PRELIMINARY REPORT ON GEOLOGIC INVESTIGATIONS IN MONUMENT VALLEY AREA, ARIZONA, 1952

By I. J. Witkind, R. W. Thaden, and C. F. Lough

Trace Elements Memorandum Report 536

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
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AEC - 815/3

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 are six copies of TEM-536, "Preliminary report on geologic investigations in Monument Valley Area, Arizona, 1952," by I. J. Witkind, R. E. Thaden, and C. F. Lough, February 1953.

In order to make the geologic maps available to the public, we plan to place figures 2, 3, and 4 in open file. We are asking Mr. Hosted to approve this plan.

Sincerely yours,

V. E. McKelvey

for W. H. Bradley
Chief Geologist

Geology - Mineralogy

This document consists of 8 pages,
plus 4 figures and 1 table.
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY REPORT ON GEOLOGIC INVESTIGATIONS IN MONUMENT VALLEY AREA, ARIZONA, 1952*

By

I. J. Witkind, R. E. Thaden, and C. F. Lough

February 1953

Trace Elements Memorandum Report 536

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

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission

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TEPCO, Washington (Including master)	5
	62

CONTENTS

ILLUSTRATIONS

TABLE

PRELIMINARY REPORT ON GEOLOGIC INVESTIGATIONS IN MONUMENT VALLEY AREA, ARIZONA, 1952

By I. J. Witkind, R. E. Thaden, and C. F. Lough

INTRODUCTION

A program of uranium investigations and geologic mapping on the Navajo Indian Reservation in Apache and Navajo Counties, northeastern Arizona (fig. 1) was undertaken by the U. S. Geological Survey on behalf of the Atomic Energy Commission during the field seasons of 1951 and 1952. Field work on this program has been completed and preliminary copies of the maps, which cover an area of about 700 square miles, are inclosed as part of this report.

The two principal objectives of the program were to establish geologic criteria useful as guides in prospecting for uranium deposits, and to appraise the favorableness of the Shinarump conglomerate and other Triassic rocks for the occurrence of uranium deposits in order to select areas that deserve exploration for concealed deposits.

A revised list of guides for prospecting is included as part of this report; this list supersedes the one originally offered by Witkind et al. (1951).

The workings of the largest mine in the area, the Vanadium Corporation of America's Monument No. 2 mine, were mapped. Results of the mine mapping will be furnished in a forthcoming Trace Elements Investigations Report.

As all known uranium ore deposits in the Monument Valley area, Ariz., are in paleochannel sediments at the base of the Shinarump conglomerate, it was felt that more should be known about the paleochannels. To this end, a program of geophysical resistivity investigations was undertaken in selected areas by W. E. David and R. A. Black of the Geological Survey. Work is still in progress and results are not available.

GEOLOGY

Consolidated sedimentary rocks having an aggregate thickness of over 5,000 feet and ranging in age from Permian to Jurassic crop out in the area. A stratigraphic section is shown in table 1.

The major structural feature in the area is the Monument upwarp, a broad, flattened anticline with a north-south axis. Structure contouring indicates four subordinate structural elements that are superimposed on this major feature (fig. 1).

URANIUM DEPOSITS

Known ore deposits in the Monument Valley area, Ariz., are in paleochannel sediments at the base of the Shinarump conglomerate. In general, the paleochannels are elongate symmetrical and asymmetrical troughs scoured in the Moenkopi and filled with Shinarump conglomerate. In width, they range from 20 feet to over 2,300 feet, and in depth from 5 feet to about 75 feet. The paleochannels have been divided into two categories on the basis of length; those less than 2 miles are classed as "discontinuous", those exceeding 2 miles as " continuous". The major ore bodies in these paleochannel deposits appear as ovate cylindrical bodies known as rolls, locally concentrated in conglomeratic sandstone lenses that are parallel to the paleochannel's trend. Preliminary work has suggested that the rolls formed in two ways. The first appears to result from supplanting of wood by silt, limonite, and carnotite (?). The second appears to result from an impregnation of sandstone by limonite and carnotite (?).

Although uranium minerals are found in strata other than the Shinarump, in Monument Valley, Ariz., they are in such small amounts as to be of academic rather than economic interest.

Of the mines and prospects examined, only the most promising are discussed in this report.

(1) Monument No. 2 mine (fig. 1). The Monument No. 2 mine is in a paleochannel that strikes about N. 18° W., ranges in width from 400 to 700 feet, and has been cut about 50 feet into the underlying strata. Most ore is in rolls, many of which represent supplantation of trees and other organic matter by silt, limonite, and carnotite (?). Many of the rolls are in fairly well-defined zones in conglomeratic sandstone lenses. These zones are elongate and conform to the shape of the lenses.

Most ore shipped from the Monument Valley area, Ariz., has been produced from the Monument No. 2 mine. Although exact production figures are unknown, a gross estimate for the three-year period from April 1948 to March 1951 is about 31,208 tons of ore. From this amount, about 123 tons of U_3O_8 and about 543 tons of V_2O_5 are believed to have been produced; the ore averaged about 0.39 percent U_3O_8 and 0.17 percent V_2O_5. It is estimated that a similar amount of ore still remains to be mined.

(2) Hunt's Mesa (fig. 1). Minor amounts of uranium and copper minerals are present in sediments filling at least two paleochannels at the base of the Shinarump on Hunt's Mesa. Discussions of Hunt's Mesa are included in two Atomic Energy Commission reports (Chester, 1951) and in a U. S. Geological Survey report (Witkind et al., 1951).

An Atomic Energy Commission drilling program on the mesa started in September 1952.

(3) Mitchell Butte Mesa (fig. 1). A small seam of carnotite (?) about 4 feet wide and one-quarter inch thick is exposed in sandstone at the base of a paleochannel that strikes N. 55° W., is 350 feet wide, and has been cut some 75 feet into the underlying Moenkopi formation. This area appears relatively favorable for uranium deposits and is being considered for resistivity and diamond-drilling programs. The major difficulty in these programs is the construction of a road to the top of this relatively inaccessible mesa.

URANIUM POSSIBILITIES OF THE AREA

Monument Valley, Ariz., is regarded as a favorable area for the discovery of new deposits of uranium ore. Work in the Monument No. 2 mine has indicated that ore is in zones along the paleochannel's length. Further, many parts of the Monument No. 2 paleochannel are barren. Therefore, the barren spots found elsewhere in other paleochannels do not necessarily mean that these other paleochannels are barren along their entire length. In a number of places drilling programs in the Monument Valley area, Ariz., have tested ground normal to a paleochannel's length, and have tested only a relatively small segment of an entire paleochannel. It is recommended that drilling programs in this area be preceded by resistivity programs to delineate the trends of the paleochannels. With this information any proposed large-scale exploration programs could be planned to test the entire paleochannel in a search for the ore zones.

GUIDES TO PROSPECTING

(1) Paleochannels. In the Monument Valley area, Ariz., all known uranium ore deposits are in paleochannels.

(2) Organic matter. In the Monument No. 2 mine many rolls have been formed by supplantation of organic matter. Thus, organic matter may be an important factor in the localization of carnotite (?) ore.

(3) Paleochannel conglomerates containing organic matter. Most of the ore in the Monument Valley area, Ariz., was found in paleochannel conglomerates containing organic matter.

GUIDES OF UNCERTAIN VALUE

(1) Limonite impregnation. Although limonite is associated with ore in the Monument No. 2 mine, the sediments filling many paleochannels are limonite-stained, but uranium minerals are absent.

(2) Copper minerals. Copper minerals, such as azurite and malachite, are associated with almost all carnotite deposits, but copper minerals, apparently unrelated to uranium ore, have been found outside of paleochannels.

(3) Bleached zone in the Moenkopi. The thickening of a bleached zone in uppermost Moenkopi strata directly below paleochannels may be a good guide. However, in places the bleached zone thins rather than thickens below paleochannels, and this anomaly lessens the value of this guide.

(4) Clay boulders, cobbles, and pebbles. In several mines in the Monument Valley area, clay boulders, cobbles, and pebbles are associated with ore. However, in the Monument No. 2 mine, concentrations of clay detritus are present in some places where ore is lacking. This suggests that the association of clay and ore found elsewhere may be fortuitous.

PLANS

Immediate plans are for laboratory studies of the sediments and ore and gangue minerals, and for compilation of structure and isopachous maps. A final report, to be transmitted as a Trace Elements Investigations Report, will be prepared during the winter of 1952-53.

Recommendations concerning physical exploration at Mitchell Butte Mesa are being considered and, as the final results of the resistivity program become available, additional areas may be considered for drilling programs.

REFERENCES

Chester, J. W., 1951, Geology and mineralization of Hunt's Mesa, Monument Valley, Arizona, with recommendations for exploratory drilling: U. S. Atomic Energy Commission, RMO 691.

Chester, J. W., 1951, Geology and mineralization of Hunt's Mesa, Monument Valley, Arizona: U. S. Atomic Energy Commission, RMO 801.

Witkind, I. J., McKay, E. J., Johnson, D. H., Finnell, T. L., Claus, R. J., and Johnson, D. L., 1951, Preliminary report on geologic studies in the Monument Valley area, Arizona: Trace Elements Mem. Rept. 318.

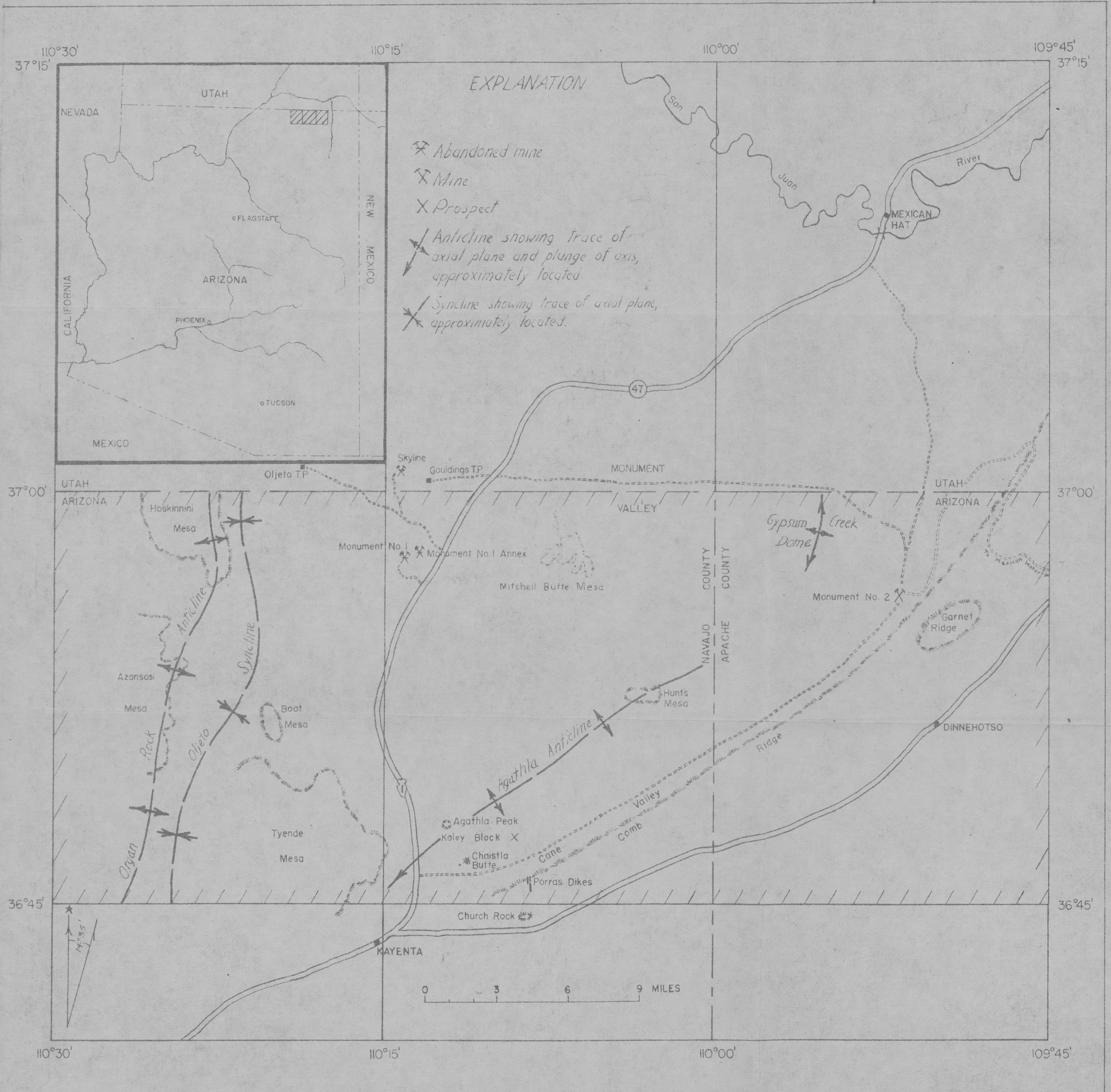

Figure 1.— Index map of part of the Navajo Indian Reservation showing area mapped (enclosed by slanted lines).

MAP EXPLANATION

CENOZOIC

Recent – Pleistocene

- Qal — Alluvium
- Qd — Dune sand
- Qcl — Colluvium
- Qsg — Sand and Gravel
- Qtb — Talus Blocks
- Ql — Landslide Block

MESOZOIC

Jurassic — Glen Canyon Group

- Jn — Navajo sandstone
- Jk — Kayenta formation
- Jwu — Upper Wingate sandstone
- Jwl — Lower Wingate sandstone

Triassic

- TRcb — b member Chinle formation
- TRcc — c member Chinle formation
- TRcd — d member Chinle formation
- TRs — Shinarump conglomerate
- TRm — Moenkopi formation

PALEOZOIC

Permian — Cutler formation

- Pho — Hoskinnini tongue
- Pdc — De Chelly sandstone member
- Por — Organ Rock tongue

Other Symbols

Fault

Strike of vertical joint

Horizontal beds

Strike and dip of beds

Triangulation station

Springs

Water well

Masonry or earth dam

Windmill

Prospect

Roads

Graded and improved

Unimproved

Trail

Streams

Perennial

Intermittent

Contacts

Known contact

Indefinite contact

Concealed contact

Planimetric base compiled from controlled aerial photographic mosaic furnished by U. S. Indian Service.

14° 35'

TRUE NORTH

MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 1951

Figure 2 - PRELIMINARY
GEOLOGIC MAP OF THE
BOOT MESA QUADRANGLE, ARIZONA

Scale 1:31680

1 1/2 0 1 2 Miles

Geology mapped in 1951-52.

Geology by: I. J. Witkind, H. E. Malde, R. E. Thaden, E. J. McKay, D. H. Johnson, and R. J. Claus, assisted by C. F. Lough and F. D. Tinsley.

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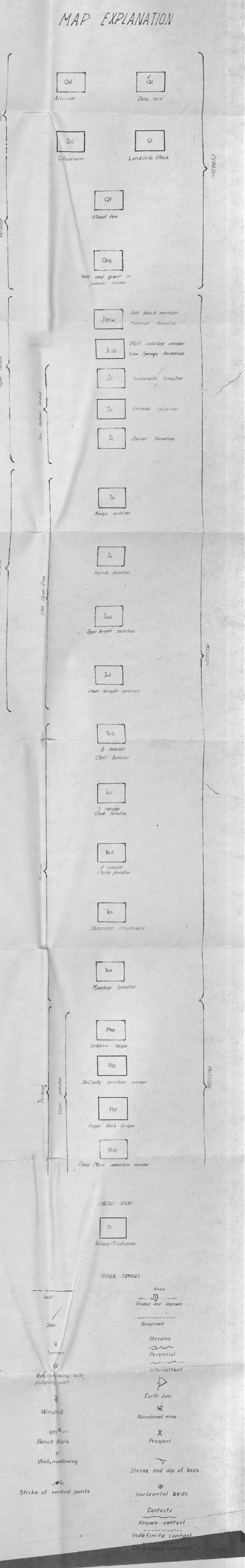


Planimetric base compiled from controlled aerial photographic mosaic furnished by U. S. Indian Service.

14°35'
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1951

Figure 3 - PRELIMINARY GEOLOGIC MAP OF THE AGATHLA PEAK QUADRANGLE, ARIZONA

Scale 1:31680

1 1/2 0 1 Miles

Geology mapped in 1951-52.

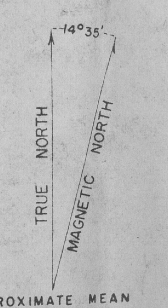
Geology by: I. J. Witkind, J. D. Sears, E. J. McKay, D. H. Johnson, and T. L. Finnell, assisted by D. L. Johnson, R. J. Claus, and F. D. Tinsley.

Planimetric base compiled from controlled aerial photographic mosaic furnished by U. S. Indian Service.

Geology mapped in 1951-52.

Geology by: I. J. Witkind, R. E. Thaden, H. E. Malde, E. J. McKay, D. H. Johnson, T. E. Mullens, T. L. Finnell, and R. J. Claus, assisted by C. E. Lough and F. D. Tinsley.

Figure 4 - PRELIMINARY GEOLOGIC MAP OF THE GARNET RIDGE QUADRANGLE, ARIZONA



APPROXIMATE MEAN DECLINATION, 1951

Scale 1:31,680

1 1/2 0 1 2 Miles

RESTRICTED

Age	Stratigraphic unit: Group	Stratigraphic unit: Formation	Stratigraphic unit: Member	Thickness in feet	Lithologic and topographic characteristics
		Morrison formation	Salt Wash member	?	Sequences of gray to chocolate-brown mudstones alternating with local white to gray fine-grained sandstone lenses.
		Cow Springs sandstone	Bluff tongue	45'	Sequence of chocolate-brown fissile siltstones alternating with red-brown fine-grained sandstones. Few discontinuous white siltstone lenses.
		Summerville formation		35'	Brown to red-brown even-bedded siltstones; cliff-former with white fine-grained sandstone 1 foot thick at base.
		UNCONFORMITY			
Jurassic	San Rafael group	Entrada sandstone		110'	Lower part orange-brown massive fine-grained sandstone that weathers as smooth, rounded slopes. Upper part chocolate-brown to red-brown even-bedded shaly siltstone and sandstone weathering into rounded "voodoo-like" structures. Base of upper part locally marked by white fine-grained sandstones 1 foot thick.
		Carmel formation		118'	Predominantly red fissile siltstone with local lenses of red platy sandstone; few discontinuous thin, ledge-forming white cross-bedded, medium-grained sandstones.
UNCONFORMITY					
		Navajo sandstone		665'	Pink and buff-colored massive, aeolian cross-bedded sandstone with interbedded thin lenses of siliceous limestone.
Jurassic (?)	Glen Canyon group	Kayenta formation		150-200'	Light-violet to red-brown irregularly bedded quartz sandstone with local lenses of conglomerate.
		Wingate sandstone		450-550'	Red-brown massive, aeolian cross-bedded siltstone and sandstone weathering as rubble-covered slope.
		Chinle formation		940-1160'	Variegated mudstones and siltstones with dark sandstone lenses near base and thin beds of gray cherty limestone near top.
Triassic		Shinarump conglomerate		50-100'	Light-gray fluviatile cross-bedded conglomeratic quartz sandstone with rounded pebbles as much as 2 inches in diameter; much silicified wood present.
		UNCONFORMITY			
		Moenkopi formation		30-250'	Red-brown evenly bedded ripple-marked shaly siltstone weathering into gentle slopes.
			Hoskinnini tongue	10-60'	Red-brown parallel-bedded siltstone with some interbedded lenses of sandstone.
			UNCONFORMITY		
			De Chelly sandstone	350-450'	Buff-colored massive, aeolian cross-bedded quartz sandstone weathering as steep rounded slopes or vertical cliffs.
Permian		Cutler formation	Organ Rock tongue	650-750'	Red-brown siltstone locally interbedded with red to gray sandstone; weathers into massive ledges about 4-5 feet thick.
			Cedar Mesa sandstone member	500'	Orange-brown cross-bedded sandstone with thin beds of gray limestone.
			Halgaito tongue	380'	Red siltstone and silty shale with thin beds of nodular weathering gray limestone.

Table 1.-- Columnar section of consolidated sedimentary units exposed in Monument Valley area, Arizona.