

U.S. DEPARTMENT OF THE INTERIOR  
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Geologic map of the Sullivan Draw North quadrangle,  
northern Mohave County, Arizona

by  
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## **INTRODUCTION**

Sullivan Draw North quadrangle (100 sq km) is located in northern Mohave County, northwestern Arizona, about 27 kilometers south of the Utah-Arizona state line (fig. 1). Elevations range from about 5,000 ft at Sullivan Draw, (northeast corner of map) to about 5,510 ft, southeast corner of quadrangle. The nearest settlement is St. George, Utah, about 48 kilometers north of the quadrangle. The main access to the area is by improved dirt road south from St. George locally referred to as the Mt. Trumbull Road (figs. 1 and 2).

The area is managed entirely by the U.S. Bureau of Land Management. The area is sparsely vegetated with sagebrush, cactus, and grass. A moderate cover of pinion pine and juniper trees cover the southwest quarter of the map.

## **PREVIOUS WORK**

There are no previous small-scale geologic maps of this area. The area is included in two state geologic maps, one at a scale of 1:500,000 (Wilson and others, 1969), and the other at 1:1,000,000 (Reynolds, 1988). Geologic maps that border this quadrangle include, on the north, the Wolf Hole Mountain East 7.5 quadrangle, Arizona (Billingsley, 1990). Geologic maps in preparation of bordering areas include, on the west, the Mustang Knoll 7.5 quadrangle, Arizona, and to the south, the Sullivan Draw South 7.5 quadrangle, Arizona.

## **GEOLOGIC SETTING**

The quadrangle lies in the northern part of the Shivwits Plateau, a sub-physiographic plateau of the southwestern Colorado Plateau Geologic Province characterized by nearly flat-lying Mesozoic and Paleozoic strata. The strata dips gently to the east about an average of 1° or 2°. The area is cut by the north trending Washington fault that displaces strata down to the west about 61 m (fig. 2). The surface rock is pockmarked with a karst topography. Cenozoic deposits are widely distributed and characterized as geomorphic surficial alluvial or mass-moved deposits based on landform development and their relationship to underlying structures and erosional changes. The surficial units often merge or intertongue and share an arbitrary map boundary.

## **STRATIGRAPHY**

About 137 m of Triassic and Permian rock strata are exposed in the quadrangle. Lower Triassic rocks once covered the entire area but have been eroded away except in the northwest corner of the quadrangle. The formations exposed are, in descending order; the Moenkopi Formation (Middle? and Lower Triassic), and the Kaibab Formation (Lower Permian). Much of the surface bedrock of this quadrangle is gray cherty limestone or gray to white siltstone and gypsum of the Kaibab Formation. Red sandstone, siltstone, and white limestone of the Moenkopi crop out in the northwest corner of the quadrangle.

Stream-deposited and minor mass-moved deposits cover much of the bedrock areas in the north-central part of the map along Sullivan Draw. Details of the stratigraphy are given in the description of map units.

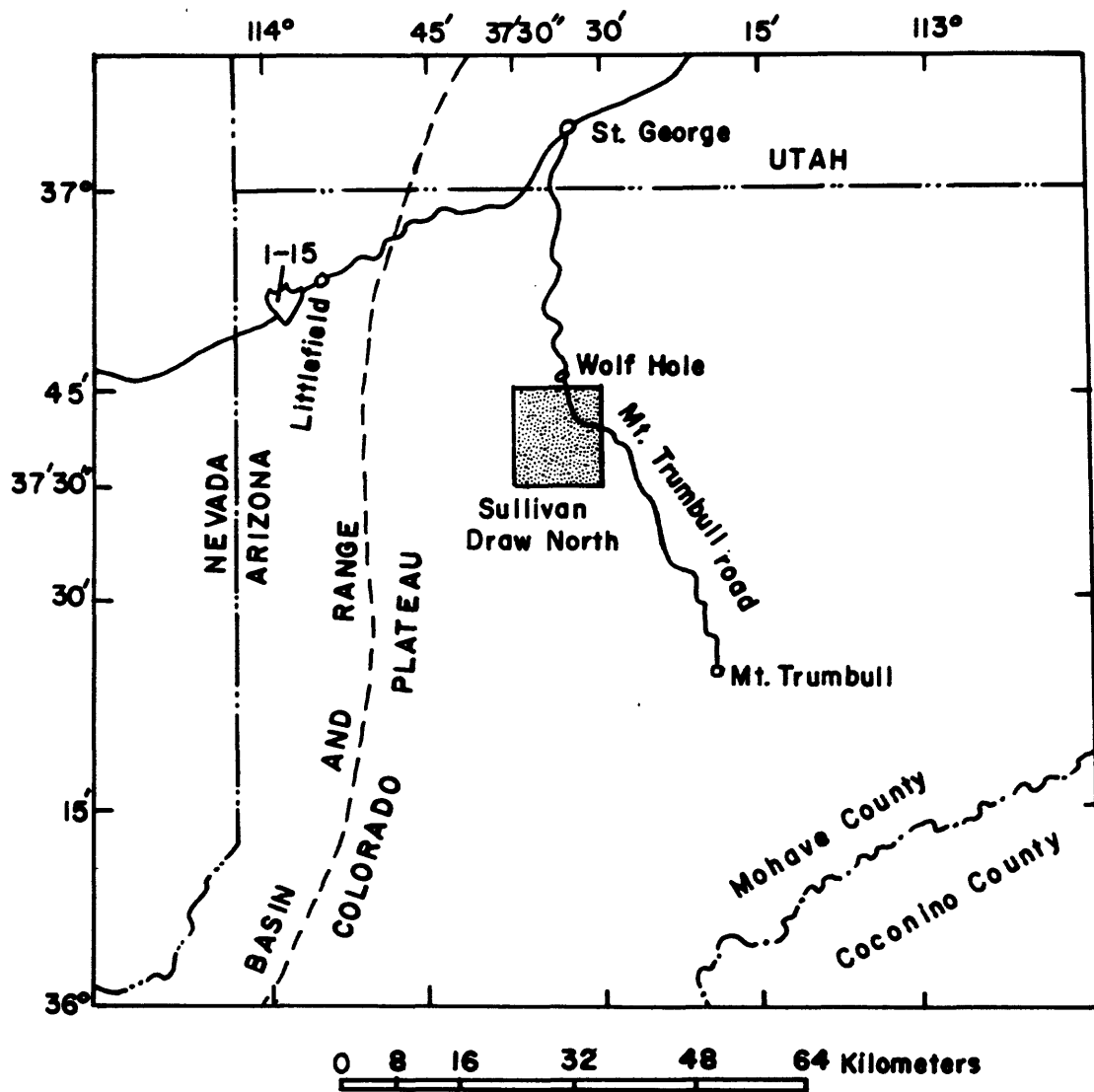


Figure 1. Sullivan Draw North 7.5 quadrangle, northern Mohave County, northwestern Arizona, showing 7.5 quadrangle mapped in this report.

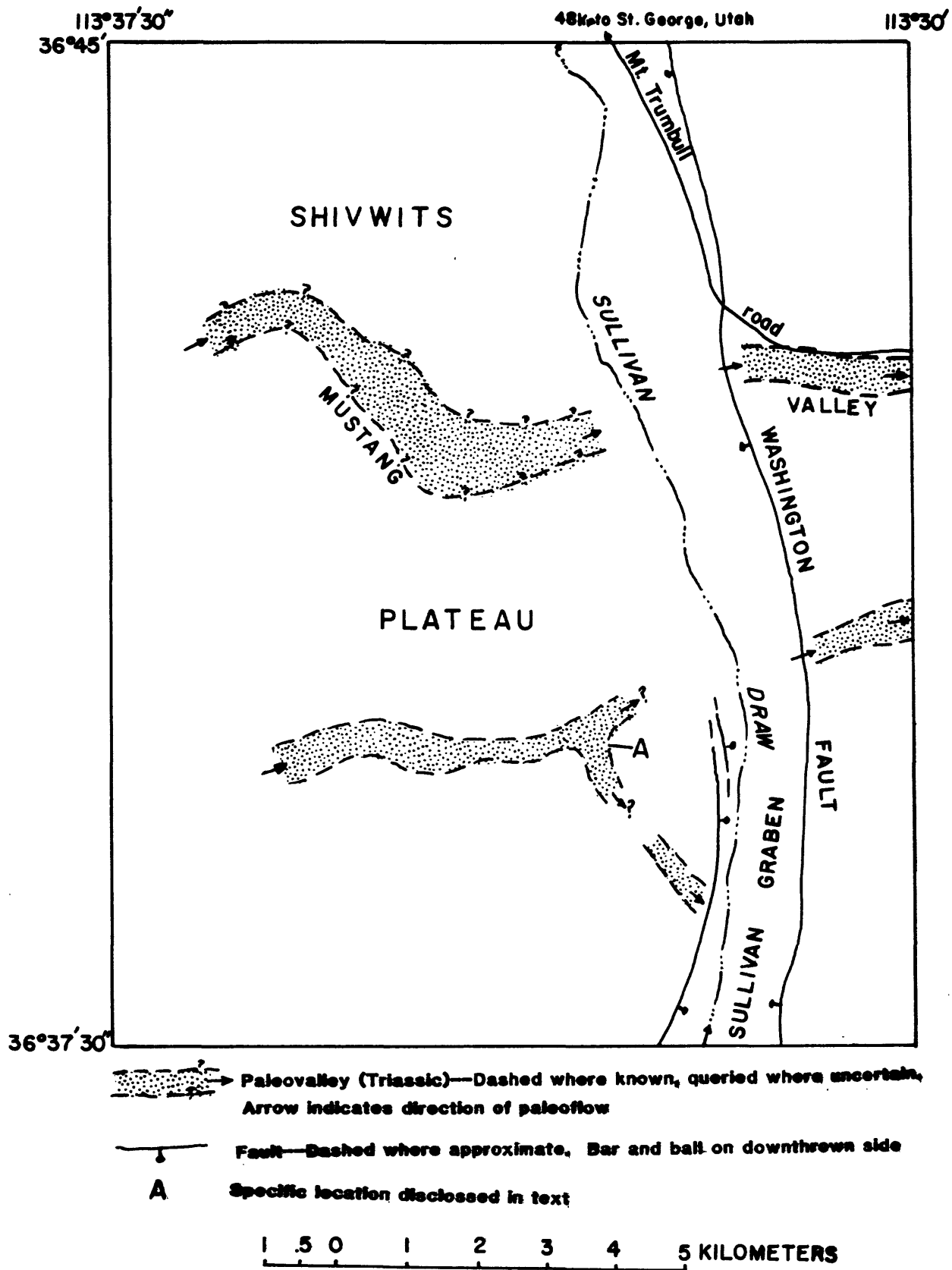


Figure 2. Selected geographic and geologic features of the Sullivan Draw North 7.5 quadrangle, northwestern Arizona.

## **STRUCTURAL GEOLOGY**

The Washington fault, named by Peterson (1963), displaces Paleozoic and Mesozoic strata down to the west an average of about 61 m for about 15 km along a north-south strike. The fault and associated Sullivan graben are the main structural features on this quadrangle. The Washington fault continues north into the adjoining Wolf Hole Mountain 7.5 quadrangle, and south into the adjoining Sullivan Draw South 7.5 quadrangle. Sullivan graben begins about the east central part of the map and continues south into the adjoining Sullivan Draw South 7.5 quadrangle. Sullivan graben averages about 0.8 km wide with about a 30 m displacement. Small local graben and fault movements have displaced alluvial fan debris at various localities along Sullivan Draw indicative of Holocene tectonic stresses.

The Washington fault marks the western boundary of a series of horst and graben structures that extend east about 12 km into the adjoining Dutchman Draw 7.5 quadrangle. The first horst is located along the east-central edge of the quadrangle.

Numerous local small sags and folds associated with solution of gypsum in the Kaibab Formation, especially near drainages, are too small and irregular to show at map scale.

### **Collapse Structures**

Circular collapse structures and other surface irregularities are due to solution of gypsum and gypsiferous siltstone. However, one circular, bowl-shaped area in the southeast corner of the map has inward-dipping strata that may be a collapse-formed breccia pipe originating in the deeply buried Mississippian Redwall Limestone (Wenrich and Huntoon, 1989). This feature is marked by a dot and the letter "C" to denote a possible deep-seated breccia pipe. Breccia pipes cannot with certainty be distinguished by surface form from shallow collapse structures caused by removal of gypsum. Moreover, some deep-seated breccia pipes are known to be overlain by gypsum collapse features (Wenrich and others, 1986). The deep-seated breccia pipes are potential hosts for economic deposits of copper and uranium; the shallow structures are unlikely to be mineralized (Wenrich, 1985).

Shallow sinkholes and karst caves are common on the bedrock surface of the map. The sinkholes and caves are marked with the letter "S" and a triangle symbol when the feature forms an enclosed depression or cave on the land surface. Many local drainages originate at open sinkhole depressions and are not shown on this quadrangle. The sinkholes are young features, Holocene and probably as old as Pleistocene.

## DESCRIPTION OF MAP UNITS

### Surficial Deposits

- Qf**      **Floodplain deposits (Holocene)**--Unconsolidated, light-gray or brown silt, sand, and lenses of pebble to cobble gravel. Intertongues and merges with valley-fill (Qv), alluvial fan (Qa<sub>1</sub>), talus (Qt), and terrace (Qg<sub>1</sub>) deposits. Thickly vegetated by cactus, rabbitbrush, and sagebrush in smaller drainages, moderately vegetated with mostly sagebrush in larger valley drainages. Cut by arroyos up to 13 m deep in Sullivan Valley. Subject to periodic flooding and local temporary ponding. Thickness about 3 to 30 m
- Qg<sub>1</sub>**      **Low terrace-gravel deposits (Holocene)**--Unconsolidated, light-brown, interstratified lenses of silt, sand, and pebble to cobble gravel. Gravel is composed about equally of well-rounded limestone to angular and subrounded chert clasts. Commonly merges with floodplain (Qf), alluvial fan (Qa<sub>1</sub>), and valley-fill (Qv) deposits. Forms bench about 1 to 4.5 m above Sullivan Draw. Thickness about 1 to 6 m
- Qa<sub>1</sub>**      **Young alluvial fan deposits (Holocene)**--Unconsolidated silt and sand; contains lenses of coarse gravel composed of subangular to rounded pebbles and cobbles of limestone and chert; partly cemented by gypsum and calcite. Merges with valley-fill (Qv), floodplain (Qf), low terrace-gravel (Qg<sub>1</sub>), and older alluvial fan (Qa<sub>2</sub>) deposits near their downslope ends. Subject to erosion by flash floods and sheet wash. Sparse to moderate vegetation of sagebrush, grass, and cactus. Thickness as much as 11 m
- Qv**      **Valley-fill deposits (Holocene and Pleistocene?)**--Partly consolidated silt, sand, and interbedded lenses of pebble to small cobble gravel. Consists of local talus (Qt), alluvial fan (Qa<sub>1</sub>), in small drainage valleys. Some deposits spread out as alluvial fans (Qa<sub>1</sub>) and merge with floodplain (Qf) deposits or other valley-fill (Qv) deposits at drainage junctions. Subject to sheetwash and ponding; cut by arroyos in larger valleys. Thickly vegetated by sagebrush, cactus, and some grass. Thickness as much as 10 m
- Qg<sub>2</sub>**      **High terrace-gravel deposits (Holocene and Pleistocene?)**--Similar to low terrace-gravel deposits (Qg<sub>1</sub>), partly consolidated; on benches about 3 to 12 m in Sullivan Valley. Merges with and locally overlain by alluvial fan (Qa<sub>1</sub>), and talus (Qt) shed from nearby bedrock surfaces. Thickness about 1.5 to 8 m

- Qa<sub>2</sub>**      **Older alluvial fan deposits (Holocene and Pleistocene)**--Similar to young alluvial fan deposits (Qa<sub>1</sub>); partly cemented by calcite and gypsum. Includes rounded basalt clasts up to 18 cm in diameter derived from basalt flows at Mustang Knoll, 2.4 km west of map area, northwest quarter of quadrangle. Older alluvial fans are partly buried by younger alluvial fans (Qa<sub>1</sub>) in Sullivan Valley indicating relatively recent down drop of Sullivan graben. Not all young alluvial fans (Qa<sub>1</sub>) are shown overlying or merging with older alluvial fans because of indifferent boundaries. Moderately vegetated by sagebrush, cactus, and grass. Thickness about 3 to 18 m
- Qt**          **Talus deposits (Holocene and Pleistocene)**--Unsorted debris consisting of brecciated gravel and blocks up to 3 m in diameter. Includes some sand and silt partly cemented by calcite and gypsum. Merges with valley-fill (Qv) and alluvial fans (Qa<sub>1</sub> and Qa<sub>2</sub>) deposits. Sparse vegetation of sagebrush, grass, and cactus. Thickness as much as 8 m

### **Sedimentary Rocks**

- Moenkopi Formation (Middle? and Lower Triassic)**--Includes, in descending order, Virgin Limestone, lower red, and Timpoweap Members as defined by Stewart and others (1972)
- ℞ mv**      **Virgin Limestone Member**--Light gray, ledge-forming, fossiliferous limestone; thin-bedded (1.3 to 7.5 cm). Only basal limestone and some siltstone of the Virgin exposed on this map. Virgin Limestone consists of three limestone beds averaging about 4.5 m thick separated by about 9 m of white to pale-yellow, slope-forming, thin-bedded gypsum and gypsiferous siltstone on adjoining Wolf Hole Mountain East 7.5 quadrangle, north of quadrangle. The limestone contains small star-shaped echinoderm columnals and some poorly preserved composita brachiopods. Thickness about 12 m
- ℞ ml**      **Lower red member**--Red and gray, thin-bedded, sandy siltstone interbedded with gray, white, and pale-yellow laminated gypsiferous siltstone and minor sandstone. Exposed in northwest quarter of quadrangle and locally elsewhere in collapse features and paleovalleys eroded into underlying Harrisburg Member of Kaibab Formation. Forms slope. Thickness about 3 to 24 m
- ℞ mt**      **Timpoweap Member**--Gray conglomerate and coarse-grained sandy limestone. Includes clasts (up to 15 cm in diameter) of dark-gray and gray limestone, white and brown fossiliferous chert, gray, coarse-grained to very coarse-grained limestone. Clasts are derived from Harrisburg Member of Kaibab Limestone. Partly fills paleovalleys eroded into Fossil Mountain Member of Kaibab Formation (fig. 2). Gradational contact with lower red member; contact not distinguished in southeast quarter of quadrangle where both members are combined (℞ mlt). Forms rounded ledges. Pebble imbrication indicates east flow of depositing stream in large

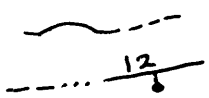
paleovalley northeast quarter of quadrangle. The Permian-Triassic paleovalley, where exposed, is about 55 m deep and 305 to 488 m wide and considered to be an eastern extension of Mustang valley from adjoining Mustang Knoll 7.5 quadrangle (Billingsley, in preparation). Buried part of Mustang Valley is queried on figure 2. Paleovalley that drains southeast appears to capture another paleovalley at A on figure 2. Thickness about 3 to 31 m

**R mlt** **Lower red and Timpoweap Members undivided**--Same lithologies as T ml and T mt above. Most outcrops are disaggregated into undistinguishable beds of light red to yellow-red siltstone and sandstone with chert conglomerate float on surface. Clasts consists of dark-gray, well rounded limestone and white to gray, fossilifereous chert derived from Kaibab Formation. Chert clasts about 2.5 to 10 cm in diameter. Fills shallow paleovalley channels eroded into Harrisburg Member of Kaibab Formation. Forms slope. Thickness about 1.5 to 15 m

**Kaibab Formation (Lower Permian)**--Includes, in descending order, Harrisburg and Fossil Mountain Members as defined by Sorauf and Billingsley (1991)

**Pkh** **Harrisburg Member**--Light-gray, fossiliferous, sandy, fine- to medium-grained, limestone interbedded with red and gray gypsiferous siltstone, sandstone, and gray gypsum beds several meters thick. Includes beds (0.6 to 1.2 m) of cherty limestone and sandy limestone that form resistant cliff 4.5 to 7.6 m near top of unit; forms surface caprock of quadrangle. Undermined thickness of gypsum and gypsiferous siltstone of upper units were eroded away prior to deposition of Moenkopi Formation. Solution of interbedded gypsum locally distorts member. Unconformable contact with Moenkopi Formation and locally obscure. Unit forms slope with limestone ledges. Thickness averages about 61 m

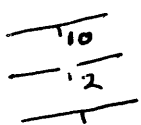
**Pkf** **Fossil Mountain Member**--Yellow-gray to gray, fine- to medium-grained, thin-bedded, fossiliferous, sandy, cherty, limestone. Chert weathers black. Gradational with overlying Harrisburg; arbitrary contact between cherty limestone and siltstone slope. Forms resistant surface or bench below slope. Bottom of member not exposed. Thickness about 24 m



**Contact**--Dashed where approximately located

**Fault**--Dashed where approximately located, short dashed where inferred, dotted where concealed; bar and ball on downthrown side. Number is estimated displacement in meters

**Strike and dip of strata**



**Inclined**

**Approximate**--Estimated photogeologically

**Implied**--Determined photogeologically, no estimate of amount determined



**Strike and dip of vertical joints**



- <sup>C</sup> **Collapse structure**--Circular collapse, strata dipping inward toward central point. May reflect deep-seated breccia-pipe collapse originating in Redwall Limestone
- ▲<sup>S</sup> **Sinkholes**--Steep walled or enclosed depression or cave

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## CORRELATION OF MAP UNITS SURFICIAL AND VOLCANIC DEPOSITS

\* See description of map units for exact unit age assignment

Qf	Qv*	Qg <sub>1</sub> *	Qa <sub>1</sub> *	Holocene	QUATERNARY
		Qg <sub>2</sub> *	Qa <sub>2</sub> *	Pleistocene	

## SEDIMENTARY ROCKS

Unconformity

		Tmv	] Middle? and Lower Triassic	] TRIASSIC
		Tml		
Tmlt		Tmt		

Unconformity

	Pkh	] Lower Permian	] PERMIAN
	Pkf		