

GEOLOGICAL SURVEY CIRCULAR 286



AN OCCURRENCE OF AUTUNITE

LAWRENCE COUNTY, SOUTH DAKOTA

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By R. C. Vickers

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ABSTRACT

In July 1952 an occurrence of autunite was found in the northern part of the Black Hills, South Dakota, during a reconnaissance for radioactive deposits.

The autunite occurs as fracture coatings and disseminations in siltstone of the Deadwood formation of Cambrian age and is concentrated mainly in the lower 2 feet of the siltstone at the contact with an intrusive rhyolite porphyry; the radioactive zone is exposed in two old workings, which are 90 feet apart. An 18-inch vertical channel sample of the autunite-bearing siltstone contained 0.048 percent uranium. The gangue minerals are fluorite and limonite.

The uranium is believed to have been introduced into the siltstone by solutions of magmatic origin that migrated along the lower contact of the siltstone after or during emplacement of the porphyry.

INTRODUCTION

Uranium minerals have been reported in the northern Black Hills by several authors. Uranium was first mentioned by Scott (1897), who reported a uranium mineral with the composition of autunite from the Poisoned Ox mine near Pactola, Pennington County, S. Dak., and along Annie Creek

at Carbonate, Lawrence County. O'Harra (1902, p. 78) states:

Uranium minerals have been observed in various places, particularly in the Poisoned Ox mine near Pactola and in the Davier mine on Anna Creek near Portland. Uranium is also reported as occurring near Carbonate. At the Poisoned Ox mine the minerals occur with copper in slates. In the Anna Creek property it is intimately associated with porphyry. At the latter place effort has been made to obtain the mineral in commercial quantities, but as yet success has not been attained.

Ziegler (1914, p. 206) described autunite ($\text{Ca}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 10\text{-}12\text{H}_2\text{O}$) from an occurrence in the phonolite porphyries on Annie Creek west of Portland, Lawrence County, S. Dak. His description follows:

...crystals are very rare, and the autunite usually occurs as a very thin micaceous coating or a series of thin irregular shaped flakes or as a number of small partially radiating moss-like aggregates, coating minute fissures in the porphyries. The cleavage is excellent, yielding thin brittle laminae of a lemon-yellow color which are weakly transparent. The luster varies from dull silky to adamantine, while an occasional square crystal shows pearly luster. The streak is deep yellow, the hardness about equal to the finger nail, and the specific gravity 3.07. It is associated with limonite and a little fluorite.

Although specimens of autunite from the northern Black Hills may be seen in the museum at the

South Dakota School of Mines, Rapid City, S. Dak., no mention has been made of the Annie Creek occurrence, so far as known, since Ziegler's report in 1914.

was re-located for uranium by L. J. Bisch, R. B. Sherman, O. B. Sherman, and F. S. Budzynski on July 11, 1952.

Because of these reported occurrences of radioactive minerals, a radiometric reconnaissance of the mining districts of the northern Black Hills was conducted by the U. S. Geological Survey during July 1952 on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. During this investigation, an occurrence of autunite was found in the Annie Creek area near Trojan, Lawrence County, S. Dak.

The autunite observed by O'Harra (1902, p. 78), and by Zeigler (1914, p. 206) is described as occurring as thin coatings on fissures in porphyry, whereas the autunite described in this report is in siltstone. It is the writer's belief, therefore, that although both occurrences are in the same general area, they probably are not the same deposit.

Location and accessibility

The autunite occurrence is 5 miles west of Lead in the Bald Mountain mining district, Lawrence County, S. Dak., in sec. 3, T. 4 N., R. 2 E., Black Hills Meridian (fig. 1). The property may be reached by following the abandoned right-of-way of the Chicago, Burlington, & Quincy Railroad north from Elmore, S. Dak., for about 2 miles to the end of the railroad fill that crosses Annie Creek, and then by walking along the abandoned Annie Creek road for a distance of about two-thirds of a mile to the first gulch on the right, north-east of Lost Camp Gulch. From there, proceed N. 70° E. up the bare ridge on the southeast side of Annie Creek, for a distance of about one-third of a mile to the prospect site (fig. 1).

History of the property

The property was located about 1890 for gold and silver. Fluorite and, to a lesser extent, uranium minerals are associated with some of the gold ores of Tertiary age in the Bald Mountain mining district, and the presence of fluorite and autunite on the property probably encouraged the owners to explore the prospect further. There is no reported production from the property, and the workings were probably abandoned soon after the underground work failed to show any gold or silver.

The prospect is on patented ground believed to be owned by the Annie Creek Mining Company, but it

Table 1.—Radiometric and chemical analyses of samples from the autunite occurrence, Lawrence County, S. Dak.

[Analyses by U. S. Geological Survey Trace Elements Laboratory, Denver, Colorado]

Field number	Equivalent uranium (percent)	Uranium (percent)	Remarks
SL-74-52	0.030	0.020	Composite dump sample
SL-75-52	.059	.048	18-inch vertical channel sample of autunite-bearing siltstone.
SL-76-52	.012	.004	Rhyolite porphyry from winze. Grab sample.
SL-77-52	.037	.016	Grab sample of siltstone from dump of prospect pit no. 1.
SL-78-52	.008	.004	Grab sample of siltstone, prospect pit no. 2

GENERAL GEOLOGY

The autunite occurrence is in an area of widespread Tertiary igneous activity in the northwestern part of the Black Hills uplift. The rocks in the vicinity of the property are sandstones, siltstones, and shales of the Deadwood formation of Cambrian age, which have been intruded and displaced by several sills and laccoliths.

In the immediate vicinity of the prospect a 30-foot thick bed of nearly flat-lying siltstone of the Deadwood formation is overlain by rhyolite and underlain by rhyolite porphyry (fig. 2). The siltstone is composed mainly of angular to subangular quartz grains, averaging 0.05 mm in length, and interstitial carbonate, which is distributed unevenly through the rock.

URANIUM DEPOSITS

A radiometric traverse of the property with a Geiger counter showed abnormal radioactivity on the dump of the underground workings and at the two prospect pits northwest of the adit. Autunite was observed in the underground workings and on the large dump. The results of radiometric and chemical analyses of the collected samples are given in table 1. The sample localities are shown in figure 2.

The workings consist of a partly caved adit about 45 feet long, a 1-foot winze, and several prospect pits. The adit was driven about 1 foot above, and parallel to, the contact of the siltstone of the Deadwood formation with the underlying porphyry. The winze, now partly filled with debris, extends through the siltstone and into the porphyry.

Mineralogy

Autunite, the only uranium mineral recognized at the property, is apple-green and highly fluorescent; it forms finely crystalline masses and well-crystallized plates, as much as 5 mm in length. The gangue minerals are purple fluorite and limonite. Semiquantitative spectrographic analyses of four samples (table 2, see p. 5) indicate that minor quantities of cesium, cobalt, molybdenum, niobium, lanthanum, and tin are concentrated in the mineralized siltstone.

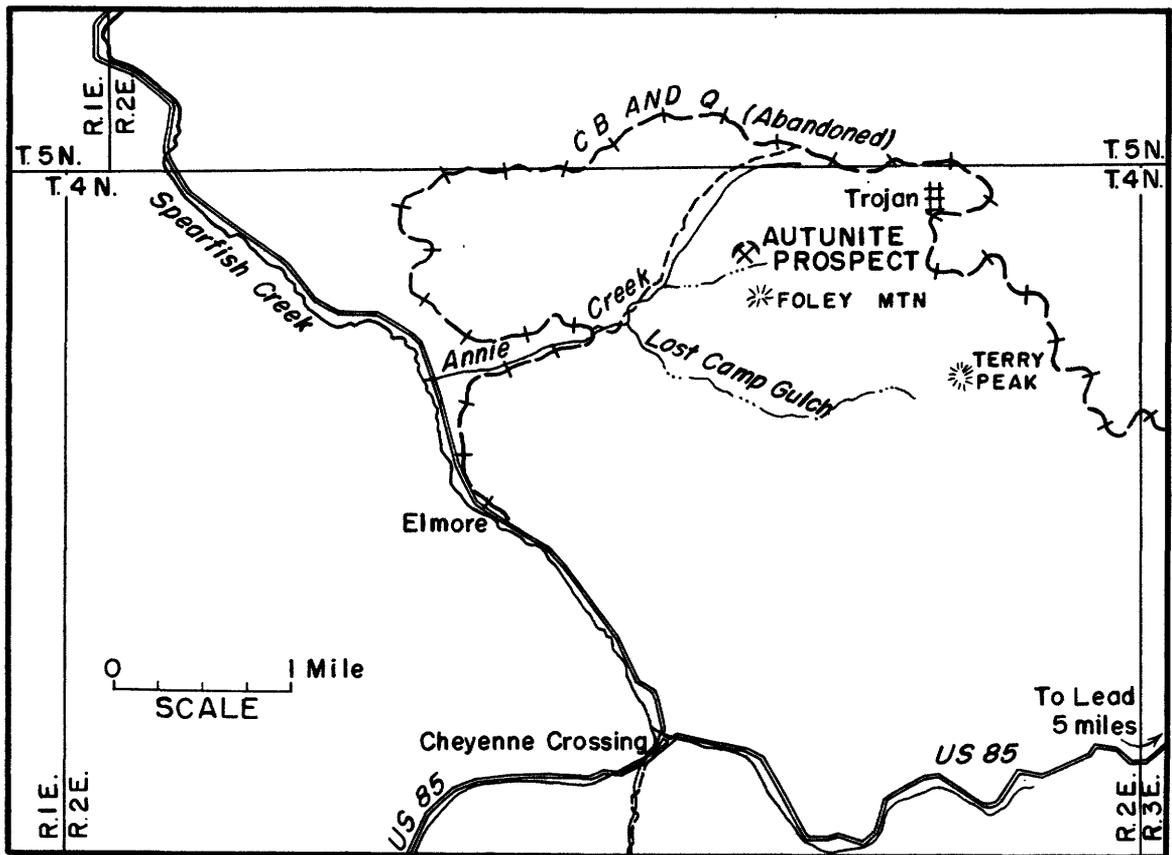
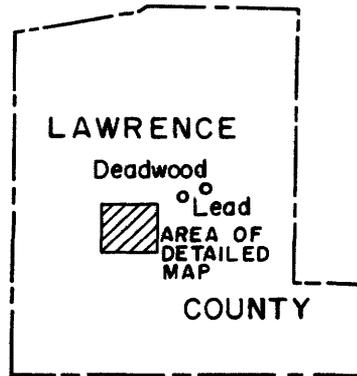


Figure 1. —Index maps showing location of the autunite prospect, Lawrence County, S. Dak.

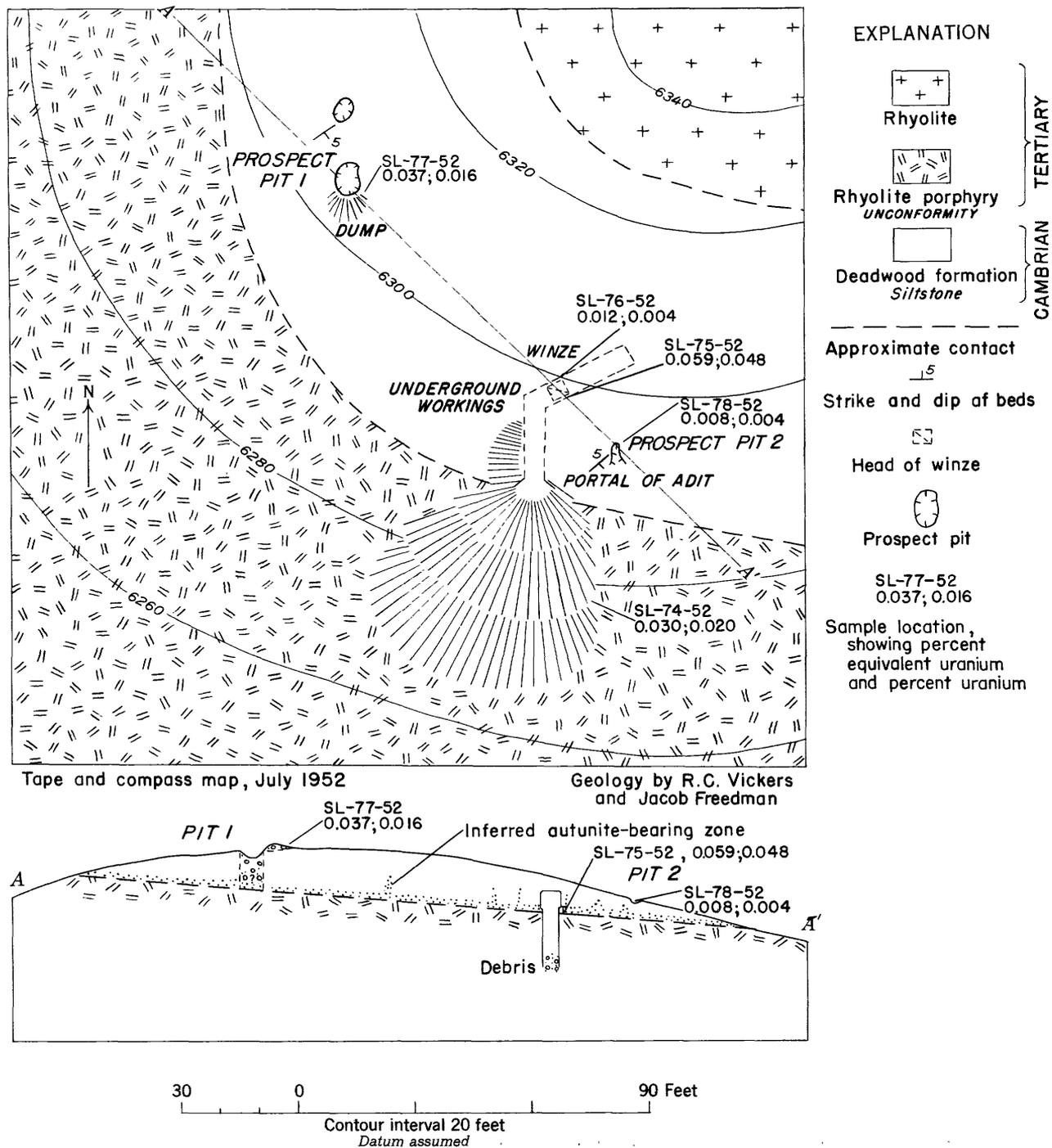


Figure 2.—Geologic map and cross section of the autunite prospect, Lawrence County, S. Dak.

Table 2.—Semi-quantitative spectrographic analyses of siltstone samples from the autunite occurrence, Lawrence County, S. Dak.

[Analyses by U. S. Geological Survey Trace Elements Laboratory, Denver, Colorado]

Field number	Ce	Co	Mo	Nb	La	Sn	Chemical uranium (percent)	Field number	Ce	Co	Mo	Nb	La	Sn	Chemical uranium (percent)
SL-74-52	---	---	.00X	.000X	---	.00X	0.020	SL-77-52	---	.000X	.0X	.000X	---	.00X	0.016
SL-75-52	.0X	.000X	.00X	.000X	.0X	.00X	.048	SL-78-52	---	---	---	---	---	---	.004

relative to their concentrations in unmineralized siltstone.

Thin sections of the autunite-bearing siltstone show that the quartz grains and the interstitial carbonate have been corroded and embayed by autunite and fluorite. The fluorite occurs mainly as small veinlets, as much as 3 mm thick, that cut the siltstone and as small irregular replacements with distinct crystal outlines.

The abundance of limonite associated with the fluorite and autunite suggests that pyrite is present in the unoxidized material and that the autunite has resulted similarly by the oxidation and alteration of a primary uranium mineral, possibly pitchblende.

Ore bodies

The autunite is concentrated mainly in the lower 2 feet of the siltstone of the Deadwood exposed in the adit, and it is believed to form a tabular, essentially flat-lying deposit in the siltstone just above the porphyry contact (fig. 2). An 18-inch vertical channel sample (SL-75-52), cut just above the porphyry-siltstone contact, contained 0.059 percent equivalent uranium and 0.048 percent uranium. A grab sample of porphyry from the winze (SL-76-52) contained 0.012 percent equivalent uranium and 0.004 percent uranium, which is similar to the radioactive content of other similar porphyries in the northern Black Hills.

Prospect pit 1, 90 feet northwest of the portal, may be an old caved shaft that reached the autunite zone (cross section, fig. 2). A grab sample of siltstone from the dump of this prospect (SL-77-52) contained 0.037 percent equivalent uranium and 0.016 percent uranium. No autunite was observed on this dump, but abundant limonite and fluorite were present.

Slight abnormal radioactivity was detected in siltstone at prospect pit no. 2, located 20 feet east of the portal, and a grab sample (SL-78-52) analyzed 0.008 percent equivalent uranium and 0.004 percent uranium.

The difference between equivalent uranium and chemical uranium in the siltstone samples suggests that some oxidation and leaching have occurred and also suggests that the near-surface samples are probably of lower uranium content than the unoxidized material.

The extent of the autunite zone is not known accurately because of the lack of suitable exposures in the area. The zone probably extends continuously from the exposures in the underground workings to the mineralized siltstone encountered in pit no. 1.

Origin

The writer believes, because of the spatial relations of the uranium minerals to the porphyry sill, that the uranium was introduced into the siltstone by hydrothermal solutions that moved along the contact between the siltstone and the underlying porphyry. The fractured siltstone near the contact with the lower porphyry, which may be the result of movement along the contact produced after or during the emplacement of the porphyry, formed a permeable zone through which the ore-bearing solutions could migrate. These solutions probably were related to a late stage of hydrothermal activity that accompanied the intrusion of the porphyries.

CONCLUSIONS

The occurrence of autunite associated with the Tertiary intrusive activity in the northern Black Hills suggests that the area should be considered as a possible source of uranium deposits. Although the deposit described in this report is not of ore grade, additional prospecting in the area might disclose higher grade deposits or sufficient tonnages of low grade material to make mining profitable.

This occurrence of autunite confirms one of the uranium mineral localities mentioned in the literature, and additional prospecting could very well confirm other uranium-bearing localities that have been reported in the literature on the northern Black Hills mining area before 1915.

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