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GEOLOGY AND DIATREMES OF DESERT MOUNTAIN, UTAH

by D. C. Rees, M. P. Erickson
and J. A. Whelan

UTAH GEOLOGICAL AND MINERALOGICAL SURVEY
affiliated with
THE COLLEGE OF MINES AND MINERAL INDUSTRIES
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GEOLOGY AND DIATREMES OF DESERT MOUNTAIN, UTAH
by D. C. Rees¹, M. P. Erickson² and J. A. Whelan³

ABSTRACT

Desert Mountain and Allison Knolls make up a group of isolated peaks rising from the Bonneville lake plain. The area, in Juab County, is located about 24 miles west of Jericho and about 35 miles north of Delta.

Sedimentary rocks consisting of the Precambrian Sheeprock Series and Ordovician Fish Haven Dolomite are exposed in the northeast part of the area. The older rock unit was thrust over the dolomite probably by the Sheeprock thrust.

Most of the bedrock in the area is intrusive—an older dark colored granodiorite or a light colored granite. Aplite, pegmatite and lamprophyre dikes cut the granite.

A diatreme complex is located east of Desert Mountain. It is characterized by an igneous matrix which has fragments and large blocks of dolomite, quartzite, slate, jasperoid and igneous rocks suspended in it.

Extrusive rocks, all thought to be equivalent to the Keg Mountain Ignimbrites, occur mainly in the east part of the area. Two altered volcanic units apparently correlate with the older rocks of the Keg Mountain Ignimbrites.

The structure is dominated by three shear directions, sheeting and the thrust fault. The three shear directions form a pattern similar to those produced in model work from strike-slip stresses or to rock fracture patterns under compression. The pattern, together with the general east-west alignment of intrusions and volcanic vents, suggests that a deep-seated structure control with left-lateral movement exists.

Generally weak, but locally moderately strong, hydrothermal alteration occurs in many areas. Some copper deposits too small to be of economic interest occur in the west part of the area.

ACKNOWLEDGMENTS

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INTRODUCTION

Location and Geography

Desert Mountain in Juab County is approximately 24 miles west of Jericho by gravel road or 35 miles north of Delta by improved dirt road. It is the highest point (6,482 feet) in a cluster of isolated peaks making up the Desert Mountain and Allison Knolls, the area mapped. The area is located mostly in T. 12 S., R. 6 and 7 W. Salt Lake Base and Meridian (figure 1).

The Jericho-Callao road provides the easiest access. Dirt roads and trails, many requiring four-wheel drive vehicles, provide ready access into the area.

The steep and jagged Desert Mountain rises from a gently southwestward-sloping lake plain. The lake plain and shoreline features flanking the mountains are related to glacial Lake Bonneville.

The region is arid; no surface water occurs in the range. The nearest water is at Judd Creek to the north or Cherry Creek to the east.

Previous Investigations

Gilbert (1890) studied Lake Bonneville and was the first to write about the Desert Mountain region. Loughlin (1920) visited the mineralized area in the west part of Desert Mountain. Cohenour (1959) mapped part of the Allison Knolls with the Sheeprock Mountains. Stringham (1961) prepared a reconnaissance map for the Utah state geologic map. Erickson (1963) conducted a reconnaissance study of the volcanic rocks and correlated them with the other volcanics of west Utah. A ground magnetic and gravity survey was done by Calkins (1970) and a more detailed geologic mapping and study of Desert Mountain by Kattelman (1968) emphasized petrographic aspects of the igneous rocks.

Present Investigation

The present work emphasizes geologic aspects not covered or recognized in previous works. Descriptions of the igneous rocks are from Kattelman (1968). Field work was done in the summer and fall of 1970. Since no quadrangle map was available for the area, the base map was constructed from the enlarged Army

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Figure 1. Index map to study area.
Map Service Delta quadrangle map; some of the plotted section lines, therefore, may be slightly in error.

Color-stereo aerial photographs of the area became available after the field mapping was completed. The area was mapped again on the stereo plotter with the original black and white vertical aerial photograph map for reference. This process provided better control and a few structures were added to the field map. About thirty-five thin sections were examined.

Samples for geochemical studies were analyzed qualitatively on the emission spectrograph and quantitatively by atomic absorption for selected elements.

GEOMORPHOLOGY

Desert Mountain is topographically isolated from any other mountains in the area. To the northeast a bajada slopes up to the Sheeprock Mountains and an extensive lake plain, a remnant of Lake Bonneville, lies on the other three sides.

The mountains themselves are steep and jagged with a local relief of about 1,000 feet. The rounded Allison Knolls have a lower relief than Desert Mountain. If present, Basin and Range type faulting is concealed. Fault scarps occur in the volcanics in the south part of the mountains.

Terraces and bars formed in former Lake Bonneville are common in many parts of the mountains and in the flats. Two bay-mouth bars occur in the northwest part of the mountains; to the west a large river drained the “Sevier body” of Lake Bonneville into the main body as the lake receded (Gilbert, 1890, p. 183).

STRATIGRAPHY

General Statement

Sedimentary rocks make up a small part of the outcrops in Desert Mountain; their inclusions are associated with diatremes in the east part of Desert Mountain and they are exposed in both plates of a major thrust fault which is exposed in the Allison Knolls.

Precambrian System

Sheeprock Series (Undifferentiated)

Interbedded quartzite and argillite are exposed in the north part of the Allison Knolls with a few outcrops south of the Jericho road. The exposures are rounded hills with few outcrops. Weathered outcrop is dark reddish brown, but the fresh surface is generally lighter. Some argillites are black, most are tan and light gray. In the north section some outcrops of tillite occur which contain small rock fragments. Cohenour (1959, plate I) called the Allison Knolls rock Dutch Peak tillite and Kattelman (1968, p. 88) designated it as the Lower Sheeprock Series. It is mapped as undifferentiated Precambrian Sheeprock Series.

Abundant argillite and quartzite inclusions are associated with diatremes to the east of Desert Mountain, therefore they are assumed to underlie that area. In the vicinity of the thrust, the rock is brecciated and silicified.

Ordovician System

Fish Haven Dolomite

A few small outcrops of dolomite occur in the north part of the Allison Knolls. One outcrop is exposed south of the Jericho-Callao road and a few blocks are found in the south part of the diatreme area. Cohenour (1959, p. 78) identified the outcrops from fossil evidence as Fish Haven Dolomite. The dolomite is dark to medium gray with some reddish tan weathered chert nodules. The outcrops have low relief and the exposed rocks are brecciated. The undifferentiated Sheeprock Series has been thrust on top of the Fish Haven Dolomite in the area mapped.

Quaternary System

Lake Bonneville Sediments

Many Lake Bonneville terraces, beaches, bars and spits occur in the Desert Mountain area. The plain surrounding the mountains is a lake plain with beaches and other evident Lake Bonneville features. Lake Bonneville deposits are shown undifferentiated on plate 1 except for some gravel cemented by calcareous material. Cemented gravel occurs in other areas also, but only in the bars and spits are the outcrops large enough to be shown on the map. Two distinct baymouth bars lie in sec. 16, T. 12 S., R. 7 W.

Alluvium

Large areas of generally unconsolidated lacustrine sediments lie in and around Desert Mountain. Post-Lake Bonneville alluvial sediments are present also.

IGNEOUS ROCKS

General Statement

Most of Desert Mountain is composed of intrusive igneous rock. Extrusive igneous rocks are exposed
on the east side of the mountains and in the Allison Knolls.

Kattelman (1968, p. 90) believes the Desert Mountain intrusives are differentiates of the same parent magma, becoming generally more acid following the normal order of crystallization. In the West Tintic mining district, Stringham (1942, p. 287) found the order of igneous rocks also appeared to follow Bowen's theory of fractional crystallization with later intrusions more acid. The West Tintic stock is the closest granitic outcrop to the Desert Mountain intrusions.

The igneous rock types are mainly granodiorite, granite, rhyolitic volcanic rock and dikes. They are described in approximate order of crystallization and by probable origin. Generally the igneous rocks contain some free quartz, which suggests a high silica magmatic source. The presence of silicified rocks further supports a high silica magmatic source.

Intrusive Rocks

Granodiorite

Granodiorite is the oldest igneous rock exposed in the Desert Mountain. It generally crops out in a northwest-trending zone across the central part of the area. Outcrops are discontinuous in the zone and some granodiorite occurs outside the zone. The younger granite, which occurs in the mapped area, is under the granodiorite; in other areas the contact appears vertical.

Granodiorite outcrops range from steep, jagged peaks to low rolling hills. Large outcrops are not abundant but small outcrops occur in most areas. The dark color of the granodiorite was used to map the unit.

Granodiorite typically has a fine-grained dark groundmass with light colored phenocrysts. Minerals that can be determined megascopically are biotite, quartz and plagioclase. Epidote is common along fractures. Locally the granodiorite grades into a quartz monzonite phase.

Most of the microscopic information presented is from Kattelman (1968, p. 90). The phenocrysts range in size from .1 mm to 3.0 mm. The rock is a microporphyry and has a granular texture with few euhedral grains. The plagioclase has an average composition of Ab$_{64}$An$_{44}$ and has normal zoning. Both quartz and potassium feldspar exhibit some resorption. For the most part the groundmass is too fine-grained to be identified.

Epidote, sericite, albite and calcite are observable microscopically indicating a weak propylitic alteration.

Kattelman's (1968, p. 91) average composition of the granodiorite (10 samples) follows:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-feldspar</td>
<td>11.4</td>
</tr>
<tr>
<td>Plagioclase</td>
<td>47.9</td>
</tr>
<tr>
<td>Quartz</td>
<td>11.8</td>
</tr>
<tr>
<td>Biotite</td>
<td>21.4</td>
</tr>
<tr>
<td>Hornblende</td>
<td>1.4</td>
</tr>
<tr>
<td>Magnetite</td>
<td>6.1</td>
</tr>
<tr>
<td>Zircon</td>
<td>(rare)</td>
</tr>
<tr>
<td>Apatite</td>
<td>(rare)</td>
</tr>
</tbody>
</table>

He noted that biotite, magnetite and the percentage of anorthite in the plagioclase generally increase to the northwest.

Odekirk (1963, p. 26) made age determinations of two rocks from Desert Mountain using the lead-alpha method on zircon crystals. A "hornblende-biotite granite," here assumed to be the granodiorite, had an indicated age of 41 million years or late Eocene.

Granite

Light colored granite is the most abundant rock type in the Desert Mountain area; it makes a bold contrast with the dark granodiorite. Its outcrop areas are isolated by broad valleys and exposures of other rock types. The granite outcrops are generally bold, forming cliffs and jagged high relief mountains. Most outcrops are large which facilitates structural studies.

The granite is thought to be younger than the granodiorite because of the contact relations as well as age determinations by Odekirk (1963, p. 26). An age of 36 million years (Oligocene) was indicated using the lead-alpha method on zircon. The contact in sec. 36, T. 12 S., R. 7 W. is sharp. The granite in this section is very fine-grained at the contact, but is locally pegmatitic a few feet back from the contact. This relationship suggests rapid cooling at the contact which released volatiles which led to the formation of pegmatitic pods. In several other areas the granite appears to be under the granodiorite suggesting that the granite was intruded in the pre-existing granodiorite.

The granite is weathered into rounded, crumbly outcrops which often contain windblown holes. An arch occurs in the granite in sec. 15, T. 12 S., R. 7 W. The texture generally appears equigranular but a closer look reveals a generally porphyritic texture with phenocrysts ranging up to 15 mm. The granite is white...
in the southwest part of the outcrop area and pink in the east outcrops. The color change is gradational and the result of feldspars. The granite possibly represents more than one intrusion, but if so, the contacts are buried under alluvium. The gradational nature of the color change of the feldspars, however, suggests a single intrusion. The granite locally grades into a quartz monzonite phase.

The following petrographic description is based on data from Kattelman (1968, p. 95) and on analyses of thin sections prepared for this report. The porphyritic portions of the granite contain up to 40 percent phenocrysts ranging in size from 3 mm to 15 mm. The groundmass grains are approximately 1 mm in size.

The feldspars are generally euhedral. Microperthite is common with the albite occurring as thin stringers. Andesine has an average composition of $\text{Ab}_{68}\text{An}_{32}$. Resorption is evident in both feldspar and quartz with common undulatory extinction in quartz. The average composition for the granite (18 samples) is:

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-feldspar</td>
<td>57.8</td>
</tr>
<tr>
<td>Plagioclase</td>
<td>12.6</td>
</tr>
<tr>
<td>Quartz</td>
<td>24.9</td>
</tr>
<tr>
<td>Biotite</td>
<td>4.0</td>
</tr>
<tr>
<td>Magnetite</td>
<td>0.7</td>
</tr>
<tr>
<td>Zircon</td>
<td>trace</td>
</tr>
<tr>
<td>Sphene</td>
<td>trace</td>
</tr>
</tbody>
</table>

Kattelman called the intrusive rock leucogranite porphyry.

Dikes

**Aplite Dikes.** Aplite dikes occur mostly in the granite. They are most common in the south and west sections, but cross the contact and continue into the granodiorite in sec. 36, T. 12 S., R. 7 W. The dikes generally are less than 2 feet thick and less than 100 feet long. They follow the shear directions.

The rock is white with a sugary texture. The grain size is generally less than 1 mm and uniform. Locally the aplite is quartz rich. Kattelman (1968, p. 100) gave the following composition (8 samples):

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-feldspar</td>
<td>62.1</td>
</tr>
<tr>
<td>Quartz</td>
<td>27.2</td>
</tr>
<tr>
<td>Plagioclase</td>
<td>9.4</td>
</tr>
<tr>
<td>Biotite</td>
<td>0.6</td>
</tr>
<tr>
<td>Muscovite</td>
<td>0.4</td>
</tr>
<tr>
<td>Magnetite</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Some microperthite is present and the plagioclase is $\text{Ab}_{96}\text{An}_4$ (Kattelman, 1968, p. 99).

**Pegmatite Dikes.** Associated with and sometimes grading into the aplite dikes are pegmatite dikes. They are usually small and are not shown on the map (plate 1). They are composed mostly of quartz and K-feldspar with some local muscovite.

**Aphanitic (Lamprophyre) Dikes.** Of the many aphanitic dikes in the Desert Mountain, most occur in the west and south parts of the granite. The fine-grained, dark colored dikes usually follow the joints and dip northerly about 60° to 70°. The dikes range up to 25 feet in width and from a few feet to over a mile in length. They are a somewhat variable dark green. The dike rocks are dense, compact and resistant to weathering.

Kattelman (1968, p. 101) classified the dikes as lamprophyres. He identified three rock types, odinite, odinite porphyry and kersantite, with the following mineral assemblages:

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odinite and odinite porphyry</td>
<td></td>
</tr>
<tr>
<td>Plagioclase</td>
<td>61.7</td>
</tr>
<tr>
<td>Biotite</td>
<td>3.5</td>
</tr>
<tr>
<td>Hornblende</td>
<td>28.7</td>
</tr>
<tr>
<td>Magnetite</td>
<td>6.1</td>
</tr>
<tr>
<td>Pyrite</td>
<td>trace</td>
</tr>
<tr>
<td>Kersantite</td>
<td></td>
</tr>
<tr>
<td>Plagioclase</td>
<td>78</td>
</tr>
<tr>
<td>Biotite</td>
<td>12</td>
</tr>
<tr>
<td>Hornblende</td>
<td>5</td>
</tr>
<tr>
<td>Magnetite</td>
<td>5</td>
</tr>
</tbody>
</table>

The most common, odinite, is slightly porphyritic and has an average grain size of 0.3 mm with hornblende crystals as long as 3 mm. In the odinite porphyry the phenocrysts range in size up to 10 mm. The plagioclase is labradorite and is $\text{Ab}_{45}\text{An}_{55}$ (Kattelman, 1968, p. 101).

The kersantite occurs only in a few places and is light green (Kattelman, 1968, p. 102).

Diatreme (?) Complex

An area of complex geology lies east of Desert Mountain. Viewed from a distance, the area is dominated by somewhat isolated, bold outcrops. These outcrops differ in color and lithology and are Precambrian...
quartzite and argillites, Ordovician Fish Haven Dolomite and igneous rocks of differing types. They occur as jumbled blocks and in many cases a matrix of igneous rock surrounds the blocks. Many blocks are quartzite with most slate blocks black. Many blocks of sedimentary rock in the complex are intensely silicified and brecciated and appear similar to the rocks near the exposed thrust fault to the north. The igneous inclusions are also of varying sizes, but not as large as the sedimentary blocks. The top of one mountain appears to be a large sedimentary inclusion. The igneous inclusions vary in composition and color, but most have free quartz.

The Desert Mountain complex is about 11,000 feet long and as much as 4,500 feet wide in its outcrop area. The complex is tadpole shaped with the large end to the north.

Kattelman (1968, p. 88) described the area:

The quartzite inclusions and roof pendants occur in a northwest trending belt...surrounded by the rhyolite porphyry which includes them. The inclusions range in size from one millimeter to several acres. As they are more resistant to weathering than the including rhyolite, the quartzites cap ragged peaks that protect the steep rhyolite slopes.

Morris and Kopf (1967) described similar features in the West Tintic Mountains as breccia pipes or diatremes. A diatreme is a volcanic vent or pipe which has cut pre-existing rock with the explosive energy of a gas-charged magma. The Desert Mountain complex is thought to be a diatreme.

The West Tintic diatremes have a stratigraphic displacement of included rock fragments of as much as several thousand feet upward (Morris and Kopf, 1967, p. C68). By comparison the upward displacement in the Desert Mountain diatremes is about 600 feet or less. The determination of the upward movement is based largely on the inferred location of the thrust fault in the area. Relatively few blocks of dolomite from the lower plate of the thrust are exposed in the diatreme complex; many brecciated and silicified blocks originate from the thrust plane. The diatremes in the West Tintic Mountains show a rude compositional zonation, especially so in the Maple Peak breccia pipe (Morris and Kopf, 1967, p. C69). In the Desert Mountain breccia area, zonation is not apparent, although detailed work might reveal faint zoning.

The contacts of the West Tintic pipes are well defined and have an apparent age of post Eocene. In the Desert Mountain area the diatreme contact with the granite is distinct and the diatreme apparently intruded the granite. The contact with the volcanics is indistinct and the volcanics appear to rest on the diatreme. That older volcanics often are exposed nearest the mapped diatreme outcrop further supports this. The volcanics are probably Miocene in age and the granite is early Oligocene so the diatreme is apparently Oligocene or Miocene in age.

In the north part of the diatreme complex, the matrix rock is green with white or pink phenocrysts and rock fragments. Many broken grains are seen with the microscope.

Composition of the rock cannot be accurately determined because of the fine-grained nature of the matrix, weak alteration and many inclusions present. Enough visible plagioclase, however, suggests that the rock is latitic. Little quartz is seen in thin section or hand specimen. Some resorption was observed.

In the south part of the diatreme complex the matrix rock differs in appearance and composition. Although green, it is lighter; quartz is commonly visible in hand specimen and no plagioclase is seen in thin section. The rock is a rhyolite porphyry. Inclusions of quartzite, slate, jasperoid and igneous rocks range from microscopic to tens of feet in diameter. The larger inclusions are in the north part of the diatreme complex. Dolomite fragments are present in the south part, but seldom occur in the north part of the complex.

Several large blocks of the north-type matrix rock were observed in the south part of the complex. This suggests that the south area was active at the same time as the north area, but was reactivated later, with a more acid rock being emplaced.

The diatremes probably were formed by a gas-rich, partially crystallized magma intruding a structurally weak zone. Volcanic material probably was thrown out with the release of gas pressure and, in the process, blocks and fragments of other existing rocks were broken loose and moved upwards. Once the pressure was released, the magma solidified.

The diatremes of the Desert Mountain area occur in a narrow, nearly straight zone in which several volcanic centers are located. The zone described by Erickson (1963) extends from Honeycomb Cliffs in the west and projects to Sunrise Peak in the East Tintic Mountains, a distance of more than 80 miles. Erickson (1963) suggested a deep-seated structure along this line or zone which allowed access of magma at depth and outbreaks of lava at the surface. Volcanic centers included the Honeycomb Cliffs rhyolite, the Spor Mountain diatremes, the Thomas Range volcanic
center, two volcanic centers in the Keg Mountains and the Sunrise Peak center of volcanic activity in the East Tintic Mountains. Since that time, Morris and Kopf (1967, p. 68) have recognized and described three diatremes in the West Tintic Mountains and one in Copperopolis Canyon (Morris, 1970, personal communication) of the East Tintic Mountains. Muessig (1951) described a feature in the north part of Long Ridge; he compared its origin to the pebble dikes of the Tintic district. The Long Ridge diatreme extends the zone beyond the East Tintic Mountains. Figure 2 shows the trend and alignment of these diatremes and volcanic centers.

Extrusive Rocks

Altered, Acid Volcanic Rocks

Altered, acid volcanic rocks occur in large areas along the east part of Desert Mountain and in the Allison Knolls. The alteration is generally argillic, but silicification and bleaching are the most conspicuous. Locally intense silicification completely obliterates the original texture. These areas are mapped as jasperoid. Pyritic alteration is locally common and usually controlled by shears.

Altered volcanic rocks occur as low rolling hills with few outcrops; they are locally bleached and iron stained which gives them a blotchy appearance. The rock apparently contained free quartz before it was altered and more quartz was added with the alteration. Small fragments of other igneous rock are present, suggesting a clastic origin.

North of the Jericho-Callao road two hills, one symmetrical, the other more elongated, are thought to be cinder cones with intensely silicified throats because of their shape. A strong possibility exists that these hills are younger than the volcanics discussed here, but because of the similarity of rock types, they are mapped with the older volcanic rocks.

Sanded-altered Volcanic Rocks

A fine-grained, sandy looking volcanic rock occurs in the central part of the map area. The rock is similar to the altered, acid volcanic rock except in texture. It is locally, intensely altered by quartz-sericite alteration (figure 3).

Rhyolitic Volcanic Rocks (Unaltered)

Along the east side of Desert Mountain and Allison Knolls are unaltered volcanic rocks, probably similar to the sanded-altered rocks but younger. The rhyolitic rocks form rugged peaks and ridges with bold outcrops and low rolling hills with few outcrops.

The rock contains many inclusions, usually igneous, some more than 10 feet in diameter. The color is varied but usually gray, sometimes pink or green. The rock usually looks porphyritic with free quartz common. Alteration is rare.

The three volcanic units in Desert Mountain probably correlate to the Keg Mountain Ignimbrites (Erickson, 1963, p. 24). The older volcanics of the Thomas Range are dated at 19 million years (Staatz and Carr, 1964, p. 116) and are probably equivalent to the Keg Mountain Ignimbrites (plate 1; Erickson, 1963, p. 24).

The rocks "contain a high percentage of broken crystals of quartz and sanidine, and are so highly
welded as to resemble rhyolite porphyries with numerous phenocrysts rather than welded tuff" (Erickson, 1963, p. 24). Kattelman (1968, p. 97) called the rock rhyolite porphyry and noted the broken and resorbed grains. He analyzed the composition as follows (9 samples):

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-feldspar</td>
<td>53.8</td>
</tr>
<tr>
<td>Plagioclase</td>
<td>7.7</td>
</tr>
<tr>
<td>Quartz</td>
<td>33.1</td>
</tr>
<tr>
<td>Biotite</td>
<td>3.3</td>
</tr>
<tr>
<td>Magnetite</td>
<td>2.1</td>
</tr>
<tr>
<td>Zircon</td>
<td>(rare)</td>
</tr>
</tbody>
</table>

Locally the volcanic rocks are of quartz latite composition (Kattelman, 1968).

GEOLOGIC STRUCTURE

General Statement

Shears, joints, faults and sheeting occur within the igneous rocks. Because of the lack of marker units in the igneous rocks, the shears or joints were mapped as such unless they were large, continuous, had gouge or topographic expression or were silicified; then they were mapped as faults.

A thrust fault of major displacement occurs along the north part of the Allison Knolls and is possibly the southern continuation of the Sheeprock thrust.

Sheeting

Sheeting occurs in all intrusive rock in Desert Mountain; it has a general strike of N. 30° W. and dips about 45° W. The sheeting is more pronounced in the west part of the map area, becoming weaker to the east. The sheeting has controlled some mineralization.

Shears, Joints and Faults

In the map area three shear, joint or fault directions appear dominant. The direction of strongest shearing is about N. 40° to 50° E. dipping steeply to the north. One joint offsets the vein in the Rockwell shaft, indicating some shears have moved. A shear having a direction of about north-south to N. 10° W. and dipping steeply to the west is not as well developed as the north-east set and it seems to be the major control of the mineralization in the map area. The third shear direction is not well developed and strikes about N. 80° E. with faults being more common than shears or joints.

Thrust Faulting

Small Local Gravity Slide

In the southeast quarter of sec. 17, T. 12 S., R. 7 W. is what is thought to be a gravity slide block in the granitic rock (figure 4). The block is detached from the main mass on a near horizontal plane. It probably moved when the mountains to the east were higher.

Sheeprock (?) Thrust

A thrust fault of major proportions exposed in the north part of the Allison Knolls is assumed part of the Sheeprock thrust. Rock of the Precambrian Sheeprock Series is thrust on top of the Ordovician Fish Haven Dolomite with a possible stratigraphic displacement of 17,000 feet. The location of the thrust is implied to the south of the Jericho-Callao road.

The thrust zone is brecciated in the dolomite and quartzite. Silicification in the upper plate is locally so intense that brecciation is nearly obliterated. The small exposures of Precambrian rock south of the Jericho-Callao road are brecciated and silicified, suggesting the fault plane is near. The approximate trace of the thrust can be located south of the Jericho-Callao road because of the locations of the Precambrian rock exposures and a small outcrop of Fish Haven Dolomite.

REGIONAL STRUCTURE

The Desert Mountain region is on a major structural zone with a direction of N. 82° E. (Erickson, 1963, p. 34). The deep seated structural zone has controlled the location of volcanic features and intrusive rocks of Desert Mountain and the region (figures 2 and 5). The east-west alignment of intrusions was noted earlier by Morris (1967, p. C68).

Many major east-west structural zones were noted in the west United States before the concepts of global tectonics had been advanced (i.e., Nolan, 1943).
Shawe (1965) related many earthquakes to deep seated strike-slip movement and now global tectonic concepts offer an explanation for both east-west structural zones and strike-slip movement. The east-west structural features were related to ocean floor spreading by King (1966, p. 2) who noted abrupt changes in the western cordillera along transverse zones, which are the landward extensions of the transform faults off the west coast of the United States. The east-west structural zones are not all related directly to transform faults in the ocean floor.

This structural zone of western Utah probably has had left-lateral movement which has caused the structural pattern observed in Desert Mountain.

HYDROTHERMAL ALTERATION

General Statement

Many rocks in Desert Mountain are fresh except for surface weathering. In many areas, however, weak hydrothermal alteration is observable and in a few areas strong alteration is present.

Propylitic Alteration

Propylitic alteration is the weakest and most widespread type of alteration in the area. Epidote is common in fractures in the granodiorite and epidote and calcite were observed in and near sec. 16, T. 12 S., R. 7 W. Other small areas of propylitic alteration were observed.

Pyritic Alteration

Pyritic alteration is characterized by limonite staining, a by-product of pyrite oxidation. Many small areas have had pyrite introduced, usually along fractures. Only larger areas of pyritic alteration are noted.

The altered, acid volcanic rocks and the sanded-altered volcanic rocks characteristically have had pyrite introduced. A large area of pyritic alteration is controlled by a nearly north-south shear in sec. 13, T. 12 S., R. 6 W. and to the north across the Jericho-Callao road with several fairly large zones in secs. 21, 22 and 28, T. 12 S., R. 7 W.

Argillic Alteration

Argillic alteration was observed north of the Jericho-Callao road and in a few other small areas. This type of alteration occurred in the granitic rocks and the altered volcanic rocks.
Table 1. Geochemical sample results (see figure 6 for sample locations).

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Rock Type</th>
<th>ppm</th>
<th>Usual Elements Present</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cu</td>
<td>Pb</td>
</tr>
<tr>
<td>1</td>
<td>Granite</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>Granite</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Granodiorite</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Volcanics</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Jasperoid in Tc diatreme</td>
<td>21</td>
<td>34</td>
</tr>
<tr>
<td>6</td>
<td>Dolomite</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>7</td>
<td>Quartzite</td>
<td>17</td>
<td>76</td>
</tr>
<tr>
<td>8</td>
<td>Granite (altered)</td>
<td>6</td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td>Shear in altered volcanics</td>
<td>13</td>
<td>84</td>
</tr>
<tr>
<td>10</td>
<td>Shear in diatreme volcanics</td>
<td>13</td>
<td>126</td>
</tr>
<tr>
<td>11</td>
<td>Quartz vein</td>
<td>680</td>
<td>2,600</td>
</tr>
<tr>
<td>12</td>
<td>Quartz veins</td>
<td>85</td>
<td>42</td>
</tr>
<tr>
<td>13</td>
<td>Jasperoid</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>14</td>
<td>Vein</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>15</td>
<td>Quartz vein</td>
<td>1,260</td>
<td>12,800</td>
</tr>
<tr>
<td>16</td>
<td>Fault gouge</td>
<td>70</td>
<td>6,200</td>
</tr>
<tr>
<td>17</td>
<td>Fluorite veins</td>
<td>3,100</td>
<td>4,200</td>
</tr>
<tr>
<td>18</td>
<td>Hematite stringers</td>
<td>32</td>
<td>52</td>
</tr>
<tr>
<td>19</td>
<td>Sanded volcanics</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>Copper vein</td>
<td>17,600</td>
<td>50</td>
</tr>
<tr>
<td>21</td>
<td>Quartz vein</td>
<td>2,600</td>
<td>415</td>
</tr>
<tr>
<td>22</td>
<td>Copper-stained granite</td>
<td>3,400</td>
<td>66</td>
</tr>
</tbody>
</table>

Silicification

Silicification is present in the Latered, acid volcanic rocks and the sanded-altered volcanic rocks. It also occurs in the granitic rock immediately north of the Jericho-Callao road. Silicification is intense enough to have produced localized jasperoids in the volcanics near and in the two probable cinder cones. In the zone of the thrust faults, it has produced jasperoid in the quartzites and argillites and many blocks in the diatremes are jasperoid. Silicification was observed in sees. 15 and 16, T. 12 S., R. 7 W. in the sanded-altered volcanic rock.

GEOCHEMICAL SAMPLE RESULTS

A few geochemical samples were collected and analyzed to compare different igneous rocks and some veins exposed in prospect holes. Samples also were collected from altered and mineralized rocks that did not contain prospect pits.

The samples were analyzed on the atomic absorption unit to determine the presence of metallic elements not normally found in rock forming minerals: Cu, Pb, Zn, Mn, Mo, Ag and Au. Some samples were qualitatively analyzed on the emission spectrograph or quantitatively analyzed by atomic absorption spectroscopy (table 1).

The metal content of some samples is high, but they were collected from obviously mineralized areas.

ECONOMIC GEOLOGY

Desert Mountain Mining District

Desert Mountain and the Allison Knolls make up the Desert Mountain mining district. Little information is available on the area. The mineralization is spotty and the deposits are small resulting in little production.

Mineralization

The mineralized dike rock in the Rockwell shaft shows mineralization took place after the dark aphanitic dikes were emplaced. The major structural control seems to be the N. 5° W. shears, joints and faults. The localization of mineralization is favored by a cross structure and locally the mineralization follows prom-
inent sheeting. Most of the mineralization is in the west part of the mountains where many small hematite stringers, with an approximate strike of N. 5° W., occur; some carry visible copper minerals. In the same locality some veins have been prospected. The vein minerals contain quartz, barite, hematite, magnetite, pyrite, chalcopyrite, bornite, chrysocolla, brochantite (and/or antlerite), manganese oxides, limonite and locally tetrahedrite, galena, fluorite and malachite. Several prospects have moderate amounts of fluorite.

Rockwell Shaft

The Rockwell shaft, located in sec. 28, T. 12 S., R. 7 W., is inclined, dipping 60° west and following a vein in granite. The shaft is 325 feet deep and has a 135-foot and 325-foot level. The 135-foot level has more than 400 feet of workings and two small stopes whereas the 325-foot level has less than 60 feet of drifts. The vein strikes N. 10° W.

The outcrop of copper-stained rock is 6 to 8 feet wide. It is partly covered by dump debris but is exposed for at least 50 feet south of the shaft, which begins in ore. The cliffs, however, on the spur just north of the shaft, although they are cut by a strong north-south fissure zone in line with the vein, show no vein material (Loughlin, 1920, p. 444).

Evidence of the vein exists in the next outcrop to the north. A dark aphanitic dike with some associated mineralization forms the footwall most of the way down the shaft. Mineralization is more intense where the vein is crossed by northeast shears; one shear offsets the vein. The best grade of "ore" is on the 325-foot level and is approximately 5 percent copper, 8 ounces silver, to as high as .17 percent U$_3$O$_8$ with a little gold and lead.

The prospect was first discovered between 1870 and 1875. The major work took place in about 1905 when as much as 200 tons of ore were shipped. Since then the shaft has been maintained and some of the dumps have been hauled away.

Lucky Shepard (?) Mine

The Lucky Shepard (?) mine lies in the north part of the Allison Knolls. The mine is apparently a small shaft in Precambrian quartzites. H. J. Hassell (1970, personal communication) visited the mine in the 1930's and observed lead-silver ore in place. After World War II he revisited the mine and the ore was gone, indicating some production from the mine. Several diggings at the location were visited. A weak structure is exposed in an adit and some pyrite and vein quartz were found on some of the dumps, but nothing suggests production or significant mineralization.

Other Prospects

Many prospects are scattered over the area. In sec. 21, T. 12 S., R. 7 W., along a fault or sheeting structure which strikes about N. 15° W., several prospects occur. Some of these small prospects apparently located small pods of relatively high grade copper "ore," which is presently on the dumps. A cluster of prospects lie in each of sees. 16 and 23, T. 12 S., R. 7 W.

Economic Potential

The economic potential of the Desert Mountain mining district, as exposed in outcrop, is not good. The Rockwell shaft, with ore-grade rock may have some potential. The only area with possible favorable alteration is just north of the Jericho-Callao road.

The major east-west structural zone controls the igneous activity and mineralization of the region. The Desert Mountain region, therefore, might be a favorable location for prospecting in areas under alluvial cover.

REFERENCES


Morris, H. T., 1970, Personal communication.


