DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY
WRI REPORT 83-4114-D

MAP SHOWING OUTCROPS OF GRANITIC ROCKS, BASIN AND RANGE PROVINCE, ARZIONA

Compiled by William D. Johnson, Jr.,
and Robert B. Scarborough

INTRODUCTION

This map report is one of a series of geologic and hydrologic maps covering all or parts of States within the Basin and Range province of the western United States. Other map reports contain information on ground-water hydrology, ground-water quality, surface distribution of selected rock types, tectonic conditions, areal geophysics, Pleistocene lakes and marshes, and mineral and energy resources. This work is a part of the U.S. Geological Survey's program for geologic and hydrologic evaluation of the Basin and Range province to identify potentially suitable regions for further study relative to isolation of high-level nuclear waste (Bedinger, Sargent, and Reed, 1984).

This map report on the granitic rocks of part of Arizona was prepared from published geologic maps and reports, utilizing the project guidelines defined in Sargent and Bedinger (1984). For this study, granitic rocks include mostly granite, quartz monzonite or adamellite, alaskite, and granodiorite; however, some intermediate and mafic rocks, such as diorite, quartz diorite, and gabbro, also are shown on the map where those rocks comprise plutons intruding granitic masses. All outcrops of granitic rocks within the Basin and Range province are shown, regardless of structural complexity. It is recognized, however, that some plutonic masses in Arizona may not extend to considerable depth because of extensive lateral displacement along low-angle faults subsequent to intrusion.

The Description of Map Units includes the geologic age, radiometric age, lithologic character, type of intrusive body, and sources of data for the granitic and related rocks in outlined and numbered areas in each county of the study area. The listed radiometric ages of the rock units are only those which are available from the literature, and do not necessarily represent the entire age range of the unit.

DESCRIPTION OF MAP UNITS
[To convert feet (ft) to meters, multiply feet by 0.3048]

County-area number	Map symbol	Geologic and radiometric age in millions of years (m.y.)	Litholgy and comments	References for county area
		COCHISE COUNTY (C)		
C-1	Tg	Oligocene 29.6±2.1 to 34.2 m.y.	Granite(?), quartz monzonite, and granodiorite in stocks and small intrusive bodies.	Cooper, 1959, 1960; Drewes, 1980, 1981, 1982; Erickson, 1981
	TKd	Early Paleocene and Late Cretaceous 57.2±1.7 to 64.3±1.9 m.y.	Small stocks of quartz diorite and quartz monzonite.	
	TKg	Tertiary or Cretaceous	Granite to granodiorite, locally porphyritic.	
	Yg	Middle and Early(?) Proterozoic 1,381±28 to 1,690±30(?) m.y.	Eight Proterozoic granitoid plutons, weakly to well foliated, occur in Dos Cabezas Mountains, but several have been metamorphosed to gneiss. Rocks are mainly medium- to to coarse-grained, in part porphyritic, leucocratic quartz monzonite, but include one pluton of rapakivi quartz monzonite and a stock of dacite porphyry. In the Chiricahua Mountains the granitic rocks are very coarse grained and coarsely poryhyritic granodiorite and some quartz monzonite. Granitic rocks are largely of Middle Proterozoic Y age, but locally a dacite porphyry may be about 1,690±30 m.y. old.	
C-2	Tg	Oligocene 30 m.y.	Medium- to fine-grained granite to granodiorite, locally porphyritic.	Cooper, 1960; Drewes, 1980
C-3	Tg	Oligocene 30 and 33 m.y.	Granite to granodiorite.	Cooper, 1959; Drewes, 1980
	Yg	Middle Proterozoic	Coarse-grained, commonly porphyritic granite.	
C-4	Jg	Jurassic 171±7, 182±7, 184±8 m.y.	Stock and associated dikes of porphyritic leucocratic alkali granite (Juniper Flat Granite). Intrudes Proterozoic schist and Paleozoic sedimentary rocks. Radiometric ages are on only main mass of Juniper Flat Granite, and some evidence suggests that part of granite may be of Precambrian age.	Drewes, 1980; Hayes and Landis, 1964; Gilluly, 1956; Marvin and others, 1978
C-5	Kg	Cretaceous	Fine-grained quartz monzonite in sill.	Hayes and Raup, 1968; Drewes, 1980; Marvin and others, 1978
	Jg	Jurassic 167±6 m.y.	Huachua Quartz Monzonite is medium-grained biotite-hornblende quartz monzonite stock.	

	Yg	Middle Proterozoic	Coarse-grained porphyritic granite containing small areas of alaskite.	
C-6	Kgd	Cretaceous 74±4 m.y.	Medium- to coarse-grained granodiorite, locally porphyritic, and on east side of Whetstone Mountains occurs as sill. Intrudes Paleozoic and Cretaceous sedimentary rocks.	Creasey, 1967b; Drewes, 1980; Marvin and others, 1973
	Yg	Middle Proterozoic	Quartz monzonite and alaskite and some aplite dikes. Intrudes Proterozoic schist.	
C-7	Kgd	Cretaceous 72 m.y.	Quartz-poor granodiorite, but ranges from porphyritic granodiorite to quartz monzonite.	Drewes, 1980; Gilluly, 1956; Marvin and others, 1973
	Yg	Middle Proterozoic	Granodiorite with calcic-oligoclase feldspar.	
C-8	Tg	Miocene and Oligocene 22±3, 24.1±2, and 27±2 m.y.	Mostly coarse-grained granite with microcline crystals, but has porphyritic border facies and an aplitic facies (Stronghold Granite)--youngest major intrusion in area.	Cooper and Silver, 1964; Drewes, 1980; Gilluly, 1956; Marvin and others, 1978
	Jg	Jurassic 181, 183±5, and 185±4 m.y.	Mainly coarse-grained quartz monzonite with crystals of plagioclase, microcline, and hornblende, but in places has an alaskite facies (Gleeson Quartz Monzonite).	
	ꞆR g	Triassic	Includes Copper Belle Monzonite Porphyry and Turquoise Granite. Copper Belle is characterized by conspicuous phenocrysts of plagioclase feldspar. Turquoise Granite is badly weathered. Questionably correlated with rocks elsewhere in southeastern Arizona which are dated at 184, 190, and 210 m.y.	
	Yg	Middle Proterozoic	Southern- and northern-most outcrops are gneissic granite; those in north-central part are quartz monzonite, which is equivalent of the Cochise Peak Quartz Monzonite, which Gilluly (1956) dated as Triassic or Jurassic; Drewes (1980) assigned a questionable Precambrian age to the Cochise Peak. The northern-most outcrops of gneissic granite were designated Tertiary or Cretaceous by Gilluly (1956) and Precambrian by Drewes (1980).	
C-9	Tg	Early Eocene and late Paleocene 51±3 and 53±3 m.y.	Generally porphyritic Texas Canyon Quartz Monzonite containing phenocrysts of potassium feldspar.	Cooper and Silver, 1964; Drewes, 1980; Marvin and others, 1978; Silver, 1978
	Yg	Middle Proterozoic 1,420±10 m.y.	Medium- to coarse-grained porphyritic hornblende-biotite granite (Tungsten King Granite).	

C-10	Xgd	Early Proterozoic 1,660±30 and 1,655±20 m.y.	Johnny Lyon Granodiorite is mainly medium- to coarse grained, somewhat porphyritic hornblende-biotite granodiorite containing plagioclase crystals. Formerly considered as Precambrian Y, but now dated as Proterozoic X.	Cooper and Silver, 1964; Drewes, 1974, 1980; Marvin others, 1978
C-11	Yg	Middle Proterozoic	Medium- to coarse-grained granite containing abundant potassium feldspar.	Cooper and Silver, 1964; Creasey and others, 1961; Drewes, 1980

GILA COUNTY (G)

G-1	Xg, pЄg	Early Proterozoic 1,710 m.y. and Precambrian	Medium- to coarse-grained granite, locally includes large quartz phenocrysts. Largest mass is red-colored Payson Granite of Proterozoic X age. Ages of adjacent Precambrian masses unknown.	Condie, 1981; Gastil, 1958; Putman and Burham, 1963; Wilson, 1939; Wilson and others, 1969
G-2	Yg, pЄg	Middle Proterozoic and Precambrian	Coarse-grained, porphyritic, biotite quartz monzonite, correlated with the Ruin Granite (Proterozoic Y) to the south. Undated granite in western part of area resembles the Payson Granite (Proterozoic X) to the northwest, consequently two ages of intrusive bodies may occur in this area. Age of Precambrian granite in eastern part not known.	Bergquist and others, 1981; Wilson and others, 1969
G-3	TKg	Tertiary and Cretaceous	Granitic rocks, undescribed; may be correlative with Tertiary quartz diorite and quartz monzonite porphyry exposed southeast of Montana Mountain.	Bromfield and Shride, 1956; Condie, 1981; Peterson, D. W., 1960, 1969; Peterson, N. P., 1954; Ransome, 1904; Wilson, and others, 1969
	Yg, pЄg	Middle Proterozoic 1,390 m.y. and Precambrian	Ruin Granite is coarse-grained, porphyritic quartz monzonite or granite containing large feldspar phenocrysts. Intrudes Precambrian metamorphics. Includes the Miami-Globe mining district. Age of most plutonic masses northeast of Globe unknown.	
G-4	Tg	Tertiary	Two small bodies of quartz monzonite porphyry having aphanitic border facies. Intrudes Precambrian schist and sedimentary rocks.	Bromfield and Shride, 1956; Cornwall and Krieger, 1978; Cornwall and others, 1971; Peterson, D. W., 1960, 1962, 1969; Peterson, N. P., 1954, 1961; Peterson, N. P., and others, 1951;
	TKg	Early Tertiary or Late Cretaceous	In Pinal Mountains unit includes porphyritic biotite quartz monzonite containing large phenocrysts of orthoclase, biotite granodiorite, and locally granite. North of Superior, the intrusive is quartz diorite.	

	YXg, p€g	Middle and Early Proterozoic 1,740 m.y. and Precambrian	Ruin Granite (Proterozoic Y) and Madera Diorite (Proterozoic X) undifferentiated. In Mescal Mountains along latitude 33°15' the Ruin contains small intrusive bodies of Madera Diorite, but apparently the amount of Madera Diorite increases northward, and the Ruin is not present northwest of Signal Peak in the Pinal Mountains, although much of those mountains is poorly mapped. Madera is quartz diorite, locally, has a mafic facies with much hornblende, described as granodiorite. Ruin Granite is coarse grained and ranges in composition from quartz monzonite to granodiorite. Ruin Granite and Madera Diorite are cut by numerous Precambrian diabase and diorite dikes. Granite at east end of Mescal Mountains and around Coolidge Dam probably largely an extension of Ruin Granite, but exact age unknown.	Ransome, 1904; Willden, 1964; Wilson and others, 1969
			GRAHAM COUNTY (GR)	
GR-1	TKg	Early Tertiary or Tertiary or Cretaceous 60±10 m.y.	Medium-grained, equigranular granite and coarse-grained, equigranular to porphyritic quartz monzonite, and some granodiorite and diorite.	Bergquist, 1979; Blacet and Miller, 1978; Bromfield and Shride, 1956; Creasey and others, 1961; Simons, 1964
	Yg, p€g	Middle Proterozoic and Precambrian	Porphyritic rock containing large phenocrysts of potassium feldspar; ranges from granodiorite to quartz diorite to quartz monzonite that has a border facies of hornblende quartz monzonite. Intrudes Precambrian schist.	
GR-2	Td	Miocene	Clinopyroxene-biotite diorite to quartz diorite.	Cooper, 1960; Thorman, 1981
	Tg	Oligocene 35.6±0.7 m.y.	Porphyritic biotite granite, composition ranges from quartz syenite to quartz monzonite to granite.	
	Yg	Middle Proterozoic 1,363±14, 1,384±39, and 1,405±65 m.y.	Multiple plutons of two-mica and porphyritic two-mica granite, and non-porphyritic and porphyritic biotite granite, some of which are poorly to well foliated by both Precambrian and possibly Tertiary tectonics. Pinaleno Mountains have a possible Tertiary history as a metamorphic core complex. The plutons intrude Precambrian gneiss and metasedimentary rocks and contain xenoliths of those rocks.	
GR-3	TKg	Tertiary or Cretaceous	Small pluton of granitic rocks, undescribed.	Wilson and others, 1969
GR-4	p€g	Precambrian	Granite, undescribed.	Wilson and others, 1969

GREENLEE COUNTY (GN)				
GN-1	Tg	Early Tertiary 51 to 63 m.y.	Stocks, laccoliths, and dikes of diorite porphyry to quartz-monzonite porphyry to granite porphyry, partly related to Morenci porphyry copper deposit.	Bennett, 1975; Lindgren, 1905; McDowell, 1971; Wilson and others, 1969
	p€g	Precambrian	Coarse-grained granite containing large grains of orthoclase and microperthite.	
LAPAZ COUNTY (L)				
L-1	TKg	Tertiary and Cretaceous	Granitic rocks.	Wilson and others, 1969
L-2	Kg	Late Cretaceous	Intrusive rocks, probably ranging from diorite to granite, as in nearby plutons.	Reynolds, 1980
L-3	Kg	Late Cretaceous 66.5±3.6 m.y.	Tank Pass biotite granite intruded by biotite granodiorite of Granite Wash Pass. Granite Wash Pass granodiorite is 66 to 70 m.y. old. Some uranium-lead evidence gives 85 m.y. date for Tank Pass granite.	Rehrig and Reynolds, 1980; Reynolds, 1980; Shafiqullah and others, 1980
L-4	Tg	Early Tertiary(?)	Muscovite granite. Probably of early Tertiary or Late Cretaceous age, because it intrudes Late Cretaceous granite in adjacent Harcuvar Mountains, post-dates most Late Cretaceous structural fabric, and yields an Eocene Rb-Sr muscovite age.	Rehrig and Reynolds, 1980; Reynolds, 1980; 1982; Reynolds and others, 1980; Richard, 1982
	p€g	Precambrian	Plutonic rocks in the Harquahala Mountains consists mostly of biotitic granodiorite, porphyritic granite, equigranular muscovite-garnet granite, and many small tabular bodies of alaskite and pegmatite. Quartz monzonite, the dominant plutonic rock, in Little Harquahala Mountains, commonly is porphyritic with phenocrysts of potassium feldspar. Harquahala Mountains are part of a metamorphic core complex, and some of the plutonic rocks at the west end, particularly the porphyritic granite, are involved in subhorizontal thrust sheets.	
L-5	Td	Paleocene 52.8±1.1 m.y.	Medium-grained, biotite diorite; intrudes metasedimentary sequence.	Reynolds, 1980; Shafiqullah and others, 1980
L-6	Mzg	Middle Mesozoic	Granitic rocks.	Reynolds, 1980
L-7	CzMzg	Cenozoic or Mesozoic	Quartz-monzonite porphyry and quartz porphyry are composed of an aphanitic groundmass and phenocrysts of quartz and plagioclase; of possible dacitic composition.	Miller, 1970

	Xg	Early Proterozoic 1,730 to 1,750 m.y.	Biotite quartz monzonite.	
L-8	Kg	Late Cretaceous	Equigranular to slightly porphyritic diorite to granite in small stocks, plugs, and dikes.	Marschak, 1980; Miller, 1970; Reynolds, 1980; Tosdal, 1982
	Mzg	Middle Mesozoic	Middle Camp K-feldspar quartz monzonite intrudes lower part of Mesozoic volcanic section. Other quartz monzonites are porphyritic and biotite rich.	
L-9	Mzg	Late Mesozoic	A large intrusive body of adamellite to granodiorite of Laramide age was mapped in the central Trigo Mountains by Wilson (1960). Other plutons of comparable age in the area are probably of similar lithology.	Garner and others, 1982; Wilson, 1960
	Yg	Middle Proterozoic 1,400 to 1,500 m.y.	Mostly rapakavi granite in lower plate of thrust fault.	

MARICOPA COUNTY (MA)

MA-1	Kgd	Late Cretaceous 68.4 m.y.	Wickenburg batholith composed mainly of equigranular biotite granodiorite and lesser amounts of diorite and porphyritic quartz monzonite. The two large outcrops north of Wickenburg, formerly mapped as Precambrian (Wilson and others, 1969), are part of Wickenburg batholith (Steven Reynolds, Arizona Bureau of Geology and Mineral Technology, oral commun., 1984). Intrudes Precambrian granite and granite gneiss.	Rehrig and others, 1980; Wilson and others, 1969
	Bg	Proterozoic 1,700± m.y.	Non-foliated, coarse-grained, porphyritic biotite granite (in part called quartz monzonite). Intrudes Precambrian granite gneiss.	
MA-2	Kg	Late Cretaceous	Intrusive rocks; formerly designated as Precambrian.	Reynolds, 1980; Wilson and others, 1969
	p€g	Precambrian	Granitic rocks.	
MA-3	p€g	Precambrian	Granitic rocks. Intrudes Precambrian metamorphic rocks.	Wilson and others, 1969
MA-4	TKg	Tertiary and Cretaceous	Leucocratic granitic rocks.	Wilson and others, 1969
MA-5	p€g	Precambrian	Granitic rocks. Intrudes metamorphic rocks.	Wilson and others, 1969
MA-6	TKg	Tertiary and Cretaceous	Granitic rocks.	Wilson and others, 1969
	p€g	Precambrian	Granitic rocks of Maricopa batholith.	Wilson and others, 1969

MA-7	p€g	Precambrian	Medium- to coarse-grained quartz monzonite porphyry, part of Maricopa batholith (unpublished field data); age about 1,400 m.y.	Wilson and others, 1969
MA-8	p€g	Precambrian	Granitic rocks of Maricopa batholith.	Wilson and others, 1969
MA-9	TKg	Tertiary and Cretaceous	Granitic rocks.	Wilson and others, 1969
	p€g	Precambrian batholith.	Granitic rocks of Maricopa	
MA-10	TKg	Tertiary and Cretaceous	Variably foliated granodiorite and granite. White Tank Mountains show characteristics of metamorphic core complex.	Rehrig and Reynolds, 1980; Reynolds, Steven, Arizona Bureau of Geology and Mineral Technology, written commun., 1984; Wilson and others, 1969
	p€g	Precambrian	Massive plutonic rocks ranging from muscovite garnet alaskites to biotite granodiorites. Coarse-grained, holocrystalline, granitic rocks in northwest corner of the White Tank Mountains.	
MA-11	TKg	Tertiary and Cretaceous	Granitic rocks.	Wilson and others, 1969
	p€g, p€d	Precambrian	Granitic rocks and several masses of diorite, diorite porphyry, and gabbro.	
MA-12	TKd, TKg	Tertiary and Cretaceous	Diorite porphyry occurs as dikes in the central Bradshaw Mountains. Composition of other, small, scattered masses unknown. Originally designated Precambrian but later of Tertiary and Cretaceous age.	Condie, 1981; Wilson, 1939; Wilson and others, 1969
	p€g	Precambrian 1,340 and 1,630 m.y.	Granite constitutes majority of plutonic rocks in southern Bradshaw Mountains. Granite is coarse textured, contains large orthoclase phenocrysts, and intrudes large mass of pyroxenite at Mount Ord. Pendants of Precambrian rocks occur within the granite. Only two age dates available; most plutonic rocks are poorly described.	
MA-13	p€g	Precambrian	Granitic rocks.	Wilson and others, 1969
MA-14	Tgd, Tg	Tertiary 25 m.y.	East half of South Mountains is occupied by mylonitic porphyritic granodiorite that is intruded by small Tertiary granite pluton, which now separates the granodiorite from Precambrian gneiss. The mountains are a metamorphic core complex.	Reynolds and Rehrig, 1980; Wilson and others, 1969

MOHAVE COUNTY (M)

M-1	p€g	Precambrian	Coarsely crystalline granite in fault contact with Precambrian metamorphic rocks.	Moore, 1972

M-2	Tg	Miocene 13.6±0.6 and 15.1±0.6 m.y.	Largely the Wilson Ridge pluton. Ranges from abundant poorly foliated hornblende-biotite granodiorite to sparse pyroxene-biotite diorite and leucocratic granite. Xenoliths of metamorphic rocks common. Northern contact inferred; small exposure south of Hoover Dam is part of the separate Boulder City pluton. Intrudes Precambrian metamorphic rocks.	Anderson, R.E., 1978; Anderson, R.E., and others, 1972; Bohannon, 1978
M-3	Kg	Late Cretaceous 65 to 72 m.y.	Seriate to porphyritic, leucocratic quartz monzonite, and minor aplite and pegmatite; associated with peripheral gold-quartz veins. Outcrop probably extends west of map boundary. Intrudes Precambrian paragneiss.	Blacet, 1975
	Bg	Proterozoic 1,400 to >1,700 m.y.	Mainly porphyritic to seriate, biotite-quartz monzonite grading to biotite-hornblende granodiorite; includes some leucocratic quartz monzonite, porphyritic granite, and alaskite. Part of Garnet Mountain pluton. Intrudes Proterozoic migmatitic gneiss and paragneiss.	
M-4	TKg	Tertiary and Cretaceous	Granite, intrudes Precambrian schist.	Wilson and others, 1969
M-5	Kg	Late Cretaceous 71.5±2.6 m.y.	Biotite-quartz-monzonite porphyry and biotite-quartz-diorite porphyry. Intrudes Proterozoic gneiss and plutonic rocks. Contains Mineral Park porphyry copper deposit.	Shafiqullah and others, 1980; Wilkinson and others, 1982; Wilson and others, 1969
	Bg	Middle Precambrian 1,180±40 m.y.	Granite.	
M-6	pЄg	Precambrian	Granite.	Wilson and others, 1969
M-7	TKg	Tertiary and Cretaceous	Granite.	Wilson and others, 1969
M-8	Kd	Cretaceous(?)	Diorite containing hornblende, and biotite-hornblende granodiorite cut by leucocratic biotite monzogranite. Resembles plutonic rocks of adjacent Chemehuevi Mountains in Nevada; probably of Cretaceous age. Intrudes Precambrian gneiss and granite.	Howard and others, 1982
	pЄg	Precambrian	Quartz monzodiorite with interstitial K-feldspar, and porphyritic granite composed of phenocrysts of alkali feldspar in matrix of quartz, biotite, and plagioclase. Granite grades into augen gneiss in southern part of Mohave Mountains and northern part of Bill Williams Mountains. Intrudes Precambrian metamorphic rocks.	

M-9	TKg	Tertiary and Cretaceous	Granite; intrudes Precambrian metamorphic rocks.	Stensrud and More, 1980; Wilson and others, 1969
	p€g	Precambrian 1,312 to 1,397 m.y.	Intrusive bodies, comprising the western Hualapai plutonic complex, extend along west flank of Hualapai Mountains and are composed of granodiorite and porphyritic quartz monzonite, and small bodies of slightly porphyritic, muscovite-biotite granite, containing xenoliths of micaceous rocks. Intrudes Precambrian metamorphic rocks. Age dates are from northern Hualapai Mountains.	
M-10	TKg	Tertiary and Cretaceous	Granite; intrudes Precambrian metamorphic rocks and granite.	Shafiqullah and others, 1980; Wilson and others, 1969
	p€g	Precambrian 1,390±40 m.y.	Granite; intrudes Precambrian metamorphic rocks. Single age date from biotite granite in northeast part of area.	
M-11	p€g	Precambrian	Granite; intrudes Precambrian metamorphic rocks.	Wilson and others, 1969
M-12	p€g	Precambrian	Granite; intrudes Precambrian metamorphic rocks.	Wilson and others, 1969

PIMA COUNTY (PM)

PM-1	Tg	Oligocene 25 to 28 m.y.	The Santa Catalina and Rincon Mountains are a large metamorphic core complex (Keith and others, 1980), and their interpretation is depicted on this map. Plutons of quartz monzonite but includes some leucocratic granite.	Banks, 1976; Creasey, 1967a; Creasey and Theodore, 1975; Drewes, 1974; 1977, 1980; Keith and others, 1980; Wilson and others, 1969
	Tgm	Eocene 44 to 51 m.y.	Muscovite granite in a series of sills and laccolithic masses and associated pegmatites, aplites, and alaskites.	
	TKd	Early Tertiary and Late Cretaceous 60 to 75 m.y.	Stocks of granodiorite porphyry and quartz diorite.	
	Yg	Middle Proterozoic 1,400 to 1,450 m.y.	Undeformed, porphyritic, coarse-grained biotite quartz monzonite (Oracle Granite) in northern part of Santa Catalina Mountains. To south and in Rincon Mountains these granitic rocks are generally highly foliated and in part mylonized, coarse-grained gneissic granodiorite and gneissic quartz monzonite.	
	Xgd	Early Proterozoic 1,600 to 1,650 m.y.	Plutonic rocks are composed of medium- to coarse-grained biotite-hornblende granodiorite and quartz monzonite. In southern Rincon Mountains, on the east flank these rocks are mapped as the Johnny Lyon Granodiorite, and on the west flank, as Rincon Valley Granodiorite.	

PM-2	Tg	Paleocene(?)	Quartz-latite porphyry.	Drewes, 1971a; Finnell, 1971; Marvin and others, 1978
	Kg	Cretaceous 71.9±2.6, 75.3±2.9, 75.5±2.0 m.y.	Mostly stocks of quartz monzonite but some of quartz diorite.	
	Yg	Middle Proterozoic	Gneissic quartz diorite, porphyritic quartz monzonite, and microcline-muscovite- quartz pegmatite.	
PM-3	Tg	Eocene to Paleocene 53.3±2.0, 54.3±2.0 m.y.	Generally granodiorite and quartz-monzonite stocks and a few quartz-diorite stocks.	Drewes, 1971a, 1971b, 1980; Marvin and others, 1973, 1978
	Yg	Middle Proterozoic 1,360±200 and 1,450±160 m.y.	Granodiorite porphyry and quartz-monzonite porphyry and associated aplite and fine-grained quartz monzonite (Continental Granodiorite).	
PM-4	Tgd	Paleocene 56.9, 58.7, 59, and 61.6 m.y.	Biotite granodiorite, some porphyritic quartz monzonite, and locally many small bodies aplite, and a younger (56.9 m.y.) plug of quartz-monzonite porphyry. Plutons associated with extensive copper-molybdenum mineralization in Pima mining district.	Cooper, 1973; Drewes 1980; Drewes and Cooper, 1973; Marvin and others, 1973
	Kd	Late Cretaceous 67 m.y.	Diorite.	
	Jg	Jurassic 145±5 and 150 m.y.	Coarse-grained granite and quartz monzonite and associated aplite; grades northward into gneiss.	
	TRg	Triassic 190±20 and 210±30 m.y.	Quartz monzonite, monzonite, granite, and granophyre.	
	Yg	Middle Proterozoic	Granodiorite and quartz monzonite; includes some granite and diorite; in part gneissic and porphyritic.	
PM-5	TKg	Tertiary or Cretaceous	Many intrusive bodies of granitic rocks, alaskite, granodiorite, quartz monzonite, and quartz diorite, probably closely related in age.	Drewes, 1980; Keith and Theodore, 1975; Shafiqullah and others, 1980;
	Kd	Cretaceous	Diorite and quartz diorite; not mapped in detail to the west.	Wilson and others, 1969
	Jg	Jurassic 145, 148, and 154±4 m.y.	Granite, quartz monzonite, and granodiorite. Radiometric dates on Amado granodiorite at north end of Tumacacori Mountains.	

PM-6	Tg, Mzg	Tertiary 58 m.y. and Mesozoic(?)	Mostly rhyodacite porphyry, containing phenocrysts mainly of plagioclase, potassium feldspar, quartz, altered biotite, and magnetite, that largely intrudes the west margin of the Jurassic intrusive mass generally in north-half of area. Leucocratic monzogranite, containing a biotite phase and a younger muscovite-garnet phase, underlies the Pozo Verde Mountains, and occurs as intrusions in the rhyodacite porphyry. At north border of area in Coyote Mountains, weakly foliated, in part gneissic quartz monzonite, diorite, and alaskite of questionable Mesozoic age (Keith, 1976) is contiguous with monzogranite of Tertiary age along latitude 32°00'.	Haxel, May, and others, 1980, 1982; Haxel, Wright, and others, 1980; Keith, 1976
	Jg	Jurassic 147 m.y.	A number of plutons composed of hornblende-biotite and biotite granodiorite and monzogranite, leucocratic biotite monzogranite and syenogranite, perthite granite, and some hornblende diorite and quartz diorite, much of which is foliated.	
PM-7	Td	Tertiary 34.1±0.3 m.y.	Pyroxene-bearing diorite.	Bikerman, 1967; Keith, 1976
	Kd	Late Cretaceous 68.6±1.4 m.y.	Diorite, as below.	
	Mzd	Mesozoic	Hornblende and biotite diorite; similar to Cretaceous diorite but generally finer grained.	
PM-8	Kg	Cretaceous 73.0±3.4, 74.5±2.2, and 76.8±2.2, m.y.	Amole Granite is Late Cretaceous stock in which granite on west side grades eastward through granite porphyry into quartz monzonite. Andesite porphyry, dated at 155 m.y., that intrudes the nearby Recreation Red Beds (previously considered to be Cretaceous by Brown, 1939) is probably not related directly to the Amole Granite.	Brown, 1939; Marvin and others, 1978; Shafiqullah and others, 1980
PM-9	Kg	Late Cretaceous 63 to 65 m.y.	A complex of plutons, sills, and dikes composed mainly of leucocratic quartz monzonite, quartz-latite porphyry, granodiorite, and quartz-monzonite porphyry; related temporally to Silverbell porphyry copper deposit. Intrudes Paleozoic and Mesozoic sedimentary rocks and volcanics. Active mining area.	Banks and Dockter, 1976; Bergquist, Banks, and Blacet, 1978; Manger and others, 1965; Wilson and others, 1969
	Yg	Middle Proterozoic	Porphyritic quartz monzonite and cross-cutting quartz monzonite.	
PM-10	TKg	Probably early Tertiary or Late Cretaceous	Porphyritic to nonporphyritic biotite-hornblende monzonite; locally quartz monzonite.	Bergquist, Blacet, and Miller, 1978
	Mzgd	Mesozoic	Hornblende-biotite granodiorite, locally porphyritic, grades into diorite.	

PM-11	TKg	Tertiary or Cretaceous	Muscovite quartz monzonite that intrudes Mesozoic schist in North Comobabi Mountains. Muscovite monzogranite and syenogranite in Artesa Mountains.	Haxel and others, 1978; Keith, 1976; May and Haxel, 1980; Shafiqullah and others, 1980
	Jg	Jurassic 100±2 and 140 m.y.	Mostly leucocratic quartz monzonite grades into granite and subordinate granodiorite and associated porphyritic and aplitic rocks; contains masses of rhyodacite porphyry gradational with and in places intrusive into the quartz monzonite. In southern part of South Comobabi Mountains and in Artesa Mountains plutonic rocks are mainly monzogranite and hornblende quartz diorite. The 100 m.y. is a K-Ar date from a diorite overlain disconformably by Cretaceous sedimentary rock.	
PM-12	TKg	Tertiary or Cretaceous	Granitic rocks.	Wilson and others, 1969
PM-13	TKg	Tertiary or Cretaceous	Plutons of rhyolite porphyry, granite, and quartz monzonite that intrude Jurassic pluton.	Rytuba and others, 1978
	Jg	Jurassic	Coarse-grained quartz monzonite having roof facies of quartz latite porphyry.	
PM-14	TKg	Tertiary and/or Cretaceous 67.6 m.y.	Granitic rocks of variable composition, ranging from granite to leucocratic and biotitic quartz monzonites, to locally porphyritic granodiorite, and quartz diorite. Intrudes Precambrian schist.	Briskey and others, 1978; Dockter and Keith, 1978; Tosdal, 1979
PM-15	TKg	Tertiary or Cretaceous	Granitic rocks. K-Ar age of 39.3±0.6 m.y. probably a reset date.	Jones, 1974; Wilson and others, 1969
PM-16	Mzg	Mesozoic	Granitic rocks.	Wilson and others, 1969
PM-17	TKg	Tertiary and Cretaceous 54 to 65 m.y.	Quartz monzonite, in part porphyritic, having border facies of quartz diorite; related to Ajo porphyry copper deposit.	Dixon, 1966; Gilluly, 1937; 1946; Shafiqullah and others, 1980
	Mzg	Mesozoic, possibly early Tertiary to Late Cretaceous	Extensive outcrops of the Chico Shunie Quartz Monzonite. Although Gilluly (1946) assigned only a Mesozoic date to the rocks, Dixon (1966) states that the New Cornelia ore body is an offshoot of the Chico Shunie Quartz Monzonite stock, so if the dates given above are applicable, the rock is Tertiary and Cretaceous.	

PINAL COUNTY (P)

P-1	pЄg	Precambrian	Granitic rocks. Shown in part on State Geologic Map as of Mesozoic age, but predominately similar to 1.4 b.y. granites of Maricopa batholith to the west (see area MA-7). Gneisses in Estrella Mountains north of granite outcrops are variably foliated Precambrian granites (Steven Reynolds, Arizona Bureau of Geology and Mineral Technology, written commun., 1983).	Wilson and others, 1969
P-2	Yg	Middle Proterozoic 1,329±40 m.y.	The oldest plutonic rock (1,329 m.y.) is biotite quartz monzonite, principally in northern Table Top Mountains and Haley Hills, which is intruded by Oracle granite, containing very large orthoclase phenocrysts. In Vaiva Hills Oracle is porphyritic, coarse-grained, biotite quartz monzonite.	Balla, 1972; Blacet and others, 1978; Dockter and Keith, 1978
P-3	Yg	Middle Proterozoic	Oracle granite composed of porphyritic, coarse-grained, biotite quartz monzonite.	Blacet and others, 1978
P-4	TKd	Tertiary and Cretaceous	Medium- to coarse-grained, biotite quartz diorite to quartz-monzonite porphyry.	Blacet and others, 1978
P-5	pЄg	Precambrian	Granitic pegmatites that intrude Precambrian schist.	Balla, 1972; Wilson and others, 1969
P-6	TKg	Tertiary and Cretaceous 61.2 to 71.3 m.y.	Two granitic stocks were intruded during Laramide revolution. The Three Peaks monzonite grades from diorite to monzonite, and has an age of 71.3 m.y. Sacaton Peak granite ranges from biotite quartz monzonite to granite containing abundant, large orthoclase phenocrysts. Sacaton Peak is about 61 m.y. old.	Balla, 1972; Bergquist and Blacet, 1979a, 1979b
	Yg	Middle Proterozoic 857(?) to 1,420 m.y.	Mostly the Oracle granite, porphyritic, coarse grained, and leucocratic, and includes some biotite quartz monzonite containing large phenocrysts of orthoclase. Oracle is about 1,420 m.y. old, and is intruded by small pluton of Sacaton granite, a muscovite-bearing granite yielding questionable age of 857 m.y. The Oracle is cut by aplite and diabase dikes. The diabase is dated at 841 m.y., but probably represents the 1,150 m.y. old diabase event of the State.	

P-7	TKg	Tertiary and Cretaceous 62.2±1.8, 64.3±1.3, and 70.3±4 m.y.	Granitic rocks, intruded during Laramide revolution, include several quartz monzonite stocks. The oldest, the Mineral Butte quartz monzonite, is biotite quartz monzonite about 70 m.y. old. The younger intrusive, the Sacaton Peak granite, is also quartz monzonite.	Balla, 1972
	Yg	Middle Proterozoic 1,341±27 m.y.	Oldest plutonic rock, the San Tan quartz monzonite, intrudes basement schists; it ranges from quartz diorite to quartz monzonite. It is intruded by the younger Oracle granite which is identical to granite in nearby Sacaton Mountains (area P-6).	
P-8	Tgd	Tertiary 24.6±0.5 m.y.	Hornblende-biotite granodiorite containing xenoliths of schist.	Banks, 1980; Davis, 1980; Yeend, 1976
	TKd	Tertiary and Cretaceous	Medium-grained equigranular diorite containing equal amounts of hornblende and biotite. Appears to intrude Precambrian gneiss. The Picacho Mountains south of this granitic terrane comprise a metamorphic core complex.	
	Yg	Middle Proterozoic	Coarse-grained, porphyritic, biotite granodiorite, containing large feldspar phenocrysts. Intrudes Precambrian schist.	
P-9	Tg	Oligocene	Largely porphyritic, biotite-hornblende quartz monzonite but includes areas of granular diorite and porphyritic granodiorite. The Suizo Mountains and Durham Hills contain mylonitic rocks resembling those of a metamorphic core complex.	Banks, 1980; Banks and others, 1977
	Yg	Middle Proterozoic	Coarse- to very coarse grained, porphyritic quartz monzonite to medium-grained, hypidiomorphic quartz monzonite that in most of the Suizo Mountains is cataclastically deformed to mylonite. The large area of Yg in the northeast part of the area is undeformed and partly covered by alluvium.	
P-10	Tg	Oligocene 25 to 28 m.y.	Two plutons of quartz monzonite that are separated from older Tertiary plutons by zone of mylonite. The Tortolita Mountains are part of metamorphic core complex.	Banks, 1976, 1980; Banks and others, 1977; Keith and others, 1980
	Tgm	Eocene 44 to 51 m.y.	Derrio Canyon granite (Keith and others, 1980) is sheet-like mass of muscovite-garnet granite and related pegmatite dikes and sheets. Banks (1980) inferred that this body was metamorphically derived from Chirreon Wash granodiorite. Bounded on south by mylonite zone.	

	TKgd	Early Tertiary and Late Cretaceous 60 to 70 m.y.	Chirreon Wash granodiorite is composite intrusion of porphyritic biotite-hornblende granodiorite, quartz diorite, diorite, and quartz monzonite; bounded by zones of mylonite and cataclastically deformed along contact with younger Derrio Canyon pluton of Keith and others (1980).	
	YXg	Middle to Early Proterozoic 1,400 to 1,650 m.y.	Mainly coarse- to very coarse grained, porphyritic quartz monzonite to medium-grained, hypidiomorphic quartz monzonite (Oracle granite; Proterozoic Y); grades to augen gneiss and schistose mylonite towards borders of younger plutons. Older (Proterozoic X) quartz diorite separated from Oracle granite by the Proterozoic X Pinal Schist.	
P-11	Tg	Paleocene	Porphyritic granite containing large feldspar phenocrysts--much may be alaskite; extends northward into Tea Cup Granodiorite (61-63 m.y.) around Grayback Mountain (area P-12). Cut by dikes of aplite, pegmatite, rhyodacite porphyry, and mafic rocks. Intrudes Precambrian granites and schist and Tertiary and Cretaceous granodiorite.	Balla, 1972; Cornwall and Krieger, 1975b; Creasey and others, 1975; Theodore and others, 1978; Wilson and others, 1969; Yeend and others, 1977
	TKgd, TKg	Tertiary and Cretaceous 71.3±2 and 123.6±4 m.y.	Equigranular, biotite-hornblende granodiorite and quartz monzonite which has been dated only at north end of area.	
	Yg	Middle Proterozoic	Three types of granitic rocks represented. The Ruin Granite, probably the most abundant, is coarse-grained, porphyritic granite and quartz monzonite. Coarse-grained, porphyritic, biotite granodiorite, containing large feldspar phenocrysts in southern part of area, is foliated and intruded by aplite and mafic dikes. Bordering Ruin Granite on the north is medium-grained, leucocratic two-mica granite containing abundant potassium feldspar.	
P-12	Tgd	Paleocene 61.4±3.2, 62.9±1.3, and 60 to 63 m.y.	The Tea Cup Granodiorite, mostly around Grayback Mountain, is medium to coarse grained, locally porphyritic, and includes feldspar and quartz phenocrysts. Granite Mountain Porphyry, which is north of Gila River, is porphyritic granodiorite.	Banks, and Krieger, 1977; Banks and others, 1972, 1977; Cornwall and Krieger, 1975a; 1975b; Cornwall and others, 1971; Creasey and others, 1975;

	Kd	Late Cretaceous 65.6±2 to 66.0±2, 71±2, and 83±2 m.y.	Small stocks of quartz diorite, ranging in composition from pyroxene-hornblende diorite through biotite-hornblende quartz diorite, all included as the Tortilla Quartz Diorite. Intrudes the Precambrian granite. Elsewhere, small intrusive bodies of diorite, hornblende diorite, and granodiorite, most of which are younger (about 66 m.y.) than Tortilla Quartz Diorite.	Damon and others, 1962; Krieger, 1974a; 1974b, 1974c, 1974d; Silver, 1968; Theodore and others, 1978; Wilson and others, 1969; Yeend and others, 1977
	Yg	Middle Proterozoic 1,420, 1,430, 1,460 m.y.	Batholitic masses principally of coarse-grained granite and quartz monzonite, mapped as the Ruin or Oracle Granite; intrudes Precambrian granodiorite and schist, and is intruded, especially in northern part of area, by many Tertiary and Cretaceous dikes and small intrusive masses. Quartz monzonite is coarse grained and porphyritic, because of phenocrysts of orthoclase, microcline, and microperthite, and books of biotite. Associated with the granite are alaskite, aplite, and muscovite granite in large masses and dikes, most of which appear to be slightly younger than the Ruin Granite. The muscovite granite has a Rb-Sr whole-rock age of 1,550±80 m.y. (Krieger, 1974b); however, this age is older than the age of the Ruin. The granodiorite that is intruded by the Ruin Granite is 1,650 to 1,700 m.y. old, according to Silver (1968).	
	YXd	Middle and Early Proterozoic	Madera Diorite locally containing abundant biotite and hornblende; intrudes Precambrian schist.	
P-13	YXg	Middle and Early Proterozoic 1,430 to 1,460 and 1,650 to 1,700 m.y.	Ruin Granite (same as Oracle granite) and an older granodiorite mapped together. The granodiorite is intruded by the Ruin Granite. The Ruin is porphyritic quartz monzonite, containing books of biotite and phenocrysts of microperthite and K-feldspar. Over parts of the area quartz monzonite grades to alaskite and lesser amounts of alaskite porphyry, aplite, and potassium-rich quartz monzonite. Ruin Granite is the more extensive plutonic rock.	Creasey, 1965; 1967a; Creasey and others, 1961; Damon and others, 1962; Krieger, 1968b, 1974b; Silver, 1968
P-14	TKgd	Early Tertiary or Late Cretaceous 68 m.y.	Cooper Creek Granodiorite is large stock and sills and dikes that intrude older Tertiary or Cretaceous volcanics and Paleozoic sedimentary rocks.	Creasey and others, 1961; Krieger, 1968a; Simons, 1964

	p€g	Precambrian	Largely granodiorite or non-porphyritic quartz monzonite and some alaskite.	
P-15	TKd	Tertiary or Cretaceous 62 m.y.	Porphyritic diorite containing phenocrysts of hornblende and plagioclase. Also includes apparently related intrusive bodies of feldspar-mica porphyry which occur as large lacccolith and smaller stocks, sills, and dikes. Both rock types are same age. Intrudes Paleozoic sedimentary rocks, and Tertiary and Cretaceous volcanics and sedimentary rocks. Associated with Christmas ore body.	Krieger, 1968c, 1974c; Willden, 1964
P-16	Kgd	Cretaceous 69.8 and 74.4 m.y.	Rattler Granodiorite ranges from quartz diorite to sodic-granite aplite, containing variable proportions of hornblende and biotite. Occurs mainly as stock that cuts Precambrian and Paleozoic sedimentary rocks and Precambrian diabase.	Cornwall and Krieger, 1978; Cornwall and others, 1971

SANTA CRUZ COUNTY (SC)

SC-1	Tgd	Oligocene 28 m.y.	Granodiorite and rhyodacite porphyry.	Drewes, 1971a, 1971b, 1980; Simons, 1974
	TKp	Paleocene and Late Cretaceous	Stocks, dikes, and a sill of quartz-latite porphyry.	
	Kd	Cretaceous 61, 62, 63, and 67 m.y.	Coarse-grained quartz diorite and large masses of quartz monzonite and some biotite quartz latite, and dikes of dioritic, andesitic, and diabasic rock. Pyroxene syenodiorite at south end of Santa Rita Mountains. The younger of the listed age dates were obtained by analytical methods having wide range of error, and Drewes (1980) assigns unit a Cretaceous age.	
	Kg	Cretaceous 68 and 69 m.y.	Stocks of quartz monzonite.	
	Kgd	Cretaceous 68 m.y.	Coarse-grained granodiorite, with porphyritic and melanocratic phases.	
	Jg	Jurassic 145, 161, and 184 m.y.	An older very coarse grained monzonite and quartz diorite (184 m.y.) intruded by younger rocks, including coarse-grained granite and quartz monzonite and some aplite bodies (145 and 161 m.y.); the granite designated as Triassic by Drewes (1971b, 1980).	
	Yg	Middle Proterozoic 1,360 and 1,450 m.y.	Granodiorite porphyry and quartz-monzonite prophyry.	

SC-2	Tp	Tertiary	Quartz-latite porphyry.	Drewes, 1980; Marvin and others, 1973; Simons, 1974
	Tg	Tertiary	Pyroxene monzonite, porphyritic; mainly intrusive rock but some may be in thick flows. Designated as Cretaceous by Simons (1974), but considered Tertiary by Drewes (1980).	
	Tgd	Paleocene 58±3, 58±5, and 63.9±2.0 m.y.	Mostly equigranular to porphyritic, biotite-hornblende granodiorite and some porphyritic, biotite granodiorite.	
	Kd	Late Cretaceous	Biotite syenodiorite.	
	Jg	Jurassic 150±20, 160±7, and 164±19 m.y.	Mostly equigranular granite and subordinate porphyritic granite, alkali syenite, and granodiorite in Patagonia Mountains. Largely biotite-hornblende quartz monzonite and quartz monzonite in Mount Benedict area. Includes monzonite porphyry correlated with 184-m.y.-old intrusive in area SC-1 designated as Triassic by Drewes (1980).	
	Yg	Middle Proterozoic 1,280±150 m.y.	Mostly biotite and biotite-hornblende quartz monzonite and some hornblende diorite. On west flank of Patagonia Mountains includes considerable hornblende-rich metamorphic and igneous rocks, including gabbro. Intruded by Jurassic and Tertiary plutonic rocks.	

YAVAPAI COUNTY (YA)

YA-1	Yg	Middle Proterozoic 1,340±50, and 1,460±50 m.y.	Granite of Chino Creek pluton.	Krieger, 1967a; Shafiqullah and others, 1980
YA-2	p€g	Precambrian	Granitic rocks.	Krieger, 1967b, 1967d, 1967e; Wilson and others, 1969
YA-3	Yg, p€g	Middle Proterozoic 1,360 m.y. and Precambrian	A complex of gabbro and related rocks, anorthorite, and quartz diorite east and west of Bagdad; intruded by by the younger, widespread Lawler Peak Granite and less extensive Cheney Gulch Granite, and by alaskite porphyry and aplite. Chief minerals in gabbro are hornblende and plagioclase, and rock is foliated. Lawler Peak is porphyritic biotite-muscovite granite, containing large orthoclase phenocrysts, and Cheney Gulch is of similar character. Age of Lawler Peak Granite is 1,360 m.y. Plutonic rocks intruded metamorphic rocks of Proterozoic Yavapai Series.	Anderson, C.A., and others, 1955; Condie, 1981; Wilson and others, 1969

YA-4	Yg p€g,	Middle Proterozoic and Precambrian	Granitic rocks; a single age date from biotite granite south of Kirkland at east edge of area is 1,250±28 m.y.	Krieger, 1967e; Shafiqullah and others, 1980; Wilson, and others, 1969
YA-5	p€g	Precambrian	Granitic rocks.	Reynolds, 1980
YA-6	p€g, p€gd	Early Proterozoic 1,680, 1,750, and 1,770±10 m.y., and Precambrian	Granitic rocks in the area are poorly studied, except where plutons extend north of latitude 34°15' into Mount Union and southwest corner of Mayer quadrangles. In those quadrangles the rocks are of about equal amounts granodiorite and quartz monzonite, both in part porphyritic. Gabbro and diorite at Towers Mountain in the Bradshaw Mountains probably are related to similar rocks southeast of Prescott (area YA-7). The plutonic rocks intruded Precambrian metamorphic rocks. Dated rocks are from only three localities in the northeast and east parts of area; the youngest listed date is on the Crazy Basin Quartz Monzonite, and the older dates on the Brady Butte Granodiorite.	Anderson and Blacet, 1972a, 1972b, 1972c; Anderson, C.A., and others, 1971; Blacet and others, 1971; Condie, 1981; Jaggar and Palache, 1905; Rehrig and others, 1980; Wilson and others, 1969
YA-7	TKgd	Early Tertiary or Late Cretaceous	Mostly granodiorite but includes locally porphyritic quartz monzonite, and in western part, quartz monzonite. Intrudes Precambrian metamorphic, plutonic, and volcanic rocks.	Anderson and Blacet, 1972a, 1972b, 1972c; Anderson, C.A., and others, 1971; Condie, 1981; Krieger, 1965, 1967c, 1967d; Shafiqullah and others, 1980; Wilson and others, 1969
	p€g, p€d, p€gb,	Middle and Early Proterozoic 1,110±40 and 1,770±15 m.y. and undated Precambrian	The oldest plutonic rocks are gabbro and related gabbroic to dioritic rocks. Granodiorite in Government Canyon and Prescott plutons is most abundant rock, and is associated with quartz monzonite, some porphyritic, and alaskite, in part porphyritic, and coarse grained, and some intensely foliated granite and fine-grained granite. Plutonic rocks intrude Precambrian metamorphic and metasedimentary rocks. Younger date on Dells Granite, and older on Government Canyon Granodiorite. Precambrian metamorphic and plutonic rocks in area southwest of Prescott poorly described.	
YA-8	p€gd, p€gb	Precambrian	Mostly Prescott Granodiorite but includes some alaskite, gabbro, and quartz diorite.	Anderson and Creasey, 1967; Krieger, 1965
YA-9	p€d, p€gb	Precambrian 1,760±15 m.y.	Quartz diorite, the most widespread granitic rock in the area, contains conspicuous hornblende prisms, biotite, and plagioclase, and is cut by many dikes of granodiorite porphyry. Older, but less abundant, plutonic rocks include gabbro and quartz porphyry, and locally granophyre. Intrudes Precambrian sedimentary and volcanic rocks. Age date on Mingus Mountain quartz diorite.	Anderson and Blacet, 1972a, 1972c; Anderson and Creasey, 1967; Anderson, C.A., and others, 1971

YA-10	pЄgd, pЄg	Precambrian	Two granodiorite plutons that intruded smaller masses of gabbro and locally foliated quartz-diorite porphyry. In the Badger Spring Granodiorite the dominant mafic mineral is biotite, and locally the pluton has a leucocratic facies. Bumblebee Granodiorite has a mafic border facies of quartz diorite characterized by hornblende. Gabbro is largely dioritic in composition and occurs essentially as pendants in the granodiorite plutons. Character of plutons south of latitude 34°15' poorly known. Intrude older Precambrian volcanics.	Anderson, 1972; Anderson and Blacet, 1972a; Wilson and others, 1969
YA-11	pЄd, pЄg	Precambrian	Chiefly diorite and quartz porphyry that intrude metamorphosed Precambrian volcanics.	Twenter and Metzger, 1963; Wilson and others, 1969
YA-12	pЄg	Precambrian	Granite. In Pine Mountain area (northern part of YA-12), plutonic rock is primarily granite, containing hornblende as principal mafic mineral and considerable magnetite as accessory mineral; locally grades to granodiorite or quartz diorite. West of Horseshoe Reservoir, the granite resembles the Ruin Granite to southeast in Miami-Globe mining district. Intrudes metamorphosed Precambrian volcanics and sedimentary rocks.	Canney and others, 1967; Wilson, 1939; Wilson and others, 1969

YUMA COUNTY (Y)

Y-1	Mzg	Mesozoic	Granitic rocks.	Wilson and others, 1969
Y-2	TKg	Tertiary and Cretaceous	Granitic rocks.	Wilson and others, 1969
Y-3	Mzg	Mesozoic	Granite to quartz diorite.	Wilson and others, 1969
Y-4	pЄg	Precambrian	Originally designated as Mesozoic granite but age later changed to Precambrian.	Shafiqullah and others, 1980; Wilson and others, 1969

Y-5	TKg	Tertiary and Cretaceous	Rocks of extensive Gunnery Range batholith consist of leucocratic two-mica granite which intrudes Mesozoic metamorphic rocks. Contacts are sharp, and in Cabezas Prieta Mountains gneissic roof pendants "float" in granite. In southern Aquila and northern Granite Mountains, plutonic rock is highly fractured and foliated monzonite, containing potassium feldspar phenocrysts. In northern Mohawk Mountains, plutonic rocks consist of hornblende-biotite granite intruded by leucocratic biotite granite; they are in upper plate of detachment fault. Designated as Mesozoic by Wilson and others (1969), but ages of 52.5$\pm$1.3 and 53.1$\pm$1.3 m.y. recorded on biotite at two localities in western part.	Mueller and others, 1982; Shafiqullah and others, 1980; Tucker, 1980; Wilson and others, 1969

REFERENCES CITED

Anderson, C. A., 1972, Precambrian rocks of the Cordes area, Yavapai County, Arizona: U.S. Geological Survey Bulletin 1345, 36 p.

Anderson, C. A., and Blacet, P. M., 1972a, Geologic map of the Mayer Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-996, scale 1:62,500.

______1972b, Geologic map of the Mount Union Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-997, scale 1:62,500.

______1972c, Precambrian geology of the northern Bradshaw Mountains, Yavapai County, Arizona: U.S. Geological Survey Bulletin 1336, 82 p.

Anderson, C. A., Blacet, P. M., Silver, L. T., and Stern, T. W., 1971, Revision of the Precambrian stratigraphy in the Prescott-Jerome area, Yavapai County, Arizona: U.S. Geological Survey Bulletin 1324-C, 16 p.

Anderson, C. A., and Creasey, S. C., 1967, Geologic map of the Mingus Mountain Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-715, scale 1:62,500.

Anderson, C. A., Scholz, E. A., and Strobell, J. D., Jr., 1955, Geology and ore deposits of the Bagdad area, Yavapai County, Arizona: U. S. Geological Survey Professional Paper 278, 103 p.

Anderson, R. E., 1978, Geologic map of the Black Canyon 15-minute Quadrangle, Mohave County, Arizona, and Clark County, Nevada: U.S. Geological Survey Geologic Quadrangle Map GQ-1394, scale 1:62,500.

Anderson, R. E., Longwell, C. R., Armstrong, R. L., and Marvin, R. F., 1972, Significance of K-Ar ages of Tertiary rocks from the Lake Mead region, Nevada-Arizona: Geological Society of America Bulletin, v. 83, no. 2, p. 273-287.

Balla, J. C., 1972, The relationship of Laramide stocks to regional structure in central Arizona: Tucson, University of Arizona, Ph.D. dissertation, unpublished, 132 p.

Banks, N. G., 1976, Reconnaissance geologic map of the Mount Lemmon Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-747, scale 1:62,500.

______1980, Geology of a zone of metamorphic core complexes in southeastern Arizona, in Crittenden, M. D., Jr., Coney, P. J., and Davis, G. H., eds., Cordilleran metamorphic core complexes: Geological Society of America Memoir 153, p. 177-215.

Banks, N. G., Cornwall, H. R., Silberman, M. L., Creasey, S. C., and Marvin, R. F., 1972, Chronology of intrusion and ore deposition at Ray, Arizona--Part 1, K-Ar ages: Economic Geology, v. 67, p. 864-878.

Banks, N. G., and Dockter, R. D., 1976, Reconnaissance geologic map of the Vaca Hills Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-793, scale 1:62,500.

Banks, N. G., Dockter, R. D., Briskey, J. A., Davis, G. H., Keith, S. B., Budden, R. T., Kiven, C. W., and Anderson, Phillip, 1977, Reconnaissance geologic map of the Tortolita Mountains Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-864, scale 1:62,500.

Banks, N. G., and Krieger, M. H., 1977, Geologic map of the Hayden Quadrangle, Pinal and Gila Counties, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1391, scale 1:24,000.

Bedinger, M. S., Sargent, K. A., and Reed, J. E., 1984, Geologic and hydrologic characterization and evaluation of the Basin and Range province relative to the disposal of high-level radioactive waste--Part I, Introduction and guidelines: U.S. Geological Survey Circular 904-A, [in press].

Bennett, K. C., 1975, Geology and origin of the breccias in the Morenci-Metcalf district, Greenlee County, Arizona: Tucson, University of Arizona, M.S. thesis, 153 p.

Bergquist, J. R., 1979, compiler, Reconnaissance geologic map of the Blue Jay Peak Quadrangle, Graham County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1083, scale 1:24,000.

Bergquist, J. R., Banks, N. G., and Blacet, P. M., 1978, Reconnaissance geologic map of the Eloy Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-990, scale 1:62,500.

Bergquist, J. R., and Blacet, P. M., 1979a, Preliminary reconnaissance bedrock geologic map of the Case Grande East Quadrangle, Pinal County, Arizona: U.S. Geological Survey Open-File Report 79-391, scale 1:24,000.

_____1979b, Preliminary reconnaissance bedrock geologic map of the Casa Grande West Quadrangle, Pinal County, Arizona: U.S. Geological Survey Open-File Report 79-390, scale 1:24,000.

Bergquist, J. R., Blacet, P. M., and Miller, S. T., 1978 Reconnaissance geologic map of the Santa Rosa Mountains Quadrangle, Pima County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-935, scale 1:62,500.

Bergquist, J. R., Shride, A. F., and Wrucke, C. T., 1981, Geologic map of the Sierra Ancha wilderness and Salome study area, Gila County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1162-A, scale 1:48,000.

Bikerman, Michael, 1967, Isotopic studies in the Roskruge Mountains, Pima County, Arizona: Geological Society of America Bulletin, v. 78, no. 8, p. 1029-1036.

Blacet, P. M., 1975, Preliminary map of the Garnet Mountain Quadrangle, Mohave County, Arizona: U.S. Geological Survey Open-File Map 75-93, scale 1:48,000.

Blacet, P. M., Bergquist, J. R., and Miller, S. T., 1978, Reconnaissance geologic map of the Silver Reef Mountains Quadrangle, Pinal and Pima Counties, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-934, scale 1:62,500.

Blacet, P. M., and Miller, S. T., 1978, Reconnaissance geologic map of the Jackson Mountain Quadrangle, Graham County, Arizona: U.S. Goelogical Survey Miscellaneous Field Studies Map MF-939, scale 1:62,500.

Blacet, P. M., Silver, L. T., Stern, T. W., and Anderson, C. A., 1971, Precambrian evolution of the Big Bug Group (Yavapai Series) and associated rocks in the northern Bradshaw Mountains, central Arizona: Geological Society of America, Cordilleran section, 67th Annual Meeting, Abstracts with Programs, v. 3, no. 2, p. 84.

Bohannon, R. G., 1978, Preliminary geologic map of the Las Vegas 1° x 2° Quadrangle, Nevada, Arizona, and California: U.S. Geological Survey Open-File Report 78-670, 6 p.

Briskey, J. A., Haxel, Gordon, Peterson, J. A., and Theodore, T. G., 1978, Reconnaissance geologic map of the Gu Achi Quadrangle, Pima County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-965, scale 1:62,500.

Bromfield, C. S., and Shride, A. F., 1956, Mineral resources of the San Carlos Indian Reservation, Arizona: U.S. Geological Survey Bulletin 1027-N, p. 613-691.

Brown, W. H., 1939, Tucson Mountains, an Arizona basin range type: Geological Society of America Bulletin, v. 50, no. 5, p. 697-760.

Canney, F. C., Lehmbeck, W. L., and Williams, F. E., 1967, Mineral resources of the Pine Mountain primitive area, Arizona: U.S. Geological Survey Bulletin 1230-J, 45 p.

Condie, K. C., compiler, 1981, Precambrian rocks of southwestern United States and adjacent areas of Mexico: New Mexico Bureau of Mines and Mineral Resources Map 13, scale 1:1,000,000, 2 sheets.

Cooper, J. R., 1959, Reconnaissance geologic map of southeastern Cochise County, Arizona: U.S. Geological Survey Mineral Investigations Field Studies Map MF-213, scale 1:125,000.

______1960, Reconnaissance map of the Wilcox, Fisher Hills, Cochise, and Dos Cabezas Quadrangles, Cochise and Graham Counties, Arizona: U.S. Geological Survey Mineral Investigations Field Studies Map MF-231, scale 1:62,500.

______1973, Geologic map of the Twin Buttes Quadrangle, southwest of Tucson, Pima County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-745, scale 1:48,000.

Cooper, J. R., and Silver, L. T., 1964, Geology and ore deposits of the Dragoon Quadrangle, Cochise County, Arizona: U.S. Geological Survey Professional Paper 416, 196 p.

Cornwall, H. R., and Krieger, M. H., 1975a, Geologic map of the Kearny Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1188, scale 1:24,000.

______1975b, Geologic map of the Grayback Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1206, scale 1:24,000.

______1978, Geologic map of the El Capitan Mountain Quadrangle, Gila and Pinal Counties, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1442, scale 1:24,000.

Cornwall, H. R., Banks, N. G., and Phillips, C. H., 1971, Geologic map of the Sonora Quadrangle, Pinal and Gila Counties, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1021, scale 1:24,000.

Creasey, S. C., 1965, Geology of the San Manuel area, Pinal County, Arizona: U.S. Geological Survey Professional Paper 471, 64 p.

_____1967a, General geology of the Mammoth Quadrangle, Pinal County, Arizona: U.S. Geological Survey Bulletin 1218, 94 p.

_____1967b, Geologic map of the Benson Quadrangle, Cochise and Pima Counties, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-470, scale 1:48,000.

Creasey, S. C., Jackson, E. D., and Gulbrandsen, R. A. , 1961, Reconnaissance geologic map of parts of the San Pedro and Aravaipa Valleys, south-central Arizona: U. S. Geological Survey Mineral Investigation Field Studies Map MF-238, scale 1:125,000.

Creasey, S. C., Peterson, D. W., and Gambell, N. A., 1975, Preliminary geologic map of the Teapot Mountain Quadrangle, Pinal County, Arizona: U.S. Geological Survey Open-File Report 75-314, scale 1:24,000.

Creasey, S. C., and Theodore, T. G., 1975, Preliminary reconnaissance geologic map of the Bellota Ranch Quadrangle, Pima County, Arizona: U.S. Geological Survey Open-File Report 75-295, scale 1:31,680.

Damon, P. E., Livingston, D. E., and Erickson, R. C., 1962, New K-Ar dates for the Precambrian of Pinal, Gila, Yavapai, and Coconino Counties, Arizona, in Weber, R. H., and Pierce, H. W., eds., Guidebook of the Mogollon Rim region, east-central Arizona: New Mexico Geological Society 13th Annual Field Conference, p. 56-57.

Davis, G. H., 1980, Structural characteristics of metamorphic core complexes, southern Arizona, in Crittenden, M. D., Jr., Coney, P. J., and Davis, G. H., eds., Cordilleran metamorphic core complexes: Geological Society of America Memoir 153, p. 35-77.

Dixon, D. W., 1966, Geology of the New Cornelia Mine, Ajo, Arizona, in Titley, S.R., and Hicks, C.L., eds., Geology of the porphyry copper deposits, southwestern North America: Tucson, Arizona, University of Arizona Press, p. 123-132.

Dockter, R. D., and Keith, W. J., 1978, Reconnaissance geologic map of the Vekol Mountains Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-931, scale 1:62,500.

Drewes, Harald, 1971a, Geologic map of the Sahuarita Quadrangle, southeast of Tucson, Pima County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-613, scale 1:48,000.

_____1971b, Geologic map of the Mount Wrightson Quadrangle, southeast of Tucson, Santa Cruz and Pima Counties, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-614, scale 1:48,000.

_____1974, Geologic map and sections of the Happy Valley Quadrangle, Cochise County, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-832, scale 1:48,000.

_____1977, Geologic map and sections of the Rincon Valley Quadrangle, Pima County, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-997, scale 1:48,000.

_____1980, Tectonic map of southeast Arizona: U. S. Geological Survey Miscellaneous Investigations Series Map I-1109, scale 1:125,000, 2 sheets.

_____1981, Geologic map and sections of the Bowie Mountain South Quadrangle, Cochise County, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-1363, scale 1:24,000.

_____1982, Geologic map and sections of the Cochise Head Quadrangle and adjacent areas, southeastern Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-1312, scale 1:24,000, 2 sheets.

Drewes, Harald, and Cooper, J. R., 1973, Reconnaissance geologic map of the west side of the Sierrita Mountains, Palo Alto Ranch Quadrangle, Pima County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-538, scale 1:24,000.

Erickson, R. C., 1981, K-Ar and Sb-Sr geochronology of the Dos Cabezas Mountains, Cochise County, Arizona, in Stone, Claudia, and Jenney, J. P., eds., Studies in western Arizona: Arizona Geological Society Digest, v. 13, p. 185-193.

Finnell, T. L., 1971, Preliminary geologic map of the Empire Mountains Quadrangle, Pima County, Arizona: U.S. Geological Survey open-file report, scale 1;48,000.

Garner, W. E., Frost, E. G., Tanges, S. E., and Germinario, M. P., 1982, Mid-Tertiary detachment faulting and mineralization in the Trigo Mountains, Yuma County, Arizona, in Frost, E. G., and Martin, D. L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada, Anderson-Hamilton volume: San Diego, California, Cordilleran Publishers, p. 158-171.

Gastil, Gordon, 1958, Older Precambrian rocks of the Diamond Butte Quadrangle, Gila County, Arizona: Geological Society of America Bulletin, v. 69, no. 12, p. 1495-1514.

Gilluly, James, 1937, Geology and ore deposits of the Ajo Quadrangle, Arizona: Arizona Bureau of Mines Bulletin 141, 83 p.

_____1946, The Ajo mining district, Arizona: U.S. Geological Survey Professional Paper 209, 112 p.

_____1956, General geology of central Cochise County, Arizona: U.S. Geological Survey Professional Paper 281, 169 p.

Haxel, Gordon, Briskey, J. A., Rytuba, J. J., Bergquist, J. R., Blacet, P. M., and Miller, S. T., 1978, Reconnaissance geologic map of the Comobabi Quadrangle, Pima County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-964, scale 1:62,500.

Haxel, Gordon, May, D. J., and Tosdal, R. M., 1982, Reconnaissance geologic map of the Presumido Peak Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1378, scale 1:62,500.

Haxel, Gordon, May, D. J., Wright, J. E., and Tosdal, R. M., 1980, Reconnaissance geologic map of the Baboquivari Peak Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1251, scale 1:62,500.

Haxel, Gordon, Wright, J. E., May, D. J., and Tosdal, R. M., 1980, Reconnaissance geology of the Mesozoic and lower Cenozoic rocks of the southern Papago Indian Reservation, Arizona--A preliminary report, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 17-29.

Hayes, P. T., and Landis, E. R., 1964, Geologic map of the southern part of the Mule Mountains, Cochise County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-418, scale 1:48,000.

Hayes, P. T., and Raup, R. B., 1968, Geologic map of the Huachuca and Mustang Mountains, southeastern Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-509, scale 1:48,000.

Howard, K. A., Goodge, J. W., and John, B. E., 1982, Detached crystalline rocks of the Mohave, Buck, and Bill Williams Mountains, western Arizona, in Frost, E. G., and Martin, D. L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada, Anderson-Hamilton volume: San Diego, California, Cordilleran Publishers, p. 377-390.

Jaggar, T. A., Jr., and Palache, Charles, 1905, Bradshaw Mountains Quadrangle, Arizona, folio 126 of Geologic Atlas the United States: U.S. Geological Survey, 11 p.

Jones, W. C., 1974, General geology of the northern portion of the Ajo Range, Pima County, Arizona: University of Arizona M.S. thesis, 77 p.

Keith, S. B., Reynolds, S. J., Damon, P. E., Shafiqullah, Muhammad, Livingston, D. E., and Pushkar, P. D., 1980, Evidence for multiple intrusion and deformation within the Santa Catalina-Rincon-Tortolita crystalline complex, southeastern Arizona, in Crittenden, M. D., Jr., Coney, J. P., and Davis, G. H., eds., Cordilleran metamorphic core complexes: Geological Society of America Memoir 153, p. 217-267.

Keith, W. J., 1976, Reconnaissance geologic map of the San Vicente and Cocoraque Butte 15' Quadrangles, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF- scale 1:62,500.

Keith, W. J., and Theodore, T. G., 1975, Reconnaissance geologic map of the Arivaca Quadrangle, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-678, scale 1:63,360.

Krieger, M. H., 1965, Geology of the Prescott and Paulden Quadrangles, Arizona: U.S. Geological Survey Professional Paper 467, 127 p.

______1967a, Reconnaissance geologic map of the Turkey Canyon Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-501, scale 1:62,500.

______1967b, Reconnaissance geologic map of the Camp Wood Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-502, scale 1:62,500.

______1967c, Reconnaissance geologic map of the Simmons Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-503, scale 1:62,500.

______1967d, Reconnaissance geologic map of the Iron Springs Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-504, scale 1:62,500.

______1967e, Reconnaissance geologic map of the Sheridan Mountain Quadrangle, Yavapai County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-505, scale 1:62,500.

______1968a, Geologic map of the Holy Joe Peak Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-669, scale 1:24,000.

______1968b, Geologic map of the Lookout Mountain Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-670, scale 1:24,000.

______Geologic map of the Saddle Mountain Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-671, scale 1:24,000.

______1974a, Geologic map of the Crozier Peak Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1107, scale 1:24,000.

______1974b, Geologic map of the Putman Wash Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1109, scale 1:24,000.

______1974c, Geologic map of the Winkelman Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1106, scale 1:24,000.

______1974d, Geologic map of the Black Mountain Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-1108, scale 1:24,000.

Lindgren, Waldemar, 1905, The copper deposits of the Clifton-Morenci district, Arizona: U.S. Geological Survey Professional Paper 43, 375 p.

Manger, R. L., Damon, P. E., and Giletti, B. J., 1965, Isotopic dating of Arizona ore deposits: American Institute of Mining Engineers Transactions, v. 232, p. 81-87.

Marshak, Stephen, 1980, A preliminary study of Mesozoic geology in the southern Dome Rock Mountains, southwestern Arizona, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 123-133.

Marvin, R. F., Naeser, C. W., and Mehnert, H. H., 1978, Tabulation of radiometric agesincluding unpublished K-Ar and fission-tracks ages--for rocks in southeastern Arizona and southwestern New Mexico, in Callender, J. F., Wilt, J. C., and Clemons, R.E., eds., Land of Cochise, southeastern Arizona: New Mexico Geological Society 29th Annual Field Conference, Guidebook, p. 243-252.

Marvin, R. F., Stern, T. W., Creasey, S. C., and Mehnert, H. H., 1973, Radiometric ages of igneous rocks from Pima, Santa Cruz, and Cochise Counties, southeastern Arizona: U.S. Geological Survey Bulletin 1379, 27 p.

May, D. J., and Haxel, Gordon, 1980, Reconnaissance bedrock geologic map of the Sells Quadrangle, Pima County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1166, scale 1:62,500.

McDowell, F. W., 1971, K-Ar ages of igneous rocks from the western United States: Isochron/West, no. 2, p. 1-17.

Miller, F. K., 1970, Geologic map of the Quartzite Quadrangle, Yuma County, Arizona: U.S. Geologial Survey Geologic Quadrangle Map GQ-841, scale 1:62,500.

Moore, R. T., 1972, Geology of the Virgin and Beaver Dam Mountains, Arizona: Arizona Bureau of Mines Bulletin 186, 65 p.

Mueller, K. J., Frost, E. G., and Haxel, Gordon, 1982, Mid-Tertiary detachment faulting in the Mohawk Mountains of southwestern Arizona, in Frost, E. G., and Martin, D. L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada, Anderson-Hamilton volume: San Diego, California, Cordilleran Publishers, p. 448-457.

Peterson, D. W., 1960, Geology of the Haunted Canyon Quadrangle, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-128, scale 1:24,000.

_____1962, Preliminary geologic map of the western part of the Superior Quadrangle, Pinal County, Arizona: U.S. Geological Survey Mineral Investigations Field Studies Map MF-253, scale 1:12,000.

_____1969, Geologic map of the Superior Quadrangle, Pinal County, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-818, scale 1:24,000.

Peterson, N. P., 1954, Geology of the Globe Quadrangle, Arizona: U.S. Geological Survey Geologic Quadrangle Map GQ-41, scale 1:24,000.

_____1961, Preliminary geologic map of the Pinal Ranch Quadrangle, Arizona: U.S. Geological Survey Mineral Investigations Field Studies Map MF-81, scale 1:24,000.

_____1963, Geology of the Pinal Ranch Quadrangle, Arizona: U.S. Geological Survey Bulletin 1141-H, 18 p.

Peterson, N. P., Gilbert, C. M., and Quick, G. L., 1951, Geology and ore deposits of the Castle Dome area, Gila County, Arizona: U.S. Geological Survey Bulletin 971, 134 p.

Putman, G. W., and Burnham, C. W., 1963, Trace elements in igneous rocks, northwestern and central Arizona: Geochimica et Cosmochimica Acta, v. 27, p. 53-106.

Ransome, F. L., 1904, Globe [Quadrangle], Arizona, folio 111 of Geologic Atlas of the United States: U.S. Geological Survey.
Rehrig, W. A., and Reynolds, S. J., 1980, Geologic and geochronologic reconnaissance of a northwest-trending zone of metamorphic core complexes in southern and western Arizona, in Crittenden, M. D., Jr., Coney, P. J., and Davis, G. H., eds., Cordilleran metamorphic core complexes: Geological Society of America Memoir 153, p. 131-157.
Rehrig, W. A., Shafiquallah, Muhammad, and Damon, P. E., 1980, Geochronology, geology, and listric normal faulting of the Vulture Mountians, Maricopa County, Arizona, in Jenney, J. P. and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 89-110.
Reynolds, S. J., 1980, Geologic framework of west-central Arizona, in Jenny, J. P. and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 1-16.
______1982, Multiple deformation in the Harcuvar and Harquahala Mountains, west-central Arizona, in Frost, E. G., and Martin, D. L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada, Anderson-Hamilton volume: San Diego, California, Cordilleran Publishers, p. 137-142.
Reynolds, S. J., Keith, S. B., and Coney, J. P., 1980, Stacked overthrusts of Precambrian crystalline basement and inverted Paleozoic sections emplaced over Mesozoic strata, west-central Arizona, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 45-51.
Reynolds, S. J., and Rehrig, W. A., 1980, Mid-Tertiary plutonism and mylonitization, South Mountains, Arizona, in Crittenden, M.D., Coney, P.J., and Davis, G.H., eds., Cordilleran metamorphic core complexes: Geological Society of America Memoir 153, p. 159-175.
Richard, S. M., 1982, Preliminary report on the structure and stratigraphy of the southern Little Harquahala Mountains, Yuma County, Arizona, in Frost, E. G., and Martin, D. L., eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River region, California, Arizona, and Nevada, Anderson-Hamilton volume: San Diego, California, Cordilleran Publishers, p. 235-242.
Rytuba, J. J., Till, A. B., Blair, Will, and Haxel, Gordon, 1978, Reconnaissance geologic map of the Quijotoa Mountains Quadrangle, Pima County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-937, scale 1:62,500.
Sargent, K. A., and Bedinger, M. S., 1984, Geologic and hydrologic characterization and evaluation of the Basin and Range province relative to the disposal of high-level radioactive waste--Part II, Geologic and hydrologic characterization: U.S. Geological Survey Circular 904-B, [in press].

Shafiqullah, Muhammad, Damon, P. E., Lynch, D. J., Reynolds, S. J., Rehrig, W. A., and Raymond, R. H., 1980, K-Ar geochronology and geologic history of southwestern Arizona and adjacent areas, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 201-260.

Silver, L. T., 1968, Precambrian batholiths in Arizona [abs]: Geological Society of America, Cordilleran section, 64th Annual Meeting, Tucson, Arizona, p. 109-110.

______1978, Precambrian formations and Precambrian history in Cochise County, southeastern Arizona, in Callender, J. F., Wilt, J. C., and Clemons, R. E., eds., Land of Cochise, southeastern Arizona: New Mexico Geological Society 29th Field Conference, Guidebook, p. 157-163.

Simons, F. S., 1964, Geology of the Klondyke Quadrangle, Graham and Pinal Counties, Arizona: U.S. Geological Survey Professional Paper 461, 173 p.

______1974, Geologic map and sections of the Nogales and Lochiel Quadrangles, Santa Cruz County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-762, scale 1:48,000.

Stensrud, H. L., and More, Syver, 1980, Precambrian geology and massive sulfide environments of the west-central Hualapai Mountains, Mohave County, Arizona--A preliminary report, in Jenney, J.P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 155-165.

Theodore, T. G., Keith, W. J., Till, A. B., and Peterson, J. A., 1978, Preliminary geologic map of the Mineral Mountain 7 1/2 minute Quadrangle, Arizona, including analytical data for K-Ar ages for the Mineral Mountain 7 1/2-minute Quadrangle Arizona, by S.C. Creasey: U.S. Geological Survey Open-File Report 78-468, scale 1:24,000.

Thorman, C. H., 1981, Geology of the Pinaleno Mountains, Arizona--A preliminary report, in Stone, Claudia, and Jenney, J. P., eds., Studies in western Arizona: Arizona Geological Society Digest, v. 13, p. 5-12.

Tosdal, R. M., 1979, Preliminary compilation of isotopic ages within the Ajo 1 x 2 Quadrangle, Arizona: U.S. Geological Survey Open-File Report 79-399, scale 1:24,000.

______1982, The Mule Mountains thrust in the Mule Mountains, California, and its probable extension in the southern Dome Rock Mountains, Arizona--A preliminary report, in Frost, E. G., and Martin, D. L., eds., Mesozoic-Cenozoic: tectonic evolution of the Colorado River region, California, Arizona, and Nevada, Anderson-Hamilton volume: San Diego, Cordilleran Publishers, p. 55-60.

Tucker, W. C. Jr., 1980, The geology of the Aguila Mountains Quadrangle, Yuma, Maricopa, and Pima Counties, Arizona, in Jenney, J.P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 111-122.

Twenter, F. R., and Metzger, D. G., 1963, Geology and ground water in Verde Valley--The Mogollon Rim region, Arizona: U.S. Geological Survey Bulletin 1177, 132 p.

Wilkinson, W. H., Jr., Vega, L. A., and Titley, S. R., 1982, Geology and ore deposits at Mineral Park, Mohave County, Arizona, in Titley, S. R., ed., Advances in geology of the porphyry copper deposits, southwestern North America: Tucson, Arizona, University of Arizona Press, p. 523-541.

Willden, Ronald, 1964, Geology of the Christmas Quadrangle, Gila and Pinal Counties, Arizona, in Contributions to General Geology, 1962: U.S. Geological Survey Bulletin 1161-E, p. E1E64.

Wilson, E. D., 1939, Precambrian Mazatzal revolution in central Arizona: Geological Society of American Bulletin, v. 50, no. 7, p. 1113-1163.

______1960, Geologic map of Yuma County, Arizona: Arizona Bureau of Mines, scale 1:62,500.

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.

Yeend, Warren, 1976, Reconnaissance geologic map of the Picacho Mountains, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-778, scale 1:62,500.

Yeend, Warren, Keith, W. J., and Blacet, P. M., 1977, Reconnaissance geologic map of the Ninety-Six Hills, NW, NE, SE, and SW Quadrangles, Pinal County, Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-909, scale 1:62,500.

☆ U.S. GOVERNMENT PRINTING OFFICE 1984—781-181