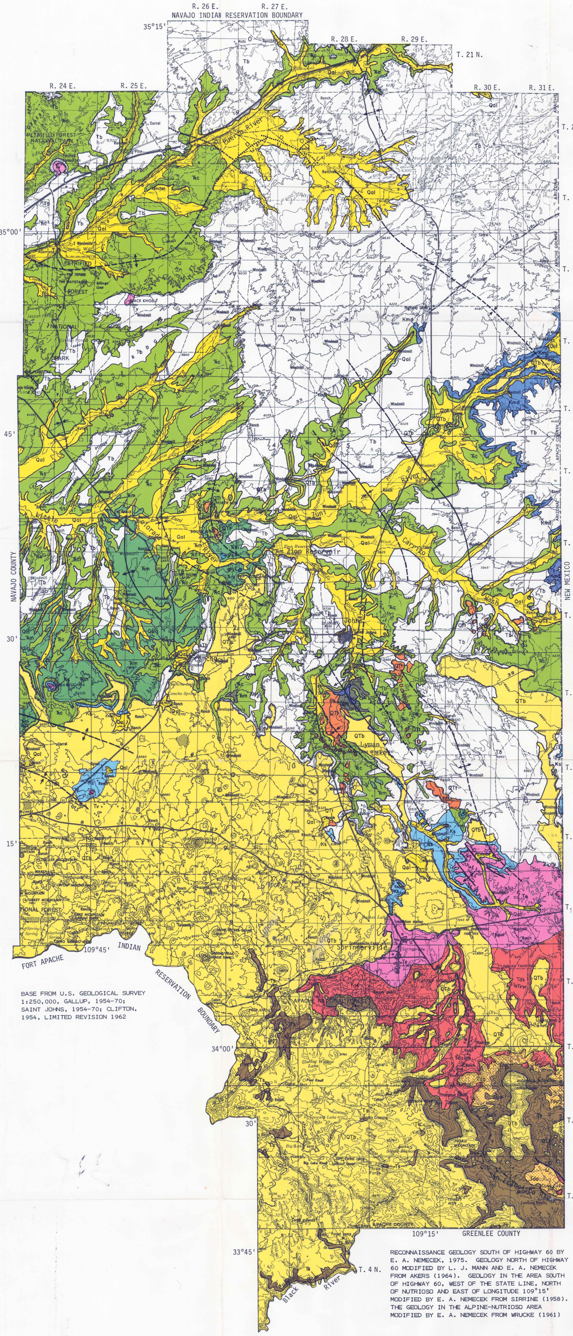

BASE FROM U.S. GEOLOGICAL SURVEY 1:250,000, GALLUP, 1954–70; SAINT JOHNS, 1954–70; CLIFTON, 1954, LIMITED REVISION 1962

RECONNAISSANCE GEOLOGY SOUTH OF HIGHWAY 60 BY E. A. NEMECEK, 1975. GEOLOGY NORTH OF HIGHWAY 60 MODIFIED BY L. J. MANN AND E. A. NEMECEK FROM AKERS (1964). GEOLOGY IN THE AREA SOUTH OF HIGHWAY 60, WEST OF THE STATE LINE, NORTH OF NUTRIOSO AND EAST OF LONGITUDE 109°15' MODIFIED BY E. A. NEMECEK FROM SIRRINE (1958). THE GEOLOGY IN THE ALPINE–NUTRIOSO AREA MODIFIED BY E. A. NEMECEK FROM WRUCKE (1961)

EXPLANATION

CORRELATION OF MAP UNITS

Aquifer	Symbol	Map unit	System
	Qal	ALLUVIUM	QUATERNARY
	QTt	TRAVERTINE DEPOSITS	QUATERNARY AND TERTIARY
	QTb	BASALTIC ROCKS	QUATERNARY AND TERTIARY
	Tv	VOLCANIC ROCKS	TERTIARY
BIDAHOCHI AQUIFER (Northeastern part of area)—May include Wingate(?) Sandstone, which is not exposed in the area	Tb	BIDAHOCHI FORMATION	TERTIARY
WHITE MOUNTAINS AQUIFER (Southern part of area)	Ts	TERTIARY SEDIMENTARY ROCKS, UNDIFFERENTIATED	TERTIARY
WHITE MOUNTAINS AQUIFER (Southern part of area)	Tdo, Tds	DATIL FORMATION—Andesite member, Tda; sedimentary member, Tds	TERTIARY
WHITE MOUNTAINS AQUIFER (Southern part of area)	Te	EAGAR FORMATION OF SIRRINE (1958)	TERTIARY AND CRETACEOUS
SPRINGERVILLE AQUIFER (Southern part of area)	Ks	UPPER CRETACEOUS SEDIMENTARY ROCKS, UNDIFFERENTIATED	CRETACEOUS
BIDAHOCHI AQUIFER	Kmd	MANCOS SHALE AND DAKOTA SANDSTONE, UNDIFFERENTIATED	CRETACEOUS
	Ŧc	CHINLE FORMATION	TRIASSIC
	Ŧm	MOENKOPI FORMATION	TRIASSIC
COCONINO AQUIFER—Includes the underlying Coconino Sandstone and the uppermost part of the underlying Supai Formation, which are not exposed in the area	Pk	KAIBAB LIMESTONE	PERMIAN

GEOLOGIC CONTACT—Approximately located

FAULT—Dashed where approximately located; dotted where concealed. U, upthrown side; D, downthrown side

MAJOR ANTICLINE—Showing trace of crestal plane; dashed where approximately located

MAJOR SYNCLINE—Showing trace of trough plane; dashed where approximately located

MAJOR MONOCLINE—Showing trace of axial plane; dashed where approximately located

DESCRIPTION OF MAP UNITS

[A thin veneer of surficial material, which is not of sufficient thickness to be mapped, caps most of the units in the area. The surficial material may include alluvium, eolian sand, and soil and other residual-weathering products]

Erathem	System	Formation or member	Approximate thickness, in feet	Lithologic description	Water-bearing characteristics
CENOZOIC	QUATERNARY	Alluvium	0-150+	Poorly sorted sand, silt, gravel, and clay.	Supplies water to wells along the channels and flood plains of the Puerco and Little Colorado Rivers and their major tributaries. Generally yields less than 20 gal/min to wells in most places, but yields of 500 gal/min or more have been obtained along the Puerco River.
	QUATERNARY AND TERTIARY	Travertine deposits	0-100(?)	Travertine, silty to sandy, flat-lying, thin- to thick-bedded.	Yields small amounts of water to springs and seeps and to one well. Generally not considered a reliable source of water.
	QUATERNARY AND TERTIARY	Basaltic rocks	0-1,000+	Mainly basalt flows, cinder cones, and cinder beds; in places the basalt flows are separated by clay lenses.	Contains ground water in fractures or cinder beds where underlain by relatively impermeable strata or where the unit is hydraulically connected to underlying units. Yields small to moderate quantities of water to springs and wells; yields about 1,000 gal/min to Concho Springs and as much as 50 gal/min to wells.
	TERTIARY	Volcanic rocks	0-150+	Mainly basaltic to andesitic lava flows and plugs.	No known water-bearing potential.
	TERTIARY	Bidahochi Formation	0-1,000+	Sandstone, mudstone, claystone, conglomerate, and travertine. Sandstone, fine- to coarse-grained quartzite, grayish-brown to light-brownish-gray; flat-lying, small- to medium-scale crossbeds. Mudstone and claystone, light-greenish-gray to dark-reddish-brown, flat-lying, and thin- to thick-bedded. Conglomerate, pale-reddish-brown, medium- to coarse-grained quartz sand, quartzite, pebbles and cobbles, chert, jasper, and basalt; ranges from a few inches to about 10 ft in thickness and is near the base of the unit. Travertine, silty, yellowish-gray, flat-lying, thin- to thick-bedded.	Upper unit of Bidahochi aquifer. Contains ground water in the northeastern part of area, near St. Johns, and in some places along U.S. Highway 666 north of St. Johns and near the east boundary; generally is hydraulically connected to sandstone beds of the underlying Mancos Shale and Dakota Sandstone. Generally yields about 5 to 20 gal/min of water to wells and springs, but in some places potentially could yield from 50 to 100 gal/min to wells.
	TERTIARY	Sedimentary rocks, undifferentiated	0-1,200	Sandstone, conglomerate, tuff, and basalt flows. Sandstone, very fine to medium grained volcanic debris, quartz, and feldspar, pale-yellowish-gray, small to massive crossbeds, weakly cemented. Conglomerate, medium to very coarse grained sand and pebble- to boulder-size basalt, pumice shards, and other volcanic debris. Tuff, partially welded pumice and fine devitrified ash, light-gray, flat-lying.	Upper unit of White Mountains aquifer in southern part of area. Yields small amounts of water to wells near Alpine, Nutrioso, Greer, and Big Lake; yields about 80 gal/min to one well near Alpine.
	TERTIARY	Datil Formation: Andesite member	0-400	Andesite flows, porphyritic, greenish-black to brownish-gray.	Middle unit of White Mountains aquifer. Yields less than 50 gal/min of water to wells near Alpine, Nutrioso, and Springerville. Andesite member yields water if it is fractured, but it is nearly impermeable and may perch water in overlying units or confine water in underlying units where it is unfractured.
	TERTIARY	Datil Formation: Sedimentary member	0-1,000+	Interbedded mudstone, sandstone, and conglomerate. Mudstone, clay- to silt-size particles, pale-red to grayish-orange, flat indistinct beds. Sandstone, mainly composed of volcanic debris, fine- to coarse-grained, flat-lying to small-scale crossbeds, weakly cemented. Conglomerate, coarse-grained sandstone and pebbles of volcanic debris; mainly present in upper part of unit.	
		Eagar Formation of Sirrine (1958)	0-600(?)	Conglomerate, sandstone, and siltstone, light-brownish-gray and pale-reddish-brown to very pale orange, flat-lying to large-scale crossbeds; conglomerate grades laterally and vertically into sandstone and siltstone.	Lower unit of White Mountains aquifer. Yields less than 50 gal/min of water to wells near Springerville and east of Springerville.
MESOZOIC	CRETACEOUS	Upper Cretaceous sedimentary rocks, undifferentiated	0-488+	Sandstone and shale. Sandstone, feldspathic, fine- to medium-grained, very pale orange to grayish-orange, thin to very thick lenticular beds; weakly to well cemented. Shale, siltstone, and mudstone, grayish-brown to dark gray; in places contains shaly coal beds a few feet thick. Includes all the Cretaceous rocks in the southern part of the area equivalent to the Mesaverde Group, Mancos Shale, and Dakota Sandstone, undifferentiated.	Forms the Springerville aquifer. Ground water occurs mainly in the sandstone beds where underlain by nearly impermeable siltstone and mudstone. Aquifer may locally be hydraulically connected to the White Mountains aquifer near Springerville and the basaltic rocks near Vernon. Yields a few to as much as 165 gal/min of water.
	CRETACEOUS	Mancos Shale and Dakota Sandstone, undifferentiated	0-265+	Sandstone, siltstone, and claystone. Sandstone, grayish- to greenish-yellow except in lower part, which is very pale orange to white; small to medium crossbeds, weakly to well-cemented with siliceous, carbonaceous, or clay cement; contains thin lenticular beds of conglomerate, coal, and siltstone. Siltstone and claystone, moderate, orange-pink to brownish-black. May include Wingate(?) Sandstone in Hardscabble Wash 2 mi southwest of Witch Well.	Lower unit of Bidahochi aquifer in the northeastern part of area. Ground water occurs mainly in the sandstone beds; the unit generally is hydraulically connected to the Bidahochi Formation. Yields 20 gal/min or less of water to wells.
	TRIASSIC	Wingate(?) Sandstone	0-100(?)	Mainly sandstone, reddish-brown, fine-grained, cross-bedded.	
	TRIASSIC	Chinle Formation	0-1600	Mainly siltstone, claystone, mudstone, and limestone. Siltstone, claystone, and mudstone, grayish-red to grayish-red-purple and reddish-brown; locally contains lenticular and wedge-shaped sandstone beds. Limestone, light-greenish-gray, discontinuous. Shinarump Member at base is a 0- to 80-ft-thick fine- to coarse-grained, yellowish-orange to pale-orange sandstone and conglomerate. Sonsela Sandstone Bed of Petrified Forest Member is a 0- to 150-foot-thick, fine- to coarse-grained, light-gray to pale-orange sandstone and conglomerate.	Locally contains water in the Shinarump Member and the Sonsela Sandstone Bed and in the thin lenticular sandstone beds in the upper part of the unit. Yields a few to about 50 gal/min of water to wells in the central and northern parts of the area, mainly near Carrizo Wash, the Zuni River, and the Puerco River. About 6 mi southeast of Navajo, some wells that obtain water from the Sonsela Sandstone Bed flow at the land surface.
	TRIASSIC	Moenkopi Formation	0-25[illegible]	Mainly siltstone and mudstone, reddish-brown to purplish-blue. Contains fine- to coarse-grained lenticular and wedge-shaped pale-red to light-yellowish-brown and gray sandstone, silty sandstone, and conglomerate beds 20 to 50 ft thick near the top and base. Includes gypsum and halite stringers, nodules, and beds.	In places contains ground water in fractures and joints in the lenticular and wedge-shaped beds of sandstone, silty sandstone, and conglomerate near the top and base of unit; yields a few to about 30 gal/min of water to wells in the central and western parts of the area near the Little Colorado River. May be hydraulically connected to the Coconino aquifer where fractured along major structural features.
PALEOZOIC	PERMIAN	Kaibab Limestone	0-350	Limestone and sandstone. Limestone, commonly silty, dolomitic, and cherty, light-gray to light-yellowish-gray and pale-olive-gray; beds are generally 1 to 4 ft thick. Sandstone, fine to very fine grained, light-yellowish-gray to light-yellowish-brown, thin-bedded to massive.	Upper unit of the Coconino aquifer; unit is hydraulically connected to the Coconino Sandstone in most of the area; yields as much as 1,000 gal/min of water to wells in most of the central and southern parts of the area.
	PERMIAN	Coconino Sandstone	175-40[illegible]	Sandstone, very fine to medium grained, light-yellowish-gray to pale-orange, local reddish-brown beds as much as 50 ft thick; weakly to well-cemented by quartz, iron oxide, and calcite. Thickens toward the northwest.	Middle unit of the Coconino aquifer; main water-bearing unit. Contains ground water in most of the area; unit is hydraulically connected to the Kaibab Limestone and the uppermost beds of the Supai Formation; unit probably will yield as much as 2,000 gal/min of water to wells.
	PERMIAN	Supai Formation: Upper member	550-1,250	Siltstone, sandstone, silty sandstone, halite, gypsum, and anhydrite. Siltstone, sandstone, and silty sandstone, very fine grained, pale-red to pale-reddish-brown, thinly laminated to massive, calcareous. Halite, gypsum, and anhydrite; the beds are 0 to 50 ft below the top of the unit. The unit thickens toward the northwest.	Lower unit of the Coconino aquifer; sandstone beds in the upper 0 to 130(?) ft of this unit are in hydraulic connection with the Coconino Sandstone. In places, yields a few hundred gallons per minute of water to wells. The underlying siltstone, halite, gypsum, and anhydrite beds may prevent ground water in the Coconino aquifer from moving downward into the underlying strata.

SCALE: 5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

RECONNAISSANCE GEOLOGY IN SOUTHERN APACHE COUNTY, ARIZONA