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PRODUCTION EVALUATION DIVISION

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Kehas questions 15th ¶, p. 8 — says channel in braided portion would scour deeper than channel in single-channel portion of stream.

DEVELOPMENT DRILLING OF THE HAPPY JACK MINE

SAN JUAN COUNTY, UTAH

by

J. D. Lowell and D. F. Spencer

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(Grand Junction, Colorado)

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ABSTRACT

The U. S. Atomic Energy Commission conducted a drilling program in the Happy Jack mine area of the White Canyon mining district, San Juan County, Utah, from March 31, 1953, to June 22, 1953. Under Contract No. AT(05-1)-221, eighty-two partly cored holes, totalling 14,973 feet, were drilled through the Shinarump member of the Triassic Chinle formation to determine the uranium reserve and the geologic associations of the uranium ore. Ore occurs in sandstone in the lower 10 feet of the Shinarump in scours in the Triassic Moenkopi formation where there are optimum amounts of mudstone and carbonaceous material and where there is brown or yellowish brown coloring of sandstone. No association of ore with any tectonic structural feature was noted.

INTRODUCTION

This report is based on drilling done from March 31 to June 22, 1953. The purpose of the drilling was to determine the uranium ore reserve in the Happy Jack mine area and to study the geologic associations of the ore. In earlier investigational drilling projects ~~(AEC drilling contracts AT(30-1)-1259, (Miller, 1952)~~ 29 ~~26~~ holes were drilled, totalling 3,~~402~~ 392 3,918 feet. The present report includes geologic data compiled in drilling 82 holes totalling 14,973 feet ~~(table I)~~ under AEC Contract No. AT(05-1)-221. Most of this footage was used in close-spaced drilling of areas where the earlier holes had intersected ore. Table I presents ~~summary~~ drilling data for all the AEC drilling projects in the Happy Jack area. The earlier, investigational drilling projects were

described by Frankovich (1952) and Miller (1952). This report incorporates the data and conclusions from the earlier drilling projects.

Accessibility

The Happy Jack mine is 75 miles west of Blanding, Utah, and is accessible either from Blanding by Utah Route 95, or via Hite from Green River, Utah, 130 miles north by Utah Route 24 (fig. 1). Both routes are graded. Green River is the nearest rail connection. There is an airstrip, suitable for small planes only, approximately one mile from the Happy Jack mine.

History of Exploration and Mining

The Happy Jack mine was operated in 1900 as a copper prospect but closed after an unknown period of operation and in 1914 reopened for a short time. Interest in the property as a potential uranium producer was aroused in 1945, and since 1949 it has been in constant production. In late 1956 the property was purchased by Texas Zinc Minerals, the present operators.

In January, 1954, a pilot plant at White Canyon, approximately 15 miles from the drilling area, was dismantled, and in 1955 the Atomic Energy Commission established an ore-buying station about one mile east of the Happy Jack mine.

Exploration Technique

Drilling was done with Joy "22" machines mounted on 6 x 6 trucks with Gardner-Denver 4" x 5" duplex mud pumps; auxiliary Deming Simplex pumps were used when low pressures were desired while coring. Three-bladed fishtail bits were found to be the most satisfactory for non-core drilling in overburden, shales, and soft sandstones; tri-cone roller-type bits were used in harder rock. Core drilling was with diamond bits, using BX or larger diameter core barrels as necessary to obtain satisfactory recovery. In nearly all holes casing was set in order to reduce water consumption and prevent cave-ins. In other drilling in the White Canyon area under the same contract most of the drilling, both core and non-core, was done with air rather than water. Air drilling gave faster penetration but resulted in greater bit consumption.

Before drilling began, the Shinarump-Moenkopi contact exposed on the rim was mapped by plane table. The regional dip of the contact between Moenkopi and Hoskinnini beds was measured, in order that the dip might be eliminated to give a true picture of the contours of the pre-Shinarump erosion surface.

During the first stage of the present project, holes were drilled on 30- to 60-foot centers in rows across the projected trend of the channel. When it became apparent that the Happy Jack ore body was of irregular shape, this pattern was altered to a rectangular one with holes located on 75- to 100-foot centers.

Acknowledgments

The writers acknowledge the cooperation and assistance of Messrs. J. W. W. R. Cooper and Bronson, the former owners and operators of the Happy Jack mine.

Leo J. Miller and Jacob Wichtner, formerly of the AEC, contributed much to the success of the work.

REGIONAL GEOLOGY

The geology of the region has been described by Gregory (1938), Benson and others (1952), Trites and others (1956), Miller (1955), ~~Frankovich (1952)~~, and Gardiner and Gruner (1950 and 1952).

The generalized stratigraphy in the Happy Jack area is shown in Figure 2. All large ore bodies are found in the lenticular and discontinuous Shinarump member of the Chinle formation. Mineralized zones and small bodies of ore-grade material have been noted in the basal Chinle where the Shinarump is absent, in the Moenkopi, and in the Cedar Mesa, but none are of economic importance. The Shinarump is discontinuous and lenticular, and its local absence may account for the uranium mineralization of the lenticular sandstones in the overlying Chinle. The prominent Moss Back member of the Chinle formation has also been mineralized locally, but to date no ore has been found in it.

GEOLOGY OF THE HAPPY JACK AREA

Tectonic Structure

The Happy Jack area is on the west flank of the Monument uplift where regional dip is about 2½ degrees west. In the area drilled the dip is uniform except in the Sunrise channel area, where a gentle syncline approximately 300 feet wide and trending northwest across the Happy Jack Mesa was mapped on the base of the Moenkopi. Numerous joints cut the Hoskinnini tongue of the Cutler formation and the Moenkopi formation; they are less apparent or absent in the Shinarump. Some joints have narrow zones of limonite alteration, but no direct relationship between jointing and uranium mineralization has been noted.

Lithology and Sedimentary Features

The Shinarump member in the area studied is composed of alternating fine- to coarse-grained light gray to brown sandstones and dark gray to brown thin laminated to massive siltstones. The member can be divided roughly into a lower sandstone-~~siltstone~~ mudstone unit which fills channels cut into the Moenkopi formation and a more widespread upper sandstone which ~~fills broad regional troughs in the Moenkopi formation and~~ covers interchannel areas. ~~The broad troughs may be warps in the Moenkopi formation, and~~ the channels may represent initial Shinarump drainage subsequent to pre-Shinarump down-warping ~~the warps~~ (McKee, E. D., ~~personal communication,~~ 1953). The sediments in the lower unit of the Shinarump are more lenticular than those in the upper unit. As in other areas of Shinarump deposits, all the large uranium deposits are in the lower unit.

Figure 3 is a contour map of the Moenkopi-Shinarump contact corrected for regional dip. Figure 4 shows contours on the base of ore-bearing sandstone of the Shinarump and is quite similar to figure 3. These maps were made from data obtained from outcrops, drill holes, and mines.

The Sunrise and Gonaway channels (fig. 3) are deep and narrow and appear to be segments of the same channel. The ore bodies in these channels are comparatively small and discontinuous.

The Happy Jack "scour" differs from the Sunrise and Gonaway channels in that it appears to be a broad paleotopographic basin, U-shaped in cross section, bounded on three sides by fairly steep banks, and opening to the west (fig. 3). Cross-stratification dip directions (fig. 5) indicate that the average direction of paleostream flow was westward through the basin toward the open end. The base of the scour is visible on the cliff near the portal of the Happy Jack mine. On the west side of the mine the scour splits, and one branch turns slightly northward and appears to be filled with Chinle mudstone with no typical Shinarump sediments present. The other branch, which contains Shinarump channel deposits, trends southwest. Owing to excessive drilling depths and difficulties imposed by topography, ~~mapping~~ drilling of this branch was abandoned, despite the fact that some ore and favorable lithology were penetrated by the most south-westerly hole (HJ-96) drilled to intersect this scour. The southwestward extension of this scour remains as a favorable unexplored portion of the area. Projection of paleochannels in the direction of average dip of the cross-stratification was attempted with some success. The extensive workings of the Happy Jack mine constituted an especially good locality for measurements, and extension of the Happy Jack ore body to the west and north was in part done by cross-stratification mapping (fig. 5). The pattern of cross-stratification directions was anlayzed by combining many individual directions into a resultant vector of the average direction of flow of the paleostream. For a description of the method used see Lowell, 1953.

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The Happy Jack basin may have been scoured by a stream which crossed the neighboring area as a braided stream, merging to a single channel at the Happy Jack basin. The single-channel portion of the stream would have more scouring power than the braided portion. Greater concentration of stream flow would both widen and deepen the channel.

Lekas believes this is backwards

ORE GUIDES

The following maps were prepared in the effort to determine ore guides:

Figure 3: Map of the configuration of Moenkopi erosion surface and corrected for regional dip.

Figure 4: Contours on the base of the ore-bearing sandstone unit.

Figure 6: Map of ratio of sandstone to mudstone in the lower 10 feet of the Shinarump member.

Figure 7: Map of total thickness of mudstone beds in the lower 10 feet of the Shinarump member.

Figure 8: Map of the relative abundance of carbon in the lower 10 feet of the Shinarump member.

Figure 9: Map of the color of sandstone in the lower 10 feet of the Shinarump member.

Each of the maps reveal certain characteristics of sedimentation or composition that are associated with ore.

All ore bodies are in Shinarump sediments filling scours in the Moenkopi formation, and these scours, or channels, as shown on figure 3, constitute the most useful ore guide. The shapes of the ore bodies correspond roughly to the shapes of the channels.

Ore occurs in sandstone in the lower 10 feet of the Shinarump in areas of interfingering sandstone and mudstone. Figure 4 shows contours on the base of

ore-bearing sandstone of the Shinarump. It will be noted that the configuration of this horizon is not greatly different from that of the Shinarump-Moenkopi contact (fig. 3). Figure 6 shows that ore occurs chiefly in the areas where the ratio of the total thickness of the sandstone beds in the lower 10 feet to the total thickness of the mudstone beds in that interval is less than 3.5. Areas of mudstone beds totalling more than 1 foot in thickness in the lower 10 feet of the Shinarump are generally favorable, as illustrated in figure 7. In the Happy Jack mine ore commonly occurs immediately above lenticular Shinarump mudstones where these lie on the eroded Moenkopi surface. Replacement by uraninite of argillaceous matrix interstitial to sand grains is fairly common. Uraninite seams $\frac{1}{2}$ inch thick or less in thin (2-inch) mudstone beds are regarded as replacements of the mudstone. It appears that mudstone may have been a precipitating agent of uranium.

Ore occurs chiefly in areas where the lower 10 feet of the Shinarump was logged as containing "some" or "abundant" carbonized wood. This relationship is shown on figure 8. Wood either acted as a precipitating agent or is an indicator of favorable sedimentary environments.

Finally, ore occurs chiefly in or adjacent to areas where the sandstone in the lower 10 feet of the Shinarump is in part or wholly colored brown or yellowish brown (fig. 9).

Pyrite abundance was not mapped, but pyrite seems to be more abundant in the Happy Jack area than in adjacent unmineralized ground outside the drilled area.

No association of ore with any tectonic structural feature was noted.

Correlation between drill holes of individual lithologic units is very difficult, owing to their great lenticularity. For this reason no drawings were prepared showing correlations between specific units.

CONCLUSIONS

The ore bodies delineated are in every case located in Shinarump sediments filling ~~paleostream channels~~ scours cut into the Moenkopi formation. Several small mineral deposits of marginal grade and size occur outside the scours. ~~channel deposits~~. Subsurface maps show an association of ore with sandstone-mudstone interfaces in the lower 10 feet of the Shinarump, with carbonaceous matter, and with brown or yellowish brown sandstone. The Happy Jack mine was proved by drilling to be in a paleotopographic depression surrounded by steep banks on three sides. ~~A favorable channel, which was not completely outlined,~~ this depression apparently extends west from the Happy Jack mine into country overlain by a thick cap of Wingate sandstone, and this probable extension remains as a favorable unexplored part of the area.

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