SOME STRUCTURAL FEATURES OF THE WEIR-PITTSBURG COAL BED

by

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HISTORY

The earliest record of coal mining in the Weir-Pittsburg District dates back to before the civil war. Along in the fifties, coal was mines in a small way in this district, by citizens of Missouri, who hauled it by wagons to Granby and other towns in Missouri where it was used for black-smithing. Near Weir City where coal was first mined, the Weir-Pittsburg bed comes to within a few feet of the surface, so that the coal was loaded directly into wagons by the use of pick and shovel. * In 1868, after the sale to the James F. Joy Company of the "Cherokee ventral lands," as they were then called, which was an area twenty-five by fifty miles in the southeastern part of the state including all of Cherokee and Crawford counties and a part of Bourbon County, Professor Wilbur of Chicago was sent out by a Chicago Company to examine the lands for coal, "He reported that the coal existed in large quantities along a narrow strip of country from Pittsburg to Weir and farther to the southwest."

In 1870, the Missouri River, Fort Scott and Gulf railroad, later the Kansas City, Fort Scott and Memphis and now the Frisco, completed its line into Baxter Springs.

* Haworth, University of Kansas Geological Survey.

Coal was mined along the outcrop at several places near Scammon and Weir, from which the coal was hauled by wagons to the nearest railroad station. The first record of deep mining was in 1874 when Scammon Brothers sank a shaft to the coal bed, from which considerable coal was produced. This first mine was located near Scammon. In 1879 the Joplin and Girard railroad was built in to this Kansas Coal field. Pittsburg originated as a coal camp with the building of this railroad.

POSITION OF KANSAS AS A COAL MINING STATE.

Geographically Kansas is very favorably located - being in the very heart of the Western Interior Coal Field. In 1923, Kansas ranked 12th in the production of bituminous coal in the United States. Coal produced in Kansas in 1870 amounted to 36,891 tons. The total production of the United States at that time was about 32,904,360 tons. From 1870 to 1923 inclusive Kansas produced 150,263,678 tons, within the same period the United States had a total production of 11,479,403,076 tons. * Since the first production of coal in Kansas in 1870 the state has produced annually as much coal as the combined annual production of its two adjoining coal-producing-states, Missouri and Oklahoma. While Kansas

* U.S. Geological Survey - Mineral Resourses.

ranks 12th in the production of coal in the United States - it produces only a little more than 1% of the total annual production of the United States.

POSITION OF THE LOCAL COAL FIELDS IN RELATION TO KANSAS.

The Weir-Pittsburg coal district lies mostly in Crawford County with its southern extension into Cherokee County. The district has a surface area of about 250 to 300 square miles, and is within the extreme southeastern corner of the state. The eastern boundry of the district, is the outcrop of the coal bed that dips about 20 feet to the mile to the west. The outcrop follows a more or less irregular line in a general north east direction from a few miles north of Columbus which seems to be its southern limit, passing just to the east of Weir, and thru th southeastern section of Pittsburg - then swings eastward and crosses the Missouri line for a mile or so then swings to the northeast to Minden, Mulberry and at least as far north as Arcadia. The western limit is more or less indefinate but apparently follows a direction roughly parallel to the eastern limit or outcrop. Workable coal is found within 2 or 3 miles east of Girard, but ends rather abruptly just west of Cherokee.

This coal bed lies at a depth of from only a few feet at the outcrop to a depth of 250 or 270 feet in the

western section of the district, it has an average thickness of about 3 feet - being slightly thicker in the south end than in the north end.

Coal is worked in other districts in Kansas, as near La Cygne, Osage, and Leavenworth, however the total production of these districts is small in comparison to the production of the Pittsburg district, partly because of the smaller area of the districts, the thinness of the coal beds, and the depth at which the coal occurs beneath the surface.

PROBLEMS OF THE SOUTHEASTERN KANSAS COAL FIELDS.

Among the features of the Pittsburg district that are well known to mining engineers who have worked in the area, are a few that seem not to have been described. Some of them, if their significance were thoroughly understood, would probably throw considerable light upon the history of this section of Kansas during Pennsylvanian time. It is proposed to describe two of these features, and to suggest some possible explanation.

The features of the Pittsburg coal bed, to which particular attention is here directed, are the character and relations, and possible origin of "horse-backs"; and the so called "faults". "Horse-backs" and"faults" are

described under Structural Features of the Coal Bed.

The eastern limit of the district is determined by the location of the outcrop, the vein dipping to the west. The western limit is not so easy to define as it has not yet been determined. The factors that determine this limit are as yet an unsolved problem.

The "horse-backs" and "faults" have considerable economic importance, the faulty regions varying in size from a few square yards to a few hundred acres in area, each area representing an area of coal unprofitable to work. Various estimates of the proportion of the area of "horse-backs" and "faults" to the area of workable coal have been made, ranging from 5 to 20 percent. It is probable the average for the district is about 10 percent of the area of workable coal, while this estimate may seem high it includes the unworkable areas between various mines where no attempt is made to work the coal. The coal bed does not have a uniform dip to the west but has an undulating or rolling structure which is great enough in some mines to seriously interfer with efficient haulage. By comparing a number of well logs, and determining the true elevation of the top of the coal, it was found that the occurrence of these fault areas had no relation to the undulating or rolling structure of the

coal bed, but that the fault areas occur sometimes at a high elevation of the coal bed and sometimes at a low elevation, it is often found that the extreme difference in elevation of the coal is separated by a distance of only a hundred feet or so, and both elevations may be within a fault. In other words there is no apparent relationship between the structural highs or lows of the coal bed and the occurence of the faults. On top of the coal in the fault areas is often found a few inches of apparently wash material locally known as "rash".. Why these faults occur in apparently disconnected or isolated patches is one of the problems of the district.

The "horse-backs" are a problem as to their origin. They represent a clay or detrital vein, usually more or less vertical across the coal bed, varying in thickness from a few inches up 12 or 14 feet, the average width probably being three or four feet. The vein usually cuts to the bottom, but in some cases was found to extend only a part of the way into the coal. The strike and dip apparently have no definate relationship or arrangement. The origin of the "horse-back" is another problem of the district. In general the "horse-backs" and "faults" are in greater abundance in the western part of the district. In some mines their occurrence determine fully 30 to 50 percent of the coal unprofitable to mine, while in some

mines it may be as low as 2 or 3 percent. However the average for the entire district is probably about 15 percent.

STRATIGRAPHY.

The coal beds of the Pittsburg district belong to the Cherokee shale division of the Pennsylvanian period. Moore * gives the Cherokee shales as 450 feet thick and resting on the Mississippian. They are made up of undifferentiated shales with a few beds of lenses of sandstone and one or two thin limestone members. Overlying the Cherokee shales are the following formations which are found in the following order, Marmaton 340 feet, Kansas City 250 feet, Lansing 140 feet, Douglas 425 feet, Shawnee 400 feet, Wabaunsee 650 feet.

DISCUSSION OF THE BEDS IN THE CHEROKEE SHALES.

The Cherokee Shales have an average thickness of about 450 feet in southeastern Kansas."* At Topeka deep drilling shows a thickness of 704 feet, at Atchinson 598 feet, at Emporia 351 feet, indicating that the formation is thicher to the north and northwest but not so thick in the west. The several coal seams and the great lithological variation both vertically and laterally indicate that there must have been considerable variation in shore and off shore conditions during the Cherokee time.

* Moore and Haynes, Kansas State Geological Survey Bul. 3.

From many well logs and from an examination of the outcrop of the base of the formation, just east of Columbus a thin bed of coal is found; above this and about 150 feet above the base of the shales another bed of coal occurs with a thickness of 12 to 18 inches. This bed lies just under the Columbus sandstone which outcrops near Columbus. The nest coal of any importance above the Columbus coal is the Weir-Pittsburg bed that will average about 36 inches thick, it lies about 250 feet above the base of the Cherokee shales, this bed is the one that produces nearly all of the coal of the district, however still above this bed is another but thinner about 27 inches known as the "upper". There are other thin beds above this but apparently these are only of local distribution and of but little importance. However the Ft. Scott coal 15 to 20 inches thick occurs about 450 feet above the base of the shales.

STRUCTURAL FEATURES OF THE COAL BED.

Irregularities in the thickness and the lateral distribution of a coal seam may be due to structures known as "partings", "squeezes", "swells", "horse-backs", "rolls", "clay veins", and "cut outs".

Partings. The seam may be divided into several thinner seams or splits by partings or lenses of clay, shale, or

sandstone, these individual or different parts of seams, are spread apart or separated and therefore out of their true position and not of normal thickness. In many cases it can be proven at least on the splits that occur on a small scale as they can be traced underground from one part of the mine to another. The origin of the split is no doubt due to the clay brought in from the surrounding land by surface waters and carried out over the swamp. The deposit of sediment of course grows thicker as it extends away from the land mass. The direct cause of the inwash of an excess of sediments might be a sinking of the basin or swamp, or a rise of the surrounding land mass, or a climatic change to a wetter climate would produce the same result. It might be noted that the direction in which the thinning takes place would indicate the direction of the flow of the streams carrying the sediment.

ROLLS AND SWELLS

The term "roll" in this district is a term applied to that structure of the coal bed in which the rock formation overlying the coal bed "rolls" or bends downward into the coal bed. Sometimes the "roll" extends down a foot or more and is several feet in width, but more often the extension downward amounts to only a

few inches. The "swell" in this district is a term applied to that structure of the coal bed in which the floor of the coal bed or rather the rock formation below the coal bed, is found to extend up into the coal bed. The swell is usually several feet in width and extends up into the coal bed for a foot or more, and has a length of a hundred feet or more. Figure 1. shows the relationship of "rolls" and "swells" to the coal bed.

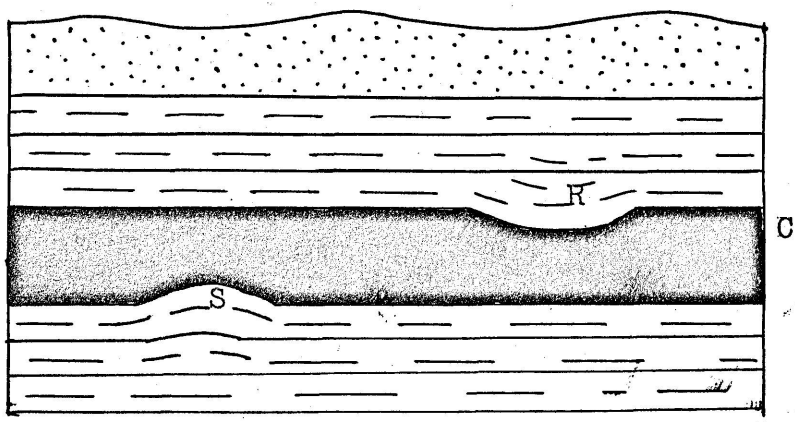


Fig. I
Diagram illustrating the relation of "rolls" and "swells" to the coal beds. C, coal bed; R, "roll"; S, "swell".

The theories usually advanced for this type of structural feature are as follows, the "roll" or "swell" in the floor being due to sediment being carried into the swamp in its early history, by streams building up long narrow

ridges of sediment which would become buried under the coal forming material. The rolls in the roof are often explained as due to streams cutting down a channel into the coal seam, the channel later becoming filled with sediment. While the above theory may account for these structures in some districts, the actual field evidence obtained in the Pittsburg district indicates that the "rolls" in that district may have been formed by a compression of the seam and its enclosing rocks. The coal being more plastic than the enclosing rocks would naturally yield and relieve the pressure of the compressive force, by being compressed or made thiner at points of maximum weakness. The cause of this compressive force will be discussed later. The evidence of the buckling of the overlying rocks is a dipping structure, that is the bedding of the overlying rock conforms to the shape of the "roll". Another possible explanation of the origin of the "rolls" is that they may represent an irregularity in the composition of the old coal swamp or peat bog, in that it would be the natural thing to expect to find at least some variation in the kind of material that was accumulating. If the material in places was of a more porous nature, we would then have a differential

compacting of the coal after the sediments were deposited on top of the coal bed, with a corresponding bending down of the formation overlying the places of greatest compacting. In shape the rolls are more or less circular in outline tho more often very irregular. In the region of these "rolls" or "swells" the coal is as a rule harder but more brittle - indicating a compacting.

"FAULTS"

This term does not apply to what a geologist would call a fault or a fracture of the earths crust withaa relative movement of the sides, but is applied to a condition of the coal bed in which the coal is not its usual thickness and most important of all the roof material is not normal, in other words the over lying strata are not of the same composition and texture as is the usual condition of the strata overlying the coal bed, but are more subject to caving, to such an extent that the bad rood conditions will not justify the expense of timbering the roof while the coal is being removed. The term "fault" is applied to this condition of the coal bed because of the fact the miner's work in extracting coal under these conditions is said to be faulty, thereby entitling him to a bonus if the coal is extracted. However some true geological faults have been reported at various places, one of the best known being the Nevius fault which is reported in the northeast part of the district

and has a N E - S W strike. The mines where this fault is reported, are at the present time worked out and abandonded. The only true fault that the writer has observed was in Jackson and Walker mine No. 17, in the 22nd south east entry at the face in Nov., 1924. The fault having a strike of north 42 degrees east and a dip of 37 degrees to the south-east, with a vertical displacement of twelve feet.

"HORSE-BACKS"

This structural feature in the Pittsburg-Weir District is different from what is known as horse-backs in other districts. They are not at all like the shape of a horse's back as are the swells in the floor of the other districts, but are a series of cracks or fissures that are more or less vertical and cut across the coal bed in various directions many of them intersecting others. The cracks or fissures have been filled with material from the floor and roof, making a typical clay vein.

CHARACTERISTICS OF THE "HORSE BACKS" AND FAULTS.

The gathering of the data and field work for this paper was done by the writer in the Spring, Summer and Fall of 1924. During this time most of the larger or deep mines were examined, and also a number of strip-mines especially in the south end where the structural

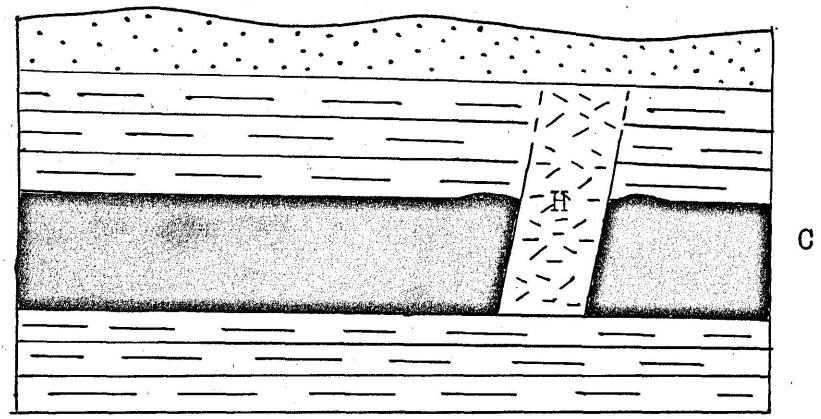


Fig. II
Diagram illustrating the relation of a "horseback" to the coal bed. H, horseback; C, coal bed.

features were more in evidence. The conditions at the Central Coal & Coke properties were studied in detail for two reasons, first their location in the district being in the western part is in a region containing a large number of the structural features in question, with the workings of this mining company being more or less continuous in a North and South direction and near the western limit of the known workable coal; second the Central Coal & Coke Company cooperated in this work, in making available any information that I desired, giving access to the underground mines, and to the mining and engineering records.

Desirable information was also obtained from the Crowe Coal Co. and Clemens Coal Co.

GENERAL CHARACTER.

So far as observed by the writer, and from information obtainable the "upper" coal bed is intirely free from the occurrence of "horse-backs" with possibly an occasional occurrence of a fault condition. The "upper" bed is subject to considerable variation in thickness. The "upper" bed lies about 45 feet above the "lower" or Weir-Pittsburg bed. In the western part of the district it is about 100 feet below the surface, in the northern section it is about 50 or 60 feet below the surface, while in the central part of the district it is only 15 to 25 feet, where it is worked to large extent by steam shovels. In the southern part of the field no trace of the bed is found. However it is being worked as far south as Cherokee. In the Wilburt and Schreeb mine, four miles west of Pittsburg, two thin beds of coal are found separated by a thin bed of shale, all occuring at about the normal elevation of the "upper bed". The shale bed is probably a parting within the "upper" bed. From east to west the "lower" bed dips about 20 feet to the mile and from south to north it dips about 4 feet to the mile, while the "upper" bed varies from this in that it has a

westward dip of only 12 feet to the mile. The regional dip of the Cherokee shales below the "lower" bed is about 20 feet to the mile, or in other words the inclination of the "lower" conforms to the bedding of the Cherokee shales below it. The difference in dip between the two coal beds indicates a considerable thickening of the shale material to the west during the interval between the formation of the two coal beds.

In general it may be said that both the "horse-backs" and faults are a great deal more common in the western part of the district than in the eastern part. "Horse-backs" may be found within the faults but usually are not in direct association with them.

The "horse-backs" in the majority of cases show that the crack containing the clay or rock material, was formed almost wholly by a tension being set up within the coal bed. This is indicated by the fact that the contact between the filling material and the wall material is a sharp well defined line of seperation. Often the minor irregularities along one wall of the fissure match up exactly with the irregularities on the opposite side, indicating a stretching force had been applied and the coal separated or pulled apart. That there was a pulling apart of the coal bed is also shown by the grequent occurrence of fragments of coal within the filling mater-

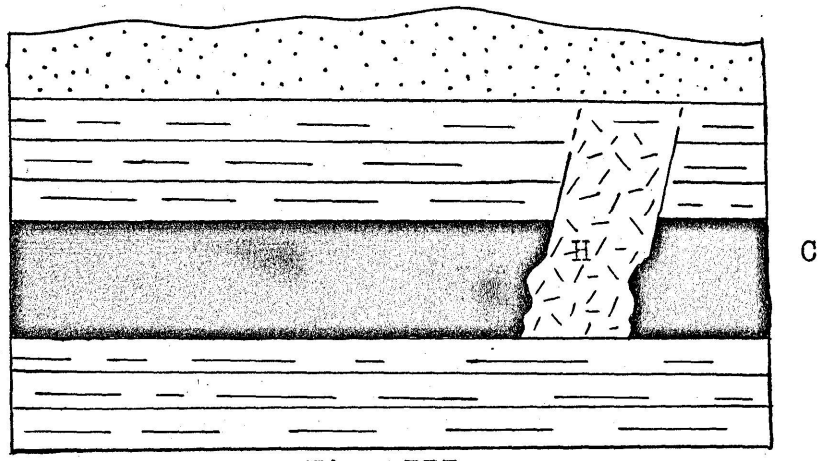


Fig. III
Diagram illustrating the relation of the walls of a "horse-back". H, "horseback"; C, coal bed.

ial, having the appearance of having dropped from the walls while the clay was being carried into the fissure, the fragments of coal contained within the clay materials hav a fresh unaltered appearance. The fissures usually extend for some distance into the overlying strata, it is not known about their downward extension, as the mining operations do not expose the strata below the coal, however it is very probable they do not extend below the coal bed. The character of the filling material varies to some extent with the width of the "horse-back". If the width is narrow, one to two feet, the filling material is usually of a softer nature, while the wider fissures seem to be filled with a harder more rock like material, often much harder than the enclosing shales, but in

most cases the filling material has a well developed slicken side appearance indicating a compressive force subsequent to the filling of the fissure. There is a usual tendency of the coal to thicken a few inches on either side of the "horse-back" for a distance of 8 or 10 feet or more. This condition is so regular that the miners can often tell if the mine workings are nearing a "horse-back" by the thickening of the coal bed. It also seems to be a general condition that in sections of the mines having a number of "horse-backs", the coal bed is often what is called "good coal". While the sections containing the "faulty" regions are more or less free from "horse-backs", but the coal is considered poor on account of its thinness and because of the bad roof conditions. Another observed characteristic of the "horse-back" is the down turning of shale layers near the top of the fissure, often the down turning is on one side only.

After examining a large number of mines and strip-pits it was not possible to say that a majority of the "horse-backs" had a uniform direction of strike or dip, however a number of the larger ones had a northeast south west strike, but in general it was found the direction of the strike is quite variable. See plate No. 1 for map of horse-backs exposed in a strip-pit. The angle

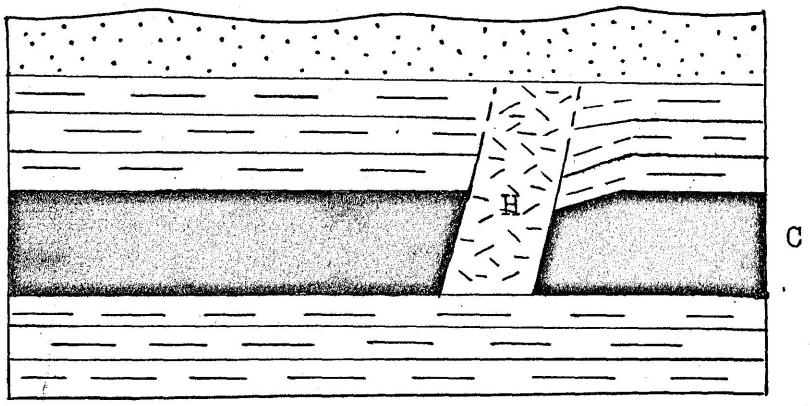


Fig. IV
Diagram illustrating the relation of the roof-rock to the coal bed, adjacent to a "horseback." C, coal bed; H, "horse-back".

of dip also varies considerable, in most cases the angle of dip is high, yet in some cases it was ovserved as low as 45 degrees.

A number of the characteristics of the "faults" have already been noted, however an outline of their more important features would be; their lack of relationship with either the structural "highs" or "lows" of the coal bed, their disconnected or isolated arrangement without any apparent system of occurrence, their extreme variation in regard to size and shape, the usual occurrence on the top of the thined part of the coal bed of a few inches of "rash" a wash like material composed largely of fragmental coal, possibly the most significant characteristic of the "faults" is the absence of what is locally known as normal

top, or in other words the faults in most all cases have a sandstone roof, while the regional roof-rock of the district is a shale containing some little amount of sand but by no means enough to be called a sandstone. This condition of the fault roof is so common, that the presence of a sand rock roof indicates at least a fault condition, and in most cases is close if not within a "fault" area. The coal in the "fault" regions is hardly ever worked even though the thickness of the bed may be nearly normal, becuase of the fact the sand rock roof will not stand without timber supports and the thinness of the bed, and the increased cost of mining will not permit its being worked. See plate # 2 for the shape and size of faults.

Generalized section of formations in the Cherokee shales above the coal bed. Hole"X" is typical of the holes in fault areas.

soil and clay	6 ft.		
limestone	4 ft.	Hole "X" continued.	
blue slate	5 ft.	black slate	5 ft.
limestone	13 ft.	coal	6 inches
black slate	2 ft.	fire clay	1 ft. 6 inches
coal	5 inches	gray sandy slate	25 ft.

fire clay	7 inches	black slate	5 ft.
sandstone	2 ft.	coal	6 inches
gray slate	86 ft.	fire clay	6 inches
black slate	6 ft.	Light gray sandy	
coal	1 ft. 5 in.	slate	23 feet.
fire clay	7 inches	coal	8 inches
limestone	3 ft. 6 in.	fire clay	2 ft. 4 in.
blue slate	6 ft. 6 inches.		
limestone	2 ft.		
black slate	3 ft.		
fire clay	1 ft.		
coal	1 ft.		
fire clay	2 ft.		
gray slate	20 ft.		
black slate	3 ft.		
coal	8 inches		
fire clay	1 ft. 4 inches		
gray slate	26 feet		

Generalized section of formations in the Cherokee shales above the coal bed. Hole "Y" is typical of the holes not in a fault area, but where the formations over the coal are "normal".

Hole # Y

surface	4 ft. 8 in.	
limestone	5 ft.	hole "Y" continued.

black shale	3 ft.	coal	5 in.
coal	2 in.	gray shale	24 ft.
shale and sandstone	97 ft.	Coal	3 ft. 4 in.
blue black shale	5 ft. 10 in.	fire clay	8 in.
coal	1 ft. 8 in.		
drab clay	4 in.		
limestone	6 ft.		
black shale	6 ft. 3 in.		
drab shale	3 ft. 8 in.		
coal	7 in.		
shale and sandstone	12 ft. 6 in.		
coal	5 in.		
shale and sandstone	5 ft. 1 in.		
blue and black shale	6 ft. 3 in.		
coal	1 ft. 7 in.		
shale and sandstone	14 ft.		
blue and black shale	5 ft.		
coal	4 in.		
shale and sandstone	26 ft.		
blue and black shale	6 ft. 3 in.		

GEOLOGICAL HISTORY OF PENNSYLVANIAN PERIOD.

The character of the sediments of the Pennsylvanian period indicate that they were deposited in shallow seas.

The surface of the Mississippian formation in eastern

Kansas sloped to the west, these sloping surface rocks being made up largely of limestone were soluble * and as a result many large underground channels were developed, in time forming a typical Karst topography which is a surface dotted with sink holes fromed when the roof of underground channels cave in. The lack of basal conglomerate indicates that the drainage from the Ozark land mass had been rather sluggish. The deposition of the Pennsylvanian took place on this truncated Mississippian surface, the submerged Karst topography and drainage systems, forming more or less disconnected bays, in which a greater thickness of sediments accumulated.

The coal swamps of the Cherokee were of the coastal type and were destroyed many times by invasions of the sea, this is indicated by the presence of several distinct coal beds within the Cherokee formation and by at least two beds of limestone containing marine fossils. That these invasions of the sea were usually simultaneous over large areas is shown by the widespread distribution of the formations. That the relations between the land and sea were very changeable is indicated by the wide variation in the lithological character and the re-

* Missouri Bureau of Geology and Mines, Vol. 13.

lative thickness of the formations. That the bog or swamp in which the coal was formed was dotted by islands or at least shallow places in the swamp is indicated by the fact that the coal beds are not of a uniform thickness over any large area, while the beds may have a rather constant average thickness, yet they sometimes thin considerably. The Cherokee time was characterized by relatively slow and uniform changes in the sea floor of the present southeastern Kansas, and the adjacent land mass. The absence of faulting or sharp folding indicates the movement could not have been a violent disturbance. That there was a movement is indicated by the great variation, both vertically and laterally, in the lithological character of the formation. At several different periods within this time of unrest and movement occurred times of stability or quiet, indicated by the several different coal beds.

At a time subsequent to the Cherokee and probably at the close of the Pennsylvanian, a slight amount of folding took place, forming low folds whose axis trend northwest and southeast. These folds may be noted in most of the deep mines, especially those in the western part of the district. Mine No. 45 of the Central Coal Mining Co. shows a number of folds trending north-west and south-

east and having a rather high angle of dip. In some cases as high as 10 degrees dip was noted. In one place in this mine, in a synclinal portion of a fold a considerable seep of petroleum occurs in the roof of the coal bed. The mine foreman gave the information that as much as a bbl. a day had been the estimated quantity of oil flowing from the strata. The bed of coal just under the oil seep was apparently saturated with oil, the saturation of the coal taking place after the mine was opened up and the roof rock broken into. No chemical analysis of the oil was made by the writer, but its physical properties appeared to be that of normal crude petroleum, it having a strong odor - as if it still contained the volatile hydrocarbons.

The shales exposed at the strip-pits in the south end of the field have numerous joint planes, running in various directions.

ORIGIN OF "HORSE-BACK" AND "FAULTS".

There have been many theories for the origin of the "horse-back". One of them is that they represent either a fissure or a solution channel along which circulating ground water has carried sediment and eventually filled the opening with the deposition of the sediment, this along with several other theories have been advanced, but so far as the writer is aware not nay of the theories

offer any suggestion as to the cause of the fissures. That they are of the true fissure type there seems little doubt.

It has already been pointed out thittthe surface of the old Mississippian region on which the Cherokee was deposited, was that of an irregular topography, caused by solution of the limestone by ground waters, and also by the presence of anticlinal ridges and synclinal valleys. Attention has been called to this condition by reference to both the Missouri and Kansas Geological Survey publications, which it is said, "Contour maps of Cherokee shale thickness are negatives of the relief or topography of the pre-Pennsylvanian floor at the time of the Cherokee sedimentation".

As has been previously stated the field evidence is conclusive that the fissures were formed by a tension type of force, or a stretching of the beds. This tension may have been due to either or all of the following factors.

1. A warping of the sea floor during subsidence may have affected only a local section of the beds, if this warping continued during Cherokee times at least intermittently, the result would be that there would be a less amount of deposition take place over the upwarped portions while the thickest places of deposition would be in the

down warps.

2. Differential settling of the sediments, the accumulation being much thicker in regions directly over sink holes or surface depressions of the old Mississippian surface, causing a down warping of the areas of maximum deposition. It is generally recognized that after sediments have been deposited and a great deal of the water has been drained from them, shrinkage will occur, and in direct proportion to the amount of compactible sediments which are present. Blackwelder * states shrinkage due to compacting of the sediments amounts to about 35% in shales. In some cases it may be as high as 60 percent.

The upper surface of the Mississippian is shown by well logs to be very uneven, the variation in depth being as much as 100 feet in a comparatively short distance. ** The surface of the land at the close of the Mississippian time was about as uneven as the present topography of the Ozarks. There is therefore little doubt but that some at least of the structural features of this district are the result of shrinkage or settling of the sediments over buried topographic features.

* Blackwelder, American Association of Petroleum Geologists, Vol. IV, page 89, 1920.

** Missouri Bureau of Geology and Mines, Vol. 4, page 32.

If the sediments were deposited in a basin or depression 100 feet deep, application of the estimate of Blackwelder for a compacting of 35 percent would account for a present structural down-warp of about 35 feet.

3. Uneven condensation of sediments due to differential compression of lithologically different clastic sediments. Blackwelder * states that shrinkage due to compacting amounts to about 2 percent in sands, 5 percent in limestones, and 15 to 35 percent in shales. The Cherokee formation is made up mostly of shales with some sandstones, the most characteristic feature of the formation is the great variation in the lithological character of the sediments.

Therefore the writer would suggest that the theories as stated under numbers 2 and 3 seem to be the most probable for the origin of the fissures forming the "horsebacks". That is they were formed by folds which were in turn formed by the shrinkage or settling of the sediments over buried topographic features of the Mississippian, and in part to a lateral shrinkage due to the loss of water from the sediments.

* Blackwelder, American Association of Petroleum Geologists, Vol. IV, pages 89, 90, 1920.

ORIGIN OF FAULTS.

The origin of the "faults" is not as clear as that of the origin of the "horse-backs", however there is probably a close relation between the two types of structural features.

One of the most common characteristics of the "faults" is presence on top of the coal bed of a few inches of wash material known locally as "rash". Labeled specimens of this rock material accompany this report, they were gathered from Mine No. 45 Central Coal & Coke Company, No. 18 Jackson & Walker Mining Company, and from several strip-pit mines in the south end of the district. They are all very similiar in that they represent a sandstone containing fragments of coal. In comparison to this are samples of the shale or normal formation over the regular thickness of coal. The examination of several hundred drill logs shows this difference in the character of the roof or of the formation directly overlying the coal bed. A possible explanation of why they are of a "wash" origin and yet not continuous for any great distance may be due to the following donditions. After the coastal type coal beds were formed, and some sediments were layed down on top of the coal, drainage systems were established when next uplifted above the sea, these drainage systems probably

being determined by the compacting of the sediments over the maximum thickness, the drainage developing into a small stream and cutting down thru the sediments but not to the top of the coal bed. At the same time the stream was cutting its way down, gentle folding took place, at right angles to the direction of the stream drainage, as these folds lifted their axis upward the stream eventually cut down across the crest of the folds eroding off the top of the coal bed and leaving the evidence of wash or rash. As this folding was only very slight it is not now in evidence being blotted out by the continued compacting of the sediments and the further settling over the old Mississippian Karst topography.

MAP of FAULT AREAS

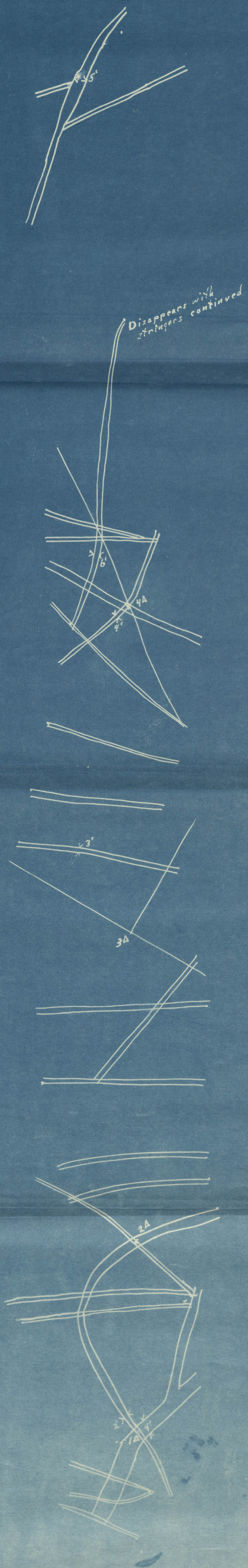
contour lines on top of coal bed.

fault areas ruled

normal coal areas solid

scale 500 ft. to 1 inch

G. E. Abernathy 1925



Plan of "Horsebacks"
Pittsburg Midway Coal Co.,
Strip-pit No. 10.

Scale 25' to 1"

G.E. Abernathy 1925