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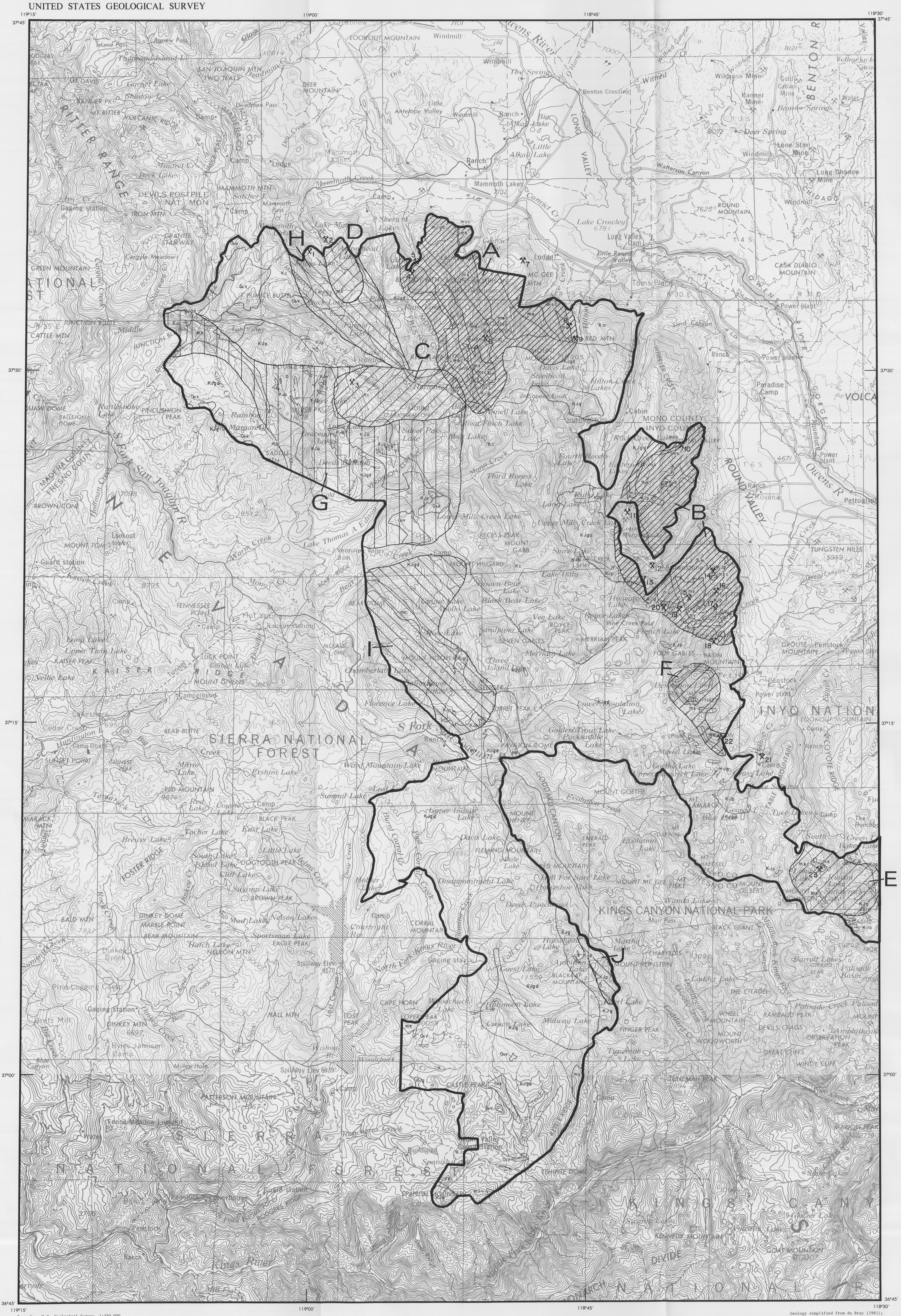


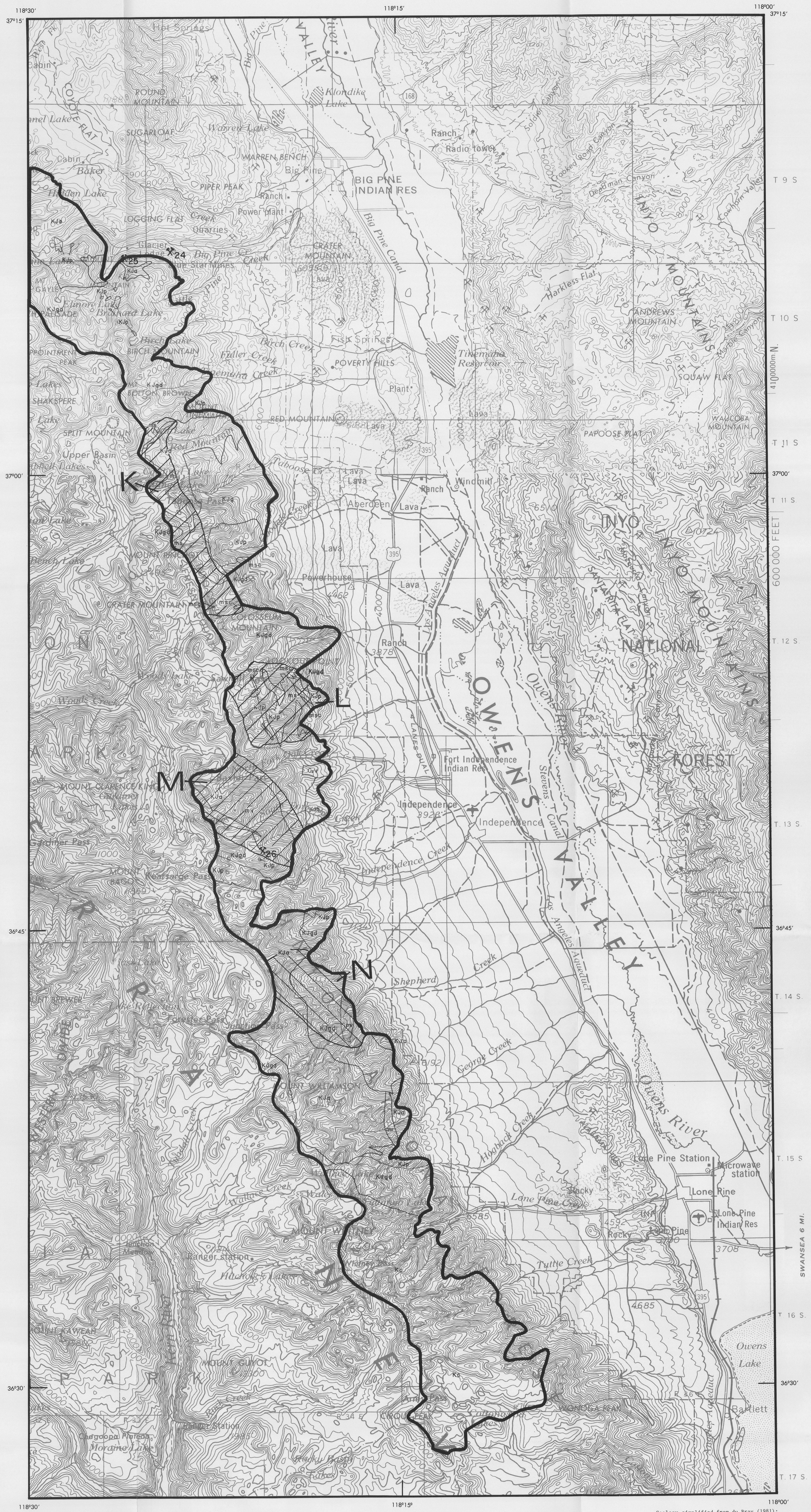
Base from U.S. Geological Survey, 1:250,000 Mariposa, 1957, revised 1970; Fresno, 1962, revised 1971

SCALE 1:125 000

CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology simplified from du Bray (1981); mineral resource potential compiled by D. A. Dellinger, 1981

NORTH HALF



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CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology simplified from du Bray (1981); mineral resource potential compiled by D. A. Dellinger, 1981

SOUTH HALF

MINERAL RESOURCE POTENTIAL MAP OF THE JOHN MUIR WILDERNESS, FRESNO, INYO, MADERA, AND MONO COUNTIES, CALIFORNIA

By

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1982

EXPLANATION

ANOMALOUS AREAS FAVORABLE FOR UNDISCOVERED MINERAL DEPOSITS - Labeled A-N

- A ▨ Area of high favorability
- C ▨ Area of moderate favorability
- H ▨ Area of low favorability
- G ▥ Area of very low favorability, based on evidence from geochemical techniques not used elsewhere in the wilderness
- ⚒ 12 MINE OR PROSPECT - Number refers to list of mines and prospects
- ~ APPROXIMATE BOUNDARY OF WILDERNESS

MINES AND PROSPECTS

1. Emerald Lake prospect
2. Mammoth Consolidated mne
3. Pick and Shovel mine
4. Hard Point mine
5. Lucky Strike prospect
6. Scheelore mine
7. Tiptop prospect
8. Nicoll Hilton Creek mine and Filipelli prospect
9. Phelps Hilton Creek mine
10. Round Valley peak prospect
11. Adamson mine
12. Pine Creek mine
13. Brownstone mine
14. Lambert mine
15. Tungstar mine
16. Alta mine
17. Sonny Boy mine
18. Basin Mountain prospect
19. Hanging Valley mine
20. Gable Lakes mine
21. Cardinal mine
22. Moly Blue prospect
23. Bishop Silver-Cobalt mine
24. Blue Star Talc mine
25. Snow White Nos. 1-5 prospect
26. Rex Montis mine

CORRELATION OF MAP UNITS

Unit	Period	Era
Czv		CENOZOIC
Kc	CRETACEOUS	MESOZOIC
KJa	CRETACEOUS OR JURASSIC	
KJg		
KJgd		
KJp		
₸m	TRIASSIC	
mv		MESOZOIC OR PALEOZOIC
msc		
ms		

DESCRIPTION OF MAP UNITS

Unit	Description
Czv	VOLCANIC ROCKS (CENOZOIC)
Kc	GRANODIORITE OF THE CATHEDRAL PEAK TYPE (CRETACEOUS)
KJa	ALASKITE (CRETACEOUS OR JURASSIC)
KJg	GRANITE (CRETACEOUS OR JURASSIC)
KJgd	GRANODIORITE (CRETACEOUS OR JURASSIC)
KJp	MAFIC PLUTONIC ROCK (CRETACEOUS OR JURASSIC)
₸m	QUARTZ MONZONITE (TRIASSIC)
mv	MAFIC AND FELSIC METAVOLCANIC ROCKS (MESOZOIC OR PALEOZOIC)
msc	CALCAREOUS METASEDIMENTARY ROCKS (MESOZOIC OR PALEOZOIC)
ms	MICACEOUS AND OTHER METASEDIMENTARY ROCKS (MESOZOIC OR PALEOZOIC)

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 resource potential survey of the John Muir Wilderness, Inyo and Sierra National Forests, Fresno, Inyo, Madera, and Mono Counties, California. The John Muir Wilderness was established by Public Law 88-577, September 3, 1964.

SUMMARY

Tungsten is the principal metallic commodity in the John Muir Wilderness; it is estimated that more than 1 million tons (0.9 million t) of tungsten resources[1] exist in the wilderness. These deposits, with associated gold, silver, copper, and molybdenum, occur near contacts between granitic intrusions and metamorphosed calcareous sedimentary rocks. The area has no known potential for coal, oil, gas, or geothermal energy.

Areas with exposed calcareous metasedimentary rocks are considered favorable for small tactite deposits; the degree of favorability is assigned on the basis of known deposits and (or) geochemical anomalies. Some areas with only geochemical anomalies have been assigned low favorability for mineral deposits.

The mineral resource evaluation is based upon a synthesis of geologic, geochemical, geophysical, and mineral-deposit information that permits the designation of areas with mineral resource potential. These designations are based on the presence of known mineral occurrences, favorable host rocks, drainage basins with groups of geochemically anomalous samples, and aeromagnetic anomalies.

The John Muir Wilderness is 755 mi^2 (1,956 km^2) in area and is located in the central Sierra Nevada. It is underlain primarily by Mesozoic granitic plutons of the Sierra Nevada batholith, which are generally felsic but include some diorite and gabbro. Pendants of metamorphosed roof rock and wallrock are preserved between plutons and occupy about 15 percent of the area. These are basaltic to rhyolitic metavolcanic rocks and quartzitic to calc-silicic metasedimentary rocks. About 5 percent of the wilderness is underlain by volcanic rocks less than 12 m.y. old.

Mining for gold and silver took place in the Kearsarge district within the wilderness from about 1864 to 1870 and in the Mammoth district from 1878 until the early 1900's. Tungsten has been mined from the Pine Creek pendant area since 1918. The Pine Creek mine, adjacent to the wilderness, is the largest producer of tungsten in the United States today.

GEOLOGY

The John Muir Wilderness is principally underlain by granitic plutons of the Sierra Nevada batholith, but metamorphic rocks and Cenozoic volcanic rocks underlie about 20 percent of the area. Most of the plutonic rocks are felsic, but small bodies of diorite and gabbro[2] are also present. The composition of the metavolcanic rocks ranges from basaltic to rhyolitic; the metasedimentary rocks are primarily quartzite and calc-silicate rocks.

The metamorphic rocks are of particular interest because they are potential hosts to metallic ore deposits. Areas dominated by metamorphic rocks include the Mount Morrison pendant[3] (area A) in the Mount Morrison, Mount Abbot, and Devils Postpile quadrangles; the Pine Creek pendant (area B) and Mount Humphreys septum[3] (area F) in the Mount Tom quadrangle; the Oak Creek pendant (area M) in the Mount Pinchot quadrangle; and the Goddard pendant in the Blackcap Mountain and Mount Goddard quadrangles. Other smaller masses of metamorphic rocks occur throughout the wilderness.

The rocks of the Mount Morrison pendant are chiefly metasedimentary rocks of early and late Paleozoic age. The bulk of the stratigraphic section is composed of dark quartz-rich hornfels; other common rock types include marble, pelitic hornfels, calc-silicate rocks, and quartzite (Rinehart and Ross, 1964). Marble adjacent to plutonic contacts has commonly been converted to pods and stringers of tactite. Resources of tungsten, with accompanying gold, silver, copper, and molybdenum, occur in these small bodies. Most of the calcareous metasedimentary rocks in the wilderness are found in the Mount Morrison and Pine Creek pendants (areas A and B); other tactite deposits, some with known tungsten production, also occur in small septa located elsewhere in the wilderness, mostly on the east side of the Sierra Nevada crest. The Mount Morrison and Pine Creek pendants are assigned a high geologic favorability for tungsten deposits; the upper Big Pine Creek, Mount Humphreys, Mount Pinchot, and Lookout Point areas (E, F, K, and L) have moderate geologic favorability for tactite deposits and associated tungsten resources.

Metavolcanic rocks are common throughout the wilderness, especially in the Goddard and Oak Creek pendants, and in the west limb of the Mount Morrison pendant (area D). Gold and silver were mined from vein deposits in altered metavolcanic rocks in the west limb of the Mount Morrison pendant, just outside the wilderness; this altered zone extends into the wilderness (area D). The Kearsarge district gold-silver mines are associated with the Oak Creek metavolcanic pendant (area M). Areas D and M have moderate geologic favorability for undiscovered gold-silver deposits.

About 50 discrete, separately emplaced plutons crop out in the wilderness. A complete range of composition between alaskitic granite and hornblende gabbro is represented.

Five percent of the John Muir Wilderness is underlain by Cenozoic volcanic rocks. These are primarily basalt flows; they are found in the Sawmill Creek (northeast of Sawmill Pass) and Taboose Creek drainages, around Pincushion Peak in the Kaiser Peak quadrangle, at the southern border of the Blackcap Mountain quadrangle, throughout the Tehipite Dome quadrangle, and south of Devils Postpile. A small body of rhyolite tuff occurs south of Devils Postpile.

The present landform of the John Muir Wilderness is primarily the result of rapid uplift, volcanism, and glaciation. Uplift and westward tilting of the Sierra Nevada block caused rapid erosion of the roof rock and exposure of the batholith. Parts of the wilderness were subsequently covered by volcanic flows and cinder accumulations. Glaciation in Pleistocene time left the range with its present form. Uplift of the Sierra Nevada is still occurring along faults on the eastern range front.

GEOCHEMISTRY

The results of the geochemical survey indicate that significant mineralization occurs primarily in metasomatic deposits at contacts between granitic and calc-silicate rocks, in silicified and (or) chloritized joints in granitic rocks, and in altered metavolcanic rocks. All of the mines and prospects in or near the wilderness are associated with one of these features. Many anomalies are apparently related to mineralization, but this study did not reveal any large undiscovered deposits. Neither the extremely high values nor the extensive lateral persistence of stream-sediment anomalies, usually associated with large deposits, were observed.

Tungsten, the element most likely to be found in economic deposits in the study area, occurs as scheelite ($CaWO_4$) in thin bands of tactite at contacts between granitic and calc-silicate rocks. Tungsten was detected in very few samples; even in some samples collected downstream from known deposits (e.g., the Hard Point and Tungstar mines), it was not detected. The very low ratio of the size of any mineralized area to the size of the area drained at a typical sampling site and the tendency for tungsten minerals to concentrate in pockets not likely to be sampled account for the low tungsten concentrations. The geochemical survey, therefore, provided very little information about the presence or absence of tungsten deposits. Further exploration using higher sampling-site density, the analysis of heavy-mineral concentrates, and analytical techniques capable of measuring smaller concentrations might detect these deposits.

Recognition of low-level anomalies in samples from some parts of the wilderness resulted from the use of sensitive analytical techniques. Most of the more sensitive analyses were done on samples from the northwestern part of the wilderness; area G was recognized largely on the basis of more sensitive analytical techniques used only there.

Many of the geochemically anomalous areas in the wilderness are associated with metamorphic pendants and some are associated with glacial till originating from metasedimentary rock units. Metamorphosed volcanic rocks have also been identified as sources of geochemical anomalies.

In addition to metamorphic rock sources, anomalous zones have been identified in or near several igneous bodies. An anomalous area in the northwestern part of the wilderness is probably attributable to the occurrence of basalt and mafic plutonic rocks there. A large mafic pluton located near Kearsarge Pass is probably responsible for the geochemically anomalous zone in that area.

A third major source of geochemical anomalies is mineralization in quartz veins. Many of these veins follow steeply dipping joint systems in the northern part of the wilderness. There are also chloritized and silicified joints that appear to have associated mineralization in the northwestern part of the area. Particular geochemical anomalies and elements are discussed in the section on economic evaluation.

GEOPHYSICS

Most of the magnetic anomalies are associated with topography or are consistent with the magnetic properties of the rocks exposed at the surface. The largest magnetic highs are associated with mafic plutonic rock, which generally contains several percent finely disseminated magnetite. Moderately high magnetic anomalies also occur over mafic metavolcanic rocks in the Mount Morrison and Goddard roof pendants, but these are not nearly as large as the 600-gamma high, at 3,300 ft (1,000 m) above the metavolcanic rocks of Iron Mountain, which locates a significant magnetite deposit about 5 mi (8 km) northwest of the northern boundary of the wilderness (Oliver, 1982). Magnetic lows are associated with the most felsic granitic rocks (alaskites and Cathedral Peak type) as well as the metasedimentary rocks, particularly the marbles in the roof pendants. Extensive magnetic lows over intermediate to mafic plutonic rocks often indicate mineralized zones, but none were revealed by the survey.

A comparison of magnetic anomalies with the geochemical anomalies reported by Dellinger and others (1982) indicates that magnetic highs are associated with many of the nickel and chromium anomalies and a few of the copper and silver anomalies. A magnetic low 2.5 mi (4 km) west of Florence Lake is associated with a tungsten and molybdenum anomaly. Magnetic lineaments over alternating metavolcanic and metasedimentary rocks on the west limb of the Mount Morrison pendant reflect the structure of the pendant and a concordant zone of silver-gold-zinc mineralization.

The magnetic data show that (1) there are no large deposits of magnetite or pyrrhotite comparable to the Iron Mountain deposit, (2) there are no buried masses of magnetite-rich serpentinite within the wilderness area such as those that contain gold and silver in the Sierra Nevada foothills, and (3) there are several nickel and chromium geochemical anomalies, substantiated by large magnetic highs, associated with mafic plutonic rocks. No major mineralized areas were revealed by the magnetic data.

ECONOMIC EVALUATION

Area A: The Mount Morrison pendant area contains five mines or prospects with more than 1,000 tons (900 t) of resources: the Hard Point mine (loc. 4), Lucky Strike prospect (loc. 5), Scheelore mine (loc. 6), Nicoll Hilton Creek mine and Filipelli prospect (loc. 8), and Phelps Hilton Creek mine (loc. 9). These properties are in tactite or metasedimentary deposits, with related tungsten, gold, silver, lead, copper, and zinc mineralization. Three geochemically anomalous zones lie within this area. Anomalous amounts of zinc, chromium, lead, silver, copper, and gold are present in stream sediments south of Convict Lake. Near Esha Canyon, about 2 miles west of Hilton Creek, and upper McGee Creek there are lead-copper-zinc anomalies attributable to the small deposits of these minerals scattered throughout the pendant (Rinehart and Ross, 1964). Stream-sediment samples anomalous in gold and molybdenum were collected in Laurel Creek, north of Bloody Mountain. The Hard Point mine (loc. 4), located at the head of the Laurel Creek, consists of sulfide-rich tactite near the contact between the Round Valley Peak Granodiorite and calcareous metasedimentary rocks of the Bloody Mountain Formation. Area A is considered to have high favorability for undiscovered deposits of tungsten, lead, copper, zinc, gold, silver, and possibly molybdenum in calcareous metasedimentary rocks.

Area B: Metasomatic tungsten deposits occur at contacts with intrusive rocks and calcareous metasedimentary rocks of the Pine Creek pendant, a 7 mi (11 km) by 1 mi (1.6 km) belt extending from Basin Mountain to Wheeler Crest. The east side of the belt contains an extensive marble zone. Tungsten deposits are preferentially related to the most silicic intrusive rocks of the area (Bateman, 1965). Over 70 percent of the known deposits are associated with the Tungsten Hills Quartz Monzonite or with alaskite. Of 20 mines and prospects located in area B, 8 have resources in excess of 1,000 tons (900 t): the Round Valley Peak prospect (loc. 10), Brownstone mine[4] (loc. 13), Lambert mine (loc. 14), Tungstar mine (loc. 15), Alta mine (loc. 16), Sonny Boy mine (loc. 17), Hanging Valley mine (loc. 19), and Gable Lakes mine (loc. 20). Production from Union Carbide Corporation mines at Pine Creek (loc. 12), adjacent to the wilderness, has been 4.5 to 5.0 million short ton units (stu)[5] (41 to 45 million kg) tungsten trioxide (WO_3), 5.5 million lb (2.5 million kg) copper, 7.0 million lb (3.2 million kg) molybdenum, and 1.0 million troy oz (5.6 million g) silver. Pine Creek mine is the largest tungsten producer in the United States today. Since 1916 production from the Pine Creek pendant area of the wilderness totals nearly 143,000 stu (1.3 million kg) WO_3. Area B has high favorability for undiscovered deposits of tungsten, molybdenum, copper, and silver in calcareous metasedimentary rocks.

Area C: Stream-sediment samples from the area around Hortense and Lee Lakes have anomalous concentrations of lead, gold, silver, zinc, copper, molybdenum, chromium, nickel, and manganese. The Pick and Shovel mine (loc. 3) within this area consists of quartz stringers and pods along joints in quartz monzonite and has indicated marginal resources of gold, silver, lead, copper, and zinc. The eastern part of the area may have tungsten resources in tactite deposits at the margins of small bodies of calcareous metasedimentary rock. The favorability for undiscovered sulfide- and scheelite-bearing tactite and lead, copper, zinc, gold, and silver deposits in veins in this area is judged to be moderate.

Area D: Stream-sediment samples from the area around Mammoth Creek are anomalous in gold, silver, and zinc, due to an altered zone in the metamorphosed latite at Arrowhead Lake. The Mammoth Consolidated mine (loc. 2) and several smaller mines and prospects are located just outside the wilderness in this alteration zone. The favorability for undiscovered gold-silver and possibly zinc deposits in metavolcanic rocks in this area is considered moderate.

Area E: The area east of Ruwau and Saddlerock Lakes in the upper Big Pine Creek drainage contains numerous small bodies of calcareous metasedimentary rocks; tungsten-bearing tactite deposits may occur at the contacts of these bodies with granitic rocks. Eleven stream-sediment samples from this area were anomalously high in silver. Most of these samples had above-average concentrations of nickel and cobalt. The Bishop Silver-Cobalt mine deposit (loc. 23) is located 2 mi (3.2 km) west of these sampling sites and contains small silver-cobalt veins in gneiss. This area has moderate favorability for undiscovered tungsten-bearing tactite bodies and vein deposits of silver and possibly cobalt.

Area F: Stream-sediment samples from the area around Mt. Humphreys were anomalous in molybdenum, copper, and silver. Bodies of metamorphosed calcareous sedimentary rocks in this area are similar to those associated with tactite deposits of tungsten elsewhere in the wilderness. The Moly Blue prospect (loc. 22), consists of pods and veins of molybdenum minerals in siliceous zones in quartz monzonite; resources are indicated and inferred subeconomic. Area F is considered to have moderate favorability for undiscovered deposits of tungsten, copper, and silver in calcareous metasedimentary rocks and of molybdenum in siliceous zones in granitic rocks.

Area G: Geochemical analyses show anomalous zinc, gold, silver, lead, molybdenum, and copper in stream-sediment samples from the area between Fish Valley and Mono Creek. This area of anomalies was recognized largely on the basis of analyses that were more sensitive than those done on stream-sediment samples collected elsewhere in the wilderness. The south and east boundaries of the area probably reflect a change to a less sensitive analytical technique rather than to lower favorability for mineral deposits. The area has very low favorability for undiscovered deposits of lead, zinc, copper, gold, and silver in veins and joints.

Area H: The metamorphosed latite of Arrowhead Lake exclusive of area D constitutes area H. Known deposits and geochemical anomalies present elsewhere in this rock unit suggest that the area may have low favorability for undiscovered deposits of gold and silver in metavolcanic rocks.

Area I: Stream-sediment samples from the area between Bear Creek and Turret Peak contain anomalous amounts of gold, lead, tungsten, copper, and molybdenum, probably due to mineralization in several bodies of altered granitic rocks in the granite of Bear Dome (called the quartz monzonite of Bear Dome by Lockwood and Lydon, 1975) and in metavolcanic rocks nearby. There are no mines in the area, but a magnetic low 2.5 mi (4 km) west of Florence Lake is associated with a tungsten and molybdenum geochemical anomaly. Area I has low favorability for undiscovered deposits of gold, molybdenum, tungsten, lead, and copper associated with altered metavolcanic and granitic rocks.

Area J: Stream-sediment samples from the area east of Blackcap Mountain are anomalous in copper and lead. Other chemical analyses (Bateman and Lockwood, 1970) show that Cenozoic volcanic rocks similar to those in this area contain more copper, nickel, and chromium than the felsic granitic rocks on which the threshold values are based. There are no mines in the area. Favorability for undiscovered vein-type deposits of copper and lead is low.

Area K: Small masses of calcareous metasedimentary rocks are present in the area near Mount Pinchot, suggesting possible tungsten deposits in tactite at contacts with granitic rocks. A single stream-sediment sample collected in this area contained above-average amounts of nickel, copper, and chromium. This sample was collected near exposures of mafic plutonic rocks, richer in the anomalous elements than the granitic rocks upon which the threshold values are based (Rose and others, 1979). The favorability for undiscovered tactite occurrences with accompaning tungsten resources in this area is moderate; favorability for other mineralization is low.

Area L: Pods of calcareous metasedimentary rocks are present in contact with granitic rocks in the area between Lookout Point and the north fork of Oak Creek, suggesting possible tactite deposits. A large positive magnetic anomaly is centered over the area, and geochemical analyses of stream-sediment samples show anomalous copper, lead, and chromium. The magnetic anomaly probably is associated with relatively large amounts of magnetite in a large body of mafic plutonic rocks in the area; the geochemical anomaly probably is attributable to high background levels of the anomalous elements in the same body. The favorability for undiscovered tactite bodies with associated tungsten or sulfide mineralization in area L is moderate; favorability for small copper-lead deposits is low.

Area M: This area southeast of Baxter Pass contains mineralized vein quartz and fault gouge in the Oak Creek metavolcanic pendant and nearby granitic rocks; the Rex Montis mine (loc. 26) is in an indicated subeconomic deposit of this type, with only small amounts of gold and silver. Analyses of the stream-sediment samples in the northwestern part of this area show minor copper and nickel. Area M has moderate favorability for undiscovered vein deposits of gold and silver and possibly nickel and copper.

Area N: Stream-sediment samples collected near metavolcanic rocks in this area are weakly anomalous in lead and copper. A weak silver anomaly located in the Symmes Creek watershed, 1 to 2 mi north of Shepherd Creek, is probably derived from glacial till. This area has low favorability for undiscovered deposits of lead, copper, and silver associated with metavolcanic rocks.

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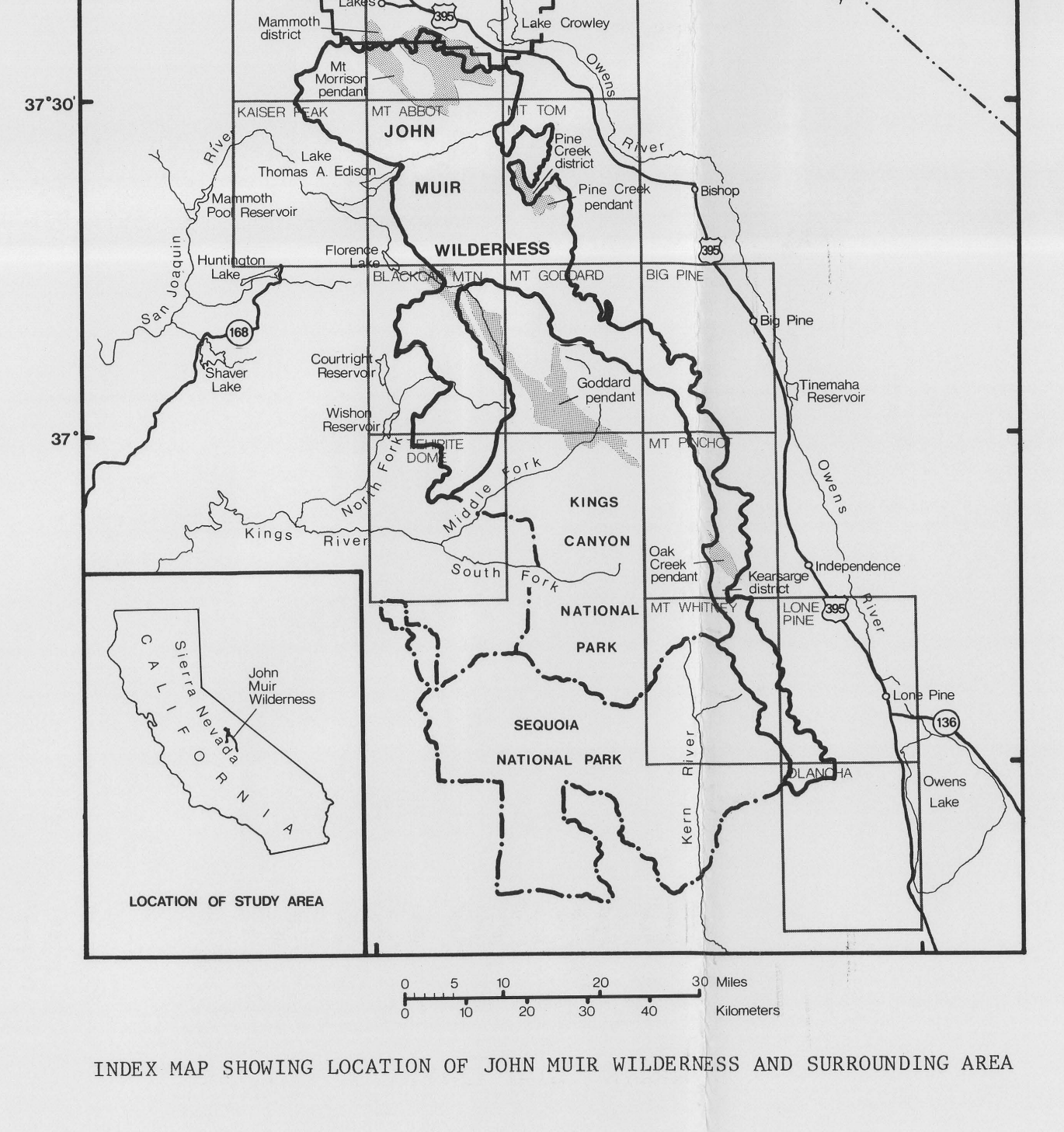

INDEX MAP SHOWING LOCATION OF JOHN MUIR WILDERNESS AND SURROUNDING AREA

Explanatory pamphlet accompanies map

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[1] The word "resource" is used here as defined by the U.S. Bureau of Mines and U.S. Geological Survey (1980): "A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible."

[2] Plutonic rock nomenclature used herein is that of Streckeisen (1973).

[3] "Pendant" or "roof pendant", as used here, means a downward projecting body of metamorphic rock, of varied shape, in a plutonic body. It is presumed to be a remnant of the roof of country rock into which the plutonic rock intruded. Many pendants separate two plutonic bodies; such a pendant that is thin and markedly elongate in outcrop is called a "septum". "Septum" (pl. "septa"), as used here, means a thin and commonly discontinuous belt of metamorphic rock at a contact between two plutonic bodies.

[4] The portal of the Brownstone mine is less than 1,000 ft (300 m) outside the wilderness boundary.

[5] A short ton unit, abbreviated stu, equals 1 percent of a short ton or 20 lb (9.072 kg) of WO_3 or 15.862 lb (7.195 kg) of tungsten (W), and is used to report tungsten assay values and to express market value of ore or concentrates.

[1] U.S. Geological Survey
[2] U.S. Bureau of Mines

Interior—Geological Survey, Reston, Va.—1982

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