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FLUORESCENT SILICA AS A GUIDE TO URANIUM ORE IN MONUMENT VALLEY, UTAH AND ARIZONA*

By

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By Richard Q. Lewis, Sr.

ABSTRACT

Preliminary studies of uranium deposits in Monument Valley, Utah and Arizona, indicate that fluorescent silica may be used as a prospecting guide.

In Monument Valley uranium ore is in the Shinarump member of the Chinle formation of Triassic age, and the ore is localized in the lower parts of channel sediments. The deposits are of uranium or uranium-vanadium minerals, usually with some copper minerals.

Fluorescent silica (hyalite or chalcedony) is associated with most of the deposits. Fluorescent silica is apparently only found near ore bodies, and is easily located by use of an ultra-violet lamp. It may prove to be a useful guide to prospecting in Monument Valley and should be investigated as a possible guide to uranium ore in other areas.

INTRODUCTION

Preliminary studies indicate that fluorescent silica surrounds some of the uranium-vanadium deposits in the Shinarump member of the Chinle formation of Triassic age in Monument Valley, Utah and Arizona. Fluorescent silica appears to be a useful prospecting guide to uranium ore in the Monument Valley area and should be tested elsewhere.

The data for this paper were compiled as a result of the studies made during the mapping of Monument Valley, Utah, in the summer of 1952, and

during subsequent visits to the area by the writer. All laboratory work was done by the U. S. Geological Survey. This report is based on work done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

Monument Valley is a uranium producing area located on the Utah-Arizona state line about 50 to 60 miles west of the Four Corners area (fig. 1). Production of uranium ore from this region started in 1942-43 with shipments from the Vanadium Corporation of America's Monument No. 1 and Monument No. 2 properties. Production has steadily increased with the discovery of new ore bodies and at present the Monument Valley district is one of the more important areas of production of uranium ore from the Shinarump member of the Chinle formation.

As production increased, interest and prospecting increased. During the last few years both the U. S. Atomic Energy Commission and the U. S. Geological Survey have had field parties working in the area mapping and studying the ore deposits.

In Monument Valley, all uranium production has been from the Shinarump member of the Chinle formation, which in this area is a conglomeratic sandstone containing minor lenses of conglomerate and mudstone. The deposits contain uranium, vanadium, and uranium-vanadium minerals associated with small amounts of copper. All of the ore deposits are in the lower parts of scour channels cut into the surface of the underlying Moenkopi formation and filled with sediments of the Shinarump member. Most of the ore is restricted to conglomerate or to fractured or porous sandstone near the base of the formation (fig. 2).

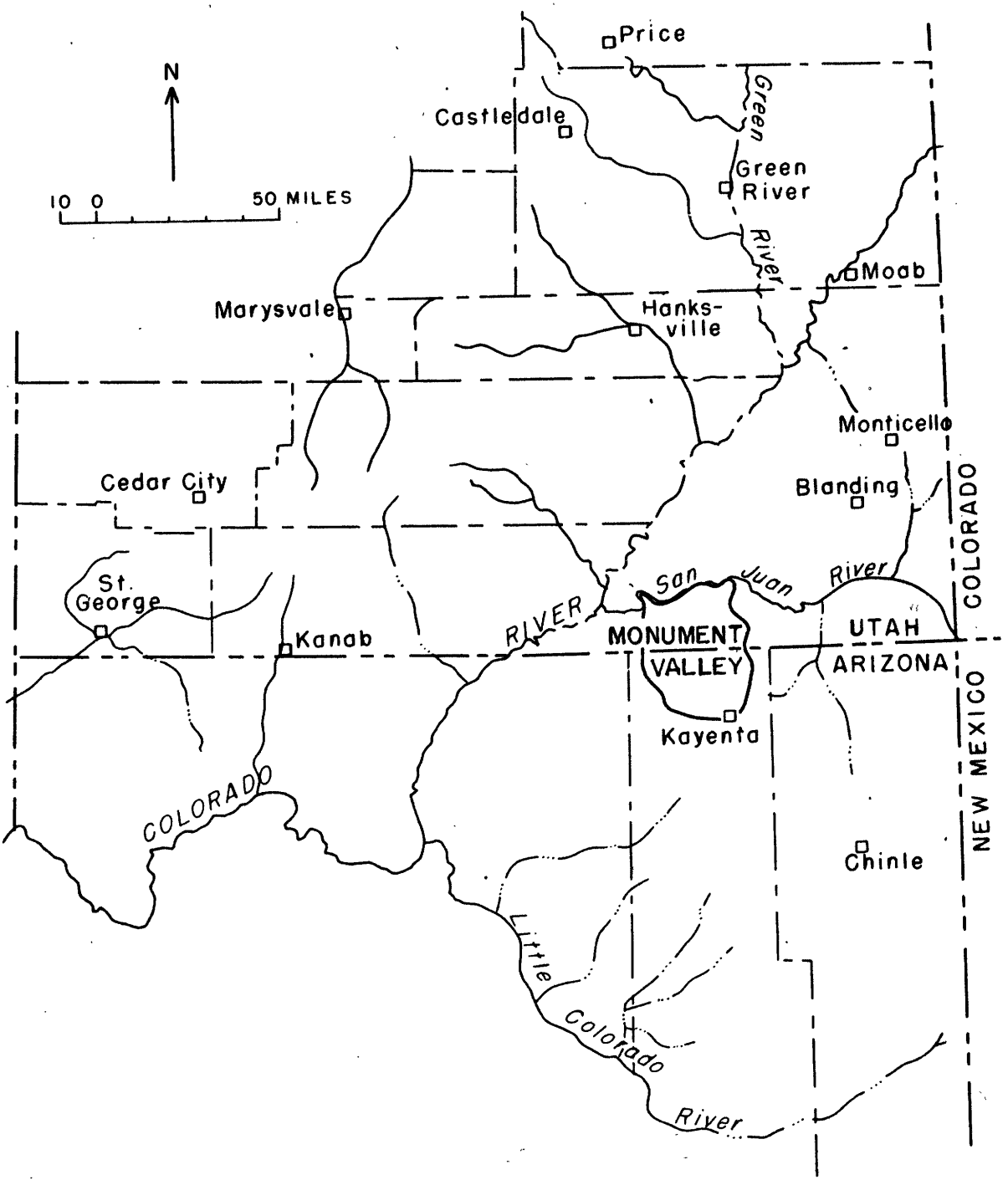

FIGURE 1.--INDEX MAP OF PARTS OF ARIZONA AND UTAH, SHOWING THE LOCATION OF MONUMENT VALLEY.

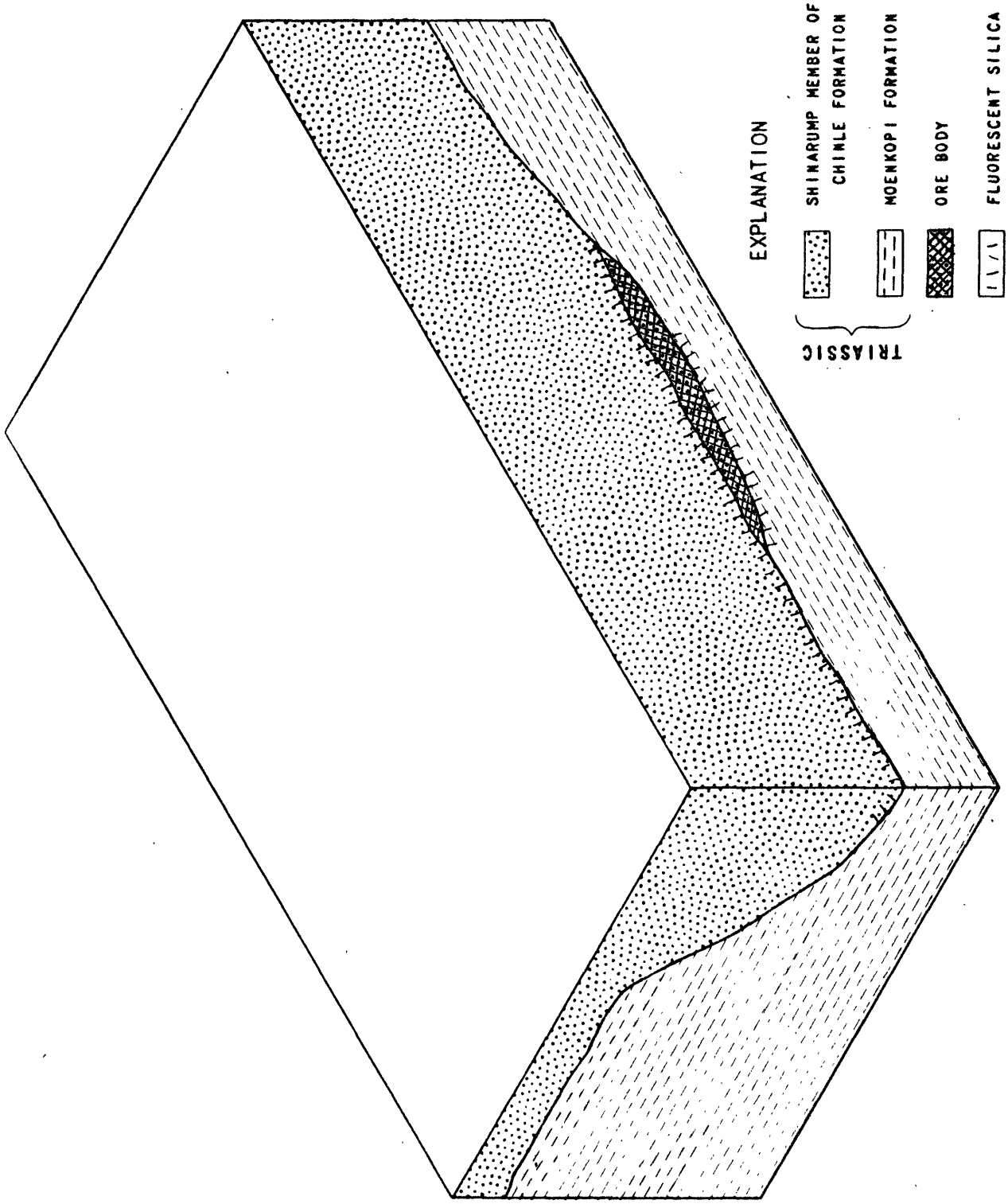

FIGURE 2.— BLOCK DIAGRAM OF SHINARUMP CHANNEL INTO THE MOENKOPI, SHOWING TYPICAL AREAS OF FLUORESCENT SILICA OCCURRENCE.

ORE DEPOSITS

The uranium-vanadium deposits occur as small tabular to lenticular bodies localized in the lowermost parts of the Shinarump channel sediments. In cross section the deposits are bi-convex or plano-convex with the greatest thickness usually coincident with the channel base. The boundaries pinch out abruptly against the margin of the channel. The thickest and highest grade ore is generally restricted to deep scours, potholes, and irregularities in the base of the channels.

The ore minerals are disseminated through the rocks, distributed along bedding planes, fractures, and joints; or as coatings on pebbles, clay galls, and carbonaceous material. In some of the deposits the ore minerals have replaced the cementing minerals (quartz and calcite) and in part replaced the pebbles and sand grains in the sandstone.

All mineral deposits observed in the area are small. They range in thickness from 1 to 2 inches to a maximum of 10 feet. Laterally the deposits are limited to the lowermost parts of channels and do not extend up the channel flanks more than 10 to 12 feet above the base. Their lineal extent has not been determined in most places, but drilling and mining operations have shown the deposits to be spotty and generally limited to 200 feet or less lineally, with barren ground separating adjacent deposits within the same channel. Within the deposits uranium minerals occur in small high-grade pockets with "lean," sparsely mineralized areas between.

The most common ore mineral is the yellow fine-grained hydrous calcium uranium vanadate, tyuyamunite $[Ca(UO_2)_2(VO_4)_2 \cdot 7\text{-}10\text{-}1/2\ H_2O]$. It occurs with lesser amounts of uranophane $[Ca(UO_2)_2Si_2O_7 \cdot 6H_2O]$, autunite $[Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12H_2O]$, torbernite $[Cu(UO_2)_2(PO_4)_2 \cdot 8\text{-}12H_2O]$, and uraninite $[UO_2]$ and $[UO_3]$.

FLUORESCENT SILICA

Fluorescent silica is associated with the uranium-vanadium deposits in Monument Valley. The silica occurs as hyalite (colorless glassy opal) and less commonly as chalcedony (microcrystalline quartz). X-ray studies give a pattern typical of quartz in the chalcedony samples or no pattern for the hyalite. Both minerals contain uranium and for convenience they are collectively referred to as silica. Semiquantitative spectrographic analyses indicate that trace amounts of elements other than uranium have been deposited with uranium in the silica. Most noticeable of these are zinc, calcium, and magnesium (table 1). These elements are disseminated in the silica and do not form identifiable minerals with either the uranium or silica. The silica coats fractures (fig. 3), joint surfaces, and pebbles, and fills shrinkage cracks around clay galls.

Laboratory studies indicate the fluorescence is due to small amounts of uranium in the silica. Though silica is widespread in Monument Valley, only that near ore is fluorescent. It is generally found near or on the flanks of the channels and downdip from deposits. Preliminary field and laboratory studies indicate that fluorescence increases directly with increase in uranium content and generally inversely with the distance from ore.

Fluorescent silica was first noted by the writer on the flank of an ore-bearing Shinarump-filled channel on Holiday Mesa near Oljeto Trading Post in Monument Valley, Utah, in 1952. During later field work additional localities were found in the Skyline Channel on Oljeto Mesa and in the Monument No. 1 - Mitten No. 2 Channel in Monument Valley, Arizona. An ultra-violet lamp of the short wave type (2537 A) was used by the writer. Fluorescence was observed in silica containing as little as 15 parts per

Table 1.--Spectrographic analysis of one hyalite sample, from near the base of the Shinarump about 10 feet from ore in the east workings of the Skyline mine, Monument Valley, Utah.

Field No.	Si	Al	Fe	Ti	Mn	Ca	Mg	Ba	Co	Cr	Cu	Mo	Sr	U	V	Zn
55-L-10	xx.	.0x	.0x	.000x	Tr	.x	.x	.00x	.00x	.000x	.00x	.00x	Tr	.x	.00x	.0x

Note that the concentrations are reported as elements, not as oxides or compounds.

Tr = concentration near threshold of spectrographic method

Analysis by N. M. Conklin, U. S. Geological Survey

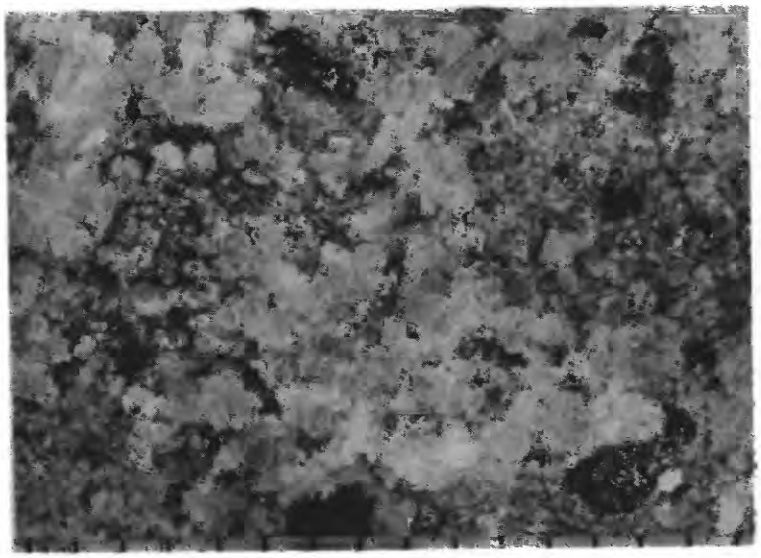

Figure 3 -- Photograph of a hand specimen, showing a typical occurrence of fluorescent silica on a fracture surface. (Magnification 3X)

million uranium. In most cases the mineral fluoresced a yellow green color similar to autunite. Samples were taken wherever fluorescent silica was observed. In all cases the intensity and color of fluorescence were noted and where possible the direction and distance to known ore were noted. All of the samples tested contained an appreciable amount of uranium. Preliminary studies on only 6 samples indicate that the uranium content and the intensity of fluorescence increase with proximity to ore (table 2). The relationship of fluorescent silica to the ore deposits and the nature of its occurrence as coating on fractures and pebbles indicated that the silica was deposited after the ore minerals.

Equilibrium studies were made by J. N. Rosholt, Jr., of the U. S. Geological Survey (table 3). The Th^{230} (ionium):uranium ratio indicates that the silica containing the uranium at the Skyline mine was emplaced not more than 35,000 years ago. However, the low amount of Pb^{210} indicates that either radium has been selectively leached from the deposit or that the deposit is much younger than the maximum age indicated above. These studies confirmed the field evidence and indicate the uranium was leached from the ore deposits and redeposited with silica in its present position during the late Pleistocene, probably during Wisconsin time.

Studies by Haberlandt and Hernegger (1946) indicate that a close correlation exists between the intensity of fluorescence and the amount of uranium contained in hyalite. Their studies were made on a large number of hyalite samples collected from localities scattered throughout the world. The results indicate that careful study of the degree of fluorescence of uraniferous hyalite can be used to determine accurately the amount of contained uranium.

Table 2.—Some fluorescent silica samples tested by quantitative chemical methods.

Number	Sample location and composition	Distance from ore	Fluorescence	Uranium (parts per million)
1	Holiday Mesa Taylor Reid No. 1 (chalcedony)	50 feet	Pale yellow green	60-80
2	Skyline Channel Skyline mine (hyalite)	10 feet	Bright green	800
3	Monument No. 1 mine (hyalite)	30 feet	Bright green	100
4	Fry No. 4 mine White Canyon (chalcedony)	24 feet	Bright green	200
5	Igneous intrusive (chalcedony) (coating on fracture)	Unknown	Very pale yellow	20
6	Tertiary porphyritic andesite Awapa Plateau, Wayne County, Utah, containing fluorescent hyalite amygdules	Unknown	Pale green	30

Analyses by J. H. McCarthy, U. S. Geological Survey.

Table 3.—Results of equilibrium studies on a sample of fluorescent silica from Skyline mine, Monument Valley, Utah.

eU percent	U percent	Th^{230}	Pa^{231}	Ra^{226}	Rn^{222}	Pb^{210}
		(Percent equivalent)				
0.12	0.26	0.068	0.20	0.10	0.08	0.22

Analyst J. N. Rosholt, Jr., U. S. Geological Survey

CONCLUSIONS

The writer believes that fluorescent silica is a good guide to ore in the Monument Valley region and may be used as a tool for both prospecting and exploration. Halos of fluorescent silica around ore deposits enlarge the target sought by uranium prospectors and thus the chance of finding concealed deposits is increased both at the outcrop and in drill core. The small amount of uranium is not detectable with a Geiger counter and is barely detectable with a scintillation counter. Prospecting with an ultraviolet light is easy and the cost of a lamp is relatively small.

Numerous reports of fluorescent silica associated with uranium deposits in other areas including Utah, Wyoming, Texas, and Oregon indicate that fluorescent silica as an ore guide might be of widespread importance in areas outside the Colorado Plateau. However, its value would have to be determined in each area.

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Haberlandt, Herbert, and Hernegger, Friedrich, 1946, Uranbeslimmungen an Glasopalen und anderen Mineralier mit Hilfe der Fluoreszenzanalyse: Akad. Wiss. Wien, Math.-natureviss. Kl., Sber, Abt. IIa, Bd. 155, H. 7-8, p. 359-370.