STUDIES RELATED TO WILDERNESS

PRIMITIVE AREAS

AGUA TIBIA, CALIFORNIA

GEOLOGICAL SURVEY BULLETIN 1319-A

Mineral Resources of the Agua Tibia Primitive Area, California

By WILLIAM P. IRWIN *and* ROBERT C. GREENE, U.S. GEOLOGICAL SURVEY,
and by HORACE K. THURBER, U.S. BUREAU OF MINES

STUDIES RELATED TO WILDERNESS—PRIMITIVE AREAS

GEOLOGICAL SURVEY BULLETIN 1319-A

An evaluation of the mineral potential of a part of the Cleveland National Forest

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1970

UNITED STATES DEPARTMENT OF THE INTERIOR

WALTER J. HICKEL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

STUDIES RELATED TO WILDERNESS

PRIMITIVE AREAS

In accordance with the provisions of the Wilderness Act (Public Law 88–577, Sept. 3, 1964) and the Conference Report on Senate bill 4, 88th Congress, the U.S. Geological Survey and U.S. Bureau of Mines are making 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. Areas classed as "primitive" were not included in the Wilderness System, but the act provides that each primitive area be studied for its suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. This bulletin reports the results of a mineral survey in the Agua Tibia Primitive Area, California. The area discussed in the report corresponds to the area under consideration for wilderness status.

This bulletin is one of a series of similar reports on primitive areas.

CONTENTS

ILLUSTRATIONS

TABLE

STUDIES RELATED TO WILDERNESS—PRIMITIVE AREAS

MINERAL RESOURCES OF THE AGUA TIBIA PRIMITIVE AREA, CALIFORNIA

By WILLIAM P. IRWIN and ROBERT C. GREENE, U.S. GEOLOGICAL SURVEY, and by HORACE K. THURBER, U.S. Bureau of Mines

---

SUMMARY

The Agua Tibia Primitive Area includes about 43 square miles of the Cleveland National Forest in San Diego and Riverside Counties near the Pala and Rincon pegmatite districts. The area contains Agua Tibia Mountain, which rises about 2,500 feet higher than the adjacent lowlands. Most of the mountain is covered by dense brush. Small stands of timber are present on the crest of the mountain and at the bottoms of canyons.

The principal rocks of the primitive area are crystalline and consist of both metamorphic and plutonic varieties. The metamorphic rocks have been correlated with both the Bedford Canyon Formation and the Julian Schist of Jurassic or older age. The plutonic rocks include San Marcos Gabbro, Bonsall Tonalite, and Woodson Mountain Granodiorite of Cretaceous and perhaps older age. Pleistocene and younger sedimentary deposits, chiefly Temecula Arkose of Mann (1955), fanglomerate, and terrace deposits, cover much of the north and west perimeter of the area. The Temecula Arkose and other rocks are cut by faults, the largest of which are part of the Elsinore fault zone.

No economic mineral deposits were found during the reconnaissance study of the primitive area. Analyses of more than 100 samples of stream sediments and bedrock collected in and adjacent to the area did not indicate the presence of geochemical anomalies commonly associated with economic mineral deposits. Magnetic anomalies detected by an aeromagnetic survey are believed to be related to gabbroic bedrock and not to economic deposits of magnetic minerals. No prospect pits or mines were seen, nor did a search of legal records reveal the existence of past or present mining claims in the primitive area.

LOCATION AND GEOGRAPHY

The Agua Tibia Primitive Area is a part of the Cleveland National Forest that straddles the boundary between San Diego and Riverside Counties in southwestern California about 40 miles north

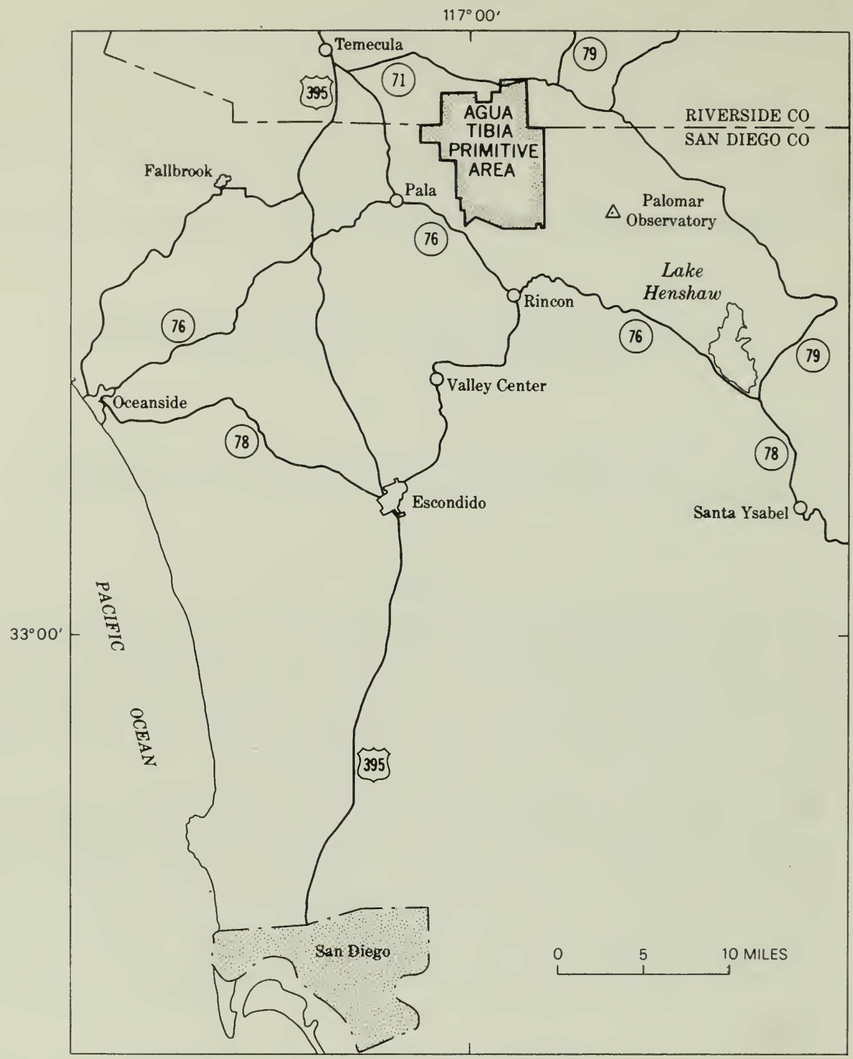

FIGURE 1.—Location of Auga Tibia Primitive Area.

of the city of San Diego (fig. 1). As considered in this report, the area includes the existing Agua Tibia Primitive Area in the northern part and most of Mission Indian Reserve in the southern part. It averages about 8 miles in length (north-south) and 5 miles in width (east-west), covering approximately 43 square miles. The area includes parts of the Pechanga, Vail Lake, Pala, and Boucher Hill 7½-minute quadrangles.

The primitive area contains Agua Tibia Mountain, which is the north end of a northwest-trending ridge that merges southeast-ward into Palomar Mountain. The crest of the ridge generally ranges between 4,400 and 5,500 feet in altitude; the southwest side of the ridge is cut by deep V-shaped canyons, and this area is generally more precipitous than the northeast side. Most of the slopes are covered by brush, much of which is virtually impenetrable. Timber is mostly restricted to small areas at the crest of the mountain and at the bottoms of canyons. Creeks in the main canyons carry considerable water during winter and spring, but are mostly dry during the remainder of the year.

The vicinity of the primitive area can be reached by State Highways 76 and 71. Palomar Divide Truck Trail and Crosely Truck Trail, which are used for fire-control access, provide restricted vehicular access to the interior of the area, connecting Highway 71 on the north to paved roads at Palomar Mountain State Park on the southeast. Other travel within the area is of necessity on foot or horseback and, owing to the dense cover of brush, is restricted mainly to following creek botoms and a few trails. The trails are principally along the crests of major spur ridges and connect Palomar Divide Truck Trail to points near the perimeter of the area. They include the Gomez, Mission, Magee, and Dripping Springs Trails.

EARLIER STUDIES

Previously published and unpublished investigations have facilitated our study of the Agua Tibia area. Larsen (1948) described the major rock units found in this general region of southern California. His mapping included the western part of the primitive area; however, it was not done in sufficient detail to be compiled in the present report. During the late 1940's, J. B. Hanley and others of the U.S. Geological Survey mapped a strip through several 7½-minute quadrangles, mostly along the Elsinore fault zone. This work is mostly unpublished, but the small part of the mapping that lies within and immediately adjacent to the primitive area is included in this report. Jahns (1954) prepared a map that includes the northwestern part of the primitive area, and in this and other publications he has described the regional geology and pegmatite deposits that lie just west of the primitive area. A description of the regional geology and mineral deposits is given by Weber (1963) as part of a study of San Diego County. Basement rocks in the eastern part of the primitive area are shown by Rodgers (1965) on the Geologic Map of California, Santa Ana sheet, at a scale of 1 : 250,000. Young sedimentary deposits at the north end of the primitive area were mapped by Mann (1955) as

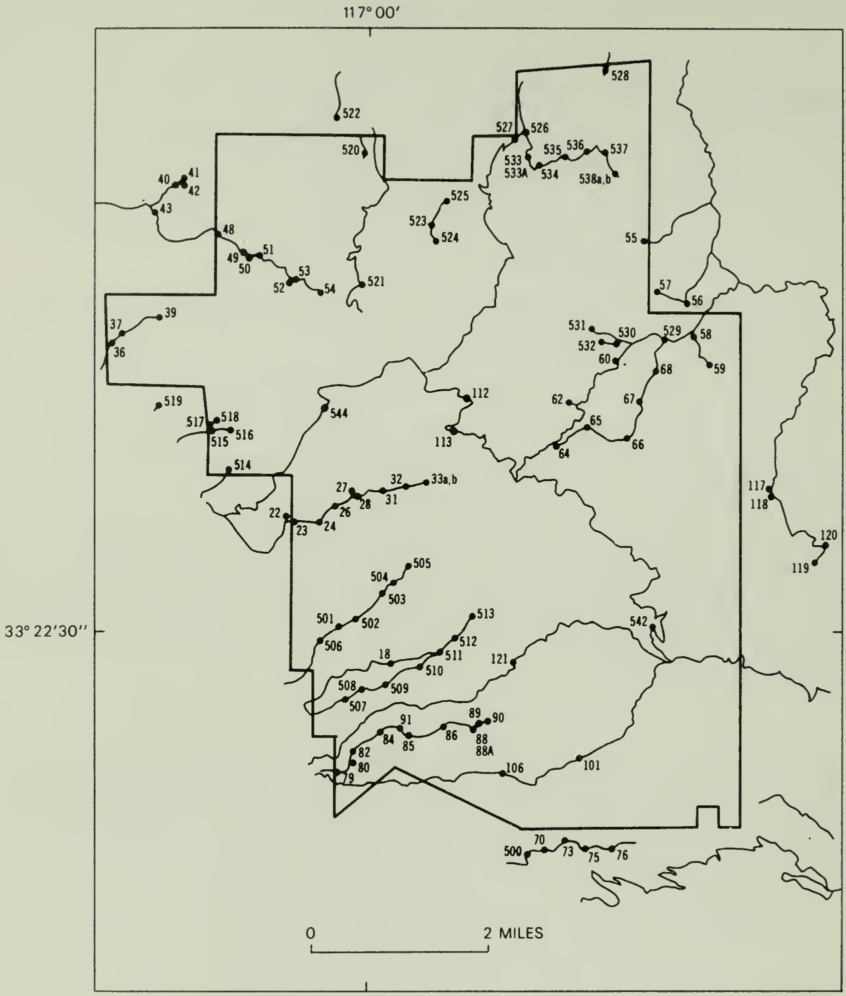

FIGURE 2.—Geologic traverses and location of chemically analyzed samples.

part of a study of the Elsinore fault zone, and part of that mapping was compiled with modification on plate 1 of this report.

PRESENT INVESTIGATION

The Agua Tibia Primitive Area was examined during 4 weeks in the spring of 1969 to determine its economic mineral potential. The routes traversed for purposes of reconnaissance were essentially restricted to the roads, trails, and major streams and are shown in figure 2. To assist in the overall geologic evaluation, a geologic map of the primitive area (pl. 1) was prepared by compiling our reconnaissance mapping with the pertinent mapping of J. B. Hanley and others (unpub. data) and Mann (1955). Aerial color photographs at a scale of 1 : 20,000 were used as an aid in determining the distribution of major rock units and geologic structures. Samples of stream sediments were collected at intervals along the creeks and were chemically analyzed to detect any significant concentrations of ore minerals that might indicate the presence of concealed ore deposits within the various watersheds. Samples of the common rock units were collected for petrologic and chemical analysis for comparison with the analysis of the stream sediments. Localities of chemically analyzed samples are shown in figure 2. An aeromagnetic survey also was made to help evaluate the mineral potential of the area.

This report is based mainly on investigations of the U.S. Geological Survey. The Bureau of Mines made a thorough search of records in the assessors' and recorders' offices of the San Diego and Riverside County Courthouses, but found no records of past or existing mining claims within the boundary of the area studied. Bureau engineers consequently did not have occasion to make field studies in the area, but did visit the Magee quarry just outside the primitive area boundary.

ACKNOWLEDGMENTS

The cooperation and assistance of the U.S. Forest Service, particularly Ranger Russell Engel of the Palomar District, are greatly appreciated by the authors. The aeromagnetic data were analyzed by Andrew Griscom of the U.S. Geological Survey. J. B. Hanley of the U.S. Geological Survey made available unpublished maps of a western portion of our map area. Irwin is indebted to Drs. R. H. Jahns and J. B. Hanley for initially introducing him to the geology of the region during the late 1940's.

GEOLOGY

GEOLOGIC SETTING

The Agua Tibia Primitive Area lies within the Peninsular Range geologic province. The province is characterized by northwesterly trending mountain ranges that consist chiefly of metamorphic and plutonic rocks of Mesozoic and older ages. The plutonic rocks range in composition from gabbro to granite and constitute the so-called Southern California or Peninsular Range batholith. Unconsolidated deposits of Quaternary age lie mainly beyond the boundaries of the primitive area. Two major parallel fault zones, the San Jacinto and Elsinore zones, trend northwest-ward through the province. The most westerly of these, the Elsinore fault zone, extends along the western edge of the primitive area.

The rock units exposed in the Agua Tibia Primitive Area are shown on plate 1 and described below.

ROCKS

The principal rocks of the Agua Tibia area are plutonic and metamorphic. The metamorphic rocks include schist, amphibolite, and calc-silicate granulite and are intruded by the plutonic rocks. The plutonic rocks are the most abundant, and the common varieties include granodiorite, gabbro, and tonalite. Granodiorite predominates, forming virtually all the high crest of the mountain. Alluvial fans and other sedimentary deposits conceal much of the metamorphic and plutonic bedrock around the north and southwest perimeter of the area.

Metamorphic Rocks

The metamorphic rocks occupy large areas on both the north and south flanks of Agua Tibia Mountain and also underlie the crest of the range at Boucher Hill and Morgan Hill in the southeast corner of the area. The original character of these rocks has been masked by metamorphism, but their wide range of composition suggests that the original rocks include both sedimentary and volcanic types. Perhaps the most common metamorphic rock, particularly in the vicinity of Pauma Creek, is a plagioclase-biotite schist with a mode close to the following example: quartz 25 percent, plagioclase 60 percent, biotite 15 percent, muscovite <1 percent. Interlayered with this schist are less feldspathic quartz-biotite-sillimanite schists, amphibolites, and calc-silicate granulites. The sillimanite-bearing schists have the following range of estimated modes: Quartz 30–60 percent, plagioclase 10–25 percent, K-feldspar 0–10 percent, biotite 15–25 percent, sillimanite 2–20 percent, muscovite 0–2 percent. These schists, as well as the more feldspathic ones, are light to dark gray, medium grained, foliate, and somewhat layered.

The amphibolites are dark gray to black rocks, commonly have weak foliation and strong lineation, and locally are layered. Modes are in the following range: Plagioclase 40–50 percent, hornblende or actinolite 35–50 percent, diopside 0–25 percent.

Calc-silicate granulites are light- to medium-greenish-gray fine-grained rocks with little foliation. Typical modes are as follows: Quartz 35–65 percent, plagioclase 20–40 percent, biotite 0–20 percent, actinolite 1–5 percent, diopside 5–25 percent, and epidote 5–9 percent.

The characteristic mineral assemblages show these rocks to be of high metamorphic grade. In the aluminous rocks, quartz-muscovite-sillimanite, quartz-muscovite-sillimanite-K-feldspar, and quartz-sillimanite-K-feldspar without muscovite assemblages are represented. None of the metamorphic rocks are more than 1 mile from a large plutonic body.

The metamorphic rocks of the Agua Tibia area have been correlated with Bedford Canyon Formation by some geologists (Larsen, 1948; Jahns, 1954) and with Julian Schist by others (J. B. Hanley and others, unpub. data); they probably are Jurassic or older in age. The problem of the correlation and age of these rocks is discussed at length by Weber (1963) and is not considered here.

Plutonic Rocks

Gabbro.—Gabbro, which is the oldest plutonic rock in the Agua Tibia area, occurs at many places, but generally is exposed poorly. It is a dark rock that ranges from medium to coarse grained and is either structureless, foliate, or layered. Typical modes are plagioclase 45–65 percent, hornblende 30–50 percent, and magnetite 1–5 percent. Some rocks contain a few percent augite, and others a few percent biotite; still others contain quartz, and some have minor chlorite, epidote, or calcite. The name San Marcos Gabbro was applied to these rocks where they were mapped by Larsen (1948) and J. B. Hanley and others (unpub. data).

Tonalite.—Sparse rounded outcrops of tonalite are exposed on ridge crests and slopes; however, the better exposures are confined to streams and are found where steep to vertical canyon walls and waterfalls are abundant. The tonalite occurs principally in four areas: near the middle part of Castro Canyon, near the lower part of Pauma Creek, and from Boucher Hill and Morgan Hill to the northwest. The rock is medium to coarse grained and commonly has light gray to white plagioclase and quartz enclosing black hornblende and biotite. Most of the rock is foliate, with patches and single crystals of biotite and hornblende exhibiting preferred orientation. Layering is absent. Typical modes are plagioclase 50–60 percent, quartz 10–20 percent, hornblende 15–25 percent, biotite 10–15 percent, and <1 percent sphene, magnetite, and apatite. Two samples that were studied have about 1 percent K-feldspar. The rock has been called Bonsall Tonalite where mapped by Larsen (1948) and J. B. Hanley and others (unpub. data).

Granodiorite.—Granodiorite and related rocks are the youngest of the plutonic rocks and underlie about two-thirds of the Agua Tibia Primitive Area. Rounded masses of light-colored granodiorite are common on ridge crests and slopes, and many of these appear to be residual boulders lying on decomposed bedrock. At some places near-vertical cliffs of bare, essentially unweathered granodiorite extend tens to even hundreds of feet upwards from bottoms of canyons.

The rock ranges in color from light gray to white and is flecked with dark minerals. It is coarse to very coarse grained, and a weak foliation marked by planar oriented biotite is apparent in most of the rock. Estimated modes have the following ranges: Total feldspar 65–90 percent, quartz 10–30 percent, biotite 1–5 percent (rarely <1 percent). Some of the rock contains trace amounts of hornblende or magnetite, but none contains muscovite. Apatite and zircon are typical accessory minerals. The ratio of plagioclase to K-feldspar, though only visually estimated, shows a wide range; however, granodiorite containing twice as much plagioclase as K-feldspar apparently is the dominant rock type of the unit. Quartz monzonite and granite are also present, as is a small amount of tonalite, transitional to the tonalite mapped separately. The name Woodson Mountain Granodiorite was used by Larsen (1948) and J. B. Hanley and others (unpub. data) where they mapped rocks of this unit.

Age relations of the crystalline rocks.—The relative ages of the major units of crystalline rocks in the primitive area seem well established by study of intrusive relations of these rocks mainly elsewhere in the Peninsular ranges. The order of these units in sequence of decreasing age, according to Larsen (1948), is (1) metamorphic rocks, (2) San Marcos Gabbro, (3) Bonsall Tonalite, and (4) Woodson Mountain Granodiorite. The only clear-cut age relations seen during our reconnaissance were those involving (1) granodiorite, which intrudes schist, gabbro, and tonalite, and (2) tonalite, which also intrudes schist.

Unconsolidated Deposits

Large areas of relatively unconsolidated sedimentary deposits lie almost exclusively beyond the boundary of the primitive area (pl. 1). The oldest of these deposits is the Temecula Arkose of

Mann (1955). This formation, which has been studied in detail by Mann, consists chiefly of white- to buff-colored arkosic sand with minor interbedded silt, marl, and tuff. It is more than 600 feet thick and was deposited on the metamorphic and plutonic bedrock during the Pleistocene. Subsequent to deposition, the Temecula Arkose was mildly folded and cut by a system of steep faults.

Alluvial fans and high-level terrace gravels are grouped together as the next youngest unit, including relatively small areas of soil and landslide (pl. 1). This unit includes the Pauba and Dripping Springs Formations of Mann (1955) at the north end of the primitive area. These deposits are clearly related to the present drainage system, having been formed and partly destroyed during several successive stages in attainment of the present stream level. Alluvial fans constitute the greater part of this unit and commonly form coalescing aprons of coarse bouldery debris that extend outward from the mouths of many of the major canyons. Where fan and terrace gravels overlie Temecula Arkose the contact is unconformable, and they proably range in age from Pleistocene to Holocene. The youngest sedimentary deposits, the sand and gravel of the present-day stream channels and closely associated low-level terraces, constitute the youngest unit shown on the geologic map.

GEOLOGIC STRUCTURE

The Elsinore fault is the dominant structure in the Agua Tibia area and was mapped by J. B. Hanley and others (unpub. data) as a zone of brecciated and sheared rock, generally ¼–½ mile in width, along the west base of Agua Tibia Mountain. Along the general trend of the fault, many major rock units crop out as elongate masses that are parallel to the breccia zone and thus may be large fault slivers. In the southern part of the map area, the Elsinore fault may be concealed beneath alluvial fans at the foot of the mountains. The kind and amount of displacement along the Elsinore fault is not known, either in the vicinity of the primitive area or on a regional basis.

Faults that are parallel to the Elsinore fault, and possibly a part of the Elsinore fault system, form much of the angular boundary between the Temecula Arkose and the basement rock at the north end of the primitive area. Other faults of this orientation are present elsewhere in the primitive area, judging from the alinement of various topographic and vegetational features seen on the aerial photographs. One of the most pronounced of these lineaments is about half a mile northeast of, and trends parallel to, the crest of Agua Tibia Mountain and marks a boundary between sharp, steep topography on the southwest and more subdued, rolling topography on the northwest. Where this lineament crosses the Crosley Truck Trail, the bedrock is highly sheared, and brecciated gabbro and granodiorite are in apparent fault contact. A lineament in the southern part of the map area (pl. 1) coincides with elongate masses of granodiorite and with a water-bearing fault zone where it crosses Nate Harrison grade on the crest of a sharp ridge half a mile south of the boundary of the primitive area.

Northeast-trending faults also occur in the northern part of the map area (pl. 1), and like the northwest-trending faults, they form straight-line contacts between Temecula Arkose and basement rock. According to Mann (1955), the faults of both trends in the area of Temecula Arkose are chiefly steep normal faults with vertical displacements that in one place may be as great as several thousand feet. Most of the faulting of the Temecula Arkose apparently occurred during the middle Pleistocene (Mann, 1955).

GEOCHEMICAL STUDIES

Deposits of commercial minerals commonly are the source of anomalous concentrations of their characteristic metals or minerals in overlying soils and in stream sediments. The geochemical detection of these anomalies provides one of the useful techniques for evaluating the presence or absence of concealed mineral deposits in areas of extensive surficial cover such as soil, brush, and timber.

In the Agua Tibia area, 92 samples of stream sediments collected from the main drainage systems were spectrographically analyzed; the results are shown in table 1 and are identified by sample numbers ending with the letter S. For purposes of comparison and to establish the background values for the metals and other elements of interest, 13 samples of the principal types of rock in the Agua Tibia area were also spectrographically analyzed; these samples are also shown in table 1 and are identified by sample numbers ending with the letter R. Both groups of samples were further analyzed by the atomic absorption method for their contents of gold, copper, lead, zinc, and silver and by the paper chromatography method for uranium; the results of these analyses are shown on the right-hand side of table 1.

In general, the geochemical studies do not indicate the presence of concealed ore or mineral deposits of commercial size in the Agua Tibia area. Essentially all the rock and stream-sediment samples were found to be barren of anomalous concentrations of metals and minerals. Possible exceptions are samples AT–40 and AT–41, the atomic absorption analysis of which show anomalous concentrations of gold and lead. These samples were taken outside the boundary of the primitive area from a stream that drains only a small part of the primitive area. These anomalous values were not, however, confirmed by the semiquantitative spectrographic analyses of the same samples. The only other sample of interest, AT–73, also was collected outside the primitive area and contains anomalous quantities of boron, beryllium, and zinc. This sample may contain traces of rare or minor minerals from pegmatite bodies in the drainage area, but by itself is probably not indicative of a significant mineral deposit nearby.

GEOPHYSICAL STUDY

As an adjunct to the geologic and geochemical studies, an airborne magnetometer survey was flown by the U.S. Geological Survey to assist in evaluating the economic mineral potential of the Agua Tibia Primitive Area. The aeromagnetic data was compiled by C. W. Kruger. The most evident features on the aeromagnetic map are two large positive anomalies in the western part of the area, only one of which is mostly within the primitive area. They lie on either side of the Elsinore fault and are centered over large areas underlain by gabbro. A small positive anomaly also is centered over gabbro nearby to the south. A large negative anomaly trends in an easterly direction on the north side of the large positive anomalies. The remainder of the aeromagnetic map is essentially featureless.

The magnetic anomalies have been analyzed by Andrew Griscom of the U.S. Geological Survey (oral commun., 1969). He concluded that the positive anomalies cover areas that are too large, relative to the amplitudes of the anomalies, to suggest the presence of concealed ore bodies. The magnetic susceptibility indicated by the large positive anomaly that lies mainly within the primitive area was computed by comparing curves (pl. 1) and was found to be equivalent to a rock containing only 2–3 percent magnetite. The large east-trending negative anomaly is a normal complementary feature associated with the positive anomalies and is caused by the inclination of the earth's magnetic field.

MINERAL RESOURCES

ECONOMIC MINERAL RESOURCES IN NEARBY AREAS

Although mineral deposits are not known to occur in the Agua Tibia Primitive Area, some have been mined nearby to the west. A significant quantity of semiprecious gems, lepidolite (lithium-bearing mica), and dimension stone have been mined in the Pala district, and a small quantity of semiprecious gems has been mined in the Rincon district (fig. 3).

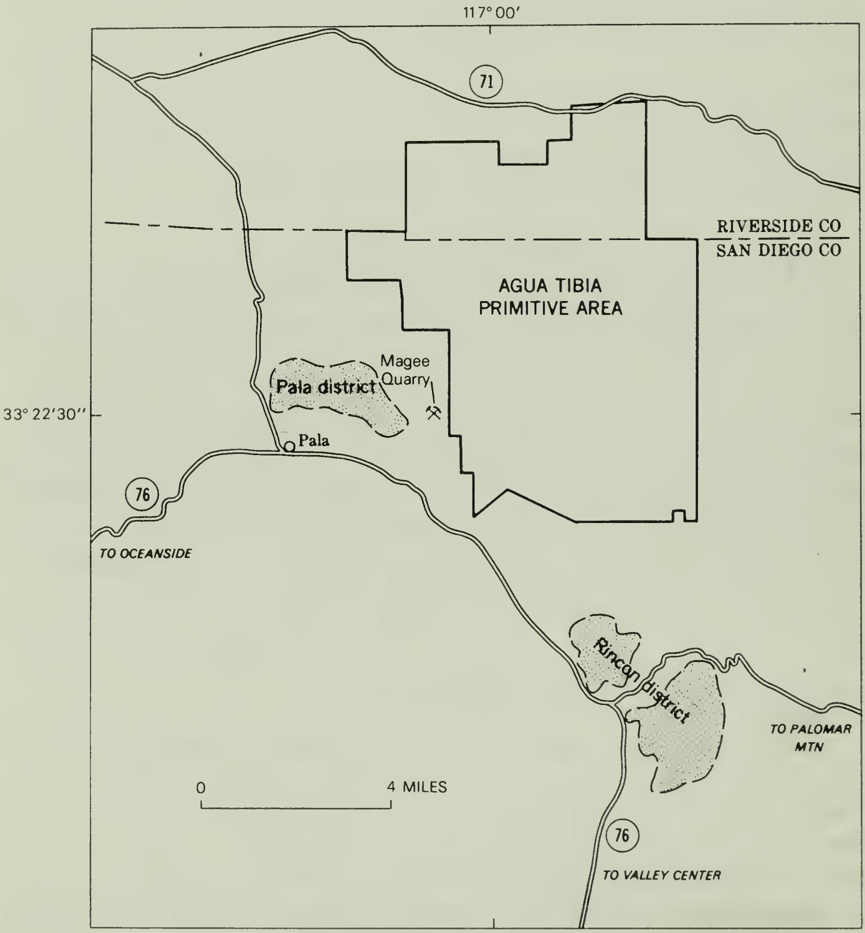

FIGURE 3.—Geographic relation of Agua Tibia Primitive Area to Pala and Rincon pegmatite districts and to Magee quarry. Areas of unusual concentration of pegmatite dikes are shown by stippled pattern.

The economic geology of the Pala district has been studied in detail by Jahns and Wright (1951), and the Rincon district by Hanley (1951). Both districts are on the southwest side of the Elsinore fault. They are characterized by an unusual abundance of pegmatite dikes that intrude the country rock. The pegmatite dikes commonly crop out as narrow ribs of light-colored rocks that are readily seen trending across the hillsides. The productive pegmatite dikes are in areas of gabbro, and the gem minerals and lepidolite are found only in erratically distributed "pockets" in some of the pegmatite bodies. The principal gem minerals are tourmaline, kunzite, and beryl in the Pala district and beryl in the Rincon district. The principal production of lepidolite in the Pala district has come from a single mine. Most of the gems and lepidolite was produced from the Pala district during the period 1900–1922; by 1947 the value of the total recorded production was approximately three-quarters of a million dollars (Jahns and Wright, 1951). The quantity of gems that have been produced from the Rincon district is not accurately known, but according to Weber (1963), less than $2,000 worth of gem minerals was mined during the main period of production.

Dimension stone has been mined from the Magee quarry in the Pala district, in SE ¼ sec. 19, T. 9 S., R. 1 W., and mining operations there were in progress at the time of our reconnaissance. The quarry is in an area of gabbro on the west edge of the Elsinore fault zone as mapped by J. B. Hanley and others (unpub. data) and has been described by Hoppin and Norman (1950). The stone is a variety of gabbro that is referred to commercially as "black granite" and has been used mainly for monuments and facing stone. At the Magee quarry it is mined chiefly from transported and residual boulders.

The production from the quarry has been small, and no reliable records are available of the total tonnage produced. According to Alvin I. Lodge, manager of Allied Granite Co., Inc., Los Angeles, Calif., the total production does not exceed a few tens of thousands of tons by all operators since the opening of the quarry. The Magee quarry is the smallest of a number of "black granite" quarries in San Diego County.

MINERAL RESOURCES OF AGUA TIBIA PRIMITIVE AREA

No evidence of significant deposits of metallic or nonmetallic minerals was found during our reconnaissance of the Agua Tibia Primitive Area. Hydrothermally altered rock, which occurs in the vicinity of many metalliferous deposits, was searched for while

TABLE 1.—*Analyses of rock and stream-sediment*

[In sample and type column, adjacent stream-sediment and rock samples are designated a, b. ber in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1. Looked for but not detected in spectro used are: N = not detected at limit of determination shown in parentheses under chemical shown; H = results not reported because of interference; -- = not looked for. Spectrographic for Au, J. G. Frisken; for Cu, Pb, Zn, and Ag, Z. C. Stephenson, L. A. Vinnola, and J. G. Denver, Colo.]

Sample and type	Semiquantitative spectrographic analyses (percent)				Semiquantitative spectrographic analyses (ppm)									
	Fe (0.05)	Mg (0.005)	Ca (0.05)	Ti (0.001)	Mn (20)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (2)	La (20)	Mo (5)	Nb (10)
							Rocks							
AT-18-R	3	0.3	1	0.1	200	10	700	1	N	N	L	50	N	L
AT-33b-R	7	2	3	.5	700	L	300	L	15	30	L	N	N	10
AT-88b-R	10	2	3	.5	1,000	20	500	N	20	20	7	N	N	L
AT-91-R	15	3	5	1	1,000	50	100	N	50	50	50	N	20	L
AT-101-R	10	2	5	.7	1,000	L	500	N	20	20	10	N	N	L
AT-106-R	2	.5	7	.2	700	100	1,000	1	N	10	N	N	N	10
AT-112-R	2	.15	.5	.07	200	10	700	1	N	N	N	20	5	L
AT-113-R	7	2	3	.5	1,000	L	500	L	15	N	L	N	N	L
AT-121-R	7	5	7	.3	1,000	L	150	N	50	700	30	N	N	L
AT-533b-R	3	1	.5	.3	200	20	1,500	L	N	100	20	20	N	15
AT-538b-R	3	.7	2	.2	500	10	500	L	5	N	L	N	N	L
AT-542-R	2	.3	1	.15	300	L	1,000	L	N	N	N	20	N	L
AT-544-R	5	5	10	.05	300	N	15	N	30	200	5	N	N	L
							Stream sediments							
AT-22-S	10	3	3	1	1,500	L	150	N	50	300	15	N	--	L
AT-23-S	10	3	5	1	1,500	N	200	N	20	150	5	N	--	10
AT-24-S	10	3	5	1	1,500	N	300	N	20	150	5	N	--	10
AT-26-S	7	3	5	1	1,500	N	200	N	15	200	L	N	--	L
AT-27-S	10	3	5	1	1,500	N	300	N	20	150	5	N	--	10
AT-28-S	10	3	5	G(1)	1,500	N	200	N	30	150	5	N	--	L
AT-31-S	10	3	5	G(1)	1,500	N	200	N	30	200	5	N	--	10
AT-32-S	10	3	5	G(1)	1,500	N	150	N	30	200	L	N	--	L
AT-33a-S	10	3	5	G(1)	2,000	N	200	N	30	200	7	N	--	10
AT-36-S	3	1	2	.5	1,000	10	700	L	5	10	N	30	--	L
AT-37-S	10	2	3	1	1,500	L	500	N	15	70	5	N	--	L
AT-39-S	10	3	5	1	2,000	L	300	N	20	150	5	N	--	L
AT-40-S	15	2	2	G(1)	3,000	N	150	N	20	150	5	20	--	L
AT-41-S	10	3	5	G(1)	2,000	N	200	L	20	500	5	N	--	L
AT-42-S	10	2	3	1	1,500	N	300	N	15	100	5	N	--	L
AT-43-S	10	3	5	G(1)	2,000	10	300	N	20	200	5	N	--	L
AT-48-S	10	2	3	G(1)	2,000	N	300	N	20	150	L	N	--	L
AT-49-S	7	2	3	.7	1,500	L	300	N	20	150	5	N	--	10
AT-50-S	7	2	3	.7	1,500	50	1,000	L	10	200	5	20	--	10
AT-51-S	15	3	3	G(1)	3,000	N	200	N	30	300	5	N	--	L
AT-52-S	10	3	3	.7	1,500	N	500	N	20	300	5	N	--	L
AT-53-S	10	3	5	G(1)	2,000	N	500	N	20	100	L	N	--	L
AT-54-S	10	3	5	1	2,000	N	500	N	20	100	L	N	--	L
AT-55-S	7	2	3	1	1,500	N	300	L	15	100	L	N	--	L
AT-56-S	7	2	3	1	1,000	N	700	L	15	100	L	N	--	L
AT-57-S	5	2	3	1	1,500	N	700	L	10	70	L	N	--	L
AT-58-S	10	3	3	G(1)	1,500	N	500	N	20	200	5	N	--	10
AT-59-S	10	3	3	1	1,500	N	500	N	20	200	5	N	--	L
AT-60-S	10	3	5	G(1)	2,000	N	500	N	20	150	5	N	--	L
AT-62-S	10	3	5	G(1)	2,000	N	500	N	20	150	5	50	--	10
AT-64-S	10	3	3	G(1)	1,500	L	500	N	15	100	L	N	--	L
AT-65-S	10	3	3	G(1)	1,500	N	300	N	20	200	L	N	--	L
AT-66-S[1]	5	.5	2	.5	700	10	700	L	N	N	N	20	--	10
AT-67-S	5	1.5	3	1	1,000	L	700	L	10	70	L	N	--	10
AT-68-S	10	2	3	G(1)	1,500	N	500	N	20	100	5	N	--	L

See footnotes at end of table.

samples from the Agua Tibia Primitive Area

For semiquantitative (six step) spectrographic analysis: results reported to the nearest num-
graphic analysis: Ag, As, Au, Bi, Cd, Sb, Sn (see footnote 1), Zn (see footnote 2). Symbols
symbol; L = detected, but below limit of determination for method used: G = greater than value
analyst: E. L. Mosier, U.S. Geological Survey, Denver, Colo. Atomic absorption analysts:
Viets. Chromatographic analysts: H. D. King and R. L. Miller, U.S. Geological Survey,

Sample and type	Semiquantitative spectrographic analyses (ppm)--Continued							Atomic absorption analyses (ppm)					Chromatographic analysis (ppm)
	Ni (2)	Pb (10)	Sc (5)	Sr (50)	V (10)	Y (5)	Zr (10)	Au (0.02)	Cu (10)	Pb (25)	Zn (25)	Ag (0.2)	U (20)
							Rocks--Continued						
AT-18-R	5	15	5	100	30	15	100	L	L	N	25	N	N
AT-33b-R	10	10	20	300	150	30	150	L	L	N	52	0.4	N
AT-88b-R	5	15	30	300	200	30	200	L	14	N	52	.4	N
AT-91-R	20	L	30	500	500	10	50	L	53	L	52	H	N
AT-101-R	7	10	30	500	200	30	100	L	19	L	56	H	N
AT-106-R	7	L	5	500	50	20	200	L	L	L	L	H	N
AT-112-R	5	15	5	N	10	30	70	L	L	N	32	N	N
AT-113-R	5	10	20	300	150	50	200	L	L	N	64	.6	N
AT-121-R	50	L	50	500	300	20	50	L	30	N	N	H	N
AT-533b-R	20	20	15	100	200	30	150	L	31	L	96	.6	N
AT-538b-R	L	L	10	200	50	10	200	L	L	N	40	.2	N
AT-542-R	5	15	7	100	30	20	100	L	L	N	25	.4	N
AT-544-R	30	N	15	500	70	N	N	L	L	L	N	H	N
							Stream sediments--Continued						
AT-22-S	70	N	30	300	500	20	100	L	20	L	30	.8	L
AT-23-S	30	L	30	200	300	50	500	L	10	L	25	.4	L
AT-24-S	30	L	30	200	300	30	300	L	12	L	35	.6	L
AT-26-S	20	N	30	150	300	50	300	L	L	L	L	.2	L
AT-27-S	20	L	30	200	300	50	300	L	L	L	25	.2	L
AT-28-S	30	L	30	150	300	50	500	L	L	L	L	.6	L
AT-31-S	50	N	30	200	300	50	500	L	10	L	L	.2	L
AT-32-S	30	N	30	150	300	50	300	L	10	L	L	.2	L
AT-33a-S	50	N	30	200	300	50	700	L	10	L	L	.4	L
AT-36-S	L	15	10	150	100	50	1,000	L	L	L	L	L	L
AT-37-S	7	10	20	200	200	30	700	L	L	L	30	.4	L
AT-39-S	7	L	30	200	300	30	200	L	L	L	30	.4	L
AT-40-S	20	L	30	100	300	50	700	1	10	L	L	.2	L
AT-41-S	50	L	30	200	300	30	300	L	L	560	L	L	L
AT-42-S	20	L	30	200	200	30	200	L	10	L	25	.4	L
AT-43-S	20	L	30	200	300	50	G(1,000)	L	L	L	L	.2	L
AT-48-S	15	N	30	200	200	50	1,000	L	L	L	L	.2	L
AT-49-S	20	L	20	200	200	30	50	L	L	L	25	.4	L
AT-50-S	30	15	15	200	150	30	200	L	10	L	L	.4	L
AT-51-S	15	N	50	L	300	50	G(1,000)	L	L	L	30	.2	L
AT-52-S	50	L	30	200	200	30	500	L	13	L	30	.2	L
AT-53-S	10	L	50	200	300	50	500	L	L	L	30	.6	L
AT-54-S	15	L	30	200	300	50	300	L	L	L	35	.6	L
AT-55-S	10	L	30	200	200	30	1,000	L	L	L	25	.4	L
AT-56-S	15	10	20	150	200	50	1,000	L	L	L	L	.2	L
AT-57-S	5	L	30	200	200	30	500	L	L	L	30	.6	L
AT-58-S	30	L	30	200	300	50	300	L	10	L	25	.4	L
AT-59-S	30	L	30	150	300	30	300	L	12	L	25	.2	L
AT-60-S	20	L	30	200	300	50	500	L	10	L	35	.2	L
AT-62-S	20	L	30	200	500	50	500	L	11	L	35	.2	L
AT-64-S	15	10	30	200	200	50	700	L	L	L	30	.4	L
AT-65-S	30	N	30	100	300	50	1,000	L	L	L	25	.4	L
AT-66-S[1]	N	10	15	100	70	100	G(1,000)	L	L	L	L	L	L
AT-67-S	10	10	20	100	150	70	1,000	L	L	L	L	L	L
AT-68-S	20	L	30	150	200	100	G(1,000)	L	L	L	L	.2	N

TABLE 1.—*Analyses of rock and stream-sediment*

Sample and type	Semiquantitative spectrographic analyses (percent)				Semiquantitative spectrographic analyses (ppm)									
	Fe (0.05)	Mg (0.005)	Ca (0.05)	Ti (0.001)	Mn (20)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (2)	La (20)	Mo (5)	Nb (10)
					Stream sediments--Continued									
AT-70-S	10	3	3	G(1)	1,500	20	200	N	30	200	10	20	--	L
AT-73-S[2]	5	1.5	2	.3	500	150	700	1.5	30	100	30	20	--	10
AT-75-S	7	2	5	.5	700	15	300	L	20	70	10	N	--	10
AT-76-S	7	2	3	.5	1,000	10	300	N	20	100	10	N	--	L
AT-77-S	7	3	5	1	1,000	20	300	N	30	150	20	N	--	10
AT-79-S	10	3	5	1	1,000	10	300	N	30	150	7	N	--	L
AT-80-S	7	2	3	.7	700	50	500	L	30	200	20	20	--	10
AT-82-S	10	2	3	1	1,000	L	300	N	30	150	7	N	--	L
AT-84-S	10	3	3	1	1,000	10	300	N	30	150	7	20	--	L
AT-85-S	7	3	3	.5	1,000	L	300	N	30	150	10	N	--	L
AT-86-S	10	3	5	1	1,000	L	300	N	30	150	10	N	--	L
AT-88a-S	7	2	5	.7	1,000	L	200	N	30	100	30	N	--	L
AT-89-S	10	2	3	1	1,000	L	500	N	30	150	5	20	N	L
AT-90-S	10	3	3	1	1,000	L	300	N	30	200	5	50	N	L
AT-117-S	10	2	2	G(1)	1,000	L	300	N	15	100	5	N	N	L
AT-118-S	3	.7	2	.2	700	L	700	1	N	10	N	N	N	L
AT-119-S	10	3	3	.7	1,000	L	300	N	30	150	7	N	N	L
AT-120-S	10	3	3	1	1,000	L	300	N	30	150	7	N	N	L
AT-500-S	10	3	3	1	1,500	50	300	N	20	100	7	20	N	L
AT-501-S	7	2	3	.5	1,000	N	500	N	15	100	5	N	N	L
AT-502-S	7	3	3	1	1,500	N	500	N	20	150	5	N	N	L
AT-503-S	10	3	5	1	1,500	L	300	N	20	150	5	N	N	10
AT-504-S	7	2	5	.5	1,000	L	500	N	15	100	5	N	N	L
AT-505-S	7	2	3	.7	1,000	N	300	N	15	100	5	N	N	L
AT-506-S	7	3	5	.7	1,500	N	500	N	15	150	L	N	N	L
AT-507-S	5	1.5	3	.5	1,000	10	700	L	5	50	N	N	N	L
AT-508-S	3	1	2	.5	700	10	700	L	7	30	N	N	N	L
AT-509-S	3	1	2	.3	700	10	700	L	5	30	N	N	N	L
AT-510-S	5	1.5	2	.5	700	10	700	L	7	50	L	N	N	10
AT-511-S	7	1.5	2	.7	1,000	L	700	N	10	70	L	20	N	10
AT-512-S	5	1	2	.3	700	L	700	L	5	30	N	L	N	L
AT-513-S	5	1	2	.3	500	10	700	N	7	50	N	N	N	N
AT-514-S	15	2	3	1	1,500	N	200	N	20	70	10	N	N	N
AT-515-S	7	2	5	.7	1,500	L	200	N	20	70	10	N	N	N
AT-516-S	7	3	5	1	1,500	L	150	N	20	70	15	N	N	N
AT-517-S	7	3	5	1	2,000	L	500	N	15	70	L	N	N	L
AT-518-S	10	3	3	G(1)	2,000	L	500	N	15	100	L	N	N	L
AT-519-S	7	2	2	.7	1,500	L	500	N	15	100	5	N	N	L
AT-520-S	7	3	3	1	2,000	L	500	N	15	200	5	N	N	L
AT-521-S	10	3	3	1	2,000	L	300	N	20	200	5	N	N	L
AT-522-S	5	2	2	.7	1,000	10	500	N	15	100	L	N	N	L
AT-523-S	5	2	2	.3	1,000	20	700	L	10	70	5	N	N	L
AT-524-S	7	2	2	.5	1,000	20	700	L	15	100	7	N	N	L
AT-525-S	5	2	2	.5	1,000	20	700	L	15	70	5	N	N	L
AT-526-S	5	2	3	.5	1,500	10	700	L	10	100	L	N	N	L
AT-527-S	5	1.5	3	.5	700	50	1,000	L	10	70	10	N	N	10
AT-528-S	7	2	3	.7	1,500	20	700	N	15	100	10	N	N	10
AT-529-S	7	3	5	1	1,500	L	500	N	20	100	L	N	N	L
AT-530-S	7	3	3	.5	1,000	L	500	L	15	100	7	N	N	L
AT-531-S	7	3	2	.5	1,000	10	500	N	15	100	L	N	N	L

See footnotes at end of table.

samples from the Agua Tibia Primitive Area—Continued

Sample and type	Semiquantitative spectrographic analyses (ppm)--Continued							Atomic absorption analyses (ppm)					Chromatographic analysis (ppm)
	Ni (2)	Pb (10)	Sc (5)	Sr (50)	V (10)	Y (5)	Zr (10)	Au (0.02)	Cu (10)	Pb (25)	Zn (25)	Ag (0.2)	U (20)
							Stream sediments--Continued						
AT-70-S	20	10	70	100	300	70	700	L	19	N	36	0.2	N
AT-73-S[2]	70	20	15	150	150	30	200	--	--	--	--	--	--
AT-75-S	30	10	30	200	200	30	150	L	16	N	56	.4	N
AT-76-S	30	10	30	300	200	30	200	L	15	N	48	.2	N
AT-77-S	50	10	50	200	200	50	300	L	32	N	32	N	N
AT-79-S	30	10	50	200	300	50	700	L	15	N	L	N	N
AT-80-S	70	15	30	150	200	50	200	L	37	L	130	.4	N
AT-82-S	30	10	30	150	200	70	700	L	18	N	25	.2	N
AT-84-S	30	L	50	150	200	50	500	L	16	N	L	N	N
AT-85-S	30	L	30	150	200	30	200	L	15	N	28	.2	N
AT-86-S	50	10	50	200	200	50	300	L	19	N	25	.2	N
AT-88a-S	30	10	30	200	200	30	50	L	34	N	52	.6	N
AT-89-S	30	L	50	150	200	50	1,000	L	12	N	L	.2	N
AT-90-S	30	L	50	100	300	70	1,000	L	10	N	L	.2	N
AT-117-S	15	10	20	100	200	30	300	L	L	N	25	.2	N
AT-118-S	L	10	15	100	70	50	200	L	L	N	25	.2	N
AT-119-S	50	10	30	100	200	70	300	L	11	N	L	L	N
AT-120-S	50	10	50	100	200	70	500	L	12	N	L	.2	N
AT-500-S	30	L	30	150	200	50	700	L	13	L	L	.2	N
AT-501-S	20	L	20	150	150	30	150	L	L	L	30	.4	N
AT-502-S	20	L	30	150	200	100	1,000	L	L	L	L	.4	N
AT-503-S	20	L	30	150	200	50	1,000	L	L	L	L	.2	N
AT-504-S	20	L	20	200	150	30	150	L	L	L	30	.2	N
AT-505-S	20	L	20	200	150	30	500	L	11	L	30	.2	L
AT-506-S	15	L	30	150	200	50	200	L	L	L	L	L	L
AT-507-S	5	10	20	150	100	50	1,000	L	L	L	L	.2	L
AT-508-S	5	10	15	100	100	30	G(1,000)	L	L	L	L	.2	L
AT-509-S	5	10	15	150	100	30	700	L	L	L	30	.2	L
AT-510-S	7	10	15	150	150	50	500	L	L	L	25	.2	L
AT-511-S	10	L	30	100	150	100	G(1,000)	L	L	L	L	L	L
AT-512-S	5	L	10	100	100	20	200	L	L	L	25	L	L
AT-513-S	7	L	15	100	100	50	1,000	L	L	L	30	.4	L
AT-514-S	10	L	30	300	500	30	200	L	20	L	55	.8	L
AT-515-S	15	L	30	200	300	20	70	L	20	L	50	1.2	L
AT-516-S	15	10	30	200	300	30	200	L	19	L	40	1.2	L
AT-517-S	5	10	30	200	200	50	700	L	13	L	40	.6	L
AT-518-S	7	L	30	300	200	50	300	L	L	L	35	.6	--
AT-519-S	20	L	30	200	200	30	300	L	12	L	35	.6	L
AT-520-S	20	L	30	200	200	30	200	L	L	L	25	.4	L
AT-521-S	50	L	30	150	200	30	300	L	L	L	25	.2	L
AT-522-S	15	10	20	200	150	20	100	L	L	L	L	.2	L
AT-523-S	15	L	20	200	150	20	100	L	L	L	45	.4	L
AT-524-S	20	L	20	200	200	30	500	L	14	L	70	.6	L
AT-525-S	20	10	20	200	150	20	500	L	10	L	60	.6	L
AT-526-S	15	L	20	200	200	50	150	L	L	L	L	.2	L
AT-527-S	20	15	15	500	150	20	200	L	12	L	55	.6	L
AT-528-S	20	L	20	200	200	20	150	L	16	L	60	.8	L
AT-529-S	15	L	30	200	200	50	G(1,000)	L	L	L	L	.2	L
AT-530-S	20	L	20	200	150	30	200	L	10	L	30	.4	L
AT-531-S	10	L	30	150	200	30	200	L	L	L	25	.4	L

TABLE 1.—*Analyses of rock and stream-sediment*

Sample and type	Semiquantitative spectrographic analyses (percent)				Semiquantitative spectrographic analyses (ppm)									
	Fe (0.05)	Mg (0.005)	Ca (0.05)	Ti (0.001)	Mn (20)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (5)	Cu (2)	La (20)	Mo (5)	Nb (10)
					Stream sediments--Continued									
AT-532-S	7	2	2	.5	1,000	L	300	L	15	100	5	N	N	L
AT-533a-S	5	2	2	.5	1,000	L	500	L	15	70	5	N	N	L
AT-534-S	7	2	3	.7	1,000	L	700	L	20	100	5	N	N	L
AT-535-S	7	2	2	.5	1,000	L	700	L	20	100	5	20	N	L
AT-536-S	10	2	2	1	1,000	L	500	L	20	100	5	N	N	L
AT-537-S	15	3	2	G(1)	1,500	L	300	L	20	150	7	N	N	L
AT-538a-S	15	2	2	G(1)	1,000	L	200	N	30	150	5	N	N	L

[1]Sn detected, but below limit of determination.

[2]Also contains Zn 300 ppm.

traversing the area, but none was seen. A few thin quartz-feldspar pegmatite dikes were found, but none appeared to be of economic interest. The lack of anomalous quantities of metals and valuable minerals in the stream-sediment samples and the results of the aeromagnetic survey also tend to substantiate the absence of any economic mineral deposit of appreciable size. In addition, a thorough search of the records of mining claims was made in the San Diego and Riverside County recorders' and assessors' offices; no records of past or existing mining claims within the boundary of the primitive area were found.

samples from the Agua Tibia Primitive Area—Continued

Sample and type	Semiquantitative spectrographic analyses (ppm)--Continued							Atomic absorption analyses (ppm)					Chromatographic analysis (ppm)
	Ni (2)	Pb (10)	Sc (5)	Sr (50)	V (10)	Y (5)	Zr (10)	Au (0.02)	Cu (10)	Pb (25)	Zn (25)	Ag (0.2)	U (20)
							Stream sediments--Continued						
AT-532-S	20	L	20	150	150	30	70	L	10	L	35	.4	L
AT-533a-S	20	10	20	150	150	30	200	L	L	N	28	.2	L
AT-534-S	15	15	30	150	200	30	500	L	L	N	28	.2	L
AT-535-S	15	15	30	200	200	30	300	L	L	N	32	L	N
AT-536-S	10	10	30	150	200	50	500	L	L	N	L	L	N
AT-537-S	10	10	50	100	200	70	700	L	L	N	25	L	N
AT-538a-S	15	L	50	100	300	100	1,000	L	L	N	L	L	N

REFERENCES CITED

Hanley, J. B., 1951, Economic geology of the Rincon pegmatites, San Diego County, California: California Div. Mines Spec. Rept. 7–B, 24 p.

Hoppin, R. A., and Norman, L. A., Jr., 1950, Commercial "black granite" of San Diego County, California: California Div. Mines Spec. Rept. 3, 19 p.

Jahns, R. H., 1954, Northern part of the Peninsular Range province, Geologic guide No. 5 *of* Jahns, R. H., ed., Geology of southern California: California Div. Mines Bull. 170, 59 p.

Jahns, R. H., and Wright, L. A., 1951, Gem- and lithium-bearing pegmatites of the Pala district, San Diego County, California: California Div. Mines Spec. Rept. 7–A, 72 p.

Larsen, E. S., Jr., 1948, Batholith and associated rocks of Corona, Elsinore, and San Luis Rey quadrangles, southern California: Geol. Soc. America Mem. 29, 182 p.

Mann, J. F., Jr., 1955, Geology of a portion of the Elsinore fault zone, California: California Div. Mines Spec. Rept. 43, 22 p.

Rogers, T. H., compiler, 1965, Geologic map of California, Santa Ana sheet: California Div. Mines and Geology, scale 1: 250,000.

Weber, F. H., Jr., 1963, Geology and mineral resources of San Diego County, California: California Div. Mines and Geology County Rept. 3, 309 p.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 382-304