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RECONNAISSANCE EXAMINATIONS OF COPPER-URANIUM DEPOSITS WEST OF THE COLORADO RIVER

By
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SUMMARY

Several relatively small copper-uranium deposits have been found in southwestern Utah along the contact of the Shinarump and Moenkopi formations of Triassic age, at least from the San Rafael Swell area of Emery County, southward through central and eastern Garfield County, southwestward into western Kane County, and westward into the southern part of Washington County. They also extend southward into northern Arizona. These deposits are highly localized and spotty in nature and, at present, seem somewhat discontinuous in their distribution. Exploration and prospecting of these deposits has only begun, due largely to the inaccessibility of the favorable areas, and a great amount of further exploration is necessary to establish the number of exposed deposits and possible trends in their distribution. Furthermore, development in the known deposits is virtually non-existent.

A few of the deposits contain very local concentrations of material assaying upwards to 1% or more U_3O_8, but channel and bulk sampling in the Escalante area of Garfield County, at least, indicate that mineable quantities of ore exposed at the surface in this area are limited in amount.

GENERAL LOCATION OF THE DEPOSITS

In a broad way, the zone of copper-uranium deposits here investigated follows the irregular and complex outcrop pattern of the Shinarump and Moenkopi formations of Triassic age from the eastern part of Wayne

County southward through central and eastern Garfield County, southwestward into western Kane County, and westward into the southern part of Washington County [1]. Both the outcrop of the formations and the distribution of the known mineralized areas are highly discontinuous and irregular, and exploration and prospecting in the broad zone are extremely incomplete at this time, due largely to the inaccessibility of the major part of the area.

GENERAL GEOLOGY OF THE DEPOSITS

The generalized stratigraphic section of the formations of Triassic age in the southern part of Utah, as given by Gregory and Moore [2] is as follows:

Formation	Generalized Lithology	Type Section
Chinle	Shale, sandstone, ash and minor limestone. Variegated red, purple, and gray colors.	Vermillion Cliffs
Shinarump	Sandstone and conglomerate. Generally white or light buff in color. Characterized by fossil wood.	
Moenkopi	Interlayered shale, siltstone, and fine-to-medium-grained sandstone. Largely reddish colors, commonly bleached to light colors in the upper beds.	Belted Cliffs

All of the copper-uranium mineralization observed by the writer, except those deposits in the Silver Reef district of Washington County, has occurred in a restricted stratigraphic horizon at the base of the Shinarump formation and in the upper few feet of the Moenkopi formation

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1. Andrews, D. A. and Hunt, C. B., Geologic Map of eastern and southern Utah, U. S. Geological Survey Oil and Gas Investigations Preliminary Map 70, 1948.

2. Gregory, Herbert E. and Moore, Raymond C., The Kaiparowits region, U. S. Geological Surv. Prof. Paper 164, 1931, p. 37.

immediately below it. The uranium mineralization of the Silver Reef district was apparently confined to the so-called Buckeye Reef sandstone member of the Painted Desert formation of Triassic age, as described in a private report on the area by Sidney Ball, dated 1920. It has also been named the Silver Reef sandstone member by P. D. Proctor [3] of the U. S. Geological Survey. This member lies several hundred feet above the Shinarump formation and therefore has been correlated by Proctor with a part of the Chinle formation.

The Shinarump formation, as observed by the writer, is predominantly a coarse-grained, rather loosely cemented white sandstone, interbedded and crossbedded with coarse conglomerate having rounded quartz pebbles up to two inches in diameter. It is characterized nearly everywhere by fragments and "logs" of petrified wood, some of which are over one foot in diameter. Where observed by the writer, the formation averages 35 to 50 feet in thickness, although exceptionally it may become as thick as 75 feet. Lying unconformably, although in many places in a parallel position, below the Shinarump formation, the upper part of the Moenkopi formation consists of thinly bedded shales and siltstones that are widely bleached to a light buff color adjacent to the contact. Several feet below the contact, however, and down through the section, the beds are rich in iron oxide and exhibit various red or reddish brown colors.

Where copper-uranium mineralization has occurred near the contact, thin coatings of secondary green, greenish yellow, or powdery black copper, uranium, and iron minerals, among others, fill the interstices between grains and pebbles of the sandstone and conglomerate of

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3. Proctor, Paul Dean, personal communication.

the Shinarump formation and the parting planes of the Moenkopi shale. Although no systematic mineralogic study of the mineralized material has been completed at this time, some of the uranium minerals have been identified as torbernite, zeunerite (a hydrated arsenate of copper and uranium), and johannite (a hydrated sulfate of copper and uranium), and some of the copper minerals are malachite and brochantite. As is typically the case with oxidized deposits, the uranium-bearing minerals are largely out of radioactive equilibrium and for this reason discrepancies between uranium determinations by radiometric and by chemical methods are common.

The outstanding characteristic of the deposits is that they are extremely spotty and apparently erratic in distribution. Sampling has shown that in a few selected places the mineralized beds may contain on the order of 1% U_3O_8 (or even higher), but a few feet away, along the same stratigraphic horizon, the rocks exhibit only the amount of radioactivity normal for shale and sandstone. Likewise above and below the mineralized zone the uranium content falls off sharply to virtually nothing. Although in general, the uranium and copper minerals appear to occur together, the visible copper staining apparently is not a reliable guide to uranium ore, for copiously copper-stained beds may exhibit little or no radioactivity, and beds with negligible copper staining may contain appreciable amounts of uranium.

KNOWN MINES, PROSPECTS, AND CLAIMS

Oiler Tunnel (Blue Bird claims), Capitol Reef National Monument, Wayne County

The Oiler "tunnel" constitutes one of the few mine workings in

southwestern Utah that exclusively explore a copper-uranium deposit, as defined in the foregoing paragraphs. It is located 2½ miles southeast of Fruita in the Capitol Reef National Monument, Wayne County.

The copper-uranium deposits are confined to the upper two or three feet of the shale beds of the Moenkopi formation immediately beneath an unconformable contact with overlying sandstone and conglomerate of the Shinarump formation. Secondary minerals including hydrous sulfates, oxides and other secondary minerals of uranium, copper, and iron fill the parting planes of the shale or cement the siltstone, sandstone, and conglomerate grains. The mineral concentrations are exposed for about 100 feet along the rim outcrop and have been explored for about 60 feet into the face by two parallel adits. Thus the extent of exposed ore is very small. Furthermore, the writer made radiometric traverses along the favorable beds for several hundred feet to the northwest, where they are cut off by the unconformity, and for about 2 miles to the south along the high cliffs east of the Hanksville Road, but no other areas of appreciable radioactivity were noted. The possibility of future production of ore from this deposit depends, in the writer's opinion, on the amount of underground development work that can be accomplished. The ore should be followed along the favorable horizon to its limit on all sides. When this is accomplished, plans for future exploration and development may be more efficiently considered in the light of structural and lithologic controls. Diamond drilling of the deposit in its present state of development would seem premature.

Following are assays from representative channel samples of the ore-bearing beds:

Width	Percent U_3O_8e	Percent U_3O_8	Percent Cu
2 feet	3.0	2.966	0.67
2.5 feet	2.5	0.846	0.92
3.0 feet	0.14	0.224	0.14

On July 31, 1950, a group interested in this prospect, represented by Merril H. Larsen of Salt Lake City, Utah, shipped 346 pounds of mineralized material from this mine to the Minerals Engineering Laboratory of the Massachusetts Institute of Technology for study and testing. In addition, Professor J. W. Gruner of the University of Minnesota is currently studying a large suite of specimens from this deposit.

Oak Creek prospect, Garfield County

The Oak Creek prospect, although not strictly in a copper-uranium deposit, is mentioned here because it is located at the base of the Shinarump formation and in the upper beds of the Moenkopi formation on Oak Creek at the eastern boundary of the Dixie National Forest, approximately 17 air miles northeast of Boulder in Garfield County. Access to the prospect is difficult, requiring a heavy four-wheel-drive vehicle. The following data were obtained from Mr. Carl Schack of the U. S. Bureau of Mines, Salt Lake City, who has had occasion to make detailed field and laboratory examinations of the prospect.

The mineralized beds attain a maximum thickness of 6 feet and are exposed by a bulldozer cut over a length of 75 feet. Laboratory study by the Bureau of Mines in Salt Lake City and by the New York Mineralogical Laboratory of the A.E.C. has revealed the presence of pitchblende, sphalerite, pyrite, clay minerals, hydrocarbon, several secondary minerals, and gypsum. Sixteen radiometric assays of channel samples range between

0.005% and 0.452% U_3O_8 equivalent (the latter over only 1½ inch) and average considerably less than 0.1% U_3O_8 equivalent. Mr. Schack is of the opinion that most of the originally exposed radioactive material has been mined.

Prospects and claims of the Escalante-Circle Cliffs area, Garfield County

General statement.

The so-called Circle Cliffs or (more generally) Escalante area of copper-uranium deposits in Garfield County lies for the most part near the headwaters of Silver Falls and Moody Creeks, approximately 28 air miles S. 80° E. of the town of Escalante, in R. 8 E., T. 35 and 36 S. The area is reached by rough truck trail over two routes, both of which require the use of a heavy four-wheel-drive vehicle; ordinary automobiles or trucks cannot pass over these trails in their present condition. The most direct route from Escalante follows the Harris Wash to the Escalante River and Silver Falls Creek to its head (Plate I). This route is 47 miles in length. The second route follows a circuitous 46 mile course from Boulder, Utah, traversing parts of Deer, Seep and Horse Creeks to the Ohio Oil Company well site and thence southward to the headwaters of Silver Falls and Moody Creeks. The air line distance from Escalante to Boulder is 29 miles. The cost of establishing a suitable road for trucking ore over the first of these two routes is estimates by Mr. Tom Costas, of the New Park Mining Co., as about $50,000, but even a good road would be subject to periodic destruction by flash floods in the box-like canyons. The second route would probably require road costs of the same order of magnitude as the first, and would increase the haulage distance.

There are at least a score of reported uranium claims in the general Circle Cliffs area, but only a few of these show substantial uranium mineralization. In general, the claims are held by two groups of Escalante townspeople - one including Loren W. Griffin and his associates, and the other, named Escalante Uranium Company, under the leadership of Claron Barney and Grant V. Twitchell. The claims of Mr. Griffin and his associates are currently leased to the New Park Mining Company.

The copper-uranium deposits of the area are especially characterized by their extremely spotty nature, both in a broad sense and in detail. The known mineralized areas occur in widely scattered positions along the cliff outcrops in which the favorable horizon is exposed. Furthermore, within a given mineralized area, for which typical individual analyses are presented in the following paragraphs, a few pounds of high-grade material may be scattered indiscriminately with material of a much lower grade. Sampling therefore must be done with extreme care and repeated sampling of the same zone by the same person would probably yield rather widely divergent results. Furthermore, field counter readings and mineralogic observation along the outcrops do not serve to distinguish clearly between zones with mixed high- and very low-grade material of uniformly medium to low grade. Only careful sampling and chemical assays can lead to locating rock that might be classified as ore in contrast with rock that is merely mineralized. Following are descriptions of individual claims that typify these characteristics.

Blue Jay claim.

The Blue Jay claim, held by Escalante Uranium Company, is at the head of Moody Creek, only a few hundred feet from the divide with the

South Fork of Silver Falls Creek, in T. 36 S., R. 8 E. (Plate I). This claim is considered by all the local prospectors to contain one of the most radioactive deposits in the district. The deposits are exposed at the base of the Shinarump formation and in the upper beds of the Moenkopi formation on the face of an east-facing cliff. The mineralized beds, which are typical geologically of the average copper-uranium deposits described above, extend for at least 40 feet along the face of the cliff and attain an average, but variable, thickness of 2 feet. Except for minor pick-and-shovel work on the face of the cliff, no development has been done on the claim, so essentially only the surface phase of the body has been sampled, with results as follows:

Number	Type Sample	Laboratory	Equivalent U_3O_8, Percent	Chemical Assay, U_3O_8	Chemical Assay, Percent Cu
F-9027 (D.L.E.)	Grab	Bureau of Mines, Salt Lake City	0.844	0.898	0.66
4105-F (Escalante Uranium Company)	Grab	New York, A.E.C.	1.0	-	-
Bulk sample - several hundred pounds		U.S. A.E.C. Grand Junction, Colorado	-	0.29	1.47

Hot Shot claims.

The two Hot Shot claims, held by the Escalante Uranium Company, are located 1½ miles northwest of the Blue Jay claim along an east-facing cliff near the headwaters of the South Fork of Silver Falls (Plate I). These claims, together with the Blue Jay, are considered by the local prospectors to be among the most promising in the district. The mineralized zone in these claims totals about 200 feet in length along the

cliff face, although the radioactivity is not uniformly strong throughout. According to the field counter, the most radioactive rocks appear to be the lower two feet of the Shinarump sandstone, but the visible secondary copper staining occurs mostly throughout 1 to 1½ feet of Moenkopi shale below the contact, and this material also yields counts of several times background. Results of sampling of the deposit are as follows:

Number	Type Sample	Width	Laboratory	Equivalent U_3O_8 Percent	Chemical Assay, Percent U_3O_8	Cu
F-9024 (D.L.E.)	Channel	2½ ft.	Bureau of Mines, Salt Lake City	0.048	0.059	1.5
4105-D (Escalante Uranium Company)	Grab	(6 lb.)	New York, A.E.C.	0.4	-	-
New Park Mining Company	Picked sample	?	Bureau of Mines, Salt Lake City	5.0	-	-
Bulk sample - several hundred pounds			U.S. A.E.C. Grand Junction, Colorado	-	.05	.09

To show the changes in radioactivity along the favorable horizon, channel samples were taken by the writer at the northern extremity of the mineralized zones in the adjacent Dud No. 1 claim of Lorin W. Griffin (Sample No. F-9025) and approximately 800 feet further to the north, across the favorable contact, where no appreciable radioactivity was noted (No. F-9026). Following are the results, as submitted by the U. S. Bureau of Mines in Salt Lake City:

Number	Width	Equivalent U_3O_8, Percent	Chemical Assay, Percent U_3O_8	Cu
F-9025	3 feet	0.041	0.012	0.01
F-9026	3 feet	.004	.002	.01

Falling Star claims.

Another typical copper-uranium claim in the area is the Falling Star claim, held by Lorin Griffin and associates and New Park Mining Company. It is located near the headwaters of the South Fork of Silver Falls Creek along the same cliff outcrop as the Hot Shot claims and about three-quarter mile to the southwest. (Plate I).

The mineralized and altered material making up the deposits on this claim appears to be high in iron and sulfate minerals and contains a black, powdery mineral or mineral aggregate which seems to produce most of the radioactivity. The zone lies within the upper bleached beds of the Moenkopi shale immediately below the irregular contact with typical Shinarump sandstone. The altered zone measures about 125 feet along the outcrop, but averages only about one foot in thickness. The rocks immediately above and below the zone register low radioactivity on the field counter.

A picked sample from this deposit is reported by New Park Mining Company to have assayed radiometrically 1.1% U_3O_8 equivalent. However, the results of channel samples collected by the writer across the radioactive zone (No. F-9022) and away from the mineralized zone, across the same favorable horizon (No. F-9023) are as follows:

Number	Width	Equivalent U_3O_8, Percent	Chemical Assay, Percent U_3O_8	Cu
F-9022	2 feet	0.096	0.07	0.03
F-9023	2 feet	.01	.005	.02

Moody claims.

The Moody claims are located approximately 6 miles down Moody

Creek from the Blue Jay claim along the cliffs on the west side of the stream. Due to transportation difficulties the writer was not able to visit these properties. However the deposits are said to be of the same type and approximately the same size as the Hot Shot deposit, and Escalante Uranium Company, which holds the claims, has submitted what is alleged to be a channel sample of the deposit to the New York Mineralogical Laboratory, which reports 0.1% U_3O_8 equivalent.

Other claims.

Other claims in the district visited by the writer include the Honeybell and Farewell claims in the South Fork of Silver Falls Creek, and the Horse Creek and Hatch claims in Horse Creek, about 12 miles air line to the northwest (Plate I). These deposits showed so little radioactivity, however, that they required only a cursory examination.

A number of the other claims on deposits of the same type as those described above, but exhibiting less radioactivity, are said to be located along outcrops to the southeast of the Blue Jay claim, in the North Fork of Silver Falls Creek, and in Death Hollow. A grab sample from one of the latter claims has been examined by the New York Mineralogical Laboratory and is reported to assay 0.1% U_3O_8 equivalent.

Prospects and claims of the Silver Reef district, Washington County, Utah

The occurrence of minor amounts of uranium minerals in the historic Silver Reef district (Plate II) has been known for a number of years. However, the area has never been studied intensively with the specific objective of determining the uranium production potentialities.

Preliminary work establishes the fact that all the uranium occurrences in the area are located in the Silver Reef sandstone member of the Chinle formation. This formation crops out as part of an anticline structure and has been explored for silver and copper in a number of relatively shallow workings.

Uranium minerals have been found by the writer in four areas within the district: (1) in the Tecumseh mine, (2) Chloride Chief claim, (3) the Duffin mine and (4) the Rough Rider claims. In addition, uranium minerals had been reported from the Eloise claims which lie across the main highway to the east of the Chloride Chief claims (Plate II). Results of sampling in the four examined areas are as follows:

		Assay of Grab Samples, Percent		
		Equivalent	Chemical	
Name	Location	U_3O_8	U_3O_8	Cu
Rough Rider No. 2 claim	East part of Silver Reef district, near Leeds, Washington Co.	0.50	0.595	1.51
Tecumseh mine	West part of Silver Reef district, near Leeds, Washington Co.	.02 .05	.005	0.77
Chloride Chief claim	West part of Silver Reef district, near Leeds, Washington Co.	.135	-	2.94
Duffin mine	East part of Silver Reef district, near Leeds, Washington Co.	.40	-	-

Some development has been initiated by Mr. Francis Willis, a lessee in the district, and about nine tons of development ore averaging 0.67% U_3O_8 has been shipped to the Monticello, Utah, plant. However, the long haulage makes it necessary for Mr. Willis to restrict his shipments

to high-grade ore. If the ore could be delivered to a point nearer to the district, much larger tonnages could be mined and development could proceed at a more satisfactory rate.

Western Gold Mines, Inc., of New York City, holds most of the claims in the district and is currently negotiating with Climax Uranium Company, of Grand Junction, Colorado, for the development of the uranium deposits on a royalty basis. No diamond drilling or large-scale underground development is contemplated at present until further geologic data are accumulated. Mineralogic studies of the ore, which contains both the minerals typical of copper-uranium deposits as well as carnotite-type minerals, are being carried out in the New York laboratory of the Commission.

Other copper-uranium claims in southern Utah

Three areas containing minor copper-uranium deposits in southern Utah were examined by the writer and were found to be of negligible economic importance, although of interest mineralogically. Data concerning these deposits are listed below:

Name	Location	Assay of Grab Samples, Percent		
		Equivalent U_3O_8	Chemical U_3O_8	Cu
Paria Road claims Nos. 1 - 6	14.2 miles east of Kanab, Kane County, Utah	Radioactivity about 3X background on a field counter.		
Rainbow claims	8.2 miles west of Pipe Springs National Monument Mohave County, Arizona	0.026	-	-
Fort Pierce	13 miles by road south of Hurricane, Washington County, Utah	.05	0.045	7.46

Reported copper-uranium deposits not visited

Since the summer of 1950, further information on reported copper-uranium occurrences has come to the attention of the General Exploration Branch. The location of these deposits, and our present information concerning them are as follows:

San Rafael Swell area.

A number of uranium deposits in the Shinarump and Moenkopi formations occur around the San Rafael Swell in south central Utah. A number of important producers of uranium-bearing asphaltic sandstones are located in the Temple Mountain area on the east limb of the Swell. In addition, several more recently developed uranium-bearing deposits in Shinarump conglomerate along 30 miles of the western limb of the San Rafael Swell have been described by Reyner [4]. Of the twelve groups of claims described only the Pay Day claim and Green Vein group contain typical copper-uranium deposits. The others consist of deposits in which uranium is intimately associated with blebs and seams of asphalt.

Marble Canyon-Lee's Ferry area.

Several reports have been received and investigated concerning minor occurrences of uranium minerals associated with petrified wood in the Chinle formation near Marble Canyon and Lee's Ferry, Arizona. In addition, several typical copper-uranium deposits recently came to our attention. These deposits are said to lie within one or two miles from the point at which U. S. Route 89 crosses the Colorado River, in the low

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4. Reyner, Millard L., Preliminary report on some uranium deposits along the west side of the San Rafael Swell, Emery County, Utah: U. S. Atomic Energy Commission, New York Raw Materials Operations, Spokane Extension, Spokane, Washington, October 1950.

ridges which lie to the east and north of the bridge. Samples from these deposits, submitted by S. C. Day, in Provo, Utah, assay up to 0.5% U_3O_8 and 5% copper.

Northern Wayne County.

A sample submitted by Mr. Willard Christensen, Salt Lake City, from an undisclosed location in northern Wayne County, assays 1.65% uranium and 2.94 copper.

CONCLUSIONS

The significant feature of the deposits described in the foregoing paragraphs appears to be the widespread distribution of copper-uranium mineralization along an easily recognizable stratigraphic horizon. The mineralogy of the deposits is apparently uniform, in the general sense, and in a few scattered and extremely localized areas the mineralized beds are known to contain a significantly high amount of uranium. The great lack at present is the amount of prospecting and development work that has been done. Prospecting of the favorable horizon has been extremely spotty and incomplete, and the few discoveries that have been made have been largely near existing roads. Several hundreds of miles of favorable outcrop have not been prospected, due largely to their inaccessibility. On the claims that have been staked, virtually no development has been done; the sole exception is the Oiler Tunnel in Wayne County and, even here, the amount of development has been negligible. The inaccessibility of most of the favorable areas will lead to very high mining costs, and any deposits that may become economic must necessarily be high-grade.