PRELIMINARY MICROSCOPIC INVESTIGATION OF ILLINOIS COAL

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In recent years a number of investigators have thoroughly studied the microscopic constitution of coal and have definitely established its vegetable composition. At first this work was general in scope, the investigations being concerned mainly with the original nature and succeeding modification of the coal material. Lately, however, Slater[1] in England, and Thiessen[2] in America have studied in minute detail specific coal seams, endeavoring to establish some sort of significant criteria for purposes of correlation.

Although pictures of thin sections cut from Illinois coals have been published in some of the literature on this subject, there has been no attempt made to determine the presence of any microscopic properties characteristic of coals of this State. A preliminary survey of this sort has been undertaken by the author under the auspices of the Illinois State Geological Survey.

A modification of the technique employed by Thiessen[3] is used in the preparation of thin sections of Illinois coal. Blocks are cut in the mine so as to make a complete column from bottom to top of the coal seam. Each block is carefully labeled and its position and orientation in the column indicated. In the laboratory the blocks are usually strengthened by immersing them in paraffin for from 24 to 48 hours at 60° Centigrade. More friable coals may be impregnated under vacuum with liquid bakelite and then baked for 12 hours at 105° Centigrade, after which they are quite hard and coherent under further treatment. Square chips about ¾ inch wide and ¼ inch thick are cut at right angles to the bedding. One face of the chip is ground flat on glass plates with successively finer carborundum powders and then polished on "selvyt" cloth using a paste of very fine slaked lime and

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[1] Slater, L., Evans, M. M., and Eddy, G. E., The Significance of Spores in the Correlation of Coal Seams, Part I, Department of Scientific and Industrial Research, Fuel Research, Physical and Chemical Survey of the National Coal Resources, No. 17, 1930.

[2] Personal Communication, Dec., 1930.

[3] White, David, and Thiessen, Reinhardt, The Origin of Coal, U. S. Bureau of Mines, Bull. 38, pp. 213-216, 1914.

water. After drying, the block is cemented on an object slide with Kollolith, a German preparation similar to Canada balsam. The chip is then ground down to transparency, first on a revolving lap, then on glass plates with the fine carborundum powders, and finally on a carefully selected Belgian hone. The final steps in the grinding demand extreme patience and care as coal at best is brittle and friable and a thin section may easily be torn and spoiled. At each step in the process of preparing a section, the number of the chip and its orientation is scratched on the coal or on the slide, and when completed a label indicates the position and uppermost side of the coal chip in the bed. After the final grinding the thin section is dehydrated with absolute alcohol and a cover glass is cemented on with Canada balsam or Kollolith.

The microscope reveals that coal is exceedingly variable in composition. Except for occasional mineral grains and mineral partings, the coal is made up exclusively of plant remains. Most of the organic material is seen to consist of a complex ground mass in which are embedded larger plant fragments. With higher magnification the ground mass resolves into disassociated fragments of wood and bark, particles of resinous matter, cuticle, and undifferentiated debris. This "attritus," as Thiessen[4] has named it, is composed of two sorts of material. It may be transparent under high magnification, or it may be opaque. The latter type has not been found in Illinois coals as yet.

Embedded in the ground mass are plant entities, spore-exines and resins being the most conspicuous. The resin particles are almost always spherical or oval in shape and were evidently strong enough to resist crushing in the processes of coalification. Dark coloured resins occur as isolated bodies or grouped in broad bands, whereas light coloured resins are distributed throughout the finely disseminated attritus or are retained in their original cellular positions in the wood.

Megaspore- and microspore-exines are prominent, the latter being one of the most common constituents in the attritus. Occasionally they are found in distorted groups and probably represent crushed sporangia. Remnants of the sporangia wall are sometimes preserved. Although the original shape of the spores was round or elongate, the exines have become flattened and disc-shaped during the process of compacting. Wing-like appendages, tufted ramenta, and other ornamentation can often be recognized on both the megaspore- and microspore-exines. Strips of cuticle are easily recognized because of their bright yellow color and distinctive form. They usually appear on one or both sides of crushed tissue, the inner surface of the cuticles being

[4] Thiessen, Reinhardt, Structure in Paleozoic Bituminous Coals, U. S. Bureau of Mines, Bull. 117, p. 25, 1920.

sharply serrate, while the entire strip may appear broken wherever stomates are encountered.

Especially noticeable in the macroscopic as well as in the microscopic study of coal are the glanz or bright bands. In thin sections these bands are long, lenticular, and of varying thicknesses, with a homogeneous appearance that marks them as individual plant structures. Often definite cell-structure is well preserved, indicating that they are crushed woody parts of the trees and shrubs that grew on the peat bog. Where cell structure is lacking it is more difficult to visualize the woody derivation of these bands. Some sort of replacement by a "fundamental jelly" may be indicated. These bright bands derived from wood are called "anthraxylon" by Thiessen.[5]

Fusain or "mineral charcoal" is a common constituent found in thin sections of coal. This is an opaque material observed in small, lenticular patches and in thin, broad partings. It retains an uncrushed, open, cellular structure, the cells sometimes being filled with secondary calcite or pyrite. By some authorities fusain is supposed to have originated from bacterial decay, although Jeffrey suggests that it represents wood charred by forest fires.[6]

The chief inorganic constituents of coal are pyrite and calcite or gypsum. Pyrite, quartz, and other small indeterminable grains are scattered irregularly through the bedding and make up a large part of the original ash of coal. Other grains of pyrite are locally abundant, sometimes in the heterogeneous ground mass and again in the anthraxylon. These are roughly spherical in shape and may have minute arms radiating out into the surrounding coal. This type of impurity was probably formed at some time after the deposition of the peat.

After establishing the plant origin of coal and identifying so far as possible the organic constituents, it has been the aim of investigators to set up some means of correlation between widely separated parts of coal horizons. Some sort of plant "index" fossil would serve this purpose admirably, but no recognizable plant identities have as yet been found in Illinois coals which do not have too wide a vertical range to be useful. Correlation may possibly be attempted with spore-exines, but a thorough and comprehensive classification must first be made. Identifying ornamentations on the exines are so modified in appearance because of the various planes in which they are cut that classification of this sort must be restricted to a relatively few groups.

[5] Thiessen, Reinhardt, Structure in Paleozoic Bituminous Coals, U. S. Bureau of Mines, Bull. 117, p. 24, 1920.

[6] Jeffrey, E. C., Origin and Organization of Coal, Memoirs Amer. Acad. Arts and Sci., Vol. 15, No. 1, 1924.

Thiessen[7] has developed a new avenue of approach to this problem. It seems probable that a complete section of a coal bed in any one place will exhibit the same gradation and vertical changes in its composition as other sections throughout the coal horizon. Therefore if a uniform profile can be set up for one coal seam and if that profile is different from those found for other coal seams, a dependable standard of correlation may be established. The proof of a method of this sort necessitates careful and detailed work. In the pursuit of such a study, other uses for coal microscopy will be earnestly sought for. Inherent characteristics of the coal as revealed in thin section may be found to have valuable applications in the industrial and commercial uses of coal.

[7] Personal Communication, Dec., 1930.