THE DISTRIBUTION OF URANIUM IN THE ALKALIC ROCKS OF SUSSEX COUNTY, NEW JERSEY

By William Lee Smith, Alexander Sherwood,
Daphne D. Riska, and George H. Hayfield

Trace Elements Investigations Report 503

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

IN REPLY REFER TO:

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

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March 11, 1955

Dr. T. H. Johnson, Director
Division of Research
U. S. Atomic Energy Commission
16th Street and Constitution Avenue, N. W.
Washington 25, D. C.

Dear Dr. Johnson:

Transmitted herewith is one copy of TEI-503, "The distribution of uranium in the alkalic rocks of Sussex County, New Jersey," by William Lee Smith, Alexander Sherwood, Daphne D. Riska, and George H. Hayfield, March 1955.

We plan to publish another report containing much of the information in TEI-503.

Sincerely yours,

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

Geology and Mineralogy

This document consists of 11 pages.
Series A.

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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By

William Lee Smith, Alexander Sherwood,
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*This report concerns work done on behalf of the Division of Research of the U. S. Atomic Energy Commission.

USGS - TEI-503

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THE DISTRIBUTION OF URANIUM IN THE ALKALIC ROCKS OF SUSSEX COUNTY, NEW JERSEY

By William Lee Smith, Alexander Sherwood,
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ABSTRACT

A suite of alkalic rocks from the Beemerville, N. J., intrusive body was separated and the percentages of their accessory minerals were determined. The rocks contain unusually large amounts of zircon and sphene. The contribution to total uranium from these minerals is estimated to approximate 1 percent or less. The relatively high uranium content (0.0019-0.0044 percent) of the rocks shows no relationship to the presence of the zircon or sphene. The uranium content of the zircon and sphene is inferred to be generally inverse to the abundance of these minerals.

INTRODUCTION

In May 1953 William Lee Smith collected specimens of alkalic rocks from the main mass of the nepheline syenite intrusive at Beemerville, N. J., and from a bostonite dike at Branchville, a few miles south. A study of these rocks and their accessory minerals was undertaken as a part of the investigation of the distribution of uranium in igneous rocks. Much of the data presented here will be incorporated in a future publication, by Charles Milton of the U. S. Geological Survey and William Lee Smith, which will describe the areal geology and petrology of the Sussex County alkalic rocks.

Northwest of Beemerville, N. J., an elongate body of nepheline syenite extends for approximately two miles along the base of Kittatinny Mountain and is conformable with the Paleozoic strata. The igneous body clearly intrudes the Martinsburg shale of Ordovician age and seems to be older than the Shawangunk conglomerate (Silurian). The predominant rock of the main mass is a gray, granular nepheline syenite. The nepheline syenite is cut by dikes of porphyritic nepheline syenite, bostonite, and nepheline porphyry. The nepheline porphyry is a mixed rock containing phases of bostonitic composition and texture. Near the main mass of nepheline syenite are plugs and dikes of alkalic rocks. At Branchville, N. J., a dike of gray bostonite cuts the Martinsburg shale.

Milton (1952) describes the main mass as possibly the largest body of nepheline syenite in the eastern United States and cites the occurrence of similar alkalic assemblages at the Monteregian Hills, Quebec; in central Arkansas; central Virginia; and at several New England localities, notably in the Boston region.

Pre-Cambrian and Paleozoic limestones are believed to underlie the Beemerville region suggesting the alkali-rich assemblage of intrusives may be the product of a sedimentary syntexis.

MINERALOGY

Separation method.--The samples were crushed by a rolls-type grinder to pass a 40-mesh screen. Sized fractions of the crushed samples were separated by means of bromoform, methylene iodide, hand magnet, Frantz isodynamic separator, and by hand picking.

<u>Accessory minerals</u>.--The accessory minerals were purified for chemical analysis. Their weights percent in terms of the total sample are shown in table 1.

No minerals were discovered that are predominantly uranium- or thorium-bearing. Pyrite is present in trace amounts in all of the rocks studied. Some fluorite was found in the porphyritic nepheline syenite and in the mixed rock. The Branchville bostonite contains traces of rutile, anatase, hematite, goethite, and serpentine and has been altered either by weathering or hydrothermally, as shown by the presence of calcite (Milton, 1952). Apatite is present in all samples, being most abundant in the more coarsely granular rocks, least abundant in the fine-grained rocks. Magnetite is 20 times more abundant in the main rocks of the Beemerville body than in the dike rocks. Varieties of garnet have been described in the Beemerville rocks by Wilkerson (1946, 1951); however, none was found in our mineral separations. No quantitative work was done on the pyriboles.

Zircon is present in each of the samples from the main mass. None was recovered from the Branchville sample (S-41). The nepheline porphyry contains the largest amount of zircon. All the zircon crystals are partly metamict. The zircon crystals vary in size; most of them are 0.15 mm in diameter. Sphene was found in all of the samples but is most abundant in the granular and porphyritic nepheline syenite. Sphene generally occurs as grains of approximately 0.15 mm in diameter; however, in the porphyritic rocks it is present as very minute particles finer than 350-mesh. Before the positive identification of zircon, the high zirconium content of these rocks suggested that the sphene present might be the varities ramsayite or lorenzenite, but

Table 1.--Percentages of accessory minerals in samples of alkalic rocks from Beemerville and Branchville, N. J.

Sample no.	Rock type	Location	Magnetite	Apatite	Zircon	Sphene	Xenotime
S-41	Bostonite	Branchville	0.03	0.002	0	Tr	0
S-42	Porphyritic nepheline syenite, main mass	Beemerville	0.05	0.06	Tr	0.1	Tr
S-43	Granular nepheline syenite, main mass	Beemerville	1.0	0.4	0.03	1.2	0
S-44	Nepheline porphyry, main mass	Beemerville	0.05	0.5	0.35	Tr	0
S-45	Bostonite porphyry, main mass	Beemerville	0.05	0.2	0.04	Tr	0

neither mineral was found.

DISTRIBUTION OF URANIUM

Chemical analyses of the rocks (table 2) show a range in uranium content from 0.0019 percent in the Branchville bostonite to 0.0044 percent in the granular nepheline syenite. This is five to ten times as high as the average for granitic rocks (Senftle and Keevil, 1947). In silicate rocks uranium is known to accompany zirconium, thorium, and the rare-earths (Rankama and Sahama, 1950), and it is concentrated in such minerals as zircon, monazite, sphene, allanite, and xenotime. Of the usually uranium-rich minerals only zircon and sphene are present in amounts suitable for analysis. Xenotime occurs only as a trace in one sample, and monazite and allanite are absent from all samples. The zircon and sphene concentrates were analyzed for their uranium content, and the percentages of uranium in the rocks traceable to the presence of these accessory minerals were established.

Spectrographic analyses of the samples (table 3) by Katherine E. Valentine of the Geological Survey show the rocks to contain more zirconium than can be accounted for by the mineral zircon.

The presence of aegirite, which has been reported to contain as much as 0.4 percent ZrO_2 (Rankama and Sahama, 1950) may easily account for the additional zirconium. Although zirconium is known to be incorporated in the structure of femic minerals, much of such zirconium may exist in the form of extremely minute included zircon crystals. There is no relation between the uranium and zirconium content of these samples.

Table 2.--Percentages of uranium in the rock, in zircon, and in sphene, and the percentages of the total uranium contributed by zircon and sphene.
Analyst: A. M. Sherwood.

Sample no.	Uranium			
	In rock	In zircon	In sphene	In rock contributed by zircon and/or sphene
S-41	0.0019	--	--	--
S-42	0.0033	--	0.0084	0.254
S-43	0.0044	0.0303	0.0031	1.04
S-44	0.0027	0.0093	--	1.21
S-45	0.0020	0.0130	--	0.260

Table 3.--Percentages of elemental zirconium.

Sample number	Percent zirconium
S-41	0.84
S-42	0.48
S-43	1.0
S-44	1.1
S-45	1.2

Chemical analyses of a larger suite of smaller samples collected by the senior author (table 4) follow.

Table 4.--Uranium content of a suite of alkalic rocks, Sussex County, N. J.

Rock type	Number of samples	Uranium content (percent)
Nepheline syenite	4	0.0013 - .0046, av. 0.0020
Porphyritic nepheline syenite	1	0.0033
Nepheline porphyry	1	0.0020
Bostonite	2	0.0018, .0025
Bostonite porphyry	1	0.0019
Ouachitite	1	0.0006
Tinguaite	1	0.0008

CONCLUSIONS

The unusually large zircon and sphene content of these rocks cannot alone account for the high uranium content. The total contribution of uranium by these accessory minerals approximates 1 percent or less. The percentages of uranium in the rocks show no relationship to the percentages of the mineral zircon, nor to any of the accessory minerals individually or combined. The number of minerals analyzed is too small to show whether the uranium content of a particular mineral is related to the abundance or paucity of that mineral, although a generally inverse relationship is inferred from the data at hand.

ACKNOWLEDGMENTS

We are indebted to E. S. Larsen, Jr., under whose supervision this study was initiated, and to Charles Milton for suggesting methods of study used in the course of this investigation. This work is part of a program conducted by the Geological Survey on behalf of the Division of Research of the U. S. Atomic Energy Commission.

REFERENCES

Milton, C., 1952, Dikes of special petrographic interest in Sussex County, New Jersey: Guidebook for 18th annual field conference of Pennsylvania geologists, p. 1-10.

Rankama, K., and Sahama, Th. G., 1950, Geochemistry, University of Chicago Press, p. 565.

Senftle, F. E., and Keevil, N. B., 1947, Thorium-uranium ratios in the theory of genesis of lead ores: Am. Geophys. Union Trans., v. 28, p. 732.

Wilkerson, A. S., 1951, Tinguaite and bostonite in northwestern New Jersey: Am. Mineralogist, v. 37, p. 120-125.

__________, 1946, Nepheline syenite from Beemerville, Sussex County, New Jersey: Am. Mineralogist, v. 31, p. 284-287.