



Geology of the South Fork molybdenum occurrence, Taos County, New Mexico

David M. Jones and James R. Norris

1984, pp. 213-218. <https://doi.org/10.56577/FFC-35.213>

in:

Rio Grande Rift (Northern New Mexico), Baldrige, W. S.; Dickerson, P. W.; Riecker, R. E.; Zidek, J.; [eds.], New Mexico Geological Society 35th Annual Fall Field Conference Guidebook, 379 p. <https://doi.org/10.56577/FFC-35>

This is one of many related papers that were included in the 1984 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual [Fall Field Conference](#) that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

GEOLOGY OF THE SOUTH FORK MOLYBDENUM OCCURRENCE, TAOS COUNTY, NEW MEXICO

DAVID M. JONES' and JAMES R. NORRIS'

'Department of Geosciences, University of Arizona, Tucson, Arizona 85721: 'Noranda Exploration, Inc., P.O. Box 50326, Tucson, Arizona 85703

INTRODUCTION

The South Fork molybdenum occurrence is exposed along the South Fork of Rio Hondo in the Sangre de Cristo Mountains, Taos County, New Mexico (Fig. 1). South Fork is in the Rio Hondo (Twining) mining district approximately 16 km northeast of Taos and 16 km south of the Questa Molybdenum mine. The South Fork prospect lies entirely within the South Fork addition to the Wheeler Peak Wilderness Area in Carson National Forest.

History

Lindgren and others (1910) document the occurrence of molybdenite in quartz veins near the mouth of the Rio Hondo. In the same paper they mention reports of "claims showing galena and stibnite at the head of South Fork." Subsequent reports on the same area (Park and McKinlay, 1948; Schilling, 1960) do not mention molybdenite mineralization, though Clark and Read (1972) note pyrite mineralization and copper and zinc geochemical anomalies in the vicinity of South Fork Peak. Climax Molybdenum Co. apparently conducted limited geologic reconnaissance over exposed molybdenite mineralization at South Fork peak in the late 1960's (Harry Olson, oral comm. 1982). Intensive study of the area did not commence until 1981 when the U.S. Geological Survey published a report documenting a quartz—pyrite—molybdenite stockwork mineralization over a square kilometer near South Fork Peak (Ludington, 1981). Subsequent reconnaissance by Noranda Exploration, Inc. determined that molybdenite at South Fork is exposed over an area of roughly 4 km². In the fall of 1981 Noranda Exploration, Inc., as well as other groups, staked claims covering exposed veining. Reconnaissance geologic mapping and water, soil, and rock-chip geochemical sampling were also completed at this time.

In 1982 we carried our detailed (1:6,000) outcrop and float mapping at South Fork. Our objective was to evaluate the extent and controls of molybdenite mineralization and to characterize the geology and alteration. This paper presents the results of our studies.

REGIONAL GEOLOGY

Precambrian metaigneous and metasedimentary rocks overlain by mid-Tertiary volcanic rocks of the Latir volcanic field and intruded by mid-Tertiary batholithic granitic rocks constitute the lithologies in this part of the Sangre de Cristo Mountains (Fig. 2). Much of the Tertiary igneous activity is related to development of the Miocene Questa caldera, although post-caldera magmatism may be of a different genesis. The regional geology and tectonics of the Questa caldera are described by Reed and others (1983) and Lipman (1981, 1982). We will discuss only the salient features of the Questa caldera as they pertain to South Fork.

Intrusive Rocks

Quartz-monzonite to granite intrusions in the Rio Hondo area represent the southern extent of regionally extensive syn- and post-caldera magmatism in the Questa region (Fig. 2). Two major intrusive bodies

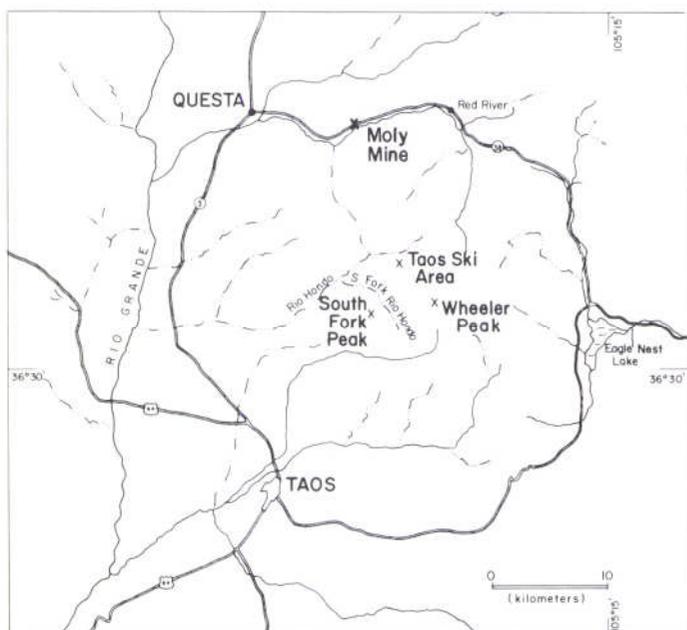


FIGURE 1. Location of map of the South Fork prospect.

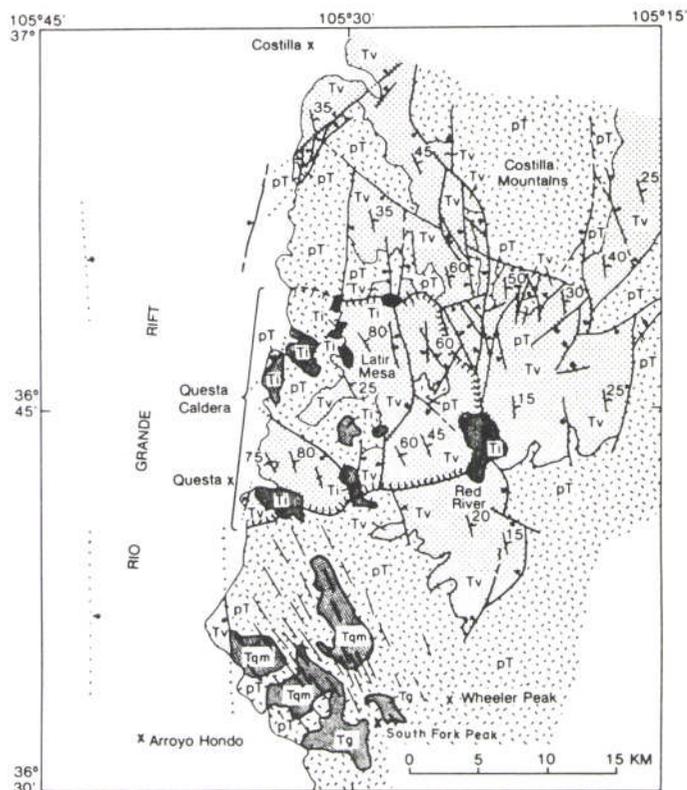


FIGURE 2. Generalized geologic map of the Questa region (from Lipman, 1981). Tg—Lucero Peak granite, Tqm—Rio Hondo quartz monzonite, Ti—undifferentiated Tertiary intrusive rocks, Tv—Tertiary volcanic rocks, pT—pre-Tertiary rocks.

are recognized, the Rio Hondo and Lucero Peak plutons. Quartz-monzonite of the Rio Hondo pluton is thought to be a southward extension of the more evolved, molybdenite-bearing Bear Canyon granite of the Bear Canyon pluton (Lipman, 1982). Granite of the Lucero Peak pluton occurs south of the Rio Hondo pluton and is exposed at South Fork. These batholithic rocks are considered cogenetic with the Latir volcanic field and the mineralized granites at Questa. Lipman (1982) reports K-Ar and fission-track age determinations of 20-26 m.y. for quartz-monzonite of Rio Hondo and 22 m.y. for granite of Lucero Peak.

A dike swarm of dominantly rhyolitic to quartz-latitic composition intrudes both the Rio Hondo and Lucero Peak plutons (Fig. 2). This dike swarm is a prominent feature at South Fork and in the region to the northwest. Characterized by northwest trends and local close spacing, the dike swarm can be tracked along strike for over 10 km. Lipman (1982) relates dike orientation to Rio Grande rift-related extension and emplacement of the batholithic rocks.

Mineralization

Molybdenum deposits in the Questa area are related to granites intruded along the southern structural margin of the Questa caldera. Molybdenum-ore zones occur within granite intrusions and their host volcanic rocks. Deposits are spatially associated with the upper contacts of causative intrusions. Both metallic mineralization and hydrothermal alteration are strongly controlled by local north-northwest fracture zones and east-northeast caldera-boundary structures (Leonardson and others, 1982).

LOCAL GEOLOGY

Lithologies

The South Fork molybdenum prospect occurs in regionally extensive Precambrian rocks intruded by mid-Tertiary biotite granite and variably porphyritic quartz-latite to rhyolite dikes. Figures 3 and 4 are a geologic map and cross section of the South Fork prospect.

Precambrian Rocks

Proterozoic amphibolite gneiss and quartz-monzonite gneiss comprise the high ridges and peaks along the south and east margins of the area. Similar Precambrian rocks are exposed at lower elevations along South Fork in the northern and western portions of the prospect. Gneissic layering and foliation in the Proterozoic rocks generally strike northeast, with moderate to steep dips to the northwest.

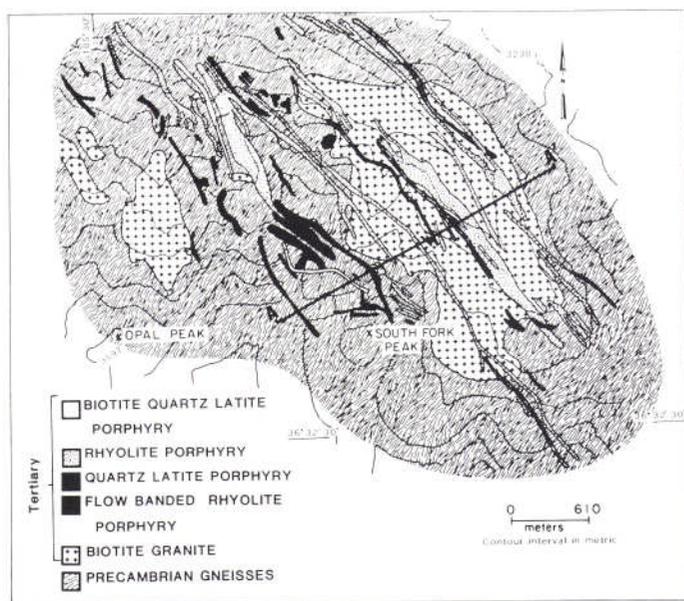


FIGURE 3. Simplified geologic map of the South Fork molybdenum prospect. (See Table 1 for lithologic descriptions of dike rocks.) The name Opal Peak is from Clark and Read (1972).

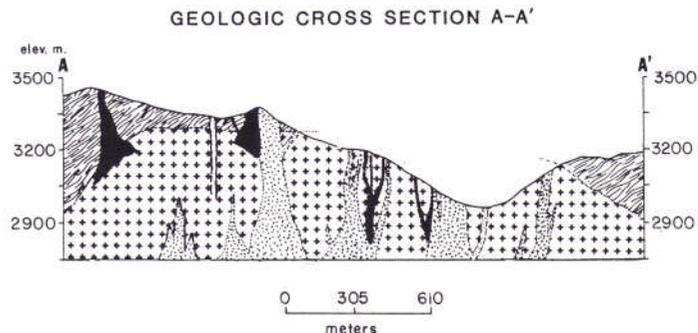


FIGURE 4. Generalized geologic cross section through South Fork. (Lithologic symbols are same as in Figure 3.)

Granite Intrusions

Biotite granite is exposed in two areas within the South Fork drainage (Fig. 3). In the eastern half of the project area a large (1.9 km²) body of granite is exposed along upper South Fork and on the northeastern slopes of South Fork Peak. The apparent north-northwest orientation of this body may be due to the level of exposure revealed by the present drainage pattern. In the western half of the area a small (0.5 km²) body of biotite granite crops out in the drainage immediately north of Opal Peak. Limited mapping indicates that biotite granite is also exposed at the western edge of the map area. The geometry of this westernmost intrusion is not known.

The southern contacts of the granite intrusions appear to be the topographic trace of a relatively flat roof. The eastern granite contact dips steeply to the north along its northern flank. Passive intrusion of the granites is indicated by the lack of contact breccias.

The biotite granite is texturally variable, ranging from porphyritic aplite and medium-grained porphyritic granite to medium- and coarse-grained granular granite. Systematic textural variations within the biotite granite were not delineated. Although aplite commonly occurs as a chilled rind at contacts with Precambrian rock, aplite bodies are also observed within granite far from contact zones. The megascopic mineralogy and texture of biotite granite in both outcrop areas are the same, suggesting they could be one intrusion.

Dike Rocks

The dominant trend of the dike swarm that transects South Fork is northwest (Fig. 3). Dikes in the northwest part of the prospect strike north to northeast. The dikes dip steeply, generally at angles greater than 60°. Dikes form up to 40% of the rock in some areas. Host rocks in these areas are present only as intradike slivers. Because they are more resistant to erosion than granite, dikes locally constitute more than 90% of the outcrop.

Our mapping delineated several dike types based upon modal mineralogy, texture, and crosscutting relations (Table 1). These dikes are depicted in simplified form in Figure 3. Flow-banded rhyolite forms the earliest dikes. These dikes intrude only Precambrian rocks above and proximal to granite contacts. They have not been observed cutting the granite. Flow-banded rhyolite is similar in composition and texture to aplitic phases of the granite. We therefore consider the flow-banded rhyolite dikes to be offshoots of the biotite granite. Quartz-latite porphyry, rhyolite porphyry, and biotite-quartz latite-porphyry dikes (Table 1) clearly cut the eastern exposure of biotite granite. Dikes are not well developed in the western outcrop of biotite granite. The western granite exposure is cut by a few thin dikes of quartz porphyry which exhibit a distinct porcellaneous texture. These dikes are not shown in Figure 3 due to their limited extent. Also not shown are two thin, northwest-trending dikes of andesite which cut the eastern granite.

Breccias

Several small breccias occur at South Fork, but are not shown in Figure 3. They occur as dike-like features or small pods which crosscut

TABLE 1. Lithologic description of Tertiary dikes at South Fork (based on megascopic examination only, rock names are field terms not based on petrographic or geochemical study; all dike rocks have an aphanitic groundmass). P—plagioclase, AF—alkali feldspar, Q—quartz, B—biotite, H—hornblende.

Unit	Distinguishing Features	Phenocrysts
Biotite-quartz latite porphyry	Biotite-rich (< 4%) character; dull gray-colored groundmass.	approximately 4% Q (1-5 mm) anhedral rounded, 9% AF (1-4 mm) subhedral to euhedral, 2%-4% B (0.5-2 mm) euhedral to subhedral.
Rhyolite porphyry	Pink to purple, but also exhibits cream-colored varieties. Q phenocrysts commonly rimmed by AF coronas. B poor.	8-20% AF (105 mm) subhedral to euhedral, 1-5% Q (1-4 mm) anhedral, 0-2% B subhedral.
Quartz-latite porphyry	Medium- to coarse-grained phenocrysts dominant, high Q:F ratio, and moderate B content; 'salt and pepper' texture.	2-6% Q (2-5 mm) anhedral, 6-9% AF (1-20 mm) subhedral to euhedral, 2-5% B+H (0.5-2 mm) euhedral to subhedral.
Flow-banded rhyolite	Flow-banding; Q phenocrysts are typically elongate, iron-oxide stained, and subhedral to glomeroporphyritic.	10-25% Q (1-7 mm) anhedral to euhedral, 10-15% AF (2-10 mm) subhedral to euhedral, 0-2% B (1-2 mm) subhedral to euhedral.

Precambrian rocks, biotite granite, flow-banded rhyolite, and rhyolite-porphyry dikes. Clasts are angular to subangular and range in width from millimeters to several centimeters. Breccia clasts are generally composed of the immediate host rocks. Drusy to massive quartz and fluorite are common matrix materials. Some clasts show quartz veining which does not cut the breccia matrix.

Alteration and Mineralization

Hydrothermal alteration is manifested as a variety of fracture-controlled vein assemblages. Pervasive, non-fracture-controlled alteration is not an extensive or volumetrically significant phenomenon.

Vein-controlled Alteration

The types and distribution of vein-controlled alteration are shown in Figure 5. The paragenetic sequence of veining was not determined due to the lack of exposed crosscutting relationships. Veinlet alteration is mostly restricted to Precambrian rocks, biotite granite, and flow-banded rhyolite dikes. Younger dike types possess only limited vein alteration consisting of fluorite \pm gypsum veinlets and quartz veinlets with little or no pyrite.

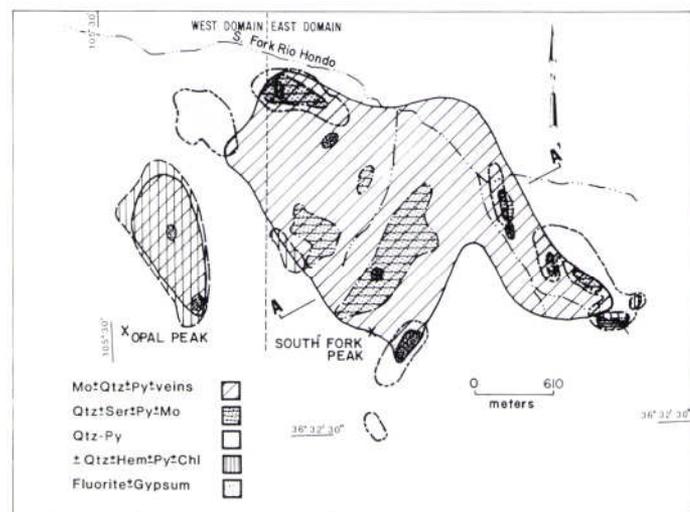


FIGURE 5. Generalized distribution of vein-controlled alteration at South Fork.

The bulk of vein-controlled alteration lies within the limits of exposed molybdenite veining (Fig. 5). Two broad areas of molybdenite-bearing veins are evident. These areas correspond with, but extend beyond, the east and west exposures of biotite granite.

Within the large eastern zone of molybdenite veining are isolated zones of quartz—sericite—pyrite \pm molybdenite, quartz—pyrite, quartz—hematite—chlorite, and fluorite \pm gypsum veins (Fig. 5). In the eastern granite, molybdenite-bearing veins are exposed over at least 183 m of relief within the granite intrusion. Orthoclase selvages on quartz—molybdenite veins are noted in only one area north of South Fork Creek at 2,957 m elevation.

The western zone of molybdenite-bearing veins is coextensive with well-developed quartz—hematite—pyrite veining (Fig. 5). Within the western granite, molybdenite veins occur over 213 vertical meters of exposure.

Veins are typically wide (>0.5 cm) and continuous (lengths >2 m). Quartz—molybdenite veins average 1-2 cm in width, but compound veins as much as 30 cm thick are present. Within the granite, rock between vein sets is commonly unaltered, spheroidally weathering granite. Only flow-banded rhyolite dikes and their host rocks exhibit many thin, discontinuous veins typical of "stockwork" deposits. Vein density in the granite is high (>2/m) in limited patches. The most extensive area of moderate to high vein density is in the western granite north of Opal Peak. Integrated vein densities greater than 1/1.5 m are exposed over large portions of the western granite and its Precambrian host rocks. The eastern granite exhibits overall low vein densities (<1/1.5 m). In both granite exposures, vein abundance does not exhibit any change with depth in the intrusion.

Pervasive Alteration

Pervasive argillization of feldspar along with associated bleaching and pyritization is best developed in the Precambrian rocks peripheral to flow-banded rhyolite dikes. This alteration is texturally destructive and typically results in 1-3% pyrite addition as disseminations and thin veinlets. The granite is not argillized to any significant extent.

In areas of closely spaced quartz—sericite—pyrite veins pervasive sericitization occurs locally as a result of overlapping sericite-vein selvages. However, some 1-3 m wide sericitized zones in the granite show no clear association with veining.

Sulfide Deposition

Molybdenite occurs dominantly as a constituent of quartz—molybdenite—pyrite and quartz—sericite—pyrite—molybdenite veins. Molybdenite is also observed as medium-grained rosettes disseminated through aplite and fine-grained granite. However, this mode of occurrence accounts for little of the total molybdenite content of the rocks.

Pyrite-bearing veins account for most of the occurrence of pyrite. Disseminated and microveinlet-controlled pyrite occur in pervasively argillized rock and zones of highly veined flow-banded rhyolite, biotite granite, and Precambrian rock. Pyrite is locally found as disseminations and in quartz veinlets in rhyolite porphyry and quartz-latite porphyry dikes.

The average sulfide content of the surface rocks at South Fork is less than 1%. Sulfide (mainly pyrite) contents up to 5% are encountered in pervasively argillized zones and limited areas of closely spaced quartz—pyrite and quartz—pyrite—sericite veins.

Structure

The orientations of joints and veins at South Fork are shown in Figure 6. Vein orientations are shown for major vein sets regardless of mineral assemblage. Data from the east and west outcrops of biotite granite are plotted as separate domains to show the variation in structural fabric.

Veins in the east domain strike northwest to west—northwest. This same orientation is shown by a bimodal distribution of joint surfaces at N35W and N55W. The strike of joints and veins in the west domain is less systematic. Veins show a range of orientation from northwest through north—northeast. Joints exhibit a north—northeast maxima and less developed west—northwest and north—northwest directions.

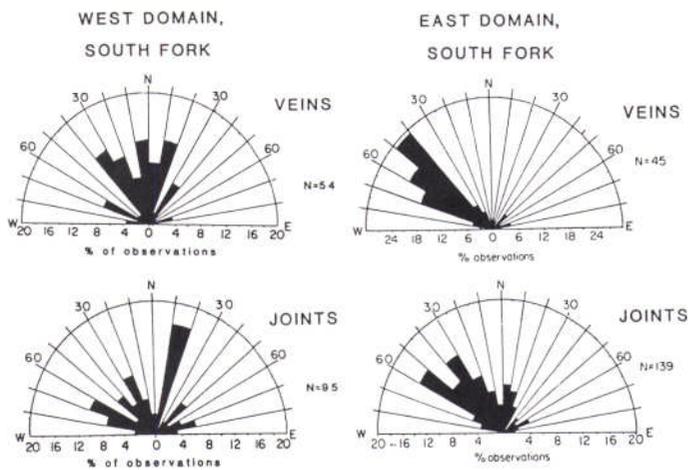


FIGURE 6. Strike rose diagrams for vein and joint orientations in the east and west domains. Figure 5 shows the boundaries for the east and west domains.

Veins and joint orientations along with dike orientations (Fig. 3) in the east and west domains indicate that two distinct structural fabrics exist in the granites at South Fork. The structural grain in Precambrian rocks does not appear to influence vein and joint orientations.

GEOCHEMISTRY

Soil Geochemistry

Soil samples were collected on 183-m centers from the area north of South Fork Peak and south of the South Fork Rio Hondo, covering only part of the area mapped. Soil samples were leached with oxalic acid as described by Alminas and Mosier (1975).

Elements exhibiting focused anomalies in the South Fork area include Mo, W, Bi, Cu, Pb, Be, and Y. As much as 5,000 ppm molybdenum is found in oxalic-acid leachates of soils at South Fork (Fig. 7). The highest anomalies center on the cirque immediately north of South Fork Peak. Q-mode factor analysis of soil-leachate geochemistry further substantiates the single-element anomalies. Factor analysis creates multi-element factors which can be interpreted as endmember components accounting for variability in the data. High-factor loadings indicate the degree to which samples contain the element suite of that factor. Figure 8 shows factor loadings for a tungsten—beryllium—bismuth—copper—molybdenum factor.

Hydrogeochemistry

Figure 9 shows the raw data for molybdenum in stream waters of the Rio Hondo drainage. This figure is based on more than 50 water samples from Rio Hondo, South Fork Rio Hondo, and primary and secondary tributaries of those streams. High concentrations of molybdenum (as much as 120 ppb) are present. For comparison, streams draining the area of the Log Cabin molybdenum orebody along the south margin of the Questa caldera contain an order of magnitude less molybdenum. The northwest trend of the anomaly correlates with dike-swarm, vein, and joint orientations in the eastern granite.

Q-mode factor analysis produced several elemental factors which account for variance in the hydrogeochemical data. Of these, two factors correlate with observed mineralization at South Fork and elsewhere in the Questa region. In part, these factors mimic the molybdenum distribution in Figure 9. They indicate high factor scores in the South Fork area and exhibit a northwest grain. Fluorine and uranium are important indicator elements of mineralization in the hydrogeochemistry of this region.

DISCUSSION

Interpretation of Alteration

Determining the origin of quartz—molybdenite, quartz—sericite—pyrite—molybdenite, and quartz—pyrite veins is critical in assessing the

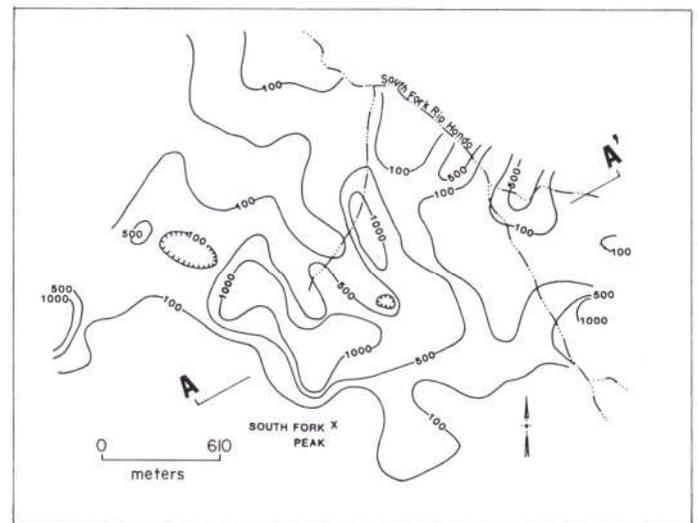


FIGURE 7. Molybdenum in oxalic-acid leachates of soil at South Fork. Concentrations in parts per million.

South Fork prospect. Much quartz—pyrite and some quartz—molybdenite veining appears genetically related to flow-banded rhyolite dikes and the granite, and apparently predates other igneous phases. However, some molybdenite veining has no obvious source. Molybdenite in the granite is not restricted to aplitic or fine-grained phases, or to its contact with Precambrian rocks. Molybdenite is found as much as 213 m below the granite contact in medium- to coarse-grained granite. The vertical continuity of the South Fork system is unknown. The unfractured and unaltered nature of the western granite between systematic vein sets is not typical of hydrofracturing related to a volatile-rich magma. However, a large volume of molybdenum-bearing fluid was required to produce the observed veining. A source other than the exposed biotite granite may be responsible for some of the molybdenite veining. While alteration of the post-granite dikes is not conspicuous, volatile content in quartz—latite—porphyry and rhyolite—porphyry dikes resulted in quartz \pm pyrite and fluorite \pm gypsum veins. This demonstrates that the later magmas exsolved silica and fluorine in hydrothermal fluids.

Interpretation of Structure

Joints, veins, and dikes in the east granite have northwest orientations indicating NE—SW extension (Fig. 6). This direction is compatible with the orientation of the regional stress field during Miocene time (Rehrig and Heidrick, 1976; Lipman, 1981). The orientation of joints, veins, and dikes in the western granite (Fig. 6) does not match those of the eastern domain. Although some northwest- to north—northwest-trending dikes are found, the west domain also shows a distinct north to north—northeast component. The northwesterly striking features may reflect northeasterly extension as exemplified by the east domain. The north to north—northeast fabric, however, is partly compatible with the orientation of Miocene and younger faults in the Latir volcanic field (Lipman, 1981, fig. 9A).

The different orientations of structural elements in the granites of the eastern and western domains indicate development in different stress regimes. Two possible reasons for variation in the stress regime are: (1) the east and west exposures of granite are temporally separate intrusions which crystallized under different regional stress conditions, and (2) the granites are essentially contemporaneous intrusions and the stress field at the time possessed local deviations.

The latter suggestion appears unlikely. The northwest-trending dike swarm in the eastern granite can be traced for 10 km with little variation. The dikes were emplaced in a regionally uniform stress field which allowed significant extension to accommodate the volume of dike rock intruded. Local perturbation of this stress field is not consistent with the areal extent of the structural fabric.

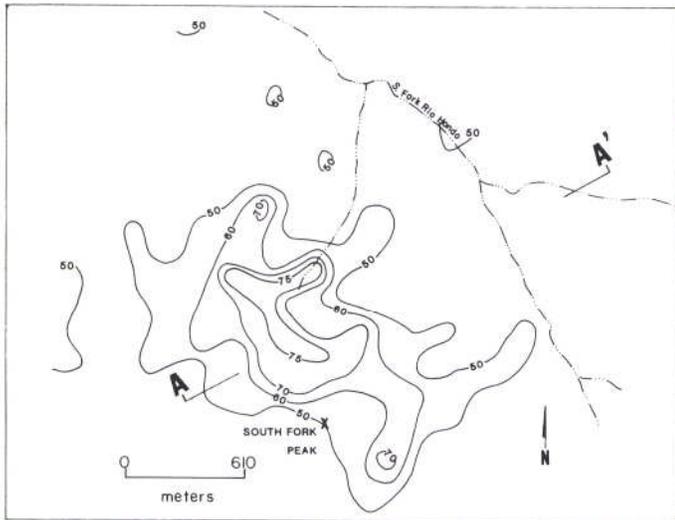


FIGURE 8. Tungsten-Beryllium-Bismuth-Copper-Molybdenum Factor for soil geochemistry at South Fork. High factor loadings indicate greater degrees of correlation between elements.

The former suggestion bears consideration. The dike swarm which cuts the east granite also cuts, and is more widespread in, the Rio Hondo quartz monzonite (Fig. 2). These dikes do not intrude the main mass of Lucero Peak granite or the west granite at South Fork. This suggests a younger age for the west granite, possibly similar to the main mass of the Lucero Peak granite which lies further to the west.

Regional Controls

Unpublished mapping by Jones indicates that South Fork and other molybdenum prospects several kilometers to the northwest are localized along an arcuate structural zone. The concave northward, inward-dipping zone is defined by rhyolite dikes northwest of South Fork prospect and Tertiary faults, hydrothermal alteration, and intrusions northeast of the prospect. The senior author favors interpreting these features as being caldera-related. Additional work on this problem is presently in progress.

Genetic Model

We envision the following model for the South Fork molybdenum occurrence. The intrusions at South Fork are high-level parts of a composite batholith which rose to even higher levels in the Questa area. The first phase of the intrusive sequence is the biotite granite. During passive emplacement of the granite magma, volatile constituents (H₂O, Mo, F) concentrated in the upper portions of the intrusion. Brittle failure of the host rocks allowed injection of volatile-rich melt forming the flow-banded rhyolite dikes. As a consequence of rapid cooling and high volatile content, the flow-banded rhyolite possesses an aphanitic groundmass and closely spaced veins of quartz, molybdenite, and pyrite. Pressure drop and water loss within the magma caused portions of the granite melt to crystallize rapidly, forming aplites and porphyries with aplitic groundmass. Volatiles remaining in the melt after formation of the flow-banded rhyolite dikes produced disseminated molybdenite and at least some of the molybdenite-bearing veins in the aplites and granites. However, the remaining volatile content was not sufficient to induce extensive hydrofracturing. As a result, extensive stockwork veining did not occur at the magma-host rock content.

At least three distinct quartz-latite to rhyolite dike types intrude the east granite. This indication of ongoing magmatism suggests that granitic plutons were intruded at depth. While alteration of the post-granite dikes is limited, volatile content in the rhyolite-porphry and quartz-latite-porphry dikes is indicated by the presence of quartz ± pyrite and fluorite ± gypsum veins. Also, fluorite-bearing breccias of hydrothermal origin cut rhyolite-porphry dikes, suggesting ongoing hydrothermal activity.

Though the age relationship between the eastern and western granites

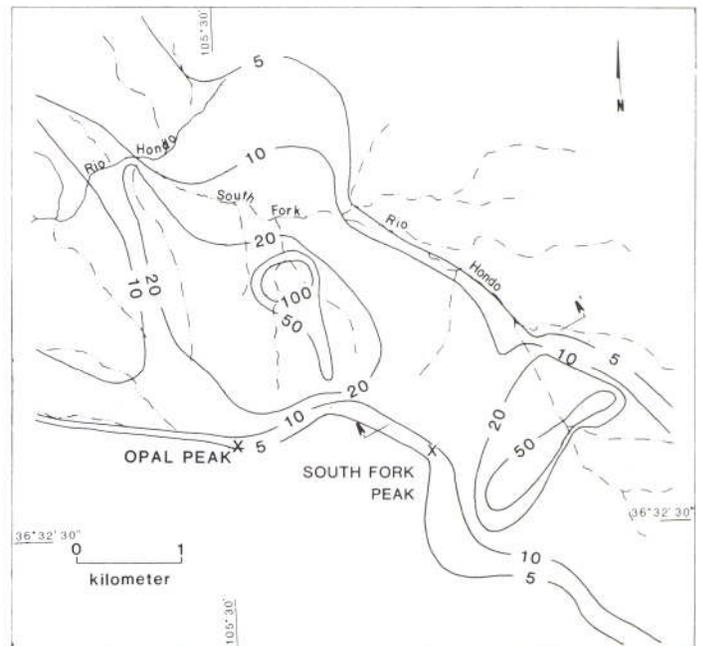


FIGURE 9. Molybdenum hydrogeochemistry of the Rio Hondo drainage. Concentrations in parts per billion.

is speculative, the exclusion of the west granite from the structural trends and diking well developed in the eastern granite argues for a younger age. If so, multiple periods of intrusion and mineralization can be inferred. If the east and west granite are of the same age, veining in the granites may be of different ages as indicated by different structural fabrics.

Several potential modes of molybdenum deposition are provided by this model. First, molybdenite veining may be the result of fluids evolved from the biotite granite. This mechanism appears responsible for much of the molybdenite showing at South Fork. Second, molybdenum veining may persist at depth in association with the source(s) of the post-granite dikes or other undiscovered intrusions. The situation at South Fork may be analogous to the "intermineral" dikes at Climax which cut surface molybdenite veins but are mineralized at depth (White and others, 1981).

CONCLUSIONS

The following conclusions are based upon observations of the geology, alteration, and mineralization at South Fork.

- (1) The South Fork prospect is a multiple intrusion system involving mid-Tertiary granitic magmatism.
- (2) Subeconomic molybdenite occurrences are found at the surface over 4 km² of the prospect.
- (3) Molybdenite veining is spatially associated with biotite granite and flow-banded rhyolite intrusions.
- (4) Alteration is composed of a variety of vein-controlled assemblages.
- (5) Dikes of quartz-latite porphyry and rhyolite porphyry cut molybdenite-bearing veins and most alteration zones. Quartz-latite-porphry and rhyolite-porphry dikes contain sparse quartz ± pyrite and fluorite ± gypsum veins suggesting derivation from a volatile-rich magma.
- (6) The parent magmas of the post-biotite granite dikes and perhaps other unknown intrusions at depth may have produced some of the molybdenum mineralization we see on the surface.

ACKNOWLEDGMENTS

We thank Noranda Exploration, Inc. for allowing us to present these data, and Albert L. Lamarre for encouraging preparation of this paper.

Dave Jones particularly wishes to thank William D. Payne for support early in this work. Robert Peale contributed to the initial recognition of mineralization at South Fork.

REFERENCES

- Alminas, H. V., and Mosier, E. L., 1975, Oxalic acid leaching of rock, soil and stream-sediment samples as an anomaly-accentuation technique: U.S. Geological Survey, Open-file Report 76-275, 25 pp.
- Clark, K. F., and Read, C. B., 1972, Geology and ore deposits of Eagle Nest area, New Mexico: New Mexico Bureau Mines and Mineral Resources, Bulletin 94, 152 pp.
- Leonardson, R. W., Dunlap, G., Starquist, V. L., Bratton, G. P., Meyer, J. W., Osborne, L. W., Atkin, S. A., Molling, P. A., Moore, R. F., and Olmore, S. D., 1982, Preliminary geology and molybdenum deposits at Questa, New Mexico: *in* The genesis of Rocky Mountain ore deposits: changes with time and tectonics: Exploration Geologists Society Symposium, Denver Region, November 1982, pp. 151-155.
- Lindgren, W., Graton, L., and Gordon, C., 1910, The ore deposits of New Mexico: U.S. Geological Survey, Professional Paper 68, 361 pp.
- Lipman, P. W., 1981, Volcano-tectonic setting of Tertiary ore deposits, southern Rocky Mountains; *in* Dickinson, W. R., and Payne, W. D. (eds.), Relations of tectonics to ore deposits in southern Cordillera: Arizona Geological Society Digest, v. 14, pp. 199-213.
- , 1982, The Miocene Questa caldera, northern New Mexico: relation to batholith emplacement and associated molybdenum mineralization; *in* The genesis of the Rocky Mountain ore deposits: changes with time and tectonics: Exploration Geologists Society Symposium, Denver Region, November 1982, pp. 133-148.
- Ludington, S., 1981, Quartz—pyrite—molybdenite stockwork near South Fork Peak, Taos County, New Mexico: U.S. Geological Survey, Open-file Report 81-1080, 8 pp.
- Park, C. F., Jr., and McKinlay, P. F., 1948, Geology and ore deposits of Red River and Twining districts, Taos County, New Mexico: New Mexico Bureau Mines and Mineral Resources, Circular 18, fig. 7 (scale 1:6,000).
- Reed, J. C., Lipman, P. W., and Robertson, J. R., 1983, Geologic map of the Latir Peak and Wheeler Peak Wildernesses and Columbine—Hondo Wilderness Study Area, Taos County, New Mexico: U.S. Geological Survey, Map MF-1570B.
- Rehrig, W. A., and Heidrick, T. L., 1976, Regional tectonic stress during Laramide and late Tertiary intrusive periods, Basin and Range province, Arizona: Arizona Geological Society Digest, v. 10, pp. 205-228.
- Schilling, J. H., 1960, Mineral resources of Taos County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 71, 124 pp.
- White, W. H., Bookstrom, A. A., Kamilli, R. J., and Ganster, M. W., 1981, Character and origin of Climax-type molybdenum deposits: Economic Geology, 75th Anniversary Volume, pp. 270-316.