TEMPLE MOUNTAIN MEMBER--A NEW MEMBER OF THE CHINLE FORMATION IN THE SAN RAFAEL SWELL, UTAH

By Raymond C. Robeck

Trace Elements Memorandum Report 800

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

IN REPLY REFER TO:

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

AEC - 745/6

May 17, 1956

Mr. Robert D. Nininger, Assistant Director
Division of Raw Materials
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Bob:

Transmitted herewith are three copies of TEM-800, "Temple Mountain member--a new member of the Chinle formation in the San Rafael Swell, Utah," by Raymond C. Robeck, March 1956.

We are asking Mr. Hosted to approve our plan to submit this report for publication as a geologic note in the Bulletin of the American Association of Petroleum Geologists.

Sincerely yours,

for W. H. Bradley
Chief Geologist

Geology and Mineralogy

This document consists of 19 pages,
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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IN THE SAN RAFAEL SWELL, UTAH*

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Raymond C. Robeck

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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.

USGS - TEM-800

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By Raymond C. Robeck

ABSTRACT

A lithologic unit, referred to as mottled purple and white, or the "pinto bed," in the San Rafael Swell has enough thickness and continuity to be formally named the Temple Mountain member of the Chinle formation. The member is characterized by the presence of: the interfingering of siltstone, mudstone, and sandstone; purple and white color; quartz grains and pebbles; jasper; and coalified material.

INTRODUCTION

Geologists who have studied the stratigraphy in the San Rafael Swell, Emery County, Utah (fig. 1), have noted an unusual lithologic unit which overlies the Moenkopi formation of Triassic age. The unit was never studied in detail and has been treated quite differently, or ignored, by the various workers. The studies that began in 1953 in the search for uranium are being done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. Enough detailed information has been gathered to permit a decision on the name and correlation of the unit. Work in the area is still in progress and the full details of the results may not be published for some time. It is hoped that this report will be of immediate usefulness to other geologists who may have occasion to work with this unit in the Swell.

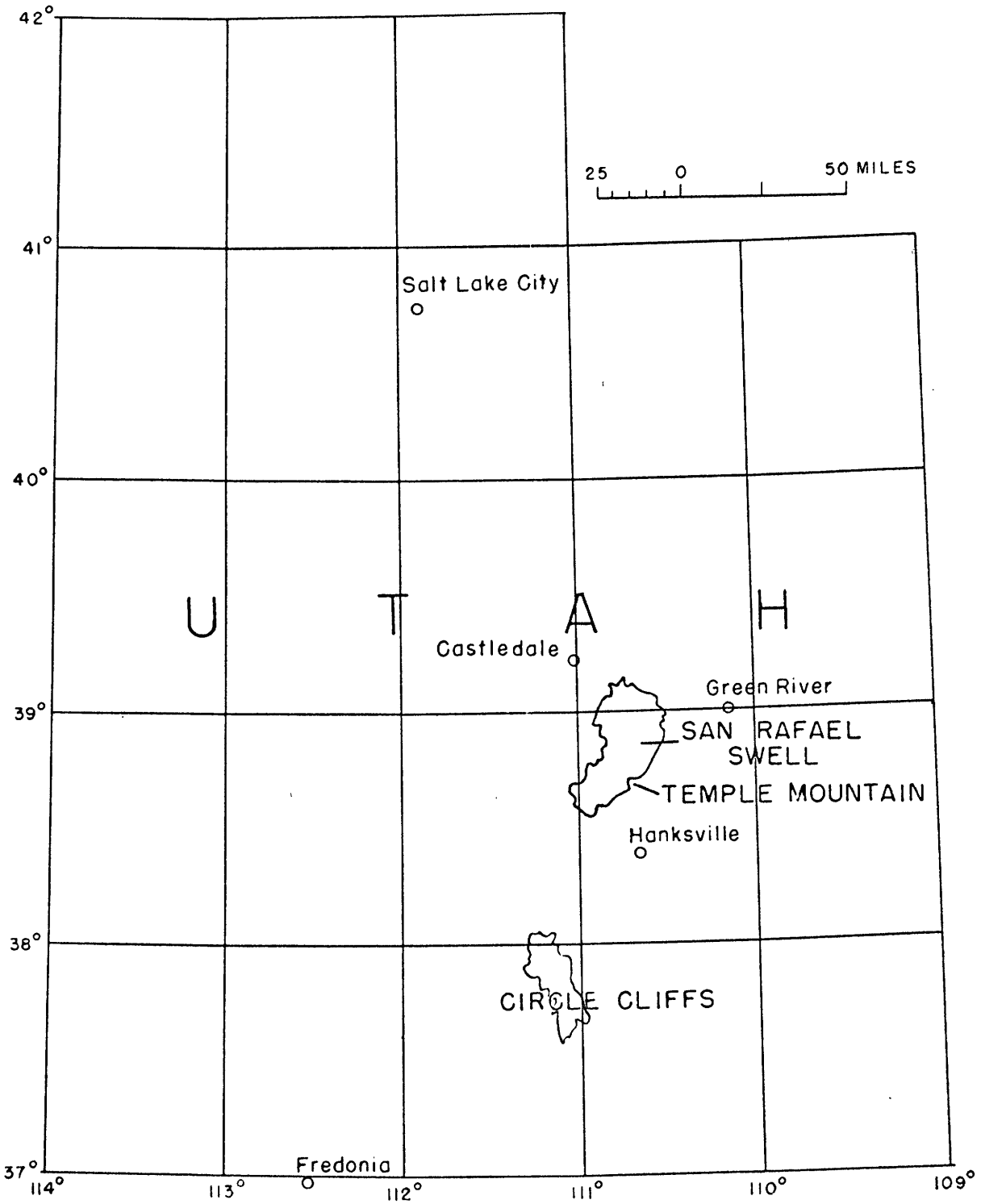

FIGURE 1.— INDEX MAP SHOWING LOCATION OF TEMPLE MOUNTAIN IN THE SAN RAFAEL SWELL, UTAH.

TEMPLE MOUNTAIN MEMBER

This unit has been referred to as the purple and white unit, mottled unit, or the "pinto bed" by geologists and prospectors. It is present in approximately 85 percent of the outcrops of the Chinle formation in the San Rafael Swell. The unit contains lithologic types ranging from mudstone to coarse-grained sandstone although the amount of each differs from area to area. Exposures showing all lithologic types are present in the Temple Mountain area on the southeast flank of the Swell where a type section is established on the northeast side of South Temple Mountain at latitude 38°41'04", longitude 110°40'20" (fig. 2). The unit is here named the Temple Mountain member of the Chinle formation of Triassic age. The description of the type section is as follows (units in descending order):

Chinle formation (incomplete) Feet

Moss Back member (incomplete): Mudstone and siltstone facies of normally conglomeratic sandstone, purplish-red 3

Unconformity: No angular unconformity, local relief on contact usually less than 1 foot except where channels are present.

Temple Mountain member:

1. Mudstone, mottled purple and white, locally grading laterally into purplish-red. The individual spots of mottling range from about one-half inch to 4 inches in diameter (fig. 3). Small areas of purple are encircled by a band of white in regular to irregular patterns.

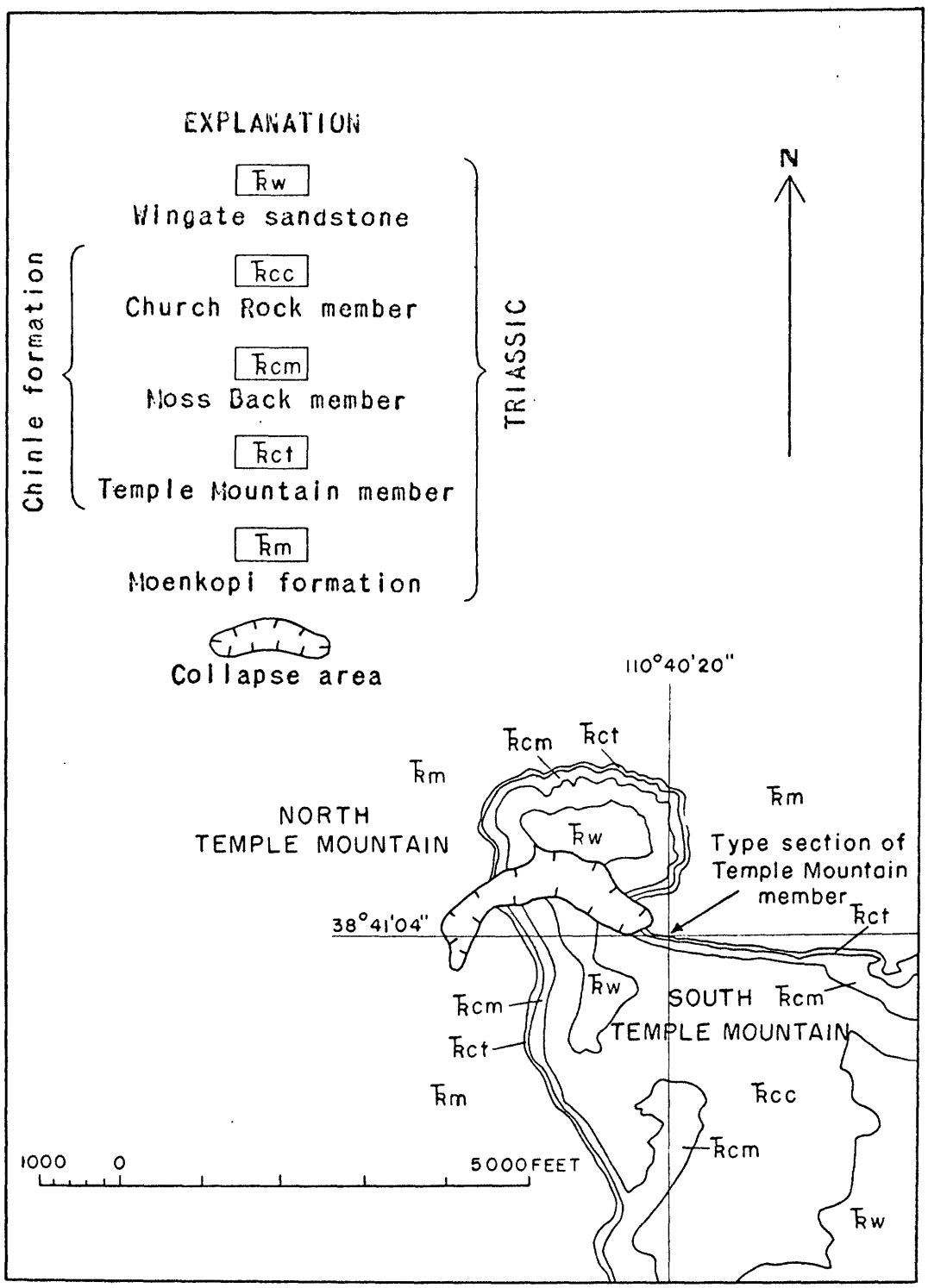

Figure 2.– GEOLOGIC MAP OF TEMPLE MOUNTAIN AREA, EMERY COUNTY, UTAH.

Figure 3. Purple and white mottling in the Temple Mountain member.

Feet

The purple and white color is also present along fractures within the purplish-red. Unit contains a few disseminated quartz grains. Bedding planes are inconspicuous or absent. The unit fractures into small irregular pieces usually less than one-quarter of an inch in size. Forms a smooth slope 2

2. Mudstone, silty, locally an intraformational breccia, shows some mottled purple and white, but much of unit is a very light gray. Contains poorly sorted clastics with a few clear coarse quartz sand grains disseminated throughout the unit. Locally contains some calcareous nodules. The unit has some calcareous cement, but similar units elsewhere in the Swell generally are cemented by silica. Contains jasper lenses as much as 3 inches thick and 3 feet long. Jasper lenses are one of the main characteristics of the member and are common elsewhere in the Swell at the top of unit 1. Forms a small ledge. 6

3. Mudstone, purple, and mottled purple and white, locally contains calcareous nodules. Unit contains a few scattered quartz grains. Thin to nonbedded. Forms smooth slope. 5

Feet

4. Siltstone, light-gray with some places showing a marked vertical banding of alternating purple and white, poorly sorted, no bedding except in or near mudstone and sandstone lenses that are present in minor amounts. Contains siltstone fragments and locally an abundance of iridescent purple-colored pebbles composed mostly of iron oxide which are characteristic of the member. At base of unit is a conglomeratic sandstone that is highly irregular in bedding, sorting, thickness, and continuity. This sandstone interfingers with the siltstone. The individual fragments of the sandstone range from silt size to pebbles three-fourths of an inch in diameter. The pebbles consist of clear, pink, white to smoky subrounded quartz. A ragged irregular cliff profile is characteristic of the member 20

Total Temple Mountain member 33

Unconformity: No angular unconformity, local relief on contact usually less than 1 foot except where channels are present.

Moenkopi formation: Mudstone, brownish-red, thin-bedded, ripple-marked . . . . . ---

The Temple Mountain member generally forms a purple ledge or slope above the ledgy slopes of the brownish-red Moenkopi formation of Triassic age and below the nearly vertical 80-foot cliff of the Moss Back member of the Chinle formation (fig. 4). The Moss Back member overlies the Temple Mountain member throughout most of the San Rafael Swell. However, in the southern third of the Swell the Temple Mountain member is overlain by the slope-forming purplish-red to red siltstone and mudstone of the Monitor Butte member of the Chinle formation which in turn is overlain by the Moss Back member.

The Temple Mountain member consists of siltstone, mudstone, and sandstone. The siltstone is usually light gray to some shade of mottled or banded purple and white. The clastic material is poorly sorted ranging from clay size to pebbles 3 inches in diameter. Sand grains are normally disseminated throughout a siltstone unit. Locally, layers of mudstone or lenses of sandstone impart a bedding effect to the siltstone. The normal hackly fracture of the nonbedded siltstone plus minor amounts of silica cement causes the unit to weather into a rough, irregularly rounded ledge.

The mudstone is purplish red, or a mottled purple and white. The purple and white is present along fractures within areas of purplish red. This fact plus the lateral gradation from purplish red to purple and white indicate that the purplish red was the original color which has been slightly altered to the purple and white and where more completely altered the color is light purple or ash white. A mudstone may interfinger with a siltstone as a discrete stratum, or there may be a complete

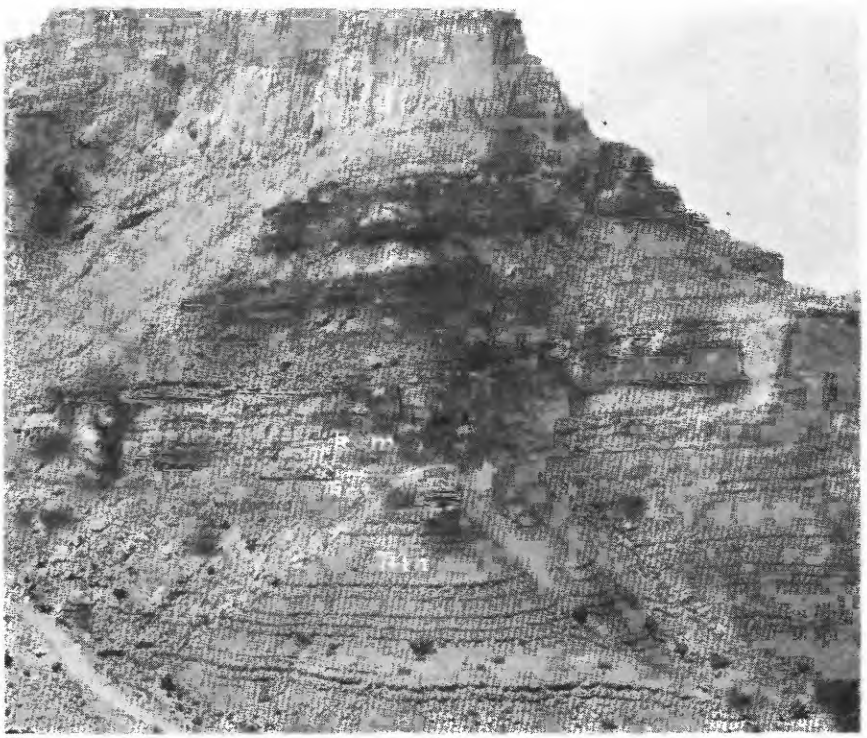

Figure 4. View of North Temple Mountain showing position of the Temple Mountain member (Rct) between the Moenkopi formation (Rm) and the Moss Back member (Rcm).

gradation of grain size from clay to silt. Quartz sand grains are disseminated throughout the mudstone. Thin bedding is found in places, but most of the mudstone has a hackly fracture, shows no bedding, and forms a smooth slope. Jasper is frequently present near the top of the mudstones.

The sandstones are light gray with a tendency to weather to a light brown; locally they are a darker brown due to the presence of iron oxides. In a few places the sandstones are a light-purple color. The sandstones tend to be coarse grained although there is always a variable percentage of particles ranging from clay to pebble size. The pebbles are nearly always quartz. There may be enough pebbles present locally to call the unit a conglomerate. Locally the sandstones are crossbedded. The sandstones tend to weather to a rounded ledge.

Coalified logs and plant remains have been found in all three lithologic types but are more abundant in the thicker and sandier sections. Uranium in small amounts is associated with coalified logs, jasper, and copper minerals.

The composition of the Temple Mountain member varies significantly within the Swell. In the southwest third the member consists mostly of purple and white mudstone with numerous lenses and layers of jasper. Toward the central portion siltstone ledges and sandstone lenses become more abundant. At the north end the member consists of alternating beds of siltstone and mudstone and numerous sandstone channels and lenses which may occur anywhere in the member. The average composition throughout the Swell is estimated to be: siltstone 40 percent, mudstone 40 percent, and sandstone 20 percent of the volume.

The interfingering of lithologic types, crossbedding, lack of sorting of grain size, and the channel and fill type of sedimentation all indicate deposition of the Temple Mountain member by streams believed to flow in a northwesterly direction.

The thickness of the Temple Mountain member in the Swell ranges from a knife-edge to 101 feet. Very local differences in thickness are a result of channelling at the base or top of the member. There is also a regional variation. In the southwest third of the Swell the member averages about 5 feet in thickness but is locally absent. Across the central portions of the Swell the average thickness is about 20 feet. At the north end the member has an average thickness of 30 feet but has a maximum thickness of 101 feet in a channel fill.

The purple and white color and the composition are distinct and persistent enough that the Temple Mountain member is a mappable unit although it cannot be mapped by reconnaissance methods.

The contacts between the Temple Mountain member and the underlying and overlying units are well marked where sandstone and mudstone are in contact, which is the case over at least half of the Swell. The contact of the Temple Mountain member and the underlying Moenkopi formation is difficult to locate where Temple Mountain mudstone rests directly on Moenkopi mudstone, because some of the purple and white coloring may extend down into the Moenkopi. Also much of the mudstone in the basal bed of the Temple Mountain may be reworked Moenkopi sediments so that the units on either side of the contact are lithologically similar. The member may be distinguished from the Moenkopi by the lack of bedding,

the rounded ledges of light-gray to buff sandstones, presence and abundance of quartz sand grains and pebbles, purple and white color, jasper, iron oxide pebbles and coalified wood. Normally the basal bed of the Monitor Butte member is a sandstone which makes it easy to pick the contact with the underlying Temple Mountain. Breccia pieces of mottled purple and white mudstone or siltstone are present in many places as reworked material in the basal sandstones of the Monitor Butte member. There are several places, however, where the exposures show only mudstone on mudstone. At such places the Temple Mountain member can be distinguished from the Monitor Butte member by the presence, in the Temple Mountain member, of the purple and white color, jasper, quartz, and iron oxide pebbles. In those few places where red Moss Back mudstone lies on purplish-red Temple Mountain mudstone they can usually be distinguished by color alone. In a few places sandstones of the Monitor Butte or Moss Back members may have the same brownish color and rounded ledges as sandstones in the Temple Mountain members. In such places it is better to use other characteristics to distinguish between the members.

The change in sedimentation from the fine-grained, even thin-bedded and ripple-marked Moenkopi beds to the fine- to coarse- grained poorly sorted and poorly bedded sediments assigned to the Temple Mountain is considered great enough change in sedimentation to warrant making the Temple Mountain the oldest member of the Chinle formation instead of the youngest member of the Moenkopi.

The age of the Temple Mountain is Triassic. No fossils other than plant remains have been found. The underlying Moenkopi is Lower Triassic and may be Middle Triassic (McKee, 1954). The Upper Chinle is assigned to Late Triassic age on the basis of Gregory's work (Gregory 1917). Specific information on the age of the Temple Mountain may be available when a study is completed on some plant remains recently found in the member.

The Temple Mountain member either has not been recognized, or has been treated in different ways by workers prior to 1954. Gilluly's Shinarump (Gilluly, 1929) is redefined by J. H. Stewart and others [1] to include the Moss Back, Monitor Butte, and Temple Mountain members of the Chinle formation. Gilluly (1929, p. 84) in his stratigraphic section of the Moenkopi appears to have included part of the Temple Mountain member as the first two units, whereas in his section of the Shinarump the lower part of unit 5 (Gilluly, 1929, p. 88) may be equivalent to the Temple Mountain member. Baker (1946, p. 55) may have included the lower part of the Temple Mountain as unit 1 of the Moenkopi. Hunt's section (Hunt, 1953, p. 48) may not contain any Temple Mountain, though his mapping indicates that he may have included the Temple Mountain in the Shinarump.

W. I. Finch (1953) reported sediments similar to those of the Temple Mountain in relatively the same stratigraphic position at many places in Utah. He was concerned mainly with the phenomenon of an alteration of color and may not have noted unaltered outcrops of the lithologic unit. The color phenomenon is important, but it is definitely of secondary importance as compared to the lithologic unit as a whole.

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[1] Stewart, J. H., Williams, G. A., Albee, H. F., and Raup, O. B., in preparation, Redefinition of Upper Triassic rocks, and stratigraphy of new Moss Back member of Chinle formation in southeastern Utah.

The regional correlation of the Temple Mountain member is based on lithology and stratigraphic position. In the Swell, the Temple Mountain member always overlies the Moenkopi formation and is overlain by the Monitor Butte member of the Chinle in the southern third of the Swell and by the Moss Back member in the northern two-thirds. Near the type locality of the Shinarump member of the Chinle formation at Fredonia, Arizona, and in the Circle Cliffs area, Utah, the same general lithologic type of material of the Temple Mountain member underlies type Shinarump sandstone.

GEOLOGIC HISTORY

The geologic history is interpreted as follows: At the end of deposition in Moenkopi time the land surface, in the area equivalent to the Swell, must have been nearly flat. Uplift somewhere to the southeast caused streams to carry coarse quartz material toward the Swell; enroute the streams picked up material from the Moenkopi surface. These streams deposited most of the sand in its deeper channels (cut into the Moenkopi), whereas, the finer sediments were deposited as a blanket over the entire area. There then seemed to be a pause in deposition during which time there was minor erosion. During this pause, silica was concentrated in layers and lenses at the top of the Temple Mountain member. In those places where there was enough permeability the silica was carried downward and spread laterally as a cement in any siltstones or sandstones present. The intimate association of silica and alteration of color particularly in fractures indicates that the solutions

which carried the silica appeared to cause the alteration of color from purplish red to the mottled purple and white. As streams again flowed over the area, the Temple Mountain member was eroded in varying amounts and in places was entirely removed, and the sediments of the Monitor Butte member were deposited. The generally fine sediments of the Monitor Butte member were deposited only across the southern third of the area. Another uplift in the southeast was great enough to bring the flood of Moss Back streams laden with coarse sediments which were deposited as a blanket on the nearly flat surface of the Monitor Butte member, or in the north, on the Temple Mountain member. Channels were cut into underlying sediments in several places. Deposition continued until the end of Chinle time.

CONCLUSIONS

In summary the main characteristics of the Temple Mountain member which serve to distinguish it from other units are in order of importance as follows: 1) stratigraphic position on top of the Moenkopi, 2) interfingering of a set of lithologic types, 3) color--especially where altered to a mottled purple and white, 4) presence and abundance of coarse quartz pebbles, 5) presence of coarse quartz sand grains disseminated in the member, 6) jasper near and at the top, 7) iridescent purple-colored iron oxide pebbles, 8) carbonaceous and coalified material, 9) lack of bedding, and 10) light-gray to buff sandstones and their tendency to weather to rounded ledges.

REFERENCES CITED

Baker, A. A., 1946, Geology of the Green River Desert-Cataract Canyon Region, Emery, Wayne, and Garfield Counties, Utah: U. S. Geol. Survey Bull. 951, 122 p.

Finch, W. I., 1953, Geologic aspects of the resource appraisal of uranium deposits in pre-Morrison formations of the Colorado Plateau--an interim report: U. S. Geol. Survey TEI-328A, 35 p., issued by U. S. Atomic Energy Comm., Tech. Inf. Service, Oak Ridge, Tenn.

Gilluly, James, 1929, Geology and oil and gas prospects of part of the San Rafael Swell, Utah: U. S. Geol. Survey Bull. 806-C., p. 69-130.

Gregory, H. E., 1917, Geology of the Navajo country, a reconnaissance of parts of Arizona, New Mexico, and Utah: U. S. Geol. Survey Prof. Paper 93, 161 p.

Hunt, C. B., 1953, Geology and geography of the Henry Mountains region, Utah: U. S. Geol. Survey Prof. Paper 228, 234 p.

McKee, E. D., 1954, Stratigraphy and history of the Moenkopi formation of Triassic age: Geol. Soc. America Mem. 61, 133 p.