STATUS OF MINERAL RESOURCE INFORMATION FOR THE SALT RIVER AND FORT MCDOWELL INDIAN RESERVATIONS, MARICOPA COUNTY, ARIZONA

Jocelyn A. Peterson
U.S. Geological Survey

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

Administrative Report BIA-63
1980

CONTENTS

SUMMARY AND CONCLUSIONS

Deposits of sand and gravel are being mined successfully and will probably continue to produce in the foreseeable future. An estimate of the reserves could be made, but this does not appear to be urgent.

The tribe should encourage further investigation of the geothermal potential of the western half of the Salt River Reservation.

There is a possibility that the tuff exposed on the Salt River Reservation may have been altered to zeolite. The tribe could consider a study to determine if the tuff has any economic potential.

Deposits of usable clay may be present; however, it would be pointless to expend time and effort on exploring them without a definite market or objective in mind.

No mineral occurrences have been reported in a small area of granitic rocks that is exposed in the eastern part of the Salt River Reservation ant the southwestern part of the Fort McDowell Reservation.

INTRODUCTION

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 Source materials included published and unpublished reports and personal communications.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

Both reservations are in Maricopa County, Arizona, in the immediate vicinity of Phoenix (Figure 1). The Salt River Reservation shares a common boundary with the suburban community of Scottsdale to the west, and the southern boundary of the Fort McDowell Reservation abuts a portion of the Salt River Reservation.

The shape of the Salt River Indian Reservation approximates a right triangle with one leg forming the west boundary extending about 9.5 miles north-south and the other leg forming the north boundary extending about 14.5 miles east-west. The Salt River forms the hypotenuse on the southeast ant a part of the southern boundary. The total area of the Salt River Reservation is 49,294 acres (U.S. Bureau of Indian Affairs, 1978). The western half of the reservation is flat or slopes gently southwest at 10-20 feet per mile and elevations range from 1,200 feet to 1,400 feet above sea level. For the most part, elevations in the eastern half range from 1,400 feet to 1,600 feet above sea level, with a few scattered hills and buttes rising to a maximum of 2,830 feet above sea level. This area is rougher than the western part of the reservation and is totally undeveloped. Maximum relief in the reservation is 1,660 feet between Mt. McDowell, in the eastern part of the reservation, and the Salt River, at the southwest corner of the reservation.

The Fort McDowell Indian Reservation is shaped like a parallelogram with its long axis extending north-south about 10 miles, along the Verde River. The width, east-west, is about 4 miles. The reservation encompasses 24,680 acres (U.S. Bureau of Indian Affairs, 1978). The flood plain, ranging in elevation from 1,340 feet to 1,500

feet above sea level, of the Verde River and its tributary Sycamore Creek forms level or gently sloping land.. From the flood plain, the land rises to the east and west generally 100-150 feet per mile. The higher areas are rough terrain. Maximum relief on the reservation is 578 feet between the Verde River (1,340 feet elevation) at the south end of the reservation and the highlands (1,918 feet elevation) near the northeast corner of the reservation.

The climate is arid; annual rainfall recorded at Granite Reef Dam on the Salt River varied from a minimum of 2.89 inches in 1956 to a maximum of 15.24 inches in 1951. The average annual precipitation is 8.86 inches for the period of record from 1931 to 1972. Weather stations north, west, and southwest of the reservations and within a distance of 20 miles or less, recorded annual rainfall from a minimum of 2.82 inches to a maximum of 24.94 inches with averages of 12.00 inches, 7.59 inches, and 6.78 inches respectively (Sellers and Hill, 1974). The driest months are generally May and June, while the hottest months are July and August. Temperatures often exceed 110º F on dry summer days; freezing temperatures occur less than 20 days each year.

Agriculture and stock raising are the dominant industries on these reservations. Irrigation water is obtained from wells and from a series of reservoirs on the Salt and Verde Rivers. The City of Phoenix operates a well field, an infiltration system, and a filtration plant along the Verde and Salt Rivers, thus supplying a substantial portion of the domestic water for the city (Phoenix Water and Sewer Department, oral communication). This water system is a primary source of employment and income on the reservations (Bureau of Indian Affairs, 1978).

Industrial and recreational development has been steadily increasing, especially on the Salt River Reservation where at least 30 various enterprises are located and an industrial park has been established (U.S. Bureau of Indian Affairs, 1978; Arizona Commission of Indian Affairs, 1978). Sand and gravel has been mined on both reservations and is an important industry.

State Highway 87 traverses the Salt River Reservation from the southwest to northeast and crosses the southern end of the Fort McDowell Reservation. In the western part of the Salt River Reservation, some of the principal streets of Scottsdale continue into the reservation, and a road runs along the length of the Fort McDowell Reservation. Secondary roads and trails give access to most parts of the rougher terrain on both reservations. Commercial air, bus, and rail transportation are available in Phoenix.

The tribal headquarters and some community facilities are located on the reservations, but most necessities are obtained from the Phoenix metropolitan area.

PREVIOUS INVESTIGATIONS

Most of the previous studies done on the reservations were water supply investigations. Reports from these investigations include Davis (1897), Lee (1905), McDonald and others (1945, 1946, 1947). Wilson and associates (1957) cover the reservations in their geologic maps of Maricopa County and (1969) in their geologic map of Arizona. Moore and Varga (1976) included the

Salt River Reservation in their map of "Nonmetallic Mineral Deposits in the Phoenix Area." Cooley (1973) includes the reservations in his map of "Alluvial Deposits in the Phoenix Area." The Bureau of Reclamation has also conducted engineering geology studies along the route of the Arizona Canal, a part of the Central Arizona Project that enters the Salt River Reservation.

MAP COVERAGE

The U.S. Geological Survey has published 7 ½-minute quadrangle topographic maps (scale 1:24,000) that cover both reservations (Figure 2). An Army Map Service map (scale 1:250,000), titled Mesa (NI 12-8), also includes the reservations. The USGS and the Arizona Bureau of Mines have published a "Geologic Map of Arizona" at a scale of 1:500,000. The USGS also publishes a base map on a scale of 1:500,000 that shows reservation locations and cultural features. All of the above maps are available from:

U.S. Geological Survey
Map Distribution Branch, Central Region
Box 25286, Denver Federal Center
Denver, Colorado 80225

The Arizona Bureau of Mines has published a "Geologic Map of Maricopa County" on a scale of 1:375,000 that is available from:

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

County road maps for Maricopa County at scales of 1 ½ in. = 2,000 ft. and 1 ¼ in. = 5 miles are available from:

Arizona Department of Transportation
Engineering Records, Room 134A
206 South 17th Avenue
Phoenix, Arizona 85007

Satellite photographs of the reservations can be obtained from:

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

PHOENIX AREA GEOLOGY

Mountain chains with cores of Precambrian granitic and schistose rock and valleys of Cenozoic sediments and sedimentary rocks that may attain great thicknesses typify the Phoenix area (Figure 3). A few small Laramide stocks and minor outcrops of Paleozoic and Mesozoic sedimentary and volcanic rocks are present within the mountains. Both early and recent investigators primarily studied ore occurrences within the mountain ranges or ground water in the basins. The geology of the Salt River and Fort McDowell reservations is shown on Figure 4, but the following discussion covers the entire Phoenix area.

Precambrian Rocks

Precambrian schists, gneisses, and granites constitute the mountain cores and comprise almost the entire Sierra Estrella and Sacaton Mountains.

Geologists distinguish three types of granite: 1) in the McDowell and Phoenix Mountains is a medium-coarse light-gray granite containing orthoclase, biotite, and quartz; 2) in the South (also called Salt River), Usury, and Goldfield Mountains is a medium-fine to medium-coarse granite similar to that mentioned above but containing more biotite and quartz; 3) there are small exposures in the Camels back, McDowell, and Santan Mountains of a coarse granite containing pink potassium feldspar altered to sericite, biotite usually altered to chlorite and epidote, and quartz. Although these granites have not been named, they probably correlate with the Oracle or Ruin Granites in other parts of Arizona. The Precambrian schists are of both igneous and sedimentary origin. The transition from biotite granite to gneiss can be traced in the White Tank and South Mountains west and south of Phoenix (McDonald and others, 1947). These schists are less thinly laminated than those of sedimentary origin. McDonald and others (1947) think some schists in the Phoenix, McDowell, and Heiroglyphic Mountains are probably of sedimentary origin due to their spatial association with quartzites, slates, and shales. These well-foliated schists strike uniformly to the northeast and dip steeply, while schists in other areas show more variations in strike. The minerals in all of these schists include sericite, muscovite, chlorite, epidote, and quartz

Paleozoic, Mesozoic, and Laramide Rocks

A small outcrop of Cambrian(?) and Devonian(?) limestone occurs in the Sacaton Mountains (Wilson, 1969). Wilson considers a small granitic body in the southern Sierra Estrella to be Mesozoic, and he also notes minor occurrences of Mesozoic diorite dikes. Stocks and aplitic dikes in the Santan Mountain area are probably Laramide. When considering mineral resource potential, the limited extent of these Paleozoic and Mesozoic sedimentary rocks makes them an unlikely major source of ore minerals, but the Mesozoic and Laramide stocks may be significant for copper mineralization.

Tertiary and Quaternary Rocks

Volcanic Rocks. Volcanic rocks ranging in composition from rhyolite to basalt occur in most of the Phoenix area mountain ranges (Moore and Varga, 1976) and are probably Tertiary in age (Wilson, 1969).

Sedimentary Rocks. Most of the sedimentary rocks filling the valleys are Quaternary but McDonald and others (1947) believe that some red conglomerates and sandstones in the McDowell Mountains and other sedimentary rocks in the Phoenix Mountains- Tempe Butte area (Figure 2) are Tertiary. These older sediments have intercalated volcanic rocks.

Quaternary sedimentary rocks and sediments constitute most of the basin fill. They are composed of gravel to clay sized particles and are well cemented to unconsolidated. Rock and mineral grains were derived from local sources and carried by streams of widely varying volume; the mountain ranges are burying themselves in their own debris. McDonald and others (1947) believe

most of the sedimentary rocks are Pleistocene in age and that there is not much recent alluvium, although there is little fossil evidence to support or refute this. Some caliche can be found in the valleys. These Quaternary sedimentary rocks fill the basins to depths of greater than 1,200 feet (Figure 3).

Structure

The Phoenix area is in the Basin and Range physiographic province characterized in this part of Arizona by northwest-trending mountain ranges between large valleys. Few papers discuss structural details of the area except to mention that the Precambrian rocks have been highly fractured (White, 1963).

Geophysics

Peterson and others (1963) discuss the gravity and aeromagnetic data for the Phoenix area. Essentially, the large aeromagnetic anomalies merely delineate areas of granites and gneiss and lesser anomalies outline volcanics. The gravity data simply that there is a deep basin north of the Palo Verde Hills (west of Maricopa Reservation) and another 13 km west of Glendale which proved to be a salt dome (Eaton and others, 1972). Data suggest that a fault zone extends from Scottsdale to the Palo Verde Hills that may have had locally significant vertical displacement. Paradise Valley (which includes part of the Salt River Reservation) has three particularly low anomalies. Another noticeable low occurs between the Sacaton and Palo Verde Mountains (in vicinity of the Maricopa Reservation).

MINERAL RESOURCES

General

Both reservations are predominantly covered by alluvium and contain only small exposures of extrusive igneous rocks, granite, and schists. Consequently, known mineral deposits are alluvial in nature, namely clays and sand and gravel. Sand and gravel is mined on both reservations, constituting a major industry that produces more than 1 million cubic yards per year. Mineral deposits on and near the reservations are shown on Figure 1.

Metallic Mineral Deposits

Introduction

No metallic mineral occurrences have been reported on either reservation. Records of the Arizona Department of Mineral Resources show that a copper deposit and a pegmatite containing titanium, columbine-tantalite, and zircon occur in the McDowell Mountains. The McDowell Mountains lie west and north of the Fort McDowell and Salt River Reservations respectively, and the southern extension of the mountain range enters both reservations. Mercury has been mined from schists of the Phoenix Mountains west of the reservations and from the Mazatzal Mountains northeast of the reservations. Tungsten has been found in the Mazatzal

Mountains east of the reservations and near Cave Creek northeast of the reservations.

Copper

No copper occurrences have been reported on either reservation. Records of the Arizona State Department of Mineral Resources show a copper mine on the eastern slope of the McDowell Mountains, six miles north of the Salt River Reservation and five miles west of the Fort McDowell Reservation. The site is in an area of Precambrian metamorphic rock. Bornite and chalcopyrite are present and contain copper, gold, and silver. Interest has been shown in this deposit for at least 40 years, but no production records were found. Several large copper deposits have been found within a radius of 50 miles of the reservations, and copper mineralization may be present on reservation lands. The most likely prospecting target is the small area of metamorphic and granitic rocks south and east of the junction of the western Fort McDowell Reservation boundary and the northern Salt River Reservation boundary.

Mercury

Mercury deposits have been mined in the Phoenix Mountains, 11 miles west of the reservations, and in the Mazatzal Mountains, about 16 miles northeast of the reservations (Ransome, 1916; Lausen and Gardner, 1927). In these areas the mercury sulfide mineral, cinnabar, occurs along faults and fractures and as disseminations in Precambrian schists.

Tungsten

Tungsten deposits were mined near Cave Creek (Dale, 1959) about 18 miles northeast of the reservations and in the Mazatzal Mountains (Dale, 1961) about 14 miles east of the reservations. The exact amount of tungsten ore produced is not known, but it does not appear to have yielded more than about 10 tons of marketable concentrate. The tungsten minerals, wolframite and scheelite, occur as erratic masses and stringers in quartz veins occupying fissures in granitic rocks.

Nonmetallic Mineral Deposits

Introduction

Sand and gravel is being mined extensively on both reservations, and it constitutes a major industry. Barite has not been found on the reservations, but a fairly large deposit has been mined just southeast of the Salt River Reservation.

Although clay deposits have not been reported on the reservations, they may be present. A deposit west of the Fort McDowell Reservation has attracted attention and considerable study, according to records of the Arizona Department of Mineral Resources.

The discovery of zeolite deposits in altered tuff north and east of the reservations (Eyde and Irvin, 1979) suggests that a tuff bed on the reservations may also have been altered to zeolites.

Sand and Gravel

Sand and gravel have been mined on both reservations for many years through leases granted to the City of Phoenix Water and Sewer Department, the Arizona State Highway Department, and various private enterprises. These activities are a major source of income and employment to the tribes. The number of leases varies from time to time. In 1979, there were four on the Salt River Reservation and two on the Fort McDowell Reservation. Leases are negotiated between the applicant and the tribal councils; they are based on a rental fee for the land involved and a royalty on the production. Excellent transportation facilities and the proximity to the Phoenix metropolitan area are significant factors in operating the pits.

Recent production figures have been obtained from BIA records and are presented in Table 1.

Table 1
Sand and Gravel Production

	Year	Production (yd^3)	Tribal Income	Leases
Fort McDowell	1974	*40,904	$ 15,789	6
	1975	*68,131	25,565	3
	1976	571	309	4
	1977	0	0	1
Salt River	1974	*1,625,249	297,546	9
	1975	*1,244,070	233,658	9
	1976	1,157,353	255,048	6
	1977	1,681,151	494,936	8

*Converted from tons by the factor 1.5 tons = 1 cu. yd.

NOTE: Production at Fort McDowell in 1974 and 1975 was attributable to construction activity at "Fountain Hills" housing subdivision adjacent to the reservation on the west.

The most extensive sand and gravel deposits are located along the Salt River on the Salt River Reservation. Smaller deposits occur along the Verde River, Sycamore Creek, and other streams and washes on the Fort McDowell Reservation. Cooley (1973) shows alluvial thicknesses in a general way (Figure 3), but the reserves are limited by the depths that can be economically mined. No estimates of the available reserves have been attempted, but the remaining reserves appear to exceed those already extracted.

The material is excavated by several types of heavy equipment and processed through washing and screening plants to obtain the desired sizes of materials. Fine material is more abundant than coarse, and considerable waste must be handled for

the amount of clean sand and gravel obtained. Deposits with a better ratio of gravel to waste exist in the Phoenix area but are less favorably situated. Deposits on the reservations can continue to supply the existing demand.

Barite

In sections 4 and 5, T. 2 N., R. 7 E., just east of the junction of the Salt and Verde Rivers and across the Salt River from the Salt River Reservation, is a deposit of barite. The claims were located in 1897 and started producing in 1931. Between 1931 and 1955, the mine produced 312,000 tons of marketable barite ore and concentrate. The deposit was mined to a depth of 300 feet where operations were stopped in 1955 owing to decreasing ore tenor and heavy water inflow.

Barite mineralization occurs in faults and fracture zones in a Cretaceous conglomerate near its contact with granite. The principal vein ranged from 6-35 feet in width, averaging 20 feet, and was explored for 2,400 feet along the vein, which strikes N. 75 W. and dips 65 -70 SW (Stewart and Pfister, l950).

Clays

No clay occurrences have been reported on either reservation, although clays have been found in abundance in geologically similar areas near Phoenix. In sections 14, 15, 22 and 23, T. 4 N., R. 6 E., immediately west of the Fort McDowell Reservation, clay intercalated with beds of sand has been reported as occurring in Tertiary lake beds. Records of the Arizona Department of Mineral Resources indicate that the deposit contains at least 7.5 million tons of clay suitable for the manufacture of tile pipe. A 1964 plan to construct a plant for the production of vitrified pipe was not executed (U.S. Bureau of Mines, Phoenix office, oral communication, 1979).

Zircon and Rare Earths

Within half a mile of the Salt River Reservation, pegmatites in section 27, T. 3 N., R. 6 E. contain zircon and rare earths, according to records of the Arizona Department of Mineral Resources. No pegmatite exposures have been reported on the reservation.

Zeolites

The ability of zeolite minerals to remove many pollutants from gases and liquids, and their use in many industrial processes have focused attention on deposits of these minerals. Some Arizona deposits of zeolites have been found suitable for commercial use, and today Arizona is the nation's largest producer of zeolite minerals for industrial application (Eyde and Irvin, 1979).

Tuff crops out in the vicinity of Sawik Mountain in T. 2 N., R. 6 E., and it was also exposed in excavating for the Arizona Canal (James Crowther, Mining Engineer, BIA, oral communication). This material has not been tested to determine if it has been altered to zeolites or if it is suitable for commercial use. Beds of zeolite minerals derived from tuff have been found at Horseshoe Dam north of the Fort McDowell

Reservation, and at Mormon Flat Lake, Roosevelt Lake, and Tonto Creek east of the reservation (Eyde and Irvin, 1979). The tuff bed on the reservation may also have been altered to zeolites. If it has, its value would depend upon finding a suitable market or upon contracting with a zeolite producer willing to explore, test, and develop the deposit.

Geothermal Energy

Hahman, Stone, and Witcher (1978) indicate that the western half of the Salt River Reservation has a high geothermal gradient. Information based on well readings indicates that temperatures of 50° C at a depth of 3,000 feet are assured; additional investigations may prove that higher temperatures exist (J. C. Witcher, oral communication, 1979). Thus, preliminary indications show this to be an area prospectively favorable for the development of geothermal energy. This situation might result in high pressure steam sufficient to generate electrical power, but it probably would yield only hot water that could be utilized for space heating or for industrial processing.

RECOMMENDATIONS

The Salt River Tribe might consider the following courses of action:

1. Closely monitoring the geothermal studies being made by the Arizona Bureau of Geology and Mineral Technology.
2. Having the exposed tuff investigated to determine if it might have economic potential as a zeolite.

REFERENCES

Arizona Commission of Indian Affairs, 1978, Fort McDowell profile: Arizona Commission of Indian Affairs, Annual Report, 20 p.

Cooley, M. E., 1973, Map showing distribution and estimated thickness of alluvial deposits in the Phoenix area, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-845-C, scale 1:250,000, 1 sheet.

Dale, V. B., 1959, Tungsten deposits of Yuma, Maricopa, Pinal and Graham Counties, Arizona: U.S. Bureau of Mines Report of Investigations 5516, 68 p.

Dale, V. B., 1961, Tungsten deposits of Gila, Yavapai and Mohave Counties, Arizona: U.S. Bureau of Mines Information Circular 8078, 104 p.

Davis, A. P., 1897, Irrigation near Phoenix, Arizona: U.S. Geological Survey Water Supply Paper 2, 98 p.

Eyde, T. H., and Irvin, G. W., 1979, Arizona zeolites: Arizona Department of Mineral Resources Mineral Report No. 1, 40 p.

Hahman, W. R., Sr., Stone, Claudia, and Witcher, J. C., 1978, Preliminary map geothermal energy resources of Arizona: Arizona Bureau of Geology and Mineral Technology Geothermal Map No. 1, scale 1:1,000,000, 1 sheet.

Lausen, Carl, and Gardner, E. D., 1927, Quicksilver (mercury) resources of Arizona: Arizona Bureau of Mines Bulletin 122, 112 p.

Lee, W. T., 1905, Underground waters of Salt River valley, Arizona: U.S. Geological Survey Water Supply Paper 136, 196 p.

McDonald, H. R., and Padgett, H. D., Jr., 1945, Geology and ground water resources of the Verde River valley near Fort McDowell, Arizona, prepared in cooperation with the City of Phoenix: U.S. Geological Survey Open-File Report, November 1, 1945, 99 p.

McDonald, H. R., Padgett, H. D., Jr., and Bluhm, F. I., 1946, Geology and ground water resources of the Verde River valley near Fort McDowell, Arizona, Further investigations: prepared in cooperation with the City of Phoenix: U.S. Geological Survey Open-File Report, 20 p.

McDonald, H. R., Wolcott, H. N., and Hem, J. D., 1947, Geology and ground water resources of the Salt River Valley area, Maricopa and Pinal Counties, Arizona: U.S. Geological Survey Open File Report (Feb. 4, 1947) 45 p.

Moore, R. T., and Varga, R. J., 1976, Map showing nonmetallic mineral deposits in the Phoenix area, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-845-J, scale 1:250,000 1 sheet.

Peterson, D. L., Mabey, D. R., and Conradi, Arthur, Jr., 1963, Gravity and aeromagnetic surveys in the area of the Central Arizona Project: U.S. Geological Survey, Technical Letter, 32 p.

Ransome, F. L., 1916, Quicksilver deposits of the Mazatzal Range, Arizona: U.S. Geological Survey Bulletin 620-F, p. 111-128. Sellers, W. D., and Hill, R. H., 1974, Arizona climate 1921-1972: University of Arizona Press, Tucson, Arizona, 616 p.

Stewart, L. A., and Pfister, A. J., 1960, Barite deposits of Arizona: U.S. Bureau of Mines Report of Investigations 5651, 89 p.

U.S. Bureau of Indian Affairs, Staff, 1978, Information profiles of Indian reservations in Arizona, Nevada, and Utah: Bureau of Indian Affairs, Phoenix Area Office, 196 p.

Wilson, E. D., 1941, Quicksilver (mercury): Arizona Bureau of Mines Circular No. 9, 13 p.

Wilson, E. D., Moore, R. T., Pierce, H. W., 1957, Geologic map of Maricopa County, Arizona: Arizona Bureau of Mines, scale 1:375,000, 1 sheet.

Wilson, E. D., Moore, R. T., and Cooper, J. R., 1969, Geologic map of Arizona: Arizona Bureau of Mines and U.S. Geological Survey, scale 1:500,000, 1 sheet.

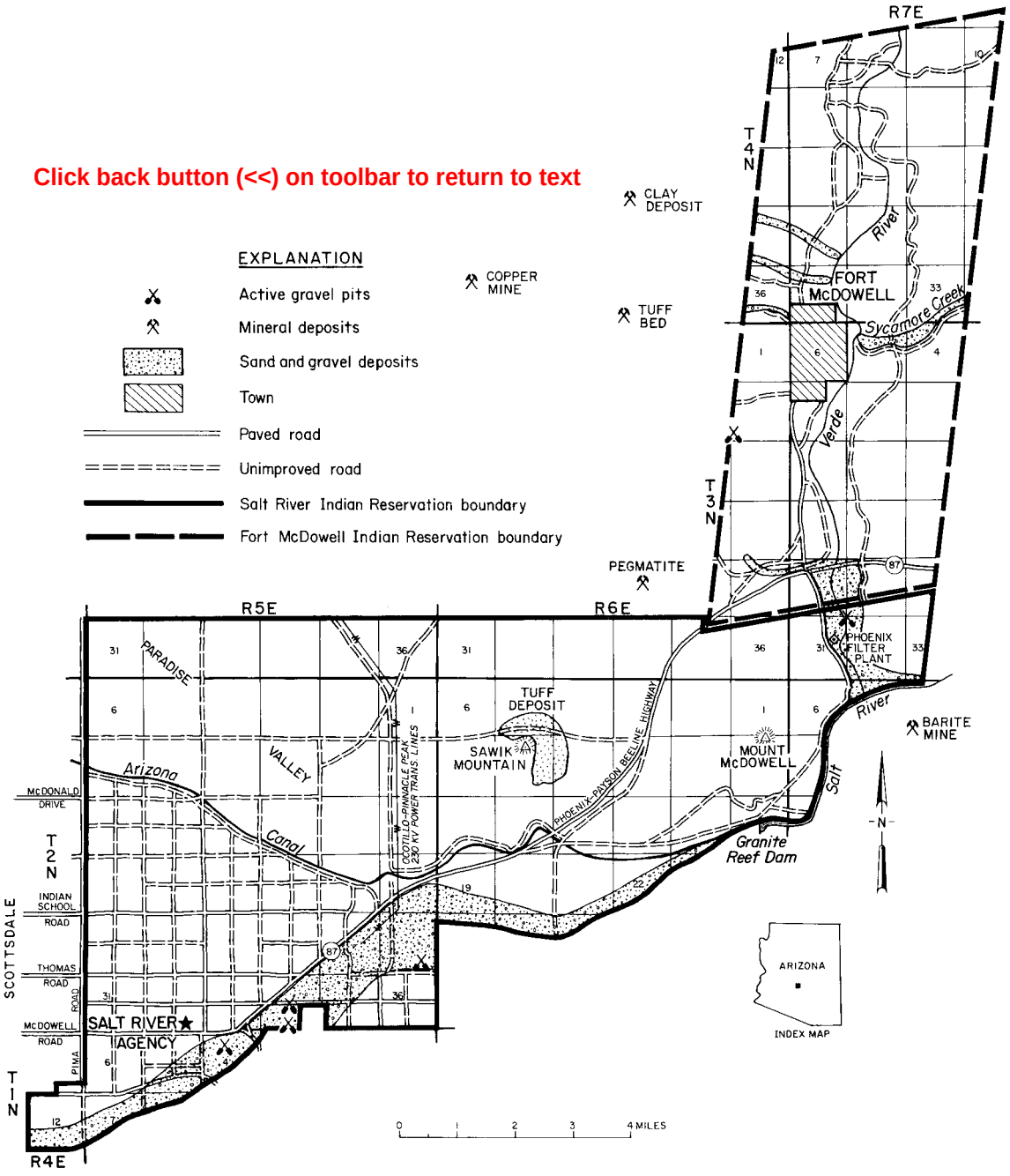

Figure 1. Index map showing mineral deposits on and near the Salt River and Fort McDowell Indian Reservations, Arizona.

Click back button (<<) on toolbar to return to text

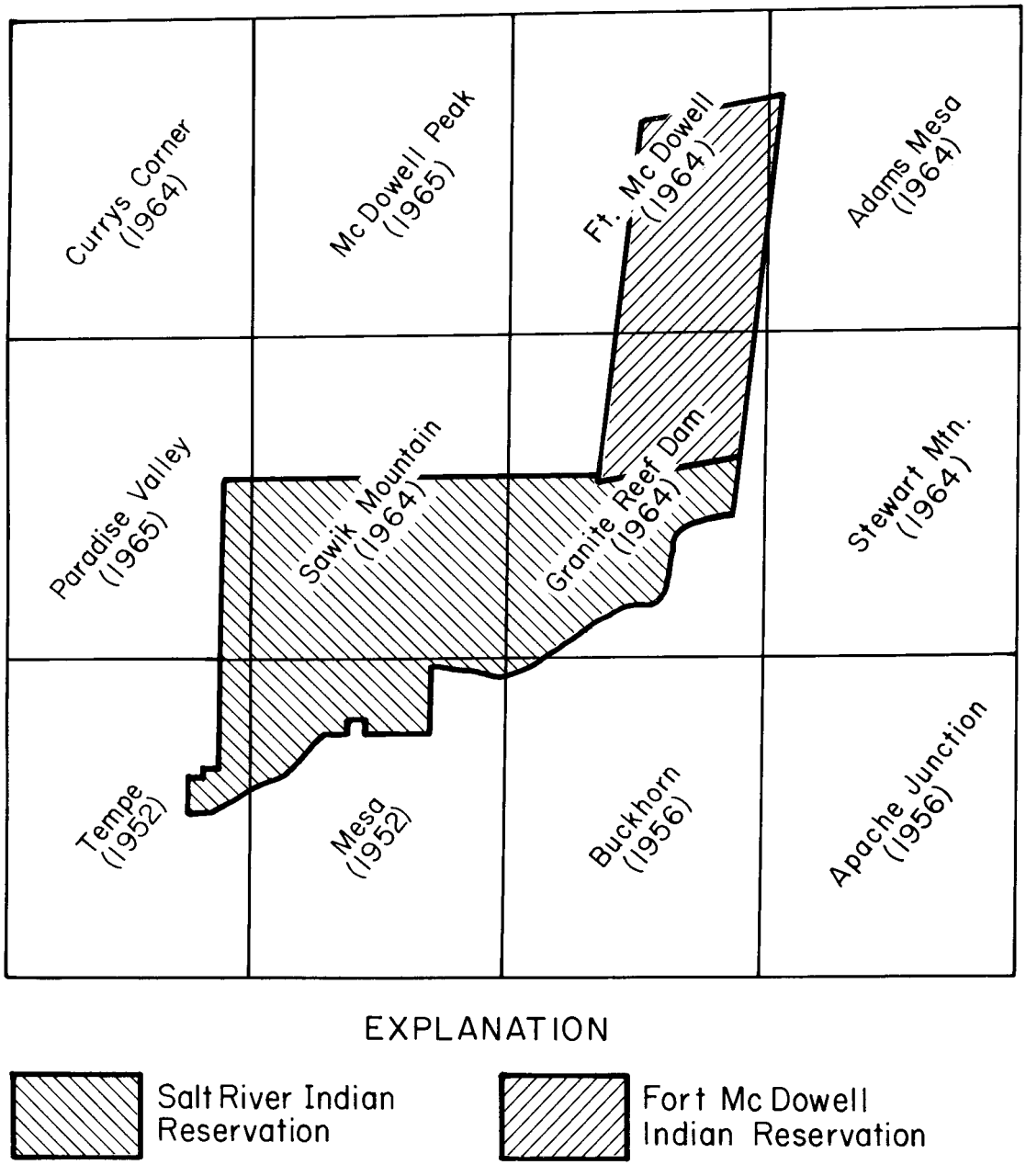

Figure 2. Index of U.S. Geological Survey 1:24,000 scale topographic map coverage of Salt River and Fort McDowell Indian Reservations and vicinity.

Click back button (<<) on toolbar to return to text

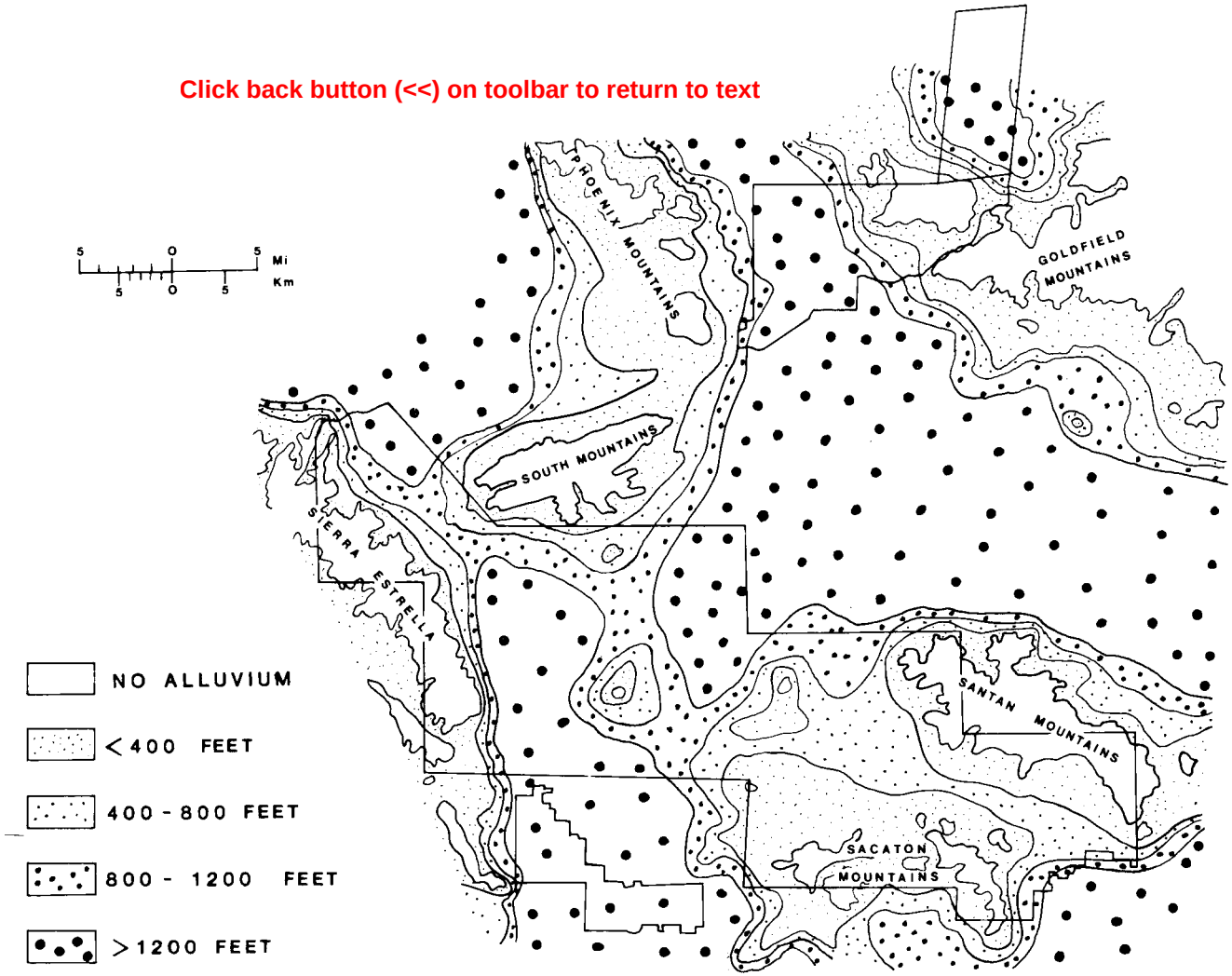

Figure 3. Map showing thickness of alluvial deposits in the Phoenix area (from Cooley, 1973).

Click back button (<<) on toolbar to return to text

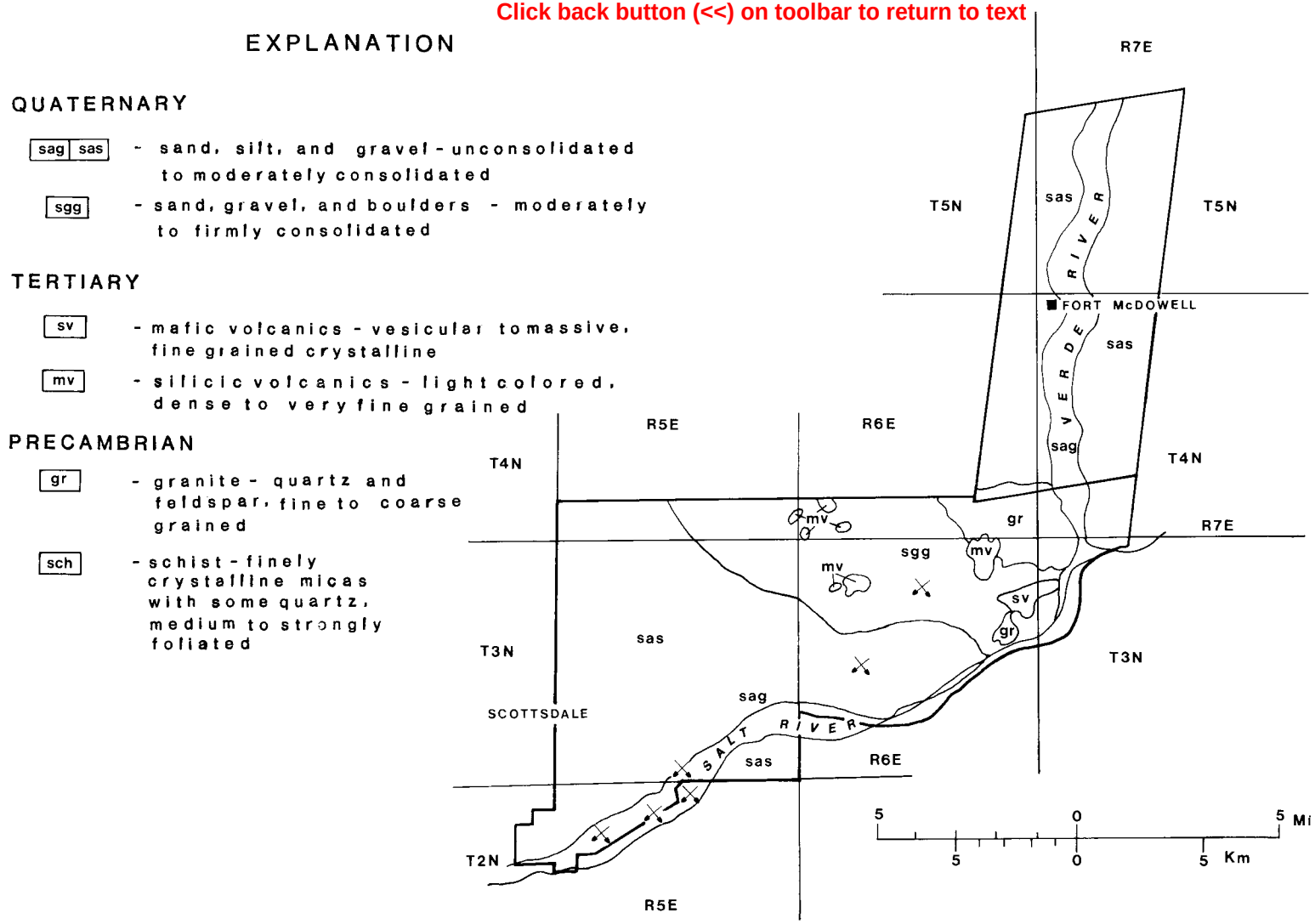

Figure 4. Geologic map of the Salt River and Fort McDowell Indian Reservations, from Moore and Varga (1976).