Geologic History — Tonto National Monument

Why is This Important?

The geologic history of central Arizona, of which Tonto National Monument is a part, is particularly interesting because of the concentration of archaeological sites found in the area. The geologic processes of erosion and deformation set the stage for where the Salado people would eventually settle. Geology provided the raw material from which they shaped tools and the building blocks for their dwellings and terraces. Additionally, geologic processes created the major stream systems, including the Salt River that the Salado used for farming.

By studying these processes, archaeologists learn about the cycles of deposition and erosion that have affected a site since its construction. Archaeologists use this knowledge to inform their decisions on interpretation, site reconstruction, and chronology building.

Introduction

The Tonto National Monument is in an area underlain by rocks that are roughly a billion years old. These rocks are now being exposed again after being buried by relatively younger gravel and conglomerate (a sedimentary rock that contains larger pebbles and is bound by smaller particles or chemical cement). They have been broken by faults, uplifted, tilted, and intruded by igneous rocks. However, the rocks we now see at the Monument reflect only a small part of the complex geologic history of central Arizona.

Determining Rock Ages

The ages of the rocks are based on two principal lines of evidence: comparisons with dated rocks in other areas and dates obtained by calculating the rate of decay of radioactive minerals in central Arizona rocks. Using the few roughly established dates as starting points, other ages are determined by extrapolation. Obviously, precise ages cannot be stated, but general ages are still meaningful because the time involved in geologic history is so great.

Geologic Events

The first geologic events we know about in central Arizona took place between 1.5 to 2 billion years ago. There is no evidence of any events that may have occurred during the preceding 2 to 3 billion years of earth's history. Seas covered central Arizona and great thicknesses of sedimentary and volcanic rocks were deposited. When the seas withdrew, the whole area was lifted, folded, and faulted.

Vast bodies of granitic igneous rocks were intruded during a period of structural deformation called the Mazatzal revolution. Some of this igneous rock is exposed where the road from Globe starts to descend into the Roosevelt basin. Many thousands of feet of these rocks were then removed during a long period of erosion, and the land surface was worn down to an almost featureless plain.

The next events geologists can reconstruct began with the encroaching of a shallow sea more than a billion years ago. The layers of siltstone, sandstone, and dolomite in this sea constitute the Apache Group and include most of the rocks exposed at the Monument. It was from the rocks in the geologic layers of the cliffs and river valleys that the Salado often fashioned their tools.

Volcanic activity somewhere in the region is indicated by thin basalt flows and by some fine-grained volcanic debris in several parts of the Apache Group. Some time after the Apache Group rocks were deposited, but still about a billion years ago, great masses of diabase were intruded into the rocks. After the diabase was intruded, many millions of years elapsed for which geologists have only a sparse record of geologic events. They know that this elapsed time ended with a period of erosion because the next event they can recognize, beginning a little less than half a billion years ago, is another encroachment of sea water over a partly beveled land surface.

This is the first of several times that central Arizona was under water in the Paleozoic era, the time from about 185 to 520 million years ago. Sedimentary rocks accumulated at the bottom of these seas and were entirely or partly worn away during periods of erosion when the seas temporarily withdrew. Of the Paleozoic rocks still remaining, the most striking are vast thicknesses of limestone, which were deposited in deep seas from between 100 to 300 million years ago.

The rocks exposed in cliffs along the road near the mouth of Queen Creek Canyon northeast of Superior are representative of the rocks deposited during this period. Geologists do not know how or when the last of the Paleozoic seas withdrew because erosion has removed the top layers of the rocks deposited. Our knowledge of the geologic events of the next 100 million years is again sketchy because almost all of the rocks that may have been deposited in the area have been removed by erosion. In the next 50 million years, an important series of events occurred and the area was subjected to tremendous forces. The rocks were wrenched apart and jumbled. Huge blocks were raised up and others dropped down, and masses of molten rock were injected.

Laramide orogeny

Hot solutions circulated through cracks in the rocks and deposited metal-bearing minerals in veins and disseminated deposits. The copper deposits in the Globe-Miami and Superior districts were emplaced during this period, but not as near to the surface as they are today. This period of intense deformation, called the Laramide orogeny, no doubt uplifted the central part of Arizona and most likely produced a region of high mountains. Mountainous country, however, is particularly subject to erosion, and these mountains were worn down so that the once deeply buried ore deposits and ancient rocks were again exposed. The exposure was temporary because a sheet of lava was poured out on to the land's surface sometime between 10 to 30 million years ago.

Part of this lava can be seen at the head of Queen Creek Canyon on the road between Miami and Superior. As soon as the lava was poured out, another period of deformation took place; the rocks were broken with some segments raised up, some dropped down, and others tilted. This period of deformation laid the foundation for the present shape of the land in central Arizona.

Gila conglomerate

The major mountain ranges of today were crudely defined by the uplifted or tilted segments. The basins began to be filled with rock debris eroded from surrounding highlands and swept into the low areas by swift streams. The gravel deposited at this time constitutes the Gila conglomerate, the rock that underlies Roosevelt basin north of the Tonto National Monument. The Gila conglomerate accumulated to tremendous thicknesses in the centers of the major basins and probably covered or nearly covered most of the lower mountain ranges. Minor volcanic activity sometimes accompanied deposition of the Gila conglomerate, as indicated by a few basalt flows with the interbedded gravel.

Finally, less than a million years ago, central Arizona along with a much larger area was lifted perhaps as much as three or four thousand feet. The uplift was fairly gentle and uniform with movement along faults in the lifted area. It was relatively insignificant, unlike the earlier stages of deformation, which broke and jumbled the rocks and created great mountain ranges and vast basins. As a result of the uplift, a new cycle of erosion was started, which is still in effect today. Major stream systems developed, and the streams began removing the tremendous accumulations of Gila conglomerate. Gradually, the Salt River cut a deep channel that enabled it to carry its deposits out to the deserts of the Phoenix area and points west.

Riparian area at Tonto National Park

The mountainous areas continue to be worn down and the rock debris deposited in the lowlands, but the rate at which the basins are being filled is slower than the rate at which the streams are removing material from the area. The result is that the valleys in central Arizona are slowly being deepened, the areas around the basins that once were buried by gravel are reappearing, and even the resistant rocks that form the mountains are steadily being worn away. Although the area experienced more recent changes such as side canyon flooding and rock falls, by 10,000 years ago the geologic landscape at Tonto National Monument looked similar to how we see it today.

This fact sheet is adapted from Robert Raup's 1962 report titled *Some Geological Features of the Tonto National Monument*. It is available through the National Park Service's archives.

For Further Reading

Tonto National Monument Fact Sheets

Geologic Features
Geology of Lower Ruins

Books

Waters, Michael. (1997). *Principles of Geoarchaeology: A North American Perspective*. Tucson, AZ: University of Arizona Press.