STATUS OF MINERAL RESOURCE INFORMATION FOR THE COLORADO RIVER INDIAN RESERVATION ARIZONA AND CALIFORNIA

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By

Jocelyn A. Peterson
U.S. Geological Survey

L. G. Nonini
U.S. Bureau of Mines

Prepared by
U.S. Geological Survey and U.S. Bureau of Mines
for U.S. Bureau of Indian Affairs

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SUMMARY AND CONCLUSIONS

The Colorado River Indian Reservation is in a region that contains diverse mineral deposits, some of which have been good producers.

Small amounts of gold, copper, sand, and gravel have been produced from the reservation. On the basis of very scanty information, gold, gypsum, and kyanite appear to be the most promising targets for exploration. Deposits of nitrate have been reported but appear to have little or no potential. Manganese deposits have also been reported but their potential is not known. Sand and gravel deposits are abundant and probably can fill any requirements within an economic shipping radius.

Three mines in lode deposits, two for gold and one for copper, have been abandoned. Ore bodies were high grade, erratic, and small. They could possibly contain recoverable quantities of lower grade material.

Placer gold deposits, originally worked by dry panning methods, may contain sufficient gold to be worked by more effective techniques. These deposits are said to contain magnetite, which might be recoverable as a byproduct.

A comparatively unexplored high grade gypsum deposit might have sufficient reserves to be utilized by nearby gypsum industries.

Reported deposits of kyanite and manganese should be confirmed and investigated for future potential.

INTRODUCTION

This report was prepared for the Bureau of Indian Affairs by the U.S. Geological Survey and the Bureau of Mines under an agreement to compile and summarize available information on the geology, mineral resources, and potential for economic development of certain Indian lands. Source material included published and unpublished reports and personal communications. No fieldwork was done.

The Colorado River Indian Reservation is about 60 miles north of Yuma, on the Colorado River in Yuma County, southwestern Arizona, and San Bernardino and Riverside counties in southeastern California (Figure 1). Eighty-five percent of the reservation is on the eastern side of the Colorado River in Arizona, and the remaining fifteen percent (the northwestern and northern part) is on the western side of the river in California. The reservation extends north and south along the Colorado River, about 45 miles long and 14 miles wide. The total area is 268,691 acres, about one quarter of which is irrigated and under cultivation. (Bureau of Indian Affairs, 1978.)

Topographically the reservation consists of relatively level, low lying land along the river valley and some scattered low mountains rising along the reservation boundaries to the north, northeast, south, and west. The lowest elevation in the reservation is 270 feet on the Colorado River at the southern end of the reservation and the highest point is 2,453 feet at Monument Peak on the northern boundary. Parker Valley, containing the cultivated areas, ranges from 270 feet to about 350 feet in elevation and is the flood plain of the river. From the flood plain, piedmont slopes rise gradually toward the mountains along the reservation boundaries. The boundary only occasionally attains elevations above 1,000 feet. Easterly and westerly flowing ephemeral streams drain toward the perennial Colorado River, but the natural drainage pattern has been extensively altered by man-made irrigation works especially in the flood plain area. The reservation is in the Sonoran Desert Section of the Basin and Range Physiographic Province (Fenneman, 1931).

The climate is arid; annual rainfall ranges from 0.5 inch to 8.5 inches, averaging about 3.25 inches, on the flood plains and piedmont slopes and somewhat more than that in the mountains. (Metzger and others, 1973.) Temperatures in the summer range well over 100ºF and rarely go below 32ºF in the winter.

Agriculture is the dominant industry, producing a gross income of $52,571,764 in 1976 from tribal land leased to agribusiness and from individual operations (Bureau of Indian Affairs, 1978). Irrigation water is obtained from the Colorado River and distributed through an extensive, elaborate, irrigation and drainage system. Plans are to increase the present 73,000 acres of irrigated land to 100,000 acres by 1980.

Mineral production consists entirely of sand and gravel. Tourism and outdoor recreation are, being actively developed and promoted. Altogether, ten commercial enterprises of various kinds are operated by the tribe or by individual tribal members.

The principal town is Parker (population about 2,000) in the northern end of the reservation, which has a well-equipped hospital and the usual community services.

The transportation network is excellent. Interstate Highway 10 runs east-west just south of the reservation and U.S. Highway 95 runs north-south on the western fringe. A good paved road runs north-south through the long axis of the reservation, and State Highways 72 and 95 angle across the northern end. A network of good secondary roads provides access to all cultivated areas. The rougher desert and mountainous sections are reasonably accessible by improved and unimproved dirt roads and jeep trails. The northern end of the reservation is crossed by the Atchison Topeka and Santa Fe Railroad, and Parker serves as a shipping point for agricultural products. A small airport is at Parker. Scheduled airline service is available at Havasu City, about 35 miles north of Parker by State Highway 95.

PREVIOUS INVESTIGATIONS

Despite extensive prospecting for gold, copper, and other metals in western Arizona and southeastern California during the latter l9th and early 20th centuries, geologic knowledge of the area, particularly of the ore host rocks, remains limited. The only detailed geologic map at a scale larger than 1:250,000 covering part of the reservation is the Big Maria Mountain 7 ½' quadrangle of Hamilton (1964). Miller (1970) published a geologic map of the nearby Quartzsite 15' quadrangle, which has a similar geologic setting. The Arizona Bureau of Mines' geologic map of Yuma County (Wilson, 1960) at a scale of 1:375,000 provides information about the Arizona part of the reservation and the California Division of Mines and Geology's Needles (Bishop, 1963) and Salton Sea (Jennings, 1967) 2º sheets cover the part of the reservation in California.

Metzger and others' (1973) water supply paper for the Parker Blythe-Cibola area contains a comprehensive study of the unmetamorphosed sedimentary units within and adjacent to the reservation. These units have little bearing on most mineral resources except sand and gravel, but are important with respect to the reservation's water supply. This and earlier papers (Metzger, 1965, 1968) describing the lithology of the units and outlining the geologic conditions under which they formed, present the most recently defined stratigraphy for the area.

Bancroft (1911) surveyed the mineral deposits of northern Yuma County, which included the land now within the reservation, and described in detail the metamorphic host rocks for the ores. At that time he considered all of the metamorphic rocks to be Precambrian. His reconnaissance map shows deposit locations and indicates metamorphic occurrences of rocks.

Several unpublished university theses dealing with portions of the Whipple Mountains (Kemnitzer, 1936), the Cienega mining district (Zambrano, 1965), and the western Buckskin Mountains (Blanchard, 1913) discuss the crystalline basement rock in and near the northern part of the reservation.

GEOLOGY

General

Schists, gneisses, and granitic-textured intrusive rocks, forming the mountain ranges and probably underlying the valleys, comprise the basement rocks. Younger Tertiary and Quaternary sedimentary and volcanic rocks include fan, estuarine, and fluvial deposits and attain a thickness of 300 m in the valleys. When the area was being extensively explored around 1900, the crystalline basement rocks were described in the literature, but there has been little subsequent detailed work on the rocks, therefore age of those rocks is still in question. In the early descriptions all of the metamorphic rocks were termed Precambrian because of their high degree of metamorphism and structural deformation, but later workers thought some of the rocks might be Mesozoic, and recent studies (Hamilton, 1964 and Miller, 1970) indicate that the crystalline rocks may be of both ages. The Cenozoic sedimentary rocks remained relatively unstudied until water resource studies began in the 1960's. Currently only the Bouse Formation, an estuarine deposit of Miocene age, has been named. Figure 2 shows a generalized geologic map of the reservation.

Stratigraphy

Crystalline Basement Rocks

General.--Metamorphic and intrusive igneous basement rocks, exposed only in the mountain ranges, may range from Precambrian to Tertiary in age. Miller (1970) proposed that metamorphic rocks in the nearby Plomosa Mountains correlate with the unmetamorphosed sedimentary rocks in the Grand Canyon region. Because age relationships and correlations between ranges have not been determined, the crystalline basement rocks will be discussed separately for each mountain range.

Riverside.--The mountains consist of well foliated schists and bedded limestone; the limestone beds may be as thick as 30 m, and limestone also occurs as pods in the schists. Verplanck (1952) distinguished three types of schist of the basis of texture and minor compositional variations, but they all contain quartz, albite, epidote, biotite, and tremolite, and the mafic minerals are subparallel. Near schist-limestone contacts, tremolite has developed in the limestone. Some of the rocks are Precambrian (Bishop, 1963), but crinoid remains in the limestones indicate that some are younger.

Whipple Mountains.--The crystalline rocks of the Whipple Mountains are a complex group of metasediments, meta-intrusives, and meta-extrusives (Kemnitzer, 1937), which were shattered and metamorphosed prior to Basin and Range deformation. Granite was metamorphosed to form augen gneisses, which were brecciated and injected by volcanic material. Kemnitzer (1937) believed the gneiss was an old pluton intruding still older sediments and interbedded volcanics which were subsequently metamorphosed to chlorite schists, limestones (marbles), thin quartzites, and banded gneisses. Metasedimentary rocks predominate in the western and northwestern parts of the mountains whereas meta-igneous rocks are common in the central and northern parts. Lamprophyre and aplite dikes, neither of which are found in rocks younger than the basement complex, intrude metamorphic rocks on the flanks of the mountain range. In the extreme western part of the Whipple Mountains an unmetamorphosed granitic intrusion may be Mesozoic in age.

Buckskin Range.--A complex sequence of metasedimentary rocks characterized by limestones (now marbles) and several types of schists comprise the Buckskin Range. In the Cienega mining district Zambrano (1965) distinguished three types of metamorphic rocks: a gneissic rock containing a series of metabasic dikes, metaconglomerate--schistose rock, and calc-silicate rocks, which pass transitionally into the other two types. Marbles in the district contain significant amounts of quartz, epidote, muscovite, hematite, and limonite, which properly make them calc-silicate rocks rather than limestone, but the term limestone has been retained in the literature. A massive impure limestone at the base of the section is overlain by greenschist. The next unit is a massive 210-m-thick limestone, which hosts ore at the Billy Mack mine; it is followed by yet another greenschist. An interlayered impure marble and schist overlying the greenschists becomes more siliceous and argillic to the east as quartzites and greenschists become more abundant. A quartzite above the interlayered unit passes transitionally into a quartz-feldspar-mica schist. On top of this lies a gneiss. Interlayered with this gneiss is a green rock, which may have once been shale. Two quartz-feldspar-epidote porphyroblastic-gneiss areas within this gneiss may represent premetamorphic igneous intrusions. In the southern part of the Cienga district are interlayered conglomerates containing elongate pebbles, quartzites, and quartz-feldspar-mica schists, which are more siliceous than those previously mentioned; there are no marbles. Zambrano (1965) thought that fossil evidence indicates a probable Carboniferous age.

Dome Rock Mountains.--In the Dome Rock Mountains, the predominant rock type is also schist. Bancroft (1911), Darton (1925), and Lausen and Gardner (1927) have outlined the nature of the schists. Lausen and Gardner (1927) noted two types of schist: a sericitic, quartzitic conglomerate schist of sedimentary origin and a chloritic schist of mafic igneous origin. The conglomerate schist's matrix has been recrystallized, but the pebbles have not been recrystallized or deformed. The color of the schists depends upon the relative amounts of mica, chlorite, epidote, and iron-oxide staining. Minor bands of dark-brown slate are interlayered with the schists. Except in the quartz-rich schists, parting planes are usually well developed, and where sericite is abundant a sheen is developed on the parting surface. Two mottled schists occurring locally south of the reservation contain magnetite and biotite, respectively. Schists near the Valensuella mine, which lies within the reservation, have been intruded by diabases and less commonly by pegmatites and minettes. Bancroft (1911) and Darton (1925) stated that a gneissic granite occurs south of Tyson Wash, and Lausen and Gardner (1927) mentioned a granite in the southern Dome Rock Mountains that intrudes the schists.

Tertiary and Quaternary Volcanic and Sedimentary Rocks

Volcanic and sedimentary rocks of Tertiary and Quaternary age occur in the Whipple and Buckskin Mountains. In the Whipple Mountains, Kemnitzer (1937) divided these rocks into two units which he called Gene Canyon and Copper Basin (included in unit Tu on Figure 2). His Gene Canyon sequence has many sandstones and boulder conglomerate beds and contains minor amounts of shale. His Copper Basin unit includes red and brown sandstone and conglomerate plus shales, lavas, and breccias. The Copper Basin unit occurs in the eastern Whipple Mountains in and around Copper Basin. The volcanics, which reach a maximum thickness of 245 m on Monument Peak, usually occur at the base of the unit where they overlie the basement complex, but they thin toward the east and gradually disappear as they interfinger with the sedimentary rocks. Most of the volcanics are andesites but some basalt and rhyolite flows also occur. The interbedded conglomerates, grit sandstone, and flaggy sandstone of Kemnitzer's Copper Basin unit may include part of the fanglomerate discussed in the next section.

In the Buckskin Range Zambrano (1965) mentioned a 30-m tuff overlain by 150 m of olivine basalt containing intercalated ash beds. These basalts are composed of plagioclase, olivine, augite, and biotite phenocrysts, in order of abundance, while plagioclase, hematite, sericite, and calcite compose the groundmass. The basalt at Black Peak, the easternmost point of the reservation, has more augite phenocrysts than other Buckskin Range basalts and is underlain by a bluish-gray diabase rather than by a tuff. Blanchard (1913) believed these basalts to be Quaternary. South of the Bill Williams River is a rhyolite prophyry whose orthoclase phenocrysts are badly altered to sericite. The groundmass is quartz, sericite, and iron hydrous compounds with abundant chlorite and hematite.

Tertiary Fanglomerate

The discussion of this and the remaining units is drawn from the papers of Metzger (1965, 1968; Metzger and others, 1973), who described the younger units in detail. A fanglomerate aquifer exposed north of Parker may extend beneath the entire Parker Valley area as indicated in wells, which are producing from this unit near Parker. Bedding surfaces dip from the mountains towards the basins. The unit is composed of cemented angular to subrounded gravels, which are poorly sorted and contain some fine grained material and, near Parker, thin basalt flows. Metzger (1965) believed the gravels were locally derived and noted they are very similar to the gravels presently being deposited by the Colorado River. The gravels derived from the basement rocks are gray, whereas the gravels of volcanic and sedimentary origin are brown to red brown. Although fossils have not been found in the fanglomerate, it has been tentatively assigned a Miocene age.

Bouse Formation

Metzger (1968) divided the Bouse Formation, deposits from a brackish-water environment, into three members: a basal limestone, an interbedded clay, silt, and sand member, and a tufa. Although the unit is nearly horizontal it does dip gently toward Parker Valley, where it is subsurface, and lies unconformably on the fanglomerate. The unit crops out, however, on the northern flanks of the Dome Rock Mountains. The type section for the Bouse Formation occurs in well LCRP 27 on the reservation in the NW ¼ NW ¼ sec. 31, T. 7 N., R. 21 W., where the thickest section is found. A complete description of the type section can be found in Metzger (1968).

Near Cibola the basal limestone has three submembers: a 15-m thin-bedded nearly white limestone containing 0.3-1.5 m beds of barnacle coquina, a 6-m light-tan barnacle coquina and a 9-m white limestone, all of which vary laterally and cannot be distinguished near Parker where the basal member is a white thin-bedded marly limestone containing a 2.5-cm thick chert layer. Gravel lenses within the limestone are thought to represent offshore bars. This basal member grades upward into the interbedded sequence.

The interbedded member near Parker is flat-lying and thin-bedded with beds grading from sand to silt. Clay minerals form about half of the unit; they are expandable and range in color from pale olive to pale yellowish green, while others may be red, yellow, or gray. On weathered surfaces the silt and fine sand may be grayish orange, light gray, or very light. They are weakly compacted and cemented, but well cuttings are much darker and more indurated. Microscopic pyrite, sometimes filling animal tests, and small pebbles can be identified in the cuttings. Although the unit contains no good marker beds, there are a few 2.5-cm-thick barnacle beds that can be traced short distances.

The tufa adheres to the pre-Bouse rocks by coating hills or cliffs, where it resembles stalactites, and shows a marked resemblance to hot-spring deposits but Metzger (1968) believed it was produced by algae. The tufa may be very hard and dense or soft and porous and may range in color from white to dark gray.

Though the number of fossil species in the Bouse Formation is small, it includes marine foraminifera, mollusks, ostracods, charophytes, and barnacles. Some of the ostracods are brackish- and fresh-water species, which indicates they probably lived near an estuarine environment. Fossil and lithologic evidence led Metzger (1968) to state that deposition took place in an embayment of the Gulf of California. The unit is assigned a Miocene age, and a tuff within the Bouse has been dated by radiometric means at 5.5±0.2 m.y. (Damon and others, 1978).

Colorado River Alluvium

Although Metzger and others (1973) divided the Colorado River alluvium into several units based on periods of aggradation or degradation, these strata are described as one unit here. The alluvium rests unconformably on the Bouse Formation and averages 40 m in thickness, consists of a heterogeneous mix of silts, sands, angular to rounded gravels, and minor clays of both local and non-local derivation. Vertebrate fossils, including turtles, snakes, lizards, birds, and large mammals, have been found west of Blythe in the upper portions of the older alluvium. Silicified wood fragments have also been found in the unit. The eolian sands on the flood plains and drainage divides have been derived from the older alluvium. The younger alluvium consists of gravels and sands which represent the last aggradation of the Colorado River before it began cutting into the terraces when it was dammed. Dates on wood fragments give ages of 5,380±300, 6,250±300, and 8,610±300 years and Metzger and others (1973) think deposition of the younger alluvium may have begun 10-15,000 years ago. Vertebrate fossils in the older alluvium are middle and late Pleistocene, and the oldest alluvial deposits may be Plio-Pleistocene.

Structure

The reservation lies within the Basin and Range province, a province formed during an episode of complex faulting and characterized by northerly-trending mountain ranges separated by broad basins. Geologists who have studied the mountain ranges adjacent to the reservation noted that most of the metamorphic rocks have been greatly sheared and faulted, and many of the rocks have been subsequently veined. Most of these geologists thought that this shearing predated the Basin and Range deformation. Kemnitzer (1937) mapped minor folds in the Whipple Mountains, but folding is a minor part of the area's structural history.

The reservation also lies close to faults of the San Andreas system, but Metzger and others (1973) mapped only a few minor faults in the Tertiary and younger sediments, so the San Andreas system has no active faults on the reservation.

MINERAL RESOURCES

General

The Colorado River Reservation is surrounded by mines and mining districts having a variety of minerals, including gold, silver, copper, lead, mercury, tungsten, iron, manganese, gypsum, barite, fluorite, kyanite, pumicite, alunite, quartz, sand and gravel. Some of the deposits were rich and productive; most were not. Few of the veins mined were productive more than 300 or 400 feet below the outcrops, suggesting that the richer ore is a result of secondary enrichment.

Minerals that have been produced on the reservation are gold, copper, sand and gravel. Other reported mineral deposits include gypsum, kyanite, manganese, and nitrate.

Metallic Mineral Deposits

Introduction

Intensive prospecting for commodities including gold, silver, copper, manganese, and mercury occurred in the mountains in and near the reservation around the turn of the century, resulting in the formation of several mining districts: the Cienega in the Buckskin Range, the Copper Basin in the Whipple Mountains, the Bendigo in the Riverside Mountains, and the La Paz in the Dome Rock Mountains. In all of these districts copper, gold, and silver occur within quartz veins in sheared or brecciated metamorphic rocks or at contacts of the schists with the limestones or younger volcanics (Bancroft, 1911; Tucker and Sampson, 1945; Wilson and others, 1934; Wright and others, 1953; and Zambrano, 1965). The ore minerals in these districts are usually chrysocolla, malachite, azurite, gold, and hematite. Sulfide occurrences are rare although Bancroft (1911) mentioned pyrite, bornite, and chalcopyrite at the Planet mine in the Buckskin Range and chalcopyrite and chalcocite in the Copper Basin district. Gangue minerals include quartz with or without calcite, siderite, and barite. In his survey of Yuma County, Bancroft (1911) discussed six types of copper occurrences as associated with the metamorphic rocks or at the contacts with overlying limestones and volcanic rocks. Because the ores occur at contacts with the volcanic rocks of Tertiary age, it may be assumed that at least some of the mineralization has occurred since their emplacement, and the great similarity of all occurrences would suggest that all mineralization might be as young as Middle to Late Tertiary.

Although Wilson (1932) mentioned Laramide stocks in the Dome Rock and Buckskin Mountains, there has been no mention of porphyry copper type ores or environments. The lack of primary sulfides and the association of the copper with gold in quartz veins are conditions not suggestive of a porphyry copper environment.

In addition to the copper, gold, and silver, minor amounts of manganese occur in the Buckskin Range (Jones and Ransome, 1920, Wilson, 1930) and the Whipple Mountains (Wright and others, 1953). In the Buckskin Range manganese occurs in sheared rocks adjacent to fault zones in the schists. Long fibrous seams of manganite and manganese and iron oxides, often accompanied by barite, impregnate the brecciated rock. In the Whipple Mountains stringers of manganese oxides occur as fissure fillings in the basalts or as cementing agents in the fanglomerates. Several prospects have produced small quantities of manganese but have little potential.

Cinnabar has been found in the Dome Rock Mountains south of the reservation in a vein a few inches to several feet thick within a fault zone of brecciated country rock. It is accompanied by the usual copper, gold, and silver ore minerals plus calcite and siderite gangue. The mercury is thought to have been derived from mercurial tetrahedrite (Bancroft, 1911) but now occurs as cinnabar and metacinnabar.

Gold Placers

The rich La Paz placer field now is mostly outside the southern boundary of the reservation, although at times it has been inside the boundary. The district was included in the Colorado River Indian Reservation during the periods 1873 to 1910 and again from 1912 to 1915 (Arizona Bureau of Mines, 1933).

After the Indians showed several gold nuggets to prospectors, placering was begun in the La Paz district, which had a large production between 1862 and 1869 (Wilson, 1932). Most of the placers were exhausted by 1900 (Johnson, 1972) although efforts were renewed briefly during the Depression of the 1930's. The gold, which occurred in washes in the steep slopes of the Dome Rock Mountains, was probably derived from quartz veins in the schists. The gravels in which the nuggets were found are unconsolidated sands and clays enclosing unsorted angular rock fragments, and the richest yields were near the bedrock. A few placers existing on the mountains' eastern slopes are similar to those on the west except that they occasionally contain cemented material (Jones, 1915). The Dome Rock area is famous for large nuggets, the largest being 65 oz (Jones, 1915). The town of La Paz died in 1880 when the Colorado River formed a new cutoff. La Paz was then without a dock, and placering in the district declined rapidly.

One major problem in working the La Paz placers is lack of water. The gold mined has been recovered by dry panning in pans and wooden bateas or in various mechanical "dry washing" contrivances. Consequently, only coarse gold has been recovered and only the richest portions of the deposits worked. Good values probably still remain in the tailings left from the "dry washing" activities and in unmined areas either too low grade to be treated by "dry washing" or too deeply buried to have been mined by earlier methods. According to the Arizona Bureau of Mines (1933), "By far the greater part of the auriferous material is unworked, especially that in the lower courses of the arroyos, where the wash is deep".

One project was started to work the field by bringing water into the area by pumps and pipelines. The effort was abandoned when the deposits were incorporated into the reservation during the

1912 to 1915 period and evidently was never revived. Renewed activity in the 1930's again resorted to dry panning and dry washers.

The source of gold in the La Paz placer field is believed to be detrital material derived from erosion of gold-bearing veins in the gneisses, schists, and granite of the Dome Rock Mountains. The Dome Rock Mountains and known gold-bearing veins extend into the southeastern portion of the reservation for about 15 miles. Possibly the washes draining this northerly extension of these mountains and other geologically similar areas also contain placer gold deposits. The value of possible deposits can be established only by exploration. With present gold prices and modern equipment, it seems possible that profitable gold placer operations might be developed.

Gold Veins

Goodman Mine and Golden Hope Claims.--Both of these mines are outside the present reservation boundary, but were inside the boundary in 1915 (Jones, 1915b). Both mines are on the same vein; it is traceable on the surface for 3 miles. Production at the time of Jones' visit had amounted to about $50,000 from ore said to range from $30 to $200 per ton in value. The mines are just outside the southern boundary of the reservation in the vicinity of the La Paz placers mentioned earlier and were discovered at about the same time as the placers. Detritus from the eroded vein appears to have contributed to the gold content of the richer portions of the La Paz placer field.

Dan Welsh Prospect (Apache Mine).--This prospect is described as being "near the south boundary of sec. 32, T. 6 N., R. 21 W." (Jones, 1915b), which does not fit the physical description of the location. A map in the same report shows the location more nearly as sec. 35, T. 6 N., R. 21 W. which does correspond to the physical description of the location. Most likely the "sec. 32" given is a typographical error.

Jones described a 2-foot quartz vein in Precambrian gneiss and schist, striking east-west and dipping 60º N. to vertical, that could be traced to 1,000 feet on the ridge, disappearing beneath alluvium on the east and pinching down to a thin seam on the west. The vein contained visible gold and ore was being mined, bagged, and packed to the river 6 miles away, for treatment in an arrastre. The operators were not permitted to continue.

The USGS 7 ½-minute quadrangle map, Moon Mountain, Arizona, shows two shafts in this location marked "Apache Mine." Keith (1978) describes an Apache mine at SE ¼ sec. 35, T. 6 N., R. 21 W., as having spotty gold and silver mineralization with minor, partly oxidized sulfides in a lensing quartz vein along a fracture zone in Mesozoic metamorphic rocks intruded by a small Laramide rhyolitic plug. The mine was worked by the Moon Mountain Gold Mining Co. and by the Mohave Mining Co. from 1935 through 1950. It produced 330 tons of ore averaging 2.4 oz of gold/ton and 0.4 oz of silver/ton.

The tonnage produced is not impressive, but the grade is. It would be interesting to know whether or not a large tonnage of lower grade ore is still present in the mine.

Mammoth Prospect (Apache No. 2).--This prospect is in sec. 12, T. 5 N., R. 21 W., about 2 miles southeast of the Dan Welsh prospect. It is described as a faulted iron- and copper-stained, pyrite-bearing quartz vein up to 10 feet wide, striking N. 70º E. and traceable for about 1,000 feet. The country rock is a schistose porphyry containing feldspar, biotite, chlorite, and epidote.

An incline shaft was sunk on the vein, but had been inactive for years prior to 1915 (Jones, 1915b). The property was restaked as the Apache No. 2 in 1914, and there has been no record of activity since that time. The quantity and value of gold found is not known.

Copper

The Valensuella (Valenzuella) mine is in the southern part of sec. 32, T. 6 N., R. 20 W., about 3 miles due east of the Dan Welsh prospect (Apache mine). The mine is well within the reservation boundary, although an earlier report (Bancroft, 1911) left this in doubt.

The vein strikes east-west, dipping 0 to 35º N. in a shear zone in coarse grained schist. Gangue materials are brecciated schist, quartz, and calcite. Ore minerals are chrysocolla, malachite, pyrite, and hematite. Ore values in early mining showed 10 percent copper and $1.50 in gold per ton (at $20.67/oz). Ore shoots were erratic, in irregular pockets and stringers. In 1910, a 900 foot incline shaft and about 700 feet of lateral workings had been driven, and a 25-ton smelter erected. The total production of the mine could not be determined.

Iron

Jones (1915b), in discussing the La Paz gold placer field, reported that "Magnetite is always found in the concentrates, and boulders of magnetite, the largest weighing several pounds, are frequently found on the surface. " No quantitative studies are known to have been made on the magnetite found here.

Manganese

On July 20, 1954, the Tribal Council granted a manganese lease to an unnamed party for an area in the Riverside Mountains described as being in secs. 6 and 7, T. 2 S., R. 24 E., San Bernardino Base and Meridian, California (BIA, Colorado River Agency Files, 1954). Further information on the presumed deposit was not available in the files of the Bureau of Indian Affairs.

Subeconomic manganese deposits are known to exist in areas near the reservation, so it is possible that deposits are present on the reservation. The history of deposits in the surrounding areas makes it seem improbable that one of present day commercial value might be found on the reservation.

Nonmetallic Mineral Deposits

Sand and Gravel

Sand and gravel are the only minerals now being produced on the reservation. Abundant quantities of sand and gravel occur in the recent alluvium of the present stream beds as well as in the outwash of the piedmont slopes.

At present three commercial companies have leases from the tribe for sand and gravel. In addition, the Arizona State Highway Department and the Bureau of Indian Affairs also mine gravel on the reservation. Leases are for specific locations and are based on an annual rental which varies according to the area involved and the lessee also pays a 15 cents per ton royalty.

Complete records were not examined, but it appears that, exclusive of material used by the Highway Department and the Bureau of Indian Affairs, 20,000 to 40,000 tons per year is mined with possibly $15,000 in revenue from rent and royalties accruing to the tribe.

The sand and gravel is used primarily as aggregate in cement and asphalt concretes. Transportation costs would preclude its being shipped any great distance.

Gypsum

Gypsum has been found on the eastern slope of the Riverside Mountains (Tucker and Sampson, 1945; VerPlanck, 1952), partly inside the Colorado River Indian Reservation. The deposit is in the NW ¼ SW ¼ of sec. 7, T. 2 S., R. 24 E., San Bernardino Base and Meridian. Another larger deposit about a mile to the northwest is outside the reservation.

The deposit on the reservation has not been explored, and estimated tonnage figures range from 2 million tons given by Tucker and Sampson to 28 million tons quoted by an entrepreneur in a lease proposal submitted to the Colorado River Indian Tribal Council (BIA Colorado River Agency Files, 1977). VerPlanck (1952) states that the gypsum occurs in a 100-foot zone striking northwestward and dipping southwest 50 degrees or more. The gypsum is interbedded with limestone and quartzite. Tucker and Sampson (1945) mention a bed 50 feet thick, and three beds aggregating 70 feet thick. They say the beds are very pure, averaging 98 percent gypsum.

In 1977, Charles M. Pensinger of Phoenix, Ariz., submitted a lease application to the Tribal Council in which he proposed to pay a royalty of 50 cents per ton to mine the gypsum deposit to supply a planned wallboard plant in the SE ¼ sec. 30, T. 9 N., R. 19 W., about 3 miles south of Parker, near the highway and the railroad line. Mr. Pensinger failed to carry out his proposal. (BIA, Colorado River Agency files.)

Gypsum deposits in the Maria Mountains and Little Maria Mountains 15 to 25 miles southwest of the reservation have been mined commercially since at least 1925 (Verplanck, 1952), the material being used principally for calcined gypsum products, such as plaster and wallboard, and as a soil conditioner. The extensive mining of gypsum in these areas has been due primarily to easy accessibility to such markets as the building trades and agricultural consumers of southern California, to low mining costs, and to the high grade of the deposits.

The deposit on the reservation is also easily accessible and high grade and as gypsum consumption is increasing annually, eventually attention may focus on this deposit. An accurate estimate of the tonnage and grade in the deposit might hasten a consideration for development.

Nitrate

Two nitrate deposits have been reported, one in the vicinity of the gypsum deposit discussed above, and the other several miles to the north-northwest but which probably extends into the reservation. Both have been investigated (Noble, 1931). The total areas are large and contain sufficient nitrate to give good assays; however, the nitrate-bearing material is entirely surficial, amounting to little more than an efflorescence confined to the topmost few inches of the ground. The reserves, therefore, are negligible and are not considered mineable deposits.

Kyanite

Stanton B. Keith (1978) shows a map location for kyanite in sec. 9, T. 4 N., R. 21 W. This is believed to be the deposit referred to by Funnell and Wolfe (1964) (Stanley B. Keith, no relation, personal communication, 1978). Details are lacking except that the deposit is said to be "1,000 feet long and substantial tonnage is present."

Kyanite is used principally as a refractory in processing metals and glass making; most of the kyanite-mullite industry is located in the eastern United States near the major centers of consumption. All but a small part of the kyanite output comes from two companies in Virginia and South Carolina. Deposits in other states containing very large reserves are not being worked or are being worked on a nominal basis (Potter, 1975). It seems unlikely that kyanite deposits on the reservation would be of immediate value.

RECOMMENDATIONS FOR FUTURE WORK

The reservation has not been mapped geologically in detail, and the economic mineral resource potential has not been adequately determined. The following kinds of investigations would help fill the gaps in knowledge and might identify some deposits that seem worthy of more intensive study:

1. Detailed geological mapping of the entire reservation with emphasis on distribution and character of potential economic mineral deposits.
2. Reconnaissance sampling of the washes draining the Dome Rock Mountains to check for gold placer deposits.
3. Detailed mapping and sampling of the gypsum deposit.
4. Reconnaissance of the reported kyanite and manganese deposits.
5. Examination of the three known lode deposits.

MAP COVERAGE

The United States Geological Survey has published quadrangle topographic maps that cover the reservation; these are shown on Figure 3. Small scale maps that include geology of the reservation are:

Geologic Map of California, 1966
U.S. Geological Survey and California
Division of Mines and Geology
Scale 1:2,500,000

Aeromagnetic and Generalized Geologic Map of Parts of Central California, 1977, Geophysical Investigation Map, U.S. Geological Survey Scale 1:1,000,000

Geologic Map of Arizona, 1969 Arizona Bureau of Mines and U.S. Geological Survey

A geologic map of Yuma County has been published (1960) which includes most of the reservation. Scale 1:375,000. The map is available from:

Arizona Bureau of Geology and Mineral Technology
845 North Park Avenue
Tucson, Arizona 86719.

A road map of Yuma County, including most of the reservation can be obtained from:

Arizona Department of Transportation
Administrative Section 134-A
206 South 17th Avenue
Phoenix, Arizona 85007

Aerial photographs of the reservation can be obtained from:

EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198.

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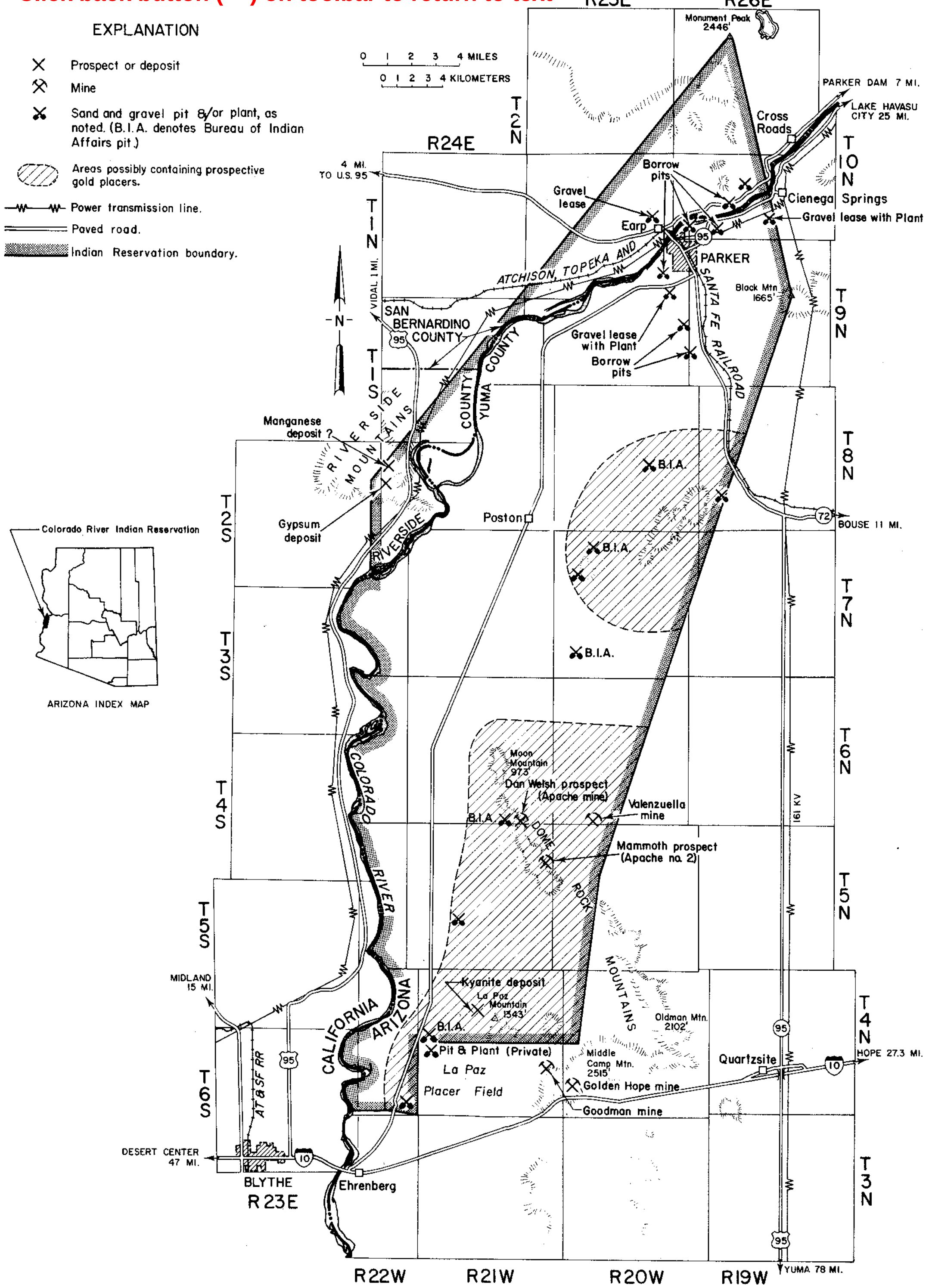

Figure 1. Index map showing mineral deposits on and near the Colorado River Indian Reservation. Note: Townships and ranges on California side of Colorado River are referred to San Bernardino Meridian; those on Arizona side are referred to Gila River Meridian.

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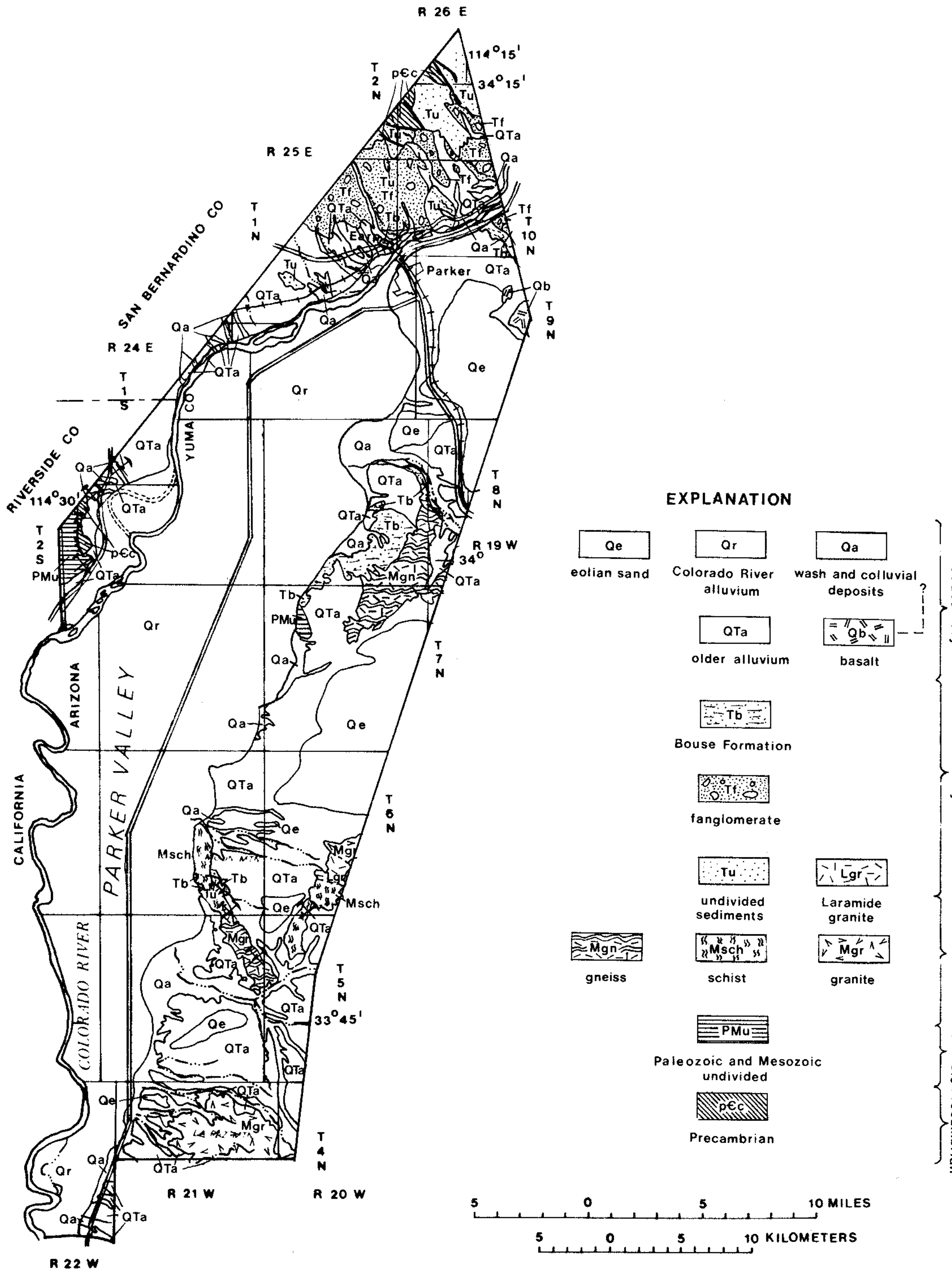

Figure 2. Geologic map of the Colorado River Indian Reservation. Geology from Bishop (1963), Hamilton (1964), Jennings (1967), Metzger and others (1973), and Wilson (1960).

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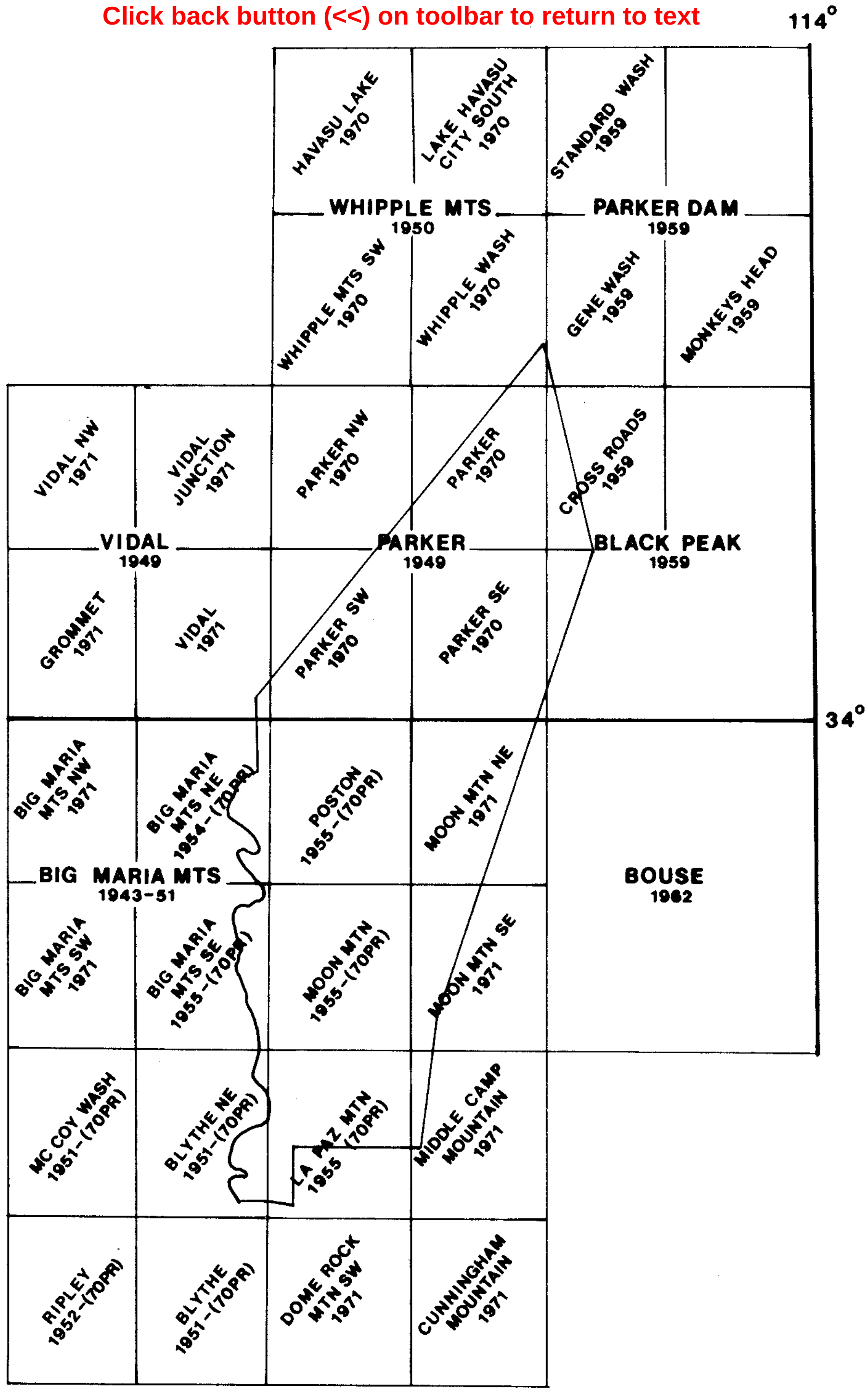

Figure 3. Map showing U.S. Geological Survey topographic map coverage of the Colorado River Indian Reservation and vicinity.