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MINERAL RESOURCE POTENTIAL OF THE LAUREL-MCGEE ROADLESS AREA, MONO COUNTY, CALIFORNIA

SUMMARY REPORT

By

Michael A. Cosca, Maurice A. Chaffee, and Edwin H. McKee
U.S. Geological Survey

and

Fredrick L. Johnson
U.S. Bureau of Mines

STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Laurel-McGee Roadless Area (5045), Inyo National Forest, Mono County, California. The 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.

SUMMARY

Geologic and geochemical investigations and a survey of mines and prospects, conducted to evaluate the mineral resource potential of the Laurel-McGee Roadless Area, Mono County, Calif. (fig. 1), reveal that several drainages within the roadless area contain anomalous concentrations of one or more metallic elements. These elements include arsenic, barium, bismuth, copper, gold, lead, silver, and tungsten that indicate possible tungsten or base-and precious-metal deposits. The elements occur in relatively low concentrations; therefore, the potential for exposed tungsten and base-and precious-metal resources is low. Areas of highest probability for the occurrence of mineral resources are on the eroding flanks of Mount McGee and west of Laurel Mountain along the contact zones between metasedimentary and plutonic rocks. Mining on Mount McGee during 1940-52 yielded a small tonnage of high-grade ore; however, no sizeable ore body has been detected to date.

Identified mineral resources in or near the Laurel-McGee Roadless Area occur at the Lucky Strike prospect where there are small resources (table 1, map sheet) of zinc, silver, copper, and lead. The Hard Point mine about 0.5 mi outside the roadless area, contains some tungsten resources and tungsten production has been recorded there and from the nearby Morhardt mine. On the basis of these occurrences, an area around and including these mines and prospects has a moderate potential for tungsten resource with low potential for silver, copper, zinc, and lead resources.

The north edge of the roadless area lies within the Long Valley caldera. Parts of this volcanic structure have geothermal resource potential. Present and past exploration for geothermal resources indicate that areas with enough heat to be a possible geothermal resource are far removed from the roadless area.

INTRODUCTION

The Laurel-McGee Roadless Area, encompasses about 14.8 mi^2 of Inyo National Forest about 30 mi northwest of Bishop and 3 mi southeast of Mammoth Lakes, Calif. (fig. 1). The area is accessible from the east by gravel and paved roads that branch off U.S. Highway 395. The roadless area, which lies between 11,067 and 7,200 ft elevation, is semiarid and sparsely covered with sagebrush, juniper, pinon pine, and limber pine.

Analysis of geologic and geochemical data and information gathered at mines and prospects were used to evaluate the mineral resource potential of the Laurel-McGee Roadless Area. During 1975 and 1982, the U.S. Bureau of Mines conducted a detailed investigation of mines and prospects in or near the roadless area and examined records and published literature for information related to mineral deposits; the U.S. Geological Survey conducted field and laboratory investigations of the roadless area in 1980 and 1981.

Enlargement of the Laurel-McGee Roadless Area to include what was originally designated the Sherwin Non-Wilderness subsequent to the U.S. Geological Survey sampling program has precluded the western area from a detailed study. The part of the mineral resource evaluation based on geologic and geochemical analyses is therefore confined to the eastern part of the roadless area. The U.S. Bureau of Mines has sampled mines and prospects in both parts of the roadless area, and the results from both areas are included in this report.

Comprehensive geologic studies of the map area were published by Rinehart and Ross (1956, 1957, 1964) and Bateman (1965). The most current and comprehensive discussion of the mines and ore deposits in the Laurel-McGee Roadless Area is in Rinehart and Ross (1964). Other reports on mineral deposits and mines in the study area include those by Hess and Larsen (1921), Mayo (1934), Lemmon (1941), Tucker and Sampson (1941), du Bray (1981), and du Bray and others (1983). The geology for this report was modified after Rinehart and Ross (1964) and Langenheim and others (1982).

GEOLOGY

The roadless area (fig. 2) consists mainly of Mesozoic plutonic rocks and subordinate Paleozoic metamorphic rocks and Cenozoic (chiefly Quaternary), sedimentary deposits;

volcanic rocks occur locally. The plutonic rocks are part of the Sierra Nevada batholith and the metamorphic rocks are part of large roof pendants within the granitic rocks of the batholith.

Paleozoic metamorphic rocks

Ordovician and Permian(?) metasedimentary rocks that are part of the Mount Morrison roof pendant occur in two structural blocks separated by a major fault on the west side of McGee Mountain. The units of these two blocks are not correlative. The western Convict Lake block (Rinehart and Ross, 1964) consists of a conformable sequence of mainly hornfels, slate, metachert, quartzite, and marble. Well-preserved Middle Ordovician graptolites have been found near the top of the stratigraphic sequence. The eastern McGee Mountain block (Rinehart and Ross, 1964), consists mainly of marble with local beds of hornfels and scattered chert nodules. The block occurs in three disconnected segments, the largest west of Hilton Creek, the others north of McGee Creek. A folded sequence of siliceous hornfels, marble, slate, and sandstone containing Ordovician graptolites stratigraphically overlies the marble.

Mesozoic plutonic rocks

The plutonic rocks of the roadless area are part of the Sierra Nevada batholith and range in age from Triassic to Cretaceous(?). The rocks are mainly granitic, but include some diorite. In general, the rocks were emplaced in order of increasing silica content. Some of the intrusions are zoned, with silica content increasing toward the center.

The oldest plutonic rock in the roadless area is the Wheeler Crest Quartz Monzonite, which occurs locally at the north end of McGee Mountain. The unit is dominantly porphyritic but grades into equigranular rock with a texture identical to that in the groundmass of the porphyritic rocks. The quartz monzonite has a primary foliation and, locally, a secondary gneissic foliation. The Wheeler Crest Quartz Monzonite has been dated at about 207 m.y. (Stern and others, 1981).

Bodies of diorite generally occur as inclusions or small pendants within individual plutons of more silicic rock. These diorite bodies are spatially associated with metamorphic rocks and many contain metamorphic inclusions. The composition and texture of the diorite is heterogeneous. Intrusive relations of the granitic bodies in the roadless area indicate that the diorite is probably Jurassic or Cretaceous (R. W. Kistler, oral commun., 1981).

Jurassic and (or) Cretaceous granitic plutons in the roadless area range from granodiorite to quartz monzonite. Quartz and feldspar are the main constitutents of these rocks; common accessory minerals include biotite, hornblende, magnetite, ilmenite, sphene, apatite, zircon, and allanite. Equigranular rocks are more common than porphyritic ones, but both are well represented.

Tertiary volcanic rocks

Volcanic rocks crop out in only two areas. A small remnant of Tertiary andesite is exposed on McGee Mountain, and an outcrop of Bishop Tuff is present about 2 mi east of the Laurel-McGee Roadless Area.

The andesite on McGee Mountain was extruded onto a surface of gentle to moderate relief prior to uplift of the Sierra Nevada. The presence of abundant bombs and scoriaceous brick-red agglomeratic materials indicate a nearby source. A Pliocene age is assigned to the andesite on the basis of a potassium-argon date of 2.6 m.y. (Dalrymple, 1963). The andesite is overlain by glacial deposits on McGee Mountain.

Quaternary sedimentary deposits

Sedimentary deposits in the roadless area are mainly glacial deposits of Pleistocene age and alluvial and colluvial deposits of Holocene age.

Most of the glacial deposits are well-defined moraines at the mouths of major canyons. Small patches of till and erratics lie on some upland surfaces.

The broad upland area of McGee Mountain is capped in part by scattered unstratified boulder deposits. The largest boulders are nearly 30 ft in maximum dimension, but most are only 10-20 ft in size. These deposits may provide information about the Cenozoic structural history of the area. McGee Creek has cut a canyon 2,500 ft deep since the deposition of the boulder deposits, which indicates that much of the relief along the range front developed after glaciation.

Alluvium forms a thin mantle on remnants of ancient land surfaces 3,000-5,000 ft above the adjacent valley floor. Because this alluvium is overlain by the glacial deposits on McGee Mountain, it is considered to be Pliocene.

Quaternary alluvial fill, alluvial fan deposits, and talus occur along the floors and slopes of major canyons and in the adjacent valleys. Talus consists of rock debris that has spilled down the oversteepened walls of glaciated valleys. Older alluvial fan deposits with dissected surfaces may represent glacial outwash from glaciers that existed higher in the Sierra Nevada. Younger alluvial fans have virtually undissected surfaces.

Structure

Structural features in the roadless area are caused by several periods of deformation. Pre-Cenozoic folds and faults are related both to pre-batholithic regional deformation and to intrusion of the Sierra Nevada batholith. Folds and faults caused by regional deformation, however, cannot always be distinguished from those caused by batholithic intrusion. Cenozoic structures, dominantly steeply dipping normal faults, are formed by uplift along the Sierra Nevada front.

The dominant pre-Cenozoic structure in the area is a steeply westward dipping homocline in overturned Paleozoic rocks of the Mount Morrison roof pendant. This fold is bounded on the east and west by faults. Most minor folds in this roof pendant, however, are steeply plunging and related to apparent lateral movement along faults. The tight folds range in amplitude from a few inches to several tens of feet. Moderately to gently plunging folds also occur, but are not as common as the steeply plunging folds.

Major steeply dipping faults with prominent scarps occur along the southwestern slope of McGee Mountain. Because nearly all the faults follow the same general northwest trend, they are inferred to be about the same age, although their age relationship to the intrusions is not known.

The dominant Cenozoic structures are numerous high-angle normal faults and gentle warps related to uplift of the Sierra Nevada. The oldest faults that cut Cenozoic rocks may be early Pleistocene in age; post-Pleistocene movement along the frontal fault system is conspicuously demonstrated at most places, however, by freshly cut alluvial fans. The area is currently undergoing deformation as evidenced by recent earthquake (1979, 1980, 1981, 1982, 1983) swarms occurring in the Convict Lake area.

GEOCHEMICAL STUDIES

The U.S. Geological Survey collected and analyzed 6 rock, 10 stream-sediment, and 10 panned-concentrate samples for the geochemical study of the roadless area. All the samples were analyzed for 31 elements (silver arsenic, gold, boron, barium, beryllium, bismuth, calcium, cadmium, cobalt, chromium, copper, iron, lanthanum, magnesium, manganese, molybdenum, niobium, lead, antimony, scandium, tin, strontium, thorium, titanium, uranium, vanadium, tungsten, yttrium, zinc, and zircon), using a six-step semiquantitative emission-spectrographic method (Grimes and Marranzino, 1968). Rock and stream-sediment samples were also analyzed for zinc by atomic-absorption spectrometry (Ward and others, 1969), and some were analyzed for gold by the same technique (Meier, 1980). Stream-sediment samples were analyzed for uranium, using a modification of the fluorometric method of Centanni and others (1956). The geochemical data are given in Cosca and Chaffee (1983).

The rock samples were collected from relatively unaltered areas in order to establish background levels of element abundances in the rocks. The stream-sediment samples were collected to provide information about mineral abundances in the drainage basins upstream from each sample site. The heavy-mineral-concentrate samples provide chemical information on a limited number of minerals, many of which commonly occur in ore deposits. For the U.S. Geological Survey's rock samples, six elements (silver, gold, copper, molybdenum, tungsten, and zinc) were selected as possibly related to mineralization. A total of 10 elements (silver, arsenic, gold, barium, bismuth, copper, molybdenum, lead, tungsten, and zinc) were investigated in the stream-sediment samples, and 11 elements (silver, arsenic, gold, barium, bismuth, copper, molybdenum, lead, uranium, tungsten, and zinc) were selected in the heavy mineral concentrate samples as related to mineralization; two elements (cobalt and iron) were considered to be related to hydrothermal alteration (pyritization).

The roadless area was divided into drainage basins corresponding to each sample locality. Anomalous concentrations of the selected elements were recorded for each drainage basin, totalled, and a numerical score assigned on the basis of the total; drainages with the highest scores represent areas of greatest mineral resource potential. The geochemical anomalies were then correlated with the geologic features.

The U.S. Bureau of Mines collected 194 samples from mines, prospects, and outcrops suspected to contain anomalous concentrations of certain metallic elements. Analyses of these samples were made to indicate qualitatively the presence or absence of these elements. The results were used to calculate resources at mines, prospects, and mineralized outcrops or to indicate areas of site-specific mineral resource potential.

MINES AND PROSPECTS

Mining and prospecting in the Bishop mining district, which includes the Laurel-McGee Roadless Area, began in the late 1800's and focused primarily on gold and silver. Tungsten was discovered in 1913, but not mined until 1916.

Tungsten prices grew to unprecedented heights in 1916 and, with production underway, many new discoveries were made. After World War I, the price of tungsten collapsed forcing the mines to close. During the 1930's, tungsten mining was intermittent, with many miners switching into gold production. A short period of high production was reached during World War II, when the price and sale of tungsten concentrates were fixed by Federal law (Bateman, 1965). Following the war, government purchases were halted, causing the price of tungsten to fall and forcing the eventual closure of most operations. Peak production for the Bishop district was reached during the Korean conflict, and moderate demands continued through the 1970's to maintain the government stockpile. The Pine Creek mine, about 15 mi south of the Laurel-McGee Roadless area, produced the majority of tungsten in the district. The mine continues to be a major world producer of tungsten.

In addition to tungsten, the Bishop mining district has yielded sizable quantities of gold, silver, molybdenum, and copper. Nonmetallic deposits of pumice, perlite, barite, talc, building stone, ceramic materials, gravel, and limestone have also been mined from the district (Bateman, 1965).

About 100 mining claims have been located in the Laurel-McGee Roadless Area. Some of the first claims were located south of Convict Lake in 1896 and in the Laurel Creek drainage in 1901. In 1928, W. E. Selbie located the Jessie Claim Group (Hard Point mine) and the Alice Claim Group (Lucky Strike prospect).

Tungsten production has been recorded from the Hard Point mine, Morhardt mine, and Tiptop mine. More than 20,000 short ton units[1] of tungsten trioxide (WO_3) were produced from the Hard Point from 1970 through 1972 by Union Carbide Corporation (Floyd Miller, oral commun., 1976); 28 tons of ore averaging 5 percent WO_3 were produced during the mid-1940's at the Tiptop mine (Tom Phelps, oral commun., 1979); and about 100 tons of ore averaging 1.0 percent WO_3 were produced from the Morhardt mine during the 1940's (Rinehart and Ross, 1964).

Identified metallic mineral resources in the roadless area occur in two geologic environments. Tungsten, predominately in scheelite ($CaWO_4$), formed within garnet-hedenbergite-quartz tactite along or near contact zones between the metasedimentary and intrusive rocks. The main deposits of this type are at the Tiptop mine, Hard Point mine, and Payday prospect. At the Lucky Strike prospect, sulfide minerals have replaced marble zones in metasedimentary rocks.

Six groups of workings are inside and seven are outside of the Laurel-McGee Roadless Area (fig. 2). Information on those mines and prospects, including assay data and resources, are summarized in table 1. Resources are calculated for the Lucky Strike prospect and Hard Point mine; resources were not calculated for other mines because of the spotty nature of exposures with tungsten minerals.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The Laurel-McGee Roadless Area has small identified resources of tungsten, zinc, silver, copper, and lead. These resources are in mineral deposits related to tactite bodies, and as replacement minerals in marble zones. Tactite bodies are most likely to yield substantial resources in the area. The Pine Creek mine about 15 mi south of the Laurel-McGee Roadless Area is an excellent example of a large and productive mine in tactites. The proximity to the Pine Creek mine and the similar geologic setting between the Pine Creek area and the Laurel-McGee area suggests the possibility of undiscovered mineralized tactites in the Laurel-McGee area. This general conclusion was the fundamental premise in the resource evaluation of the area. Actual assessment of mineral resource potential was based on evaluation of existing mines and prospects in or near the roadless area, the assumption being made that additional mineralized rock exists at these sites and in surrounding rocks if they are of a similar type. In the eastern part of the roadless area, evaluation of specific mines and prospects was augmented by geochemical sampling of stream sediments as a means of exploration for previously undiscovered mineralized rock. Drainage basins with anomalous concentrations of elements considered indicative of tactite mineralization may contain unexposed mineral deposits with resource potential.

Two parts of the Laurel-McGee Roadless Area have moderate potential for tungsten resources, and possibly copper, gold, lead, silver, and zinc resources in or near existing mines and prospects. One area includes the Lucky Strike prospect and Morhardt mines, the other includes the Payday prospect and Tiptop mine. An area of up to about 0.5 mi^2 around these mines, containing mostly metasedimentary rocks and possibly additional tactites has moderate potential for undiscovered mineral resources. Farther from these mines and in the vicinity of other less promising properties (Laurel Creek prospect, Section 17 prospect), the mineral resource potential is low (fig. 2). In the eastern part of the roadless area, areas that include the Tiptop mine and the Payday prospect have moderate resource potential for tactite resources. The area south of the Tiptop mine has low potential for tactite and possibly base-and-precious metal vein deposits on the basis of anomalous amounts of arsenic,

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[1]A short ton unit equals 1 percent of a short ton or 20 lbs of tungsten trioxide or 15.862 lbs of tungsten and is used to report tungsten assay values and to state market value of ore or concentrates.

barium, bismuth, copper, gold, lead, silver, and tungsten in stream-sediment samples.

The north edge of the roadless area lies within the Long Valley caldera. Parts of this volcanic structure have geothermal energy potential. Present and past exploration, including surface heat measurements, drilling, evaluation of hot springs, geologic mapping, and radiometric dating of volcanic rocks, indicate that probable geothermal resources related to this volcanic system are in areas far removed from the Laurel-McGee Roadless Area.

REFERENCES CITED

Bateman, P. C., 1965, Geology and tungsten mineralization of the Bishop district, California: U.S. Geological Survey Professional Paper 470, 208 p.

Centanni, F. A., Ross, A. M., and DeSesa, M. A., 1956, Fluorometric determination of uranium: Analytical Chemistry, v. 28, no. 11, p. 1651-1657.

Cosca, M. A., Chaffee, M. A., Diggles, M. F., Fey, D. L., Hill, R. H., and Sutley, S. J., 1983, Chemical analyses of samples of rock, minus 60-mesh stream-sediment, and nonmagnetic heavy-mineral concentrate, Laurel-McGee and Wheeler Ridge Roadless Areas, Inyo and Mono Counties, California: U.S. Geological Survey Open-File Report 83-3, 107 p.

Dalrymple, G. B., 1963, Potassium-argon dates of some Cenozoic volcanic rocks of the Sierra Nevada, California: Geological Society of America Bulletin v. 74, p. 379-390.

du Bray, E. A., 1981, Generalized bedrock geologic map of the John Muir Wilderness, Fresno, Inyo, and Mono Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1185-A, scale 1:125,000.

du Bray, E. A., Dellinger, D. A., Oliver, H. W., Diggles, M. F., Johnson, F. L., Thurber, H. K., Morris, R. W., Peters, T. J., and Lindsey, D. S., 1982, Mineral resource potential map of the John Muir Wilderness, Fresno, Inyo, Madera, and Mono Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1185-C, scale 1:125,000.

Grimes, D. J., and Marranzino, A. P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Hess, F. L., and Larsen, E. S., 1921, Contact metamorphic tungsten deposits of the United States: U.S. Geological Survey Bulletin 725-D, p. 245-309.

Langenheim, V. A. M., Donahoe, J. L., and McKee, E. H., 1982, Geologic map of the Laurel-McGee and Wheeler Ridge Roadless Areas, Inyo and Mono Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1411-A, scale 1:62,500.

Lemmon, D. M., 1941, Tungsten deposits in the Sierra Nevada near Bishop, California—a preliminary report: U.S. Geological Survey Bulletin 931-E, p. 79-104.

Mayo, E. B., 1934, Geology and mineral resources of Laurel and Convict Basins, southwestern Mono County, California: California Journal of Mines and Geology, v. 30, no. 1, p. 79-88.

Meier, A. L., 1980, Flameless atomic-absorption determination of gold in geological materials: Journal of Geochemical Exploration, v. 13, no. 1, p. 77-85.

Rinehart, C. D., and Ross, D. C., 1956, Economic geology of the Casa Diablo Mountain quadrangle, California: California Division of Mines and Geology Special Report 48, 17 p.

——1957, Geology of the Casa Diablo Mountain quadrangle, California: U.S. Geological Survey Geologic Quadrangle Map GQ-99, scale 1:62,500.

——1964, Geology and mineral deposits of the Mount Morrison quadrangle, Sierra Nevada, California: U.S. Geological Survey Professional Paper 385, 106 p.

Stern, T. W., Bateman, P. C., Morgan, B. A., Newell, M. F., and Peck, D. L., 1981, Isotopic U-Pb ages of zircon from the granitoids of the central Sierra Nevada, California: U.S. Geological Survey Professional Paper 1185, 17 p.

Tucker, W. B., and Sampson, R. J., 1941, Recent developments in the tungsten resources of California: California Journal of Mines and Geology, v. 37, no. 4, p. 565-588.

Ward, F. N., Nakagawa, H. M., Harms, T. F., and VanSickle, G. H., 1969, Atomic-absorption methods of analysis useful in geochemical exploration: U.S. Geological Survey Bulletin 1289, 45 p.

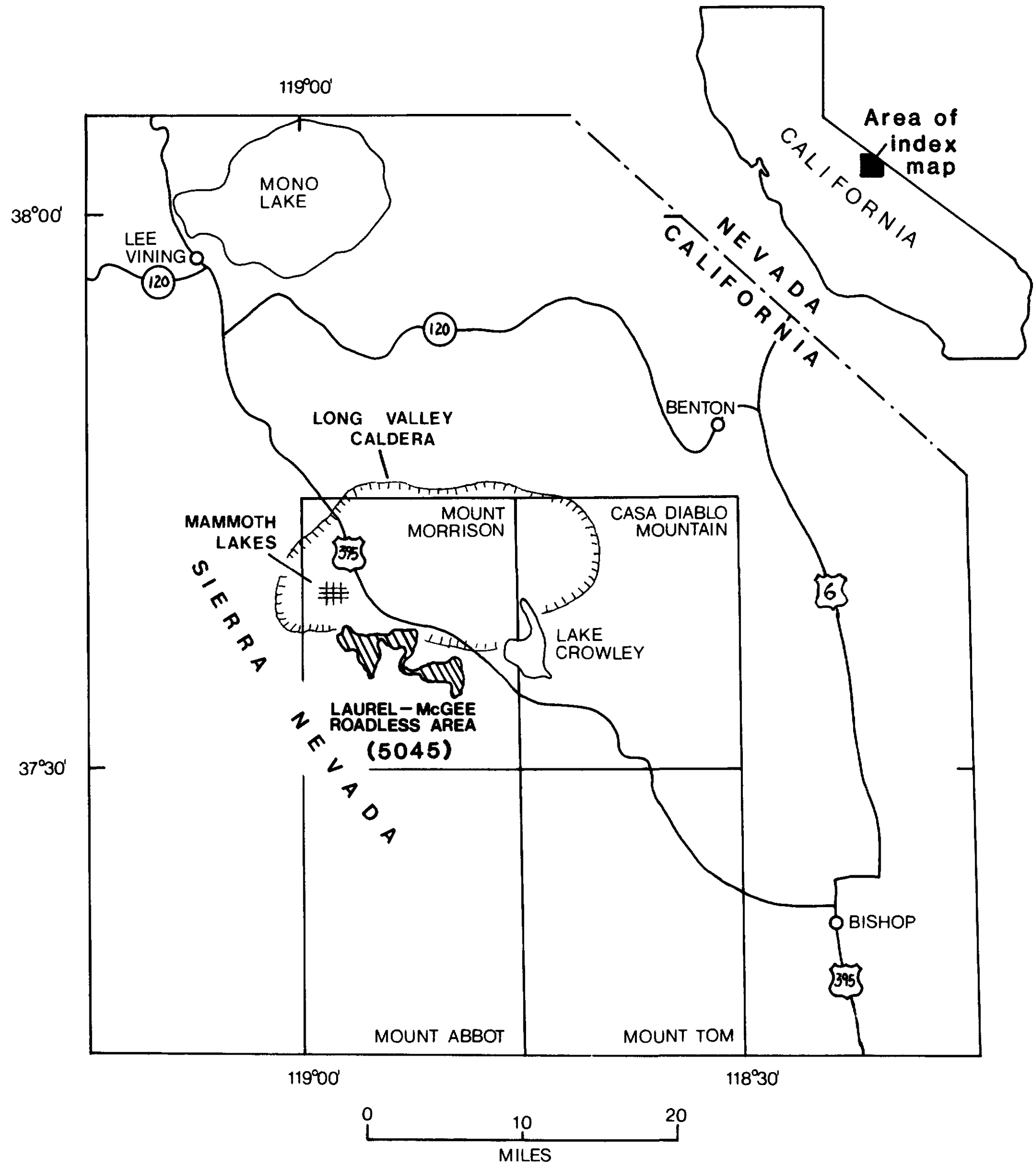

Figure 1.--Index map showing location of roadless area in east-central California and the 15-minute quadrangles covering the study area.

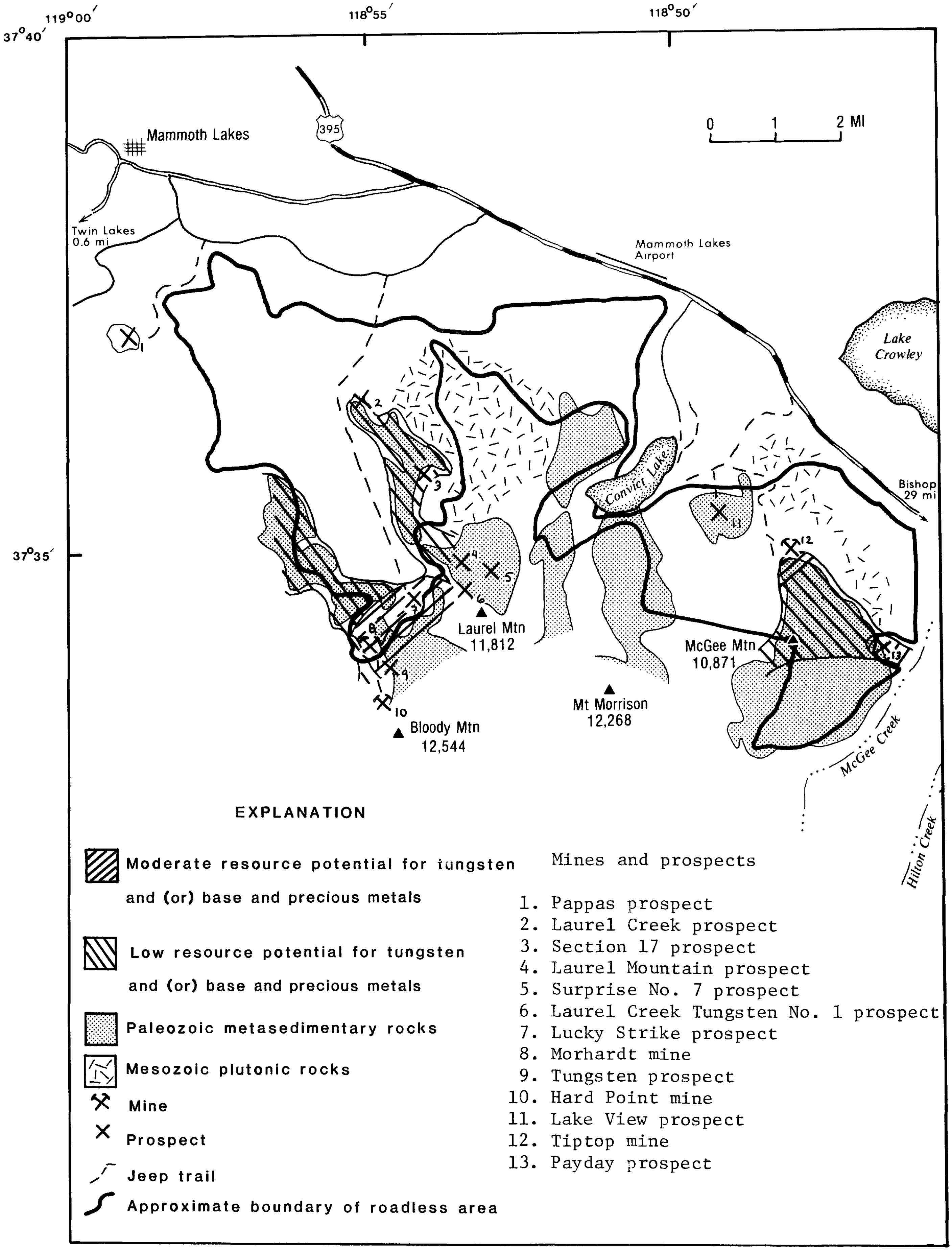

Figure 2.--Laurel-McGee Roadless Area showing generalized geology, areas with mineral resource potential, and location of mines and prospects.