

## Triassic and Jurassic History

Major changes in the tectonics of the Southwest occurred in the Late Permian, the last period of the Paleozoic, and in the Triassic, the oldest period in the Mesozoic. Plate convergence between this part of North America and oceanic plates in the Pacific was accommodated by a subduction zone that drove oceanic plates beneath the region. Water that was expelled from the subducting plates caused melting in the overlying mantle, producing a magmatic arc that crossed Arizona from northwest to southeast. Triassic arc-related igneous rocks are sparsely preserved in the region, but Triassic volcanic activity is recorded by volcanic ash, pebbles, and volcanic-derived sand grains in the Late Triassic Chinle Formation, the main unit in the Painted Desert and Petrified Forest National Park.

Jurassic rocks are widespread in southern Arizona, both as volcanic units and as granitic rocks, as part of the magmatic arc (▼). The most common Jurassic volcanics are felsic rocks

with quartz and feldspar crystals in a finer grained matrix. Many of these rocks represent ash-flow tuffs that were erupted from calderas, some of which have been identified. Others are rhyolite flows or are intrusions that rose to very shallow levels of the crust.

Within some of the Jurassic volcanics are sedimentary units of various types, including conglomerates and wind-deposited sandstone. Some Jurassic sequences contain conglomerates derived from nearby volcanics, but other conglomerates contain clasts from older rocks exposed in uplifted areas.

Most Jurassic rocks in southern Arizona have been metamorphosed and deformed, so they are schists and other metamorphic rocks. Granitic rocks of this age also bear the overprints of these structural and metamorphic events.



*Triassic and Jurassic tectonic features*

The lowest and oldest Mesozoic unit in the region is the Early to Middle Triassic Moenkopi Formation (▼). This series of reddish brown sandstones and siltstones, which can simply be called redbeds, contain cream-colored lenses and thin layers of gypsum in places, with these



layers becoming more abundant and continuous to the northwest, such as near St. George, Utah. It was deposited close to sea level, sometimes above and sometimes below. The Moenkopi is well exposed in and around Flagstaff and along the valley of the Little Colorado River. It forms reddish ledges in front of the Vermilion Cliffs.

*Moenkopi Formation on subsidiary road near US 89 milepost 460*

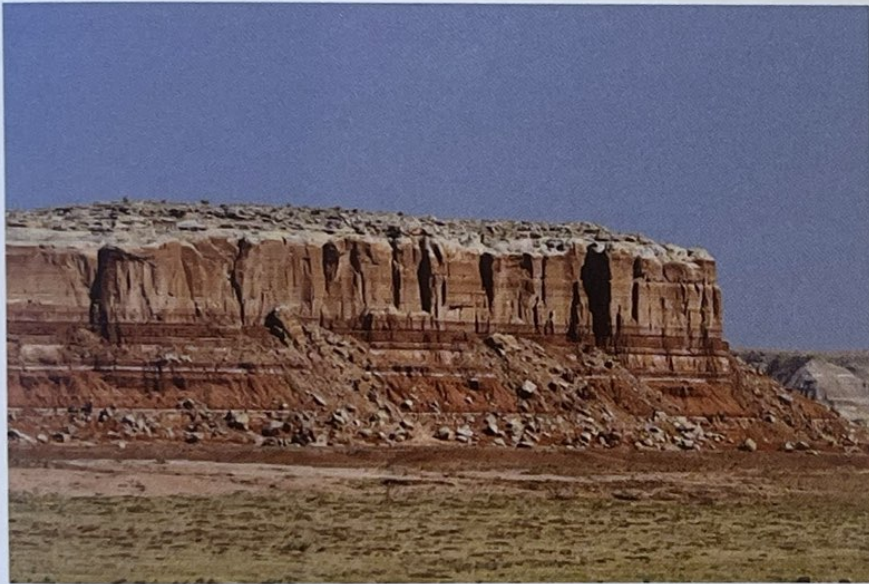
Above the Moenkopi is the Late Triassic Chinle Formation, exposed in the foreground in this view (▼). Much of the Chinle consists of easily eroded, ash-derived mudrocks. At its base



is the Shinarump Conglomerate member. On top of the Chinle are formations of the Late Triassic and Early Jurassic Glen Canyon Group, forming the reddish cliffs, ledges, and slopes in this photograph. The lower reddish slope and ledge are the Moenave Formation, the middle part is the Kayenta Formation, and the wind-deposited Navajo Sandstone caps the cliff.

*Triassic and Jurassic units in Echo Cliffs near US 89 milepost 490*

The San Rafael Group in Arizona consists of four units, two cliff-forming sandstones and two slope-forming units with reddish and cream-colored stripes. The units are, from top to bottom, the cliff-forming, pinkish-tan Bluff Sandstone (◄), the underlying, thinly layered Summerville Formation, and the reddish Entrada Sandstone, forming the base of the slope. The low area in front of the cliff consists of the fourth unit, the reddish, easily weathered Carmel Formation. The four formations are Middle Jurassic in age.



*San Rafael Group near Red Mesa, US 163 milepost 453*

Triassic and Jurassic units are also exposed in southern and western Arizona but generally have been at least somewhat metamorphosed. These include metasedimentary units, like the dark



Triassic Buckskin Formation and overlying, lighter-colored Jurassic Vampire Formation (◄). The region also has abundant Jurassic subduction-related volcanic and plutonic rocks in a broad belt from Quartzsite through the Tohono O'odham Nation and eastward to Bisbee. These rocks are commonly metamorphosed and highly deformed.

*Early Mesozoic units along Shea Road, Buckskin Mountains*