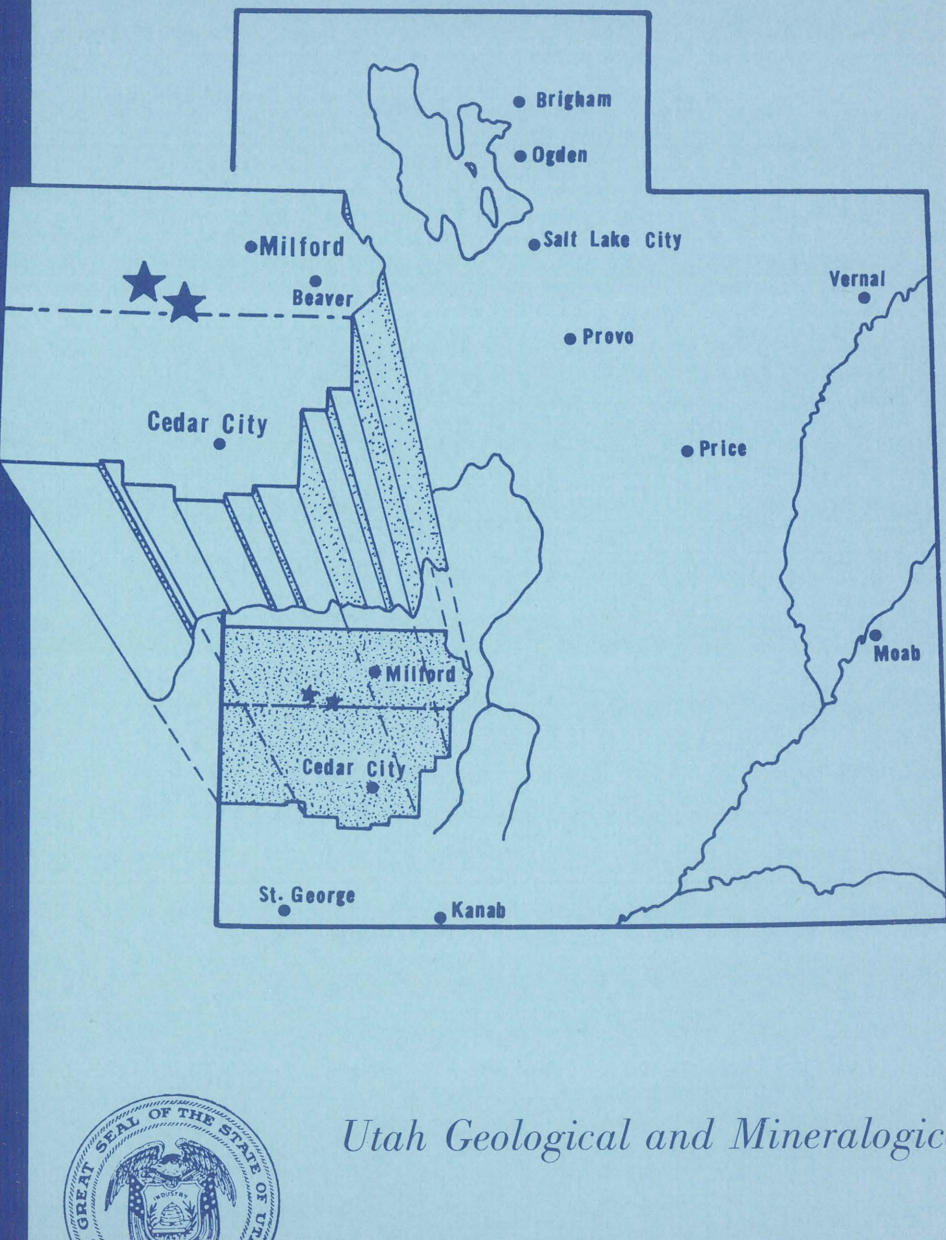
GEOLOGY AND HYDROTHERMAL ALTERATION IN NORTHWESTERN BLACK MOUNTAINS AND SOUTHERN SHAUNTIE HILLS, BEAVER AND IRON COUNTIES, UTAH



Utah Geological and Mineralogical Survey

Special Studies 6

UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

103 Civil Engineering Building
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Salt Lake City, Utah 84112

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William P. Hewitt, 1961-
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GEOLOGY AND HYDROTHERMAL ALTERATION IN NORTHWESTERN BLACK MOUNTAINS AND SOUTHERN SHAUNTIE HILLS BEAVER AND IRON COUNTIES, UTAH

by Max P. Erickson and E. Julius Dasch
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A view of the alteration area facing southwesterly.

Utah Geological and Mineralogical Survey
affiliated with
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ABSTRACT

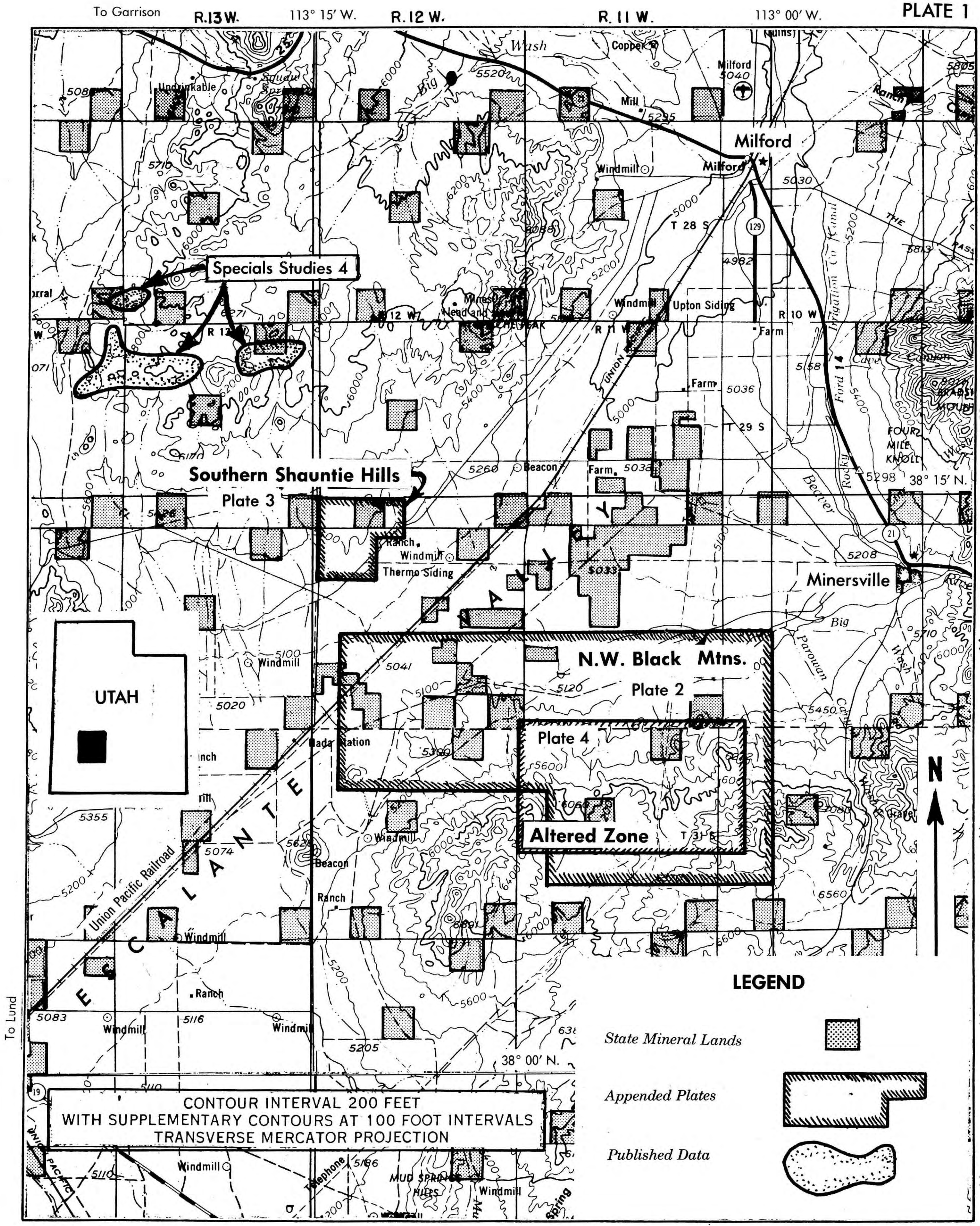
Zones of hydrothermal alteration are exposed within the Tertiary Isom Ignimbrite and within local, rhyolitic and andesitic flow-rock in the northwestern Black Mountains and southern Shauntie Hills of southwestern Utah. Alteration in both zones primarily consists of argillization and alunitization, but concentrations of silica and iron oxide also are present. No economic mineralization occurs in the surface rocks of either zone.

Two positive magnetic readings of 5,100 and 2,850 gammas were recorded in the altered zone of the northwestern Black Mountains. Most of the background magnetic measurements in the area range from 800 to 1,200 gammas. Induced polarization data collected over the areas of the magnetic anomalies are mainly erratic with respect to the magnetic data. Resistivity measurements over the apex of the 2,850 magnetic anomaly, however, are lower than background measurements by about 380 ohm-feet.

A rhyolite porphyry intrudes volcanic strata at two localities in the southern Shauntie Hills; strata around and between the intrusions are altered, and it is probable that fluids associated with the intrusions caused the alteration. Paleozoic carbonate rocks probably are in contact with the porphyry at shallow depths.

Further exploration of the magnetic anomalies in the northwestern Black Mountains, and the area of the rhyolite intrusions in the southern Shauntie Hills, may disclose subsurface economic mineralization associated with the altered rocks.

PLATE 1



See Plate 2 for further index information.

Index Map Showing Area of Study

Modified from AMS sheets, Richfield and Cedar City.

0 5 10 Miles

INTRODUCTION

The association of economic mineralization and hydrothermal alteration has generated considerable interest in the altered areas of the Great Basin. Two exposures of altered rock and the contiguous volcanic strata are the subject of this report.

Plate 1 shows the location of the areas which were studied. The northwestern Black Mountains are separated from the southern Shauntie Hills by a broad, alluvium-filled valley; these two areas are thus discussed separately in this report.

Purpose

The object of this study was to understand better an area of possible economic significance within the State of Utah; the project was financed by the Uniform School Fund of the University of Utah. The selection of the area was an outgrowth of a State-financed, summer mapping project by Max P. Erickson and A. Harold Rhoades in 1961.

Geography

The northwestern Black Mountains and the southern Shauntie Hills are in south central Beaver County and north central Iron County.

Both areas are located in the northern half of the 15-minute Thermo quadrangle of the U.S. Geological Survey. The northern half of the Thermo quadrangle is subdivided into the 7.5-minute Ninemile Knoll quadrangle, which includes the northwestern Black Mountains, and the 7.5-minute Lund 4 NW quadrangle, which includes the southern Shauntie Hills and the westernmost part of the northwestern Black Mountains. The Beaver-Iron county line crosses the southern part of the two 7.5-minute quadrangles (pl. 2).

Two towns, Milford and Minersville, are within 15 miles of the mapped areas. State Highway 21 (see inset to pl. 2) is the nearest hard-topped road. Graded roads, however, make all but the most hilly parts of the northwestern Black Mountains easily accessible. The Union Pacific Railroad traverses the Escalante Desert between the two areas of study (pl. 1).

Large capacity irrigation wells have been completed in the deep alluvium of the Escalante Desert between the northwestern Black Mountains and Milford. These sediments also yield water to scattered windmill-pumped wells between the mapped areas; a few wells produce from thinner alluvium within the hills. No permanent surface water is present in the area.

A few peaks of the northwestern Black Mountains are over 7,000 feet in elevation; the higher parts of the southern Shauntie Hills are about 5,680 feet. The center of the valley is about 5,000 feet above sea level.

Mountainous parts of the area belong to the Public Domain and have no permanent dwellings.

Vegetation and wildlife of the region reflect the desert environment.

Field and Laboratory Methods

The geologic units shown on plates 2 and 3 were mapped in the field on U.S. Geological Survey topographic sheets; some use also was made of vertical aerial photographs. Rock samples were collected for laboratory study, and geophysical data were obtained in the altered zone of the northwestern Black Mountains.

Thin sections of the principle rock types were made and studied in the Mineralogy Department of the University of Utah. Minerals were identified by optical methods, and by means of X-ray diffraction, infrared absorption, and differential thermal analyses.

Field and laboratory data were collected during the summer of 1962.

Acknowledgements

John F. Powers of the Cerro Verde Company of Salt Lake City, and M. LeRoy Jensen of Yale University loaned geophysical instruments to the writers for several days during the field season; the loans are gratefully acknowledged.

Thanks are extended to Barbara J. Anderson and Peter B. Stifel of the University of Utah for rock analyses and for fossil identifications.

Richard L. Armstrong of Yale University permitted the writers to use several of his unpublished radiometric ages for volcanic rocks in the region.

P. K. Roberts of the University of Utah read and criticized the paper.

REGIONAL GEOLOGY

The region, a part of the Basin and Range structural province, is characterized by faulted and uplifted blocks of strata separated by valleys. The faulting mainly postdates the extrusive rock sequence, although in some areas faulting and volcanism were concurrent (Mackin, 1960).

Most of the ranges are capped by, or consist entirely of, Tertiary volcanic strata. Paleozoic and Mesozoic strata underlie the volcanic sequence in this part of Utah, but no rocks older than Tertiary crop out in the mapped areas.

Tertiary strata in the region of the mapped areas are primarily welded, semi-welded, and unwelded fragmental tuff (ignimbrite), and local units of flow-rock. Subordinate amounts of volcanic breccia, volcanic conglomerate, and tuffaceous sedimentary rock also are present, as well as intrusive igneous rock. These volcanic rocks are primarily latite, rhyolite, and andesite. Basalt, which generally postdates the large-scale faulting, covers extensive parts of the region. Patches of hydrothermally altered rock are exposed in many of the outcrops. Economic mineralization is associated with alteration in places outside of the mapped areas, for example near Marysvale and near the abandoned mining town of Frisco.

NORTHWESTERN BLACK MOUNTAINS

The Black Mountains form the southern boundary of the Escalante Desert southwest of Minersville. Foothills and small outcrops of volcanic rock are present between the higher mountains and the desert floor; these exposures define the almost straight, northern termination of the range. Most of the valleys in the mapped area trend north and are inclined northward toward the desert floor. Graded roads which are located in some of these valleys give easy access to typical outcrops of volcanic rocks that make up the range; the alteration zone is visible in part from the roads.

Stratigraphy

The volcanic rocks may be grouped chronologically as "pre-alteration" or "post-alteration." Each of the widespread flow-rocks was mapped separately; local volcanic rocks were grouped to facilitate their mapping. Mapping of each of the less extensive volcanic strata probably would have confused the over-all succession of geologic events, for the correlation of some of these limited units is uncertain.

Except for the ignimbrites, the rocks described below are not given formational status; they are designated by their chief lithic characteristics. The oldest rocks are described first.

Pre-Alteration Rock

Rock formed prior to hydrothermal alteration in the area mainly consists of ignimbrites, a rhyolitic group of rocks, and an andesite. Some of the earlier volcanic strata are correlated with the Needles Range and Isom ignimbrites. These formational names were proposed by Mackin (1960) for widespread ignimbrites that are typically exposed in the Iron Springs district and in the Needles Range.

Needles Range Ignimbrite: Welded tuff that forms the outcrops at Ninemile Knoll (pl. 2) is correlated with Mackin's Needles Range Ignimbrite on the basis of lithic similarity. The rock is a part of the earliest of Mackin's widespread ignimbrites.

It occurs only in two small, isolated outcrops within the northwestern Black Mountains; the strata dip about 30° to the east at these exposures (pl. 2). The rocks protrude above the valley fill and crop out more than a mile from the main front of the Black Mountains to the south.

The tuff is semi-welded to welded, and varies in color from pink to red. It contains abundant fragments of various rock types, phenocrysts of black hornblende, and pumice lapilli.

Several samples of Needles Range Ignimbrite from southwestern Utah and southeastern Nevada have been dated radiometrically by Richard L. Armstrong of Yale University. His results, which were obtained by the potassium-argon method, indicate rock ages ranging from 24 to 26 million years; because of difficulty in analysis, however, Armstrong suspects that a more nearly correct age for the rocks is about 29 million years, or Oligocene (written communication).

Isom Ignimbrite: Welded tuff that crops out mainly in the middle and higher parts of the range is correlated with Mackin's Isom Ignimbrite. A few exposures of the tuff also are found in the foothills to the north (pl. 2). The rock is more widespread in the mapped area than is the Needles Range Ignimbrite.

The Isom is a dark-red to purple-red welded tuff; it is dense and glassy, and typically contains flattened, chalcedony-filled vesicles. It does not contain as many crystals, lapilli, or rock fragments as the Needles Range. The strata characteristically weather into discrete blocks that are formed by closely-spaced, vertical and horizontal fractures.

Hornblende Andesite: A hornblende andesite is one of the more easily correlated, local flow-rocks in the northwestern Black Mountains. The largest outcrop is in the central part of the mapped area (pl. 2), where the andesite is exposed under an extensive basalt which caps most of the foothills.

The rock may be light pink, light green, or light gray. Numerous black hornblende laths average about 4 mm. in length and are roughly aligned in the light-colored andesitic matrix.

Rhyolite, miscellaneous flow-rock, and pyroclastic rock: Numerous types of local flow-rocks and pyroclastic rocks comprise a large part of the northwestern Black Mountains. The rocks are mainly rhyolitic in composition. Most of them have a limited distribution and are not easily correlated. The most persistent and widespread rock in the group is a rhyolite flow-rock. The rhyolite and the rocks associated with it were grouped in mapping; they occur between the hornblende andesite unit and the uppermost volcanic unit described below.

The rhyolite is a light-pink to medium-dark red flow-rock. It is dense and glassy and is brecciated in places. The remainder of the strata in the grouped unit chiefly consists of rhyolite conglomerate, a rhyolite breccia, rhyolitic, or latitic pyroclastic rock, and tuffaceous sedimentary rock and debris. A few of the rocks exhibit well-developed flow banding.

Post-Alteration Rock

Post-alteration strata in the area consist of basalt, latite, basalt conglomerate, and Quaternary alluvium.

Basalt and latite: Basalt, dark latite, and basalt conglomerate cap most of the larger foothills in the northwestern Black Mountasin; the same strata are exposed extensively in the higher parts of the mountains to the south. The rocks are grouped into a single unit because they were extruded after the period of extensive alteration, and because they probably represent closely related episodes of volcanism.

The basalt and the latite are dark and very fine-grained. They contain few phenocrysts. Chalcedony is present as amygdule filling in many of the basalts. In two small outcrops the basalt contains peculiar sphere-shaped structures. The spheres and the basalt matrix are identical petrologically, and are separated by an extremely thin layer of clay-like material. Basalt conglomerates, some of which more properly may be termed lahars, are extensive in the mapped area.

Quaternary alluvium: The most extensive exposure of Quaternary alluvium is the floor of the Escalante Desert. Stream alluvium, which may range in places up to several tens of feet in thickness, is present within the mountains.

The alluvium, which consists of silt, sand, and gravel, was eroded from bedrock in the highlands. Caliche is visible in some of the alluvium exposed along the dry washes. Hot springs, which issue from the alluvium, are located in the desert far from the nearest bedrock (pl. 2).

Lake Bonneville extended into part of the mapped area, but lake sediments were found in only one place (see note in northern part of pl. 2). A small collection of fossil snails was recovered from the sediments. They were identified by Peter B. Stifel of the University of Utah as *Amnicola longinqua* Gould, a species living today, and two forms of *Lymnaea bonnevillensis* (Call), a fossil species of little stratigraphic significance (oral communication).

Structure

A few faults in the northwestern Black Mountains are shown by Plate 2, but it is likely that others are present. Unmapped faults are suggested by the steep dips of volcanic strata, the alignment of types of alteration within the altered zone, the elongation of the altered zone, and several topographic features. The linear, northern termination of the range may be evidence of a large fault. Local volcanic rocks mask the faults and make them difficult to recognize.

More faults are present in the older strata than in the younger strata; for example, the Isom Ignimbrite contains more recognizable faults than the rhyolite unit. No significant faults were observed in the basalt unit and the extrusion of these rocks must have largely postdated the major faulting in the area. The exact relationship between faulting and the extrusion of lava and pyroclastic debris is not shown clearly by the rocks in the mapped area.

Zone of Alteration

Part of the strata in the northwestern Black Mountains has been hydrothermally bleached and altered. Because of possible economic mineralization within this zone of alteration, it was studied in more detail than the adjacent rock.

The altered zone is about 4 1/2 miles long and about 1/4 to 1 1/2 miles wide. It is linear in an east-west direction (pl. 2). The visible alteration effects are primarily in the rhyolite and andesite units; a lesser amount of alteration occurs in the Isom Ignimbrite.

The bleached appearance of the zone is a striking contrast to the adjacent unaltered, predominantly pink to red strata. The most highly altered rock is egg-shell white; it is present in small outcrops near the approximate center of the altered zone. The altered rocks are progressively darker away from the highly bleached zone, although all mixtures of white and red are present.

Altered Rocks

The principal result of alteration is bleached rock, but concentrations of silica and iron oxide are also present in the zone. Only the more distinct and widespread altered rocks were mapped within the northwestern Black Mountains (pl. 4). No attempt was made to subdivide altered rocks on the basis of thin-section study or other methods of laboratory examination. Contacts between the different types of altered rocks generally are gradational. Although the four types of alteration shown on Plate 4 may have occurred in a sequence, the sequence cannot be determined from the available data; no chronology of events is inferred by the relative positions of alteration types under "Explanation" on Plate 4.

Except for slightly bleached strata, the most widespread altered rock is a brilliant white massive unit. This rock type is made up of fine-grained quartz, alunite, and kaolinite. An abandoned mining claim is located in these rocks (pl. 4), and a small amount of rock has been dislodged by blasting on the claim.

The second most prominent altered rock is a dense silica-rich unit with varying shades of limonite stain. The silica-limonite rock occurs in small outcrops in and near the quartz-alunite-kaolinite altered rock. (See Chemical Analysis in Appendix.)

Two other types of altered units were mapped: an intensely opalized rock which contains disseminated hematite; and a rock which is characterized by limonite on joint surfaces.

Mineralogic and Geochemical Data

A thin section study of the altered rocks indicates that the chief effect of alteration was a change of unaltered, glassy to fine-grained volcanic rock to clayey and alunitic rock. This change seems to have taken place largely by the replacement of feldspar and other primary minerals by clay and alunite. The most altered or bleached rocks are composed of kaolinite, alunite, and quartz. Less altered rocks may contain minerals such as feldspar and tridymite; they also may show primary volcanic features, such as flow banding and phenocryst outlines. Infrared analyses and differential thermal analyses of selected altered rocks show that most of the lateration products are fine-grained mixtures of alunite and kaolinite. Chalcedony, opal, zeolite, cristobalite, and carbonate minerals also are present in some of the altered rocks.

Hematite, limonite, and very small amounts of pyrite are the only base metal minerals found in the altered rocks. Qualitative spectrographic analyses of seven altered rocks failed to reveal significant amounts of base metals other than iron. Most of the analyses showed traces of titanium, manganese, and vanadium, but these data do not appear to be significant. Barbara J. Anderson of the University of Utah ran a partial, semi-quantitative spectrographic analysis of the quartz-alunite-kaolinite rock. The results are tabulated on the following page:

Element	Percentage	Element	Percentage
Al	4.0	Mg	0.01
Be	-	Mo	-
Ca	0.6	Mn	-
C	-	Ni	-
Cr	trace	Si	35.0
Cu	-	Ti	0.05
Fe	0.1	V	-

Sulfur occurs in small amounts of pyrite, and in alunite, which is ubiquitous in the altered rocks. Sulfur also is present in large selenite crystals which occur sparsely at one location within the zone of alteration; the gypsum probably grew in loose, altered and disintegrated clayey material. The crystals had been uncovered in the loose clay and silt by a small-scale digging operation. M. LeRoy Jensen of Yale University has analyzed isotopically sulfur from some of these selenite crystals. The ratio of the sulfur isotopes indicates to him that the sulfur is magmatic-hydrothermal in origin (written communication).

Geophysical Data

A magnetometer survey and an induced polarization survey were made in the northwestern Black Mountains alteration zone during the summer of 1962. The instruments used in the surveys were borrowed and were only briefly available; thus the data obtained from them are not abundant. Several geophysicists and geologists familiar with the analysis of magnetic and induced polarization data were consulted about the information obtained from the surveys. Opinions varied greatly concerning the interpretation of the data. Because the interpretations were not in agreement, they are omitted from the following paragraphs which describe the surveys. Several possibilities suggested by the geophysical data are mentioned, however, in the discussion of results.

Magnetometer survey: Reconnaissance magnetic data were obtained in the alteration zone by a hand-held, vertical intensity magnetometer. About 400 measurements were made along north-south traverses; the traverses were about 1,000 feet apart and ranged from 1/4 to 1 3/5 miles in length. Measurements were made along the traverses at intervals of approximately 200 feet. The measurements are plotted areally on Plate 5.

These data are recorded on plates 5, 6, and 7. The locations of the traverses are shown on Plate 4, and the traverses are presented in profile on Plate 7. On Plate 5 the readings are contoured on a 250 gamma interval. To reduce minor irregularities, and to emphasize the major magnetic features, neighboring pairs of measurements were averaged, and the averages were contoured on a 250 gamma interval (pl. 6). The relation of the traverses to the areal geology is shown by Plate 4.

The two contour maps, and traverse profiles B-B' and E-E' clearly show two positive anomalies. The western magnetic anomaly (traverse B-B') has a maximum reading of 5,100 gammas; it is essentially a one-point anomaly. The eastern magnetic anomaly (traverse E-E'), which contains a maximum reading of 2,850 gammas, covers a relatively large area (pl. 5). Background magnetic measurements in the area are mainly in the range of 800 to 1,200 gammas. The polarity of the anomalies is shown on Plate 5; both of the positive anomalies are near to, and mainly north of, negative or low, positive values.

Induced polarization survey: Electrical resistivity measurements and data necessary for computing metal factors were collected in the areas of the two major magnetic anomalies by the use of a variable frequency, induced polarization instrument. The location of the induced polarization traverses are shown on Plate 4.

In the area of the eastern magnetic anomaly, the electrical data were obtained from 20 stations, 100 feet apart, along a north-south traverse which coincided with part of magnetometer traverse E-E' (pl. 9). The survey was planned so that the location of the highest magnetometer reading was near the approximate middle of the induced polarization traverse. The measurements are shown in the following table:

Centers of Electrode Configuration Interval = 100 feet	Resistivity Ohm-feet	Apparent Metal Factor Millivolt - sec/volt
1 (south)	675	40.7
2	795	97.0
3	754	79.3
4	412	197.8
5	660	102.5
6	600	84.6
7	810	100.8
8	640	47.1
9	258	99.6
10	273	124.0
11	254	59.4
12	278	16.8
13	251	30.0
14	251	30.0
15	207	13.6
16	285	0.0
17	314	41.0
18	646	12.6
19	755	8.4
20 (north)	480	26.2
		(based on frequency of 2.5 cycles/sec.)

A similarly planned induced polarization traverse was made over the center of the western magnetic anomaly. Measurements were made at nine stations along a north-south traverse that coincided with a part of magnetometer traverse B-B' (pl. 8). These data are recorded in the following table:

Centers of Electrode Configuration Interval = 100 feet	Resistivity Ohm-feet	Apparent Metal Factor Millivolt - sec/volt
1 (south)	213	14.7
2	210	44.8
3	292	40.7
4	269	28.0
5	348	27.1
6	306	43.0
7	271	7.0
8	355	10.6
9 (north)	382	34.5
		(based on frequency of 2.5 cycles/sec.)

Resistivities and metal factors are shown in profile on Plates 8 and 9; these illustrations also show the magnetometer profile along each of the induced polarization traverses. The geologic setting of the induced polarization traverses may be seen on Plate 4.

The eastern magnetic anomaly is reflected roughly by the low resistivity values shown on Plate 9. Metal factors, however, appear to be erratic with respect to resistivities and magnetic intensities across the eastern magnetic anomaly. The sharp peak of the western magnetic anomaly apparently has no anomalous counterpart in a plot of either the metal factors or the resistivities (pl. 8).

SOUTHERN SHAUNTIE HILLS

The southern part of the Shauntie Hills is located in the extreme northwestern corner of the 15-minute Thermo quadrangle. The area consists of low bedrock hills, which, for the most part, are composed of volcanic strata; they are the foothills of the Shauntie Hills to the north.

The area was mapped in order to complete the detailed study of the bedrock geology within the 7.5-minute Lund 4 NW quadrangle. Mapping revealed a small alteration area and rhyolite porphyry intrusive rocks (pl. 3). No geophysical data were collected within the area.

Except for the basalt, latite, and hornblende andesite, the strata mapped in the northwestern Black Mountains also occur in the southern Shauntie Hills. Two additional rock types are present, however, a limestone and a rhyolite porphyry. Strata of the southern Shauntie Hills were formed prior to hydrothermal alteration processes, except for Quaternary alluvium.

Pre-Alteration Rock

Pre-alteration rock in the southern Shauntie Hills is similar to pre-alteration rock of the northwestern Black Mountains. The Needles Range and Isom ignimbrites, and a rhyolite group are also present in the southern Shauntie Hills.

Needles Range Ignimbrite: A small outcrop directly north of Dead Horse Reservoir (pl. 2) is lithically similar to the lowermost welded tuff of the northwestern Black Mountains; it is tentatively correlated with the Needles Range Ignimbrite.

Isom Ignimbrite: Most of the bedrock within the southern Shauntie Hills consists of welded and semi-welded tuff, which is correlated with the Isom Ignimbrite of the northwestern Black Mountains.

A few beds of rhyolite conglomerate and breccia were grouped with the ignimbrite in the mapped area; the chief lithology, however, consists of pink to red, slightly fragmental tuff units that are characteristic of the Isom. Flattened pumice lapilli and chalcedony-filled vesicles are common in these rocks. Most of the hydrothermal alteration in the mapped area took place in the Isom Ignimbrite.

Rhyolite, undifferentiated: The youngest volcanic rock in the area is a rhyolite flow-rock; minor amounts of rhyolite breccia, and tuffaceous rock and sediment were grouped with this rhyolite. The rocks are lithically similar to those of the rhyolite unit of the northwestern Black Mountains. In addition, the rhyolite units of both areas occur directly above the Isom Ignimbrite, and consequently they are thought to be correlative.

<u>Tertiary limestone:</u> A layer of limestone is intercalated with the Isom Ignimbrite. The limestone forms a few small outcrops on the southwestern flank of the southern Shauntie Hills (pl. 3). Because the limestone is not present at any other locality in either of the two mapped areas, it is described separately.

The unit is about three feet thick at the few places where both upper and lower contacts are exposed. The limestone is extensively recrystallized and is composed of individual calcite crystals which range from 1/2 to 4 inches in length. The rock is whitish grey.

A small prospect in the southwestern part of the mapped area clearly shows that the limestone occurs between volcanic rocks, and therefore is Tertiary. The rock probably was deposited in a small fresh-water lake which formed during a lull in volcanic activity. Later volcanism may have caused the recrystallization of the calcite.

Intrusive Rhyolite Porphyry

Intrusive rhyolite porphyry crops out in two places within the southern Shauntie Hills (pl. 3). The hill near Dead Horse Reservoir is composed of this rock; an outcrop of lithically similar porphyry occurs in the northern part of the area.

The rock is a white or very light pink, fine-grained rhyolite. It has phenocrysts of clear and colorless quartz which average about 1/8 to 1/4 inch in length. The phenocrysts have been rounded by partial resorption.

The porphyry does not weather as readily as the adjacent Isom Ignimbrite. Its color contrasts sharply with the pink and red flow-rock of the adjacent Isom Formation.

Post-alteration Quaternary Alluvium

Unlike the rock units in the northwestern Black Mountains, all of the volcanic rock of the southern Shauntie Hills formed prior to hydrothermal alteration in the area. Quaternary alluvium is the only post-alteration unit that was mapped. Stream alluvium within the hills is apparently very thin. Water wells have been constructed in the thicker alluvial fill of the adjacent Escalante Desert to the south and southwest.

Structure

Along the eastern flank of the southern Shauntie Hills, the Isom Ignimbrite dips, in places, from 30° to 40° to the east-southeast. The topography suggests that several north-northeast striking faults occur in the area. The approximate locations of the more apparent faults are shown on the map (pl. 3).

Several outcrops of the Isom Ignimbrite dip gently around the edge of the northern rhyolite porphyry intrusion. Field relations nearest the intrusion, however, are obscured by alteration.

Zone of Alteration

Hydrothermally altered rocks are exposed in the northern part of the southern Shauntie Hills. Two mappable rock types are present within the zone of alteration (pl. 3). This zone was not mapped in detail as was the altered zone of the northwestern Black Mountains. Only a few mineralogic and geochemical determinations were made of the altered rocks. No economic mineralization was found in the altered zone at the surface.

The unit that is called "zone of slight bleaching" on Plate 3 consists of slightly to moderately bleached Isom Ignimbrite. The northern outcrop of intrusive rhyolite porphyry occurs in the middle of the main altered zone. The alteration in the Isom appears to vary with the distance from the intrusion, for the rocks nearest the porphyry are the most highly bleached. The porphyry, however, is not significantly altered. Altered rock near this northern intrusive porphyry comprises the most extensive alteration zone, but small patches of bleached rock occur throughout the southern Shauntie Hills. These exposures appear to be localized near faults and joints within the volcanic strata. No significant alteration occurred in the rocks adjacent to the intrusive porphyry near Dead Horse Reservoir.

Considerable amounts of silica were introduced or concentrated in the areas which are labelled "highly silicified" on Plate 3. In most places the silicified rocks are associated with breccia which crops out along the northwestern side of the mapped area. The rocks are composed of chalcedony with minor amounts of opal and tridymite. Generally, they are very dense and many of them are stained by limonite along the fracture surfaces.

RESULTS AND PROPOSALS FOR FURTHER WORK

This study is primarily concerned with alteration zones in the two mapped areas. Adjacent strata were mapped in order to understand better the geology of the altered zones. Although no economic mineralization was found at the surface of the two zones, ore may be present at depth within either area.

Northwestern Black Mountains

The Isom Ignimbrite and local rhyolite and andesite flow-rock were the principal surficial hosts for hydrothermal alteration in the mapped area. The alteration can be dated only as mid or late Tertiary; it preceded, however, the extrusion of basalt and latite which apparently was quite recent. The principal effect of the alteration fluids was bleaching by argillization and alunitization. The introduction or concentration of silica, traces of iron, and sulfur resulted in the formation of different alteration rock types; these rocks may have been formed by the introduction of fluids with different chemical compositions.

Magnetic anomalies in the zone of alteration may be caused by an east-west trending subsurface fault. Such a fault may explain the abrupt northern termination of the mountains; later, basalt and alluvium could have concealed the traces of the fault.

The anomalies could be attributed to magnetite in a basaltic neck or fissure-rock which may be related to the basaltic flow-rock in the area.

If the anomalies are caused by mineralization, the mineralization must occur only at depth, for none was found at the surface of the altered zone.

The origin of the alteration is not known. Fluids associated with the extrusion of either the rhyolite flow or the basalt and latite group of flows may have caused the alteration. The elongate shape of the zone may be attributed to the upward movement of hydrothermal fluids along a subsurface fault; porosity associated with the fault plane could have supplied the major passageways for the fluids.

If the area is further explored for mineralization, attention should first be focused on the areas where the magnetic anomalies occur. More sensitive instruments, and different kinds of instruments could be used to understand better these anomalous areas. Test holes would, of course, provide the most information on the subsurface rocks in the altered zone.

Southern Shauntie Hills

After the extrusion of the ignimbrites and the rhyolite flow, a rhyolite porphyry was intruded into the volcanic layers at two places in the mapped area. Because alteration is most intense close to the northern exposure of porphyry, it is probable that fluids associated with the intrusion caused the bleaching. Alteration probably preceded intrusion, for the porphyry is not altered significantly.

Volcanic rocks in the area are probably not thick, because the Isom Ignimbrite, which forms most of the outcrops, is close to the lower contact of Tertiary volcanic sequences in nearby ranges. Paleozoic carbonate rocks occur directly beneath the volcanic cover in neighboring ranges; they probably are also present beneath the volcanic strata in the southern Shauntie Hills. Ore is in many places associated with the contact between carbonate rock and intrusive porphyry in the Great Basin.

The contact of the intrusive rhyolite porphyry and the subsurface carbonate rocks should therefore be explored in the southern Shauntie Hills, especially within the zone of alteration which surrounds the northern intrusion.

REFERENCE

Mackin, J. H., 1960, Structural significance of Tertiary volcanic rocks in southwestern Utah: Am. Jour. Sci., V. 258, p. 81-131.

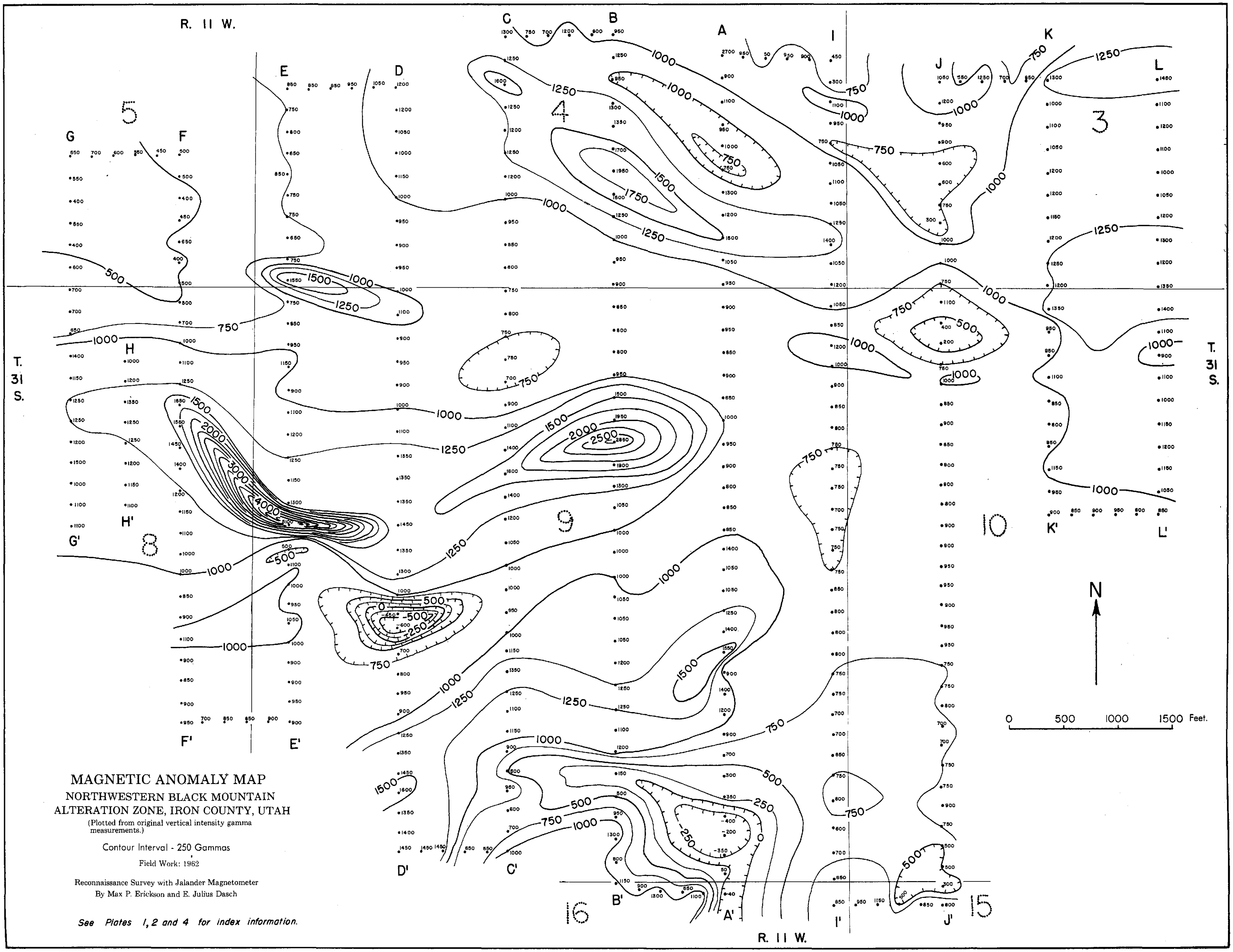
APPENDIX

Chemical Analysis of High Silica Clay

	%
SiO_2	78.6
Al_2O_3	8.0
Fe	0.15
CaO	0.10
MgO	0.10
P_2O_5	0.07
Ignition Loss	9.6 *
TOTAL	96.62

*Ignition loss remained constant at tests of 500 - 1,000 C.

Analyst: Lester Butcher


MAGNETIC ANOMALY MAP
NORTHWESTERN BLACK MOUNTAIN
ALTERATION ZONE, IRON COUNTY, UTAH
(Plotted from original vertical intensity gamma measurements.)
Contour Interval - 250 Gammas
Field Work: 1962
Reconnaissance Survey with Jalander Magnetometer
By Max P. Erickson and E. Julius Dasch
See Plates 1, 2 and 4 for index information.
R. 11 W.
T. 31 S.
N
0 500 1000 1500 Feet.

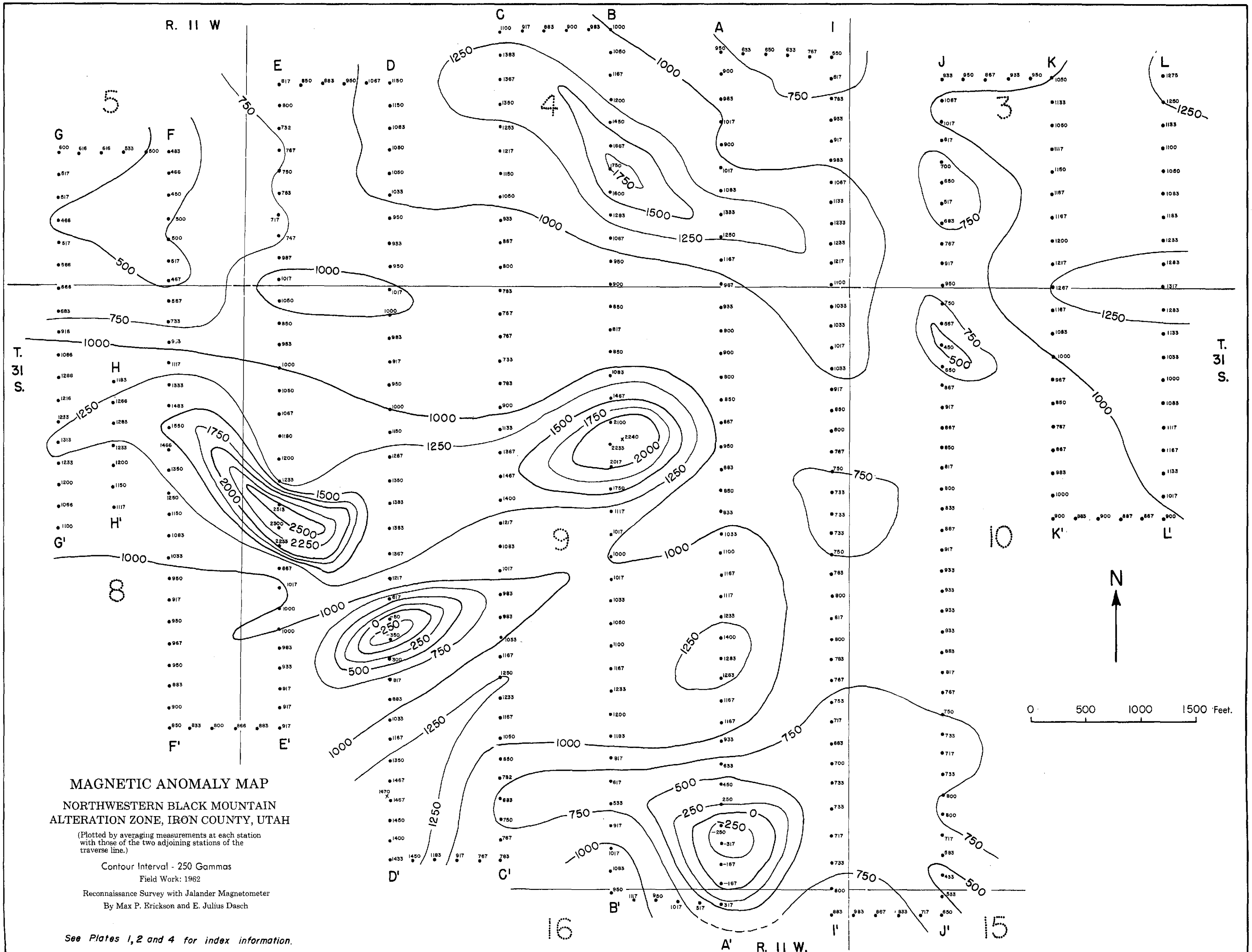
Data for Plate 5. — Magnetic Anomaly Map Data (original data)

FROM NORTH TO SOUTH

G-G^{1}	H-H^{1}	F-F^{1}	E-E^{1}	D-D^{1}	C-C^{1}	B-B^{1}	A-A^{1}	I-I^{1}	J-J^{1}	K-K^{1}	L-L^{1}
550	1000	500	850	1200	1300	950	2700	450	1050	1300	1450
550	1200	500	750	1200	1250	1250	900	300	1200	1000	1100
400	1350	400	800	1050	1600	950	1100	1100	950	1100	1200
550	1250	450	650	1000	1250	1300	950	950	900	1050	1100
400	1250	650	850	1150	1200	1350	1000	750	600	1200	1000
600	1200	400	750	1000	1250	1700	750	1050	600	1200	1050
700	1150	500	750	950	1200	1950	1300	1100	750	1150	1200
700	1100	500	650	900	1000	1600	1200	1050	300	1200	1300
650		700	750	950	950	1250	1500	1250	1000	1250	1200
1400		1000	1550	1000	850	1000	1050	1400	1000	1200	1350
1150		1100	750	1100	800	950	950	1050	750	1350	1400
1250		1250	850	900	750	900	900	1200	1100	950	1100
1250		1650	950	950	800	850	950	1050	400	950	900
1200		1550	1150	900	750	800	850	850	200	1100	1100
1500		1450	900	1000	750	800	900	1200	750	850	1000
1000		1400	1100	1100	700	950	650	1000	1000	600	1150
1100		1200	1200	1350	900	1500	1000	900	850	850	1200
1100		1150	1250	1350	1100	1950	950	850	900	1150	1150
		1100	1150	1350	1400	2850	900	800	850	950	1050
		1000	1300	1450	1600	1900	800	750	800	900	850
		1000	5100	1350	1400	1300	850	750	800		
		850	500	1300	1200	1050	850	750	800		
		900	1100	1000	1050	1000	1400	700	900		
		1100	1000	-450	1000	1000	1050	750	900		
		900	950	-600	1000	1000	1050	750	950		
		850	1050	700	950	1050	1250	750	950		
		900	1000	800	1000	1050	1400	850	900		
		950	900	950	1150	1050	1550	800	950		
			900	900	1350	1200	900	800	950		
			950	1250	1250	1250	1400	800	750		
			900	1350	1100	1100	1200	750	750		
				1450	1150	1200	900	750	800		
				1600	900	150	700	700	700		
				1350	500	500	300	700	700		
				1400	950	950	350	650	750		
				1450	600	1300	-400	750	750		
					700	800	-200	800	900		
					1000	1150	-350	600	750		
							50	700	500		
							-40	850	300		
								850	800		

FROM WEST TO EAST

G-F	F^{1}-E^{1}	E-D	D^{1}-C^{1}	C-B	B^{1}-A^{1}	A-I	I^{1}-J^{1}	J-K	K^{1}-L^{1}
550	950	850	1450	1300	1150	2700	850	1050	900
700	700	850	1450	750	900	950	950	550	850
600	850	850	1450	700	1300	50	1150	1250	900
550	850	950	650	1200	650	950	500	700	950
450	900	1050	650	800	1100	900	850	850	800
500	900	1200	1000	950	-40	450	800	1300	850


MAGNETIC ANOMALY MAP
NORTHWESTERN BLACK MOUNTAIN
ALTERATION ZONE, IRON COUNTY, UTAH
(Plotted by averaging measurements at each station with those of the two adjoining stations of the traverse line.)
Contour Interval - 250 Gammas
Field Work: 1962
Reconnaissance Survey with Jalander Magnetometer
By Max P. Erickson and E. Julius Dasch
See Plates 1, 2 and 4 for index information.
R. 11 W
R. 11 W.
T. 31 S.
T. 31 S.
N
0
500
1000
1500
Feet.
A
A'
B
B'
C
C'
D
D'
E
E'
F
F'
G
G'
H
H'
I
I'
J
J'
K
K'
L
L'
3
4
5
8
9
10
15
16

Data for Plate 6. — Magnetic Anomaly Map Data (adjusted data)

FROM NORTH TO SOUTH

$G-G^1$	$H-H^1$	$F-F^1$	$E-E^1$	$D-D^1$	$C-C^1$	$B-B^1$	$A-A^1$	$I-I^1$	$J-J^1$	$K-K^1$	$L-L^1$
600	1183	483	817	1150	1100	1000	950	550	933	1050	1275
517	1266	466	800	1150	1383	1050	900	617	1067	1133	1250
517	1283	450	732	1083	1367	1167	983	783	1017	1050	1133
466	1233	500	767	1050	1350	1200	1017	933	817	1117	1100
517	1200	500	750	1050	1253	1450	900	917	700	1150	1050
566	1150	517	783	1033	1217	1667	1017	983	650	1167	1083
666	1117	467	717	950	1150	1750	1083	1067	517	1167	1183
683		567	747	933	1050	1600	1333	1133	683	1200	1233
916		733	987	950	933	1283	1250	1233	767	1217	1283
1066		953	1017	1017	867	1067	1167	1233	917	1267	1317
1266		1117	1050	1000	800	950	967	1217	950	1167	1283
1216		1333	850	983	783	900	933	1100	750	1083	1133
1233		1483	983	917	767	850	900	1033	567	1000	1033
1313		1550	1000	950	767	817	900	1033	450	967	1000
1233		1466	1050	1000	733	850	800	1017	650	850	1083
1200		1350	1067	1150	783	1083	850	1033	867	767	1117
1066		1250	1180	1267	900	1467	867	917	917	867	1167
1100		1150	1200	1350	1133	2100	950	850	867	983	1133
		1083	1233	1383	1367	2233	883	800	850	1000	1017
		1033	2513	1383	1467	2017	850	767	817	900	900
		950	2300	1367	1400	1750	833	750	800		
		917	2233	1217	1217	1117	1033	733	833		
		950	867	617	1083	1017	1100	733	867		
		967	1017	-50	1017	1000	1167	733	917		
		950	1000	-350	983	1017	1117	750	933		
		883	1000	300	983	1033	1233	783	933		
		900	983	817	1033	1050	1400	800	933		
		850	933	883	1167	1100	1283	817	933		
			917	1033	1250	1167	1283	800	883		
			917	1167	1233	1233	1167	783	817		
			917	1350	1167	1200	1167	767	767		
				1467	1050	1183	933	753	750		
				1467	850	817	633	717	733		
				1450	782	617	450	683	717		
				1400	683	533	250	700	733		
				1433	750	917	-250	733	800		
					767	1017	-317	733	800		
					783	1083	-167	717	717		
						950	-167	733	583		
							317	800	433		
								883	533		
									650		

FROM WEST TO EAST

G-F	F^1-E^1	E-D	D^1-C^1	C-B	B^1-A^1	A-I	I^1-J^1	J-K	K^1-L^1
600	850	817	1433	1100	950	950	883	933	900
616	833	850	1450	917	1117	633	983	950	883
616	800	883	1183	883	950	650	867	867	900
533	866	950	917	900	1017	633	833	933	887
500	883	1067	767	983	517	767	717	950	867
483	917	1150	783	1000	317	550	650	1050	900

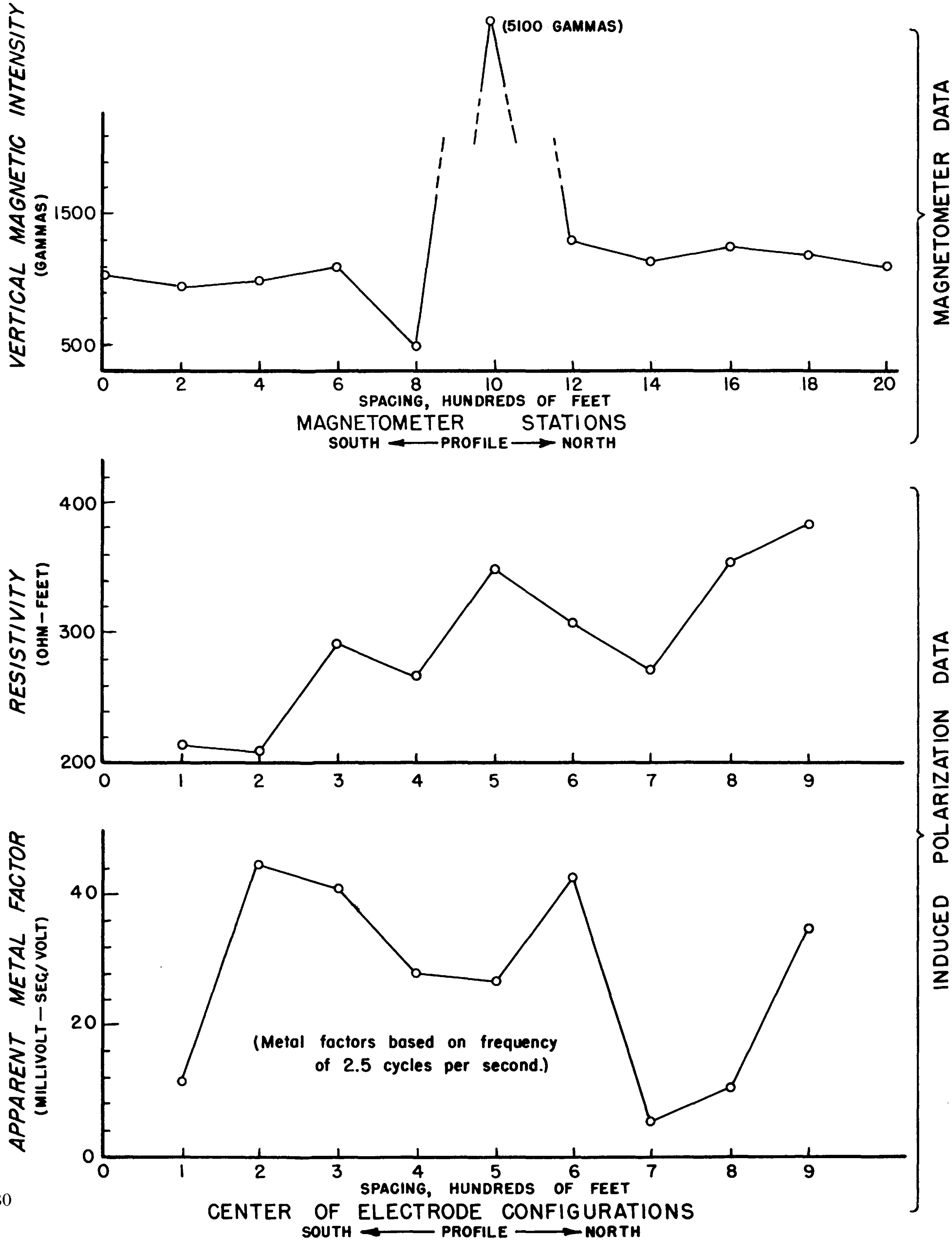
GEOPHYSICAL DATA

IN AREA OF WESTERN MAGNETIC ANOMALY

PLATE 8

(For location of profiles, see Plate 4.)

Data from survey made 10 August 1962.



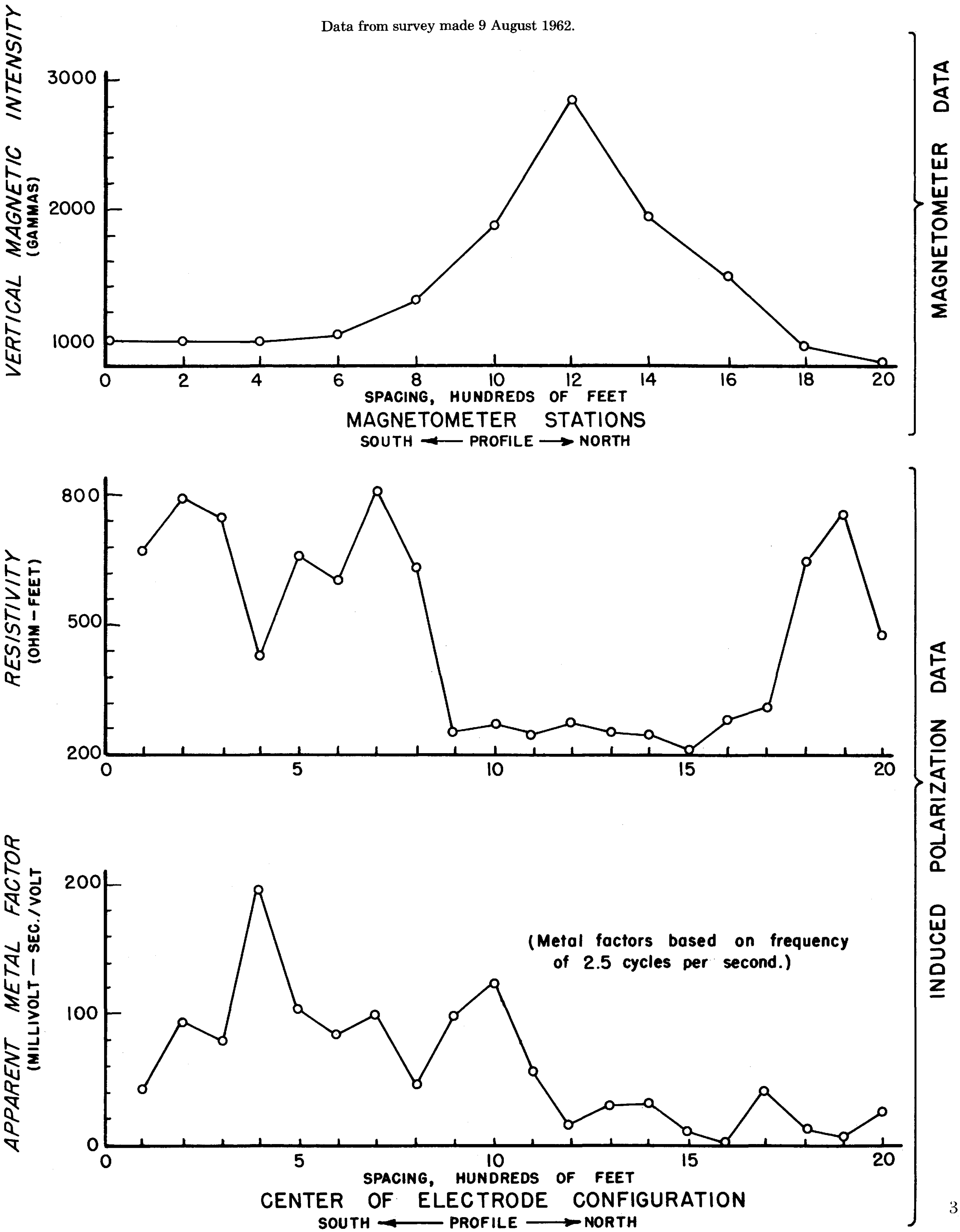
GEOPHYSICAL DATA

IN AREA OF EASTERN MAGNETIC ANOMALY

PLATE 9

(For location of profiles, see Plate 4.)

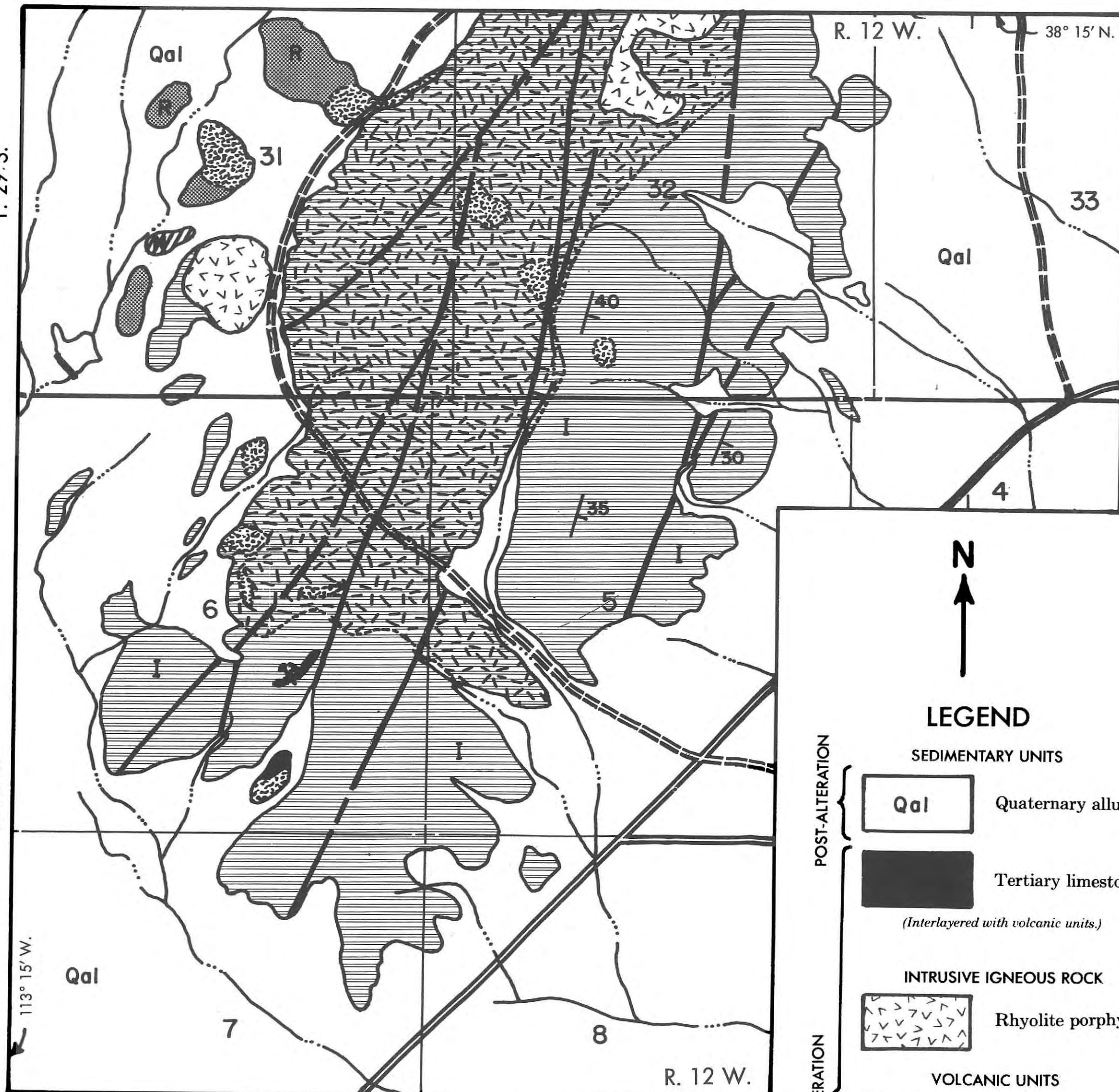
Data from survey made 9 August 1962.

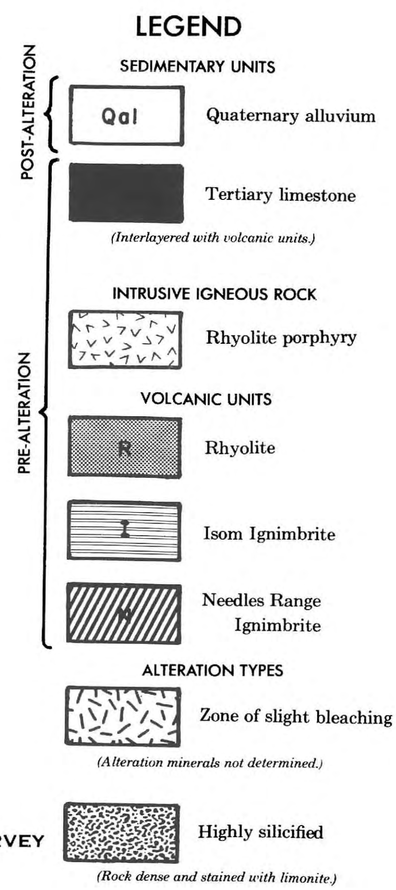


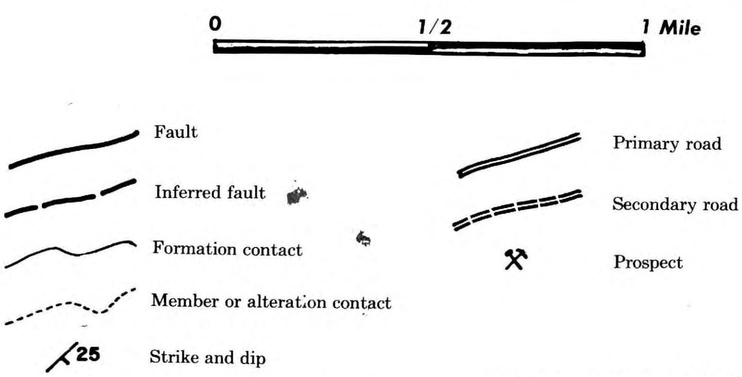
GEOLOGY OF THE SOUTHERN SHAUNTIE HILLS, BEAVER CO., UTAH

PLATE 3

By Max P. Erickson and E. Julius Dasch







See Plates 1 and 2 for index information.

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GEOLOGY OF THE NORTHWESTERN BLACK MOUNTAINS, BEAVER AND IRON COUNTIES, UTAH
By Max P. Erickson and E. Julius Dasch
1 3/4 1/2 1/4 0 1/2 1 Mile
Field Work: 1962
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SALT LAKE CITY 12, UTAH
See Plate 1 for more information pertaining to the location of the area.
N
W
E
INDEX MAP
MILLARD
BEAVER
IRON
PIUTE
UTAH
Area of Index
Sevier Lake
Fillmore
Kanosh
Black Rock
Cove Fort
Milford
Beaver
Lund
Parowan
Panguitch
U.P.R.R.
PLATE 2
PLATE 3
PLATE 4
38° N.
113° W.
EXPLANATION
Zone of alteration
Fault
Inferred fault
Formation contact
Member contact
Strike and dip
Intermittent stream
Spring
Railroad
Primary road
Secondary road
LEGEND
POST-ALTERATION ROCK
Quaternary alluvium
Qal
VOLCANIC UNITS
Basalt and latite
B-L
B
L
PRE-ALTERATION ROCK
Rhyolite, flow-rock and pyroclastic rock
R
Rf
Rp
Hornblende andesite
A
Isom Ignimbrite
I
Needles Range Ignimbrite
N
R. 12 W.
R. 11 W.
R. 10 W.
T. 30 S.
T. 31 S.
113°10′ W.
113°07′30″ W.
113°05′ W.
113°00′ W.
38°10′ N.
38°07′30″ N.
38°05′ N.
ESCALANTE DESERT
BLACK
MOUNTAINS
BEAVER COUNTY
IRON COUNTY
Springs
Hot Springs
Lake Bonneville sediment
UNION PACIFIC RAILROAD
To Milford, 15 Miles
To Minersville, 4 Miles
To Lund, 14 Miles
Government Well
The Sink
Ninemile Knoll
Old Rambler Hill
Brown Knoll
Well
Hot Springs Canyon
Black Canyon
Red Hill
Mound Mountain
Marshall Well
Dry Willow Spring
Robbery Hill
Baboon Seep
Baboon Peak


ALTERATION ZONE, NORTHWESTERN BLACK MOUNTAINS, IRON COUNTY, UTAH
By Max P. Erickson and E. Julius Dasch
2000
4000 Feet
PUBLISHED AND SOLD BY THE
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UNIVERSITY OF UTAH
SALT LAKE CITY 12, UTAH
See Plates 1 and 2 for index information.
Field Work: 1962
Plates 5-7 show results of geophysical work within area of Plate 4.
N
W
E
LEGEND
Rock characterized by limonite stains on joint surfaces; brownish in color.
Rock intensely opalized and contains disseminated hematite; red to light pink in color.
Rock mainly fine-grained mass of quartz, alunite and kaolinite; hard to powdery; white in color.
Dense silica with varying amounts of limonite stain.
Contact between altered rock types. (Contacts generally gradational.)
Contact between altered rock and post-alteration rock.
Lines of magnetometer traverse. (See Plates 5, 6 and 7.)
Lines of induced polarization traverse. (See Plates 8 and 9.)
R. 11 W.
R. 10 W.
T. 31 S.
BEAVER COUNTY
IRON COUNTY
113°05'00" W.
Monument Knolls Res.
Hot Springs Canyon
Hot Springs Canyon Pond
Prospect
Red Hill
Black Canyon
Mound Mountain
BLACK MOUNTAINS
TELEPHONE LINE
Marshall Well
Baboon Seep
X 5847
X 5694
X 5913
5798
5697
5722
5677
5999 X
X 6395
X 6526
X 6360
5879
6023
6102
X 7249
31
32
33
34
35
6
5
4
3
2
7
8
9
10
11
12
18
17
16
15
14
13
19
20
21
22
23
24

VERTICAL MAGNETIC INTENSITY PROFILES

NORTHWESTERN BLACK MOUNTAIN ALTERATION ZONE, IRON COUNTY, UTAH

(For location of profile traverse, see Plate 4.)

Vertical Scale in Gammas

Reconnaissance Survey with Jalander Magnetometer
By Max P. Erickson and E. Julius Dasch

Field Work: 1962