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Interpretation of the aeromagnetic pattern of the Uncompahgre primitive area San Juan Mountains, Colorado

by

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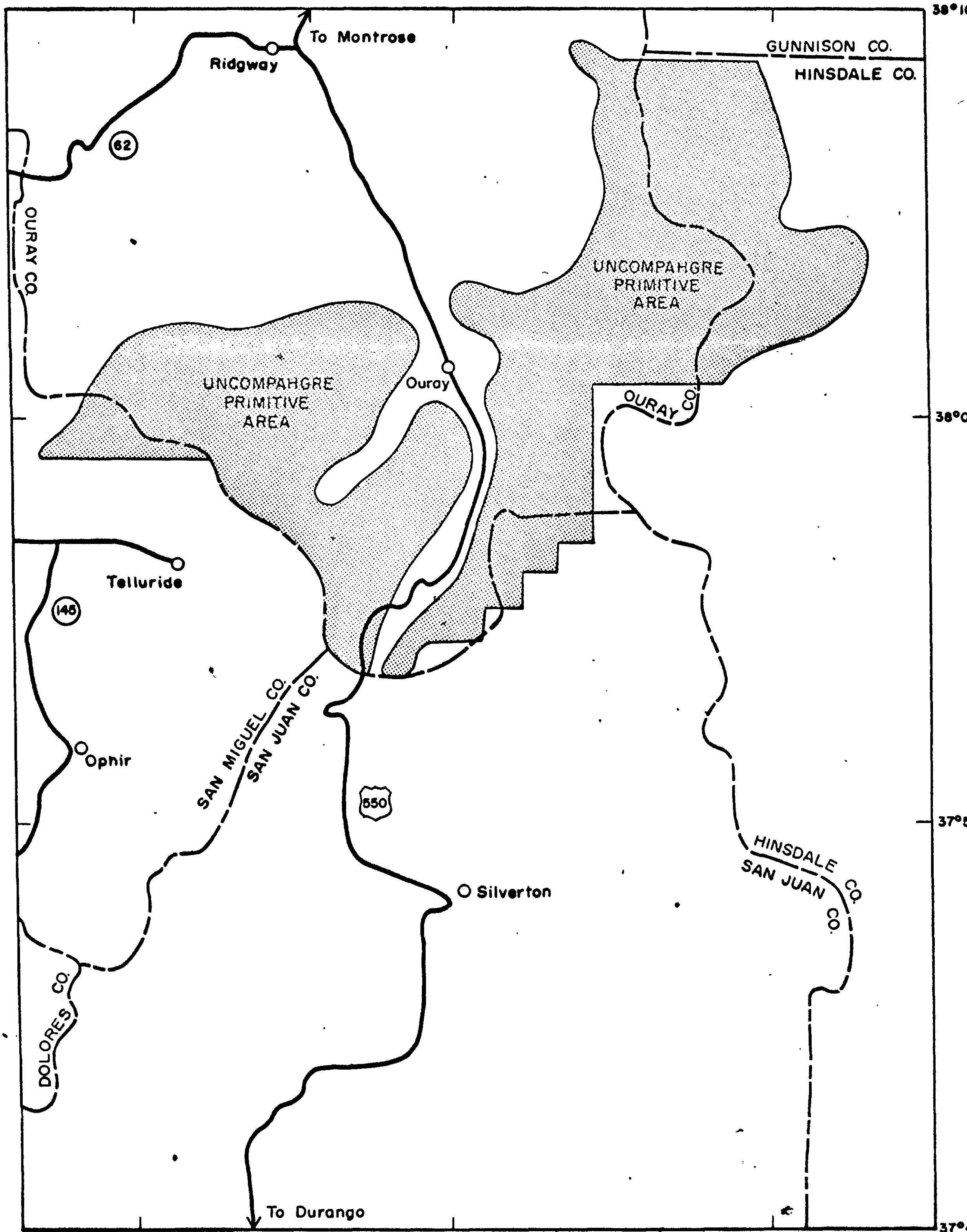

FIGURE 1 - INDEX MAP SHOWING LOCATION OF THE UNCOMPAHGRE PRIMITIVE AREA

Interpretation of the aeromagnetic pattern of the Uncompahgre primitive area San Juan Mountains, Colorado

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Introduction

An aeromagnetic survey of the Uncompahgre primitive area (fig. 1) was flown by the U. S. Geological Survey in 1969 as part of the wilderness investigation program. Traverses spaced about a mile apart were flown in an east-west direction at a barometric elevation of about 14,500 feet; the total intensity magnetic field was recorded with an ASQ-10 flux-gate magnetometer. An aeromagnetic map of the primitive and surrounding areas is shown on figure 2.

The geology and mineral resources of the Uncompahgre primitive area have been described in U. S. Geological Survey Bulletin 1261-C (Fischer and others, 1968), and the geologic map from this Bulletin should be used in conjunction with and as an underlay for the aeromagnetic map (fig. 2). The Tertiary volcanic units, however, are not subdivided on the geologic map in Bulletin 1261-C; therefore, the reader may wish to refer to the geologic maps of the Ouray (Luedke and Burbank, 1962), Ironton (Burbank and Luedke, 1964), and Telluride (Burbank and Luedke, 1966) quadrangles as well as Professional Paper 258 (Larsen and Cross, 1956) for a more detailed discussion of the geology of the area.

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The aeromagnetic pattern shown on figure 2 is extremely complex because of the diversity of the geologic sources of the anomalies and because of the extreme topographic relief in the area. Most of the anomalies shown on figure 2 are the compound effect of many causes and are difficult to interpret without extensive rock magnetic data. Many of the anomalies are, however, directly related to surface geology whereas other anomalies appear to have no obvious geologic cause. This second group of anomalies are of particular interest as they may indicate the presence or extent of blind intrusives or areas of extensive alteration, and thus areas of potential economic interest.

We wish to thank Donald Plouff of the U. S. Geological Survey for use of a preliminary gravity map of the San Juan Mountains region, and for discussions on the geophysical aspects of the area.

General magnetic field

The northwestern San Juan Mountains which includes the Uncompahgre primitive area appears to be a broad magnetic plateau. The northern edge of the plateau is marked by a discontinuous steep north-dipping gradient located approximately along the north boundaries of both parts of the primitive area (fig. 2). The southern edge of the plateau is bounded by a steep south-dipping east-trending linear gradient through the Whitehead Gulch area (Popenoe and Steven, 1969) located just south of the southern edge of figure 2. The western edge of the plateau, is less well defined and occurs about at 107°55' west longitude.

The level of the magnetic field over this broad plateau ranges from about 900 to 1200 gammas. Surrounding the plateau the magnetic field ranges from about 600 to 800 gammas. The total intensity of the earth's magnetic field within the plateau area is approximately 55,000 gammas, and increases about 100 gammas per 10 minutes latitude in a north-northeastern direction. Thus, a residual magnetic map with the earth's field removed, should give magnetic values about 300 gammas lower than the observed values along the northern edge of the plateau than along the southern edge.

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Superimposed on this magnetic plateau are a number of sharp aeromagnetic highs associated with the known middle Tertiary plutons such as Mount Wilson (A on figure 2), Ophir (B), Sultan Mountain (C) and Grizzly Peak (Popenoe and Steven, 1969). Within the primitive area sharp highs are associated with the known middle Tertiary plutons at Campbell Peak (D) and Mount Wilson (E). Sharp aeromagnetic highs are also associated with volcanic and intrusive rocks at Wetterhorn Peak (F), the divide south of Wetterhorn Peak (G), and an area north of Uncompahgre Peak (H). Most of the eastern part of the primitive area lies in the high regional aeromagnetic plateau and contains some of the highest regional magnetic levels associated with the plateau.

Aeromagnetic lows are also superimposed upon the plateau and include a low associated with the Silverton cauldron (I), the Eureka graben (J) (Luedke and Burbank, 1968), a narrow trough-like anomaly which strikes northeast diagonally across the primitive area between Ouray and Telluride (K), and in the eastern part of the primitive area at L.

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General gravity field

The Uncompahgre primitive area lies approximately at the western apex of a broad regional gravity low that is roughly triangular in shape and includes near its minima the towns of Silverton and Ouray in the west, South Fork in the southeast, and Poncha Pass in the northeast (American Geophysical Union, 1964). Gravity values range from a regional level of about -275 milligals to a minimum within the low of less than -325 milligals, particularly in the vicinity of Lake City, Silverton, Ouray, and Creede. The regional gravity low is bounded by steep gradients that locally average over 5 milligals per mile thus indicating that the cause of the anomaly must be in the shallow crust. Plouff (oral communication, 1970) believes the San Juan gravity anomaly to be similar to a large gravity low that follows the Colorado Mineral Belt to the northeast of the San Juan area. Case (1967) has interpreted the Colorado Mineral Belt gravity low as partially caused by a concealed batholith of relatively low density rock that underlies the Mineral Belt. The Tertiary porphyritic rocks associated with mineralization in the mineral belt are apophysis and cupolas of this underlying batholith. If the gravity low in the San Juan area reflects a similar batholith, it would be the source of the many cubic miles of volcanic debris of the San Juan volcanic field as well as the many middle Tertiary plutons found throughout the area.

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Magnetic and density measurements

Measurements were made of the magnetic susceptibilities and densities of rock samples collected within and surrounding the Uncompahgre primitive area (fig. 2) to estimate the influence of the various rock types upon the earth's magnetic and gravity field. The magnetic susceptibilities and densities of these rock samples are shown in table 1. Measurements of some additional rocks from nearby areas are given in table 2. Samples collected are not oriented, hence remanent directions and polarities will be estimated from a study of the aeromagnetic map (fig. 2) and profiles presented later.

One sample of intrusive rock of Cretaceous-Tertiary age (Laramide) was measured, and this sample of granodiorite from the Cow Creek laccolith has an intermediate susceptibility of 1.4×10^{-3} emu/cc. Intrusive rocks of Laramide age produce only small amplitude or no aeromagnetic anomalies in the Uncompahgre primitive area, therefore the sample is probably representative of this age of intrusive rock.

The magnetic data (tables 1 and 2) indicate the mafic middle Tertiary intrusive rocks have by far the highest magnetic susceptibilities. These rocks range in composition from granodiorite to gabbro and their magnetic susceptibilities range from 3.6×10^{-3} to 10.0×10^{-3} emu/cc and average 6.1×10^{-3} emu/cc. These high susceptibilities indicate a magnetite content ranging from 1 to 3 percent by volume (Lindsley, 1966). The high magnetic anomalies of Sultan Mountain, Mount Wilson, Ophir, and Mount Sneffels intrusive plutons support this high average susceptibility.

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The Koenigsberger ratio (Q) of these intrusive rocks of about .3 indicates that the induced magnetization is much stronger than the remanent magnetization and that they will produce normal magnetic anomalies with dipole lows to the north of them. The similarity of the magnetic properties of the separate plutons may indicate that they had a common source and were intruded during the same interval of geologic time, or at least that the composition of their magnetite is similar.

Two samples of the intrusive body on Dolly Varden Mountain (27 and 28 in table 1) and a sample of the pluton on the North Fork of Henson Creek (29), all of middle Tertiary age, have much lower susceptibilities ranging from $.1 \times 10^{-3}$ to $.9 \times 10^{-3}$. These rocks are rhyolitic in composition and do not produce recognizable anomalies or only small anomalies on the aeromagnetic map. Along the northern boundary of the primitive area and north of the primitive area much of the San Juan Formation must have reversed polarity as it is the cause of strong magnetic lows (anomalies M of fig. 2). In other areas such as between Cow Creek and the Uncompahgre River Valley the San Juan Formation produces weak positive anomalies that reflect the topography. This magnetic differentiation within the San Juan Formation must reflect geologic time divisions as well as lithologic divisions.

Most of the volcanic rocks measured have intermediate to low magnetic susceptibilities. Exceptions to this are one sample of Picayune Formation from Potosi Peak, two samples of the Henson Formation, one from Dolly Varden Mountain and one from Niagara Peak, and two samples of the Potosi Volcanic Group, one from Cutler Creek and one from Matterhorn Peak.

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All of these samples ranged between 2.2×10^{-3} and 4.8×10^{-3} emu/cc.

Densities of the mafic intrusive rocks of Tertiary age from Mount Sneffels, Grizzly Peak, Sultan Peak and Mount Wilson averaged 2.73 gms/cm^3; the rhyolitic intrusive rocks of the same age averaged 2.36 gms/cm^3, which is an exceptionally low density for rhyolitic rocks. The Tertiary volcanic rocks average 2.55 gms/cm^3, and the Precambrian rocks average 2.62 gms/cm^3.

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Table 1. - Magnetic, density and other measurements of rocks collected within and surrounding the Uncompahgre primitive area.

Sample Number	Description and Location	Density g/cm^3	$K \times 10^{-3}$ 1/	$J \times 10^{-3}$ 2/	Q 3/
1	Intrusive, granodiorite, Cow Creek	2.49	1.4		
2	San Juan Formation, W. side Whitehouse Mountain	2.23	2.2	0.5	0.4
3	San Juan Formation, S. side Potosi Peak	2.80	6.7	3.7	1.0
4	San Juan Formation, Potosi Peak	2.69	2.5	1.1	0.8
5	San Juan Formation, Idarado Mine	2.65	0.1	0.1	2.6
6	San Juan Formation, Imogene Basin	2.68	0.6	0.2	0.5
7	San Juan Formation, Amphitheater	2.57	0.1	0.0	0.2
8	San Juan Formation, Sister Peak	2.57	0.6	4.0	12.1
9	San Juan Formation, Sister Peak	2.63	0.1	1.8	21.5
10	San Juan Formation, Forsman Creek	2.60	0.3	2.6	14.2
11	San Juan Formation, Dexter Creek	2.55	0.1	0.3	6.2
12	San Juan Formation, Cutler Creek	2.61	1.7	0.2	0.2
13	San Juan Formation, Cimarron Ridge	2.57	2.7	3.7	2.5
14	Picayune Formation, Potosi Peak	2.69	4.8	4.7	1.8

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Table 1. - (Continued)

Sample Number	Description and Location	Density g/cm^3	K x 10^{-3} 1/	J x 10^{-3} 2/	Q 3/
15	Eureka Tuff, Mountain Top Mine	2.50	0.7		
16	Burns Formation, Richmond Basin	2.48	0.1	0.2	2.7
17	Burns Formation, North Fork Henson Creek	2.62	1.3		
18	Henson Formation, Silver Basin	2.58	1.5		
19	Henson Formation, Richmond Pass	2.64	0.4		
20	Henson Formation, Dolly Varden Mountain	2.69	3.2		
21	Gilpin Peak Tuff, Potosi Peak	2.57	0.0	0.8	
22	Gilpin Peak Tuff, Potosi Peak	2.58	0.0	0.2	
23	Potosi Volcanic Group, Cutler Creek	2.54	2.2		
24	Potosi Volcanic Group, Engineer Mountain	2.40	0.8		
25	Potosi Volcanic Group, Matterhorn Peak	2.62	4.1		
26	Intrusive, gabbro, Mount Sneffels	2.86	10.0		

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Table 1. - (Continued)

Sample Number	Description and Location	Density g/cm^3	K x 10^{-3} 1/	J x 10^{-3} 2/	Q 3/
27	Intrusive, rhyolite, Dolly Varden Mountain	2.25	0.9		
28	Intrusive, rhyolite, Dolly Varden Mountain	2.38	0.7		
29	Intrusive, rhyolite, North Fork Henson Creek	2.46	0.1	0.1	0.1

Footnote:

1/ K = Apparent volume magnetic susceptibility in emu/cm^3 measured with an induction type apparatus.

2/ J = Intensity of remanent magnetization in in emu/cm^3.

3/ Q = Koenigsberger ratio of remanent magnetization intensity to induced magnetization intensity.

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Table 2. - Magnetic, Density and other measurements of rocks collected near the Uncompahgre primitive area.

Description	Density	K x 10^{-3} 1/	J x 10^{-3} 2/	Q 3/
Gneiss, Animas River Valley	2.69	1.7		
Gneiss, Animas River Valley	2.62	1.2		
Granite, South Fork Gunnison River Valley	2.60	0.0		
Eolus granite, Needle Mountains	2.63	0.1		
Eolus granite, Needle Mountains	2.55	0.2		
San Juan Formation, Bridal Veil Basin	2.64	1.4	0.0	0.0
San Juan Formation, Lower Ice Lake Basin	2.71	0.2	0.8	0.6
Picayune Formation, Burrows Park	2.39	0.0		
Eureka Tuff, McCarty Basin	2.70	1.2	0.1	0.2
Eureka Tuff, Mill Creek	2.68	0.1		
Burns Formation, Eureka Gulch	2.69	0.0		
Burns Formation, Cinnamon Basin	2.61	0.0		
Henson Formation, Niagara Peak	2.70	4.5	1.9	0.7
Gilpin Peak Tuff, Rio Grande Valley	2.36	0.7		

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Table 2. - (Continued)

Description	Density	K x 10^{-3} 1/	J x 10^{-3} 2/	Q 3/
Sunshine Peak Rhyolite, Burrows Park	2.40	0.8		
Sunshine Peak Rhyolite, Burrows Park	2.55	0.2		
Sunshine Peak Rhyolite, Sunshine Peak	2.58	0.1	1.3	19.5
Sunshine Peak Rhyolite, North side Slumgullion Pass	2.53	1.2		
Intrusive, gabbro, Mount Wilson	2.71	5.8		
Intrusive, quartz diorite, Mount Wilson	2.52	4.9		
Intrusive, quartz diorite, Mount Wilson	2.75	6.0		
Intrusive, gabbro, Ophir	2.87	7.2	1.4	0.3
Intrusive diorite, Ophir	2.85	10.0		
Intrusive, granodiorite, Ophir	2.71	4.8		
Intrusive, granodiorite, Sultan Mountain	2.68	3.8	1.4	0.6
Intrusive, granodiorite, Grizzly Peak	2.69	5.4	0.9	0.3
Intrusive, granodiorite, Grizzly Peak	2.74	3.6	0.7	0.3
Intrusive, granodiorite, Sultan Mountain	2.70	6.1	1.3	0.3

Footnote:

1/ K = Apparent volume magnetic susceptibility in emu/cm^3 measured with an induction type apparatus.

2/ J = Intensity of remanent magnetization in emu/cm^3.

3/ Q = Koenigsberger ratio of remanent magnetization intensity to induced magnetization intensity.

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Magnetic and gravity profiles

Because of the complexity of the geology and aeromagnetic pattern, the extreme topographic relief, and the heterogeneous properties of the rocks, an examination of geologic sections and their corresponding magnetic and gravity profiles of the northwestern San Juan Mountains is necessary for a meaningful geophysical interpretation of the Uncompahgre primitive area. Figure 3 shows the aeromagnetic and gravity profiles along parts of five geologic sections from Larsen and Cross (1956, pl. 2). Sections A, B, and C are east-west profiles. Sections G and H are north-south profiles. Figure 4 shows the aeromagnetic profile along the modified geologic section (Fischer and others, 1968, pl. 1) across the Uncompahgre primitive area. Each of these sections and their magnetic and/or gravity profiles are discussed separately. The locations of those profiles relative to the primitive area are shown on the aeromagnetic map (fig. 2).

Profile A crosses north of the Uncompahgre primitive area and lies mainly in a broad magnetic low (anomalies M of fig. 2) north of the magnetic plateau (fig. 2). The San Juan Formation is the apparent cause of the magnetic low and in this area has a reversed polarity as suggested by the general conformity of the low to the outcrop pattern of the formation and the correlation of the minimums to topographic highs.

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This broad area of low magnetic values is reinforced by a dipole effect of the magnetic plateau to the south. Several small highs are developed on the low; the largest is over Sheep Mountain (anomaly N of fig. 2) which is capped by the Potosi Volcanic Group underlain by the upper San Juan Formation and intrusive middle Tertiary quartz latite sills (Larsen and Cross, 1956). The amplitude of the anomaly suggests that either the Potosi Volcanic Group and Upper San Juan Formation have very high susceptibility in this area or that the anomaly marks an intrusive center of mafic rocks, perhaps a volcanic vent. A comparison of this aeromagnetic expression with that of similar ridges capped with the same formations to the east suggests an intrusive center.

Profile B extends east southeasterly through the Uncompahgre primitive area. At the west end of the aeromagnetic profile are three anomalies associated with intrusive plutons of intermediate to mafic composition. The middle and sharpest anomaly is related to the Mount Sneffels gabbroic pluton, while the western one is related to the granodiorite plutons in and west of Campbell Peak (anomalies D and E of fig. 2). The third anomaly east of Mount Sneffels appears to be in part a northeast extention of the Mount Sneffels anomaly; this extension includes Potosi Peak and Whitehouse Mountain that are capped by mainly the San Juan Formation, a small thickness of the Picayune Formation, and the Gilpin Peak Tuff (Luedke and Burbank, 1962; Burbank and Luedke, 1966). Depth estimations from the gradients suggest that the top of the anomalous body is at about ground elevation. The magnetic properties of the rock samples from Potosi Peak (fig. 2, table 1)

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show the San Juan and Picayune Formations have unusually high susceptibilities. The San Juan Formation in section A was shown to be reversely polarized, however in this area it must be strongly magnetic and normally polarized to be the cause of this anomaly. Three possible explanations may account for this contradiction: 1) a stratigraphically higher and more mafic facies of the formation was deposited during an interval of normal earth polarity; 2) the area may be underlain at a very shallow depth by mafic intrusive rock similar to that of Mount Sneffels; and 3) the formations may have been locally metamorphosed by the Mount Sneffels intrusive pluton to the extent that the magnetic properties were changed.

East of the three highs and west of the intersection G-G' in section B is an area or trough of low magnetic intensity that extends from the vicinity of Ouray southwestward to the vicinity of Telluride. This magnetic low is a composite of effects partially related to topography, thin section of volcanic rocks, and magnetic reversal in the lower part of the San Juan Formation. In this area a thin section of volcanic rocks overlies a moderately thick section of Precambrian crystalline and Paleozoic and Mesozoic sedimentary rocks. This area is also moderately to locally intensely altered and mineralized; the magnetic low crosses about at right angles many generally northwest-trending productive veins. The magnetic low is too coincident with the altered and mineralized area not to speculate that hydrothermal solutions destroyed much of the original magnetite in the rocks and that alteration is partially responsible for the low.

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The altered sample of San Juan Formation from the nearby Idarado mine area with a measured low susceptibility (table 1) tends to support alteration as part of the cause. A magnetic low similar to this but larger is associated with mineralized areas of the Boulder batholith of Montana (Hanna, 1969).

A northeast trending positive anomaly of about 100 gammas (Q of fig. 2) parallels the magnetically low trough and separates it from the magnetic low representing the Silverton Cauldron (anomaly I) and an area of thin volcanic rocks along Red Mountain Creek (anomaly R). The anomaly no doubt represents the combined effects of thickened volcanic section across the topographic divide and the numerous small plutons of intermediate to silicic composition intruding this part of the ring fracture zone of the cauldron.

The eastern half of profile B crosses a broad aeromagnetic high that occurs over a thick section of intermediate to mafic volcanic rocks in the Silverton Volcanic Group, normally polarized thick ash flow tuffs in the Potosi Volcanic Group, and intermediate to silicic middle Tertiary plutons. Most of the eastern primitive area lies in this large high.

In profile B, the gravity profile shows that the entire San Juan area lies within the regional San Juan gravity low. Very little gravity anomaly is associated with the quartzite and slate in the Precambrian Uncompahgre Formation. A striking contrast is evident between the gravity expression of the known Precambrian rocks and those both to the north and south (see sections G and H). One can postulate that the Precambrian rocks here are a thin roof on a batholith underlying the northwestern San Juan Mountains.

Section C is south of the primitive area but in many respects is similar to section B. The large sharp aeromagnetic anomalies at the west end of the profile are related to the Mount Wilson and Ophir intrusive bodies (anomalies A and B, fig. 2), and the low west of the intersection G-G' on the aeromagnetic profile is associated with the Silverton Cauldron. This low as seen in figure 2 (anomalies I and J) outlines the cauldron and the northeast trending Eureka graben and probably reflects the high amount of alteration of the rocks, particularly in the western half of the cauldron. A strong magnetic ridge east of the cauldron (anomaly S, fig. 2) is associated with a northeast trending fracture zone among the rim of the cauldron. This ridge probably reflects intrusive bodies along the fracture zone.

Section G crosses the eastern half of the primitive area and shows large magnetic highs over the Sultan Mountain intrusive body to the south and the eastern primitive area to the north. The magnetic high (anomaly T, fig. 2) over the eastern primitive area is caused by the intermediate intrusive bodies in Cow Creek and the mafic lithologies in the upper San Juan formation.

The gravity profile shows the San Juan gravity low from the Needle Mountains on the south to west of the Powderhorn area on the north and the match of the gravity gradients with gradients of the San Juan magnetic plateau.

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Section H is east of the primitive area and occurs just east of the eastern boundary of figure 2. The profile, however, shows the large regional high over the northwestern San Juan Mountains with superimposed sharp magnetic anomalies related to surface volcanic units and topography. The gravity profile likewise shows the regional San Juan gravity low and the close relationship of the gravity low with the regional aeromagnetic high.

Figure 4 shows the modified geologic section (Fischer and others, 1968, pl. 1) and its related aeromagnetic profile within the Uncompahgre primitive area. Some of the volcanic units have been added to the cross section to show their corresponding aeromagnetic expressions. The western end of the profile crosses both the Campbell Peak and Mount Sneffels plutons which have been previously discussed. Local plateaus and steep gradients on the east side of the anomalies are related to the volcanic units on Whitehouse Mountain and Potosi Peak and were discussed on page 15.

The magnetic profile (fig. 4) crosses the broad low in the vicinity of Ouray where Precambrian, Paleozoic and Mesozoic rocks crop out. The increase of 100 gammas that builds the shelf on the east side of the low is caused by the proximity of the magnetometer to the more magnetic Late Cretaceous-early Tertiary (Laramide) intrusives in and surrounding the Blowout. The magnetically low area is due to the totally lacking or very thin section of volcanic rocks overlying nonmagnetic sedimentary rocks.

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East of this low the magnetic level increases eastward over the San Juan Formation. Although much of the magnetic increase is closely related to topography, which brings the magnetic materials closer to the magnetometer, and thickening of the volcanic units, steep gradients occur where the San Juan Formation is above 11,000 feet in altitude, thus indicating that the upper 1,500 feet of the formation contains more highly magnetic rock (see samples 11, 13, table 1). The area is also intruded by numerous middle Tertiary stocks, dikes, and sills which do not contrast significantly with the volcanic units to cause recognizable individual anomalies. Sharp anomalies occur over Wetterhorn Peak and over a peak south of Wetterhorn Peak (anomalies F and G of fig. 2). These sharp magnetic highs occur where the magnetometer came very close to the Potosi Volcanic Group which is highly magnetic in this area (sample 25, table 1) and caps the peaks. The large magnetic anomaly just northeast of Uncompahgre Peak (anomaly H of fig. 2) is caused by both a thickening of the Potosi Volcanic Group and probably a blind middle Tertiary intrusion similar to Mount Sneffels of intermediate to mafic composition that intrudes the San Juan Formation in this area and to which the individual small intrusions evident at the surface are attached at depth.

Between Matterhorn and Uncompahgre Peaks, the profile touches a closed magnetic low (anomaly L of fig. 2). This low occurs over a topographic low casued by the East Fork of the Cimarron River, however, it also occurs over a highly altered and locally mineralized area on the northeast side of Matterhorn Peak.

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General discussion and computed magnetic model

Although the upper part of the San Juan Formation and the Potosi and Silverton Volcanic Groups are relatively highly magnetic in the eastern primitive area and many of the magnetic gradients are stratigraphically related, the general high has gradients that cross stratigraphic boundaries in map view. The northern gradient of the large magnetic plateau does not appear to be related to mapped geologic units. The low (M of fig. 2) over reversely polarized San Juan Formation appears larger than can be totally explained by the magnetic reversal and is strongly suggestive of the dipole effect of a large thick normally polarized magnetic body to the south, similar to anomalies O and P in the eastern primitive area. All of this plus the coincidence of the aeromagnetic high in the primitive area and the area to the south with scattered middle Tertiary intrusive dikes, sills and plutons of intermediate composition related in age to the Mount Sneffels-Stony Mountain intrusive bodies (Fisher and others, 1968) suggest that the chief cause of the high is a large stock of intermediate to mafic material underlying the eastern primitive area at a very shallow depth. Analyses of the intrusive quartz latites in the Ouray quadrangle (Larsen and Cross, 1958) show that the intrusive rocks contain 2 to 4 percent magnetite and thus would have a susceptibility similar to the Mount Sneffels intrusive.

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In order to test whether the general magnetic buildup observed in the eastern primitive area and specific anomalies could be generated by topography on a slab of relatively magnetic material overlying a slab of lower magnetic susceptibility, a 2-dimensional magnetic model was computed utilizing the geologic cross section of figure 4 and maximum susceptibilities measured for the volcanic rocks in the area. This model and the resulting magnetic profile are shown on figure 4.

A good correlation exists between the observed topographic anomalies and the calculated model, however no magnetic buildup is seen in the eastern primitive area on the calculated model. The difference between the observed profile and the calculated model could be accounted for by a body of magnetic material extending to a far greater depth than can be shown by a geologic projection of the volcanic rocks, or a large mafic pluton of similar composition for Mount Sneffels underlying the entire eastern primitive area.

The anomaly over Wetterhorn peak (F) is probably related entirely to topography. The model was calculated to show that the aircraft flew at a constant barometric level of 14,500 feet when in reality it probably varied within several hundred feet of this elevation. Thus, a larger anomaly could have been generated by the peak such as the anomaly calculated over Uncompahgre Peak where the aircraft theoretically passed within 300 feet.

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The poor match of the observed and calculated profiles east of Uncompahgre Peak shows that the observed anomaly probably reflects both a thickening of the magnetic volcanic rocks and a large cupola of intrusive rocks in this area.

The large eastern primitive area high thus probably reflects a near surface projection from the larger batholith that Plouff believes underlies the entire San Juan area from magnetic and gravity evidence. This particular pluton is not defined by a corresponding gravity low because it is intermediate to mafic in composition and thus fairly dense.

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Conclusions

The most interesting anomalies in the Uncompahgre primitive area especially from an exploration viewpoint are not the magnetic highs but the lows that probably reflect areas where the magnetic minerals have been destroyed by hydrothermal solutions. The magnetic low or trough between Ouray and Telluride, which is a known mineralized area discussed by Fischer and others (1968), is an excellent example (anomaly k, fig. 2). Another highly altered and locally mineralized area is the western part of the Silverton cauldron in the southern part of and south of the primitive area (I, fig. 2). A further untested example is the magnetic low area between Wetterhorn and Uncompahgre Peaks which overlies a highly altered area (fig. 2). In an area of complex magnetic patterns such as the Uncompahgre primitive area, other such anomalies, although smaller, may exist but are obscured by the larger anomalies present. These might be better disclosed by a lower flight level or a ground survey.

A second interesting feature of the aeromagnetic map is the general eastward increase of the magnetic level. Individual anomalies related to surface and near-surface features are a part of this increase and have magnetic gradients clearly related to particular stratigraphic horizons in the volcanic units. However, the overall magnetic increase reflects both a thickening of the volcanic section and possibly a large intrusive body of intermediate to mafic rock at a shallow depth from which the middle Tertiary plutons are cupulas and apophyses.

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