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IGNEOUS ROCKS OF THE ELK MOUNTAINS AND VICINITY, COLORADO CHEMISTRY AND RELATED ORE DEPOSITS

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INTRODUCTION

Late Mesozoic and Cenozoic igneous rocks of the Elk Mountains and vicinity (fig. 1) may be divided into three suites on the basis of field relations, isotope dating, and petrochemical data. Each igneous suite is associated with coeval metallic mineral deposits. In this paper we outline the chemical characteristics of each suite and summarize the nature of the associated mineral deposits. Major element rock chemical data used are from Bryant (1979), Cross (1894), Cunningham (1976), Ernst (1980), Godwin and Gaskill (1964), Mutschler (1968, and unpublished data), Vanderwilt (1937), and Young (1972). These data are available in a computer-readable data bank—PETROS (Mutschler and others, 1981).

LARAMIDE (LATE CRETACEOUS AND PALEOCENE) SUITE

Hornblende quartz diorite, quartz porphyry, aplite, and aplite porphyry form sills and fault-controlled plutons in the Aspen mining district on the west flank of the Sawatch Range (Bryant, 1979). These rocks, which have K-Ar ages of 67-72 m.y. (Table 1), were emplaced during Laramide uplift of the Sawatch Range (Obradovich and others, 1969). Westward gravity gliding of a sheet of upper Paleozoic and Mesozoic sedimentary rocks from the Sawatch Range produced the Elk Range thrust fault at about the same time. Volcanism in the Sawatch Range probably occurred during the Laramide plutonic event since the Paleocene Ohio Creek Formation in the Ruby Range, West Elk Mountains, and Piceance basin contains clasts of fine-grained igneous rock. Volcanism probably continued into early Eocene time, since the lower part of the Wasatch Formation in the Ruby Range and Piceance basin contains tuffaceous beds and numerous clasts of fine-grained igneous rock. Only seven major-element chemical analyses are available for Laramide rocks from the Aspen area. Bryant (1979) has pointed out that these analyses show a bimodal distribution of SiO, values (fig. 2). Such bimodality is not a characteristic of Laramide igneous suites elsewhere in the Rocky Mountains, suggesting either that it may represent a sampling artifact or that other Laramide plutons with intermediate silica content may be present at depth in the Aspen area.

The great Laramide silver-lead-zinc manto deposits of the Aspen district produced ore valued at more than $100,000,000. Argentian tetrahedrite-tennantite, pearcite, argentite, argentiferous galena, and sphalerite in a barite-carbonate-quartz gangue were the main hypogene minerals, but supergene native silver was locally common to depths of up to 250 meters.

MIDDLE TERTIARY (OLIGOCENE) SUITE

Middle Tertiary granodiorite rocks are widespread in the western Sawatch Range, Elk Mountains, Ruby Range, and West Elk Mountains. Available K-Ar ages (Table 1) show that they were emplaced in the five million year interval between 34 and 29 m.y. These voluminous Oligocene rocks are temporally and chemically similar to Oligocene igneous rocks of the San Juan volcanic field (Lipman and others, 1969). In contrast to the San Juan volcanic field, significant ash-flow tuff eruptions and caldera formation did not occur in the Elk Mountains area. On the basis of Pb and Sr isotopic data, Lipman and others (1978) have suggested that the San Juan Oligocene magmas were generated in the mantle and that they were significantly contaminated by interaction with the lower crust and Precambrian cratonic lithosphere.

The Elk Mountain Oligocene suite shows a typical calc-alkaline trend on an AMF plot (fig. 3). Most samples have silica contents (calculated volatile free) between 58 and 70 percent (fig. 2). The "double maxima" at 59 and 67 percent SiO_2 on Figure 2 represents in part an oversampling of volumetrically minor mafic phases of plutons, but in part, also reflects the mafic character of the West Elk Breccia (see below).

Field relations and isotopic dating suggest that the Oligocene suite may be subdivided into the following four stages. There is probably some time overlap between stages.

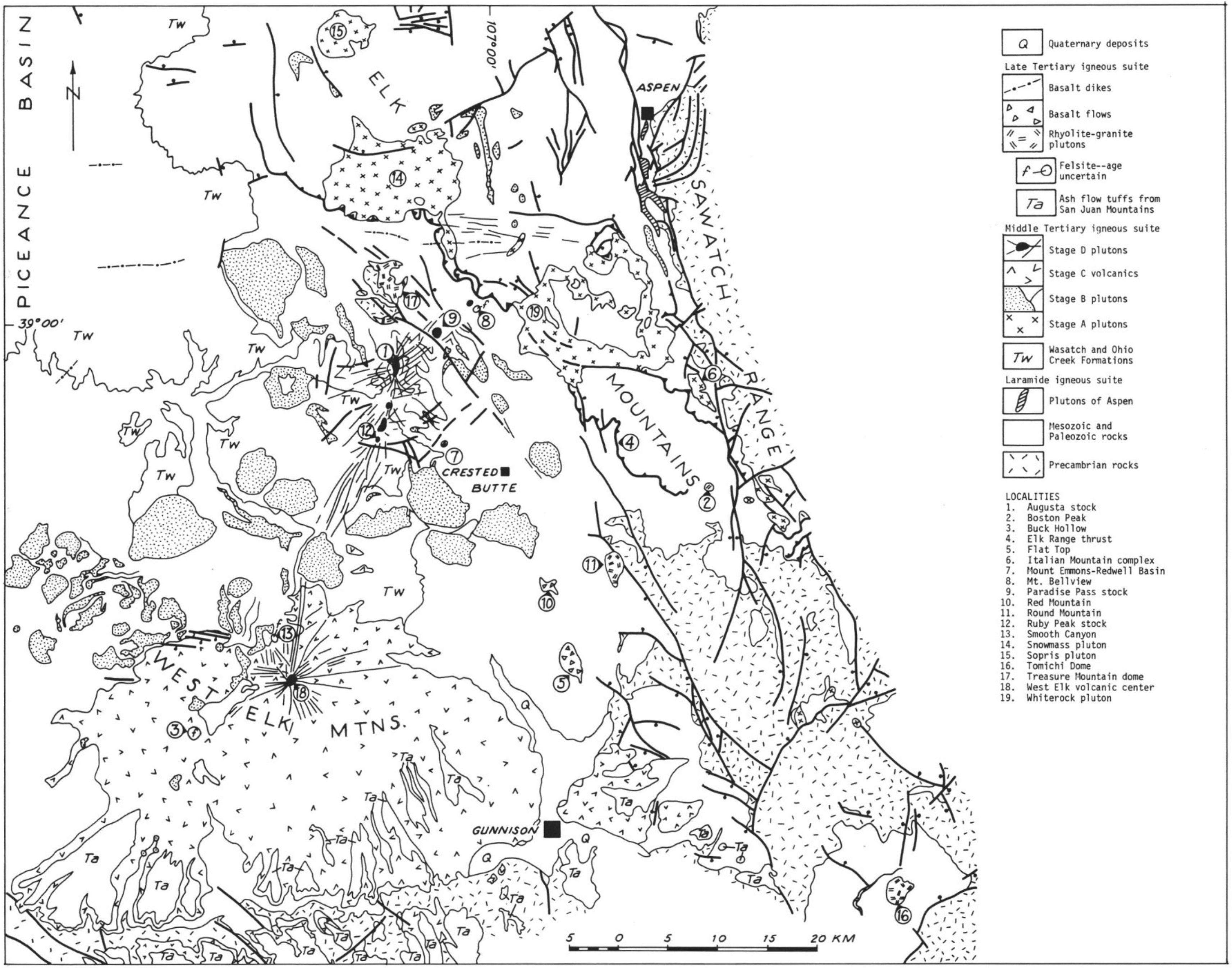

Figure 1. Geologic sketch map, Elk Mountain and vicinity, Colorado. Modified from Tweto and others (1976, 1978). Numbers refer to localities described in legend and text.

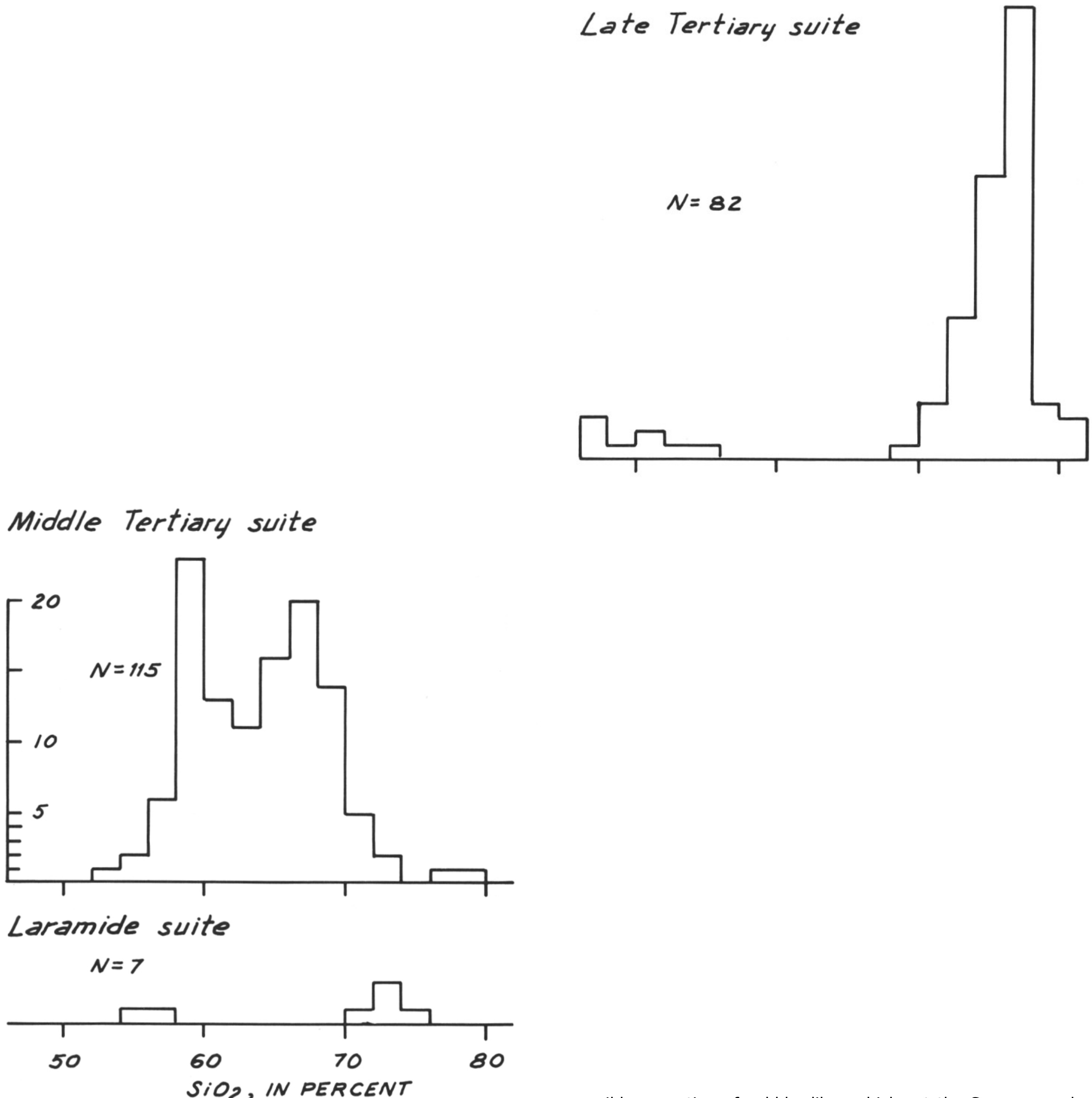

Figure 2. Histograms of SiO_2 contents for rock suites. Interval for SiO_2 is 2 percent. Plotted from analyses recalculated to 100 percent free of volatiles. N = number of analyses.

Fig
A
of

Stage A

Emplacement of large plutons of equigranular to porphyritic granodiorite in the Elk Mountains marked the onset of Oligocene magmatism. From north to south the major plutons include the Sopris, Snowmass, and Whiterock plutons, and the Italian Mountain complex (fig. 1). The Snowmass and Whiterock plutons and the Italian Mountain complex each show a chemical progression from early mafic granodiorite border phases and apophyses to late silicic granodiorites (fig. 4). Cunningham (1976) has shown that venting occurred in the Italian Mountain complex, but with the possible exception of pebble dikes which cut the Snowmass pluton (Mutschler, 1970) no other evidence of venting has been observed. Extensive contact metamorphic aureoles surround Stage *A* plutons.

Ore deposits associated with Stage A plutons include:

1) A contact metamorphic limestone replacement magnetite-pyrite deposit in Belden limestone adjacent to the Whiterock pluton (Bryant, 1979).

2) Disseminated pyrite-chalcopyrite-molybdenite showings straddling contacts of the Whiterock pluton (Bryant, 1971).

3) Numerous small fissure vein and limestone replacement silver-bearing, lead-zinc-copper sulfide deposits in, and adjacent to,

Table 1. K-Ar ages for igneous rocks, Elk Mountains and vicinity, Colorado.

Suite		Rock Type	Location	Age (m.y.)	Reference
Laramide (Late Cretaceous and Paleocene)		Quartz-muscovite porphyry	Aspen	72.2 ± 2.2	Obradovich and others (1969)
		Aplite	Aspen	70.0 ± 2.3 67.4 ± 2.2	Do
Middle Tertiary (Oligocene)	Stage A	Granodiorite	Sopris pluton	34.2 ± 0.8	Cunningham and others (1977)
		Granodiorite	Snowmass pluton	34.1 ± 1.4	Obradovich and others (1969)
		Granodiorite	Whiterock pluton	33.9 ± 1.0	Do
	Stage B	Granodiorite porphyry	Snowmass Creek sill	31.2 ± 1.1	Do
		Granodiorite porphyry	Crested Butte laccolith	29.1 ± 1.0	Do
	Stage D	Granodiorite	Paradise Pass stock	29.0 ± 1.1	Do
Late Tertiary (Miocene)		Rhyolite porphyry	Mount Emmons	17.7 17.3	Dowsett and others (1981)
		Rhyolite porphyry	Round Mountain	13.9 ± 0.3	Cunningham and others (1977)
		Granite porphyry	Treasure Mountain	12.4 ± 0.6	Obradovich and others (1969)
		Microgranite	Tomichi Dome		
		Rhyolite	Boston Peak		
		Basalt flows	Red Mountain and Flat Top mesa	10.9 - 9.7 ± 0.6	C. S. Robinson (personal communication, 1979)

the Snowmass and Whiterock plutons and the Italian Mountain complex. Pyrite, argentiferous galena, sphalerite, and chalcopyrite in a quartz-calcite gangue characterize these deposits. Ruby silver minerals have been reported from the Sylvanite mine adjacent to the Whiterock pluton by Emmons and others (1894). Although some high grade ore was shipped as early as the 1870's and 1880's, total value of production from these deposits has probably not exceeded $100,000.

Two unique nickel-cobalt-silver vein deposits occur in large inclusions, or roof pendants, of Paleozoic sedimentary rocks in the Whiterock pluton (Emmons and others, 1894). Pyrite, sphalerite, galena, chalcopyrite, argentite, pyrargyrite, proustite, marcasite, native silver, nickel- and cobalt-bearing loellingite, smaltite, skutterudite, and erythrite in a calcite-siderite-barite gangue have been reported from these deposits (Eckel, 1961).

Stage B

Granodiorite porphyry dikes cut Stage A plutons in the Elk Mountains. Similar granodiorite porphyry forms sills, laccoliths and dikes elsewhere in the Elk Mountains and in the Ruby Range and West Elk Mountains. Most of these Stage B granodiorite porphyry plutons are relatively silicic, containing 64 to 68 percent Si°, (fig. 4), but locally they contain more mafic granodiorite xenoliths similar to the early mafic granodiorites of Stage A plutons. Contact metamorphism adjacent to Stage B plutons is not as extensive as that associated with Stage A plutons.

No metallic mineral deposits are known to have formed during Stage B.

Stage C

During Stage C a group of composite andesitic stratovolcanoes developed in the West Elk Mountains. The eruptive products of these volcanoes constitute the West Elk Breccia described by Gaskill and others (1981). The bulk composition of the West Elk Breccia is less silicic than most of the granodiorites of Stages A and B (fig. 4).

The West Elk Breccia is lithologically and chemically similar to the early intermediate lavas and breccias of the San Juan volcanic field which formed in the interval 34.7-31.1 m.y. (Steven and Lipman, 1976). We have not dated the West Elk Breccia directly, but on stratigraphic grounds we believe it formed in the interval between Stage B plutons (31-29 m.y.) and Stage D plutons (29 m.y.). In the San Juan volcanic field the early intermediate lavas and breccias were followed by caldera related ash-flow eruptions of more silicic composition. The Blue Mesa Tuff dated at > 27.8< 28.4 m.y. by Steven and Lipman (1976) is the oldest of these San Juan ash-flow tuffs which overlie West Elk Breccia.

Small sub-volcanic intrusives, generally of mafic andesite or hornblende granodiorite, occur in the vent areas from which the West Elk Breccia was erupted. Some of these plutons formed early in the volcanic cycle, but the radial dike swarm of the West Elk volcanic center (here referred to Stage D) cuts some of the youngest preserved volcanic strata.

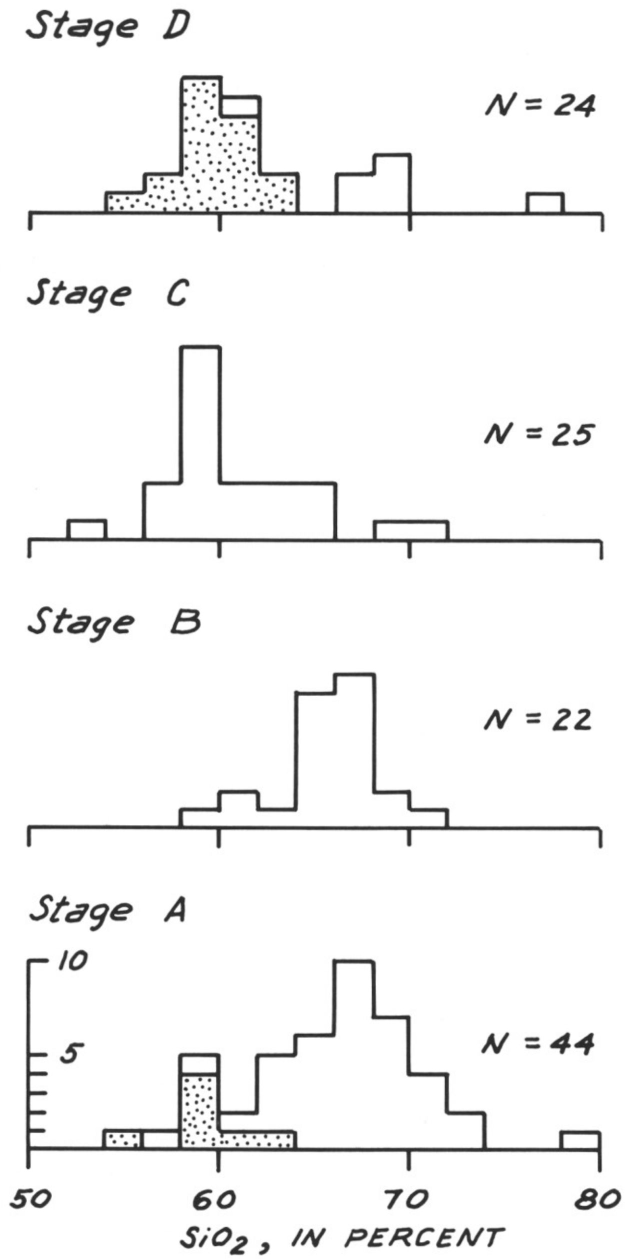

Figure 4. Histograms of SiO_2 contents for stages of middle Tertiary suite. Interval for SiO_2 is 2 percent. Plotted from analyses recalculated to 100 percent free of volatiles. N = number of analyses. Stippled areas include mafic border phases of stocks (Stage A); and mafic border phases of stocks and rocks of West Elk volcanic center (Stage D).

No metallic mineral deposits are known to have formed during this volcanic event.

Stage D

A northeast-trending zone of small stocks, several of which are the centers of radial, or linear, dike swarms extends from the West Elk volcanic field (West Elk volcanic center), along the crest of the Ruby Range (Ruby Peak, Mount Owen, Afley, Augusta, and Paradise Pass stocks), to the Elk Range (Schofield stock). The West Elk volcanic center represents the high-level intrusive center of a stratovolcano, and it is possible that some of the other stocks may be roots of volcanoes. The central stock and radial dikes of the West Elk volcanic center are mafic (58-62 percent SiO_2) andesites. The Mount Owen, Augusta, and Schofield stocks have borders of mafic granodiorite. These mafic borders and related dacite dikes (Gaskill and Godwin, 1966; Gaskill and others, 1967) represent the early phases of each stock, since they are cut by more silicic (66-70 percent SiO_2) dikes or stock-interior granodiorites.

In contrast to Stage B granodiorite porphyry plutons, the small granodiorite stocks of the Ruby Range have contact metamorphic aureoles that extend one or more kilometers into the wall rocks. Metallic mineralization associated with Stage D plutons in the Ruby Range includes: (1) disseminated pyrite-chalcopyrite-molybdenite deposits; (2) quartz-pyrite-base metal sulfide vein and replacement deposits; (3) calcite-pyrite-base metal sulfide vein and replacement deposits; and (4) quartz-ruby silver-arsenopyrite-sulfantimonide veins and replacement deposits. The sequence 1 to 4 is both spatial and temporal—representing increasing distance from the central stock, and progressively younger mineralization. Although Gaskill and others (1977) have reported several areas of hydrothermal alteration and geochemical anomalies, no significant metallic mineral showings have been found at the West Elk volcanic center. This may be a function of the fact that only mafic andesites are present at the West Elk center, whereas more silicic, and more highly differentiated, granodiorites occur in the Ruby Range stocks. Alternatively, the lack of mineralization at the West Elk center may be a function of level of erosion. The West Elk center has not yet been eroded to the base of its volcanic pile, whereas any volcanics originally present in the Ruby Range have been stripped away.

Mineral Deposits

Disseminated pyrite-chalcopyrite-molybdenite deposits

The Paradise Pass stock (Mutschler, 1968, 1970) at the north end of the Ruby Range shows well-developed disseminated sulfide mineralization typical of a "granodiorite molybdenite system" (Mutschler and others, 1981). Medium-grained hypidiomorphic granodiorite makes up the bulk of the stock. Thin dikes of fine-grained allotriomorphic-granular aplite and alaskite cut the stock and Mancos Shale albite-epidote-hornfels adjacent to the stock. Large areas of the stock are cut by a stockwork of quartz-sericite-pyrite veins which locally carry molybdenite and chalcopyrite. Pervasive quartz-sericite-pyrite alteration between veinlets is locally developed. The most intense alteration shows a close spatial relation to the margins of the stock (fig. 5). Comparison of major- element analysis of fresh and altered granodiorite (Table 2) show an increase in Si°, and H_20+, and a decrease in Na_2O, in the altered rock. This is typical of quartz-sericite-pyrite alteration. Three small "pipes" or areas of almost complete replacement of granodiorite by quartz, sericite, and sulfides occur in the northern part of the stock (fig. 5).

Surface areas which contain more than 100 ppm Mo in rock are generally coincident with areas of intense quartz-sericite-pyrite alteration and are restricted to the Paradise Pass stock. Areas in which Cu in rock exceeds 100 ppm form a crude circular sheath surrounding the stock. Copper anomalies tend to extend radially outside of molybdenum anomalies.

Quartz-pyrite-base metal sulfide and calcite-pyrite-base metal sulfide veins cut molybdenite-bearing quartz-sericite-pyrite veins. A late period of argillic alteration, which is largely fracture controlled, occurred contemporaneously with the base metal event. Isolated molybdenite-bearing quartz-sericite-pyrite veins occur in the Augusta stock, and disseminated pyrite occurs in the Ruby Peak stock.

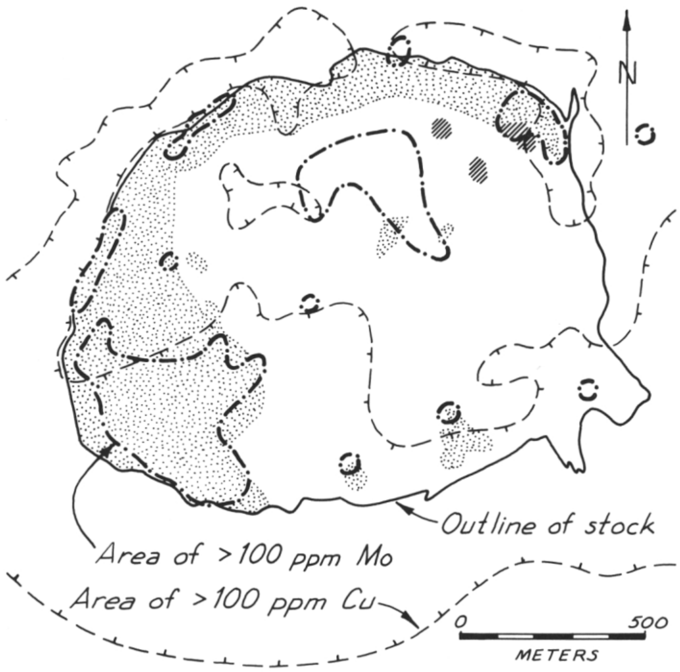

Figure 5. Sketch map showing surface alteration and metallization of Paradise Pass stock. Areas of intense quartz-sericite-pyrite alteration are stippled. "Pipes," or areas of almost complete replacement by quartz, sericite, and sulfides, are diagonally ruled.

Ruby silver deposits

Ruby silver veins in the Ruby Range were originally prospected in the 1870's and 1880's. The entire area is pockmarked with prospects, but only two areas have produced more than a few tons of ruby silver ore. In the Ruby (Irwin) district, east of the Ruby Peak stock, production has come from northeast-, northwest-, and east-trending quartz-arseno-pyrite-pyrargyrite-proustite-tetrahedrite-galena-argentite- pyrite-chalcopyrite-sphalerite veins. In the Augusta (Poverty Gulch) district veins consisting of quartz-pyrite-calcite-rhodochrosite-galena-sphalerite-ruby silver minerals-tetrahedrite-boulangerite-jamesonite and owyheeite have been worked. These veins occur both within, and peripheral to, the August stock. Total production of ruby silver ores from these two districts probably had a value of less than $1,000,000.

LATE TERTIARY (MIOCENE) SUITE

During Miocene time a bimodal assemblage of basaltic and rhyolitic magmas reached a high crustal level, and locally vented to the surface, in the Elk Mountains and environs. Similar late Tertiary bimodal suites are widespread in the western United States and are believed to be emplaced in an extensional tectonic setting (Christiansen and Lipman, 1972; Mutschler and others, 1978). Isotopic studies of the late Tertiary bimodel suite in the San Juan Mountains (Lipman and others, 1978) suggest that the basaltic magmas were derived by partial melting of the upper lithospheric mantle, and that the rhyolites may represent partial melts of the lower crust.

In the Elk Mountains and vicinity basaltic rocks include remnants of lava flows on Red Mountain and Flat Top mesa between Ohio Creek and the East River north of Gunnison, and scattered small dikes of gabbro porphyry and lamprophyre in the Elk Mountains and Ruby Range.

Table 2. Chemical analyses of rocks from Paradise Pass stock. (1, 2 = fresh granodiorite; 3 = fresh aplite dike; 4 = altered granodiorite).

	1	2	3	4
SiO_2	67.40	68.00	77.20	78.90
Al_2O_3	16.10	15.50	12.40	7.70
Fe_2O_3	1.80	1.90	0.37	2.20
FeO	1.70	1.60	0.12	0.40
MgO	1.60	1.10	0.14	0.62
CaO	3.10	3.30	0.19	2.40
Na_2O	3.40	3.40	1.60	0.28
K_2O	3.00	3.40	7.30	3.30
H_2O+	0.85	0.80	0.45	1.70
H_2O-	0.10	0.17	0.06	0.31
TiO_2	0.39	0.40	0.10	0.16
P_2O_5	0.34	0.29	0.02	0.15
MnO	0.07	0.02	0.00	0.30
Co_2	0.05	0.02	0.02	0.82
Total	99.90	99.90	99.97	99.24

Miocene rhyolitic rocks include the granite of Treasure Mountain (Mutschler, 1968, 1970), a rhyolite breccia pipe complex in Redwell Basin (Gaskill and others, 1967; Sharp, 1968), a buried rhyolite-granite plug at Mount Emmons (Dowsett and others, 1981), the Round Mountain rhyolite prophyry stock, rhyolite vents and a breccia pipe at Boston Peak (Ernst, 1980), a rhyolite and microgranite pluton at Tomichi Dome (Stark and Behre, 1936; Ernst, 1980), and small dikes and sills in the Elk Mountains and Ruby Range. Typical analyses of these rocks are given in Table 3.

Venting clearly occurred at Boston Peak (Ernst, 1980) and venting has been suggested to have occurred at Treasure Mountain (Mutschler, 1968), Redwell Basin (Sharp, 1978), and Tomichi Dome (Ernst, 1980). Any of these areas could have been the source for rhyolite pumice tuff which underlies 10.9 m.y. old basalt flows on Red Mountain and Flat Top (Gaskill and others, 1981).

Chemically the Miocene rhyolites and granites are granites in the sense of Tuttle and Bowen (1958). That is, their norms show Or + Ab + Q > 80%, and when Or, Ab, and Q are normalized to total 100%; Or > 20%, Ab > 20%, and Q > 20%. All of these rocks show significant enrichment of the lithophile elements Be, Cs, F, Li, Nb, Rb, Sn, Th, U, W, Y, and Yb. They also show significant depletion of Ba, Cu, Sr, and Zr relative to the average low calcium granite of Turekian and Wedepohl (1961). The trace element enrichment and

*Table 3. Chemical analyses of Miocene rhyolites and granites. (*Total Fe reported as Fe_2O_3.)*

	1	2	3	4	5	6	7	8
SiO_2	75.80	76.80	79.00	74.20	70.60	75.84	75.80	75.90
Al_2O_3	12.80	12.50	12.00	12.80	14.60	13.29	13.80	12.28
Fe_2O_3	0.01	0.35	2.10	1.40	1.60	1.02*	0.52	1.44*
FeO	0.55	0.24	0.45	1.00	0.52		0.12	
MgO	0.18	0.12	0.30	0.50	0.22	0.07	0.10	0.30
CaO	0.81	0.24	0.05	0.95	1.50	0.42	0.39	0.19
Na_2O	3.40	3.30	0.20	3.50	3.20	3.96	4.10	2.75
K_2O	5.10	5.30	3.80	4.60	4.90	4.60	4.40	4.82
H_2O+	0.10	0.31	1.85	0.10	1.00	0.81	0.45	1.47
H_2O-	0.22	0.08	0.10	0.10	0.41		0.14	
TiO_2	0.16	0.17	0.05	0.30	0.27	0.08	0.04	0.14
P_2O_5	0.00	0.00	0.04	0.16	0.10	0.02	0.00	0.01
MnO	0.00	0.03	0.15	0.05	0.03	0.09	0.13	0.14
Co_2	0.05	0.02	0.35	0.30	0.05		0.02	
F	0.25	0.01	0.10	0.10	0.08	0.16	0.21	0.13
S			0.06	0.40				
Total	99.43	99.47	100.60	100.46	99.08	100.36	100.22	99.57

1. Treasure Mountain - Granite porphyry
2. Treasure Mountain - Rhyolite porphyry
3. Redwell Basin - Rhyolite porphyry (altered)
4. Mount Emmons - Aplite
5. Round Mountain - Rhyolite porphyry
6. Boston Peak - Rhyolite
7. Tomichi Dome - Microgranite
8. Tomichi Dome - Rhyolite (breccia pipe)

depletion patterns in the Miocene rhyolites and granites of the Elk Mountains and vicinity are strikingly similar to those reported by Hildreth (1978) for the early erupted part of the Bishop Tuff from the Long Valley caldera, California. Hildreth suggested that these patterns resulted from convention-driven thermogravitational diffusion in a large silicic magma chamber. If the highly differentiated rhyolites and granites of the Elk Range and vicinity formed in a similar mariner, it raises the possibility that they may represent "warts," or cupolas, extending above a single silicic batholith. Such a batholith would have to be over 80 km (distance between Treasure Mountain and Tomichi Dome) long in a northwesterly direction. If this speculation is correct it suggests that a significant part of the Tertiary batholith, which gravity data (Isaacson and Smithson, 1976) indicate underlies the region, may be of Miocene, rather than Oligocene, age.

Mineral Deposits

Many samples from the Miocene rhyolites and granites fit the chemical criteria which Mutschler and others (1981) and F. E. Mutschler, S. Ludington, and M. Ikramuddin (manuscript) believe characterize the source rocks of "granite" or "Climax type" molybdenite systems (see Table 4). Important stockwork molybdenite deposits similar to those at Climax and Henderson, Colorado have recently been discovered at Mount Emmons (Dowsett and others, 1981) and Redwell Basin (Sharp, 1978), and genetically similar, but to date uneconomic, molybdenite mineralization has been recognized associated with the granite of Treasure Mountain (Mutschler, 1976). Molybdenite deposits of this type typically have ore shells consisting of a stockwork of quartz-molybdenite veins draped above, or in the upper part of, a granite- or rhyolite-porphyry source pluton. The ore shell is typically coincident with a

Table 4. Chemical characteristics of source rocks for granite molybdenite systems. (Numbers in parentheses are alternate values.)

SiO_2 ≥ 74%

Molecular Al_2O_3 > Molecular $Na_2O + K_2O$

CaO ≤ 1.5 (1.0)%

K_2O/Na_2O ≥ 1.25

Rb/Sr > 5 (10)

F ≥ 1000 ppm

Li > 30 (50) ppm

Nb > 20 (40) ppm

U >10 (8) ppm

Zr < 100 (150) ppm

zone of potassic alteration and is overlain by quartz-sericite and argillic alteration zones. The potassic alteration zone and the quartz-molybdenite ore shell are formed by fluorine-rich magmatic fluids concentrated in, and released from, the source pluton; the quartz-sericite and argillic alteration zones are produced by mixed magmatic and meteoric fluids (Mutschler and others, 1981).

It seems probable that the economic potential of these Miocene granite molybdenite deposits far exceeds that of any of the older Oligocene mineralization in the Elk Mountains and vicinity.

Base-metal vein and replacement deposits are associated with both the Mount Emmons-Redwell Basin and Treasure Mountain dome centers of molybdenite mineralization. These base metal deposits are comparable to the "late barren stage" veins recognized at Climax and Henderson (Wallace and others, 1968; Wallace and others, 1978).

Base metal deposits at the Mount Emmons-Redwell Basin center include the Keystone and Daisy mines which worked pyrite-sphalerite-galena-pyrrhotite-chalcopyrite veins and small replacement bodies.

Miocene base metal mineralization related to the granite of Treasure Mountain shows a distinct zoning pattern. Skarn replacement and vein deposits showing a typical contact metamorphic paragenesis are concentrated close to the granite on the south and southeast sides of the Treasure Mountain dome. Early silicates (hedenbergite, diopside, tremolite, andradite, epidote, scapolite, and quartz) are followed by iron oxides (specular hematite with minor magnetite); followed by pyrite and pyrrhotite; followed by chalcopyrite, bornite, sphalerite, tetrahedrite, galena, and pyrite. Quartz-calcite-base metal sulfide vein and replacement deposits occur on the outer flanks of the dome, particularly on the northeast side in the area, including Sheep Mountain, Lead King Basin, and Schofield Park. Most of these deposits are characterized by pyrite, galena, sphalerite, chalcopyrite, tetrahedrite, and marcasite in a quartz-calcite gangue. Fluorite is a ubiquitous mineral in all of the Miocene deposits in the Treasure Mountain area.

FELSITE PLUTONS OF UNCERTAIN AGE

Several rhyolitic plutons of uncertain age are present in the area. These plutons have major-element chemistries similar to the Miocene rhyolites and granites, but their trace element chemistry is not diagnostic of either the Miocene or the Oligocene suites. These enigmatic plutons include an altered felsite breccia pipe at Mt. Bellview on the western edge of the Elk Range (Mutschler, 1970) which is currently being explored as a molybdenite prospect; and rhyolite porphyry plutons in Smooth Canyon and Buck Hollow in the West Elk Mountains (Gaskil I and others, 1981).

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