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Geology of the Desert Mountain Intrusives Juab County, Utah*

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ABSTRACT.—The Desert Mountain intrusives comprise a group of isolated peaks rising above the Pleistocene alluvium about 30 miles north of Delta and 20 miles west of Jericho in Juab County, Utah. Two genetically related intrusive igneous bodies, of contrasting mineralogy, dominate the area. A dark colored granodiorite is intruded by a leucogranite. Adjacent to the leucogranite is a rhyolite porphyry containing inclusions and roof pendants of Precambrian (?) metasediments.

Two minor igneous differentiates occur on the periphery of the main intrusives. An adamellite is present at several localities on the margins of the leucogranite and granodiorite, and as inclusions within the leucogranite. An alaskite porphyry is found in several isolated outcrops adjacent to the leucogranite and rhyolite porphyry bodies, and at one locality is in contact with the rhyolite porphyry.

Cutting the leucogranite are aplite, pegmatite and lamprophyre dikes, which have intruded along a prominent joint system.

Post-magmatic hydrothermal solutions have resulted in mineralization of the southwestern leucogranite exposures, forming small mineral deposits containing chrysocolla, malachite, chalcopyrite, and fluorite. Because of the small size and remote location of the deposits, they have had little economic significance.

The mineral composition of the several intrusive differentiates supports field observations in determining their genetic relationship. Acidity of the various rock types generally increases with their order of crystallization.

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TEXT

*A thesis submitted to the faculty of the Department of Geology, Brigham Young University, in partial fulfillment of the requirements for the degree Master of Science, July 15, 1967.

ILLUSTRATIONS

INTRODUCTION

Location and Description

Desert Mountain is located 30 miles due north of Delta and 20 miles west of Jericho in Juab County, Utah (Text-fig. 1). The area of study includes the western one third of T. 12 S., R. 6 W., and the eastern two thirds of T. 12 S., R. 7 W., Salt Lake Base and Meridian. Also included are parts of adjacent sections that are part of the main physiographic unit.

Desert Mountain is most easily reached by the Jericho-Callao road, which passes through the northern part of the study area. It has a gravel surface and is maintained by the county. From Delta, the area is accessible by a secondary road which passes through Desert Mountain Pass, dividing the area into approximately equal halves. Dirt roads and trails, which for the most part are passable by passenger car, are numerous and afford accessibility to the perimeter of all the isolated rock bodies. The nearest railroad station is at Jericho.

The intrusives are exposed in a group of rugged peaks rising from gentle southward-sloping Pleistocene lake sediments. These sediments surround individual outcrops of the Desert Mountain area, and have an approximate elevation of 5,000 feet. Local relief is greatest just to the west of Desert Mountain Pass, where the highest peak attains an elevation of 6,482 feet. Five different isolated peaks, in a northwest-trending elliptical pattern around the periphery of the mapped area, attain elevations greater than 6,000 feet.

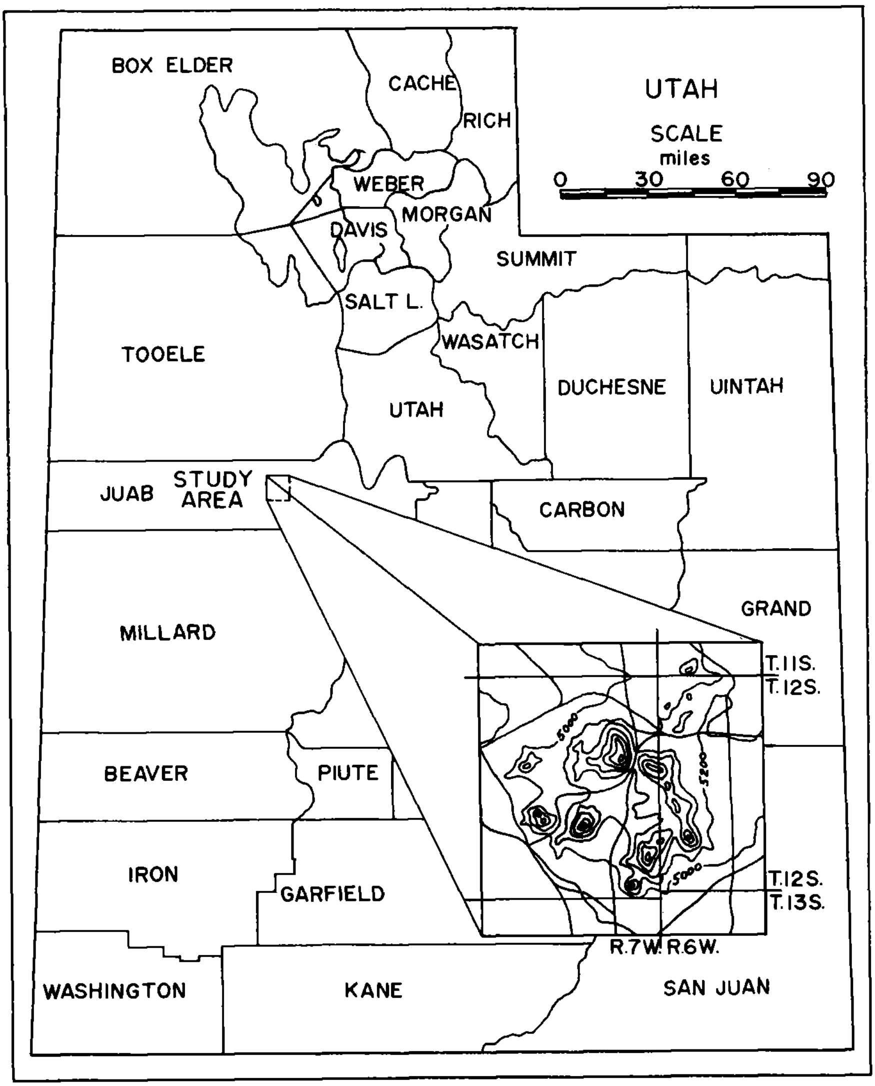
Cherry Creek, nine miles east of Desert Mountain Pass, and Judd Creek, seven miles northwest of Desert Mountain Pass, are the nearest sources of water. Because of the arid climate, vegetation within the mapped area is sparse. Sagebrush is prominent, even at the highest elevations. Juniper trees are common, though usually confined to the leucogranite areas, and aided greatly in distinguishing the granite-alluvium contact on aerial photographs. Although grass is coarse and scattered, it is present in sufficient quantities to permit winter grazing of sheep.

Purpose and Scope

The purpose of this paper is to provide an accurate geologic map and petrographic description of the Desert Mountain intrusives, and to determine the relative age of the genetically related intrusive differentiates by field observations and petrographic analyses.

Previous Work

Geologic literature concerning the Desert Mountain area is extremely sparse. The area is shown on the state geologic map as Precambrian metasediments and Tertiary volcanics, intruded by undifferentiated Tertiary granite. Although the area was briefly described by Loughlin (in Butler *et al.,* 1920, p.



TEXT-FIGURE 1.—Index map of the Desert Mountain area, in east-central Juab County, Utah.

444-445), he visited only the very southwest exposure. Absolute age determinations were made by Odekirk (1963) on samples of adamellite and leucogranite from Desert Mountain Pass, and a brief description of the area given. Cohenour (1959) briefly mentioned the area in his discussion of the Sheeprock Mountains. The only topographic coverage of Desert Mountain is the Delta Quadrangle (1:250,000).

Methods of Investigation

Field mapping was done from 1964-1966 on a series of 23 aerial photographs with an approximate scale of 1:20,000. Geologic data were transferred to a high altitude photograph that had been enlarged to a scale of 1:22,260. Since radial displacement of topographic units of moderate relief is very small on high altitude photographs, and most of the geologic contacts are at approximately the same elevation as that of the center of the photograph, the final map was traced directly from the enlargement. Radial displacement at the margin of the enlargement is 0.040 inches per hundred feet of elevation difference. Maximum radial displacement is west of Desert Mountain Pass where it approaches 0.164 inches.

A series of 80 thin sections was prepared from samples of the different rock types. When practical, the mineral composition of each thin section was determined quantitatively by Rosiwal analysis. The rock classification used is that of Johannsen (1931). Plagioclase determinations were made using the statistical method of Michel-Lévy, and the correlation chart of Kerr (1959, p. 258).

Acknowledgments

The writer wishes to acknowledge the assistance of Dr. Kenneth C. Bullock of the Geology Department of Brigham Young University in developing the project and criticizing the manuscript.

Appreciation is expressed to my wife, Kenna, for her patience and understanding, and for typing the manuscript.

STRATIGRAPHY

General Statement

Because the majority of the sedimentary rocks in the Desert Mountain area occur as massive roof pendants within igneous intrusives, the writer was unable to measure a stratigraphic section or distinguish differences in lithologic character of the major rock types at different locations. Stratigraphic correlation of sedimentary rocks with those of surrounding areas is little better than an educated guess, since outcrops are metamorphosed, and are separated by Pleistocene lake sediments and Tertiary intrusives.

Precambrian (?) System

Quartzites

The predominant metasedimentary rock at Desert Mountain is a light gray quartzite, which may be equivalent to the Precambrian quartzites of the lower Sheeprock Series. Exposures are more common toward the northern part of the Desert Mountain range in the Allison Knolls, and are almost continuous with Precambrian exposures in the Sheeprock Mountains. No evidence was found, however, to make this correlation. Argillites are also present in the larger exposures, but are subordinate to the quartzites.

The quartzite inclusions (Plate 2, fig. 1) and roof pendants occur in a northwest trending belt in the western one third of T. 11 and 12 S., R. 6 W., 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 rhyolites, the quartzites cap rugged peaks that protect the steep rhyolite slopes.

Although a freshly fractured surface of the quartzite is usually light gray, outcrops appear dark brown because of desert varnish. In places it is impossible to tell the quartzite from the rhyolite without examining a fresh surface.

Petrographic examination of the quartzite indicates that the individual quartz grains average 0.3 mm in size. They are rough, interlocking, recrystallized grains, with a random orientation.

Fault Breccia

Just to the north of the mapped area, the quartzite outcrops contain zones of intense brecciation. These breccia zones have been included in the Dutch Peak tillite (middle Precambrian) by Cohenour (1957, pl. I); but the writer believes that they are fault breccias and offers the following criteria for this interpretation:

1. Breccia outcrops are concentrated along faulted contacts between Precambrian quartzites and Ordovician dolomites.
2. Brecciated fragments are comprised entirely of quartzite and do not include other rock types as do fragments in the main exposures of the Dutch Peak tillite.
3. The matrix is compact and composed entirely of recrystallized quartzite grains; it does not have a slaty texture like that of typical tillites in central Utah.
4. Outcrops become less fragmented away from discernible fault zones.
5. Slickensides are present within some brecciated outcrops.

Tillites were not observed in the Desert Mountain range or the Allison Knolls.

Ordovician System

Fish Haven Dolomite

The Fish Haven dolomite is exposed in small patches to the north of the present study area in the northern Allison Knolls (Cohenour, 1957, Pl. II). Its southernmost exposure is in the SE¼, SE¼, Sec. 32, T. 11 S., R. 7 W.

Separated from the Precambrian quartzites by intensely brecciated fault zones, the dolomite forms low-lying outcrops flanking the more resistant quartzite.

The dolomite is medium to dark gray, and is brecciated throughout. Locally it contains chert nodules that are resistant to weathering and form small proturberances from the surface of the rock.

White Dolomite Marble

A single outcrop of white dolomitic marble occurs as an inclusion within the granodiorite in the SW¼, NW¼, Sec. 11, T. 12 S., R. 7 W. Its area of exposure is about 60 square yards.

The carbonate grains are recrystallized and have a rough subhedral, interlocking appearance. They range in size from 0.1 to 0.7 mm. Polysynthethic twinning and rhombohedral cleavage are characteristic of the mineral grains. Garnet appears as a minor accessory. The apparent specific gravity of the carbonate is 2.845, indicating that the rock is almost pure dolomite.

Age of the dolomite has not been established.

Pleistocene System

Unconsolidated lacustrine sediments of Lake Bonneville surround the individual outcrops of Desert Mountain, and form remnant beach terraces, stacks, and bars of the receding lake. Several remnant terraces, such as those in the NE¼, Sec. 16, T. 12 S., R. 7 W., occur several hundred feet above the valley deposits.

IGNEOUS ROCKS

General Statement

The Desert Mountain intrusives are composed of a suite of igneous rocks that the writer believes to be differentiates of the same parent magma. Acidity of the various rock types generally increases with their normal order of crystallization. Igneous rocks, in their approximate order of crystallization, include granodiorite, adamellite (quartz monzonite), leucogranite porphyry, dellenite (quartz latite) porphyry, rhyolite porphyry, alaskite porphyry, and aplitic, lamprophyric, and pegmatitic dikes.

The main intrusives consist of a northwest trending granodiorite, flanked by leucogranite on the northeast and southwest. Occurring as inclusions within the leucogranite, and in small exposures on its margins, is an adamellite (quartz monzonite).

On the margins of the main phaneritic intrusives are several aphanitic porphyries of which rhyolite porphyry is the most prevalent. Alaskite porphyry is exposed in isolated outcrops adjacent to the leucogranite and rhyolite porphyry bodies. An outcrop of dellenite (quartz latite) porphyry flanks the granodiorite at one locality.

Cutting the leucogranite are numerous dikes which follow the trend of a prominent joint system, and include aplites, lamprophyres, and pegmatites. Aplitic dikes have an alaskite composition. Lamprophyres include odinite, odinite porphyry, and kersantite.

The following descriptions of igneous rock types are presented in their approximate order of crystallization.

Phaneritic Rocks

Granodiorite

Occurring in a northwest trending belt that crosses the entire area of study is a granodiorite, the oldest magmatic differentiate exposed. The granodiorite exposures, although discontinuous because of the Pleistocene lacustrine cover and subsequent intrusions, form a definite pattern about one and one half miles wide and five miles long. Outcrops occur in both towering peaks and low rolling hills. The contact with the granitic rocks to the northeast and southwest is usually sharp, but at some localities the two differentiates interfinger and are separated by a narrow alteration zone.

The black color of the granodiorite provides a sharp contrast with the light-colored granitic rocks which intrude it (Plate 2, fig. 2). Outcrops are usually resistant to weathering, although in the central part of the study area they have a relatively low relief. Hand samples of the rock are compact, and freshly fractured surfaces show no apparent alteration. The granodiorite is a fine-grained phanerite; the small size of the mineral grains have probably caused it to be called a quartzite at some localities. Megascopically discernible minerals include biotite, plagioclase, and epidote.

Although the granodiorite appears to be fine grained phaneritic in hand sample, it is actually microporphyritic. The percentage of phenocrysts determined by ten Rosiwal analyses averages 58.5. Phenocrysts range in size from 0.1 mm, to 3.0 mm, and average 1.2 mm. The groundmass is microcrystalline. Individual grains average 0.02 mm. and cannot be identified except for biotite. Microscopic examination reveals a hypautomorphic granular texture; but in some samples euhedral grains are totally lacking.

Essential minerals include plagioclase, quartz, and potassium feldspar. Plagioclase is present as euhedral to subhedral phenocrysts. Albite, Carlsbad, and pericline twinning are all present and well developed. Normal plagioclase zoning is conspicuous and well developed. The plagioclase variety is andesine, having an average composition of Ab_{56}, An_{44}. Quartz and potassium feldspar are subordinate and occur as subhedral to anhedral grains, which exhibit a high degree of resorption. Essential minerals are impossible to identify in the ground mass and the average mineral composition given is that of the phenocrysts.

Varietal minerals include biotite and hornblende. Hornblende is not always present and is subordinate to biotite. Biotite is highly pleochroic from medium green to dark green.

Accessory minerals include magnetite, zircon, and apatite, although the latter two minerals are rare and seldom seen in thin section.

Mineral trends within the granodiorite differentiate indicate that it is more basic to the northwest (Table 1). Magnetite and biotite show slight decreases to the southeast, while the percentage of anorthite in plagioclase shows a definite increase to the northwest, ranging from 36 percent at the southeast to 49 percent at the northwest.

An average of ten Rosiwal analyses (No. 1-10, table 1) indicates the following primary mineral composition:

K-feldspar	11.4%
Plagioclase	47.9%
Quartz	11.8%
Biotite	21.4%
Hornblende	1.4%
Magnetite	6.1%
Zircon	(Rare)
Apatite	(Rare)

Johannsen Classification —227 P—Granodiorite.

Secondary alteration occurs in varying degrees of intensity. Alteration products include sericite, albite, and calcite. Total alteration products range from one to fifteen percent.

Epidote occurs as a secondary introduction mineral in many samples, especially in those taken from near the granite contact.

Adamellite

Transitional in color and composition between the granodiorite and the leucogranite that intrudes it is an adamellite (quartz monzonite). It occurs as

TABLE 1
Mineral Composition of Igneous Rocks

Sample Number	Rock Type	Johannsen Number	Plag. % An.	K-spar.	Primary Minerals, percent by volume					
					Plag.	Qtz.	Bio.	Mus.	Horn.	Mag.
1*	Tgd**	227 P	49.0	11.8	48.7	8.7	27.7	....	....	3.1
2	Tgd	237'P	51.0	18.6	41.7	9.9	13.5	....	2.3	14.0
3	Tgd	227 P	49.0	8.3	46.9	17.1	19.1	....	....	8.6
4	Tgd	227 P	49.5	8.1	53.3	11.1	17.1	....	....	10.4
5	Tgd	227'P	42.0	12.7	39.1	16.3	29.5	....	....	2.4
6	Tgd	227'P	48.0	19.3	36.2	13.6	17.6	....	0.5	12.8
7	Tgd	227'P	42.0	13.4	43.6	13.6	25.8	....	3.6	64.5
8	Tgd	227 P	41.0	11.3	47.5	12.9	24.5	....	1.6	2.2
9	Tgd	227 P	37.0	12.7	57.8	9.3	17.8	....	....	2.3
10	Tgd	227 P	36.0	7.4	48.4	12.1	19.5	....	10.7	2.1
11	Tad	226'P	32.5	44.7	21.5	12.2	13.2	....	3.3	5.1
12	Tad	226'P	35.0	57.2	18.0	24.5	4.7	....	....	0.6
13	Tad	226'P	42.0	37.6	23.3	19.2	17.1	....	....	2.8
14	Tad	226'P	42.0	36.5	26.8	21.8	11.5	....	1.6	1.8
15	Tad	226'P	40.0	35.2	23.3	26.2	13.5	....	....	1.8
16	Tlg	126 P	33.5	58.0	16.0	23.0	2.0	....	....	1.0
17	Tlg	126 P	29.5	62.0	6.0	30.0	2.0	....	....	Tr
18	Tlg	226 P	32.0	58.0	12.0	25.0	4.5	....	....	0.5
19	Tlg	226'P	31.0	49.0	15.0	30.0	6.0	....	....	0.5
20	Tlg	226 P	28.5	69.0	6.0	20.0	5.0	....	....	Tr
21	Tlg	126'P	30.5	48.4	15.7	34.3	1.2	....	....	0.4
22	Tlg	126 P	33.0	66.9	8.2	22.6	1.2	....	....	1.1
23	Tlg	226'P	32.0	46.4	18.7	27.2	5.9	....	....	1.8
24	Tlg	126 P	29.0	55.0	15.0	27.0	2.5	....	....	0.5
25	Tlg	226 P	33.0	60.0	14.0	22.0	4.5	....	....	0.5
26	Tlg	226 P	38.0	60.0	15.0	19.5	5.0	....	....	0.5
27	Tlg	226 P	33.0	55.0	15.0	20.0	9.0	....	....	1.0
28	Tlg	226'P	35.0	54.5	17.0	20.0	7.5	....	....	1.0
29	Tlg	226'P	34.5	53.0	17.0	23.0	6.0	....	....	1.0
30	Tlg	226 P	35.5	54.0	14.0	21.5	5.0	....	....	0.5
31	Tlg	126 P	32.0	70.0	7.0	22.0	1.0	....	....	Tr
32	Tlg	126 P	33.0	60.0	8.0	29.5	1.5	....	....	1.0
33	Tlg	126 P	31.0	59.5	8.0	30.0	2.0	....	....	0.5
34	Tlg	126 P	30.0	50.5	5.6	40.4	1.5	....	....	0.8
35	Tlg	126 P	28.5	64.0	8.0	26.0	2.0	....	....	Tr
36	Tlg	126 P	30.5	57.0	12.0	30.0	1.0	....	....	Tr
37	Tdp**	227 E	33.0	21.5	32.1	21.7	3.4	....	11.3	10.0
38	Trp**	115 P	33.0	59.1	2.7	37.1	0.6	....	....	0.5
39	Trp	226'P	35.0	39.4	21.2	20.4	6.5	....	....	12.5
40	Trp	126 P	28.5	67.6	4.6	26.7	....	....	....	1.1
41	Trp	226 P	34.0	43.9	4.7	44.5	6.1	....	....	0.8
42	Trp	226 P	34.0	49.8	5.1	39.4	4.0	....	....	1.7
43	Trp	226 P	46.0	64.9	6.7	21.2	7.2	....	....	....
44	Trp	126 P	40.0	50.0	6.1	43.7	....	....	....	....
45	Trp	126 P	33.0	62.5	13.7	20.0	2.5	....	....	1.3
46	Trp	126 P	34.0	46.9	4.4	45.3	2.4	....	....	1.0

TABLE 1 (Continued)

47	Tap	116 P	8.0	64.7	4.7	22.7	....	0.8	....	2.1
48	Tap	116 P	....	73.7	7.9	17.6	....	0.8	....	....
49	Tap	116 P	8.0	62.4	8.0	26.7	....	0.5	....	0.7
50	Ta	116 D	5.0	55.3	5.3	37.9	....	0.7	....	0.8
51	Ta	116 D	5.0	76.6	8.0	15.4	....	....	....	....
52	Ta	116 D	3.0	66.8	5.7	25.1	0.9	1.5	....	....
53	Ta	116 D	6.0	56.2	11.1	32.7	....	....	....	....
54	Ta	116'D	2.0	60.2	21.8	17.3	0.7	....	....	....
55	Ta	116 D	6.5	61.5	5.0	31.5	1.0	....	....	1.0
56	Ta	116 D	6.0	64.3	5.5	27.1	1.6	1.5	....	....
57	Ta	116 D	2.0	55.5	13.1	30.7	0.4	....	....	0.3
58	Tod	2312 D	55.0	....	59.7	....	12.5	....	17.4	10.4
59	Tod	2312 D	54.0	....	54.8	....	2.8	....	35.3	7.1
60	Tod	2312 D	55.0	....	56.2	....	....	....	39.1	4.7
61	Tod	2312 D	55.0	....	74.3	....	....	....	19.8	5.9
62	Tod	2312 D	56.0	....	63.6	....	2.0	....	31.8	2.6
63	Tod	3312 D	55.0	....	43.7	....	....	....	46.6	9.7
64	Top	2312 D	56.0	....	62.7	2.0	5.2	....	25.3	4.8
65	Tk	2312 D	56.0	....	78.0	....	12.0	....	5.0	5.0

*Samples of any one rock type are listed from northwest to southeast (see Plate 1).
**Composition of phenocrysts only

Tgd— granodiorite
Tad— adamellite
Tlg— leucogranite porphyry
Tdp— dellenite porphyry
Tap— alaskite porphyry
Ta— alaskite
Tod— odinite
Top— odinite porphyry
Tk— kersanite
K-spar—potassium feldspar
Plag.— plagioclase
Qtz.— quartz
Bio.— biotite
Mus.— muscovite
Horn.— hornblende
Mag.— magnetite

inclusions within the leucogranite and in small outcrops on the northeast margin of the southwesternmost leucogranite exposure.

Wherever the granodiorite is in contact with the leucogranite, the contact is sharp and distinct with no indication of an adamellite transition zone, indicating that the adamellite exposures represent a separate phase of magmatic differentiation rather than an alteration zone due to the intrusion of a more acidic magma. When the adamellite is in contact with the leucogranite, the contact is sharp and distinct, like that of the leucogranite-granodiorite contact. Although the total area of adamellite exposed is relatively small, the writer believes that it represents a larger intrusion that has almost entirely been assimilated by the leucogranite differentiate.

The adamellite is a medium-gray phaneritic rock, which is fairly resistant to weathering. Biotite is the most conspicuous mineral in hand sample. Plagioclase can also be distinguished. When it occurs as inclusions, the adamellite often contains epidote pods surrounding limonite; examples of which are found to the west of the Desert Mountain-Delta road as it crosses Desert Mountain Pass.

Microscopically, the adamellite exhibits an even-grained to porphyritic, hypautomorphic granular texture, with from zero to thirty percent phenocrysts. The average size of the mineral grains in the groundmass is 0.7 mm. Phenocrysts, when present, are as large as 6.0 mm.

Essential minerals include potassium feldspar, plagioclase, and quartz. Potassium feldspar and quartz are prominent in the groundmass of porphyritic samples as subhedral to anhedral grains. Resorption of quartz grains is advanced.

Plagioclase grains are euhedral to subhedral, and occur as phenocrysts in the porphyritic samples. They display well developed albite, Carlsbad, and pericline twinning. Normal zoning is well developed, especially in the larger exposures. The plagioclase variety is andesine, with an average composition of Ab_{60} An_{40}.

The chief varietal mineral is biotite. Hornblende is present in minor amounts. Biotite pleochroism varies from light yellow-green to dark brown.

Magnetite and zircon are present as accessory minerals. Zircon occurs as minute euhedral crystals, which are light transparent tan in color, and are of two main types—(1) stubby with complex forms, (2) prismatic with simple and complex forms. They are free from inclusions and have no apparent surface staining (Odekirk, 1963, p. 19). Prismatic crystals are approximately 0.01 mm. thick and 0.02 to 0.20 mm. long. The stubby variety is dominant in the larger exposures, but both types are prominent in included outcrops like the one at Desert Mountain Pass.

An average of five Rosiwal analyses (No. 11-15, table 1) yields the following primary mineral composition:

K-feldspar	41.2%
Plagioclase	22.6%
Quartz	20.8%
Biotite	12.0%
Hornblende	1.0%
Magnetite	2.4%
Zircon	(Trace)

Johannsen Classification —226'P— Adamellite (Quartz Monzonite).

Secondary alternation minerals include sericite, calcite, and kaolinite. Alteration in the larger bodies is usually less than one percent, but varies from eight to twenty percent in the inclusions.

Epidote occurs as a secondary introduction mineral in the included outcrops and forms clusters surrounding limonite.

A lead-alpha age determination was made by Odekirk (1963) on a sample of the adamellite from Desert Mountain Pass, It was dated at 41 million years (Oligocene) and was considered by Odekirk to be contemporaneous with the leucogranite at the same locality.

Leucogranite Porphyry

Intruding the granodiorite and adamellite differentiates is a light-colored granite which forms the majority of the prominent peaks in the Desert Mountain area. The granite outcrops in two northwest trending belts, which lie to either side of the granodiorite. The outcrops are not continuous but are isolated by Pleistocene lake sediments. Isolation of the outcrops is probably due to faulting that parallels the trend of the two prominent joint sets cutting the granite. Outcrops are most prominent at Desert Mountain Pass and at the peaks in the southwest part of the area. At Desert Mountain Pass, granite cliffs tower 2,300 feet above the lake sediments.

The granite-granodiorite contact is very distinct at most locations. In some areas however, such as the SE¼, Sec. 13, T. 12 S., R. 7 W., leucogranite and granodiorite interfinger and are separated by an alteration zone that varies from a few feet to 25 feet in thickness. At such locations its is impossible to tell the relative age of the two instrusives and they must be considered contemporaneous. Where sharp distinct contacts occur, apophyses from the granite pluton intrude the granodiorite. At the high peak to the west of Desert Mountain Pass the granite-granodiorite contact is sharp and the granite surrounds a large body of granodiorite. The dip of the granite-granodiorite contact is 65-80 degrees away from the included granodiorite.

The leucogranite has typical granitic weathering and occurs in rounded, crumbly outcrops. Weathering is less conspicuous on the chilled margins of the intrusive. The joint pattern has been accentuated by weathering along the joint sets. Megascopically, the rock appears light gray to white with prominent pink euhedral feldspar phenocrysts. Quartz, plagioclase, and biotite can be distinguished in the groundmass. Quartz also occurs as phenocrysts. Its color varies from smoky to clear. Brown hydrothermal staining is typical of the granite to the west of Desert Mountain Pass.

The microscopic texture of the leucogranite is hypautomorphic granular with a porphryitic interrelationship between mineral grains. Phenocrysts range in size from 3.0 to 15.0 mm and comprise as much as 40 percent of the rock. The groundmass is phaneritic with an average grain size of 1.6 mm. Rocks from the chilled margins of the granite have a porphryritic texture with an aphanitic groundmass. Phenocrysts range in size from 0.2 mm to 9.0 mm and comprise an average of 55.5 percent of the rock. The average grain size of the groundmass is 0.03 mm.

Essential minerals, in the order of their importance, are potassium feldspar, quartz, and plagioclase. Potassium feldspar is present as euhedral pink phenocrysts, but is also prominent in the groundmass. Carlsbad twinning is almost always present in the larger feldspar crystals. The crystals are microperthitic, the albite intergrowths occuring as thin stringers that comprise about 20 percent of the crystal. Quartz is smoky to clear and occurs as subhedral to anhedral grains in the groundmass and euhedral to subhedral grains when present as phenocrysts.

Undulatory extinction is typical of the quartz grains, especially of the smoky variety. Resorption of quartz and feldspar is common at the periphery of the intrusion.

Plagioclase is present as anhedral grains in the groundmass. Albite and Carlsbad twinning are common, as is normal plagioclase zoning. The plagioclase variety is andesine with an average composition of Ab_{68} An_{32}. Zoning within individual plagioclase grains is as much as 5.5 percent anorthite.

The only prominent varietal mineral is biotite which is usually present in quantities of less than five percent. It is strongly pleochroic from nearly colorless to medium green. Biotite is intimately associated with small amounts of magnetite and zircon, which are the only important accessory minerals.

Zircon is common throughout the leucogranite and occurs as minute euhedral crystals of an essential uniform length of 0.1 mm. Simple and complex forms are present. Crystals are light transparent tan with no surface staining or inclusions (Odekirk, 1963, p. 19).

The following primary mineral composition is the average of 18 samples (No. 16-33, table 1):

K-feldspar	57.8%
Plagioclase	12.6%
Quartz	24.9%
Biotite	4.0%
Magnetite	0.7%
Zircon	(Trace)
Sphene	(Trace)

Johannsen Classification —126 P— Leucogranite Porphyry.

Alteration products include sericite, calcite, and kaolinite. Alteration is greatest at the margin of leucogranite where the total alteration products comprise an average of 7.0 percent of the rock. In the center of the intrusive, the amount of alteration varies from 1.5 to 2.5 percent of the total primary minerals. Weathering is greater in the central areas of the leucogranite where the texture is coarser.

Odekirk (1963) dated a sample of leucogranite from Desert Mountain Pass by the lead-alpha method, and obtained a figure of 36 million years. Considering the 10 million year margin of error of the lead-alpha method for samples that are less than 100 million years old, the age of intrusion could range from Oligocene to Miocene.

Aphanitic Rocks

Dellenite Porphyry

On the southeast margin of the granodiorite (NE¼, Sec. 31, T. 12 S., R. 6 W.), is a small outcrop of dellenite (quartz latite) porphyry, which appears to be of a different origin than the rhyolite porphyry which nearly surrounds it. Similar bodies that are entirely included by the rhyolite porphyry occur just to the north of the main dellenite porphyry outcrop. These inclusions, unlike the main outcrop, are highly altered.

The color of the dellenite porphyry varies from dark purple to black. Its texture is porphyritic with an aphanitic groundmass. Plagioclase is the only megascopically discernible mineral. In the main exposure the rock is compact and fairly resistant to weathering. The inclusions, however, are highly altered and weather easily.

Microscopically, the rock displays a xenomorphic granular texture with a porphyritic interrelationship between the mineral grains. Phenocrysts range in size from 0.3 to 5.0 mm. The average grain size of the groundmass is 0.01 mm. Phenocrysts comprise 32 percent of the rock. The only identifiable minerals in the groundmass are biotite and hornblende.

Potassium feldspar, plagioclase, and quartz comprise the essential minerals and can be distinguished only when present as phenocrysts. Potassium feldspar is microperthitic and is highly altered.

Hornblende is the chief varietal mineral and occurs in the groundmass and occasionally as phenocrysts. Biotite occurs only in the groundmass.

The only discernible accessory mineral is magnetite, which occurs both as phenocrysts and in the groundmass.

Explanation of Plate 2

FIELD AND AERIAL VIEWS OF ROCKS IN THE DESERT MOUNTAIN AREA

Fig. 1.—Quartzite inclusion in rhyolite porphyry in NW$\frac{1}{4}$, NE$\frac{1}{4}$, Sec. 32, T. 12 S., R. 6 W.

Fig. 2.—Granite-grandiorite contact in SW$\frac{1}{4}$, Sec. 36, T. 12 S., R. 7 W.

Fig. 3.—Odinite dike cutting leucogranite in NW$\frac{1}{4}$, NW$\frac{1}{4}$, Sec. 27, T. 12 S., R. 7 W.

Fig. 4.—Aerial photograph showing jointing pattern in leucogranite in Secs. 21, 22, 27, 28, T. 12 S., R. 7 W.

PLATE 2


1


2


3


4

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The following primary mineral composition is that of the phenocrysts in a typical example:

K-feldspar	21.5%
Plagioclase	32.1%
Quartz	21.7%
Biotite	3.4%
Hornblende	11.3%
Magnetite	10.0%

Johannsen Classification —277'E/227'P— Dellenite (Quartz latite) Porphyry.

Feldspar alteration is advanced and yields sericite, calcite, and kaolinite as secondary alteration minerals. Total alteration products range from five percent in the main exposure to fifteen percent in the inclusions.

Rhyolite Porphyry

Outcropping on the eastern margin of the main igneous intrusives is a shallow intrusive and/or extrusive with approximately the same mineral composition as that of the leucogranite. Its texture, however, is porphyritic with an aphanitic groundmass; and for this reason, it has been called a rhyolite porphyry. Evidence that the rhyolite porphyry is extrusive, aside from its aphanitic groundmass, is totally lacking. On the other hand, it may be safely called a shallow intrusive at most localities south of the Jericho-Callao road because it contains numerous inclusions and roof pendants of Precambrian metasediments.

The trend of the outcrop is north by northwest. On its western margin, the rhyolite is in contact from north to south with the alaskite porphyry, leucogranite porphyry, adamellite, granodiorite, and dellenite porphyry differentiates. All contacts are sharp and show no indication of an alteration zone. Flow structure was not observed in any of the exposures.

Inclusions range in size from a few millimeters to several acres. The large quartzite roof pendants are extremely resistant to weathering and cap rugged peaks; the slopes of which are composed of the less resistant rhyolite porphyry.

Outcrops of rhyolite porphyry are relatively compact when protected by the resistant quartzite but form a subdued topography when protective quartzite caps are absent. The southern Allison Knolls are the prime example of this type of topography.

The color of the rock ranges from pink to light greenish gray. Its texture is porphyritic with an aphanitic groundmass. Megascopically identifiable minerals are quartz and potassium feldspar. Inclusions are prominent in most exposures south of the Jericho-Callao road (Plate 2) and include quartzite, argillite, granodiorite, and dellenite porphyry. To the north of the Jericho-Callao road, the number of smaller inclusions diminishes, and the rock becomes less porphyritic and lighter in color.

Microscopic examination reveals that the groundmass of the rhyolite porphyry is microcrystalline. Phenocrysts are almost always anhedral; but, occasionally, subhedral crystal outlines can be distinguished. Rosiwal analyses indicate that the average amount of phenocrysts present is 42 percent. This percentage is fairly consistent in all samples.

Essential minerals include potassium feldspar, plagioclase, and quartz Potassium feldspar is highly altered and occurs in anhedral to subhedral grains.

Carlsbad twinning and microperthitic intergrowths are sometimes present, but are not common. Quartz is usually angular or resorbed, but occasionally occurs as subhedral grains. Some quartz grains appear to be shattered and could indicate movement of a partially cooled magma.

Plagioclase grains are highly altered and obscure. Albite twinning and normal plagioclase zoning can be seen in some grains. The plagioclase variety is andesine with an average composition of Ab_{65} An_{35}.

Biotite is the only varietal mineral. It is strongly pleochroic from nearly colorless to medium green.

Intimately associated with biotite are accessory minerals, which include magnetite, and rarely, zircon.

The following primary mineral composition is the average of nine Rosiwal analyses (No. 38-46, table 1).

K-feldspar	53.8%
Plagioclase	7.7%
Quartz	33.1%
Biotite	3.3%
Magnetite	2.1%
Zircon	(Rare)

Johannsen Classification —226 P— Rhyolite Porphyry.

The percentage of melanocratic minerals present is less than five percent in approximately one half of the samples analyzed (see Table 1). Therefore, the name leucorhyolite porphyry might be more appropriate.

Alteration products include sericite, calcite, and kaolinite. Alteration is advanced and varies from five to ten percent of the total mineral content.

The only mineral trend that was observed within the exposed rhyolite is a slight decrease in the percentage of plagioclase to the north (Table 1).

Alaskite Porphyry

At several isolated outcrops on the perimeter of the leucogranite and rhyolite differentiates, a white alaskite porphyry is exposed. Outcrops occur just to the north of the Jericho-Callao road in Secs. 6 and 7, T. 12 S., R. 6 W., and in the northern parts of Secs. 15 and 16, T. 12 S., R. 7 W. At the latter location, the alaskite is separated from fine-grained leucogranite by a high Pleistocene lake terrace. The alaskite porphyry outcrop exposed to the north of the Jericho-Callao road is in contact with rhyolite on its eastern margin. The contact is sharp and no alteration zone is apparent.

Outcropping alaskite porphyry is fairly resistant to weathering, and is compact in hand sample. Quartz and potassium feldspar are visible megascopically. Brown staining partially masks the otherwise white color of the rock.

The alaskite is porphyritic in all exposures, but the groundmass varies from phaneritic to aphanitic. When a specimen has a phaneritic groundmass, the microscopic texture is usually hypautomorphic granular; but few euhedral grains are present in samples having an aphanitic groundmass. The size of the grains in the groundmass ranges from 0.02 to 0.08 mm in aphanitic specimens and 0.1 to 1.0 mm in phaneritic specimens. Phenocrysts range in size from 0.2 to 5.0 mm in specimens of both textures.

Essential minerals are potassium feldspar, quartz, and plagioclase. Potassium feldspar occurs both as euhedral to subhedral phenocrysts, and as anhedral grains in the groundmass. It has a white megascopic color, and had both microperthitic and micropegmatitic intergrowths. Quartz occurs as unaltered but partially resorbed phenocrysts, and as anhedral grains in the groundmass.

Plagioclase grains occur only in the groundmass. They exhibit both Carlsbad and albite twinning. Reverse zoning is present in some specimens. The plagioclase variety is albite, with an average composition of Ab_{95}, An_5.

Muscovite is the only varietal mineral. Accessory minerals include magnetite and traces of zircon and hematite.

The following primary mineral composition is the average of three Rosiwal analyses (No. 47-49, table 1):

K-feldspar	62.4%
Plagioclase	8.0%
Quartz	26.7%
Muscovite	0.5%
Magnetite	0.7%
Hematite	(Trace)
Zircon	(Trace)

Johannsen Classification —116 P— Alaskite Porphyry.

Feldspar alteration is advanced forming sericite, calcite, and kaolinite, which are present in amounts up to eight percent of the total mineral content. Magnetite alters to limonite, resulting in a brown stain that partially masks the white color of the rock.

The composition of the alaskite porphyry is almost identical to that of the aplitic alaskite dikes which intrude the leucogranite. The two units are probably of the same derivation and represent a late stage of magmatic differentiation.

Dikes

Alaskite Dikes

Throughout the leucogranite exposures are alaskite dikes that vary in thickness from one inch to nearly 30 feet. The larger dikes usually parallel the trend of the jointing pattern, but are discontinuous and cannot be traced for more than a few hundred feet. The dikes are found only within the leucogranite and adamellite exposures and are most common in the southwestern exposures of leucogranite where sheet jointing is best developed. Granite-alaskite contacts are always sharp and show no indication of an alteration zone.

The white, sugary textured alaskite dikes are fairly compact and unaltered. Megascopically discernible minerals include quartz, biotite, and muscovite.

Microscopic examination reveals an even-grained, xenomorphic granular texture, which accounts for the sugary megascopic appearance. Individual grains vary in size from 0.1 to 4.0 mm and average 0.7 mm.

Potassium feldspar, quartz, and plagioclase are the primary essential minerals. Potassium feldspar grains occassionally contain microperthitic and micropegmatitic intergrowths.

The plagioclase variety is albite with an average composition of Ab_{96} An_4. Individual grains usually exhibit albite twinning. Normal plagioclase zoning is rarely present.

Varietal minerals include biotite and muscovite. Both may be present in the same sample. Biotite is strongly pleochroic from nearly colorless to pale yellow-green.

The only accessory mineral is magnetite.

The following primary mineral composition is the average of eight Rosiwal analyses (No. 50-57, table 1):

K-feldspar	62.1%
Plagioclase	9.4%
Quartz	27.2%
Muscovite	0.4%
Biotite	0.6%
Magnetite	0.3%

Johannsen Classification —116 D— Alaskite.

The composition of the alaskite dikes is essentially the same as that of the larger alaskite porphyry bodies. Both probably originated from the same late magmatic differentiate.

Secondary alteration is minor, yielding sericite, calcite, and kaolinite in amounts of less than two percent.

A slight increase in the melanocratic minerals occurs in the alaskite dikes to the southeast. The percentage of muscovite increases slightly to the northwest (Table 1).

Pegmatite Dikes

Small poorly developed pegmatite dikes are present in all parts of the leucogranite. They are often parallel, and sometimes gradational to the alaskite dikes. The pegmatites are composed mainly of quartz but occasionally have border zones containing perthite and muscovite. Their thickness is usually less than six inches.

Pegmatites also intrude the Precambrian quartzites. Traces of gold and silver are present in these exposures.

Lamprophyre Dikes

Intruding the leucogranite along zones of weakness parallel to the prominent jointing system are numerous lamprophyre dikes. Although kersantite dikes are rarely present, the dominant lamprophyre rock type is odinite.

Odinite.—Odinite dikes are present in all isolated leucogranite exposures, with the exception of the large granite outcrop to the west of Desert Mountain Pass. Like the alaskite dikes, however, they are more numerous in the southwestern granitic exposures. Both jointing directions are paralleled by odinite dikes.

Their thickness varies from one foot to 25 feet. Several dikes are continuous for more than one mile. The largest odinite dike is 25 feet thick and one and one half miles long, trending N. 49° E. across sections 27, 28, 22, 23, T. 12 S., R. 7 W. It has an average dip of 70° to the northwest (Plate 2, fig. 3).

Resistant odinite dikes usually form ridges in the granite exposures. The black color of the aphanitic rock makes megascopic mineral identification difficult. Only hornblende and pyrite can be distinguished.

Microscopic examination reveals a slightly porphyritic, hypautomorphic granular texture. Plagioclase laths in the groundmass have a felty appearance. The average grain size is 0.3 mm, but hornblende phenocrysts as long as 3.0 mm are common.

The only primary essential mineral is labradorite, which occurs as anhedral to subhedral grains in the groundmass, ranging in size from 0.07 to 0.3 mm. It has an average composition of Ab_{45} An_{55}. Albite twinning is present but is poorly developed. Normal plagioclase zoning was observed in a few grains.

Hornblende is the chief varietal mineral and occurs as euhedral to subhedral phenocrysts and in the groundmass. Its grain size varies from 0.07 to 3.0 mm. Pleochroism, from light to medium brown, is typical of the hornblende grains. Biotite is also present in minor amounts.

The only accessory mineral is magnetite, which is usually present in amounts greater than five percent.

The primary mineral composition indicated by the average of five Rosiwal analyses (No. 58-62, table 1) is as follows:

Plagioclase	61.7%
Biotite	3.5%
Hornblende	28.7%
Magnetite	6.1%
Pyrite	(Trace)

Johannsen Classification —2312 D— Odinite.

Secondary alteration of plagioclase yields albite, sericite, and calcite, in amounts of less than three percent. Introduced minerals include calcite and epidote.

Odinite Porphyry.—A single odinite porphyry dike trends N. 57° E. across Sec. 13, T. 12 S., R. 7 W., and dips 60° to the northwest. It is displaced by a fault at Desert Mountain Pass, but is otherwise continuous for a distance of about one half mile. Its maximum thickness is 20 feet. A two-foot wide chill zone usually flanks the dike on either side.

The dike is fairly resistant to weathering; hand samples are compact and unaltered. It has a coarse-grained porphyritic texture with a light-gray phaneritic groundmass. Minerals that can be identified visually are biotite, hornblende, and plagioclase.

Mineral grains are subhedral to anhedral. Phenocrysts vary in size from 1.0 to 10.0 mm. The average grain size in the groundmass is 1.0 mm.

Plagioclase is the only primary essential mineral, occuring both as phenocrysts and in the groundmass. The plagioclase variety is labradorite, with a composition of Ab_{44} An_{56}. Albite and Carlsbad twinning are present, but are poorly developed. Potassium feldspar and quartz are frequently present as remnants of the intruded granite.

Hornblende is the chief varietal mineral and occurs both as phenocrysts and in the groundmass. Biotite is also present but is subordinate to hornblende.

The only accessory mineral is magnetite.

A typical example has the following primary mineral composition:

Plagioclase	62.7%
Hornblende	25.3%
Biotite	5.2%
Magnetite	4.8%
Quartz	2.0%

Johannsen Classification —2312 D–– Odinite Porphyry.

Calcite, sericite, and albite are present as alteration products of plagioclase.

Kersantite.—Kersantite dikes, in which biotite is the chief varietal mineral, are present at a few localities. They are similar in occurrence and appearance to the odinite dikes. The only megascopic difference is that the color of the kersantite dikes is light gray to green, rather than dark green to black.

A typical sample has the following primary mineral composition:

Plagioclase	78.0%
Biotite	12.0%
Hornblende	5.0%
Magnetite	5.0%

Johannsen Classification —2312 D— Kersantite.

Plagioclase alteration is advanced, forming calcite, sericite, and kaolinite in amounts up to ten percent.

SUMMARY OF IGNEOUS GEOLOGY

Area of Exposure

Areas of exposed igneous rocks in the study area are listed in Table 2. Their total area of exposure is twelve and one half square miles. This figure is, perhaps, misleading since individual outcrops are surrounded by Pleistocene lake sediments. Within the perimeter of the igneous outcrops, lacustrine sediments are probably a thin veneer covering additional igneous rocks. If the veneer were removed, the area of exposure would probably be doubled.

TABLE 2
Areas of Igneous Rock Exposed

Rock Type	Area (sq. mi.)	Area (Acres)	Area (%)*
Granodiorite	4.24	2715	33.8
Adamellite	0.11	70	0.9
Leucogranite Porphyry	4.24	2710	33.8
Dellenite Porphyry	0.07	43	0.5
Rhyolite Porphyry	3.73	2387	29.8
Alaskite Porphyry	0.13	83	1.0
Alaskite	0.01	7	0.1
Odinite (Porphyry)	0.01	7	0.1
Totals	12.54	8022	100.0

*Percent of total area of exposure

Depth of Emplacement

The igneous intrusives in the previous descriptions all probably solidified in the epizone of the earth's crust, but direct evidence of the magnitiude of depth is unavailable because sedimentary rocks have been completely stripped away except for inclusions and roof pendants in the shallower intrusives. Since the texture of the aphanitic rocks indicate that they cooled rapidly, they probably solidified on the margin of the main intrusives where the loss of volatiles could also have facilitated crystallization. The phaneritic texture of the granodiorite and leucogranite porphyry does not necessarily indicate that they cooled at a greater depth than the aphanitic porphyries. It is more probable that the leucogranite and granodiorite owe their coarse-grained texture to the fact that they crystallized in a relatively thick igneous body rather than to the insulating properties of overlying sedimentary rocks.

The rhyolite porphyry is almost certainly shallow intrusive in origin, as is indicated by the following evidence:

1. The groundmass is microcrystalline.
2. Phenocrysts are subhedral to anhedral; quartz is often angular.
3. Inclusions and roof pendants of Precambrian metasediments are numerous.
4. Flow structure was not observed in any of the rhyolite porphyry outcrops, indicating that it is not of extrusive origin.

Relative Age

Field relationships between the intrusive differentiates partially indicate their relative order of crystallization. A summary of the field criteria used to establish their genetic relationship is as follows:

1. Granodiorite: the granodiorite does not intrude any of the other igneous rocks.
2. Adamellite: Inclusions of adamellite are present in the leucogranite, which intrudes the granodiorite.
3. Leucogranite Porphyry: Inclusions of granodiorite and adamellite are present within the leucogranite. Leucogranite dikelets intrude the granodiorite.
4. Dellenite Porphyry: Exposures are present on the margin of the granodiorite intrusive as inclusions within rhyolite porphyry.
5. Rhyolite Porphyry· The rhyolite porphyry body contains inclusions of granodiorite, dellenite porphyry, adamellite, and quartzite.
6. Alaskite Porphyry: Alaskite porphyry is present on the margin of the leucogranite. It appears to intrude the rhyolite porphyry.
7. Alaskite: Alaskite dikes cut the adamellite and leucogranite intrusives.
8. Pegmatite: Pegmatites cut the leucogranite exposures. They often parallel, and occasionally grade laterally into alaskite dikes.
9. Lamprophyre: Lamprophyre dikes intrude the leucogranite parallel to the jointing system. They occasionally intrude along the same joints as did alaskite dikes and contain alaskite inclusions. Post magmatic hydrothermal solutions have mineralized a lamprophyre dike at the Rockwell shaft, thus linking the lamprophyres with the other differentiates.

The following genetic sequence can be definitely established from cross-cutting relationships:

1. Granodiorite
2. Leucogranite Porphyry
3. Alaskite Dikes
4. Pegmatite Dikes
5. Lamprophyre Dikes

In addition, the position of the adamellite, dellenite porphyry, and rhyolite porphyry can be partially established.

The adamellite occurs as inclusions within the leucogranite and rhyolite porphyries, thus establishing that it is older than these two rocks. Its relationship to the granodiorite, however, has not been established by field evidence.

The dellenite porphyry occurs as inclusions within the rhyolite porphyry, indicating that it is older. Its relationship to older igneous rocks has not been established.

The rhyolite porphyry is definitely younger than the granodiorite, dellenite, and adamellite, but its relationship to younger rocks has not been established.

The mineral composition of the rhyolite and leucogranite is almost identical, indicating that the two differentiates may be related.

The alaskite porphyry bodies have the same composition as the alaskite dikes. Both are considered by the writer to be late magmatic differentiates of the residual magma.

The genetic sequence of rock types established by cross-cutting relationships shows a definite increase in acidity. Rock types that can be partially placed in sequential order on the basis of cross-cutting relationships can be further defined on the basis of their activity. The following sequential order seems most likely.

1. Granodiorite
2. Adamellite
3. Leucogranite Porphyry
4. Dellenite Porphyry
5. Rhyolite Porphyry
6. Alaskite and Alaskite Porphyry
7. Pegmatite Dikes
8. Lamprophyre Dikes

Absolute Age

The two lead-alpha age determinations made by Odekirk (1963) are the only ones available in the Desert Mountain area. Adamellite from an inclusion in the leucogranite at Desert Mountain Pass was dated at 41 million years. Leucogranite from the same locality was dated at 36 million years. However, the precision of the lead-alpha method on rocks younger than Cretaceous is ten million years (Gottfried, *et al.,* 1959, p. 57), and the age of intrusion could vary from Oligocene to Miocene.

STRUCTURE

Structural Trend

The structural trends present in the Desert Mountain intrusives are essentially parallel to those of the Sheeprock Mountains to the north. The N. 37° W.

trend of the Sheeprock granite closely compares to the N. 31° W. trend of the Desert Mountain leucogranite and granodiorite. Jointing patterns within the two granitic bodies are also approximately parallel.

Faulting

Structural relationships between different areas of the Desert Mountain intrusives are difficult to ascertain because of the absence of stratified rocks and the separation of topographic units by Pleistocene lake sediments. Within the study area, direct evidence of faulting is limited to two locations.

In the NE$\frac{1}{4}$, NW$\frac{1}{4}$, Sec. 27, T. 12 S., R. 7 W., a N. 49° E. trending lamprophyre dike is displaced 150 feet in a horizontal plane. If fault movement is assumed to be essentially vertical, the throw of the fault is approximately 250 feet. The trend of the fault probably parallels the N. 31° W. trending joint set.

Another lamprophyre dike, located in SE$\frac{1}{4}$, NW$\frac{1}{4}$, Sec. 13, T. 12 S., R. 7 W., appears to have been faulted. Horizontal displacement of the N. 57° W. trending dike is about 480 feet. The maximum throw of the fault is 810 feet.

Faulting probably occurs at numerous places along the joint sets, as is indicated by the trend of the granite-alluvium contact (Plate 2, fig. 4). Isolation of the separate topographic units is almost certainly structurally controlled.

Jointing

Two prominent joint sets are present in the leucogranite and are especially pronounced in the southwestern most exposure (Plate 2, fig. 4). They trend N. 31° W. (dipping 45-65° W.), and N. 49° E. (dipping 60-80° N.), forming a conjugate pattern which is emphasized by weathering along the joints. Lamprophyre dikes have frequently intruded along these zones of weakness.

ECONOMIC GEOLOGY

General Statement

Post-magmatic mineralization has resulted in small mineral deposits in the southwestern exposures of the leucogranite. The deposits are of three main types: (1) copper mineral veins, (2) hematite veins, (3) fluorite-barite veins. Although a number of prospects are present in the area, the only one that has been developed is the Rockwell claim.

Copper Mineral Veins

Copper mineralization is concentrated along a sheeted fissure zone that strikes N. 5° E. and dips 60° W. Mineralization is discontinuous and is evident at only a few locations along the trend of the fissure zone. The fissure zone is about two miles long and cuts through the western parts of Secs. 16, 21, 28; T. 12 S., R. 7 W. Several prospects along the trend of the fissure zone have yielded hematite and malachite; but the only major development has been at the Rockwell claim, which is located in the NW$\frac{1}{4}$, NW$\frac{1}{4}$, Sec. 28, T. 12 S., R. 7 W.

The Rockwell claim is the southernmost of 15 unpatented, contiguous claims, which are part of the Deseret Mountain Mining District. At the Rockwell claim, the mineralized vein strikes N. 10° W., and dips 60° W. It is probed by an inclined shaft to a depth of about 300 feet. The copper-stained vein is from two to six feet wide at the surface, and extends at least 50 feet south of the shaft where it is covered by mine tailings. Mineralization is not evident at the surface in the granite cliffs to the north of the shaft, and Pleistocene lake sediments conceal any southern continuation of the vein.

Loughlin (in Butler *et al.,* 1920, p. 445) described the upper part of the vein as follows:

> The inclined shaft is said to be 235 feet deep and to follow the vein along its dip for almost the entire distance, but it was accessible to a depth of only about 100 feet. The width of the vein through this distance varies considerably. At one place the sheets of granite between close parallel fissures are impregnated and strongly stained with the blue silicate or green carbonate to a thickness of 3 to 4 feet; at another, mineralization is limited to a few streaks of the silicate or carbonate along the hanging wall of the fissure zone. At no place is replacement of the granite very pronounced, and the average copper content can not be much, if any, over 5 percent. The bottom of the shaft cuts a diabase dike which is said to lie along the footwall of the vein. Fragments of this diabase on the dump are mineralized, proving the dike to be older than the vein.
>
> The primary ore is chalcopyrite in large and small irregular grains partly altered to brownish-black iron oxide, accompanied by a little pyrite in small irregular grains. It occurs both in fissure fillings and in grains impregnating the granite and diabase. The gangue minerals are quartz and barite, which fill cavities and impregnate the wall rock for an inch or two, so that no sharp line can be drawn between vein and wall. The texture of the impregnated granite is preserved, but its feldspars and biotite are completely replaced by aggregates of microscopic sericite, quartz, and sulphides. Secondary minerals are brownish-black iron oxide, which marks the former presence of chalcopyrite in partly or wholly leached rock, and chrysocolla, which with malachite and secondary quartz fills veinlets cutting all the minerals of veins and wall alike, including the brownish-black iron oxide. The secondary quartz, either as minute glassy crystals or as chalcedony, continued to be deposited even after the copper silicate and carbonate.
>
> The whole shaft is above water level, but the downward leaching of the ore is far from complete. Chalcopyrite can be found close to the surface, and considerable leaching, to judge from mineralized diabase fragments on the dump, has taken place at the bottom of the shaft. Chrysocolla and malachite are distributed all along the shaft and drift walls and show no special tendency to concentrate into bunches of high-grade ore.

The main vein is said to cut a smaller hematite vein at about 300 feet. Silver contents at this point were as high as 30 ounces per ton. Abandonment of the workings at the 300 feet level was forced because of flooding mine waters (James O'Brien, 1966, personal communication).

Assessment work for the year 1967 had been done at the 125 foot level.

Hematite Veins

Small hematite deposits are scattered throughout the leucogranite exposures, but the only one of significant size occurs on the abandoned Rattlesnake claims in the SE$\frac{1}{4}$, SE$\frac{1}{4}$, Sec. 21, T. 12 S., R. 7 W.

Here, a hematite vein trends N. 6° W. and dips 30° W. At the surface, the width of the vein varies from several inches to two feet. The length of the vein, parallel to its trend, is about 500 feet; but mineralization is discontinuous and totals less than 150 feet.

The vein is composed predominantly of specular to massive hematite; but small amounts of malachite are present, indicating that the vein may be related at depth to the hematite vein at the 300 foot level of the Rockwell shaft.

Fluorite-Barite Veins

A single fluorite-barite vein is located in the NW¼, SW¼, Sec. 27, T. 12 S., R. 7 W. The outcrop of the vein is only about 50 feet long; its maximum width is two feet. This essentially vertical vein trends N. 31°W., following the dominant jointing direction. The white, opaque barite is cut by thin stringers of light purple to clear fluorite.

Future of the District

The absence of suitable sedimentary host rocks containing possible replacement deposits is the limiting factor of the economic importance of the mineral deposits in the Desert Mountain Mining District. Erosion of the granite is deep, and sedimentary rocks have been completely stripped away. Possible sedimentary rocks on the periphery of the intrusion are concealed by Pleistocene lake sediments. Known mineral deposits are fissure fillings and are presently uneconomical because of their small size and remote location.

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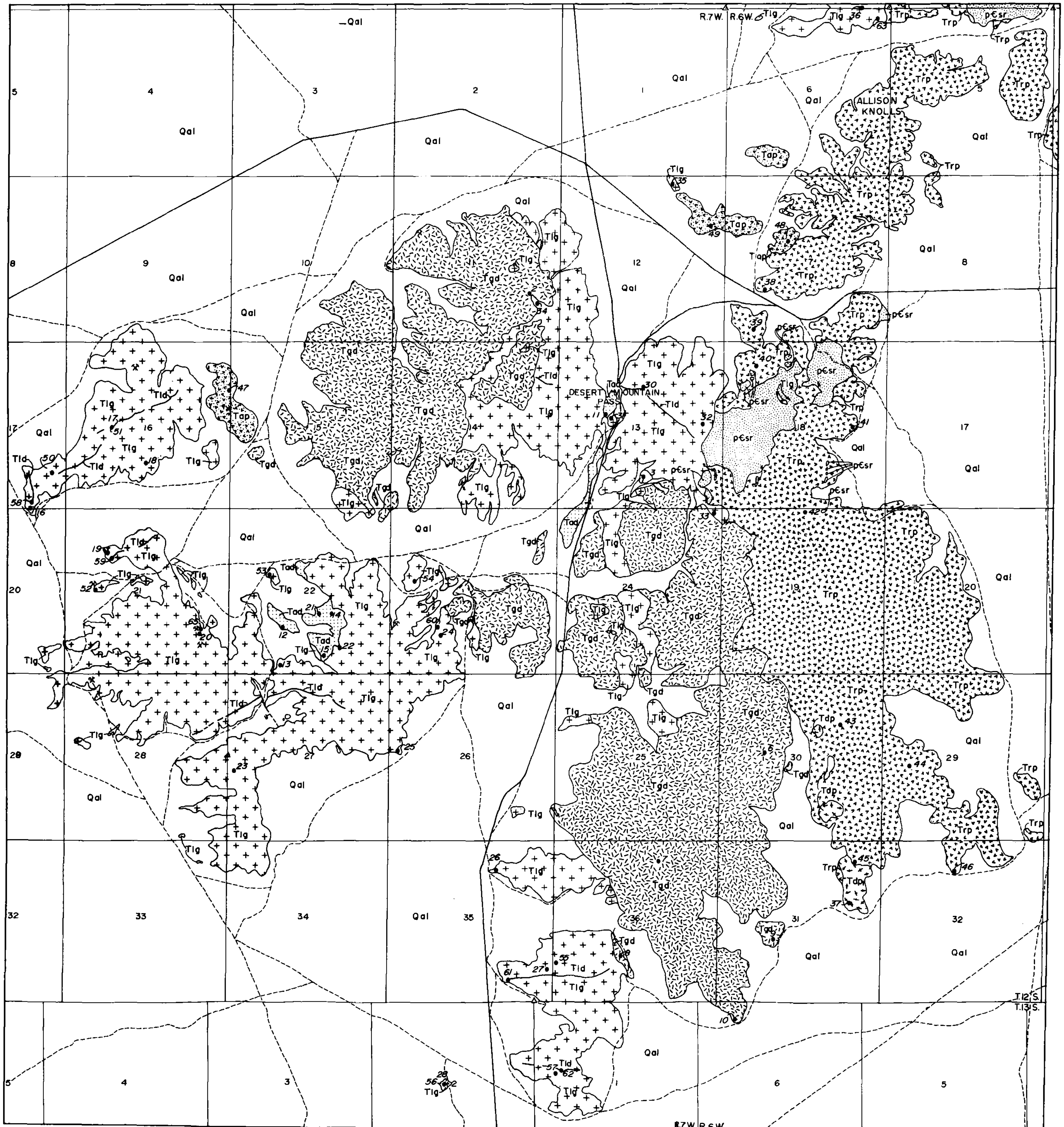

EXPLANATION

SEDEMENTARY ROCKS

QUATERNARY SYSTEM

Qal ALLUVIUM

PRECAMBRIAN(?) SYSTEM

p€sr QUARTZITE (SHEEPROCK SERIES)

IGNEOUS ROCKS (TERTIARY)

Tld LAMPROPHYRE DIKES

Tap ALASKITE PORPHYRY

Tlg LEUCOGRANITE PORPHYRY

Trp RHYOLITE PORPHYRY

Tad ADAMELLITE

Tdp DELLENITE PORPHYRY

Tgd GRANODIORITE

SYMBOLS

GEOLOGIC CONTACTS

FAULTS

SAMPLE LOCATION

SECTION CORNER CONTROL

MAIN ROADS

DIRT ROADS

SCALE

MILES

0.5 0 0.5 1.0

MAGNETIC DECLINATION

16°

TRUE NORTH

MAGNETIC NORTH

DONALD F. KATTELMAN

1967