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PRELIMINARY STATEMENT OF THE ANALYSES OF GROUND WATER FROM THE MORRISON FORMATION, SOUTHWESTERN COLORADO AND SOUTHEASTERN UTAH

Trace Elements Memorandum Report 137

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

IN REPLY REFER TO:

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

SEP 12 1951

AEC - 107/2

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 Dr. Merritt:

Transmitted herewith for your information and distribution are 8 copies of Trace Elements Memorandum Report 137 "Preliminary statement of the analyses of ground-water from the Morrison formation, southwestern Colorado and southeastern Utah", by David A. Phoenix, August 1951.

A comprehensive report on the ground-water study is now being prepared, and will include recommendations for additional chemical study of the ground water.

Other copies of this report are being distributed as shown on the attached distribution sheet.

Sincerely yours,

Acting Chief Geologist

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plus 1 figure and 1 table. Series A.

CATEGORY VII (Colorado Plateau
Geology)

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY STATEMENT OF THE ANALYSES OF GROUND WATER FROM THE MORRISON FORMATION, SOUTHWESTERN COLORADO AND SOUTHEASTERN UTAH

by

David A. Phoenix

August 1951

Trace Elements Memorandum Report 137

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PRELIMINARY STATEMENT OF THE ANALYSES OF GROUND WATER FROM THE MORRISON FORMATION, SOUTHWESTERN COLORADO AND SOUTHEASTERN UTAH

By David A. Phoenix

ABSTRACT

As part of a study of the carnotite deposits of the Colorado Plateau, samples of ground water from the Salt Wash sandstone and Brushy Basin shale members of the Morrison formation have been analyzed to determine their chemical character and metal content. The Salt Wash ground water is largely a bicarbonate solution with variable amounts of calcium and magnesium ions; that from the Brushy Basin is either a sulfate or bicarbonate solution with sodium. The ground water from the Salt Wash and Brushy Basin members is generally weakly alkaline. In most samples, the metal ions of uranium, vanadium, copper, lead, and selenium are present in amounts of less than 1 part per million.

It is concluded that if the ground water responsible for introduction of the uranium and vanadium metals into the Salt Wash was comparable to the recent ground water, it contained very small amounts of the metal ions.

INTRODUCTION

Twenty-three samples of ground water from the Colorado Plateau have been analyzed as a part of the ground-water studies that the Colorado Plateau project of the U. S. Geological Survey has undertaken on behalf of the U. S. Atomic Energy Commission. These ground-water studies have been undertaken to determine the influence recent and past ground waters have played in the genesis and emplacement of the uranium-vanadium ore deposits_/.

_/ Phoenix, D.A., Preliminary plans for ground-water studies: U.S. Geol. Survey Trace Elements Memorandum Rept.99, December 1949.

ACKNOWLEDGMENTS

Analyses for the ionic constituents in the water samples were made by the Geochemistry and Petrology Branch, Geologic Division, and by the Quality of Water Branch, Water Resources Division, U. S. Geological Survey. The manuscript describing these results has profited by the critical review of C.S. Howard, L.B. Riley, and R. P. Fischer.

RESULTS

The chemical character of the ground water is shown by complete analyses of 23 samples (table 1 and fig. 2) collected from mines, springs, and wells in the Salt Wash sandstone and Brushy Basin shale members of the Morrison formation. Localities from which these samples were collected are shown on figure 1. All samples from the Salt Wash were collected near ground known to contain uranium- and vanadium-bearing ore minerals. Samples from the overlying Brushy Basin member presumably had not percolated through or near rocks containing these ore minerals.

Most of the ground water from the Salt Wash member contains moderate amounts of dissolved constituents, chiefly as bicarbonate, calcium, and magnesium ions. Samples from the Brushy Basin member contain larger quantities of total dissolved solids, of which sodium, bicarbonate, and sulfate ions are the chief constituents. The pH of all the water samples was determined in the laboratory. Only one sample ($50/18W-9A_1$), that from the Matchless mine, is acid; it has a pH of 6.8. All other samples are alkaline, ranging in pH from 7.4 to 9.4 while the median pH is 7.9. A few pH determinations were made in the field. These are somewhat lower than the pH determined in the laboratory, probably as the result of the loss of carbon dioxide before analysis. It is believed that the ground water in the Morrison formation is most commonly a weakly alkaline solution.

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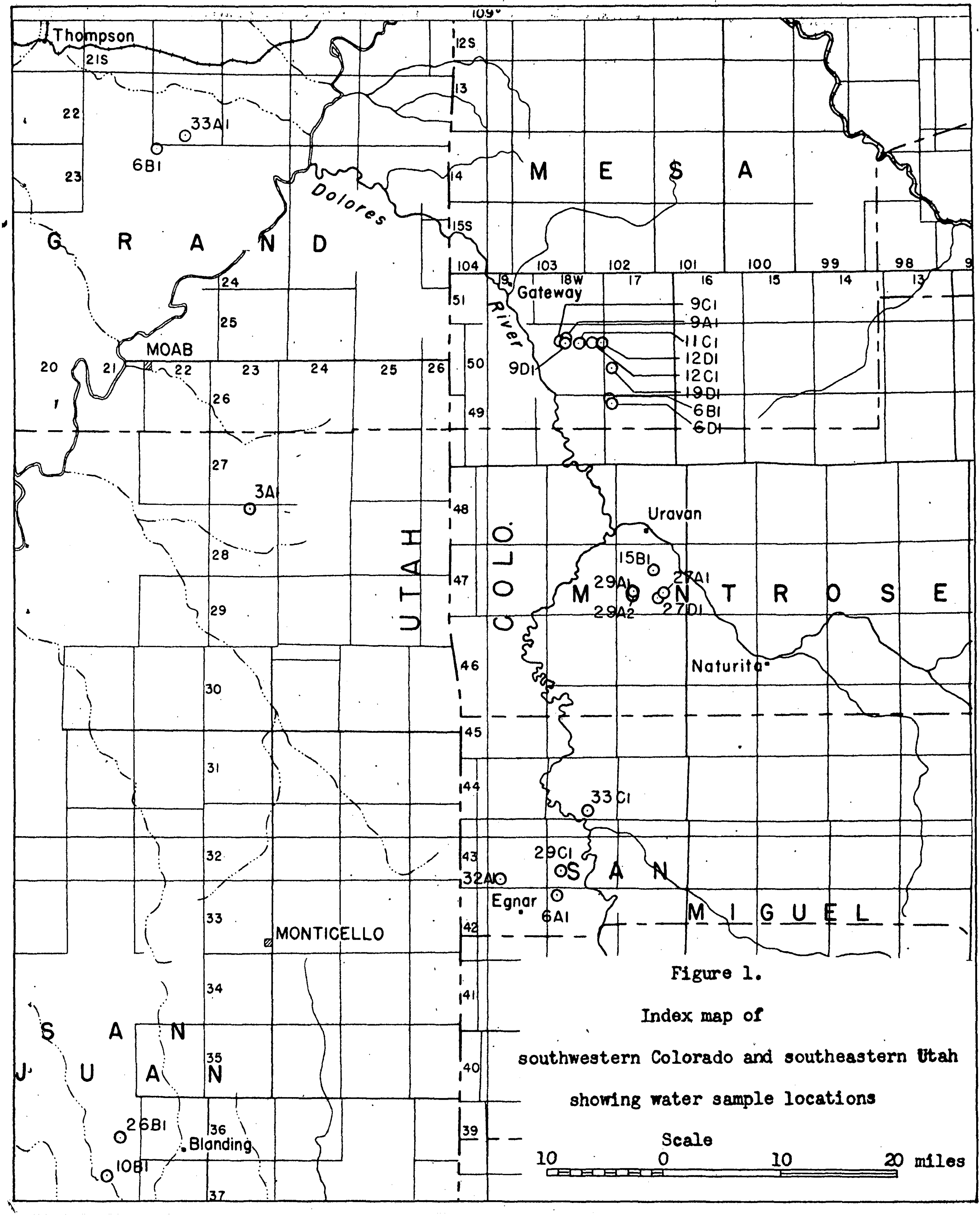

Figure 1.

Index map of southwestern Colorado and southeastern Utah showing water sample locations

The milligram equivalents, or reacting values_/, of the soluble ions, have been computed for 22 of the analyzed samples. The equivalents per million for each sample are shown graphically on figure 2; they indicate the chemical character of the water from each locality at the time the water was sampled for analysis. Of the 22 samples, 13 are classed as calcium bicarbonate water, 2 as calcium or magnesium sulfate water, 3 as sodium sulfate water, and 4 as sodium bicarbonate water. The water, therefore, differs in its reaction capacity. These differences in character are probably determined in part by the distance that the ground water has percolated through the rocks, by the composition and physical properties of the rocks, by the presence or absence of soluble salts in the paths of ground-water movement, and by the degree to which the solution has been concentrated by evaporation and plant transpiration.

The uranium, vanadium, copper, lead, and selenium content of 20 of the 23 water samples are shown in parts per million on table 1. The lower limit or threshold of detection for uranium, vanadium, copper, and lead is about 0.01 parts per million, while the limit of detection for selenium is 0.05 parts per million. Where 0.00 parts per million is reported for selenium, it indicates less than 0.05 parts per million; for the other metals, it indicates a concentration of less than 0.01 parts per million_/. As a general rule, these metals were found in

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_/ Palmer, Chase, The geochemical interpretations of water analyses: U. S. Geol. Survey Bull. 479, pp. 5-9, 1911.

_/ Rader, Lewis F., Jr., personal communications.

amounts of less than 1 part per million, although some are present in such small amounts that they are just within the threshold of detection. Although the concentrations of these metals differ within these limits, the amounts present do not seem to increase or decrease with variations in the determined chemical character of the parent waters.

Uranium and vanadium in small amounts were detected in all the water samples that were analyzed for these metals. The greatest amount of uranium and vanadium was detected in ground water from sumps in the Matchless and East Bank mines. In the water from the Matchless mine sump (50/18W-9A_1, collected 11/16/49), as much as 18 parts per million of uranium and 95 parts per million of vanadium were detected, while water from the East Bank mine sump (37/21E-10B_1) contains 8.7 parts per million uranium and 22.8 parts per million vanadium. It seems likely that these waters are not representative of normal ground water, for when collected they were turbid with suspended minerals due to mining activity. A clean sample was later collected from the Matchless mine. This sample (50/18W-9A_1, collected 7/29/50) contains only 0.82 parts per million uranium and 11.8 parts per million vanadium. In the remaining 18 samples neither metal is present in amounts greater than 1.2 parts per million, while the median amount of either metal ion in the normal ground-water solution is only about 0.1 parts per million.

It was expected that there might be a difference in the uranium and vanadium content between the waters collected from the Salt Wash sandstone member and those collected from the overlying Brushy Basin shale member, for the Salt Wash contains practically all the ore deposits found in the Morrison formation. This relationship, however, is not suggested by the analyses, for samples of ground water from both the Brushy Basin and Salt Wash members contained about the same amounts of these metals (see samples 49/17W-6D_1 and 49/17W-6B_1).

Secondary migration of the uranium and vanadium suggested that the concentration of the uranium and vanadium ions in the ground water might bear some diagnostic spatial relationship to the ore deposits. To test this suggestion, sample 49/17W-6B_1 was collected at a spring issuing from the ore-bearing sandstone of the Salt Wash, at a point approximately 2,000 feet down dip from the nearest known ore body, and sample 47/17W-29A_1 was collected from an underground spring in the immediate vicinity of sandstone observed to be mineralized. The first sample contained 0.02 parts per million uranium and 0.16 parts per million vanadium while the second contained 0.2 per million uranium and less than 0.1 parts per million vanadium. The higher concentration of uranium ions in the sample of ground water collected from near an ore body suggests a difference that may be directly related to the position of the deposits. The significance of the difference in concentration of vanadium ions in the two water samples cannot be determined from the few samples available.

Visual observations of the efflorescent coating of various bicarbonate and sulfate salts around the rims of spring or seep outlets show no indication that carnotite, or some similar mineral, is being precipitated from the normal ground water. On the other hand, the carnotite observed coating many fracture surfaces in the ore-bearing sandstone, near the ore deposits, and above the present water table, suggests that uranium and vanadium are migratory. It is suggested that this carnotite formed either from earlier ground water or that possible capillary water in the zone of aeration dissolves at least the uranium and vanadium of previously deposited minerals and carries them for a short distance before redepositing them.

Copper and lead were detected in trace amounts in some of the samples collected from the ore-bearing Salt Wash sandstone. At the localities from which these waters were collected these metals are known or believed to occur as minor accessories with the uranium-vanadium ore.

Selenium is not a constituent of all samples of Salt Wash ground water. It was, however, detected in sump water collected from the Matchless mine ($50/18W-9A_1$), the Telluride 18 mine ($23/22E-6B_1$), and the Cactus Rat mine ($22/22E-33A_1$), as well as in water from a spring on Blue Mesa ($49/17W-6B_1$). The three water samples from the Brushy Basin shale that were analyzed for this metal ($50/18W-9D_1$, $49/17W-6D_1$, and $43/19W-32C_1$) contain 0.05 parts per million of selenium, an amount which is about at the threshold of detection.

CONCLUSIONS

The analyses of the samples of ground water collected from the Brushy Basin and Salt Wash members of the Morrison formation are believed to represent the chemical character of the ground water contained in these rocks. The Salt Wash ground water is a weakly alkaline bicarbonate solution with variable amounts of calcium and magnesium ions; that in the Brushy Basin is likewise weakly alkaline but is either a sulfate or bicarbonate solution with sodium.

The Salt Wash ground water, regardless of its chemical character, generally contains less than 1 part per million of the uranium, vanadium, copper, lead, and selenium ions. Uranium, vanadium, and selenium ions, in amounts of less than 1 part per million, are also believed to be typical constituents of Brushy Basin ground water. The significance of the amounts of these ions present in both Salt Wash and Brushy Basin ground water in regard to spatial relationships to the ore bodies cannot be determined from the number of samples analyzed. If the ground water responsible for introduction of the uranium and vanadium metals into the Salt Wash was comparable to the recent ground water, it contained very small amounts of the metal ions.