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GEOLOGIC GUIDES TO CARNOTITE DEPOSITS
PROGRESS REPORT

TEM MEMORANDUM REPORT ~~11~~ 101

COLORADO PLATEAU PROJECT

by
DORIS H. BLACKMAN

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Letz for Rose
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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

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MAR 23 1950

Dr. P. L. Merritt, Assistant Manager
Raw Materials Operations
Atomic Energy Commission
P. O. Box 30, Ansonia Station
New York 23, New York

Dear Phil:

Transmitted herewith for your information and distribution are five copies of Colorado Plateau Project Memorandum Report 11 by Doris Blackman entitled "Geologic guides to carnotite deposits, progress report." For some time Miss Blackman, under the guidance of Dr. R. P. Fischer, has been critically analyzing all of the data recorded by the field geologists that might serve as guides to ore. This memorandum report summarizes the present status of this review. In an effort to arrive at a possible semi-quantitative evaluation of these different guides this study is being continued. We hope that through this means it will be possible to appraise the significance of those cases where one or two of the guides are found favorable, but others may be lacking, or do not agree with one another. If this phase is successful an attempt will then be made to apply these data to an appraisal of various blocks of ground that have been or are being drilled.

As soon as the appraisal of these other factors is available, we will transmit the complete report to you. We hope this will be in May.

Sincerely yours,

E. S. Larsen

(for) W. E. Bradley
Chief Geologist

Enclosures 5

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOLOGIC GUIDES TO CARNOTITE DEPOSITS

BY

Doris H. Blackman

Progress Report

Memorandum Report 11

March 1950

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GEOLOGIC GUIDES TO CARNOTITE DEPOSITS

Progress Report

By Doris H. Blackman

Introduction

In order to evaluate certain geologic features as guides to exploration for carnotite deposits on the Colorado Plateau, a detailed study is being made of the geologic logs of diamond-drill holes in six areas drilled by the Geological Survey. This advanced summary presents the important basic data obtained from this study and summarizes the conclusions based on these data. In the final report on this study a numerical rating system will be used to appraise these features collectively.

The data presented apply only to the sandstone unit that contains most of the carnotite deposits, here called the "ore-bearing sandstone," and to the associated mudstone. The data are expressed statistically in five tables, one for each of the geologic features that appear to be most useful in guiding exploration. These features are (1) thickness of the ore-bearing sandstone, (2) color of the sandstone, (3) alteration of mudstone within the sandstone, (4) alteration of mudstone below the sandstone, and (5) abundance of carbonaceous material.

Each table shows the development of these features in blocks coextensive with the deposits and in 100-foot wide zones outward as far as 400 feet from the deposits, to aid in focusing attention to the drilling target. Where enough holes are present in each zone to yield sufficient

information to express relations statistically, fairly systematic variations are evident. Apparently one to two dozen holes in each zone are necessary; some of the zones represented on the tables lack enough holes. No attempt has been made to show on the tables the relation of these features in holes more than 400 feet from the deposits, for in most areas the holes are too few or otherwise inappropriately spaced to yield information that can be treated in a comparable statistical manner. Even so, information from the holes remote from the known deposits has been considered in the over-all picture, and the relations observed are useful in recognizing the larger targets of ground favorable for deposits and in recognizing unfavorable ground so it can be eliminated from further drilling.

Although these geologic features show fairly systematic variations with regard to the proximity of ore deposits, it must be clearly noted that variations from the norm at single points of observation, such as individual drill holes, require that these relations be used with caution. Furthermore, the norms differ somewhat from one area to another (see tables 1 to 5). Actually, the relations are so subtle that knowledge based on experience is essential in guiding exploration

Geologic guides

Thickness of the ore-bearing sandstone.—The thickness of the ore-bearing sandstone is a valuable criterion because it can be used on a broad scale to delimit ground unfavorable for containing ore. In the areas drilled, no large deposits, and only a few small ones, have been found where the sandstone is less than 40 feet thick. Most deposits are in sandstone that is 40 to 60 feet thick (see table 1). Some deposits, however, are in thicker sandstone.

Color of the ore-bearing sandstone.—Near ore deposits the ore-bearing sandstone is light yellow-brown in color and speckled with limonite stain. In unfavorable ground, on the other hand, much of the sandstone is light red-brown or has a reddish cast. For statistical purposes it seemed most feasible to record the abundance of sandstone with a reddish cast, thus expressing a factor of unfavorability. The general increase in abundance of reddish sandstone outward from ore deposits is shown in table 2.

Alteration of mudstone within the ore-bearing sandstone.—The ore-bearing sandstone is overlain and underlain by mudstone; and lenses, seams, and pebbles of mudstone occur within the sandstone. Near ore deposits this mudstone has been altered from red to gray. The proportion of gray (altered) mudstone to red (unaltered) mudstone within the sandstone is shown in table 3. A relatively high proportion of altered mudstone to unaltered mudstone is indicative of the proximity of ore.

Alteration of mudstone below the ore-bearing sandstone.--The thickness of altered mudstone immediately below the ore-bearing sandstone is one of the most useful guides to carnotite deposits, for not only is mudstone present nearly everywhere below the sandstone, but the altered part commonly extends several hundred feet or more from the deposits, thus offering a large target (table 4). The altered mudstone is generally thickest near deposits, though the thickest part is not necessarily coextensive with the ore. In general, the minimum favorable thickness of altered mudstone is about 2 feet, and above this minimum the favorability increases with increasing thickness of alteration, at least to as much as 4 feet, above which increasing favorability is not evident.

Abundance of carbonaceous material.--It has been suggested that the ore deposits were localized in the chemical environment of decaying organic matter, which is now present in the sandstone as carbonaceous (coaly) material. Table 5 shows that in general more holes in and near carnotite deposits contain abundant carbonaceous material than in the zones away from deposits.

Table 1

Average thickness of the ore-bearing sandstone
(figures do not include thickness of mudstone within the ore-bearing sandstone)

Zones coextensive with and outward from ore deposits	Calamity group		Maverick group		Outlaw Mesa (north-central part)		Club Mesa		Radium group		Legin group	
	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet
Coextensive with	177	49.2			96	55.2	53	54.6	49	44.3	112	62.2
0-100 feet outward	225	47.4		not	57	45.8	6	47.5	58	46.9	55	59.4
100-200 feet outward	79	46.5		deter-	17	46.5	20	55.5	46	45.8	37	56.1
200-300 feet outward	48	44.2		mined	6	50.7	17	56.4	25	47.7	12	52.0
300-400 feet outward	35	42.6			7	29.8	18	47.2	18	43.6	5	56.0

Table 2

Average percentage of the ore-bearing sandstone that has a reddish cast

Zones coextensive with and outward from ore deposits	Calamity group		Maverick group		Outlaw Mesa (north-central part)		Club Mesa		Radium group		Legin group	
	Number of drill holes in zone	Average percentage with red cast	Number of drill holes in zone	Average percentage with red cast	Number of drill holes in zone	Average percentage with red cast	Number of drill holes in zone	Average percentage with red cast	Number of drill holes in zone	Average percentage with red cast	Number of drill holes in zone	Average percentage with red cast
Coextensive with	177	0.7	42	7	96	3.0	53	6.6	49	10.4	112	4.5
0-100 feet outward	225	2.3	28	27	57	5.3	6	6.1	58	9.6	55	4.1
100-200 feet outward	79	3.9	7	8	17	2.6	20	7.9	46	15.8	37	3.9
200-300 feet outward	48	7.1	8	35	6	none	17	4.8	25	18.4	12	11.0
300-400 feet outward	35	5.2	7	29	7	6.2	18	7.0	18	22.7	5	21.2

Table 3

Ratio of gray (altered) mudstone to red (unaltered) mudstone within the ore-bearing sandstone

Zones coextensive with and outward from ore deposits	Calamity group		Maverick group		Outlaw Mesa (north-central part)		Club Mesa		Radium group		Legin group	
	Number of drill holes in zone	Average ratio of gray to red mudstone	Number of drill holes in zone	Average ratio of gray to red mudstone	Number of drill holes in zone	Average ratio of gray to red mudstone	Number of drill holes in zone	Average ratio of gray to red mudstone	Number of drill holes in zone	Average ratio of gray to red mudstone	Number of drill holes in zone	Average ratio of gray to red mudstone
Coextensive with	177	2.3 : 1	42	6.7 : 1	96	3.0 : 1	53	6.5 : 1	49	0.8 : 1	112	3.1 : 1
0-100 feet outward	225	1.1 : 1	28	3.3 : 1	57	1.8 : 1	6	1/	58	0.3 : 1	55	1.7 : 1
100-200 feet outward	79	0.6 : 1	7	1.1 : 1	17	4.0 : 1	20	0.4 : 1	46	0.4 : 1	37	0.9 : 1
200-300 feet outward	48	0.5 : 1	8	0.7 : 1	6	1/	17	0.1 : 1	25	0.1 : 1	12	0.2 : 1
300-400 feet outward	35	0.7 : 1	7	0.2 : 1	7	13.3 : 1	18	0.2 : 1	18	0.2 : 1	5	0.2 : 1

1/ No mudstone present

Table 4

Average thickness of gray (altered) mudstone at base of ore-bearing sandstone

Zones coextensive with and outward from ore deposits	Calamity group		Maverick group		Outlaw Mesa (north-central part)		Club Mesa		Radium group		Legin group	
	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet	Number of drill holes in zone	Average thickness in feet
Coextensive with	177	3.4	42	5.8	96	4.2	53	2.2	49	1.0	112	1.6
0-100 feet outward	225	1.9	28	3.3	57	1.9	6	0.2	58	0.4	55	1.2
100-200 feet outward	79	1.3	7	6.4	17	2.7	20	1.5	46	0.6	37	0.6
200-300 feet outward	48	0.8	8	3.4	6	3.2	17	1.8	25	0.2	12	0.2
300-400 feet outward	35	0.6	7	2.1	7	1.1	18	1.9	18	0.04	5	0.5

Table 5

Number and percentage of drill holes that cut abundant carbonaceous material

Zones coextensive with and outward from ore deposits	Calamity group			Maverick group			Outlaw Mesa (north-central part)			Club Mesa			Radium group			Legin group		
	Number of drill holes in zone	Number of holes that cut abundant carbonaceous material	Percentage of holes that cut abundant carbonaceous material	Number of drill holes in zone	Number of holes that cut abundant carbonaceous material	Percentage of holes that cut abundant carbonaceous material	Number of drill holes in zone	Number of holes that cut abundant carbonaceous material	Percentage of holes that cut abundant carbonaceous material	Number of drill holes in zone	Number of holes that cut abundant carbonaceous material	Percentage of holes that cut abundant carbonaceous material	Number of drill holes in zone	Number of holes that cut abundant carbonaceous material	Percentage of holes that cut abundant carbonaceous material	Number of drill holes in zone	Number of holes that cut abundant carbonaceous material	Percentage of holes that cut abundant carbonaceous material
Coextensive with	177	69	39	42	9	21	96	50	52	53	20	38	49	27	55	112	38	34
0-100 feet outward	225	27	12	28	2	7	57	17	30	6	2	33	58	18	31	55	6	11
100-200 feet outward	79	9	11	7	none	0	17	3	18	20	5	25	46	9	20	37	5	14
200-300 feet outward	48	6	12½	8	none	0	6	1	17	17	1	6	25	8	32	12	3	25
300-400 feet outward	35	6	17	7	none	0	7	none	0	18	1	6	18	none	0	5	2	40