THE OIL YIELD AND URANIUM CONTENT OF SOME BLACK SHALES

By Vernon E. Swanson

Trace Elements Investigations Report 205

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

IN REPLY REFER TO:

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

October 31, 1958

AEC-146/9

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 TEI-205, "The oil yield and uranium content of some black shales," by Vernon E. Swanson, October 1958.

This report is an abstract of a paper with the same title that is planned for publication as a chapter of a Geological Survey professional paper. A copy of the entire report is in the TEPCO files.

Sincerely yours,

John H. Eric

for W. H. Bradley
Chief Geologist

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

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

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ABSTRACT

Most black shales are distinguished by their contained organic matter, and because they will yield oil when subjected to destructive distillation and because some contain as much as 100 times more uranium than other common sedimentary rocks they commonly are referred to as oil shales and uraniferous shales. Some of these black shales have been considered as potential sources of both oil and uranium; thus oil yield and uranium determinations have been made on over five-hundred samples of these shales and are recorded in this report.

Slightly over half of these samples are from the Chattanooga shale and its correlatives of Late Devonian age in the eastern and midcontinent areas of the United States. In central Tennessee, the upper member of the Chattanooga shale is about 15 feet thick, contains 0.006 percent uranium, and will yield about 10 gallons of oil per ton of shale. Limited data indicate that the Chattanooga shale in Alabama and southern Kentucky, the Antrim shale of Michigan, the New Albany shale of southern Illinois, northwestern Kentucky and adjacent areas, and the Chattanooga and Woodford shales of the midcontinent area have slightly lesser values for both oil and uranium. A channel sample of 5 feet of the Doublehorn shale member of the Houy formation in central Texas indicates that this unit has a uranium content of 0.009 percent and an oil yield of 21.8 gallons of oil per ton of shale.

Some of the marine black shales in the cyclothems of Pennsylvanian age in Illinois, Kansas, and Oklahoma contain between 0.004 and 0.010 percent uranium and yield 8 to 15 gallons of oil per ton of shale, but generally these shales are less than 3 feet thick. Some shale units in the Phosphoria formation of Permian age in southwestern Montana, which are on the order of 10 feet thick, will yield 10 to 15 gallons of oil per ton of shale, but their uranium content is relatively low, 0.002 to 0.004 percent.

From the few data available, the Sharon Springs member of the Pierre shale in the Great Plains area has an oil yield of less than 8 gallons per ton of shale and a uranium content of about 0.003 percent. The Green River formation of Eocene age in Colorado and Utah has beds of oil shale tens of feet thick that will yield more than 25 gallons of oil per ton of shale, but the uranium contents of these beds are low, generally between 0.0003 and 0.0010 percent.

Both oil and uranium have been recovered on a large scale from the Upper Cambrian black shales of Sweden, which yield about 14 gallons of oil per ton of shale and about 0.023 percent uranium. Some other foreign oil shales that yield 50 or more gallons per ton generally contain on the order of 0.0005 percent uranium or less.

A crude linear relation between oil yield and uranium content exists for some of these shales, particularly for parts of the Chattanooga shale in small areas and the Antrim shale, but in other shales little or no relation is apparent. In some of the Pennsylvanian shales and in those in the Phosphoria formation the uranium is more closely related to the contained phosphate.

Whereas the oil from these shales is inherent to and derived directly from the organic matter, most of the uranium is attached to or precipitated in the presence of organic matter just before or during the time of deposition of the organic-rich sediment. It is suggested that two types of organic matter should be distinguished, the sapropelic type derived principally from algae, pollen and spores, resins, and the fatty tissues of animals, and the humic type which is derived principally from cellulose and lignin or the woody parts of plants. The sapropelic type of organic matter yields on the order of four or five times more oil than the humic type, but, because of its general resistance to decay, is thought to be insignificant in the process of concentrating uranium. The humic type of organic matter, in its solid form, as soluble humic acid extracts, or indirectly by creating a reducing and acidic environment during its decay, is believed responsible for the precipitation or sorption of the uranium in black shales. Other factors remaining constant, only when the proportion of sapropelic to humic type of organic matter remains the same in a black shale, will the oil yield and uranium content have a high positive correlation.