposited proximal to these distant positive areas.

Diagenetically, the presence of caliche is significant. It is associated with the latest stage in the accumulation of the cyclothem when marine deposition was ending and poorly preserved and thin continental deposition was beginning. It is probable that portions of the regressive carbonate have been eroded locally, but other than the conglomerates along the extreme northern study area, evidence for any significant erosion is nil. This is suggested by occasional lithoclasts preserved at the top of the regressive carbonates. Subaerial crusts of laminated caliche that now cap the regressive carbonate may have succeeded the weathering and loss of the uppermost, less resistant carbonate sediments. Local carbonate-pebble conglomerates and apparent channeling on the northern shelf indicate that erosion locally extended downward at least 10 feet (3 m) (DuBois, 1979; Watney, 1980).

Although laminated caliche has been recognized in oolitic grainstone facies, another form of calichification is also noted. A cement is similar in texture and color to what is described as caliche. Brown, locally microlaminated, microcrystalline cement coats solution pores and forms pendants beneath grains (Fig. 3.20). Commonly associated with these microcrystalline cements are voids that are solution-enhanced interparticle pores. These voids have a unique reticulate shape. This pore structure has been noted particularly in cores of the H-Zone of the Tideway #1 Beauchamp (Fig. 3.20 B) and the K-Zone of the Texaco #1 Litsey and Clinton #2-D Stegman and from widely scattered areas on the shelf. The microfabric of the cement is analogous to caliche surrounding root casts and even more so the dense, crinkly laminated caliche in the subaerial crusts. The pendant shape suggests its formation in a hanging water droplet beneath a grain. The association with a caliche crust strongly suggests a subaerial origin of this rather unique cement.

Dolomitization

Another important form of diagenetic overprinting of these carbonate rocks is dolomitization. Dolomite on the northern shelf is most abundant in the upper portion of the regressive carbonate, where it is microcrystalline and has selectively replaced both micritic matrix and grains. The formation of moldic porosity and very fine intracrystalline porosity was not unusual. Only infrequently was more than the upper portion of the carbonate dolomitized. Ferroan dolospar, commonly milky translucent with undulose extinction, is abundant in pores. This coarse crystalline dolomite occludes vuggy, oomoldic, and intergranular porosity in the southern part of the study area. It also commonly replaced grains and fills existing pores resulting in a poikilotopic habit. This ferroan dolomite succeeds an earlier, finely crystalline, rim-distributed calcite cement. It preceded the coarser calcite cement and generally has a very patchy distribution.

The concentration of dolospar in the southern area was perhaps related to mixing between meteoric waters infiltrating the sediments on the exposed shelf and migrating southward to pass laterally through the carbonate layer, particularly through the abundant oolitic grainstones. During this migration the water slowly precipitated dolomite as mixing and displacement of the saline connate water occurred. This is similar in principle to the observations and conclusions of Land (1973) and Badiozamani (1973) who invoked low-salinity water with relatively low Mg:Ca ratio compared to seawater for dolomitization. Formation of secondary pores, recrystallization of the lime mud, and the precipitation of the initial calcite cement preceded the dolomitization. The dolomite appears to be a later, more passive filler of pores and not closely associated with the processes of pore formation.

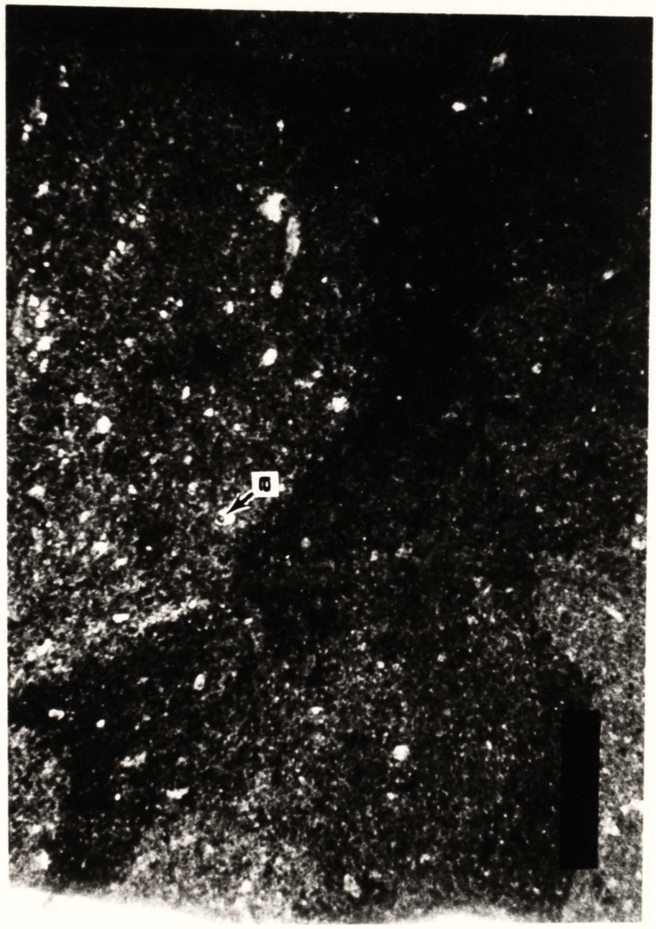
Choquette and Steinen (1980) attributed microcrystalline dolomitization of lime mudstone and wackestone underlying lenses of ooid grainstone, comparable to dolomitization on the upper shelf of this study, to meteoric and marine water mixing. Another dolomite des-

Figure 3.26. Other examples of carbonate diagenesis.

A. Texaco #4 Litsey, 3754 feet, slab photograph (bar scale in centimeters) of middle portion of upper carbonate of K-Zone. Light brown lime mudstone contains dark brown rounded centimeter-sized mottling, some rimmed by buff microgranular calcite. Also dark-brown calcite, open or spar-filled fractures, and sutured stylolites are abundant.

B. Cities Service #D-2 Conover, 4597 feet, Photomicrograph (plane-polarized, bar scale 1 mm) from similar zone as in A. Calcite microspar matrix with pinpoint-sized vugs (a). Mottled light and dark with diffuse boundaries between them is unlike that suggested at larger scale in slab photograph above.

B



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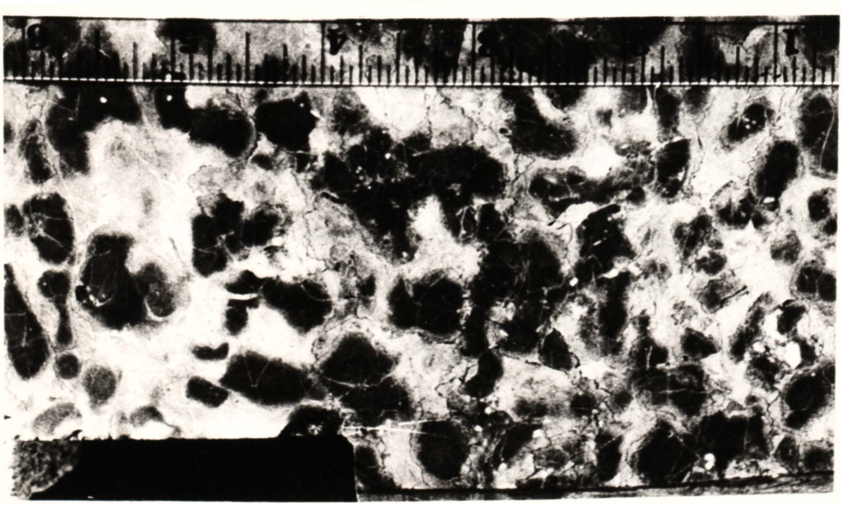


cribed by these workers is perhaps analogous to the coarse dolomite so abundant on the southern shelf. This dolomite was interpreted as a deep-phreatic, late-generation cement that is coarse, equant, and iron rich. It apparently, however, preceded the deep burial of the strata and the development of stylolites. In western Kansas the precipitation of dolomite before the coarse calcite which may be associated with latest stage solution and styolitization of the carbonate rock during deeper burial is compatible with the observations of their study.

Intense Recrystallization

The mudstones and wackestones that directly underlie the thick oolitic grainstones in the southern study area are recrystallized to centimeter-sized, mottled, oval-shaped patches of brown microspar. The resulting mottled pattern affects over fifty percent of the rock in some cases (Fig. 3.26 A). The recrystallized rock is gray and commonly rimmed by darker, more argillaceous microgranular spar that is locally dolomitic. The altered áreas contain barely discernible molds of shells and small vugs in a patchy microgranular calcite that formed by partial recrystallization of micrite. The successive stages of this diagenesis include fractures, fossil-molds and vugs, and finally recrystallization of the micrite to micro- and granular spar. This typically results in the formation of small, erratically distributed mostly unconnected pores. Consequently, the rock is generally nonpermeable and is not a good reservoir facies.

Similar diagenesis has occurred in the Bethany Falls Limestone in the outcrop in southeastern Kansas. The fact that in both cases closely related facies underwent similar diagenesis suggests that the high porosity of oolite may have provided an avenue for movement of fluid that percolated down into the underlying mudstone and wackestone, altering lime mud as well as the oolite. Undersaturated waters could have caused the dissolution of oolites and recrystallization of lime mud to micro- and granular spar. This extensive oolite facies must have been an important hydrologic unit during late regression.

Depositional and Early Diagenetic Environment of the Regressive (Upper) Carbonate and Implications Regarding Development of Cycles

Locally on the northern shelf the lower part of the regressive carbonate rock is punctuated by thin intervals of grainstone or packstone composed of abraded mixtures of skeletal fragments within a wackestone matrix. Storm waves with relatively deep penetration may have produced these thin, washed layers. DuBois (1979), however, suggested that some of these grainstones represent correlative minor regressive and transgressive events based on their occurrence in 30 cores from this study area. More of these shoal-water deposits would be expected on the northern shelf, if the water level was lower during deposition of these generally subtidal carbonate rocks.

Shallower water on the northern shelf is also suggested by the frequent intervals of light-colored, strikingly bioturbated, silty and argillaceous carbonate rocks containing scattered but diverse marine fossils. This facies is distincly different from the dark micrites of the southern shelf that are broken by layers of dark gray to black shale. The maps described later will be used to describe the transition from the northern to the southern shelf based upon associated thickness and facies changes.

The dark micrites on the southern shelf are considered to be part of an extended transition from stagnant water conditions to increasingly more normal, open-marine environments. With continuous core samples available from only the upper interval of this facies, it is not possible to detail the exact nature of this transition. Wireline logs suggest that 10 to 30 percent of the regressive carbonate is of this facies in the south.

While an established oxygenated water column developed on the northern shelf, the southern shelf was perhaps still deep enough to have intermittent bottom stagnation and low oxygen (dysaerobic) conditions developed in the lower water column. Broken but unabraded invertebrate fossils in the lower part of the regressive carbonate may simply represent lag deposits associated with nondeposition when bottom conditions became anoxic and benthic life forms died. With continued shallowing of the water column, however, dsysaerobic conditions may have been no longer possible.

The upper part of the regressive carbonate includes the shoal, high-energy facies and the restricted-marine, shallow-water carbonate representing low-energy environments. The oolitic facies is thickest in the J- and K-Zones in the southern study area. The restricted, low-energy facies appears to be exceptionally thin when associated with this oolitic facies. Thin zones of wackestones or packstones locally occupy intervals at the tops of regressive carbonates thought to be time equivalent to the oolite. These contain quartz silt, lenses of dark-rimmed bioclastic grains (#21-5 Scheulfer), corroded grains, fine peloid-oolitic grainstone, with occasional fenestral fabric and even some diagenetic textures such as solution piping, and thin caliche crusts (K-Zone, #7 Lemon in Sec. 13-34-2w). Yet these units are at most only several feet thick, while the oolite facies are sometimes tens of feet thick. Many of these thin deposits also mantle thick accumulations of oolite. Thus they are unlikely to represent the same total time span. They would appear to be in part time equivalent.

No gradual transitions from open-marine wackestone to oolite appeared in the cores described. Progradation of the carbonate as previously mentioned does not appear to be a significant factor in the shallowing of the carbonate sediment-water interface. Nevertheless, the scouring and general erosion beneath the oolite may have removed much of the earlier deposits. Ball (1967) described oolite bars on the Great Bahama Bank that rest on platform interior muds and sands, which can generally be described as marine deposits increasingly restricted toward the interior resulting from fluctuating salinity (Bathurst, 1976). The oolite bodies prograded over the outer limits of the restricted platform as spillover lobes, but not necessarily eroding and removing the underlying mud-rich carbonate. In contrast on the southern shelf of the study area the oolites appear to have spread over a more open-marine, subtidal, deep-water shelf perhaps during lowering of the water level.

The thickness of the restricted intertidal-supratidal facies on the northern shelf is less than might be anticipated if, for example, the oolite on the southern shelf had formed an extensive restricted lagoon to the north. Yet, for this relationship between facies to exist on the shelf the slope would have to have been almost nil. Evidence presented earlier suggests that this is not true. Moreover, most of the oolite deposits to the south, for example, greatly exceed the thickness of the entire cyclothem on the northern shelf.

On the northern shelf the high-energy facies also commonly has a sharp basal contact with subtidal, open-marine facies. The low-energy, restricted-marine facies sharply overlies the same subtidal wackestones when the high-energy deposits are not present. These observations suggest an abrupt change in environment on a regional scale paralleling a comparable change on the southern shelf. This comparison is not meant to suggest that these represent synchronous events. Prather (1981) also concluded that the abrupt changes in carbonate facies were not synchronous from his work in Hitchcock County, Nebraska.

The oolite facies in the southern shelf does not appear to have an easily identified equivalent facies to the north, particularly if paleoslope was at all significant. With shoal-water conditions present on the southern shelf, the northern shelf in excess of 100 miles

(160 km) distant would probably have been emergent. These shallow-water environments in general could have easily migrated southward across the shelf through time to produce diachronous facies at the top of the regressive carbonate, given even a slight slope to the depositional surface. A change in level of the sea would be a logical means of bringing about the abrupt, late-stage change to shallow water, restricted-marine, high- and low-energy facies without an intervening gradational interval by essentially skipping expected transition-type facies. With a southerly sloping surface, the oolite facies would have formed considerably after the development of the shoals in the north as sea level fell. A broad low-relief shelf setting on the northern interior of the epeiric sea may have prevented any sustained currents and waves that permitted the development of oolite to the south.

Effects of early diagenesis are pervasive in all of the regressive carbonates of the zones studied. The extent of this diagenesis varies in a predictable manner with increasing intensity, greater vertical penetration, and apparent longer duration northward across the shelf in western Kansas and southern Nebraska. This progression of diagenesis also complements the changes in facies, strongly suggesting a fall in sea level as the cause of shallowing and eventual emergence across this shelf. More intense subaerial exposure and freshwater percolation occurred on the northern shelf, while the southern shelf, mainly an open-marine carbonate province including accumulation of thick oolitic facies, contained less striking examples of subaerial diagenesis. Available information, however, is considered sufficently diagnostic of extensive emergent conditions developed on the southern shelf late during the deposition of each zone, albeit over shorter times and with less intensity.

The shelf-wide variation of diagenesis and the correlation with the patterns of depositional environments suggests a shelf with a gentle southerly slope of variable relief. The northern shelf was higher than the southern shelf, and shallowing occurred sooner on the north. Late in the cycle, emergence was more prolonged over this landward position on the shelf. This interpretation will be substantiated with the results of the regional mapping reported below.

Upper Shale

The uppermost lithofacies of the Missourian cyclothems is the regressive shale. This unit is predominately continental in the region of investigation. The shales here are all relatively thin with the exception of the northwestern and extreme southwestern portions. As Heckel and Baesemann (1975) have demonstrated very elegantly, the regressive shale can be either continental or marginal-marine deltaic sediments. These terrigenous detritus actually overcame carbonate sedimentation before emergence occurred in some Missourian cyclothems in southeastern Kansas, but this has not been observed in the carbonate-dominated shelf of western Kansas. The shales in these four cyclothems in the area of this present study are all less than 30 feet (9 m) thick and are typically just a veneer. Marine fossils such as brachiopods and crinoids are limited to the basal portions of a very few regressive shales and are commonly intermixed with lithoclasts of the underlying carbonate. These fossils may be simply a lag accumulation originating from the underlying carbonate unit or representative of limited terrigenous influx in a shallow-marine setting. Algal stromatolites have been recognized in very small occurences on the northern shelf, but these may be freshwater deposits rather than intertidal marine accumulations. Kaesler (1982) examined microfossils in upper shales and found no signs of marine fauna from samples scattered across this area of study. Table 11 provides selected examples of the variation in the upper shales across the shelf in the area of study. Figures 3.27 and 3.28 illustrate the evidence for subaerial diagenesis in the upper shales. Nonmarine character and paleosol features dominated these shales cored in this area.

The upper shales have been demonstrated to passively fill depositional and structurally-formed paleotopography (DuBois, 1979; Watney, 1980; Prather, 1981). Thickness generally decreases very slowly southward across the shelf except locally in association with the underlying topography. The phylloid algal buildups of the underlying carbonates in the D, G, and H-Zones in Rawlins County, for example, were deposited in an open-marine, subtidal setting preceding the influx of terrigenous mud that formed shales that cover and surround these buildups. Ebanks and Watney (in press) illustrated this later influx of clastics, citing an example where a leached pore system produced from the solution and collapse of algal plates of the D-Zone was later infiltrated by silt-sized quartz and shale. The green-

Table 11. Pervasive Evidence for Subaerial Exposure During Accumulation of the Upper Shale

1. Oxidized red-brown nonfossiliferous argillaceous siltstone with nodules and millimeter-sized blebs of microcrystalline calcite (caliche and root casts) and fractures and fissures (desiccation features)--J-Zone, Cities Service A-1 Holmdahl, Sec. 29-3s-31w and K-Zone, Cities Service F-5 Reese, Sec. 22-5s-20W.

2. Olive-green mottled maroon nonfossilferous shale with veins, nodules and blebs of microcrystalline calcite--H-Zone, Cities Service 506-W Dorr Unit, Sec. 16-9s-16w, K-Zone, Gore 4 Findley, Sec. 23-11s-21w.

3. Thin (<2 feet) gray silty unfossiliferous shale containing centimeter- and millimeter-sized mottles of microcrystalline calcite (caliche and root casts), cracks filled with microcrystalline and sparry calcite, lithoclast debris at base--K-Zone, Sam Gary #21-5 Scheufler, Sec. 21-33s-20W; I-Zone, Tideway 1 Beauchamp, Sec. 19-30s-40w.

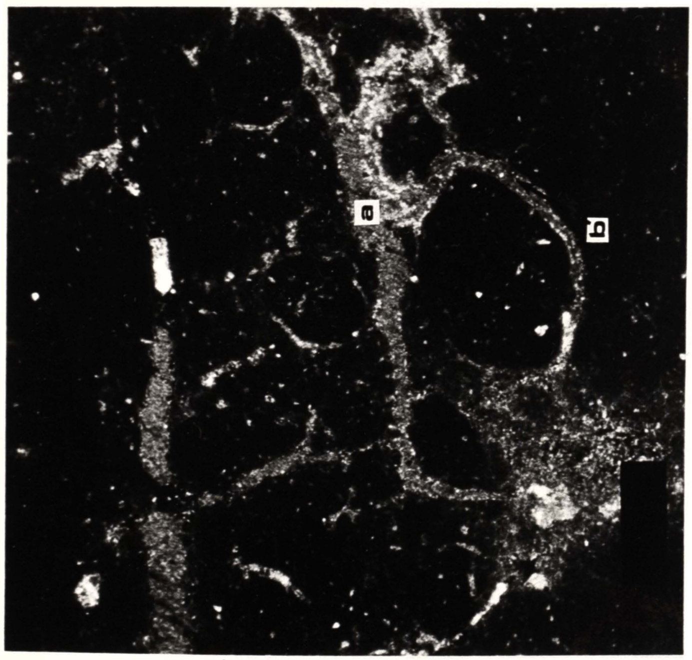
4. Thin, reworked, or missing regressive shale--H-Zone, Tideway 1 Beauchamp, Sec. 19-30s-40w; H-Zone, Pan American #B-6 Ohlson, Sec. 28-14s-14w; H-Zone and I-Zone Stanolind 3 Denker, sec. 10-22s-12w; K-Zone Clinton #2-D Stegman, Sec. 11-16s-17w.

Figure 3.27. Evidence of subaerial exposure in regressive shale.

A. Cities Service #A-1 Knudson, 4276 feet, slab photograph (bar scale in centimeters) of lower portion of very silty green to gray, mottled yellow upper shale of K-Zone. Abundant longitudinal and transverse cuts of pedotubules (a) some surrounded by a thin halo of brown microcrystalline calcite cement (b). Lighter areas are concentrations of microcrystalline calcite interpreted as caliche nodules.

B. Gore #5 Findley, 3742.5 feet, photomicrograph (plane-polarized, bar scale 1 mm) from upper shale of K-Zone. Irregular lighter-shaded fissures (a) filled with mixture of microdolospar and argillaceous dolomicritic quartz siltstone. Larger sparry cement is dolospar. Fissures surround denser cemented matrix (b) resembling circumgranular cracks. Sample is interpreted to display incipient calichification with intermittent desiccation.

B



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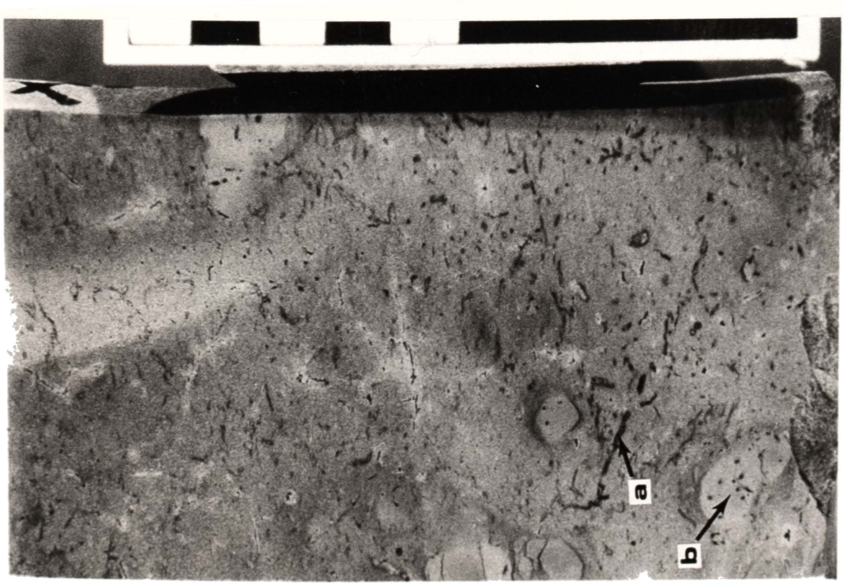
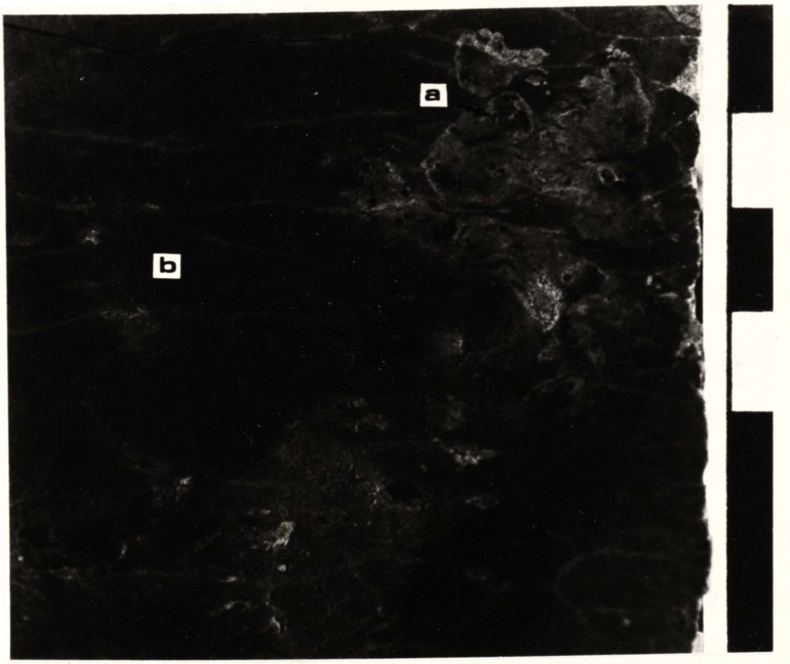


Figure 3.28. Evidence of subaerial exposure in regressive shale. Slab photographs, bar scale in centimeters.

A. Sam Gary #21-5 Scheufler, 5817 feet, upper shale, K-Zone. Color-mottled, light-gray to green argillaceous, unfossiliferous siltstone contains light-colored nodular microcrystalline calcite (caliche) cut by scattered pedotubules (a). Subhorizontal fractures (b) are stained lighter gray perhaps associated with desiccation. Dark line in upper portion of photograph is a fracture that is an artifact of core preparation.

B. Clinton #2-D Stegman, 3405.5 feet. Solution-pitted, darkened clast of carbonate rock is from within upper portion of 3-foot bed of upper shale of J-Zone. Shale matrix (not shown) is moderately soft, blocky, green with red mottles with centimeter-sized vertical fissures and tubes filled with softer shale containing patches of caliche.

A



B

tinted quartz siltstone that fills pores only in the upper portion of the carbonate resembles a vadose internal sediment carried into the carbonate by percolating, meteoric fresh water (Dunham, 1969). This silt and shale match the lithology of the overlying basal portion of the upper shale. A period of exposure and the development of a freshwater lens appear to have preceded the upper shale. The upper shale is characteristically red-brown argillaceous siltstone or claystone across the northern study area becoming predominately green and gray to the south (Table 3). Locally, it is sandy in the north and extreme southwest. Poorly preserved current bedding in the silty shale of the J-Zone in Hitchcock County, Nebraska, led DuBois (1979) to conclude that intermittent overland flow was important in transporting this silty sandstone. Furthermore, channeling into the underlying regressive carbonate is recognized by DuBois.

Evidence of soil development is common in the upper shale. The strata are mottled with white or pink microcrystalline calcite on the northern shelf. Watney (1980) attributed the precipitation of microcrystalline calcite and local dissolution and replacement of quartz grains by calcite spar and microcrystalline calcite to calichification. Anastomosing shrinkage cracks, circumgranular cracks, and root casts are all common to this soil-forming process and calichification. The root casts are commonly rimmed by oriented clay cutans and dense halos of microcrystalline calcite. The millimeter-size and tubular nature of these root casts are similar to modern analogues (Stephen, 1960). The inverse relationship between the abundance of the interstratified mixed-layer clay minerals and feldspar have also been attributed to soil processes (Watney, 1980). Furthermore, the soils described are similar to those developed in a semiarid environment. Reddish-brown, locally very calcareous clayey siltstone matrix with carbonate nodules, decreasing feldspar with increasing mixed-layer clays, oriented clay-coated sand grains and clay-lined pedotubules are some of the characteristics of modern soils in semiarid northwestern Texas (U.S.D.A.). Occasionally the soil profile includes the topmost regressive carbonate. The carbonate rock has been fractured and broken and mud has infiltrated into it during weathering, converting it to the C-horizon of the soil.

The distribution and composition of this unit suggests that this deposit succeeded the deposition of the regressive carbonate in a subaerial setting rather than being locally concurrent with or overwhelming carbonate accumulation in the marine environment. A subaerial deposit would be expected to complement the topography of the land, filling in the valleys. Notable thinning of the upper shale on sharply weathered carbonate surfaces over widespread areas of the CKU is a strong argument for relief over this region during the accumulation of each of the cyclothems. The upper shale represents a continuation of the regression in the cyclothem and is therefore referred to as the regressive shale (Tables 3 and 4).

Summary

The succession of lithofacies varies considerably but in a predictable way across the shelf. The transgressive (lower) carbonate is thin (less than 5 feet thick) and grades upward across the entire shelf from shallowest water to deepest water facies with diverse invertebrates. In some cycles the transgressive carbonate is extremely thin (less than 0.5 feet) or missing altogether along the northern (landward) portion of the study area (Table 5). The marine (lower) shale typically is thin and contains a radioactive dark fissle shale facies. Along the northern shelf the unit is commonly significantly thicker, generally silty, and lacks the dark-shale facies. Over the CKU the unit is commonly thin, nonradioactive, and not black.

The regressive (upper) carbonate is a shallowing-upward limestone with peritidal deposits invariably present at the tops, however thin. On the northern shelf where the shoal-water deposits are thinner and more commonly restricted micritic and limited skeletal grain-rich carbonates. They are generally more silty and overall lighter colored along the northern shelf.

The regressive (upper) shale is thicker, siltier, and along the northern shelf contains more oxidized iron coinciding with more intense weathering and freshwater diagensis of the underlying regressive carbonate. To the south the regressive shale is thinner and lacks significant oxidized iron. It is nevertheless nonmarine. The interpretation of a shallower, more landward setting to the north that was emergent early and was a source area for some terrigenous clastics is based on the integration of observations from all four lithofacies. Even though each cyclothem or zone has its unique character, all of the cyclothems examined here vary similarly across the shelf. Differences, however, are enough to encourage the separate analysis of each cyclothem.

The information from the cores is extended through the investigation of wireline logs which provide a record of certain mappable physical properties of the strata. This is the topic of a later section.

CHAPTER FOUR

PETROLEUM GEOLOGY

The Lansing and Kansas City groups have contributed a major share of petroleum reserves in southwestern Nebraska, western Kansas, and the panhandle areas of Texas and Oklahoma. The ultimate recovery from the Pennsylvanian rocks in the Midcontinent was estimated by Rascoe and Adler (1983) to be 8.84 billion barrels of oil of which 3.79 billion is from giant fields (greater than 100 million barrels) and 2.66 billion from significant oil fields (between 25 and 100 million barrels). The Hall-Gurney oil field discovered in 1931 in Russell and Barton counties on the CKU is the only giant oil field in Kansas that produces from Pennsylvanian rocks. Its principal production is from the Lansing and Kansas City groups; 139 million barrels of oil have been produced from this field. Nonassociated natural gas produced from Pennsylvanian reservoir rock from the Midcontinent now totals 31.9 trillion cubic feet (tcf), 12.5 tcf from giant fields (greater than 600 billion cubic feet, bcf) and 6.0 tcf from significant fields (between 150 and 600 bcf). Just over one-fourth of the ultimate oil production in this region will come from smaller fields while over 40 percent of the gas will be from such fields.

The frequency distribution of numbers of fields ranked by size (numbers of wells) and the median number of wells per field were prepared for eight divisions of the study area (Plate 2). The median size of the fields ranges from 2 wells in northwest Kansas (area #1) to 5 wells per field in areas #3 and 4. The surface area underlain by production in each area varies significantly from only 0.41 percent in northwest Kansas to 13.9 percent on the CKU in Area #6. The CKU is the most mature, most densely-drilled region in the U.S., while the area west of it is still undergoing active exploration and development. The distribution of the fields ranked according to increasing size in the CKU approximates a hyperbolic decline (Plate 2). In contrast, the distribution is much less defined in the developing areas. It perhaps could be anticipated that the frequency distribution in the developing areas would eventually approach that of the mature region if geological conditions were similar between areas. The evidence presented in this study, however, does not suggest that this is the situation.

Selected reservoir parameters for fields in each of the eight areas are listed in Table 12, 13. Most of the fields that are listed are those previously described in the literature. The selection for that reason is arbitrary and therefore is not considered to be representative of the area. Recovery factors are expressed in barrels per acre and in some cases barrels per well when the total number of present and past producing wells is known. Many fields have multiple pays, particularly those that are structurally controlled. The production is commingled and for that reason it is difficult or impossible to determine the fraction produced from the Lansing and Kansas City groups alone. Morrison (1979) noted that in Gove and Trego counties, Kansas, exceptional wells can produce as much as 150,000 bbls over the average life of 15 years, while the average amount of oil production per well for the same area is 65,000 bbls. Unusually

Table 12. Field Data of Selected Lansing and Kansas City Group Reservoirs, Western Kansas.

AREA #	FIELD NAME	LOCATION	COUNTY	DISCOVERY DATE	DEPTH	PAY ZONE	THICK-NESS	BOPD INITIAL PRODUC. DISC. WELL
1	Adell	6S-26W	Sheridan	1944	3750	LKC all zones	2-20 ft.	840
	Comments: developed on 20 acre spacing; 50-60 ft. oil column; trap large elongate anticline (Lane, 1959, p. 1-3)							
1	Llanos	6S-37W	Sherman	1958	4440	LKC+ Marm Cher	12 ft.	289
	Comments: Trap: small anticline (Byers, 1959, p. 92-97)							
2	Gove	13-30W	Gove	1953	4120	LKC+ Miss	4-6 ft. multiple	154
	(Bear, 1959, p. 24-28)							
3	Eubank	28S-34W	Haskell	1958	4100	LKC+ Marm Cher Mor. Miss	14 ft. multiple	131 and 3068 MCFD
	Comments: 20 ft. oil column; oomoldic porosity; BHP = 1330 PSI; trap: combination structural (anticline) - stratigraphic (Fugitt and Wilkinson, 1959, p. 13-28)							
3	Nunn	21S-34W	Finney	1945	4300	LKC	13 ft.	779 no water
	Comment: LKC disc. 7 yrs. after field disc; 34 API (Aukerman, 1959, p. 118-125)							

4	Pollnow	3S-29W	Decatur	1953	3730	LKC	4 ft.	79

Comment: BHP = 1050 PSI; trap = combination structural-stratigraphic; (Geol. Dept., Anderson-Prichard Oil Corp., 1959, 141-144)

4	Feely	5S-27W	Decatur	1952	3600	LKC	2-5 ft. 3 zones	784

Comment: developed on 20 acre spacing (Lane, 1959, p. 21-23)

5	Laton	9S-16W	Rooks	1928	3225	LKC Toronto	33 ft. cum.	
6	Fairport	12S-15W	Russell	1923	2950	LKC B. Penn Arbuckle Reagan	12 ft.	
6	Hall-Gurney	14S-13W	Russell	1931	2985	LKC+ Wab Shaw B. Penn Arbuckle	28 ft.	
7	Max	21S-12W	Stafford	1938	3356	LKC+ Simp. Arbuckle	16 ft.	
8	Cunningham	27S-11W	Pratt Kingman	1931	3600	LKC+ Viola Simpson Arbuckle	33 ft.	432+ 3500 MCFD

Comments: BHP 1100 PSI; trap = domal closure on anticline (Curtis, 1956, p. 19-28)

	Fitzsimmons						
8	27S-13W	Pratt	1953	4056	LKC	9-13 ft.	1052 (Bomb test)

Comments: 1470 BHP; trap = small anticline with 10 ft. closure with oil/water contact (Brown, 1956, p. 38-41)

8	Coats 29S-14W	Pratt	1945	4139	LKC+ Simpson Arbuckle	8 ft. oomoldic	2485 MCFD + 81 BWPD

Comments: structural trap, dome; (Curtis, 1956, p. 19-24)

Abbyville						
24S-7W	Reno	1927	3540	LKC	9 ft. oomoldic	385 + 57 BWPD

Comments: trap = combination structural-stratigraphic (Geol. Dept., Skelly Oil Co., 1956, p. 1-3)

Rosedale						
29S-6W	Kingman	1954	3700	LKC	6 ft.	144 22% wtr.

Comments: BHP 1540 PSI; trap = anticline (Richardson and Matthews, 1956, p. 85-87)

TABLE 12. Field Data of Selected Lansing and Kansas City Group Reservoirs, Western Kansas (cont.)

LOCATION	(ACRES) SIZE	(BBLS) CUM. PRODUCTION	NO. PRODUC. WELLS	RECOVERY BBLS/WELL	BBLS/ACRE	DRIVE MECHANISM	API GRAVITY
Adell	1200	8,067,720	54 max. 24 pres.	149,402/ well	6723	water	30-41.5
Llanos	280	779,086	7	111,298/ well	2782	water	33.8-39.5
Gove	80	37,861	2	18,931/ well	473	pressure depletion	36-39
Eubank	1440	10,000,000	72	139,000/ well	6944	pressure depletion	34.4
Nunn	9000 bbls before being comingled with Marmaton; 1 LKC well in field						
Pollnow	600	1,193,339	15	79,556/ well	1988	pressure depletion	38
Feely	160	388,654	7	55,522/ well	2429	water and gas drive	34-39
Laton	5160	12,569,470	129	97,438/ well	2436		30
Fairport	10,770	45,001,142	359	125,351/ well	4178		
Hall-Gurney	42,160	135,055,809	1054	128,136/ well	3203		
Max	2600	11,798,300	65	181,512/ well	4538		

Cunningham	1680	6,758,075	42	160,907/ well	4023/acre	solution gas and gas cap	40-41
Fitzsimmons	120	197,615	3	65,872/ well	1647		
Coats	160	517,951	8 4 present	64,744/ well	3237		
Abbyville	600	1,189,311	28 1 present	42,475/ well	1982		38
Rosedale	1360	3,178,458	34	93,484/ well	2337		43

TABLE 13. Examples of Secondary Recovery from Lansing and Kansas City Group Carbonate Reservoirs, Western Kansas

FIELD NAME	LOCATION	COUNTY	PRODUC.	NO. INPUT	NO. ZONES	THICKNESS ZONES	AVE. POROSITY	DISC DATE	WATERFLOOD BEGAN	REPORT DATE	WELL SPACING	
	cumulative						cumulative since waterflood					
	BO	BW	BO/yr	BW/yr			BO		BW		BO/yr	BW/yr
		daily production before waterflood					current daily production					
		BOPD	BWPD				BOPD		BWPD			
					maximum daily production after waterflood							
					BOPD		BWPD					
Feely	5S-27W	Decatur	4	2	3	4;4;3ft.	14%	1952	3-63	1-65		
	253,000	unknown	23,000	--			63,000		70,000		35,000	38,889
		14	13				77		116		(from Great Bend SPE, 1965)	
					--		--					
Adell	6S-26W	Sheridan	20	9	6	42.5ft. total	--	1944	7-62	1-74		
	4,843,421	3,180,000	269,079	176,667			1,554,332		14,500,000		124,347	1,160,000
		639	2,500				199		3,126		(from Great Bend SPE, 1974)	
					750		2,500					
Basil (Spivey-Grabs-Basil)	30S-7W	Kingman	6	4	1 H-Zone	--	18%	7-53	5-71	1-74	10 acre	
	695,000	990,000	40,882	58,235			99,467		644,000		37,254	241,534
		65	260				30		630		(from Great Bend SPE, 1974)	
					280		1,200					

high daily flow rates have been realized from single wells in excess of ten thousand of barrels per day, from the larger fields on the CKU. Fracturing of the carbonate very possibly has been a large factor in such high levels of production (Amyx, Bass, and Whiting, 1960).

The primary reservoir-drive mechanisms are water drive and pressure depletion. Primary recoveries are on the order of 30 to 35 percent of the original oil in place (A.P.I., 1978). The initial production from a new reservoir is usually appreciably higher than the sustained, long-term production, particularly in pressure depletion reservoirs when the early drop in pressure is greatest.

Secondary recovery by waterflooding on the CKU can come close to doubling the primary production (Walters, 1981, personal communication). The variable distribution of porosity is inferred to be the cause of significantly reduced sweep efficiency in some waterfloods and is probably a limiting factor in the success of the waterflooding projects. Table 13 lists the published results of three waterfloods in reservoirs in the Lansing and Kansas City groups. Feely field mentioned in Table 13 represents a combination structural-stratigraphic trap with an updip-pinchout of porosity. After nearly two years of waterflood operations in this field, daily oil production reached in 1965 five times the level before waterflooding began. Waterflood in Adell and Basil (now Spivey-Grabs-Basil field) have been less successful (Table 13). Daily production of oil is actually down significantly as water has increased due to the waterflood.

However, signifcant incremental oil recovery was obtained for both Adell and Basil leases based upon comparison of projected decline curves for primary production and the actual production curve during waterflood.

Water will tend to move more readily through high permeability channels common in carbonate reservoirs and eventually a water block can occur at the producing well. This tends to occur because as the fraction of water produced (water cut) increases, the relative permeability to oil decreases (Amyx, Bass, and Whiting, 1960). Means of plugging high permeability channels such as fractures or vug systems would probably add considerably to the efficiency of waterflooding projects in general for the area.

Characteristics of some crude oils and reservoir rock from the L-KC make them potential candidates for miscible-carbon dioxide flooding. This tertiary recovery method depends on reaching a miscibility pressure beyond which the carbon dioxide combines with the oil to produce a fluid which is more mobile and subsequently easier to remove from the reservoir. The miscibility pressures for a number of crude oil samples from reservoirs on the CKU range from 1200 to 1500 psi. These pressures are within the range of original reservoir conditions although the present pressures are usually lower due to pressure depletion resulting from production. After both primary and secondary (water-flood) recovery, nearly half the original-oil-in-place may still be in the reservoir (Green and Azadeh, 1983). It's this large remaining volume of oil that is sought with the use of tertiary-recovery techniques. The percent oil actually recovered from tertiary methods typically amounts to an incremental recovery of 15% of the original oil in place (Lewin and Assoc., 1976). The geology of the reservoir is an essential ingredient in feasibility studies and planning for both secondary and tertiary recovery processes.

The Lansing and Kansas City groups have maintained their position as a major producing interval and are the most actively explored in Kansas. Reservoirs in the interval accounted for over one-third of all oil discoveries in Kansas during 1981 and 1982. While most oil and gas fields are found on the CKU new developments are occurring to the west of the CKU. The Collier Flats field located in south-central Kansas is a recent example of successful exploration in this western region. Fifty-four wells have thus far produced in excess of a million barrels of crude oil from a single zone within the Kansas City Group, the regressive carbonate of the K-Zone. Initial production of some wells was greater than 100 BOPD. The producing wells are located on a southerly-plunging, anticlinal nose. Dry holes, however, are immediately updip from this accumulation and suggest that a pinchout of porosity has provided the trap for oil on this non-closing anticline (Watney and Paul, 1983, Figure 18).

Limited-structural closure and areal-restriction of porous carbonate are the main reasons for limited field size in western Kansas. For example, in the northwestern area of study many fields produce from single pay zones commonly the J- or K-Zones. In contrast, the Cahoj field discovered in Rawlins County in 1959 has produced over

6.9 million barrels from 28 wells from all zones in the LKC somewhere within the limits of the field. The field is located on a prominent dome that had demonstrable paleorelief during the accumulation of the Lansing and Kansas City groups (Watney, 1980). Development of porosity in the zones is apparently enhanced through the localized accumulation of grain-supported carbonates plus freshwater diagenesis (Watney, 1980). This structure is exceptional in size, number of producing zones, and amount of production and is in distinct contrast to the surrounding fields discovered in Rawlins County.

The exploration for subtle traps will have to be emphasized in the future because the odds favor the smaller or more purely stratigraphic fields since most of the obvious structures have been found. The search for stratigraphic traps or combination structural-stratigraphic traps will rely increasingly on the knowledge of the regional framework of potentially favorable reservoirs. This will be based on examining rocks and identifying how porosity is developed. The recognition of a potential site of hydrocarbon entrapment might then include the identification of structural anomalies that coincide with a trend of favorable development of reservoir rock. The prospective accumulation might also be sited using some other subsurface or geophysical tool available to the explorationist. The integration of the analysis of lithofacies and the evaluation of wireline logs emphasized in this study should help to establish the first objective in defining an exploration target in these strata, i.e. identification of the trends of porous carbonate rock.

CHAPTER FIVE

INTEGRATION OF LITHOFACIES AND WIRELINE LOGS

Wireline logs run in the borehole after a well is drilled measure both physical and chemical characteristics of the rock representing both natural and induced emissions. Common sedimentary rocks present various combinations of logged responses that are generally not unique because the bulk composition of the rock can vary considerably. The wireline logs respond to changes in lithology, pore volume, and composition of the fluid in the pores. The signature of the analog curves of log response versus depth on the wireline logs provides an accurate record of thickness of major lithologic units and hence serves as a useful tool to interpret the stratigraphy.

In the last 30 years the responses on well logs have been standardized and calibrated; recordings have been made more sensitive and now measure additional properties of the rock using new instrumentation. For these reasons logging has been made more directly applicable to the interpretation of the physical and chemical nature of the rocks. Since major exploration began in western Kansas in the late 1940's, well logs have become an essential tool in determining lithology and porosity and detecting the presence of hydrocarbons and hence were available for this study. The most effective and economic logging tool suite commonly used combines the natural gamma ray, neutron, and resistivity logs. These three logs permit the resolution of the stratigraphic succession and identification of lithology.

Log response or signature, however, must be correlated to lithology based on core or sample descriptions.

The four basic lithofacies that comprise the cyclothems of this study can usually be recognized by their distinctive signatures on wireline logs. Wireline logs are useful in translating lateral variations in lithofacies within these cyclothems and also provide a means to compare lithofacies between cyclothems (Watney, 1979). Table 14 summarizes these observations, and Appendix C summarizes the principles of interpretation of the wireline logs used in this study.

Cross plots of wireline log values from the same cyclothem can be compared among wells in different areas to examine and characterize gross changes in sedimentation, e.g., influx of terrigenous clastics. In addition, plotting a succession of data ranked by depth from one cyclothem reveals a characteristic trend from transgressive to late regressive lithofacies. This basic pattern is repeated in the adjacent cyclothems. This is a good demonstration that the zones are composed of a succession of rock types that were repeated again and again. Cross plots of wells that are far apart in the study area result in noticeable changes of the positioning of the points on the cross plots, but the general pattern of points is maintained. These changes, however pronounced, vary predictably according to subtle changes in lithofacies (Watney, 1979).

Figure 5.1 is a gamma ray and neutron-porosity (compensated) cross plot of the K-Zone for the Amoco #A-2 Lee well located on the southern margin of the study area (sec. 4-26S-36W, Kearny County). A cross plot of the gamma ray and neutron-porosity of the Gulf #1

Table 14. Summary of Wireline Log Response and Corresponding Lithofacies.

	LITHOFACIES	LOG RESPONSE
1.	Regressive shale	a. 50-80 A.P.I. GR units (locally higher in dark-gray shale) b. Low neutron counts (high porosity index) (higher counts when shale is silty or calcareous) c. Low resistivity (moderate when calcareous)
	Comment: Most uniform of all lithofacies; closely approximates the average shale	
2.	Regressive Carbonate	a. Low gamma radiation (15-40 A.P.I. units) in upper and middle portions of regressive carbonate. Medium levels of GR (40-60 A.P.I.) locally in lower regressive carbonate in northern area of study. GR (60-100 A.P.I.) in some lower regressive carbonates in southern area of investigation.
	Comment: Low gamma radiation implies clean, more pure carbonate while elevated GR values alone only suggests presence of shale, chert, organic matter, mineralized fractures.	
		b. Very high neutron counts (very low porosity index) in nearly pure, dense carbonate. Decreasing neutron counts proportional to logarithm of porosity except in gas-filled void spaces. Decreasing neutron counts with increasing shale content. No change with silici-

fication or presence of dispersed organic matter or pyrite.

c. Resistivity levels are high in dense, clean or siliceous carbonate or clean oil- or gas-filled porous carbonate. Lower values of resistivity with increasing concentrations of shale or increasing porosity that is filled with formation brine.

Comment: Moderate to high gamma radiation (60-100 A.P.I.) and moderate to high neutron count (low porosity index) (3-18 P.I.) commonly associated with micritic carbonates containing clay and small amounts of organic matter (Watney, 1979); shale fraction does not explain the entire gamma ray response; moderate gamma ray and high neutron count found over all of study area while high gamma ray and moderate to low neutron count found in extreme southern study area where it is associated with darker argillaceous mudstone-wackestone facies. Low neutron count (high porosity index) and low gamma ray typically coincide with clean porous carbonate. Porosity at top of regressive carbonate is commonly associated with void space in leached packstone or grainstone, a conclusion reached in Watney (1980). Thick development of highly porous carbonate (greater than 6 to 8 feet) is commonly associated with oolite facies on central and southern shelf.

3. Marine Shale

a. 50-120 A.P.I. unit gamma radiation in gray to black facies is similar to regressive shale; >150 A.P.I. units in dark gray to black shale facies;

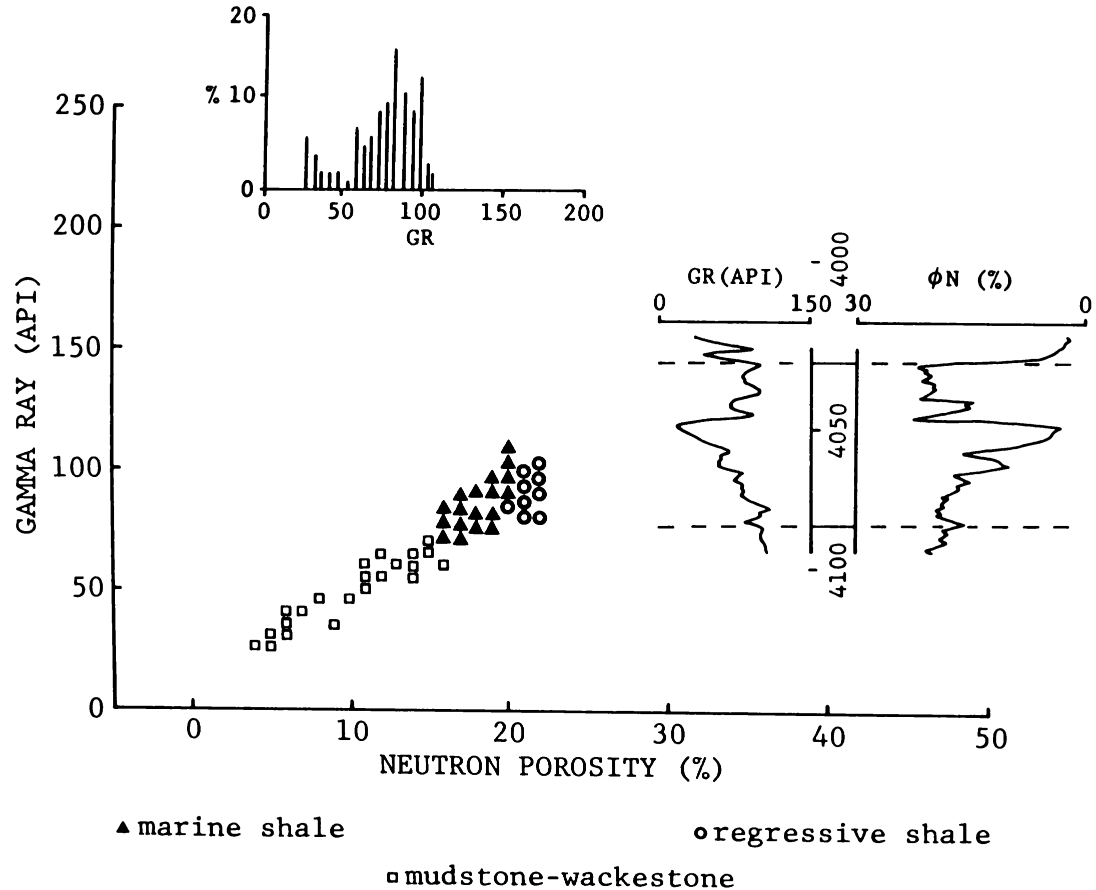
b. Neutron counts ranges from generally low to moderate.

c. Resistivity is low.

4. Transgressive Carbonate

a. Gamma radiation level is commonly moderate in the range of 50 to 90 A.P.I. units; elevated values in part due to thinness and its position below a high gamma ray unit; yet some of higher gamma radiation is attributed to possible uranium enrichment associated with dispersed organic matter commonly imparting darker hues to this carbonate unit.

Figure 5.1. Gamma radiation (GR) in API units plotted versus neutron porosity (ØN) in percent for the Texas Oil and Gas (TXO) #1 Bierig well located in W/2 E/2 SW Section 34-30s-42w in the extreme southwestern portion of the area of study. Points represent readings at one-foot increments over the K-Zone. The points are identified by lithofacies based on sample cuttings and corelation of the well to cored wells with known lithofacies. Mudstone-wackestone is in the mid and lower regressive carbonate interval. Note the presence of only a relatively thin interval of low GR and clustered pattern of these points. Distinction between the marine shale and regressive shale on this plot is not possible. Both have intermediate GR and ØN. Vertical distribution of GR-ØN is shown on right side of illustration with vertical scale in feet. A small plot in the upper left illustrates the frequency of GR values sampled on a per foot basis is expressed as normalized percent for the K-Zone. GR values are bimodal with a small peak for the limited clean carbonate and a broader more prominent peak for the shaley lithofacies.


GAMMA RAY (API)
NEUTRON POROSITY (%)
% 10
20
GR
GR(API)
ΦN (%)
4000
4050
4100
▲ marine shale
○ regressive shale
□ mudstone-wackestone

Hughes well is shown for comparison. This well is located on the northern area (sec. 22-9S-29W, Sheridan County) (Fig. 5.2). The major differences in lithofacies between the K-Zones in these two wells include the interval with low gamma-radiation, the highly porous oolitic facies of the upper portion of the regressive carbonate in the A-2 Lee well, interval of higher gamma radiation in the basal portion of the regressive carbonate also in the #A-2 Lee well, and the thicker, less calcareous regressive shale prominently developed in the #1 Hughes well. The high level of gamma radiation (greater than 150 API units) associated with the marine shale in both wells decreases dramatically just north of the #1 Hughes well (Watney, 1979).

The TXO #1 Bierig in sec. 34-30S-42W is located on the southwestern positive area. The cross plot of the K-Zone in Figure 5.3 resembles that of wells on the northernmost shelf including low gamma-ray values in thicker marine shale, a thick regressive shale, and a thin, regressive carbonate. The points on the cross plot are clustered, a characteristic of areas affected by a more sustained influx of terrigenous clastics (Watney, 1979). The carbonate lithofacies become increasingly argillaceous and the marine shale resembles the regressive shale in these areas of terrigenous clastic influx.

These cross plots illustrate the applicability of log signatures in interpreting the variation in lithofacies. Core or samples are available at or near the sites of these examples. The interpretation

Figure 5.2. Gamma radiation (GR) plotted versus neutron porosity (ØN) for the Gulf #1 Hughes well located in SWSW Section 22-9s-29w found in the north-central portion of the study area. Points are plotted on one-foot increment. Points are identified by lithofacies in the legend. Vertical profiles of the GR and ØN signatures are shown on the upper portion of the illustration. Normalized GR for the one-foot samples from the K-Zone are plotted in the upper left. Note the spread to the GR values compared the Lee well in Figure 5.1.

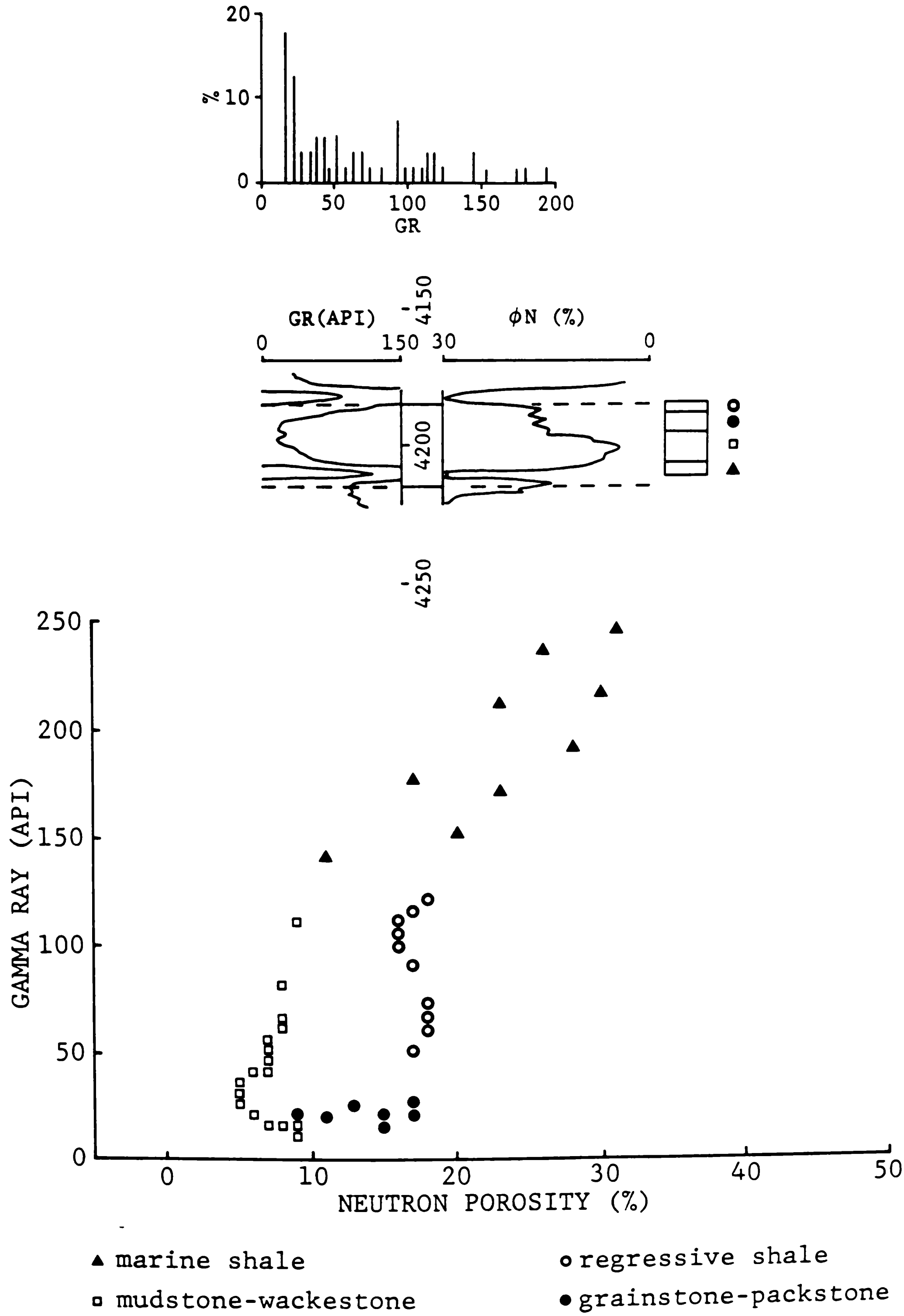
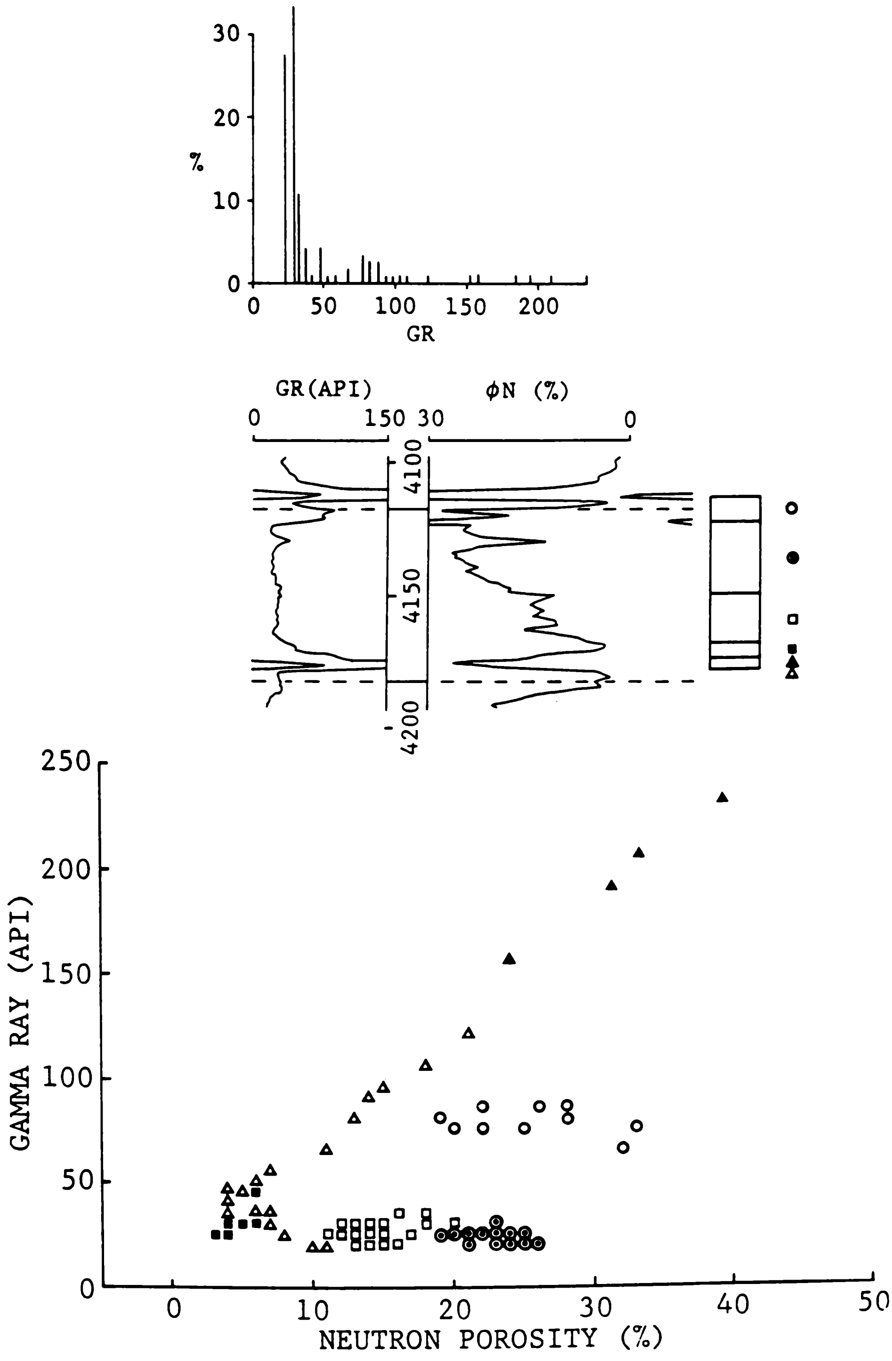

20
%10
0
0
50
100
150
200
GR
4150
GR(API)
ϕN (%)
0
150
30
0
4200
4250
250
200
GAMMA RAY (API)
150
100
50
0
0
10
20
30
40
50
NEUTRON POROSITY (%)
▲ marine shale
○ regressive shale
□ mudstone-wackestone
● grainstone-packstone

Figure 5.3. Gamma radiation (GR) in API units plotted versus neutron porosity (ØN) in percent for the Amoco #A-2 Lee well located in SWNW Section 4-26s-36w in the southwestern portion of the area of study. Points represent readings at one-foot increments over the K-Zone. The points are identified by lithofacies based on sample cuttings and nearby core:log combinations. Mudstone-wackestone is in the mid and lower regressive carbonate interval. Note the very low GR and relatively high ØN values for the oolitic facies. Vertical distribution of GR-ØN is shown on top of illustration with vertical scale in feet. Frequency of GR values sampled on a per foot basis is expressed as normalized percent for the K-Zone is shown as a small plot in the upper portion as well. GR values are predominately low values indicative of clean carbonate rock which comprise much of the cyclothem at this position on the shelf.



● oolite ▲ marine shale

○ regressive shale △ transgressive carbonate

□ mudstone-wackestone

■ lower regressive carbonate (high GR)

of these logs without the rock may be successful, but is not recommended.

Mapping With Wireline Logs In The K-Zone

The cyclothems of the Missourian Kansas City Group are readily identified on wireline logs and can be subdivided into lithofacies components according to the previous discussion. The results desired and the time available require that one carefully select what aspects are to be mapped. Regional trends and local anomalies of each cyclothem are sought for identification and interpretation. A specific objective is to define variation in the structural configuration and lithofacies distribution during the accumulation of each cyclothem. The thinning shown on the composite interval isopach map (Fig. 2.9) associated with the CKU is striking, but the question is whether this broad structure affected the cyclothems equally. Similarly, the interpretation of regional thickening and implied differential subsidence as indicated by the composite isopach can be extended to maps of individual cyclothems. Deviation in the pattern on the composite map may be significant.

Variables were selected from each cyclothem for mapping to aid in interpreting the origin of the cyclic succession and to resolve the distribution of favorable trends of reservoir development in the regressive carbonate. The resulting maps were used to integrate the information from both major sources of data in this study: cores and wireline logs. The patterns and trends resolved from mapping provide another perspective for interpreting the stratigraphic framework established by the cores.

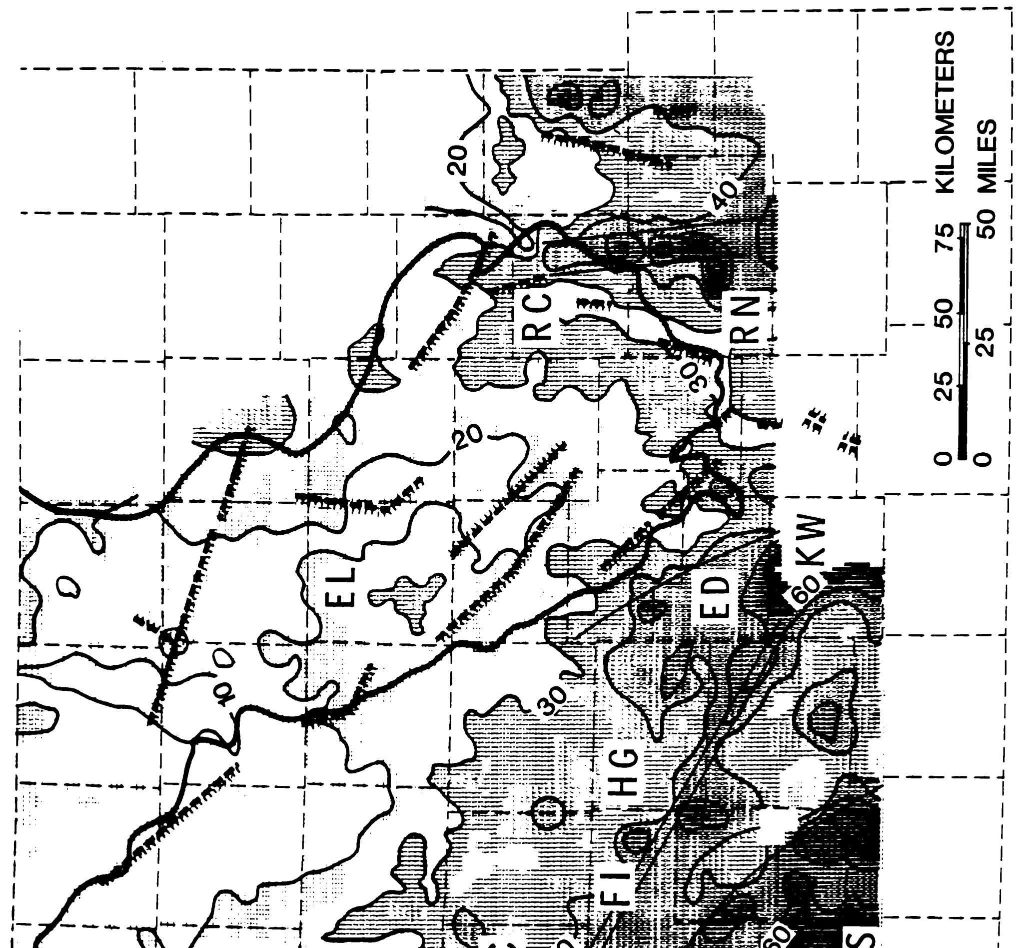
Marine Interval Isopach

Figure 5.4 is a map of the thickness of that part of the K-Zone that extends from the top of the regressive carbonate to the base of the cyclothem, i.e., the bottom of the transgressive unit referred to here as the marine interval (See Figure 1.4). The thickness of the marine shale is generally insignificant in this interval except on the northern shelf, where more pronounced influx of terrigenous clastics occurred. Hence, most of the interval is composed of the regressive carbonate.

The thickness of the marine interval changes primarily in response to sedimentological variation in the regressive carbonate. Cores or good samples of cuttings are imperative in order to characterize these changes. These variations have included buildups of current-transported and washed carbonate grainstone or buildups of carbonate rock resulting from an accumulation of lime mud trapped by organisms or simply buildups of lime mud shaped by hydrodynamics (Ebanks and Bubb, 1975). Moreover, proliferation of sediment-producing and sediment-binding organisms such as phylloid algae resulted in the development of biohermal carbonate mudbanks in the northern portion of the study area (Watney, 1980).

Understanding the occurrence of favorable reservoir rock requires a knowledge of the effects of diagenesis and depositional environment. The thickness of the marine interval provides some of

Figure 5.4. Thickness of the marine interval of the K-Zone in the study area of western Kansas including the top of the regressive carbonate to the base of the cycle. Interval of shading is 5-feet (1.5 m) while the contour lines highlight only the 20-foot (6.1 m) intervals. Black areas represent thicknesses in excess of 65 feet (20 m). Selective counties are labeled for reference in text. Subcrop of the Mississippian strata surrounding the CKU and CA is indicated here by a heavy line. Major faults that offset the Pre-cambrian basement are illustrated with heavy dashed hatured lines. Curved line segments identify trends in thickened marine interval described in the text. Counties are abbreviated as follows: WA - Wallace, WH - Wichita, ST - Stanton, SC - Scott, HS - Haskell, FI - Finney, HG - Hodgeman, EL - Ellis, ED - Edwards, KW - Kiowa, RC - Rice, and RN - Reno.


WA
WH
SC
FI
HG
ED
KW
RN
RC
EL
ST
HS
20
30
40
50
60
0 25 50 75 KILOMETERS
0 25 50 MILES

the information needed to interpret these conditions. An accumulation of grainstone with primary intergranular porosity can fill a pre-existing bathymetric low as described for the Drum Limestone by Stone (1979) and not be shown on the map of thickness of the overall limestone in which it is included. Local relief and general variation in thickness of the limestone beneath the grainstone would be diminished by the filling of the bathymetric lows. Grainstones also have been found on or adjacent to bathymetric highs (small-scale as in Figure 52, Watney, 1980; or large-scale as in Figure 11, p. 46, Price, 1981), which are subtle and poorly illustrated in this kind of thickness map. Porosity and permeability associated with these originally porous units can be either preserved or later occluded by cement. Later this cement or the grains could be leached to form secondary porosity. The thickness of the marine interval can provide a means of identifying the trends and similar patterns that can be used with lithologic information to establish a means to translate some of the lithofacies information.

In Kansas, the best development of reservoir quality rock in the Lansing and Kansas City groups occurs in high-energy carbonate facies. The grain-support provides a relatively rigid architecture or network that assists the leaching of grains and mud necessary to produce porosity and permeability (Watney, 1980). The recognition of grain-rich facies provides encouragement that one will also encounter porosity.

Varying rates of accumulation of carbonate mudstones, however, can create local relief. The crest or flanks of the positive areas may later become the site of accumulation of grainstone or be the focus of early diagenesis and secondary porosity development, e.g., solution of phylloid algal blades and collapse and disruption of supporting micrite (Ebanks and Watney, in press). The expression of micritic carbonate buildups on such a map as this may also help to identify areas with more favorable sites for porosity development.

Figure 5.4 also provides an important means of describing shelf-wide changes in the depositional conditions of the carbonate rock. Further mapping and description of lithofacies from core then gives additional data to complement this interpretation. The regional southward thickening observed in the marine interval is in a basin-ward direction and strongly suggests that subsidence was greater toward the Anadarko basin. Sedimentation and early diagenesis also vary most significantly from north to south across this shelf area spanning in excess of 200 miles (320 km) and suggesting that regional relief existed in addition to subsidence.

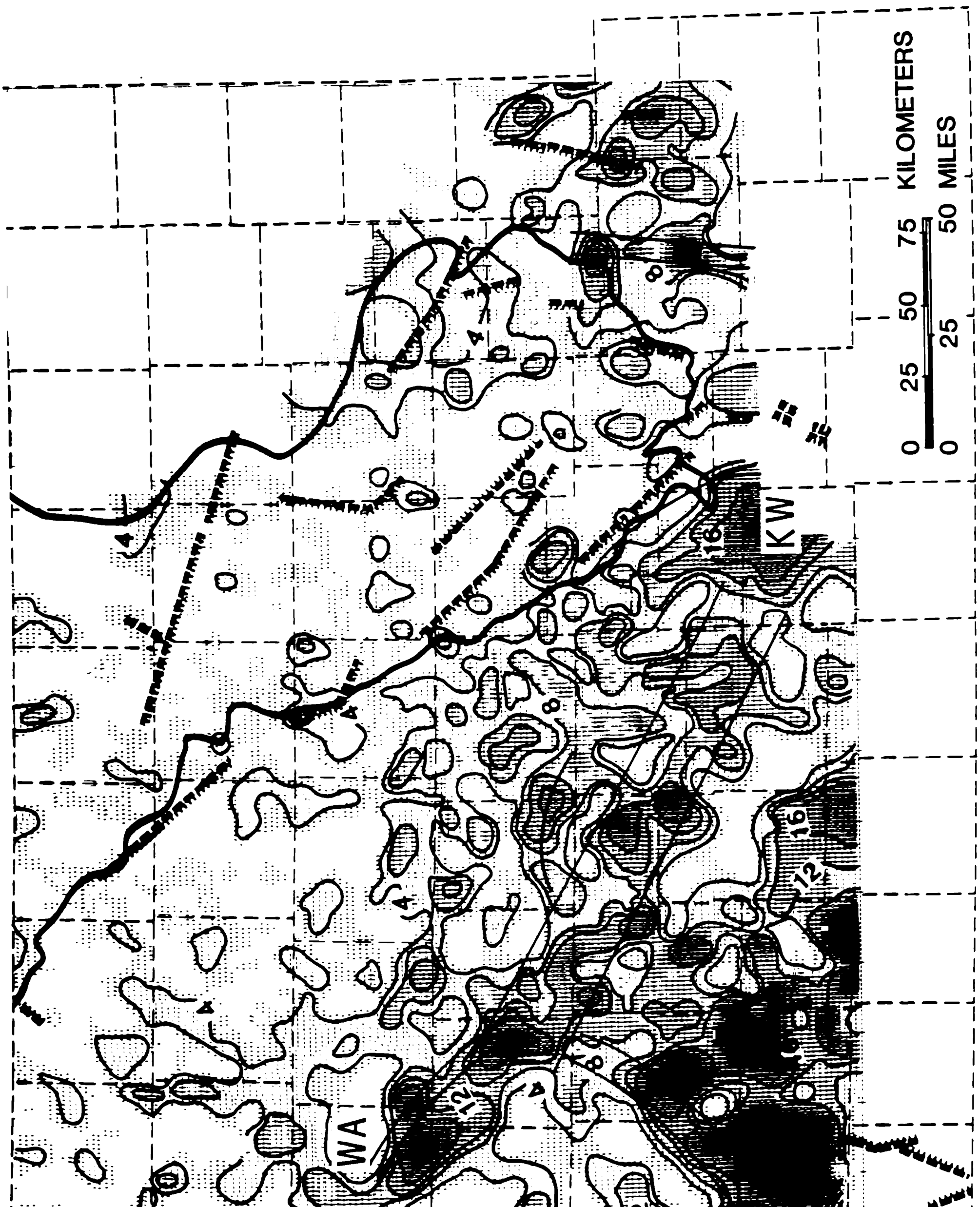
More locally, however, the K-Zone marine-interval isopach map in southwestern Kansas shows substantial thickening along an arcuate trend that is concave to the west. This 20-mile-wide (32 km) belt runs 150 miles (241 km) from Wallace County (WA) in the north, south-east to Wichita (WH) and Scott (SC) counties and then southwest into Stanton (ST) County in southwestern Kansas. Another region of thick rock occurs as lobate volumes in Haskell (HS) County. An elongate multilobed development (multigray toned on the map) trends west to east and northwest to southeast covering portions of Finney (FI), Hodgeman (HO), Edwards (ED), and Kiowa (KW) counties. Another thick marine interval in the K-Zone forms a prominent, narrow N-S trending lobe in Rice (RC) and Reno (RN) counties.

Marked regional southward thickening generally occurs south of the 35- to 40-foot isopach lines. The 35-foot isopach line extends through west-central Kansas around the southern CKU and back northward onto the east side of the CKU. The significance of this regional southern thickening will be discussed later.

Thickness of Porous Carbonate

Figure 5.5 shows the thickness of rock exceeding 8 percent porosity in the porous regressive carbonate. It more closely approximates the locations of prospective reservoir rock. The 8 percent value derived from wireline log interpretation was chosen as the cut-off porosity above which the pore space is considered to be permeable (greater than 0.4 millidarcies), i.e., effective porosity (see Watney, 1980). This porosity cut-off is a good index of the presence of sufficient permeability with two exceptions: 1) oomoldic carbonate rock can be impermeable even when porosity exceeds of 20 percent, and 2) porosity in fractured carbonate rock is commonly permeable at values considerably below 8 percent (Tixier, 1962). Hence the thickness of porous carbonate determined in this way is probably overly optimistic if oomoldic porosity is present. Nevertheless, the data can be rapidly obtained from porosity logs and can provide useful information on prospective trends of porous carbonate to aid in determining the genesis of this porosity.

Figure 5.5. Thickness of porous carbonate rock in the K-Zone regressive carbonate. Shaded interval is 4 feet (1.2 m) which is equal to the contour interval. The black area represents thickness in excess of 24 feet (8 m). Other symbols of map are as described in Figure 5.4. Wallace (WA) and Kiowa (KW) counties are identified.



KILOMETERS
0 25 50 75
MILES
0 25 50
WA
KW

The K-Zone porosity map in Figure 5.5 represents the thickness of all porous rock in the regressive carbonate. Similar maps of porous rock separated into upper and lower intervals of regressive carbonate reveal that most porous carbonate rock is restricted to the upper portion of the K-Zone. The uppermost interval is typically the site of high-energy carbonates facies.

The thickness of porous carbonate rock in the K-Zone corresponds very closely to the thickness of the marine interval over the southern portions of the mapped area. The lobate patterns of porous carbonate, generally 10- to 15- mile-wide (16 km to 24 km), nearly coincide with the trends of thicker marine interval across the southern area. A major belt consisting of multilobed occurences of porous carbonate rock extends 25 mi. (40 km) to either side of a 180- mile-long (238 km) line running NW to SE from Wallace County to Kiowa County. The northern border of this trend of porous carbonate rock closely coincides with the 35-foot isopach line of the marine-interval isopach map. The large area of regionally continuous porous carbonate rock in the south is also the area of greater thicknesses of the marine interval.

Another area of thickened porous carbonate rock includes an oval mass in southwestern Kansas well south of the northern edge of the regional thickening but immediately south of the thinned area identified earlier as the southwestern positive area. Both areas of thickened porous carbonate rock coalesce around the eastern side of the previously mentioned arc extending from Wallace County to Stanton

County surrounding the southwestern thin in Wichita County. Prominent porosity trends are shown in the southeastern and southwestern areas of the map and coincide with locations of regionally-thickened marine intervals.

On the northern shelf the relationship between a thick marine interval and the development of porosity is not apparent. For example, localized areas of a thin marine interval in Rawlins County are locations of thickened, grain-supported, high-energy carbonate rocks potentially containing favorable porosity (Watney, 1980, Figs. 52 and 53).

Thickness of the Regressive Shale

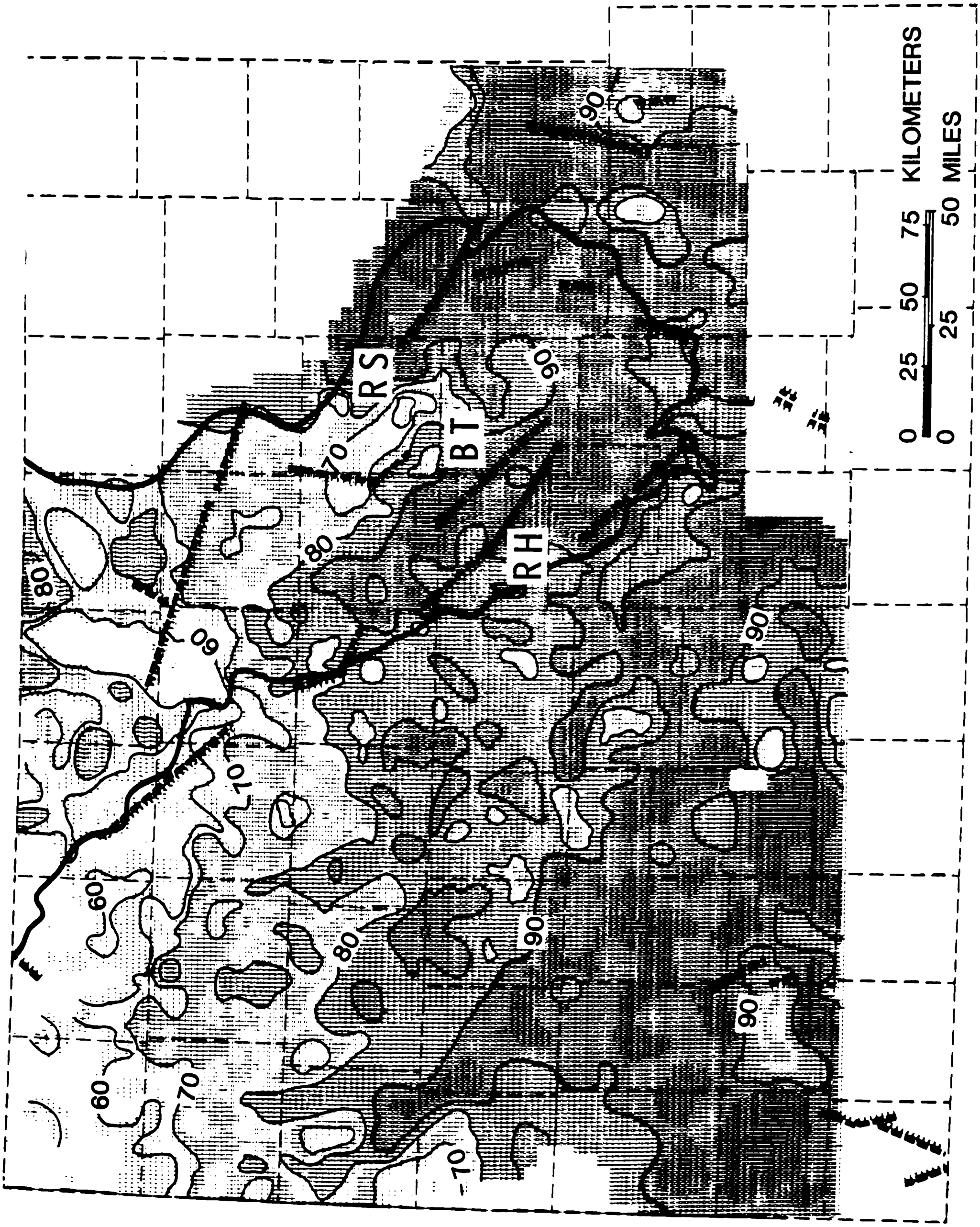
The regressive shale at the top of the K-Zone cyclothem is typically silty, unfossiliferous, and commonly contains structures and textures attributed to soil formation (see Tables 4 and 5). In addition, it has been shown (Watney, 1980; DuBois, 1979) that the unit characteristically thins over paleohighs in northwestern Kansas and southwestern Nebraska; this thinning has been interpreted as representing paleotopography caused by buildup of the underlying marine interval or local structural growth. An isopach map of this unit is thus an important tool in recognition of these paleohighs. The regressive shale thins dramatically to the south and in many areas such as on the CKU and the southern shelf, the unit reaches the minimum detection limit of the wireline logs (one to two feet). This is also true for regressive shales in the other cyclothems.

The thickness of the regressive shale of the K-Zone is expressed here as a ratio of the underlying marine interval to the total thickness of the cyclothem (Fig. 5.6). Thus the low-percentage contours in the northern study area represent a greater percentage of regressive shale in the cyclothem. The lower percentage contours form a broad apron representing thickening of the regressive shale to the north. A rather narrow lobe of the regressive shale ranging from 10 to 20 mi. (16 to 32 km) wide extends around the eastern margin of the CA down into Russell County on the northern edge of the CKU. The probable source area for the regressive shale is to the north where it is thickest. A broader lobe covers much of the upper two tiers of counties in northwestern Kansas. The thickness of this shale is less than 10 ft (3.0 m) across the southern two-thirds of the mapped area, an area with a ratio exceeding 80 percent.

The ratio exceeds 90 percent over most of the southern third of the area of study (see Figure 5.6). The arcuate buildup of the marine isopach and porosity thickness maps in southwestern Kansas is also the site of a local ratio in excess of 90 percent marine interval (Fig. 5.4 and Fig. 5.5). The percentage of regressive shale immediately west of the arc abruptly increases to values similar to the northwestern area of the shelf even though the entire cyclothem remains thin.

Another region where the marine interval exceeds 90 percent of the cyclothem is over portions of the CKU, an area associated with maximum thinning of the composite-interval isopach map of the H-, I-, J-, and K-Zones (Fig. 2.9) and the K-Zone marine interval (Fig. 5.4).

Figure 5.6. Marine interval percentage of the K-Zone. Low values indicate a greater fraction of regressive shale. Contour interval is 10 percent. Other symbols of the map are described in Figure 5.4. Russell (RS), Barton (BT), and Rush (RH) counties are identified.


KILOMETERS
0 25 50 75
MILES
0 25 50
RS
BT
RH
60
70
80
90

An area of pronounced thinning and low percentage of regressive shale is in eastern Rush and western Barton counties, coinciding with a northwest-southeast trending Precambrian basement horst commonly referred to as the Rush rib (Merriam, 1963). Here the Kansas City Group locally rests directly on the Precambrian surface. The area was perhaps isolated from an influx of terrigenous clastics possibly because of its local topographic relief.

The 90 percent isopach line generally runs from east to west coinciding with the northern border of the region of thicker marine interval and regionally continuous porous carbonate rock to the south. The diminished abundance of the regressive shale south of this line in both percentage and actual thickness probably resulted from two factors: 1) isolation by distance from a major source of clastic terrigenous sediment to the north, and 2) a greater accumulation of carbonate rock to the south. The more locally variable buildup of oolitic carbonate rock and perhaps more complex topographic relief of its surface may have inhibited the southerly progradation of this thin superjacent shale.

Influx of siliciclastics from a southerly direction in the K-Zone is insignificant. The regressive shales in these same cyclothems in southeast Kansas and eastern Oklahoma, however, are much thicker and increasingly the dominant members of the succession. These regions are closer to the major source of siliciclastics, the Ouachita orogenic belt. It was not until the later accumulation of the Lansing and Douglas groups that this southeastern source began significantly to affect the study area and only then the extreme southeastern portion, east and south of the CKU.

Maximum Gamma Radiation in the Marine Shale

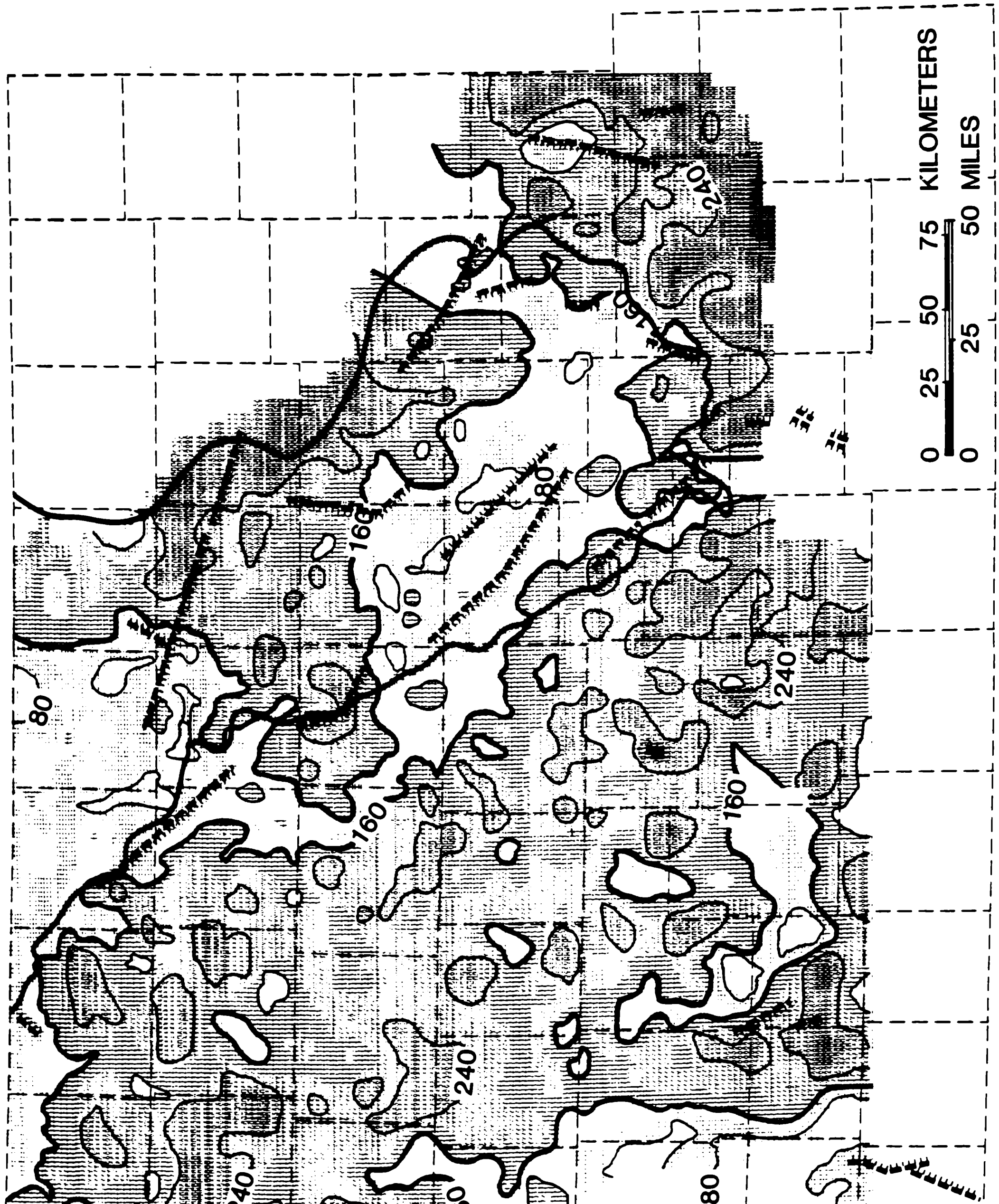
Variations in the character of the marine shale provide additional clues to the origin and development of each cyclothem. The depositional setting of this shale is critical to deciphering the history of each cyclothem. The characteristics of the shale, were perhaps affected by relief of the seafloor and variation in bottom water conditions. It has previously been suggested that the areas of positive relief controlled the location of high-energy conditions and potential reservoir quality rock in overlying regressive carbonate. The marine shale of the K-Zone cyclothem is relatively thin across most of the shelf area studied with the exception of the extreme northern region, where it can exceed a third of the thickness of the marine interval. Along these northern reaches the upper portion of the gray-green fossiliferous shale appears to grade laterally southward into an argillaceous regressive carbonate that in turn grades into a cleaner, micritic lower regressive carbonate. The marine shale in general thins rapidly to the south away from an inferred source of sediment along the northern margin of the shelf. Coincident with this facies change, the natural gamma radiation (GR) measured adjacent to this shale increases southward (Watney, 1979). In the north the GR reading of the marine shale is commonly very similar to the GR of the regressive shale (Table 14). The gamma ray values of the lower portion of the regressive carbonate may be very similar to the intermediate GR intensity of the marine shale. The GR log alone can therefore give thicker values of marine shale without another log such as a neutron or resistivity log to confirm the presence of shale lithology.

Southward, darker-colored marine shales are more abundant. The GR value recorded adjacent to these shales is higher. The GR exceeds 150 API units in the black shale. Its black color is due to abundant organic matter (Evans, 1967; James, 1970). Higher gamma radiation associated with these black shales results from the presence of uranium (Watney, 1979).

The natural gamma radiation emitted by this shale is readily obtained from wireline logs. This reading provides an indication of the concentration of uranium or thorium that apparently is related to the abundance of organic matter and apatite (Wood et al, 1974). Figure 5.7 depicts the maximum gamma radiation recorded by the gamma ray log in the marine shale of the K-Zone cyclothem. The marine shales as well as the regressive shales in the northern-most part of the study area typically range from 70 to 100 API units and are gray to green or red-brown. Thicker shale is also more silty, suggesting that the source of the gamma radiation in this case has been diluted by the influx of terrigenous clastics or that the gamma radiation simply represents the background values of potassium-40 and thorium incorporated in clay mineral lattices (Watney, 1979).

The striking feature of this map (Fig. 5.7) is that the gamma radiation of this shale varies significantly across the southern and central portions of the shelf. The CKU is surrounded by marine shale

Figure 5.7. Maximum gamma radiation recorded by the wireline logs in the marine shale of the K-Zone. Contour interval is 80 API units. Other symbols of the map are as described in Figure 5.4. Greeley (GL), Hamilton (HA), and Stanton (ST) counties are identified.


0 25 50 75 KILOMETERS
0 25 50 MILES
80
160
240
GL
HA
ST

that emits low GR. Local thinning of the marine shale coinciding with the crestal areas of the CKU may cause the thickness of the shale to fall below the resolution limit of the GR logging tool (approx. 2 feet). This would diminish or eliminate the high reading even though a black shale may be present. The intensity of the gamma radiation, however, is generally such that the hot shale can be resolved even at thicknesses as little as 0.3 ft. (9 cm) I-Zone marine shale in the #9 Morel, Sec. 15-9S-21W is 0.3 ft. (9 cm) thick (in core) and recorded gamma intensity exceeds that of average shale by approximately 45 A.P.I. units. Cores confirm the loss of the black facies and in some cases the pinchout of the marine shale over the crestal areas of the CKU. The region encompassed by the low GR values for the marine shale over the CKU and CA closely coincides with thinned regions on the marine interval isopach map of the K-Zone (Fig. 5.4) and the H- to K-Zone composite-interval isopach map (Fig. 2.9). The narrow N-S trending structural high along the Pratt anticline (PA) that extends southward off the CKU in Pratt County also coincides in Figure 2.12 with a southward protrusion of low GR. The thick, porous carbonate rock covering much of the southwestern study area also thins onto the west flank of the PA (Fig. 54.5), suggesting that this area of the shelf was perhaps a positive area during the accumulation of the K-Zone.

In the extreme western edge of Figure 5.7 in Greeley (GL), Hamilton (HM), and Stanton (ST) counties, GR values in the marine shale are again low (<100 API). The area also corresponds to a thinner marine interval, porous carbonate rock, and present day structural high. Although the marine shale is noticeably thinner over the CKU, at the other site of the low gamma radiation it is thicker in the Greely-Hamilton, Stanton county area. The regressive shale is also substantially thicker in this cyclothem at this location, parallelling a similar relationship on the northern shelf. Either dispersal of organic matter in the marine shale by local influx of terrigenous detritus or environment unsuited for accumulation of radioactive material possibly decreased the GR. Moreover, higher concentrations of quartz sand in the regressive carbonates is associated with a pronounced increase in numbers of significant intercalations of bedded shale (see #1 Beirig cross plot and well log, Fig. 5.3). The eastern limit of this reduced GR region also coincides with the western concave portions of the arcuate trend of buildups on the marine interval (Figs. 5.7, 5.4) and the thickness of porous carbonate (Fig. 5.5) in the K-Zone. These relationships strongly imply that this area was a positive site on the shelf during the deposition of this cyclothem. Terrigenous clastics originating from the Cimmaron arch to the west may account for the abundance of shale and the increase of silt and the low gamma radiation of the marine shale. Yet, the rimming buildups of carbonate rock suggest a positive shelf setting as well. Structurally, the area is perhaps an eastward extension of the Cimmaron arch.

In general, there is a remarkable coincidence of the GR map and the isopach maps. The CA, CKU, PA, southwestern positive area, and northwest shelf are locations where the GR values are less than 150

API units. Even the present-day structural saddle separating the CA and CKU is apparent on this map as a narrow band of higher gamma radiation. Detailed mapping with all available data on the scale of townships or counties should reveal additional, local variation in GR of these shales. This information may assist in substantiating the existence of paleorelief and potentially, the site of favorable reservoir development. Such interpretations should be substantiated with the other stratigraphic maps and samples of the rock.

Variation in the GR recorded in the marine shale across the shelf may be controlled by bathymetry. Depth and configuration of the seafloor may have had a substantial effect on the degree, frequency, and duration of bottom stagnation and hence the maximum GR recorded in the marine shale. The area of reduced GR on the CKU is also represented by thinning on the marine-interval isopach map. The thinning amounts to only 20 feet (6 m) across the positive region of the CKU. This thinning is probably the minimum relief of the seafloor during the time of accumulation of this shale. The upper surface of a bottom anoxic water layer may have fluctuated at least by this much. Accumulation of organic material may have been diminished by periodic oxidation over the positive areas that were situated intermittently above the anoxic layer. The uranium associated with the organic matter perhaps was released when portions of the organic matter were lost on these more positive areas during more extended periods of intermittent oxygenated conditions or perhaps physically transported off these areas by deeply penetrating storm-generated currents. This mobilized uranium could then accumulate elsewhere in the more anoxic pools. Local enrichment may have resulted from such flux and perhaps was controlled by water currents.

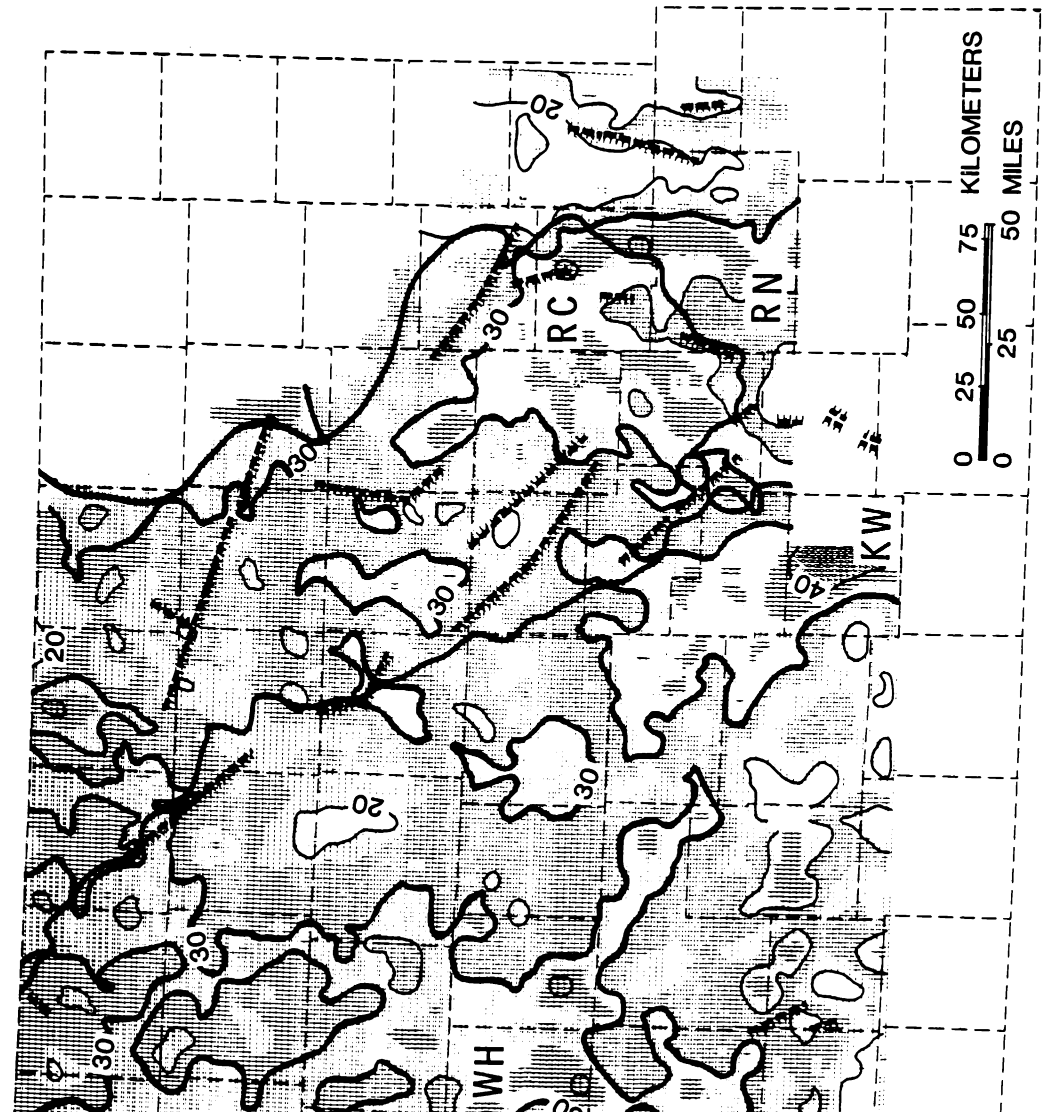
K-Zone Contribution to the
Combined H to K Interval

Figure 5.8 depicts the percentage thickness of the K-Zone in the total thickness of cyclothems, H, I, J, and K. The proportion of the K-Zone is around 25 percent. The areas of deviation imply some form of compensating relationship between, for example, sites of exceptional buildups in one cyclothem and later thinning of another. Note that the K-Zone comprises in excess of 35 percent of the entire thickness of the four-cyclothem interval around the arc surrounding the southwestern positive area. These high percentages are also observed in south-central Kansas in Kiowa County and along the N-S trend in the southeastern region of Rice and Reno counties. These high values also coincide with thicker intervals of porous regressive carbonate. The arc-shaped buildup extending from Wallace to Stanton counties was an exceptional buildup. Relief on this feature may have persisted well into the deposition of the succeeding cyclothem. Why it developed can be answered more definitively by considering the map along with the information from the study of the rocks themselves.

Summary of K-Zone Maps

Corresponding patterns and relationships found in the maps were used to define subdivisions of uplift and subsidence over the area of

Figure 5.8. Percentage thickness of the K-Zone in the entire four-zone interval, H to K. Shaded interval is 5 percent while the contour interval is 10 percent. Small arrows in the southwestern mapped area indicate the location of relatively thin K-Zone, while the bold arrows in the south highlight the regions of relatively thick K-Zone. Other symbols of the map are described in Figure 5.4. Wallace (WA), Wichita (WH), Stanton (ST), Kiowa (KW), Reno (RN), and Rice (RC) counties are identified.


KILOMETERS
0 25 50 75
MILES
0 25 50
RC
RN
KW
WA
WH
ST
20
30
40

study (Fig. 5.9). Simple thinning of the marine-interval isopach map suggests a positive location, while thickening implies defferential subsidence of that region. Besides the marine-interval isopach map, other maps provide attributes that assisted in dividing the shelf into these different settings (Table 15).

The subdivisions also identify areas that were similar in depositional and diagenetic setting during the accumulation of the K-Zone cyclothem as suggested by the examination of rock samples. The three basic subdivisions of the shelf include: 1) shelf areas that underwent broad, gentle subsidence during the time that the K-Zone accumulated, 2) positive areas that subsided less rapidly than the shelf areas, and 3) areas of flexure that underwent greater subsidence and tilting. In particular, the areas of uplift include the CKU-CA and southwestern positive area. Areas of subsidence encompass the southern shelf area. These features on the shelf are best depicted with the aid of the marine-interval isopach map of the K-Zone illustrated here as the lower polygonal net surface of the perspective diagram in Figure 5.9. The subdivisions are outlined both on the surface of the net and on the top face of this diagram.

The recognition of these relationships between maps and the subdivisions aids in interpreting the core data from the K-Zone. Integration of both data provides an improved understanding of the trends and patterns of depositional facies in the carbonate rock. Definition of trends of prospective reservoirs is also enhanced by this approach.

Table 15. Map Attributes Used To Identify Shelf Setting.

A. Top H to base of K-Zone interval isopach: broad thins and thicks that closely coincide with the thickness of the marine interval of the K-Zone indicating regional uplift or subsidence on the shelf.

B. Structure contour and 3rd-order trend surface residual contour map of top of K-Zone: locates present day positive areas (higher elevations and positive residuals) some of which closely match other thins confirming continued development of some structural elements, e.g., CA, CKU, southwest Kansas positive area. For CKU, note particularly the development of the Rush rib during the accumulation of the K-Zone.

C. Thickness of porous carbonate in the K-Zone regressive carbonate: thicker porous intervals are contained south of the flexure on the shelf defined by the marine-interval isopach map crossing the southern area of study and rimming the southwestern Kansas positive area (thin surrounded by thick intervals of porous carbonate); upper shelf and CA-CKU are similar in appearance on this map--both have restricted occurrence of regionally continuous porosity; distribution of porous carbonate on the northern shelf is thin and erratic at this scale and density of controls points (1 per 12 square miles).

E. Percentage of marine interval in the K-Zone: northern shelf and southwest are areas that were significantly affected by influx of terrigenous clastics (lower percentage values equaling greater proportion of regressive shale); 90% line closely coincides with the northern limit of the flexure on the shelf (i.e., thickening is primarily due to the marine interval); southern positive area of Pratt anticline (PA) and CKU are locations with a higher percentage of this ratio indicating the greater abundance of the marine interval (primarily regressive carbonate) due to the isolation from influx of clastics from the north because of distance and probably local topographic relief as previously described.

F. Maximum GR of marine shale: areas of low GR closely coincide with previously defined positive areas (PA, CKU, CA, southwestern positive area) and broad northerly area of influx of terrigenous clastics (northwestern study area).

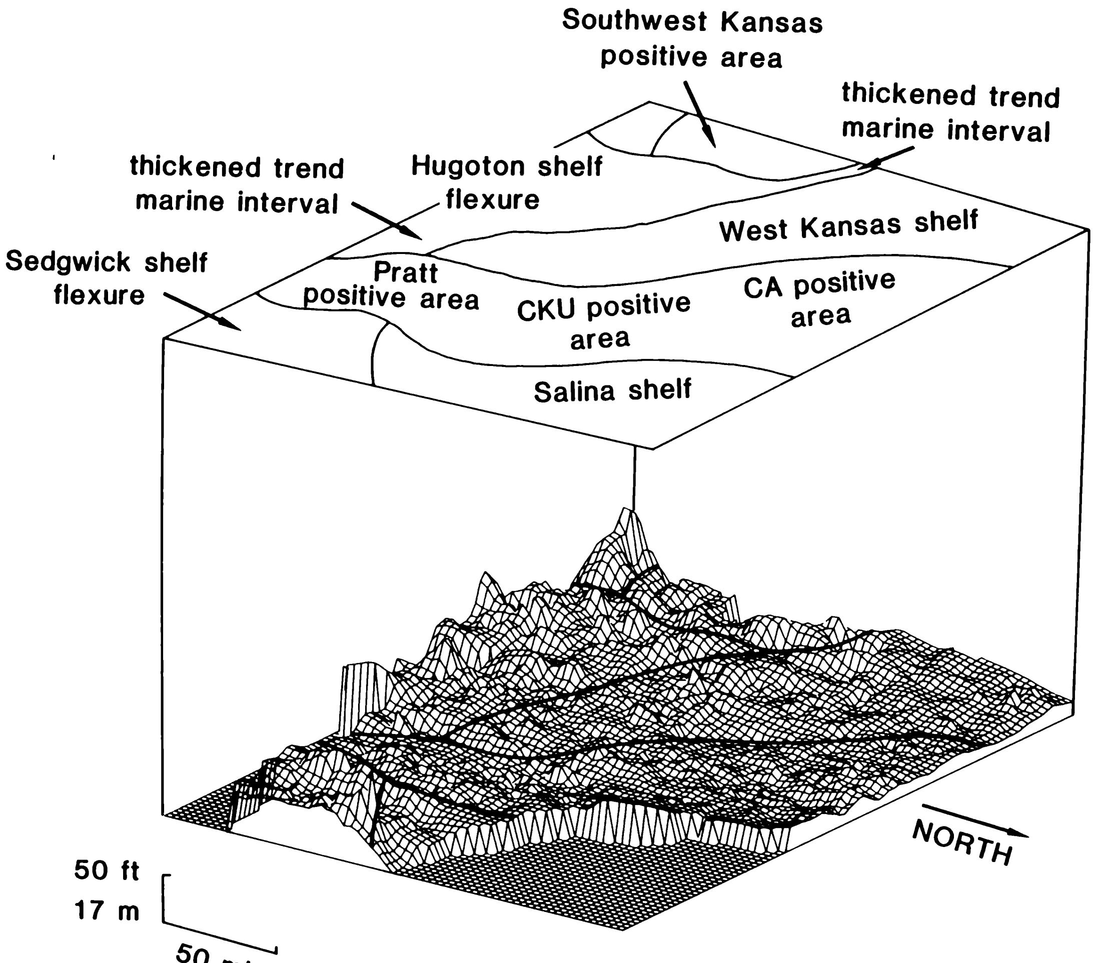
Distribution of Oolite in the K-Zone Using Logs and Core

Plate 1 displays the facies identified in cores of the K-Zone cyclothem. Figure 5.10 graphically summarizes the cored intervals of selected wells from the K-Zone using the shelf setting identified in Plate 1. The total thickness of the K-Zone cyclothem is indicated by the length of the graphic column of the cored portion plus the interval marked no core recovery.

The upper regressive carbonate is invariably composed of shallow-water facies that are quite variable in texture and faunal composition. Restricted shallow-water facies occupy greater portions of the cyclothem in southern Nebraska and over the CA and CKU. More than half of the vertical succession of carbonate from these areas are intertidal and supratidal low- and high-energy deposits. Moreover, the #3 Denker core located on the southern portion of the CKU and the #4 Litsey core located on the eastern flank of the Pratt anticline shown in Plate 1 illustrate that even at these southern locations, the local setting offered an opportunity for significant periods of accumulation of restricted-marine, shallow-water carbonate. Both locations were apparently influenced by the higher elevations associated with these uplifts. Log-derived maps assist in the resolution of these depositional sequences and identification of potential reservoirs.

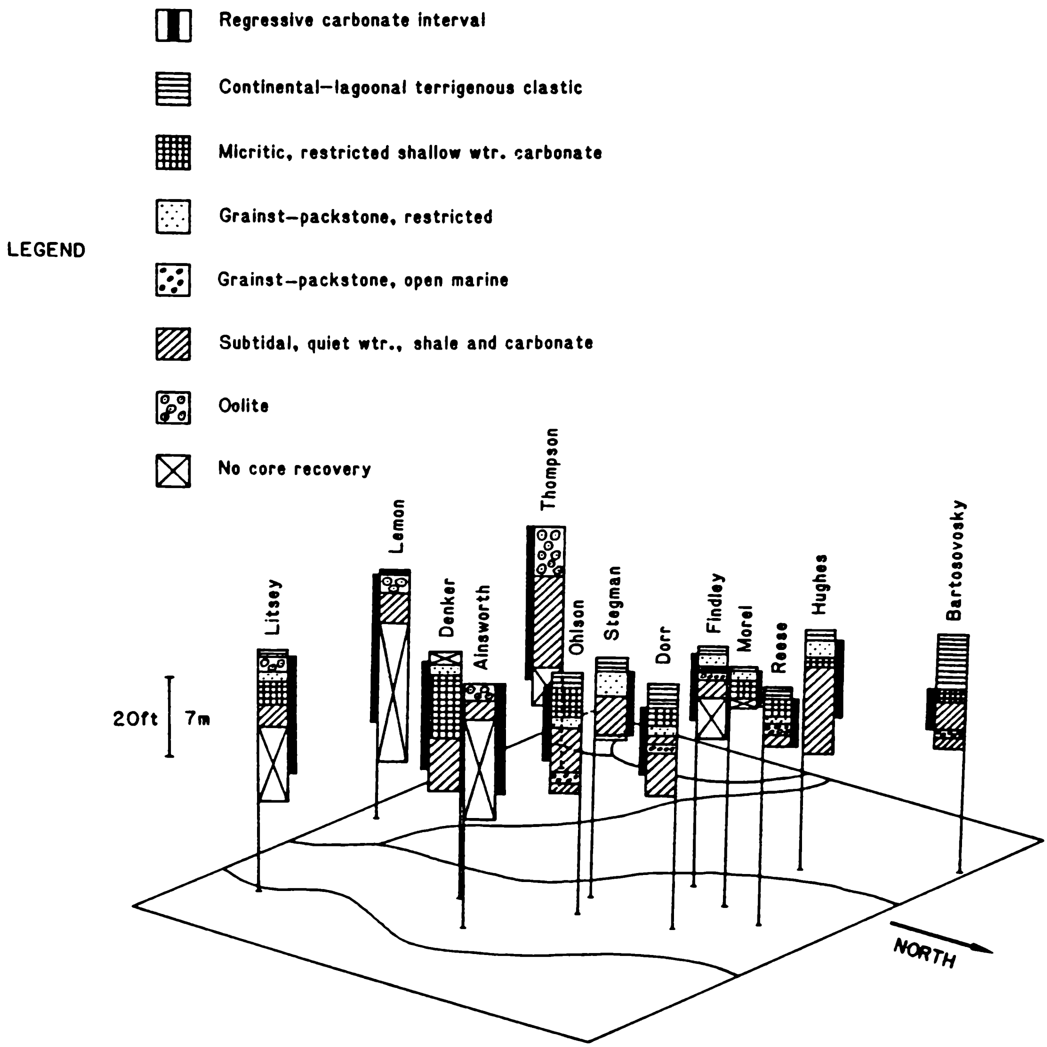
The uppermost portion of the regressive carbonate in the K-Zone

Figure 5.9. Perspective diagram of the thickness of the marine interval mapped in Figure 5.4 as observed looking down on the study area toward the southwest. Northern border is Kansas-Nebraska border and the western border is the Kansas-Colorado border. The surface above the plot contains outlines of the various structural subdivions of the western Kansas shelf during the Missourian. These lines are also identified on the lower plot. Division of the shelf is determined using the criteria defined in Table 15.



K-ZONE MARINE INTERVAL THICKNESS

Figure 5.10. Perspective view of the mapped area in western Kansas annotated with structural subdivisions of shelf looking toward the southwest. Projecting above the surface are selected graphic core facies interpretations for the K-Zone. Total thickness of the zone is shown including the uncored interval when necessary. Solid bar along each column shows location and thickness of the regressive carbonate interval. Illustration complements Figure 5.9.



K–Zone lithofacies from core

of the #4 Litsey and #E-2 Thompson cores is thick oolitic grainstone. The lithologies and interpretation of depositional environments of the K-Zone are illustrated with traces of selected wireline logs in Figures 5.12 and 5.13. A contrasting K-Zone, the #2-D Stegman and #506-W Dorr cores and logs, is also illustrated. The locations of these wells are shown in Figure 5.11. The wells are situated on the flanks of the positive area of the Pratt anticline and out on the southwestern shelf, respectively. This distinctive shoal-water facies is pervasive around the southern portions of the uplift and over the southern mapped area. The deposition of the oolite required persistent tidal action in shallow water. Essentially all of the porous carbonate in the southern mapped area that exceeds 10 feet (3 m) in thickness is similarly oolitic, according to both sample data and limited core control. This facies is generally oomoldic which accounts for the typical high porosity readings for the logs. The combination of gamma ray and porosity logs is adequate to identify this oolitic facies. The oolitic zone is typically recognized by its low value, block-shaped gamma ray trace and very high porosity (generally greater than 15 percent) (Figs. 5.12 and 5.13).

Unlike the extensive development of oolitic grainstone across the southern shelf, the occurrences of porosity in the northern region do not necessarily follow thicker trends of the marine interval (Fig. 5.4). Cores obtained from the northern shelf indicate that porosity is primarily associated with grain-supported carbonate intervals; but most of these carbonate grains were affected by only minor and infrequent transportation. These grains are generally only

Figure 5.11. Index map locating core-log examples illustrated in Figures 5.12 and 5.13. Black = oil.

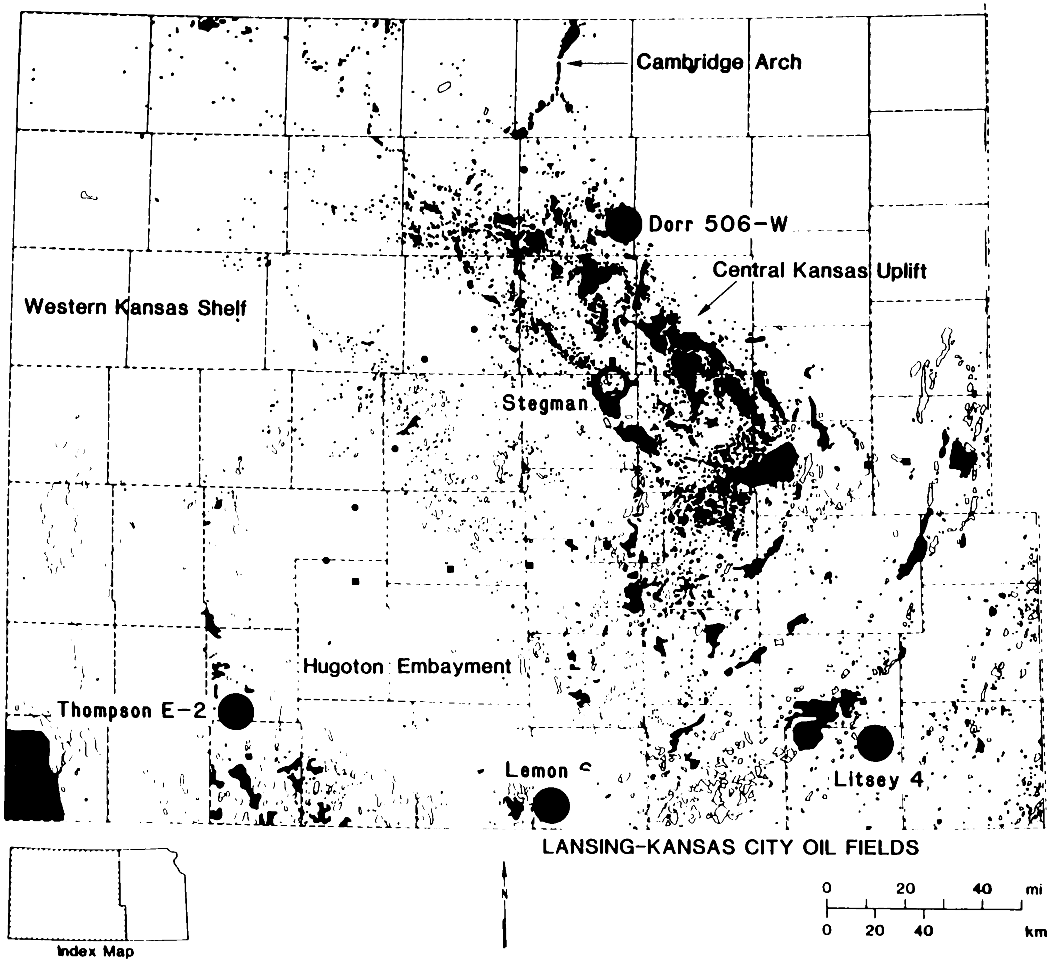
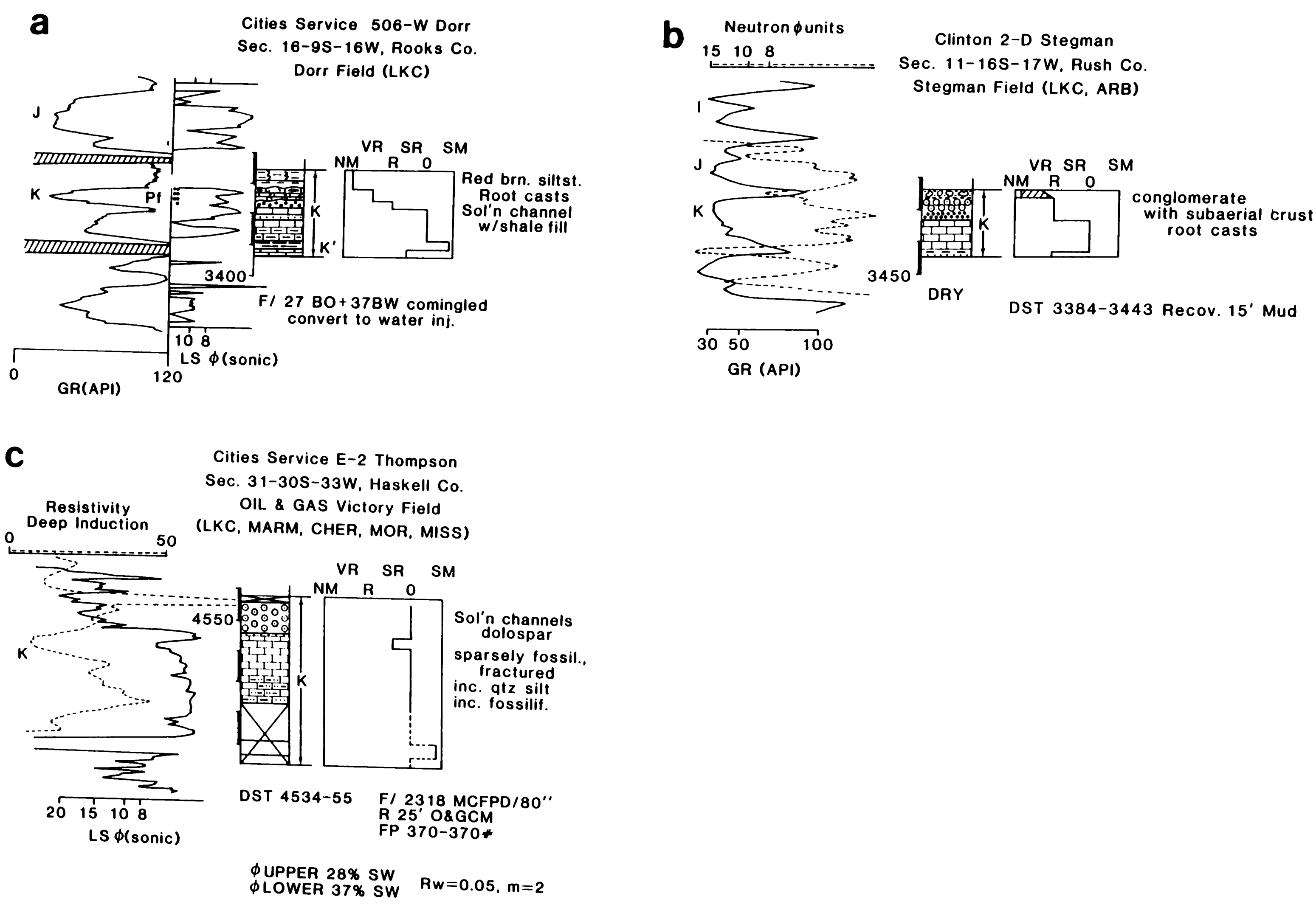
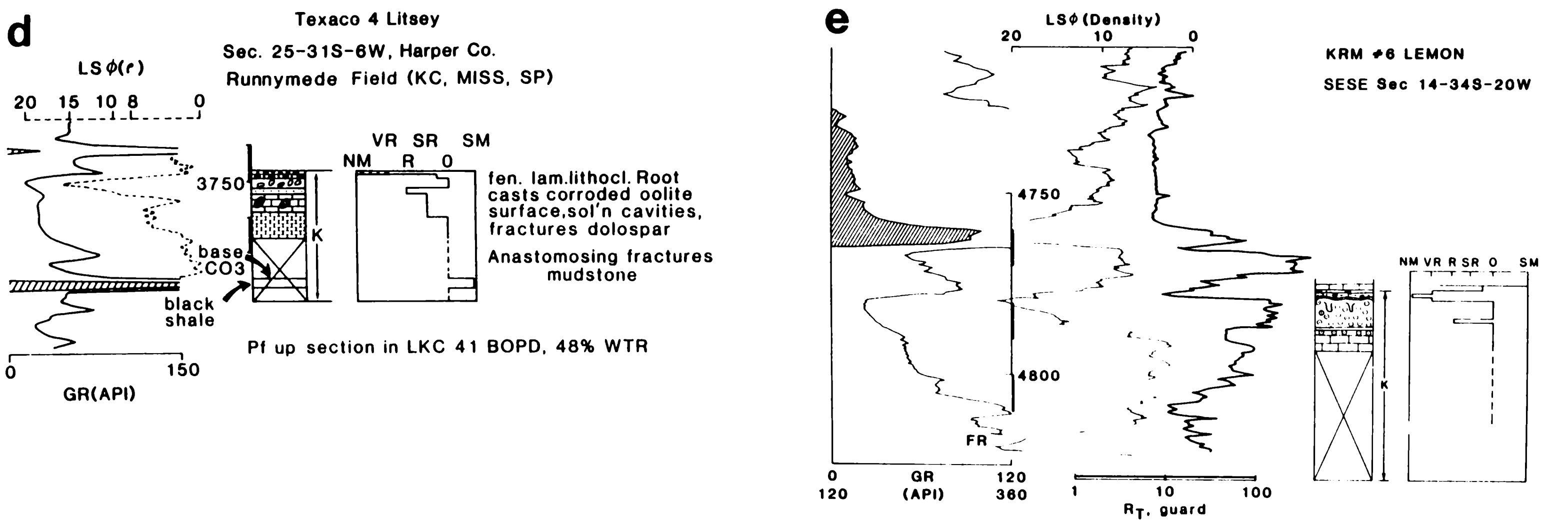

Cambridge Arch
Dorr 506-W
Central Kansas Uplift
Western Kansas Shelf
Stegman
Hugoton Embayment
Thompson E-2
Lemon C
Litsey 4
LANSING-KANSAS CITY OIL FIELDS
N
0 20 40 mi
0 20 40 km
Index Map

Figure 5.12 and 5.13. Combined wireline logs and core descriptions of the K-Zone for five wells in the study area. Gamma ray (GR), porosity (Ø) from sonic, neutron, and density (ρ) logs are shown. Sonic and density porosity is determined for a limestone matrix. Lithologic symbols described previously in Appendix D. "X" in graphic core column represents no core. The despositional environment for specific intervals of core are indicated in the right-most block. The vertical line segments lie beneath one- and two-letter codes defined as follows: NM - nonmarine; VR - very restricted (unfossiliferous to low diversity fauna); R - restricted; SR - slightly restricted (mixed fossil assemblage, but not all normal fauna present or abundant; O - open marine; SM - stagnant, anoxic marine (black marine shale). Certain features about the rock are mentioned in the right margin including: fen. lam. - fenestral laminated mudstone. Results of drill stem (DST) or production tests are written below the core description including Pf - perforated; F - flowed; R - recovered; FP - flowing pressure; O - oil; GCM - gas cut mud. Depths are in feet below the surface. Productive zones are abbreviated in the title: ABC - Arbuckle; KC - Kansas City; MISS - Mississippian; SP - Simpson; MARM - Marmaton; CHER - Cherokee; MOR - Morrow. In well (C), #E-2 Thompson, the oolite contains an upper portion that is more porous than the bottom. The information at the bottom of that illustration indicates that water saturation (SW) in this oolite is 28 % and 37 % for the upper and lower intervals using the resisitivity logs and the Archie equation with water resistivity (R_W) of 0.05 ohm-m and a cementation exponent (m) of 2. The interval in fact was capable of producing hydrocarbon at the time the interval was logged.



a
Cities Service 506-W Dorr
Sec. 16-9S-16W, Rooks Co.
Dorr Field (LKC)
J
K
Pf
K'
3400
VR SR SM
NM R 0
Red brn. siltst.
Root casts
Sol'n channel
w/shale fill
F/ 27 BO+37BW comingled
convert to water inj.
10 8
LS ϕ(sonic)
0 120
GR(API)
b
Neutron ϕ units
15 10 8
Clinton 2-D Stegman
Sec. 11-16S-17W, Rush Co.
Stegman Field (LKC, ARB)
I
J
K
3450
VR SR SM
NM R 0
conglomerate
with subaerial crust
root casts
DRY
DST 3384-3443 Recov. 15' Mud
30 50 100
GR (API)
c
Cities Service E-2 Thompson
Sec. 31-30S-33W, Haskell Co.
OIL & GAS Victory Field
(LKC, MARM, CHER, MOR, MISS)
Resistivity
Deep Induction
0 50
VR SR SM
NM R 0
4550
K
Sol'n channels
dolospar
sparsely fossil.,
fractured
inc. qtz silt
inc. fossilif.
20 15 10 8
LS ϕ(sonic)
DST 4534-55
F/ 2318 MCFPD/80''
R 25' O&GCM
FP 370-370#
ϕUPPER 28% SW
ϕLOWER 37% SW
Rw=0.05, m=2


d
Texaco 4 Litsey
Sec. 25-31S-6W, Harper Co.
Runnymede Field (KC, MISS, SP)
LS ϕ(r)
20 15 10 8 0
3750
base CO3
black shale
K
VR SR SM
NM R 0
fen. lam.lithocl. Root casts corroded oolite surface,sol'n cavities, fractures dolospar
Anastomosing fractures mudstone
Pf up section in LKC 41 BOPD, 48% WTR
0 150
GR(API)
e
LSϕ (Density)
20 10 0
KRM #6 LEMON
SESE Sec 14-34S-20W
4750
4800
FR
NM VR R SR O SM
K
0 GR 120
120 (API) 360
1 10 100
R_T, guard

poorly sorted, heavily micritized, and have few if any concentric oolitic laminations. The thick micritized rims of these grains probably resulted from sitting on the ocean floor for long intervals while being attacked by endolithic organisms, such as blue-green algae. Sustained tidal action, which was necessary to keep grains moving and promote the formation of oolite during late regression, was limited on the northern shelf. A broad platform with a low paleoslope on the northern shelf dampened most current action. Prominent paleohighs and many sites of pronounced thinning, some of which are coincident with present-day structural anomalies, were locations of the formation of oolite on the northern shelf. Oolite formed locally along the Jennings anticline on the western edge of the CA crossing several townships in Sheridan and Decatur counties, Kansas (Brown, 1983). Storms and periods of strong wind probably accounted for most washing and removal of lime mud in many of these shoal-water accumulations without significant transportation of larger particles.

To the south a steeper slope of the shelf is suggested by the marine-interval isopach map (Fig. 5.4) and supported by the other maps and core information. The northern edge of the thickening to the south is most abrupt and is interpreted as an increase in slope which crossed west to east over western Kansas. Waves may have broken along the shallowing of the shelf and current action may have been greater here also during later regression. This interpreted increase in slope or flexure is also the northern-most limit of the extensive tract of oolitic grainstone. It is probable that the development of the oolitic grainstone is closely related to the presence of this zone of flexure and those areas to the south with greater slopes than to the north. Conversely, the lack of development of oolite is related to lower slopes.

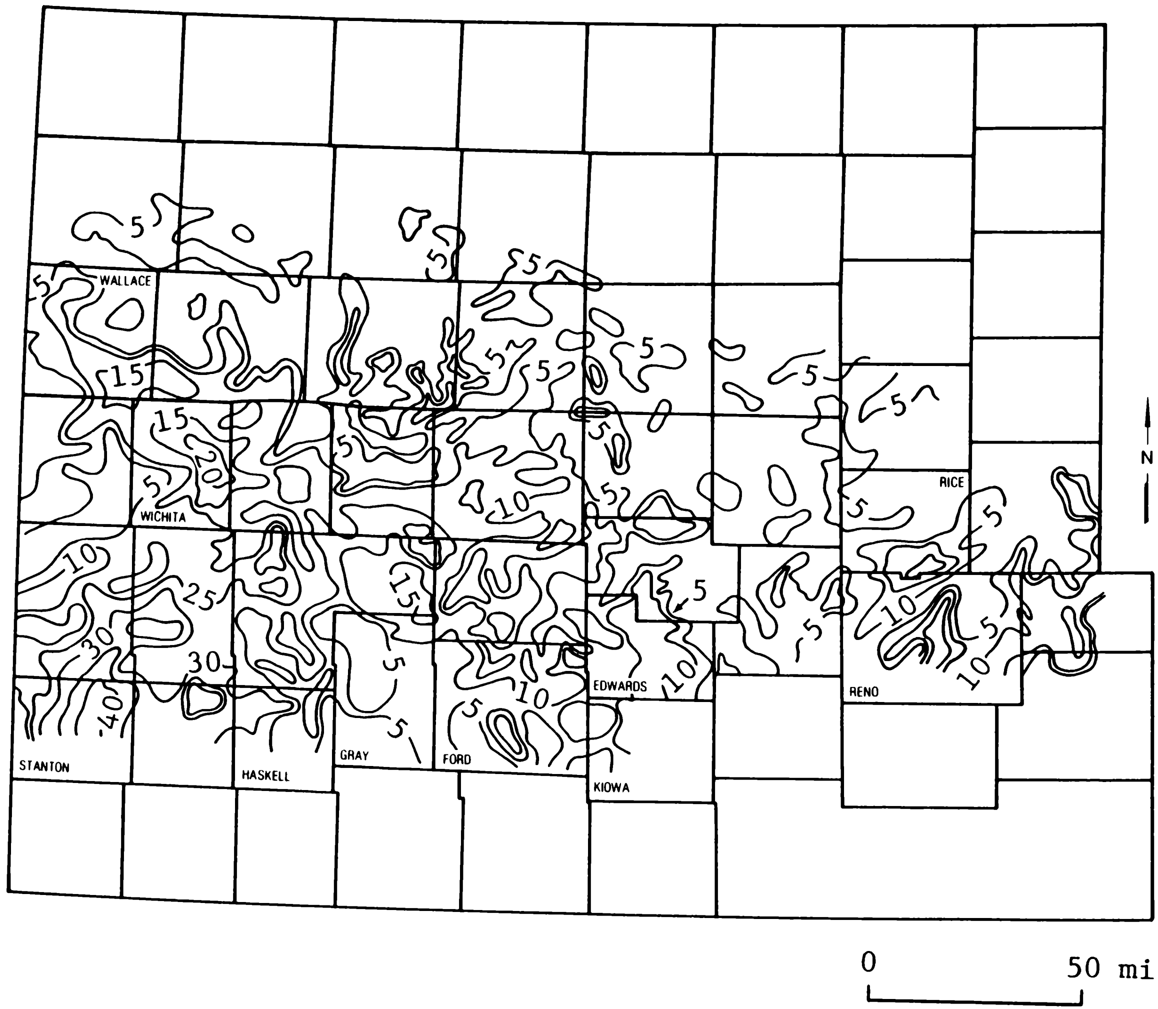
The southwestern positive area was flanked by a rim of strikingly thick oolitic grainstones. These accumulations are interpreted to have formed on an even more abrupt change in depositional slope at a location where wind and current energy were focused on the sea floor during late regression. The slope here is judged to have been greater because of greater rates of thickening of other evidence of a positive location on the shelf. This would be a very favorable site for accumulation of oolites because it is also near the southern margin of the shelf near the more turbulent open water. A prominent band of oolite shoals runs NW-SE into Kiowa County (trend of thick porous rock, Figure 5.5). It is perhaps no coincidence that the prolific Lemon Ranch field, located in Comanche County, is on trend with this development of porosity. This reservoir flanks what was a positive shelf area along the PA. Today the Lemon Ranch field is located on the axis of a southwesterly plunging structural nose. The pinchout of porosity on the northeast end of the field forms the updip seal for the oil accumulation in the K-Zone. Similar development of thick reservoirs would be expected to occur northwest along this trend. The lack of effective porosity is the common problem associated with these oolitic zones. Local paleohighs along this trend would perhaps provide opportunities for more extended freshwater diagenesis and secondary leaching and fracturing which might enhance the quality of the reservoir such as at Lemon Ranch field.

Figure 5.14 is a more detailed, hand-contoured version of the thickness of porous regressive carbonate of the K-Zone. All data points were plotted and contoured including an area along and south of the W-NW trending shelf flexure as interpreted from the thickness of the marine interval. The objective of manual contouring was to emphasize trends possibly not recognized by the computer contouring.

The trends of thick, porous carbonate surrounding the southwestern Kansas positive element are also apparent on this hand-contoured map. A strong northwest to southeast trend extends from Wichita County to Kiowa County. Smaller areas of porous carbonate, some lobate in form, within this latter trend in township 15S and ranges 36 to 40W and township 19S and ranges 33W to 37W are oriented northeast-southwest. The thickest lobes range from 20 feet (6 m) to 64 feet (19 m) in thickness. The maximum observed buildup of porous oolite lies immediately south (basinward) of the southwestern positive area in Stanton County previously mentioned as a optimum site for the formation and accumulation of oolite.

In Wichita County the lobe of porous carbonate rock tapers off substantially to the northwest. Between townships 11S to 14S and range 40W to 42W the southerly dip on the shelf may have been reversed on approach to the southwestern Kansas positive area. The elongate lobe of porous carbonate (oolite) probably prograded northwestward into this area from the thickest buildup in township 15S and

Figure 5.14. Hand-contoured map of the thickness of porous carbonate rock of the K-Zone in the study area of western Kansas. Compare with the computer-generated version in Figure 5.5. This map more clearly shows the elongate lobes formed by the porous carbonate rock. In particular the thick (greater than 5 feet) occurrences are interpreted from available cores, selected cutting, and log signature to represent oolitic grainstone.

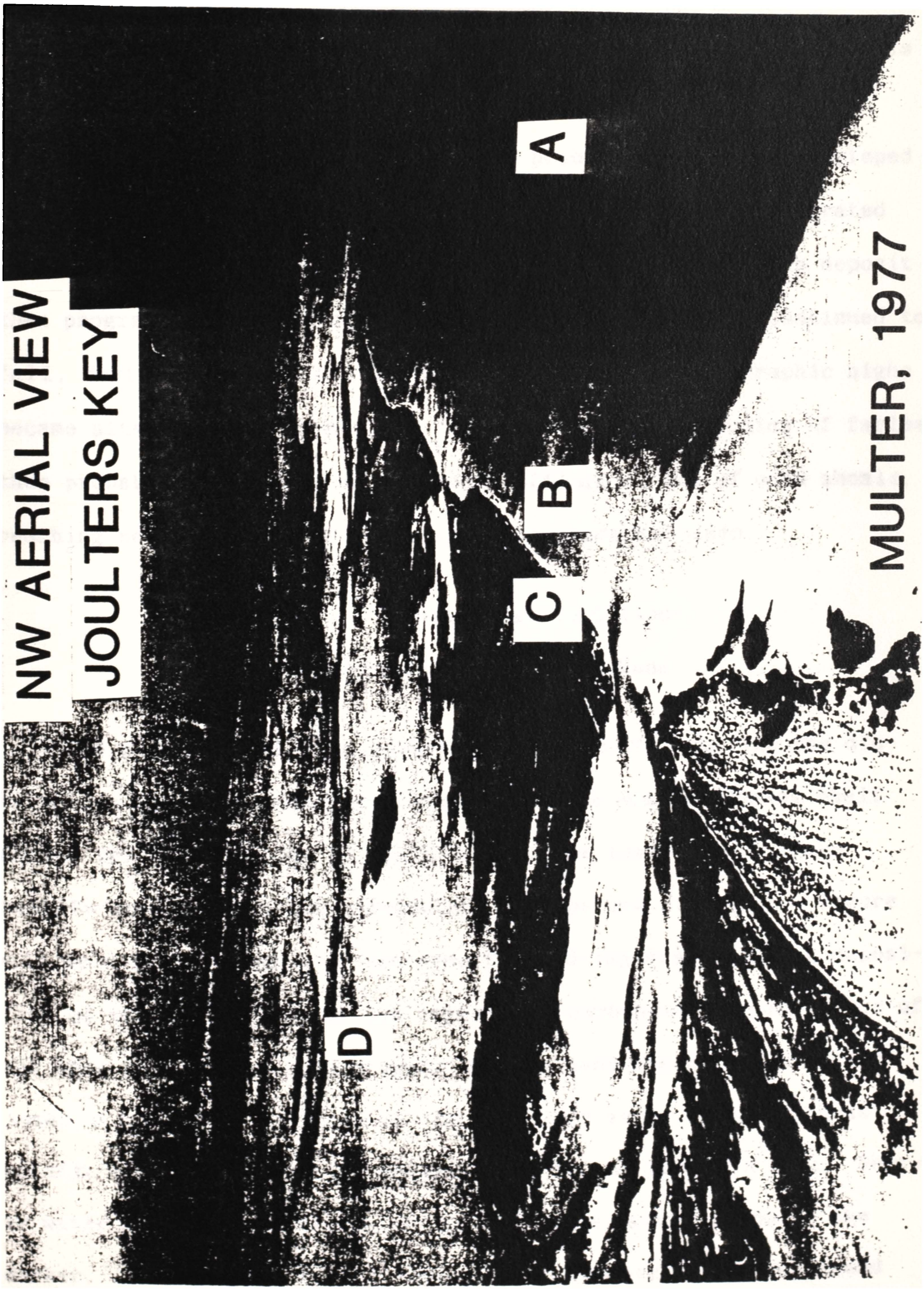

WALLACE
WICHITA
STANTON
HASKELL
GRAY
FORD
EDWARDS
KIOWA
RENO
RICE
N
0
50 mi

range 36W to 39W.

Lobes of porous carbonate form finger-like projections from the area of regionally continuous porosity. These lobes range in size from 30 miles (48 km) long and 5 to 10 miles (8 to 16 km) wide to probably less than 3 miles (4.8 km) in length or width which is less than spacing between data points. The lobes resemble large oolite banks similar to the spillover lobes developing today in the Bahamas. Some of these Pennsylvanian examples though are up to five times as large as the largest modern example from the Bahamas. This large-scale progradation of oolite resembles that of the Pleistocene Miami Oolite that covers much of extreme southeastern Florida (Multer, 1977). In the modern setting oolite develops near the platform edge facing the open ocean. Perhaps in a similar way the break in paleo-slope that developed during the accumulation of the K-Zone (Swope unit) may have became the locus of ooid development during shallow-water conditions. Storm surges were probably dominant forces in moving the ooids northward beyond the flexure to form these large, finger-like lobes that resemble modern ooid spillover lobes (Ball, 1976). An oblique photograph of Joulters Key in the northeastern Bahamas (Fig. 5.15, from Harris, 1979 and Multer, 1977) helps to provide a perspective of the environmental setting thought to have existed during accumulation of these ooid facies in the Late Pennsylvanian.

The complicating factor in the Pennsylvanian example is the length of time required to deposit this oolite. Using the total duration of the average cyclothem as 400,000 years, perhaps only the

Figure 5.15. Oblique aerial photograph of the east side of Joulters Cays looking northwest. Oolite formed along the mobile sand belt south of B is moved by storms through tidal channels into the interior of the platform as spillover lobes. With time the lobes coalesce to form sand sheets commonly mixed with mud as these sediments are bioturbed. Large active spillover lobes are composed of cross-bedded sets of well-washed oolite. From Multer (1977).


NW AERIAL VIEW
JOULTERS KEY
A
B
C
D
MULTER, 1977

last 5 percent or 20,000 years of the cyclothem was the length of time that shoal conditions occupied this part of the shelf. This is comparable in time to the duration of the Pleistocene age Miami Oolite. The oolite-dominated shoreline probably initially developed and aggraded along the northern hinge or flexure and then migrated southward to other local, positive areas on the shelf. This deposit then prograded seaward (south) through time as sea level continued to fall, during which times other breaks in slope and topographic highs became sites of ooid formation. The resulting distribution of facies then probably represents an imbricate offlapping set of ooid shoals, reaching southward toward the rim of the Anadarko basin.

Summary of Depositional Conditions During Accumulation of the K-Zone

The block diagrams in Figures 5.16 and 5.17 summarize the distribution of depositional environments on the western Kansas shelf during two time periods of the K-Zone (Swope Limestone). These results are based on the integration of maps and core data. Figure 4.16 is a block diagram of the area for mid-regression during deposition of the mid-portion of the regressive carbonate. Accumulation of the unit in subtidal, clear water was dominant except for possibly locally emergent conditions on the Cambridge arch, Central Kansas uplift, and possibly on the southwestern Kansas positive area. Deeper water probably existed to the south, where accumulation of the darker, lower portion of the regressive carbonate facies continued

Figure 5.16. Block diagram of the western Kansas shelf in the vicinity of the study area during the deposition of the mid-portion of the K-Zone regressive carbonate. Gross facies patterns are indicated. North is toward the upper left. Shallow to emergent portion of the shelf are located over the CKU, CA, and the western edge of the southwestern positive area.

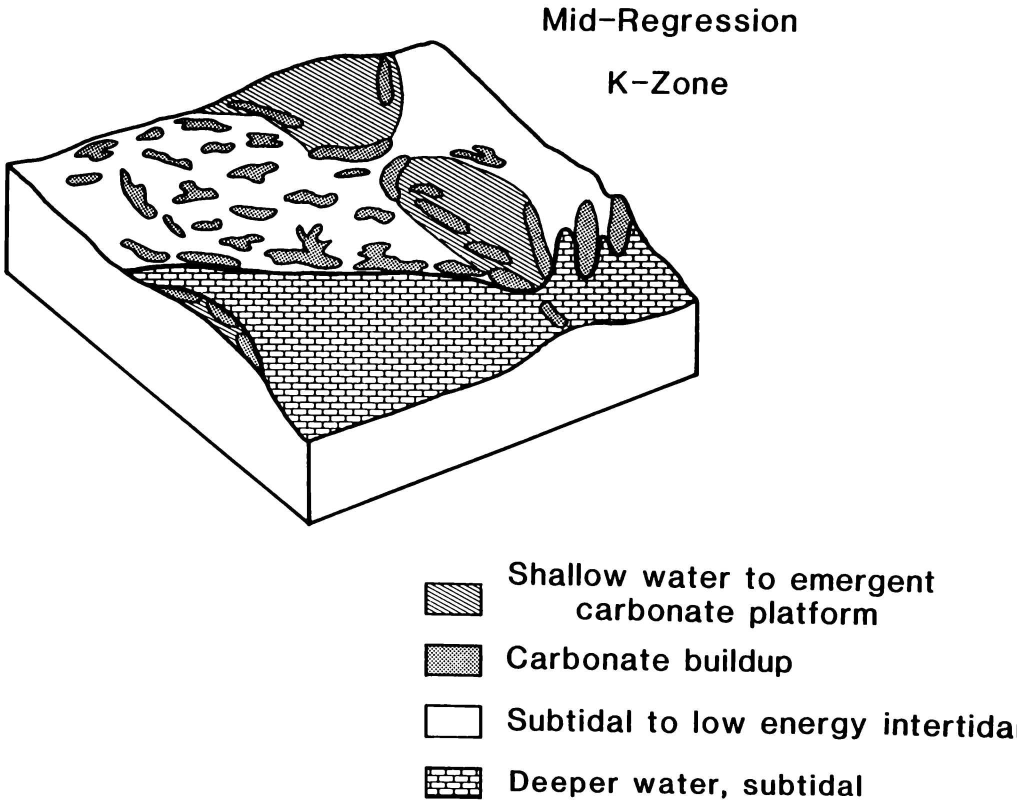
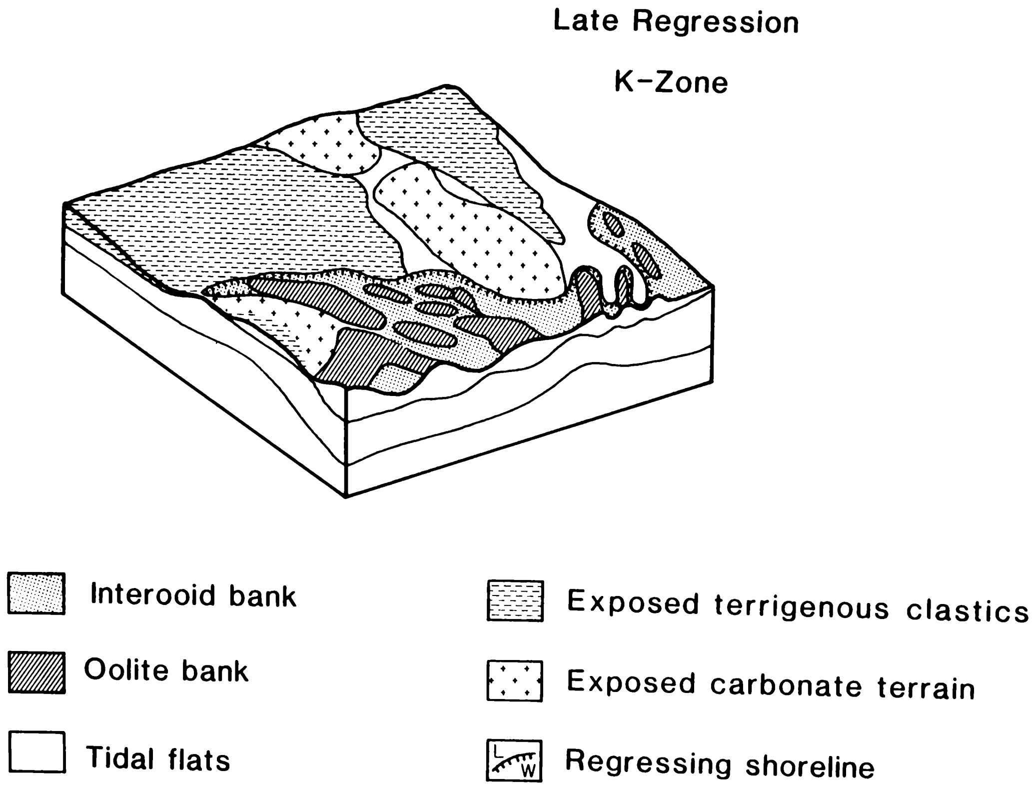

Mid-Regression
K-Zone
Shallow water to emergent carbonate platform
Carbonate buildup
Subtidal to low energy intertidal
Deeper water, subtidal

Figure 5.17. Block diagram of the western Kansas shelf in the vicinity of the study area near the end of deposition of the K-Zone during late regression. Emergent areas included the northern shelf with carbonate-dominated terrane over the CKU and CA and terrigenous clastics to either side. Oolitic facies reside in the area of the Hugoton shelf flexure (Fig. 5.9). The southwestern positive area is an emergent region of the shelf composed of mixed carbonate-terrigenous clastics bordering the Hugoton shelf flexure on the west (Fig. 5.9). This area perhaps is an extension of the Cimmaron arch. Symbols only refer to upper surface of block diagram.

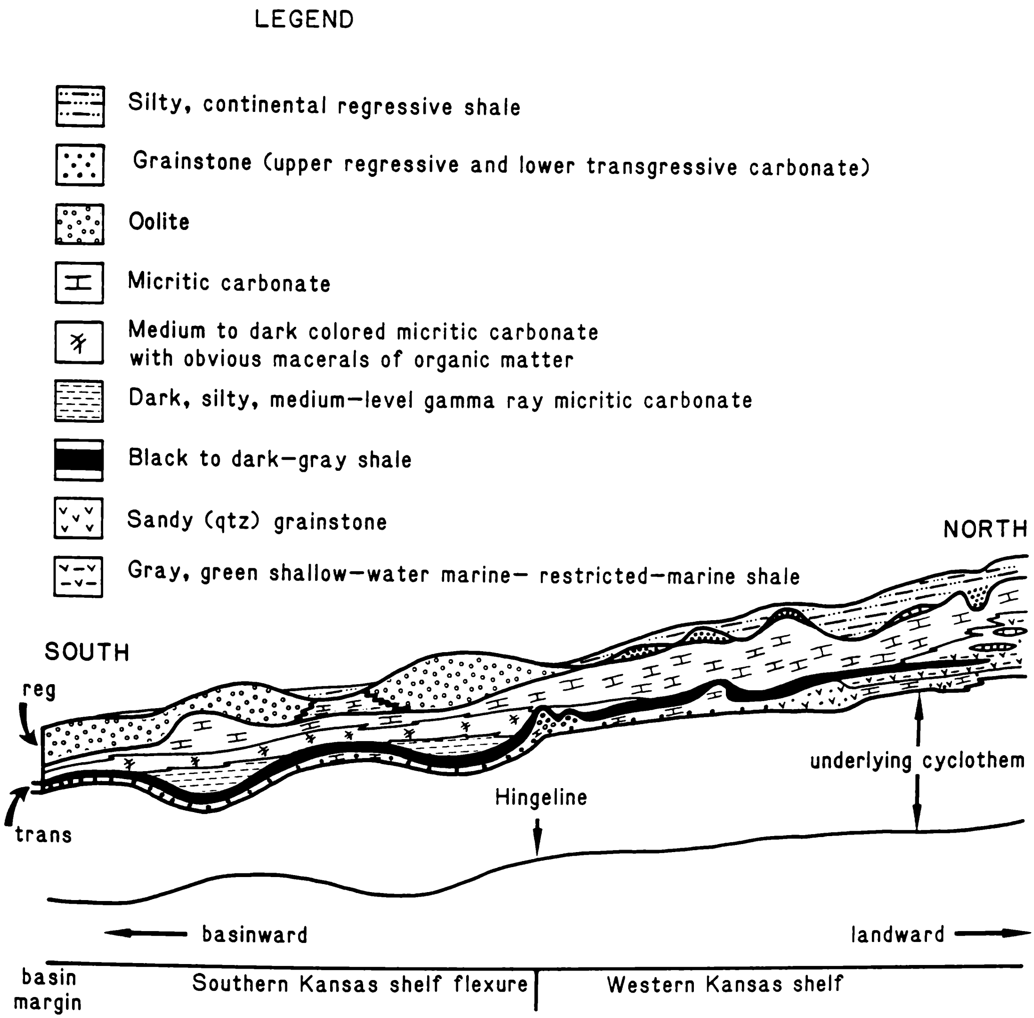

Late Regression
K-Zone
Interooid bank
Oolite bank
Tidal flats
Exposed terrigenous clastics
Exposed carbonate terrain
L
W
Regressing shoreline

(Table 8). Across the central-western and northwestern shelf areas bathymetric highs were locally above wave base resulting in restricted-fauna, micritic successions and high-energy shoals such as over Cahoj field in Rawlins County (Watney, 1980).

During late regression (Fig. 5.17) with the onset of the accumulation of oolite facies under shoreline conditions on the southern shelf, the northern shelf was already or soon to be subaerially exposed. Terrigenous clastics prograded southward across northwestern and west-central Kansas. Interspersed among this prograding clastic debris were sites of emergent carbonate terrane still exposed to subaerial weathering. The complex topographic surface of the oolite tract perhaps blocked the southward advance of terrigenous clastics.

Figure 5.18 is a diagrammatic south-to-north cross section depicting the K-Zone across western Kansas spanning some 200 miles (322 km). The relief is exaggerated, and the relative abundances of facies represent a combination of core and wireline-log interpretations. Lithofacies were deposited during the K-Zone on a southerly sloping shelf. The transgression apparently occurred rapidly. Many of the cored, basal portions of the transgressive deposits provide evidence of high-energy conditions during this transgression. Nevertheless, transgression appears to have caused little reworking or erosion of the underlying deposit except on the extreme northern shelf. Here local areas with coarser terrigenous clastics apparently supplied by reworking of the underlying regressive shale or limited influx of clastics from the shelf produced transgressive, coarsening-

Figure 5.18. Diagrammatic north to south lithofacies cross section of the K-Zone cyclothem in the study area in western Kansas. Thin transgressive (trans) portion of the cyclothem below the marine shale covers the entire area. Dark grey to black marine shale extensively developed over the southern shelf grades into thicker non-black shale in the north. Local thinning and pinchout of marine shale over the CKU is not illustrated. This shale thickens at the expense of the lower regressive carbonate in the extreme northern area of investigation (southern Nebraska and northern-most Kansas). Dark, silty lowermost regressive carbonate on southern shelf with medium-level gamma radiation is inferred to be restricted to lows although it was not mapped separately. Uppermost regressive carbonate is exposed across the entire shelf, while the northernmost portion is noticeably eroded as indicated by the local channeling. Regressive shale prograded unto the carbonate-dominated shelf from a source to the north after the shelf was subaerially exposed.



A Model Cross Section of a Missourian Cyclothem on a carbonate-dominated, stable shelf upward sandy successions (sometimes oil productive, e.g., J-Zone in Cheyenne County).

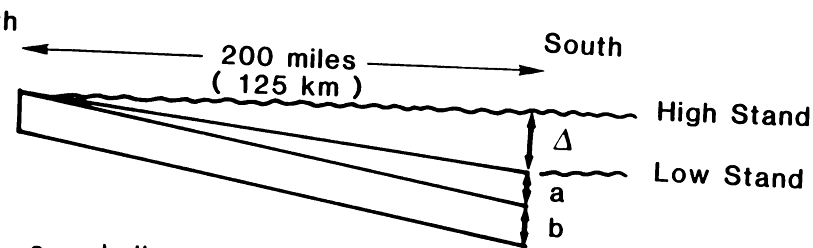
The marine shale is thin but exceptionally widespread over most of the shelf. It becomes noticeably thicker near the source of terrigenous clastics in northwestern Kansas and southwestern Nebraska and loses the black shale facies. The regressive carbonate contains the lower, darker argillaceous facies in southern Kansas in an area beyond the initial flexure of the shelf. This facies is probably equivalent to the very lowermost micritic regressive carbonate on the northern shelf. While open-marine, subtidal, clear, oxygenated waters were present on the northern shelf, the bottom water in the south perhaps was episodically depleted in oxygen.

During late regression sea level fall accelerated and produced a relatively thin accumulation of widespread sheets of intertidal, restricted deposits interspersed with high-energy facies. More frequent agitation along a more steeply-dipping southern shelf resulted in the formation of ooid grainstone. Storms pushed these deposits northward of the zone of flexure on the shelf. The northern-most ooid lobes are perhaps relicts of these very short-term storms. With continued fall of sea level, the carbonate sediment was cemented early, insuring preservation of these geomorphic features.

In Figure 5.19 a hypothetical north-south cross section is used to estimate the amount of sea level change required to expose the entire shelf to subaerial processes. The width of the shelf in Kansas alone is 200 miles. The K-Zone regressive carbonate extends

Figure 5.19. Hypothetical north-south cross section across the area of study in western Kansas used to illustrate the determination of minimum paleoslope to the south into the Anadarko basin. The minimum estimate of slope is determined from the average rate of thickening of the composite four-zone interval (0.5 feet per mile or 0.95 m per km). Actual dip must have been greater because the distribution of these sediments would be expected to more likely a veneer covering the shelf as sea level changed because sediment did not have the opportunity to prograde and aggrade to sea level to form a wedge of these dimensions. Entire shelf was subaerially exposed requiring that the change in sea level was at least equal to the relief across the shelf less the aggraded thickness of the sediment added during the accumulation of the zone.

Minimum Change in Sea Level, Δ for K-Zone in Western Kansas



a shallow water sediment wedge

b subtidal, deeper water sediment layer

Approximate paleoslope $\approx$ 0.5 ft/mi. $\therefore$ relief $\sim$ 100 feet

Change in sea level, Δ = 100 feet - a = 70 feet (42 m) southward for at least 30 miles (50 km) into Oklahoma and northward at least 75 miles (120 km) into central Nebraska. Moreover, Heckel (1980) suggested that these same Missourian carbonate rocks can be correlated to the Dakotas resulting in possibly several hundred miles more of continous deposition. More conservatively, however, at least 300 miles (480 km) of southerly-dipping shelf was probably associated with the area of study.

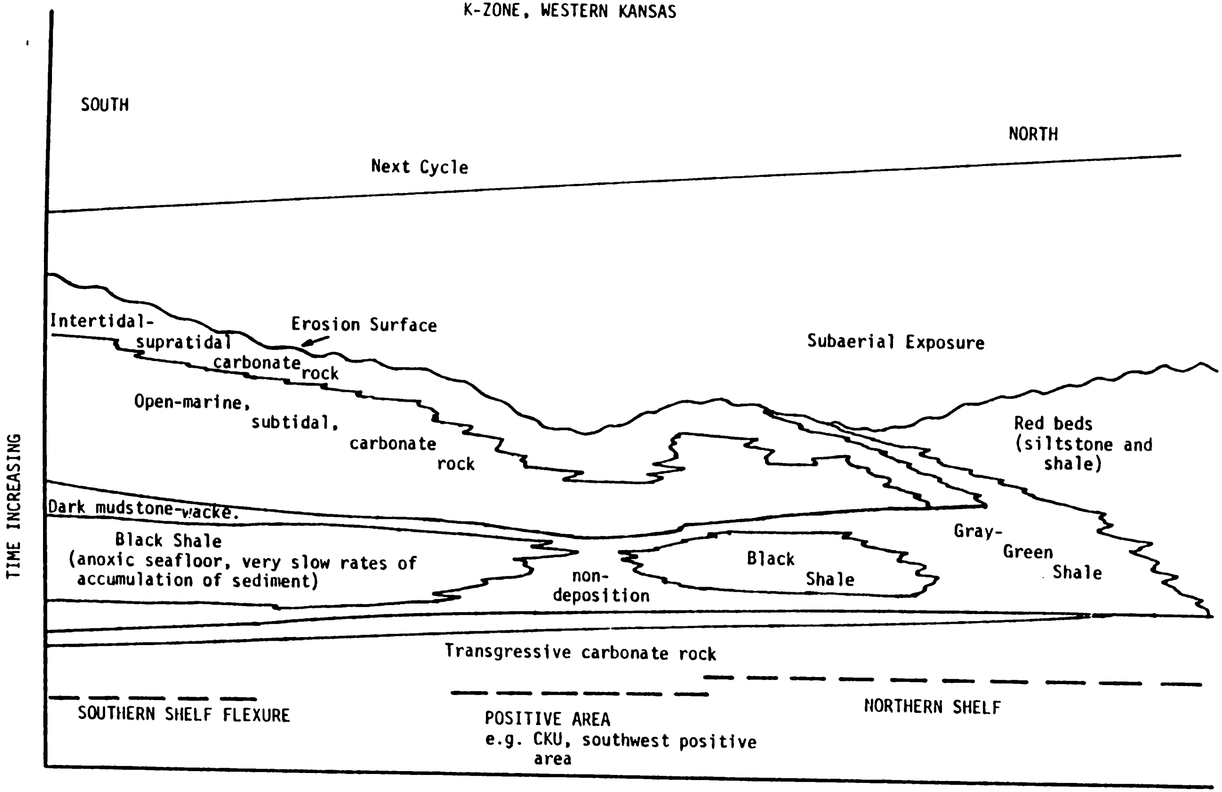
Paleodip may have been quite complex across this area, as is suggested by the mapping (Figs. 5.4 and 5.5). Certainly it was not a simple ramp. The minimum estimated paleoslope of 0.5 ft/mi. (1.0 m/km) is suggested from regional southward thickening. This value is the same as that previously suggested by numerous authors for epeiric seas (e.g., Irwin, 1965). For 300 miles (480 km) of shelf this gives a value of 150 feet (46 m) of relief, less the aggraded thickness of the cyclothem from north to south of around 30 feet (9 m). This results in a minimum change in sea level of 120 feet (37 m). Consideration of additional breadth of the K-Zone accumulation onto the upper shelf and perhaps greater water depths associated with the accumulation of the marine shale makes this a minimum value. The rough estimate of relief on the shelf from the interval isopach alone is inherently quite conservative if sea level did in fact fall and the shoreline moved back and forth across the shelf depositing a veneer of diachronous sedimentary strata. These aspects are all supported by the information presented here.

Figure 5.20 is a hypothetical north-south chronostratigraphic cross section of the K-Zone illustrating the estimated time rela-

Figure 5.20. North-south chronostratigraphic cross section across the study area in western Kansas. Horizontal axis is distance, approximately 200 miles (124 km). Vertical axis is time which is estimated to be approximately 400,000 years for top to bottom of the cycle. Central portion of cross section illustrates the effects on sedimentation over a positive area on the shelf.

CHRONOSTRATIGRAPHIC CROSS SECTION

K-ZONE, WESTERN KANSAS



tionships between the lithofacies comprising the K-Zone.

Structural Implications of Mapping in the K-Zone

Subtle paleostructures on the shelf present during the accumulation of the K-Zone coincide closely with earlier, prominent structures. Also areas such as the zone of flexure are less pronounced and without obvious earlier structural activity. The bending of the shelf suggested by this flexure may have been produced by the tectonic stress created by the adjacent rapidly subsiding Anadarko basin. The location and trend of the flexure perhaps is related to the structural grain of the Precambrian surface west of the CKU as described earlier in the tectonics section. The lobes of thick, porous carbonate rock of the K-Zone (Fig. 5.5), for example, coincide with the northwesterly trends of magnetic intensity (Fig. 2.18) across southwest Kansas. The southwestern positive area as defined by this same mapping was also an area of curved-shaped, but poorly defined patterns on the pole correction map of the magnetic field (Fig. 2.18). As this portion of the shelf was stressed, basement discontinuities suggested by the patterns on the magnetic anomaly map may have been reactivated according to the location, relative weakness, and the orientation in relation to the dominant stress field. This adjustment of the basement apparently had a profound effect on the development of the K-Zone.

Strong magnetic lineations running northeast-southwest in the vicinity of the Pratt anticline, Sedgwick basin, and southern CKU were interpreted earlier to have been derived from shallow basement discontinuities, very likely faulting and basaltic intrusives associated with the CNARS (Yarger, 1983, Figure 2.21). Notice a strong north or northeasterly grain in all the maps shown for the K-Zone in this southeastern region. Furthermore, structural trends of younger strata are coincident with these basement trends. The northeast-southwest trend represents the areally restricted, elongate CNARS. This feature cuts the trend of the older Precambrian terrane almost at right angles. The interference of these cross-trending basement features is particularly noticeable in the vicinity of the southern CKU and Pratt Anticline. This younger, apparently structurally weaker basement trend perhaps was a dominant control in defining the southern margin of the CKU, the location of the Pratt anticline, and the parallel anticlines in that area, e.g., Voshell and Halsted-Graber. It is in this area that the patterns seen on the maps of the K-Zone are significantly different from those that occur to the west. The zone of flexure follows a northeast-southwest trend in this area of the map. An important question is how this pattern of subsidence and uplift that controlled the accumulation of the K-Zone was maintained or modified during the accumulation of the succeeding cyclothems. The positive elements may represent passive features that were simply draped by sediment, or they may have been structurally active. The coincidence of mapped features thus far indicates the long-term existence of the structural features that may have been relicts from more active tectonic periods. The comparison with the J-, I-, and H-zones will examine changes in the structural configuration of the shelf, if any, over a much shorter time frame. Moreover, the comparison will further examine the relationship of basement terrane and the patterns and trends on the zone maps. The persistence of local or subregional structures on the shelf and additional comparison with the core and wireline log information may provide an important means of understanding the nature of cyclic sedimentation. Furthermore, combined use of available subsurface information on the zone displayed in map form and the magnetic maps may permit better extrapolation of thickness, lithofacies, or favorable reservoir development into areas with poor subsurface control.

CHAPTER SIX

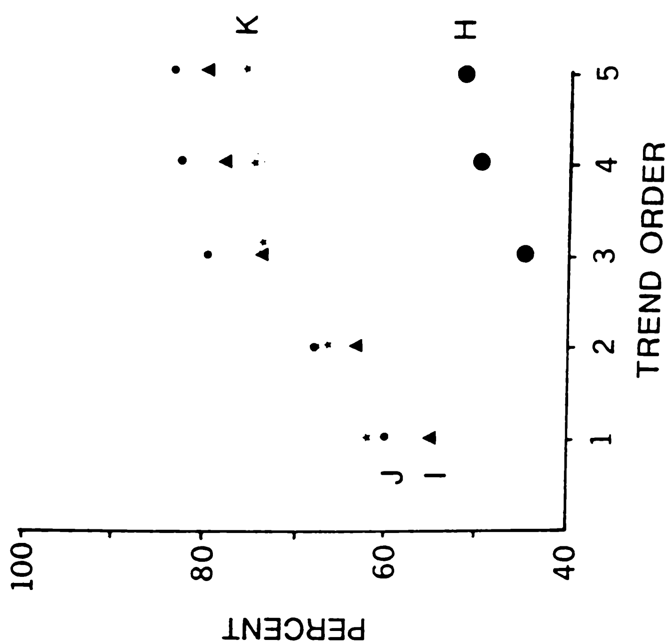
INTERCYCLOTHEM VARIATION:

USE OF CORES AND WIRELINE LOGS TO SUMMARIZE CHANGES BETWEEN CYCLOTHEMS

Trend-surface modeling of the thickness of the marine interval of four cyclothems is used to summarize the changes in lithofacies between these cyclothems. While the J- and K-Zones represent times of extensive oolite accumulation on the southern shelf, the younger I- and H-Zones are notably different. In distinct contrast, oolite development in the I-Zone is limited to the extreme southwestern portion of the study area. The H-Zone represents widespread accumulation of low-energy carbonate mudbanks with only local high energy grainstone.

Polynomial trend surfaces were computed for the marine interval thicknesses of each cyclothem to facilitate comparison between the cyclothems. The marine-interval isopach was selected because it best depicts changes in the cyclothems due to the structural setting of the shelf and more local variations in deposition. The computations are described in Appendix B. The trend model accepted here represents the best statistical fit using the lowest order trend surface. The trend surface itself provides the broad regional patterns that facilitate comparison of each cyclothem, while a map of the residuals reveals important local anomalies. Figure 6.1 is plot of the statistical goodness of fit in percent versus the order of the polynomial

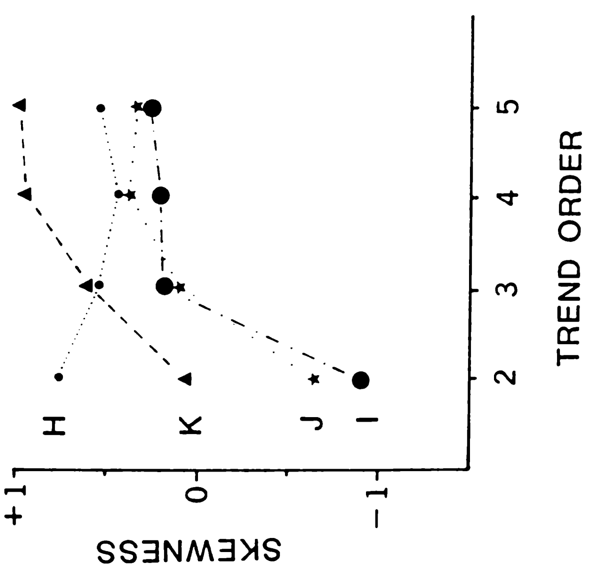
Figure 6.1. Plot of the statistical goodness of fit of various orders of trend surfaces from 1st to 5th order for the thickness of the marine interval for the H-, I-, J-, and K-Zones. The goodness of fit is defined as the ratio of the sum of squares due to regression to the total sum of squares. The result is expressed here in percent. The 1st- and 2nd-order fits are less than 40% for the H-Zone. The 4th- and 5th-order trend surfaces of the marine interval of the K-Zone are somewhat poorer fit to the original data than the I- and J-Zones. The marine interval of the H-Zone is least well fit by all of these lower order trend surfaces suggesting a more complicated surface.


PERCENT
100
80
60
40
TREND ORDER
1
2
3
4
5
J
I
K
H

surface that was fitted to the marine interval for each zone. The H-Zone demonstrates a relatively poor fit of the lower-order trend surfaces as well as a weaker increase in fit with increasing order. While goodness of fit exceeds 50 percent for the other cyclothems for all orders of the trend, goodness of fit values are all less than 50 percent for the trend surfaces less than 5th-order for the H-Zone. The surface created by the marine interval thickness of the K-Zone is more complex than the others, and consequently the low- order polynomials do not provide adequate variability to result in a good fit. Figure 6.2 is plot of the skewness of the frequency distribution of the residuals versus the order of the trend surface polynomial. A positive skewness describes an asymetrical plot of the frequency of residuals that has more positive deviations than negative. In order to optimize the statisical fit, one would also attempt to minimize this skewness. The information, however, provided by skewness has geological significance and is not minimized during optimization of the statistics. The frequency distribution of the residuals for all trend surfaces up to 5th-order of both the K- and H-Zones are positively skewed. This will be discussed later.

The fourth-order trend surface of each thickness of the marine interval was chosen to make the comparisons. The fourth-order fit represents the highest order that provides a substantial improvement from the next lower-order surface (Fig. 6.1). At increasingly high orders the additional fit is small and results from the fitting of the trend surface to more local features. The fourth-order represents, in essence, a compromise between geological significance and

Figure 6.2. Plot of the skewness of the frequency distribution of the trend surface residuals of the marine intervals of the H-, I-, J-, and K-Zones versus the order of the trend surfaces. The skewness is reduced appreciably for the I- and J-Zones while the K-Zone shows an increase in skewness.


SKEWNESS
+1
0
−1
H
K
J
I
2
3
4
5
TREND ORDER

the statistical fit. The major pattern present on each of these maps is a thinning associated with the CKU. Limitations in the complexity of the lower-order polynomial surface emphasizes the effect of this major structural feature. The approach is similar to that used by Wermund and Jenkins (1970) to interpret Pennsylvanian sandstones in north-central Texas.

K-Zone

The fourth-order trend surface contour map of the K-Zone and the corresponding map of the residuals are shown in Figures 6.3 and 6.4. These maps of the K-Zone were previously shown (Figs. 5.4 through 5.8). The discussion of the K-Zone here is confined to the trend surface mapping to facilitate the comparison with the other zones. The map of the original surface (Fig. 5.4) is much like the trend surface map in Figure 6.3. Nevertheless, the recognition of broad patterns that facilitate comparison of maps is best observed using the trend surface. Thinning is pronounced over the CKU. The flexure zone is located along the 35-foot (10 m) trend contour line. Oolite development was south of this line. The map of the residuals in Figure 6.4 reveals an irregularly shaped positive anomaly in the southwest, south of the arcuate buildup of porous oolitic grainstone that surrounds the southwest Kansas structurally positive area which was active during deposition of the K-Zone. The area flanking this structure, a location of high rate of dip, apparently was a optimal site for the formation of oolite. In particular, the pronounced

Figure 6.3. Shaded isopach map of the fourth-order trend surface of the marine interval thickness, K-Zone. Regional southward thickening occurs beyond zone of flexure (coinciding with the northern edge of the Hugoton shelf flexure, Fig. 5.9) identified in this figure. Note that the trend-surface contouring constructed by Surface II continues beyond the limits of the data on the northeastern and extreme southern portions of this map (compare this to the distribution of data, Fig. 1.2).

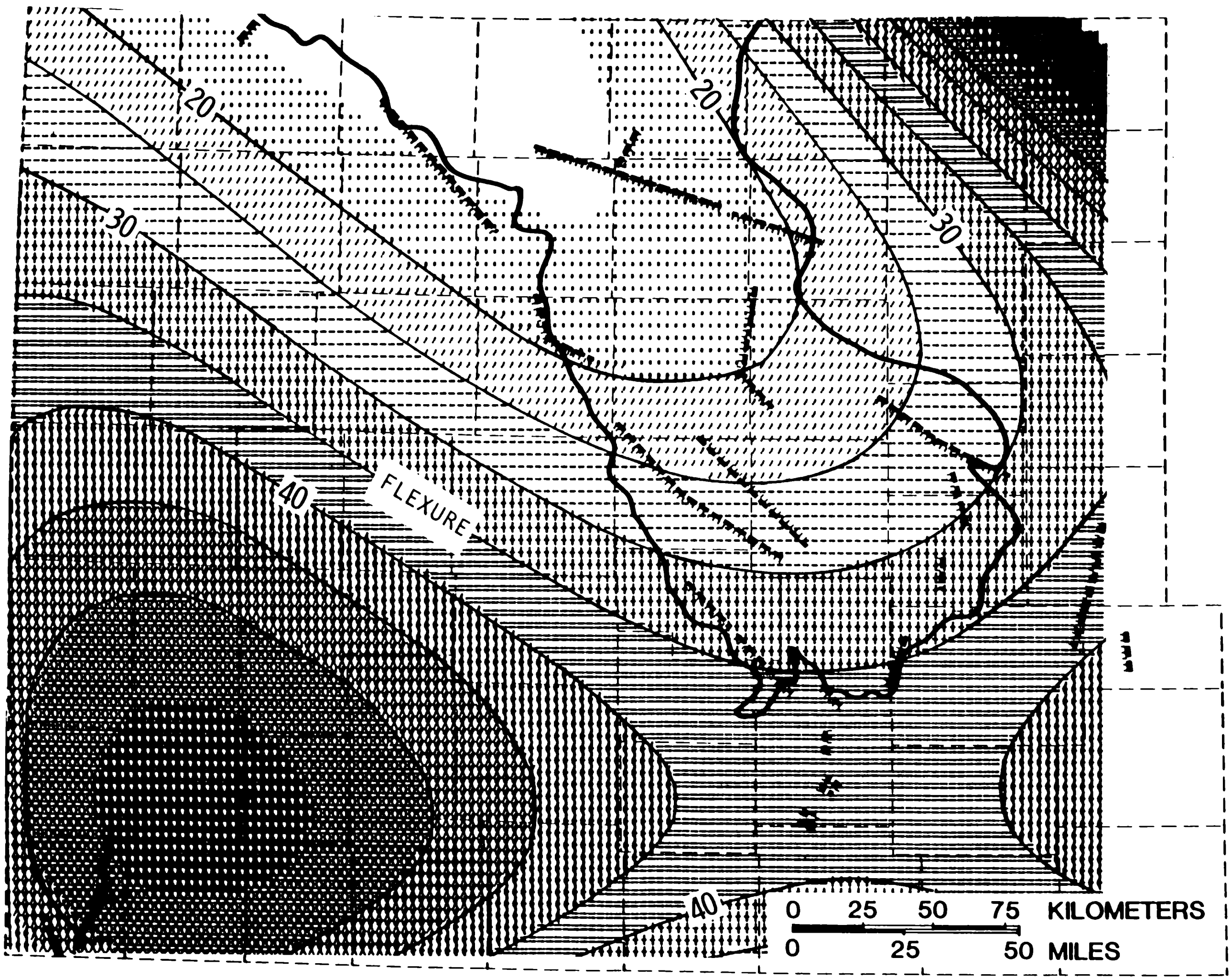
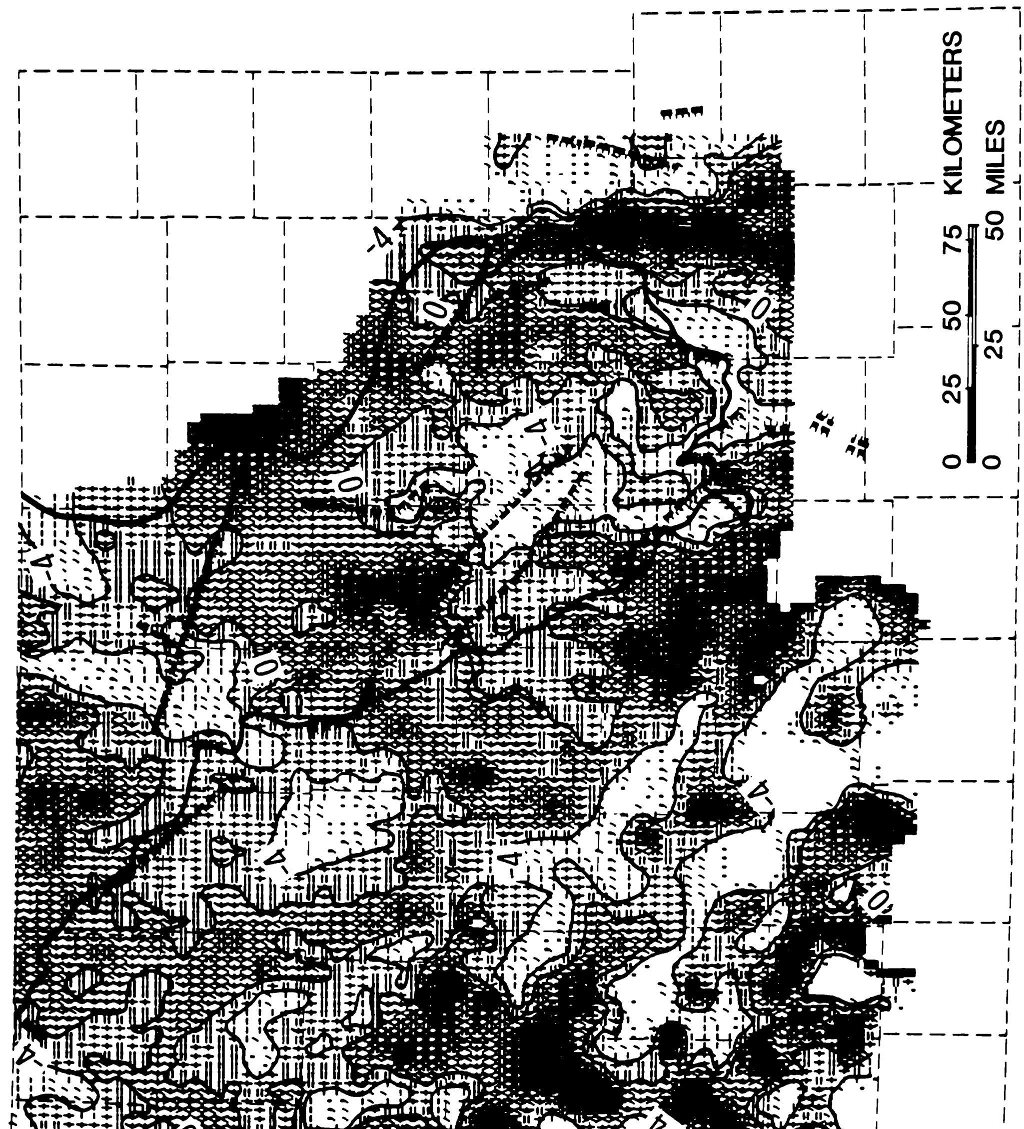

20
20
30
30
40
FLEXURE
40
0 25 50 75 KILOMETERS
0 25 50 MILES

Figure 6.4. Shaded isopach map of the residuals of the trend surface for the marine interval thickness of the K-Zone. Positive residuals ring the southwest positive area (SWP), noted here by broad negative anomaly (less than -4 feet). Most prominent positive and negative anomalies in the southwestern mapped area trend northwest-southeast, all south of and paralleling the flexure zone defined in Figure 6.3. SWP area is also the location of patches of missing grid mapping elements. Note that mapped area for residuals does not project beyond limits of information as did trend surface map (Figs. 6.3).


KILOMETERS
0 25 50 75
MILES
0 25 50
SWP
0
-4

buildup immediately south suggests an even higher slope on the southern, seaward side, a location most suited for the proliferation of oolite. Farther east along the southwestern flank of the CKU another strong positive anomaly is present. Cuttings and signature of wireline logs support the interpretation of an oolite shoal at this location.

The southwestern structurally positive area indicated here by negative residual (thinning of the interval) and the surrounding isolated positive residuals were the cause for the poorer fit by the 4th- and 5th-order polynominal surfaces of the K-Zone (Fig. 6.1). This southwestern Kansas structure accounts for much of the positive skewness (Fig. 6.2) in the frequency plot of the residuals of the K-Zone marine interval thickness. The local, structurally positive area on the southern CKU, the Rush rib, is identified in Figure 6.4 as a small isolated negative residual that coincides with the structural residual (Fig. 2.15). Differential relief, probably expressed at the time the interval accumulated as differential subsidence around this feature, is strongly suggested.

J-Zone

The series of maps constructed for the J-Zone is included in summary Plate 3. The trend surface and residual maps for the J-Zone (Figs. 6.5 and 6.6) illustrate a broadened region of thinning over the northern part of the area that extends significantly west of the CKU. Thinning is more pronounced over the CA in the J-Zone than in the K-Zone. The broad, negative residual reflecting this thinning on

Figure 6.5. Shaded isopach map of the fourth-order trend surface of the marine interval thickness, J-Zone. Range of thickening is greatest of all cycles. Significant thickening occurs south of a zone of flexure at approximately the 35 foot contour. Contour interval equals 5 feet.

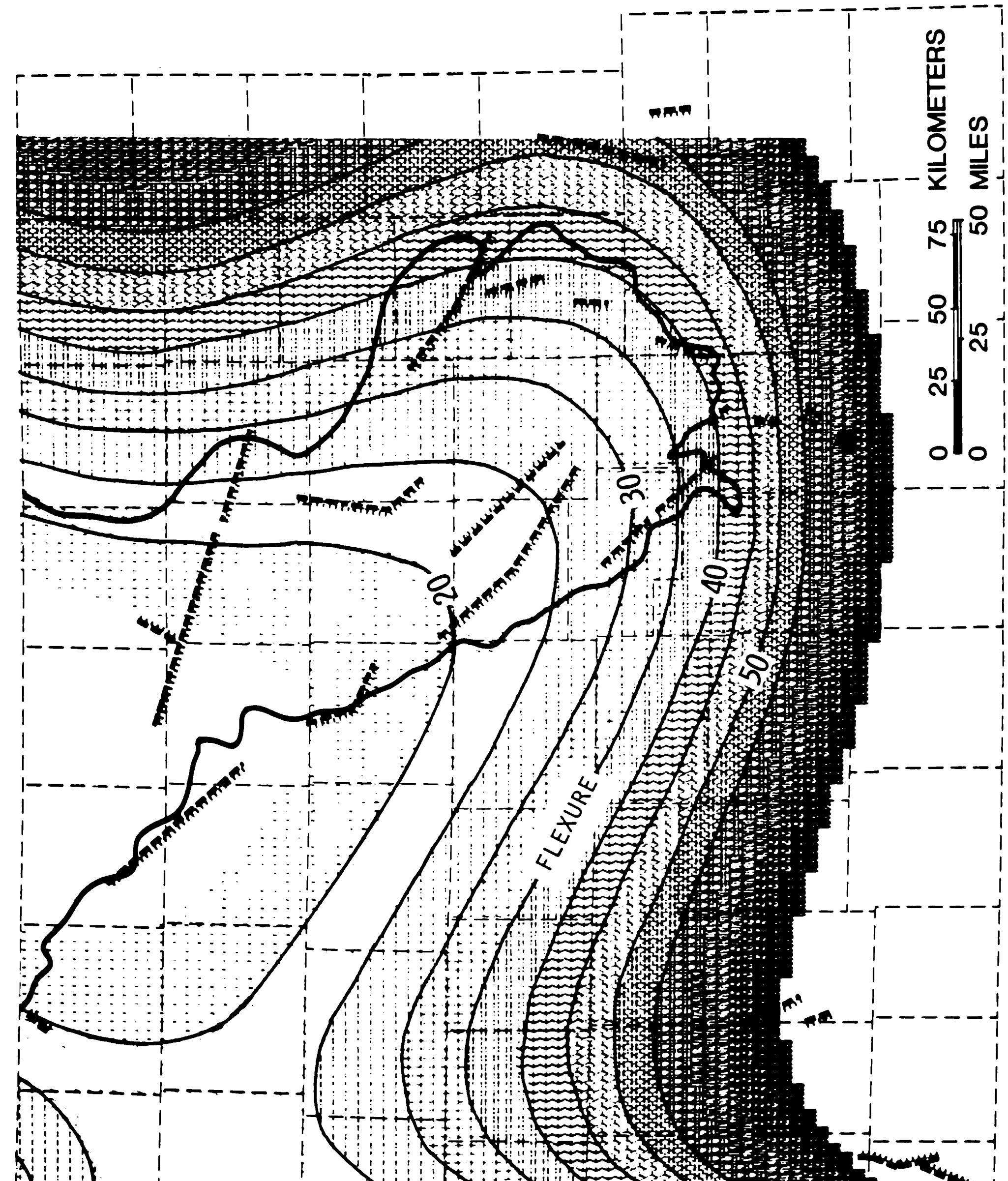
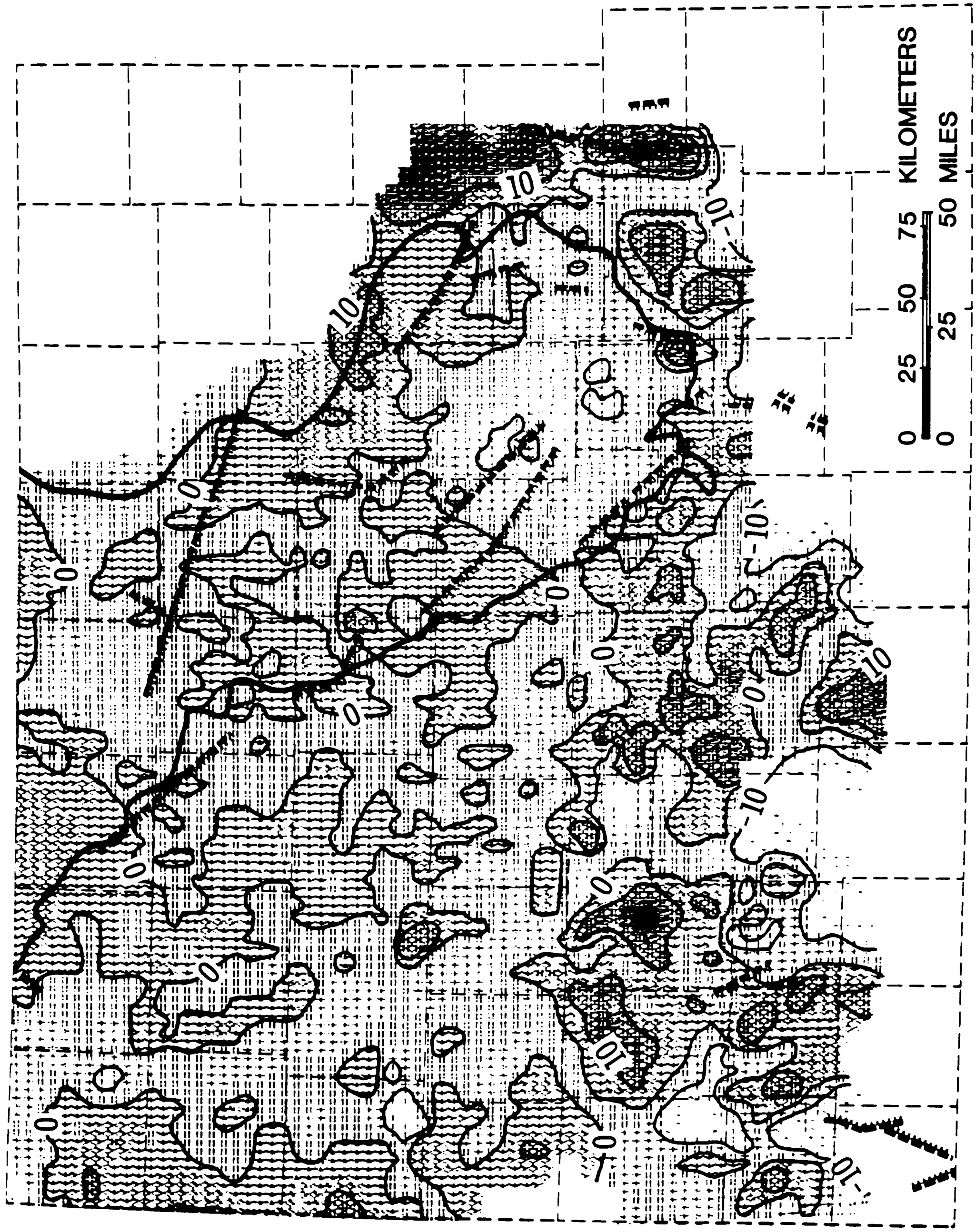

KILOMETERS
0 25 50 75
MILES
0 25 50
FLEXURE
20
30
40
50
30
20
20

Figure 6.6. Shaded isopach of the residuals of the trend surface of the marine interval of the J-Zone. Zero and -10 foot contours are shown. Darker shading is increasingly positive in 5 foot increments. Note that no significant thinning is associated with the SWP.


0 25 50 75 KILOMETERS
0 25 50 MILES

the north also covers a much larger area than that of the underlying K-Zone. Furthermore, southward thickening is more uniform in the J-Zone across the southern mapped area than in the K-Zone. The area along the extreme southern part of the CKU is no longer a notable region of thinning and suggests that this portion of the shelf was no longer elevated during the accumulation of the J-Zone.

The 35- to 40-foot contours of the thickness of the marine interval for both the K- and J-Zone represent the northern limit of the region of rapid thickness variation in this isopach and that of the porosity development in the regressive carbonate. As previously discussed, this area noted by a convergence of contours is interpreted as the break in the slope, a flexure zone. The flexure zone at approximately the 35 foot (11m) contour in Figure 6.5 of the J-Zone is more abrupt and is displaced southward of that in the K-Zone. It is not surprising that the accumulation of oolitic grainstone was widespread in the southern region similar to what occurred during deposition of the K-Zone cyclothem. Nevertheless, the southwestern positive area so important during deposition of the K-Zone was apparently absent during the accumulation of the J-Zone. The 40-foot contour of the marine interval isopach map of the J-Zone extends westward then bends southward as an arc that is concave to the south over the previously identfied southwestern positive area (Fig. 6.6). Immediately south of this bend in Kearney and Finney counties is a very thick lobe of the J-Zone marine interval. This lobe extends east-southeastward as a series of thickened lobes over to the western flank of the Pratt anticline in Kiowa County just south of the zone of flexure. The prominent buildup of carbonate, however, does not extend over the southwestern Kansas positive area, suggesting that it was probably somewhat higher than the area to the south, albeit more subdued in relief than during deposition of the K-Zone. The southern crestal region of the CKU in the vicinity of the Rush rib is again a pronounced negative residual indicating positive relief.

The depositional grain in the southwestern area is west-northwest in the J-Zone. The westerly component is thus greater than in the K-Zone, where slope is more directly facing the basin to the south. Perhaps there is a relationship between the amount and the orientation of the slope in relation to the more abundant grainstones on the upper shelf. The slight change in orientation of the paleoslope to a position facing more directly toward the Anadarko basin and the margin of the shelf may have been a factor favoring conditions of higher energy farther north on the shelf during the J-Zone. A shoreline more directly facing the currents and wave action particular on the distal northern shelf would be a setting that would have had more opportunity for sorting of grains and of lime mud (Wilson, 1975).

The buildup of carbonate rock of the J-Zone in Reno, Harvey, and McPherson counties forms a northeasterly or northerly trend around the southeast flank of the CKU platform. The trend surface contours similarly bend around this region also converging here again to suggest the continuation of the shelf flexure.

The local, closed positive residuals on the thickness maps of the J- and K-Zone marine interval are generally offset from one another particularly over the southern shelf. Areas of thickening in the K-Zone are commonly locations of thinning in the J-Zone marine interval (Figs. 6.4 and 6.6). The younger J-Zone appears to have filled in low areas on the K-Zone surface now expressed here as local thinning of the interval. Depositional relief was apparently maintained on the K-Zone and perhaps even accentuated with emergence and subaerial exposure of the surface. The processes associated with transgression must have been weak in their attempt to rework the upper surface of the K-Zone, possibly due to the rapidity of transgression. This relief maintained during transgression is not unusual judging from the abundant evidence of control of recent carbonate sedimentation by relict Pleistocene topography along the shelf margin of South Florida (Enos and Perkins, 1979).

The maps of maximum gamma radiation of the marine shales of the J- and K-Zones (Plate 3 and Figure 5.7) identify nearly coincident locations of maximum gamma radiation of less than 160 API units. In particular, note that the broader areas also coincide with areas having less than 40 feet of marine interval and overlying the CKU and CA in both zones (Plate 3 and Figure 5.4). The present day structural sag between the CKU and CA in Rooks, Graham, and Trego counties is the site of higher gamma radiation. Moreover, very low levels of gamma radiation, less than 80 API units, are coincident with what are interpreted as pronounced positive areas of the CKU (the Rush rib in Barton and Rush counties and over the CA). The marine interval is also exceptionally thin at these locations.

The west-central portion of both maps of maximum gamma radiation include broad areas of higher gamma radiation (some areas exceptionally high), while locations on the southern shelf are sites of relatively low gamma radiation. The southern part of the area of study, however, is interpreted as having been a location of deeper water during the time of maximum transgression. Simple stagnation of the bottom waters and the development of anoxic conditions appears not to be simply related to water depth alone. The enrichment of organic matter and uranium in the black shales as suggested by the gamma radiation involves other environmental factors on the shelf, namely circulation patterns, local depressions, and availability of organic matter.

A lobe of terrigenous clastics belonging to the regressive shale (Plate 3) of the J-Zone hugs the western flank of the CA and CKU. The lobe thickens to the north from where it probably originated. It then prograded from this northwesterly source to as far south as Pawnee County. This restriction of the prograding lobe of clastics to the western area of the map further suggests that the CKU was a location with topographic relief. A separate lobe of the J-Zone regressive shale interval spread into the southwestern area of the map through Hamilton and Stanton counties, and possibly originated from the vicinity of the southwestern Kansas positive area. These terrigenous clastics may have been shed from the much more positive area of the Cimmaron arch in southeastern Colorado where coarse-grained terrigenous clastics of Missourian age are the dominant lithofacies (Maher, 1953).

Porous regressive carbonate that exceeds 10 feet (3 m) in thickness (Plate 3 and Figure 5.5) is generally restricted to a region south of the shelf flexure in both the J- and K-Zones. The ratio of the thickness of the J-Zone to the total four-cyclothem interval exceeds 40 and 50 percent locally in Ford and Clark counties in the extreme south-central portion of the mapped area and in Reno, McPherson, and Saline counties in the southeastern part of the area. Perhaps pronounced flexing along the southern portion of the shelf areas occurred during the accumulation of the J-Zone and resulted in considerable buildup of the J-Zone in these areas south of the flexure.

The map showing the locations of cores of the J-Zone (Plate 1) illustrates the wide range of thickness of the cyclothem. The distribution of facies in the J-Zone is also wide-ranging across the shelf. The limited number of cores from the south is augmented by cuttings descriptions that indicate the presence of widespread, thick oolitic facies in the upper portion of the regressive carbonate (Figs. 6.7-6.9). The oolitic facies of this zone has a characteristic signature on the wireline log. Figure 6.10 is a detailed, hand-contoured map of the porosity of the J-Zone in the area crossing the zone of flexure where the finger-like lobes of porous rock project northward. These projections resemble those of Todd (1976) and Bebout and Schatzinger (1978).

The regressive carbonate rock on the extreme northwestern shelf becomes increasingly argillaceous in the lower subtidal portion of

Figure 6.7. Index map for examples of wireline logs from wells that contain oolitic grainstone facies in the J-Zone in Figures 6.8 and 6.9. Wells are located on this map by index numbers and named on the wireline log themselves. Outlined region on this map identifies an area of detailed mapping of the thickness of porous regressive carbonate of the J-Zone shown in Figure 6.10.

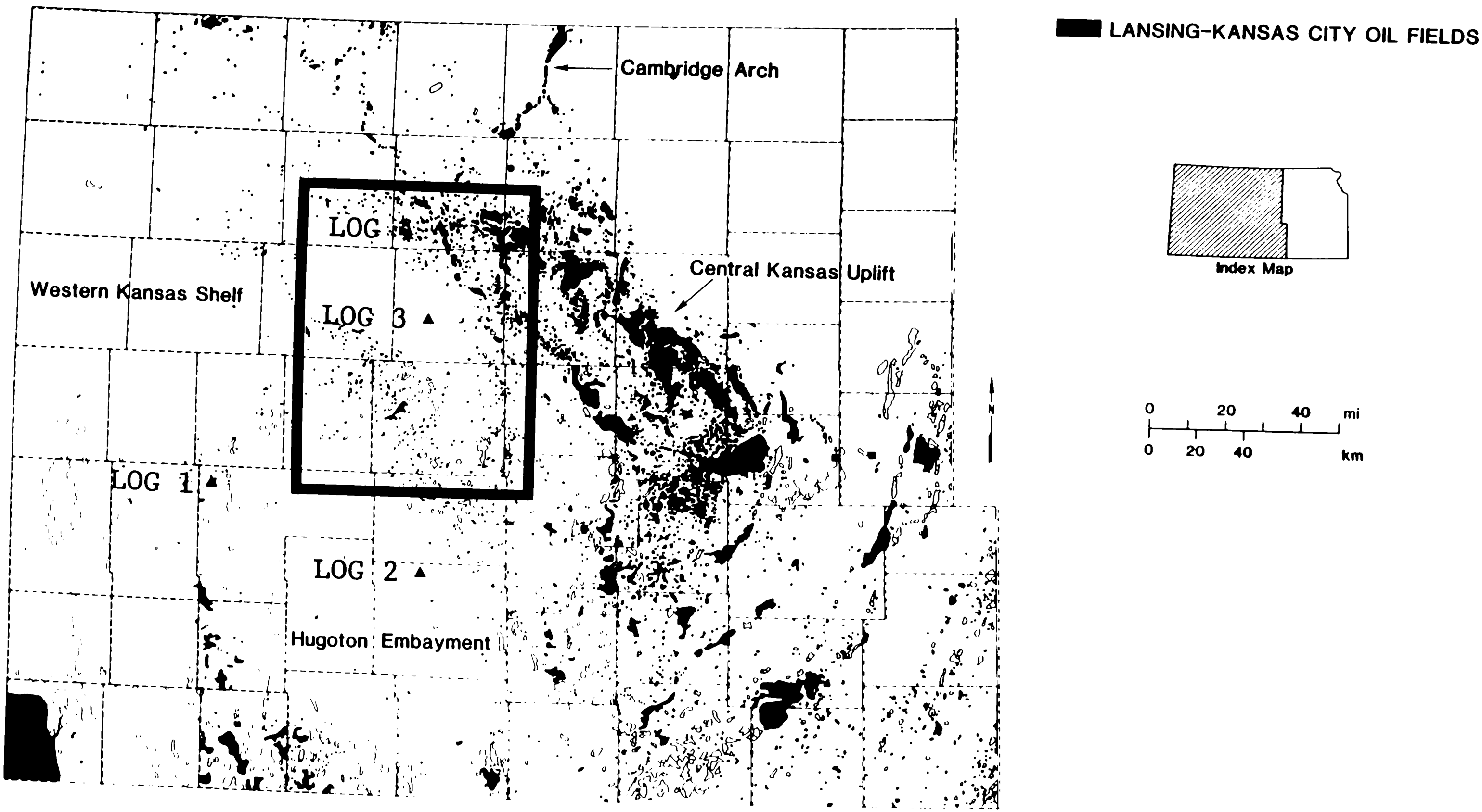
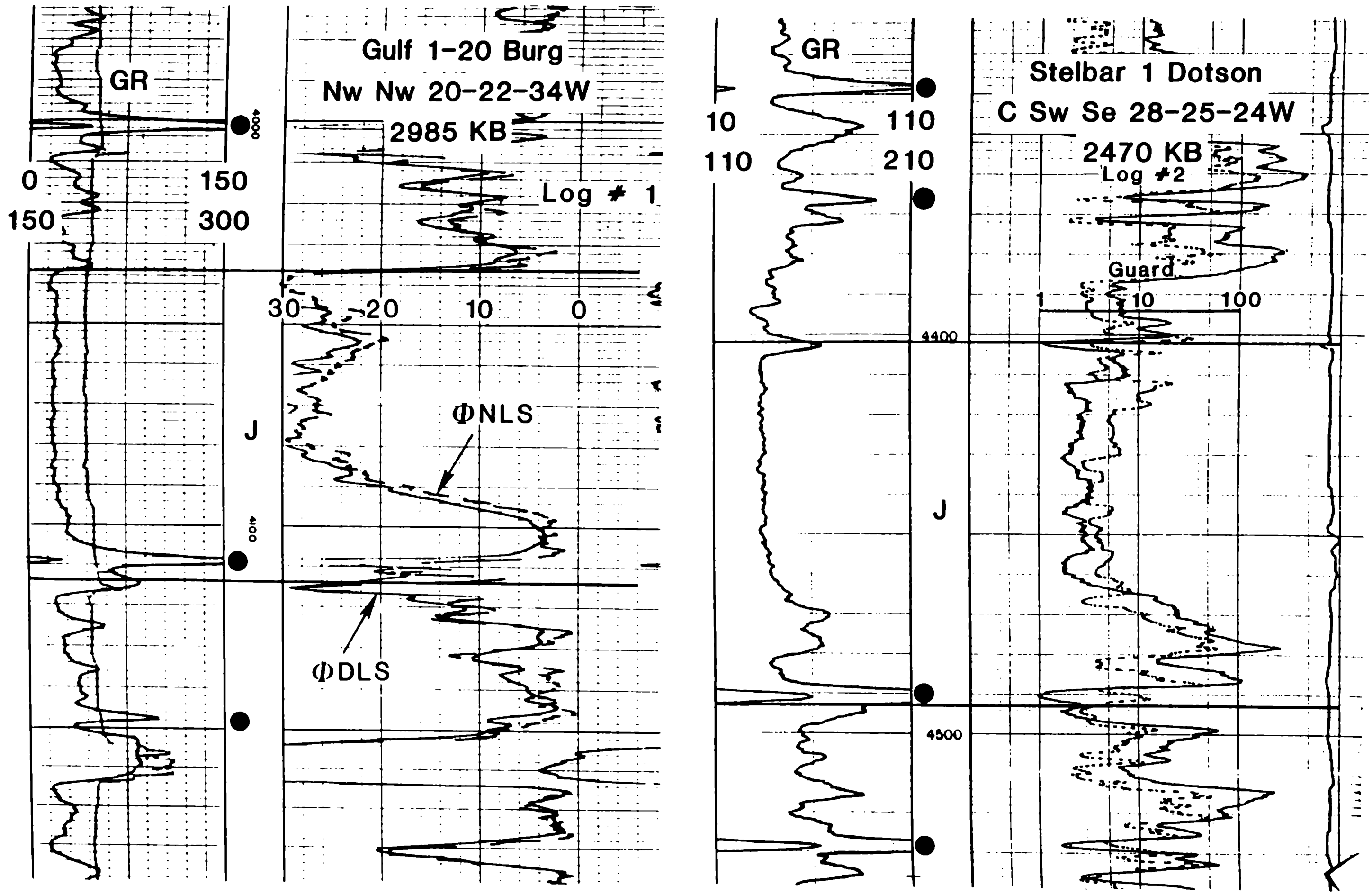

LANSING-KANSAS CITY OIL FIELDS
Cambridge Arch
Central Kansas Uplift
Western Kansas Shelf
Hugoton Embayment
LOG
LOG 3
LOG 1
LOG 2
Index Map
0 20 40 mi
0 20 40 km
N

Figure 6.8 and 6.9. Series of four wireline logs illustrating the varied log signatures for J-Zone with and without prominent oolitic grainstone facies. Solid dots at center of log denote position of marine shales. Wells #1 and #2 have a very well developed section of porous oolitic grainstone, from 4037 to 4085 feet in well #1 and 4405 to 4464 feet in well #2. Notice low GR and exceptionally high porosity. Wells #1 and #2 also reside south of the zone of flexure defined in Figure 6.3.



GR
0
150
150
300
Gulf 1-20 Burg
Nw Nw 20-22-34W
2985 KB
Log # 1
30
20
10
0
J
ΦNLS
ΦDLS
GR
10
110
110
210
Stelbar 1 Dotson
C Sw Se 28-25-24W
2470 KB
Log #2
Guard
1
10
100
4400
J
4500

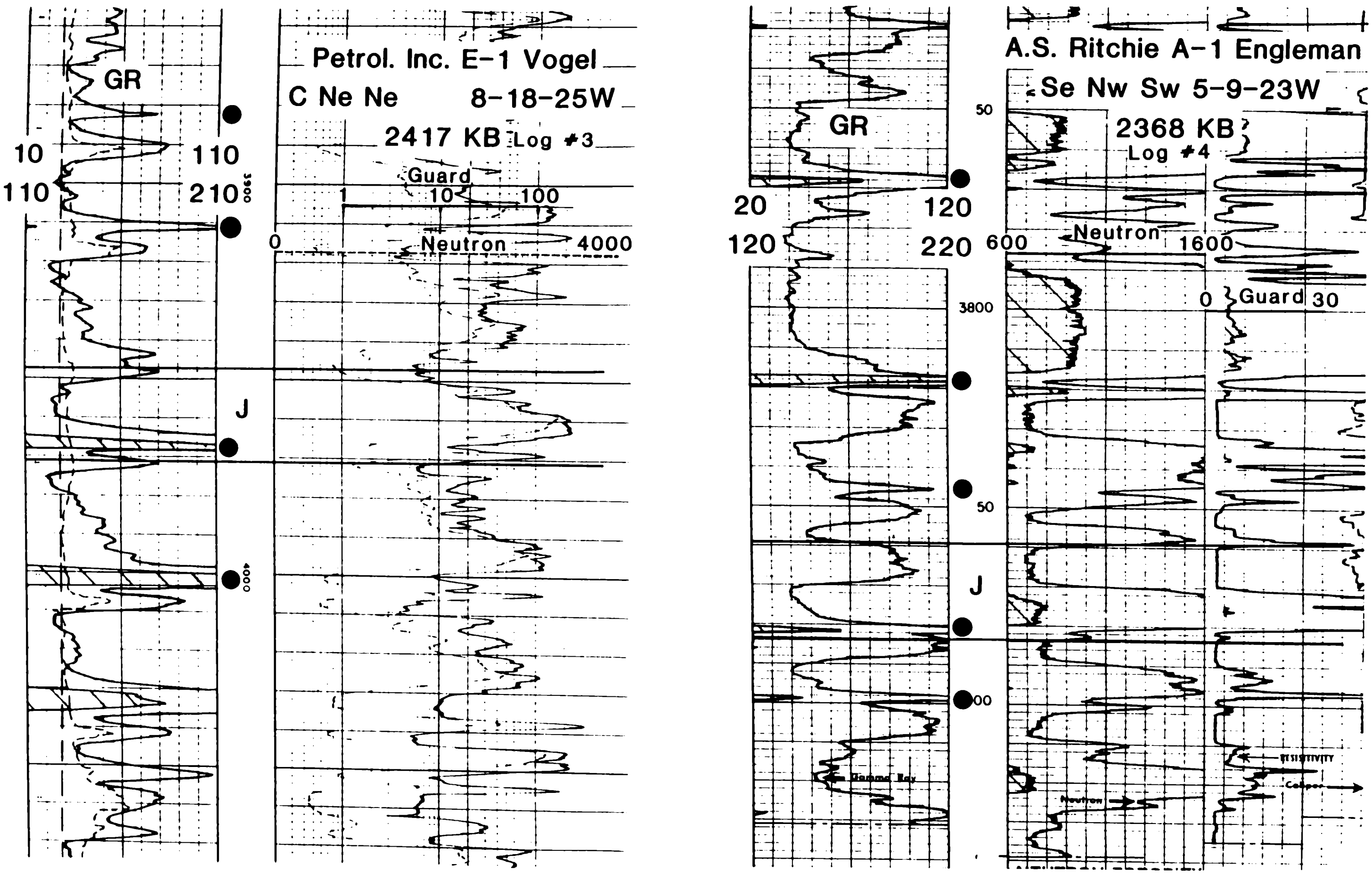
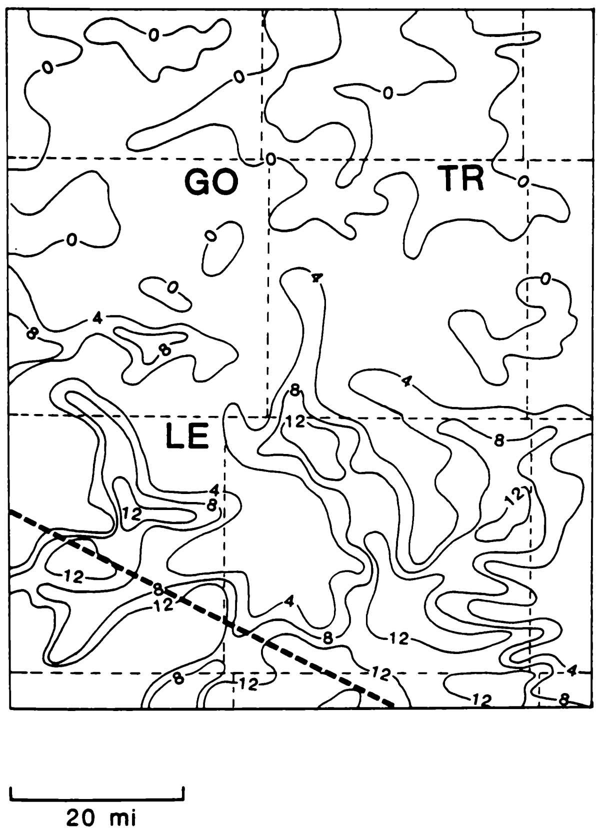

GR
10
110
110
210
Petrol. Inc. E-1 Vogel
C Ne Ne 8-18-25W
2417 KB Log #3
Guard
1
10
100
0
Neutron
4000
J
A.S. Ritchie A-1 Engleman
Se Nw Sw 5-9-23W
2368 KB
Log #4
GR
20
120
120
220
600
Neutron
1600
0
Guard
30
3800
50
J

Figure 6.10. Hand-contoured version of thickness of porous regressive carbonate for the J-Zone indexed in Figure 6.7. Contours are in feet. Heavy, dashed, northwest trending line denotes general location of zone of flexure which is the northern border of regional southern thickening of this interval (see Plate 3). Abbreviation are as follows: GO - Gove County; TR - Trego County; LE - Lane County.


GO
TR
LE
0
4
8
12
20 mi

the unit. Yet, the top commonly contains several feet of mixed bioclastic grainstone or packstone. Weathering and general subaerial-diagenetic overprinting is evident in the J-Zone regressive carbonate as are well-developed soil features in the overlying regressive shale in the northern area (Watney, 1980). Thin grainstones commonly occupy the middle, dominately micritic portions of the regressive carbonates in the northern area indicating an earlier interception of wave base with the sea floor than in areas to the south. Greater proportions of restricted-marine, micritic carbonate rock cover the CA and CKU than in the K-Zone; yet open-marine wackestones are present in all cores on the southern shelf. The distribution of grainstone is erratic on the upper shelf. This facies is also only very locally oolitic above the flexure on the shelf as was also true for the K-Zone.

Regional correlation of lithofacies and wireline log signatures suggests the presence of a regional interruption in the deposition of the J-Zone cyclothem. Studies by Frost (1975) of the Dennis Limestone in outcrop in southeastern Kansas and DuBois (1979) in Hitchcock County, Nebraska, provide evidence that a sudden regional transgression and regression may have occurred during deposition of the middle part of the regressive carbonate. DuBois (1979) recognized a thin layer of extensive, high-energy grainstone or a less argillaceous micritic limestone layer near the middle of the J-Zone regressive carbonate. This unit was considered by DuBois (1979) to be analogous to the oolitic zone of Frost (1975) and to represent a brief regressive-transgressive pulse. A thin interval of higher gamma radiation and lower resistivity occurs midway in the J-Zone over much of the southern study area. Also the Oeser South core on the crest of the CKU contains a thin regressive carbonate composed mostly of oolite grainstone (Plate 1). The interval of oolite is broken by a subaerial crust. The regressive portion of this pulse may have developed during conditions of shoal water, perhaps resulting from widespread emergence followed by another rise in sea level. Close examination of this regional interruption in the accumulation of this cyclothem may provide a marker for correlation that approximates a time line. The identification of depositional conditions across the shelf during this period in geologic time could contribute much toward defining synchronous events on the shelf and refine the estimation of paleoslope conditions.

I-Zone

The 4th-order trend surface and residual maps of the marine interval of the I-Zone (Figs. 6.11 and 6.12) illustrate that greater differences exist between this cyclothem and the K-Zone than between the K- and J-Zones. The I-Zone thins markedly northward into northwestern Kansas and eventually the marine portion of the zone passes into red silty shale combined now with the regressive shale of the underlying J-Zone. The effective pinchout of the I-Zone occurs before reaching the northern border of Kansas.

The trend surface contours become more closely spaced at thicknesses greater than 30 feet along the southern mapped area (Fig.

Figure 6.11. Shaded isopach map of the fourth-order trend surface of the marine interval of the I-Zone in the study area of western Kansas. Contour interval equals 5 feet. Zone of flexure is located at approximately 30 feet. Zero contour defines only approximate location of northward pinchout of J-Zone marine interval.

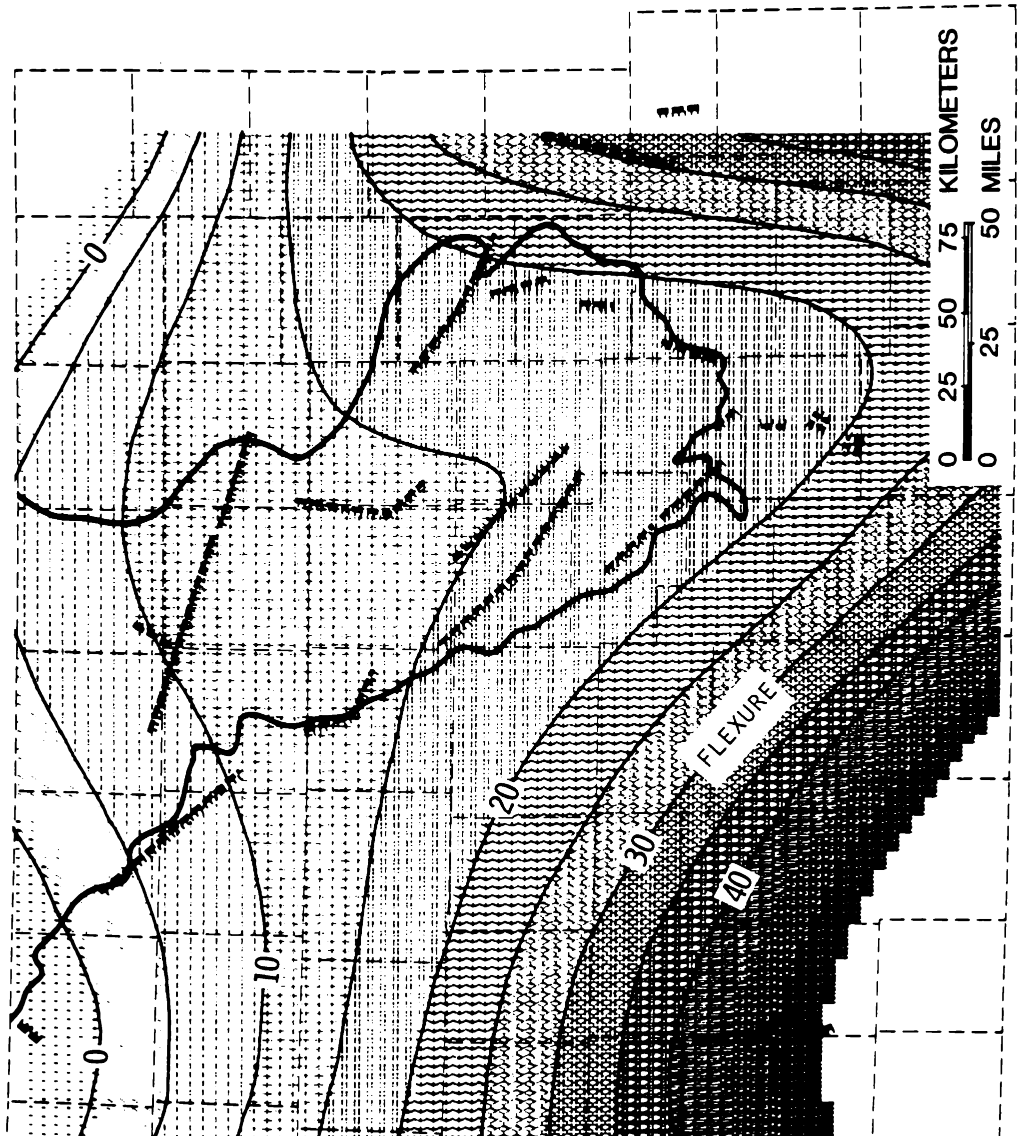
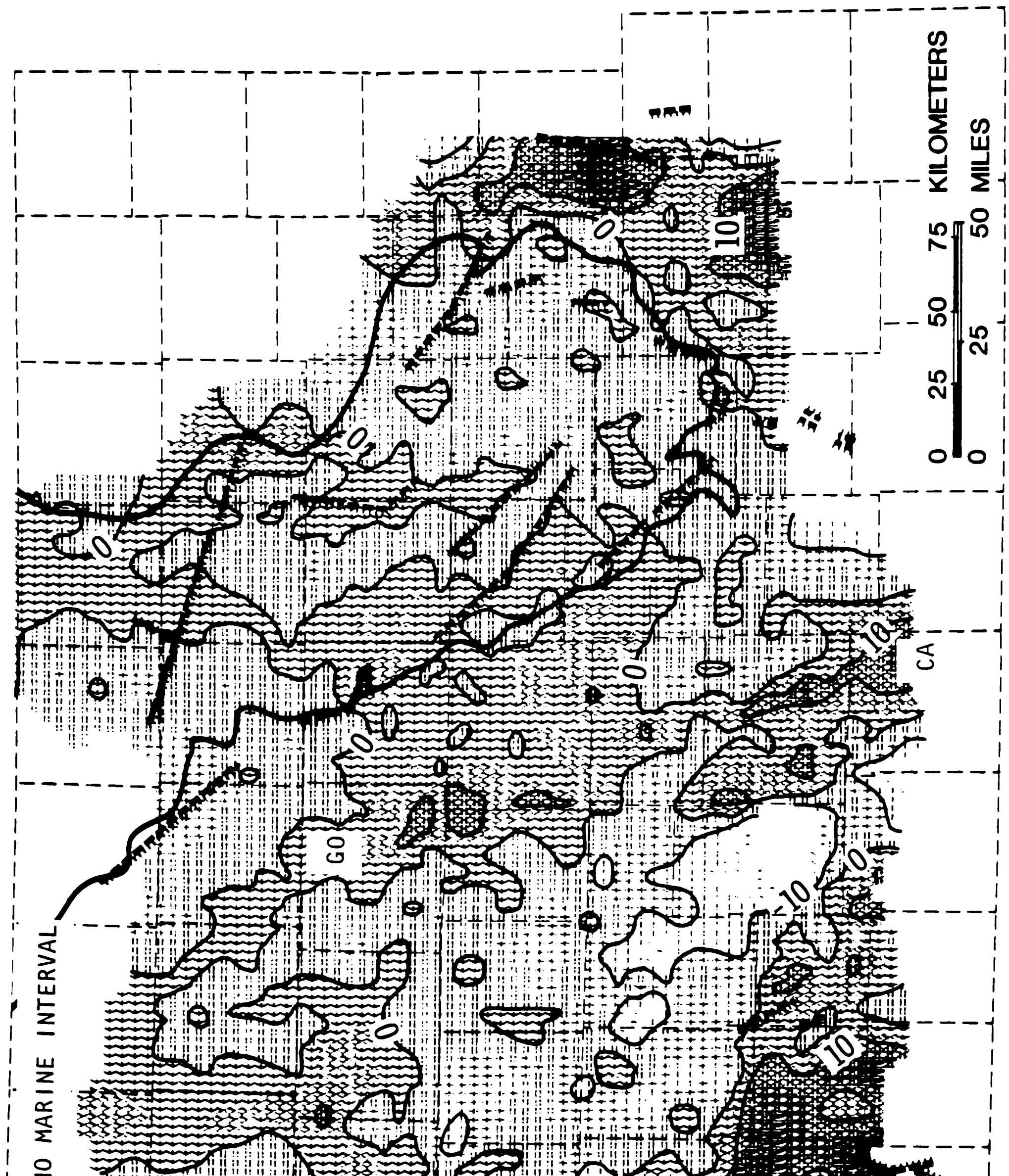

0
0
10
20
30
40
FLEXURE
0 25 50 75 KILOMETERS
0 25 50 MILES

Figure 6.12. Shaded isopach map of the residuals of the fourth-order trend surface map of the marine interval of the I-Zone. Zero, +10, and -10 foot contours shown and labeled. Darker shades represent more positive residual. Area mapped in northwest sector that contains no shading is area lacking the marine interval of the I-Zone. Gove (GO) and Clark (CA) counties are identified along a north-south trending positive.


NO MARINE INTERVAL
GO
CA
0
10
0 25 50 75 KILOMETERS
0 25 50 MILES

6.11). This contour may be considered the northern edge of another zone of flexure. The thinning over the CKU-CA is pronounced. The J- and the K-Zone marine intervals are thicker than the I-Zone in all areas. The positive residuals of the I-Zone marine interval vary as greatly south of the 30-foot contour as did those of the preceding cyclothems (Fig. 6.12). The trend of these positive residuals is again northwesterly over the southwestern shelf and northeasterly over the southeastern shelf. These trends are similar in orientation to the preceding cyclothems, except for the more northernly-trending linear residual extending from Gove (GO) down into Clark (CA) County (Fig. 6.12). This development is in distinct contrast to the previous cyclothems. The 30-foot interval contour on the marine isopach (Plate 4) almost parallels this thickened region on its eastern side.

In southeastern McPherson County a prominent northeast-southwest-trending positive residual is present. This local thickening coincides with the structural low between the Voshell anticline and the southeastern flank of the CKU (Fig. 2.12). This thickening overlies an area of thinned J-Zone that is developed between three lobes of substantially thicker J-Zone. Moreover, other areas of thickening of the I-Zone are generally sites of thinning of the underlying J-Zone much like the relationship recognized between the J- and K-Zones.

Structural activity along the Pratt anticline is suggested again by thinning of the marine interval extending southward beyond the CKU. The I-Zone is less than 15 feet (4.5 m) thick over most of the CKU and CA. Locally less than 10 feet (3 m) of I-Zone is present on the CKU in Rush and Barton counties, areas previously mentioned for noticeable thinning. Abrupt thickening occurs off the southeastern flank of the CKU (Plate 4).

Generally, the area of thinning associated with these prominent uplifts is just as marked as in J- and K-Zones, albeit different in position. Slight modifications to the rates and amounts of subsidence of this magnitude (less than 50 feet, 15 m) on the shelf over the period of time represented by these cyclothems (200,000 to 400,000 years) is not out of the question. Officer and Drake (1982) have indicated rates of 0.8 cm/yr in elevation change along the east coast since late Pleistocene, independent of glacial rebound, resulting in 140 m change over 3000 km (0.047 m/km) versus, for example, 20 feet over 60 miles (6.1/96.6 = 0.06 m/km). The rate of epeirogenic deformation is roughly 6.1 m/200,000 yrs = $3. \times 10^{-5}$ m/yr. (maximum), a rate that is substantially less than along the east coast. This Pennsylvanian setting also was near an active plate boundary in the Ouachitas, the Ancestral Rocky Mountains, and adjacent to the rapidly subsiding Anadarko basin. Consequently, isostatic adjustment could be expected to have been substantial on this shelf because of a more tectonically energetic setting.

Porous carbonate rock exceeding five feet in thickness is generally limited to the southwestern regions beyond the 20-foot marine interval isopach line and within the area where the marine interval is in excess of 90 percent of the cyclothem (Plate 4). The trends of porosity development generally parallel the marine interval contours

(Plate 4). Areas of greater than five feet of porous carbonate are also scattered over the southern portions of the CKU and the northern Pratt anticline. The prominent northwest-southeast- trending thick marine interval from Gove County to Clark County is associated with significant porosity development only on its southern extremity, south of the 30-foot trend surface contour (Plate 4). This contour, in fact, defines a northern limit to most of the thicker porosity development.

Twelve selected cores of the I-Zone were shown earlier on a map of the study area in Plate 1. Carbonate facies over the CKU range from faunally deficient and low diversity sandy mudstone and wackestone (#B-2 Reidel, 31-9S-24W) to nearly all open-marine grainstone and oolite in cores located on the southern margin of the uplift (3 Denker). Close to the pinchout of the I-Zone along the northern shelf the transgressive unit grades rapidly into the regressive carbonate, e.g., B-2 Reidel, without the intervening marine shale, not unlike other locations with the shale to the south (#B-6 Ohlson, 28-14S-14W and #2-D Stegman, 11-16S-17W). In the Reidel core the lower portion of the regressive carbonate is a brachiopod-echinoderm wackestone that contains abundant quartz grains. This basal sandy section probably represents the transgressive unit of the cyclothem.

The 1-22 Hughes well (sec. 22-9-29W), about 20 miles (32 km) south of the pinchout, is predominately a faunally deficient, low diversity mudstone-wackestone that is dolomitized and generally very intensely diagenetically altered. The alteration included solution channels with silicified walls filled with vadose quartz silt, extensive calichification, in situ brecciation at its top, and general millimeter-sized voids interpreted as root casts scattered through the micrite. The F-5 Reese on the crest of the CA also contains spectacular evidence for intense weathering: lithoclastic conglomerate with darkened grains or grains coated with dark-micritic calcite, solution pipes penetrating the in situ section of the carbonate, fissures showing distortion thought to be the result of compaction, root casts, and fracturing.

All that remains of the I-Zone in the Bartosovsky well in sec. 9-1-34W at a location north and beyond the occurrence of the marine lithofacies of the I-Zone is a 3 foot (0.9 m) interval of gray-green shale grading upward to dark-gray shale near the base of a 15 foot (4.6 m) thick, red, silty shale that contains evidence of multiple paleosoil horizons. Here beyond the I-Zone pinchout this entire interval of shale is regarded as part of the regressive shale of the J-Zone. Resolution of this remnant of I-Zone is only suggested in core through this subtle color and lithologic change. This is not recognizable on the wireline logs.

These observations of cores and wireline logs of the I-Zone can be summarized as follows: 1) the regressive carbonate is restricted marine in its entirety near where it pinches out; 2) early intense and prolonged subaerial exposure affected these northerly sites; 3) although shale laminations and quartz sand become an increasingly significant component to the north in the regressive carbonate of the I-Zone, the thick lobes of regressive shale in the J-Zone do not define the location and shape of the pinchout, implying that the pinchout was not entirely due to the carbonate sedimentation being overwhelmed by influx of terrigenous clastics (Shapes of contours might be expected to be more comparable if terrigenous clastics had overwhelmed the regressive carbonate of the I-Zone.); 4) finally, isopachs reveal progressive, regional thinning of the cyclothem onto the upper shelf without the usual decrease in the percentage of the marine interval.

The average thickness of the cyclothem is less than the J- and K-Zones, while the overall character of the trend surface of the marine interval is similar. Together this information suggests that the I-Zone represents an inundation of the western Kansas shelf that was less extensive than the preceding two cyclothems. The configuration of the shelf did not change significantly. Terrigenous clastic influx was comparable to the previous cyclothems and did not overwhelm the carbonate sediments and terminate the cyclothem. Rather, the carbonates on the upper shelf were probably exposed for a time preceding appreciable influx of terrigenous clastics. Quartz grains are quite abundant in the I-Zone carbonates because of the proximity of the regressive carbonate to the shoreline.

The limited samples of the I-Zone in the southwestern study area indicate oolitic grainstone was present (D-2 Conover) coinciding with the typical high porosity and low gamma-ray signatures observed in the J- and K-Zones. However, the presence of phylloid-algal facies overlying the oolite in the D-2 Conover well is difficult to explain. Also the development of regionally extensive porosity that is most

Figure 6.13. Shaded isopach map of the fourth-order trend surface of the marine interval of the H-Zone. Contour interval equals 5 feet. Zone of flexure comparable to regions of increased thickening of the three earlier cyclothems is limited to extreme southeastern portion of map approximately along the 25-foot contour. Area in northeast that is rapidly thickening to northeast represents projection into area without data. Large isolated thick area in west is attributed to a buildup of the regressive carbonate. Pronounced thinning over southeastern portion of the CKU. Range of values mapped is 60 to 80 percent less than ranges in thickness for trend surfaces of K-, J-, and I-Zones, i.e. much less variable in thickness.

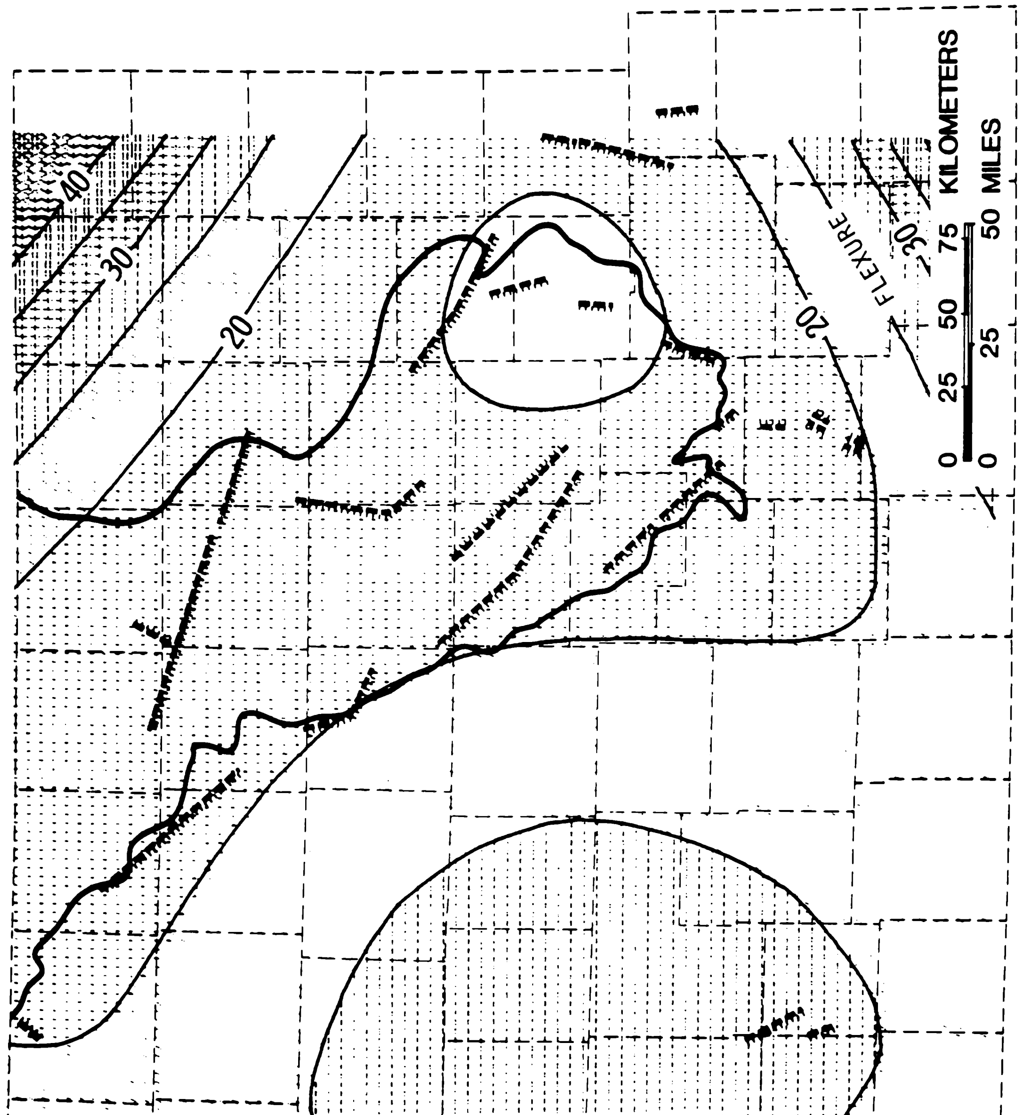
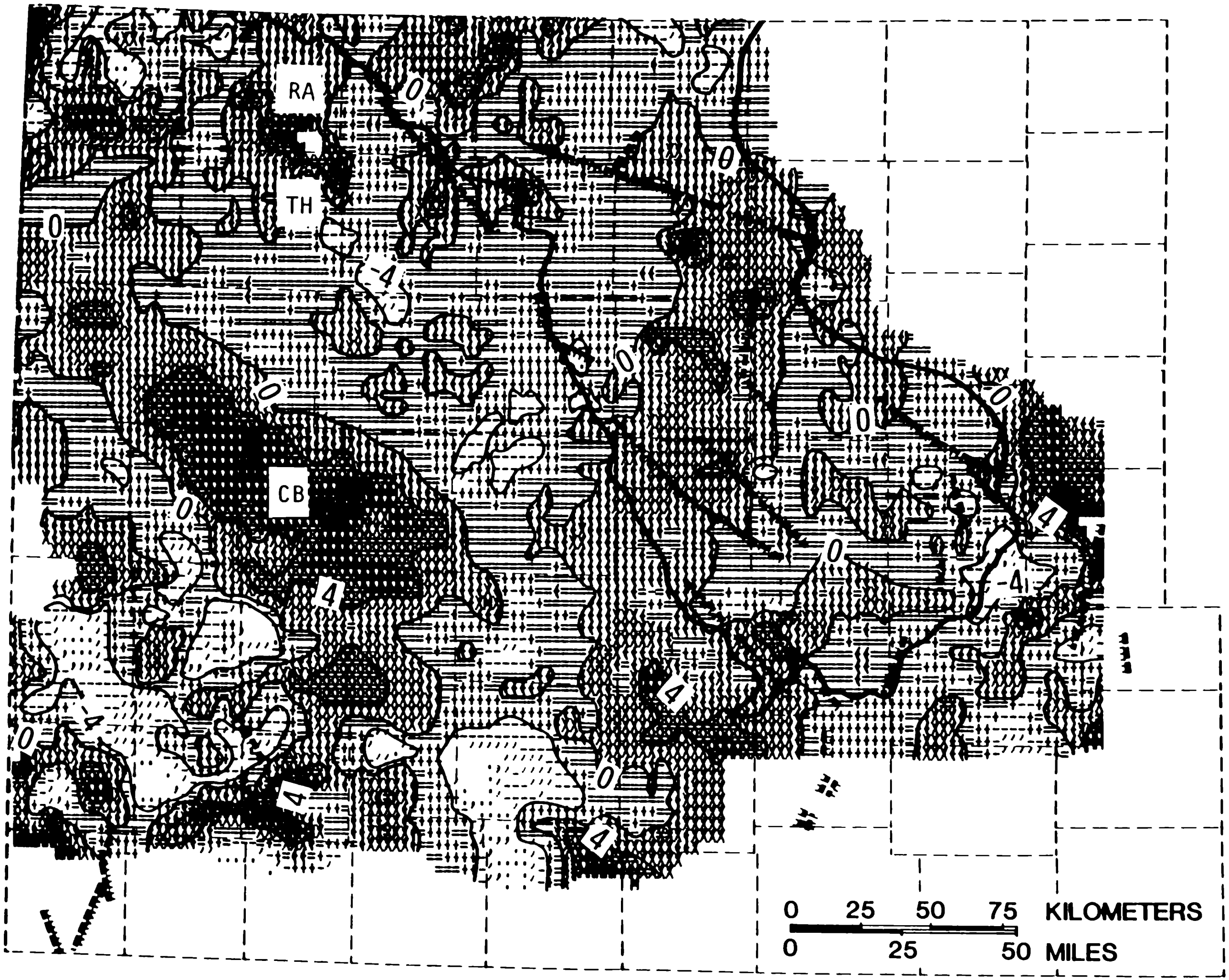

40
30
20
FLEXURE
30
20
0 25 50 75 KILOMETERS
0 25 50 MILES

Figure 6.14. Shaded isopach map of the residuals of the trend surface of the marine interval of the H-Zone. Zero, +4, and -4 contour marked and labeled. Darker shading represents greater positive residual. A broad carbonate buildup is identified (CB). Rawlins (RA) and Thomas (TH) counties are locations of carbonate buildups in the zone which have been identified from cuttings to contain phylloid algae.


RA
TH
CB
0
-4
4
0 25 50 75 KILOMETERS
0 25 50 MILES

common to the lower portions of the I-Zone in this area is not well understood because of too few cores and seemingly anomalous succession. As in the J-Zone the cause may be a short-term drop in sea level during I-Zone accumulation (2nd-order cyclothems). Complete sections of core from the I-Zone are not available to answer this problem.

H-Zone

The youngest cyclothem, the H-Zone, represents a marked change in the configuration of the shelf as revealed by the trend surface and residual maps of the marine interval thickness (Figs. 6.13 and 6.14). First of all, note that the range in thickness of the bar scale bar on the trend surface map is only 17 feet (5.1 m), while the previous ones range between 50 and 80 feet (15 and 24 m). The southward thickening on the southern shelf present in preceding cyclothems is absent in the H-Zone. Without this southern basinward slope it is not unexpected then that oolitic grainstone facies is not a thick widespread development in this zone. Rather without a shelf break where current and wave energy could focus during late regression, micrite-rich, low-energy carbonate buildups accumulated.

Sample cuttings from small positive residuals in Rawlins and Thomas counties in northwestern Kansas (Fig. 6.14) were composed of abundant phylloid-algal wackestone (Watney, 1980). A very broad buildup of carbonate rock with dimensions of 160 km (100 miles) by 80 km (50 miles) by up to 40 feet (12 m) is centered in Scott and Lane counties (Fig. 6.14). The northwest-southeast trend is the only characteristic that is similar to the positive anomalies present in the older cyclothems. This region of rather localized, thickened carbonate rock is the primary anomaly in the isopach that has made the fit of the lower-order trend surfaces so poor (Fig. 6.1). The substantial thickening also accounts for the positive skewness of the residuals (Fig. 6.2). The very anomalous thickness of this feature is apparent as positive areas on both of the trend surface and trend residual maps (Figs. 6.13 and 6.14).

Other wireline log-derived parameters and core information provide a more detailed interpretation of the configuration of the shelf at the time the H-Zone was deposited (Plates 1 and 5, Fig. 6.12). Significantly, the southwestern positive area was active again, as described below, and probably provided a southern barrier to current and wave activity generated in the deeper, open water to the south. The level, protected-shelf area immediately to the northeast became the site of a large complex of carbonate buildups in Scott and Lane counties. In general, the shelf was affected by lower energy conditions during the H-Zone because of the less inclined, more stable-shelf setting and perhaps more rapid regression once it began.

A thickened marine interval in McPherson County parallels the nearly north-south trending 20-foot (6 m) isopach that defines the eastern limit of an unusually broad zone of thinning centered along the CKU positive region developed during the H-Zone. This particular buildup may represent either a high- or low-energy carbonate because of its position along a flexure bordering a particularly positive region on the shelf.

The marine interval is less than 20 feet (6 m) thick over much of the shelf ranging from large areas over the CKU and CA (both well defined by this contour) to smaller patches in the south-central and southwestern area (Plate 5). Several isolated areas with thicknesses less than 10 feet (3 m) are found on the southeastern margin of the CKU in Ellsworth and Rice counties. The area of thinning is appreciably broader than noted previously over the Pratt anticline now extending considerably farther to the east into Reno County. This notable thinning also extends southward off the mapped region. Thinning of the marine interval noted on the upper reaches of the shelf, however, is not nearly as prominent as it was for the earlier cyclothems, particularly over the CA.

Many areas having a thin marine interval are also the sites for low gamma-radiation levels in the marine shale (Plate 5), particularly over the CKU. Areas with marine shale in excess of 150 API units of gamma radiation are more limited when compared to the same maps of the J- and K-Zones. This, in fact, may imply that the level of inundation may have been slightly less than during deposition of the J- and K-Zones, but more than during the accumulation of the I-Zone.

Areas with low gamma radiation for the marine shale (less than 100 API) cover the CKU over a very broad area including areas extending appreciably beyond the previous eastern and southern limits of the CKU. The CA region is associated with a considerably smaller area displaying radiation of less than 100 API units. Coinciding thinning of the marine interval, however, is not as substantial as it was to the south. A rather broad southwestern area of low gamma radiation circumscribes several isolated lobes of thinned marine interval. The areas of low gamma radiation extend eastward of the previously defined southwest positive area. This attenuated gamma radiation suggests the redevelopment of a prominent southwestern positive area that had not been significantly active since the accumulation of the K-Zone.

The areas of higher gamma-ray values of the marine shale are scattered as irregular patches over the east-central shelf and north of the southwestern positive area. The largest area of elevated gamma radiation also coincides with the lobe-shaped marine interval thickness in Gove County. This area of high gamma radiation includes portions which lie beneath the large micritic-carbonate buildup. Possibily more sustained anoxic bottom conditions were encouraged by positive surroundings promoting stagnation and resulting in the accumulation of more radioactive shale. The development of the carbonate buildup would have been encouraged at least in part by the accumulation in the protected slightly lower region. Water conditions including temperature, salinity, and energy conditions may have been favorably affected by this setting leading to proliferation of organisms.

The porous carbonate thicker than four feet identified in Plate 5 is located: 1) on irregular but large patches of shelf on both the western and eastern flanks of the southern CKU, Pratt anticline, and southwestern positive area, 2) the area immediately west of the Pratt anticline in Edwards, Stafford, and Pratt counties, 3) at and near where the large carbonate buildup and the southwestern positive area converge in Finney County, and 4) on the northwestern flank of the same carbonate buildup in Wichita and Logan counties. This porosity was primarily derived from grain-supported carbonate facies in the upper portion of the regressive carbonate, some of which has been described as oolitic. The marine interval thickens rapidly immediately southeast of the CKU, which may be the only zone of flexure in the area of study during the H-Zone interval. Regionally continuous porosity developed in the regressive carbonate appears to be near the location of this zone of flexure, yet in a much more restricted area when compared to the underlying cyclothems.

The thickest development of regressive terrigenous clastics in the H-Zone forms a broad band covering northwestern Kansas (Plate 5). The southern margin of the thickest portion, defined roughly by the 8-foot contour, runs from Phillips County located on the east edge of the CA to Wichita County in extreme west-central Kansas. Moreover, the regressive shale is more uniformly developed then the underlying zones. Four areas, however, contain less than four feet of this shale: 1) the east-central portion of the CKU centered in Barton and Russell counties, 2) over the Pratt anticline in Stafford and Pratt counties, 3) the southeast portions of the southwestern positive area, and 4) over portions of the area covered by the thick marine interval centered in Scott County. The thin regressive shale at these locations suggests that positive shelf locations were coincident with both the buildup of carbonate rock and structurally elevated areas. The widely distributed but thin regressive shale in these other areas suggests that the topographic relief was not pronounced. This is the first time in the succession of the four cyclothems examined here that measurable, regressive, terrigenous clastics prograded so far south.

The ratio of the thickness of the H-Zone to the thickness of the total four-cyclothem interval provides a stark contrast to similar maps in the underlying three cyclothems (Plates 3, 4, and 5 and Figure 5.8). While the CA was a strongly positive area, this map suggests diminished relief. More than 40 percent of the four-cyclothem interval is composed of H-Zone in the CA area in Graham County. Much of the H-Zone here, however, is composed of terrigenous clastics of the regressive shale. On the southern shelf the absence of abrupt thickening and hence a zone of flexure is dramatically expressed over an area where the H-Zone contributes less than 20% to the total thickness of the four cyclothem package.

Locations of twelve cores examined in the H-Zone are shown in Plate 1. Three north-centrally located cores, the #9 Morel, #D-2 Reidel, and #1-22 Hughes, are all composed of predominately open-marine sequences in the H-Zone with the exception of their very tops. The predominance of the open-marine conditions is in contrast to the other cyclothems at this northern location on the shelf. Alternatively, the eastern and southeastern cores, the 506 Dorr, the B-6 Ohlson, #3 Denker, and the 11 Ainsworth, have increasingly less open-marine intervals, particularly toward the southeast. This is also contrary to the observations in previous cyclothems. However, the thinnest marine interval of the H-Zone on the entire shelf is located near the 11 Ainsworth core in Rice County. It is significant that the H-Zone in the #3 Denker core has the most faunally restricted section in spite of its southern location. This demonstrates that this area of the CKU was quite positive during the accumulation of the H-Zone.

The marine interval in the wells to the south and southwest is thicker than on the CKU. Moreover, the 1 Beauchamp core in Stanton County reveals a thick succession of open-marine lithofacies. The 1 Beauchamp lies on the eastern edge of the southwestern positive area, the site of a prominent minimum gamma radiation of the marine shale. Although diversely fossiliferous, the marine shale in the 1 Beachamp core is thin, silty, and dark gray. The uppermost regressive carbonate is thin with 13 feet of oolitic grainstone that is capped by a subaerial crust. Furthermore, the core is located on a trend of regionally continuous porosity (Plate 1 and Plate 3). The area apparently was the location of an influx of terrigenous clastics probably coming off the Cimmaron arch. The presence of abundant oolite, the lack of black shale, and the higher percentage of siliciclastics strongly suggest the presence of local pronounced relief at this location on the shelf.

Only limited occurrences of thick (greater than five feet), regionally continuous porosity and associated grain-rich carbonate rocks are present on the southern shelf in the H-Zone, unlike the J- and K-Zones. However, like older cyclothems, thinner, less continuous grain-rich intervals in the H-Zone also serve as petroleum reservoirs in the northern area of study such as in the Cahoj field in Rawlins County where grainstone developed on a paleohigh (Watney, 1980). Local paleohighs may be a very important factors in determining the location of the grainstone, particularly with such a broad, flat setting as that of the shelf during the H-Zone.

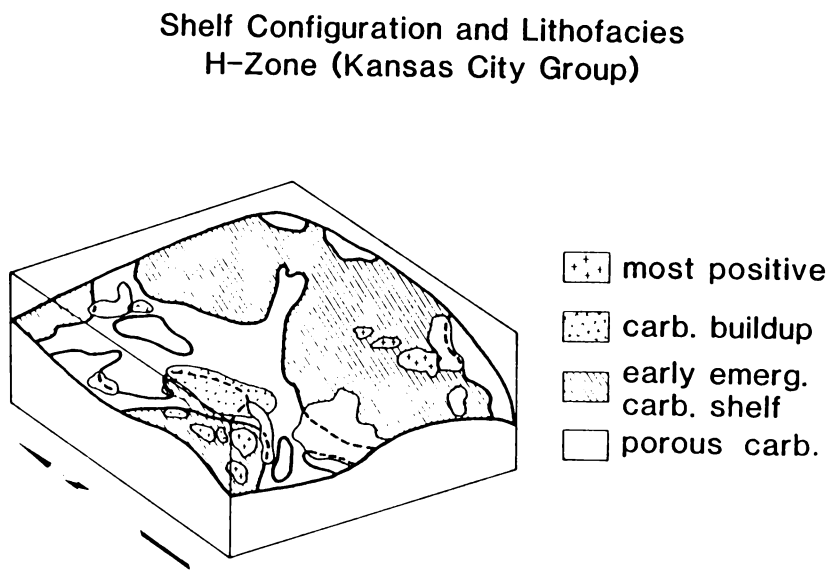
The carbonate buildup composed of phylloid algae recognized in Rawlins County was initially considered unusual (Watney, 1980). Younger cyclothems (G and D) also had carbonate buildups attributed to phylloid algae (Ebanks and Watney, in press). Locally, the phylloid algae have been leached by freshwater to produce a very porous rock. Yet, this porosity is erratic and very difficult to predict, except that it may be associated with anomalous thickening of the regressive carbonate. The large lobate buildup of carbonate rock centered in Scott County has not been studied in detail. It is an accumulation of micrite rather than grainstone. The lobe may represent a complex of mud mounds that accumulated through the proliferation of phylloid algae or other organisms that trapped sediment and inhibited strong current activity. The wide-shelf setting of the H-Zone where current and wave action were generally dissipated was probably conducive to the formation of these buildups. Certainly, the H-Zone is different from the preceding cyclothems. Yet, it is concluded that the level of inundation of the shelf by the sea was comparable to that of the J- and K-Zones, during the deposition of which the configuration of the shelf was closer to a level platform on which several broad topographic highs including the southern CKU and the broad southwest positive area were developed (Fig. 6.15).

The development of differential relief changed during the succession of cyclothems, apparently independent of the cyclic pattern of sedimentation. The effect of the varying configuration of the shelf on the sedimentary rocks was dramatic. The composite-interval thickness map of the four cyclothems (Fig. 2.9), however, suggests a simple interpretation of draping and thinning over the prominent CA-CKU trend.

Summary--Intercyclical Variation, Causes and Effects

Differential structural movement of the shelf occurred as the whole shelf tilted and subsided in conjuction with downwarping of the Anadarko basin. The locations of some of the first- and second-order structural activity on this shelf, such as the formation of flexures and uplifts, may be related to basement heterogeneity and weaknesses as indicated by faulting and geophysical anomalies. In particular, linear elements and patterns on the magnetic intensity map of Kansas separate the Precambrian basement into different terranes. Apparently some terranes are strong, unitized masses, while others are weak and possibly fractured or faulted blocks. Together they define the mechanical integrity that significantly affected the location and style of deformation that influenced the overlying sedimentary stra-

Figure 6.15. Perspective block diagram of the structural configuration of the western Kansas shelf during the accumulation of the H-Zone. Interpretation based on the series of subsurface maps and core data. Shelf was more level than previous cyclothems. CKU and southwest positive (SWP) apparently were active during the accumulation of the H-Zone. Areas of notable thinning are associated with the southern CKU and SWP. Large complex of carbonate buildups immediately northeast of the SWP. Carbonate buildups in Rawlins (RA) and Thomas (TH) counties are phylloid algal mudbanks (See Fig. 6.14). Regionally continuous porosity in the H Zone is commonly associated with the southern, basinward-directed edges of the carbonate buildups or areas of structural relief, e.g. southwest and southeast positive areas (Plate 5).


Shelf Configuration and Lithofacies
H-Zone (Kansas City Group)
most positive
carb. buildup
early emerg. carb. shelf
porous carb.

ta. Although the shelf setting was maintained during this period, localized crustal areas responded differently to the external forces affecting them.

Price (1981) in a surface study of the Middle Pennsylvanian Pawnee Limestone in the Midcontinent concluded that the positive relief over the Bourbon arch influenced the distribution of facies in this unit; the arch was notably an environment that was more conducive to proliferation of algae resulting from relatively clearer water, more light, and better circulation and nutrient supply. Gentile (1967) had similarly noted the effect of structural movement on sedimentation in the same area as did McMillian (1956). Closer to this study area, Moore and Nelson (1974) had previously reported on the effect of the Cambridge-Chadron structural trend on thicknesses of Paleozoic and Mesozoic strata.

Fisher (1980) recognized the influence of the Nemaha uplift and associated lesser structures on the sedimentation and diagenetic pattern of beds in the uppermost Hamlin Shale and Americus Limestone in northeastern Kansas. In particular, erosion and reworking of strata along a disconformity between the Hamlin and Americus are noted over the crestal areas of the Nemaha uplift. Variations in thickness and composition of the upper Americus limestone are also attributed to the influence of paleorelief over the Nemaha uplift. The Nemaha uplift had a similar episode of major uplift during the Late Mississippian and Early Pennsylvanian as the CKU (Merriam, 1963).

Recently, Bornemann and Doveton (1983) described lithofacies in the Viola Limestone in south-central Kansas over the area of the Pratt anticline. The influence of this positive structural element on sedimentation is apparent from core and log analyses. More grain-rich carbonate facies flank this feature suggesting that a precursive structural element substantial enough to affect sedimentation existed during the Ordovician. The authors, furthermore, concluded that the grain of the lithofacies coincides with the suspected basement faults associated with the Precambrian Midcontinent rift system suggesting that the faults were active intermittently and influenced depositional trends, diagenetic patterns, erosional history, and the location of traps for Viola fields.

Obviously, these authors were convinced that the relationships of structure and sedimentation are more than circumstantial. The persistence of a structural element such as the Pratt anticline and the effects that this positive relief had on deposition over long periods of geologic time are testimony to recurrent structural movement. Other workers have addressed recurrent movement of basement structures and reactivation of faults in the interior regions of the U.S. with widely ranging ramifications and applications: 1) influence of the Transcontinental arch on Cretaceous marine sedimentation (Weimer, 1978); 2) tectonics and sedimentation in the northern Denver basin (Sonnenberg and Weimer, 1981); 3) late Paleozoic movement along the Los Animas arch (Rascoe, 1979); 4) post-Cretaceous faulting at head of Mississippian embayment; 5) rift precursor to Mississippi embayment (Ervin and McGinnis, 1975). Causes of the internal motion of the crustal plate along unhealed fault blocks are increasingly being sought by invoking major tectonic forces focused along boundaries of the plate.

The periodicity or oscillation of shelf-wide structural deformation has not been demonstrated. Sloss and Speed (1974) suggested that while regional tectonic deformation such as uplift and subsidence was an important cause of change in sea level, the frequency of deformation needed to produce cyclothems was too high. The deformation on the Pennsylvanian shelf in western Kansas was dominated by subsidence for successive cyclothems. The southward tilting ramp was modified by local, resistant, positive elements that subsided less rapidly than the surrounding shelf. These features varied in time as well as in overall degree of subsidence, e.g., H-Zone compared to the rest of the cyclothems. This shelf as a whole was apparently responding to the much stronger subsidence of the Anadarko basin. Conceptually it is difficult to invoke periodic uplift to cause the emergence of the shelf evidenced by the sedimentary record.

Structural oscillation of this tectonic province associated with the subsidence of the Anadarko basin and probably the activity of the Ouachita orogeny becomes an even less acceptable explanation for change in sea level when one attempts to apply it to other areas of the Midcontinent or distant areas that were undergoing comparable carbonate-shelf cyclic sedimentation, e.g., Russian platform, on the Eurasian continent. The spacial and vertical regularity of the epeirogenic deformation as described here was not uniform between cyclothems. Furthermore, its influence on sedimentation appears to have been only a second-order effect, due to tilting and differential uplift. Consequently, it seems necessary to invoke a change of sea level in order to produce the cyclicity that apparently affected broad areas of the craton.

CHAPTER SEVEN

EUSTATIC SEA LEVEL CHANGE

Many workers, such as Evans (1979), have described evidence in Quaternary sediments for eustatic change in sea level. This evidence is important to the interpretation of observations in this investigation. In particular, the observed simularities of these Pennsylvanian strata to Quaternary sedimentary cyclothems induced by glacial-eustatic changes in sea level are evident. The record of Pleistocene coastal sedimentation is one of punctuated transgression dominated by progradational sedimentation during stillstand and then gradual but fluctuating fall in sea level with accompanying sedimentation. Each succession is concluded by subaerial exposure. The repetition of the Quaternary transgression and regression is due to glacially-controlled eustatic change in sea level described in the introduction. Beard et al. (1982) have subdivided the terrigenous-clastic-dominated Quaternary stratigraphic succession on the Gulf Coast, U.S.A., into eight recognizable cyclothems using paleontological, sedimentological, and seismic evidence. They concluded that these cyclothems were controlled by glacial eustacy, each depositional sequence representing a conformable succession of genetically related strata bound by unconformities at the top and base. The duration of each of these recognized cyclothems then would average over 200,000 years, double the length of time of the average glacial cycle recognized from deep sea cores. Precise correlation of these events would be needed to compare their development.

The shelf along the Gulf Coast was subaerially exposed during low stand of sea level. Sediment then bypassed the shelf and was deposited on the continental slope resulting in the progradation of the shelf. Transgressive sediments, as Evans (1979) noted, are typically thin. The depositional sequence is thus dominated by the prograding terrigenous clastic deltaic deposits. The shelf-wide distribution of thin transgressive deposits and extensive, but thicker regressive sediments of the study area in western Kansas are analogous to these deposits. The reciprocal nature of carbonate and clastic sedimentation, particularly the periodic progradation of terrigenous clastics across the shelf and into the slope and basinal areas of the eastern edge of the Anadarko basin in Oklahoma is very similar to the overall processes of development of the Gulf Coastal region (Figs 2.3 and 2.4; Galloway et al, 1977; Kumar and Slatt, 1984).

The key element observed and illustrated in western Kansas is the repetition of a sequence of strata over a very wide area. Sedimentary processes alone cannot easily explain the evolution of the observed succession and lateral distribution of sediment across the gently inclined shelf. Neither can processes of sedimentation alone explain the shelf-wide early freshwater diagenesis, subaerial exposure, and limited erosion that affected each cycle. The regularity in thickness between cycles, the repetition of sedimentary units, and the breadth-to-thickness ratio, such as the minimally 300-mile-wide shelf with the cyclothem averaging 30 feet in thickness giving a ratio of thickness to lateral extent of 52,000 in the study area, make this a phenomenal record of widespread but rapidly changing lithofacies.

The model of Quaternary coastal sedimentation provided by Evans (1979) and Beard et al. (1982) illustrates a response to processes predominately controlled by changing sea level. Significant aspects of this model that are similar to the Missourian rocks of western Kansas include the following. 1) The rise of sea level is interpreted to have been rapid, quickly leading to a succession of thin sedimentary facies from shallow to deeper water. 2) The maximum transgression is characterized by commonly widespread stagnation across the shelf during times of diminished rates of sedimentation resulting in a condensed interval of black shale or possibly concentrations of glauconite and phosphorite. 3) Regression is relatively slow, possibly with minor fluctuations in sea level but with a general trend toward shallowing conditions across the platform. Generally thick regressive coastal sediments result. 4) The thickness of the sediments in either case does not represent the actual depths of water that covered the shelf. 5) Regressive sedimentation is encouraged by the progradation and aggradation of sediment, but alone they cannot account for the distribution of facies or the pattern of diagenesis. 6) The maximum extent of regression suggested in the Pennsylvanian and Quaternary examples is substantial. In both examples the sea apparently totally withdrew from the shelf subjecting the sediments to subaerial exposure and weathering. Thin, weathered, oxidized surfaces (diastems) separate the sedimentary sequences as sea level fell beyond the margins of the shelf. Reciprocal sedimentation brought significant clastic detritus to the slope and basins in both settings leading to periodic progradation of the shelf margins. 7) Depositional topographic relief and much of the sediment itself, however, are preserved in both examples even during intense weathering and erosion on the upper parts of the shelves, an important point that was stressed by Evans (1979). The actual modification to the upper carbonate in the Pennsylvanian study by intercyclothem exposure may be even more substantial than that recorded in the few cores that are available.

Investigations of equivalent Missourian strata from other settings have also recognized the presence of subtle unconformities. Locally on the outer shelf margin of the Midland basin in central Texas the Missourian carbonate rocks (Canyon Group) merge to become a stacked sequence of buildups of micrite-rich limestone composed of phylloid algae. A.A. Brown (1979) described multiple development of a caliche subaerial crust and compaction breccias in micritic limestone immediately beneath the upper surfaces of regressive sequences of phylloid algal biomicrites. Brown interpreted these as subaerial unconformities and concluded that at least the tops of the mounds were exposed during a lowstand in sea level. Exposure was followed by rapid transgression that trapped clastics nearshore and encouraged the deposition of more extensive carbonates across the shelf.

Ross (1971) also found unconformities separating the cyclothems of carbonate-dominated rocks of the Late Pennsylvanian in the Glass

Mountains of west Texas. He concluded that the withdrawal of the sea was extensive, and he traced the shallow carbonate rocks 427 feet (130 meters) stratigraphically below what he interpreted as a shelf edge. This is comparable to the amount of sea-level fall proposed by Van Siclen (1958), who studied equivalent strata along the eastern shelf of the Midland basin. Furthermore, the interpretation of Beard et al. (1982) of the shelf margin of the Gulf Coast is not appreciably different from the model of Van Siclen (1972), which is complemented by the studies of Ross (1971) and Brown (1979).

Other studies of Early and Late Pennsylvanian carbonate-rock-dominated shelf margins in the southwestern U.S. have also suggested a pronounced withdrawal of the sea between each cyclothem because of a substantial fall in sea level, perhaps a mimimum of 100 to 150 feet (Wilson, 1967; Winchester, 1976; Toomey et al, 1977). Upper Pennsylvanian cyclothems in the Oquirrh Group in central Utah are interpreted to have been deposited in a strongly fluctuating shelf environment as indicated by alternating thin carbonate rocks and thicker terrigenous rocks (Stevens, et al, 1983).

In the Appalachian basin, the Brush Creek and Cambridge cyclothems, thought to be equivalent to cyclothems within the Kansas City Group, contain red-bed sequences more than 10 ft. (3 meters) thick near the top of the regressive sequences (Sturgeon, 1958). These shales are mottled red, brown, buff, and green, and locally contain small ferruginous limestone masses. Further study is needed to determine if a paleosol is present or if there is other evidence of subaerial exposure. However, punctuated succession of marine and non-marine oxidized and reduced rocks imply marked fluctuation in environments of deposition. The overlying transgressive limestones of these successions, the Brush Creek and Cambridge limestones, are dark gray to black regionally extensive units only 1 to 2 feet thick. They locally grade upward to a fossiliferous sandstone or conglomerate containing clasts of marine limestone pebbles or cobbles. Although the marine sediments are limited in the succession, they are significant in terms of their influence on the environmental setting of the shelf, representing a marked change over a wide area. There are six similar transgressions in the Missourian rocks in Ohio (Wanless, 1975), at least three of which can be traced into Pennsylvania and West Virginia. Moreover, to the west in the Illinois basin thirteen transgressions are recognized, each of which becomes increasingly more marine to the west (Wanless, 1975). Greater water depth during transgression and/or reduced clastic influx would increase the obvious evidence for the marine incursion and help to explain the greater number and more marine character of cyclothems to the west.

Marine transgression induced a rapid environmental transition across the shelf. The large deltas on the eastern edge of the craton periodically were apparently synchronously inundated. Baird and Shabica (1980), for example, described simultaneous inundation of actively prograding deltas of Middle Pennsylvanian age in the Illinois and Midcontinent interior basins. This brought about the destruction of separate distributary systems and resulted in the deposition of the Francis Creek Shale. They termed the shale a syntransgressive delta unit. This shale contains well-preserved, soft-bodied invertebrate organisms and plants that died during catastrophic burial at the time of this transgression. This deposit is followed by the accumulation of the Mecca Quarry Shale Member, generally a black shale, relatively thin but correlative over large areas. It is, in fact, considered to be equivalent to the black shale beneath the Verdigris Limestone in Kansas (Wanless and Wright, 1978). Other inundations that occurred during active delta progradation were described in Upper Pennsylvanian deposits of the Brush Creek (Missourian) transgression of the Appalachian basin (Morris, 1967; Rollins et al., 1979).

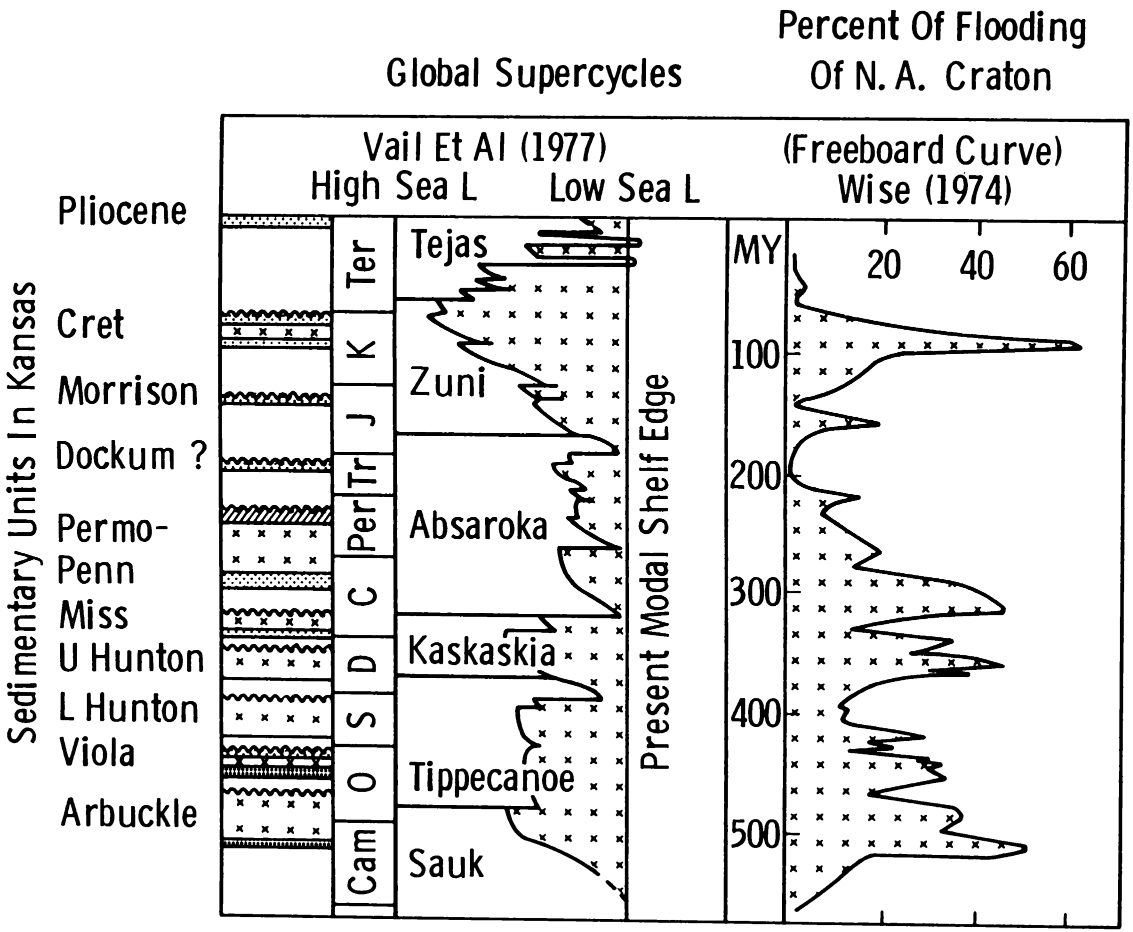
The midcyclothem or core stratum deposited during late transgression and maximum inundation on the shelf is the black shale facies (see discussion on marine shale). Such marine shales as the Excello and Heebner have provided the correlation between regions of the Midcontinent (e.g., Wanless, 1964; Heckel, 1977). Marine shales of the Missourian zones studied in western Kansas are widespread but are not usually cited for their extensive black-shale facies. The carbonate-dominated portions of the typical Late Pennsylvanian Kansas cyclothem, however, also are found considerably farther eastward in the Illinois basin. The Fithian cyclothem in Illinois described by Heckel (1980) is correlated to middle to lower Missourian and hence equivalent to a portion of the interval investigated here. The composition of the cyclothem is very similar to the succession described in Kansas. The conodont distribution, for example, is analogous to the Kansas-type cyclothem described by Heckel and Baesemann (1975). The black shale, although thin, has the richest assemblage of conodonts of any member of the cyclothem. This unit separates limestones resembling the transgressive lower limestone from the regressive upper limestone. The regressive carbonate is overlain by coal and underclay and succeeded by outside, regressive shale and sandstone, all of which contain only rare or no invertebrate fossils or conodonts. The succession is quite similar to the eastern Kansas strata of equivalent age because of the significant thicknesses of regressive shale. Correlative marine members farther east in Illinois, Indiana, and Ohio, however, punctuate a stratigraphic column dominated by terrigenous clastics because of the proximity to the source of terrigenous clastics.

An estuarine model used in this report to explain the development of anoxia during accumulation of the black shale is analogous to that of Demaison and Moore (1979, 1980). It utilizes the most available and likely components to produce an anoxic sea floor on the craton: 1) abundant terrestrial organic matter produced in a humid, tropical climate, and 2) abundant influx of freshwater during the period of rapid transgression, during deepening water conditions where influx of heavier, cooler marine waters together with tropical heating of surface waters produced stratification of the water mass. Oxygen was depleted, influx of terrigenous detritus had been eliminated or greatly minimized except along the very edges of the cratonic sea, and slow sedimentation ensued. The result was a thin, black, dense, faunally restricted shale commonly repeated in many Middle and Upper Pennsylvanian cyclothems across the Midcontinent. Favorable climate, organic-matter productivity, and positive water balance were thus the crucial ingredients to the formation of these extensive black-shale units.

The depth of water during the deposition of this shale was probably nearing or at its maximum, due to its extensive lateral distribution and indications of slow rates of deposition. Once the supply of fresh water from the inundated mainlands was eliminated and mixing with normal sea water began, the sea bottom was restored to normal-marine conditions. Perhaps the seafloor closer to the sources of freshwater remained anoxic for longer periods due to high organic productivity and continued stratification of the water column resulting in, for example, very high values of certain minor elements such as molybdenum (Coveney and Martin, 1983). Shales at these nearshore locations apparently contain more metals, phosphate, and organic matter because they were provided by the mainland. The growth of bottom endolithic algae, apparently lacking during and immediately before and after the accumulation of black shale, is an indication of unfavorable conditions on the seafloor. This was perhaps not because the seafloor was below the photic zone, but possibly because of abnormal pH or Eh, or toxicity of the bottom waters.

The lateral facies change of black shales to gray and green open-marine shales on a stable, low-lying shelf environment is associated with overlying and underlying carbonate rocks that show no significant change in lithofacies over long distances. Furthermore, thin marine limestones are just as likely to be present at upper shelf locations without an accompanying black shale facies. The minor regional slope of the shelf apparently controlled the several locations of the black shales with only moderate effects on the adjacent carbonates suggesting that the black shales were not deposited in substantially deeper water than either the lower portion of the regressive carbonate or the uppermost portion of the transgressive carbonate. Rather the marine shale interval was probably deposited in somewhat deeper water perhaps during the building and climax of an interglacial stage as many have suggested. Sea level curves of Vail et al. (1977) suggest that the Late Pennsylvanian was a time of only intermediate inundation of the continents (Fig. 7.1). During normal interglacial periods the sea level would approach this intermediate level of inundation on the cratons. Absolute depths of water on the shelf then were probably between the estimated maximum 980 feet (300 m) above present, during the Late Cretaceous (Hays and Pittman, 1973) and the present low-stand in sea level. This intermediate level of mean sea level without the effects of glaciation perhaps is close to 400 feet (120 m) as suggested by previous workers (Van Siclen, 1958; Ross, 1971). A drop in sea level to the shelf edge would suggest then a minimum change in sea level of 400 feet (120 m). The range in Pleistocene sea level change as mentioned previously is between 330 to 490 feet (100 to 150 meters) (Donovan and Jones, 1979). These values are comparable as might be anticipated if glacial eustacy were to be used to explain the cyclothemic

Figure 7.1. Second-order global cycles of relative sea level change (coastal onlap) during Phanerozoic time (from Vail et al., 1977) and extent of inundation on continent according to Wise (1974). Kansas stratigraphic column is shown on left-side of the illustration. Pennsylvanian (Late Carboniferous) was a period of lower relative position of sea level.


Global Supercycles
Percent Of Flooding Of N. A. Craton
Vail Et Al (1977)
High Sea L
Low Sea L
(Freeboard Curve)
Wise (1974)
Sedimentary Units In Kansas
Pliocene
Cret
Morrison
Dockum ?
Permo-Penn
Miss
U Hunton
L Hunton
Viola
Arbuckle
Ter
K
J
Tr
Per
C
D
S
O
Cam
Tejas
Zuni
Absaroka
Kaskaskia
Tippecanoe
Sauk
Present Modal Shelf Edge
MY
100
200
300
400
500
20
40
60

strata of the Upper Pennsylvanian.

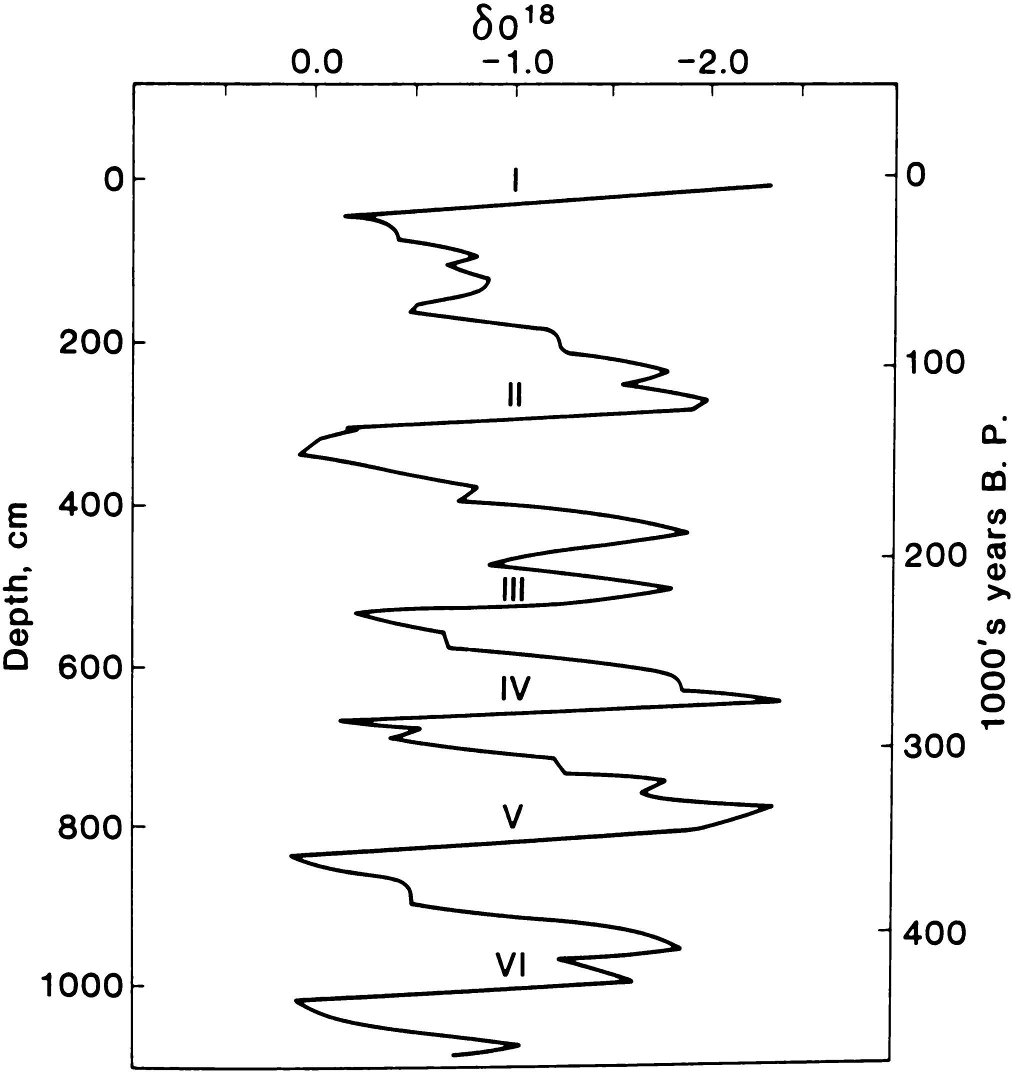
Static interglacial, high-stand conditions developed during the Quaternary at times when seawater rapidly submerged the shelf but not to extreme depths. Sea level then fell as a result of renewed glaciation producing a shallowing-upwards succession of sediments that were finally exposed to subaerial processes. Evidence presented by Ross (1971) for the Midland basin and Galloway et al. (1977) and Lane (1979) for the Anadarko basin support a substantial fall in sea level beyond the shelf margin. Terrigenous clastic sediment apparently bypassed the shelf late during regression, prograding and extending the shelf margin seaward. This is analogous to the description of the Quaternary succession by Beard et al. (1982). The fall of sea level below the shelf margin could perhaps account for an appreciable portion of the total range of the fluctuation of sea level. The argument suggests that products of subaerial exposure are probably at least as extensive and significant as those sediments deposited during maximum transgression and hence could be very useful in denoting the cyclothems. The recognition is hampered, however, as a result of thinness and commonly the presence of only subtle criteria to indicate subaerial exposure.

The Gazelian-Kaslmovian cyclothems on the Russian platform summarized by Rauser-Chernovsova (1979) are similar in thickness and composition to those in the equivalent interval of the western Midcontinent, but they apparently lack the black shale. In particular, the Missourian equivalent (Kasimovian) in this area is dominated by diversely fossiliferous carbonate rock. Much thinner shale and siltstone were deposited only in the latest stages of these cyclothems. Erosional surfaces with some suggested topographic relief separate the individual cyclothems much like those described here in Kansas. The higher latitudinal position of the Russian platform (Parrish, 1982) may have been significant in accounting for the apparent failure to form the black shale facies. Reduced levels of organic matter production in a temperate setting, a decrease in amount of precipitation, and wider range of temperature may have eliminated the development of temperature or salinity stratification of the water mass and limited the extent and amount of low oxygen waters needed for anoxic conditions to develop. The fact that these cyclothems are even developed with the character and periodicity resembling the Midcontinent, however, strongly suggests a global mechanism such as eustatic change in their formation. A detailed accounting of the numbers, thickness, and character of the repetitive successions in the Kasimovian and the comparison to the Kansas carbonate-dominated succession would aid substantially in the interpretation of their origin.

Variation in the eccentricity, obliquity, and precessional pertubations of the earth's orbit could have produced the 400,000 year periods estimated to have been the duration of the Pennsylvanian cyclothems. Fisher (1982) contended that these orbital properties even controlled climate during nonglacial episodes and accordingly affected sedimentation, perhaps by providing a rhythm. Computer modelling of a simulated climatic system incorporating the variables of atmosphere, oceans, continents, and ice sheets indicates that there is a natural or preferred frequency of oscillation of the glacial event (Covey, 1984). For the Pleistocene the frequency obtained from the modelling is 100,000 years. Moreover, a model that invokes bedrock loading by ice and its subsequent depression followed by isostatic rebound of the bedrock when the ice melts shows damping of the frequency. This in turn provided a better fit of the model to the actual cross sectional area of restored volumes of ice and the periodicity documented in the depth oriented, stable oxygen isotope curves obtained from Quaternary deep-sea sediments (Covey, 1984). Bedrock volume, elevation, and composition may have been very important factors in determining the periodicity of the eustatic cyclothems indicated for the late Paleozoic. Variations in axial tilt and cycle of precision both have shorter periods, but provided only 2nd and 3rd order influence during the Pleistocene superimposed on the dominating eccentricity (Hays et al, 1976). Variations in the harmonics of these cycles could have produced irregularities such as minor cycles and changes of maximum level of inundation of the shelf. The dominant period for these cycles of 100,000 years is evident from the vertical variations in the abundance of oxygen-18 in foraminifera in deep sea cores (Fig. 7.2). The curve is interpreted to imply a change in sea level. It closely resembles the signature of the gamma ray log of the Missourian cyclothems (see Figure 1.4). The variation in levels of inundation of the craton by the sea may have been caused by the combination of minor causative cycles.

Crowell (1978) provided additional data to support Late Paleo-

Figure 7.2. Oxygen isotope analyses of foraminifera _Globigerinoides Rubra_ plotted versus depth in a deep sea core from the Caribbean (after Broecker and Van Donk, 1970).



⟷ Standard error in δO^{18}
sedimentation rate 2.35 cm/1000 years

zoic continental glaciation and submitted that it was the cause of cyclothems, doing so with as much vigor as Wanless and Shepard (1936) did previously. The late Paleozoic ice age apparently lasted 90 million years from Early Carboniferous to the mid-Permian. The ice centers built out and retreated over the supercontinent Gondwana as it drifted near and across the south pole. Sea level was lowered no more than a few hundred meters each time a major glacial stage ensued in this area (Crowell, 1978). Over 100 repetitions in sediments ranging in age from Visean to Kazanian in North America, Europe, and Africa were cited by Crowell. Plate 6 describes the probable series of general shelf conditions that evolved during one Late Pennsylvanian cyclothem on the Midcontinent.

CHAPTER EIGHT

SUMMARY AND CONCLUSIONS

The Missourian Lansing and Kansas City groups consist of a dozen cyclothems of carbonates and shale that were deposited across a wide continental platform in the western Midcontinent. This shelf was bounded on the south in northern Oklahoma and the Texas panhandle by an east to northeast-trending shelf margin bordering deep water in the Anadarko basin. The rates of subsidence in the Anadarko basin were high during the Late Pennsylvanian, caused in part by overthrusting from the south. This subsidence caused the downwarp of adjacent shelves including western Kansas but at a much lower rate. The northern Kansas shelf tilted slowly southward, allowing accumulation of thin wedges of carbonate-dominated cyclothems of sediment that gradually thickened southward. Accentuated thickening occurred in several cyclothems along the southern margins of this shelf platform near zones of flexure. In contrast, sediments accumulating in the Anadarko basin were predominantly terrigenous clastics, much of which had been derived from the eastern and southern edges of the Anadarko basin during low stands of sea level.

Western Kansas was the site of limited thicknesses of terrigenous clastic sediment because the region was of low relief and separated by considerable distance from any major uplifts such as the Ancestral Rockies. The Ouachitas were not an important source of terrigenous clastics for western Kansas because of the separation by deep water in the Anadarko basin as well as by distance. Rates of sedimentation eventually exceeded those of subsidence in the eastern Anadarko basin during the Virgilian allowing thick terrigenous clastics to prograde into the southeastern portion of the study area.

The four zones examined in this study are representative of the Pennsylvanian carbonate-dominated cyclothems. The integrated study of cores and wireline logs provides new understanding of these cyclothems and is crucial to defining trends of prospective carbonate reservoir rock. These cyclothems resulted from sedimentation controlled by changing sea level and epeirogenic movement on a broad shelf. Differential movement and tilting of the shelf varied appreciably during the accumulation of each cyclothem, but closely adhered to basement structure. Local topographic relief on the underlying cyclothem also modified sedimentation of the suceeding unit. Individual cyclothems must be examined separately to identify details of depositional and diagenetic facies and to ascertain the critical developments in structure on the shelf that affected that particular cyclothem.

Marine lithofacies dominate each sequence except in the northern shelf where nonmarine terrigenous-clastic sedimentation was significant. Evidence of transgression at the base of the cyclothem is limited to a veneer of reworked material overlying a recognizably eroded surface that is sometimes veneered by conglomerate. Scattered organic matter in the subtidal portion suggests lower oxygen conditions were developing late in this transgressive deposit. While only a few feet (1 m) thick, in general, its distribution can be widespread (thickness: width ratio greater than 5 X 10^5). This carbonate is an excellent marker as it is thin, continuous, and easily recognized on geophysical logs.

A marine shale overlies the transgressive unit; and, although normally thin over much of the mapped area, all examples studied thicken appreciably in the northwestern part of the study area. Intensity of the maximum natural gamma radiation associated with this shale varies significantly across the shelf. The radiation recorded by wireline logs is related to the content of organic matter and the abundance of the organic matter is thought to correlate to the degree of anoxia developed over much of this shelf during and approaching maximum transgression. If levels of thermal maturation of the organic matter are sufficiently high in this shale, it is probable that this dark-colored, marine shale is a source rock for some of the oil in reservoirs of the Lansing and Kansas City groups (Demaison and Moore, 1980).

As sea level fell, the stagnation on the sea floor ended and circulation was re-established. Accumulation of regressive carbonate began with subtidal, open-marine wackestones. The southern shelf during this early stage of regressive carbonate deposition remained a site of moderate, intermittent reducing conditions on the seafloor and, consequently, dark mudstones are common. On the northern two-thirds of the shelf this facies was replaced by lighter-colored, shallower-water, subtidal wackestones.

As regression continued shallower-water carbonates--including restricted-marine, low-energy micrites, wackestones, high-energy oolites, and skeletal grainstones--were deposited on the shelf. Restricted-marine sediments are generally thin across the shelf. The vertical succession from subtidal, open-marine to restricted-marine facies is also abrupt. This rapid change in facies and the generally thin, shallow-water interval together suggest that progradation and aggradation of sediment alone cannot explain the succession across the entire shelf, particularly given any inclination to the depositional surface. Wave base first reached the seafloor along the upper portion of the shelf and certain prominent paleotopographic highs. As sea level continued to fall, more southern localities became sites of shallow-water deposits. The I-Zone apparently represents only an intermediate level of inundation of the shelf by the sea. Consequently, the marine shale typifying deeper water was only poorly developed in the I-Zone. The marine portions of this cyclothem pinch out before reaching the northern border of the study.

During the latest stages of regression, the regressive shale was deposited. Subaerial exposure preceded or was contemporaneous with the deposition of this shale over most of the study area. Diagnostic evidence of subaerial exposure of the regressive carbonate are abundant across the entire shelf including subaerial crusts, microcrystalline pendant cements, root casts, in situ breccia, and solution vugs filled with internal sediment.

Sharp vertical changes in lithofacies; broad facies patterns embodied in thin carbonates and shales; and widespread, extensive, and prolonged periods of subaerial weathering preclude simple tectonic movement of the shelf as the sole cause of this cyclic sedimentation. Tectonic movement did vary between cyclothems, however, affecting local uplifts and tilt of the shelf.

Furthermore, these cyclically recurring facies cannot be easily explained by invoking a model using only facies progradation and aggradation on a periodically subsiding shelf. Rather, glacial-eustatic changes in sea level have a periodicity and magnitude that are compatible with Pennsylvanian cyclothems and are concluded to have been the cause. Tectonics and aggradation of sediment affected sedimentation, but only at a level that is secondary to the eustatic changes in sea level.

During the Early Pennsylvanian two major related uplifts were formed, the Cambridge arch and Central Kansas uplift. These uplifts were activated concurrently with others in the western Midcontinent. They were also sites of previous uplifts. Second-order deformation along these uplifts is, in part, related to discontinuities such as fracture systems in the basement, faults, and simply changes of rock type. Recent hypotheses suggest that these structures were reactivated in response to processes related to the collision of Laurasia and Gondwana along the Appalachian-Ouachita-Maraton orogenic belt. The driving force for the subsidence of the Anadarko basin is also thought to have resulted from this plate collision.

Differential movement of the CA and CKU with respect to the adjacent shelves produced marked lateral changes during the deposition of each cyclothem. The actual outline of these positive areas, as recognized in each cyclothem did not exactly coincide with the initial, major Early Pennsylvanian uplift, but neither did the ancestral uplifts of these same structures. Regressive carbonates not only demonstrate considerable thinning over these uplifts, they also are composed entirely of restricted-marine, shallow-water carbonates in some cyclothems. Regressive and marine shales also change in character over these structures.

The apparent movement of the positive areas during Missourian sedimentation was probably a case of subsiding at slower rates than the surrounding areas. Subsidence along the southern margin was greater than in the northern region of the study area. Moreover, a line of flexure is defined for several cyclothems from the increased rate of thickening of the marine interval to the south toward the shelf margin. As sea level fell, tide- and wind-generated currents interacted with this break in bottom slope for an extended time and oolitic shoals resulted. Lobed-shaped bodies of oolitic grainstone prograded off bathymetric highs and filled surrounding low areas. Ooids were also swept northward by storm currents onto the slightly restricted, lower energy shelf and formed large bar fingers tens of miles long.

As sea level fell across the northern reaches of the broad shelf, shoals developed on local topographic highs and breaks in slope. Tidal currents, however, were quickly dissipated on this wide shallow shelf setting leaving only wind-generated currents. The grainstone accumulations on this area are typically represented by thin-coated or micritized skeletal grains that accumulated as lag deposits as a result of intermittent currents that removed only the fines or provided only limited transportation, perhaps during storms. Restricted-marine carbonate deposits are generally more abundant over the uplifts and toward the northern, landward portion of the shelf. These deposits, however, are much thinner than expected if sediment aggradation were the only cause of regression.

The processes that have affected carbonate rocks now serving as petroleum reservoirs in the Lansing and Kansas City groups are complex. These carbonate rocks vary considerably in pore geometry because of diagenetic overprinting with development of secondary porosity and precipitation of cement. However, the carbonate units generally vary in thickness and areal extent according to the occurrence of favorable depositional facies. On the northern shelf the thin scattered grainstones of the upper regressive carbonate serve as important reservoir rock. The southern deposits of thick oolitic grainstone in the K- and J-Zones appear to offer much potential as reservoir rock, but are commonly limited in effective porosity due to cementation. They have predominantly oomoldic porosity, commonly associated with low permeability. Regional, mappable trends of buildups, however, are most apparent in these oolitic grainstones. Opportunities for thick sections of porous and permeable rock make them most lucrative intervals for larger accumulations of petroleum.

A potential site for continued exploration in the oolite belt is on the edges of paleohighs, sites that were not as heavily affected by freshwater percolation. Possibly fewer oomolds would have been formed and primary porosity may have been better preserved. Also, sites down the flank of the ooid lobes may have been part of a more open hydraulic system where there was slow percolation and lateral movement of groundwater over longer distances. In that case, if ooid-molds were formed, the primary porosity could be preserved if the carbonate dissolved during the formation of oomolds was dispersed to distant parts of the aquifer system. A trap for the petroleum could be developed along an updip pinchout or where the location of buildup of oolite combines with a reversal in structural dip. This kind of occurrence would be more likely to be found on the northwestern fringes of the thick oolite buildups across the southwestern study area between the southwest positive area and the CKU. Regional dip there is generally southeastward.

The development of porosity on the western shelf north of the oolite trend is not as laterally extensive. Porosity is still associated with grain-supported carbonates commonly associated with paleohighs, which are more commonly overprinted by more extensive freshwater diagenesis. On the northern shelf and locally over the CA and CKU intense freshwater diagenesis also created reservoir rock from previously tight carbonate rich in lime mud. The reservoir properties of the carbonate rocks on the CKU are generally good. Influx of terrigenous clastics was also limited, resulting in clean carbonates that were commonly heavily leached by intense freshwater diagenesis and consequently fractured. There are excellent opportunities for future exploration in the Lansing-Kansas City in western Kansas and southern Nebraska. The success in finding reservoirs will vary according to the degree that exploration strategies integrate more sedimentological information from cores and wireline logs. Notably, the distribution of favorable reservoir facies varies in each cyclothem. This requires attention to the nature of individual cyclothems in order to decipher the locations of favorable trends for drilling. As the explorationist searches for more subtle traps, incorporation of stratigraphic and sedimentologic data will become a necessity in order to develop a successful exploration strategy.

CHAPTER NINE

RECOMMENDATIONS FOR FURTHER STUDY

Recommendations for further study are to: 1) examine more closely the details of development of cyclothems in local areas that can demonstrate more fully the nature of oolite-shoal development over the shelf flexure; 2) characterize the sedimentation in the vicinity of the local positive areas in order to detail the transition of the black marine shale to the nonblack or its pinchout; and 3) document the erosional geomorphological elements on the northern shelf.

Another very important topic of research would be to examine in more detail, for a specific cyclothem or set of cyclothems, the nature of the shelf margin south of this area of study and also the rapid transition with terrigenous, possibly deltaic clastics to the southeast. Seismic stratigraphy would be of distinct benefit to a study such as this, providing a continuous profile of major and hopefully correlative markers that could be tied to wireline logs and cores much the same as was done by Galloway et al. (1977) and Kumar and Slatt (1984).

The prospects for the discovery of petroleum reservoirs through studies such as this are great. The configuration of the carbonate shelf margin to the south and its relationship to terrigenous clastic influx to the east could hold considerable promise for finding quartzose sandstone trapped in front of the carbonate shelf margin, sandstone that prograded into the area after the margin had formed, a setting similar to the Upper Cretaceous Tuscaloosa Sandstone in

Louisiana.

In fact, the fall in sea level and the positioning of the strandline near the bathymetric break along the shelf margin would seemingly be conducive to deposition of additional high-energy carbonate facies. The predominant of shallow-water, oolitic grainstone recognized by Lane (1978) in the fan deposits is one facies whose would help to identify the shelf margin and its expression around the edge of the Anadarko basin. The petroleum potential of this margin in any case should not be overlooked. Thicker, multiple-pay sections could be present.

Western Kansas should be an ideal setting to continue subsurface investigations as described in this report for many similar Pennsylvanian stratigraphic intervals. Additional core and more sophisticated logs from many more wells in this area will provide an ideal data base for regional assessment of stratigraphical and sedimentological problems.

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APPENDIX A.

PROCEDURES USED IN COMPUTER MAPPING OF WIRELINE LOGS AND LISTING OF DATA.

Wells were selected for mapping which met several criteria: 1) that they penetrated the Kansas City Group and preferably the base of the Pennsylvanian; 2) optimally a gamma ray log was run through the interval of interest or at least a higher resolution resistivity or porosity log run in the borehole; and 3) up to three widely-spaced wells in a township area.

The wireline logs were correlated and information recorded unto coding sheets. These data were key punched unto cards and later transferred to magnetic tape. Data recorded for each of the wells are listed in a compressed format in table 2. Table 1 lists those fields of information included in this list and the width of each field.

Table 1. Data Fields Listed In Table 2.

Field Number	Size (Characters)	Description
1.	4	Sequential identification number
2.	20	Well operator, number, lease name
3.	6	Spot location, quarter-quarter-quarter
4.	6	Section, township, range
5.	1	Range direction from meridian (W-west)
6.	6	Wireline logs available for examination
7.	3	Scale of wireline log in inches per one hundred feet
8.	5	Kelly Bushing (surface elevation-log zero)
9.	5	Top Stone Corral Formation
10.	5	Base of Heebner Shale member
11.	5	Top Lansing Formation

12.	5	Top H-Zone regressive shale
13.	5	Top H-Zone regressive carbonate
14.	5	Base H-Zone regressive carbonate
15.	2	Thickness of porous carbonate rock, upper H-Zone
16.	2	Thickness of porous carbonate rock, lower H-Zone
17.	5	Top I-Zone regressive carbonate
18.	5	Base I-Zone regressive carbonate
19.	2	Thickness of porous carbonate rock, upper I-Zone
20.	2	Thickness of porous carbonate rock, lower I-Zone
21.	5	Top J-Zone regressive carbonate
22.	5	Base J-Zone regressive carbonate
23.	2	Thickness of porous carbonate rock, upper J-Zone
24.	2	Thickness of porous carbonate rock, lower J-Zone
25.	5	Top K-Zone regressive carbonate
26.	5	Base K-Zone regressive carbonate
27.	2	Thickness of porous carbonate rock, upper K-Zone
28.	2	Thickness of porous carbonate rock, lower K-Zone
29.	4	Maximum gamma radiation, H-Zone marine shale
30.	4	Maximum gamma radiation, J-Zone marine shale
31.	4	Maximum gamma radiation, K-Zone marine shale
32.	5	Base Pennsylvanian
33.	5	Top Mississippian

The data file, herein called the input file, was transformed to a set of plot files corresponding to specific isopachs of individual zones, larger interval isopachs, e.g., top Stone Corral to base Heebner, structural contour maps, ratio maps of thicknesses, and porosity thickness and gamma radiation maps. The maps chosen have been illustrated throughout the Figures and Plates 3, 4, and 5. The calculations are trivial but numerous and computer processing and display are most advantageous for analysis.

Initially, a short FORTRAN program was written as a batch job to create the plot files. Modifications to the file required loading the tape to disk and editing cryptic lines with a text editor. Later as a model for managing large files of subsurface data the rudimentary FORTRAN program was expanded to utilize the interactive CRT editing system on Data General MV/8000 minicomputer. Now both generation of plot files (stratplot) and update of the master input file (stratupdt) are possible in a much shorter time. The listings of stratplot and stratupdt are found in Table 3 and Table 4.

I am indebted to the programmers who assisted in the design and implementing those rather complex programs. Richard Brownrigg provided the first level of sophistication to the programming, Owen Spitz developed the subroutine to transform the spot and section-township-range location to latitude-longitude coordinates. Charles Ross and Joseph Brentano wrote subroutines to transform the latitude-longitude to an X,Y coordinate system that represents inches on a Lambert conformal conic projection of Kansas. Young Chang and Stephen Cheng updated the programs to accomodate changes in the computer operating system.

After the plot files were created an error checking was done both visually and using the error analysis option of SURFACE II. Contour maps were originally prepared, but later it was realized that the patterns were more readily interpreted when examining the maps on a regional scale. SURFACE II again provides an option that creates maps using bands of characters on a dot matrix printer. Contour level, size or scale of map, and type of printing are given as options in the program. Color graphics generated from the grid have been particularly effective assisting in visualizing variation between the maps.

Table 2. Well Data

1T.L. FERRIER 1 FISCHNENENE352424WGRNG	2.52472.1598.4028.4097.4306.4820.4820.4310.4334. 0 0166.4336.4358. 0 04359.4434.52 0284.4
2LANDES EXPL. 1KELLY NESWSW 72313WGRNGC	2.51912. -1.3340.3497.3611.3842.3842.3614.3629. 3 0 62.3631.3646. 0 03648.3676. 5 4106.3
3PET. MAN 1 LANMAN NESWSW050117WGRNG	2.52104. -1.3336.3384.3509. -1. -1.3520.3541. 0 0170.3542.3554. 0 03562.3554. 0 2266.3
4L.BAIRD 4 WALKER SENWSW030118WGRNG	5.2029. -1.3202.3247.3364. -1. -1.3372.3391. 0 0125.3394.3404. 0 03414.3430. 0 0215.3
5ARGONAUT 1 GORACKE NWNW130118WGRGS	5.2162. -1.3379.3417.3537. -1. -1.3547.3568. 0 0135.3572.3582. 0 03590.3610. 0 0225.3
6PET. MAN. 2 RAKESTRAW2NENE310118WGRNG	5.2250.1829.3394.3441.3553. -1. -1.3563.3582. 2 0 95.3588.3599. 3 03604.3620. 0 0170.3
7FELDT-MAYTAG 1 MEKEN CSESE250119WGRNG	2.52209.1792.3363.3407.3522. -1. -1.3523.3532. 2 4120.3555.3567. 0 03574.3596. 0 1190.3
8FITZGERALD 1 NELSON CNESW330120WSPRS	2.52104.1815.3369.3411.3529.3750. -1.3539.3554. 0 2 -1.3562.3568. 0 03574.3590. 2 0 -1.3
9NAT. ASSOC A-1 BECK CNWSW350120WGRN	2.52142.1815.3372.3417.3532.3786. -1 3545.3563. 4 2235.3568.3575. 2 03584.3595. 0 0140.3
10EMPIRE 1 ATENS EST. SESESW060122WSPR	2.52287.1927.3354.3397.3502.3648. -1.3506.3527. 0 0 -1.3544.3550. 0 03560.3574. 0 0 -1.3
11SINCLAIR 1 RORABALCH CSENE200122WGRRS	2.52414.1982.3440.3482.3584.3745. -1.3594.3610. 2 0 -1.3620.3621. 0 03631.3640. 0 0 -1.3
12C-G DRLG 1 KINDALL NENENE310122WSPRM	2.52433.2001.3455.3500.3600.3755. -1.3609.3626. 2 0 -1. -1. -1. 0 03644.3651. 0 0 -1.3
13FREDRICK 1 BALLINGE CNESW140123WGRRS	2.52260.1895.3320.3362.3465.3602. -1.3472.3491. 0 0 -1. -1. -1. 0 03506.3514. 0 0 -1.3
14SAUVAGE 1 MELROY NWNWSW220123WSPRS	2.52443. -1.3393.3435.3536.3687. -1.3541.3562. 0 0 -1.3572.3574. 0 03576.3582. 0 0 -1.3
15RAYMOND 1 SAVER CSWNW310123WGRRS	2.52472.2008.3414.3458. -1.3708. -1.3564.3582. 0 0 85.3592.3594. 0 03599.3606. 0 0 -1.3
16RAYMOND 1 MCKINNEY CNWNW150124WGRRS	2.52273.1895.3259.3298.3392.3546. -1.3401.3421. 3 0110.3436.3437. 0 03442.3450. 4 0 89.3
17TILCO 1 GUENZER CSENW270124WGRN	2.52420.1943.3330.3362.3468.3643. -1.3477.3489. 0 0 -1. -1. -1. 0 03513.3520. 0 0 -1.3
18GEOCHEM 1 JENKINS CNESW090125WGRRS	2.52341.1857.3183.3220.3320.3516. -1.3328.3350. 0 0 87. -1. -1. 0 03370.3378. 0 0 -1.3
19SMITH 1 ANKENMAN CSWSW230125WGRN	2.52509.2020.3362.3404.3502.3680. -1.3511.3530. 0 0 -1. -1. -1. 0 03552.3562. 0 0 -1.3
20ABERCROMBIE 1 SUMMER CNENW040126WGRNG	2.52547.2011.3282.3324.3425.3613. -1.3434.3451. 0 0 80. -1. -1. 0 03476.3488. 3 0 85.3
21ABERCROMBIE B-1 CHAMSWSWNW130126WGRNGC	2.52372.1853.3154.3192.3299.3514. -1.3309.3326. 0 3 85. -1. -1. 0 03349.3358. 0 0 85.3
22ABERCROMBIE 1 MAPES SESEN.220126WGRNGC	2.52468.1928.3221.3263.3358.3552. -1.3368.3385. 2 0 73. -1. -1. 0 03407.3418. 0 0 93.3
23TILCO 1 CARTER CSWSE330126WGRNGC	2.52488.1950.3264.3308.3403.3623. -1.3412.3429. 0 0 83. -1. -1. 0 03452.3461. 2 0125.3
24SAUVAGE&CUNN 1 KILZESESENE020127WGRN	5.2592.1969.3238.3275.3385. -1. -1.3393.3415. 0 0 -1. -1. -1. 0 03437.3451. -1.3
25CITIES SER 402 WARKENENWSE110127WGRN	2.52537. -1.3158.3197.3302. -1. -1.3310.3331. 0 0 56. -1. -1. 0 03350.3364. 3 0 85.3
26HEWIT 1 A WELSH CNESW170127WGRRCC	2.52571.1992.3246.3286.3394.3650. -1.3402.3420. 0 0120. -1. -1. 0 03440.3457. 3 0170.3
27BURCH 1 CORCORAN CSENE280127WGRRS	2.52452.1868.3148.3178.3280.3526. -1.3288.3307. 0 0110. -1. -1. 0 03329.3345. 0 4192.3
28S&W DRLG. 1 SAUVAGE CNENE060128WGRNRC	5.2649.2262.3466.3452.3616.3972. -1.3628.3645. 0 0130. -1. -1. 0 03674.3689. 3 0105.3
29PET. MAN. 1 MCCARTA SESENW190129WGRNR	5.2587.2303.3512.3545.3674.4048. -1.3676.3692. 0 0120. -1. -1. 0 03714.3731. 0 0120.3
30JONES ETAL 1 CAMPBELLSWSESE290129WGRNR	5.2693.2358.3610.3658.3772.4155. -1.3779.3795. 0 0 90. -1. -1. 0 03814.3833. 6 0125.3
31RAINS-W. 1 WALDS CSWSW230130WGRRS	2.52672.2422.3615.3653.3770.4177. -1.3780.3795. 0 0 95. -1. -1. 0 03814.3836. 6 0115.3
32EMPIRE 1 GRILL CNWSW330130WSPRSC	2.52651.2420.3615.3645.3765.4168. -1.3774.3792. 0 0 -1. -1. -1. 0 03812.3835. 0 4 -1.3
33OXFORD 3-8 PETTERA CSENE 30131WGRN	5.02856.2705.3854.3888.4017. -1. -1.4031.4051. 0 0110. -1. -1. 0 04075.4090. 0 2 80.4
34E FOSTER B1 NEIMEIH CSENW200131WGRRS	2.52856. -1.3843.3869. -1.4408. -1.4016.4030. 0 2 -1. -1. -1. 0 04057.4077. 0 0 -1.4
35BASS ENTER 1 GRAFEL CSWSE270131WGRNG	5.02775.2572. -1. -1.3896.4335. -1.3906.3924. 2 0125. -1. -1. 0 03942.3964. 0 6 92.3
36LADNER-MURF 1 STOLTE CNWNW 60132WGRRS	2.52847.2662.3691.3757.3896.4390. -1.3910.3934. 2 0110. -1. -1. 0 03958.3978. 3 0160.3
37SKELLY 1 KCMFUS SWSWSW330132WGRLLN	2.52571.2723.3830.3891.4010.4481. -1.4022.4041. 3 0 -1. -1. -1. 0 04068.4092. 4 4 -1.4
38PETROL.MAN. 1 PALMERSWSWSW 50133WGRNG	2.53017.2847.3860.3914.4034.4526. -1. -1.4074. 0 0 95. -1. -1. 0 04108.4128. 4 0 97.4
39THUNDERBIRD 1 VAP CNWNE150133WGRNGC	5.02544.2782.3848.3893.4017. -1. -1.4040.4062. 3 0100. -1. -1. 0 04085.4108. 0 0158.4
40MACK 1 BOLTE CNWNW340133WGRNLL	2.53048.2871.3951.4006.4123.4636.4636.4149.4168. 2 0170. -1. -1. 0 04192.4216. 0 0168.4
41PICKRELL 494 FIKAN CNWS 10134WGRNG	5.03020.2861.3854.3911.4051. -1. -1.4064.4087. 0 0 90. -1. -1. 0 04107.4124. 3 2118.4
42IMPERIAL 1 FIKAN SENWNW140134WGRNG	2.53144.2986.4000.4056.4194.4705.4705.4203.4224. 4 0120. -1. -1. 0 04244.4270. 2 0140.4
43PLAIR ASSOC 1B VAF CSWSE330134WGRRS	2.53091.2953.4001.4046.4184.4668.4668.4201.4219. 0 0110. -1. -1. 0 04242.4261. 4 0120.4
44ABERCROMBIE 1 SIS CNWNE120135WGRNE	2.53080.2954.3947.3997.4139. -1. -1.4153.4175. 0 0135. -1. -1. 0 04199.4221. 0 0183.4
45PURCO 27-1E CAHOJ CSESE270135WGRRSC	2.53120.2981.4000.4053.4184.4704.4704.4203.4216. 2 0110. -1. -1. 0 04242.4266. 2 0130.4
46HUSKY 3-31 REEH CNENW310135WGRRS	2.53273.3147.4174.4226.4370. -1. -1.4383.4403. 0 0135. -1. -1. 0 04428.4446. 0 4210.4
47TWIN CRLG. 1 VACHUTASWSWSW130136WCML	2.53268.3185.4178.4217.4345.4924.4924.4375.4394. 2 3 -1. -1. -1. 0 04416.4436. 3 0 -1.4
48SMITH-TAYLOR 1 FRISB CSESE250136WGRRSC	2.53203.3195.4112.4162.4310.4843.4843.4322.4342. 3 0 98. -1. -1. 0 04366.4384. 0 5140.4
49ABERCROMBIE 1 WILKIN CNENW340136WGRSR	5.03237.3146.4133.4183.4326.4859.4859.4341.4361. 4 0105. -1. -1. 0 04384.4403. 0 0145.4
50NELSON ETAL 1 DAVID CNESW210137WSPCR	2.53288. -1.4216.4261.4406.4966.4566.4419.4436. 0 2 -1. -1. -1. 0 04466.4485. 0 0 -1.4
51SHAKESPHERE 1 PURKPA CNESW320137WGRRO	2.53181.3114.4091.4122.4268.4833.4833.4287.4303. 0 0120. -1. -1. 0 04333.4354. 0 4225.4
52WESTH-NEUST 1 GLASCO CSESE100138WSPCRML	2.53090.3056.4018.4051.4190.4768.4766.4206.4223. 0 0 -1. -1. -1. 0 04256.4277. 0 0 -1.
53SHAKESPHERE 1 E HAN CSWNE130138WGRRSP	5.03182.3163.4124.4170.4313. -1. -1.4333.4349. 0 0128. -1. -1. 0 04382.4402. 4 0165.4
54WAGGONER 1 HARRISCN CNESW220139WGRRS	2.53206.3195.4145.4186.4323. -1. -1.4338.4354. 4 0 85. -1. -1. 0 04384.4407. 0 3118.4
55KERN 1 GALVIN CSENE330139WSPCML	2.53212.3171.4141.4182.4330.4960.4960.4339.4367. 3 0 -1. -1. -1. 0 04383.4404. 0 0 -1.4
56J.O. FARMER 1 CRABIR CSESE140140WGRRS	2.53363.3368.4298.4336.4474.5084.5084.4489.4506. 3 0 68. -1. -1. 0 04523.4556. 4 0111.4
57SHAKESPHERE 1 WHITE CNENE200140WGRRO	5.03485.3505.4414.4462.4607. -1. -1.4622.4644. 0 0190. -1. -1. 0 04669.4692. 0 0120.4
58CABOT 1 PALMER CNESW300141WGRRS	2.53598.3608.4502.4548.4702.5429.5429.4719.4747. 3 0216. -1. -1. 0 04765.4795. 4 2172.4
59DEEP ROCK 1 CLARK SWSWSW230142WGRR	2.53456.3500.4393.4440.4593.5246.5246.4604.4640. 6 0 -1. -1. -1. 0 04676.4692. 010 -1.4
60TIGER 1 E. HILT CNESE360142WSPR	2.53549.3532.4443.4487.4636.5293.5293.4652.4672. 0 6 -1. -1. -1. 0 04707.4729. 0 0 -1.4
61LASKY 1 HABIGER SESESW340211WSPR	2.51907.1002.2906.2955.3054.3701.3701.3074.3102. 0 5 -1.3116.3140. 4 03146.3158. 2 0 -1.3
62NAT ASSOC F 1 MORGANNWNWNW050217WSPRML	2.52093.1703.3344.3394.3507. -1. -1.3521.3536. 0 3 -1.3547.3556. 0 0 -1. -1. 0 0 -1.
63ANSCHUTZ 1 CANNON SWSWSE170217WSPR	2.52028.1638.3270.3315.3432.3776. -1.3444.3460. 4 0 -1.3449.3476. 0 03487.3498. 0 3 -1.3

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64PETROL MAN C3 KANZEL CNENW 7021BWGRNGC 2.52233.  -1.3334.3382.3494.  -1.  -1.3504.3522. 0 0103.3530.3541. 0 03544.3558. 0 2140.
65SIERRA 1 IPM         N2NWNW19021BWGRN   2.52165.  -1.3250.3295.3416.  -1.  -1.3420.3434. 0 0 -1.3442.3454. 2 03459.3476. 0 0 -1.
66JONES ETAL 1 DOPAN   SESENW28021BWSPR   2.52068.1706.3309.3350.3464.3759.  -1.3475.3492. 6 0 -1.3500.3510. 0 03517.3529. 0 0 -1.3
67TEXAS CO 1 BAYNES    SWSWNW 80219WSPR   2.52249.1868.3446.3491.3604.3884.  -1.3620.3638. 8 0 -1.3643.3651. 0 03660.3679. 0 0 -1.3
68PEAKER 1 VAN DYKE    CNESW010219WGRNG   2.52256.1819.  -1.3425.3541.  -1.  -1.3550.3566. 0 4100.3573.3584. 0 03590.3608. 0 0153.3
69DEEP ROCK 1 VANFOOTENWNWSE150219WSPR    2.52209.  -1.3338.3390.3501.3725.  -1.3513.3530. 4 0 -1.3534.3544. 0 03551.3566. 4 0 -1.3
70CARTER 1 GAREEN      CNWSW360219WGRN    2.52061.1528.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 5 0  -1.  -1. 6 0 -1.
71NAT ASSOC 1 VANCIEST CNWNE280220WSPR    2.52231.1928.3476.3525.3634.3870.  -1.3648.3664. 6 0 -1.3670.3676. 0 03684.3696. 0 0 -1.3
72JONES ETAL 1 COX     NWNWSE310221WSPR   5. 2322.2028.3550.3594.3698.2855.  -1.3707.3723. 4 0 -1.3732.3734. 0 03747.3752. 0 0 -1.3
73HELL BRO 1 SEVERNS   NWSENE 90222WGRNG  5. 2338.1917.3400.3445.3546.3732.  -1.3555.3573. 3 0103.  -1.  -1. 0 03594.3599. 0 0 80.3
74PURCO  16-13 DROPPER CSWS.160222WSPRS   2.52474.1903.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 2110.  -1.  -1. 0 0  -1.  -1. 0 0 96.
75EMPIRE 1 BROOKS      SESEN.190222WSPR   2.52218.1896.3362.3407.3508.3641.  -1.3517.3532. 3 0 -1.  -1.  -1. 0 03550.3555. 0 0 -1.3
76D&D 1 BROWN          SWSWSW 50223WGRN   5.2442.1971.3403.3445.3545.2701.  -1.3552.3569. 0 0 73.  -1.  -1. 0 03582.3586. 0 0 73.3
77SINCLAIR 1 MCLROY    NWSE 030223WSPRCML 2.52391.1954.3391.3428.3525.3693.  -1.3532.3550. 0 0 -1.  -1.  -1. 0 03568.3573. 0 0 -1.3
78TILCO 1 BRIGHT       CNWNE180223WCRNG   2.52418.1967.3381.3429.3527.3670.  -1.3535.3552. 0 0100.  -1.  -1. 0 03568.3574. 0 0100.3
79GEAR PET 1 FISHER    CSENE230223WGRNG   5.02340.1912.3354.3402.3495.  -1.  -1.3509.3525. 4 0 80.  -1.  -1. 0 03536.3545. 0 0 80.3
80SNYDER 1-35 GREEN    NENWSW250223WSPGRR 2.52236.1911.3370.3412.3513.3630.  -1.3521.3537. 0 0112.  -1.  -1. 0 03556.3562. 0 0 96.3
81SHIELDS 1 PETER      SESESE010224WGRNRSP5.02467.2003.3414.3458.3556.3698.  -1.3562.3578. 0 0100.  -1.  -1. 0 03594.3600. 0 0 82.3
82SINCLAIR 1 THIELE    NENWNE200224WGRRS  5.02471.2002.3391.3437.3534.3705.  -1.3541.3559. 0 0 -1.  -1.  -1. 0 03576.3582. 0 0 -1.3
83R.G. SMITH 1 FOLEY   CSWSW360224WGRNG   2.52289.1945.3367.3410.3504.3650.  -1.3512.3528. 5 0152.  -1.  -1. 0 03543.3550. 0 0147.3
84READINGBEATES 1 LECO CSENW 10225WCARS   5.02477.1990.3351.3392.3489.3587.  -1.3501.3532. 0 0 -1.  -1.  -1. 0 03534.3551. 2 0 -1.3
85R.G. SMITH 1 MILLER  CSESE250225WGRNCC  2.52488.2026.3419.3464.3556.3770.  -1.3566.3585. 4 0128.  -1.  -1. 0 03602.3608. 0 0144.3
86C-G SHIELDS 1 RUEEACKENENW350225WGRNR   5.2500.2038.3429.3473.3567.3792.  -1.3576.3594. 3 0 62.  -1.  -1. 0 03616.3626. 0 0 73.3
87ABERCROMBIE 1 SCHWAB CSWSW 50226WGRNG   5.2602.2050.3360.3397.3494.  -1.  -1.3501.3523. 3 0 83.  -1.  -1. 0 03542.3550. 0 0115.3
88MURFIN 1 CARTER      CSWSW210226WSPR    2.52614.2122.3452.3495.3585.2880.  -1.3602.3621. 5 0 -1.  -1.  -1. 0 03639.3645. 0 0 -1.3
89JONES ETAL 1 HOLDEN  NWNWNW300226WSPRPL 2.52669.2210.3527.3565.3662.2552.  -1.3672.3692. 0 0 -1.  -1.  -1. 0 03712.3724. 0 2 -1.3
90MURFIN 1-5 MCFEE     SWNENW 50227WGRNG  5.2475.1928.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 3 0 87.  -1.  -1. 0 0  -1.  -1. 5 0130.
91GEORGE STOEF -1 SIPP CSWSE100227WSPRGRS2.52639.2190.3496.3530.3627.2504.  -1.3639.3656. 4 0 60.  -1.  -1. 0 03672.3688. 0 0132.3
92STOEFFELBERTH 1 SIPP CSWSE100227WSPGRRS2.52639.2189.3489.3530.3630.2504.  -1.3638.3656. 4 0 42.  -1.  -1. 0 03672.3688. 0 0132.3
93CITIES SER 2-1 MILLERSENE 310227WSPRGRD 5.2652.2314.3606.3646.3743.4072.  -1.3754.3774. 0 0 60.  -1.  -1. 0 03789.3802. 0 0 90.3
94WALT SAVAGE 1 SMICK  CNWNW 90228WSPRGRS2.52643.2300.3556.3590.3705.4041.  -1.3712.3732. 2 0 74.  -1.  -1. 0 03747.3770. 2 0132.3
95WALT   SAVW -1 SPICK CNWNW090228WSPRGRS2.52643.2302.3554.3596.3704.4041.  -1.3712.3732. 0 0 78.  -1.  -1. 0 03748.3764. 0 0136.3
96MURFIN 1 A.MILLER    CNESW120228WSPGRRS2.52450.2073.3345.3390.3494.3848.  -1.3501.3522. 0 0 96.  -1.  -1. 0 03536.3554. 0 0154.3
97WAGGONEEST -1 HELPKA CSWNE050229WSPRGRS2.52761.2480.3692.3734.3844.4204.  -1.3854.3869. 0 0 95.  -1.  -1. 0 03887.3906. 0 0225.3
98ABERCROMB -1 GREEN   CSESW150229WGRNC   2.52678.2420.3642.3687.3790.  -1.  -1.3795.3817. 0 0118.  -1.  -1. 0 03834.3852. 0 3 98.3
99JONES  SHEL -1 SCOTTSESENE200229WGRNG   2.52668.2410.3638.3684.3785.4146.  -1.3795.3816. 0 0 87.  -1.  -1. 0 03834.3850. 8 0146.3
100TILCO  ETAL -1 TOHLUN2SWNE350229WGRNG  2.52649.2412.3664.3706.3810.  -1.  -1.3814.3832. 0 0108.  -1.  -1. 0 03853.3872. 2 0100.3
101LERSACKM J -1 WEBER SESENW020230WSPRCRS2.52653.2418.3598.3642.3756.4184.  -1.3766.3786. 0 0 75.  -1.  -1. 0 03800.3820. 5 3147.3
102HALLIBURTON -2 MINESNWSWNE140230WGRN    2.52813.2544.3760.3796.2902.  -1.  -1.3911.3926. 0 0100.  -1.  -1. 0 03948.3966. 0 0140.3
103HALLIBURTON AT1 MINESESENE140230WGRN   2.52773.2503.3707.3754.3855.  -1.  -1.3870.3886. 0 0 97.  -1.  -1. 0 03905.3922. 3 0125.3
104ED ACKMASSG -1 HELPC CSWSW280230WGRNG   5.2895.2720.3896.3940.4045.  -1.  -1.4055.4073. 0 0110.  -1.  -1. 0 04092.4109.06 0160.4
105WAGGONEEST -1 HAFNER CSESW270231WSPRGRS2.52559.2728.3874.3936.4044.4478.  -1.4053.4072. 4 0 88.  -1.  -1. 0 04094.4112. 5 0120.4
106EDWIN FOST B-1 N IF CSWNW010232WSPRCRS2.52863.2630.3770.3808.3925.4416.  -1.3938.3960. 4 2 -1.  -1.  -1. 0 03780.4006. 0 0 -1.4
107MURFIN DRI -1 PITNER CNWSE140232WGRNG  2.52714.2460.3602.3636.3760.  -1.  -1.3772.3792. 8 0132.  -1.  -1. 0 03816.3836. 6 0148.3
108EDWIN  FOST -1 CAPSC CNWNE170232WSPRGRS2.52844.2640.3710.3818.3945.4373.4373.3958.3978. 0 0120.  -1.  -1. 0 04004.4027. 2 0147.4
109AMERADAHESS -1 HOLTER CSWN 310232WSPS  2.52526.2710.3871.3912.4026.4518.4518.4042.4062. 0 6 -1.  -1.  -1. 0 04084.4134. 4 0 -1.4
110THUNDERBIRD -1 WOLTERS N 100233WGRNGC 5.2857.2695.3813.3851.3993.4485.4485.3993.4013. 2 0 95.  -1.  -1. 0 04038.4060. 2 0135.4
111EDWIN  FOST B-1 SAMS CSWNW210233WSPRGRS2.53017.2805.3926.3969.4101.4500.4500.4112.4134. 0 0110.  -1.  -1. 0 04158.4178. 3 0180.4
112EDWIN  FOST -1 MORIN CNWSW290233WSPRGRS2.53134.2750.3871.3914.4042.4510.4510.4057.4076. 0 3 -1.  -1.  -1. 0 04096.4118. 0 0 -1.4
113MACK   OIL -1 HALLER CNWSW070234WGRNSPL2.53137.2978.4027.4077.4222.4723.4723.4234.4256. 0 3100.  -1.  -1. 0 04276.4295. 4 0186.4
114K&E    DRIL -1 FOCKENWNWSE160234WSPR   2.53136.2950.4010.4055.4196.4676.4676.4208.4228. 0 6 -1.  -1.  -1. 0 04250.4269. 0 0 -1.4
115SKELLY OIL -1 ANKLE SENWNE320234WSPR   2.53039.2805.3916.3956.4098.4577.4577.4112.4130. 0 3 -1.  -1.  -1. 0 04153.4171. 0 3 -1.4
116ABERCROMB -1 HEADRIC CSWNW170235WGRNG   5.3265.3150.4165.4214.4363.4868.4868.4379.4390. 0 3107.  -1.  -1. 0 04419.4438. 0 0144.4
117EDWIN  FOST -1 PRENT CSENW290235WSPRGRS2.53255.3100.4132.4179.4328.4843.4843.4344.4362. 0 4 -1.  -1.  -1. 0 04388.4406. 0 0 -1.4
118WESTHEIMER -1 CAHOW NWNWNE130236WSPRMC 2.53307.3184.4284.4322.4446.4960.4960.4466.4484. 0 0 -1.  -1.  -1. 0 04500.4514. 0 0 -1.4
119MIAMI  PET A-1 DOEBSSWSENW190236WSPCRMC2.53382.3285.4368.4410.4528.5088.5088.4557.4572. 0 0 -1.  -1.  -1. 0 04588.4604. 0 0 -1.4
120MACK   OIL -1 WILKENS2SESE080237WSPRGRN2.53324.3238.4226.4274.4425.4997.4997.4437.4456. 0 0120.  -1.  -1. 0 04488.4512. 3 0260.4
121MIAMI  PET C-1 FRANKNWSENE130237WSPRGRS2.53391.3308.4373.4408.4529.5052.5052.4558.4579. 2 0 -1.  -1.  -1. 0 04593.4609. 0 0 -1.4
122MACK   OIL -1 EDIE   CNESW160237WGRNSPR2.53350.3240.4230.4278.4428.4980.4980.4442.4459. 0 0151.  -1.  -1. 0 04492.4511. 3 0208.4
123JOHN   FAR -1 KEHLEE CSENE200237WSPRGRS2.53375.  -1.4262.4307.4457.5010.5010.4470.4487. 0 3 80.  -1.  -1. 0 04520.4537. 0 0130.4
124NATIONAL A-1 GORTHY  CSESW060238WSPR   2.53261.3195.4181.4226.4374.4988.4988.4384.4410. 0 0 -1.  -1.  -1. 0 04430.4451. 5 0 -1.4
125JOHN   FAR -1 PUGH   CSENE390239WGRNG  2.53231.3120.4090.4140.4301.4950.4950.4304.4322. 0 0100.  -1.  -1. 0 04341.4382. 0 0298.4
126JOHN   FAR -1 WAGNER CSWSW050240WSPGRS 2.53523.3493.4422.4470.4636.  -1.  -1.4642.4660. 0 0137.  -1.  -1. 0 04686.4710. 0 0110.4
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127MACK    OIL -1 COOK   CSES.090240WSPRCRG2.53482.3432.4349.4444.4582.5243.5243.4602.4619. 0 0 85.  -1.   -1. 0 04648.4672. 0 0 90.4
128PAN     AM -1 CARMICH CSESE140240WSPRGNS2.53307.3322.4279.4332.4480.5120.5120.4494.4510. 0 0113.  -1.   -1. 0 04542.4560. 0 0108.4
129TOTO    GAS -1 ZWEYSA CSWSW340240WSPRC  2.53343.3224.4218.4254.4406.5038.5038.4420.4450. 0 0 -1.  -1.   -1. 0 04542.4560. 0 0108.4
130ATHENS E J -L RATH    CNWNW110241WSPRMC 2.53457.3424.4358.4392.4552.5230.5230.4563.4590. 0 0 -1.  -1.   -1. 0 04460.4492. 2 3 -1.4
131MACK    OIL -1 RAILE  CSESE250241WSPRGRG2.53542.3450.4400.4452.4604.5280.5280.4618.4634. 0 0 -1. ,-1.   -1. 0 04611.4634. 0 0 -1.4
132ATHENS E.J -1 ZIMBEL  CSWSW280241WSPRMC 2.53659.3560.4492.4544.4700.5372.5372.4710.4734. 0 0 94.  -1.   -1. 0 04662.4688. 0 0162.4
133CITIES SER A-1 RAILENWNWSW240242WGRSC  5.3699.3625.4528.4580.4739.5405.5405.4754.4773. 0 0 -1.  -1.   -1. 0 04748.4786.10 0 -1.4
134CITIES SER A-1 NORTHNWNWSE280242WGRSC  5.3703.3601.4498.4542.4687.  -1.   -1.4698.4734. 0 0 92.  -1.   -1. 0 04801.4832. 0 2133.4
135ATHENS E.J -1 ZWEYGA CSESE340242WSPRMC 2.52726.3630.4541.4590.4748.5406.5406.4756.4787. 0 0 80.  -1.   -1. 0 04743.4776. 0 0180.4
136OREILI CON -1 CONPLANESWSE030313WGRNG  2.51931.1275.3062.3106.3200.3832.3832.3207.3216. 0 0 -1.  -1.   -1. 0 04806.4836. 0 0 -1.4
137CARTER OIL -1 MUNYON CSWSW050316WSPR    5.2006.1525.3183.3232.3363.3723.  -1.3368.3386. 0 0105.3224.3236. 0 03242.3264. 0 0192.3
138NORTHERORD -1 ROLAND CSENW270317WSPR   2.51851.1376.3072.3116.3243.3625.  -1.3249.3265. 0 0 -1.3392.3402. 0 03410.3430. 0 0 -1.3
139DAVIS  CHI -1 BEYERL CSWNE170318WSPR    5.1567.1562.3186.3226.3344.3614.  -1.3354.3369. 0 0 -1.3276.3283. 0 03292.3308. 0 0 -1.3
140CARTER OIL -1 SHAW   CNWNW230318WSPR    5.1562.1558.3208.3248.3374.3628.  -1.3384.3398. 0 0 -1.3378.3388. 0 03394.3407. 0 0 -1.3
141BEACON A-1 ZILLINCERNESWSW330318WGRNG  2.51928.1507.3128.3172.3288.3532.  -1.3301.3320. 4 0155.3325.3336. 0 03423.3435. 0 0 -1.3
142KBE DRILL. -1 VELM  SESWSE260319WGRNG  2.52062.1547.3167.3210.3322.  -1.  -1.3338.3356. 0 0186.3360.3372. 0 03342.3357. 0 0220.3
143NATL.ASSOC.-1 GEORGENWNWSW320319WSPR   2.52068.1654.3244.3290.3400.3586.  -1.3412.3426. 0 0 -1.3434.3444. 0.03376.3380. 0 0240.3
144JONES SHEL -1 HAYS  SWSWNE150321WSPR   2.52313.2008.3544.3588.3700.3847.  -1.3711.3724. 0 0 -1.3736.3740. 0 03450.3468. 0 0 -1.3
145JONES SHEL -1 RLESLRNWNWSE260321WSPR   2.52320.1980.3543.3590.3694.3860.  -1.3706.3720. 0 0 -1.3728.3732. 0 03747.3759. 0 0 -1.3
146PETROL. INC -1 ALLENSESENE300322WSPR   2.52417.2042.3532.3572.3674.3800.  -1.3686.3700. 0 0 -1.  -1.   -1. 0 03738.3746. 0 0 -1.3
147BURCH  CR.-1 HENDERSSWSWNW100323WGRNG  2.52286.1860.3314.3356.3455.3574.  -1.3465.3480. 0 0 90.  -1.   -1. 0 03719.3728. 0 0 -1.3
148NIXON OPE. -1 SHELTOSESESW200323WGRNG  2.52277.1960.3415.3458.3554.3682.  -1.3560.3577. 0 0 77.  -1.   -1. 0 03494.3502. 0 0 95.3
149KBE DRILL -1 HOMESKYNENESW280323WSPRMC 2.52460.2033.3498.3540.3636.3772.  -1.3645.3660. 0 0 -1.  -1.   -1. 0 03592.3600. 0 0 94.3
150JONES SHEL -1 LEHAW SESENE330323WSPR   2.52420.2000.3467.3510.3603.3744.  -1.3616.3629. 0 0 -1.  -1.   -1. 0 03676.3686. 0 0 -1.3
151HARRY GCRE -2 CALVINNESESE250324WSPLLML2.52408.1990.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.   -1. 0 03645.3654. 0 0 -1.3
152THUNDBIRD B-1 ELLIS  CSWNE310324WGRNC  5.02444.2024.3447.3485.3585.3843.  -1.3598.3614. 0 0 -1.  -1.   -1. 0 0 -1.  -1. 0 0 -1.
153R. W. SHIELDS 1 HICK CSWNE020325WSPR    5.2482.2023.3418.3462.3556.3758.  -1.3567.3582. 0 0 53.  -1.   -1. 0 03633.3640. 0 0104.3
154THE NAT OIL 1 ELLICELSESENW170325WGRNC  5.2465.2064.3452.3495.3590.3919.  -1.3596.3617. 0 0 -1.  -1.   -1. 0 03601.3606. 0 0 -1.3
155TOMLINSON -1 SCHOEN  CSWNW230325WGRNCS 2.52395.1950.3354.3395.3457.3730.  -1.3508.3524. 0 0 93.  -1.   -1. 0 03628.3650. 0 0120.3
156TOMLINSON -1 SCHOEN  CSWNW230325WGRN   2.52255.1948.3354.3395.3457.3730.  -1.3508.3524. 0 0112.  -1.   -1. 0 03538.3544. 0 0128.3
157PAN AMER -1 VERNON   CSWSW190326WSPRGRS2.52638.2210.3563.3608.3704.3598.  -1.3717.3736. 0 0112.  -1.   -1. 0 03538.3544. 0 0128.3
158PAN AMER. -1 VERNON  CSWSW190326WSPRGRS2.52638.2210.3565.3608.3705.4014.  -1.3717.3737. 0 0 48.  -1.   -1. 0 03752.3762. 0 0 80.3
159PAN. AM. 1 VERNON    CSWSW190326WSPRGRC2.52638.2210.3564.3608.3705.4014.  -1.3717.3737. 0 0 48.  -1.   -1. 0 03753.3764. 0 0 81.3
160OOLYARD OIL -1 CECIL CSWNW300326WGRNG   5.2620.2193.3552.3596.3657.4022.  -1.3708.3732. 0 0048.  -1.   -1. 0 03753.3765. 0 0084.3
161OKMAR OIL -1 GILLESP CSWSE100327WGRNG  2.52650.2255.3580.3624.3724.  -1.  -1.3734.3754. 0 0 70.  -1.   -1. 0 03743.3754. 0 0 98.3
162JOHN O. -1 JOHNSON   CNENW270327WSPRGRN2.52623.2210.3546.3586.3690.4004.  -1.3698.3720. 0 0 80.  -1.   -1. 0 03770.3787. 3 0197.3
163RAYMOND -1 STEFFEN  NENWNW340327WGRNC  2.52619.2146.3480.3523.3622.3906.  -1.3630.3654. 0 0147.  -1.   -1. 0 03734.3752. 0 0155.3
164RAINSSCHAMF -1 SMITH CSWSW010328WGRNG  2.52674.2390.  -1.3715.3818.  -1.  -1.3828.3848. 0 0160.  -1.   -1. 0 03676.3691. 0 0183.3
165VINCENT OIL -1 SCOTTSWNENW100328WGRNG   5.2663.2375.3650.3692.3791.  -1.  -1.3802.3822. 0 0 86.  -1.   -1. 0 03865.3878. 0 0190.3
166BURCH EXPL. -2 WITT  CNWNE210328WGRNG  2.52761.2436.3716.3758.3860.  -1.  -1.3867.3885. 0 0 78.  -1.   -1. 0 03837.3854. 0 0158.3
167NAT. CRUDE -1 PACHLRNENENW280328WGRNG   5.2731.2405.3674.3730.3834.  -1.  -1.3843.3858. 0 0 80.  -1.   -1. 0 03896.3918. 0 0170.3
168HUGHES KEL.-1 VAHECC CSWNW340328WGRNG   5.2792.2406.3710.3754.3852.  -1.  -1.3862.3879. 0 0110.  -1.   -1. 0 03880.3892. 0 0130.3
169SOLAR OIL -1 VOLLIE  CNWNW060329WGRNG  2.52762.2520.3740.3786.3894.  -1.  -1.3900.3922. 0 0 85.  -1.   -1. 0 03896.3912. 0 0142.3
170SOLAR 1 VOLLIE       CNWNW060329WGRNG  2.52762.2520.3740.3787.3894.  -1.  -1.3900.3922. 0 0100.  -1.   -1. 0 03940.3960. 0 0172.3
171SAUVAGE&CONN 1 LARSONWNENE070329WSPR   2.52700.2532.3784.3830.3925.4340.  -1.3900.3922. 0 0100.  -1.   -1. 0 03940.3960. 0 0175.3
172NAT. ASSO. -1 HAROLD CSESW360329WGRN   2.52772.  -1.  -1.3942.4038.4386.  -1.3940.3956. 0 0 -1.  -1.   -1. 0 03977.3989. 0 0 -1.4
173M. J. LEUSACK 1 HAGENENENE030330WGRNG  2.52801.2590.3770.3838.3948.4336.4336.4048.4065. 2 0 -1.  -1.   -1. 0 04082.4096. 7 0 -1.4
174KSF DRIL. -1 TONGISH CSESW240330WSPRCS 2.52663.2478.3746.3785.3890.  -1.  -1.3956.3975. 0 6106.  -1.   -1. 0 03993.4012. 0 0137.4
175HALLIBURTON -1 JENKS CSESW050331WGRN   2.52595.  -1.3968.4015.4125.  -1.  -1.3700.3916. 0 0 -1.  -1.   -1. 0 03735.3948. 4 0 -1.3
176HALLIBURTON 1 JENKS  CSESW050331WGRNS  2.52595.  -1.3968.4015.4126.  -1.  -1.4134.4155. 2 0170.  -1.   -1. 0 04177.4194. 4 0310.4
177SAUVAGE DR. -1 CEDERSWSWSW230331WSPRGRN2.52874.2682.3884.3317.4032.4486.4486.4134.4155.02 0143.  -1.   -1. 0 04178.4194.04 0310.4
178SAUVAGE 1 CEDERLING SWSWSW230331WGRNGRC2.52874.2682.3885.3917.4032.4486.4486.4042.4061. 0 6105.  -1.   -1. 0 04082.4100. 2 4162.4
179CITIES SER. A-1 HOLMNESWSW290331WGRCO  5.2920.2724.3886.3928.4038.4520.4520.4042.4061. 006108.  -1.   -1. 0 04083.4101.0204165.4
180NAT. GAS -1 LEWIS    SWNWNE210332WSPR   2.53018.2800.3978.4012.4128.  -1.  -1.4044.4065. 0 4132.  -1.   -1. 0 04084.4102. 0 0231.4
181MACK OIL -1 KOGL     SWNENE030333WGRNSPR2.52811.2586.3736.3778.3902.4393.4393.4144.4160. 0 5 -1.  -1.   -1. 0 04184.4198. 0 0 -1.4
182MACK 1 KOGL          SWNENE030333WGRN   2.52811.2586.3736.3779.3902.4393.4393.3910.3932. 4 0 98.  -1.   -1. 0 03956.3973. 3 0145.3
183CLINTON -1 ELMA ROGE CNESW100333WGRNRCS2.53028.2780.3932.3980.4102.  -1.  -1.3910.3932.04 0100.  -1.   -1. 0 03957.3974.03 0148.3
184CLINTON 1-W E. ROGER CNESW100333WGRNCRS2.53028.2779.3933.3980.4102.  -1.  -1.4110.4130. 4 0153.  -1.   -1. 0 04156.4175. 0 2180.4
185AMER. ENERGY 1 CAHOJ CN2SE190333WGRBDC 2.53045.2770.3936.3972.4095.  -1.  -1.4110.4130.04 0155.  -1.   -1. 0 04156.4175. 002193.4
186AMERICAN -1 HENRY CA CN2SE190333WGRCD  2.53045.2770.3936.3972.4095.  -1.  -1.4101.4124. 0 0121.  -1.   -1. 0 04150.4168. 0 0206.4
187RAYMOND CO -1 SAMSONSESESE050334WGRLLR 2.52927.2685.3806.3850.3987.4456.4456.4100.4123. 0 0130.  -1.   -1. 0 04150.4168. 0 0203.4
188RAYMOND 1 SAMSON     SESESE050334WGRLLSC2.52927.2685.3807.3850.3987.4456.4456.4000.4020. 4 0137.  -1.   -1. 0 04046.4064. 7 0197.4
189F&M OIL CO. -1 CLOE  CSENW100334WGRNG  2.53078.2824.3963.4010.4148.  -1.  -1.4156.4175. 6 0154.  -1.   -1. 0 04196.4216.10 0160.4
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190F&M 1 CLOE            CSENW100334WGRNGC 2.53078.2824.3963.4010.4148.  -1.  -1.4156.4175.06 0098.  -1.  -1. 0 04196.4217.10 0165.4
191MACK OIL -1 REINERT   CNWNE340334WGRNSPR2.52974.2685.3844.3886.4010.4482.4482.4017.4040. 4 0112.  -1.  -1. 0 04061.4078. 0 0224.4
192MACK 1 REINERT        CNWNE340334WGRN   2.52974.2685.3845.3887.4010.4482.4482.4017.4040.04 0116.  -1.  -1. 0 04061.4079. 0 0226.4
193ABERCOMBIE -1 WRIGHT CNENE140335WGRNG   5.3030.2787.3901.3948.4082.4595.4595.4092.4112. 5 4127.  -1.  -1. 0 04138.4156. 3 0160.4
194EMPIRE DR. -1 BEESON CSWSW180335WGRSPR 2.53293.3085.4164.4210.4348.4852.4852.4359.4381. 3 0 -1.  -1.  -1. 0 04403.4426. 5 0 -1.4
195**BLANK RECORD**                   W    0.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
196JOHN O. -1 BEESON     CSESE190335WSPRGRS2.53144.2895.4008.4058.4196.4706.4706.4204.4224. 0 0 77.  -1.  -1. 0 04250.4268. 0 0138.4
197SHAMROCK B-1 GAINES SESENW010336WSPR    2.53232.3064.4111.4160.4305.4820.4820.4320.4341.0502 -1.  -1.  -1. 0 04365.4383.02 0 -1.4
198SHAMROCK B-1 GAINES SESENW010336WSPRMC 2.53233.3064.4111.4160.4309.4820.4820.4320.4341. 5 2 -1.  -1.  -1. 0 04365.4382. 2 0 -1.4
199PICKRELL A-1 HUBBARD CNWSW280336WGRNG  2.53299.3076.4138.4192.4336.  -1.  -1.4340.4363. 0 0170.  -1.  -1. 0 04387.4408. 0 0180.4
200PICKRELL A-1 HUBBARD CNWSW280336WGRNG  2.53299.3076.4139.4192.4336.  -1.  -1.4341.4363. 0 0118.  -1.  -1. 0 04388.4408. 0 0180.4
201CITIES A-1 CORSCH    SESWSW040337WGRNC  5.03431.3296.4307.4357.4512.5062.5062.4525.4545. 0 0200.  -1.  -1. 0 04573.4591. 0 0181.4
202CITIES SER. A-1 CORSSESWSW040337WGRNC   5.3431.3295.4307.4357.4512.  -1.  -1.4524.4545. 0 0180.  -1.  -1. 0 04573.4591. 0 0167.4
203MURFIN DR. 1-3 SHAY  CSWN.030339WGRNG   5.3470.3342.4321.4370.4523.  -1.  -1.4537.4551. 0 0 82.  -1.  -1. 0 04576.4606. 0 0210.4
204MURFIN DR. -1 MARTIN CNENE080339WGRNG   5.3302.3167.4137.4188.4345.  -1.  -1.4359.4373. 0 0 64.  -1.  -1. 0 04403.4431. 0 5132.4
205NORBLA OIL -1 FONCAN CSESE180339WSPRMC 2.53438.3283.4280.4328.4483.5140.5140.4494.4508. 3 2 -1.  -1.  -1. 0 04544.4565. 3 2 -1.4
206NORBLA 1 FONCANNON    CSESE180339WSPR   2.53439.3284.4280.4328.4483.5141.5141.4494.4508.0302 -1.  -1.  -1. 0 04542.4565.0302 -1.4
207FALCON SEA. 1 ZWEYGASFSESW010341WSPRLL 2.53527.3378.4345.4382.4536.5174.5174.  -1.  -1. 0 0 -1.  -1.  -1. 0 04580.4612. 0 0 -1.4
208SHAKESPEARE -1 RUBENSESESW040341WGRNG   5.3627.3479.4422.4474.4623.  -1.  -1.4638.4656. 0 0 66.  -1.  -1. 0 04678.4703. 0 4108.4
209NORBLA OIL -1 KNORR  CSWSW150341WSPRMC 2.53522.3368.4330.4380.4536.5180.5180.4550.4568. 0 0 -1.  -1.  -1. 0 04592.4621. 0 0 -1.4
210NORBLA 1 KNORR        CSWSW150341WSPR   2.53522.3368.4330.4381.4536.5180.5180.4551.4568. 0 0 -1.  -1.  -1. 0 04592.4621. 0 0 -1.4
211SUN OIL CO. -1 RUEH  CSESE090342WSPRMC 2.53734.3580.4503.4543.4704.  -1.  -1.4720.4742. 0 0 -1.  -1.  -1. 0 04775.4797. 0 0 -1.4
212R.G. LAWTON -1 RUEB  CSESE130342WSPRMC 2.53643.3488.4432.4470.4635.5300.5300.4646.4669. 0 0 -1.  -1.  -1. 0 04688.4727. 0 0 -1.4
213R.G. LAWTON -1 LEIBB CNWSE360342WMCR    5.03652.  -1.4408.4444.4604.5250.5250.4617.4642. 3 0 -1.  -1.  -1. 0 04658.4697. 0    -1.4
214FLYNN OIL -1 WILLIS NENENE080416WSPR    2.51801.1340.3047.3095.3226.3645.  -1.3233.3252. 0 0 -1.3262.3269. 0 03278.3294. 0 0 -1.3
215G. VYE 1 C.A.JOHNSONNWNWNW340417WSPR    2.51757.1256.2976.3024.3146.3502.  -1.3156.3173.06 0 -1.3181.3192. 0 03199.3214. 0 0 -1.3
216BEACON RES. 1 ZILLINNWNESW040418WGRNG   2.51975.1548.3178.3220.3340.3590.  -1.3352.3370. 0 4130.3374.3387. 0 03392.3408. 0 0212.3
217WOODMAN 1 ERECPEIER NWNWNE180418WGRNC   2.51528.1484.3075.3134.3251.  -1.  -1.3262.3281.04 0098.3286.3299. 0 03303.3320. 002202.3
218PET. MGT 1 STONEMAN SESWNE200418WGRNGC 5.01524.1448.3031.3122.3240.3475.  -1.3252.3271. 0 0170.3275.3287. 0 03292.3310. 0 0310.3
219PET. MGT. 1 MORGAN  SWSENW270418WGRNG   5.01814.1333.2977.3020.3138.3169.  -1.3149.3168. 0 0160.3172.3183. 0 03190.3208. 003260.3
220OHIO PET. 1 KHELY    SESES.010419WGRLLMR2.52013.1570.3181.3222.3338.3582.  -1.3350.3367. 0 0 -1.3373.3384. 0 03390.3406. 0 0 -1.3
221AMER. PET. A-2 GRAL  SWNWNW020419WGRNG   5.2051.1548.3165.3208.3324.  -1.  -1.3339.3353. 3 4127.3356.3368. 0 03373.3390. 0 2203.3
222PET. MGT. 1 FLANICANSWNWSE100419WGRNC   5.01552.  -1.3118.3163.3275.3504.  -1.3288.3307. 0 0133.3311.3322. 0 03327.3345.0002204.3
223NAT. ASSOC. A-1 LAFFNWSWSE190419WGRNC   2.51965.1507.3109.3157.3272.3492.  -1.3282.3300. 3 0205.3304.3316. 0 03320.3336. 0 0317.3
224PET. MANG. -1 ACEE   SENWNE300419WGRN    5.1569.  -1.3098.3144.3257.3448.  -1.3266.3284. 0 2 90.3289.3300. 4 03304.3320. 0 0157.3
225ABERCROMBIE-1 PATTONNWSENE230420WGRNG    5.2057.1638.3218.3258.3374.3534.  -1.3382.3398. 0 0133.3404.3415. 0 03420.3436. 0 0220.3
226LELAND R. -1 ROEKEL SWSESE270420WGRS     5.1940.  -1.3060.3104.3217.  -1.  -1.3227.3244. 0 0 -1.3249.3260. 0 03264.3278. 0 0 -1.3
227NAT. ASSOC. 1 SCHICKNWNWSW040421WGRNGC 2.52236.1857.3445.3492.3596.  -1.  -1.3608.3622. 5 0 94.3628.3634. 0 03640.3649. 0 0 97.3
228F & M OIL -1 LUTZ-W. CNENE260421WGRS      5.2122.  -1.3316.3362.3470.  -1.  -1.3481.3496. 0 0 -1.3502.3511. 0 03517.3528. 0 0 -1.3
229D. G. HANSEN 1 TIREENENENW320421WSPR     2.52130.1756.3303.3348.3451.3596.  -1.3463.3478. 4 0 -1.3484.3490. 0 03497.3506. 0 0 -1.3
230CONT. OIL -1 HEMPHIL CNESW080422WSPRGRS2.52570.2017.3517.3560.3661.2796.  -1.3671.3687. 0 0 67.3692.3700. 0 03706.3714. 0 0103.3
231LEHEN OIL -1 ARCHER  CNESW260422WGRNG   2.52144.1780.3296.3340.3442.3574.  -1.3452.3466. 0 0 89.3474.3477. 0 03484.3494. 0 0 92.3
232GEAR PET. -1 BAGGESS CNESW320422WGRNGC  5.2170.1765.3300.3341.3442.3424.  -1.3452.3468. 0 3 76.3474.3478. 0 03485.3492. 0 0 94.3
233TILCO STAL -2 HANSENSWSES.350422WGRNG   2.52130.1753.3274.3320.3420.3595.  -1.3432.3448. 0 0112.3453.3457. 0 03463.3474. 0 0140.3
234A. AINSWORTH 1 HARTINGSWSW 200423WGRNG  2.52291.1952.3458.3483.3586.2717.  -1.3593.3608. 0 2 70.  -1.  -1. 0 03624.3631. 2    98.3
235ANADAR. PR.A-1 ARCH    CNE170423WGRNCD   5.2410.2016.3499.3540.3640.2807.  -1.3649.3664. 0 4 57.  -1.  -1. 0 03679.3688. 0 0 88.3
236C&G DR.&HANS. 1 PLAKNENENW240423WGRNG   2.52208.1898.3394.3436.3538.3691.  -1.3546.3563. 0 0 72.  -1.  -1. 0 03579.3590. 0 0111.3
237STERLING DR. 1 SHEWE CSESE240423WSPRS   2.52437.2050.3595.3587.3688.2553.  -1.3693.3714. 0 3 -1.  -1.  -1. 0 03722.3731. 0 0 -1.3
238JOHN O. A-6 SCHOEN   CWLN.020424WGRN    2.52446.  -1.3493.3533.3598.3760.  -1.3608.3622. 0 0 -1.  -1.  -1. 0 03638.3646. 0 0 -1.3
239JOHN O. B-5 SCHOEN   NWNWNE020424WGRN   2.52428.1996.3446.3487.3582.  -1.  -1.3590.3607. 0 0 -1.  -1.  -1. 0 03622.3633. 0 0 -1.3
240D. G. HANSEN 1 ESSERNWNWSE030424WGRNG   2.52488.2058.3439.3540.3642.2826.  -1.3652.3670. 0 2 92.  -1.  -1. 0 03682.3690. 2 0310.3
241CONT. OIL -1 WILFIONNWNWNW090424WSPRGRS2.52485.2061.3504.3542.3645.2856.  -1.3652.3669. 0 0 67.  -1.  -1. 0 03682.3693. 0 0 74.3
242AURORA GAS. 1 ZIMMERSWSWNE110425WGRNG  2.52465.2052.3482.3525.3624.2864.  -1.3634.3650. 3 0 96.  -1.  -1. 0 03664.3674. 0 0118.3
243ANSCHUTZ DR. 1 ZIERLNWNWSE360425WSPR   2.52406.2015.3479.3520.3620.2867.  -1.3632.3651. 3 0 -1.  -1.  -1. 0 03663.3672. 0 0 -1.3
244JOHN FARMER 1 FARRISSWSWS.070426WGRNG  2.52566.2152.3510.3553.3654.3944.  -1.3658.3680. 4 0 80.  -1.  -1. 0 03694.3703. 2 0175.3
245HARRY GORE -1 NORRISNWNWNW120426WSPR   2.52415.2030.3426.3470.3564.2866.  -1.3576.3592. 2 0 -1.  -1.  -1. 0 03611.3621. 0 0 -1.3
246ABERCOMBIE -1 WOLF    NWSE200426WGRNG    5.2574.2148.3514.3560.3660.  -1.  -1.3665.3684. 2 3 82.  -1.  -1. 0 03698.3709. 4 0120.3
247JOCELYN V. 1 HARDESTSWSWNW330426WGRNG  2.52624.2207.3530.3634.3734.4012.  -1.3737.3756. 3 0 70.  -1.  -1. 0 03768.3780. 0 2150.3
248TOMLINSON -1 TILDEN SENENE030427WGRNG  2.52640.2160.3514.3554.3654.3996.  -1.3664.3684. 0 0 -1.  -1.  -1. 0 03702.3712. 2 0202.3
249OKMAR OIL 1 PETRACEKNESENW090427WGRN   2.52669.2175.3517.3564.3664.4005.  -1.3672.3690. 0 0 -1.  -1.  -1. 0 03714.3724. 0 0 -1.3
250MURFIN DR. 1 PETRACE CNENE230427WGRNG  2.52555.2084.3438.3482.3583.3888.  -1.3590.3609. 4 0110.  -1.  -1. 0 03623.3636. 3 0150.3
251THUNDER. DR. 1 SKUBASESENE350427WGRNG  2.52608.2115.3490.3531.3628.  -1.  -1.3637.3654. 0 0124.  -1.  -1. 0 03670.3682. 0 0207.3
252HALLIBURTON 1 VAVRCCSESENE040428WGRNG  2.52689.2356.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 2 85.  -1.  -1. 0 0  -1.  -1. 5 0170.
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253C & G DR. -2 BISHOP NESWSW080428WGRNG  2.52780.2570.3862.3906.4003.  -1.   -1.4009.4026. 5 0 96.  -1.   -1. 0 04042.4058. 4 0120.4
254THUNDERBIRC 1 ARMSTRNWNWNW230428WGRNGC 2.52687.2474.3812.3857.3956.  -1.   -1.3974.3989. 0 0 94.  -1.   -1. 0 03997.4011. 4 0130.4
255HALLIBURTON 1 MUIRHESWNWNE330428WGRN   2.52684.2475.3817.3862.3964.  -1.   -1.3970.3988. 3 0 -1.  -1.   -1. 0 04008.4021. 0 0 -1.4
256JONES SHE. 1 WYMORE SWSWSE030429WSPR   2.52802.2620.3902.3950.4048.4470.4470.4055.4072. 0 0 -1.  -1.   -1. 0 04089.4106. 4 0 -1.4
257D. R. LAUK -1 YOUNG  CSCSE170429WGRNG  2.52777.2580.3866.3918.4015.4407.4407.4023.4039. 0 0 50.  -1.   -1. 0 04058.4072. 0 0259.4
258MACK OIL -1 ALSTROM  CSENW310429WSPRGRS2.52811.2562.3862.3910.4018.  -1.   -1.4018.4030. 4 0 95.  -1.   -1. 0 04057.4072. 3 0184.4
259CITIES SER. A-1 SCRE  NWSE030430WGRNC   5.2799.2612.3856.3903.4070.4418.4418.4077.4091. 0 0127.  -1.   -1. 0 04095.4112. 0 0 69.4
260K & E DR. -1 RITTER  CSWNE120430WSPRMCS2.52752.2575.3832.3881.3983.  -1.   -1.3993.4011. 6 0 -1.  -1.   -1. 0 04029.4042. 0 0 -1.4
261S & W DR. 1 ROBINSON CNWNE280430WGRNGC  5.2811.2595.3847.3900.4002.4413.4413.4008.4025. 3 6 53.  -1.   -1. 0 04049.4064. 0 0 78.4
262GENERAL CRUD. 1 SCHM CSWSE180431WSPR   2.52790.2553.3777.3823.3934.4383.4383.3942.3964. 010 -1.  -1.   -1. 0 03983.4002. 0 0 -1.4
263EMPIRE CR. A-1 DEWEY CSENE290431WSPRGRS2.52965.2723.3963.4010.4123.4528.4528.4130.4150. 3 6 -1.  -1.   -1. 0 04170.4190. 2 0 -1.4
264TRANS-ERA -1 VRBAS  NWNWNW200432WSPR   2.53044.2755.3954.4000.4107.4532.4532.4115.4134. 0 3 -1.  -1.   -1. 0 04164.4182. 0 6 -1.4
265EMPIRE CR. A-1 BROWN CNENW360432WSPR   2.52832.2570.3794.3840.3949.  -1.   -1.3960.3980. 0 4 -1.  -1.   -1. 0 04005.4020. 0 5 -1.4
266MURFIN CR. -1 MCCAIN CSESE070433WGRNG  2.53127.2840.4020.4060.4182.4657.4657.4188.4210. 5 0124.  -1.   -1. 0 04234.4256. 0 5240.4
267AMER. PET. -1 WALTERNENESW170433WSPRMC.2.53084.2795.3984.4023.4142.4609.4605.4150.4170. 0 5 -1.  -1.   -1. 0 04196.4212. 6 0 -1.4
268AMERADA PET. -1 RLCANWNWNW230433WGRRLL 2.52557.2683.3872.3913.4026.4466.4466.4039.4055. 3 0 -1.  -1.   -1. 0 04081.4100. 0 5 -1.4
269SANDS AMER. 1 LYNCON CSESW040434WGRNG   5.3116.2810.3985.4029.4155.4640.4640.4163.4193. 0 6173.  -1.   -1. 0 04209.4227. 0 0155.4
270JACKSON -1 BOWLES    CSWSW240434WGRNG   5.3115.2810.3984.4031.4147.4620.4620.4154.4177. 0 0154.  -1.   -1. 0 04205.4224. 6 0197.4
271THOED. GORE 1 MCFEE  CNESE330434WGRNG   5.3132.2797.3983.4030.4147.  -1.   -1 4156.4176. 0 0 94.  -1.   -1. 0 04204.4221. 0 3158.4
272STONEHENGE 1 MAYFIEL CNENE100435WGRGCS 2.53235.2950.4110.4155.4283.4765.4765.4293.4313. 3 5 74.  -1.   -1. 0 04340.4357. 3 4115.4
273BEACON RES. 1 WEBER  CNWNW230435WGRRG  2.53176.2850.4022.4066.4190.4692.4692.4198.4221. 3 0102.  -1.   -1. 0 04244.4261. 0 4173.4
274AMAX PET. 1 WILLIAMS CNENE040436WSPRGRS2.53274.3058.4135.4184.4322.4880.4880.4333.4357. 6 0146.  -1.   -1. 0 04378.4394. 0 0216.4
275EMPIRE DR. 1 W. RANC CSENW110436WSPRGRS2.53206.2977.4080.4128.4264.4840.4840.4276.4296. 3 0 80.  -1.   -1. 0 04322.4338. 0 0202.4
276FRONT. REF. A-1 BRIN CNWSW200436WSPRGRS2.53334.3075.4176.4225.4358.4877.4877.4368.4388. 0 3110.  -1.   -1. 0 04416.4432. 4 0138.4
277JAMES OIL 1 HARRISON CSESE320436WSPRMC 2.53378.3103.4231.4270.4394.4900.4900.4406.4426. 0 0 -1.  -1.   -1. 0 04455.4468. 0 0 -1.4
278MURFIN CR. 2 CASFCRC CNWNW160437WGRNG  2.53450.3222.4236.4351.4485.  -1.   -1.4498.4517. 4 0 90.  -1.   -1. 0 04547.4567. 8 0150.4
279SMITH & BEN 1 HAACK  CSWSW200437WSPRGRS2.53435.3207.4278.4331.4464.5022.5022.4474.4491. 2 0 64.  -1.   -1. 0 04536.4544. 0 0126.4
280ABRAXAS PET. 1 GIESO  NWNE250437WSPRGRN 5.3340.3064.4152.4202.4332.4848.4848.4342.4363. 0 4155.  -1.   -1. 0 04387.4405. 0 0180.4
281SHAKESPEAR  1 REUBER CSWNE360437WGRNG   5.3381.3106.4214.4263.4388.  -1.   -1.4400.4427. 3 0120.  -1.   -1. 0 04441.4460. 0 5142.4
282SAFFA BRA. 1 WEAVER  CSESE130438WGRNG  2.53471.3240.4312.4369.4502.5068.5068.4514.4544. 4 0107.  -1.   -1. 0 04571.4582. 0 0132.4
283M. E. BANG. 1 LILLIC CSWNE200438WSPRGRS2.53512.3267.4316.4372.4506.5068.5068.4517.4538. 0 6 -1.  -1.   -1. 0 04568.4590. 0 0 -1.4
284PHILL. PET. 1 S. FRAWSNWSE150439WSPRMC 2.53498.3271.4306.4354.4492.5070.5070.4506.4527. 2 6 -1.  -1.   -1. 0 04550.4576. 7 0 -1.4
285ATOMIC CR. 1 MUNCHEN CNESE180439WGRN   2.53527.3300.4333.4378.4516.5131.5131.4532.4560. 0 0128.  -1.   -1. 0 04575.4610.11 0204.4
286TEXAS CRUDE 1 ANDERS CSWNW280439WGRNG  2.53514.3257.4292.4343.4486.5090.5090.4495.4522. 5 C135.  -1.   -1. 0 04542.4570. 6 0210.4
287TOTO GAS -1 HUED     CNESE140440WSPRCS 2.53516.3303.4326.4376.4520.5165.5165.4528.4553. 4 0 -1.  -1.   -1. 0 04574.4608. 0 0 -1.4
288E. J. ATHENS 1 COLTH CSWSW270441WSPRMC 2.53591.3358.4371.4408.4566.5256.5256.4578.4604. 2 0 -1.  -1.   -1. 0 04628.4655. 0 0 -1.4
289E. J. ATHENS 1 SCHIR CNESW030442WSPRMC.2.53696.3505.4458.4492.4658.5304.5304.4674.4700. 0 0 -1.  -1.   -1. 0 04710.4745.12 0 -1.4
290MACK OIL -1 HART     CNWSE230442WSPRGRS2.53549.3317.4242.4325.4480.5076.5076.4494.4516. 3 0 91.  -1.   -1. 0 04543.4574. 2 0216.4
291PET. MAN. -1 JACKSONNWSWN 160517WGRNGC 2.51946.1437.3106.3149.3284.  -1.   -1.3290.3308. 4 0138.3310.3324. 4 03329.3349. 4 0242.3
292PET MGT 1 KELTEN     S2SWNE170517WGRNGC 2.51964.   -1.3121.3168.3298.  -1.   -1.3305.3322.04 0150.3327.3337. 0023342.3360.0404225.3
293NAPCO A-1 PULGHUM    SESENE190517WGRNR 2.51899.1397.3029.3072.3201.  -1.   -1.3208.3226.0403133.3231.3242. 0033249.3266.06 0200.3
294RAINS&WILL. -1 SHAW NENENE100518WGRNGC  5.1886.1336.3024.3067.3191.  -1.   -1.3196.3216. 3 0 -1.3222.3232. 3 03238.3256. 0 5 -1.3
295BIRM.-BART. WILUCAT SESENW140518WGRN    2.52057.1450.3185.3230.3356.  -1.   -1.3362.3382. 0 0 -1.3345.3396. 0 03402.3420. 3 4 -1.3
296RAINS&WILL. 2 MCKINLSENESW240518WGRNC  2.51962.1363.3071.3114.3243.3470.   -1.3250.3268. 0 3165.3273.3282. 0 03288.3308. 2 4220.3
297SUAVAGE&DUNN 1 RLESFSENWNW030519WGRN   2.51954.1584.3205.3247.3362.3594.   -1.3375.3393. 0 2 94.3397.3409. 3 03414.3430. 0 5162.3
298D.G. HANSON -1 FOR  SESESE170519WSPR    2.52111.1724.3328.3370.3486.3646.   -1.3493.3512. 6 0 -1.3516.3528. 0 03532.3548. 0 0 -1.3
299MARTIN OIL -1 HILL   CNWNW310519WGRNG  2.52064.1650.  -1.3304.3420.  -1.   -1.3429.3447. 0 0132.3430.3453. 0 03466.3482. 0 0194.3
300HANKOFF OIL 7 BROWN SWNESE030520WGRNG  2.51596.1510.3041.3127.3238.3350.   -1.3249.3267. 4 2141.3272.3283. 2 03286.3300. 0 0170.3
301HELM & PAYNE 1 MCCLUSWSWNW080520WGRNGC 2.52619.1581.3197.3232.3346.3437.   -1.3350.3365. 0 0140.3371.3380. 0 03382.3395. 0 0165.3
302SKELLY OIL 13 GRAHAMNWSWNE230520WGRNG   5.2148.1634.  -1.  -1.  -1.  -1.   -1.  -1.  -1. 6 0167.  -1.   -1. 0 0  -1.  -1. 0 3210.
303CITIES SER. A-3 WALLNENWSE290520WGRN    5.2197.  -1.3312.3356.3466.  -1.   -1.3475.3490. 0 2 91.3496.3505. 5 03508.3520. 0 0100.3
304ISERN-WELLS 1 GLENNENENWNW140521WGRR   2.52082.1665.3242.3283.3390.  -1.   -1.3400.3415. 0 2 54.3419.3427. 4 03430.3444. 3 0 66.3
305OSAGE OIL&GAS 1 KEPPSESESW230521WGRNSP 2.52220.1810.3364.3408.3520.3629.   -1.3525.3542. 0 0 -1.3546.3553. 3 03556.3568. 2 2 -1.3
306KIMBARK EXP. 1 BAIRDSWSWSW240521WGRNG  2.52206.1785.3340.3386.3496.3648.   -1.3503.3519. 3 2 73.3524.3530. 0 03530.3547. 0 4 90.3
307PHIL. PETR. 3 KEMPERSENENW260521WSPR    5.2250.1837.3388.3432.3540.3659.   -1.3548.3564. 5 0 -1.3569.3576. 0 03578.3592.      -1.3
308LEBEN DRLG. 1 VOSS   CSESE300521WGRNGC 2.52288.1890.3440.3486.3586.  -1.   -1.3596.3612. 0 2 87.3615.3621. 0 03626.3640. 4 0117.3
309TILCO ETAL 1 STENGER CNENW020522WGRNGC 2.52146.1768.3289.3333.3432.3605.   -1.3442.3456. 0 0 80.3453.3468. 0 03474.3482. 3 0100.3
310CITIES SER. 1 ARCHERSESWSW120522WSPR    5.2133.1717.3257.3298.3398.3542.   -1.3409.3422. 5 0 -1.3429.3433. 0 03441.3451. 0 0 -1.3
311CHIEF DRLG 1 ARMSTRO CNWNE250522WGRN   2.52264.1854.3399.3442.3545.3704.   -1.3557.3573. 0 0 90.3579.3583. 0 03593.3604. 0 0 91.3
312ABERCOMBIE 1 HILDEBRSENWNW150523WGRNGC  5.2207.1844.3358.3395.3502.  -1.   -1.3514.3534. 0 0 86.  -1.   -1. 0 03545.3554. 0 0184.3
313F & M OIL 1 SCHABER SWNENW220523WGRNGC  5.2172.1807.3316.3355.3463.3689.   -1.3473.3490. 0 3 63.  -1.   -1. 0 03504.3513. 0 0 65.3
314F & M OIL -1 RAHJES SWSENE260523WGRNGC  5.2256.1860.3388.3431.3537.3770.   -1.3548.3563. 0 0117.  -1.   -1. 0 03577.3585. 0 0102.3
315MURFIN DRLG. 1 GOODR CSENE060524WGRNGC  5.2422.2014.3489.3530.3629.3516.   -1.3638.3654. 0 0 45.  -1.   -1. 0 03670.3680. 0 0 73.3
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316MURFIN 1-C BERRY     CSWNE110524WGRNGSP2.52368.1963.3461.3502.3605.3843.   -1.3614.3632. 0 0 71.  -1.  -1. 0 03642.3651. 0 0108.3
317JONES&FARM. H-1 MOORSESENE130524WGRNG  2.52309.1910.3424.3464.3568.3842.   -1.3577.3595. 0 0102.  -1.  -1. 0 03606.3616. 0 0 98.3
318NAPCO -1 A. MINDRUP  CNWSW140525WGRN   2.52458.   -1.3529.3571.3678.3964.  -1.3685.3700. 0 0 80.  -1.  -1. 0 03714.3724.    220.3
319MURFIN DRLG. 1 LINDESESWNW200525WGRNG  2.52530.2133.3582.3618.3724.4028.   -1.3728.3745. 3 0 87.  -1.  -1. 0 03759.3768. 2 0112.3
320K & E DRLG. 1 SPIESSNWNWSW350525WSPRMC 2.52507.2110.3565.3603.3706.  -1.   -1.3716.3736. 2 0 -1.  -1.  -1. 0 03745.3757. 6 0 -1.3
321QUINT. LITT. 1 SCHEENENENE040526WGRNN  2.52589.2173.3575.3618.3716.4007.   -1.3724.3743. 4 0 51.  -1.  -1. 0 03756.3767. 3 0110.3
322JONES&FARM. 1 SHIMENWNESW100526WSPR    2.52634.2231.3654.3694.3795.4107.   -1.3803.3818. 0 0 -1.  -1.  -1. 0 03834.3842. 0 0 -1.3
323STERLING OIL 1 NOCKESWNENW270526WGRNG  2.52598.2207.3626.3666.3767.  -1.   -1.3773.3790. 0 0 90.  -1.  -1. 0 03806.3815. 0 0 63.3
324RAYMOND OIL 1 FEELY NWSWNW020527WGRNGC 2.52645.2207.3575.3618.3716.  -1.   -1.3724.3744. 0 0135.  -1.  -1. 0 03760.3772. 0 0210.3
325HARRY GORE 1 HAROLD SWSWSW200527WSPR   2.52657.2452.3824.3874.3963.4400.   -1.3988.4008. 4 0 -1.  -1.  -1. 0 04024.4032. 2 0 -1.4
326CONT. OIL 1 HARDESTYSENENE220527WSPR   2.52651.2223.3605.3643.3747.4053.   -1.3751.3767. 7 0 -1.  -1.  -1. 0 03788.3798. 0 0 -1.3
327BURCH DRLG. 1 GRITZ SWSWNF250527WGRNGC 5.2614.2254.3667.3708.3813.  -1.   -1.3820.3839. 3 0100.  -1.  -1. 0 03854.3868. 0 0116.3
328LOHMA.&JOHN. 1 JOHNSNWNWSW100528WSPLLPL2.52694.2495.3840.3890.3994.4372.4372.4004.4019. 0 0 -1.  -1.  -1. 0 04035.4043. 0 0 -1.4
329FITZGERALD 1 MEITL   CNENE160528WGRNCC 2.52715.2510.3845.3892.3996.  -1.   -1.4004.4019. 0 0190.  -1.  -1. 0 04037.4050.02 0191.4
330THEOD. GORE 1 COULTESESENW300528WGRRCN 2.52790.2562.3907.3952.4057.  -1.   -1.4064.4080. 0 0123.  -1.  -1. 0 04099.4112. 3 0188.4
331K & E. DRLG. 1 KOEFENWNWNE160529WSPRGRS2.52778.2535.3898.3895.3998.4402.4402.4004.4021. 3 0 -1.  -1.  -1. 0 04039.4053. 0 0 -1.4
332K.& E. DRLE. C-1 ANCNESESW290529WSPR    5.2770.2512.3817.3862.3966.4357.4357.3973.3989. 0 0 -1.  -1.  -1. 0 04008.4018. 4 0 -1.4
333E. K. CAREY 1 WACHENNENES.350529WSPR   2.52814.2572.3902.3946.4050.4464.4464.4055.4071. 0 0 -1.  -1.  -1. 0 04092.4106. 5 0 -1.4
334ABERCOMBIE 2 HUBER   CNENW210530WGRNGC  5.2853.2622.3904.3953.4057.  -1.   -1.4064.4081. 0 0138.  -1.  -1. 0 04104.4117. 3 0160.4
335CITIES SER. A-1 SCHMSWSESW220530WGRNCC 5.02869.2582.3868.3916.4021.4464.4464.4029.4046. 0 0218.  -1.  -1. 0 04067.4080. 0 0252.4
336CITIES SER. E-2 GAVINENWSE250530WGRNCD  5.2846.2583.3872.3922.4020.  -1.   -1.4026.4044. 3 0218.  -1.  -1. 0 04062.4076. 4 0188.4
337MULL DRLG. 1 BROWN   CSWSE020531WGRNGCS2.52848.2578.3827.3877.3984.  -1.   -1.3990.4010. 0 0178.  -1.  -1. 0 04032.4052. 0 4187.4
338EMPIRE DRLG. 1 SCHMANWNWNW090531WSPRCS 2.52950.2680.3918.3964.4075.  -1.   -1.4087.4106. 0 5 -1.  -1.  -1. 0 04127.4142. 0 0 -1.4
339MULL DRLG. 2 WOERFEL CSESW130531WGRNCCS2.52933.2646.3914.3965.4072.  -1.   -1.4078.4096. 0 0180.  -1.  -1. 0 04116.4133. 5 0180.4
340TCOCO & FARMER 1 BAR CSESW350531WGRNG  2.52568.2671.3962.4009.4122.4544.4544.4131.4151. 0 0127.  -1.  -1. 0 04168.4190. 004174.4
341CITIES SER. E-1 RYANNWSWNW140532WGRCD   5.3027.2725.3956.4004.4112.4570.4570.4114.4153. 0 2 95.  -1.  -1. 0 04175.4187. 0 0153.4
342CITIES SER. A-1 RYANSWNWNE240532WGRNCD  5.2949.2632.3871.3921.4031.4470.4470.4035.4073. 0 8101.  -1.  -1. 0 04088.4104. 4 0 85.4
343BASS ENT. 1 HENNINGS CSESE310532WGRNGC  5.3078.2759.4004.4053.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 0 0 -1.
344NEILSON ENT. 1 CURTI  SENW100533WGRNGC  5.3099.2751.3959.4007.4126.4587.4587.4134.4162. 0 7 95.  -1.  -1. 0 04185.4200. 6 0123.4
345AMERADA PET. 1 GAILI CNESW150533WSPRPC 2.52576.2632.3856.3908.4026.4502.4502.4034.4064. 6 3 -1.  -1.  -1. 0 04083.4101. 0 3 -1.4
346JACKSON & PAP. 1 GHO CSWNE320533WGPNG  2.53157.2825.4058.4107.4226.4704.4704.4235.4260. 7 4 90.  -1.  -1. 0 04272.4297. 014175.4
347MUSGROVE PET. 1 FALC CNWNW120534WGRNC  2.53207.2893.4086.4136.4253.4748.4748.4262.4284. 4 0134.  -1.  -1. 0 04307.4329.10 0164.4
348THUNDERBIRD 1 JENSEN CSENE190534WGRNG   5.3265.2940.4122.4172.4296.4752.4792.4306.4331. 4 0116.  -1.  -1. 0 04352.4369. 0 0171.4
349UCO & CARTER 1 HENRYSWSWNW270534WGRNG  2.53195.2885.4042.4132.4252.4782.4782.4265.4290.06 0133.  -1.  -1. 0 04313.4331.0203133.4
350EMPIRE DRLG. 1 DEBEY CSWNW030535WSPRGRS2.53183.2883.4034.4080.4204.4682.4682.4214.4235. 2 0 -1.  -1.  -1. 0 04260.4276. 0 4 -1.4
351EMPIRE 1 BREWSTER     CNWSW140535WGPRSC 2.53228.2899.4074.4127.4253.4789.4785.4263.4283. 0 0 -1.  -1.  -1. 0 04302.4324. 004 -1.4
352FARMER 1 EULRISS      CNESE350535WGRNLL 2.53294.2948.4142.4190.4316.4852.4852.4326.4346.04 0 -1.  -1.  -1. 0 04365.4387. 006 -1.4
353SHAKESPEARE 1 COOPERSWSWSE060536WGRNCC 5.03382.   -1.4222.4272.4399.4918.4918.4410.4435. 0 0164.  -1.  -1. 0 04449.4473. 005300.4
354PICKRELL A-1 PEPUERT CNWSE190536WGRNCC  5.3229.2938.4076.4130.4256.4828.4828.4268.4287. 0 0 93.  -1.  -1. 0 04308.4333. 2 3188.4
355THUNDERBIRD 1-B HRIN CNWSE310536WGRNGC 5.03417.3104.4245.4293.4407.4924.4524.4417.4439.05 0 68.4447.4452. 0 0  -1.4486. 005210.4
356SMITH & TAYLOR 1 NEL CSESW070537WSPRGRS2.53389.3128.4232.4284.4416.4995.4995.4425.4452. 0 0 89.4460.4472. 0 04477.4493. 0 0117.4
357ABERCROMBIE 1 FISHER CSESE270537WGRNCC 5.03267.2964.4043.4146.4271.4838.4838.4283.4304.04 0100.4309.4318. 0 04331.4348. 006158.4
358ABERCROMBIE 1 FISHERSWSWNW350537WGRNGC 5.03324.3016.4144.4200.4325.4889.4885.4337.4359.04 0118.4364.4371. 0 04385.4401. 002161.4
359KRE 1 HENDRICKS       CSWSW280538WGRNG  5.03509.3176.4287.4338.4476.5055.5055.4487.4511. 0 0 89.4519.4523. 0 04541.4565. 0 0151.4
360FARMER&MLSG. 1 NEITZ CNWNE030539WGRNCSP2.53516.3239.4295.4350.4493.5088.5088.4500.4528.04 0149.  -1.  -1. 0 04547.4574.09 0161.4
361BANGERT 1 RLODER      CSWSW290539WGRNG  2.53529.3214.4300.4357.4499.5113.5113.4510.4538.02 0149.4541.4544. 0 04557.4586.08 0163.4
362SMITH-TAYLOR 1 WATER CSENE010540WSPRGRS2.53636.3387.4433.4486.4625.5250.5250.4632.4661. 0 0114.  -1.  -1. 0 04677.4708. 0 0186.4
363TEXAS CO 1 WALZ      SWNWNW030542WSPR  2.53547.3275.4249.4290.4441.5050.5050.4448.4462. 0 0 -1.  -1.  -1. 0 04502.4528. 0 0 -1.4
364MURFIN 1 SCHRITTER   CSENE350542WSPRGRS2.53791.3501.4522.4567.4714 5396.5396.4724.4748. 004 -1.  -1.  -1. 0 04774.4803.03 0 -1.4
365NAT. ASSOC. 1 RIFFELNWNESE310617WGRNGC 2.51939.1350.3037.3079.3205.3403.  -1.3210.3229. 0 0170.3234.3245. 0 23251.3272. 0 0304.3
366TRANS & KRU. 1 BAUEISENENW120618WGRN   2.51500.1390.3039.3083.3211.  -1.   -1.3215.3234. 4 0 -1.3237.3250. 4 33255.3274. 0 3 -1.3
367LEO J. DRLG 1 MCGEE NWNWNW160618WGRNC  2.51971.1467.3163.3204.3330.3502.   -1.3337.3356. 0 0222.3363.3372. 0 03376.3393. 0 0320.3
368JOHN FARMER 1 BROBST  NESE070619WGRNCC  5.2108.1685.3282.3323.3444.3590.   -1.3451.3470. 0 0105.3474.3486. 0 03491.3506. 0 0184.3
369D & D DRLG. 1 SCHAUMSESENE360619WGRNR  2.52003.   -1.3202.3243.3366.3550.   -1.3375.3393. 0 0157.3396.3409. 0 03415.3430. 0 0210.3
370BRANDT OIL 1 HANSEN SESWSE020620WGRNGC  5.2074.1657.3260.3297.3413.3536.   -1.3423.3440. 0 0107.3445.3456. 0 03459.3474. 3 0188.3
371ROSEN OIL 1 STEELE   CE2SW040620WGRNC  2.52147.1749.3347.3385.3499.3616.   -1.3508.3525. 0 0142.3530.3541. 4 03544.3556. 0 0200.3
372CITIES SER. 2 BURGE NENWNW060620WSPR   2.52171.1670.  -1.  -1.  -1.3557.   -1.3437.3456. 3 0 -1.3460.3471. 4 03473.3486. 0 0 -1.3
373D. A. HINDM. 3 HINDMSENWNE360620WGRN   2.52059.   -1.3250.3290.3412.3563.   -1.3422.3439. 0 0 -1.3443.3455. 3 03460.3474. 2 0 -1.3
374JONES & FARM. 1 BOYSSWSWNE060621WSPR   2.52228.1932.3458.3507.3620.3884.   -1.3628.3643. 0 0 -1.3648.3655. 0 03658.3669. 0 0 -1.3
375JOHN FARM. 1 BARBER NESESE140621WSPRCS 2.52231.1860.3454.3495.3604.3744.   -1.3612.3630. 0 0 -1.3634.3644. 3 03647.3661. 0 0 -1.3
376ALLAN & DRLG. 1 WALLSWNENW300621WGRNGC 2.52293.1946.3508.3548.3665.3866.   -1.3673.3689. 0 0101.3694.3702. 0 03704.3716. 0 0106.3
377VEEDER 1 RUSH        NWNWNW150622WGRNG  2.52333.1980.3540.3584.3693.3872.   -1.3702.3720. 0 0 63.3725.3732. 0 03738.3750. 3 0 92.3
378SCOTT RICHIE 1 KEISWSWNESE270622WGRNG   5.2273.1937.3410.3533.3642.  -1.   -1.3652.3669. 0 0 60.3674.3680. 0 03684.3697. 3 0 96.3
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379F & M OIL 1 SCHUCK  NESWNW090623WGRNGC  5.2435.2060.3592.3636.3741.  -1.  -1.3752.3767. 0 0175.3773.3778. 0 03784.3792. 0 0186.3
380TRANS ERA PET. 1 SCHNENENW090623WSPR   2.52428.2068.3586.3629.3736.3963.  -1.3744.3757. 5 0 -1.  -1.  -1. 0 03774.3782. 0 0 -1.3
381IMPERIAL OIL 1 OLIVE CNESW240623WGRNG  2.52359.2035.3602.3644.3755.  -1.  -1.3766.3782. 0 2130.3784.3790. 0 03795.3810. 2 0112.3
382PATRICK PET. 1 ELLIONWSWNE310623WGRNC  5.2519.2202.3740.3780.3896.  -1.  -1.3901.3919. 0 0122.  -1.  -1. 0 03927.3939. 3 0 66.3
383JONES & FARM. 1 CASENENESE350623WSPR   2.52411.2080.3632.3674.  -1.4008.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 0 0 -1.
384IMPERIAL OIL U-1 TRE CSESE360623WGRNG  2.52361.2012.3570.3610.3720.  -1.  -1.3732.3747. 0 0110.  -1.  -1. 0 03751.3758. 0 0 97.3
385MUSGROVE PET. 1 LOGUNWNWNE080624WSPR   2.52475.2091.3594.3632.3737.4100.  -1.3747.3764. 0 0 -1.  -1.  -1. 0 03774.3785. 0 0 -1.3
386MURFIN CRLG. 1 SCHOE CNESE010625WGRNGC 2.52453.2080.3574.3613.3716.4018.  -1.3724.3739. 0 0 96.  -1.  -1. 0 03755.3764. 0 0 98.3
387D. G. HANSEN 1 CARPESWSWSW130625WGRNG  2.52561.  -1.3691.3728.3834.  -1.  -1.3842.3860. 0 2 70.  -1.  -1. 0 03870.3882. 6 0 70.3
388LFO DRLG 1 HICKERT  SWSWS.270625WGRNGC 2.52571.2167.3668.3708.3818.4166.  -1.3824.3844. 0 2162.  -1.  -1. 0 03855.3863. 0 0196.3
389MURFIN CRLG. 1 SLIFK CSENW010626WGRNGC 2.52489.  -1.3536.3575.3673.4059.  -1.3684.3701. 6 0 85.  -1.  -1. 0 03716.3725. 3 0 72.3
390C-G DRLG. 1 SLOAN   SWSWNW150626WGRNG   5.2620.2273.3734.3773.3883.4295.  -1.3890.3909. 0 2140.  -1.  -1. 0 03923.3932. 4 0 82.3
391ABERCROMBIE 1 VAHLNGSWNESW240626WGRNGS 2.52616.2184.3653.3695.3796.4076.  -1.3808.3826. 0 0135.  -1.  -1. 0 03839.3849.03 0110.3
392RAINS & WIL 1 BRANDTSWSWS.270626WGRNGC 5.02656.2282.3758.3799.3913.  -1.  -1.3922.3941. 002186.  -1.  -1. 0 03958.3969. 002143.3
393CONTINENTAL 512 ACLLSENESW020627WGRNGC 2.52604.2157.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0160.  -1.  -1. 0 0  -1.  -1. 0 0190.
394FARMER 1 MCWERY      CNWSE340627WGRNGS 2.52702.2408.3845.3887.4003.4414.4414.4013.4033. 0 0205.  -1.  -1. 0 04046.4060. 004145.4
395THREE G 1 SIDESINGERSESENE350627WGRNGC 2.52701.2396.3850.3890.4008.  -1.  -1.4016.4033.06 0120.  -1.  -1. 0 04047.4058.04 0118.4
396PET MGT 1 TROMMETER SESESE060628WGRNGC 5.02808.2574.3944.3989.4095.  -1.  -1.4104.4125.06 0191.  -1.  -1. 0 04140.4153.04 0143.4
397PET MGT 1 GEISINGER SESENW160628WGRNG  5.02761.2528.3899.3943.4053.  -1.  -1.4062.4081.04 0174.  -1.  -1. 0 04097.4114.03 0181.4
398LEBEN 1 COOPER      SWSWSW230628WGRNG  2.52664.2408.3796.3842.3951.4359.4359.3958.3978.02 0167.  -1.  -1. 0 03997.4007.05 0161.4
399DREILING 1 RITTER   SWSWSW100629WGRNGC 2.52837.2581.3918.3963.4071.  -1.  -1.4079.4100. 0 0220.  -1.  -1. 0 04118.4130. 0 0220.4
400WESTPAN 1 WESSEL    SWNWNW270629WSPLLML2.52821.2545.3901.3944.4050.4448.4448.4058.4074.03 0 -1.  -1.  -1. 0 04093.4107. 0 0 -1.4
401CITIES SER 1 STROHWINWSESE110630WSPRCRS2.52879.2595.3918.3962.4065.4490.4490.4078.4094. 0 0150.  -1.  -1. 0 04114.4129. 004162.4
402TOM KAT 1 FARBER    CSENE260630WSPRGRS2.52901.2595.3947.3992.4105.4552.4552.4113.4130. 002147.  -1.  -1. 0 04150.4167.03 0153.4
403N D FITZGER. 1 GILCH CSES.300630WGRNCC 2.52956.2637.3967.4010.4130.  -1.  -1.4137.4155. 0 0180.  -1.  -1. 0 04182.4194. 4 0170.4
404V.&DEV. OIL 1 SEEBERSWSWSW340630WGRNG  2.52517.2590.3952.3996.4111.4546.4546.4120.4138. 3 0150.  -1.  -1. 0 04160.4176. 0 0150.4
405RAINS & WM 1 HARNETINWNWSE080631WGRNG  2.52965.2645.3930.3980.4090.4548.4548.4103.4129. 0 0146.  -1.  -1. 0 04143.4163. 005170.4
406NELSON PET. 1 DICKERNWSEN 150631WSPRCR  5.2558.2640.3943.3981.4091.4530.4530.4103.4133. 4 0172.  -1.  -1. 0 04150.4162. 0 2178.4
407TARGET CRLG. 1 PREST CSESW340631WSPRC  2.52918.2652.3961.4008.4119.4548.4548.4122.4153. 0 0 -1.  -1.  -1. 0 04177.4192. 2 2 -1.4
408CITIES SER. A-1 MCGRNENWNE180632WGRCD   5.2561.2634.3891.3939.4052.4519.4519.4062.4092. 0 4108.  -1.  -1. 0 04106.4133. 0 0125.4
409MACK OIL 1 OLSN      CNENE210632WGRNGC 2.53054.2695.3972.4019.4131.4592.4592.4140.4162. 0 0112.  -1.  -1. 0 04190.4207. 0 0172.4
410TARGET 1 FOSTER      CSEN.340632WSPRC  2.53034.2677.3971.4018.4131.4595.4595.4142.4160. 0 0 -1.  -1.  -1. 0 04190.4202. 0 0 -1.4
411SO TEX DEV 1 FRANKLN CNWN.110633WGRNG  2.53107.2701.3947.3996.4101.4576.4576.4112.4132. 0 0108.  -1.  -1. 0 04153.4174. 004190.4
412EMPIRE 1 SPIELMAN    CNWSW340633WGRRSP 5.03152.2785.4057.4104.4227.  -1.  -1.4232.4256. 0 0 -1.4272.4279. 0 04287.4299. 0 0 -1.4
413JAMES OIL CO 1 DONN NWNWNW040634WGRRLLC2.53137.2812.4031.4080.4204.4716.4716.4214.4235. 002 -1.4244.4249.03 04260.4280.06 0 -1.4
414SCHAFER 1 AMOS      CNESE260634WGRNC  2.53171.2813.4066.4113.4236.4722.4722.4244.4266.04 0198.4272.4276. 0 04291.4316. 004239.4
415THUNDERBIRD C-1 CLPRNWNWSE020635WGRNRGC5.03256.2893.4079.4147.4272.4774.4774.4285.4309.04 0 99.4319.4323. 0 04332.4353. 003164.4
416NORBLA 1 LACEY       CNWSW100635WGRNG  2.53287.2919.4122.4170.4296.4793.4793.4306.4326. 0 0176.4332.4337. 0 04354.4372. 003280.4
417GENERAL CRUDE 1 WILLSWWNW220635WGRNCC 2.53245.2858.4076.4123.4255.4750.4750.4264.4285. 2 0163.4292.4295. 0 04308.4327. 0 5110.4
418JACKSON SHR 1 BRINEY CSWNW060636WGRLLC 2.03416.3103.4205.4306.4424.4945.4945.4432.4453.03 0 -1.4461.4468. 0 04480.4505. 0 0 -1.4
419THUNDERBIRD V-3 MILL CNEN.130636WGRNR 5.03351.2981.4166.4218.4340.4806.4806.4354.4370. 0 0116.4375.4380. 0 04364.4412.06 0148.4
420CONTINENTAL 1 GARY C CNWNW220636WSRRGRC2.53382.3030.4170.4236.4362.4816.4816.4374.4393.03 0111.4400.4406. 0 04417.4435. 002132.4
421GRAVES 1 KOLLIER     CSENE350636WGRNG  2.53277.2873.4072.4118.4242.4742.4742.4254.4279. 0 0110.4286.4292. 0 04304.4321.04 0151.4
422PHILLIPS 2 LLANOS    CNWNE100637WGRNC  5.03450.3100.4236.4290.4415.4950.4950.4431.4450. 0 0 78.4456.4462. 0 0  -1.  -1. 004142.4
423ABERCROMBIE 2 COOPER CSE140637WGRNCC 5.03414.3078.4233.4286.4416.4947.  -1.4426.4448. 0 0 70.4449.4459. 0 04475.4496. 0 0119.4
424PET INC 1-C COOPER   CNWSE170637WGRNR  5.03463.3106.4250.4304.4436.5030.5000.4450.4473. 0 0 91.4477.4485. 0 04496.4517.05 0220.4
425PHILLIPS 3 SHERMAN   CNESE210638WGRLLC 2.53425.3066.4200.4250.4386.4368.4368.4400.4421. 0 0 -1.4434.4444. 0 04453.4475. 0 0 -1.4
426JAMES OIL CO 1 KUFRT CNWNW280638WGRNRLL2.53562.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.02 0 -1.  -1.  -1.03 0  -1.  -1. 0 0 -1.
427SCHAFFER OIL 1 HICKS CNESW350638WGRSPR 2.53531.3160.4324.4378.4511.5098.509  4520.4544. 0 0 -1.4550.4560. 4 04584.4603. 0 0 -1.4
428FARMER & 1 ZIMBELMAN CSWSE030639WSPRGRN2.53592.3253.4357.4410.4550.5165.5165.4562.4584. 0 0 -1.4595.4603. 0 04614.4639. 0 0 -1.4
429LAWTON 1 PETERS      CNENE020640WSPRC  2.53628.3294.4353.4421.4556.5256.5256.4569.4590. 004 -1.  -1.  -1. 0 04620.4640. 0 0 -1.4
430MACK OIL A11 SLAMAN  CSWSW170640WSPR   2.53709.3341.4425.4479.4622.5300.5300.4634.4658. 0 0 -1.4665.4670. 0 04679.4704. 004 -1.4
431NORBLA 1 DEFRIES     CNENW220641WSPRC  2.53709.  -1.4408.4462.4607.5302.5302.4615.4638. 0 0 -1.4648.4654. 0 04670.4692. 0 0 -1.4
432NORBLA 1 ELBER       CSENW330641WSPR   2.53774.3367.4452.4510.4654.5345.5345.4661.4685. 0 0 -1.4697.4702. 0 04708.4737.05 0 -1.4
433SIEGEL&TERR. 1 FIAAG CSENW290642WSPRGRS2.53867.3502.4559.4608.4745.5422.5422.4753.4778. 0 0112.4786.4792. 0 04804.4832. 0 0224.4
434PET MGT. 1 ENOCH     NWSWNW320715WGRNGC 2.51854.1182.2934.3038.3178.  -1.  -1.3184.3204.04 0133.3211.3222. 0 03228.3252. 004280.3
435GUNGOLL 1 MUIR       NWSWSE100716WGRNCD 5.01706.  -1.2896.2942.3076.3357.  -1.3081.3100. 0 0145.3103.3119.05 03126.3148. 0 0300.3
436FCD LTD 1 YOUNG      NWNWSW180716WGRNGC 5.01754.1108.2833.2880.3006.3238.  -1.3010.3030. 003174.3034.3046. 0 03052.3074.05 0240.3
437D&D 1 LALA            CSWSE360716WGRNR  2.51878.1232.3090.3139.3276.3615.  -1.3283.3303. 0 0158.3308.3320.03 03327.3351. 003210.3
438NAPCO 1 LEIGH MUIR  NWNWNW050717WGRNGC 2.51933.1346.3034.3078.3203.3384.  -1.3209.3229. 0 0150.3233.3244. 0043248.3268.08 0318.3
439CITIES SERV E-2 SIMOSWSWSW110717WGRNR  5.01877.1217.2953.3001.3126.  -1.  -1.3135.3155. 0 0 -1.3158.3171.02 03177.3198. 002 -1.3
440MURFIN 1 REED        SWSENW260717WGRNRC 2.51790.1123.2854.2896.3024.3225.  -1.3032.3052. 0 0110.3056.3070. 0 03075.3096.02 0218.3
441RICHARDSON 1 CARSTENNESENE320717WGRN   2.51925.1271.3056.3100.3223.3297.  -1.3231.3250.03 0131.3255.3265. 3023270.3291. 006330.3
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442GULF 1 ZILLINGER     SWNWNE310718WGRLLML2.51849.1297.2990.3033.3155.3322.   -1.3164.3182.02 0 -1.3186.3197.03 03202.3219. 0 0 -1.3
443MCCANGLESS 2 DRAY    SENWSE350718WGRNRC 2.51914.1307.3052.3095.3220.3397.   -1.3227.3246. 0 0143.3250.3262. 0043266.3286. 003200.3
444NAGEL 2 LIVINGSTON   NESWSE040719WGRNG  2.52018.1536.3173.3214.3336.3460.   -1.3342.3358.02 0116.3364.3378.03 03383.3401.05 0198.3
445MURFIN 1 OREGAN      SWNESL060719WGRNGS 2.52046.1555.3226.3266.3386.3527.   -1.3394.3413.04 0144.3417.3430.03 03434.3450.06 0211.3
446TERRELL 1 WITMER     NWNWNW170719WGRN   2.51985.  -1.3137.3179.3300.3479.   -1.3308.3323. 002 95.3327.3341.04 03344.3360.04 0185.3
447DEEP ROCK 1 ROY      NWNESL220719WGRLLML2.51897.1379.3047.3086.3213.3382.   -1.3218.3236. 0 0 -1.3239.3253.03 03257.3276. 0 0 -1.3
448IMPERIAL 1 WESTERN A CSESW070720WGRNG   2.52133.1710.3324.3361.3480.  -1.   -1.3489.3504. 0 0116.3509.3520.02 03523.3534.02 0139.3
449SHIELDS 1 LESAGE     CSWSW090720WGRNC   5.02192.1744.3382.3419.3543.3655.   -1.3550.3567.0302125.3570.3583. 0 03585.3598. 0 0218.3
450ZENITH 1 COOPER      SESESE140720WGRNC  5.02842.  -1.3216.3257.3381.3494.   -1.3388.3406. 0 0264.3410.3422. 0 03425.3440. 0 0320.3
451IMPERIAL A-1 HOLSMAN CSESW120721WGRNG   2.52165.1757.3355.3392.3513.3683.   -1.3522.3539. 0 0 93.3542.3554.05 03556.3567.02 0133.3
452HERNDON 1 KENYON     NWNWNW150721WSPR   2.52142.1721.3360.3394.3517.3656.   -1.3523.3539. 0 0 -1.  -1.  -1. 0 03544.3567. 0 0 -1.3
453WILSON A-1 SAYERS    NWNESE310721WGRNG  2.52124.1724.3314.3348.3470.3659.   -1.3476.3492. 0 0 70.3496.3506. 0043508.3528.02 0138.3
454KEATING 1 WORCESTER  NWNWNE120722WSPLL  2.52248.1847.3452.3474.3608.3768.   -1.3618.3632. 0 0 -1.  -1.  -1. 0 03645.3658. 0 0 -1.3
455IMPERIAL B-3 FABRICI CSWSE100722WGRN    2.52268.1883.3482.3522.3638.  -1.   -1.3648.3667. 0 0 -1.  -1.  -1. 0 03672.3693.05 0 -1.
456PET INC D-1 WORCESTERNWNWSE210722WGRNR  5.02264.1895.3449.3489.3603.3824.   -1.3617.3630. 0 0 80.3635.3646. 0 03651.3662. 0 0 88.3
457NATL OIL 1 KORB      CSESW270722WGRNGC  2.52217.1818.3420.3458.3577.  -1.   -1.3587.3602. 0 0 78.3608.3613. 0 03617.3630. 0 0100.3
458MURFIN 1 DRURY       CSESW010723WGRNG   2.52405.2057.3630.3673.3783.4073.   -1.3797.3812.03 0 59.3817.3823. 0 03826.3838. 0 0100.3
459GRM MCHLS 1-17 BRANTNENENE170723WGRNCG 5.02418.2108.3659.3698.3812.  -1.   -1.3825.3844.02 0100.  -1.  -1. 0 03853.3865.03 0 78.3
460PHILLIPS 1 MOORE      CNWSE220723WGRNRSC2.52298.  -1.3526.3569.3681.3948.   -1.3691.3709. 0 0101.3714.3720. 0 03726.3741. 0 0124.3
461IMPERIAL A-8 FABRICI CSENE250723WGRNG   2.52248.1858.3450.3493.3610.  -1.   -1.3620.3638.04 0116.3642.3648.02 03650.3666.06 0 92.3
462EMPIRE 1 ZCHNER      SWSWSW150724WSPR   2.52504.2226.3760.3801.3918.4225.4225.3925.3950. 0 0 -1.  -1.  -1. 0 03960.3972. 0 0 -1.3
463FARMER 1 SCHURTZ     NESENE170724WGRNC  2.52482.  -1.3724.3765.3872.4218.4218.3884.3909. 0 0126.  -1.  -1. 0 03918.3932. 0 0 88.3
464PET INC 1 NOBLER     SWSWSW170724WSPR   2.52496.2192.3732.3777.3888.4233.4233.3897.3920.06 0 -1.  -1.  -1. 0 03933.3945.06 0 -1.3
465G-MCL B1-31 CUMMINGSNENESW310724WGRNGC 5.02417.2125.3677.3717.3827.  -1.   -1.3839.3857.04 0 95.3862.3867. 0 03880.3893. 0 0105.3
466IANNITTI 1 HARDMAN   SWSWSE360724WGRNG  2.52358.2036.3587.3621.3740.  -1.   -1.3750.3768.05 0139.3772.3778.02 03786.3800.04 0 95.3
467HALLIBURTON 1 WILCOXNESENW070725WGRNG  2.52554.2133.3624.3662.3768.  -1.   -1.3778.3797. 0 0230.  -1.  -1. 0 03812.3822.03 0118.3
468HARDMAN 1 SHUGHART   SWSWNW080725WSPR   2.52533.2120.3618.3661.3766.4054.4094.3776.3794. 0 0 -1.  -1.  -1. 0 03807.3817. 0 0 -1.3
469FEM 2 DUGAN          CNENE100725WGRNRC  5.02501.2146.3650.3690.3800.  -1.   -1.3810.3829.06 0271.  -1.  -1. 0 03840.3851.04 0176.3
470CHIFF 4 MOCHT        CN?360725.GRNCC    5.02438.2136.3679.3721.3832.  -1.   -1.3844.3861.03 0105.3865.3869. 0 03881.3894.05 0119.3
471EMPIRE 1 ALLEN O. S.SWSWSW030726WSPR    2.52550.2278.3754.3799.3911.  -1.   -1.3920.3937.06 0 -1.  -1.  -1. 0 03950.3962.04 0 -1.3
472LYNCO 1 SLOAN        NENENE070726WGRNGC 5.02627.2328.3810.3851.3965.  -1.   -1.3975.3994.03 0165.  -1.  -1. 0 04009.4020.03 0160.4
473FARMER 1 BARNETT     NWNWNE230726WSPR   2.52573.2269.3768.3808.3925.4314.4314.3935.3956. 0 0 -1.  -1.  -1. 0 03963.3975.03 0 -1.3
474ANSCHUTZ 1 MARSHALL  SWSWSW300726WSPR   2.52637.2320.3807.3853.3971.4404.4404.3978.3999.05 0 -1.  -1.  -1. 0 04016.4028.04 0 -1.4
475MURFIN 1 SCHWARZENBESESENE310726WGRNC  2.52583.2248.3747.3795.3913.  -1.   -1.3922.3940. 0 0180.3945.3949. 0 03956.3969. 0 0180.3
476BURCH 1 SHEETZ       CSEN.350726WGRNG   2.52542.2206.3705.3738.3864.  -1.   -1.3874.3892. 0 0143.3896.3900. 0 03908.3921. 0 0166.3
477NATL OIL 1 SNIFFEN   NESENE020727WGRNC  5.02683.2366.3816.3855.3972.  -1.   -1.3976.3997. 0 0160.  -1.  -1. 0 04010.4024.03 0150.4
478MAHONING 1-4 WALDEN  SWNWSE040727WSPRC  2.52705.2432.3854.3911.4024.  -1.   -1.4030.4054. 0 0 -1.  -1.  -1. 0 04067.4082. 004 -1.4
479RAINS 1 HOXIE CITY   CSWSE320727WGRNGC  2.52716.2409.3840.3922.4044.  -1.   -1.4050.4077. 0 0220.4085.4088. 0 04096.4109.03 0188.4
480JORDAN 1 SCHAMBERGER CSWSW040728WGRNGC  5.02790.2523.3922.3964.4083.  -1.   -1.4089.4110.04 0187.  -1.  -1. 0 04129.4141.04 0173.4
481EMPIRE 1 WATKINS     SESES.150728WSPR   2.52784.2497.3915.3958.4078.4492.4492.4081.4100. 0 0 -1.  -1.  -1. 0 04118.4130.05 0 -1.4
482EMPIRE 1 STEWART     SESENE350728WSPR   2.52744.2457.3883.3932.4055.4476.4476.4061.4087.04 0 -1.  -1.  -1. 0 04104.4117. 0 0 -1.4
483FARMER 1 BELL        SESENE200729WGRNGC 2.52878.2547.3935.3975.4097.  -1.   -1.4104.4123. 0 0180.4132.4136.04 04144.4158.04 0186.4
484ZENITH 1-27 HILL     CNW..270729.GRN.C  2.52854.2511.3925.3964.4082.  -1.   -1.4092.4110. 0 0140.4115.4123. 0 04132.4146. 0 0199.4
485KING 1-3 HUBER       CSWS.030730WSPRGRD2.52884.2570.3947.3985.4101.4512.4512.4112.4131. 0 0168.  -1.  -1. 0 04151.4166.02 0164.4
486GULF 1 GILCHRIST     CNENE200730WGRCC   5.02907.2570.3949.3991.4110.4538.4538.4118.4135. 0 0154.  -1.  -1. 0 04164.4179. 0 0180.4
487RASS ENT. 1 ROSO     CSEN.270730WGRGRC  5.02540.2598.3990.4030.4149.4584.4584.4160.4179.02 0106.  -1.  -1. 0 04202.4217.04 0124.4
488TARGET 1 SIBLE       CNWSE080731WSPR    *.03030.2792.3974.4040.4155.  -1.   -1.4163.4183.02 0 -1.4198.4201. 0 04219.4231. 0 0 -1.4
489GULF 2-15 MCCORMICK  CSESE130731WGRRN   5.02930.2601.3958.4001.4123.  -1.   -1.4131.4153. 0 0148.  -1.  -1. 0 04176.4193. 0 0191.4
490GULF 1-24 MCCORMICK  CNENW240731WGRNCC  5.02532.2592.3951.3993.4115.  -1.   -1.4127.4150. 0 0135.  -1.  -1. 0 04170.4187. 0 0199.4
491GULF 1 RALL          NWNWNW350731WGRNC  5.02595.2657.4033.4073.4195.  -1.   -1.4201.4225.02 0123.4236.4240. 0 04250.4267.04 0208.4
492FARMER 1 FLANAGIN    CNENE100732WSPR    5.02599.  -1.3946.3993.4107.4560.4560.4115.4137.04 0 -1.  -1.  -1. 0 04168.4188. 0 0 -1.4
493MUSGROVE 1 FLANAGIN  CNENE100732WSPR    2.52559.2650.3947.3994.4106.4574.4574.4116.4135.04 0 -1.  -1.  -1. 0 04168.4188. 0 0 -1.4
494DREILING 1 FLANAGIN  CSWSW120732WGRNG   2.53034.2686.3994.4042.4157.  -1.   -1.4163.4183.04 0100.4195.4202. 0 04215.4234. 0 0172.4
495CITIES SER A-1 KNUDSNESENW160732WGRDC   5.03065.2722.4027.4069.4189.4620.4620.4196.4215. 0 0 97.4227.4232. 0 04240.4266.02 0221.4
496CITIES SR A-2 KNUDSNSWNENW160732WGRNR   5.03075.2724.4032.4075.4198.  -1.   -1.4203.4221. 0 0113.4232.4240. 0 04253.4277. 0 0210.4
497VIRGINIA 1 COOPER    NENENE120733WSPR   2.53091.2717.4011.4058.4179.  -1.   -1.4190.4211. 0 0 -1.4221.4227. 0 04231.4253. 0 0 -1.4
498MIAMI A-1 STEWART    NWNWNW280733WGRLLR 2.53129.2808.4105.4152.4285.4715.4715.4294.4314. 0 0 -1.4322.4328. 0 04338.4358. 0 0 -1.4
499COLORADO 1 HILLS     SESESW220734WGRLLML2.53219.2848.4137.4182.4315.4854.4854.4326.4348. 0 0 -1.4354.4361.03 04370.4390.0207 -1.4
500ATHENS 1 NICKELS     CNENE260735WGRR    2.53198.2796.4065.4110.4236.4700.4700.4248.4269. 0 0 -1.4278.4284. 0 04293.4311.0302 -1.4
501NIELSON 1 GOETSCH    CSWNE030736WGRNGC  5.03332.2941.4148.4197.4321.4809.4809.4333.4353.03 0113.4364.4370. 0 04377.4401. 003210.4
502NCRA 1 GUISE         SWSWSE150736WGRR   2.53398.2997.4205.4250.4378.4812.4812.4388.4410.06 0 -1.4416.4422. 0 04428.4454. 0 0 -1.4
503HANSEA 1 DAVIS       CSESE270736WGRNGC  5.03370.2941.4162.4207.4348.4850.4850.4358.4379. 0 0119.4386.4394. 0 04400.4426. 0 0210.4
504US SIGNAL 1 BAIRD 71 CNEN.040737.SPRGRD2.53467.3109.4277.4332.4469.5051.5051.4478.4502.03 0120.4511.4521.02 04532.4551. 0 0305.4
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505MIAMI C-1 DEAN        CSWSW180737WGRLLS 2.53498.3146.4328.4380.4514.5086.5086.4526.4548.04 0 -1.4563.4571.03 04584.4605. 002 -1.4
506MIAMI A-1 DAVIS       NWNWNW240737WGRLLS 2.53391.3026.4218.4268.4404.4962.4962.4414.4435.02 0 -1.4444.4453. 0 04462.4485. 0 0 -1.4
507MACK OIL 1 BAIR       CNWSW180741WGRNRSP2.53862.3403.4522.4559.4720.  -1.  -1.4730.4752.04 0128.4764.4768. 0 04779.4805. 004252.4
508D&D 1 CORNWELL        CSESW270813WGRN    2.51691. 884.2857.2915.3058.3452.   -1.3065.3085. 0 0144.3087.3100. 0 03106.3135.06 0248.3
509VEAIL 1 SARVER        CSENE290813WGRRCS 2.51763. 980.2936.2989.3135.3564.   -1.3146.3168.04 0103.3171.3184. 0 03190.3217.02 0190.3
510VEAIL 1 BLISS         CSESE300813WGRNRC 5.01847.1082.3079.3135.3287.3782.3782.3293.3314.05 0169.3317.3334. 0 03336.3365.05 0318.3
511VEAIL 1 SWANGER       CSENW090814WGRNGS 5.01751.1001.2923.2968.3118.3504.   -1.3124.3143. 0 0115.3146.3164. 0 03167.3196.10 0220.3
512CITIES SERV 1 DALES   CSWNW140814WGRLL  5.01803.1027.2972.3034.3169.3584.   -1.3179.3196.05 0 -1.3198.3215. 0 03218.3245.06 0 -1.3
513TRANS ERA 1 HACKENOTSWSESF190814WGRLLML5.01810.1079.3013.3072.3205.3537.3537.3217.3233.04 0 -1.3235.3255.02023259.3286. 0 0 -1.3
514TEXACO 1 THORNBURG      CSW240815WSPRGR 2.51850.1142.3057.3103.3247.3589.3589.3251.3270.0406 -1.3273.3292.04033296.3322. 0 0 -1.3
515VEAIL 1 GRIFFIN       CSENW290815WCSGRR 2.51964.1212.3138.3183.3326.3708.   -1.3330.3352.0203165.3356.3366. 0033372.3398. 0 0270.3
516TRANS-ERA 1 KOELLINGSESWNW350815WGRLLML2.51523.1163.3099.3145.3290.3682.   -1.3295.3314.12 0 -1.3317.3335. 0023340.3368. 0 0 -1.3
517CHESNEY C-4 CHESNEY   CNWSW180416WGRNR  2.51898.  -1.2986.3029.3156.3360.   -1.3164.3183. 0 0140.3144.3198.03 03204.3228.04 0200.3
518NATL CRLG 1 CHESNEY   CNWSW200816WGRNG  5.01935.1236.3050.3094.3223.3474.   -1.3227.3246. 0 0142.3248.3262. 0 03268.3292.12 0290.3
519CITIES SERV ACW ALPSNESWSE330816WGRN    5.01953.  -1.3021.3061.3195.  -1.   -1.3205.3225. 0 0120.3228.3241.03 03247.3274.0206225.3
520WHITE 1 LARSON        S2SWSW110817WGRNGC 5.01931.1263.3049.3094.3224.3430.  -1.3234.3251. 0 0174.  -1.  -1. 0 03256.3292.0204220.3
521CLINTON 2-D WELLS     SWNESW170817WGRNR 5.01889.1231.3007.3050.3172.3307.   -1.3172.3200. 0 0178.3204.3216. 0 03220.3240. 003220.3
522HANSEN 6 REEDER       NESESE190817WGRNCC 5.01536.1267.3046.3088.3212.3352.  -1.3220.3238.03 0133.3242.3255. 0 03260.3278. 004220.3
523CONTINENTAL 1 HRAUL SENWSE350817WGRNG   2.51926.1198.3030.3074.3202.3377.   -1.3208.3228.0203115.3231.3243.03043250.3272.0202320.3
524CLINTON 1 PEASLEE     SWSWNW100818WGRNG 5.01921.1306.3056.3099.3221.3373.   -1.3228.3244. 0 0 95.3248.3260. 0 03265.3281. 0 0260.3
525PATE 1 REYNOLDS       NESWNW170818WGRNG 5.01980.1363.3104.3145.3265.  -1.   -1.3276.3294. 0 0 68.3298.3310. 0 03315.3328. 0 0174.3
526CITIES SERV 1-B SCHNSWSWNE100819WSRRGRS5.01591.1420.3161.3201.3324.3513.   -1.3334.3351. 005215.3354.3366. 0043370.3388. 006240.3
527RAYMOND 1 VERVERKA    SESENW250819WGRR  2.52050.1467.3214.3254.3378.3494.   -1.3384.3402. 0 0114.3405.3416. 0 03418.3437. 0 0240.3
528OFS 3 THYFAULT         NESESW060820WGRNRC 2.51573.1539.3162.3200.3322.3486.  -1.3329.3346. 004 70.3351.3362.02 03364.3379.06 0189.3
529GRABOL 1 HINKHOUSE    SENESW260820WGRNG 2.52056.1574.3251.3289.3413.3599.   -1.3421.3439. 0 0 80.3442.3458.08 03460.3475. 0 0198.3
530NAPCO 1 THIRZUIT      S2SENW300820WGRN   2.52628.1572.3241.3283.3412.3594.   -1.3418.3435. 0 0120.3433.3451.04 03453.3471.06 0250.3
531ANSCHUTZ 1 KENYON     SESESE050821WSPR   2.52077.1639.3233.3274.3392.3574.   -1.3401.3418. 0 0 -1.3421.3432. 0 03434.3447. 0 0 -1.3
532TRANS ERA 1 KENYON    NENESE030821WSPR   2.52007.1554.3193.3231.3354.  -1.   -1.3362.3377. 0 0 -1.3393.3392. 0 03394.3405. 0 0 -1.3
533BENNETT 1 KENYON      SWSWSW170821WGRLLML2.52085.1633.3274.3315.3437.3638.  -1.3444.3462. 0 0 -1.3465.3476. 0 03478.3492. 0 0 -1.3
534BEACON 1 BUCKNER      SENEN 010822WGRNG 5.02101.1674.3272.3306.3424.3643.   -1.3433.3449. 0 0 75.  -1.  -1. 0 03455.3478. 0 0118.3
535IMPERIAL 1 HARRISON   CSEN 040822WGRNG  2.52181.1807.3399.3438.3555.  -1.   -1.3565.3580. 0 0 68.3586.3592. 0 03596.3609. 0 0 85.3
536HOOVER 1 CUIAT        SWNWSE150822WGRNRC 5.02203.1818.3419.3455.3578.  -1.  -1.3589.3605.02 0104.3611.3617. 0 03626.3639. 0 0136.3
537SHIELDS A-1 SMITH ESNWNWSE230822WGRNG  2.52159.  -1.3350.3397.3520.  -1.   -1.3529.3543. 0 0 -1.3549.3557.03 03559.3573.02 0 -1.3
538RITCHIE A-1 MONTGMRYSWSWN 080823WGRNGC 5.02248.1897.3469.3508.3623.  -1.   -1.3636.3654. 0 0 91.3659.3666.02 03674.3687. 0 0115.3
539JENNINGS 1 RADCLIFFENWNESE230823WGRNG  2.52138.1753.3352.3392.3516.  -1.   -1.3518.3534.0204110.3542.3551.06 03556.3573.03 0260.3
540CAREY 3 GOFF           NWSEN 030824WGRN  2.52284.  -1.3490.3512.3645.  -1.   -1.3655.3671.07 0 -1.3675.3686.04023688.3700. 003 -1.3
541HERNDON E MCKINLEY    NESWSE310824WGRNG 2.52431.2124.3720.3761.3881.  -1.   -1.3891.3909.0304101.3913.3924.07 03733.3948.03 0214.
542NATIONAL 1 DRUMMAGE   NENENW360824WGRNGC 5.02378.2063.3658.3710.3827.  -1.  -1.3837.3855. 0 0 83.3862.3870.03 03873.3886. 0 0170.3
543APTNELL 1 FOX ESTATENWNWN 010825WSPR    5.02418.2147.3708.3742.3865.  -1.   -1.3881.3900.07 0 -1.3905.3909. 0 03925.3934. 0 0 -1.3
544C-G & APPLEMAN 1 TCLSWSESW050825WGRNG  2.52512.  -1.3752.3792.3906.  -1.   -1.3918.3938.02 0168.3939.3943. 0 03953.3967.05 0152.3
545IMPERIAL 1 DAVIS       SESWSW050825WGRNG 2.52511.  -1.3755.3795.3910.  -1.   -1.3918.3938.04 0160.3942.3950. 0 03955.3967.03 0123.3
546TEXAS A-3 MACLEN &CACESEN 170825WSPR    2.52362.  -1.3602.3634.3755.  -1.   -1.3765.3784. 003 83.3787.3733. 0 03798.3819.06 0148.
547BANKOFF 1 COLLEY       NWNWS 280825WGRNCC 2.52516.2233.3764.3906.3924.  -1.  -1.3934.3952. 0 0110.3956.3964.02 03973.3986.03 0159.3
548TEPPER 1 NIBLOCK      SESWN 020826WGRNG  2.52507.2132.3638.3678.3795.  -1.   -1.3802.3822. 002190.3827.3833.02 03839.3852.04 0170.3
549TEXACO 1 ALHERS       CNESW050826WSPR    2.52552.2193.3716.3757.3877.4316.4316.3888.3905.04 0 -1.3911.3914. 0 03925.3935. 0 0 -1.3
550HANSEN 2 TAYLOR        CSESW190826WGRNG  2.52481.2106.3594.3632.3752.  -1.   -1.3758.3778.08 0163.3784.3791. 0 03798.3811.04 0218.3
551CPEILINC 1 ZEIGLER    CSWS 300826WGRNG   2.52566.2176.3653.3695.3810.  -1.   -1.3818.3840. 0 0174.  -1.3849. 0 03856.3872. 005144.3
552MUSGROVE 1 SENGER     NENENE340826WSPR   2.52545.2158.3608.3706.3829.4210.4210.3835.3853.04 0 -1.3858.3862. 0 03874.3885. 0 0 -1.3
553LEBEN 1 TOCTHAKER     SESESE070827WSPR   5.02604.2355.3823.3871.3985.4431.4431.3996.4017. 0 0 -1.  -1.  -1. 0 04036.4049. 0 0 -1.4
554IMPERIAL 1 HAFNER      CSWNE150827WGRLLML2.52577.2244.3752.3789.3918.  -1.4442.3924.3944. 0 0 -1.3950.3956. 0 03963.3977. 0 0 -1.3
555AURORA 1 PENCERGASS    CSWNW240827WGRNGSP5.02518.2170.3641.3702.3817.4258.4258.3822.3842.08 0121.3848.3855. 0 03865.3875. 0 0123.3
556HEATHMAN A-1 BROWN     NWNWNW260827WSPR   2.52555.2190.3684.3722.3838.4294.4294.3845.3866.08 0 -1.3873.3878. 0 03885.3901.07 0 -1.3
557SMITH 1 HILL           CSWSE260827WGRNC  2.52573.2186.3696.3728.3841.  -1.   -1.3847.3868. 008188.3876.3883. 0023891.3903.04 0272.3
558SLAWSON N-2 MOSIER     SWSESW340827WGRNGC 5.02604.2213.3710.3746.3867.  -1.  -1.3875.3895. 0 0150.3902.3913. 0 03919.3932. 003176.3
559PICKRELL 1 WEIS        CSESE020828WGRN    2.52727.2438.3892.3922.4044.4472.4472.4054.4073. 0 0149.4079.4085. 0 04091.4105.0303138.4
560CITIES SERV B-1 JAMENENENW070828WSPR    5.02778.2473.3900.3940.4058.4474.4474.4069.4091.03 0 -1.4098.4102. 0 04111.4125.06 0 -1.4
561PICKRELL I-1 CAMPBELL CSESE140828WGRN   2.52642.2338.3833.3891.3961.4395.4395.3968.3989. 0 0115.3996.4003. 0 04010.4025. 0 0121.4
562RITCHEE 1 SHAW         SWNENW330828WGRNGC 5.02710.2346.3792.3828.3953.  -1.  -1.3960.3981.04 0195.3986.3993. 0 04003.4021.03 0198.4
563ROCK IS 1 SCHRUBER     SENESW080829WGRNG 2.52889.2558.3977.4014.4139.  -1.   -1.4149.4169. 0 0150.4177.4185. 0 04197.4215. 0 0180.4
564HALLIBURTON 1 EDWARD CNWSE260829WGRNG   5.02739.2363.3818.3855.3976.  -1.   -1.3984.4002. 0 0108.4013.4023. 0 04030.4047. 004160.4
565JONES 1 KOSTER          SESESW290829WSPR  5.02757.2424.3850.3889.4016.  -1.   -1.4024.4044. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 0 0 -1.4
566TEPPER 1 KOSTER         SESENW320829WGRNG 2.52843.2468.3908.3946.4075.  -1.   -1.4080.4099.06 0165.4111.4123. 0 04131.4149.03 0240.4
567SLAWSON A-1 COX         E2NESE320830WGRN   2.52958.2577.3988.4026.4154.  -1.   -1.4157.4175. 0 0130.4186.4198. 0 04206.4227.08 0220.4
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568FARMER 1 HCUSTON      CNWNW170831WGRNG  5.03009.2738.4114.4152.4283.  -1.  -1.4291.4308. 0 0 71.4321.4332. 0064346.4365.03 0172.4
569SHAKESPEARE 1 FREERK CSWNW320831WSPRGRN5.03050.2671.4092.4080.4216.  -1.  -1.4226.4244. 0 0 98.4252.4264. 0 04280.4298. 0 0300.4
570MURFIN 1 CHRISTENSONNENENE340831WGRNGC 2.52977.2600.3982.4020.4147.  -1.  -1.4154.4172.02 0140.4186.4202. 0 04212.4232. 0 0220.4
571SLAWSON A-1 HOEGER   CSWNE280832WGRNG  5.03095.2693.4047.4087.4221.4652.4652.4230.4251. 0 0130.4259.4266. 0 04277.4304. 0 0181.4
572VEEDEN 1 KINDIG      NENESE300832WSPR  2.53135.  -1.4074.4113.4248.  -1.  -1.4258.4278. 0 0 -1.  -1.4297. 0 04310.4328. 0 0 -1.4
573RAINS 1 BASTIN       CNWNE340832WGRNG  2.53102.2690.4050.4090.4223.4652.4652.4233.4253. 0 0155.4263.4272. 0 04280.4308.06 0235.4
574JONES 1 BAKER        NENENW210833WSPR  2.53173.2769.4096.4138.4275.4731.4731.4285.4311.04 0 -1.4315.4320. 0 04333.4355.0607 -1.4
575SLAWSON B-1 VACIN    CNENW240833WGRN   2.53125.2739.4069.4113.4245.4699.4699.4253.4276.04 0204.4282.4290.03 04300.4320.03 0240.4
576NATL OIL 1 LEAKE     NWNWSE360833WGRNG 2.53150.2743.4098.4136.4274.4725.4725.4292.4310. 0 0155.4317.4326. 0 04335.4355. 0 0168.4
577PLACID 1 BERTRAND    CNENE070834WSPRGRS2.53247.2804.4094.4137.4272.4769.4769.4282.4305. 0 0185.4312.4319. 0 04328.4347. 0 0228.4
578CHIEF 1 SCHILLKE     CNWSE160834WGRNEC 5.03261.2795.4082.4127.4258.4707.4707.4267.4288.02 0173.4296.4303.06 04313.4332. 0 0190.4
579FARMER 1 CELL        CSESE270834WGRNG  2.53236.2782.4112.4154.4302.4746.4746.4310.4332. 0 0157.4340.4349. 0 04361.4379. 0 0247.4
580SLAWSON A-1 GARVEY   CSESW070835WGRNR  2.53324.2845.4096.4140.4280.4779.4775.4289.4311. 0 0185.4319.4326. 0 04333.4358. 0 0204.4
581PLACID 1 HELLE       CSENE130835WGRSPS 2.53263.2803.4110.4152.4290.4778.4778.4300.4323.02 0195.4331.4339. 0 04350.4368. 0 0240.4
582VIRGINIA 1 FAULKNER  NENENE270835WGRNG 2.53273.2798.4086.4134.4274.4750.4750.4284.4307.02 0184.4316.4324. 0024334.4352.03 0266.4
583MURFIN 1 CAWLS       CNWSW310835WGRNC  2.53359.2846.4132.4179.4320.4857.4857.4330.4354.04 0150.4363.4375. 0044382.4406. 002220.4
584MORRISON 1 FULWIDER  CNENE070836WGRNG  2.53392.2929.4147.4191.4334.4864.4864.4344.4365. 0 0180.4375.4384. 0 04394.4416.0303320.4
585MURFIN 1 JUISE       SWSWNW180836WGRNGSP2.53436.2934.4163.4209.4352.4922.4922.4362.4385.04 0163.4391.4403. 0 04414.4435.03 0210.4
586TARGET 1 HANSON      CNENW270836WGRNG  5.03338.2847.4106.4155.4292.4805.4805.4301.4323. 0 0112.4331.4339. 0 04342.4375. 006280.4
587SKELLY 1 MULLENDER   CNWNE130837WGRSPLL2.53447.2956.4169.4216.4358.4931.4931.4369.4392.04 0 -1.4400.4409. 0 04423.4438.02 0 -1.4
588JAMES OIL 1 PATE     NWNWSW190837WGRNSP 2.53531.3045.4252.4301.4445.5006.5006.4457.4480. 0 0 -1.4490.4505. 0 04518.4533. 0 0 -1.4
589PHILLIPS 6 GOODLAND  NWNWNE290838WGRLLML2.53583.3080.4291.4340.4484.5102.5102.4494.4522. 0 0 -1.4534.4549. 0 04552.4572. 0 0 -1.4
590MURFIN 1 LINSCOTT    CSWSE300838WGRNG  2.53607.3107.4295.4348.4502.5106.5106.4516.4543. 0 0175.4552.4563. 0 04572.4593. 0 0220.4
591MACK OIL 1 ARMSTRONG CSENW060839WGRN   2.53664.3168.4326.4374.4520.5172.5172.4532.4555.04 0200.4567.4575. 0 04588.4608. 0 0166.4
592MUSGROVE 1 TRACHEL   CSENW230839WGRNG  2.53633.3143.4329.4376.4526.  -1.  -1.4535.4562.06 0137.4574.4582. 0 04594.4616. 0 0280.4
593MACK OIL 1 FEVNER    CNWSE120840WGRNG  5.03678.3164.4334.4379.4525.5178.5178.4537.4560.02 0125.4572.4580. 0 04595.4613.03 0205.4
594ATHENS 1 ZEIBIG      CSWSW100842WSPRC  2.53671.3373.4435.4538.4684.5358.5358.4691.4712. 0 0 -1.4725.4732.03 04746.4773. 0 0 -1.4
595ANDERSON 1 WEISNER   SWNWN 050915WGRLLPL2.52050.1301.3208.3246.3390.  -1.  -1.3397.3416. 0 0 -1.3422.3433. 0 03440.3466. 0 0 -1.3
596TRANS-ERA 1 FINNSEY  NWNTN 150915WGFLLPL2.52014.1255.3177.3224.3365.3714.  -1.3372.3390. 0 0 -1.3393.3408.02 03412.3443.0402 -1.3
597RITCHIE 1 NORRIS     SESESW180915WGRNGC 5.02018.1223.3156.3209.3351.  -1.  -1.3356.3375. 0 0 88.3379.3389. 0 03398.3424. 0 0163.3
598TRANS-ERA 1 WHITE    SESENW270915WGRNG  2.52023.1238.3175.3227.3362.3702.  -1.3367.3388. 005125.3373.3406. 0 03416.3439. 002310.3
599BARNETT 1 [illegible]  CSWNW340915WSPLLCD2.51581.1292.3156.3220.3355.3686.  -1.3359.3380. 0 0186.3344.3374. 0 03402.3429. 0 0240.3
600COHEN E-2 MCFADDEN   SENESWC30916WGRN   2.51590.1273.3006.3048.3184.  -1.  -1.3187.3208.07 0124.3211.3223.0402322B.3256.0604274.3
601PHILLIPS 1 CASEY     NESWNE210916WGRNG  5.02076.1298.3165.3207.3341.  -1.  -1.3345.3366.05 0131.3370.3384.05 03388.3413.05 0310.3
602BURCH 1 SEEC.        SWSWNW260916WGRNC  2.52042.1268.3154.3195.3336.3535.  -1.3340.3361.05 0137.3363.3376.04 03381.3408. 002280.3
603F&M 1 COLGHAN        SWNWNW330916WGRNGC 5.02643.1252.3145.3188.3316.  -1.  -1.3321.3341.04 0186.3345.3359.03023363.3388. 0 0220.3
604PICKRELL E-2 HRABE   NESWNW030917WGRNCC 2.52026.1329.3135.3178.3304.3455.  -1.3313.3331. 0 0145.3335.3348. 0 03353.3374. 003220.3
605HERNDON 1 WESTHUSIN  SESENE150917WGRNG  2.52029.1295.3127.3168.3297.3450.  -1.3303.3324.0504125.3330.3341. 0043345.3366. 002280.3
606EDMISTON 1 HAKA      SESENE230917WGRNCR 5.02097.1384.3219.3260.3385.3615.  -1.3395.3416. 003140.3419.3433. 0023438.3459. 0 0320.3
607TILCO 1 LINDQUIST    SESWSE350917WGRNC  2.52068.1391.3170.3211.3340.3556.  -1.3347.3369.04 0120.3374.3388. 0 03392.3412. 0 0265.3
608CONTINENTAL 4 THOMPSNESENE060918WGRN   2.52072.  -1.3204.3245.3352.3487.  -1.3355.3393.04 0 67.3397.3408.04 03412.3429.02 0152.3
609CITIES SERV A-1 HILGSESENW210918WGRN   5.02170.  -1.3243.3326.3450.3560.  -1.3455.3474.10 0192.3478.3492.07 03494.3514. 003272.3
610EDMISTON 2-2 STUCKY  SENWSE300918WGRNGC 5.02191.1558.3320.3362.3488.  -1.  -1.3493.3510. 0 0101.3513.3521. 0 03527.3546.02 0210.3
611TILCO 1 CUENAGEN     SWSWN 050919WGRN   2.52035.  -1.3216.3257.3378.3498.  -1.3385.3403.0302 88.3405.3418.12 03421.3437. 0 0148.3
612PHILLIPS 1 KOHA      NENESE140919WGRNC  5.02055.  -1.3187.3228.3345.3463.  -1.3357.3375.02 0 76.3378.3390.02 03392.3410. 0 0165.3
613SUTTON 2 STULL       SENENW170919WGRNGC 5.02078.1489.3241.3281.3405.3522.  -1.3413.3429. 0 0 91.3431.3442. 0 03444.3464. 0 0164.3
614MURFIN 2 DAUPHIN-DESNESENE070920WGRNGC  5.02152.1683.3385.3424.3553.3764.  -1.3557.3573. 0 0102.3578.3588. 0 03592.3610. 0 0179.3
615HINKLE B-1 KERN      SESESE100920WGRNGC 2.52144.1672.3335.3372.3501.3637.  -1.3508.3525. 0 0 70.3529.3544. 0 03547.3560. 0 0194.3
616NADEL 12 HINKHOUSE   SESESW270920WGRN   2.52282.  -1.3479.3526.3653.  -1.  -1.3661.3679.06 0 78.3683.3698.04 03702.3716.04 0168.3
617THREE G 1 HERROLD    NWNESE030921WGRNGC 5.02161.1624.3313.3354.3482.3700.  -1.3489.3506. 0 0108.3510.3521. 0 03523.3537. 0 0140.3
618CONTINENTAL 5 MOREL  CNENE150921WSPRGRN2.52243.1687.3373.3412.3540.3705.  -1.3546.3563. 0 0 96.3567.3579.04 03581.3595.02 0131.3
619ALLISON A-1 SMITH    NESWNW300921WGRN   2.52248.1843.3518.3558.3685.3899.  -1.3694.3711. 0 0256.3715.3727. 0 03729.3747. 0 0248.3
620ALLISON 2 LAMBERT    SESWSW360921WGRN   2.52279.1770.3508.3549.3675.3880.  -1.3682.3698. 0 0172.3702.3714. 0 03717.3734. 0 0314.3
621PICKRELL A-1 BORLAND CNWSE030922WGRNR   2.52156.1751.3406.3445.3576.3814.  -1.3580.3597.02 0108.3601.3611. 0033614.3627.02 0138.3
622RAYMOND 1 RICE       NWSESE090922WGRNGCS2.52294.1847.3506.3549.3680.3916.  -1.3683.3699. 0 0110.3705.3713. 0023717.3732. 0 0210.3
623CITIES SERV C-1 BARBNWNESW260922WGRNR  5.02269.1836.3540.3598.3710.  -1.  -1.3714.3732. 0 0105.3739.3749. 0013755.3771.04 0168.3
624PET INC E-1 MANAUGH  CNENW290922WGRNCML5.02389.1920.3604.3641.3769.  -1.  -1.3775.3792.03 0147.3795.3804. 0 03807.3824.04 0240.3
625RITCHIE A-1 ENGLEMANSCNWSW050923WGRNGC 5.02368.2011.3664.3707.3823.  -1.  -1.3832.3849. 0 0114.3850.3859. 0 03870.3884. 0 0166.3
626FARMER 1 KLENK       NWSWNE180923WGRNCG 5.02354.2011.3649.3692.3814.  -1.  -1.3817.3834. 0 0 88.3839.3847. 0 03856.3870. 0 0156.3
627PET INC 2 VESPER     SWNESE360922WGRN   5.02415.1964.3648.3682.3814.  -1.  -1.3819.3836.01 0 -1.3841.3850. 0 03859.3873.06 0 -1.3
628CHAMPLIN 7 KLITH     SESENE040924WSPR   5.02437.2140.3744.3784.3905.  -1.  -1.3914.3931. 0 0 -1.3938.3946.02 0  -1.3973. 0 0 -1.3
629PET MGT 1 POORE      NWSWSW270924WGRNGC 5.02536.2185.3842.3877.4003.  -1.  -1.4014.4031. 0 0124.4035.4044. 0 04053.4067.01 0208.4
630KOCH 16-E KNOBEL     CSESE360925WGRNGC 5.02604.2302.3861.3899.4020.  -1.  -1.4030.4048. 0 0108.4056.4068.06 04076.4090. 0 0145.4
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631KEATING 1 MINIUP     SLSESW150925WSPR    2.52594.2269.3866.3906.4033.4446.4446.4044.4064. 0 0 -1.4068.4078. 0 04084.4097. 0 0 -1.4
632IMPERIAL 1 RICHMEIER CNWSE300925WGRNG    2.52604.2246.3843.3875.4009. -1.  -1. 4014.4033. 0 0 91.4037.4047. 0 04058.4073.04 0131.4
633AMERADA 1 SHEEHAN    CNWNE030926WSPRC    2.52594.2215.3732.3774.3890.4304.4304.3897.3913.04 0 -1.  -1.  -1. 0 03936.3948. 0 0 -1.3
634BROWN 1 RICHARDS     SWSESW170926WGRNA   5.02698.2273.3803.3842.3960.  -1.  -1.3968.3987. 0 0131.3992.4001.08 04012.4026. 0 0181.4
635C-C DRILLING 1 CURRE CNWNW240926WGRNG    5.02663.2314.3887.3926.4043.  -1.  -1.4052.4071. 0 0106.4074.4084.10 04093.4108.04 0165.4
636IMPERIAL 1 FRIEND    CNWNW290926WSPRSGR5.02652.2238.3781.3815.3941.  -1.  -1.3945.3964. 0 0 -1.3970.3980. 0 03989.4002.03 0 -1.4
637SLAWSON A-1 MCFADDENSENENE090927WGRNR    5.02677.2269.3783.3823.3937.  -1.  -1.3947.3966.05 0168.3973.3981. 0 03987.4000.02 0256.4
638DREILING 1 HAFFNER   SLSESE180927WGRNG   2.52746.2348.3853.3892.4012.  -1.  -1.4020.4041. 0 0116.4048.4056. 0 04068.4082. 0 0179.4
639BASS 1 ZIEGLER       CSWNE240927WGRN     5.02693.2304.3816.3846.3972.4400.4400.3981.3999. 0 0100.4007.4014.03 04024.4038. 0 0128.4
640TEXAS 1 FARBER EST   SENWNW030928WGRNCS  5.02658.2290.3758.3796.3920.4335.4335.3926.3945. 0 0173.3951.3958. 0 03968.3984.02 0248.3
641CHIEF 1 POSIER       W2SWSW060928WGRNG   2.52629.2302.3755.3790.3917.  -1.  -1.  -1.3950. 0 0158.3958.3966. 0 03976.3991. 0 0189.4
642HEATHMAN A-1 DECKER  NWNWNW060928WSPRC   2.52730.2342.3794.3827.3954.4377.4377.3961.3985. 0 0 -1.3992.3997. 0 04009.4025. 0 0 -1.4
643DREILING 1 LINDEMAN  NWSWSW120928WGRNG   2.52768.2382.3847.3903.4023.  -1.  -1.4028.4048. 0 0140.4055.4061. 0 04073.4088.04 0170.4
644DREILING 1 OCHS      SESWSW130928WGRNG   2.52779.2385.3878.3911.4042.  -1.  -1.4054.4073. 0 0135.4080.4089.02 04098.4113.07 0213.4
645TRANS-ERA E-1 BELL   SESESE130928WSPR    2.52766.2363.3873.3900.4022.4443.4443.4029.4054.07 0 -1.4058.4066. 0 04077.4093. 0 0 -1.4
646EMPIRE 1 PATMON      SESENE050929WSPR    2.52857.2484.3927.3970.4094.4514.4514.4101.4118.04 0 -1.4130.4136. 0 04148.4163.04 0 -1.4
647PRATT 1 CLARK        CNWNW270929WGRN     5.02881.2485.3953.3996.4116.  -1.  -1.4123.4143. 0 0123.4150.4161. 0 04173.4194. 0 0180.4
648FARMER 1 WIGGINGTON  CSESE240930WGRSC    2.52903.2518.3961.4003.4132.4549.4549.4139.4158. 0 0116.4165.4178. 0 04188.4210. 0 0213.4
649NAPCO A-1 BOGER COPM CSWNW320930WGRNG    2.52984.2544.3978.4022.4155.4610.4610.4165.4187. 0 0115.4195.4206. 0 04217.4238.03 0238.4
650FARMER 1 SCHWARZ     CSESE340930WGRSC    5.02943.2537.3985.4024.4161.4592.4592.4167.4188. 0 0117.4197.4209. 0 04218.4241. 0 0240.4
651MULL 1 SCHWARTZ      CNWSW010931WGRNC    2.52959.2569.3962.4002.4133.  -1.  -1.4141.4156. 0 0115.4174.4186. 0 04203.4221.04 0228.4
652MULL 1 SPACARO       CSENW040931WGRNG    2.53024.2632.4012.4049.4187.  -1.  -1.4194.4210. 0 0 98.4224.4237.04 04247.4267. 0 0214.4
653TRENO 1 PAGE         CSWSE160932WSPRCRD2.53062.2638.4023.4063.4208.4627.4627.4215.4237. 0 0185.4248.4258. 0 04268.4290. 0 0240.4
654RFREN 1 KELLER       SWNWSW190932WGRNG   5.03108.2655.4026.4067.4212.4650.4650.4222.4245. 0 0133.4253.4263. 0 04271.4289. 0 0175.4
655AINSWORTH 1 CHASE    CSWSW350933WSPRGRS2.53178.2741.4075.4138.4284.4754.4754.4291.4315.04 0158.4322.4331. 0024343.4362. 0 0192.4
656ISERN 0-1 HEMBEL     CSESE220933WGRNCC 5.03134.2667.4028.4066.4210.4651.4651.4219.4241. 0 0168.4248.4257. 0 04270.4298.03 0178.4
657PET INC E-1 GARVEY   SESWNE310933WGRNGC 5.03197.2742.4108.4147.4296.4754.4754.4304.4324. 0 0170.4329.4340. 0 04350.4371. 0 0160.4
658ETAL 1 KISTLER       CSWSE340934WGRNG    2.53253.2779.4137.4174.4328.4804.4804.4333.4354. 0 0148.4361.4371. 0 04382.4402.06 0268.4
659THUNDERBIRD 1 NIKL    CSESW340935WGRNGC 5.03233.2822.4119.4168.4311.4832.4832.4320.4342. 0 0136.4350.4356. 0 04363.4379. 0 0275.4
660THUNDERBIRD B-1 WEIL  CSENE130935WGRNGC 5.03276.2792.4114.4156.4302.4834.4834.4312.4334. 0 0130.4342.4351. 0 04361.4385. 0 0178.4
6610 & G 71-1 PENNY     CNENE310936WSPRCRS2.53468.2862.4157.4198.4350.4898.4898.4361.4386. 0 0144.4394.4409. 0 04418.4435.02 0320.4
662LAUCK 1 RICHARD      CSWNE290937WGRP     2.53463.2861.4170.4218.4365.4537.4537.4375.4399.0302 60.4407.4421. 0074434.4449. 0 0 -1.4
663PHILLIPS 4 GOODLAND  SWSWSE120938WGRLLPL5.03539.2987.4240.4288.4435.5008.5008.4453.4477. 0 0 -1.4485.4501.03024510.4527.03 0 -1.4
664MUSGROVE 1 VANDONCE  NWNWSE310938WSPF    5.03637.3047.4280.4326.4478.5085.5085.4491.4515. 0 0 -1.4525.4535. 0 04541.4564.03 0 -1.4
665BADGER 1 HOUSE       CNWSE110939WGRNGC 2.53625.3077.4280.4330.4483.5090.5190.4496.4523.04 0149.4531.4540. 0 04546.4575.07 0274.4
666PHILLIPS 3 GOODLAND  NENESW210939WGRLLML5.03768.3128.4327.4376.4537.5148.5148.4547.4571. 0 0 -1.4540.4591. 0 04601.4625.0302 -1.4
667SLOSSON 1 RILEY      SENESW140940WGRLLML2.53744.3163.4360.4410.4566.5230.5230.4577.4600. 0 0 -1.4614.4624. 0 04638.4657. 0 0 -1.4
668LAUCK 1 PHILBRICK    CSENE160940CWGRRS   2.53765.3183.4359.4409.4558.5216.5216.4572.4597. 0 0158.4608.4616. 0 04632.4650. 0 0160.4
669JAMES 1 MURRY        CSWSE350940WGRNSP 2.53702.3097.4239.4352.4499.5156.5156.4512.4535. 003 -1.4545.4554. 0 04568.4588. 0 0 -1.4
670N. H. VEAIL. 1 MEYER  CSWN 151014WGRNC    2.52005.1144.3150.3213.3354.3752.    -1.3362.3377. 0 0246.3379.3398. 0 33400.3431. 0 0320.3
671NAPCO B-1 MEHARG      SWSWNE321014WGRNN   2.51810. 950.2974.3025.3188.3448.    -1.3171.3189.02 0118.3191.3209.02023212.3244. 0 0200.3
672T. E. ANDERS. 1 FINNS2S2NE021015WGPNGC   5.1879.1093.3027.3078.3216.  -1.    -1.3219.3239. 3 2 -1.3240.3258. 4 03262.3292. 0 4 -1.3
673SCHIO 1 ISENBERG     SWSWSW141015WGRLLML2.51861.1014.2974.3023.3165.3436.    -1.3167.3187.05 0 -1.3199.3204.07 03210.3240. 0 0 -1.3
674C & G DRLG. 1 GREENEN2SWNE271015WGRNGC   5.1788.0916.2900.2949.3083.  -1.    -1.3085.3106. 4 0145.3138.3123. 0 03132.3159. 0 0220.3
675GRAHAM 1-34 ANGEL     E2SW341015WGRN      5.01823.  -1.  -1.  -1.  -1.  -1.    -1.  -1.  -1. 0 0210.  -1.  -1. 0 0  -1.  -1. 0 0 -1.
676CITIES SER. E-W TRACSWSWSW021016WGRN     2.51525.  -1.3028.3073.3210.  -1.    -1.3213.3232. 5 0 -1.3235.3250. 3 03253.3279. 3 3 -1.3
677MURFIN DRLG. 1 ROGERSWSWNE141016WGRNGC   5.2675.1243.3182.3230.3364.3826.    -1.3366.3387. 0 0105.3390.3403. 4 03408.3439. 4 0210.3
678CITIES SER. 4-U SPIT  NESE151016WGRNLLR 5.2003.1176.3101.3145.3275.3516.    -1.3281.3302. 5 0114.3305.3317. 5 03323.3348. 3 3240.3
679MURFIN DRLG. 1 WETHRNESESESE321016WGRNGC 5.2069.1251.2232.3273.3404.3650.    -1.3408.3430. 3 3122.3432.3445. 0 03450.3475. 0 2220.3
680TILCO ETAL 1 MELVILLNWSENW021017WGRNGC 2.52662.1296.3170.3212.3342.  -1.    -1.3348.3369. 3 3140.3373.3387. 0 03391.3411. 0 2272.3
681STERLING DRLG. 1 JONSWSENE091117WGRNG    2.52662.1332.3196.3233.3366.  -1.    -1.3374.3392. 0 0116.3374.3408. 0 03414.3436. 0 4220.3
682KWB OIL MANG. 1 BRUNNESWNE331017WGRNGC   5.2011.1263.3198.3240.3371.3617.    -1.3377.3396. 0 0113.3401.3415. 0 03418.3438. 0 0205.3
683HUMMON OIL 1 REMPE   SESENW171018WGRNGC   5.2190.1593.3380.3424.3546.  -1.    -1.3552.3570. 2 0 98.3573.3586. 0 03590.3606. 0 0233.3
684VINCENT OIL 1 VINE   NWNWSE331018WGRNGC 2.52042.1387.3239.3285.3406.3654.    -1.3412.3430. 5 0141.3435.3446. 2 03448.3466. 0 0220.3
685D.8 BOTHWELL 1 HEARINWNESW021019WGRLL    2.52144.1495.3303.3346.3472.3670.3670.3480.3497. 2 0 -1.3500.3512. 0 03514.3532. 0 0 -1.3
686WALTERS DRLG. 2 HENDE2SWNE091019WGRLLML 5.2202.1568.3380.3420.3546.3734.    -1.3555.3572. 3 2 -1.3574.3584. 0 03587.3604. 3 0 -1.3
687REACON RESO. 1 OBRIESENWNW271019WGRNC   2.52149.1490.3324.3364.3485.3686.    -1.3494.3511. 3 0157.3513.3526. 5 03528.3546. 0 0320.3
688OKMAR OIL 4-A VEAICHE2NENW091020WGRN    2.52180.1658.3404.3444.3572.  -1.    -1.3580.3598. 0 0 -1.3602.3616. 0 03618.3633. 0 0 -1.3
689CONTINENTAL 7 DESBIESWNWNW121020WGRNG   2.52227.1660.3442.3480.3606.3818.    -1.3612.3633. 2 0152.3636.3646. 0 03649.3666. 0 0232.3
690CALVIN NOAH 4 ANNON W2SWNE271020WGRNGC  5.2159.1610.3382.3418.3545.3708.    -1.3557.3570. 0 0 70.3574.3584. 0 03590.3603. 0 0105.3
691PHILLIPS 1 ACREL     SESESE031021WGRN    2.52296.  -1.3511.3552.3680.3864.    -1.3688.3705. 4 0 -1.3708.3723. 0 03727.3742. 0 0 -1.3
692MURFIN DRLG. 1 GRECIE2SWNE171021WGRNGC 2.52286.1777.3507.3547.3688.  -1.    -1.3686.3702. 0 4 97.3706.3719. 4 03722.3738. 5 0162.3
693ANDERSON FR. 4 MCFRCSWNWNW251021WGRLLPL2.52152.1622.3379.3422.3554.3722.    -1.3559.3576. 0 3 -1.3583.3592. 3 03596.3612. 0 0 -1.3
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694JOHN FARM. 1-F NOAH NENE3532102IWGRLLML2.52206.1700.3478.3520.3652.3854.  -1.3661.3676. 6 0 -1.3681.3696. 5 03699.3716. 8 0 -1.3
695KFDCO CCRP. 1 BROWN W2W2NL011022WGRNG   5.2233.1809.3520.3559.3685.  -1.  -1.3696.3713. 0 0 94.3719.3732. 0 03735.3750. 5 0134.3
696PETROL. INC. 2-M FAUNWSENW271022WGRNGC  5.2324.1819.3543.3580.3711.  -1.  -1.3717.3734. 3  110.3737.3750. 4 03753.3771. 0 0158.3
697MURFIN ORLG. 1-E CRENENENE301022WGRNG  2.52356.1873.3607.3645.3778.4133.  -1.3782.3800. 3  108.3802.3812. 0 23814.3838.12 0192.3
698D. G. HANSON 1-C GANNESENE071023WGRNG  2.52391.  -1.  -1.3737.3866.  -1.  -1.3872.3889. 8 0 99.3891.3901.10 03910.3928. 5 3108.3
699JEN. & PRIPE 1 GANO SESESE071023WGRNG  2.52405.  -1.3720.3750.3887.  -1.  -1.3894.3912. 2 8 98.3915.3922. 2 03930.3946. 4 0144.3
700H. SEELIGSON 1 IRWINSWSWNL121023WGRNG  2.52411.1942.3648.3686.3818.4110.  -1.3823.3842. 5 8 -1.  -1.  -1. 0 03846.3855. 0 2 -1.3
701STANOLIC & G. DORPANSWSESE201023WGRNG  2.52411.1963.3634.3670.3808.  -1.  -1.3815.3832. 4 0 83.3838.3848. 2 33855.3870. 6 0132.3
702DON PRATT 1 L. GANO NWNWNE111024WGRNGC 2.52503.2124.3800.3835.3964.  -1.  -1.3971.3990. 0 0150.3993.4000. 0 04011.4026. 0 0166.4
703DON PRATT 1-B ESTATESWNENW201024WGRNG  2.52446.  -1.3709.3748.3872.  -1.  -1.3879.3899. 2 0150.3904.3909. 0 03922.3938. 3 0196.3
704MURFIN ORLG. 1 BRAAGNENESW341024WGRNG   5.2363.1984.3686.3736.3856.4267.4267.3862.3879. 0 0138.3883.3891. 0 03902.3920. 4 0118.3
705KIPBARK CC. -1 BRLAGNESENE061025WGRNG  2.52577.2193.3784.3814.3953.4366.4366.3960.3978. 4 0112.3984.3994. 0 34005.4020. 0 0136.4
706KIMHARK CC. -1 ROPE SESENW101025WGRNG  2.52520.2157.3752.3790.3918.  -1.  -1.3924.3943. 7 0100.3946.3958. 0 03970.3984. 0 0146.3
707DERRICK AM. 2-A BALNSWNESW221025WGRNC  2.52535.2170.3785.3823.3951.  -1.  -1.3960.3977. 4 0 -1.  -1.  -1. 0 0. -1.  -1. 0 0 -1.
708J. O. FARMER 1-C ERU CSENW291025WGRNG  2.52520.2178.3804.3843.3970.  -1.  -1.3977.3994. 4 0 76.3998.4006. 5 04020.4033. 4 0138.4
709HINKLE OIL -1 WILLSOSWNENE141026WGRNGC  5.2576.2202.3787.3827.3956.  -1.  -1.3963.3984. 6 0116.3987.3996. 0 04007.4022. 3 0172.4
710LEO J. DRLG. 1 TILIO CNESW301026WGPNGC 2.52544.2147.3740.3777.3907.4336.4336.3916.3936. 0 0140.3940.3953. 2 03962.3978. 0 0220.3
711ABERCROMBIE -1 ZEHR SWSENW 41027WGRNGC 2.52691.2269.3807.3848.3974.  -1.  -1.3980.4000. 0 0135.4004.4013. 0 04024.4040. 0 0210.4
712J. DRLG. -1 ZERR      CSESE111027WGRNGC 2.52661.2247.3816.3858.3985.  -1.  -1.3988.4008. 4 0176.4015.4025. 0 04036.4052. 4 0220.4
713MURFIN CRLG. 1 WEIPE CNENE141028WGRNGC 2.52689.2250.3772.3816.3942.  -1.  -1.3950.3970. 0 0157.3978.3988. 3 04000.4015. 0 0220.4
714IMPERIAL OIL -1 DONOKENESW271028WGRNG   5.2736.2297.3828.3867.3995.4428.4428.4005.4025. 0 0130.4032.4050. 7 04053.4073. 7 0204.4
715BRADEN CRLG. 1-15 BLSENENE151029WGRNGC 2.52835.2437.3924.3960.4096.  -1.  -1.4102.4118. 0 0130.4128.4140. 0 04151.4172. 0 0220.4
716EMPIRE DRLG. 1 STEWANENESW161029WSPR   2.52839.2433.3920.3957.4090.4512.4512.4099.4118. 6 0 -1.4128.4141. 0 04156.4173. 0 0 -1.4
717EMPIRE CRLG. 1 KOERBSESESE241029WSPR   2.52771.2350.3852.3895.4028.4464.4464.4035.4054. 5 0 -1.4060.4069. 0 04072.4104. 0 0 -1.4
718DON PRATT -1 ROHMEN  CNWNE321029WGRNG   5.2831.2390.3998.3937.4074.  -1.  -1.4085.4101. 0 0158.4111.4125. 0 04141.4158. 0 0120.4
719M. MAHONEY 1 BROECKE CSWSW361030WSPR   2.52975.2544.3982.4026.4162.  -1.  -1.4172.4190. 0 0126.  -1.  -1. 0 04234.4249. 0 0220.4
720SIKES OIL -1 ALBERS  CSENE151030WGRNRC  5.2889.2456.3920.3962.4100.  -1.  -1.4110.4124. 0 0167.4137.4148. 0 04156.4180. 2 0253.4
721DON PRATT 1-31 BAALM CNWSW311130WGRNGC  5.2583.2533.3993.4032.4178.  -1.  -1.4185.4209. 0 0153.4213.4217. 0 04239.4262. 0 0220.4
722TILCO [illegible] 1 OSTMEYE [illegible] 011031WSPR  2.52560.2532.3978.4015.4152.  -1.  -1.4162.4179. 0 0201.4191.4204. 0 04222.4243. 0 0320.4
723MUSGROVE PET. 1 BEIRSESENE061031WSPR    5.3067.2613.4045.4077.4227.4669.4669.4239.4260. 0 0 -1.4272.4282. 0 04293.4308. 0 0 -1.4
724JOHN FARMER 1 FELLHO CSWNE341031WGRNGC 2.52535.2452.3942.3982.4126.4554.4554.4131.4154. 0 0155.  -1.  -1. 0 04159.4174. 0 0125.4
725CITIES SER. 1-A FLIP CNESW181032WRUC    5.3051.2610.4002.4042.4188.4652.4652.4196.4219. 0 0222.4226.4236. 0 04248.4268. 0 0 92.4
726TOTO GAS 1 BECKMAN    CSESW251032WSPR    5.3008.2560.4094.4046.4188.4665.4665.4199.4221. 0 0 -1.4230.4239. 0 04250.4271. 3 0 -1.4
727D.C. SLAWSON 1-A PEE CSENW321032WGRNR   5.3039.2542.3954.3992.4132.4579.4575.4141.4162. 0 0210.4169.4179. 0 04180.  -1. 0 0210.4
728D.C. SLAWSON 2-G NOL SWSENW151033WGRNR   5.3163.2668.4058.4102.4250.4705.4705.4254.4275. 0 0180.4286.4296. 0 04305.4324. 0 0210.4
729CHIEF DRLG. 1 BOGART CSENW361033WGRNGC  5.3125.2623.4030.4091.4235.4728.4728.4243.4266. 5 0149.4275.4288. 0 04296.4318. 4 0220.4
730PET. INC. 1-E KRISS  CNESW031034WGRNGC  5.3252.2780.4134.4174.4323.4818.4818.4329.4352. 0 0150.4359.4373. 0 04384.4401. 0 0186.4
731JOHN FARMER 1 BERTRANDWNWNW241034WGRNG  2.53180.2688.4078.4116.4266.4744.4744.4274.4297. 0 0114.4306.4320. 0 04338.4351. 0 0160.4
732D.R. LAUK 1 STOVER   SWSWNE291035WGRLLML2.53326.2804.4148.4190.4341.4900.4900.4353.4374. 0 0 -1.4382.4391. 0 04401.4428. 0 0 -1.4
733CHIEF DRLG. 1 CRUPPA CSESE101036WGRNCC  5.3369.2782.4030.4131.4278.4822.4822.4289.4313. 2 3210.4321.4336. 0 04351.4366. 0 0176.4
734EXCELSIOR 1 MARSHALL CNWNW171036WGRLLR 2.53416.2805.4119.4164.4318.4914.4514.4329.4353. 2 0 -1.4364.4380.     4391.4408.       -1.4
735PHILLIPS 1 GOODLAND SWSE 5W071039WSPLLML2.53645.3012.4237.4286.4439.5098.5098.4452.4478. 6 0 -1.4490.4498. 0 04503.4528. 2 0 -1.4
736PHILLIPS 2 LAUGHLIN SESENW101039WGRLLML2.53632.3008.4232.4304.4460.5124.5124.4472.4497. 4 0 -1.4508.4518. 0 04527.4547. 6 0 -1.4
737MACK OIL 1 CARNAUER   CNWNW031040WSPRGRN2.53741.3120.4321.4375.4532.5200.5200.4539.4559. 0 0 79.4571.4579. 0 04588.4611. 5 0146.4
738K&F DRLG. 1 JAMES    CNWSW231040WSPRCS 2.53774.3170.4319.4370.4523.5297.5297.4530.4560. 0 0 -1.4568.4578. 0 04588.4610. 0 0 -1.4
739MACK OIL 1 M. BROWNE CNENE131041WGRNLL 2.53813.3180.43[illegible].4404.4562.5294.5294.4572.4596. 0 0209.4604.4615. 0 04622.4644. 0 0235.4
740VAN GRISSO 1 GOLDEN SESESE241042WSPR    2.53860.3158.4392.4344.4535.5244.5244.4548.4572. 4 0 -1.4583.4592. 0 04602.4622. 4 5 -1.4
741TERREL DRLG. 1 POCRE CSWSW361042WSPRCS 2.53699.3150.4332.4387.4536.5260.5260.4547.4576. 0 0 -1.  -1.4589. 5 04600.4622. 4 0 -1.4
742RUPP FERGUS 1 MEIZ   NWNWNW331107 WRNG   5.1553.  -1.2591.2681.2848.3538.  -1.2851.2876. 0 0 77.2878.2893. 0 02896.2918. 0 0166.2
743REXAMCHARIS 1 WOODWAH CNWNE331112WGRLLR 2.51745.0734.2919.2980.3132.3410.3410.3136.3152. 2 0 -1.3155.3166. 0 03174.3214. 0 0 -1.3
744F & M OIL 1 GILLETT NWNENE331113WGRNC   5.1783.0837.2380.3038.3184.  -1.  -1.3186.3207. 2 0138.3209.3220. 0 03223.3262. 8 0320.3
745W. GREEN. 1 ANGEL    SESESE031115WSPR   5.1825.0954.2956.3009.3145.3446.  -1.3147.3167. 0 0 -1.3170.3183. 0 03189.3219. 0 0 -1.3
746STEARNS PET. 1 KRAMESWSWSW061115WSPR    5.1910.1084.3067.3110.3248.3544.  -1.3250.3276. 0 0 -1.3279.3286. 0 03290.3323. 8 0 -1.3
747CLINTON OIL 1-V ALBRSENWNW071115WGRNGC  5.1659.1073.3049.3098.3231.3515.  -1.3233.3253. 0 0122.3256.3268. 0 03273.3301. 0 0220.3
748SHIELDS OIL 2-C REICSWNESW151115WGRNGC  5.1854.0927.2935.2987.3126.3321.  -1.3130.3148. 2 0110.3152.3162. 0 03168.3200. 7 0257.3
749GRAVES CRLG. 1-26 EUN2SESW261115WGRNGC  5.1885.0961.2993.3048.3180.3373.  -1.3182.3200. 0 0140.3202.3216. 0 43223.3252. 0 4210.3
750NADEL&GUSS. 1 STRECKNENENE281115WGRNGC 2.51863.0935.2954.3006.3141.3321.  -1.3149.3164. 4 0112.3170.3178. 0 03186.3216. 0 0225.3
751OKMAR OIL 1 SLIMMER NESENE191116WGRNG  2.51863.1035.3030.3059.3176.  -1.  -1.3179.3200. 6 3 83.3203.3220. 7 03226.3246. 0 0176.3
752PETROLEUM INC. 1 COMSESWNW221116WGRNRC  5.1842.0998.3009.3059.3187.3418.  -1.3190.3210. 3 0 80.3212.3227. 6 03232.3259. 5 0210.3
753PAN AM. PET. 7-A CARS2SENW181117WGRN   2.51884.1130.3056.3098.3225.3388.  -1.3230.3250. 0 0113.3256.3266. 0 03268.3290. 3 0167.3
754CITIES SER. 2-A JOHANENWNE221117WGRN    5.1926.1138.3084.3125.3258.3445.  -1.3262.3283. 0 0 67.3287.3304. 8 23308.3330. 8 3220.3
755CONTINENTAL & WATKIN CSWNW021118WGRNR   5.2050.1343.3225.3266.3393.3570.  -1.3399.3418. 0 0123.3424.3435. 5 03437.3455. 8 0218.3
756CHIEF DRLG. 1 GASAWANENENE031118WGRNG  2.51589.1332.3204.3246.3370.3593.  -1.3377.3397. 0 0105.3401.3413. 0 03417.3433. 0 0150.3
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757LARIO OIL&GAS 5 MEADSENWNE221118WGRN   2.51983.  -1.3167.3210.3334.3522.   -1.3341.3360. 0 0100.3364.3370. 3 03378.3397. 6 0300.3
758C-G DRLG. 1 MCRMAN   SWNESW021119WGRLLML2.52115.1430.3273.3314.3436.3630.   -1 3444.3461. 0 0 -1.3464.3470. 0 03477.3497. 3 0 -1.3
759THREE G OIL 1 AMMERIW2W2SE061119WGRNGC  5.2153.1528.3375.3415.3548.3730.   -1.3547.3563. 4 0 90.3567.3578. 0 03583.3599. 0 0140.3
760CONTINENTAL 6 DEVINENWNWSE231119WGRLLML2.51986.1308.3156.3198.3328.3488.   -1.3335.3353. 3 0 -1.3355.3364. 0 03370.3386. 2 0 -1.3
761OSAGE OIL&GAS 1 ALBESWNENE301119WGRLLN 2.52113.1476.3343.3383.3506.  -1.   -1.3514.3531. 0 0 -1.3533.3546. 0 03550.3566. 0 0 -1.3
762THUNDERBIRD 1 JENSENNENWSW361119WGRNGC 2.52095.1434.3320.3360.3487.3638.   -1.3494.3513. 0 0104.3516.3528. 0 03530.3552. 0 0210.3
763R. PIERCE 1 VEACH    SESENE041120WSPR     5.2030.1467.3304.3342.3468.3704.   -1.3475.3492. 6 0 -1.3494.3510. 0 0  -1.  -1. 0 0 -1.3
764KAISER FRANCIS 1 WALSESENE071120WGRNG     5.2037.1489.3299.3336.3464.3633.   -1.3470.3488. 0 0111.3491.3506. 6 03509.3523. 0 0145.3
765MURFIN DRLG. 1 HUCK SENESW321120WGRNGC 2.52180.1598.3449.3481.3620.3833.   -1.3628.3646. 0 0102.3652.3668. 0 03672.3698. 6 0113.3
766NADEL&GUSS. 4 ZIEGLEW2E2NE041121WGRNR  2.52145.1611.3375.3414.3552.3740.   -1.3558.3576. 6 0116.3580.3594. 0 03598.3613. 0 0190.3
767DAVIS BROTH. 1-A LANNNWNW071121WGRNG   2.52118.1575.3367.3404.3537.3756.   -1.3546.3563. 0 0 -1.3568.3584. 3 03586.3604. 2 0 -1.3
768F & M OIL 1 HILLMAN SESWSE031122WGRNGC  5.2159.1680.3440.3479.3612.3881.   -1.3619.3636. 0 0102.3642.3656. 0 03662.3680. 0 0162.3
769SCOTT RITCHIE 1 SEPURENENE031122WGRNGC 2.52207.1700.3452.3491.3626.3910.   -1.3632.3650. 0 0111.3656.3670. 0 03675.3693. 0 0200.3
770SCOTT RITCHIE 2 RICHSWSENE191122WGRNGC  5.2233.1695.3432.3487.3626.  -1.   -1.3630.3648. 0 0107.3650.3660.10 03662.3685. 3 0213.3
771CITIES SER. 1-A MILLRESENW241122WGRDC    5.2256.1722.3510.3549.3676.3958.   -1.3684.3700. 0 0127.3704.3717.10 03722.3743. 0 4245.3
772JOHN FARM. 1 SCHAEEN CSENW031123WGRNGC 2.52296.1790.3515.3554.3684.  -1.   -1.3690.3707. 0 0 53.3710.3719. 0 03722.3743. 7 0200.3
773MACK OIL  1 LARUE    CSESW2H1123WGRNR     5.2254.1892.3658.3695.3825.4278.4278.3837.3856. 4 0135.3860.3871. 0 03878.3894. 0 0162.3
774MACK OIL 1 VERIL     SESENW011124WGRNC    5.2306.1910.3635.3670.3803.  -1.   -1.3813.3828. 0 0121.3832.3846. 2 03852.3866. 3 0228.3
775CLINTON OIL 1-V MALIN2NWNW211124WGRNR   2.52464.2060.3766.3805.3932.4338.4338.3938.3956. 0 0111.3963.3973. 0 03983.3997. 0 0210.4
776PHILLIPS 1 MALIKOWSKSESESW211124WGRNGC  5.2502.2093.3816.3852.3982.  -1.   -1.3989.4006. 5 0 86.4010.4021. 0 64032.4049. 0 0124.4
777R&WILLIAMSON 1 PFEIFSENESW361124WGRNGC  5.2456.2021.3779.3813.3947.4352.4352.3955.3973. 0 0134.3976.3988. 0 43998.4016. 4 0205.4
778THEO. GORE 1 BARNES SESENE101125WGRLLPL 5.2382.1998.3698.3739.3881.4288.4288.3883.3903. 4 0 -1.3907.3916. 0 43928.3944. 3 0 -1.3
779MACK OIL 1 CONNOR     CNENE151125WGRSRNR2.52501.  -1.3788.3828.3964.4390.4390.3970.3988. 4 0132.3992.4000. 0 34012.4026. 0 0192.4
780TOM PALMER 1-A WEISS CNENE331125WGRNSP 2.52561.  -1.3854.3889.4028.4454.4454.4036.4055. 0 0156.4061.4069. 0 04080.4093. 5 0170.4
781CITIES SER. 1-C FLORE2NEN 031126WGRSPH 2.52521.2136.3781.3814.3947.4386.4386.3954.3974. 4 0117.3978.3990. 0 04000.4013. 3 0186.4
782AMERADA 1 YANDA      NENENE121126WGRR    5.02500.2122.3789.3830.3965.4395.4395.3974.3991. 0 0 -1.3995.4006. 0 04019.4035. 0 0 -1.4
783KIMBARK 1 ELLITHROPE CSENE011127WGRNLL 2.52638.2250.3861.3995.4033.  -1.   -1.4043.4061. 0 0134.4066.4077. 0 04087.4103. 0 0177.4
784L.J. CRELLINC 1 FEIC CNWNW211128WGRNGC 2.52767.2290.3857.3898.4032.4428.4428.4037.4057. 0 0123.4062.4077. 0 04088.4109. 0 0205.4
785FARMER 1 HARTMAN      CSESW131129WGRCSSP5.02781.2311.3855.3894.4029.4443.4443.4034.4052. 0 0135.4060.4075. 0 04085.4100. 0 0240.4
786FARMER B-1 BERTRAND  CSESE221129.SPSG-N2.52826.2360.3308.3950.4093.4530.4530.4102.4118. 0 0 -1.4128.4144. 0 04154.4175.03 0 -1.4
787FARMER 1 DICKMAN      CNENW051130WSPPGRC5.02542.2470.3955.3992.4132.4558.4558.4137.4159. 0 0150.  -1.  -1.03024194.4212.02 0240.4
788ANSCHUTZ 1 CAMPBELL  CSES 221130WSPRCRS2.52910.2384.3839.3943.4083.4540.4540.4088.4110. 0 0180.4118.4128.04 04142.4164. 0 0240.4
789NATL OIL 1 JENSON     CSES 331130WSPGNC 5.02809.2337.3857.3893.4041.4489.4485.4047.4073. 0 0143.4078.4090. 0 04108.4128. 0 0210.4
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792MURFIN F-9 JOHNSON    CSESW101132WGRN    5.03072.  -1.4010.4054.4203.4641.4641.4208.4231.05 0103.4239.4249. 0 04261.4282.04 0233.4
793PICKRELL D-1 SWART    CSWNW121132WGRNGC 5.03034.2546.4032.4044.4191.4610.4610.4199.4219. 0 0160.4227.4237. 0 04250.4272. 0 0220.4
794PICKRELL B-1 HARRISC CSENE241132WGRNGC 5.02584.2490.3960.4002.4152.4594.4594.4159.4182. 3 0175.4189.4202. 0 04211.4234.06 0220.4
795SLAWSON H-1 COOK      CSESW111133WGRNR   5.03075.2577.3997.4038.4180.4640.4640.4187.4208.06 0200.4217.4232. 0044238.4258.06 0200.4
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797ABERCROMBIE 1 JAMES   CSENE051134WGRNGC 5.03244.2732.4115.4156.4310.4824.4824.4315.4340.04 0158.4347.4356. 0 04362.4391. 0 0218.4
798BEN SLAWSON 1-P JAP   CSWNW221134WGRNGC  5.3176.2642.4050.4091.4242.  -1.   -1.4251.4275. 6 0 96.4282.4290. 5 04294.4326. 7 0139.4
799ABERCROMBIE 1 COLULA CSENW361134WGRNGC  5.3185.2656.4063.4110.4268.4770.4770.4277.4301. 0 0140.4303.4325. 0 04329.4351. 3 0220.4
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801NATIONAL ASS. 1 GUNN CNWNW051137WGRNR   2.52283.2709.4036.4080.4238.4845.4845.4247.4271. 0 0200.4275.4286. 0 04301.4322. 0 0200.4
802TEXACO INC. 1 KLAUCAN CSESW241137WGRLLSP2.53248.2622.3972.4015.4174.4754.4754.4184.4207. 0 2 -1.4211.4230. 3 04235.4253. 5 0 -1.4
803U.S. SIGNAL 1 COLLIN CNWNW341137WSPRGN32.53275.2682.3944.3938.4150.4756.4756.4159.4184. 3 0110.4190.4213. 0 74221.4244. 0 2235.4
804NATURAL GAS 1 HILL    CNWNW211141WSPR     5.3800.3088.4235.4340.4500.5254.5254.4513.4538. 7 0 -1.4544.4563. 0 04572.4594. 3 0 -1.4
805D. R. LAUCK 1 JONES   CSWSW121142WSPRCL 2.53893.3137.4334.4406.4560.5290.5290.4571.4593. 0 0 -1.4602.4616. 2 04620.4641. 0 0 -1.4
806K & E DRLG. 1 KANE    CNEN 271142WSPRCS 2.53685.3080.4288.4338.4498.5214.5214.4505.4528. 0 0 -1.4537.4547. 0 04550.4577. 0 0 -1.4
807STATES OIL 1 HAROLD  CSESW321142WSPR    2.53942.3083.4309.4356.4504.5257.5257.4517.4536. 6 0 -1.4548.4560. 0 04567.4588. 6 0 -1.4
808K.ELLISON 1 HARMS    SENWSE 91207WGR-LAT2.51362.  -1.2632.2663.2802.3108.3108.2804.2823. 3 0 -1.2827.2844. 0 02848.2862. 0 0 -1.2
809J. STEWART 1 CARTER SWSWSE 21213WGR N  5.01761. 780.2931.2987.3143.  -1.   -1.3149.3165. 0 0 92.3168.3179. 0 03182.3217. 6 0220.3
810STEARNS 1 FINK       SWSESE081214W GR-LA2.51769. 837.2888.2944.3088.3288.   -1.3090.3104.03 0 -1.3106.3124. 0 33127.3162. 012 -1.3
811SOHIO A-28 CSWALD-WISWSENE 81215WGR-N  5.01808. 861.2890.2943.3073.  -1.   -1.3076.3096. 6 0105.3098.3112. 3 03118.3144. 0 0220.3
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813WOODMAN-I 1 KINGSLEYNWNENE231215WGR-LL 5.01707. 765.2816.2869.3004.3152.   -1.3006.3023. 4 0 -1.3026.3040. 3 63046.3075. 0 0 -1.3
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815JJ HALL D-4 OSWALD   SWSWNW111216WGR-N  5.01849.1020.3013.3061.3192.3332.   -1.3196.3213. 2 0128.3215.3231. 0 63235.3259. 5 0220.3
816SOLAR PET A-18 CSWALSENWSW111216WGRDN  5.01842.0998.2996.3044.3177.3322.   -1.3181.3198. 4 0115.3200.3216. 0 43220.3245. 0 3233.3
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818KEWANEE E-10 FROLICHNWSESE271216WGR-N  2.52027.1160.3183.3238.3362.3484.   -1.3368.3386. 6 0 98.3389.3404. 0 43406.3432. 4 0220.3
819PHILLIPS 3 BERTHA    E2NWSE 51217WGR-N  2.52108.1313.3276.3320.3444.3569.   -1.3451.3471. 0 0 88.3476.3498. 0 03493.3512. 0 0155.3
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821G.R. NYE A-1 KARLIN NESESW 11218WGR-N  2.52114.  -1.3308.3352.3480.  -1.  -1.3486.3510. 4 0 -1.3513.3530. 3 03532.3548. 0 2 -1.3
822PETROL INC 1-F KARLIN2NWNW 11218WGR-N  2.52019.1272.3223.3270.3394.  -1.  -1.3401.3421. 0 0120.3426.3438. 3 03440.3468. 0 0230.3
823WOODMAN-IAN 1 STACKHN2SENW 71218WGR-N  2.52179.1494.3414.3457.3579.3742.  -1.3586.3608. 5 0130.3614.3626. 0 03635.3648. 0 0285.3
824BANDR DRLG.A-5 STACKSWNENE231218WGR-LL 2.52131.1372.3332.3377.3504.3724.  -1.3512.3534. 0 0 -1.3537.3548. 0 03551.3570. 0 0 -1.3
825KAN-TEX 1 VOLNKER    SESENE 91219WGR-N  2.52226.1545.3452.3494.3620.3854.  -1.3628.3650. 7 0 93.3654.3667. 2 03669.3688. 0 0195.3
826CRESCENT 2 SPHLEN   NWSENE171219WGR-N  2.52244.1570.3489.3533.3652.3922.  -1.3655.3687. 5 0105.3692.3706. 0 03710.3724. 3 0 78.3
827RAYMOND 1 CNEILING  NWSESC271219WGR-N  2.02146.1472.3404.3448.3572.3784.  -1.3581.3601. 0 0 86.3605.3620. 0 03623.3640. 0 6104.3
828NORTON 2 KARLIN     SESENW 81220WGR-N  2.52315.1693.3569.3606.3734.4016.  -1.3744.3763. 4 0130.3766.3781. 0 0  -1.3804. 0 0150.3
829PRATT 1 ARMBRISTER  NWNESE101220WGR-N  2.52275.1679.3555.3597.3730.3962.  -1.3737.3754. 0 0 78.3759.3774. 0 03777.3794. 0 4 75.3
830PHILLIPS A-1 STAAB   CSESE231220WGR-G  2.52210.1570.3482.3524.3657.3914.  -1.3664.3684. 0 0 82.3688.3704. 0 03708.3728. 0 0115.3
831SUNRAY A-5 HUBER     CSWNW311220WGR-LL 2.52197.1548.3435.3474.3601.3851.  -1.3610.3627. 0 0130.3630.3650. 3 03654.3673. 0 0145.3
832WOODMAN-IAN 1 KOHL  SESWSW 21221WGR-N  2.52313.1756.3580.3616.3747.3574.  -1.3754.3769. 0 0105.3770.3786. 2 03790.3806. 6 0 90.3
833TENNECO 2 HURT      SENESE151221WGR-LLN2.52289.1700.3593.3579.3710.3934.  -1.3717.3734. 2 0120.3737.3753. 0 03757.3771. 3 0125.3
834RESOURCES IN 1 PERRISENWSE331221WGR-N  5.02211.1597.3467.3501.3634.3895.  -1.3640.3657. 0 0135.3660.3677. 2 03680.3698. 0 0120.3
835LITTLE GEO 1 HILLMANNWSES.041222WGRNCA 5.02402.1846.3639.3677.3814.4110.  -1.3819.3837.04 0158.3839.3851. 0 03859.3875.04 0168.3
836C-G DRLG 1 STAAB     NWNWNW201222WGR-N  2.52419.1832.3656.3692.3830.4128.  -1.3836.3854. 0 0120.3856.3876. 5 03880.3894. 0 0130.3
837PHILLIPS A-4 HASEK  NWNESE121223WGR-N  5.02299.1810.3614.3651.3788.  -1.  -1.3793.3811. 4 0108.3815.3829. 3 03833.3851. 7 0100.3
838RAINS AND W 1 DLINESSWNESE261223WGR-N. 5.02341.1809.3670.3706.3842.4222.4222.3849.3866.   170.3869.3886. 0 03892.3909. 6 0185.3
839RAINS WILL. 1 DLINESSWNESE261223WGR-N  5.02341.1808.3670.3706.3842.4222.4222.3849.3866. 0 0165.3870.3886. 0 03892.3909. 6 0185.3
840J.O.FARMER 1 WOLFF   CNWNE101224WGR-N  5.02480.2047.3812.3848.3991.4399.4399.3996.4014. 0 0125.4018.4029. 0 04034.4060. 0 0172.4
841GULF 1-16 BRANDENFER CNESW161224WGRNG  5.02491.2060.3830.3867.4007.4422.4422.4014.4033. 5 0 98.4039.4050. 0 04061.4079. 2 0125.4
842PRATT OIL 1-2 HOBBS SWSWNE021225WGRNGC 5.02565.2153.3874.3909.4051.  -1.  -1.4058.4077. 0 0138.4081.4096.02 04102.4118.03 0148.4
843LEBEN 1 CTOOLE       NWNWSE081225WGRNC  2.52603.2191.3898.3934.4076.4511.4511.4081.4103.03 0140.4109.4122. 0 04131.4148.03 0175.4
844FARMER 1 ZEMAN       SWSESW121225WGRNC  2.52517.2101.3845.3881.4027.4462.4462.4031.4050. 0 0 92.4053.4067. 0 04075.4089. 0 0125.4
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846LAUCK 1 GRAHAM       CNENE151226WGRRG   2.52672.2265.3949.3988.4132.4586.4586.4139.4162.06 0110.4167.4179.06 04181.4207.10 0180.4
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848FARMER 1 WALDMAN     CNENE061227WGRGC   2.52692.2243.3859.3898.4036.4482.4482.4041.4069. 0 0135.4070.4086.04024095.4115. 0 0291.4
849THUNDERBIRD C-1 ZIMMNWNENW341227WGRNGC  5.02662.2154.3843.3888.4031.4486.4486.4034.4056.03 0 94.4055.4342. 0024096.4112. 0 0145.4
850MURFIN 1 KATT        SNESW401229WGRPAC  2.52742.2270.3879.3925.4064.4510.4510.4068.4089. 0 0292.4095.4111. 0 04126.4149. 0 0320.4
851NEWMONT 1 LAMORLACK NWNWSW 081229WGRPK  5.02831.2315.3891.3936.4070.4492.4492.4077.4099.05 0 -1.4109.4121. 0 04134.4155.04 0 -1.4
852TIDEWATER 1 BLANC    CNESE231229WSPRGR 2.52761.2270.3853.3887.4036.4459.4459.4041.4064.04 0126.4073.4099.06 04107.4127.03 0240.4
853SLAWSON A-1 SCHOENCA CNESW281230WCS     5.02771.  -1.3774.3821.3964.4389.4385.3972.4000. 0 0 -1.4002.4017. 0 04026.4052.03 0 -1.4
854SLAWSON K-1 WEBER    CSWNW131231WGRN    5.02506.2398.3935.3945.4098.4502.4502.4107.4131. 0 0123.4137.4150. 0 04158.4181.03 0210.4
855SLAWSON J-1 MARTIN   CSWNE241231WGRN    5.02885.2378.3838.3945.4087.4500.4500.4094.4119. 0 0140.4123.4137. 0 04151.4172.04 0146.4
856THUNDERBIRD 1 SFIKIN CNWSE011232WGRNGC  5.02978.2518.4003.4050.4195.4645.4645.4200.4225. 0 0178.4233.4243. 0 04253.4278.02 0220.4
857CHIEF 1 JOHNSTON      SWSE061233WGRNGC  5.03181.2663.4069.4111.4270.4744.4744.4280.4303. 0 0143.4310.4325. 0 04329.4352.06 0220.4
858ARGO A-1 SCHAFFER    CNENW131233WGRLLML 2.53102.2605.4044.4085.4244.4686.4686.4249.4272. 003100.4278.4292. 0 04298.4320. 0 0200.4
859HOOVER 1 HUBERT      CSWSE171234WGRNCC  5.03170.2630.4027.4074.4236.4740.4740.4246.4270. 0 0100.4277.4294. 0064300.4320.03 0210.4
860TOTO 1 VAN EATON      NWSW231234WGRRSC  5.03178.2632.4096.4088.4247.4786.4786.4257.4280. 0 0191.4291.4306.06 04312.4335.08 0240.4
861HOOVER 1 HOLMBERG    CSWSE191235WGRN    5.03194.2596.3955.4005.4166.4712.4712.4181.4201. 003119.4235.4228. 0 04236.4251. 0 0210.4
862MUSGROVE 1 FLEMMER   CSESE231235WGRR    2.53185.2613.4015.4053.4222.4758.4758.4231.4255. 0 0 -1.4260.4282. 0084289.4306. 0 0 -1.4
863LAUCK 1 KELLER       CSWNE261236WGRGA   2.53150.2523.3927.3972.4134.4714.4714.4144.4170. 0 0 98.4175.4196. 0 04201.4220.10 0205.4
864WYCOFF 1 BRETZ      NENESE091237WGRLLML 2.53262.2571.3999.3952.4121.4710.4710.4131.4156. 003147.4161.4187.05064191.4212. 00517*.4
865GEN C-U2. 1 ADAMS   SWN NE151235WSPRPL  2.53561.2823.4118.4162.4321.4764.4564.4330.4359.05 0 -1.4369.4392. 0 04389.4407. 004 -1.4
866TOTO 1 STOVER         NWNW071240WGRR    5.03723.3018.4294.4342.4504.5245.5245.4516.4545.04 0210.4553.4567. 0 04581.4600.07 0240.4
867NAT GAS 1 BURKE       SWSE271241WSPRGAS5.03706.2339.4218.4269.4430.  -1.  -1.4435.4461.04 0 -1.4469.4482. 0 04485.4509. 0 0 -1.4
868KEWANEE 1 RAHMIER   NWNWSE 81335WGR-LL  2.51749.  -1.2787.2913.3044.3427.3427.3049.3062. 0 0 -1.3354.3074. 3 03080.3128. 8 4 -1.3
869NAT ASSOC 1 LINDBERG CSESE161312WGR-N-R2.51625.  -1.2700.2793.2925.3168.  -1.2928.2944. 0 0105.2946.2958. 0 02964.3002. 0 0250.3
870PICKRELL 1 SIDEY *A*SESENW181312WGR-N   2.51825. -1. 2934.3015.3154.3460.  -1.3158.3174. 3 0175.3176.3186. 2 03190.3230. 8 0320.3
871**BLANK RECORD**                  W     0.  -1.  -1.  -1.  -1.  -1.  -1.  -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
872KOCH 1 ROGG          NWNENE101313WGR-N-L2.51652. 688.2824.2910.3033.3330.  -1.3036.3052. 0 0100.3057.3067. 0 23070.3108. 0 0240.3
873K AND E 1 PACHIN     NWNWSE 41314WGR-N  2.51779.  -1.2899.2952.3097.  -1.  -1.3100.3114. 3 0 81.3116.3132. 0 03136.3166. 4 0270.3
874JAY-BEE OIL 1 ROGG   SESENE 71314WGR-N  2.51699.0737.2810.2865.3004.3140.  -1.  -1.3021. 0 0 -1.3023.3036. 4 03043.3076. 0 4 -1.3
875CITIES A-2 EHRLICH   SENESE281314WGR-N  2.51853.  -1.2950.3000.3147.3273.  -1.3149.3165. 4 0 47.3165.3173. 0 23177.3213. 8 4162.3
876KIM OIL 7 BROWN      SESWNE311314WGR-N  2.51873.  -1.2981.3031.3174.3302.  -1.3174.3190. 4 0 -1.3190.3206. 8 63211.3242. 7 0 -1.3
877J.O.FARMER 1 BRUNGARSESESE151315WGR-N  5.01873. 947.2991.3033.3166.3289.  -1.3169.3186. 4 0 93.3187.3203. 0 23207.3232. 7 0163.3
878HOMESTAKE C W-11 MER CNESE321315WGR-N   2.51910. 952.3010.3058.3196.3313.  -1.3200.3217. 4 0 90.3219.3236. 5 03239.3266. 3 0160.3
879TERRELL  1 WEIGEL   SESENE 81316WGR-N  5.01565.  -1.3160.3211.3349.3490.  -1.3352.3362. 0 0 80.3364.3379. 3 43382.3403. 5 0140.3
880RAYMOND 1 RIEDEL     NESWNW151316WGR-LL 2.51954.1080.3142.3194.3322.3472.  -1.3320.3345. 3 0112.3350.3366. 2 03370.3390. 0 4178.3
881KEWANEE 88 GIEBLER   SENWSE101317WGR-LL 2.52004.  -1.3222.3270.3398.  -1.  -1.3402.3424. 6 0135.3428.3442. 0 03445.3465. 0 0192.3
882LAUCK 9 GEIST        SENWNE271317WGR-N  2.51595.1210.3252.3305.3435.3550.  -1.3438.3459. 0 0120.3440.3475. 0 03477.3499. 0 0180.3
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884K AND E B-1 LANG      NENESW291317WGR-N  2.52065.1290.3312.3367.3496.3656.   -1.3500.3520. 4 0105.3525.3537. 0 03540.3563. 2 0137.3
885PRATT B-1 STAAB       NWSENE121318WGR-N-L2.52129.1367.3348.3394.3519.3634.   -1.3523.3544. 0 0 -1.3548.3561. 0 03563.3532. 0 0 -1.3
886SHIELDS 2 BRAUN       NENWNW151318WGR-N  5.02159.1433.3407.3459.3578.3705.   -1.3583.3603. 0 0120.3607.3620. 3 03622.3641. 0 0 98.3
887VIRGINIA DRLG. 1 BRUSWSWSW191318WGRLLML2.52622.1316.3297.3344.3463.3667.   -1.3469.3492. 6 0 -1.3496.3509. 0 03512.3532. 0 0 -1.3
888CLINTON OIL 1-V WITTNWNWSE231318WGRNRC 2.52127.1380.3377.3424.3550.3666.   -1.3554.3575. 0 0 63.3578.3590. 0 03593.3612. 0 0 80.3
889MURFIN,ETAL 1 KALETZS2SESW 31319WGR-N  2.52077.1429.3367.3409.3538.3740.   -1.3543.3562. 0 0102.3565.3579. 0 03582.3602. 0 3100.3
890CLINTON OIL 2 PFEIFENWNENW191319WGRNR   5.2179.1503.3460.3503.3628.2855.   -1.3632.3651. 0 0160.3653.3672. 5 03678.3694. 2 3138.3
891ABERCROMBIE 1 HUPF  NESWSE221319WGRNGC  5.2094.1400.3357.3403.3532.  -1.   -1.3538.3556. 0 0 97.3560.3575. 0 03580.3596. 6 0 83.3
892J.S. TOMLINSON 1 FIC CE2NW311319WGRNR   5.2231.1528.3480.3523.3656.3844.   -1.3654.3675. 5 0110.3678.3696. 0 03701.3714. 5 4 98.3
893CLINTON OIL 2-D KINGSESWNW101320WGRNR  2.52108.1458.3368.3406.3533.3762.   -1.3543.3562. 0 0108.3566.3586. 0 03592.3614. 0 0200.3
894IMPERIAL 2-C GIEHLERSWSWNE271320WGRNG  2.52206.  -1.3444.3484.3612.3822.   -1.3618.3636. 0 0122.3639.3656. 2 03660.3681. 7 0112.3
895IMPERIAL 3-C GIEFLERW2W2NE271320WGRN   2.52202.  -1.3436.3477.3606.3821.   -1.3612.3631. 0 0 -1.3634.3652. 6 03655.3676. 8 0 -1.3
896LEBEN DRLG. 1 KNOECEKNWNW311320WGRLL   2.52279.1613.3527.3566.3696.3527.   -1.3702.3720. 4 0 -1.3722.3742. 4 03748.3766. 6 0 -1.3
897EUWER PET. 1 GLASS  SWNESW091321WGRNGC  5.2220.1618.3494.3527.3660.3922.   -1.3668.3684. 0 0 80.3687.3706. 0 03708.3747. 0 0131.3
898ABERCROMBIE 2 M. AGNN2NENE241321WGRNGC  5.2212.1558.3493.3521.3648.3534.   -1.3653.3674. 9 0102.3677.3694. 4 03700.3720.10 0150.
899D.C. SLAWSON 1-B PAR CNWSE311321WGRNGC  5.2313.1720.3634.3667.3799.4129.   -1.3804.3824. 0 0113.3826.3846. 0 03853.3870. 0 0120.3
900CHIEF DRLG. 1 RIEDEL CSESE051322WGRNCC  5.2300.1773.3631.3667.3804.4175.4175.3811.3819. 0 0117.3821.3850. 0 03852.3867. 0 0 90.3
901MACK OIL 3 ARNOLD   NWSENW121322WGRNR   5.2271.1694.3566.3599.3731.4064.4064.3740.3758. 5 0117.3761.3779. 4 03781.3798. 0 0 95.3
902D.C. SLAWSON 1-D NEL CSESW351322WGRNGC  5.2350.1775.3702.3736.3868.4231.4231.3874.3892. 0 0110.3895.3916. 0 63919.3940. 0 0120.3
903MACK 1 MICHEL         CNESE 51323WGR-R  2.52456.1943.3791.3828.3968.4388.4388.3977.3994. 0 0120.3997.4012. 0 04018.4038. 0 0109.4
904MACK OIL 1 ELLA       CNESE111323WGRNGC  5.2289.1864.3717.3755.3896.4323.4323.3899.3917. 0 0101.3920.3940. 2 03945.3960. 0 0 86.3
905J. FARMER 1 MAI     NWNWNE211323WGRN    2.52406.1875.3746.3783.3925.4340.4340.3932.3950. 0 0 -1.3953.3970. 3 03977.3988. 0 0 -1.3
906ANSCHUTZ CALC 1 DEINSWSWNW241323WGRN   2.52437.1928.3773.3814.3958.4362.4362.3964.3981. 0 0 -1.3989.4002. 4 04008.4024. 0 0 -1.4
907R.& B. DRLG. 1-A FCLSWSWSW311323WGRNG  2.52353.1810.3676.3715.3862.4300.4300.3868.3887. 5 0130.3896.3908. 0 03913.3928. 0 0 89.3
908J. FARMER 1 KARST     CNENW011324WGRNG   2.52455.1958.3785.3821.3964.4376.4376.3976.3993. 0 0118.3998.4012. 0 04018.4038. 0 0144.4
909ANSCHUTZ 1 SCHNEIDER CSWNW351324WGRNR   2.52254.1815.3652.3703.3850.4294.4294.3856.3875. 6 0172.3877.3894. 7 03900.3920. 0 0130.3
910GULF OIL 1-6 EDNA     CNESW0 1325WGRNCC  5.2520.2085.3820.3860.4010.4442.4442.4016.4037. 0 0104.4042.4063. 0 04066.4079. 0 0130.4
911D.R. LAUCK 1 HILLING CSWN.161325WGRCSR 2.52480.2022.3770.3810.3960.4372.4372.3967.3989. 5 0 80.3994.4008. 0 04016.4036. 0 5150.4
912MURFIN 1 FLAGLER      CSWNW231325WGR-N   2.52457.1977.3734.3776.3926.4352.4352.3934.3954. 4 0130.3958.3974. 3 03984.3999. 4 0109.4
913PET. INC. 1 PURINTON CNWSE321325WGRN    2.52377.1879.3642.3681.3833.4262.4262.3841.3862. 3 0116.3867.3896. 3 03892.3908. 0 0228.3
914W.S IANNITTI 1 BLACK CSES 081326WGRNGC  5.2569.  -1.3844.3884.4035.4466.4466.4042.4062. 0 0105.4067.4085. 0 04093.4112. 0 0188.4
915BEREN CORP. 1 FAHLY  CNWSW191326WGRN     5.2451.1962.3677.3717.3864.4301.4301.3870.3891. 3 0108.3895.3916. 8 03928.3945. 0 0210.3
916ABERCROMBIE 1 MEIER  CNENE261326WGRNCC  5.2450.1947.3698.3725.3876.4292.4292.3884.3907. 3 0 99.3910.3929. 5 03936.3950. 0 0200.3
917PICKRELL DRLG. 1-E H CSWN 341326WGRNCC 5.02455.1955.3700.3741.3885.4308.4308.3894.3916. 6 0117.3920.3940. 8 03949.3965. 0 2214.3
918R.& WILLIAMSON 1 FCR CNENE011327WGRSRC 2.52655.2186.3884.3922.4068.4507.4507.4074.4095. 4 0 80.4104.4112. 0 04128.4146. 4 0151.4
919N.& GUSSMAN 1 CCBERL CSESE151327WGRNGC 2.52470.2000.3647.3726.3876.4304.4304.3878.3901. 6 0 98.3907.3926. 0 03938.3956. 0 0200.3
920CHIEF 1 CAROLL        CNWSE321327WGR-N   2.52573.2058.3754.3793.3945.4381.4381.3950.3974. 6 0110.3980.3998. 0 04008.4028. 0 2220.4
921MILES DRLG. 1 ROBERT CNESW231328WGRNGC 2.52695.2190.3847.3883.4035.4477.4477.4038.4062. 6 0126.4066.4090. 0 04100.4121. 3 0220.4
922GULF OIL 1 CRIST      CSENW351328WGRSPR 2.52619.2082.3762.3800.3957.4383.4383.3960.3980. 0 0126.3985.4006. 0 04013.4037. 0 0240.4
923MULL DRLG. 1 LEWIS  NESENW201329WGRNGC  5.2830.2297.3898.3940.4088.4535.4535.4094.4117. 2 0147.4122.4137. 3 04146.4169. 0 0210.4
924SCOTT RITCHIE 1-A CO CN2SE251329WGRNCC  5.2734.2197.3826.3863.4022.4458.4458.4026.4049. 0 0160.4054.4074. 0 04084.4106. 0 0210.4
925D. C. SLAWSON 1-C HO CSESW351329WGRNGC  5.2750.2257.3874.3912.4066.4511.4511.4070.4098. 0 0168.4104.4121. 0 04128.4155. 2 0210.4
926NATIONAL OIL 1 WILSCSWNWNW151330WGRNC   5.2846.2290.3850.3893.4043.4474.4474.4053.4077. 0 0185.4082.4095. 0 04104.4129. 0 0295.4
927MURFIN DRLG. 1 CATTL CSWN 231330WGRNCC  5.2877.2316.3878.3915.4068.4495.4495.4077.4101. 0 0150.4135.4122. 4 04127.4152. 0 0220.4
928CHIEF DRLG. 1 OTTLEY CSENW291330WGRNGC  5.2807.2280.3848.3890.4058.4502.4502.4067.4091. 0 0185.4095.4110. 0 04118.4142. 7 0220.4
929ABERCROMBIE 1 PHEY   CSENW091332WGRNGC  5.2589.2440.3946.3992.4150.4634.4634.4156.4178. 0 0121.4184.4197. 4 04205.4229. 0 0218.4
930ABERCROMBIE 1 OELZEINTSWNE141332WGRNCC  5.2551.2456.3922.3961.4128.4574.4574.4133.4156. 0 0116.4164.4176. 0 44182.4210. 5 3218.4
931TOTO GAS 1 LAIGN      CSWNW241332WGPRI   5.2915.2402.3897.3933.4085.4578.4578.4101.4122. 0 0 -1.4132.4142. 0 34133.4176. 0 0 -1.4
932BEREN CORP.1 CUNNING CNWNW271332WGR-N  2.53033.2510.3992.4038.4198.4662.4662.4206.4228. 0 0140.4238.4252. 0 04260.4280. 0 0220.4
933TOTO GAS 1 WILLANE   CSESW191333WGRLLSP 5.2518.2326.3789.3840.4002.4527.4527.4009.4034. 5 0145.4038.4058. 2 64064.4084. 0 0240.4
934ABERCROMBIE 1-B BLTR CSWNE291333WGRNGC  5.2876.2313.3739.3806.3972.4500.4500.3980.4003. 0 0123.4007.4025. 0 04035.4056. 0 0210.4
935BEREN CORP. 1 S. VALSENESE341333WGRNGC 5.2895.2340.3806.3850.4028.  -1.  -1.4034.4059. 4 0110.4065.4085. 2 34089.4112. 0 0150.4
936ABERCROMBIE 2 S. VALNWNESW351333WGRNRC  5.2500.2341.3800.3840.4020.4514.4514.4029.4055. 3 0147.4063.4079. 8 04083.4104. 0 0210.4
937VIRGINIA DRLG. 1 JANNWNWSW011334WGRLLML 5.2990.2437.3861.3915.4080.4605.4605.4088.4108. 0 0 -1.4118.4137. 0 54140.4166. 0 0 -1.4
938WYCOFF BROTH. 1-A PO CSESW171334WGRR    5.3002.2384.3826.3876.4045.4589.4585.4049.4075. 3 0 88.4079.4102. 0 54109.4129. 0 0145.4
939J. S. CARTER 1 ROSS SESESE361334WGRLLML 5.2849.2267.3720.3770.3935.4480.4480.3946.3972. 2 0 -1.3974.3993. 0 43998.4022. 0 0 -1.4
940VIRGINA 1 AYE         NENENE 41335WGR-N  2.53077.2500.3875.3920.4096.4637.4637.4104.4130. 6 0110.4133.4155. 0 64161.4180. 0 0163.4
941ABERCOMBIE 1 VEJL     CSWNW091335WGRNGC  5.3045.2448.3836.3879.4047.4580.4580.4056.4082. 4 3100.4086.4107. 0 04117.4134. 3 0210.4
942ABERCCMBIE 1 REPSHIR CNWSE291335WGRNGC  5.2966.2353.3759.3808.3975.4544.4544.3986.4013. 0 3165.4018.4038. 0 24042.4064. 4 2220.4
943PEEL-HARDMAN 1 FLUPR CSWNE111336WGRSPR 2.52976.2360.3759.3802.3972.4556.4556.3980.4010. 5 2 -1.4015.4036. 0 44041.4061. 7 0 -1.4
944VIRGINA 1 MARSON     SESESE281336WGR-N  2.53121.2462.3870.3917.4098.4688.4688.4100.4130. 0 4159.4134.4160. 0 34166.4191. 6 0172.4
945BURNETT CORP. 1-A LE CSWSW041339WGRG     5.3385.2592.3908.3958.4130.4805.4805.4138.4165. 0 0192.4173.4196. 0 04198.4221. 8 0230.4
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946BURNETT CORP. 1 LEWI CNENW051339WGRGC   5.3400.  -1.3916.3965.4130.4800.4800.4142.4169. 0 0152.4176.4198. 0 04202.4228. 9 0176.4
947BURNETT CORP. 1 FINL CSWSE071339WSPRGRS 5.3459.2658.3960.4016.4188.4883.4883.4199.4227. 0 0148.4234.4259. 0 04262.4289. 0 0200.4
948BURNETT CORP. 1 HOLC CNWNW161339WGRR    5.3340.2538.3847.3897.4063.4743.4743.4073.4099. 0 0120.4109.4131. 0 34134.4161. 0 5160.4
949TARGET DRLG. 1 FANKH CNENE311339WGRNCC  5.3389.2580.3899.3958.4134.4820.4820.4142.4174. 0 0 64.4178.4203. 0 04207.4230. 3 0188.4
950HRADLEY-SHAW 1 FINLE CNESE131340WGR-G  2.53417.2608.3930.3976.4152.4819.4815.4160.4187. 0 6160.4196.4222. 0 04229.4249. 0 0235.4
951SKELLY OIL 1 SEXSCN NWNESW191342WGRNSP 2.53856.2903.4161.4218.4388.5144.5144.4396.4420. 2 0 -1.4426.4450. 0 04452.4484. 0 0 -1.4
952SKELLY A-1 SEXSON   SESENW291342WGR-LL 2.53881.2912.4202.4253.4426.5154.5154.4435.4460. 4 0 -1.4470.4485. 0 04491.4520. 0 6 -1.4
953MACK  1 PETERMANN    CSENE281409WGR-LLN5.01655.  -1.2626.2754.2902.3198.   -1.2907.2919. 0 0130.2921.2935. 0 22944.2982. 0 0232.2
954GORSKI A-15 VOPAT    SWNWSE211410WGR-N  5.01677. -1. 2675.2789.2925.  -1.   -1.2934.2947. 0 0 -1.2949.2960. 0 02963.3006. 0 0 -1.3
955PICKRELL A-1 STCPFELSWNENW171411WGR-N  2.51710. 548.2727.2825.2970.3208.   -1.2972.2989. 0 0125.2994.3004. 0 03008.3050.12 4220.3
956GLEN RUPE 1 STOPPEL  CSENE241411WGR-N  2.51680.  -1.2667.2776.2916.3150.   -1.2921.2938. 0 0103.2943.2954. 0 02956.2996. 4 2220.2
957MARTINSKELLER 1 GOLDNCNWSW 71412WGR-N  2.51813. 757.2888.2974.3112.3320.   -1.3116.3130. 0 0100.3134.3147. 0 03149.3186. 0 0220.3
958NATIONAL 1 WITT      NWNENW101412WGR-N  2.51841. 717.2831.2983.3124.3382.   -.13129.3146. 4 0187.3150.3166. 0 03168.3202. 0 4320.3
959SKELLY 3 PLNARCK     SESESW311412WGR-N  2.51767. 670.2845.2944.3077.3230.   -1.3080.  -1. 2 0 -1.3090.  -1. 2 03116.3144. 3 0 -1.3
960TEXAS CO. 11 MOHL    SWSESE181413WGR/LL 2.51814. 800.2900.2988.3110.3258.   -1.3112.3129. 0 6 -1.3131.3144. 0 03147.3175. 0 6 -1.3
961CITIES A-4 GRAHAM    CNWNW281413WGR-N   5.01748.  -1.2806.2896.3030.  -1.   -1.3033.3049. 3 0 85.3051.3066. 5 03069.3094. 0 6130.3
962COLO C&G  1 WEIMASTEW2SENW361413WGR-N  2.51712. -1. 2774.2870.2996.3134.   -1.2998.3016. 4 0 -1.3019.  -1. 6 03038.3064. 3 0 -1.3
963PAN AM 10 ROXHERGER NWSENW101414WGR-LL 2.51845. 833.2934.2996.3132.3252.   -1.3136.3150. 4 0 86.3150.3169. 0 43172.3198. 0 0151.3
964CRUDE PROD 1 STALCKESENWSW361414WGR-N  5.01761.  -1.2862.2928.3078.3198.   -1.3084.3098. 0 0208.3100.3112. 0 03117.3139. 0 0227.3
965SUNRAY A-3 DUMLER    SWNWNW111415WGR-N  2.51863.  -1.2976.3031.3164.  -1.   -1.3168.3183. 4 0 40.3183.3200. 5 33201.3230. 4 3 98.3
966SHIELDS  A-2 NIEDENTN2NENE231415WGR-N  5.01849.  -1.2955.3019.3154.3255.   -1.3156.3173. 0 0 -1.3173.3188. 2 03196.3222. 2 0 -1.3
967WICKS 3 DUMLER       N2S2NW361415WGR-LL 2.51752. 820.2925.2983.3115.3218.   -1.3122.3137. 0 0 -1.3140.3153. 0 03159.3187. 0 0 -1.3
968ALPINE 1 GOETZ       NWNWSE 81416WGR-N  2.51936.1050.3149.3196.3354.3446.   -1.3358.3373. 0 0 62.3376.3394. 0 03404.3422. 0 0 78.3
969SUTTON 1 HAMPENSCHPINWNESW121416WGR-LL 2.51918.1000.3102.3152.3309.3416.   -1.3311.3329. 0 0 70.3333.3352. 0 03362.3378. 0 0125.3
970ATLANTIC 1 DREILING NESWSW221416WGR-N   2.51857. 950.3047.3074.3232.3344.   -1.3236.3254. 5 0 -1.3257.3273. 0 03276.3298. 2 3 -1.3
971THUNDERBIRD 1 WAGNERNENENE261416WGR-LL  2.51884. 970.3074.3124.3250.3357.   -1.3262.3281. 0 0 -1.3283.3300. 4 03304.3324. 2 0 -1.3
972OKMAR 1 BRAUN         SESENE 31417WGR-LL 2.51597.1175.3243.3293.3417.3753.   -1.3420.3442. 0 0 -1.3445.3460. 0 03463.3483. 0 0 -1.3
973BLACK PET 1 DINKEL   CN2NW201417WGR-N   2.51560.1138.3135.3241.3366.3528.   -1.3373.3394. 0 0148.3376.3409. 0 03410.3432. 2 3128.3
974CIRCLE OIL 1 DINKEL  CNWNW281417WGR-N   2.51972.1120.3133.3236.3362.3511.   -.13371.3390. 0 0122.3394.3404. 0 03404.3427. 0 0100.3
975NATIONAL 1 FEFTIES   NWNENW 71418WGR-LL 2.52088.1354.3348.3397.3520.3710.   -1.3526.3547. 0 0128.3548.3565. 4 03568.3582. 0 0 52.3
976HUDSON 1 MENEHAN      SWSENW291418WGR-N  2.52085.1290.3324.3378.3500.3707.   -1.3508.3528. 0 0108.3530.3544. 0 43547.3567. 5 0 92.3
977BEACON 1 PFANNENSTIELSENESW351418WGR-N   2.52015.1193.3249.3297.3421.3618.   -1.3426.3444. 0 0110.3444.3460. 4 03463.3483. 6 0 80.3
978FRONTIER 1-10 KINDERSWSWSE 81419WGR-N   5.02198.1476.3450.3484.3623.3652.   -1.3630.3648. 0 0 75.3650.3666. 4 03671.3688. 4 0 72.3
979STERLING 1 KISNER     NWNWSW111419WGR-N  5.02213.1503.3490.3540.3660.3860.   -1.3665.3683. 0 0 81.3686.3699. 2 03703.3730.18 0 77.3
980AL TIPTON 1 KRAUS    W2SWNW221419WGR-N  2.52118.1393.3372.3418.3542.3740.   -1.3547.3566. 0 0108.3568.3590. 0 23592.3610. 3 0 75.
981MURFIN 1 ROHR         CNWNW301419WGR-N   2.52161.1038.3417.3461.3550.3742.   -1.3599.3619. 0 0130.3622.3642. 0 03645.3668. 3 0160.3
982ABERCROMBIE 1 GABEL NENWSE 51420WGR-N   2.52239.1556.  -1.3527.3658.2877.   -1.3667.3687. 3 0113.3690.3708. 3 03710.3730. 3 0135.3
983MURFIN 1 HONAS       NESESW111420WGR-N  2.52203.1498.3442.3462.3612.3818.   -1.3618.3638. 0 0135.3640.3660. 4 03662.3684.10 0125.3
984NATIONAL OIL 1 PFIEF CNWNW111420WGR-N   5.02236.1528.3474.3514.3643.3856.   -1.3652.3669. 0 0140.3672.3691. 0 03694.3715. 3 3128.3
985RAINES-WIL 1 SOL-EERSWNENE281420WGR-N   2.52154.  -1.3566.3404.3534.3749.   -1.3539.3557. 0 0105.3560.3580. 5 03582.3598. 6 0 96.3
986BIRMINGHAM 1 KUPPETZSESWSW 41421WGR-N   2.52282.  -1.3591.3630.3760.4049.   -1.3768.3789. 6 0 -1.3792.3812. 0 03816.3835. 0 0 -1.3
987ZEMAN 5 ZEMAN         NWSWSE211421WGR-N  5.02125.1415.3417.3453.3587.  -1.   -1.3592.3612. 0 0 43.3615.3635. 0 03640.3659. 4 0 64.3
988J.O.FARMER A-3 HOLTS CNWNW351321WGR-N   5.02094.1421.3382.3421.3555.2855.   -1.3564.3582. 0 0118.3585.3602. 0 03608.3623. 0 0108.3
989SLAWSON 1-A WEECIA T CSWNW 11422WGR-N   2.52252.1700.3602.3636.3767.4050.   -1.3780.3776. 0 0 84.3794.3418. 2 03821.3844. 7 0140.3
990MURFIN 1 WESSLER     CNESW201422WGR-N   2.52255.1670.3617.3653.3795.4200.   -1.3802.3819. 0 0135.3822.3840. 4 03844.3864. 3 0108.3
991AURORA 1 WASINGER    CNWSW241422WGR-LL  5.02179.1584.3558.3595.3725.4117.4117.3746.3756. 6 0 -1.3739.3780. 0 03783.3803. 5 0 -1.3
992CRA-WOODMAN 1 DEWALD CNENE151423WGR-N   5.02293.1760.3658.3697.3843.4239.4235.3848.3865. 4 0100.3869.3887. 6 03897.3914. 0 0125.3
993J.O.FARMER 1 SCHMEIC CNENE261423WGR-N   5.02257.1680.3640.3680.3825.4230.4230.3832.3848. 0 0 -1.3850.3868. 3 03875.3896. 0 0 -1.3
994PICKRELL 1-1 GAITHER CNENE231424WGR-N   2.52344.1762.3892.3632.3782.4206.4206.3792.3806. 0 0133.3813.3828. 8 03833.3857. 0 0 95.3
995GULF OIL 1-13 PARKE  CNWNE131425WGR-ND  5.02266.1766.3589.3627.3775.4229.4229.3788.3806. 0 0129.3809.3826. 2 03832.3850. 4 0 84.3
996RAINS-WIL 1 OTOOLE   CSWSW211425WGR-LL  2.52398.  -1.3662.3700.3854.4310.4310.3862.3881.00 0166.3884.3900. 7 03911.3926. 0 0180.3
997TIME PET 1 OTOOLE    CSWSW341425WGR-N   2.52200.1757.3583.3626.3780.4212.4212.3784.3805. 0 0195.3808.3832. 0 03840.3858. 0 4193.3
998PATRICK PET. 3 SUICLNESENW071426WGRNGC  5.2558.2015.3736.3777.3930.4356.4356.3936.3960. 4 0100.3964.3987. 0 03995.4015. 0 0210.4
999MULL DRLG. 1 EBBERT  CNWNW101426WGR-N   2.52582.2072.3842.3880.4036.4476.4476.4043.4068. 5 0138.4072.4094. 0 04104.4122. 0 0200.4
1000PATRICK PET. 1 MARTINWNENE261426WGRNGC  5.2426.1926.3707.3747.3905.4338.4338.3912.3934. 0 0106.3937.3955. 0 03966.3981. 0 0210.3
1001THUNDERBIRD 1 BOLLIN CSWSW331426WGRNGC  5.2275.1832.3616.3655.3810.4255.4255.3815.3836. 0 0 88.3840.3864. 0 03874.3897. 4 0210.3
1002TIDEWATER 1 HUTTON   CNESE 61427WGR-LL 2.52569.2037.3738.3778.3925.4356.4356.3932.3958. 6 0 90.3963.3984. 0 03990.4013. 0 0240.4
1003TIDEWATER 1-9 ADAMS  CSWSW 91427WGR-LL 2.52534.1978.3695.3733.3890.4324.4324.3893.3917. 3 0130.3921.3942. 0 03953.3974. 4 0240.3
1004CHIEF DRLG. 1-B SUIC CNWSW121427WGRNGC  5.2543.1983.3717.3753.3909.4343.4343.3917.3940. 4 0 88.3943.3965. 0 43975.3994. 3 0280.4
1005PICKRELL 1-F LEIGHTO CSENW291427WGRNG   5.2452.1925.3632.3668.3828.4315.4315.3832.3850. 0 0121.3853.3882. 0 03891.3913. 5 0220.3
1006THUNDERBIRD 1-C SMITSWNWNE181428WGRNGC  5.2650.2103.3749.3787.3944.4389.4385.3952.3976. 0 0134.3983.4002. 3 04008.4033. 8 0260.4
1007D.C. SLAWSON JJ COBESWSENW221428WGRNR   5.2592.2023.3694.3733.3887.  -1.   -1.3890.3913. 2 0140.3916.3944. 5 43951.3975. 9 0210.3
1008AURORA G?SC. 1 BEESLSESESE321428WGRNG  2.52566.1976.3660.3698.3866.4310.4310.3874.3998. 5 0130.3930.3924. 0 03933.3950. 3 0298.3
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1009CHIEF DRLG. 1 WEBE   CSENE321428WGRNG   5.2578.2000.3675.3713.3874.4335.4335.3885.3910. 6 0160.3919.3936. 3 03943.3964. 0 0210.3
1010MURFIN DRLG. 1 BEESL   CSW061429WGRNCC  5.2681.2124.3685.3724.3880.4301.4301.3886.3911. 0 0148.3915.3932. 0 03936.3959. 0 0271.3
1011CITIES SER. 1 SHAW  NWNWNW231429WSPR    5.2656.2092.3713.3754.3920.4328.4328.3928.3949. 0 0 -1.3956.3973. 0 53979.4004. 0 0 -1.4
1012GLEN R. NYE 1 LUNDGRNWNWNW291429WGRN    5.2589.2013.3611.3649.3814.4257.4257.3821.3847. 4 0 -1.3854.3870. 0 43875.3901. 0 5 -1.3
1013DUNLAP & CORN. 1 HUM CNENC341429WGRNLLR 5.2569.1998.3646.3682.3850.4292.4292.3859.3885. 0 0180.3889.3907. 0 03912.3938. 0 0240.3
1014OLYMPIC PET. 1 KRUG  CSWSE251430WGRNGC  5.2641.2054.3657.3693.3858.4297.4297.3862.3888. 4 0153.3896.3911. 0 63916.3945.10 0234.3
1015THUNDERBIRD 1-N HAAC CSESE311431WGRNGC  5.2609.2069.3619.3658.3830.4292.4292.3835.3860. 0 0145.3865.3884. 0 33893.3920. 0 0210.3
1016PLACID OIL 1 BROTHER CSWSW341431WSPRGRS2.52623.2081.3650.3685.3853.4324.4324.3861.3884. 0 0120.3892.3908. 0 03913.3938. 2 0223.3
1017NAT. ASSOC. 1-A TRUSNWSWSE151432WGRNG  2.52719.2143.3683.3719.3889.4383.4383.3893.3917. 3 0 90.3922.3942. 2 23947.3978. 2 0193.3
1018ABERCROMBIE 1 KRECS  CNWNW341432WGRNCC  5.2660.2096.3620.3656.3830.4344.4344.3839.3864. 0 0 86.3868.3889. 0 03893.3916. 4 0220.3
1019PEEL HARDMAN 1 HRIGG CNWSE121433WGRLLSP2.52774.2232.3722.3768.3934.4443.4443.3942.3964. 0 0 -1.3970.3988. 0 43994.4017. 3 0 -1.4
1020TOTO GAS 1 HAWES     CSWSW231434WGRLLR  5.2994.2386.3846.3897.4064.4624.4624.4075.4103. 3 0126.4107.4122. 0 04127.4151. 0 0240.4
1021PHILLIPS PET. 1 CELANSNESE081435WSRLLML 5.3223.2592.4033.4091.4261.4508.4508.4269.4299. 0 0 -1.4303.4325. 0 44327.4350. 2 5 -1.4
1022PEEL HARDMAN 1 HARVE CNWNW341435WGRLLRS2.53036.2381.3822.3870.4046.4606.4606.4050.4082. 3 0 -1.4086.4106. 0 04110.4134. 0 0 -1.4
1023SCHAFER OIL 1 FOTCPO CNWNW071436WGRNG  2.53389.2717.4112.4160.4353.5051.5051.4365.4396. 7 0164.4400.4418. 0 04421.4450.10 0230.4
1024SHAMROCK OIL 1-D SURNWNWNW061437WGRMLR 2.53318.2620.3938.4049.4226.4914.4914.4236.4264. 0 0 -1.4270.4280. 0 44286.4319. 4 0 -1.4
1025SHAMROCK OIL 1 SURRA CSWSW331437WGRLLML2.53411.2698.4082.4139.4324.5006.5006.4332.4364. 2 3 -1.4370.4392. 0 04399.4418. 0 0 -1.4
1026D. R. LAUCK 1 JENNIN CNENE021439WGRSCH 2.53368.2560.3909.3960.4134.4780.4780.4142.4169. 0 0110.4176.4198. 0 04202.4224. 0 0180.4
1027NATURAL GAS 1 WARLEC CSWNW211440WGRLLR  5.3724.2811.4140.4192.4355.5116.5116.4363.4387. 0 3188.4395.4412. 0 04412.4441. 5 0148.4
1028WICHITA INC. 1 KUEHL CNWSE361440WGRR    5.3640.2754.4118.4174.4357.5112.5112.4365.4389. 3 0137.4396.4418. 0 04421.4439. 0 0116.4
1029BRADLEY & SHAW 1 PEA CNESE021441WGRNG  2.53634.2758.4083.4141.4312.5030.5030.4320.4345. 6 0165.4353.4367. 0 04370.4396. 0 0150.4
1030CITIES SER. 1 PEARCENWSESW101441WSPR    5.3772.  -1.4144.4216.4386.5084.5084.4398.4423. 5 0 -1.4432.4450. 0 04457.4481. 5 0 -1.4
1031BRADLEY SHAW 1 COLLI CNENE051442WGRGC  2.53882.2899.4203.4262.4425.5186.5186.4437.4454. 0 0215.4464.4488. 0 04495.4517. 0 0220.4
1032TREND EXPL. 1 WAUGH  CNESW161442WSPRGRC2.53851.2818.4131.4185.4357.5148.5148.4366.4390. 0 0248.4398.4418. 0 04422.4445. 0 0256.4
1033UTE PROD. 22-41 WESK CNENE321442WGRNG   5.3856.2798.4124.4186.4352.  -1.  -1.4362.4382. 0 0160.4390.4410. 0 04415.4441. 0 0210.4
1034SKD CORP. 1 KYLER    SESESW 51507WGR-N  2.51711. 540.2613.2748.2922.3212.3212.2924.2937. 0 0110.2939.2363. 0 52968.3012. 014180.3
1035SIEGEL 1 N.BAPTIST C CNWSE111507WGR-N  2.51713.  -1.2613.2757.2926.3244.3244.2930.2946. 0 0 83.2950.2972. 0 02974.3030.1014211.3
1036MACK OIL 1 WARTA     NWNWN.151508WGR-NL 5.01640. 241.2511.2648.2801.3051.   -1.2805.2819. 2 0 92.2821.2844. 0 82846.2888. 5 3197.2
1037SUN  1 DOHATA        CSENE151509WGR-L   2.51555.  -1.2524.2655.2798.3027.   -1.2805.2817. 0 0 74.2820.2832. 0 02836.2878.10 0204.2
1038WOODMAN-IAN 1 KATZENSWSENE311509WGR-N  5.01717.  -1.2736.2854.3006.3216.   -1.3011.3025. 0 0 86.3029.3040. 0 03044.3084. 3 0187.3
1039GRAVES-LEE P. 1 VCHANTNES-151510WGR-N  5.01751.  -1.2757.2885.3027.3248.   -1.3032.3046. 4 0132.3048.3065. 0 03068.3104. 6 3320.3
1040CITIES A-4 ZVOLANEK NESWNW321510WGR-N  5.01756. 605.2837.2950.3086.3281.   -1.3090.3104. 4 0 78.3105.3117. 0 03119.3160.10 0168.3
1041HENDERSON A-2 ZVOLAKSESENE321510WGR-N  2.51770.  -1.2802.2918.3060.3289.   -1.3066.3080. 3 0 83.3083.3096. 0 03100.3140. 0 0197.3
1042SHIELDS 1 HAPPL      NENESW 41511WGR-N  2.51777.  -1.2833.2935.3082.3277.   -1.3084.3100. 2 0195.3103.3114. 0 03118.3140. 0 6145.3
1043PAN-WESTERN 1 HOCH  NWNWSW131511WGR-N  5.01829. 680.2869.2976.3125.3320.   -1.3129.3142. 0 0 99.3145.3160. 0 03161.3199.12 4235.3
1044ROZENERANTZ U-1 DANIW2W2SW221511WGR-N  2.51704.  -1.2748.2853.2998.  -1.   -1.3002.3016. 0 0 -1.3018.3028. 0 03032.3067. 0 0 -1.3
1045**BLANK RECORD**                  W     C.  -1.  -1.  -1.  -1.  -1.  -1.   -1.  -1.  -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
1046HARTON 2 HARRINGTON S2N2SW301511WGR-N  5.01818.  -1.2878.2984.3126.  -1.   -1.3129.3142. 0 0 48.3144.3162. 0 03164.3198.15 2225.3
1047GLICKMAN 3 KYNER     NESENW331511WGR-N  2.51775.  -1.2820.2925.3066.3243.   -1.3070.3083. 0 0 53.3086.3102. 0 43102.3140.10 0175.3
1048CITIES 9 COOK        SWSWSW 41512WGR-N  5.01818.  -1.2876.2964.3108.3257.   -1.3110.3126. 5 0 94.3128.3146. 6 03149.3180.10 3288.3
1049ALLISON 1 HOETKEMEYESWNENE141512WGR-N  2.51857. 747.2839.3003.3137.3313.   -1.3141.3156. 3 0165.3158.3173. 4 03175.3198. 7 4109.3
1050GORE 1 LUEBMAN       N2SWNE241512WGR-N  5.01818.  -1.2882.2980.3110.  -1.   -1.3115.3127. 0 0 -1.3130.3146. 0 23151.3180.10 0 -1.3
1051PHILLIPS 3 ROLSNER    CNESE 91513WGR-N  5.01883.  -1.2976.3071.3202.3331.   -1.3205.3221. 0 2120.3224.3240. 3 03242.3269.10 0140.3
1052J.O. FARMER 1-4 SELLN2N2NW261513WGR-N  5.01834. 785.2925.3020.3148.3288.   -1.3151.3167. 5 0 74.3170.3193. 0 03188.3209. 0 0130.3
1053CRA 3 H SELLENS      CNENW301513WGR-NLL2.51869. 858.2980.3048.3194.3331.   -1.3200.3214. 0 0 -1.3216.3230. 0 03232.3258. 7 0 -1.
1054HLACK 1 DRISCOLL     SENENE 81514WGR-NG 2.51829. 828.2962.3022.3166.  -1.   -1.3172.3185. 0 0107.3186.3202. 9 53207.3239. 0 0288.3
1055NCRA  D-2 FL-GLER    SENESW111514WGR-NR 2.51846. 848.2983.3048.3193.3345.   -1.3196.3212. 0 0130.3214.3227. 0 43230.3255. 2 0153.3
1056VINCENT E-1 NUSS     W2SWSW271514WGR-N  5.01890. 900.3047.3110.3254.3350.   -1.3259.3272. 7 0184.3272.3286. 0 03289.3320. 6 0125.3
1057CHAPMAN 1 POLCYN     NWNENW101515WGR-N  5.01821.  -1.2938.3056.3190.3280.   -1.3194.3211. 6 0123.3212.3226. 0 03230.3256. 0 0270.3
1058IMPERIAL 1 WEGELE    SWSESW141515WGR-LL 2.51887. 928.3060.3121.3254.3361..  -1.3258.3274. 3 0 95.3276.3289. 0 03298.3319. 0 0240.3
1059BRUNSON-SP 1 WEGELE  SWNWSE321515WGR-NG 5.01933. 938.3141.3199.3334.3479.   -1.3339.3356. 6 0 97.3357.3374. 3 03376.3394. 0 0 95.3
1060CITIES A-1 RAJEWSKI NESWNW 41516WGR-NL 5.01855. 988.3083.3125.3263.3424.   -1.3266.3282. 3 0126.3284.3298. 9 03300.3326. 310 97.3
1061ZENITH 1 URBAN       SENESE331516WGR-NG 2.51850. 968.3036.3142.3276.3444.   -1.3278.3298. 4 0100.3300.3313. 0 03320.3345. 0 0 -1.3
1062TILCO ETAL 1 PH. RANSWSWSW111517WGRNGC 2.51955.1102.3207.3254.3385.3597.   -1.3391.3410. 0 3112.3414.3428. 8 03434.3450. 0 0100.3
1063PETROL MAN 7 STECKLENENESE181517WGR-N  5.01977.1124.3217.3269.3395.3563.   -1.3399.3418. 0 0110.3421.3434. 0 03437.3460. 3 0 -1.3
1064TENECO 1 SCHMIDT     NESWNW221517WGRLL  2.51960.1118.3218.3266.3393.  -1.   -1.3398.3419. 0 0 -1.3422.  -1. 0 03436.3474. 0 0 -1.3
1065CLINTON 1-W JACOBS   NESWNE351517WGR-N  5.01890.1034.3141.3192.3323.3516.   -1.3326.3347. 0 4136.3351.3366. 0 23384.3402. 5 0 -1.3
1066HANSEN 2 ROHR        NESENW 81518WGR-LLN2.52013.1183.3242.3290.3418.3600.   -1.3422.3443. 6 0125.3444.3462. 4 43466.3473. 6 0 97.3
1067UNION TX  A-3 PIVCAK CSESW221518WGR-LL 2.52017.1162.3251.3301.3423.3556.   -1.3427.3447. 0 0 98.3450.3464. 0 03468.3488. 0 0102.3
1068ALPINE 4 PFANNENSTIENENENW 11519WGR-N  5.02098.1307.3332.3378.3505.  -1.   -1.3511.3533. 4 0205.3534.3551. 4 03555.3581. 0 0 -1.3
1069RAYMOND 1 WERTH      NENWNE221519WGR-N  2.51596.1200.3244.3291.3422.3632.   -1.3430.3450. 6 0 98.3454.3467. 0 03472.3496. 2 0125.3
1070FARMER 1 DINKEL      NWNESE281519WGR-N  5.02030.1237.3272.3316.3447.3632.   -1.3450.3471. 0 0 96.3476.3491. 2 03496.3516. 0 2106.3
1071TIME PET 1 WANN      CSENE131520WGR-LL 2.52047.  -1.3288.3336.3464.3656.   -1.3471.3492. 4 0 82.3495.3512. 2 03517.3541. 0 0 98.3
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1072COLO OIL 1 STEPHENS SWNWNE331520WGR-I  2.52258.1503.3529.3575.3706.3985.  -1.3712.3733. 0 0 86.3736.3755. 4 03759.3782. 3 0174.3
1073RAYMOND 8-1 ELMORE  E2SESW351520WGRN   2.52162.1368.3420.3465.3591.3818.3818.3601.3617. 0 0112.3622.3638. 0 03641.3665.06 0168.3
1074FARMER 1 CRAWFORD     CSENE 91521WGR-N  5.02240.1598.3624.3666.3801.4169.4169.3811.3827. 0 0130.3831.3849. 0 03856.3872. 4 0160.3
1075ABERCROMBIE 1-A OREN CSESW121521WGRNGC 2.52187.1460.3461.3505.3636.3960.3960.3644.3664. 0 0 90.3668.3686. 0 03690.3709. 0 0 96.3
1076HINKLE 1 PRICE       CNWNW221521WGRGS  2.52292.1645.3683.3726.3863.4267.4267.3869.3891. 0 0105.3893.3910. 0 03916.3933. 0 0135.3
1077DREILING 1 GASHLER  SWNWSE111522WGRNG  2.52279.  -1.3636.3673.3812.4243.4243.3818.3839. 0 0 60.3845.3859. 0 03865.3887. 0 0 60.3
1078DREILING 1 FREEMAN   CSESE281522WGRLL  .252309.1673.3689.3727.3867.4287.4287.3874.3896.08 0210.3901.3918. 0 03923.3947. 0 0228.3
1079CHEROKEE 1 HARM-SCHN CSWNE211523WGRNRCS2.52372.  -1.3746.3784.3930.4344.4344.3935.3953. 0 0 90.3956.3977.02 03986.4004.05 0 98.4
1080SMITH-TOTO 1 FLAX   SESEN.341523WGR-NLL2.52426.1807.3799.3837.3982.4359.4395.3985.4004. 6 0 -1.4008.4028. 3 04038.4055. 0 4 -1.4
1081FARMER 1 FLOYD       CSWNE081524WGRNG  2.52288.1820.3691.3721.3880.4366.4366.3886.3905.04 0100.3908.3929. 0 03939.3958.03 0163.3
1082SINCLAIR 1 MONTGOMRY CSENW151524WGRLLSP2.52374.1802.3690.3728.3886.4311.4311.3888.3907.06 0 -1.3912.3932. 0 03941.3963. 804 -1.3
1083OKMAR 1 LUETTENS     CSWSW191524WGRNG  2.52471.1932.3812.3852.4015.4476.4476.4020.4039. 0 0 80.4043.4059. 0 04074.4091. 0 0158.4
1084HAWLEY TRUST 2 BRLNG CSWNE131525WGRLLR 2.52432.1898.3753.3794.3946.4400.4400.3956.3971. 0 0136.3975.3997. 6 04006.4027. 3 0180.4
1085HAWLEY 1 BRUNCASEL   CSWSE131525WGRLLR 2.52455.  -1.3781.3822.3975.4424.4424.3982.4004.07 0 95.4008.4027. 0 04040.4057. 0 0240.4
1086MULL 1 STUTZ          SWSE181525WGRNG  2.52442.1903.3724.3766.3945.4353.4353.3951.3969.0406 76.3980.3998. 0043998.4013. 0 0136.4
1087MULL 1 SPLITTER     W2SESW211525WGRNG  2.52424.1876.3721.3762.3917.4345.4345.3931.  -1. 0 0 70.3980.3993. 0 03996.4030.08 0180.4
1088BRACK 1 STUTZ-BRADLENENENE011526WGRNG  5.02275.1805.3609.3651.3803.4241.4241.3811.3831. 0 0109.3834.3855.05 03865.3884. 0 0310.3
1089EMPIRE 1 JACKA       CSESE081526WGRNR  5.02231.1760.3564.3601.3772.4200.4200.3774.3798.04 0121.3800.3828. 0 03839.3858. 0 0240.3
1090EMPIRE 2 BABCOCK     CSWNE281526WGRLL  5.02527.1962.3767.3807.3968.4409.4409.3974.3993. 0 0114.3996.4023.06 04030.4053.04 0248.4
1091FARMER 1 MILLER        NESW041527WGRNGC 5.02472.1909.3640.3676.3832.4284.4284.3836.3857. 0 0121.3859.3888. 0 03895.3916.02 0228.3
1092PET INC 1 EARVEY     NENESW111527WGRML  2.52423.1862.3621.3661.3825.4277.4277.3831.3852. 0 0 -1.3856.3889. 0 03891.3915.0206 -1.3
1093DUNNE 1 BENTLEY      NENWSE191527WGRNGC 5.02451.1924.3642.3677.3848.4329.4329.3853.3876.06 0198.3884.3913. 0 03919.3941. 0 0310.3
1094NAT. ASSOC. 1 BENTLYNENESE341527WGRNSPR2.52568.2008.3768.3803.3972.4397.4397.3978.4000. 0 0120.4003.4030. 0 04037.4060. 0 0248.4
1095SLAWSON E-1 BENTLEY   NWNE091528WGRN    5.02506.1935.3627.3663.3826.4270.4270.3836.3859. 0 0144.3867.3886. 0 03893.3916.07 0210.3
1096FUNK C-1 BENTLY      CSENW221528WGRGCS 2.52471.1904.3625.3665.3832.4283.4283.3840.3862. 0 0135.3868.3887.03 03892.3922. 0 0250.3
1097THUNDERBIRD A-1 DAVISWNENW291528WGRNGC 5.02520.1953.3644.3681.3845.4288.4288.3854.3877. 0 0 93.3886.3902.02 03906.3937. 0 0310.3
1098CLINTON 3 PHELPS    W2SWNW051529WGRNR  5.02596.  -1.3603.3643.3811.4250.4250.3816.3840. 0 0 73.3846.3861. 0 03866.3888. 0 0210.3
1099PICKRELL 1-C HANNA   CSENE101529WGRNGC 5.2567.1970.3637.3674.3845.4284.4284.3859.3880. 0 0200.3886.3903. 0 03907.3939. 0 3310.3
1100HERNDON 1 JASPER     NENENE301529WGRLLML2.52553.1961.3630.3658.3804.4238.4238.3814.3837. 0 0 86.3844.3862.06 03866.3903. 009200.3
1101BROWN-TOPER 1 FLEPAGNENE0.101530-GRLLML2.52574.2009.3695.3721.3855.4329.4325.3864.3888. 0 0105.3894.3915. 0 03920.3944. 0 0132.3
1102CHIFF DRLG. 1 SETTLE CNWSW211530WGRNGC  5.2650.2079.3643.3720.3901.4338.4338.3508.3934. 0 0145.3941.3957. 0 03962.3990. 0 0210.3
1103KERMIT 1 MALCOX      CSWNE321530WGRCS  5.02727.2156.3772.3811.3990.4436.4436.3998.4024. 0 0144.4030.4042. 0 04045.4082. 0 0240.4
1104BEREN CORP. 1 RYAN   CSWNE231532WGRNCC 5.2840.2255.3806.3845.4023.4512.4512.4028.4055. 0 0134.4061.4076. 0 04082.4119.14 0220.4
1105VICKERS PET. 1 DEWLESWSWSW131533WGRLLMC2.52755.2194.3719.3765.3932.4470.4470.3937.3964.10 0 -1.3967.3989. 0 63987.4032. 0 6 -1.4
1106TOTO GAS 1 WOOD      CNESW101534WGRNLLR 5.2925.2294.3780.3826.4002.4553.4553.4008.4037. 0 0110.4043.4061. 0 54066.4096.10 0208.4
1107BEREN CORP. 1 MCDANI CNENW361534WGRNGC 2.52516.2293.3814.3860.4047.4624.4624.4050.4082. 0 0180.4088.4108. 0 04115.4136. 5 0210.4
1108WICHITA INC. 1 FRAISNWNWSE161539WGRNCC 5.3622.  -1.4104.4155.4352.5093.5093.4359.4385. 4 0138.4392.4416. 0 04421.4434. 0 0164.4
1109PHILLIPS 2 WALLACE   CNWSE181541WGRLLSP2.53757.  -1.4120.4172.4366.5122.5122.4374.4398. 0 0 -1.4406.4432. 0 04437.4453. 0 0 -1.4
1110TEXAS OIL&GAS 1 HIBB CSWSW061542WGRNC  5.3529.  -1.4178.4245.4415.5209.5209.4425.4447. 0 0180.4455.4481. 0 04486.4503. 4 0210.4
1111PHILLIPS 1 WAL. PROS CSWSW071542WGRLLSP2.53936.2828.4166.4224.4400.5146.5146.4409.4431. 0 0 -1.4439.4462. 0 04470.4487. 0 0 -1.4
1112NATURAL GAS 1 RUSSEL CSESW211542WGRSPLL 5.3542.2852.4206.4272.4450.5264.5264.4457.4482. 0 0174.4490.4514. 0 04516.4541. 4 2198.4
1113DEEP ROCK 3 L. THESSSWNWNE201531WGRLLML2.51313.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1.10 0 -1.
1114NAT. ASSOC. 2 OLSON  CNWNW201603WGRLLML2.51273.  -1.2073.2245.2452.2941.2941.2466.2488. 0 0 -1.2492.2506. 0 02508.2579.14 0 -1.2
1115NAT. OIL 1 PETERSON SESESW331604WGRNR   5.1526.  -1.2292.2499.2682.3197.3197.2686.2708.14 0110.2711.2743. 0 02745.2821. 814210.2
1116RUPP FERG. 1 HECHMERSWSWSE321605WGRNC   5.1594.  -1.2491.2693.2844.3317.3317.2847.2870. 716 90.2872.2909. 0 02913.2977. 8 0220.2
1117CONTINENTAL 1 WEUSTESE2SE2NW051606WGRNG  2.51666.  -1.2557.2748.2906.3217.3217.2902.2923. 3 0 80.2924.2945. 0 02948.3006. 3 3168.3
1118CONTINENTAL 1 EFFINNENENW101606WGRNG    2.51619.  -1.2533.2728.2878.3272.3272.2882.2900. 0 0 33.2902.2922. 0 02926.2993. 5 0222.2
1119CONTINENTAL 1-A JOHNNWNWSW351606WGRNC  2.51445.  -1.2365.2544.2684.3066.3066.2688.2708. 0 0 97.2712.2741. 0 02746.2803. 0 0230.2
1120LEHEN DRLG. 1 ROLLFS CNESW301607WGRNG    5.1578.  -1.2468.2644.2793.3138.3138.2797.2810. 0 0 78.2813.2838. 0 02841.2886. 0 0177.2
1121JOHN FARM. 2 DOLLCHESWNWSW011608WGRN    5.1559.  -1.2409.2548.2711.2959.  -1.2715.2729. 0 0 84.2731.2745. 0 02748.2789. 5 0152.2
1122T. I. LEBEN 1 MISKA NWNWNE271608WGRNR   5.1617.  -1.2541.2690.2864.3120.3120.2868.2880. 0 0160.2882.2894. 0 42898.2940. 6 0305.2
1123ROCK ISLAND 1 DOUBRANENWSW061609WGRLLS 2.51757.  -1.2766.2891.3035.  -1.  -1.3044.3058. 0 0 88.3063.3080. 0 03082.3124. 0 0198.3
1124PET. INC. 1 DEDRASEK CNWSE101610WGRN   2.51840. 625.2858.2973.3114.3388.  -1.3120.3130. 2 0 68.3133.3154. 2 03154.3194. 0 5240.3
1125R. M. EDWARDS 6 MATOSENESE171610WGRNR   5.1884. 673.2920.3045.3175.3348.  -1.3186.3199. 0 4 82.3202.3217. 0 03218.3252. 0 0200.3
1126CITIES SER. 7-C SCHR   CNW341610WGRLLSP2.51826. 595.2844.2967.3110.  -1.  -1.3115.3127. 0 4 78.3130.3146. 0 03146.3180. 0 3172.3
1127S & K OIL 2-A J. PRUS2N2NE201611WGRNGC  5.1861. 713.2885.3000.3138.3279.  -1.3141.3158. 6 0 67.3161.3172. 0 03172.3216.17 0175.3
1128MURFIN DRLG. 2 FREESNWSENW341611WGRN   2.51930.  -1.2978.3092.3237.3362.  -1.3242.3255. 8 0 -1.3259.3270. 0 03272.3304. 5 0 -1.3
1129NAT. CO-OP 5 WOYZIAKN2SWNE121612WGRN   2.51885. 735.2935.3044.3184.3356.  -1.3187.3201. 0 0135.3207.3219. 0 73222.3250. 0 0266.3
1130**BLANK RECORD**              W         C.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
1131PET. INC. 1-B HITSCHSWSWSE281612WGRNR  2.51904. 776.3006.3119.3240.3378.  -1.3248.3259. 0 0 76.3262.3276. 0 03278.3305. 0 0 80.3
1132PHILLIPS 6 N. BITTERNESWNE061612WGRN   2.51908.  -1.3022.3090.3244.3334.  -1.3248.3261. 6 0 -1.3263.3276. 0 03282.3310. 0 0 -1.
1133HALLIBURTON 1 RUDE  S2NESW141613WGRNGC. 5.1913. 850.3040.3133.3266.3400.  -1.3269.3284. 0 0 64.3289.3302. 0 03305.3332. 6 0128.3
1134ARBEA OIL 2 PRUSA   NWNWNE201613WGRN  , 5.1561.  -1.3034.3172.3299.3407.  -1.3301.3317. 2 2 86.3319.3333. 3 43336.3364. 0 0171.3
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1135MCKNAB DRLG. 1 KUSS NWNWNW051614WGRLLML2.51897. 894.3046.3110.3253.3368.   -1.3256.3268. 0 0 -1.3268.3273. 0 03275.3286. 0 0 -1.3
1136H.& PAYNE 1-A MILLERNESWNE211614WGRSPR 2.51968. 948.3124.3194.3334.3437.   -1.3335.3351. 6 0 67.3351.3364. 6 03369.3390. 0 0127.3
1137IMPERIAL OIL 1 STRECNWSENW261614WGRN   2.51948. 910.3092.3160.3314.3426.   -1.3315.3331. 4 0 96.3333.3346. 0 03348.3370. 0 0235.3
1138E. H. ADAIR 1 FUNK   CSESE181615WGRLLSP 5.1956.1042.3200.3260.3397.3555.   -1.3400.3417. 4 0 89.3419.3434. 4 03436.3452. 0 0 74.3
1139TILCO ETAL 1 SCHAFFESWSENW361615WGRNC  2.51999.1008.3186.3247.3394.3514.   -1.3397.3411. 3 0103.3411.3427. 0 03431.3452. 6 0128.3
1140RAINS&WILL. 3. SHAEENESWSW051616WGRN    5.1919.1039.3137.3191.3330.3493.   -1.3333.3352. 3 0195.3354.3368. 0 03370.3387. 0 0128.3
1141J. A. ALLISON 1 URBANWSENW101616WGRNGC  5.1956.1065.3163.3220.3357.3538.   -1.3362.3378. 0 0 80.3380.3404. 0 03408.3421. 0 0 58.3
1142SHIELDS OIL 1 STREPEAWNESW181616WGRN   2.51954.1093.3193.3245.3377.3536.   -1.3381.3402. 0 0 -1.3404.3416. 0 03419.3448. 0 0 -1.3
1143JAY BEE OIL 1-B RCTHSESWNE031617WGRNGC 2.51954.1097.3205.3256.3385.3533.   -1.3390.3411. 0 0 90.3414.3429. 0 03431.3448. 4 0 75.3
1144FRONTIER OIL 1-A STESWNESE221617WGRN   2.52009.1132.3249.3301.3436.3596.   -1.3439.3460. 0 0113.3462.3476. 0 03480.3499. 0 0 96.3
1145KAISER-FRAN. 1-A FERAWNWNW301617WGRNG  2.52017.1143.3239.3292.3421.3594.   -1.3425.3446. 2 0 88.3447.3463. 0 03465.3484. 0 0 97.3
1146JOHN FARM. 1 BAHR    SESESW091618WGRNCC 2.51989.1154.3227.3274.3402.3560.   -1.3406.3428. 4 0100.3432.3445. 0 03450.3468. 0 0 77.3
1147IMPERIAL OIL 2-A HERAWNWNW121618WGRNG  2.51989.1128.3218.3266.3392.3544.   -1.3396.3416. 0 0 83.3420.3431. 0 03431.3458. A 0 63.3
1148A. & BLACK 1 L. ESTAN4SWNW231618WGRNGC 2.52074.  -1.3250.3300.3426.3603.   -1.3433.3454. 0 0 80.3459.  -1. 2 03465.3495. 0 0102.3
1149J. A. ALLISON 2 ECCH CW2N.231618WGRNG  2.52049.1172.3254.3304.3428.3566.   -1.3434.3456. 0 0 90.3458.3473. 0 03476.3498. 0 0150.3
1150CLINTON OIL 1-V KLENSWNESW021619WGRNR  2.52019.1228.3262.3305.3434.3612.   -1.3438.3459. 0 0120.3462.3478. 0 03482.3507.10 0137.3
1151F & M OIL 1 GRAHAM  E2E2SW271619WGRN    5.2032.1248.3326.3370.3511.3721.   -1.3517.3538. 0 0102.3541.3558. 0 03562.3588.10 0102.3
1152ROCK ISLANC 3 OHNPACNWSESW321619WGRNG  2.52074.1296.3389.3434.3572.3796.   -1.3575.3596. 0 0 84.3600.3618. 0 33622.3648. 7 3102.3
1153ROCK ISLANC 5 OHNNACSESWSW321619WGRN   2.52068.1294.3397.3442.3579.3812.   -1.3583.3605. 0 0 81.3608.3626. 0 03630.3656.12 0 79.3
1154D. SLAWSON 1-B CROTI CNENE031620WGRNLL 2.52147.1366.3404.3448.3575.3794.   -1.3581.3601. 4 0 66.3605.3623. 0 03627.3650. 7 0132.3
1155D. SLAWSON 1-B JEANI CSWNE171620WGRNGC  5.2192.1465.3554.3604.3740.4056.4056.3743.3765. 0 0105.3768.3784. 0 03789.3816.10 0107.3
1156RAYMOND OIL 1-A STEPSESWSW271620WGRNGC 2.52124.1380.3458.3503.3641.3907.   -1.3646.3667. 5 0 66.3672.3687. 2 03694.3720.11 0 85.3
1157PICKRELL 1-C H. KEND CSWSW111621WGRSPR 2.52270.1564.3660.3705.3845.4214.4214.3850.3870. 6 0 79.3873.3890. 0 03898.3922. 6 0156.3
1158NCRA 1 HOWELL        CSESE181621WGRR    5.2231.1640.3731.3771.3911.4297.4297.3918.3937. 0 0094.3943.3960. 6 03970.3995. 0 0098.3
1159GRAVES DRLG. 1 WYMAN CSENW041622WGRNGC 2.52399.1760.3778.3818.3962.4377.4377.3968.3988. 0 0107.3992.4010. 0 04019.4041. 0 0122.4
1160NAT. OIL 1 FOSSETT   SWNENW081622WGRNR  5.2360.1712.3720.3758.3900.4323.4323.3907.3928. 0 0106.3933.3948. 4 03961.3984. 0 0137.3
1161N.& GUSSMAN 1 MUSSEL CNESW231622WGRNGC 2.52437.1778.3850.3890.4037.4474.4474.4042.4062. 0 0111.4066.4082. 0 04095.4117. 0 2140.4
1162RAYMOND OIL 1 DAPEER CSESW351622WGRLLSP2.52258.1671.3774.3816.3959.4378.4378.3963.3984. 0 0 92.3990.4007. 0 04018.4037. 7 0 65.4
1163PALOMINO 1-B SCHERZINWSENE211623WGRNGC  5.2469.1814.3836.3873.4015.4434.4434.4027.4045. 0 0 93.4050.4069. 4 04075.4097. 3 0108.4
1164PET. INC. 1-C FLAX   CNWNW161624WGRNR   5.2532.1906.3880.3921.4080.4528.   -1.4091.4107. 0 0 73.4111.4128. 3 04137.4165. 6 5 64.4
1165PUBLISHERS 1 HORCHERS.NES.351624WGRNR   5.2522.1845.3851.3905.4065.4472.   -1.4069.4087. 0 0157.4093.4111. 2 04119.4141. 5 0136.4
1166PET. INC. 2 KALLR     CSWSE111625WGRNR   5.2564.1951.3844.3927.4092.4518.   -1.4096.4115. 0 0120.4119.4138. 0 04140.4170.12 0 84.4
1167PATRICK PET. 1 BEAHM CSES.261625WGRNC   5.2520.1888.3848.3885.4054.4505.   -1.4060.4078. 0 0170.4080.4101. 0 04103.4133.13 0275.4
1168CHIFF DRLG. 8 MICHAE CW2N.291625WGRN    5.2570.  -1.3835.3875.4044.4492.4492.4052.4073. 6 0 -1.4075.4100. 0 04106.4124. 0 0 -1.4
1169M. C. HOOVER 3 GULIC CNWSW231625WGRNGC  5.2588.1957.3857.3897.4071.4500.4500.4077.4095. 0 0108.4098.4124. 3 04128.4150. 0 0162.4
1170M. C. HOOVER 4 GULIC CSWS.291625WGRNGC  5.2575.1945.3847.3888.4061.4506.4506.4072.4090. 0 0121.4094.4118. 4 04122.4144. 5 0 88.4
1171D.C. SLAWSON 1-A THOMPSON.031626WGRNRC  5.2590.2028.3856.3900.4062.4498.4498.4068.4087. 0 0106.4090.4110. 7 04123.4143. 0 0210.4
1172THUNDERBIRC 1-E EVLL CSWNE131626WGRNGC  5.2544.  -1.3824.3866.4032.4500.4500.4034.4054. 0 0112.4048.4084. 0 04091.4115. 0 0210.4
1173THUNDERBIRC 1-A HCRCNESENW211626WGRN   5.2646.2068.3917.3956.4118.4564.4564.4128.4146. 0 0 63.4149.4180. 0 04184.4205. 6 0160.4
1174D.C. SLAWSCN 1-A OFFSCSWN 021627WGRNGC  5.2483.1916.3720.3755.3918.4364.4364.3924.3946. 3 0137.3949.3775. 0 03982.4007. 0 0220.4
1175RAINS&WILL. 1 BENTLESESEN.171627WGRNGC 2.52729.2162.3961.4001.4162.4613.4613.4167.4188. 0 0 94.4191.4221. 4 04227.4252. 0 3310.4
1176D.A. SUTTON 1 BAILEY CSENW361627WGRNGC 2.52600.2072.3919.3959.4124.4558.4558.4128.4149. 3 0141.4151.4199. 0 04188.4210. 2 0220.4
1177ABERCROMBIE 1 SHANLI CNESC041628WGRNGC  5.2587.2064.3745.3743.3952.4386.4386.3961.3984. 0 0120.3992.4011. 0 04018.4038. 0 0220.4
1178A. SCOTT RITC. 1 TILNWSENE191628WGRNGC  5.2756.2166.3906.3947.4114.4530.4530.4118.4143. 0 0105.4147.4168. 0 04173.4200.11 0169.4
1179ABERCROMBIE 1 STROTH CNWN.021629WGRNGC  5.2629.2048.3739.3777.3954.4379.4375.3956.3980. 0 0183.3990.4007. 0 04011.4038.11 0220.4
1180THUNDERBIRC 1-C JENNNWSWNW211629WGRNGC  5.2763.2177.3344.3883.4046.4492.4492.4060.4084. 0 0148.4087.4110. 3 04114.4143. 0 0220.4
1181CHIFF DRLG. 1 JENNISSWNENW301629WGRNGC  5.2823.2224.3983.3920.4097.4530.4530.4104.4130. C 0110.4136.4155. 0 04157.4180. 0 0201.4
1182PICKRELL 1-B ROEMER  CSWNE121630WGRN    5.2789.2192.3898.3983.4057.4460.4460.4066.4093. 0 0 88.4097.4118. 0 04124.4150. 0 0220.4
1183VIRGINIA DRLG. 1 FARSLSWNW261630WSPR   2.52855.2254.  -1.3998.4120.4564.4564.4132.4160. 0 0 -1.4165.4183. 0 24185.4223. 0 6 -1.4
1184M.A. CHAPMAN 1 FARPE CNENW101631WGRNGC  5.2895.2307.3900.3940.4119.4569.4569.4122.4150. 3 0 93.4153.4174. 2 04180.4203. 2 0152.4
1185ABERCROMBIE 1-A SWIL CHWNE151631WGRNGC  5.2916.2332.3932.3971.4147.4618.4618.4153.4180. 3 0119.4187.4208. 0 04216.4240. 2 0109.4
1186MALLONEE-M. 1 HARFERNWNWNE321631WGRNGC  5.2944.2330.3929.3971.4150.4615.4615.4158.4188. 0 0110.4191.4211. 0 64215.4249. 0 0210.4
1187ABERCROMBIE 1 GRAVES CNESW361631WGRNGC  5.2907.2316.3943.3980.4163.4631.4631.4167.4199. 0 0137.4203.4224. 0 04230.4247. 8 0210.4
1188THE HEFNER 1 KOEHN    CSESE111634WGRSRC 2.53119.2470.3985.4023.4218.4774.4774.4221.4256. 0 4 98.4260.4282. 0 04286.4316. 9 0210.4
1189D.R. LAUCK 1 CARSCN   CNWSW251634WGRSRC 2.53107.2422.3972.4016.4207.4769.4769.4210.4245. 0 0210.4248.4270. 0 04274.4299. 0 0210.4
1190ANADARKO 1-7 HONEYBE CSWNE071637WSPR    5.3395.2645.4058.4102.4303.5064.5064.4307.4338. 4 0 -1.4343.4363. 0 04372.4403. 0 0 -1.4
1191PHILLIPS 1 N.W. LETI CNWSE321638WGRLLR 2.53455.2615.4055.4100.4304.5048.5048.4308.4336. 0 0 -1.4340.4350. 0 04350.4386. 2 4 -1.4
1192GRAHAM-MICH. 1-7 RIN CNESW071640WSPRGR 2.53669.2658.4056.4109.4302.5030.5030.4307.4332. 0 0190.4338.4360. 0 04362.4398.14 0200.4
1193JOHN KIUE 5 ANDERSCNSESWNW231701WGRN   2.5   -1.   -1.   -1.   -1.   -1.   -1.   -1.   -1.   -1. 4 0 96.   -1.   -1. 0 3  -1.   -1. 4 0248.
1194GLICKMAN OIL 1 BURCHSWNESE311701WGRN   2.51345.   -1.  -1.2089.2262.2655.2655.2268.2275. 0 0 45.2278.2308. 0 02310.2364. 0 0237.2
1195ALADDIN PET. 1 OLSCNSWSWNW031702WSPR   2.51515.   -1.2092.2348.2509.2936.2936.2513.2531. 0 0 -1.2534.2564. 0 02566.2621. 014 -1.2
1196ALADDIN PET. 1 JACOBNWNESW201702WSPRGRN2.51442.   -1.2080.2318.2587.2995.2995.2507.2521. 0 0111.2521.2560. 4 32568.2630. 811330.2
1197NAT. ASSOC. 1 KNACKSSWSWNE081704WGRN    5.1522.   -1.2294.2505.2674.3163.3163.2678.2698. 0 7 83.2702.2728. 0 02730.2814.20 0107.2
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1198THE TEXAS CO. 1 HELAW2SWSE361704WGRN   2.51348.  -1.2046.2270.2446.2920.  -1.2454.2474. 0 0 -1.  -1.2488. 0 02488.2539. 0 0 -1.2
1199CONTINENTAL 1 LARSCNSWSENW051706WGRNG  2.51622.  -1.2520.2704.2854.3168.3168.2859.2873. 0 0 77.2875.2902. 0 0  -1.  -1. 2 0180.2
1200CONTINENTAL 1 JOHASO CSENW091706WGRNG  2.51581.  -1.2489.2681.2824.  -1.  -1.2828.2845. 3 0 85.2848.2878. 0 02882.2932. 6 4215.2
1201SHENANDOAH 1 R. GRAY CSENW051707WGRNR  2.51614.  -1.2578.2747.2884.3178.3178.2888.2908. 012 96.2910.2936. 0 42938.2977. 610208.2
1202CITIES SER. 1-C ROLLNESENE161707WGRNLL  5.1672.  -1.2647.2803.2966.3265.3265.2971.2983. 0 0 90.2985.3003. 0 03006.3043. 6 9123.3
12030.A. SUTTON 1 RODGERSWSENW281707WGRNG  2.51705.  -1.2604.2756.2935.3265.  -1.2938.2954. 0 6 51.2956.2980. 2 02982.3014. 5 0 80.3
1204LEBEN DRLG. 1 ANDREWNWNESE041708WGRNC  2.51769.  -1.2674.2824.2984.3193.  -1.2987.3002. 0 0104.3004.3019. 0 03022.3063. 0 0258.3
1205F & M OIL CO. 1 RATHSWSWSW061708WGRNC  2.51782. 355.2696.2840.2990.3195.  -1.2994.3007. 0 0 90.3009.3022. 0 03024.3066. 0 6220.3
1206CONTINENTAL 1 BAKER SESESE211708WGRN   2.51795. 404.2696.2838.3005.3222.  -1.3009.3018. 0 0 50.3018.3034. 4 03036.3072. 9 0128.3
1207CONTINENTAL 11-B JANKWNESW341708WGRN   2.5  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 6 7 -1.
1208WESTERN PET. 1 KRUSESESESESE041709WGRNG  2.51821. 490.2795.2928.3084.3296.  -1.3087.3097. 0 0 80.3100.3112. 0 03114.3152. 3 0155.3
1209CITIES SER. 7 WESSELNENWSE191709WGRN    5.1772.  -1.2750.2883.3036.3205.  -1.3039.3051. 0 0 52.3055.3066. 0 03068.3103. 6 0104.3
1210R.M. EDWARDS 3 DEES  CNWNW231709WGRNR    5.1775.  -1.2718.2854.3004.3177.  -1.3007.3019. 0 0 83.3021.3041. 0 03044.3075. 3 3147.3
1211PETROLEUM INC. 1 THE CSWSE021710WGRNRCS2.51822.  -1.2819.2944.3096.3266.  -1.3104.3110. 0 0 65.3112.3130. 3 03132.3166. 510190.3
1212CITIES SER. 14-A HOGS2NWNE111711WGRNR    5.1556. 747.2983.3101.3242.3391.  -1.3245.3259. 0 0 86.3261.3275. 0 03277.3313. 3 5147.3
1213PAN AMERICAN 7 SOLNESESENW221711WGRLLSP2.51841.  -1.2832.3013.3148.3272.  -1.3152.3166. 0 0 98.3169.3184. 0 03184.3220. 0 0126.3
1214PICKRELL 1-A STIEFERSWNWS 321711WGRNCC 2.51811. 638.2913.3036.3171.3338.  -1.3174.3186. 0 0 97.3188.3202. 0 03202.3236. 6 3130.3
1215MAYFIELD-SMITH 1 PETW2NENW021712WGRN   2.51852.  -1.2969.3080.3222.3347.  -1.3226.3241. 4 0 83.3245.3257. 0 03260.3290. 0 0155.3
1216HENN.&ROBERTS 2 HOEFE2SWNE321712WGRNG  2.51830. 712.2986.3098.3230.3342.  -1.3232.3250. 0 0 96.3252.3268. 0 03271.3296. 0 0142.3
1217AMBER OIL 1 FEDELTZKE   CNW031713WGRNC   5.1954. 873.3087.3186.3311.3414.  -1.3313.3328. 0 0 90.3332.3344. 0 03348.3370. 0 0167.3
1218K & E PET. 1-C ROBINNWSESW141713WGRNGC  5.1852. 761.3005.3104.3235.3346.  -1.3237.3255. 0 0 87.3260.3271. 0 03273.3300. 0 3137.3
1219THREE G. OIL 1 KAHLES2SESE071714WGRNGC  5.1936. 917.3103.3170.3316.3433.  -1.3318.3332. 0 0088.3332.3346. 0 03349.3371. 2 0 98.3
1220SUNRAY-MID 9 CONNOR SWSWSW211714WGRLLSP2.51899. 882.3056.3133.3275.3393.  -1.3278.3294. 0 0 -1.  -1.  -1. 0 03296.3306. 0 0 -1.3
1221BEN F. BRACK 1 SLIELAWNWSW091715WGRLL  2.51959.  -1.3194.3254.3394.3556.  -1.3397.3408. 5 0 -1.3411.3427. 0 03430.3444. 0 0 -1.3
1222HUMMON OIL 1 MENZER SENWSE221715WGRNGC  5.1982.1020.3205.3270.3405.3575.  -1.3411.3425. 6 0 54.3426.3442. 0 03444.3459. 3 0 60.3
1223CITIES SER. 1-D PEAR CNWSE301715WSPRGRS2.52022.  -1.3260.3322.3464.3608.  -1.3466.3482. 6 0 75.3484.3500. 0 03503.3515. 4 0 89.3
1224NAT. OIL CO. 1 DIEL NWSESE011716WGRNGC  5.2029.1108.3253.3313.3452.  -1.  -1.3455.3461. 3 0 71.3471.3485. 0 23487.3505. 6 0 60.3
1225CITIES SER. 1 BRACK NWNWSW161716WGRSELL 5.2033.1159.3283.3340.3472.3620.  -1.3474.3492. 6 0 57.3494.3514. 4 03514.3530. 0 0 93.3
1226FRONTIER OIL 1-A STISWSWSW111717WGRN    5.2060.1146.3254.3311.3444.  -1.  -1.3448.3469. 0 0 -1.3471.3485. 0 03490.3506. 6 0 -1.3
1227IMPERIAL OIL 1 MILLESWSWNW321717WGRNG  2.52021.1100.3266.3323.3454.3604.  -1.3460.3480. 4 0 80.3484.3497. 0 03502.3518. 7 0 63.3
1228F & M OIL CO. 1 MOLDSENWSW071718WGRNC   5.2125.1244.3405.3450.3588.3804.  -1.3594.3615. 0 0112.3620.3635. 0 03640.3670. 0 6149.3
1229JOHN FARMER 1 FICKEN   CN 241718WGRNCC  5.2074.1167.3302.3352.3488.  -1.  -1.3492.3514. 4 0110.3513.3533. 2 03534.3556. 0 0106.3
1230R-RATTLEFF 2 MORAN  SESESE061719WGRNCC 2.52105.1320.3414.3457.3602.3846.3846.3604.3627. 0 0108.3632.3648. 0 03652.3680. 3 5118.3
1231PHILLIPS 4-B DEWALD SESWNW131719WGRNGC  5.2167.1345.3465.3510.3658.3900.  -1.3660.3682. 4 0 92.3686.3699. 0 03710.3733. 2 4115.3
1232CITIES SER. 1-A LEGGSWSWNW211719WSPRGRC2.52215.1468.3555.3602.3751.4019.  -1.3754.3775. 0 0 67.3780.3797. 0 03803.3832. 8 0 72.3
1233JOHN FARMER 1 AXMAN SESENE271719WGRNGC  5.2155.1338.3481.3528.3678.3932.  -1.3684.3704. 0 0 97.3709.3724. 0 03731.3758.16 0 88.3
1234NATL DEV.CO. 1 HOLMA CNWNW231720WGRNGC  5.2189.1440.3602.3648.3810.4172.4172.3815.3836. 0 0117.3844.  -1. 0 03867.3884. 7 0126.3
1235THUNDERBIRD 1 GARD     NESW231720WGRNCC  5.2137.1369.3508.3552.3694.4034.  -1.3701.3722. 0 0101.3728.3744. 4 43752.3780.16 0106.3
1236MCKNAB PROD. 1 IRVIN CSWNW011721WGRNGC 2.52175.1444.3562.3605.3744.4103.4103.3751.3773. 3 0 80.3779.3796. 0 03805.3828. 6 0 66.3
1237CHIEF DRLG. 1 MULLER CNENE131721WGRNGCS2.52165.1422.3542.3579.3723.4078.4078.3730.3751. 0 0 45.3758.3772. 0 03778.3806.12 0 41.3
1238D.C. SLAWSON 1-D PCC CNWSW271721WSPRCHN2.52180.1447.3612.3656.3803.4211.4211.3810.3832. 3 0100.3838.3854. 0 03854.3890.10 0112.3
1239LEBEN DRLG. 1 HAIR   CNWSE091722WGRNR   5.2264.1692.3802.3840.3984.4413.  -1.3994.4016. 0 0 61.4021.4040. 0 04045.4082.12 0 74.4
1240NADEL&GUSSMAN 1 MYER CSWNW121722WGRSPH 2.52292.  -1.3716.3840.3982.4393.4393.3988.4009. 0 0 90.4014.4032. 0 04038.4060. 4 0 97.4
1241D.C. SLAWSON 1-B LVE CSESE191722WGRCSH 2.52256.1582.3692.3734.3880.4300.4300.3888.3908. 0 0 96.3915.3933. 6 03944.3964. 0 0 70.3
1242TILCO ETAL 1 LANER    CSENW261722WGRN   2.52238.1493.3632.3674.3822.4212.4212.3834.3853. 0 0200.3857.3876. 0 03885.3910. 7 0125.3
1243TILCO ETAL 3 OPPLIGE   SWSE171723WGRNRC  5.2450.1757.3812.3847.3997.4418.4418.4004.4024. 0 0168.4030.4048. 0 04052.4082. 6 3128.4
1244PET. INC. 1-B LYNCH    NESW291723WGRNR   5.2403.1700.3745.3824.3972.4404.4404.3778.4000. 0 0127.4005.4325. 0 04029.4055.10 0 96.4
1245PICKRELL 1-A TILLITS CSWNW071724WGRNGC  5.2451.1795.3813.3854.4010.4442.4442.4018.4037. 0 0 92.4040.4060. 0 04063.4094.11 0122.4
1246RAINS&WILL. 1 YOST   CNESE111724WGRNCC 2.52487.1797.3836.3878.4038.4460.4460.4042.4062. 4 0 90.4066.4384. 0 04088.4120.14 0 80.
1247WALTERS DRLG 1 STIAW CNWNW201724WGRNGC  5.2404.1684.3723.3764.3921.  -1.  -1.3924.3947. 0 0100.3951.3775. 0 03979.4002. 3 4118.4
1248THUNDERBIRD 1-H SILT CSESW081725WGRNGC  5.2521.1880.3822.3861.4032.4459.  -1.4036.4056. 0 3135.4059.4084. 0 04087.4109. 0 2274.4
1249THUNDERBIRD 1-A HIBB CSENE111725WGRNGC  5.2447.1784.3786.3828.3985.4411.4411.3995.4012. 0 0 85.4018.4039. 0 04039.4068. 8 0140.4
1250MAGNOLIA 3 POTTER   SWNENE261725WGRLLN 2.52498.1747.3781.3823.3982.4420.4420.3990.4007. 0 0 -1.4011.4034. 0 04036.4064. 0 0 -1.4
1251PALOPINO PET. 11 CLSAWNESE331725WGRNGC  5.2402.1646.3655.3698.3864.4294.4294.3869.3889. 2 0100.3874.3919. 0 03919.3944. 0 0160.3
1252PICKRELL 9 DLMLER C.  NESW111726WGRNGC  5.2615.1982.3898.3939.4110.4559.4559.4114.4135. 8 0127.4140.4167. 0 04170.4204. 0 0220.4
1253OXFORD EXPL. 1 WHEATSESENW051727WGRNGC  5.2664.2078.3901.3940.4108.4537.4537.4113.4134. 6 0107.4136.4171. 0 04174.4201. 0 0210.4
1254G. R. O. 1 HANKS      CNESE071727WGRNLLR2.52721.2126.3962.4002.4164.4609.4609.4172.4196. 0 0130.4202.4229. 6 44232.4261. 0 0240.4
1255D.C. SLAWSON 1-D SPR CSENW321727WGRNGC  5.2710.2106.3352.3385.4158.4624.4624.4167.4191. 0 0100.4198.4224. 3 04227.4258.13 0210.4
1256MULL DRLG. 1 VYCITAL  SENE361727WGRNGC  5.2660.2059.3930.3972.4146.4587.4587.4152.4169. 0 0 86.4172.4201. 0 24210.4237. 8 0310.4
1257THUNDERBIRD 1-B BOHLNWSWSW031728WGRNGC  5.2764.2158.3950.3991.4162.4582.4582.4168.4193. 0 0145.4197.4220. 0 04226.4252. 4 0210.4
1258MULL DRLG. 1 RICHARD CSWSE151728WGRNGC  5.2752.2136.3933.3970.4145.4582.4582.4154.4178. 0 0128.4183.4208. 0 04210.4235. 4 0210.4
1259ABERCROMBIE 1-B CARTAWSESW271728WGRNGC  5.2737.2127.3911.3950.4124.4570.4570.4133.4160. 0 0127.4163.4183. 0 04187.4219.10 0210.4
1260CHIEF DRLG. 1 EATON   NWNE021729WGRNGC  5.2804.2202.3925.3965.4133.4570.4570.4140.4167. 0 0198.4171.4190. 3 04193.4227. 5 0197.4
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1261CHIEF DRLG. 3-A GILLNESENE021729WGRNGC  5.2799.2191.3910.3951.4120.4552.4552.4127.4152. 0 0116.4156.4178. 0 04183.4217. 9 0210.4
1262TOMLINSON 1 MUNSELL  CSESE051729WGRNGC  5.2823.2227.3920.3959.4134.4574.4574.4140.4169. 0 0101.4172.4193. 4 04199.4222. 0 3158.4
1263AEREN CORP. 1 BILDERNWNESE191729WGRNGC  5.2826.2218.3914.3953.4135.4569.4569.4137.4166. 0 0102.4168.4192. 0 04198.4226. 0 3286.4
1264MULL DRLG. 1 CRONIC  CNWNE311729WGRNGC  5.2831.2218.3914.3952.4133.4551.4551.4137.4170. 0 0168.4173.4194. 4 04197.4225. 0 0188.4
1265KERMIT OIL 1 STONE   CSESE041730WSPRGRS 5.2868.2247.3894.3930.4115.4542.4542.4121.4147. 0 0143.4151.4173. 0 04177.4204. 0 0240.4
1266MULL DRLG. 1 HUEBNERNWSENE141730WGRNGC  5.2854.2252.3927.3965.4137.4550.4550.4142.4173. 3 0123.4180.4197. 0 04207.4230. 0 0193.4
1267H. & PYKE INC. 1 SHA CNESW141731WSPRGRS2.52920.2285.3908.3944.4136.4587.4587.4141.4172. 0 0 78.4176.4198. 0 04205.4233. 4 0158.4
1268SHAKESPEARE 1 RODENB CNENE171731WGRNRC  5.2959.2295.3904.3945.4132.4611.4611.4141.4172. 0 0160.4179.4195. 8 04200.4226. 3 0210.4
1269CLEARY PET. 2 SEE    CSENE191731WGRGSSP2.52959.2295.3894.3933.4119.  -1.  -1.4122.4154. 0 0 -1.4157.4179. 0 04183.4218. 0 0 -1.
1270D.R. LAUCK OIL 1 SEE CNENW191731WGRLLR 2.52957.2287.3884.3923.4115.4560.4560.4120.4150. 0 0156.4153.4175. 3 04178.4218. 0 0240.4
1271THUNDERBIRD 1 HUCK   CNENE291731WGRNGC  5.2977.2313.3910.3947.4138.4584.4584.4142.4176. 0 0210.4181.4200. 0 04203.4230. 4 0287.4
1272CLEARY PET. 1-16 JAN CSESE161732WSPRGRS 5.2994.2332.3942.3988.4174.4683.4683.4178.4212. 4 0148.4216.4241. 0 44241.4279.11 0260.4
1273PEEL-HARDMAN 1 HERRO CSWNE211733WGRNLLR2.52968.2330.3912.3957.4146.4716.4716.4150.4184. 0 4 -1.4187.4210. 0 04213.4242.13 0 -1.4
1274TOTO GAS 1 EICHLHEER  SWSE021735WGRLLSP 5.3150.2477.4038.4087.4276.4918.4918.4284.4319. 2 0216.4322.4342. 0 04347.4380. 0 0240.4
1275TOTO GAS 1 BAUCK      SWSE211738WGRLLR  5.3450.2560.4026.4072.4276.5060.5060.4283.4308. 0 0100.4311.4330. 0 04332.4361.12 0 84.4
1276PHILLIPS 1-F SHAFFER   CNE291739WGRSFPC 5.3554.2599.4057.4112.4317.5078.5078.4323.4344. 0 0210.4349.4378. 0 44383.4425. 3 9150.4
1277GLICKMAN OIL 6 HOLLANWNENE031801WGRN    2.51391.  -1.1890.2118.2298.2704.2704.2303.2314. 0 0 -1.2316.2354. 0 02363.2398. 5 0 -1.2
1278GLICKMAN OIL 1 MESSI CNWNW051801WGRN    2.51373.  -1.1900.2132.2306.2705.2705.2307.2320. 2 0 -1.2322.2354. 3 02357.2414. 0 0 -1.2
1279GLICKMAN OIL 2-C STASENESE211801WGRN    2.51422.  -1.1947.2169.2346.2748.2748.2356.2363. 0 0 -1.2365.2400. 0 02402.2445. 0 0 -1.2
1280DORSET CO. 1 LINDBERNWSWSE021802WGRNGC 2.51450.  -1.2026.2254.2437.  -1.  -1.2443.2456. 0 0108.2456.2486. 0 02488.2554. 0 0318.2
1281NAT. ASS. 2 K.PETERSSESWNE171802WSPR    2.51514.  -1.  -1.2390.2568.3050.3050.2573.2590. 0 0 -1.2591.2630. 0 02632.2697.18 0 -1.2
1282TIME PET. 1 BERGGRENNWNWNE271803WSPR    2.51533.  -1.  -1.2441.2632.3120.3120.2640.2668. 0 0 -1.2670.  -1. 0 0  -1.  -1. 0 0 -1.
1283K&E DRLG. 1 OLSON    SWSWSE021804WGRLL  5.1424.  -1.2193.2417.2587.  -1.3059.2587.  -1.10 0 -1.2622.  -1. 0 02675.2736.11 0 -1.2
1284HOME-STAKE 1 SELLBERNENENE351804WSPR    2.51509.  -1.  -1.2470.2638.3117.3117.2638.2672.16 0 -1.  -1.2710. 0 02710.2794.22 0 -1.2
1285HUMMON OIL 1 BRUCE   CSWSE291805WGRNGC  5.1581.  -1.2503.2726.2883.3386.3386.2886.2909. 0 0 77.2912.2945. 6 02950.3009.14 0193.3
1286SUN OIL CO. 3 HEINKESENWNW181806WGRLLML2.51698.  -1.  -1.  -1.  -1.  -1.  -1.  -1.2955. 3 8 -1.  -1.2963. 0 0  -1.3001. 5 5 -1.
1287ROCK ISLAND 1 BENDER CSENW321806WGRLLCS2.51671.  -1.2597.2774.2947.  -1.  -1.2953.2965. 0 0 77.2965.2982. 0 02984.3023. 9 0130.3
1288IMPERIAL 1 NICHOLS   CSESW321807WGRNLL 5.01713.  -1.2648.2814.2967.3198.3198.2973.2988. 0 0 84.2989.2999. 0 02999.3046.11 6138.3
1289GRAVES DRLG 1 SPEIT  CSENW051808WGRNGC 2.51754. 410.2733.2983.3036.3248.3248.3043.3051. 0 0115.3053.3069. 0 03072.3108. 5 6166.3
1290SCHUSTERMAN 2 ROSS   E2SENW111808WGRNGC 2.51775.  -1.2630.2850.3002.3290.3290.3007.3018. 0 0110.3020.3036. 0 03038.3071. 6 0135.3
1291CONTINENTAL 3 AINSWORSWSESE241808WGRN   2.51709.  -1.2584.2747.2896.  -1.  -1.2902.2913. 0 0 80.2915.2931. 0 02932.2964. 3 3118.2
1292W.IANN. DRLG. 1 HALD CSWN 291808WGRNGC  5.1732.  -1.2716.2876.3027.3222.3222.3038.3049. 0 0 75.3053.3068. 0 03070.3098. 3 4163.3
1293CLINTON OIL 1-V SCHMSWNESE071809WGRNRS 2.51733. 420.2742.2880.3028.3243.  -1.3031.3047. 0 0100.3050.3066. 0 03068.3098. 6 0122.3
1294ISERN BROTHERS 5 GRONWSESE101809WGRMLR 2.51733. 397.2736.2889.3028.3278.  -1.3035.3045. 0 0 -1.3054.3068. 0 03071.3100. 0 3 -1.3
1295CONSOLIDATED 1 GRGTHSESENW271809WGRNGC 2.51725.  -1.2721.2878.3018.  -1.  -1.3022.3035. 0 0 74.3037.3048. 0 03050.3094. 5 7100.3
1296SOHIO PET. 5-A ROESLNESWSE051810WGRNR   5.1769.  -1.2785.2920.3060.3207.  -1.3062.3079. 4 0 58.3083.3093. 0 03095.3128. 6 0 89.3
1297R.M. EDWARDS 1 SCHLLN2SESE201810WGRNR   5.1746. 478.2790.2931.3078.3290.  -.13081.3095. 0 0 70.3098.3115. 0 03117.3149.11 0 93.3
1298ACOBE OIL&GAS 1 DCHRNESWSW271810WGRNGC  5.1745. 432.2750.2892.3044.3231.  -1.3046.3060. 0 0 75.3062.3079. 0 43081.3114. 3 0136.3
1299SKELLY OIL 2-A VOLKL CS2NW271810WGRN   2.51752. 438.2725.2862.3010.3153.  -1.3012.3026. 0 0 -1.3029.3044. 0 03046.3083. 612 -1.3
1300PETROLEUM INC. 5 GESSESESE091811WGRNRC  5.1800. 630.2938.3065.3200.3344.  -1.3203.3217. 0 0 76.3220.3230. 0 03230.3261. 3 0147.3
1301NAT. COOP 1-6 B.TRA N2SWNW301811WGRNGC  5.1809. 635.2941.3109.3245.  -1.  -1.3247.3264. 6 0 75.3265.3280. 0 03282.3312. 9 0 88.3
1302PET. INC. 1 COLL     SWSWNW301811WGRN   2.51747. 502.2842.2978.3105.3303.  -1.3112.3130. 0 9 -1.3133.3147. 3 43147.3189. 6 0 -1.3
1303KATHOL PET. 1 WIRTH SESWNW041812WGRNSPR2.51805. 594.2970.3089.3220.3361.  -1.3221.3238. 3 0 81.3242.3256. 0 23259.3285. 0 3114.3
1304WOODMAN-IANN. 2 THITS2SWN.121812WGRNGC 2.51848. 702.3002.3122.3261.  -1.  -1.3264.3278. 0 0 85.3281.3300. 0 03300.3324. 0 0124.3
1305NADEL&GUSS. 9-H EVE N2NWNE181812WGRN   2.51806. 707.2994.3106.3240.3393.  -1.3242.3257. 3 0 57.3261.3276. 0 03276.3304. 3 7170.3
1306SKELLY OIL 5 ROBISONSWNWSW081813WGRNGC 2.51816. 740.2980.3078.3206.3304.  -1.3209.3222. 0 0 60.3226.3239. 0 03242.3267. 0 0120.3
1307PENSOA MIN. 4-22 TINSENENE221813WGRNGC  5.1810. 753.2955.3069.3197.  -1.  -1.3203.3215. 0 0 67.3218.3233. 0 43236.3253. 4 0123.3
1308CLINTON CO.0-7-D HIESWSWNE341814WGRN   2.51552.  -1.3118.3198.3330.3418.  -1.3334.3350. 3 0106.3352.3360. 4 03365.3382. 0 3 71.3
1309GMR OIL CO. 1 MELIKENWSWSW041814WGRLLML2.52002. 960.3171.3245.3384.  -1.  -1.3387.3403. 8 0 -1.3407.3416. 0 03418.3435. 0 2 -1.3
1310SHIRER OIL 5 MCCALLE CS2NE121814WGRN   2.51866.  -1.3018.3107.3235.3351.  -1.3235.3254. 0 0150.3256.3266. 0 03268.3291. 0 0210.3
1311RAYMOND OIL 1 TRESTESENWN.331814WGRNCC 2.51518. 882.3150.3242.3382.3526.  -1.3385.3400. 0 0100.3402.3419. 0 03423.3436. 0 0135.3
1312NORTHERN PUMP 1 PAKESWSESW111815WGRLLML2.51548. 970.3180.3262.3391.3548.  -1.3400.3412. 0 0 -1.3412.  -1. 0 03418.3431. 0 0 -1.3
1313IMPERIAL OIL 1 KUHLMSWNWSW231815WGRNR  2.51525. 930.3157.3237.3375.3560.  -1.3378.3393. 0 0111.3394.3412. 0 03415.3432. 6 0 58.3
1314JOHN FARMER 1 JUNO     NWNE031816WGRNGC  5.2013.1078.3223.3279.3417.3529.  -1.3419.3436. 0 0 74.3439.3452. 4 03452.3470. 0 0 90.3
1315SKELLY OIL 4 DYER    NESENW211816WGRLLML2.51936.  -1.3164.3224.3372.3509.  -1.3374.3393. 0 0 -1.3395.3408. 0 03418.3428. 0 0 -1.3
1316MUSGROVE INC. 1 SCHRSESWNE261816WGRNGC  5.1937. 970.3157.3225.3368.3500.  -1.3372.3387. 4 0 71.3398.3404. 0 63407.3422. 0 0 64.3
1317AYLWARD DRLG. 1 ROBI CNWNW021817WGRN    5.2009.  -1.3193.3248.3386.  -1.  -1.3389.3408. 0 0 56.3412.3422. 0 03426.3444. 0 0 71.3
1318AYLWARD DRLG. 2 ROTH CSENE111817WGRNR   5.1595.1062.3223.3276.3416.3564.  -1.3421.3440. 0 0108.3442.3456. 0 03459.3475. 0 0 70.3
1319AYLWARD DRLG. 1 OBOR CSWSE181817WGRSG  2.52012.1135.3355.3414.3558.  -1.  -1.3563.3583. 0 0 78.3586.3603. 3 03608.3628. 0 0 72.3
1320ABERCROMBIE 1 JONES NESWNE151818WGRNGC 2.52038.1193.3366.3420.3566.3785.  -1.3564.3584. 0 0 74.3588.3605. 0 03610.3633. 0 5108.3
1321SINCLAIR OIL 3 JONESNWNWSW151818WGRLLML2.52089.1244.3412.3464.3606.3803.  -1.3610.3628. 0 0 -1.3633.3650. 0 03656.3674. 0 0 -1.3
1322J.A. ALLISON 1 DEIGNW2NENE261818WGRNR   5.1592.1120.3310.3364.3508.3713.  -1.3513.3533. 0 0 77.3538.3551. 0 03556.3577.12 0 69.3
1323MACK OIL 1 ANDERSON SWSWSE091819WGRNGC 2.52113.1312.3495.3540.3697.4025.  -1.3701.3723. 0 0 84.3728.3746. 0 03753.3777. 0 4 97.3
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1324MACK OIL 1 JONES      CNENW221819WGRNGC 2.52036.1228.3428.3476.3622.2934.   -1.3626.3647. 0 0 81.3650.3669. 7 03676.3705.16 0 91.3
1325NAT. COOP. 1 MURRAY   CSWNE321819WSPRGRC 2.52084.1277.3500.3546.3692.4036.  -1.3696.3716. 0 0 81.3722.3740. 4 53746.3776. 0 4185.3
1326C-G DRLG. 1 BOLT      SESE151820WGRNGC 2.52061.1284.3492.3538.3689.4036.4036.3692.3714. 0 0 78.3719.3736. 0 03740.3766. 0 4 92.3
1327HELLAR DRLG. 1 ALMOU CSENW251820WGRNG  2.52125.1336.3596.3590.3736.4115.   -1.3740.3760. 0 0 60.3764.3783. 0 03790.3821. 0 0 78.3
1328PICKRELL 1-A FRANK    CSWNE321820WGRNGC 2.52129.1375.3620.3667.3818.4208.4208.3823.3844. 0 0105.3852.3867. 0 03877.3906. 0 9180.3
1329HALLIBURTON 1 MCCORMSENESW031821WGRNG  2.52154.1414.3585.3632.3780.4190.4190.3788.3808. 0 0104.3815.3834. 0 03840.3868.14 0 79.3
1330RAINS&WILL. 1 JANKE NWSENW111821WGRNGC 5.2156.1388.3593.3641.3782.4196.4196.3797.3820. 2 0135.3826.3840. 0 03849.3872. 3 0103.3
1331PICKRELL 1-C GEADL    CSESE171821WGRNC  2.52161.1421.3625.3672.3822.4250.4250.3830.3852. 4 0136.3858.3880. 2 03885.3916.12 0106.3
1332D.C. SLAWSON 1-C STR CSWSE311821WGRNSPR 2.52124.1367.3582.3628.3786.4210.4210.3792.3814. 0 0120.3819.3842. 0 03846.3868. 0 4160.3
1333D.C. SLAWSON 1-D SCH CNWNW081822WGRNGC 2.52243.1496.3631.3674.3825.4254.4254.3831.3852. 0 0 93.3859.3884. 0 03888.3909. 0 0 82.3
1334PICKRELL 1-B WEGELE   CNWSE211822WGRSPR  5.2237.1543.3703.3748.3899.   -1.   -1.3904.3926. 4 0 98.3931.3957. 5 03960.3983. 9 0 77.3
1335L.J. DRLG 1 SCHULTZ   CNENE231822WGRNGC 2.52189.1468.3645.3690.3845.4284.4284.3852.3873. 0 0107.3878.3903. 0 03909.3934. 9 0 87.3
1336WALTERS DRLG. 1 BLAR CSWSE161823WGRNGC  5.2201.1573.3710.3754.3902.4316.4316.3908.3929. 0 0 74.3936.3959. 2 03964.3985. 8 0 89.3
1337THUNDERBIRD 1-A GILT  SENE211823WGRNGC  5.2270.1540.3668.3712.3862.4330.4330.3864.3887. 3 0117.3892.3915. 0 03920.3942. 6 0 94.3
1338SIDWELL&GAS 1 G-HOLL  SWNE251823WGRNGC  5.2257.1577.3714.3756.3908.   -1.   -1.3915.3935. 0 0104.3944.3967. 0 03976.4002. 0 0 80.4
13390.A. SUTTON 1 HAWKIN CSENW341823WGRNGC 2.52265.1567.3711.3756.3912.4362.4362.3918.3939. 0 0 89.3944.3970. 0 33976.4000. 6 0 64.4
1340THUNDERBIRD 9-C PFAN CSWSW011824WGRNC  5.2270.1681.3768.3811.3970.4411.4411.3976.3997. 0 0157.4002.4022. 0 04029.4054. 9 0173.4
1341THUNDERBIRD 3-B LEIK CSESE131824WGRNGC 5.2319.1576.3692.3735.3887.   -1.   -1.3895.3918. 0 0130.3925.3944. 0 03947.3974.14 0 91.3
1342THUNDERBIRD 1-A WELL CNWNE161824WGRNG  2.52212.1601.3698.3739.3901.4339.4339.3909.3931. 0 0122.3936.3956. 2 03962.3988. 0 0108.3
1343PALOMINO 1-B CROWELL CSENW341824WGRNGC 5.2343.1618.3719.3760.3920.4351.4351.3923.3946. 4 0136.3952.3972. 0 03976.3997. 2 0113.4
1344PET. INC. 1-E VOGEL  CNENE081825WGRNGC 5.2417.1670.3682.3726.3889.4322.4322.3893.3915. 9 0115.3919.3946. 6 03951.3970. 0 0210.3
1345D.C. SLAWSON 1-G STE CSESE141825WGRNGC 5.2413.1693.3760.3804.3969.4392.4392.3973.3996. 0 0140.4002.4020. 0 04024.4050. 0 0156.4
1346THUNDERBIRD 1 THEISE  NENW281825WGRNGC  5.2508.1789.3827.3871.4040.4467.4467.4046.4067. 4 0 96.4072.4095. 0 04097.4122. 0 0150.4
1347PICKRELL 1-E WHIPPLE CSESW091826WGRNR  5.2637.2008.3937.3976.4143.4605.4605.4148.4171. 0 0 93.4175.4206. 3 04211.4238. 3 0210.4
1348THUNDERBIRD 1 MCLIES  NENW191826WGRNGC  5.2655.2037.3966.4003.4172.4633.4633.4177.4201. 3 0106.4234.4236. 4 04239.4263. 4 0192.4
1349COOP. REFIN. 1-P THOSWNWNE241826WGRLLML 2.52522.1778.3774.3818.3984.4433.4433.3989.4010. 0 0 -1.4014.4040. 0 34043.4072. 0 0 -1.4
1350COOP. REFIN. 1-A SUTNWSWNW241826WGRLLML 2.52525.1792.3768.3809.3976.4422.4422.3981.4005. 0 0 -1.4009.4030. 0 44036.4068. 2 0 -1.4
1351MULL DRLG. 1 MCFALCI CNWSW151827WGRNGC 2.52690.2064.3332.3369.4150.   -1.   -1.4155.4182. 0 0 82.4188.4216. 3 04222.4247. 4 0190.4
1352ABERCROMBIE 1 ECKELLSNWNW 061828WGRNGC  5.2731.   -1.3897.3935.4111.4552.4552.4118.4145. 0 0135.4199.4170. 0 04175.4209.12 0210.4
1353ABERCROMBIE 1 FILEER CNWSE101828WGRNGC  5.2740.2130.3950.3987.4168.   -1.   -1.4172.4198. 3 0117.4202.4222. 0 04226.4255. 7 0195.4
1354MULL DRLG. 1 HINEMAN CSWNE331828WGRNGC 2.52752.2172.3938.3976.4162.4407.4307.4171.4203. 0 0140.4206.4229. 5 04233.4263. 0 6205.4
1355A.SCOTT R. 1 [illegible] CSIN 031829WGRNGC 5.2753.2140.3888.3930.4105.4554.4554.4110.4143. 0 0119.4195.4170. 2 04174.4206. 0 0204.4
1356PICKRELL 1-C REIFSCHSESWS.171829WGRNGC  5.2826.2077.3911.3956.4125.4563.4563.4134.4167. 3 0143.4169.4193. 3 04198.4235.17 0206.4
1357MULL DRLG 1 PEEKER    CNWNE231829WGRNGC  5.2791.2157.3940.3975.4163.4644.4644.4167.4199. 0 0123.4203.4226. 0 04231.4260.10 0170.4
1358ABERCROMBIE 1 SHULL   CSWSW161830WGRNGC  5.2683.2155.3836.3938.4128.4570.4570.4134.4170. 0 0152.4172.4199. 0 04193.4224. 4 0212.4
1359THUNDERBIRD 2 COBERENWNWNE231830WGRNGC  5.2851.2186.3886.3930.4123.4561.4561.4128.4165. 0 0148.4168.4190. 0 04199.4223. 0 0170.4
1360THUNDERBIRD 1-D KAPS CNES.021831WGRNG   5.2522.2268.3830.3930.4115.4555.4555.4123.4157. 0 0 73.4161.4181. 0 04184.4218.16 0132.4
1361THUNDERBIRD 1 STRICKSENESW361832WGRNG  5.2572.2290.3904.3949.4143.4563.4582.4146.4182.16 0 93.4188.4237. 0 04210.4242. 7 0120.4
1362OLYMPIC PET. 1 DURR  CSWSE161833WGRNG   5.3000.2322.3951.3937.4195.4805.4805.4197.4231. 0 0144.4236.4257. 0 04261.4294.14 0155.4
1363BROWN&WOOLSEY 1 SIFE CS2NE361833WGRNR   5.2537.   -1.3911.3957.4150.4683.4683.4153.4187. 3 0210.4191.4214. 2 04219.4253.16 0162.4
1364PICKRELL 1-A SHLAPPI CNENE211834WGRNG   5.3131.2472.4019.4065.4269.4814.4814.4272.4306. 7 0162.4308.4338. 5 04343.4376.17 0201.4
1365D.R. LAUCK 1 IHORLA   CNENE331834WGRSPRS2.53136.2370.4012.4057.4258.4860.4860.4262.4296. 0 0142.4278.4324. 4 04326.4367.12 0165.4
1366MUSGROVE PET. 1 PICH CSESE251836WGRLLML2.53225.2400.4021.4066.4268.5030.5030.4276.4310.10 0 -1.4313.4336. 0 74339.4378. 6 3 -1.4
1367MUSGROVE OET. 1 PANT CSWSE331836WGRLLML2.53264.2345.3926.3978.4168.4698.4898.4175.4203. 0 0 -1.4206.4217. 0 04217.4257. 8 5 -1.4
1368CAULKINS OIL 1 FANNH CNWNE211839WGRLLSP2.53469.2410.3977.   -1.   -1.   -1.   -1.   -1.4430. 0 0 -1.4434.4464. 0 04464.   -1. 0 0 -1.
1369SMITH&SUCER. 1 EYERL CSWSW021840WGRGR  2.53508.2515.3772.4042.4257.5100.5100.4256.4283. 0 0127.4294.4314. 0 04323.4346. 4 0159.4
1370PELICAN 1 WEAVER      CSES 141840WGRLLR 2.53561.2532.3950.4024.4232.5164.5164.4234.4260. 0 0228.4260.4284. 0 04290.4315. 0 0133.4
1371A. AINSWORTH 1 WHELL CNWS.051841WGRNGC 2.52725.2564.4030.4082.4294.5174.5174.4298.4324. 0 0122.4331.4357. 0 04363.4394. 0 0160.4
1372NATL. OIL 1 KOHLN     SWSWNE021901WGRNC  5.1520.   -1.2013.2256.2428.2840.2840.2430.2446. 3 0171.2496.2498. 0 42492.2534.10 0320.2
1373PATTON OIL 1-C HATZL CSWNE241901WGRNGC  5.1583.   -1.2070.2314.2504.2920.2920.2506.2521. 0 0 87.2523.2552. 0 02556.2602. 0 0177.2
1374RED DRLG. 1 ANDERSONNWSWN.301901WGRN   2.51563.   -1.2083.2319.2490.2532.2532.2496.2516. 0 0 59.2516.2535. 0 02540.2597. 7 0182.2
1375N.C.R.A. 1 EPG SWE    NENWSE291904WGRLLML2.51561.  -1.2426.2651.2824.3312.3312.2832.2847. 0 0 -1.2849.2894. 4 02900.2970.1410 -1.2
1376LEBEN DRLG. 1 HORN   SWSWSE051905WGRNC  2.51651.   -1.2600.2827.2987.3483.3483.2997.3008. 0 0206.3010.3048. 5 03050.3109.14 0320.3
1377SIERRA PET. 4-A SWANE2SWNW301905WGRN   2.51625.   -1.2598.2805.2992.   -1.   -1.3000.3014. 0 0 -1.3016.3050. 0 03052.3110.18 0 -1.3
1378CHIEF DRLG. 1 JENNINNWNWNW161906WGRNG   5.1632.   -1.2572.2770.2930.3268.3268.2935.2950. 0 7 68.2950.2968. 0 02970.3022. 0 6108.3
1379CONTINENTAL 5 CARLSOSWNWNE361906WGRLLML2.51588.   -1.2542.2759.2936.3340.3340.2942.2956. 0 0 -1.2959.2993. 0 02998.3049. 512 -1.3
1380NADEL&GUSSMAN 1 WRIG CNENW031907WGRNGC 2.51705.   -1.2657.2827.2993.3280.3280.3000.3010. 0 0 60.3010.3026. 0 03026.3076.10 5120.3
1381IMPERIAL OIL 1 WRIGH CSESW061907WGRLL  2.51761.   -1.2704.2870.3032.3238.3238.3038.3049. 0 0 96.3051.3067. 0 03067.3104. 9 5126.3
1382PICKRELL 1-D TEMPLE  CSWSW151907WGRNLLR2.51711. 200.2704.2874.3032.3252.3252.3039.3042. 6 0 46.3043.3074. 0 43077.3108. 0 0 89.3
1383ALPINE DRLG. 1 THIESNENENE151908WGRNR   5.1762. 318.2693.2861.3009.3189.   -1.3018.3027. 0 0 58.3028.3040. 0 03042.3072. 9 0100.3
1384CHAMPLIN OIL 3 ONTJE  SWSE201908WGRNG   5.1715. 294.2734.2900.3030.3208.3208.3040.3059. 0 0 84.3061.3076. 6 03078.3114. 6 3130.3
1385O.A. SUTTON 1 ROBERT CNESE321908WGRN   2.51690. 273.2730.2898.3848.   -1.   -1.3046.3059. 0 0 60.3062.   -1. 0 43088.3114. 6 0 86.3
1386OIL PROPERTY 5 HUTCHNWSWSW081909WGRN   2.51727.   -1.2753.2914.3056.3246.   -1.3061.3076. 5 0 71.3080.3090. 0 03092.3127. 0 7100.3
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1387SOHIO PET. 8-A CHAPMSWNWNW151909WGRLLML2.51702. 327.2706.2861.3003.  -1.  -1.3013.3025. 0 0 -1.3028.3040. 0 03043.3077. 2 9 -1.3
1388FELL & WOLF 9 GROVE  CNENE291909WGRNGC  5.1717. 333.2743.2892.3034.3200.  -1.3037.3054. 0 0 68.3056.3072. 0 03075.3103. 0 3102.3
1389KEENER OIL 1 CLARY  SWNESW361909WGRNM  2.51714. 307.2722.2874.3038.3218.  -1.3044.3053. 0 0 68.3056.3068. 0 03070.3106. 4 9130.3
1390J.O. FARMER 1-B HOOPNESENE081910WGRNGC  5.1761.  -1.2847.2997.3129.  -1.  -1.3132.3145. 0 0 82.3147.3168. 0 03161.3193. 0 0 91.3
1391SKELLY OIL 3 HUTCHINSWSWSE231910WGRNG  2.51747. 414.2787.2942.3077.  -1.  -1.3082.3094. 0 0 65.3096.3113. 0 03116.3141. 0 0110.3
1392TOM-KATHOL 2 STEWARTNENWSE231910WGRNG  2.51761.  -1.2798.2954.3086.3262.3262.3091.3104. 4 0 93.3107.3118. 0 03121.3153. 4 0 98.3
1393VAUGHN WIGG. 2 RINGWNWSESE321910WGRNG  2.51804. 483.2866.3016.3154.3283.  -1.3157.3170. 0 0101.3173.3188. 0 03190.3219. 4 0 99.3
1394CLINTON OIL 2-D MLSE CSESE101911WGRN   5.1773.  -1.2906.3040.3177.3346.  -1.3180.3197. 9 0 55.3199.3217. 0 03217.3243.10 0 67.3
1395PABCO DRLG. 3 THILL SWSENW281911WGRN   2.51785. 512.2922.3062.3198.3340.  -1.3202.3214. 0 0 -1.3218.3230. 0 03230.3260. 0 0 -1.3
1396ALADDIN PET. 8-A KLLNWSENW121912WGRN   2.51801.  -1.2942.3078.3211.  -1.  -1.3214.3229. 6 0 -1.3232.3242. 0 33244.3271. 2 7 -1.3
1397CLINTON OIL 1-V DALTNWSESW161912WGRNWSC2.51889. 733.3054.3196.3328.  -1.  -1.3333.3347. 4 0 66.3350.3364. 0 03368.3389. 0 0 99.3
1398CRESCENT O&G 3 JOHANNNNESE351912WGRN   2.51803.  -1.2943.3080.3217.3332.  -1.3220.3233. 4 0 -1.3236.3250. 0 03252.3276. 6 0 -1.3
1399SCHERMERHORN 1 POINTNWSESE101913WGRN   2.51517. 812.3120.3228.3356.3475.  -1.3361.3375. 4 0 -1.3379.3390. 0 03390.3411. 0 0 -1.3
1400WESTERN PET. 1 TAYLONWSENE181913WGRLL  2.51867.  -1.3107.3217.3340.  -1.  -1.3344.3358. 0 0 63.3361.3372. 0 03376.3397. 4 0100.3
1401HONAKER DRLG. 2-A CSSESESE211913WGRLLML 5.1851. 740.3050.3162.3285.3416.  -1.3293.3307. 0 0 -1.3310.3324. 0 03327.3349. 0 0 -1.3
1402PETR. MANG. 6 ESSPILAESWSW261914WGRNG   5.1877. 788.3089.3184.3313.  -1.  -1.3316.3330. 3 0 50.3333.3343.-3 03346.3370. 5 0136.3
1403SKELLY OIL 2 G. SCHUSWNWNE051915WGRN   2.52005.1003.3231.3300.3454.3614.  -1.3457.3469. 3 0 -1.3471.3488. 0 03490.3512. 7 0 -1.3
1404PYRAMID 2-A PASCOE  NWSWSW111915WGRNG  2.51543. 850.3158.3236.3373.3533.  -1.3376.3394. 0 0 85.3397.3406. 0 03406.3440. 0 0 65.3
1405W.L. HARTMAN 1 MERTESWSWNE351915WGRLLML2.51919. 872.3190.3276.3414.3602.  -1.3417.3434.      -1.3437.3450.      3452.3474.      -1.3
1406THE TEXAS CO. 4 CIRKNESENW271916WGRN   2.52055.1100.3363.3434.3580.3720.  -1.3583.3600. 5 0 55.3602.3618. 6 03620.3632. 7 0 66.3
1407TENNECO OIL 1-34 HAGENENESE341916WGRNG  2.52005.  -1.3320.3395.3533.3686.  -1.3536.3552. 2 0 78.3554.3571. 2 23576.3594. 2 0 80.3
1408MULL DRLG. 1 STEJSKASESENW091917WGRNLLR2.52067.1172.3414.3466.3610.3812.  -1.3626.3640. 0 0 66.3644.3660. 2 03663.3682. 5 0 99.3
1409THE NATL. OIL 1 GRAVSENWNW191917WGRNGC  5.2121.1217.3462.3515.3667.3902.  -1.3672.3691. 0 0 87.3695.3713. 0 63716.3737.11 0120.3
1410PICKRELL 1-C BRANNANNENENE221917WGRNLLR2.52146.1237.3481.3533.3682.3518.  -1.3688.3705. 4 0100.3710.3726. 0 63729.3748. 5 4 98.3
1411PETR. INC. 1-C WEST  CSWSW031919WGRNR  2.52145.1320.3554.3602.3748.4066.  -1.3753.3772. 0 0 60.3778.3797. 8 03805.3831. 0 4 71.3
1412VIRGINIA DRLG 1 SELTN.NWN.171919WGRNLLR 5.2232.1408.3656.3702.3848.4199.  -1.3853.3873. 0 0110.3877.3892. 0 03900.3934.14 0 95.3
1413MULL DRLG. 1 SELTMAN CNWSE281919WGRNLLR2.52279.1438.3692.3738.3888.4150.  -1.3893.3909. 0 0 80.3914.3930. 5 03941.3966. 0 0 86.3
1414REPUBLIC NAT. 1-C WENDENENE161920WGRLLML2.52215.1428.3685.3730.3883.  -1.  -1.3888.3908. 0 0 -1.3913.3930. 3 03938.3972. 0 0 -1.3
1415MULL DRLG. 1 WELLS   CNWS 291920WGRNLLR 5.2238.1453.3747.3790.3935.4361.4361.3945.3966. 7 0 80.3972.3993. 0 44001.4032. 3 0 63.4
1416SHIELDS OIL 1-D MILL CNWNW351920WGRNR   5.2270.1447.3756.3797.3958.  -1.  -1.3965.3984. 0 0 57.3987.4004. 0 04008.4044.10 0 46.4
1417W.L. BROWN 1 STIEBENS2NENW171921WGRNGC  5.2216.1452.3674.3738.3894.4295.4295.3901.3923. 0 0104.3932.3949. 0 03958.3983.10 0 72.3
1418CITIES SER. 2-B MCCR CNWSW301921WGRNLLR 5.2273.1508.3758.3806.3965.4399.4395.3976.3999. 0 0 34.  -1.4027. 6 04030.4055. 0 0 75.4
1419KERN-LANDES 1 MOORE  CNWNW341921WGRLLR 2.52272.1504.3738.3834.3993.4435.4435.4000.4020. 0 0 83.4026.4053. 0 04058.4082. 3 0 79.4
1420COLORADO O&G  1 NESS CNESE201922WGRLLR 2.52245.1537.3728.3775.3934.4419.  -1.3941.3965. 6 0 -1.3963.3993. 3 04003.4027. 6 0 -1.4
1421CITIES SER. 2-A HEPU CSESE251922WGRLLR  5.2283.1506.3745.3795.3955.4352.4392.3967.3988. 0 0114.3975.4017. 0 04024.4046. 8 0 85.4
1422MULL DRLG. 1 MCDONAL CNESW041924WGRSPNR2.52331.1617.3724.3766.3924.4378.4378.3932.3955. 0 0108.3959.3985. 0 03988.4009. 6 0140.4
1423PALOPINO PET. 1 SHAU CE2NW071924WGRNGC  5.2361.1636.3731.3773.3940.4403.4403.3946.3966. 0 0117.3973.3996. 0 03999.4028. 0 4167.4
1424KEDCO MANGE. 1-A LENSESESW331924WGRNGC  5.2319.1591.3705.3750.3911.4360.4360.3918.3940. 0 0120.3944.3973.12 03976.3998. 0 0114.4
1425THUNDERBIRD 2 SCHLEG  SWSW101925WGRNGC  5.2522.1816.3892.3934.4100.4536.4536.4107.4129. 0 0130.4135.4160. 0 04164.4185. 0 0210.4
1426THUNDERBIRD 1-A FITZ CSWNW261925WGRNGC  5.2443.1717.3814.3856.4028.4473.4473.4032.4056. 0 0100.4059.4088. 3 04097.4117. 0 0210.4
1427LEHEN DRLG. 1 FRENCH CNESW231925WGRNLLR2.52561.1828.3888.3932.4102.4566.4566.4108.4131. 4 6144.4138.4157. 0 64162.4194. 0 6240.4
1428KERN-LANDIS 1 WARD   CSWNE041926WGRLLRC2.52552.1858.3851.3893.4062.4519.4515.4068.4092. 5 0103.4096.4132. 0 04136.4156. 4 0240.4
1429PICKRELL 1-R ANTENEN  SESWIH1926WGRNGC  5.2636.1936.3303.3345.4118.4586.4586.4124.4148. 0 0113.4151.4188. 6 04192.4216.10 0177.4
1430THUNDERBIRD 1-N PEPH CSWSE241926WGRNGC  5.2619.1888.3938.3990.4152.4605.4605.4157.4180. 0 0110.4186.4212. 4 44217.4242. 0 0207.4
1431GRAYBEL OIL 1 WHIFFL CNES.151927WGRNGC 2.52658.2000.3930.3995.4165.4634.4634.4174.4204. 0 0170.4211.4234. 6 04236.4273.20 0230.4
1432**BLANK RECORD**          W          C.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
1433D.C. SLAWSON 1-A ROY CSENE331928WGRNR   5.2728.2130.3924.3970.4152.4587.4587.4157.4189. 0 8163.4177.4218. 0 24219.4248. 0 6210.4
1434D.C. SLAWSON 1-P HIN CNWSW201928WGRNGC  5.2791.2140.3975.4018.4205.4635.4635.4215.4248. 3 0148.4250.4270. 0 04273.4303. 0 8172.4
1435D.C. SLAWSON 2-P HIN CNESW201928WGRNR   5.2799.2144.3974.4017.4206.4642.4642.4212.4240. 3 0175.4244.4266. 0 04269.4301. 8 0109.4
1436ABERCROMBIE 3 WARE   CNWNW241928WGRNGC  5.2760.2100.3976.4015.4193.  -1.  -1.4197.4228. 0 0 78.4231.4256. 0 54258.4289.11 0192.4
1437ABERCROMBIE 1 HUTCHI CNESW071929WGRNGC  5.2853.2167.3938.3990.4168.4640.4640.4186.4212. 0 7167.4214.4238. 3 04243.4278.10 0144.4
1438D.C. SLAWSON 2-A RICSWSWSE151929WGRNGC  5.2844.2184.3976.4019.4215.4636.4636.4220.4254. 0 9146.4256.4280. 0 04283.4311. 4 0210.4
1439D.G. HANSON 1 ARMANTNENENW041930WGRNGC  5.2886.2169.3894.3936.4130.4561.4561.4135.4168. 0 8134.4172.4198. 0 64198.4233. 011180.4
1440TARGET DRLG. 1 MOORA  NWNE151930WGRNGSP 5.2880.2173.3918.3965.4153.4595.4595.4159.4192. 0 0150.4197.4216. 0 04218.4251. 0 3246.4
1441ABERCROMBIE 1 SCHULZ  NESW011931WGRNGC  5.2924.2249.3909.3956.4144.4580.4580.4146.4181. 0 0120.4183.4205. 0 34209.4242.10 0190.4
1442JAMES ELY 2 ELY-SCOT CNWSE221932WGRNG  2.53015.2336.3984.4030.4222.4738.4738.4227.4258. 0 0187.4261.4281. 0 04284.4319.14 0174.4
1443BROWN&WOOLSEY 1 HLSHSWSWNW121933WGRNR   5.2947.  -1.3904.3947.4157.4803.4803.4159.4195. 4 0210.4197.4226. 8 04230.4261.12 0218.4
1444YUCCA PET. 1 SMITH   CSENW261933WGRSPR 2.52967.2170.3812.3852.4078.4625.4625.4081.  -1. 0 0 63.4093.4108. 0 94110.4146. 010140.4
1445BROWN&WOOLSEY 1 FAIR CSENE251934WGRNR   5.3017.  -1.3892.3943.4149.4774.4774.4151.4188. 5 0190.4191.4218. 0 84220.4263.19 0218.4
1446THUNDERBIRD 1 MINNIX CNWSE281934WGRNGC  5.3109.2313.3973.4024.4227.4905.4905.4231.4263. 0 0217.4266.4299. 2114299.4334.18 0133.4
1447SHENANDOAH 1 W. TRUS CNESW071936WGRNCD  5.3224.2253.3845.3895.4101.4963.4963.4104.4132. 0 0181.4135.4166. 0114171.4198. 8 0138.4
1448TEXACO 1 ROBERTS     CNWNW261938WGRSPR 2.53415.2378.3956.4007.  -1.5003.5003.  -1.4245. 4 0183.  -1.4260. 0 0  -1.4292. 010158.
1449PIERCE&DEHL. 1 FECHT CNESW031940WGRCSR 2.53586.2485.3982.4032.4244.  -1.  -1.4250.4273. 0 0122.4279.4303. 0 04312.4345. 312155.4
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1450VAN GRISSC 1 CLIFT   CSWSW091990WSPRC  2.53616.  -1.4036.4094.4308.  -1.  -1.4307.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 0 0 -1.
1451BROOKS-HALL 1 THOPFS   CNE281990WSPRGRC2.53606.2482.4024.4077.4294.5218.5218.4298.4327. 4 0183.4332.4357. 0 04361.4418.24 0248.4
1452D.R. LAUCK 1 HARRIS  CSESE031991WGRCSR 2.53675.2484.4011.4069.4298.5172.5172.4296.4319. 0 0127.4324.4355. 0 04362.4400. 414193.4
1453HONAKER-DAVIS 1 PEAR CNESW171991WGRLLR 2.53714.2470.4006.4064.4288.5197.5197.4296.4321. 4 0 -1.4324.4357. 0 04361.4391. 8 7 -1.4
1454GUERNSEY PET. 2 YOUN CSENE082001WGRNDC  5.1566.  -1.2087.2339.2518.2938.2938.2520.2541. 0 0 84.2543.2584. 0 02586.2630. 0 0216.2
1455NATL. DEV. 2 OTTE    CNENW322001WGRNCR  5.1529.  -1.2089.2349.2520.2962.2962.2522.2544. 0 0 61.2546.2586. 0 62588.2639. 6 0272.2
1456ALFREC KOEHN 1 UNRUHNWNWNE042002WGRN   2.51539.  -1.2072.2324.2510.2964.2964.2515.2536. 3 0 80.2536.2581. 5 32581.2639.13 0252.2
1457HUMMON OIL 1 ZERGER  CNWNE192002WGRDC   5.1512.  -1.2115.2376.2559.3026.3026.2559.2594.10 0 78.2594.2628. 0 02630.2649. 0 0168.2
1458PICKRELL 1-B JOHNSCNNWSWSW252002WGRNC   5.1522.  -1.2064.2311.2496.2945.2945.2499.2518. 8 0 51.2518.2566. 0 02571.2619. 4 0196.2
1459GUERNSEY PET. 1 KREHNESWSE112003WGRN    5.1499.  -1.2131.2364.2543.  -1.  -1.2543.2570. 0 0 62.2570.2611. 6 02614.2646. 0 0 68.2
1460ALFREC KOEHN 1 STUCKSENWNW272003WGRN   2.51480.  -1.2160.2420.2592.  -1.  -1.2594.2621. 0 0 64.2621.2666. 0 02668.2702. 0 0 77.2
1461MOBIL OIL 5 KNACKSTEN2NWNW302005WGRRCS 2.51530.  -1.2488.2730.2894.3268.  -1.2900.2910. 0 0 95.2912.2950. 4 32950.3000. 910254.3
1462NATL. COOP. 1 JOHANN CNESE072036WGRNCC  5.1682.  -1.2687.2880.3067.  -1.  -1.3073.3080. 0 0 78.3082.3102. 0 03104.3142. 0 0170.3
1463BRADEN DRLG. 1 ROSE NENWNE142006WGRN   2.51543.  -1.  -1.2704.2897.3252.3252.2902.2916.10 0 73.2917.2950. 3 02952.2995. 9 0180.3
1464PHILLIPS 3 HANSON   CSE2NW362006WGRLLML 5.1524.  -1.2437.2725.2904.3297.3297.2910.2918. 0 0 -1.2921.2954. 0 02956.3012.15 8 -1.3
1465RAINS& WILL. 1 HUNTENENWSW032007WGRNCC  5.1704.  -1.2718.2896.3058.3384.3384.3070.3077. 0 0 80.3079.3099. 0 03101.3132. 0 0 72.3
1466ASPEN DRLG. 1 BARKER CNESE322007WGRNGC 2.51623.  -1.2691.2886.3040.3326.3326.3051.3060. 0 0 76.3062.3076. 0 03079.3123.15 0130.3
1467BEN HYDE 3 SHUMWAY  SENESW092008WGRNG  2.51661. 243.2726.2892.3056.  -1.  -1.3055.3067. 0 0 77.3069.3086. 0 03088.3119. 6 0110.3
1468PETROLEUM INC. 1 PEA CNESE302008WGRNR  2.51681.  -1.2770.2935.3100.  -1.  -1.3109.3118. 0 0 95.3120.3132. 0 03132.3176. 0 0143.3
1469FELL & WOLFE 5 MILLE CW2NE092009WGRNGC  5.1719. 309.2744.2907.3042.3227.  -1.3046.3060. 0 3 73.3062.3079. 0 03083.3117. 0 4 97.3
1470O.A. SUTTON 8 SMISCHNWNESW232009WGRLLR  5.1678. 258.2726.2895.3042.3268.  -1.3047.3058. 0 2 84.3061.3076. 0 03076.3118. 3 0145.3
1471PETROLEUM INC. 1 FROHENESW142010WGRGRC 2.51812.  -1.2900.3068.3197.3398.  -1.3200.3214. 0 2110.3217.3234. 0 03237.3268. 3 0140.3
1472T. KATHOL 7 BRESSLERSWNWNE142010WGRSPLL2.51794. 450.2869.3026.3164.3317.  -1.3168.3178. 0 0 56.3182.3199. 0 03201.3231. 0 2116.3
1473H.& PAUCO 3 SCHURR  NWNESW212010WGRLLML2.51783. 458.2865.3018.3154.  -1.  -1.3158.3172. 0 0 -1.3177.3188. 0 03190.3220. 3 0 -1.3
1474PAN AMERICAN 8 SCHARNWNWNW022011WGRN    5.1766.  -1.2873.3017.3153.3280.  -1.3156.3170. 3 0 -1.3173.3190. 0 03191.3220. 3 4 -1.3
1475CITIES SER. 1 PETERSN2S2NW242011WGRN    5.1752. 453.2850.2998.3132.3250.  -1.3135.3148.10 0 93.3152.3170. 0 03170.3193. 0 0112.3
1476MONSANTO 3 STECKLE  S2W2SW052012WGRSPLL2.51827. 650.3022.3156.3286.3398.  -1.3290.3304. 0 0104.3306.3320. 3 03322.3348. 0 0120.3
1477SKELLY OIL 7 O. LANTNENWSW162012WGRN   2.51841. 650.3049.3188.3316.3437.  -1.3319.3336. 7 0 -1.3339.3352. 2 03356.3382. 0 6 -1.3
1478NATL. COOP. 2 WALTERS2NWNW342012WGRNGC 2.51833. 617.3020.3165.3288.3356.  -1.3291.3306. 6 0 89.3309.3317. 0 03322.3348.16 0115.3
1479PARRISH OIL 1 SCHARTSWNWSE092013WGRNR   5.1845. 724.3092.3205.3342.3430.  -1.3347.3364. 7 0 68.3367.3377. 0 03379.3403. 0 0 88.3
1480PHILLIPS 3 FORSEL    NWNWSW282013WGRNGC  5.1895. 771.3155.3273.3410.3595.  -1.3414.3429. 3 0 70.3432.3446. 0 53448.3467. 6 0 70.3
1481TEXACO INC. 1 ACHEN SESESE222014WGRNC  2.51560. 822.3174.3290.3405.3576.  -1.3411.3426. 5 0 94.3428.3440. 5 03445.3466. 4 0 82.3
1482ALPINE DRLG. 1 WEATHSESENE362014WGRN    5.1907. 787.3160.3274.3405.3524.  -1.3410.3427. 6 0 -1.3432.3441. 0 03443.3468. 4 0 -1.3
1483KAN-NEB. NAT. 5 ACCL CNWNE162015WGRLLR 2.52017.  -1.3332.3416.3564.3738.  -1.3569.3584. 6 0 -1.3586.3599. 0 33606.3623. 4 0 -1.3
1484MAGNOLIA PET. 4 RADENESWSE242015WGRLLSP2.51516.  -1.3198.3296.3425.3572.  -1.3428.3443. 0 0 -1.3446.3458. 0 03462.3480. 0 0 -1.3
1485B-HARTLETT 1-B ALPGUNENESW152016WGRN   2.52665.  -1.3337.3478.3616.3778.  -1.3620.3636. 5 0 67.3639.3652. 4 03659.3682. 0 0 76.3
1486ROACHSLICHTY 1 HANSOSWSWNE152016WGRLLML2.52049.1070.3380.3460.3596.3752.  -1.3600.3616. 3 0 -1.3670.3632. 0 03640.3662. 0 0 -1.3
1487VICKERS PET. 5 GATESSWNESE262016WGRLLML2.52027.  -1.3352.3448.3582.3759.  -1.3585.3600. 3 0 -1.3600.3616. 0 03623.3646. 0 7 -1.3
1488CHIEF DRLG. 1 BEHRENSESENE022017WGRNG  2.52140.1195.3438.3564.3705.3900.  -1.3709.3725. 2 0 74.3728.3746. 3 53750.3771. 3 4 93.3
1489O.A. SUTTON 1 PENICK CSWSE292017WGRN   2.52121.1188.3528.3602.3746.3551.  -1.3752.3770. 6 0 59.3773.3792. 3 03798.3817. 7 0137.3
1490SHELB.& FARM. 1 GILLNWNWSE072018WGRNG  2.52245.1377.3682.3732.3892.4228.  -1.3897.3917. 4 0 74.3920.3944. 6 33950.3970. 6 0190.3
1491ROCK ISLAND 1 FOX    NWNWNE292018WGRNGC 2.52163.1252.3559.3605.3764.4008.  -1.3769.3787. 4 0 68.3792.3809. 0 03818.3843. 0 3150.3
1492N.C.R.A 13 HAGERMAN SWNENW102019WGRLLML2.52220.1380.3673.3718.3880.4179.  -1.3885.3904. 6 0 -1.3906.3926. 3 03942.3965. 0 0 -1.3
1493CLINTON OIL 1-V FARTSENWSW202019WGRNRS 2.52218.1368.3662.3710.3872.4275.4275.3879.3899. 3 0 89.3902.3924. 0 03932.3959.12 0138.3
1494RAYMOND OIL 1 BOYE   NENESW252019WSPLLR 2.52179.1306.3621.3672.3828.4222.4222.3834.3852. 0 0 85.3855.3870. 0 03883.3909. 0 6203.3
1495C & G DRLG. 1 ISAAC  CSWNE052020WGRNGC 2.52215.1410.3729.3776.3934.4338.4338.3940.3960. 6 0 64.3962.3985. 3 63994.4020. 6 0 70.4
1496PICKRELL 1-B LANTERM CSESW102020WGRN   2.52228.1340.3702.3752.3906.4312.4312.3912.3932. 4 0 88.3937.3963. 0 03968.3992. 4 0 96.3
1497PICKRELL 2-A SEELYE  CNWNE312020WGRNGC 2.52218.1390.3734.3785.3951.4366.4366.3960.3980. 4 0 83.3989.4004. 0 64012.4041. 010148.4
1498CITIES SER. 1-B KRAM CSWNW102021WGRLLR  5.2249.1478.3759.3806.3967.4357.4397.3974.3996. 0 0121.4002.4025. 0 04032.4064. 012108.4
1499R.V. LEHNER 1 TRIPPE CSWNW202021WGRNG  2.52262.1468.3767.3814.3980.4410.4410.3987.4008. 6 0 98.4012.4038. 4 64042.4068.10 0120.4
1500D.C. SLAWSON 1-B LEE CSESE262021WGRNG  2.52202.1388.3708.3760.3924.4333.4333.3931.3952. 3 0 75.3954.3980. 0 33987.4014. 0 0132.4
1501C & G DRLG. 1 STROHL CNENE102022WGRN   2.5  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1.13 0  -1.  -1.12 0 -1.
1502MACK OIL 2 BARRICKLO CNWNE282022WGRNGC  5.2187.1420.3690.3741.3914.4356.4356.3920.3942. 3 0 94.3945.3972. 4 03978.4002.10 0158.4
1503D.G. HANSEN 2 MCFADD  SWNW342022WGRNGC  5.2182.1398.3664.3714.3878.4314.4314.3883.3904. 7 0107.3908.3934.12 03940.3969.10 0152.3
1504CITIES SER. 1 KANAGA CSWNE092023WSPREPC 5.2294.1532.3756.3805.3972.4425.4425.3979.4001. 0 0118.4004.4028. 0 44030.4066.17 0178.4
1505PICKRELL 1-C UETZ    CNENE132023WGRLLSP2.52222.1427.3664.3710.3877.4233.4233.3884.3906. 4 0120.3912.3935. 0 03940.3969.12 0202.3
1506RAYMOND OIL 1 PETERS CNWNE212023WSPRGR 2.52282.1534.3740.3788.3958.4388.4388.3969.3988. 0 0116.3992.4021. 0 04025.4048. 6 0200.4
1507THE NATL. 1 ROTHE    CNWSE102024WGRNGC  5.2350.1596.3758.3806.3979.4451.4451.3989.4012. 0 0124.4014.4039. 8 04042.4070.11 0285.4
1508R.V. LEHNER 16 LEHNE CNENE242024WGRNGC 2.52324.1550.3740.3789.3957.4386.4386.3963.3986. 0 0 -1.3989.4016. 0 44018.4042. 6 0 -1.4
1509HELLAR DRLG. 1 GIBSO CSESE072025WGRNS  2.52483.  -1.3846.3894.4066.4508.4508.4074.4096. 0 0104.4098.4126. 0 54130.4162.12 0220.4
1510MURFIN DRLG. 1 GIBSO CSWSW172025WGRNGC 2.52460.1700.3818.3859.4037.4474.  -1.4044.4066. 0 0138.4068.4101. 0 04104.4134.16 0220.4
1511BEARDMORE 1-A FOULKS CSWNE082026WGRSPNR2.52613.1908.3930.3971.4153.4639.4639.4157.4182. 0 0 96.4189.4226. 0 34232.4256. 0 0151.4
1512PICKRELL 1-C JAMES   CSWSE112026WGRNGC  5.2526.1767.3844.3888.4060.4520.4520.4067.4090. 0 6114.4094.4118. 0 64123.4163. 0 9143.4
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1513MOBIL OIL 1 WINANS    CSENW322027WSPHGRS2.52616.1897.3856.3894.4088.4530.4530.4091.4119. 0 0112.4121.4147. 0 04149.4180. 9 0188.4
1514SUN OIL 1 PAUGHLIN    CNENE352027WGRLLR 2.52551.1848.3844.3888.4075.4514.4514.4081.4109. 8 0111.4112.4138. 0 04142.4179. 5 0240.4
1515ABERCROMBIE 1 MURPHY CSWSW162028WGRNGC  5.2796.2120.4003.4042.4231.4669.4669.4234.4264. 0 0 90.4268.4298. 0 04298.4338.20 0216.4
1516ABERCROMBIE 1 THOMAS CNENE152030WGRNGC  5.2890.2150.3956.4000.4187.4647.4647.4190.4222. 3 0114.4225.4246. 0 04246.4294. 510174.4
1517HERNON DRLG. 1 STILL CSWSW232030WGRNGC  5.2871.2116.3940.3985.4172.4620.4620.4174.4208. 8 0167.4210.4236. 0 64240.4276. 0 0224.4
1518MOBIL OIL 1 H. ESTAT CSWNE172031WSPRGHS2.52870.2158.3887.3927.4128.4604.4604.4130.4164. 4 0155.4168.4187. 0 04189.4240.26 0320.4
1519MALLONEE 1 PETRO      CNENW232033WSPRGHP2.52951.  -1.3800.  -1.4052.4690.4690.4056.4087. 0 0200.4089.4116. 4 04119.4155. 0 0212.4
1520BROWN&WAYNE 1 JLANG   CNENE022034WGRNR  2.53013.  -1.3885.3926.4124.4786.4786.4126.4150. 7 0210.4153.4186. 0 04189.4250. 012218.4
1521MORRISON 1 BOYER      CSWNE172034WRGRNSP2.53111.2287.3962.4006.4217.4917.4917.4220.4252. 0 0196.4255.4276. 0 04279.4326.26 0150.4
1522CITIES SER. 2-H CRIS CSWNE322034WGRNLL  5.3089.2217.3930.3979.4192.  -1.  -1.4195.4228. 0 0200.4230.4254. 0 04257.4307.24 0132.4
1523CLEARY PET. 1 KUNKEL CNESE272035WGRNR   5.3162.2257.3970.4020.4230.4948.4948.4238.4266. 0 0200.4269.4297. 0 04300.4345.29 0200.4
1524LEBEN DRLG. 1 KLEFLC CSWNW302035WGRNR   5.3222.2286.3958.4013.4224.  -1.  -1.4233.4261. 0 0168.4264.4290. 0 04293.4338.29 0 84.4
1525MAURICE TRUST 1-F SM CSWS.042036.GRNR   5.3237.2240.3882.3932.4142.4942.4942.4155.4178. 0 0195.4180.4208. 0 04211.4252.24 0193.4
1526TEXTAR CORP. 1 GIFFA CSWN.122036WGRNRR 2.53202.2302.3960.4012.4221.5114.5114.4226.4253. 6 0164.4257.4284. 0 44281.4322. 3 9 87.4
1527ANADARKO 1-A SONLERE CSWSW332036WGRLL   2.53276.2237.3822.3853.4074.4976.4976.4080.4101.10 0 -1.4110.4131. 7 04135.4179. 9 5 -1.4
1528DAVIDOR&DAV. 1 DURIS CSWSW122038WGRNC   2.53384.2330.3992.3992.4198.5020.5020.4204.4228. 0 0190.4232.4258. 4 04264.4315.32 0228.4
1529PIERCE&DEHL. 1 CARPE CNESW162039WGRR    2.53527.2419.4022.4074.4296.5218.5218.4300.4330. 6 0 60.4334.4361. 0 04368.4409.18 0132.4
1530D.C. SLAWSON C-1 KLANESESW112101WGR-N   2.51520.  -1.2116.2352.2538.2966.2966.2543.2550. 0 0 53.2550.2600.15 02605.2658. 0 0240.2
1531CONOCO 5 KINGBLADE  NENESW202101WGR-N   2.51489. -1.22073.2308.2483.2924.2924.2490.2502. 0 0 -1.2502.2552. 0 02556.2601. 0 0 -1.2
1532OSBORN 1 DIRKSEN     SENWNE272101WGR-S   2.51513.  -1.2100.2359.2539.2974.2974.2544.2556. 4 0 -1.2559.2600. 0 02604.2646. 0 0 -1.2
1533CITIES B-3 JONES     NWSWSW322101WGR-N   5.01473.  -1.  -1.2317.2495.2917.2917.2499.2520. 7 0 -1.2523.2563. 5 02565.2612. 0 0 -1.2
1534**BLANK RECORD**                    W    C.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
1535CONSOL SOUTH 1 BALZE CNENE212103WGR-N   5.01449.  -1.2129.2397.2583.3053.3053.2588.2603. 6 0 64.2605.2654. 6 02658.2697. 0 0141.2
1536SUTTON 1 STUCKY      CSWN.252103WGR-R   2.51463.  -1.  -1.2421.2622.3139.3135.2629.2656. 0 0 83.2656.2697. 0 02700.2763. 012154.2
1537PICKRELL C-1 WEINS  NENWSW112104WGR-N   5.01468.  -1.2362.2620.2784.3282.3282.2792.2810. 3 0 80.2810.2870. 0 02870.2930. 0 0 93.2
1538WALTERS 1 KLASSEN    CNESE152104WGR-N   2.51447.  -1.2340.2605.2771.3267.3267.2780.2793. 0 0 77.2795.2852. 7 02852.2916. 0 0122.2
1539SUTTON 1 KREHBIEL    SWNESW302104WGR-N   2.51520. -1. 2442.2690.2903.3377.3377.2908.2930. 4 0 67.2932.2982. 0 02984.3044. 4 3143.3
1540GRAVES 1 FETERSON    SWSWNW 52105WGR-N   2.51524.  -1.2520.2728.2921.3330.3330.2932.2945. 0 4100.2948.3005. 0 03008.3042.10 0160.3
1541HOLL & FREEMAN       SENWSE 42106WGR-N   5.01622.  -1.2628.2827.3043.3426.3426.3047.3058. 0 0 61.3060.3086. 0 03088.3135. 6 3195.3
1542STERLING 1 RAMSEY    CNESE 72106WGR-N   2.51657.  -1.2760.2968.3148.3530.3530.3152.3168. 3 0 68.3170.3194. 0 03196.3235. 0 0161.3
1543J AND C OIL 1 HOWE   CNESW272107WGR-N   2.51607.  -1.  -1.2916.3093.  -1.  -1.3098.3110. 4 0 67.3112.3135. 0 03137.3178. 2 0198.3
1544PICKRELL 1 BELL      SWSWN.152108.GR-LL 2.51640.  -1.2750.2939.3093.3301.3301.3097.3107. 0 0 -1.3119.3124. 0 03128.3160. 4 6 -1.3
1545PURE 2 COSSITT       CNENW262108WGR-LL 2.51634.  -1.2769.2953.3121.3357.3357.3126.3134. 0 0122.3138.3153. 0 23156.3194.11 0118.3
1546ALLEN 1 SCHAFER      NWSESE 22109WGR-N   5.01675. 274.2762.2925.3073.  -1.  -1.3077.3092. 2 0 92.3094.3115. 0 03118.3154. 0 0138.3
1547THUNDERBIRD 1 FALER SENWNE 22109WGR-N   2.51681.  -1.2755.2924.3070.3278.3278.3075.3088. 0 0 57.3090.3112. 0 03114.3149. 0 4105.3
1548H-30 1 BROWN         CNWSE142109WGR-N   2.51667. 261.2808.2978.3122.3290.3296.3125.3142. 5 0 -1.3144.3162. 0 63164.3200. 510 -1.3
1549KFENER OIL 1 PANTIAGSENEN.212109WGRN    5.1681. 257.2773.2958.3117.3329.3329.3120.3128. 0 0 78.3131.3151. 0 53151.3189. 4 0111.3
1550CITIES 1 FAIR-HECK   CSWSF302109WGR-N   5.01711.  -1.2836.3004.3152.3336.  -1.3155.3174. 7 0 82.3177.3194. 4 03197.3230. 0 3144.3
1551N. AMERICAN 1 FAIR  NENWSW142110WGRLLML2.51712.  -1.2834.2987.3138.3330.  -1.3141.3156. 0 0 -1.3160.3176. 5 63179.3210. 0 0 -1.3
1552NADEL&GUSS. 1 SEFERE CSWS.352110WGRNCC 2.51731. 379.2909.3077.3222.3450.  -1.3225.3240. 0 6 80.3242.3264. 0 83266.3301. 6 6142.3
1553VEEDER 4 DIETS       SESESE 6.111WGR-N   2.51809. 572.3002.3145.3278.3437.  -1.3280.3296. 0 0 68.3298.3316. 7 03317.3346. 010 81.3
1554CITIES SER. 5-H SIFESENWSE092111WGRLL   5.1770. 521.2959.3116.3297.3389.  -1.3250.3264. 0 0 -1.3265.3290. 0 03280.3310. 2 0 -1.3
1555F.G. HOLL 2-L SMITH SENWNE212111WGRNGC  5.1740. 478.2993.3094.3222.3376.  -1.3226.3242. 0 8 62.3245.3260. 6 03262.3284. 0 4107.3
1556CLINTON OIL 1-V WERFNWSESW092112WGRNR   2.51849. 653.3070.3216.3336.3424.  -1.3340.3356. 6 0 81.3358.3375. 4 03377.3394. 3 0120.3
1557CIRCLE OIL CO. 7 HEISWSWNW212112WGPN    2.51863.  -1.  -1.3263.3384.3520.  -1.3386.3403. 8 0106.3406.3418. 0 03422.3442. 6 0151.3
1558CIRCLE 3 REISER      NWSENW212112WGR-LL 2.51853. 656.3196.3252.3374.3435.  -1.3377.3390. 5 0 91.3393.3409. 0 03412.3435. 3 0135.3
1559UTICA SOUTH 1 MCMILLSWSENE252112WGR-N   5.01862. 567.3355.3208.3340.3493.  -1.3342.3362.13 0 57.3364.3378. 5 03382.3406. 5 4 64.3
1560CIRCLE OIL 1 SIFES   NENWNW112113WGR-N   2.51871. 717.3121.3271.3382.3526.  -1.3385.3400. 4 0 70.3402.3418. 0 03420.3442. 0 0150.3
1561GRAVES DRLG. 1 FISCHNESWNW172113WGRNG   5.1516. 807.3209.3341.3463.3571.  -1.3467.3481. 4 0 58.3493.3499. 3 03503.3520. 3 0 70.3
1562ABERCROMBIE 3 LINKE NESWNE272113WGR-N   2.51887.  -1.3205.3335.3465.3608.  -1.3466.3486. 6 0 66.3489.3501. 2 03504.3528. 6 0115.3
1563NCRA A-4 FREY        NENWNE 72114WGR-N   2.51929. 886.3256.3365.3450.3610.  -1.3493.3508. 5 0 96.3510.3522. 6 03528.3550. 6 0 80.3
1564SINCLAIR 4 CPIE      NWSENW 72114WGR-LL 2.51934.  -1.3260.3370.3491.3626.  -1.3493.3509. 0 0 -1.3512.3525. 0 43530.3556.12 0 -1.3
1565LAUCK & SUNRAY 3 MORSENWSW212114WGRNG   2.51944. 872.3290.3416.3534.3678.  -1.3538.3554. 7 0 79.3554.3571. 0 03574.3601. 0 0113.3
1566PHILLIPS 4 FILE      S2NWSE272114WGRLLML5.1938. 850.3281.3412.3531.3674.  -1.3534.3553.10 0 -1.3555.3575. 3 03577.3598. 5 0 -1.3
1567F & M OIL CO. 1 DARCNWSWSE112115WGRNC   5.1939. 901.3282.3399.3513.3668.  -1.3517.3534. 6 0 93.3536.3549. 0 03555.3574. 0 0 93.3
1568MUSGROVE PET. 1-B SCNWNWNE172115WGRLLML2.51958. 940.3328.3438.3560.3764.  -1.3564.3580. 3 0 -1.3582.3594. 4 03603.3626. 2 0 -1.3
1569SCOTT RICHIE 1 SCHARSWSESE342115WGRNGC 5.1975. 937.3362.3481.3606.3866.  -1.3616.3624. 0 0 68.3626.3643. 0 23647.3670. 0 0130.3
1570CHAMPLIN 5 MILES     SWNESE272116WGR-LL 2.51935. 994.3375.3503.3624.3761.  -1.3630.3646. 0 3 -1.3648.3664. 0 03670.3696. 2 0 -1.3
1571THE NATL. OIL 1 BOYD CS2S092117WGRNRC   5.2093.1127.3517.3612.3743.  -1.  -1.3747.3763. 0 0 84.3766.3779. 4 03788.3812. 0 0204.3
1572AMERADA PET. 1 MINORSWSESE252117WGRLLML2.52066.1070.3467.3548.3683.3920.  -1.3688.3700. 3 0 -1.3704.3722. 0 03732.3754. 0 0 -1.3
1573T.H. ALLAN 1 HAYS    SWSWSE282117WGR-LL 2.52033.1040.3416.3512.3654.3518.  -1.3663.3677. 2 0 -1.3680.3700. 0 03703.3727. 3 0 -1.3
1574NATIONAL 1 GROVE     NWNWNE152118WGR-N   2.52096.1147.3493.3566.3712.4016.  -1.3718.3736. 2 0116.3741.3758. 4 33770.3791. 3 0238.3
1575DAVIS&REED 1 SMITH   CSWNW 52119WGR-N   5.02139.1307.3670.3725.3894.4253.  -1.3903.3924. 3 0103.3929.3949. 2 03955.3976. 0 0220.3
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1576JONES-GEBERT 1 ICEKENWNWSE022119WGRSPLL 5.2142.1283.3680.3732.3900.4318.4318.3906.3925. 5 0 96.3928.3945. 0 23958.3990.14 0248.3
1577PICKRELL 1-B REECE    CNWNW172119WGRNGC 2.52113.1264.3655.3715.3882.4278.4278.3888.3910. 0 0 90.3913.3939. 0 33947.3972. 0 0200.3
1578SCHREINER 1 RIEDHER SESESE102120WGR-N  2.52107.1252.3616.3668.3839.4241.4241.3844.3864. 0 0120.3866.3892. 5 03895.3922. 6 0182.3
1579HULL DRLG. 1 LIPP     CSWNE242120WGRNG   5.2094.1214.3595.3647.3813.4226.4226.3828.3842. 0 0 96.3846.  -1. 6 03987.3943. 0 0272.3
1580BEARDMORE 1-A CHAFFE CNENW132121WGRSC    5.2125.  -1.3622.3675.3844.4262.4262.3853.3875. 3 0 90.3878.3898. 0 03904.3932. 0 0114.3
1581JONES-GEBERT 1 MOORE CNWSE172121WGRNSPR 5.2141.1305.3663.3716.3890.4325.4325.3895.3917. 9 0 78.3919.3946. 0 03948.3978.12 0168.3
1582NATIONAL 1 KLEIN     SENWNW252121WGR-N  2.52121.1265.3666.3724.3895.4309.4309.3903.3924. 5 0 96.3927.3948. 4 03954.3984.10 0126.3
1583COLORADO 1 KLINGE     CSESW 82122WGR-LL 2.52250.1428.3718.3766.3932.4372.4372.3939.3961. 3 0 -1.3964.3992. 2 03995.4022. 2 0 -1.4
1584JOHN FARMER 1 CHAFFE CNESW022122WGRNCC  5.2167.1340.3672.3723.3900.4351.4351.3908.3929. 0 0 88.3932.3952. 0 33955.  -1.16 0153.3
1585PICKRELL 2 COX        CSWSW082122WGRSPLL 5.2269.1440.3726.3776.3940.4390.4390.3947.3968. 0 0 -1.3971.3992. 0 03997.4031.10 0 -1.4
1586BROOKS HALL 1 HALLIN CNWNW292122WGRNGC  5.2295.1482.3822.3876.4044.4486.4486.4055.4074. 0 0113.4078.4103. 0 24106.4132. 0 4160.4
1587NADEL&GUSS. 1 WATERH CNWN 122123WGRN    2.52287.1491.3794.3846.4020.4480.4480.4027.4048. 0 0155.4051.4083. 4 04087.4112. 5 0288.4
1588THUNDERBIRD 1 HAFFERNWNWNW272123WGRNGC  5.2366.1592.3883.3935.4110.4556.4556.4116.4139. 0 0 83.4141.4172. 0 04174.4200.10 0162.4
1589TENNESSEE G&O 1 JOHN CNWSE29212[illegible]SPLL2.52360.1620.3838.3951.4122.4578.4578.4129.4151. 0 0 -1.4154.4178. 3 04178.4212. 7 7 -1.4
1590PICKRELL 1-J NELSON  CNESE102124WGRN    5.2306.  -1.3762.3913.3986.4422.4422.3992.4012. 0 0164.4016.4040. 0 04042.4084.20 0218.4
1591ADAIR 2 WEGE          CSWNE202124WGR-N  2.52339.1568.3771.3820.3997.4414.4414.4006.4027. 2 0158.4030.4059. 0 04062.4087. 3 0320.4
1592OASIS PET. 1 DEUTSCH CNESE332124WGRNCC  5.2423.1680.3920.3971.4151.4612.4612.4159.4176. 0 0124.4179.4209. 0 04209.4243.14 0158.4
1593O.A. SUTTON 1 SINCLA CSWSW092125WGRNGC  5.2357.1584.3701.3741.3913.4377.4377.3920.3943. 0 0118.3946.3975. 0 03978.4016.20 0210.4
1594RAYMOND 1 WILLIAMS   CSESW262125WGR-N  2.52414.1638.3832.3894.4075.4539.4539.4083.4101. 0 0138.4104.4130. 0 04134.4173. 9 0220.4
1595FRONTIER 1 SINCLAIR  CNWSW 22126WGR-LL 2.52404.1609.3708.3753.3928.4402.4402.3934.3959. 2 0132.3962.3994. 0 03996.4029. 5 6172.4
1596PATRICK PET. 1 EVANS CNWNE092126WGRNGC  5.2450.1670.3755.3798.3982.4446.4446.3989.4014. 0 0105.4016.4048. 0 04051.4094. 6 6218.4
1597THE NATL. 1 RAMSEY   CSWSW102127WGRNRC  5.2672.1924.3964.4004.4194.4653.4653.4199.4226. 7 0177.4229.4256. 0 04258.4297.10 3318.4
1598CITIES SER. 1-A FINN CSWNW202127WGRSC   5.2720.1977.3990.4027.4221.4675.4675.4224.4251. 7 0127.4253.4276. 0 04278.4320. 0 8214.4
1599GOFF 1 CHENNELL       CSWSW222128WGR-LL 2.52757.1936.3959.3998.4187.4660.4660.4192.4222. 6 0 -1.4224.4250. 0 04253.4293. 0 0 -1.4
1600MACK OIL CO. 1 SCHNE CNESE232129WGRNR   5.2676.1876.3840.3880.4071.4571.4571.4074.4107. 0 0 99.4109.4127. 0 04130.4187.38 0141.4
1601ANADARKO 1-H JOYCE    SWNE162131WGRNPC  5.2515.2151.3959.4008.4202.4706.4706.4207.4239. 3 0125.4239.4273. 0 04278.4311. 6 0238.4
1602ANADARKO 1-E DAVIS    CSENE192131WSPRLL  5.2511.2137.3960.3998.4196.4780.4780.4204.4236. 0 0 -1.4239.4260. 0 04264.4310.22 0 -1.4
1603CITIES SER. 1-A HELL CNENW04213[illegible]SRCNSP 5.2559.2191.3954.4001.4205.4818.4818.4216.4250. 0 0153.4252.4281. 0 04283.4323.12 0200.4
1604BARNSTROM 1 FUNK      CNWN 142133WGRNR   5.2893.2073.3858.3904.4128.4782.4782.4132.4164. 0 0200.4167.4192. 0 04194.4253.35 0200.4
1605SKELLY OIL 1-A FINNU CSWNW282133WSPRGRS2.52650.2018.3777.3820.4026.4600.4600.4030.  -1.      -1.4062.  -1. 0 64100.4152.23 0200.4
1606M.L. BROWN 10 MAUNE  CNENE312133WGRNR   5.2898.  -1.3782.3830.4036.4716.4716.4038.  -1. 3 0155.4071.  -1. 0 04081.4114.23  160.4
1607THUNDERBIRD 1 HURTIS CSWSW022134WGRNC  2.52564.2107.3835.3884.  -1.4721.4721.  -1.4128. 4 0198.  -1.4192. 0 0  -1.4165. 3 5 80.
1608ABERCROMBIE 1 DAVIDS  NESE022135WGRNCC  5.3165.2222.3939.3984.4190.4891.4891.4194.4224. 6 0122.4227.4261.    64261.4317.32 0 96.4
1609GAS PROD. 2 WILLIAMS CNESW122135WGRGR   5.3078.  -1.3901.3951.4172.4900.4900.4180.4210. 5 0172.4215.4242. 0 54245.4307. 0?2162.4
1610M.L. BROWN 2 DEYMER  CSWSE282135WGRNR   5.3121.2132.3850.3920.4127.4824.4824.4129.4159. 3 0210.4161.4191. 8 04193.4254.43 0210.4
1611BLAIR OIL 1 LISETTE  CSWNE232138WSPR    2.53336.2165.3788.3840.4035.4850.4850.4039.4072. 4 0 65.4076.4104. 4 04104.4148. 017160.4
1612L.V.O CORP. 1 SMITH  CSENW362138WSPR    2.53357.2208.3874.3930.4111.4906.4506.4123.4144. 0 0 -1.4150.4177. 0 04177.4225. 0 0 -1.4
1613LIVINGSTON 1 UNIT    CNESW142141WSPR    2.52630.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.10 0 -1.  -1.  -1. 8 0  -1.  -1. 0 0 -1.
1614ASCOT OILS 1 LEWIS    SENW212142WGRNCC  5.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0108.  -1.  -1. 0 0  -1.  -1. 0 0 72.
1615M.L. BROWN 5 NUNN     SWNE272164WGRNR   5.2959.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 2 8 90.  -1.  -1. 0 04194.4218. 0 4 74.
1616LEE PHILLIPS 1 WEDELNWSESE122202WGRN   2.51460.  -1.  -1.2332.2508.2940.2940.2510.2522.10 0 -1.2524.2562. 0 02564.2625. 3 0 -1.2
1617VINCENT OIL 1 ADRIANSWNESW172202WGRCC   5.1465.  -1.2220.2455.2656.2165.3165.2658.2682. 0 0100.2649.2730. 0 02734.2780. 0 0210.2
1618TOMLINSON 2 HOESE     NENWNW242202WSPNCC 2.51470.  -1.2110.2330.2504.2540.2940.2511.2530. 0 0 22.2533.2567.11 02571.  -1. 0 0 -1.
1619D.C. SLAWSON 1-B SPESWNWNW282202WGRSPR  5.1450.  -1.  -1.2452.2636.2150.3150.2643.2668. 0 0 56.2674.2713. 6 02717.2774.10 0285.2
1620BRUNSON-SPINES 1 MAP CNESE192203WGRN    2.51440.  -1.2278.2470.2638.2171.3171.2646.  -1. 3 0 59.2711.2748. 3 02752.2824. 0 0 86.2
1621OSAGE OIL&GAS 1 UNFUNWNWSW072204WGRLLML2.51486.  -1.2459.2659.2889.3354.3354.2885.2900. 5 0 -1.2903.2946. 4 02950.3014.16 8 -1.3
1622CITIES SER. 1 UKHOLMSWSENW162205WGRLLSP 5.1576.  -1.2614.2836.3032.3471.3471.3038.3054. 0 0 -1.3036.3108. 5 03112.3154. 6 0 -1.3
1623BRUNSON-SPINES 2 FRISWNWNE222206WSPNC  2.51565.  -1.2650.2868.3075.3513.3513.3080.3103. 3 0 71.3108.3134. 0 03134.3174. 0 0138.3
1624PETROL. MANG. 1 NELSNESENE342206WGRNGC  5.1555.  -1.2660.2872.3077.3532.3532.3081.3098.10 0 74.3100.3135. 0 03137.3183.10 0165.3
1625SKELLY OIL 1 GOSSAGE CSWSE172207WGRLLSP2.51603.  -1.2738.2945.3133.3574.3574.3137.3152. 5 0 78.3159.3180. 0 03182.3224. 8 0240.3
1626STEARNS PET. 1 MOORMNENENE322207WGRLLPL2.51609.  -1.2809.3018.3195.3518.3518.3202.3214. 0 0 -1.3218.3242. 0 03242.3298.13 0 -1.3
1627RAINS&WILL. 1 CAREY  CNESE282208WGRNG  2.51677. 237.2926.3128.3307.3612.3612.3310.3322. 3 0 70.3325.3346. 2 03348.3393. 0 0225.3
1628KINDERHOOK 2 CULBERTSESESW082209WGRNCC  5.1733.  -1.2918.3085.3242.3470.  -1.3246.3260. 3 0 54.3262.3280. 0 73282.3316. 0 0118.3
1629RAYMOND OIL 1 ABBOTTSWSWSE262209WGRNG  2.51718. 330.2987.3173.3325.3555.3555.3328.3341. 4 0150.3344.3362. 0 43364.3402. 0 0172.3
1630SHIELDS OIL 1 PROFFITNENWNE122210WGRNGC  5.1755. 385.2927.3093.3244.3449.3449.3248.3263. 5 0 71.3266.3282. 0 03288.3318. 0 0108.3
1631PYRON EXPL. 1-C SNAKNWNESW132210WGRNGC  5.1744. 384.2969.3142.3296.3554.3554.3302.3314. 0 0 71.3316.3333. 0 03336.3369. 0 0113.3
1632ASPEN DRIG. 1 MC KAYNESWNE112211WGRN    2.51764. 466.2982.3144.3276.3456.  -1.3280.3294. 8 4 62.3297.3312. 0 03314.3342. 0 6106.3
1633ASPEN DRIG. 1 RICHARSESENE202211WGRNGC 2.51824. 572.3083.3246.3376.3574.  -1.3380.3395. 9 0 62.3398.3410. 0 03414.3440. 0 0 84.3
1634ENERGIES RES. 8 ALLEE2W2SW312211WGRDNC  5.1826.  -1.3086.3253.3397.  -1.  -1.3400.3414. 6 0 45.3417.3439. 5 03441.3483. 2 0177.3
1635PHILLIPS 1 HITZ        CSENW072212WGRN   2.51881. 702.3178.3322.3448.3676.  -1.3452.3468. 9 0 44.3474.3487. 0 03490.3514. 0 2 57.3
1636PAN AMERICAN 5-A TEIKENWSE102212WGRLLSP2.51853.  -1.3133.3285.3413.3670.  -1.3417.3429. 4 0 72.3432.3443. 3 33448.3476. 0 0125.3
1637DAVIS BROTHERS 1 SCHRENENW272212WGRLLML2.51869. 650.3154.3309.3436.3591.  -1.3441.3458. 0 0 -1.3461.3475. 0 03477.3503. 6 0 -1.3
1638HALLIBURTON 2 KRANKENWSWSW272212WGRN   2.51850. 634.3134.3289.3428.3590.  -1.3425.3440. 0 0 44.3442.3455. 4 03458.3484. 4 5 80.3
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1639CIRCLE OIL CO. 1 HAMSWSWNL10221 3WGRNGS 2.51893. 751.3235.3382.3500.3661.  -1.3505.3520. 4 0 43.3522.3540. 9 03542.3564. 4 0136.3
1640BROOKS PIERCE 1 SPAT CN2SE26221 3WGRNGS 2.51887.  -1.3225.3371.3507.3640.  -1.3508.3520. 0 0 65.3524.3535. 0 03535.3564. 0 0 80.3
1641CLINTON OIL 1-V HIDDNWSENW29221 3WGRNR  2.51909. 788.3305.3454.3570.3768.  -1.3574.3593. 9 0 61.3596.3609. 0 03612.3635. 0 4 89.3
1642SUNRAY DX 1 KEENLA  SESWNE02221 4WGRLLSP2.51939. 830.3291.3425.3546.3670.  -1.3550.3567. 0 0 56.3570.3585. 4 03590.3610. 5 0130.3
1643F & M OIL CO. 2 MCALE2SENW32221 4WGRNRC  5.1966. 879.3335.3536.3651.3906.  -1.3656.3672. 6 0 54.3674.3689. 0 03690.3718.11 0104.3
1644GRAVES DRIG. 1 MILLENWSWNE36221 4WGRNR  2.51923. 837.3306.3454.3567.3744.  -1.3571.3594.15 0 40.3596.3610. 0 03613.3638.12 0 93.3
1645F & M OIL CO. 1 KOEHS2S2NE14221 5WGRNGC  5.1970. 927.3382.3506.3632.3860.  -1.3638.3664. 0 7 65.3668.3688. 5 03692.3720. 0 0123.3
1646TOMLINSON-K. 1 YEACEAWNWNW30221 5WGRNRC 2.52003. 965.3423.3546.3668.3908.  -1.3672.3693.10 0 82.3696.3712. 0 03717.3739. 0 0177.3
1647R.W. RINE DRLG 3 LCVSWSENW35221 5WGRNGC  5.1992. 934.3418.3556.3680.  -1.  -1.3684.3702. 6 0 63.3705.3721. 0 0  -1.  -1. 0 0 -1.
1648D.R. LAUCK 1 WURM   NWSENE02221 6WGRNGC  5.2003. 986.3412.3526.3651.3851.  -1.3660.3672. 0 0 54.3674.3690. 0 03695.3721. 0 0108.3
1649ALPINE DRLG. 1 CLARKNENENE23221 6WGRNGC  5.2013. 991.3452.3571.3695.3930.  -1.3702.3722. 9 3 70.3725.3738. 0 03742.3767. 0 3112.3
1650WHITE & ELLIS 1 BRCWS2S2NE32221 6WGRDPC  5.2062.  -1.3579.3703.3838.4104.4104.3835.3855. 0 6 80.3857.3871. 0 03881.3918. 7 0154.3
1651BELL BROTHERS 1-A EISLSENW19221 7WGRNSPR2.52102.1160.3634.3738.3872.4254.4254.3877.3893. 5 0 78.3895.3914. 5 03924.3954.10 0192.3
1652COLORADO DRG 3 JORDAN2W2SW32221 7WGRNC  2.52076.1134.3635.3744.3882.4254.4254.3888.3906. 9 0 70.3910.3930. 0 63936.3966. 0 0176.3
1653BELL BROTHERS 2 BIRDNWNWSE13221 8WGRNGC  5.2063.1122.3573.3678.3808.4195.4195.3812.3829. 0 0 99.3831.3849. 2 53858.3894. 4 8216.3
1654DRELLING OIL 1 MECKF CNENE17221 8WGRNGC 2.52059.1152.3534.3690.3828.4186.4186.3836.3855. 6 0 84.3858.3878.-6  3886.3916. 0 4200.3
1655CLINTON OIL 1-V PALM CSENE35221 8WGRNRSP2.52113.1207.3697.3804.3940.4322.4322.3947.3966. 6 0 69.3968.3991. 0 63997.4030. 6 2200.4
1656GRAYHOL OIL 1 SCHART CNENW09221 9WGRNG  2.52099.1215.3665.3755.3898.4308.4308.3906.3923. 0 0 95.3925.3948. 0103954.3989.14 0198.3
1657BEREN CORP. 1 WAGNER CSESE33221 9WGRNGC  5.2138.1304.3759.3858.3999.4400.4400.4004.4025.10 0 89.4026.4050. 0 54055.4085. 0 0173.4
1658WALTERS DRLG. 1 ARNO CNWSE35221 9WGRNGC 2.52160.1283.3760.3860.3997.4422.4422.4004.4025. 8 0 87.4028.4048. 0 04054.4088.13 0190.4
1659D.R. LAUCK 1 BRYANT SENWSE09222 0WGRNGC 2.52180.1273.3687.3770.3916.4346.4346.3920.3942. 8 0 77.3944.3965. 0 03969.4010.22 0 55.4
1660D.R. LAUCK 1 JONES  NENENE09222 0WGRNG  2.52169.  -1.3681.3767.3910.4314.4314.3918.3937. 6 0 78.3940.3963. 0 53968.3998.12 0116.4
1661RAINS&WILL. 1 RICKER CSWNW01222 1WGRSPRS2.52130.  -1.3682.3762.3914.4366.4366.3922.3942. 6 0 96.3947.3971. 8 03975.4008. 7 3150.4
1662MACK OIL CO. 1 PORRI CNENW10222 1WGRNRC  5.2136.1289.3702.3764.3933.4356.4356.3940.3963.10 0 90.3966.3996.13 03998.4024. 4 0123.4
1663CITIES SER. 1-C NICH CNESW25222 1WGRPDC  5.2297.  -1.3859.3908.4087.4509.4509.4090.4114. 2 3 88.4117.4144. 0 04147.4184.10 4131.4
1664MACK OIL CO. 1 MUCKE CSWNE23222 1WGRNGC  5.2157.1333.3771.3835.4005.4455.4455.4011.4032. 0 0 73.4038.4056. 0 04060.4095. 010 83.4
1665SUNRAY MIDC. C MILLE CNENW08222 2WGRLLR 2.52307.1476.3855.3907.4075.4521.4521.4082.4102. 4 0120.4105.4128. 0 04132.4170. 3 8168.4
1666BROOKS HALL 1 MILLERNCN2SE12222 2WGRNGC  5.2207.1353.3742.3802.3966.4417.4417.3972.3995. 8 0 99.3997.4018. 0 04020.4062. 811120.4
1667IMPERIAL OIL 1 HANA SWNWNW26222 2WGRLLRS2.52164.  -1.3720.3780.3945.4388.4388.3950.3972. 5 3130.3976.3998. 0 04003.4036. 0 0105.4
1668PETROL. INC. 1-H GOE CNWSW05222 3WGRNRC  5.2359.1670.3951.4013.4192.4640.4640.4200.4221. 6 0150.4224.4253. 0 04258.4277. 0 6210.4
1669RAINS&WILL. 1 MALC   CNESW15222 3WGRNC  2.52236.1565.3906.3962.4136.4600.4600.4143.4162. 0 0193.4165.4190. 3 04190.4228.12 0285.4
1670EDMISTON OIL 2 HAYS N2SESW19222 3WGRNRC  5.2400.1654.3955.4007.4190.4649.4649.4197.4218. 5 0172.4221.4249. 0 04251.4283. 6 8320.4
1671EDMISTON OIL 3 HAYS  CNESW19222 3WGRNRC  5.2424.1682.3984.4037.4220.4673.4673.4228.4251. 7 0160.4254.4282. 2 04284.4320. 811304.4
1672EDMISTON OIL 4 HAYS S2NWSE19222 3WGRNCC  5.2423.1683.3987.4035.4222.4672.4672.4235.4253. 6 0171.4255.4280. 0 04283.4324.11 8294.4
1673OASIS PET. 1 DIXON   CNENE04222 4WGRNG   5.2464.1716.3967.4018.4158.4633.4633.4209.4228. 0 0128.4230.4261. 0 04261.4289. 5 0182.4
1674PETROL. INC. 1-B SCH CNENW17222 4WGRNR   5.2486.1684.3934.3988.4175.4623.4623.4182.4202. 4 0132.4205.4236. 0 04238.4270. 6 0210.4
1675CITIES SER. 2-D DAVI CSWNE26222 4WGRNCC  5.2297.  -1.3931.3981.4173.4655.4655.4180.4202. 5 0107.4206.4245. 0 04245.4271. 4 9190.4
1676STELBAR OIL 1 HENRIC CSESE06222 5WGRLLR  5.2519.  -1.3857.3902.4090.4550.4550.4090.4121. 2 3 -1.4125.4152. 9 04152.4213.1620 -1.4
1677KEWANEE OIL 7 LARKIN CSESE15222 5WGRNC  2.52514.1685.3930.3951.4140.4604.4604.4146.4168. 0 0140.4172.4209. 4 04206.4259.19 5200.4
1678O.A. SUTTON 1 SHRIBI CSESE34222 5WGRNGC 2.52522.1714.3966.4025.4213.4682.4682.4222.4244. 4 0148.4247.4275. 3 04286.4330.24 0200.4
1679D.R. LAUCK 1 SCHLERE CSENE06222 6WGRLLR 2.52471.1677.3806.3854.4047.4512.4512.4054.4078. 8 0110.4081.4112. 2 04117.4157.15 0229.4
1680JOHN FARMER 1-B STAP CSWNE14222 6WGRNCC 2.52475.1654.3848.3896.4096.4532.4532.4105.4130. 4 0 91.4134.  -1. 6 04171.4200. 4 3168.4
1681KAISER-FRANCIS 1 COS CNESW26222 6WGRLLR 2.52571.1740.3942.3988.4150.4658.4658.4198.4218. 0 0106.4221.4239. 3 04242.4297. 8 6240.4
1682HELM.&PAYNE 1 CALLIS CSWNW31222 6WGRLLRS2.52617.1773.3946.3987.4184.4649.4645.4191.4213. 0 0168.4216.4238. 9 34241.4292. 8 6210.4
1683VIRGINIA DRIG. 1 RCH CNWSW20222 7WGRNG   5.2552.1719.3818.3862.4058.4538.4538.4064.4088. 3 0128.4090.4117. 0 44125.4152. 2 4120.4
1684MACK OIL CO. 2 MAI   CNESW14222 9WGRNR   5.2675.1864.3870.3914.4111.4579.4575.4114.4141. 0 0100.4143.4167. 9 04170.4207.18 0 89.4
1685MACK OIL CO. 1 FOSTE CNESE31223 0WGRNR   5.2868.  -1.3982.4038.4232.4748.4746.4239.4267. 4 0108.4269.4292. 8 04294.4351.29 4210.4
1686THUNDERBIRD 1-A LAS  CNENW12223 1WGRNGC  5.2889.2112.3938.4014.4216.4707.4707.4220.4252. 6 0206.4254.4284. 6 04284.4333.1112310.4
1687COOP. REF. 1-A SCHONENENE21223 1WGRLLML2.52513.2102.3376.4022.4215.4740.4740.4222.4252. 0 0 -1.4254.4280. 8 04282.4340.28 0 -1.4
1688AMARILLO NAT. 1 GREA CSESW05223 2WSPRS  2.52898.2496.3882.3925.4136.4772.4772.4140.4170. 0 0120.4174.4198. 6 04200.4276.51 0257.4
1689THE TEXAS CO. 1 KISNSENENE13223 3WGRLLML2.52853.2030.3888.3952.4158.4774.4774.4162.4192. 0 0 -1.4195.4215. 0 04215.4252. 910 -1.4
1690LONITA OIL 1 GARDEN SENESE17223 3WGRLLC  5.2901.  -1.3802.3888.4053.4711.4711.4056.4087. 8 0 -1.4090.4118. 0 04121.4179. 5 0 -1.4
1691CHAMPLIN REFG. 1 RCLAWNWNE34223 3WGRLLML 5.2861.1959.3810.3853.4074.4729.4729.4081.4107. 4 0 -1.4108.4141. 0 04146.4201. 010 -1.4
1692KIMBARK CO. 1 BILLIN CNENE04223 4WSPRGRP 5.2970.2037.3784.3830.4050.4714.4714.4053.4084. 0 0222.4087.4118. 0 04118.4172. 625 95.4
1693GULF ENERGY 1-20 ELR  NWNW20223 4WGRSPR  5.2985.1957.3730.3790.4006.4660.4660.4008.4020. 4 0 55.4022.4038.10  4038.4112.58 0183.4
1694PETROLEUM 1 WILLIAMS CSWSE04223 5WGRNR  2.53107.2093.3848.3906.4096.4862.4862.4100.4124. 6 0210.4127.4160. 3114163.4230.40 0210.4
1695J.A. ALLISON 2-C RCO  SWNE20223 5WGRNNC  5.3085.2043.  -1.3855.4072.4852.4852.4075.4098. 0 0173.4100.4139. 0 94141.4196.1810176.4
1696GULF OIL 1 FOSTER    CSWSW34223 5WGRCR   5.3043.2020.3808.3869.4084.4914.4914.4086.4112. 0 0 -1.4114.4139. 4 04142.4207.1812 -1.4
1697GULF OIL 1 CAMPBELL  CSESE24223 6WGRLLSP2.53119.2057.3813.3866.4076.4878.4878.4079.4101. 6 0128.4103.4135.14 34139.4216.60 0128.4
1698PAN AMERICAN 3 .ATTEN2N2SE23223 8WGRGRSC2.53328.2138.3814.3876.4073.4914.4914.4073.4105. 5 0100.4108.4141. 0134144.4198.1318174.4
1699CLEARY PET. 1 CAMPEE CNENE36223 8WSPRGRS2.53312.2108.3789.3850.4053.4821.4821.4057.4071. 0 0 88.4075.4103. 0 04106.4168. 538132.4
1700KANSAS NEB. 1 WEDEL  CNENW01224 1WGRLLML2.53617.2282.3991.4058.4253.5315.5315.4256.4285.10 0 -1.4290.4307. 0 04313.4368. 0 6 -1.4
1701LITTLE GEORGE 1 GRCVSWSWNW27230 1WSPRDPC2.51415.  -1.  -1.2360.2572.3033.3033.2576.2610. 0 0 -1.2610.2638. 0 02642.2692. 6 0 -1.2
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1702FERGUSON OIL 1 LIAN SWSENW272302WGRNG  2.51399.  -1.2128.2366.2580.3014.3014.2584.2614.10 0 93.2615.2641. 6 02645.2700. 0 0254.2
1703HOME STAKE 1-W DAY   CE2NW192303WGRN   2.51465.  -1.  -1.2525.2764.3250.3250.2772.2787. 0 0127.2772.2822. 5 42825.2900. 0 9157.2
1704ADAIR OIL CO. 1 NCEL CSWNE292303WGRNGC  5.1441.  -1.2284.2519.2758.3285.3285.2764.2790. 0 0116.2796.2822. 3 02830.2892. 0 0204.2
1705TOMLINSON 7-B EVANS N2NWNE232304WGRN   2.51466.  -1.2344.2530.2754.3243.3243.2762.2771. 0 0 44.2773.2819. 0 02821.2897.1910101.2
1706ROSEN OIL CO. 1 ALBR CSENE282304WGRN   2.51481.  -1.2428.2592.2815.3322.3322.2821.2834. 5 0 38.2834.2870. 0 02870.2968.14 6 76.2
1707SCOTT RITCHIE 1 GRABN2SENW342304WGRN   2.51474.  -1.2380.2584.2795.3302.3302.2799.2814. 4 0 -1.2816.2860. 0 02864.2945. 9 0 -1.2
1708DRIG.& EXPL. 1 MILLESLNENE332305WGRNG  2.51503.  -1.2484.2730.2940.3395.3395.2950.2962. 0 0 82.2963.2992. 0 02998.3054. 0 3158.3
1709CITIES SER. 1 HAMILTSWSWSW222306WGRGC  2.51560.  -1.2732.2936.3138.3592.3592.3146.3158. 0 0 71.3160.3182. 0 63195.3238.24 0136.3
1710JAY-BEE OIL 1 ENCELL CSESE102307WGRNG  2.51579.  -1.2784.2986.3178.3592.3592.3182.3201. 8 0 81.3203.3228. 0 03228.3278.12 0180.3
1711STERLING DRIG 1 CIX  CSWNW162307WGRNG  2.51607.  -1.2836.3040.3238.3609.3609.3243.3256. 0 3 64.3256.3280. 0 03280.3340. 912250.3
1712SOLAR OIL CO. 1 OVERSENESE142309WGRNG  2.51713. 367.3056.3240.3422.3741.3741.3427.3443. 4 0 83.3443.3459. 0 03461.3516. 9 0266.3
1713SOLAR OIL CO. 2 OVER CNWSE142309WGRN   2.51721.  -1.3054.3243.3422.  -1.  -1.3426.3442. 0 0 70.3444.3468. 0 03470.3515. 0 0267.3
1714W. LANMITTI 1 HINSHA CNESW092310WGRNG  2.51772. 418.3056.3248.3396.3638.3638.3402.3415. 0 0 73.3418.3436. 0 33438.3471. 0 7130.3
1715CITIES SER. 5-A ESTENWSENW142310WGRSPR  5.1770. 428.3066.3257.3420.3629.3629.3423.3432. 0 0 87.3436.3455. 0 43457.3490. 0 0148.3
1716STELBAR OIL 1 YUST     NWNE202310WGRNDRC2.51792. 460.3080.3266.3412.3652.3652.3410.3432. 0 0 91.3435.3453. 0 03455.3486. 0 4128.3
1717REPUBLIC N. 2-B SNOWSWSWNE212310WGRN   2.51780. 455.3110.3263.3434.3636.3636.3439.3452. 0 0 -1.3456.3472. 0 03478.3510. 0 5 -1.3
1718INDEPENDENT 1-11 ZENE2W2NE312310WGRN   2.51798.  -1.3106.3292.3436.3671.3671.3441.3454. 4 0 -1.3459.  -1. 0 03475.3507. 2 3 -1.3
1719DELTA WESTERN 2 MINNSENENE072311WGRNRC  5.1824. 558.3132.3302.3435.3719.3719.3442.3457. 6 0 89.3460.3472. 0 03474.3504. 5 9165.3
1720WESTERN PET. 1 LICHTSENENE102311WGRLLSP2.51799.  -1.3094.3273.3404.3604.3604.3411.3422. 0 0 65.3429.3437. 0 03440.3470. 4 3112.3
1721HENDERSON OIL 1 KREYSESENE132311WGRNG  2.51792. 472.3090.3275.3416.3644.3644.3420.3433. 6 0 66.3436.3452. 0 03454.3487. 0 0116.3
1722J.W. HERSHE. 1 HOWE SESENW262311WGRNG  2.51806. 513.3124.3310.3448.3658.  -1.3452.3466. 6 0 67.3469.3483. 0 03486.3521. 0 7131.3
1723SKELLY OIL 2 BRENN  NWNESE192313WGRNG  2.51924. 815.3367.3517.3652.  -1.  -1.3654.3670. 2 0 83.3670.3682. 0 03686.3718. 5 0124.3
1724HINKLE OIL 1 LUTZ   NWSWNE272313WGRSPNR2.51896. 752.3323.3486.3610.3837.  -1.3614.3629. 6 0 72.3633.3642. 0 03644.3674. 0 6108.3
1725HALLIBURTON 1 WATSONNWNESW162314WGRNEC  5.1969. 886.3412.3557.3673.3936.  -1.3679.3695. 6 0 68.3697.3713. 0 03717.3749. 0 7 96.3
1726KANSAS EXPL. 1-A CADNWNESE302314WGRNG  2.51578. 885.3447.3594.3714.3980.  -1.3717.3736. 5 0 77 3738.3754. 0 03756.3790.11 3100.3
1727KANSAS EXPL. 3 CADMASENENE302314WGRNGC 2.51973. 890.3442.3588.3707.  -1.  -1.3710.3732.10 0 70.3734.3748. 0 03750.3782.12 0102.3
1728F & M OIL CO. 1 JONES.SENE112315WGRNCC  5.2602. 953.3438.3605.3727.3954.  -1.3729.3749.10 0118.3752.3768. 0 03771.3800. 0 7133.3
1729ALPINE DRIG. 1 COSSMSESENW202315WGRNGC  5.2051.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 5 0 50.  -1.  -1. 3 0  -1.  -1.16 0 80.
1730WELCH&OLSSON 1 KASSENWNWNE142316WGRLLML2.52037.1010.3508.3635.3766.4021.4021.3771.3791. 0 0 -1.3794.3810. 6 03820.3842. 0 0 -1.3
1731KEDCO CORP. 1 SCHARTSWSWNW352316WGRNGC  5.2075.1023.3556.3675.3805.  -1.  -1.3808.3827. 3 0 97.3831.3849. 2 03853.3882. 0 4190.3
1732CLARK KNIGHT 3 EWINGNWSENE042317WGRN   2.52056.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 78.  -1.  -1. 6 0  -1.  -1. 0 2140.
1733HILTON DRIG. 9-4 MUTHW2SWN 172317WGRNG  2.52103.  -1.3676.3792.3927.4248.4248.3934.3952. 7 0 79.3957.3974. 0 03978.4011. 6 6200.4
1734IMPERIAL OIL 1-27 ST   NENW272317WGRNC  5.2097.1128.3649.3776.3908.4227.4227.3912.3931. 0 0 63.3933.3949. 0 03954.3991. 0 9172.3
1735HINKLE OIL CO. 1 GAINENESE272318WGRNGC  5.2108.1173.3737.3855.3992.4364.4364.4000.4015. 0 0 56.4018.4036. 0 44038.4076.10 4165.4
1736WALTERS DRIG. 1 GRIF CNENE112319WGRNGC 2.52192.1310.3777.3884.4017.4410.4410.4023.4040. 5 0100.4043.4066. 4 44074.4104. 4 0166.4
1737THE NATL. OIL 1 SCHM CNENE312319WGRNGC 2.52232.1368.3878.3986.4127.4551.4551.4134.4152. 0 3 76.4154.4180. 7 04180.4222.1110112.4
1738FERGUSON OIL 1 LIFFO CSWNE072320WGRLLSP  5.2302.1434.3915.4006.4143.4578.4578.4151.4175. 3 4125.4178.4199. 5 04204.4249. 514153.4
1739MACK OIL CO. 1 WERNE CNESE152320WGRNRC 2.52315.1458.3952.4053.4155.4612.4612.4200.4223.12 0 87.4226.4246. 0 04250.4292.16 0142.4
1740JAMES HERSH. 1 SCHPI CNWNW292320WCSGRGR2.52216.1464.3934.4093.4242.  -1.  -1.4246.4266. 5 0 92.4268.4282. 0 04286.4334. 01415A.4
1741J.M. HUBER 1 KINGHY  CSES 032321.GRLLSP2.52345.  -1.3908.3998.4135.4577.4577.4144.4166. 0 0 96.4169.4190. 0 04194.4235. 0 3 69.4
1742W.J. COPPINGER 1 OLE  CSENE322321WGRNG  2.52274.1480.3987.4083.4232.4678.4678.4238.4265.14 0 76.4268.4290. 0 04290.4330. 513 72.4
1743PHILLIPS 3-A HALDREY CSWSW032322WGRNGC  5.2187.1303.3736.3802.3971.4409.4405.3979.3998. 7 0 75.4001.4022. 0 04025.4055. 0 9 72.4
1744MACK OIL CO. 1 CHILS CNWNE112322WGRNSPR2.52219.1365.3800.3871.4033.4470.4470.4038.4058. 3 0107.4061.4080. 0 04082.4130.23 0200.4
1745KATHOL PET. 1 GLEASO CNWNW342322WGRNC  2.52252.1366.3833.3932.4098.4550.4550.4104.4124. 0 0128.4126.4143. 0 04145.4193.32 0112.4
1746PICKERELL 1-6 SMITH  CSEN.012322WGRNRC 2.52219.1367.3764.3826.4000.4455.4455.4004.4024. 3 0142.4027.4048. 4 04048.4096.1012294.4
1747TEXACO INC. 7 LIPPOL CNESW142323WGRNGL  5.2219.1438.3830.3896.4070.4512.4512.4074.4095. 0 0124.4098.4118. 0 04118.4158.24 0 80.4
1748D.C. SLAWSON 1-A LAP CSWSW272323WGRNR   5.2267.1530.3922.3990.4169.4631.4631.4174.4195. 0 0136.4138.4228. 6 04231.4274.16 0210.4
1749AMERICAN ENE. 1 SINC CSES.032324WGRNGC  5.2301.1495.3820.3867.4058.4548.4548.4064.4085. 5 0183.4087.4120. 0 04122.4167.28 0260.4
1750RAINS&WILL  1 PINER  CSWNW182324WGRNGC 2.52477.1683. 010.4062.4265.4730.4730.4275.4292. 0 0130.4274.4326. 0 64326.4376. 024200.4
1751LEE BANKS 1 HUMPHREY CSWSW332324WGRNG  2.52490.1660.4007.4062.4264.  -1.  -1.4277.4294. 0 0 95.4296.4331. 0 04334.4384.22 0210.4
1752JOHN FARMER 1 SINCLA CNWSE052325WGRNCC 2.52551.1750.4006.4067.4258.4710.4710.4262.4284. 0 0150.4288.4317. 0 04317.4368.1114211.4
1753JONES-GEBERT 1 JOHNS  NENW102325WGRNLL  5.2459.1658.3943.4006.4202.4648.4648.4208.4227. 0 0166.4230.4245. 0 04245.4304. 6 6240.4
1754O.A. SUTTON 1 WILSON CNWSW312325WGRNGC 2.52511.1698.4008.4071.4260.4709.4705.4269.4288. 0 0 97.4292.4316. 0 04316.4368.23 5152.4
1755PRIME DRIG. 1 EOKEER CNWNE212326WGRLLSP 5.2605.1764.4017.4067.4267.4748.4748.4275.4298. 3 0112.4300.4319. 0 04319.4386. 416150.4
1756NORTH. NATU. 1-27 CO   CSW272326WGRDNC  5.2602.  -1.4050.4106.4301.4756.4756.4306.4333. 5 0110.4337.4363. 0 04368.4416.16 0263.4
1757NATL. OIL CO. 1 KALL CNWN.252328WGRNRC  5.2733.1870.4032.4079.4284.4763.4763.4292.4315. 0 4193.4317.4344. 0 04347.4383.17 0240.4
1758THUNDERBIRD 1 MAXWEL CNWSW322329WGRNGC 2.52794.1936.4019.4068.4266.4774.4774.4273.4303. 6 4126.4305.4330. 0 64332.4384.37 0136.4
1759DAVID&DAVICOR 1 HAAGNWNESW062330WSPRGRD2.52867.2009.3972.4020.4224.4734.4734.4226.  -1. 8 0112.4258.  -1. 3 24298.4328. 4 4160.4
1760KEWANEE OIL 1 HAAG   CNENE082330WSPRGRN2.52838.2010.3974.4023.4220.4722.4722.4223.4252. 0 0 90.4254.4280. 0 04280.4350.44 0218.4
1761TEXAS OIL&GAS 1 TREK  SESE012331WSPRGR  5.2863.2051.3979.4026.4224.4750.4750.4234.4259. 0 0100.4262.4282. 0 04284.4331. 7 0 58.4
1762DAV.&DAV. INC. 1 TAT CNENW232331WSPRGR 2.52886.2047.3986.4034.4236.4776.4776.4241.4272. 3 0143.4275.4298. 0 04300.4366.46 0244.4
1763AMOCO 1 A. J. STRASS  SWNW282332WGRS    5.2845.  -1.3807.3851.4077.4703.4703.4079.4104. 9 0110.4109.4120. 0 44122.4218.2532220.4
1764PAN AMERICAN 1 FINNUNENENW032333WGRLLSP2.52880.1968.3411.3860.4075.4714.4714.4078.4108. 7 5158.4111.4150. 0134153.4212.38 0210.4
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1765PETROLEUM INC. 1-B F CSWSW122333WGRGRSP2.52887.1966.3834.3879.4096.4753.4753.4100.4128.10 0128.4132.4169. 5 04167.4234.1328185.4
1766PAN AMERICAN 1-B GAR CSWNE332333WSPRGRS2.52913.  -1.3876.3928.4148.4853.4853.4151.4174. 0 0 78.4178.4211.12 04214.4284. 834176.4
1767AIKMAN BROTH. 1 GARC CSWSE142334WSPRGRS 5.2940.1912.3751.3806.4035.4615.4615.4037.4048. 0 0 66.4053.4069. 0 74074.4129.1714 84.4
1768CITIES SER. 2-B GARD CNWSW312334WGRPDC  5.2984.1920.3758.3808.4056.4780.4788.  -1.  -1. 3 0 90.4060.4094. 0104096.4155.40 0130.4
1769CITIES SER. 2-B GARD CNWSW312334WGRLLSP 5.2984.1914.3759.3809.4031.4788.4788.4035.4057. 0 0 97.4060.4095. 0 4  -1.4106.38 0115.4
1770CITIES SER. 1-B STEE CNESW272335WGRSOR 2.53025.1870.3792.3845.4074.4885.4885.4077.4104. 0 0136.4107.4135. 0 04138.4191.12 5 95.4
1771PAN AMERICAN 1 FOOTE CSENW232336WSPRGRS2.52137.  -1.3804.3858.4085.4927.4927.4085.4107. 0 0 46.4110.4148. 0 04153.4219. 424192.4
1772ZENITH DRLG. 1 TATE  CSESW212337WGRCCP 2.53296.  -1.3783.3838.4034.  -1.  -1.4036.4068. 7 0 45.4068.4090. 0 94090.4164.1524155.4
1773WOODWARD 1 O.P. BLCKSESENW152339WGRLLPL2.53373.2136.3900.3959.4194.5206.5206.4197.4222. 0 0 -1.4227.4262. 0 04265.4314. 0 0 -1.4
1774KAN-NEB. 1 WILCOX      CSE362339WSPRGR 2.53341.2063.3843.3899.4135.5152.5152.4138.4163. 6 0 -1.4165.4204. 0 04206.4263. 011 -1.4
1775LIVINGSTON 1 MINGERS CSWNE242341WSPRGR 2.53393.1987.3784.3843.4072.  -1.  -1.4077.4094. 0 0 -1.4097.4147. 0 94153.4185. 0 0 -1.4
1776**BLANK RECORD**             W         0.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
1777ACAIR 1 CHAVEZ        CSESE252401WGR-N  2.51424.  -1.2160.2425.2656.3152.3152.2660.2688. 0 0240.2694.2718. 4 42722.2772. 3 0320.2
1778FANOM 1 HAALMANN     SESENE 72402WGR-N  5.01424.  -1.  -1.2514.2778.3325.3325.2786.2804. 0 0138.2812.2839.12 02843.2907. 3 0320.2
1779OLYMPIC 1 SWAN EST.  CSWS.292402WSP-N  2.51413.  -1.2315.2542.2808.3370.3370.  -1.  -1. 6 0 -1.2859.2878. 7 02884.2952.20 0 -1.2
1780NATIONAL 1 WENDLING SWSESW 12403WGR-N  5.01428.  -1.2318.2530.2782.3362.3362.2792.2812. 0 0107.2821.2950.14 02878.2931.15 0304.2
1781TED FERRIER 1 DEVENPNWNWNE182403WGR-N  2.51450.  -1.2259.2622.2845.3397.3397.2856.2876. 6 0115.2884.2913. 3 02927.2995. 0 8130.2
1782SHAWVER-A 1 ZIMMERMASESWNE342403WSP-R  2.51430.  -1.  -1.2632.2874.3424.3424.2885.2910. 8 0 -1.2921.2937. 6 02969.3024.15 0 -1.3
1783C.D.JOHNSON 6 WELCH SWSWSW 92404WGR-N  2.51474. -1. 2382.2592.2808.3284.3284.2814.2829. 0 0 68.2830.2854. 0 02856.2942.13 0105.2
1784**BLANK RECORD**             W         0.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1.-1-1 -1.  -1.  -1.-1-1  -1.  -1.-1-1 -1.
1785A.S.RITCHIE 1 BAKER  CSWSW042405WGR-N  2.51525.  -1.2562.2751.2976.3430.3430.2984.3003. 0 0120.3003.3040. 0 03046.3093. 0 4220.3
1786OIL PROP 1 SCHROCK  SWNENE272405WGR-N  5.01530.  -1.2466.2680.2915.3388.3388.2924.2942. 5 0 90.2942.2978. 0 32993.3076. 6 9 83.3
1787OIL PROP 1 SCHROCK  SWNENE272405WGR-N  5.01530.  -1.2466.2680.2915.3388.3388.2924.2942. 5 0 90.2942.2978. 0 32993.3076. 6 9 83.3
1788OSAGE O-G 1 BENTON  NWNWSE 62406WGR-N  2.51583.  -1.2822.3011.3202.3676.3676.3207.3228.10 0 44.3228.3258. 4 03262.3312.14 0138.3
1789RAM PET 1 EISMINGER NWNWNW172407WGR-N  5.01636.  -1.2946.3145.3337.3746.3746.3341.3358. 9 0 61.3359.3384. 2 03384.3450.22 0254.3
1790RAM PET 1 EISMINGER NWNWNW172407WGR-N  5.01636.  -1.2946.3145.3337.3746.3746.3341.3358. 9 0 61.3359.3384. 8 03384.3450.22 0254.3
1791RAM PET 3 EISMINGER SENENE182407WGR-N  5.01636.  -1.2951.3142.3338.  -1. -1. 3340.3360.12 0 99.3361.3385. 3 03387.3448.17 0307.3
1792RAM PET 3 EISMINGER SENENE182407WGR-N  5.01636.  -1.2951.3142.3338.  -1. -1. 3341.3360.12 0 99.3361.3385. 0 03387.3448.17 0307.3
1793ARGONAUT 1 CHOW      CSWNE 52408WGR-G  5.01674.  -1.3024.3197.3350.3712.3712.3394.3410. 0 0 84.3412.3430. 0 03430.3488. 4 0360.3
1794ARGONAUT 1 CHOW      CSWNE 52408WGR-G  5.01674.  -1.3024.3197.3350.3712.3712.3394.3410. 0 0 84.3412.3430. 0 03430.3488. 4 0360.3
1795PLATT VALLEY 2 MORTOSENWNE172408WGR-N  5.01671. 249.2969.3158.3351.  -1.  -1.3356.3367. 0 0 60.3359.3389. 3 03389.3452.13 0240.3
1796NCRA 1 BARNES         62NENE342408WGR-N-G5.01623. 183.2981.3186.3363.  -1.  -1.3368.3385. 5 0 58.3387.3420. 0 03424.3470.10 5218.3
1797GRAVES 1 MCECKLE      CSWNE 62409WGR-N  2.51736. 372.3118.3307.3474.3734.3734.3480.3492. 2 0 72.3495.3511. 0 03511.3567. 9 0180.3
1798SIERRA 1 EICK         CSWNW152409WGR-N  5.01702.  -1.3101.3306.3472.3784.3784.3476.3489. 0 0 48.3491.3514. 3 03524.3572. 0 0192.3
1799APACHE 1 HORTON       CSENW302409.GR-N  2.51720. 415.3153.3350.3522.3826.3826.3528.3544. 2 0 85.3544.3566. 0 03568.3624. 8 0290.3
1800SHELL 1 PAINE         CNWNW 52410WGR-N  2.51787.  -1.3111.3283.3431.3638.3638.3435.3451. 4 0 -1.3451.3468. 0 03471.3507. 0 0 -1.3
1801BRADEN-ZENITH 1 ZO-1 CNWSW112411WGR-N  5.01816. 511.3193.3380.3518.3715.3715.3520.3534. 2 0 74.3536.3554. 6 03554.3591. 5 6130.3
1802DELTA WEST 1 IRVINE SENWNE302411WGR-N  2.51843. 610.3298.3481.3617.  -1.  -1.3620.3634. 5 0 99.3636.3652. 5 03652.3724. 811195.3
1803COLUMBIA 1 BYER      E2NWSE172412WGR-N  2.51894. 716.3335.3514.3642.3890.3890.3644.3660. 4 0 52.3661.3674. 0 03676.3710. 0 0 89.3
1804SUN 1 HUDCIE         NENESW272412WGR-N  2.51878. 676.3357.3517.3656.3920.3520.3659.3676. 4 0 -1.3676.3690. 3 03690.3739. 0 6 -1.3
1805PETROL INC A-3 RIXONNESWSW 72413WGR-N-G5.01929. 429.3420.3580.3704.3966.3966.3706.3722. 3 0 55.3724.3738. 0 03738.3777. 2 0 88.3
1806PETROL. INC. 3-A RIXNESWSW072413WGRNCC  5.1929. 829.3420.3580.3704.3967.  -1.3706.3722. 3 0 56.  -1.3738. 0 03738.3777. 2 0 88.3
1807GARNER ESBEN 1 GARNERNWNW122413WGRNCC  5.1905.  -1.3352.3515.3642.3863.  -1.3645.3660. 4 077. 3662.3675. 0 03677.3712. 011 92.3
1808ARTNELL 4 ICLAND      NESWNW282413WGR-LL 2.51535. 810.3426.3584.3713.3975.3975.3719.3732. 0 0 -1.3734.3748. 0 03750.3784. 2 7 -1.3
1809LAUCK 1 THERON        SWSWSW152414WGR-N  2.51978. 913.3515.3678.3802.4104.4104.3806.3818. 3 0 66.3820.3838. 0 03840.3875.16 0 99.3
1810LAUCK 1 MASON         SENENE242414WGR-N  2.51541. 816.3438.3603.3726.4022.4022.3733.3746. 0 0 34.3749.3762. 0 03762.3804.20 0 83.3
1811CHIEF DRLG. 1 SNYDERSESWNW282414WGRNG  2.51578.  -1.3558.3704.3826.4134.4134.3830.3848.10 0 52.3847.3860. 0 03862.3903.14 384. 3
1812CHIEF ETAL 1 SNYDER SESWNW282414WGR-N  2.51578.  -1.3558.3703.3826.4134.4134.3831.3848.10 0 38.3850.  -1. 0 03862.3903.14 3 74.3
1813TOMLINSON 5 HARKNESS 2W2NW112415WGRNGC  5.2023. 948.3479.3625.3750.4052.  -1.3753.3773. 9 0 82.3775.3791. 0 03793.3829. 710103.3
1814MURFIN DRLG. 1 MCLCO CNENW212415WGRNGC  5.2039.1015.3621.3774.3897.4203.  -1.3900.3919. 4 0 67.3921.3934. 0 03936.3968. 2 7120.3
1815NATURAL GAS 1 ENLOW SENENW092416WGRLLML2.52076.1028.3567.3704.3834.4099.4095.3840.3851. 0 0 -1.3853.3870. 0 03875.3907. 0 0 -1.3
1816ET AL INC. 2 MCWELL   NENE122416WGRNGC  5.2060. 982.3499.3634.3764.4028.  -1.3770.3788. 7 0 60.3790.3805. 0 03811.3844. 0 0134.3
1817F.G. HOLL 1 LUNZ     NWNWSW212416WGRNGC 2.52086.1108.3689.3836.3964.4258.4258.3968.3985. 4 0 93.3988.4004. 4 04008.4049.1111220.4
1818CHIEF DRLG. 1 MILLHOSESESE022417WGRNG   5.2095.1113.3695.3825.3962.4271.4271.3970.3987. 0 0 65.3990.4006. 0 04010.4043. 0 6194.4
1819F.G. HOLL KS. 1 NEWS CNWSE212417WGRNRC  5.2121.1146.3738.3873.4005.4346.4346.4009.4031. 8 0 71.4034.4050. 0 04055.4102. 710210.4
1820F.G. HOLL 1-29 CROSSNESWSW292417WGRNR   5.2143.1179.3828.3967.4102.4529.4529.4109.4127. 7 0 60.4130.4148. 3 04152.4198.25 0187.4
1821MACK OIL CO. 1 ISEAB CSWSE052419WGRSPLL 5.2181.1320.3862.3976.4112.4546.4546.4118.4143.13 0 96.4146.4159. 0 04163.4214. 018132.4
1822STERLING 1-A TAYLOR SENWSW122419WGRNDC  5.2143.1251.3811.3926.4068.4476.4476.4074.4093. 3 0 73.4098.4120. 6 04124.4163. 5 4182.4
1823RAINS & WILL. 1 JOHN CSESW302419WGRNGC  5.2195.1351.3922.4043.4182.4609.4609.4187.4212.10 0 -1.4215.4228. 0 04233.4281.29 0 -1.4
1824L.C. MARKLEY 1 BRAKE CNWNE062420WGRN    2.52310.1460.3984.4098.4236.4683.4683.4242.4262. 3 0 87.4266.4278. 0 04282.4327. 410181.4
1825MACK OIL CO. 1 MORAN CSWSW232420WGRLLCS2.52215.1378.3925.4040.4175.4612.4612.4184.4212.16 0132.4214.4228. 0 04231.4283. 8 9 -1.4
1826J.W. HERSHE. 3-A STR CSWNW092421WGRNSPR 5.2371.  -1.3974.4073.4220.4667.4667.4231.4254. 9 0 69.4256.4278. 0 04282.4315.12 8 79.4
1827THUNDERBIRC 1-A BLAK  SWSE162421WGRNGC  5.2333.1468.3993.4097.4247.4711.4711.4253.4277. 6 0136.4280.4301. 0 04301.4355.32 0150.4
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1828RAINS & WILL 1 SCHAL CNESW242421WGRLLCS2.5220A.1428.3997.4108.4256.4728.4728.4272.4288. 6 0108.4290.4311. 0 04313.4358. 014136.4
1829DENVER ENERGY 1-A HI CNWNL112422WGRNCC  5.2256.  -1.3906.3998.4147.4612.4612.4153.4177. 7 0 98.4180.4202. 0 04202.4257. 824244.4
1830SUNRAY D-X 2 MELLECK CSESE172422WGRLLSP 5.2397.1533.3937.4097.4258.4707.4707.4265.4285. 0 0127.4286.4301. 0 04307.4352. 7 4122.4
1831THUNDERBIRC 1 GRASSE  SWSW232422WGRNCC  5.2351.1490.3988.4088.4239.4714.4714.4245.4269. 7 0 92.4273.4292. 8 04293.4357.1916224.4
18320.A. SUTTON 1 KLUG  NWNWNW312422WGRNSP 2.52406.  -1.4034.4134.4305.4755.4755.4315.4335. 0 8 -1.4339.4365. 8 04368.4406. 4 8 -1.4
1833D.C. SLA.SON 1-B KRA CNWNE092423WGRNGC  5.2444.1611.4013.4086.4276.4732.4732.4285.4306. 0 0102.4308.4339. 0 04340.4385.24 0210.4
1834PICKRELL 1-C GARDNER CSWNW152423WGRNGC  5.2384.1545.3959.4038.4228.4684.4684.4228.4249. 0 0100.4251.4279. 0 04279.4342.41 0218.4
1835THUNDERBIRC 1-A BRAD CSENW182423WGRNGC  5.2465.1595.3997.4061.4264.4773.4773.4272.4294. 0 0130.4297.4324. 0 04326.4379.24 0248.4
1836M.B. ARMER 4 SCHRAEDSENWNW032424WGRLLML2.52478.1604.3942.3999.4202.4668.4668.4212.4232. 0 8 -1.4234.4266. 0 04266.4309.12 8 -1.4
1837DUNNE & GARD. 1 DEAIW2NWNE092424WGRNLLR2.52488.1632.3982.4038.4240.4746.4746.4249.4266. 0 0126.4270.4302. 8 04302.4360. 621248.4
1838MACK CIL CC. 1 HARPS  NWNW272425WGRNG   5.2550.1686.4092.4173.4362.4864.4864.4369.4391. 0 0106.4394.4421. 0 04424.4486.44 8152.4
1839IRON CRLG. CO. 1 SCHSENWSE012426WGRSPR 2.52567.  -1.4060.4124.4322.4794.4794.4334.4351. 0 8 -1.4354.4380. 0 04382.4430.17 8 -1.4
1840HARBRA OIL 1 FINDLEYSWSWSE072426WRGR    5.2635.  -1.4068.4144.4324.4811.4811.4335.4358. 8 0 -1.4362.4395. 7 34395.4429.11 6 -1.4
1841DEEP ROCK CIL 1 SCHA CNWNE332428WGRLLML2.52752.1844.4073.4126.4327.4856.4856.4343.4371. 0 0 -1.4376.4400. 0 04403.4458. 718 -1.4
1842SUNRAY&SMITH 1 DODGESWSWNW342428WSPRI  2.53211.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 3 0 -1.  -1.  -1. 0 0 -1.  -1.24 8 -1.
1843ATKINS&BOWERS 1-0 KRU CSWNW182429WGRNGC  5.2815.1956.4063.4111.4318.4836.4836.4324.4354.14 0 85.4358.4382. 8 84382.4435.37 8127.4
1844SENECA OIL 1 WERNER  CSENW022430WRGR    5.2824.1954.4024.4077.4274.4774.4774.4278.4307. 9 0124.4310.4343. 7114347.4387.18 0132.4
1845THUNDERBIRC 1 BRANDT CSENE122431WGRNGC  5.2885.2043.4030.4082.4285.4840.4840.4294.4326. 0 3132.4328.4360. 7 94365.4426. 014330.4
1846F.K. JOHNSON 1 KISNESWSWSW212431WGRLLML2.52913.2009.3996.4044.4262.4815.4815.4267.4298. 5 0 -1.4302.4328. 8 04332.4480.1712 -1.4
1847PAN AMERICAN 1 WOCC  CSWNE282432WSPRGRS2.52865.  -1.3882.3925.4152.4798.4798.4158.4188. 5 0130.4190.4225. 3 04227.4302.25 6268.4
1848GREENLANC 2-A SPRATT CNWNW192433WSPRIMC2.52941.  -1.3900.3952.4184.4946.4946.4190.4216. 0 8 -1.4217.4248. 3 64248.4328.1519 -1.4
1849CITIES SER. 2-C TAIT CNWSW272433WMCR    5.2894.  -1.3875.3940.4154.4935.4935.4157.4187. 2 0 -1.4187.4220. 4 04221.4290. 4 8 -1.4
1850CITIES SER. 5-C TAIT CSENW272433WMCR    5.2909.  -1.3875.3929.4150.  -1.  -1.4154.4180. 3 0 -1.4182.  -1. 0224231.4294.2125 -1.4
1851CHAMPLIN 1-15 SHARER CNWNW152434WGRSC   5.2912.1851.3733.3778.3991.4740.4740.3999.4027. 8 0 82.4029.4060. 0 04064.4129. 810185.4
1852GREENLANC 1-B HAMLIN CNWNW292434WSPICR 2.52963.  -1.3768.3816.4046.4832.4832.4053.4074. 0 0 -1.4076.4106. 0144108.4171.1313 -1.4
1853CHAMPLIN 3-A GARDEN  CNWSE012435WGRPC   5.2586.1930.3779.3822.4052.4847.4847.4054.4071. 2 0 50.4073.4112. 8 04112.4184.1426 85.4
1854AIKMAN CORP. 1 BLAIR CNWSW172435WGRGSPR2.53000.1865.3710.3765.3994.4822.4822.3997.4018.20 0 58.4022.4054. 0 54058.4120.1916110.4
1855MALLONEE 1 CARSON    CNESW332435WGRGR   5.2572.1821.3691.3738.3977.4810.4810.3979.4006. 0 0 63.4009.4042. 5 74044.4114.20 7129.4
1856PAN AMERICAN 1-F HIC CSWNE352435WSPRGRS2.52820.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0100.  -1.  -1. 0 0  -1.  -1.3613252.
1857CITIES SER. 1-A MOSE  NENW312436WGRS    5.2110.  -1.3698.3738.3965.4820.4820.3973.3992. 0 0 46.3995.4021. 0 04024.4094.1614190.4
1858CITIES SER. 2-P HEGG  SESE322436WGRDC   5.3027.1806.3623.3667.3886.4734.4734.3888.3910. 4 0 43.3913.3942. 0 03945.4008.1914216.4
1859PAN AMERICAN 1 CURMA CSWNE142437WSPRMC 2.53251.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 4 0 -1.  -1.  -1. 0 8  -1.  -1.24 0 -1.
1860PAN AMERICAN 1-M KRO CNWSE152437WSPRGRS2.53275.  -1.3877.3934.4164.  -1.  -1.4168.4196. 5 0 56.4230.4238. 0 24242.4304.1810224.4
1861HORIZON CO. 1-20 KRE CSESE202437WSPRGRS2.53282.2050.3864.3922.4153.5210.5210.4157.4190. 7 2 55.4192.4237. 0134241.4303.1414 56.4
1862CARTER OIL CO.1 OVERNENESW242441WSPLLML2.53269.  -1.3636.3698.3934.5149.5145.3942.3958. 0 0 -1.3962.4018.10 04032.4074.22 8 -1.4
1863LION CIL CC. 1 TATE  CSWSW172442WGRLLML2.53290.1760.3589.3654.3884.5150.5150.3890.3910. 0 0 -1.3914.3961. 8 83964.3998. 8 8 -1.4
1864CARLOCK 1 WILSON     NWNWNE132501WSP-R  2.51376.  -1.  -1.2367.2558.3082.3082.2604.2630. 0 0 -1.2634.2660. 9 32672.2714. 9 0 -1.2
1865ALLISON 1 WILLIAMS   CSWNW182502WGR-N  2.51405.  -1.2338.2583.2831.3394.3394.2836.2868. 2 0 86.2872.2896. 6 22902.2960. 0 0230.2
1866RUPP AND SIN. 1 JCRGNWNENE102503WSP-R  2.51430.  -1.  -1.2612.  -1.3442.3442.2900.2932. 6 8 -1.2938.  -1.10 02989.3028. 9 0 -1.3
1867NCRA 1 SCHLICKON     SENENE162504WGR-N  2.51486.  -1.2521.2757.3007.3527.3527.3011.3027. 0 0 93.3030.3056. 0 03070.3135. 5 0130.3
1868SCOTT RITCHIE 1 HAINSWNWSW 52505WGR-N  2.51558.  -1.2539.2780.2998.3471.3471.3002.3020. 0 0109.3021.3355. 3 03071.3120. 0 8132.3
1869A.S. RITCHIE 1 POFF NENWSW112505WGR-N   2.51550.  -1.2547.2771.3008.3496.3496.3013.3036. 6 0132.3036.3065. 0 03068.3130. 4 0190.3
1870HUMMON 1 WOODRUFF    CNWNE172505WGR-N  2.51501.  -1.2498.2727.2946.3420.3420.2954.2975. 0 0 70.2975.3012. 6 43022.3077.15 0164.3
1871F & M 1 EDWARDS      NESWNE152506WGR-N  5.01486.  -1.2549.2858.3047.3503.3503.3053.3064. 4 0142.3066.3105. 0 03109.3153. 5 0182.3
1872SUTTON 1 FOWLER      NESWSE252506WGR-LL 5.01446.  -1.2524.2786.2992.3474.3474.2998.3018. 0 0115.3020.3069. 5 03073.3119. 8 0320.3
1873LARI OIL&GAS 2 HORNM CSENE292506WGRLLSC2.51555.  -1.2704.2926.3144.3600.3600.3151.3166. 0 0 75.3170.3208. 0 03212.3260. 6 0320.3
1874STEARNS PET. 1 HURLISWSESE032507WGRNC  2.51586. 227.  -1.3130.3314.3772.3772.3319.3337. 4 0 77.3339.3364. 0 03368.3422.18 0310.3
1875SHAWER-ARMOUR 1 LINSNWNWNE022508WGRNG  2.51613.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 72.  -1.  -1.11 0  -1.  -1. 0 0240.
1876PRATER 1 HYNES       CSWSE212508WGR-N  5.01604.  -1.3062.3277.3445.3812.3812.3452.3468. 0 0 -1.3470.3506. 0 03509.3550. 8 0 -1.3
1877GEAR PET 1 LAYMAN    CSWSW262508WGR-D  5.01571.  -1.2975.3203.3374.3772.3772.3379.3392. 2 0 93.3393.3425. 3 03426.3480.14 0230.3
1878EVANS 1 BREDENSTEIN NENENW 12509WGR-N  5.01676.  -1.3115.3309.3487.3818.3818.3492.3506. 2 0 68.3509.3532. 0 03535.3588. 0 0222.3
1879I.K. HENDRICK 1 RAIL CNWNE152509WGRSCR 2.51666. 330.3128.3328.3504.3841.3841.3508.3536. 3 0 81.3536.3546. 0 03546.3610.16 0320.3
1880ANADARKO 1-A MAUCK  NWSENW222509WGRNDC  5.1658. 323.3136.3343.3503.3832.3832.3506.3524. 2 0 52.3524.3546. 0 03546.3608.13 2270.3
1881SCHERMERHORN 1 DEVENS2SWSW012510WGRLLML 5.1740. 442.3213.3412.3584.3910.3910.3587.3598. 0 0 -1.3600.3617. 8 03617.3680. 8 0 -1.3
1882L.C. SMITHE 1 ZINK  NENENE312510WGRNG  2.51787.  -1.3316.3521.3684.3960.3960.3687.3702. 4 0 78.3705.3732. 8 03732.3778. 6 0224.3
1883A. AINSWORTH 1-B PCCS2S2NL042511WGRNGCS2.51783. 541.3225.3412.3555.  -1.  -1.3560.3572. 0 0 80.3574.3588. 0 03591.3632. 8 0183.3
1884IMPERIAL 1-B DENISTO CSWSW322511WGRNGC 2.51849. 610.3370.3569.3716.3936.3936.3720.3734. 4 0 83.3736.3751. 0 03752.3796. 0 9132.3
1885HILTON DRLG. 1 GAREYNENESE082512WGRNG  2.51850. 700.3394.3570.3724.3940.  -1.3726.3740. 6 0 81.3742.3777. 2 03781.3819. 8 0196.3
1886MUSGROVE DRLG. 3 SLASWSWSW352512WGRLLSP2.51863.  -1.3391.3589.3742.3584.3984.3746.3760. 0 0 96.3762.3776. 7 03776.3819. 8 8168.3
1887PETROL. INC. 1-B SEESESENE062512WGRNG  2.51950. 850.3492.3663.3794.4150.4150.3796.3813. 5 0 73.3816.3827. 0 03829.3870. 7 0300.3
1888HALLIBURTON 1 PRIESSWNENW102513WGRNGC  5.1939. 803.3480.3655.3784.4098.4090.3788.3804. 7 0 74.3808.3819. 8 03821.3858. 010108.3
1889MCKNAB PROD. 3 MCC  NWSWNE302513WGRSPLL2.51965. 835.3546.3733.3868.4202.4202.3871.3884. 0 0 -1.3887.3902. 5 03905.3942. 0 6 -1.3
1890PHILLIPS 1-A SUITER NENESW072514WGRNGC  5.2005.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 55.  -1.  -1. 8 8  -1.  -1. 910 95.
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1891CITIES SER. 1-B NEELNENESE162514WGRN   2.51973.  -1.3467.3628.3764.  -1.  -1.3767.3788.11 0 -1.3791.3808. 9 03808.3854. 418 -1.3
1892SKELLY OIL CO. 2 WILNWNESW272514WGRNG  2.51981. 866.3526.3706.3842.  -1.  -1.3846.3861. 5 0 80.3864.3878. 0 03888.  -1. 2 7 -1.
1893NATL. COOP. 3-A HART CSWSW152515WGRNGC 2.52026. 960.3624.3790.3925.4226.4226.3930.3951.10 0 60.3951.3966. 3 03966.4014. 419132.4
1894KWB OIL 1-A STAMBAUGS2NWSW242515WGRNGC  5.2010. 975.3661.3831.3967.4262.4262.3972.3990. 6 0 74.3990.4007. 0 64007.4051.1110126.4
1895D.R. LAUCK 1 STAMBAU CNENE332515WGRSPLL2.52030.1000.3668.3824.3968.4290.4290.3972.3994.12 0 -1.3997.4010. 0 04012.4062. 314 -1.4
1896D.R. LAUCK 1 MAURINEE2SESE072516WGRNGC  5.2096.1095.3742.3904.4036.4391.4391.4041.4060. 8 0 61.4062.4076. 2 04080.4124. 314188.4
1897D-G-L OIL 1 JOHNSON  CSENW172516WGRNGC 2.52091.1100.3702.3838.3970.4323.4323.3977.3996. 0 6 92.3938.4014. 0 04017.4054. 0 6220.4
1898R.T. LEEPER 4 RUSSEL CSESW262516WGRNG  2.52060.1052.3718.3874.4010.4364.4364.4016.4034. 0 0 51.4036.4050. 0 04052.4108. 014162.4
1899IMPERIAL 1-16 JIPPIESENENE 62517WGR-N-L5.02141.  -1.3829.3969.4111.4506.4506.4114.4130. 0 0 61.4132.4151. 0 04156.4201. 020198.4
1900NORTH AMER 1 INGRAHA CNWNE162517WGR-N  5.02105.  -1.3805.3952.4083.4462.4462.4088.4108. 0 6 99.4110.4125. 0 04129.4170.20 0269.4
1901AURORA 1 HUPP        SWSWSE172517WGR-N  5.02143.1170.3830.3972.4107.4456.4456.4111.4132. 2 0 -1.4135.4155. 4 04160.4200. 4 2 -1.4
1902PICKRELL A-1 INGRAHA CSWSE252517WGR-N  5.02100.1134.3805.3956.4088.4463.4463.4094.4116.10 0 72.4118.4133. 0 04136.4181.1210152.4
1903IMPERIAL 1-11 CURTIS CSWNE112518WGR-N  5.02160.1233.3868.4005.4146.4531.4531.4149.4169. 8 0 48.4171.4189. 0 04193.4236. 314135.4
1904IMPERIAL 1-17 FAIRC NWSESE172518WGR-N  5.02199.1309.3953.4098.4239.4637.4637.4244.4266. 0 6 86.4270.4291. 0 04291.4332. 2 6168.4
1905PICKRELL A-1 NEFF    CSWNE262518WGR-N  5.02172.1277.3911.4052.4188.4574.4574.4192.4213. 6 0 77.4216.4238. 6 04238.4285.26 0137.4
1906PICKRELL 1-C ARENSPA CNESW232519WGR-N  2.52199.1283.3960.4091.4232.4640.4640.4239.4262.10 0131.4266.4290.'4 04290.4323. 7 0192.4
1907BENSON MINERAL 1-364 CNESW362519WGR-G  5.02218.  -1.4008.4146.4296.4771.4771.4302.4326. 5 0110.4334.4362. 0 04362.4398. 014182.4
1908SUNRAY 1 L.BUTLER    CNESE 72520WGR-LL 2.52274.1410.3994.4102.4255.4700.4700.4262.4283. 8 0 77.4286.4307. 5 04310.4364.30 0169.4
1909EDMISTON 1 ALSPAUGH  CNWNE152520WGR-N  2.52239.1383.3986.4109.4256.4689.4689.4261.4286.12 0150.4288.4316. 5 04318.4354. 0 7186.4
1910HONAKER-DAVIS 1 SEBANENWNE 82521WGR-N  5.02238.1458.4018.4125.4286.4752.4752.4291.4314. 6 0102.4317.4337. 0 04341.4384.19 0110.4
1911AMARILLO 5 BUTLER     CNENW332521WGR-D  2.52353.1450.4070.4190.4358.4814.4814.4368.4392. 5 0112.4394.4415. 0 04418.4461. 010152.4
1912OKMAR 1 IMEL         CSENW112522WGR-N  2.52406.1525.4044.4152.4320.4774.4774.4325.4347. 6 0125.4350.4382. 8 04384.4422. 012220.4
1913JONES 1 IMEL         CNWSE172522WGR-N  2.52442.  -1.4082.4190.4368.4830.4830.4375.4396. 3 0128.4400.4422. 0 04426.4468.15 0197.4
1914RAINS AND W. 1 GEISS CSESW262522WGR-N  5.02432.1550.4113.4225.4405.4878.4878.4412.4430. 0 0 78.4434.4459. 0 84465.4515.1716160.4
1915DUNNE 1 WARNER      SESESE 52523WGR-LL 2.52231.1458.3927.4012.4200.4672.4672.4208.4228. 0 0 -1.4231.4265.12 04265.4310. 8 4 -1.4
1916ANCHOR 1 WARNER      CNWSE102523WGR-N  2.52403.1527.4017.4116.4295.4769.4769.4306.4327. 0 0101.4330.4362. 7 04366.4401. 5 0214.4
1917MACK 1 FEIST        NWNWSE322523WGR-N  2.52470.1548.4076.4183.4373.4861.4861.4383.4400. 0 0150.4402.4442. 0124444.4486.12 7230.4
1918MARTIN 1 LEIDIGH     CNESW222524WGR-N  2.52453.1604.4128.4228.4418.4970.4970.4428.4448. 0 0105.4452.4479. 0 04482.4550.46 0252.4
1919STELMAR 1 COTSON     CSWSW282524WGR-N  5.02470.1585.4070.4160.4346.4861.4861.4352.4370. 0 0 83.4373.4402. 0104404.4493.58 0160.4
1920PICKRELL F-1 ENGLISH CSWNW352524WGR-N  5.02497.1574.4035.4187.4374.4889.4889.4384.4404. 5 0132.4409.4442. 0 94444.4507.39 0203.4
1921TERREL 1 MASKUS      CNWNW 12525WGR-LL 2.52452.1570.3998.4095.4268.4785.4785.4273.4299. 0 6125.4302.4332. 0 64334.4393. 630230.4
1922TERREL DRLG. 1 MASKU CNWNW012525WGRLLR 2.52452.1597.4000.4096.4268.4795.4795.4274.4299. 0 6123.4301.4332. 0 04335.4373. 523230.4
1923KINGWOOD 1 CAIN      CSENW182525WGR-LL 2.52613.1712.4128.4232.4403.4908.4508.4411.4432. 0 0 -1.4435.4476. 0144476.4536.24 0 -1.4
1924KINGWOOD OIL 1 ROSE  CNWNW222525WGRR   2.52575.1713.4148.4252.4435.  -1.  -1.4444.4464. 0 0 -1.4466.  -1. 3 8  -1.4517. 0 0 -1.
1925KINGWOOD 1 ROSE      CNWNW222525WGR-LL 2.52575.1687.4148.4252.4434.4558.4998.4445.4465. 5 0 -1.4458.  -1. 0 84520.4572. 012 -1.4
1926HELMERICH 1 DREWES   CSWSW242526WGRR   2.52613.  -1.4158.4260.4441.4954.4954.4450.4471. 0 0 -1.  -1.4519. 0 04522.4598. 0 0 -1.4
1927H & P 1 DREWES       CSWSW252526WGR-G  2.52613.1708.4158.  -1.4442.4954.4554.4451.4472. 0 0 -1.  -1.4519. 0224522.4598. 7 0 -1.4
1928PATRICK 1 SNOWBARGER CNWNW 62528WGR-N-D5.02766.  -1.4070.4154.4325.4864.4864.4336.4363. 4 0128.4366.4391. 0 04393.4456.24 0102.4
1929GEAR PETROL. 1 FINNU CSWSE332529WGRCCP 5.2711.  -1.4038.4125.4306.  -1.  -1.4305.  -1. 0 0 -1.  -1.4357. 0 0  -1.  -1. 0 0 -1.
1930GEAR 1 FINNUP        CSWSE332529WGR-N-D5.02711.  -1.4038.4125.4295.4809.4809.4306.4334. 0 0180.4336.4358. 5 04358.4417.10 4174.4
1931THUNDERBIRD A-1 WART CNESW292530WGR-LL 5.02761.1813.3989.4078.4272.4861.4861.4280.4311. 8 0168.4313.4342. 7 04345.4404. 9 7257.4
1932THUNDERBIRD 1-A WART CNESW292530WSPRGR  5.2761.  -1.  -1.4078.4273.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 0 0 -1.
1933AMOCO PROD. 1-B HICK  SESW162532WGRPCD  5.2919.  -1.3928.  -1.4208.4814.4814.4214.4244. 0 0190.4246.4282. 0 04286.4352.1018257.4
1934MOBIL OIL CO 1 STATE CSENW012533WGRSC  2.52903.1927.3932.3955.4183.4868.4868.4186.4220. 0 0197.4222.4260. 0 04265.4322. 610237.4
1935CITIES SER. 2-C SPRG CNESE082533WSPRMCS2.52552.  -1.3904.3955.4202.4595.4595.4208.4234. 4 0 -1.4238.4277. 0 64288.4345. 812 -1.4
1936HELMERICH 1-A WALKER CSESE072534WSPRGRS2.52551.  -1.3820.3853.4114.4970.4970.4120.4148. 0 0 63.4150.4190. 0 24193.4250. 313 95.4
1937HELM.&PAYNE 1-P URCE CSWSW192534WSPRGRS2.52C01.  -1.3808.3854.4107.4988.4988.4114.  -1. 8 0 -1.4142.  -1. 6704198.4265.1021 -1.4
1938THUNDERBIRD 1-B REEV CSWNE322534WGRNGC  5.2557.1880.3837.3886.4152.5002.5002.4156.4181.10 0 53.4184.4219. 0 74223.4285.1616112.4
1939BRADEN DRLG. 1 CAPFB CNESE182535WSPRI  2.52C28.  -1.3783.  -1.4065.4961.4561.4072.4098. 6 0 -1.4100.4140. 0 04142.4208.1013 -1.4
1940NATIONAL OIL 1 WHITE CSWSE272535WGRNC  2.52C08.1890.3824.3881.4127.5034.5034.4134.4159. 8 0 66.4162.4230. 0 04203.4283.2414320.4
1941PAN AMERICAN 1 CAPFB CNENE182536WSPRGRD2.53036.  -1.3628.3676.3894.4771.4771.3895.3918.12 0 50.3920.3956. 0 63960.4024.1814222.4
1942PAN AMERICAN 1-C SPE CNESW282539WSPRGRS2.53329.  -1.3997.4058.4305.5398.5398.4307.4328. 0 0 60.4330.4370. 0 44375.4399. 0 0 77.4
1943W.J. COPPINGER 1 ANI CNWSW192541WGRLLR 2.53609.2026.3882.3936.4190.5464.5464.4194.4211. 0 0 61.4213.4268. 0 04271.4308. 011 81.4
1944MUSGROVE 1 BRAY      NWNWNW262541WGRLLML2.53542.2040.3845.3930.4204.5419.5419.4208.4231. 0 0 -1.4231.4280. 0 04283.4334. 0 0 -1.4
1945UNITED CARBON 3 HELF  SWSE062542WGRLLML 5.3600.  -1.3764.3827.4061.  -1.  -1.4066.4094. 4 0 -1.4099.4136. 0 04142.4175. 0 0 -1.4
1946ANTARES OIL 1 M. HCR CW2E2142542WGRSPRC 5.3640.2038.3896.3946.4187.5514.5514.4193.4218. 0 0 78.4221.  -1. 0 04265.4298. 0 8 94.4
1947GLEN RUPE 1 TITUS    CSWSW042619WGRNGC 2.52228.1320.4014.4154.4302.4718.4718.4308.4334.11 0107.4337.4354. 0 04357.4399.11 6130.4
1948PICKRELL 1-B KING    CSESE262619WGRLLMC2.52221.1281.4030.4177.4339.4783.4783.4347.4369. 3 0 -1.4373.4386. 6 04390.4439. 017 -1.4
1949LEE PHILLIPS 1 LEWAL CNENE322619WGRNGC  5.2252.1300.4058.4205.4377.4822.4822.4383.4407. 0 9 88.4410.4432. 0 04436.4474.10 8104.4
1950VOYAGER PETR. 1 MANNSESESE022620WGRNG   5.2251.1294.4008.4136.4298.4750.4750.4303.4324. 8 0 81.4327.4350. 0 04352.4398.1212125.4
1951SINCLAIR OIL 1 QUASEW2NWNW182620WGRLLR 2.52253.1311.3998.4121.4286.4750.4750.4292.4316. 0 2 99.4320.4344. 6 44347.4389. 7 7167.4
1952MACK OIL CO. 1 BANK  CSENE272620WGRNLLR2.52263.1283.4040.4174.4343.4822.4822.4351.4376.12 0 94.4379.4402. 0 04405.4458. 6 7132.4
1953OXFORD EXP. 6-6 TCALSESENW062621WGRNGC  5.2269.1440.4097.4215.4395.4913.4913.4404.4427. 4 0104.4429.4450. 0 04452.4504.1014168.4
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1954WALTERS DRLG. 1 RUED CNESL062621WGRNLL 2.52338.1413.4057.4175.4352.4818.4818.4359.4382. 4 0143.4383.4408.10 04409.4454.1013176.4
1955OKMAR OIL CO. 1 KLRT CSESE132621WGRNGC 2.52254.1316.4009.4137.4304.4762.4762.4310.4333. 6 0100.4330.4359. 6 04362.4403. 010120.4
1956MERLIN ENERGY 1 PEINNENENE322621WGRSPR 5.2316.1354.4055.4183.4358.4823.4823.4366.4390. 6 0104.4393.4420. 4 04424.4468. 012175.4
1957COASTAL OIL 1 STICKN  SENE042622WGRCPD 5.2416.1508.4116.4227.4414.4888.4888.4422.4440. 0 0105.4444.4466. 0 04469.4519.17 0 60.4
1958ASHLAND OIL 1 TAYLOR CNESW062622WGRLLR 2.52509.  -1.  -1.  -1.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 017  -1.  -1. 6 4 -1.
1959D.C. SLAWSON 1-D ELE CNWNE142623WGRNR  2.52432.1512.4104.4213.4402.4946.4946.4408.4434. 9 0 72.4436.4458. 7 04458.4525.29 4352.4
1960LADD PETROL. 1 KLIES CSESW292623WGRCRS 2.52475.1557.4142.4255.4442.4962.4962.4449.4466. 0 0135.4468.4518.12154518.4599.55 0198.4
1961PICKRELL 1-A FARMLAN   CSE222624WGRNGC  5.2546.1660.4217.4326.4524.5023.5023.4531.4549. 0 0115.4552.4581. 6 04586.4650.1210210.4
1962KEWANEE OIL 1 CONVERSWSWSW102625WGRN   2.52626.1746.4249.4356.4548.5100.5100.4556.4575. 3    -1.4578.4618. 4 34618.4684.1224 -1.4
1963D.C. SLAWSON 1-A SFN CNWNE142629WGRNGC  5.2719.  -1.4086.4145.4350.4883.4883.4357.4386. 0 7130.4388.4414. 0 04414.4484.32 5210.4
1964CONOCO 1 C.S. LAIRD E2E2SW152630WGRLLML2.52798.1870.4090.4145.4358.4987.4987.4364.  -1. 0 8 -1.  -1.4431. 0124434.4491. 5 0 -1.4
1965ANADARKO 1-A CHONIA   NWSE232631WGRSC   5.2830.1903.4086.4140.4363.  -1.  -1.4373.4398. 0 0130.4400.4433. 0 04436.4509. 011136.4
1966YONNGBLOOD 1-A KLLYS CNENE292631WSPRGRS2.52834.  -1.4014.4065.4296.4903.4903.4304.4331. 0 0225.4334.4369. 3 04372.4446.16 7256.4
1967PAN AMERICAN 1 SOLZE  NWN.102632WGRCCP  5.2855.  -1.3962.4005.4262.4945.4945.4269.4295. 0 0187.4237.4332. 0 04434.  -1.1710217.4
1968N. APPLEMAN 3 OHMES  CSENE142632WSPRMCS2.52907.  -1.4054.4088.4344.5008.5008.4347.4378. 0 0 -1.4382.4414. 0 04420.4500.3114 -1.4
1969R. MAGUIRE 1 FINNLP  CSWSW282632WSPR    2.52869.1896.4006.4056.  -1.  -1.  -1.  -1.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 0 0 -1.
1970MORRISON 1 MOWURAY   CSESW082633WSPR    2.52920.  -1.3914.3960.4228.5054.5054.4231.4252. 0 0 67.4255.4292. 0 04296.4377. 0 0 88.4
1971M. MAHONEY 1 STONE   CSENE182633WSPR    2.52937.  -1.3926.3976.4244.5080.5080.4246.4270. 6 0 -1.4272.4304. 0 04306.4386.2720 -1.4
1972PAN AMERICAN 1 KISAE CNWSE362632WSPRGRS2.52909.  -1.3997.4046.4303.5052.5052.4313.4337. 3 0 -1.4340.  -1. 4 04353.4394. 4 0 -1.4
1973MCKNAB&LINDSAY 3 DEVNESWSE192634WSPRMC 2.53C07.1890.3884.3932.4202.5056.5056.4206.4232. 7 0 -1.4235.4279. 3 04286.4344.54 0 -1.4
1974H.& PAYNE 1-C JONES  CSWNW282634WSPR    2.52980.1878.3876.3924.4188.4984.4984.4198.4220. 0 8 -1.4225.4264. 0 04268.4341.60 0 -1.4
1975WHITE EAGLE 9-A USA  CNEN.322634WGRN    2.52591.1880.3862.3909.4178.4960.4960.4185.4206. 9 0 70.4208.4258. 8 64264.4325. 827145.4
1976H. & PAYNE 1 MOBIL   CSWNE022635WSPRGRS2.53022.1890.  -1.3918.4186.  -1.  -1.4186.4221.11 0 65.4222.4262. 4 64265.4330.2213168.4
1977D. & FITZG. 1-12 USA CNESW122635WGRNGC  5.2993.1867.3841.3890.4156.4999.4995.4163.4201. 7 0 67.4204.4231. 0 04235.4297.1416 96.4
1978AIKMAN BROTH. 1 WHIT CNESE162635WSPRGRS2.53050.1879.3898.3895.4154.5098.5098.4162.4182. 3 0 84.4185.4230. 4 74233.4293.1012240.4
1979KAN-NEB. CO. 8-4 HCM  SENW042636WGRCCNP 5.3C55.  -1.3680.3726.3955.4842.4842.3959.3992.10 0 65.3992.4022. 0 04026.4091.1216207.4
1980SHELL OIL CO. 1 AREA CNESW272637WSPRGRS2.53094.  -1.3760.3812.4085.5227.5227.4087.4107. 0 4 -1.4109.4159. 0 04163.4213.10 6 -1.4
1981PAN AMERICAN \ SPEAC CSWNE042638WSPRGRS2.53235.  -1.3817.3862.4126.5333.5333.4131.4150. 0 0122.4150.4196. 0 04200.4252. 0 0240.4
1982TESORO PETRCL. 1 SPI  SWN-192639WGRCC   5.3340.  -1.3806.3862.  -1.5354.5354.  -1.4126.21 3 86.  -1.  -1. 0 0  -1.4257. 012 34.
1983COPPINGER 1 KRITZPIRNWNWSE252640WGRLLPL2.53357.  -1.3932.3896.  -1.5488.5488.  -1.  -1. 0 0 -1.  -1.  -1. 0 0  -1.  -1. 0 0 -1.
1984CHAMPLIN 1 A.D. EYER CSENW062642WSPRGRS2.53458.  -1.3648.3705.3928.5361.5361.3940.3958. 0 0 44.3960.4008. 0 04012.4044.12 0120.4
1985GEAR PETROL. 1 HERRMANNWNWNW112719WGRNGC 5.2252.1262.4054.4212.4375.4812.4812.4383.4405. 6 0 40.4407.4425. 0 94428.4472. 810104.4
1986BEARDMORE 1-5 DAVIES CNESW172719WGRNC   5.2260.1248.4051.4210.4370.4807.4807.4380.4399. 4 0105.4403.4428. 6 04431.4471.10 7122.4
1987PICKRELL 1-B TAYLOR  CSENW352719WGRSPR 2.52259.1218.4060.4224.4382.4829.4829.4388.4409. 0 0 84.4412.4438. 4 04440.4478.10 6138.4
1988BARBARA OIL 1-F EINS CSWNW072720WGRN    2.52295.1317.4080.4216.4390.4842.4842.4398.4420. 8 0 80.4423.4455.16 04458.4495.12 6112.4
1989ROLAND HONC 1 ZIEGLE CNWSW282720WGRNG  2.52312.1310.4115.4268.4434.4888.4888.4439.4459. 0 3 86.4462.4492.15 04495.4545. 7 6158.4
1990MULL DRLG. 1 SCHUPAC CNWNE102721WGRNLL 2.52295.1347.4082.4213.4392.4860.4860.4397.4420. 6 0117.4423.4450. 3 24454.4501.22 6146.4
1991D.C. SLAWSON 1-C EOL CNWSW172721WGRNLL  5.2381.1438.4151.4284.4465.4951.4551.4474.4496. 2 0121.4499.4518. 5 04518.4569. 610210.4
1992D.C. SLAWSON 1-A HIR CSWSE232721WGRNSPR 5.2316.1310.4102.4248.4425.4900.4900.4436.4459. 9 0112.4463.4488. 5 34492.4543.1210252.4
1993RAYMOND OIL 1 SMITH  CSESE102722WGRLLSP2.52420.1470.4185.4316.4502.5002.5002.4510.4530. 6 0106.4534.4560. 2104560.4626. 522240.4
1994AIKMAN 1 C. ENGLISH  CSEN.132723WGRLLR 2.52436.1520.4192.4319.4523.5018.5018.4532.4552. 0 0 -1.4555.4598. 0 64601.4651. 9 5 -1.4
1995TEXAS OIL&GAS 1-F AN CSESE222724WGRCPC  5.2511.  -1.4206.4328.4524.5060.5060.4532.4550. 0 4139.4552.4587. 0 04592.4650.10 9195.4
1996MACK OIL CO. 1 WOCES CNESE232724WGRNLLP2.52507.1530.4208.4325.4537.5070.5070.4544.4560. 4 0132.4563.4598. 0 64602.4665. 020195.4
1997D. FITZGERALD 1 BARNNENENW352724WGRNGC  5.2522.1500.  -1.4348.4543.5074.5074.4551.4564. 0 0124.4566.4608. 0 84610.4666. 014140.
1998TUCCA PETR. 1 EASTPA CSENW202729WGRCSR 2.52774.1800.4152.4210.4460.5012.5012.4462.4474. 0 0 40.4474.4490. 9 04492.4539. 0 0 87.4
1999F. SEABOARD 1 GONCEH CNWN 172730WSPRGRS2.52789.  -1.4133.4154.4398.  -1.  -1.4406.4429. 0 0145.4432.4468. 4 04471.4538. 6 0240.4
2000ZENITH DRLG. 1 NUSSE  SWN.102731WSPRLL  5.2822.  -1.4378.4135.4371.5068.5068.4383.4409. 4 0 -1.4410.4455. 0 04460.4496.12 0 -1.4
2001H.& PAYNE 1 WINGER   CSWSW262731WSPRGRS2.52843.  -1.4036.4153.4395.5154.5154.4412.4433. 4 0 72.4435.4440. 5 04484.4556. 9 6228.4
2002SUN OIL CO. 1 N. HAR CSWNE312731WSPRCS 2.52872.  -1.4151.4204.4466.5173.5173.4474.4502. 0 0 -1.4504.  -1. 0 0  -1.4562. 0 0 -1.4
2003CHAMPLIN 1 BARHEL    CSWSE172732WGRLLML2.52890.1872.4039.4090.4345.5134.5134.4355.4382. 0 0 -1.4386.4434. 0 04439.4514. 816 -1.4
2004FERGUSON OIL 1 THOMP CSESW282732WSPRCS 2.52516.1920.4084.4134.4400.5181.5181.4406.4433. 6 0 -1.4436.4482. 0 04486.4564.26 0 -1.4
2005H.& PAYNE 3-C U.S.A.N2SWNE062734WSPRGRS2.53C15.1913.3887.3930.4155.5048.5048.4207.4226. 0 0 -1.4229.4279. 0 04283.4352. 0 0 -1.4
2006WHITE EAGLE 3-32 JCN CSWNW092734WGRN    2.53001.1840.3847.3898.4178.4995.4995.4189.4208. 0 0 -1.4210.4261. 4 34268.4337. 620 -1.4
2007H.& PAYNE 1-F U.S.A. CSENE152734WSPRGRS2.52986.  -1.3906.3952.4232.5052.5052.4243.4264. 0 0 -1.4267.4317. 0 04322.4396. 7 0 -1.4
2008M. MAHONEY 1 RIXON   CSESE262735WSPRGRD2.53068.1892.4002.4048.4327.5368.5368.4342.4365. 0 0 50.4368.4418. 0 24422.4500.1620222.4
2009PLEA. PRAIRIE 1 PCLL CSESE362735WSPRMC 2.53072.1903.4005.4050.4358.5412.5412.4368.4383. 4 0 -1.4392.4448. 0 54452.4538.17 7 -1.4
2010CITIES SER. 1-B CCRL CSENW112736WGRCN  2.53102.1872.3900.3947.4232.5314.5314.4238.4258. 7 0 38.4261.4310. 0 84317.4390.1318258.4
2011COLUMBIAN 2-B HOFFMA CSENW162736WGRLLSP2.53140.1877.3892.3943.4216.5322.5322.4222.4254. 0 7 -1.4257.4324.11144327.4412.1518 -1.4
2012COLUMBIAN 2-B E.ADAM CNESW362736WARLLR 2.53153.1923.3996.4045.4316.  -1.  -1.4325.4356.14 8 -1.4359.4430. 6 84434.4526.2116 -1.4
2013SHELL OIL CO. 1 AACE CSWNE072737WSPRGRS2.53083.1754.3755.3810.4094.5234.5234.4098.4122. 6 0 -1.4126.4189. 5 04191.4245. 012 -1.4
2014MOBIL OIL 1 1. SMITHNWSESE132737WSPRGRS2.53064.  -1.3782.3831.4116.5190.5190.4122.4144. 0 3 40.4147.4212. 0 84216.4298.1314222.4
2015PAN AMERICAN 1-D KII CSWNE122739WGRLL  2.53179.1756.3730.3805.4063.5306.5306.4068.4088. 5 0 -1.4090.4154. 0 94157.4234.1428 -1.4
2016PAN AMERICAN 1 HELML CSWNE212739WSPRGRS2.53197.  -1.3724.3796.4045.  -1.  -1.4051.4068. 0 0 90.4071.4148. 0 64152.4202. 712 72.4
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2017DAV.&DAV. 1-1B COLLI CNWSE132740WSPRCD 2.53276.  -1.3666.3716.3986.5316.5316.3988.4010. 0 0 -1.4010.  -1. 0 04108.4147.11 7 -1.4
2018AN-SON PETR. 1 RANEY   CNE152741WSPR    2.53327.  -1.3646.3712.3974.5305.5305.3978.4002. 0 0 -1.4006.4076. 0 34076.4143.23 4 -1.4
2019MUSGROVE 1 J.D. COCK   CSE182741WSPRCS 2.53397.  -1.3662.3720.3978.5390.5390.3980.4006. 8 0 -1.4006.4072.12 74074.4121.12 0 -1.4
2020BURK ROYALTY 1 LOBE  CSWSW242741WSPRGRC2.53327.  -1.3669.3720.3988.5256.5256.3991.4016. 6 0 63.4018.4088. 0 54090.4136. 4 0270.4
2021MUSGROVE 1 COCKRUM   CSWNE162742WSPRMC 2.53455.  -1.3647.3712.3991.5397.5397.3996.4020. 0 0 -1.4020.4053. 0 04055.4104.13 4 -1.4
2022MUSGROVE 1 MERRILL     CNW272742WSPRS  2.53462.  -1.3660.3722.  -1.  -1.  -1.3990.4007. 2 0 -1.  -1.  -1. 3 34034.4071. 0 0 -1.4
2023AMARILLC OIL 1 CULLI CNWSE022743WGRSC  2.53542.  -1.3698.3758.4016.5502.5502.4020.4039. 2 0 75.4042.4072. 0 04074.4111. 0 0 72.4
2024PETROL. INC. 1-E ROB CNENW152819WGRNR  2.52275.1196.4106.4273.4443.4892.4892.4449.4467. 4 0 70.4470.4490. 0 04492.4535. 610124.4
2025J.M. RICHARC. 1 SEAC CSENE232819WGRNCR 2.52262.1177.4094.4266.4435.4863.4863.4440.4460. 8 0144.4463.4483. 0 04486.4537. 8  256.4
2026PICKRELL 2-A EURINGT CNENW362819WGRNGC  5.2289.1222.4150.4328.4488.  -1.  -1.4494.4516. 6 0 87.4520.4541. 0 04543.4580. 9 0128.4
2027OKMAN OIL 1 BRENSING CNENE092820WGRNCC  5.2319.1312.4141.4305.4475.  -1.  -1.4485.4502. 4 0116.4506.4531. 6 04534.4585. 8 4220.4
2028PETROL. INC. 1-C SHE CNENE112820WGRNR   5.2293.1260.4110.4273.4438.4876.4876.4445.4466. 6 0140.4469.4498. 0 84500.4558.10 5210.4
2029RAINS&WILLIA. 1 SLCA CSESE272820WGRNGSC2.52246.1279.4182.4360.4524.4975.4975.4531.4551. 8 0127.4555.4588. 6 04595.4650. 0 0220.4
2030TEXAS OIL&GAS 1 ALST  N2NW142821WGRDPC  5.2253.1339.4150.4304.4493.4973.4573.4499.4518. 4 0122.4520.4550. 0 04550.4618.26 0240.4
2031TEXAS OIL&GAS 1-B MA  N2SW142821WGRPC   5.2282.  -1.4188.4347.4531.5004.5004.4537.4557. 6 0128.4560.4580. 0 04587.4657.2511265.4
2032HALLIBURTON 2 CHALFO   CNE362821WGRCCP  5.2233.1287.4157.4330.4511.5019.5019.4518.4537. 4 0240.4540.4568. 0 04570.4640.15 4240.4
2033ISERN PET. 1-A KAY    CSENE362822WGRGNC 5.2449.1407.4308.4481.4664.5179.5179.4671.4691. 4 0167.4692.4724. 4 24727.4801. 328198.4
2034FIVE NATION 1 COPELANWNWNW252823WGRGNC 2.52486.1484.4298.4449.4644.5166.5166.4650.4666. 0 0120.4669.4722.10214724.4798.1829194.4
2035KEWANEE OIL 1 BURNETSWSESW222825WGRLLN 2.52624.1641.4328.4450.4656.5185.5185.4661.4678. 0 0 -1.4678.4729. 5 94729.4793. 619 -1.4
2036HORIZON&OZARK 1 VOTH CNESW092829WGRLLSP2.52812.  -1.4194.4256.4506.5128.5128.4506.4533.11 0 -1.4536.4546. 4 24567.4602. 3 0 -1.4
2037MOBIL OIL CO. 1 HARR CSWNW242829WSPRGRS2.52793.1821.4223.4282.4530.5118.5118.4534.4560.11 4 67.4564.  -1. 0 04615.4680.23 0108.4
2038BEARDMORE 1 YEAGER    CNENE202830WSPRGRS2.52810.1777.4106.4168.4412.5198.5198.4421.4448. 8 0160.4452.4498. 4 44500.4581. 811240.4
2039ANADARKC 1-A CONVERS  SWNE112831WGRCP   5.2883.1883.4156.4215.4468.5150.5150.4474.4499.11 0130.4501.4550. 0 04554.4630.1112250.4
2040JONES&PELLOW 1 HAINL CSENW292831WSPRGRC2.52921.  -1.4144.4197.4470.5194.5194.4477.4506. 9 0180.4508.4562. 8 04566.4642.16 4248.4
2041FALCON DRLG. 1 MEAIR CSENW182832WGRLLSP2.52961.1898.4120.4171.4445.5298.5298.4452.4485. 9 0 -1.4488.4556. 5144561.4618.14 0 -1.4
2042WALTER KUHN 1 MASCNE CSWSW302832WSPRGRS2.52544.  -1.4098.4153.4436.5326.5326.4444.4481.16 0 -1.4484.4549. 0124554.4630.10 6 -1.4
2043SIDWELL OIL 1 ORTH    CSWSW212833WSPRGRS2.52579.  -1.4102.4156.4438.5378.5378.4446.4476. 0 0164.4479.4543. 7 84546.4616. 5 0212.4
2044PAN AMERICAN 1-G WAT CNESW262833WSPRCRS2.52558.  -1.4084.4135.4422.5310.5310.4428.4464.12 0145.4466.4523. 0164531.4610. 814240.4
2045M. MAHONEY 1 STEWART CNESW302833WGRCPD  5.2977.  -1.4041.4091.4371.  -1.  -1.4376.4408. 7 0155.4411.4470. 5104474.4548.10 0292.4
2046W.J. COPPING. 2 CLEO CNESW082834WSPRCRS2.53070.  -1.4046.4094.4368.5411.5411.4372.4398. 0 0 95.4405.4450. 0 94464.4536.1416220.4
2047W.J. COPPING. 1-A HU CWWNE222834WGRSPR 2.53032.  -1.4028.4078.4347.5384.5384.4354.4379. 8 0 83.4383.4443. 4104446.4516.18 9155.4
2048G.B. MCCLEL. 1 MCCOY CSENE322834WGRLLSP2.53019.1870.4016.4065.4234.5256.5256.4343.4366. 0 0 98.4369.4426.11 94430.4510.1612216.4
2049CITIES SER. 2-A KAY   CSWNW212835WSPRGRC2.53079.1870.4006.4052.4352.5470.5470.4356.4378. 8 0128.4381.4434. 0104440.4528.2718215.4
2050MOBIL OIL CO. 1 LULA CNWNW052836WSPRGRS2.53088.  -1.3880.3926.4220.  -1.5095.4224.4249. 4 0 -1.4252.4310. 0124312.4399.2014 -1.4
2051CITIES SER. 1-C HARP CNESW132836WGRCPD  5.3095.  -1.3982.4038.4325.  -1.  -1.4332.4353. 0 0 80.4355.4413. 3 04417.4504.2119171.4
2052CITIES SER. 4-B DAVA  NWNW132836WGRCPD  5.3099.1854.3966.4024.4310.  -1.  -1.4313.4338. 8 0 97.4340.4398. 3 84402.4486.1517235.4
2053ANADARKO 1-A CASSITY CSENW132837WGRSPR 2.53000.  -1.3759.3812.4091.5320.5320.4094.4116. 8 0 57.4120.4192. 8154198.4267.1115219.4
2054PAN AMERICAN 1 SCHAR CNWSE232837WSPRGRS2.53077.  -1.3779.3841.4124.5494.5494.4128.4148. 4 0 -1.4151.4220. 8144226.4302.1119 -1.4
2055PAN AMERICAN 1-H CLE CNESW082839WSPRGRS2.53199.1740.3726.3774.4038.5320.5320.4042.4068. 0 5 -1.4071.4138. 6104152.4222. 028 -1.4
2056MILLIARC 1 BATTERTON  NENW052442WGRCP   5.3516.  -1.3670.3732.4000.5538.5538.4003.4026. 0 0 69.4026.4064. 4 04069.4130. 0 6 45.4
2057AMPECO 1 COCKREHAM    NESE122443WGRCP   5.3553.  -1.3650.3714.3984.  -1.  -1.3988.4028. 0 0 61.4028.4047. 0 04050.4093.15 0 96.4
2058GULF OIL 1 LAPKIN    NWNWSE132319WGRLLML2.52345.  -1.4257.4445.4613.5114.5114.4620.4642. 9 0 -1.4645.4672. 3 44674.4724. 4 6 -1.4
2059LAUCK&TEXAS 1-H MILLNWNWNE222315WGRNG   5.2353.1286.4258.4454.4616.5060.5060.4621.4639. 4 0120.4645.4668. 0 04671.4731.12 0240.4
2060TEXAS OIL&GAS 1 MANKA-NWSE062320WGRCPD  5.2255.1348.4249.4419.4600.5067.5067.4609.4627. 4 0190.4632.4663. 0 04666.4732. 6 4127.4
2061TEXAS OIL&GAS 1-C HI   CN2162320WGRCP   5.2399.  -1.4283.4460.4632.5101.5101.4637.4654. 0 0130.4657.4689. 0 04692.4780. 612300.4
2062TIPE PETROL. 1 JAY-H CNWN 072921WGRLLSP2.52413.1358.4256.4424.4616.5121.5121.4624.4641. 0 0167.4643.4679. 3 44683.4759. 6 0311.4
2063IMPERIAL OIL 1 FLETC   CSE292921WGRNR   2.52414.1450.4338.4590.4772.5297.5297.4778.4801. 5 0210.4803.4840. 5 04840.4921.1921210.4
2064DAY PETROL. 1 DARST   CNESW262322WGRNG   2.52420.1370.4333.4562.4715.5236.5236.4729.4746. 0 0158.4749.4775. 4 74802.4852. 020214.4
2065O.A. SUTTON 1 MESCHE CSENW072923WGRNGC  5.2523.1524.4320.4466.4675.5231.5231.4684.4703. 0 0137.4732.4740. 9 84742.4810. 022130.4
2066TENNECO OIL 1 UIHNEY CNWSW192923WGRNCC 2.52534.1518.4352.4506.4722.5262.5262.4728.4747. 0 0174.4747.4792. 4 04796.4860. 419140.4
2067LEBEN DRLG. 2 MCCCAN CNWNE342925WGRNSPR2.52582.  -1.4354.4508.4730.5275.5275.4737.4749. 0 0111.4749.4794. 3 54794.4877.1626243.4
2068PAN EASTERN 1 GAMBLE CSWSE222928WGRCP   5.2705.  -1.4220.4302.4562.5191.5191.4572.4593. 5 0168.4596.4633. 6 04637.4686. 0 0 88.4
2069KING RESOU. 1-23 NORSESESE232923WSPRGRS2.52768.  -1.4167.4237.4483.5273.5273.4487.4516. 9 0150.4518.4575. 0 34580.4651. 7 0240.4
2070TEXACO INC. 1 DAVEAP CSENW352930WSPRSGR2.52793.  -1.4216.4288.4548.5266.5266.4558.4582. 5 0132.4582.4640. 4129644.4705.14 6185.4
2071JONES&PELLOW 1 WEDELNWNWNW152931WSPRGRP2.52863.  -1.4148.4212.4484.5264.5264.4490.4512. 0 4106.4514.4557. 0 04560.4643. 016211.4
2072PAN AMERICAN 1 KLLMA CSWNE202932WSPRGRS2.52917.  -1.4110.4168.4465.5346.5346.4478.4498. 0 0208.4505.4560. 0 04562.4633. 0 0320.4
2073CITIES SER. 2-B UARU CNENW072933WSPRGRP2.52963.  -1.4050.4100.4383.5256.5356.4389.4420. 2 0130.4423.4486. 6 84492.4563.12 0237.4
2074AMOCO 1 S.G. HALL     CSESE282933WGRCPD  5.2954.  -1.4071.4129.4414.5346.5346.4420.4456.12 0166.4459.4520. 5 94526.4605. 7 0270.4
2075ASHLAND 6 KOENIG      CNWSE042934WGRCPC  5.3005.  -1.3967.4018.4293.  -1.  -1.4297.4327. 6 0135.4329.4390. 6104394.4474.14 0252.4
2076ASHLAND 5-IU O. RAY  CNWSW212934WSPRGRD 5.2996.  -1.3979.4039.4314.5309.5309.4319.4356.20 0160.4359.4418. 0 84410.4504. 5 0300.4
2077UNITED PROD. 4 RAY    CNWNE212934WGRN    2.52982.1816.3982.4042.4322.5308.5308.4328.4360. 5 0 -1.4364.4418. 0 94421.4506. 6 5 -1.4
2078PAN AMERICAN 1 GOERT CNWSE052938WSPRGRS2.53140.  -1.3809.3862.4146.5564.5564.4151.4166. 0 0 -1.4172.4241. 0174246.4336. 822 -1.4
2079PAN AMERICAN 1-E JUL CSENW232940WSPRGRS2.53261.  -1.3694.3762.4032.5358.5358.4036.4068. 2 0 42.4072.4129. 0 04148.4181. 510146.4
```

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2080PAN AMERICAN 1 DYCHE  SENW362940WSPRGRS2.53244.   -1.3708.3775.4053.5434.5434.4058.4086. 8 0 72.4088.4149. 0 04152.4214. 512106.4
2081CHEROKEE 1 WILKERSON   CNW312941WSPRGRP2.53437.   -1.3582.3648.3930.5386.5386.3934.3948. 0 0 78.3952.3988. 0 03978.4060.14 0 98.4
2082TILCO OIL 1 MEYERS   CSESW032942WGRNCR 2.53458.1560.3608.3671.3934.5424.5424.3941.3961. 4 0176.3965.4014. 0 04018.4086. 0 0150.4
2083THE NATIONAL 1 BILBE CNWSW182942WGRNGC  5.3548.   -1.3633.3705.4003.5542.5542.4038.4062. 4 0 70.4065.4091. 0 04103.4132. 3 7 68.4
2084B.M.G. INC. 1 MILLER CSESW342943WGRSC   5.3634.   -1.3565.3642.3930.5517.5517.3988.4013. 0 0 58.4020.4052. 0164055.4100. 8 6 76.4
2085ANADARKO 4-B ROGERS   SESW093019WGRCS   5.2268.   -1.4222.4438.4602.5055.5055.4606.4631.11 0 91.4635.4661. 0 64664.4732. 9 0177.4
2086PETROL. INC. 1-J WAR CNWSE253019WGRNRC  5.2223.1166.4239.4440.4608.5078.5078.4614.4635.10 0146.4637.4661. 6 04661.4723.12 0218.4
2087JONES-GEBERT 1 PRICE CNENW063020WGRSPNR 5.2371.1338.4358.4533.4708.5218.5218.4715.4734. 0 0151.4738.4779. 4 04786.4848.1416328.4
2088D-N-D DRLG. 1-A HLCK CNWNW203020WGRN    5.2295.1270.4322.4517.4698.5194.5194.4705.4727. 0 0178.4730.4772. 0 04784.4832. 8 0320.4
2089G.R. JONES 1 HAGENBU   CSLOH3021WGRNGC  5.2320.   -1.4302.4497.4689.5233.5233.4695.4718. 6 0144.4726.4768. 0 04776.4842.12 0276.4
2090IMPERIAL 1-11 BRENSI CSWSE113021WGRGCN  5.2260.1320.4352.4548.4730.5252.5252.4736.4758. 6 0164.4760.4802. 9 04805.4886. 6 0324.4
2091PICKRELL 3-B HALLING CSESW143022WGRNR   5.2352.1350.4347.4527.4727.5327.5327.4731.4759. 7 2117.4760.4807. 8 04812.4889.33 0210.4
2092MUSGROVE DRLG. 1 FYL CNWNW243023WGRSPLL 5.2455.1433.4394.4571.4775.5341.5341.4782.4808. 8 0 -1.4810.4858.16204865.4946. 013 -1.4
2093PICKRELL 1-D ALLEA   CNWNW333023WGRNGC  5.2516.1487.4460.4638.4858.5392.5392.4863.4882. 0 0103.4883.4931. 5 04936.5020.20 0216.5
2094D.G. HAMILTON 1 SHELLSWSWSW033024WGRNRSP 5.2547.   -1.4368.4528.4734.5309.5309.4740.4765. 9 0168.4767.4802. 6144805.4895.1022216.4
2095SUN OIL CO. 1 ESPLLA CNESW223024WSPRGR 2.52526.   -1.4394.4565.4778.5359.5359.4783.4797. 0 0 91.4797.4835. 4104837.4942.143024C.4
2096PICKRELL 1-C ENGLISH  NWSE333024WGRNGC  5.2559.1535.4470.4643.4849.5481.5481.4855.4868. 0 0 42.4870.4918. 0 74922.5019.10 6185.5
2097SUN OIL CO. 1 LATZKE CNWSE163025WSPRGRS2.52573.   -1.4368.4522.4747.5324.5324.4754.4766. 0 0 57.4769.   -1. 0 44830.4900. 5 9240.4
2098O.A. SUTICA 1 LEWIS   CNWSE273025WGRNGC  5.2556.1530.4355.4513.4742.5318.5318.4747.4762. 2 0 67.4764.4807. 4124812.4915.1225210.4
2099BROOKS HALL 1 BEESON CNWSE313025WGRCRS 2.52596.1611.4378.4529.4758.5365.5365.4763.4776. 0 0 75.4777.4799.15 04832.4904. 326235.4
2100BURK ROYALTY 1 ELAND CNWNE303026WSPRCS 2.52509.   -1.4256.4388.4608.5247.5247.4616.4639. 0 0 -1.4639.4684. 9 84692.4750.2913 -1.4
2101BURK ROYALTY 1-A HIL CNWSE343026WSPRCS 2.52545.   -1.4324.4472.4695.5317.5317.4704.4722. 0 0 -1.4722.4762. 6114764.4855. 7 0 -1.4
2102PRICE EXPL. 1 COPEAH     SE343027WGRPDC  5.2472.   -1.4223.4354.4578.5255.5255.4582.4601. 3 0 45.4604.4649. 0 64654.4724.26 0113.4
2103NATIONAL OIL 1 SCHPI CSWSE203029WGRPCC  5.2774.   -1.4307.4375.4655.5345.5345.4668.4696.11 0112.4699.4759. 0 64764.4822. 3 4270.4
2104CITIES SER. 1-H GRIF CSWSE233032WGRS    5.2861.   -1.4148.4214.4503.5388.5388.4509.4536. 3 0160.4538.4606. 3 44610.4669. 8 0215.4
2105PAN AMERICAN 1 HOBEL  NESW153033WSPRGRS2.52558.   -1.4030.4152.4438.5390.5390.4444.4480.16 0128.4484.4548. 0144553.4644.16 0200.4
2106PAN AMERICAN 1-C EIA CSWNE173033WSPRGRS2.52974.1820.4051.4112.4412.5388.5388.4416.4447.12 0 -1.4449.4522. 8174526.4600. 8 8 -1.4
2107PAN AMERICAN 2 SCHNE CSESE303033WSPRCRS2.52957.1774.4007.4072.4378.   -1.   -1.4380.4402. 8 3 74.4406.4467. 4134472.4553. 0 0168.4
2108MALL.-CCPP. 2 ROONEY CNWNW053034WSPRGRD2.53012.1612.4020.4097.4377.5372.5372.4382.4415.15 0120.4418.4478. 8104481.4584. 0 0213.4
2109PAN AMERICAN 2 SMITH CSWNW243034WSPRGRS2.52573.   -1.4050.4124.4406.5333.5333.4410.4440.12 0 98.4443.4504. 0104513.4607.1213172.4
2110ANADARKO 1-3 MAKIPSO CSESW313034WSPRGRS2.52916.1698.3972.4098.4345.5463.5463.4350.4368. 4 0157.4370.4438. 7 94448.4546.16 7235.4
2111WALTER DRLG. 1 ENGLE CNESE343034WSPRCS 2.52851.   -1.3995.4070.4372.5501.5501.4377.4403.10 0 -1.4404.4460.20104475.4580. 7 0 -1.4
2112ANADARKO 1-B STANLEY  NWSE133035WGRPCC  5.2938.   -1.3930.4024.4326.5519.5519.4333.4355. 8 0117.4357.4427. 7 64431.4524. 6 6256.4
2113H.A. CHAPMAN 1 CHRIS CSWNE213035WGRPCC  5.2854.   -1.3858.3918.4217.5420.5420.4222.4247. 6 0 75.4247.4318. 0 44320.4417.16 0300.4
2114BLAIK OIL 1 LYNN SCO CSESE273035WSPRGRS2.52869.   -1.3873.3956.4247.5428.5428.4251.4280.12 0151.4282.4354. 4104356.4462.11 0240.4
2115RINE DRLG. 1 ALFORD  CSEN.023036WSPRGRS2.53015.1790.3908.4073.4366.5654.5654.4375.4410.16 0128.4413.4489.10144492.4581.11 7247.4
2116LA CIMA CORP. 1 JONE CNWSE133036WSPRGRS2.53003.   -1.4010.4097.4385.5640.5640.4394.4421. 5 0 67.4425.4502. 6124505.4595. 9 8213.4
2117MESA PETR. 2-16 UCSSNWSENW163037WSPRGRS2.53105.   -1.3928.4005.4323.5659.5659.4327.4354. 0 0 57.4359.4423. 4144425.4516. 016160.4
2118PAN AMERICAN 1 CEBEL CSWN 193039WSPRGRS2.53224.   -1.3805.   -1.4183.5670.5670.4187.4214. 0 0 79.4214.4290. 0 04295.4358. 015117.4
2119THUNDERBIRD 1 BROWN  CSENE173040WSPRGRN2.53310.1636.3673.3744.4018.5425.5425.4029.4052. 0 4102.4055.4118. 6184130.4175.18 6 83.4
2120F. SEABOARD 1-A BEAU CSWSW193040WSPRCS 2.53345.   -1.3634.3696.3954.5329.5329.3962.3983. 4 0 -1.3985.   -1. 8 04038.4074. 6 6 -1.4
2121PAN AMERICAN 1-C HIN CSEN.243040WSPRGRS2.53239.   -1.3796.3824.4130.5522.5522.4133.4152. 0 0 60.4152.   -1. 4 04240.4291.1012 70.4
2122AL LUKKEN 1 HARMON   CSWNW033041WSPRGRS2.53388.1557.3602.3665.3932.5416.5416.3938.3958. 0 0124.3961.4002. 0 04008.4073. 410 37.4
2123GRAHAM-MICH. 1-19 EA CSESW173041WGRCPC  5.3451.   -1.3608.3680.3931.5396.5396.3930.3974. 4 0 62.3976.4024.10 04031.4091. 0 2113.4
2124BEREN OIL 1 BEALCHAMSWSEN.233041WGRCPC  5.3363.   -1.3595.3658.3912.5348.5348.3916.3938. 4 0115.3942.3994. 0 04002.4072. 012 75.4
2125AMPECO 1 GRAY ESTATE   CNE073042WGRCPD  5.3552.   -1.3573.3618.3850.5447.5447.3910.3924. 4 0 84.3932.3984. 0 04003.4062. 0 0100.4
2126TEXAS OIL&GAS 1 BIERNWSESW343042WGRCPC  5.3526.   -1.3554.3646.3862.5316.5316.3894.3917. 0 0 78.3922.3957. 0 03986.4031. 0 7 92.
2127CHAMPLIN 1 ROHICK    CNWNW123043WSPRGRS2.53615.   -1.3633.   -1.3550.5489.5485.3967.3997. 3 0 45.4001.4048. 0 0  -1.4104. 0 0 85.4
```

Table 3. FORTRAN Program Listing of Stratplot

```
            ; program stratplot.recoded
      ;
      ; author : cheng, wai leung
      ;
      ; date : march 15, 1984
      ;
      ; purpose : this program is to recode the stratplot program
      ;           so as to make it work under both the data general
      ;           and the zenith terminals too.
      ;           originally, it only works properly under the
      ;           dasher 200 terminal
      ;           for the program function, it serves the same
      ;           function as the stratplot does.
      ;
      implicit integer(a-z)common
      fieldcount,plot_description(63),plot_datum(63),datum(26)
      dimension standard_plot(10,7)
      data standard_plot/9,1,2,3,4,7,9,11,13,5,
     *          8,15,16,17,18,19,20,21,22,0,
     *           6,23,24,25,26,27,28,0,0,0,
     *          9,29,30,31,44,41,42,43,61,51,
     *           8,32,33,34,45,48,49,50,52,0,
     *          9,35,36,37,46,55,56,57,62,53,
     *           9,38,39,40,47,58,59,60,63,54/
      ;
  dimension screen_buffer_1(7), screen_buffer_2(13),
     *     screen_buffer_3(12)
      dimension temp_plot1(14), temp_plot2(26), temp_plot3(23)
      ;
      ;
      ; open files to do console I/O.
      ;
      open 10,'@OUTPUT',ATT='SO'
      open 11,'@INPUT',ATT='SIB'
      ;
      ;-------------------------------------------
      ;
      ;
      ; initialize forms package; call sterm. read the first form
      ; (rform). Display it and enable forms edit mode (DSPEDIT).
      ;
      ;-------------------------------------------
      write(10,721)
721   format(' <14>IF YOU ARE USING ZENITH 100 TERMINAL')
      write(10,722)
      write(10,723)
      write(10,724)
      write(10,725)
      write(10,726)
```

```
      write(10,727)
722   format(' HAVE YOU TYPED IN THE CLI COMMAND YET')
723   format(' )CHAR/OFC')
724   format(' IF NOT, PLEASE TYPE "X" TO EXIT THIS PROGRAM')
725   format(' TYPE THAT COMMAND AT CLI LEVEL AND THEN')
726   format(' RE-EXECUTE THIS PROGRAM AGAIN')
727   format(' JUST TYPE ANY OTHER CHARACTER TO CONTINUE')
      READ(11,102)DUMMY
102   FORMAT(A1)
      IF ((DUMMY .EQ. 'X ').OR.(DUMMY .EQ. 'x ')) go to 939
      ;
      call sterm
      call rform('stratplot.1',error)
      if (error .ne. 1) go to 900
 10   call dform
      call fmode(error)
      if (error .ne. 1) go to 10
      ;
      ; check user's input - at most one field may be chosen.
      ; if more than one field is chosen the print an error message
      ; and re-display the first form.
      ;
      field = '  '
      flag = -1
      do 40 i=1,7
         call gufld(i,field,1)
         if (field .eq. '  ') go to 40
 20      if (flag .ne. -1) go to 50
 30      flag = i
 40      continue
         go to 60
      ; normal exit from loop, continue processing.
      ;-------------------------------------------
      ;
 50   continue
      ;
      ; error more than one field was indicated.
      ; have user try it again.
      ;
      call blm("PLEASE SELECT ONLY ONE FIELD - TYPE 'NL' TO TRY AGAIN")
      read(11,16) dummy
 16   format(a1)
      go to 10
 60   continue
      ;
      ; check to see if a field has been chosen. if flag = -1,
      ; then no field was indicated, meaning that the user wants to
      ; specify the content of a 'non-standard' plot file. therefore,
      ; must read second form and display/edit before proceeding to
      ; section 2.
      ; if a single field was chosen, then the user wants one of the
```

```
    ; standard plot files, so proceed on to section 2.
    ;
    if (flag .eq. -1) go to 90
 70 fieldcount = standard_plot(1,flag)
    do 80 i=1,fieldcount
       plot_description(i) = standard_plot(i+1,flag)
 80 continue
    go to 200
    ;
    ; done, go to logical end of this routine.
    ;
    ; ****************************************
    ; non-standard plot file is wanted.
    ;  read second form and display/edit.
    ;
 90 call rform('stratplot.docu',error)
    if (error .ne. 1) go to 920
366 call dform
    call fmode(error)
    if (error .ne. 1) go to 366
    call gufld(1,dumfield,1)
    ;
    ; now start to generate non-standard plot file
    ;
    call rform('stratplot.2.1',error)
    if (error .ne. 1) go to 920
    ; form not found - error.
100 call dform
    call fmode(error)
    if (error .ne. 1) go to 100
    ;
    ; get input from the first temporary buffer
    ;
    ;
    call guscr(screen_buffer_1)
    call unpack(screen_buffer_1,1,7,temp_plot1,1)
    ;
    ;  now call the second form's part II
    ;
300 call rform('stratplot.2.2',error)
    if (error .ne. 1) go to 920
301 call dform
    call fmode(error)
    if (error .ne. 1) go to 301
     call guscr(screen_buffer_2)
     call unpack(screen_buffer_2,1,13,temp_plot2,1)
    ;
    ;  now call the second form's part III
    ;
302 call rform('stratplot.2.3',error)
    if (error .ne. 1) go to 920
```

```
303   call dform
      call fmode(error)
      if (error .ne. 1) go to 303
      call guscr(screen_buffer_3)
      call unpack(screen_buffer_3,1,12,temp_plot3,1)
     ;
     ; now map the three temporary buffer into the working buffer
     ;
     do 304 k = 1,14
        plot_description(k) = temp_plot1(k)
304  continue
     ;
     ; here comes the second temporary buffer
     ;
     r = 15
     do 305 k = 1,26
        plot_description(r) = temp_plot2(k)
        r = r + 1
305  continue
     ;
     ; the third temporary buffer
     ;
     r = 41
     do 306 k = 1 ,23
       plot_description(r) = temp_plot3(k)
       r = r + 1
306   continue
      ;
      ; now we work with the plot_description buffer
      ;
     j = 0
     do 120 i=1,63
        if (plot_description(i) .eq. '  ') go to 120
110     j = j + 1
        plot_description(j) = i
120   continue
      fieldcount = j
200  call fend
     call filmgr
     ; should never fall through here
     ;
     ;*******************************
     ;
     ; 'missing forms' error messages...unrecoverable error, fall
     ; through to wrapup.
     ;
900  miss_form_no = miss_form_no + 1
920  miss_form_no = miss_form_no + 1
     write(10,930) miss_form_no
930  format(' fatal error!',/,' form #',i1,' is missing from library')
     ;
```

```
     ; wrap-up stop
     ;
     call fend
939  stop
     end

     ; subroutine pltgen
     ;
     ; this subroutine is modified by:
     ;                                        cheng,wai leung
     ;
     ; date: march 16, 1984
     ;
     ; purpose: please refer to the original pltgen document
     ;
     ;------------------------------------------------------------
     ;
     subroutine pltgen
     implicit integer(a-z)
     common fieldcount,plot_description(63),plot_datum(63),datum(26)
     ;
     dimension structures(14) ;indices of the strcuture datums.
     data structures/2, 3, 4, 5, 6, 7, 8, 9, 13, 14, 17, 18, 22, 23/
     ;
     ;
     dimension carbs(3,4)
     data carbs/8,9,5, 13,14,9, 17,18,14, 22,23,18/
     ;
     dimension iso(2,26)
     data iso/2,3, 2,4, 2,5, 2,6, 3,4, 3,5, 3,23, 3,6,
    *  4,5, 4,23, 4,6, 5,23, 5,6, 23,6, 5,8, 8,9, 5,9,
    *  9,13, 13,14, 9,14, 14,17, 17,18, 14,18, 18,22,
    *  22,23, 18,23/
     ;
     dimension zprcnt(2,4)
     data zprcnt/5,9, 9,14, 14,18, 18,23/
     ;
     do 190 i=1,fieldcount
     ; is next field a porosity-percentege-gamma ray?
     if (plot_description(i) .ge. 41) go to 60
     ;is next field an isopach?
30   if (plot_description(i) .ge. 15) go to 50
     ;
     ;------------------------------------------------------
     ;
40   j = plot_description(i) ;j is index into structures array
     plot_datum(i) = structur(datum(1),datum(structures(j)))
     go to 190
     ;
50   j = plot_description(i) - 14 ;adjust index into iso table.
     plot_datum(i) = isopach(datum(iso(1,j)),datum(iso(2,j)))
```

```
      go to 190
      ;
      ;
60    if (plot_description(i) .ge. 44) go to 80
      ;
70    if (plot_description(i) .eq. 41)
     *   plot_datum(i) = datum(10)  ;porosity-upper
      if (plot_description(i) .eq. 42)
     *   plot_datum(i) = datum(11)  ;porosity-lower
      if (plot_description(i) .eq. 43)
     * plot_datum(i) = sumporos(datum(10),datum(11))
       go to 190
       ;
       ;
80    if (plot_description(i) .ge. 48) go to 100
       ;
       ; carbonate percentage for the selected zone.
       ;
90    j = plot_description(i) - 43 ;adjust index into carbs table.
      plot_datum(i) = carbonat(datum(carbs(1,j)), datum(carbs(2,j)),
     * datum(carbs(3,j)))
       go to 190
       ;
100   if (plot_description(i) .ge. 51) go to 120
       ;**********************************************
       ;
       ; porosities of the i zone
       ;
110    if (plot_description(i) .eq. 48)
     *    plot_datum(i) = datum(15) ;porosity-upper
       if (plot_description(i) .eq. 49)
     *    plot_datum(i) = datum(16) ;porosity-lower
       if (plot_description(i) .eq. 50)
     *   plot_datum(i) = sumporos(datum(15),datum(16))
          go to 190
        ;
120     if (plot_description(i) .ge. 55) go to 140
        ;
        ;zone percentages - ratio of zone to entire interval.
        ;
130     j = plot_description(i) - 50 ;adjust index to zprcnt table.
        plot_datum(i) = zoneprcnt(datum(zprcnt(1,j)),
datum(zprcnt(2,j)),
     *   datum(5), datum(23))
        go to 190
        ;
        ;
140     if (plot_description(i) .ge. 61) go to 180
        ;
        ;else porosities of the j and k zones...
        ;
```

```
150     if (plot_description(i) .ge. 58) go to 170
        : j zone porosities.
160     if (plot_description(i) .eq. 55)
   *     plot_datum(i) = datum(19) ;porosity-upper.
        if (plot_description(i) .eq. 56)
   *     plot_datum(i) = datum(20) ;porosity-lower.
        if (plot_description(i) .eq. 57)
   *     plot_datum(i) = sumporos(datum(19),datum(20))
         go to 190
        ;
        ; k zone porosities.
        ;
170     if (plot_description(i) .eq. 58)
   *      plot_datum(i) = datum(24)  ;porosity-upper.
        if (plot_description(i) .eq. 59)
   *      plot_datum(i) = datum(25)  ;porosity-lower.
        if (plot_description(i) .eq. 60)
   *      plot_datum(i) = sumporos(datum(24),datum(25))
          go to 190
        ;
        ;gamma rays for the zones.
        ;
180     if (plot_description(i) .eq. 61) plot_datum(i) = datum(12)
        ; h zone.
        if (plot_description(i) .eq. 62) plot_datum(i) = datum(21)
        ; j zone.
        if (plot_description(i) .eq. 63) plot_datum(i) = datum(26)
        ; k zone.
        ;-----------------------------------------------------------
        ;end of loop
        ;
190     continue
        ;
        ; done..all datums have been computed for this record
        ; return to caller.
        ;
        return
        end

      ; subroutine filemgr
      ; this subroutine is recoded by
      ;     cheng, wai leung
      ;
      ; for the reason that there is no original coding stored in
      ; the tape
      ; and make it be f77 program so as to be compatible with
      ; the recent system modifications.
      ;
      ; for the program function description, please refer to the
      ; original filmgr documentation.
      ;
```

```
; date : march 16, 1984
;
;============================================================
;
subroutine filmgr
implicit integer(a-z)
common fieldcount,plot_description(63),plot_datum(63),datum(26)
dimension filename(20)
dimension spot(3) ;store the master flespot location.
data master_in, plot_out/2*0/
real long,lat,x,y ;real variables for the calculated coordinates
double precision dbl_long,dbl_lat ;ctrll expects d.b. coords.
;
;============================================================
;
call setlc
;
write(10,10)
10 format(' <14>ENTER FILE NAME FOR THE PLOT FILE: ')
call RDLIN(11,filename,returned,error)
call check(error)
BYTE(filename,returned) = '<NUL>'
open 2,':udd:gi.stratos:stratmaster',LEN=150,ATT='RE'
open 3,filename,ATT='SO'
write(10,12) ;caution user that this takes a short while
12 format(' <BEL>THIS TAKES A SHORT WHILE...PLEASE BE PATIENT')
;
;
15
read(2,20,end=1000)record_number,spot,sec,twn,rng,ew,(datum(i),i=1,26)
20 format(i4,20x,3a2,3i2,a1,9x,9i5,2i2,i4,2i5,2i2,2(2i5,2i2,i4))
master_in = master_in + 1
;
; call pltgen to do the work of interpreting the input
; of the user and producing the desired datums
; for the plot file.
;
call pltgen
;
;now must obtain calculate coordinates for the well based off
; of the spot, s-t-r, and direction (e/w) information available
; on the master file. this is a two step process: 1) must first
; compute the lambert conformat projected coordinates at
; 1:500,000.
; call ctrll to convert spot info. into longitude/latitiude.
;
call ctrllx(twn,rng,ew,sec,J=3,spot,dbl_long,dbl_lat,error)
if (error .eq. 0) go to 180
170 long = 0.0 ;missing value
lat = 0.0
go to 190
```

```
      ;
      : call transf to convert long/lat to a projected lambert coord.
      : scaled at 1:500,000.
      ;
 180  long = sngl(dbl_long) ;convert double precision to single p.
      lat = sngl(dbl_lat)
      call transf(long,lat,x,y)
      long = x
      lat = y
      ;
      ; write a plot record to the plot file.
      ;
 190  write(3,200)record_number,long,lat,(plot_datum(j),j=1,fieldcount)
 200  format(i6,2f7.3,63i6)
      plot_out = plot_out + 1
      go to 15 ;back and read another master file record
      ;
      ;==================================================
      ;
      ; eof on master - print stats and close up.
      ;
1000  write(10,1010)
1010  format('<14>') ;erase page on a dasher terminal
      write(10,1020) master_in
1020  format(' strat. master records in: ',i6)
      write(10,1030) plot_out
1030  format(' plot records output: ',i6,/)
      write(10,1040)fieldcount
1040  format(' number of fields on plot file: ',i6,/,
     * "(format for surface 2 is: '(f6.0,2f7.3,xf6.0)' where ",/,
     * " 'x' is the number of fields given above )")
      write(10,1050)
1050  format(/,' remember coordinates where projected at 1:500,000')
      ;
      stop
      end
```

Table 4. FORTRAN Program Listing of Stratupdt

```
 C      program id - stratupdt
C      date        - march 19, 1984
C      recoded by - cheng, wai leung
C
C      updated     - aug 28, 1984
C
C      function: this collection of routines provides an "on-lines"
C         maintenance facility for the stratigraphic master file,
C         based around the functions provided by the survey's AOS
C         Forms library.
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
       implicit integer(a-z)
       dimension fstat_packet(25) ;?fstat's parameter packet
       dimension remainder(2)     ; double-word integer arg.
       dimension file_size(2)
       dimension rec_length(2)  ; constant used as arg. to DWDIV
       dimension recnum_fld(2)
       dimension default_values(75), stratrec(75), buffer(75)
       data default_values/23*'  ','  ','-1','. ',' -','1.','  ','-1',
    *  '. ',' -','1.','  ','-1','. ',' -','1.','  ','-1','. ',' -
    *  ','1.',
    *  '  ','-1','. ','0 ','0 ','-1','. ',' -','1.','  ','-1','. ',
    *  '0 ','0 ',' -','1.','  ','-1','. ','0 ','0 ','-1','. ',' -',
    *  '1.','  ','-1','. ','0 ','0 ','-1','. '/
       data mstr_read, mstr_written, modifications, appended/4*0/
       data rec_length/0,150/
       data append_flag/0/
       common error, buffer, recnum_fld
C
C open files.
C
       open 2,':udd:gi.stratos:stratmaster',len=150,att='RA'
       open 10,'@OUTPUT',att='SO'
       open 11,'@INPUT',att='SIB'
C
C initialise forms package. read in form. display.
C
       call sterm  ; forms library routine.
       call rform('stratmstr',error) ; forms library.
       if (error .ne. 1) go to 1000
   10  call dform ;forms library
C
C prompt user - what type of transaction?
C
   20  call blm(' type M(modify), A(append), or D(done): ')
       read(11,30)action
   30  format(a1)
       if ((action .eq. 'A ') .or. (action .eq. 'a ')) go to 70
```

```
      if ((action .eq. 'M ') .or. (action .eq. 'm ')) go to 140
      if ((action .eq. 'D ') .or. (action .eq. 'd ')) go to 1010
      ; else invalid action type, try again.
   60 go to 20
C
C--------------------------------------------------------------------
C append section
C
C user specified an append transaction. issue a system call to get the
C status of the master file; compute what the last record number on
C the file is so that new records may be appended to the end of file.
C
   70  if (append_flag .eq. 1) go to 80 ;file has been appended
       append_flag = 1
       call qfstat(0,':udd:GI.STRATOS:stratmaster',fstat_packet,error)
       call check(error) ; run-time routine
C
C divide "file size in bytes" by "record length in bytes" to get
C "# records on file" = record number of last reocrd on file.
C
      file_size(1) = fstat_packet(16) ; these words contain a double-
word
      file_size(2) = fstat_packet(17) ; integer =file size in bytes
      call dwdiv(rec_length,file_size,remainder,error) ;csp routine
   80 file_size(2) = file_size(2) + 1
      write_address = file_size(2)
      encode(recnum_fld,85)write_address
   85 format(i4)
C
C move computed record number into display area, move default values
C for all other fields into corresponding foreground areas.
C
   90 call puscr(default_values) ;forms library
      call pufld(1,recnum_fld,1,4) ; forms library
C
C enable forms edit mode. wait for return by user. if abnormal return
C then re_display the form.
C
   92 call fmode(error) ; forms library
      if (error .ne. 1) go to 90
C
C now edit the data entered by the user.
C
  100 call guscr(buffer) ;forms library
      call edit
      if (error .eq. 1) go to 110
  102 call dform
      call puscr(buffer)
      go to 92
C
C else, input is o.k., write record to master file.
```

```
C
  110    buffer(75) = IAND(buffer(75),177400k) ;zero out lower nibble
         buffer(75) = IOR(buffer(75),10) ;insert a nl character into
there
         call writrw(2,write_address,buffer,1,error)
         call check(error)
         mstr_written = mstr_written + 1
         appended = appended + 1
         call blm(" type 'newline' to continue, 'D' to stop: ")
         read(11,120)action
  120    format(a1)
         if ((action .ne. 'D ') .and. (action .ne. 'd ')) go to 80
         ; else, go to higher level
  130    go to 20
C
C end of append section
C
C---------------------------------------------------------------
C
C modify record section
C
C user specified a modify transaction. prompt user for record number.
C read record. display and enable edit mode.
C
  140     call blm(' enter record number (zero to stop): ')
          read free(11)read_address
          if (read_address .eq. 0) go to 20
  142     encode(recnum_fld,144) read_address
  144      format(i4)
  150      call readrw(2,read_address,stratrec,1,error)
          if (error .eq. 1) go to 180
  160     call blm(' record does not exist - type nl to continue: ')
          read(11,170)action
  170      format(a1)
          go to 140
  180     mstr_read = mstr_read + 1
  190     call dform
          call puscr(stratrec)
  192     call fmode(error)
          if (error .ne. 1) go to 190
C
C
C normal exit from edit mode. call edit
C
  200     call guscr(buffer)
          call edit
          if (error .eq. 1) go to 210
  202     call dform
          call puscr(buffer)
          go to 192
C
```

```
C else, write modified record to the master file.
C
  210    buffer(75) = IAND(buffer(75),177400k) ;zero out lower nibble
         buffer(75) = IOR(buffer(75),10) ;insert nl into lower nibble
         call writrw(2,read_address,buffer,1,error)
         call check(error)
         mstr_written = mstr_written + 1
         modifications = modifications + 1
         go to 140
C
C end of modify record section
C------------------------------------------------------------------
C error messages and closing section.
C
 1000    type "error occurred trying to read form"
         type " error code= ",error
C
C end of job. print tabulations and stop.
C
 1010    call fend ;close up forms package
         type "***summary***"
         type "<NL>master records read: ",mstr_read
         type "master records written: ",mstr_written
         type "<NL>records modified: ",modifications
         type "records appended: ",appended
         stop
         end

        ; subroutine edit
        ;
        ; recoded by : cheng, wai leung
        ;
        ; date : march 21, 1984
        ;
        ; purpose : because there was no copy of this subroutine's
        ;           original codings stored in the tape.
        ;           this subroutine is recoded so as to keep a copy of
        ;           it being stored in the tape.
        ;
        subroutine edit
        implicit integer(a-z)
        common error, buffer(75), recnum_fld(2)
        dimension strata(6)
        dimension strata_names(2,6)
        data strata_names/'SC','RL','HE','EB','LN','SG','B-','G ',
     *    'B-','P ','MS','SP'/
        dimension zone_names(2,8)
        dimension zone_strata(8)
        data zone_names/'T-','H ','B-','H ','T-','I ','B-','I ',
     *    'T-','J ','B-','J ','T-','K ','B-','K '/
        dimension porosity(8)
```

```
      dimension porosity_names(2,8)
      data porosity_names/'H-','UP','H-','LO','I-','UP','I-','LO',
     *   'J-','UP','J-','LO','K-','UP','K-','LO'/
      dimension gamma(3)
      dimension gamma_names(2,3)
      data gamma_names/'H-','ZN','J-','ZN','K-','ZN'/
      dimension record(2)
C
C decode the buffer into the individual fields to be edited.
C if an error occurs, it must indicate non-numeric data in a numeric
C field. the user must locate the source of the problems and correct it.
C
      decode(buffer,10,err=410)record,sec,twn,rng,ew,kb,(strata(j),
     * j=1,6),(zone_strata(k),k=1,2),(porosity(l),l=1,2),gamma(1),
     *
(zone_strata(m),m=3,4),(porosity(n),n=3,4),(zone_strata(o),o=5,6),
     *
(porosity(p),p=5,6),gamma(2),(zone_strata(q),q=7,8),(porosity(r),
     * r=7,8),gamma(3)
   10 format(2a2,26x,3i2,a1,9x,9i5,2i2,i4,2i5,2i2,2(2i5,2i2,i4))
C
      error = 1
C
C  has record number been altered?
C
      do 55 i=1,2
   20 if (record(i) .eq. recnum_fld(i)) go to 55
   30 error = 3
      call pufld(1,recnum_fld,1,4)
      call blm(' ')
      write(10,40)
   40 format(' RECORD NUMBER MAY NOT BE ALTERED!')
      write(10,50)
   50 format(' ...VERIFY DATA AND THEN RE-SEND')
      go to 370
   55 continue
C
C edit sectin number: 0 <--> 36
   60 if ((sec .ge. 0) .and. (sec .le. 36)) go to 90
   70 error = 3
      write(10,80)
   80 format(' SECTION IS INVALID - 0 < SECTION < 36')
C
C edit township number : 0 <--> 35
C
   90 if ((twn .ge. 0) .and. (twn .le. 35)) go to 120
  100 error = 3
      write(10,110)
  110 format(' TOWNSHIP IS INVALID - 0 < TOWNSHIP < 35')
C
C edit range number: 0 <--> 43
```

```
C
  120   if ((rng .ge. 0) .and. (rng .le. 43)) go to 150
  130   error = 3
        write(10,140)
  140   format(' RANGE IS INVALID - 0 < RANGE < 43')
C
C edit kb: -1 <--> 4300 feet
C
  150   if ((kb .ge. -1) .and. (kb .le. 4300)) go to 180
  160   error = 3
        write(10,170)
  170   format(' KB IS INVALID - -1 < KB < 4300')
C
C edit the various strata. their depths may not be greater than
C 8000. ft. and they amy not overlap each other.
C
  180   do 210 i = 1,6
        if ((strata(i) .ge. -1) .and. (strata(i) .le. 8000)) go to 210
  190   error = 3
        write(10,200)(strata_names(j,i),j=1,2)
  200   format(1x,2a2,' IS INVALID - -1 < datum < 8000')
  210   continue
C
        do 240 i = 2,6
        if (strata(i-1) .eq. -1 .or. strata(i) .eq. -1) go to 240
        if (strata(i-1) .le. strata(i)) go to 240
  220   error = 3
        write(10,230)(strata_names(j,i-1),j=1,2),
     *     (strata_names(k,i),k=1,2)
  230   format(1x,2a2,' AND ',2a2,' OVERLAP!')
  240   continue
C
C edit the tops and bases of the 4 zones: they may not be greater than
C 8000 and must not overlap.
C
        do 270 i=1,8
        if ((zone_strata(i) .ge. -1) .and. (zone_strata(i) .le. 8000))
     *   go to 270
  250   error = 3
        write(10,260)(zone_names(j,i),j=1,2)
  260   format(1x,2a2,' IS INVALID -  -1 < datum < 8000')
  270   continue
C
        do 300 i=2,8
        if (zone_strata(i-1) .eq. -1 .or. zone_strata(i) .eq. -1) go to
     *   300
        if (zone_strata(i-1) .le.  zone_strata(i)) go to 300
  280   error = 3
        write(10,290)(zone_names(j,i-1),j=1,2),
     *    (zone_names(k,i),k=1,2)
  290    format(1x,2a2,' AND ',2a2,' OVERLAP!')
```

```
  300    continue
 C
 C edit porosity values : 0 <--> 60
 C
        do 330 i=1,8
         if ((porosity(i) .ge. -1) .and. (porosity(i) .le. 60)) go to
 330
  310    error = 3
         write(10,320)(porosity_names(j,i),j=1,2)
  320    format(1x,2a2,' POROSITY IS INVALID -  -1 < POROSITY < 60')
  330    continue
 C
 C edit gamma ray values: -1 <--> 500
 C
         do 360 i=1,3
          if ((gamma(i) .ge. -1) .and. (gamma(i) .le. 500)) go to 360
  340    error = 3
         write(10,350)(gamma_names(j,i),j=1,2)
  350    format(1x,2a2,' GAMMA RAY IS INVALID -  -1 < GAMMA RAY < 500')
  360    continue
 C
 C edit east/west designator: 'e' or 'w'
 C
         if ((ew .eq. 'E ') .or. (ew .eq. 'e ')) go to 370
  362     if ((ew .eq. 'W ') .or. (ew .eq. 'w ')) go to 370
  364    error = 3
         write(10,366)
  366    format(' EAST/WEST DESIGNATOR NOT "E" OR "W"')
 C
 C through editing. return if O.K., or prompt user to continue
 C if editing errors were encountered.
 C
  370    if (error .eq. 1) go to 430
        ;else an error occurred...
  380    write(10,390)
  390   format(' TYPE NEWLINE TO RE-DISPLAY FORM')
        read(11,400) dummy
  400   format(a1)
        go to 430
C
C decoding error
C
  410   errors = 3
        write(10,420)
  420   format(' NON-NUMERIC INPUT IN A NUMERIC FIELD. PLEASE CORRECT')
        go to 370
C
C return to caller
C
  430   return
        end
```

APPENDIX B

STATISTICS USED IN TREND SURFACE ANALYSIS

A simple statistic using regression and total sum of squares was chosen to establish the fit of the polynomial trend regression surface to the original data. The sum of squares due to regression is the variation in the trend surface itself and is expressed as:

$$SS_R = \hat{\Sigma}\ z^2 - \frac{(\hat{\Sigma}\ z)^2}{n}$$

, where z = original value
$\hat{z}$ = trend surface value at z
n = number of data points

In the trend surface examples the variable z is the subsea elevation at a given well location or the thickness of the strata. The variable $\hat{z}$ is the estimated subsea elevation or the thickness and is the solution to the trend surface polynomial equation.

The sum of squares of the residuals is:

$$SS_D = \hat{\Sigma}\ (z - \hat{z})^2$$

SS_D is the difference between the original z and $\hat{z}$ estimated from the trend surface. The total variation in the original data can be expressed as the total sum of squares:

$$SS_T = \hat{\Sigma}\ z^2 - \frac{(\hat{\Sigma}\ z)^2}{n}$$

The total sum of squares, SS_T, is also:

$$SS_T = SS_R + SS_D$$

A statistical measure of the fit between the regression surface (SS_R) and the original surface (SS_T) can be accomplished with analysis of variance with the degrees of freedom equal to n-1. The F-ratio can also be calculated as a ratio between the variance of the values of the polynomial trend surface and the variance of the residuals around the trend

$$F = \frac{SS_R/n - 1}{SS_D\ /n - 1}$$

(Koch and Link, 1980; Davis, 1973). The F-ratio for the K-Zone structure is highly significant for all of the regression surfaces above the first order. Thus the statistical model of the original surface is a reliable description.

The ratio of the sum of squares due to regression and the total sum of squares is the goodness of fit. The square root of the goodness of fit is the multiple correlation coefficient. The goodness of fit is expressed here as a percent:

$$R^2\ (\%) = (SS_R/SS_T) * 100$$

Skewness is defined here as:

$m_3 = 1/n * \ (x - \bar{x})^3$, the third moment about the mean.

, where x = residuals calculated by subtracting the solution of the trend equation from the original datum
x = mean value
n = number of data points

Dimensionless skewness is determined by dividing the skewness by the square root of the cube of the second moment, i.e., the variance:

$sk = m_3 / (m_2{}^3)^{0.5}$ ---> $sk = m_3 / (m_2{}^3)^{0.5}$

where $m_2 = 1/n \hat{\Sigma}\ (x - \bar{x})^2$ ---> $m_3 = 1/n \quad (x - \bar{x})^3$

APPENDIX C

WIRELINE LOGS USED IN STUDY

Natural Gamma Ray Log

The natural gamma radiation log records the radiation emitted by the elements K^{40}, thorium series, and uranium series (Fertl, 1983). Shales are generally associated with higher natural gamma radiation than are limestones and sandstones. The former usually contains more clay minerals including mica or sericite in which potassium and the naturally occurring K^{40} isotope are more abundant. The variation in the type of clay can affect gamma ray response. Furthermore, rocks containing abundant organic matter and phosphorite commonly contain elevated uranium concentrations and hence high natural gamma radiation (Adams and Weaver, 1958; Fertl, 1983). Thorium tends to concentrate in the more refractory clay minerals (<100 ppm) which represent residues of weathering and in resistant heavy minerals where concentrations of thorium can exceed 1000 ppm. Gamma radiation can thus be high in these materials (Fertl, 1983). Average abundance of potassium, uranium, and thorium concentrations in common sedimentary rocks are summarized in Table 1.

Table 1. Common Range and Average Concentrations of K, U, and Th in Sedimentary Rocks (from Fertl, 1983)

	Potassium(%)		Uranium(ppm)		Thorium(ppm)	
	range	average	range	average	range	average
carbonates	0.-2.0	0.3	0.1-9.0	2.2	0.1-7.0	1.7
common shales	1.6-4.2	2.7	1.5-5.5	3.7	8-18	12.0
shales (200 samples)		2.0		6.0		12.0
sandstone	0.7-3.8	1.1	0.2-0.6	0.5	0.7-2.0	1.7

The concentrations of these elements vary substantially, even within a single lithology. The simplest way of relating gamma ray to lithology is to define an average gamma ray value for shale and one for nonclay lithology. Clean (low gamma ray and low shale content) rock might be limestone or sandstone. Intermediate gamma ray values could be correlated to the percentage of shale using a simple linear relation between the nonshale and shale formations. The problem, however, is that this empirical relation is not applicable to all shales, carbonate rocks, or sandstones because the chemical compositions of each of these major rock groups are not the same. Rather, variation in composition severely limits the amounts of lithologic information derived from only a gamma ray curve.

Neutron Log

The neutron log is commonly run in most holes drilled in the area of investigation. The tool emits a stream of neutrons that penetrate the rock in the vicinity of the borehole colliding with its atomic particles in the rock. Hydrogen ions, especially those in water, including water that is free to move through the pores in the rock will absorb most of the energy carried by the neutrons since hydrogen atoms have nearly the same mass. Hydrogen atoms bound in the crystal lattice of a mineral such as the hydroxyl ions in clay minerals or waters of hydration in gypsum will also absorb these neutrons. Neutron capture will result in the emission of gamma radiation. The borehole device is designed to detect either this radiation or the neutrons that are not captured but continue to travel through the rock and return to the detector. The neutrons that do return to the detector also collide with other atomic particles in the formation, but because the masses of the other particles are so much larger, the collision with them and the neutrons is elastic and the neutrons continue to travel through the formation.

Minerals and elements can be characterized by their hydrogen index, that is, their ability of absorb neutrons relative to that of water. The hydrogen index of oil is similar to that of water while natural gas is much less. Shales with their associated bound water and structural hydroxyl anions would be expected to have a relatively high hydrogen index.

Quartz and carbonate minerals generally have very low hydrogen indices, but shaly or porous rocks of these mineralogies exhibit an intermediate logged response between water and that of the pure mineral composition due to the added hydrogen ion. Yet, other impurities, many unknown unless sufficient sample is available for analysis, can cause slight to moderate variations in expected response.

The amount of porosity, $\emptyset$, can be empirically correlated to the neutron counts, N, in the following equation:

$$N = C\ e^{-k\emptyset}$$

, where C and k are constants related to the borehole, the lithology, and the configuration of the tool. Several other empirical methods are used to approximate the conversion of neutron counts to porosity. Modern neutron devices automatically transform the neutron count to porosity units reported in either limestone or sandstone porosity units.

The resistivity and density logs provide other means for differentiating the various lithofacies. Their response is similar to that of the neutron log, but for different reasons. The density device measures the electron density which in turn is correlated to the bulk density. The density log is scaled in bulk density and/or porosity units with respect to a certain lithology either limestone or sandstone.

Resistivity Log

The exploration geologist desires to know what kind of fluid is in the pore space. The resistivity log is necessary to calculate probable fluid composition. The rock matrix as well as hydrocarbon are electric insulators while the saline water, common in the pores in the subsurface, provides a path for electrical currents. The amount and tortuosity (degree of interconnectedness) of the pore space filled by saline water determines the relative resistance measured by the resistivity log. Thus, this log records an important property of the rock related to its pore system.

The contribution of the fluid in the pore space to the resistivity of the rock is measured by the formation factor, F, in the relation:

$$R_o = F\ R_w$$

, where R_o is resistivity of a water saturated rock and R_w is resitivity of the connate water in ohm-meters. As the tortuosity of the pores increases F also increases.

The cementation exponent, m, is also related to the interconnectedness of pores. This interconnectedness varies tremendously, for example, between fractured oomoldic porosity and inter-ooid porosity. The greater the restrictions in interconnectedness of the intergranular pores, the greater the cementation exponent. This factor, m, relates porosity to the formation factor, F, using, for example, the generalized Archie equation:

$$F = a\ /\ \emptyset^{m}$$

Porosity, Ø, is expressed as a fraction so as m increases so F also increases, but at a much higher rate. The constant, a, for carbonate rocks is generally close to 1 and m varies from less than 2 for fractured rocks to 2.5 in oomoldic intervals (Tixier, 1962).

The relative saturation between insulating hydrocarbon and conducting saline water in the pores is obtained from the relation:

$$S_w = (F\ R_w/R_t)^{0.5}$$

where S_w is the water saturation and R_t is the resistivity of the formation as calculated from a deep investigating resistivity device. Obviously, lithology has a very important part in the determination of F. Furthermore, the clay minerals which have cation exchange capacity also can conduct electicity. Resistivity in rocks with this clay must be adjusted for the presence of this material.

Use of Wireline Logs in Integrated Subsurface Study

Multivariate statistics and simplier cross plotting (Watney, 1979, 1980) have been used to identify the sources of lithologic variation on wireline logs. Cross plotting can be done routinely and quickly for many samples. The use of computers that can process tapes of wireline logs and graphic hardware and software can easily and quickly perform multivariate statistical analysis. This might be a necessary step if one desires to find the quantitative relationship between the log signatures and lithology, to characterize an unusual log response, to normalize log response, or to conduct a more discriminating analysis of lithologic effects on the logs (e.g., Boremann and Doveton, 1983). There is ample opportunity for advanced studies in this developing area of geological applications of wireline log analysis. This treatment though is beyond the objectives of this study.

Core or sample cutting data provide a qualitative classification of the rock. These lithologies can then be correlated to the responses of the logs. The analog signature of the logs can be calibrated, and then used with caution to extrapolate many gross lithofacies. Subtle variations in lithology can be recognized on the logs and the values of the logs themselves can be used to create a map of this variation. Watney (1979) describes several examples that use a combination of gamma ray and neutron curves to characterize changes in depositional environment along the northern border of this study area. Cores described in this study provides the means to relate the rocks to the petrophysical changes indicated by the wireline logs.

Provided sufficient samples are available, the integrated log response can be attributed to the presence of specific minerals, pore space, and the fluids that fill this pore space. This is the basic principle behind quantitative log analysis in order to determine basic lithology, pore fraction, and the presence of crude oil, natural gas, or formation water that occupy the pore space.

Unless rock samples are available, assumptions like pure carbonate, average shale, and clean sandstone need to be made when porosity is determined. The greater the number of logs available which measure different properties of the rock, the better the resolution is of the lithology and the porosity, e.g., using the solution of simultaneous equations to solve for porosity and major lithologic components. Logs can thus extend in a restricted sense the vision of the geologist beyond where he or she has examined the rock.

APPENDIX D

CORES USED IN THIS STUDY

Twelve core descriptions are included as pocket enclosures. These are representative of much of the variation in lithofacies across the area of study. The descriptions are based upon binocular examination of core slabs and petrographic study of selected thin sections. Symbols used in the descriptions are identified in Figure 1. Significant features are written as comments on the core description forms.

Figure 1.

Symbols Used In Description Of Cores