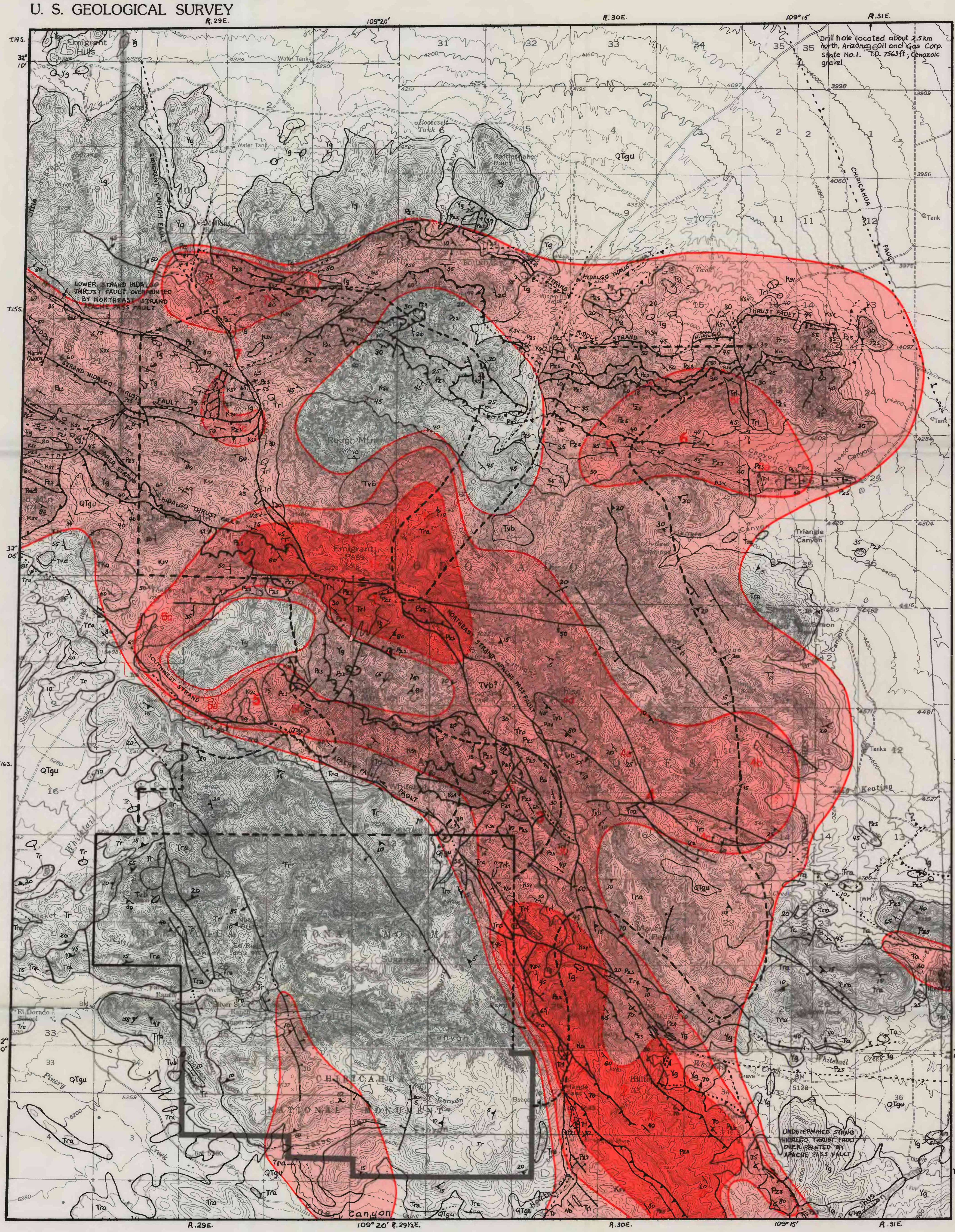
DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1412-D
PAMPHLET ACCOMPANIES MAP



Base from U.S. Geological Survey 1:62,500; Cochise Head and Vanar, 1950, and Chiricahua Peak and Portal, 1958

SCALE 1:50 000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology compiled by Harald Drewes in 1978 and 1979, assisted by Jeffrey Edwards in 1978 and Richard Langford, Joseph Pleshka, and Michael Sekulich in 1979

MINERAL RESOURCE POTENTIAL MAP OF THE NORTH END ROADLESS AREA, CHIRICAHUA MOUNTAINS, COCHISE COUNTY, ARIZONA

By
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1983

EXPLANATION

MINERAL RESOURCE POTENTIAL--Area and site locations are based on known or inferred geologic, geochemical, and geophysical features. Typically, the geologic features on which an evaluation of mineral resource potential is based are gradational

Areas showing mineral resource potential

- Low
- Moderate
- High

2 2a Location of areas described in text--Areas numbered in order of their decreasing mineral resource potential. Numbers with letters show specific sites discussed in text

CORRELATION OF MAP UNITS

Unit	Age	
QTgu	Holocene to Pliocene	QUATERNARY AND TERTIARY
Tr	Miocene	TERTIARY
Tra, Tvb, Ta, Trl, Tg	Oligocene	TERTIARY
TKa	Eocene(?) to Upper Cretaceous	TERTIARY TO CRETACEOUS
Ksv	Upper to Lower Cretaceous	CRETACEOUS
Pzs		PALEOZOIC
Yg	Proterozoic Y	PROTEROZOIC
Xm	Proterozoic X	PROTEROZOIC

DESCRIPTION OF MAP UNITS

QTgu GRAVEL AND OTHER SURFICIAL DEPOSITS, UNDIVIDED (HOLOCENE TO PLIOCENE)--Detritus, mainly subrounded to subangular, ranges in grain size from silt to boulders; includes some coarse blocky deposits. Unsorted to moderately well sorted, mostly unindurated but locally cemented by caliche, pale-brownish-gray deposits; on alluvial fans, fan aprons, and stream terraces. Mainly of alluvial origin but includes deposits of colluvial and landslide origin

Tr RHYOLITE CANYON FORMATION (MIOCENE)--Mainly welded ash-flow tuff; includes some air-fall tuff, volcanic sandstone, and a rhyodacite lava flow (on Sugarloaf Mountain). Typically forms two bold cliffs of strongly columnar jointed, light-brownish-gray to grayish-red welded tuff. Probably thicker than 2,300 ft

Tra RHYOLITE TO ANDESITE (OLIGOCENE)--Mainly rhyolite and rhyodacite; includes some latite, dacite, and andesite. Pyroclastic rocks, lava flows, intercalated sedimentary rocks, and possible small intrusive bodies or extrusive domes. Upper part equivalent to Faraway Ranch Formation of Fernandez and Enlows (1966). As thick as about 5,000 ft; thins considerably over or against preexisting uplands

Tvb VENT BRECCIA (OLIGOCENE)--Mainly rhyolite to dacite breccias, pipes and irregular masses, and some laminated rhyodacite possibly in vents. Rocks resemble rhyolite to andesite (map unit Tra) and may mark source vents of those rocks. Breccia pipe on south side of Rough Mountain has disseminated pyrite

Trl RHYOLITE OR QUARTZ LATITE PORPHYRY (OLIGOCENE)--Occurs as plugs and large dikes and sills; includes a latite-porphyry breccia body at Emigrant Pass that was emplaced at deeper levels than the vent breccias. Typically pale-yellowish-gray rocks that contain abundant phenocrysts of quartz and plagioclase, and sparse chloritized biotite. May be related to two dike swarms too small to be mapped at scale 1:50,000 (Drewes, 1981b, 1982). Many intrusive bodies are pyritized, and some dikes are associated with base-metal enrichment

Ta ANDESITE (OLIGOCENE)--Lava flows, small intrusive bodies, and intercalated clastic rocks derived from andesite. Typically greenish-gray, slightly propylitized, containing phenocrysts of plagioclase, amphibole, and pyroxene. Forms basal unit, extensive south of study area, of major rhyolitic volcanic pile. Locally pyritized. As thick as 650 ft

Tg GRANODIORITE (OLIGOCENE)--Stocks and small intrusive pods of granodiorite and quartz monzonite, and some aplite and diorite; emplaced at deeper levels (hypabyssal) than rhyolite or quartz latite porphyry unit (Trl), and may grade vertically into these rocks

TKa ANDESITE (EOCENE? TO UPPER CRETACEOUS)--Plugs of propylitized andesite. Mainly greenish-gray, aphanitic or finely porphyritic, contains some feldspar and amphibole phenocrysts. Resembles lower Tertiary andesitic rocks of adjacent areas such as Pat Hills (Drewes, 1980) and Peloncillo Mountains (Drewes and Thorman, 1980)

Ksv SEDIMENTARY AND VOLCANIC ROCKS (UPPER TO LOWER CRETACEOUS)--Upper suite of sandstone, siltstone, and conglomerate having volcanic clasts and some intercalated andesite or dacite lava flows and rhyolite welded tuff. Lower suite (Lower Cretaceous, Bisbee Group) of shale, sandstone, limestone-clast conglomerate, and some fossiliferous limestone. At least 2,400 ft thick

Pzs SEDIMENTARY ROCKS (PALEOZOIC)--Limestone, dolomite, shale, sandstone, and quartzite of Permian Concha Limestone to Upper Cambrian Coronado Sandstone or Middle Cambrian Bolsa Quartzite (Sabins, 1957; Drewes, 1981a). Many formations are fossiliferous and cherty. Rocks widely metamorphosed around stocks along Apache Pass fault zone. Locally some carbonate rocks are altered to skarn and enriched in base metals. Thickness about 7,500 ft; probably thinned by thrust faulting from original thickness of 7,800-9,000 ft

Yg GRANODIORITE (PROTEROZOIC Y)--Brownish-gray, very coarse grained, coarsely porphyritic or porphyroblastic granodiorite and some quartz monzonite, aplite, and aplitic rocks. Quartz, albitized(?) plagioclase, and microcline abundant; chloritized biotite common; and some magnetite, apatite, sphene, and zircon. Typically dated as 1,450-1,650 m.y. old

Xm FINAL SCHIST (PROTEROZOIC X)--Mainly schist and phyllite; includes some metaquartzite, metavolcanic rocks, and granitic gneiss. Commonly medium-brownish-gray, weakly weathering rock containing scattered veinlets and pods of quartz and some diorite and aplite dikes. Includes rock dated as 1,715 m.y. old. Thickness unknown but probably large

CONTACT--Dotted where concealed

FAULT--Showing dip; dotted where concealed; queried where conjectural. Composite-movement symbols show diverse recurrent movement

Normal fault--Bar and ball on downthrown side

Thrust fault--Sawteeth on upper plate

Strike-slip fault--Showing relative horizontal movement

STRIKE AND DIP OF BEDS

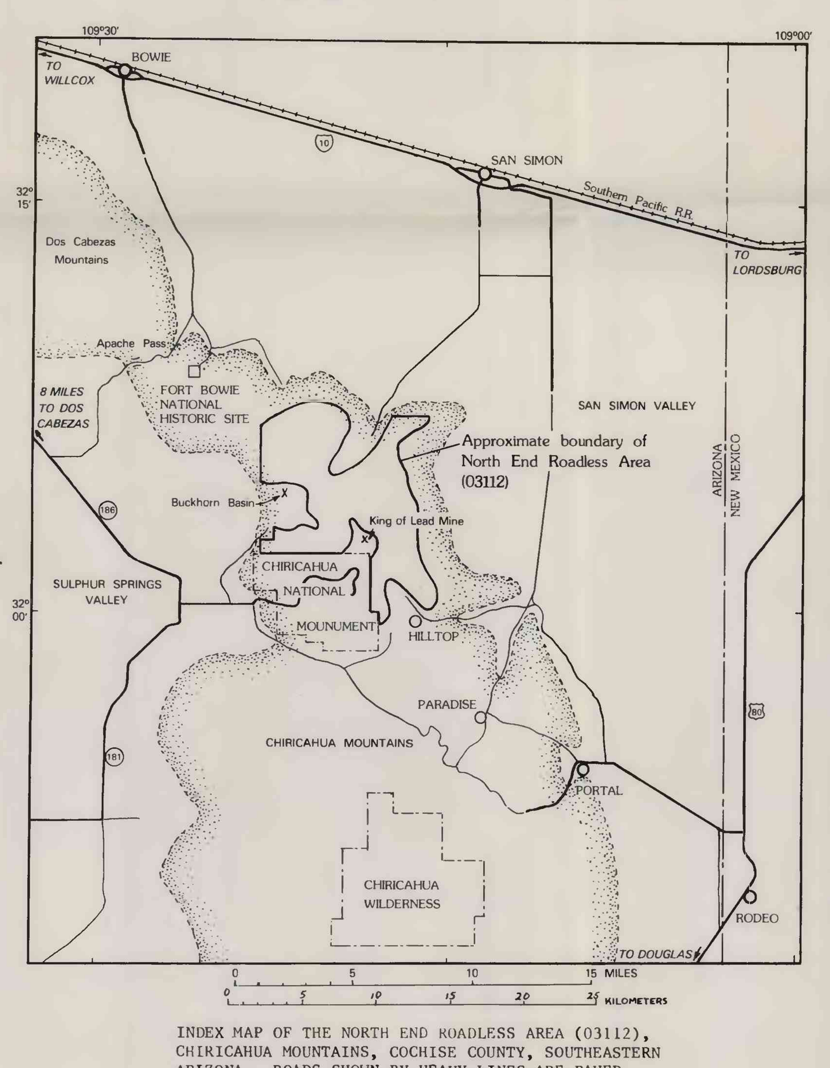
- 10 Inclined
- Vertical
- 60 Overturned

STRIKE AND DIP OF FOLIATION--Includes primary or flow foliation of volcanic rocks and secondary foliation of metamorphic rocks

- Inclined
- Vertical

APPROXIMATE BOUNDARY OF ROADLESS AREA

BOUNDARY OF SOUTH END OF CHIRICAHUA NATIONAL MONUMENT--North end abuts roadless area



INDEX MAP OF THE NORTH END ROADLESS AREA (03112), CHIRICAHUA MOUNTAINS, COCHISE COUNTY, SOUTHEASTERN ARIZONA. ROADS SHOWN BY HEAVY LINES ARE PAVED. SHADED LINES SHOW MOUNTAIN FRONTS.

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the North End Roadless Area (03112) in the Coronado National Forest, Cochise County, southeastern Arizona. The North End Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

Studies conducted in 1978-79 in the North End Roadless Area indicate that about one-fifth of the area has a moderate or high metallic-mineral resource potential. The area has potential for disseminated or stockwork-type molybdenum deposits, copper-lead-zinc-silver vein deposits, lead-zinc-silver limestone replacement deposits, and tungsten-bearing contact-metamorphic skarn deposits. The area also contains rocks suitable for cement manufacture and marble dimension stone. The area has a low potential for petroleum and natural gas.

INTRODUCTION

The North End Roadless Area covers 40 sq mi of the northern end of the Chiricahua Mountains near the southeastern corner of Arizona. It is adjacent to the north and east sides of the Chiricahua National Monument and is about midway between the towns of Portal and Bowie, in the Coronado National Forest. The roadless area consists of moderately high terrain that is partly forested. Access to the area is by road up the larger canyons from county roads or State highways, which are in the intermontane valleys east and west of the mountains. A few trails are in the interior of the area.

GEOLOGY

The North End Roadless Area is underlain by a wide variety of sedimentary, volcanic, and plutonic rocks, many of which are strongly faulted (Sabins, 1957; Drewes, 1980, 1981a, 1982). Schist and granodiorite plutons of Precambrian age are the oldest rocks of the area, and form a basement for four sequences of overlying sedimentary and volcanic rocks. The lowest of these sequences is mainly Paleozoic limestone, about 8,100 ft thick. The next higher sequence is Mesozoic shale and sandstone, about 6,500 ft thick. The third sequence is Tertiary rhyolite and andesite; it is about 2,500 ft thick near a major volcanic center in the eastern part of the roadless area, but it thins abruptly and is absent in much of the area. The capping sequence, Tertiary and Quaternary gravel, is thin throughout most of the roadless area but is at least 6,000 ft thick beneath the San Simon Valley east of the area.

The faults cutting these rocks are the key features that guided the emplacement of Tertiary granitic plutons, influenced the distribution of metamorphism, and probably controlled mineralization. The Apache Pass fault zone trends northwest through the roadless area and consists of a belt of broken rock 0.5-1 mi wide. This fault zone is almost vertical, and the faults in the zone have been active at various times between the Precambrian and late Tertiary. The Hidalgo thrust-fault zone trends west across the northern part of the area and also trends along the Apache Pass fault zone. The thrust faults dip moderately at the surface but presumably flatten at depth, and are cut by some faults having the latest movement on the Apache Pass fault zone. Many of the faults and the broken rock near them provided conduits for movement of Tertiary granitic magma and mineralizing fluids from deep sources into the rocks of the Paleozoic and Mesozoic sequences. Near the intrusive rocks, the Paleozoic and Mesozoic rocks are metamorphosed and locally contain lead, silver, zinc, and copper.

MINING DISTRICTS AND MINERALIZATION

Mining began in 1881 near the roadless area with the early development of claims that later became the Hilltop mine, 1 mi south of the area. Scattered prospects and a few patented claims lie within or just outside the roadless area. During the time of the study, there was sporadic development work at the King of Lead mine and nearby claims in an area between the Chiricahua National Monument and the roadless area. Base-metal and silver ore has been produced from the Hilltop mine (about $1.1 million production between 1902 and 1950), and a small amount of similar ore was probably produced from the King of Lead mine and from mines in the Buckhorn Basin about 0.5 mi west of the roadless area.

In general the greatest mineral resource potential is along the Apache Pass fault zone or within a 0.5- to 1.5-mi-wide northeast extension of that zone (Drewes, 1980, 1981b, and 1982). The Apache Pass fault zone is a major zone of fractured rock along which fluids--magma, hydrothermal water, and ground water--have migrated. Areas of lesser mineral resource potential that extend farther than 1.5 mi from the northeast side of the fault zone may contain branch faults, buried stocks, and rock types favorable for metallic mineral deposits. The mineral resource potential of these areas is moderate; they have not been previously prospected.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Base and precious metals

On the map, areas of high and moderate mineral resource potential are numbered from 1 to 7, generally in order of decreasing potential, although some successive numbered areas have very nearly equal potential. The assessment is based on known or inferred geologic, geochemical, and geophysical features. Sites showing minor variations of geologic or other features within the numbered areas are shown by letters following the number. Typically, the geologic features on which an evaluation of mineral resource potential is based are not sharply delineated.

Area 1.--Area 1 near the center of the roadless area has a high mineral resource potential. Prospects there are few and mostly small, and because the area is not accessible by jeep or wagon track, little if any ore has been shipped from them. Part of area 1 lies on the northeast strand of the Apache Pass fault zone, from site 1b to 1c, and a prong of the area extends to the northeast at site 1d. The rocks southwest of this fault strand include Paleozoic metamorphosed limestone, two plugs of Tertiary rhyolite or latite porphyry, and the edge of a granodiorite stock. Tertiary rhyolite occurs northeast of the fault strand and is underlain by Mesozoic volcanic and sedimentary rocks and by Paleozoic sedimentary rocks. A volcanic breccia pipe lies just east of this area. The volcanic rocks near site 1a form a subcircular area at least 0.6 mi wide and are pyritized and oxidized reddish brown to yellowish brown.

Sites 1a, 1b, and 1c lie within a zone shown by analyses of samples to contain anomalously high concentrations of base and precious metals (samples 211-214, 221, and 222, Bigsby, 1983). Chip samples from rocks at the small prospects and from some outcrops show concentrations of copper, lead, zinc, molybdenum, barium, and silver. Bismuth is present at site 1d. The distribution of metals in samples of alluvium suggests mineralized rock at moderate depth (many hundreds to a few thousand feet) near site 1a (Watts and others, in press). Aeromagnetic data show that the roof of the large granodiorite stock southwest of site 1b plunges gently southeast, parallel to the trend of the fault strand.

We conclude that vein and replacement deposits of lead, zinc, and silver may occur in the sedimentary rocks and, locally, contact-metamorphic skarn deposits may occur near the stock. Furthermore, a molybdenum porphyry deposit may lie at moderate depth beneath site 1a. The porphyry deposit is suggested by anomalous amounts of bismuth and molybdenum, disseminated pyrite, and oxidized rock. The mineralized rock at site 1d, like the nearby volcanic breccia pipe, may have resulted from upward movement of fluids from a more steeply dipping subsurface segment of the northeast strand of the Apache Pass fault zone or the influence of a northeast-trending fault in pre-Tertiary rocks, a segment of which appears along lower Wood Canyon.

Area 2.--Area 2 is an elliptical area of high mineral resource potential along the Apache Pass fault zone, centered about the Hilltop mining camp, and is largely outside the roadless area. However, the area between sites 2c and 2d is in the southernmost arm of the roadless area. Area 2 is underlain by metamorphosed Mesozoic and Paleozoic sedimentary rocks (Drewes, 1982); a large granodiorite stock is south of site 2b, and a small stock and plugs of rhyolite porphyry or latite porphyry are at 2c and 2d. Site 2c lies near the junction of a major strand of the Apache Pass fault zone and a branch fault extending south along the North Fork of Pinery Canyon.

All samples from area 2 contain anomalously large amounts of base and precious metals. In addition, site 2d may have a moderate potential for small tungsten-bearing contact-metamorphic skarn deposits. Copper, lead, zinc, molybdenum, and bismuth were introduced into the rocks of the central part of the area, around site 2a. Only copper was found near site 2b, and lead, barium, and silver were found in the rocks between 2c and 2d. Typically, copper, molybdenum, and bismuth are found near the middle or base of this vein or replacement kind of ore body, whereas barium, lead, and silver are found near the upper part. The assemblage of metals in alluvial samples from this area suggests that the focus of the mineralization was shallow (Watts and others, in press) and probably produced the deposits at the Hilltop mine. A spur of a major aeromagnetic positive anomaly lies around sites 2a and 2b (Moss, in press), from which we infer that the crest of the granodiorite stock of Jhus Canyon plunges gently northwestward to Hilltop; the stock could have been the source of mineralization there.

Area 2 has a high potential for metallic mineral resources because of the Hilltop mining district, from which metals production has been in the $10 million range (Bigsby, 1983). Although this investigation is not intended simply to rediscover old mining camps, this comparison does provide an approximate basis for calibration with the results obtained within the study area nearby. Thus, a general comparison may be made, for example, between area 2 and areas 1 or 4. The ore zone, which is shallow at sites 2a and 2b, appears to plunge northwest at sites 2c and 2d, where it may be a similar but deeper exploration target.

Area 3.-- Area 3 has a moderate resource potential for lead-zinc-silver in vein and replacement deposits at moderate depth. It lies along the central part of the Apache Pass fault zone of much-faulted and moderately propylitized Mesozoic and Paleozoic sedimentary rocks, and scattered dikes and small plugs of rhyolite and latite porphyry. At the time of this study, the King of Lead mine and some properties 0.7 km southeast of the mine were undergoing sporadic development.

The area is assigned only a moderate potential because it contains fewer known sites of mineralized rocks than do areas 1 and 2, and, although lead, zinc, barite, and silver have been concentrated locally, copper and molybdenum occurrences are fewer than in areas 1 and 2. The association of metals in alluvial deposits suggests that the rocks may have been mineralized at shallow to intermediate depths. Furthermore, aeromagnetic data show three positive anomalies that resemble the signatures of small buried stocks, features favorable to skarn, contact, stockwork, or disseminated deposits.

Apparently area 3 lies in a structurally lower terrane than areas 1 and 2, and the rocks and conditions favorable for mineral deposits lie deeper and are harder to find. If contact-metamorphic, stockwork, or disseminated deposits occur, they may be near the inferred buried stocks, perhaps about 0.5 mi beneath the ground surface.

Area 4.--Area 4 has moderate potential for metallic mineral resources. It lies northeast of the Apache Pass fault zone where there are no mines or prospects. It is underlain by Tertiary rhyolitic to andesitic rocks and a few breccia pipes, carbonate reefs, and intrusive or near-intrusive welded-tuff bodies. A few faults of small displacement cut the rocks.

Chip samples of the carbonate reefs indicate that the reefs contain concentrations of lead, barium, molybdenum, and silver. The assemblage of metals in alluvial samples suggests a potential for mineralized rock at moderate depth near site 4a, at somewhat greater depth at 4b and 4c, and at great depth at 4d (Watts and others, in press). Aeromagnetic data show that a stock may underlie site 4b and extend northwestward a short distance east of sites 4a and 4d (Moss, in press).

Sediment samples from some streams in area 4 contain anomalously large amounts of tin, which may indicate a resource potential for, or which may indicate the presence of, associated rare metals. The tin probably occurs in cassiterite derived from the volcanic rocks capping the ridge south of sites 4a and 4c. Although tin concentrations in lava and tuff are commonly too low to be of current interest, areas underlain by granite bodies associated with the volcanic systems from which lava and tuff have come may have mineral resource potential. The vent sites of these rocks are possibly at the breccia pipes and the near-intrusive(?) welded-tuff mass southwest of sites 4a and 4d. Thus, the inferred buried stock near area 4, shown as the aeromagnetic anomaly M10 (Moss, in press), may contain an anomalously high concentration of tin.

Area 4 is of special interest because it may have several kinds and sites of mineral resource potential where prospects are absent. One favorable location is beneath the young volcanic rocks along the zone of carbonate reefs at the faults in secs. 15 and 16, T. 16 S., R. 30 E. (mapped by Drewes, 1982). The small young faults along which the reefs lie are probably reactivated segments of larger faults that connect to the nearby Apache Pass fault zone. Accordingly, at depths of 3,500-5,000 ft the rocks may be more severely fractured and of a kind more readily replaced. The carbonate-reef mineral enrichment may thus be a relatively young deposit remobilized from an older and larger deposit at depth. Other favorable locations are at sites 4a, 4b, and 4d, where stocks may underlie the volcanic pile. Replacement or contact-metamorphic deposits may occur in limestone adjacent to these stocks, and the stocks themselves may contain anomalously high concentrations of tin.

Area 5.--Area 5 has moderate metallic mineral resource potential and is within the Apache Pass fault zone, but largely west of the roadless area. It is underlain mainly by Mesozoic sedimentary rocks and thrust-faulted Paleozoic limestone. The area lies on the flanks of a large granodiorite stock, which includes a mass of aplite near site 5a. Plugs and dikes of rhyolite and latite porphyry are also present. Most of the rocks around the stock are metamorphosed to hornfels and marble, and in places between sites 5a and 5b they are also pyritized. The southwest strand of the Apache Pass fault zone appears to have guided most of the mineral enrichment, and the fault slivers along the east-trending segment of the fault may indicate tensional stress particularly favorable for fluid movement.

The study of prospects (Bigsby, 1983) indicates that area 5 has a potential for small irregular contact-metamorphic deposits and tungsten-bearing skarn in altered limestone. Copper and lead were mobilized in the area, and locally bismuth and barite, also. The analyses of samples indicate that site 5b may have anomalously high mineral concentrations at depth (Watts and others, in press). The area lies on the southern and western flanks of a strong aeromagnetic positive anomaly centered around the granodiorite stock (Moss, in press). The magnetic gradient at site 5c is steeper than at 5a or 5b, which may indicate a steeper dip on that side of the stock, and consequently a narrower, less favorable site for mineralization.

Although it is considered an area of moderate mineral resource potential, area 5 probably contains small areas of replacement, vein, or contact-metamorphic deposits along the fault zone near site 5b, but mainly outside the roadless area.

Area 6.--Area 6 has a moderate potential for metallic mineral resources but lies largely outside the roadless area to the northeast. It is underlain mainly by unmetamorphosed Mesozoic and Paleozoic sedimentary rocks. Small plugs and dikes of rhyolite and latite porphyry are at sites 6a and 6b, and a few small mines and prospects also are at 6a. Thrust faults follow bedding planes, and both dip moderately to the south.

Assays of samples taken near site 6a indicate a moderate potential for contact-metasomatic and replacement deposits of base and precious metals, as well as for tungsten skarn deposits. Chip samples from sites 6a and 6c show some enrichment in copper and barium (Watts and others, in press). The analyses of alluvial samples indicate that mineralized rocks may lie at moderate depth from sites 6a to 6b, and may be very deep, 2,500-5,000 ft, southwest of 6a. Aeromagnetic data suggest that the area is on the south flank of a deep east-plunging stock (Moss, in press).

Area 6 may contain some small buried veins or replacement deposits at accessible depths and some deeper contact deposits; both types would provide a challenge to locate, because surface indications are limited to some faults and the few small intrusive bodies.

Area 7.--Area 7 has low to moderate mineral resource potential for base and precious metals. It is underlain by metamorphosed Mesozoic and Paleozoic sedimentary rocks and Precambrian granitic rocks, and is intruded by Tertiary stocks and pods. These rocks are cut by many steeply dipping faults, including the northeast strand of the Apache Pass fault zone and its branch, the Emigrant Canyon fault. A few prospects occur at site 7c.

Analyses of chip samples from rocks at site 7c show that arsenic, antimony, and silver were mobile elements along with the more common copper, lead, and zinc. The analyses of alluvial samples indicate that mineralized rocks may be present at depth beneath sites 7a and 7b. The shape and intensity of an aeromagnetic anomaly (Moss, in press) indicate that the crest of the stock exposed 2 mi west of site 7c plunges gently northeast. This stock probably is related to the small granodiorite pods and the widespread metamorphism of rocks in area 7.

Although several geologic features in area 7, such as the Apache Pass fault zone and stocks, seem likely to be associated with mineral deposits, few deposits have been found. Consequently, the area has low to moderate potential. The mineral enrichment which may be present would require much detailed study to find.

Other commodities

Marble and lime rock occur in the area, and other commodities--silica rock, sand and gravel, and graphite--are present or have been reported in or near the roadless area. All these products are more accessible and abundant at and near old quarries or outcrops outside the roadless area.

The North End Roadless Area lies within the Cordilleran overthrust belt (Drewes, 1980, 1981a) and is of interest for petroleum and natural gas resources. Although rocks deep in the subsurface could contain traps for these fluids, the abundant steep faults and stocks in the roadless area suggest that such fluids would not likely be preserved.

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