

## THE CLAY SEAMS (HORSEBACKS) IN THE NUMBER 5 COAL BED, NEAR SPRINGFIELD, ILLINOIS.

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The principal coal seam exploited in western Illinois, over the area between Springfield and Peoria, was designated in the Worthen reports as number 5. The following section shows the character of the strata associated with the number 5 coal in the Springfield quadrangle:

	FEET
Sandstone or shale .....	10 to 30+
Light gray shale or soapstone .....	1½ to 4
Limestone cap rock .....	½ to 1⅔
Black, fissile shale .....	2½ to 4½
Coal (Number 5) .....	5 to 6½
Fire clay .....	1½ to 5

One of the conspicuous features of the number 5 coal seam is the presence of numerous clay-filled fissures that extend down into, or through, the coal seam from the overlying beds. The fissures are generally from two or three to sixteen inches in width, although the larger ones attain a width of three or four feet. Their walls are slickensided, but do not show any traces of weathering. The spaces between the walls are filled with a light gray shale or soapstone.

These fissures, with their fillings, are known to the miners as horsebacks. There is no regularity in the distance between these horsebacks, or clay seams, or in the direction in which they extend. In some mines they are encountered about forty to sixty feet apart, while in others they are separated by a distance of two hundred to four hundred feet, or more. They traverse the coal seam in various directions, no single direction greatly predominating even in the same mine.

The shale filling the fissures is light gray in color and is gen-

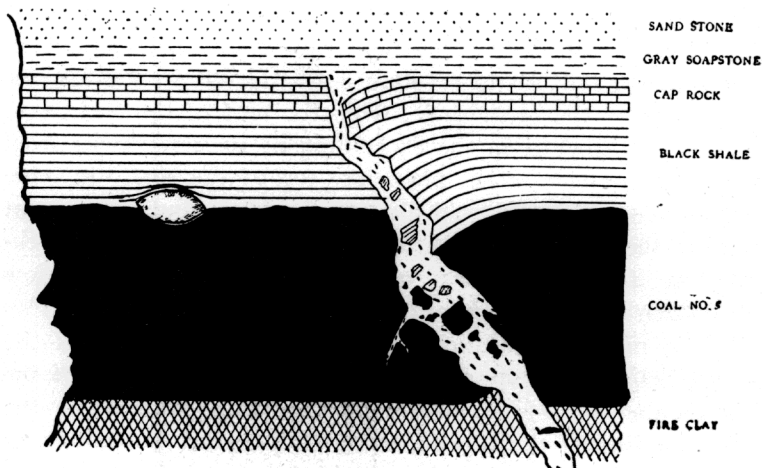
erally rather soft. In rare cases it is so hard that it emits sparks when struck with a hammer, but usually it soon slakes down into an incoherent mass upon exposure to the air. Where the horseback enters the top of the coal seam the fissure at once becomes wider. The upper laminæ of the coal, immediately adjacent to the fissure on the overhanging side, are more or less steeply bent downward, the bending or buckling of the layers fading out laterally within a few feet from the fissures. Fragments of the black shale, from the roof of the coal, were seen at many points in the clay filling of the horsebacks from five to twenty-nine inches below the top of the coal. In mine number 5 of the Springfield Coal Mining Company, a fragment of coal, six inches long and three fourths of an inch in thickness, was found in the clay of a horseback nine inches below the bottom of the coal seam.

In the mine last mentioned there was seen in three of the horsebacks a slight upward bending of the lower edge of the coal on the side of the fissure opposite to that in which the down-bending at the top occurred. This upward bending at the bottom, however, is only one third to one half as great as the down-bending of the coal at the top of the seam in the same horseback. When the clay seam passes into the coal bed in a nearly vertical direction there is a down-bending of the coal at the top of the seam on each side of the fissure. However, the more nearly vertical the direction in which the horseback cuts through the coal, the less is the distance through which the edges at the top and bottom of the seam are bent.

In no instance was there seen a true faulting of the beds. I wish to emphasize the fact that in no case was there a slipping of the middle part of the coal seam on one side of the fissure above the level of the corresponding part of the seam on the opposite side. The only vertical displacement is a downward pushing of the cap rock and roof shale, and a down-bending of the upper laminæ of the coal on the overhanging side of the fissure, through a vertical distance of from two to twenty inches; and, less frequently, a much smaller upward bending of

the lower edge of the coal seam on the opposite side of the fissure, as shown in the accompanying figure.

HORSEBACK IN MINE NO. 5  
OF  
SPRINGFIELD COAL MINING CO.



In this area the fissures have a very limited vertical extent. In the Mechanicsburg mine a coal seam was formerly worked about thirty-five feet above the number 5 bed which is at present being mined. Although these two coal seams are separated by an interval of less than forty feet, the number 5 coal is traversed by numerous clay seams, while none were encountered in the upper bed.

It seems certain that there was a somewhat ready yielding of the coal mass in a lateral direction when the fissures were formed. This is shown in the fact that the walls of the fissure are much wider apart in the coal bed than in the overlying roof shale and cap rock. The clay seams always cut the bed in an oblique or a vertical direction, never following the partings or stratification planes of the coal seam, even where these are well marked. The amount of downward slipping of the cap rock is always less than the extent to which the upper edge of the coal seam overhanging the fissure is bent downward. All of

the movement, both horizontal and vertical, that has taken place in connection with the clay-filled fissures seems to have been made possible by the yielding of the materials within the coal seam itself.

That the coal offered accomodation to the strains that caused the formation of the fissures is shown by the fact that within the coal seam the smaller fissures often divide into a number of branches which eventually die out without passing entirely through the bed.

The clay filling the fissures is thought to have been pressed downward through the break in the cap rock and roof shale into the coal from the bed of gray shale or soapstone overlying the cap rock. As this clay was forced downward into the fissures it caught the overhanging and unsupported edges of the cap rock, roof shale and coal, bending those edges downward on the overhanging side of the fissure.

That this clay was, for the most part, squeezed downward from above the coal horizon is indicated by the manner in which the upper edge of the coal seam overhanging the fissure has been bent downward to a much greater extent than the lower edge of the coal on the foot-wall side has been forced upward. It is shown in the fact that fragments of black shale from the roof of the coal are common in the clay filling of the horse-back several inches below the top of the coal seam; and fragments of coal also occur in the clay some inches below the bottom of the seam. In no case were coal fragments found in the clay filling at a level higher than the top of the coal.

#### SUGGESTED ORIGIN OF THE CLAY SEAMS.

It is thought that the formation of these clay filled fissures was intimately related to the character of the beds above the number 5 coal. It is probable that the character of the underlying fire clay, which here is dry and does not creep readily, is also a conditioning factor. The fissures were not formed, as at present, until after the vegetal mass composing the coal seam had been compressed to near its present volume. This

is shown in the fact that the clay seams show no bending or buckling such as would result if much compression of the coal had occurred after the horsebacks were completely formed. Where the lower edge of the coal rests upon the clay filling of the horseback, the laminæ are not curved upward adjacent to the fissure as they would be if the coal at a distance from the fissure had been compressed or settled downward since the horseback was formed. That a degree of consolidation of the coal sufficient to permit of jointing had occurred prior to the formation of the horsebacks is shown by the fact that in some places the clay from the fissures has spread into the joints of the coal adjacent to the horseback.

Campbell\* suggests that joints are developed early in the process of coal formation, and that the carbonization of the coal, beyond the lignite condition, depends upon the presence of joints and cleavage planes along which the gases could find a way of escape. If this is the case, there would be a considerable amount of compression and contraction of the coal seam after the joints were formed, before the vegetal mass reached the condition of bituminous coal.

It is assumed that as the mass of vegetal material, under the weight of overlying sediments, was slowly transformed into coal, there would be somewhat unequal contraction in different parts of the seam, owing to the lack of homogeneity of the vegetal materials making up the coal beds; and that the contraction of the coal materials continued long after a high degree of consolidation of the coal had taken place. So long as the materials possessed some degree of mobility the unequal shrinking in the different parts of the coal seam would be equalized by the movement of some of the mass towards the points of least pressure. When the consolidation reached a certain point such adjustment would be no longer possible. After this, the continued unequal shrinking of the vegetal mass would cause unequal strains in the roof of the coal under its load of superposed sediments.

If the roof of the coal seam was a soapstone, or somewhat

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\*Campbell: Economic Geology, Vol. I, No. 1, p. 30.

plastic shale, the mobility of the shale particles would permit this zone to adjust the inequalities of strain resulting from the unequal contraction in the coal seam. Such conditions exist in the roof of coal number 6 in the Carterville-Zeigler district of southern Illinois. Rock rolls occupying depressions in the top of the coal are here common, but no clay seams penetrate the coal bed. In the vicinity of these rolls the roof shale is cut by slickensided zones for a distance of several feet from the center of the roll, indicating a considerable lateral movement in the shale in accomplishing the adjustment of the strains. However, the roof of coal number 5 is a hard, brittle shale whose constituent particles do not possess the mobility requisite for such adjustment. If the limestone cap rock was very thick it might be able to withstand, without fracture, the unequal strain due to unequal contraction in the underlying coal seam. But the cap rock of this coal is thin, averaging only twelve to fourteen inches. The combined strength of the roof shale and cap rock was not sufficient to withstand the unequal strain to which they were subjected, and fissuring of the beds resulted.

Immediately above the cap rock of this coal seam is a bed of rather soft, gray shale or soapstone whose particles were sufficiently mobile to bring about adjustment in the unequal strains which, by the fissuring of the roof shale and cap rock, had been transferred to this higher horizon. The materials from this shale horizon were immediately squeezed downward through the fissures as wedges into the coal seam, until the inequality of pressure was adjusted. Under these conditions the place in which adjustment was accomplished was limited to a narrow zone below the point where the fracture was made in the roof shale and cap rock. Hence the effects were confined to a narrow zone horizontally, but they became thus strongly marked in a vertical direction.

It is probable that from time to time, as the shrinking in the coal mass continued, more clay was forced downward into the coal seam, fissuring it still deeper and spreading the walls of the fissure constantly wider apart. The abundant evidences that the clay filling the fissures in the Springfield coal seam was

pressed down from above the coal have been given on a preceding page. In this manner, also, the slickensiding was accomplished by the slipping of the clay in the fissure, and not by the movement of the walls of the fissure upon each other.

It is thought that the principle of unequal contraction in the different parts of the coal seam, during the progress of its consolidation, applies also in the formation of the more common types of rock rolls in the top of coal seams in Illinois. The character and sequence of the beds above the coal seam are considered the chief factors in determining whether rolls or clay seams will be formed in the adjustment of the strains arising from such unequal contraction.

It seems probable that clay seams have been formed in different ways in different areas, under varying conditions of roof and floor, and varying degrees and kinds of strains to which the strata were subjected. It is not possible that earthquake phenomena or general crustal strains, such as produce wide-spread faulting, could be concerned in the formation of the fissures of the clay seams in the Springfield region. Fractures from the above-mentioned causes would not be limited to a few feet in vertical height, or to one particular coal seam, as in the area under discussion.