Proceedings of the Iowa Academy of Science

Volume 67 | Annual Issue Article 37

1960

Some Notes on the Occurrence of a Coal Seam in the Cedar Valley Formation of Johnson County, Iowa

Verne E. Dow
Iowa State University

Some Notes on the Occurrence of a Coal Seam in the Cedar Valley Formation of Johnson County, Iowa

VERNE E. DOW[1]

Abstract. Samples of carbonaceous material from several exposures of the Cedar Valley formation have been studied in order to establish a basis for calling the material a coal. Examination has shown that the material is a "cannel" coal, and it is believed to be one of the earliest known coals in North America.

Two years ago when U. S. Highway 6 was widened near the west end of the Iowa Avenue bridge in Iowa City workmen uncovered a bed of black, coal-like material in the Cedar Valley limestone. This deposit had been exposed in earlier years, but weathering had made it difficult to see. The origin and nature of this substance raised some discussion among geologists and others in the area. Is the material a coal? If so, of what is it composed, and under what conditions was it formed?

This coal was first mentioned in literature by D. D. Owen in 1849 (History of Johnson County, 1882, p. 549) in a report dealing with the geology of Wisconsin and Iowa. Owen referred to the material as "an earthy, carbonaceous substance, a kind of coal of humus. . . ."

This unit was discussed briefly by Dow (1959) and there has been some mention by others, but no detailed work has ever been done with it in order to establish what it is. There is no economic interest, but if it is a coal it would be one of the oldest known in North America and worthy of note from that standpoint.

LOCATION AND DESCRIPTION OF OUTCROPS

The unit in question is exposed at several places in the county, of which all but one can now be found. The best exposure is about one foot above street level at the west end of the Iowa Avenue bridge (NE¼ NE¼ SE¼ Sec. 9, T. 79 N., R. 6 W). The lithology at this location is as follows:

Coal, jet black when wet, dries to very dark brownish-black, very finely laminated, flat flakes, with strippled surfaces, alternating discontinuous very thin stringers of shiny black material and some thin layers of dark reddish-brown material with a resinous luster, a few masses of yellow-brown waxy material; some scattered lenticular masses of calcite between the lamina-

[1]Department of Geology, State University of Iowa, Iowa City, Iowa.

tions; readily breaks into rough cubes; the upper and lower contacts of the unit with the limestone are very sharp, and show some limonitic weathering products.

Material of similar lithology was exposed about two blocks south of this point at the site of the Hillcrest Dormitory addition, but construction work has since covered this exposure. The coal seam can also be traced northward along the exposure and quarry face near the Art Building. However, weathering here makes it difficult to identify the unit.

West of Iowa City, at Klein quarry (NW¼ NE¼ Sec. 2, T. 79 N., R. 7 W.) along the south wall in the Coralville member the following lithology can be seen:

> "Coal", black when wet, dries to dark blackish-brown, very fine grained; with thin laminations; darker bands of coalaceous material separated by interlaminated carbonate with some quartz sand; some lenticular masses of calcite up to 1 mm. between the fine laminations, most of the carbonate appears to be of a fragmental nature; very thin stringers and "globs" of vitreous, black "asphaltic" material, some thin discontinuous brown resinous bands; a few brachiopods and corals in the dark material; near a small fault there are some laminations of gray argillaceous material.

The exposures in the Vogel quarry north of Iowa City (center NE¼ Sec. 27, T. 80 N., R. 6 W.) and in the River Products Company two miles south-southwest (NW¼ Sec. 33, T. 80 N., R. 6 W.) show similar lithology to that in the Klein quarry, except that the material in the Vogel quarry carries a greater amount of carbonate.

Methods of Study

Insoluble Residue. The samples were treated with dilute acetic acid to save any conodonts which might be present, and the resulting residues were studied with the binocular microscope.

The insoluble residue from the Iowa Avenue and Hillcrest sections showed the following features:

> Mostly very dark, brownish-black flaky fragments with a stippled surface; 4-5 per cent irregular elongate masses of shiny black brittle material, with a conchoidal fracture; some pyrite, most of which has been altered to limonite; traces of brown waxy material; fish plates, teeth, scolecodonts, and unidentifiable black brittle masses with a stippled surface.

The insoluble residue from all other exposures showed similar constituents, but some of the flaky material was a lighter brown. There was very little sand or clay present in any of the residues.

Thin Sections. Thin sections from representative samples were made both parallel to and at right angles to the bedding. The descriptions are as follows:

Iowa Avenue bridge section—In the section cut normal to the bedding the material appears as very thin brown to yellow-brown rather indistinct bands 0.015-0.06 mm. thick, the bands are predominately brownish-colored with some yellow-orange bodies of what appears to be resin, some dark brown nearly opaque bodies, probably fish remains (plates, teeth, etc.). Between the laminations are tiny lenticular masses of calcite from less than 0.015-0.06 mm. (some larger masses of calcite were seen before sectioning). No silica was observed.

The section parallel to the bedding revealed microspores, fish remains, etc. These sections indicate 85-90 per cent carbonized spore exines, 5-10 per cent hydrocarbons, 1-2 per cent resins, waxes, and 2-3 per cent carbonate.

The thin sections from Klein, Vogel, and River Products quarries were quite similar and showed the following characteristics:

Thin stringers of dark brownish-black material 0.03 mm. alternating with layers of carbonate. Some of the carbonate occurs as lenticular masses between laminae, but most of it occurs as various sized fragments of fossils—corals, bryozoans, and brachiopods. Silica is present as subrounded to rounded grains of detrital quartz. The sections cut parallel to the bedding show the carbonaceous material better; spore exines and microspores were also observed. Carbonaceous material in these sections appears to be 40-50 per cent and carbonate and accessory material about 40-50 per cent.

Laboratory Determination. The following tests were made in order to establish a basis for identifying this material as a coal: specific gravity, weight percent of moisture and ash, and a check for hydrocarbon.

The specific gravity was determined for a number of samples with a low determination of 1.35 and a high of 1.38. The specific gravity of coal is considered as 1-1.80 (Ford, 1955).

Determinations of moisture and ash for samples from the Hillcrest and Iowa Avenue bridge sections are as follows:

	Weight per cent moisture	Weight per cent ash
Hillcrest sample	2.5690	24.3553
Iowa Avenue sample	8.4979	22.5250

In order to check for the presence of hydrocarbons in the sample, a small amount was powdered and placed in a vial of acetone. The coal imparted a deep brown color to the solvent and the solution glowed with a pale blue color under ultraviolet light. This simple test is an indicator of hydrocarbon.

Microfossils

The insoluble residues contained a number of scolecodonts. Scolecodonts are the jaws of polychaete annelids which are almost exclusively marine and capable of living in most any bottom environment. These fossils have very little value stratigraphically and have changed little from the Ordovician to Recent.

The only other microfossils found were a number of microspores which were recovered from macerated samples. The microspores have been mounted on slides, but as yet have not been identified with certainty.

The following evidence is suggested to support the idea that the coal is composed primarily of spore material, either megaspores or sporangia.

In a recently opened area of the Klein quarry a portion of the Lime Creek formation was exposed, consisting of dolomitic pyritiferous material with abundant fish teeth and some thin stringers of green plastic dolomitic shale. The residue from acetic acid consists of more than 95 per cent light yellowish-brown flattened sporangia, or megaspores (Dr. Grace S. Brush, personal communication), some pyrite, conodonts, and rounded quartz sand.

The spore cases from the Lime Creek did not impart a "cut" in acetone until after they had been carbonized over a flame. When the spore cases were heated they gave off the same coaly smell and heavy brown tar-like liquid as did the coal.

Some of the carbonized material was reduced to ash to compare it with the ash of the coal. The two appeared to be the same under the microscope except for the presence of conodonts in the Lime Creek sample.

Finally the carbonized material was compared with insoluble residue from the coal and found to be nearly identical.

The evidence cited above is sufficient to indicate that the same general type of material makes up this Lime Creek deposit and the Cedar Valley coal deposit. The state of preservation of the spore material probably represents, however, extremes in environment of deposition.

Interpretation

The Devonian coal-like material of Johnson County is believed to have been deposited under conditions similar to those of the well-known "black shales". Black shales may accumulate under a variety of conditions (Ulrich, 1911; Pettijohn, 1957) in both shallow and deep water, but in all cases there is little or no circulation of the bottom waters and there is low oxygen content. These conditions are often met in sea water, because salt water tends to impede overturn (Twenhofel, 1939). Schuchert (1910) postulated that carbonaceous material might accumulate in depressions in a shallow sea, and Goldman (1924) found such features in Chesapeake Bay.

There should be little doubt that this coal was deposited in water with low oxygen content in the bottom layers, and the general absence of clastics indicates little or no current. The question is whether the coal was deposited over a large continuous body of water or at the same time in a number of shallow disconnected basins. Was it laid down in an irregularly shaped body with small reefs, etc., projecting above the surface or was it deposited in deep basins in an otherwise shallow sea?

Except for the exposures at Hillcrest, Iowa Avenue bridge, and across from the Art Building, this unit is not traceable directly. However, the bed can be found in about the same stratigraphic position at other exposures in the county.

In the Klein, Vogel, and River Products Company quarries the coal becomes interlaminated with clastic carbonates and some sand, indicating that in these areas the material was more nearly marginal in deposition. These exposures could represent detrital deposition in disconnected basins, or they may be deposits from adjacent areas which projected above the water.

It is possible that this unit could be traced in the subsurface if well cuttings were sampled very carefully, but the unit is so thin and the material so light in weight that it is easily lost in drilling. The writer studied all available samples of wells drilled in Johnson County up to 1959 and was not able to detect any of the coal.

The Cedar Valley formation has been considered (Dr. A. C. Tester, personal communication) to have formed under a very shallow sea, as evidenced by ripple marks, cross bedding, etc. If this is the case, then slight fluctuation of sea or land would have a marked effect on the type of sediments accumulating in the area. The limestone on which the coal is deposited shows sufficient features associated with shallow water that the idea of deposition in deep basins should be excluded.

The writer thinks that during Cedar Valley time the seas of this area were quite shallow and contained irregularities such as reefs or shoals. If the land were uplifted only a slight amount, or if sea level dropped, the irregularities would project above the surface. If reefs or small ridges were then above the surface, two things would be accomplished; the reefs would serve as barriers to prevent circulation of water due to tides, etc., and they would provide a place for plants to grow. Such an environment must have been suitable for plants, as evidenced by the amount of spore material that accumulated. The spore material collected in the shallow stagnant water of the basins. Near the margin of the basin or basins, and around any low islands, detrital carbonate and some sand was laid down with the plant material.

These conditions prevailed for a relatively short time, however. Then either the land was submerged or erosion removed the barriers as limestone began to accumulate uniformly as before.

Some time after the spore material was accumulated, it was carbonized. Portions of the volatile materials were localized into thin asphaltic stringers as globules between the layers of compressed exines.

Conclusion

On the basis of laboratory study it has been determined that the material exposed in the Iowa Avenue bridge section, the Hillcrest section, and the exposure across from the Art Building is a coal. The material which makes up the unit is primarily exinite and hence would fall into the category of "cannel" coal, although it does not fit all the qualifications of a true cannel coal. In addition, the material cannot be called a coal in all exposures because of the amounts of detrital material present. However, regardless of the amounts of detritus in certain localities, the same type of organic material is always present and hence the unit may be identified in all localities.

This coal in the Cedar Valley is one of the oldest known in North America. Its association with limestone also represents an unusual set of circumstances. Nevertheless, an apparent reasonable explanation has been proposed.

Acknowledgments

The writer wishes to express his gratitude to Dr. W. M. Furnish, State University of Iowa, for his help in editing the final manuscript and for suggestions on certain tests which could be used.

Professor Allen C. Tester, also of the State University of Iowa, readily made available laboratory facilities which enabled the writer to do his quantitative and petrographic studies.

Literature Cited

Anonymous. 1882. History of Johnson County, Iowa City, Iowa, p. 544.

Brush, G. S. 1960. Personal communication.

Dow, V. E. 1959. Stratigraphy and ground water resources of Johnson County, Iowa. Unpublished Masters thesis, State University of Iowa, p. 57-58.

Ford, W. E. 1955. A textbook of mineralogy with an extended treatise on crystallography and physical mineralogy. John Wiley and Son, Inc., p. 778.

Goldman, M J. 1924. Black shale formation in and about Chesapeake Bay. Bull. Amer. Assoc. Petrol. Geol., vol. 8, pp 195-201

Parr, S. W. 1932. The analysis of fuel, gas, water and lubricants. McGraw-Hill Book Co., 4th ed., pp. 208-217.

Pettijohn, F. J. 1957. Sedimentary rocks. Harper and Brothers, 2nd ed., pp. 622-626.

Schuchert, C. 1910. Biologic principles of paleogeography. Pop. Sci. Mon., pp. 598-599.

Tester, A. C. 1960. Personal communication.

Twenhofel, W. H. 1939. Environments of origin of black shales. Bull. Am. Assoc. Petroleum Geol., vol. 23, pp. 1178-1198.

Ulrich, E. O. 1911. Revision of the Paleozoic systems. Geol. Soc. Am. Bull., vol. 22, pp. 356-359.