URANIUM-BEARING CARBONACEOUS NODULES OF SOUTHWESTERN OKLAHOMA

By James W. Hill

Trace Elements Memorandum Report 898

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

February 25, 1957

AEC - 314/7

Mr. Robert D. Nininger
Assistant Director for Exploration
Division of Raw Materials
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Bob:

Transmitted herewith are three copies of TEM-898, "Uranium-bearing carbonaceous nodules of southwestern Oklahoma," by James W. Hill, September 1956.

We plan to submit this report for publication as a Bulletin of the Oklahoma Geological Survey.

Sincerely yours,

John H. Eric
for W. H. Bradley
Chief Geologist

Geology and Mineralogy

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

URANIUM-BEARING CARBONACEOUS NODULES OF SOUTHWESTERN OKLAHOMA*

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James W. Hill

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*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

USGS - TEM-898

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URANIUM-BEARING CARBONACEOUS NODULES OF SOUTHWESTERN OKLAHOMA

By James W. Hill*

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, and predominantly nodular shaped. One specimen, by analyses, was found to contain 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, H. D. Miser of the U. S. Geological Survey, Mr. E. A. Debolt, Mr. Frank Gouin, and many ranchers of southwestern Oklahoma kindly assisted the writer in obtaining samples and information. All analyses were made by the U. S. Geological Survey.

*Deceased, February 1954.

I. A. Breger of the U. S. Geological Survey through coordinated work with research laboratories assisted in analyzing the carbonaceous nodules. 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 Pennsylvanian and early Permian age. 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 subsidiary folds.

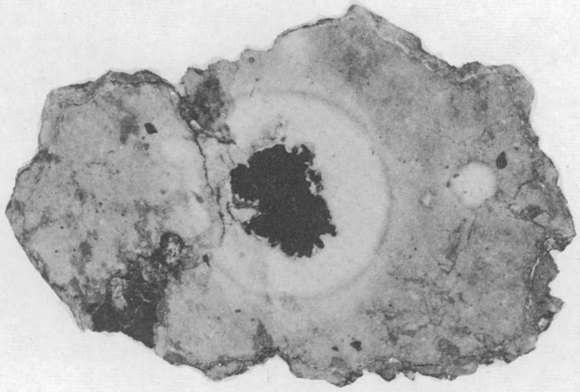
URANIUM-BEARING CARBONACEOUS NODULES

Uranium-bearing carbonaceous nodules were found exposed in the Wellington, Garber, and Hennessey formations of Permian age on the subsidiary folds along the north flank of the Wichita Mountains over an area of more than 200 square miles (fig. 1). They 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).

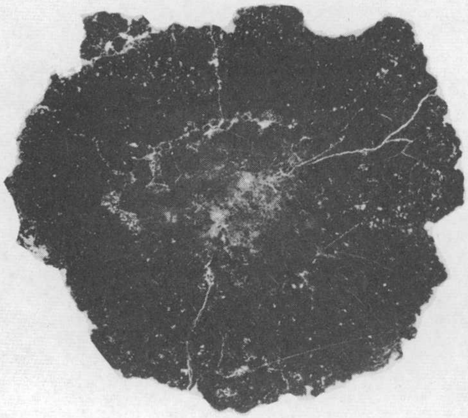
The nodules are in close proximity to Paleozoic rocks that are highly petroliferous. These petroliferous rocks are represented by asphalt seeps in the Arbuckle group of Cambrian and Ordovician age, by traces of soft viscous asphalt introduced into lenticular sandstone lenses within the Garber and Wellington, and by asphaltic sandstone in the Wellington.

Most of the nodules observed and collected for study are combustible, hard, brittle, highly lustrous, and largely insoluble in carbon disulfide or benzene. In size, they range from about 1 millimeter to 5 centimeters 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 and radial fractures that are the result of weathering. All these internal features are crosscut by an irregular pattern of small fractures.

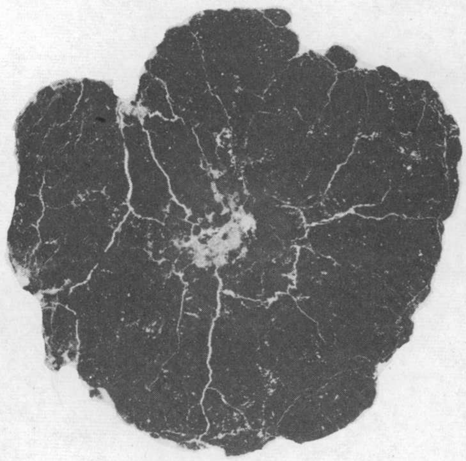
Many of the nodules are homogeneous, but some contain small irregular grains of limestone as a nucleus. A few of the larger nodules contain a small nucleus of pyrite or limonite, suggesting concretionary growth about a center. The nodules are largest and most numerous in permeable zones and along fracture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



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



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



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

Figure 2.--Photomacrographs of polished sections of carbonaceous nodules.

Laboratory studies were made of the nodules and of several nearby crude oils. Spectrographic analyses of the nodules show them to contain 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 some of 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, in the petroleum from this area, and in the carbonaceous nodules.

One nodule which was analyzed for carbon and hydrogen by E. B. Brittin of the U. S. Geological Survey had an ash content of 44.08 percent, and contained 41.61 percent carbon and 2.90 percent hydrogen; the ratio of carbon to hydrogen is 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 form, 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 necessitates that they were transported by petroleum, aqueous solutions, or both.

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