Oklahoma Geological Survey

CARL C. BRANSON, Director

MINERAL REPORT 33

URANIUM-BEARING CARBONACEOUS NODULES OF SOUTHWESTERN OKLAHOMA

By

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PREFACE

James W. Hill, Commander, U.S.N.R., was killed February 13, 1954, in the crash near Denver of his jet fighter, while on a routine training mission with Naval Reserve Aviation Fighter Squadron 711, of which he was commander. Hill had prepared a draft report prior to his death; the report was completed by his Geological Survey colleagues, principally James W. Mytton and Garland B. Gott.

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Uranium-bearing carbonaceous nodules of southwestern Oklahoma

JAMES W. HILL*

U. S. GEOLOGICAL SURVEY

Abstract

Uranium-bearing carbonaceous nodules have been found along the north flank of the Wichita uplift in southwestern Oklahoma. The carbonaceous nodules are black, hard, brittle, highly lustrous, and largely insoluble in carbon disulfide or benzene. One specimen by analysis had approximately 42 percent carbon and 3 percent hydrogen. The uranium, vanadium, cobalt, arsenic, nickel, lead, and iron contents each range between 1 and 10 percent. It is concluded that the carbonaceous nodules are epigenetic and that the organic and inorganic constituents were derived from mobile solutions.

Introduction

During an investigation of the helium- and radon-bearing gases of the Texas Panhandle field, it was discovered that uranium-bearing carbonaceous nodules are sparsely disseminated in the gas-producing formations. This discovery led to the suggestion that similar nodules might occur in equivalent formations where they are exposed in the Wichita Mountains of southwestern Oklahoma. These ideas were later verified, and this report briefly covers the field and laboratory studies of this material.

Members of the Oklahoma Geological Survey, Mr. H. D. Miser of the U. S. Geological Survey, Mr. E. A. Debolt, Mr. Frank Gouin, and many ranchers of southwestern Oklahoma furnished samples and information. Mr. I. A. Breger coordinated the research and analytical work on the carbonaceous nodules in the laboratory of the U. S. Geological Survey. The author is indebted to these people and to many others who supplied helpful suggestions This paper concerns work done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

Geology

The dominant structural feature of the area in which the uranium-bearing carbonaceous nodules occur is the Amarillo-Wichita uplift, a northwest-trending geanticline that extends from the Wichita Mountains in southwestern Oklahoma across the Texas Panhandle.

The Wichita Mountains (fig. 1), which are the topographic expression of the Precambrian complex that forms the backbone of the uplift, occupy an area of approximately 1,200 square miles. These mountains are made up of isolated knobs of igneous and metamorphic rocks flanked by steeply dipping Cambrian and Ordovician marine limestones that are unconformably overlain by relatively flat-lying red beds of late early Permian age.

‡Publication authorized by the Director, U. S. Geological Survey

*Deceased, February 1954

Table 1. Chemical and spectrographic analyses of ashes of carbonaceous nodules and crude oils.

Sample No.	Field No.	Description and Location	Ash content (percent)	Uranium in ash (percent)	Uranium in nodules (percent)	Uranium in oil (ppb*)	More than 10% (XX.)	1.0 to 10% (X.0)	0.1 to 1.0% (O.X)	0.01 to 0.1% (O.OX)	0.001 to 0.01% (0.00X)	0.0001 to 0.001% (0.000X)	Tr.*
1	2-42	Carbonaceous nodules (Garber-Wellington), J. B. Sloan farm, SW-NE 30-6N-14W, Kiowa County, Okla.	15.84	2.36	0.7		Si,Ca	Al,Fe Mg,U,V	Ti, Mn, Na,K,As, Ba,Co, Cu, Ni, Pb,Sr,Y	Zn,Zr	Ag,B,Bi, Cr,Sc	Be	Ga
1A	2-42	do.	9.2	9.38	0.6		Si,Ca U	Al,Fe Mg,As, Co,Ni Pb,V,Y,	Ti,Mn, Na,K,Ba, Cu,Zn, Zr	Ag,B, Bi,Cr, Sc,Sr	Be,La		Ga
2	2-40a	do.	12.42	3.58	0.5		Si,Ca	Al,Mg–, K–,As–, U	Fe,Ti–, Na,Co–, Ni,Pb, V+,Y	Mn+,Ba, Cu, Dy, Er,Gd, Sr,Yb–, Zn,Zr	Ag–,B+, Cr,Sc	Be	Ga
3	3-211	Carbonaceous nodule — NE-NW-10 6N-17W (Pennsylvanian?), Royal Petrol. Co.-Krieger No. 3 (-1000') (not in area of map)						As+	Al,Ca+, Co,Ni, U+,(Si?)*	Fe+,Ti–, Mg+,Na, Ba+,Cu+, Pb,V,Y+, Zr+	Mn+,B–, Sr,Yb	Ag,Cr	
4	2-59	Frank Buttram — Boy Coy Sip No. 1, (Permian) asphaltic oil, NE-NE-2-6N-14W, Caddo County, Okla.	1.22	0.002		240	Na	V	Si,Ca, Mg,Ni, Sr	Ti,B,La	Al,Fe, Co,Cr, Cu,Mo	Mn	Ba, Ga
5	2-60	Z. N. Smith No. 1, 40° gravity oil, Apache Oil Field, 2-5N-12W, Caddo County, Okla.	0.0005	0.002		.1		Si,Fe,P, Mg,Na, Ni,V	Al,Ti, Ca,K, Ce,La, Nd,Sm,Zn, Zr	Mn,B,Ba, Co,Cr,Cu, Pb	Mo,Sr,Y	Ag,Ga	
6	2-62	N. B. Smith Well No. 4, 28° gravity oil, Apache Oil Field, 3-5N-12W, Caddo County, Okla.						Si,Al, Fe,Ca, Mg,Na, Ni,V	Ti,K,Co, Mo,Pb, Zn,Zr	Mn,B,Ba, Cr,Cu, Sr	Ga,Y	Be	
7	3-49	Debolt well, SW-NE-14-5N-15W, (Pontotoc group) asphaltic oil, Kiowa County, Okla.	0.021	0.0016		3.4		Si,Al–, Fe+, Cu–,Ni, Pb–,V	Ti–,Ca+, Mg,Na, K,Zn, Zr–	Mn,B,Ba+, Co,Cr, Mo–,Sn–, Sr+,Y–	Be–,La	Ag,Ga	
8	3-53	Adams Hill seep, Ft. Sill Military Res., (Garber-Wellington) asphalt 10-2N-11W, Comanche County, Okla. (not in area of map)	0.264	0.0011		29.0	Fe	Si,Ca+, V–	Ai–,Mn–, Mg,Na, Ba–,Ni+, Pb,Sr–	Ti+,Co, Cn,Zn, Zr	B+,Cr+, La,Mo+, Y	Be–	Ga
9	3-79	Amerada Petrol. Co.—B. F. Estes lease, (Missouri Series) asphaltic oil 10-5N-9W, Caddo County, Okla. (not in area of map)	0.064	0.0006		3.8	V	Si,Na–, Ni	Al,Fe+, Ca,Mg–, Zr	Ti–,Mn–, Ba–,Co+, Cu–,Pb, Sr	B–,Cr+, La,Mo	Ga	Be

Analysts: Spectographic analyses by A. T. Myers, Pauline J. Dunton, and P. R. Barnet, U. S. Geological Survey; and chemical analyses by C. A. Horr, U. S. Geological Survey

Explanation

*ppb—parts per billion

*(Si?)—probable amount of silica; not looked for in sample

*Tr.—trace near threshold amount for spectrographic analysis

+ means 4.6 to 10 percent, 0.46 to 1.0 percent, and 0.046 to 0.1 percent, etc.; – means 1.0 to 2.15 percent, 0.1 to 0.215 percent, and 0.01 to 0.0215 percent, etc.

The red beds consist of red arkosic shales overlain by red highly compacted shales that are interfingered with sandstones and argillaceous limestones. The Wellington formation, Garber sandstone, and Hennessey shale of Permian age are the most widespread units in the area and contain most of the uraniferous nodules.

Subsidiary folds that have resulted in the exposure of lower Paleozoic and Precambrian rocks parallel the main uplift along its northeast margin. The area locally known as the Limestone Hills is a reflection of these folds.

Uranium-bearing carbonaceous nodules

Uranium-bearing carbonaceous nodules are best exposed in the drainage of Saddle Mountain Creek, where the red beds unconformably overlie the lower Paleozoic and Precambrian rocks. Many of the nodule-bearing rocks exhibit a striking pattern with light-green or white bleached halos around each nodule (fig. 2a).

The nodule-bearing formations are associated with rocks of Paleozoic age that are highly petroliferous. These petroliferous rocks contain asphalt seeps in the Arbuckle group of Cambrian and Ordovician age, traces of soft viscous asphalt introduced into lenticular sandstone lenses within the Garber and Wellington, and asphaltic sandstone in the Wellington.

Most of the nodules collected for study are combustible, hard, brittle, highly lustrous, largely insoluble in carbon disulfide or benzene, and range from about 1 to 5 millimeters in diameter. The outer surface is ordinarily botryoidal, but the most weathered nodules have been altered to a soft pasty mass. The internal structure is radiating and fibrous, concentric and platy, or massive. Polished sections of nodules in figures 2b and 2c show the concentric radial fractures that are the result of weathering. All these internal features are cross-cut by an irregular pattern of small fractures.

Many of the nodules are homogeneous, but some contain small irregular grains of limestone as a nucleus. A few of the larger nodules contain a small nucleus of pyrite or limonite, suggesting concretionary growth about a center. The nodules are largest and most numerous in permeable zones and along fracture openings.

Laboratory studies were made of the nodules and of several nearby crude oils. Spectographic analyses of the nodules show an assemblage of trace metals similar to that found in crude oils (table 1). The most abundant metals of the carbonaceous nodules, in the approximate order of their percentages, include uranium, vanadium, aluminum, iron, nickel, cobalt, lead, arsenic, and yttrium. X-ray patterns show that the nodules contain smaltite, uraninite, and possibly coffinite.

Autoradiographs indicate that the uranium is uniformly distributed. The source of these metals is not clear. The spectrographic data show that similar metal suites exist in the igneous complex of the nearby Wichita Mountains and in the petroleum from this area.

One nodule, which had an ash content of 44.08 percent, was analyzed by E. B. Brittin of the U. S. Geological Survey, and found to contain 41.61 percent carbon and 2.90 percent hydrogen, a ratio of 14.4.

The nodules must have been either deposited in their present form as hard detrital grains, as a soft viscous material and after burial altered to their present from, or were introduced after lithification of the rocks.

It is improbable that the nodules are detrital because they have a botryoidal surface, lack abrasive marks or fractured surfaces, have a concretionary structure, are heterogeneously distributed, and lack accordance with bedding planes. It is also improbable that they were originally deposited in the form of a soft viscous material. This is indicated by the absence of sand grains within the nodules and the absence of horizontal flattening of the nodules, which would be the result of load compaction. The writer, therefore, concludes that the carbonaceous nodules are epigenetic and were formed by accretionary growth. The introduction of the organic and inorganic components of the nodules requires transportation by petroleum, aqueous solutions, or both.

SELECTED BIBLIOGRAPHY

Faul, Henry, Gott, G. B., Manger, G. E., Mytton, J. W., and Sakakura, A. Y., 1954, Radon and helium in natural gas: 19th Internat. Geol. Congress, Algiers, Comptes Rendus, vol. 9, p. 339-348.

Gott, G. B., and Erickson, R. L., 1952, Reconnaissance of uranium and copper deposits in parts of New Mexico, Colorado, Utah, Idaho, and Wyoming: U. S. Geol. Survey Circ. 219, 16 p.; see p. 5-8.

Hoffman, M. G., 1930, Geology and petrology of the Wichita Mountains: Oklahoma Geol. Survey, Bull. 52, 80 p.

Miser, H. D., 1954, Geologic map of Oklahoma: Okla. Geol. Survey and U. S. Geol. Survey. Scale 1:500,000.

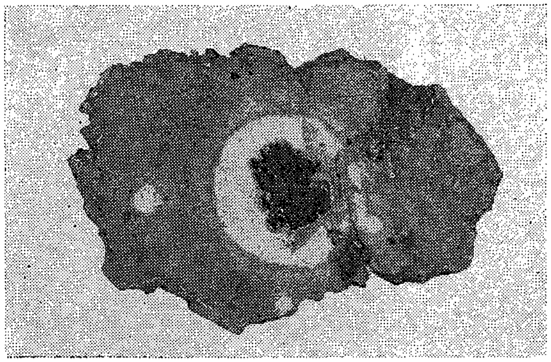
Perutz, Max, 1939, Radioactive nodules from Devonshire, England: Min. pet. Mitt. (Zeitchr. Kristallographie Mineralogie u. Petrographie, Abt. B) vol. 51, p. 141-161. [English text]

Schreiter, Rudolph, 1931, Bericht über die Exkursion nach Tharandt and Freiberg: Fortschr. Mineralogie, Kristallographie, u. Petrographie, vol. 16, p. 11.

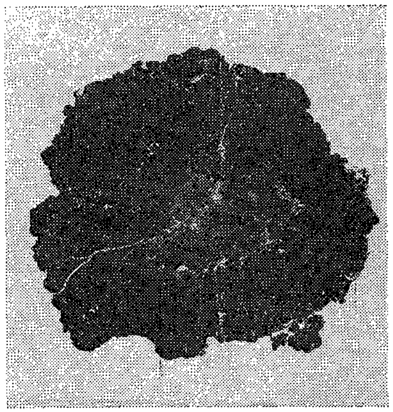
Selk, E. L., 1951, Types of oil and gas traps in southern Oklahoma: Amer. Assoc. Petroleum Geologists, Bull., vol. 35, p. 582-606.

Tulsa Geological Society, 1951, Mid-Continent region, Anadarko Basin, *in* Ball, M. W., ed., Possible future petroleum provinces of North America: Amer. Assoc. Petroleum Geologists, Bull., vol. 35, p. 316-343.

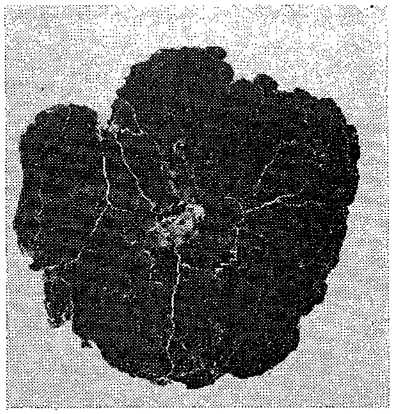
Figure 2. Photomacrographs of Polished Sections of Carbonaceous Nodules.



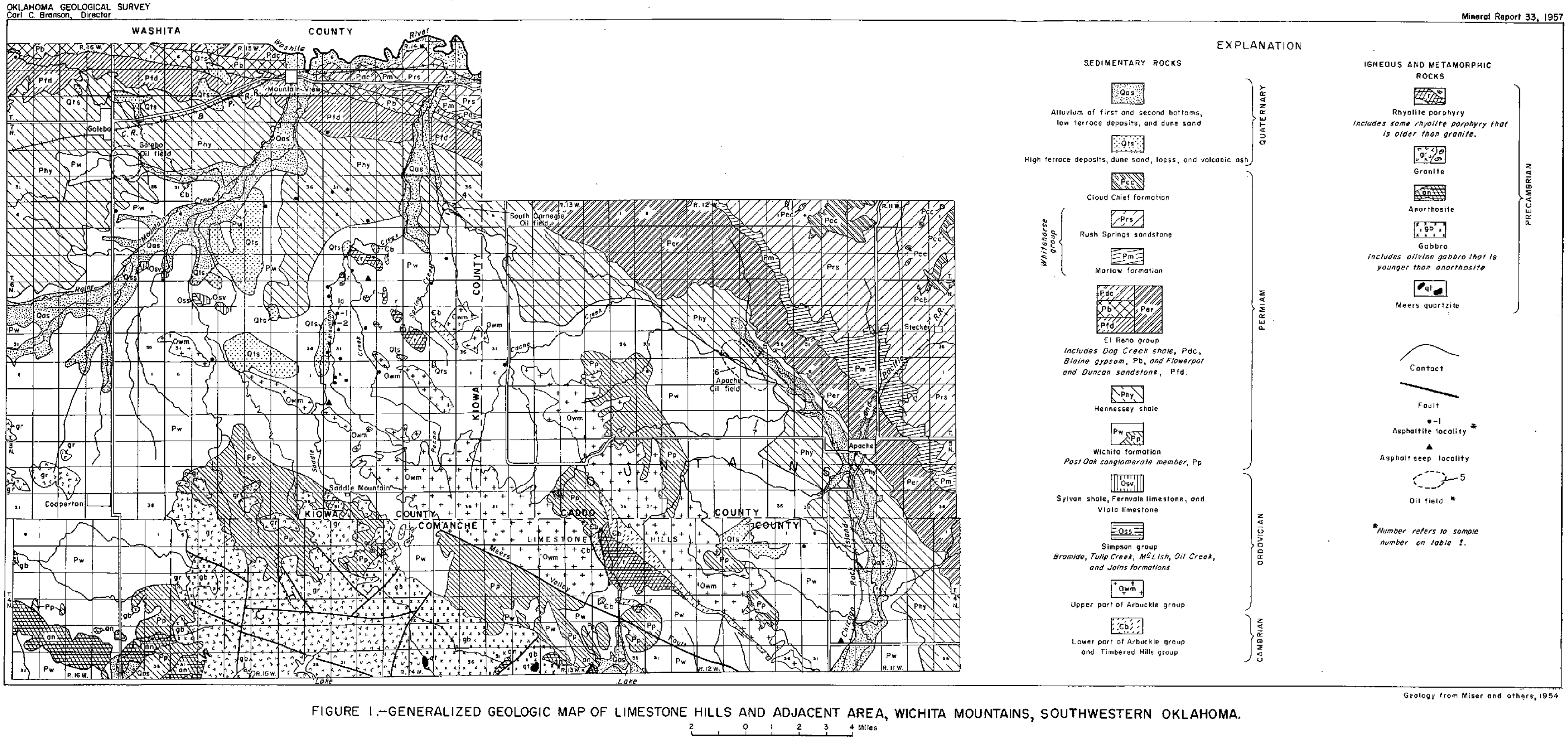
a. Photomacrograph of polished section of red calcareous shale with imbedded carbonaceous nodule surrounded by light-green halo. Diffused light. X3.8.



b. Photomacrograph of polished section of carbonaceous nodule showing radiating fractures caused by weathering. Diffused light. X3.8.



c. Photomacrograph of polished section of carbonaceous nodule showing metallic nucleus, and concentric radial fractures caused by weathering. Diffused light. X2.6.



Geology from Miser and others, 1954

FIGURE 1.–GENERALIZED GEOLOGIC MAP OF LIMESTONE HILLS AND ADJACENT AREA, WICHITA MOUNTAINS, SOUTHWESTERN OKLAHOMA.