PRELIMINARY REPORT ON CORRELATION BETWEEN GAMMA-RAY LOGS AND PERMEABILITY LOGS OF THE ORE-BEARING SANDSTONE IN THE MORRISON FORMATION, CALAMITY MESA, MESA COUNTY, COLORADO

Trace Elements Memorandum Report 270

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

IN REPLY REFER TO:

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

OCT 1 5 1951

AEC - 395/2

Dr. Phillip L. Merritt, Assistant Director
Division of Raw Materials
U. S. Atomic Energy Commission
P. O. Box 30, Ansonia Station
New York 23, New York

Dear Phil:

Transmitted herewith for your information and distribution are 3 copies of Trace Elements Memorandum Report 270, "Preliminary report on correlation between gamma-ray logs and permeability logs of the ore-bearing sandstone in the Morrison formation, Calamity Mesa, Mesa County, Colorado," by David A. Phoenix, October 1951.

The studies reported here show that zones of low permeability in non-uraniferous portions of the ore-bearing sandstone on Calamity Mesa are more radioactive than normal. These zones of low-permeability and high-radioactivity are found most commonly near the contact of permeable and impermeable strata.

This report was prepared in answer to a request by Mr. J. J. Hosted in his letter of June 26, 1951.

Sincerely yours,

/s/ W. H. Bradley

W. H. Bradley
Chief Geologist

JAN 3 0 2001

UNCLASSIFIED

This document consists of 8 pages, plus 1 figure, Series A.

CATEGORY VII (Colorado Plateau Geology)

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY REPORT ON

CORRELATION BETWEEN GAMMA-RAY LOGS AND PERMEABILITY LOGS OF THE ORE-BEARING SANDSTONE IN THE MORRISON FORMATION CALAMITY MESA, MESA COUNTY, COLORADO

By

David A. Phoenix

October 1951

CAUTION

This report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

Trace Elements Memorandum Report 270

USGS - TEM Report 270

The distribution (Series A) of this report is as follows:

3 copies	AEC, Washington (J. C. Johnson)
8 copies	AEC, New York (P. L. Merritt)
1 copy	AEC, Denver (C. C. Towle, Jr.)
1 copy	AEC, Spokane (E. E. Thurlow)
1 copy	AEC, Grand Junction (F. H. MacPherson)
1 copy	AEC, Grand Junction (T.W. Oster)
1 copy	Columbia Univ., New York (P. F. Kerr)
1 copy	Univ. Minnesota, Minneapolis (J. W. Gruner)
1 copy	USGS, Washington (Mineral Deposits Branch)
1 copy	USGS, Denver (A. H. Koschmann)
1 copy	USGS, San Francisco (E. H. Bailey)
1 copy	USGS, Prescott, Ariz. (C. A. Anderson)
1 copy	USGS, Joplin (David Gallagher)
1 copy	USGS, Madison (Carl Dutton)
1 copy	USGS, Knoxville (R. A. Laurence)
1 copy	USGS, Salt Lake City (R. J. Roberts)
1 copy	USGS, Washington (Geochemistry & Petrology Branch)
1 copy	USGS, Washington (Geophysics Branch)
1 copy	USGS, Washington (Fuels Branch)
1 copy	USGS, Washington (Alaskan Branch)
1 copy	USGS, Washington (V. E. McKelvey)
1 copy	USGS, Denver (L. R. Page)
1 copy	USGS, Denver (J. F. Smith, Jr.)
2 copies	USGS, Grand Junction (R. P. Fischer)
1 copy	USGS, Spokane (A. E. Weissenborn)
1 copy	USGS, Plant City, Fla. (J. B. Cathcart)
4 copies	USGS, Washington (TEPCO)
(Including master copy)	

CONTENTS

Page

Introduction 4

General geology. 4

Permeability and porosity. 6

Gamma-ray activity 7

Conclusions 8

Reference 8

ILLUSTRATION

Figure 1. Geologic logs of core from three diamond-drill holes on Calamity Mesa, Mesa County, Colo., showing correlation between the gamma-ray logs and the permeability and porosity of the ore-bearing sandstone of the Salt Wash sandstone member of the Morrison formation . . . . . in envelope

PRELIMINARY REPORT ON CORRELATION BETWEEN GAMMA-RAY LOGS AND PERMEABILITY LOGS OF THE ORE-BEARING SANDSTONE IN THE MORRISON FORMATION CALAMITY MESA, MESA COUNTY, COLORADO

By

David A. Phoenix

INTRODUCTION

A study of the hydrologic properties and geologic relations of the ore-bearing sandstone in the Salt Wash sandstone member of the Morrison formation has been undertaken because uranium and vanadium are believed to have been introduced into the sandstone by circulating ground water.

This report describes the geologic and hydrologic characteristics of the ore-bearing sandstone as determined in the core samples from three diamond-drill holes on Calamity Mesa, Mesa County, Colo., and correlates these data with localized gamma-ray activity detected in the three drill holes. These data are illustrated on figure 1 by the combined geologic, permeability, porosity, and gamma-ray logs.

This study is part of the program of geologic studies on the Colorado Plateau conducted by the Geological Survey on behalf of the Atomic Energy Commission. This preliminary report describing the results of this study has benefited from the suggestions and criticisms of L. B. Riley of the Geological Survey.

GENERAL GEOLOGY

The Salt Wash sandstone member of the Morrison formation is composed of alternating strata of sandstone and finer-grained sediments. By common

usage, the term "mudstone" has been adopted for the finer-grained sediments. The sandstone strata commonly, although not invariably, occur in groups. The topmost group of these sandstone strata in the Calamity Mesa area is the "ore-bearing sandstone".

The ore-bearing sandstone contains as many as four sandstone strata that are separated by strata of mudstone. The sandstone strata are broadly lenticular and range in thickness from a feather edge to about 26 feet near their central portions. Locally, the thick parts of two or three sandstone strata are superimposed and the contact between them is a disconformity, but generally each sandstone stratum is separated by a mudstone stratum ranging from a few inches to nearly 17 feet in thickness. The total thickness of this group of sandstone and mudstone strata ranges from 35 to 75 feet. The probable position of the contacts separating the strata is shown on the geologic logs (fig. 1). The geologic logs of core samples from drill holes CA-254 and CA-635 illustrate the thick ore-bearing sandstone composed almost entirely of strata of sandstone. The geologic log of core samples from drill hole CA-269 illustrates the ore-bearing sandstone where the sandstone strata are thin and separated by thick strata of mudstone.

Beds, distinguished from each other by changes in the physical properties of the sediments, are contained within the strata of the ore-bearing sandstone. A sandstone stratum may contain only one or as many as five beds of light colored, medium- to fine-grained sandstone with poorly defined inclined or horizontal laminae. Concentrations of clayey siltstone occur as seams, films and pellets and separate the beds locally. The mudstone strata are composed of beds of dark-colored, abundantly laminated, fine-grained sandstone, dark-colored siltstone, and dark-colored clayey siltstone. Commonly, a bed of clayey siltstone is at the top of a mudstone

stratum. This bed of clayey siltstone, where it underlies the ore-bearing sandstone, has been called by the exploration geologists the "basal mudstone". The beds in the strata of the ore-bearing sandstone range in thickness from 6 inches to 11 feet in the three holes that are illustrated by the geologic logs on figure 1.

PERMEABILITY AND POROSITY

The most permeable beds of the ore-bearing sandstone, as shown by the permeability logs, are those within the sandstone strata. Beds in the lowermost sandstone stratum of the ore-bearing sandstone, however, are usually well-cemented for as much as 16 feet above the basal mudstone and therefore are nearly impermeable. In some places sandstone near the top and bottom of a bed is less permeable than sandstone near the middle of the bed, and this change in permeability helps to distinguish one bed from another.

Not all the beds, however, are so characterized. Some of them exhibit changes in permeability that are due partly to progressive textural changes or to local concentrations of cementing materials. Concentrations of impermeable clayey siltstone as seams, films, and pellets locally separate the beds and further help to distinguish one bed from another.

The beds of clayey siltstone that compose a large part of the mudstone strata are impermeable and other beds within the mudstone strata are almost impermeable.

On the basis of the three permeability logs, the ore-bearing sandstone on Calamity Mesa is composed of alternating strata of permeable sandstone and impermeable mudstone. Commonly, the permeable strata are separated by strata containing impermeable or almost impermeable beds, but locally the permeable strata compose almost the full thickness of the ore-

bearing sandstone.

The porosity of the beds in the ore-bearing sandstone is characteristic for each bed, but the changes in porosity that help to distinguish one bed from another are less well-defined than are the corresponding changes in permeability. Generally, the permeable sediments near the center of the beds have a greater porosity than the less permeable sediments near the top or bottom of the beds. Likewise, the beds of cemented sandstone at the base of the ore-bearing sandstone are less porous than are the beds of permeable sandstone. The porosity of the clayey siltstone could not be determined in the laboratory.

GAMMA-RAY ACTIVITY

The gamma-ray logs of drill holes CA-254, CA-269, and CA-635 are shown together with the geologic, permeability, and porosity logs on figure 1. The logs of the gamma-ray activity are correlated with these data through lines of arc.

The gamma-ray activity shown on the logs of these three holes does not reach the intensity of gamma-ray activity in sandstone of ore-grade. Nevertheless, if the gamma-ray logs are compared with the permeability and geologic logs, reading from the top downward on the graphs, it will be noticed that the gamma-ray activity gradually increases in intensity throughout most of the permeable sandstone beds until it reaches a high at the base of the permeable beds. The intensity then drops sharply. This steplike rise and fall is repeated about as frequently as the base of the permeable beds is penetrated. Gamma-ray activity is also localized (1) within or near the top of the cemented and nearly impermeable sandstone above the basal mudstone, and (2) near the top of impermeable clayey siltstone, or basal mudstone, just below the ore-bearing sandstone.

Rogers (1950) described a similar association of abnormal radioactivity with the tops of impermeable strata in the Salt Wash member in the Legin group area, San Miguel County, Colo. In that area, Rogers observed that many radioactivity anomalies, small in magnitude, are present at the top surface of the thick impermeable basal mudstone underlying the ore-bearing sandstone, as well as at the top surfaces of thin lenticular impermeable mudstone seams within the ore-bearing standstone. Rogers concluded that the distribution of these anomalies in the Legin group area suggested that ground water had leached radioactive material from the ore bodies and carried it down dip and laterally along the top surfaces of underlying impermeable mudstone strata.

CONCLUSIONS

Correlation of the gamma-ray logs with the geologic and permeability logs of the ore-bearing sandstone in three drill holes on Calamity Mesa indicates that the radioactivity in zones of reduced permeability that impede the movement of ground water is above the normal radioactivity of the ore-bearing sandstone and below radioactivity of ore-grade significance. These zones are: (1) near the base of the permeable sandstone beds and above clayey siltstone found at the base of these beds; (2) at the top of a basal zone of cemented sandstone; and (3) near the top of mudstone just below the base of the ore-bearing sandstone.

REFERENCE

Rogers, A. S., 1950, Distribution of leached radioactive material in the Legin group area, San Miguel County, Colorado: U. S. Geol. Survey Trace Elements Memorandum Rept. 171.