Palynological analyses of several Pennsylvanian coal beds from Santa Fe County, New Mexico

Robert M. Kosanke and Donald A. Myers

New Mexico Geology, v. 8, n. 3 pp. 54-56, Print ISSN: 0196-948X, Online ISSN: 2837-6420.
https://doi.org/10.58799/NMG-v8n3.54

This page is intentionally left blank to maintain order of facing pages.

Palynological analyses of several Pennsylvanian coal beds from Santa Fe County, New Mexico

by *Robert M. Kosanke* and *Donald A. Myers*, U.S. Geological Survey, Denver, CO 80225

Introduction

Samples of two Pennsylvanian coal beds were collected from the Sandia Formation, Glorieta quadrangle, Santa Fe County, for palynological analysis to ascertain whether they were of Morrowan or Atokan age. The first sample was collected 1,320 ft due north of BM 6610, on the south side of a ravine, approximately 500 ft west of the Atchison, Topeka and Santa Fe railroad tracks. It was taken from Sutherland and Harlow's (1973) section 93, bed 19, and was assigned to maceration 696–A, USGS Paleobotanical loc. no. D6662. The sample consists of 6 inches of bone coal at the base of a brown fissile shale sequence that overlies a thin seat rock and a brown micaceous shale.

The second sample was taken from an area northeast of section 93 (described above) on the south side of Galisteo Creek, east of the railroad tracks. This locality is approximately 2.5 mi northeast of Lamy, 3 mi southwest of Cañoncito, and 13 mi south–southeast of Santa Fe (Fig. 1). The sample was collected 2,493 ft N30°E from BM 6610 in the abandoned bed of an old wagon trail, at approximately 6,780 ft elevation, in a southwest-draining ravine that drains into Galisteo Creek. At this locality, the entire outcrop of the Sandia Formation lies in an area approximately 700 ft long from north to south and 100 ft wide from west to east. These rocks were originally assigned to the Yeso Formation by Booth (1977). Beds within the outcrop area are laterally offset by many northwest-striking minor faults whose displacements range from a few inches to less than 5 ft. The coal bed is badly sheared and occurs in a fault block in which the bedding is nearly vertical. The sample was assigned to maceration 696–B and USGS Paleobotanical loc. no. D6663, and it was subsequently reassigned to D6663–E when additional productive samples had been collected. To the west of the above locality, the Sandia Formation is in fault contact with Precambrian granite (granite gneiss of Booth, 1977; Embudo granite of Budding, 1972) along Booth's (1977) Apache Canyon fault, which is an extension of Budding's (1972) Garcia Ranch fault. To the east and south, the Sandia Formation is in fault contact with the Sangre de Cristo Formation (Wolfcampian) and the Yeso(?) Formation.

Sample preparation

Maceration 696–A (D6662) readily yielded palynomorphs, but because of the high non-coal content, it was treated with HCl and HF to remove carbonates and silicates. This treatment was followed with Schulze's solution, which contains one part of a saturated aqueous solution of $KClO_3$ and three parts of cold HNO_3 (90%), to partially oxidize the coaly material. This partially oxidized sample was washed with H_2O until a pH of approximately 7 was obtained. The sample was then treated with a 10% solution of KOH, which resulted in a soluble portion (salts of humic acids) and an insoluble portion (preserved botanic ingredients). The second sample (696–B) was treated in a similar manner, but did not yield a satisfactory assemblage of palynomorphs initially. The maceration process was repeated several times on this sample. Ultimately, palynomorphs were freed from the matrix, and an oily substance that covered the surface of the maceration beaker was released. Both macerations were screened using a 210-mesh Tyler screen. The fine fraction containing the small spores and pollen grains was mounted in balsam.

Palynology and coal petrology

We concluded that, palynologically, these two coal beds are Atokan, or close to the Atokan–Desmoinesian boundary. We based this conclusion on the presence of several species of *Laevigatosporites* (Table 1) in both macerations 696–A and 696–B. The genus first occurs in the Reynoldsburg Coal Member (Pennsylvanian) of Illinois (basal Abbott Formation = Atokan) and in the upper part of the New River Formation in the proposed Pennsylvanian System stratotype of West Virginia. However, the presence of *L. medius* Kosanke in both sets of New Mexico coal samples suggests a slightly younger age because the first occurrence of this taxon in West Virginia is in the basal part of the Kan-

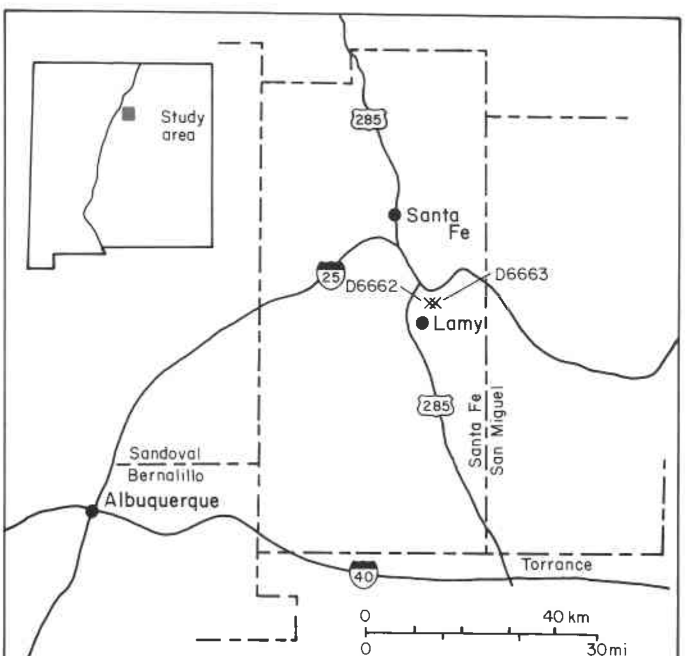


FIGURE 1—Geographic area where samples for this investigation were collected; **X** refers to approximate sample locations.

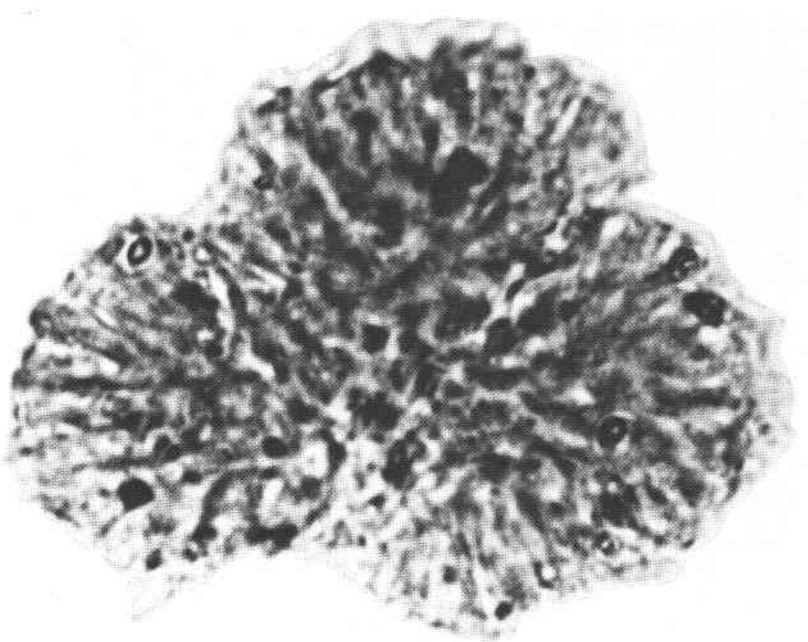


FIGURE 2—Three coalescing colonies of *Botryococcus* cf. *B. braunii* Kützing from maceration 696–Brr (D6663–E), slide 6, and microscope coordinates 98.5 × 7.7. The maximum overall diameter is 63 microns.

awha Formation. Differences between palynomorph assemblages in macerations 696–A and 696–B may be the result of better recovery and preservation in maceration 696–A. We do not believe the two samples are widely separated stratigraphically. The taxa identified from macerations 696–A and 696–B are given in Table 1.

TABLE 1—Comparison of palynomorphs extracted from the two coal beds from the Sandia Formation, Glorieta quadrangle, Santa Fe County. These samples were assigned laboratory maceration numbers 696–A and 696–B and USGS Paleobotanical loc. nos. D6662 and D6663–E, respectively. **X** indicates presence of taxon; 696–A is 6 inches of bony coal; 696–B is badly sheared coal in a fault block in which the bedding is nearly vertical.

Taxon	696–A	696–B
Acanthotriletes triquetrus Smith and Butterworth	X	
Ahrensisporites guerickei (Horst) Potonié and Kremp		X
Apiculatisporis abditus (Loose) Potonié and Kremp	X	
Botryococcus cf. *B. braunii* Kützing		X
Calamospora breviradiata Kosanke	X	
C. mutabilis (Loose) Schopf, Wilson, and Bentall	X	
C. parva Guennel	X	
C. sp.	X	X
Cyclogranisporites aureus (Loose) Potonié and Kremp		X
C. multigranus Smith and Butterworth		X
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall		X
Dictyotriletes castaneaeformis (Horst) Sullivan		X
Endosporites sp.	X	X
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	X	X
Florinites sp.	X	
Granulatisporites pallidus Kosanke		X
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	X	X
L. latus Kosanke	X	X
L. medius Kosanke	X	X
L. ovalis Kosanke	X	X
Leiotriletes priddyi (Berry) Potonié and Kremp	X	
Lophotriletes gibbosus (Ibrahim) Potonié and Kremp	X	
Lycospora granulata Kosanke	X	
L. sp. 1		X
L. spp.	X	X
Raistrickia cf. *R. prisca* Kosanke		X
R. sp. 1		X
R. sp. 2	X	
Reticulatisporites reticulatus (Ibrahim) Ibrahim	X	X
Vestispora fenestrata (Kosanke) Spode *in* Smith and Butterworth	X	
V. tortuosa (Balme) Spode *in* Smith and Butterworth	X	
V. sp.	X	
Monosaccate	X	
Unassigned	X	

The reason for the release of the oily substance in maceration 696–B is the common occurrence of the alga *Botryococcus* cf. *B. braunii* Kützing, which produces large amounts of oil. The body of *Botryococcus* is a free-floating colony that is enclosed by a cartilaginous and hyaline envelope (Fig. 2).

Sample 696–B can be considered a sapropelic coal because it is composed of finely degraded plant residue with a low anthraxylon (wood) content. Such coals are formed under stagnant anaerobic conditions and contain abundant spores, pollen grains, or algae. There are three primary types of sapropelic coals: cannel, boghead, and torbanite. Cannel coal is characterized by an abundance of spores and a small amount of anthraxylon; megascopically it has a dull luster and conchoidal fracture. Boghead coal is similar in physical appearance to cannel coal, but it contains an abundance of algae. Torbanite coal is equivalent to boghead coal because it contains abundant algal remains, but it is actually a highly carbonaceous shale. Its name was derived from Torbane Hill in Scotland.

The coal sample maceration 696–B, which contains abundant specimens of *Botryococcus,* cannot be classified as a true boghead coal because it contains equally abundant spores and pollen grains. Kosanke (1951) described a type of boghead coal from the Tarter Coal Member of the Abbott Formation (lower half of the Atokan Series) in Illinois that may be similar to the New Mexico coal sample. A 40-inch-thick sample of this coal from western Illinois contained abundant specimens of *Botryococcus* in the top 2–2.5 inches of the coal bed and a normal complement of spores and botanic ingredients in the remainder of the coal. The coal bed from New Mexico is sheared and distorted so that thickness and orientation of the bed are obscured. Because both spores and algal remains are reasonably abundant, perhaps this New Mexico coal (maceration 696–B) is partly normal coal and partly sapropelic coal. Stach et al. (1975, p. 236) reported that "It is assumed that bogheads were deposited mainly towards the centers of small swamp lakes, the cannels more toward the lake margins."

Botryococcus is an extant alga and, as such, is a living fossil. *B. braunii* Kützing is a planktonic alga that is widely distributed, although rarely abundant, in lakes of the United States and is sometimes found in permanent or semipermanent pools (Smith, 1933). The question of whether or not the Paleozoic forms of *Botryococcus* should be assigned to the extant species *B. braunii* has long been debated (*see* Blackburn and Temperly, 1936; Kosanke, 1951; and Traverse, 1955).

Fossil material identified as *Botryococcus* has been reported from Australia, France, Scotland, South Africa, Alaska, and other parts of the U.S., and Pennsylvanian boghead deposits or types of boghead deposits are known from Pennsylvanian, Kentucky, Illinois, and now from New Mexico. Thiessen (1925) reported *Botryococcus* from Mississippian, Pennsylvanian, and Permian deposits as well as some modern sapropelic occurrences. Schopf (1949) interpreted differences in appearance of *Botryococcus*-like genera to be a product of extreme variation in colony-form of *Botryococcus.*

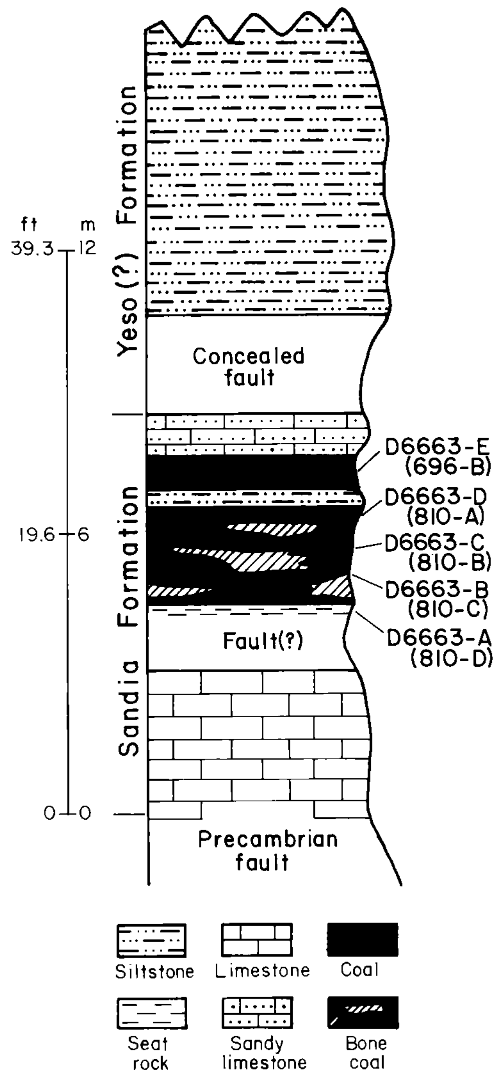


FIGURE 3—Stratigraphic section showing position of *Botryococcus*-bearing beds, USGS paleobotanical loc. nos. D6663–A—E. Maceration samples 810 A–C are impure, bony coal.

Because the occurrence of *Botryococcus* is rather unusual, we decided to collect additional coal samples below the original maceration (696–B). These additional samples were assigned to maceration series 810 as shown in Figs. 3 and 4. Two other samples were collected approximately 1,580 ft southwest of the boghead deposits from Sutherland and Harlow's (1973) units 31 and 39 in the Glorieta quadrangle. All samples assigned to the 810 maceration series yielded *Botryococcus* as well as spores and pollen grains. The assignment of paleobotanical collecting numbers and maceration numbers is shown in Fig. 3. The presence of *Botryococcus* in the seat rock and throughout the coal suggests a somewhat similar environment of deposition for these samples.

Maceration 808, USGS Paleobotanical loc. no. D6715, is a coal bed sample from Sutherland and Harlow's (1973) section 93, unit

FIGURE 4—Outcrop of 810 maceration series, USGS paleobotanical loc. nos. D6663–A—D. See Fig. 3 for measured section of this outcrop. The staff in collecting site D6663–D is 5 ft long.

31. This sample yielded only two palynomorphs: *Laevigatosporites latus* Kosanke and *Calamospora* sp. Maceration 809, USGS Paleobotanical loc. no. D6716, section 93, unit 39 of Sutherland and Harlow (1973) are plant-bearing shales (their "lignite"). This maceration yielded an interesting assemblage of palynomorphs including a number of specimens of *Torispora securis* (Balme) Alpern, Doubinger, and Horst. Kosanke (1973) reported that *Torispora securis* was present in northeast Kentucky from the Princess No. 5 coal bed through the Princess No. 9(?) coal bed. This distribution includes the upper part of the Breathitt Formation up to and including the base of the Conemaugh Formation. Kosanke (1984) reported that *Torispora securis* occurs from the top segment sample of the Stockton coal bed in West Virginia and throughout all of the coal beds of the Charleston Sandstone in the proposed Pennsylvanian System stratotype. Thus, the range zone of this taxon in West Virginia starts near the top of the Kanawha Formation. This and other information suggests that the occurrence of *Torispora securis* in maceration 809 from New Mexico is indicative of a stratigraphic position toward the middle of the Desmoinesian Series.

Summary

The palynomorph assemblages of the two coal beds sampled from the Sandia Formation suggest that they are Atokan, or close to the Atokan–Desmoinesian boundary. One of these samples, maceration 696–B, contained an alga—*Botryococcus* cf. *B. braunii* Kützing. This alga is a colonial form that produces large quantities of oil. *B.* cf. *B. braunii* has been reported from the Tarter and Willis Coal Members (Abbott Formation) of Illinois. The stratigraphic occurrence in Illinois is somewhat similar to the one in New Mexico. Four additional samples were collected below maceration 696–B and assigned to macerations 810 A–D (Fig. 3). All of these samples contained *Botryococcus*, which suggests a somewhat similar environment of deposition to that of maceration 696–B. Finally, two other samples were collected from Sutherland and Harlow's (1973) section 93. These were from units 31 (maceration 808) and 39 (maceration 809). Maceration 809 contains *Torispora securis* (Balme) Alpern, Doubinger, and Horst, which indicates that the age of the sample is middle Desmoinesian. In order for maceration 809 to be part of the middle Desmoinesian Series, the section must either be foreshortened or displaced by a fault.

ACKNOWLEDGMENTS—We wish to acknowledge the help provided by B. J. LeMaster and Mary Ellen Zayhowski who prepared the samples and assisted in the preparation of the illustrations. Also, thanks are expressed to Dr. R. William Baxendale, Amoco Production Company, Denver, Colorado; Frank Campbell, New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico; and Dr. John H. Hanley, USGS, Denver, Colorado, for kindly reviewing the manuscript.

References

Blackburn, K. B., and Temperly, B. N., 1936, *Botryococcus* and the algal coals: Royal Society of Edinburgh Transactions, v. 58, pp. 841–868.

Booth, F. O., III, 1977, Geologic map of the Galisteo Creek area, Lamy to Cañoncito, Santa Fe County, New Mexico: U.S. Geological Survey, Miscellaneous Field Studies Map MF–823, scale 1:12,000.

Budding, A. J., 1972, Geologic map of the Glorieta quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geologic Map 24, scale 1:24,000.

Kosanke, R. M., 1951, A type of boghead coal from Illinois: American Journal of Science, v. 249, pp. 444–450.

Kosanke, R. M., 1973, Palynological studies of the coals of the Princess Reserve district in northeastern Kentucky: U.S. Geological Survey, Professional Paper 839, 22 pp. [1974]

Kosanke, R. M., 1984, Palynology of selected coal beds in the proposed Pennsylvanian System stratotype in West Virginia: U.S. Geological Survey, Professional Paper 1318, 44 pp. [1985]

Schopf, J. M., 1949, Cannel, boghead, torbanite, oil shale: Economic Geology, v. 44, no. 1, pp. 68–71.

Smith, G. M., 1933, The fresh-water algae of the United States: McGraw-Hill Book Company, Inc., New York and London, pp. 121–135.

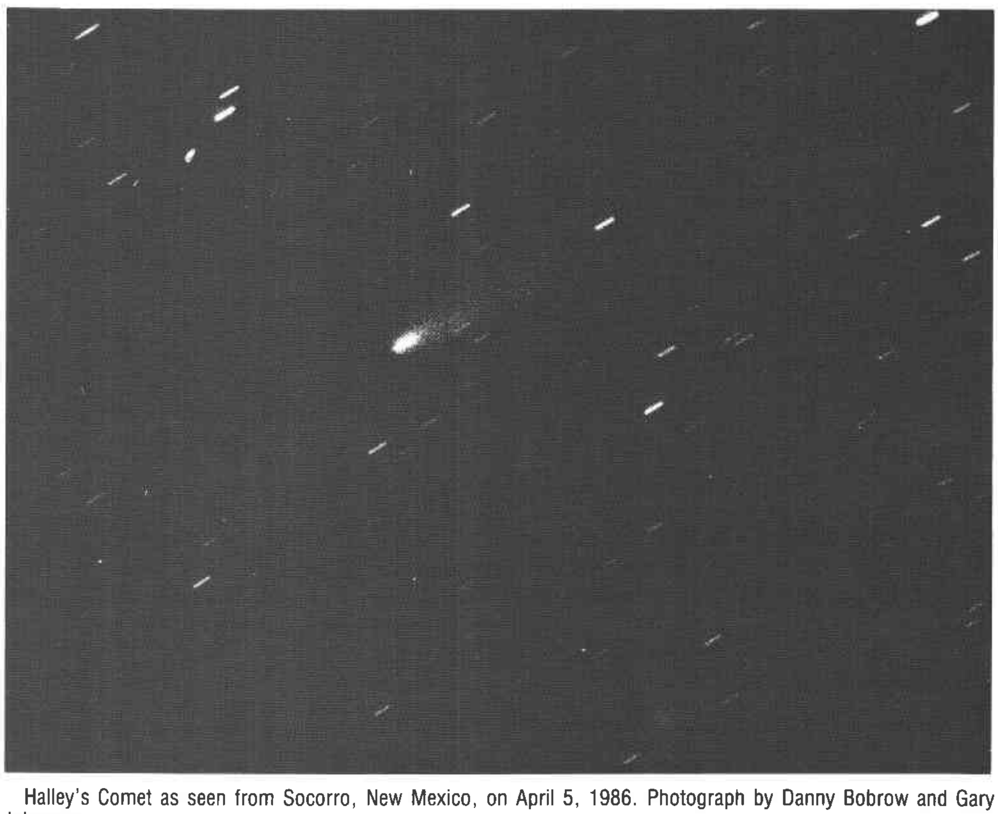
Stach, E., Mackowsky, M.-Th., Teichmüller, M., Taylor, G. M., Chandra, D., Teichmüller, R.; translation by Murchison, D. G., Taylor, G. H., and Zierke, F., 1975, Stach's textbook of coal petrology: Gebrüder Borntraeger, Berlin and Stuttgart, 428 pp.

Sutherland, P. K., and Harlow, F. H., 1973, Pennsylvanian brachiopods and biostratigraphy in southern Sangre de Cristo Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Memoir 27, pp. 130–132.

Thiessen, Reinhardt, 1925, Origin of boghead coals: U.S. Geological Survey, Professional Paper 132–I, pp. 121–138.

Traverse, Alfred, 1955, Occurrence of the oil-forming alga *Botryococcus* in lignites and other Tertiary sediments: Micropaleontology, v. 1, no. 4, pp. 343–350. □

Halley's Comet



Halley's Comet as seen from Socorro, New Mexico, on April 5, 1986. Photograph by Danny Bobrow and Gary Johnpeer.