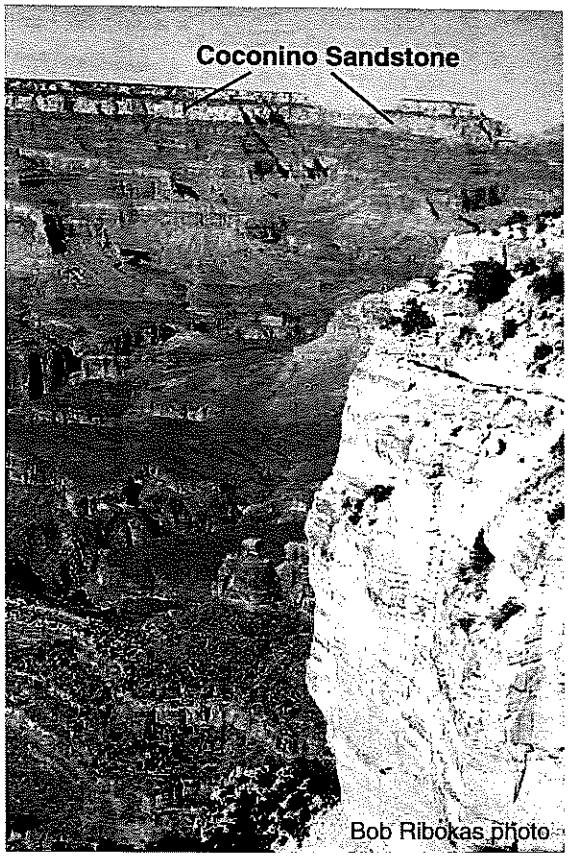
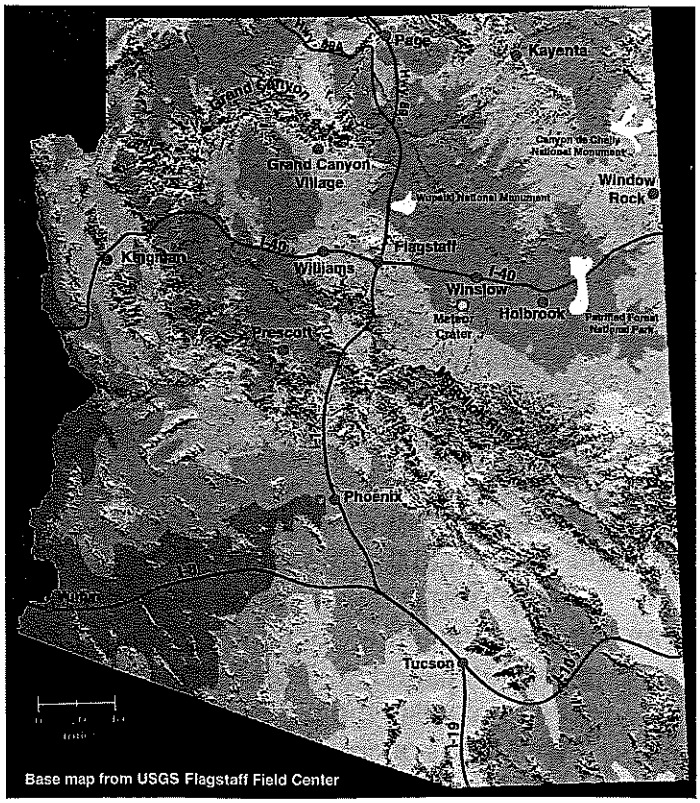
COCONINO STORIES

As you stand on the edge of the South Rim of the Grand Canyon gazing north, one layer of rock catches your eye in particular. It is almost pure white and appears just below the rim of the canyon, sandwiched between the darker layers of the Supai Group below and the Toroweap Formation above. It is often called the bathtub ring because of its appearance near the top of the canyon. This is the Coconino Sandstone.



The Coconino Sandstone is composed of well-rounded, pure quartz sand. Think about it. Where would you go to find such pure, rounded, well-sorted quartz sand today? At the beach!

As it turns out, a beach environment probably wouldn't provide enough sand to create a formation as extensive as the Coconino. Geologists have found outcrops of Coconino Sandstone many places on the Colorado Plateau, including southwest of Meteor Crater and south near Flagstaff, at the Mogollon Rim, and near Sedona. In fact, the Coconino



Sandstone covers nearly half the state of Arizona and is up to 1000 feet thick near the Mogollon Rim!

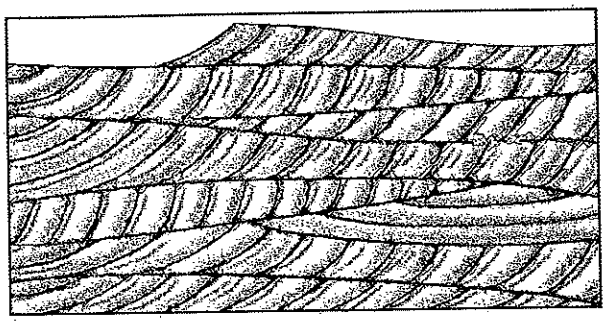
If the Coconino didn't form on a beach, then where? Geologists have found other clues to the possible environment in which the sand was deposited. They have seen large **crossbeds** in outcrops of Coconino Sandstone. You can see the crossbeds in the picture at the top of the next page. Crossbeds are thin layers that lie at different angles. They occur when the wind blows sand over the edge of a dune or (less often) when water moves sand down a stream. Geologists use crossbeds to help them tell which way the wind or water carrying the sand was moving.

Generally, crossbeds in windblown deposits are larger than those created in streambeds.

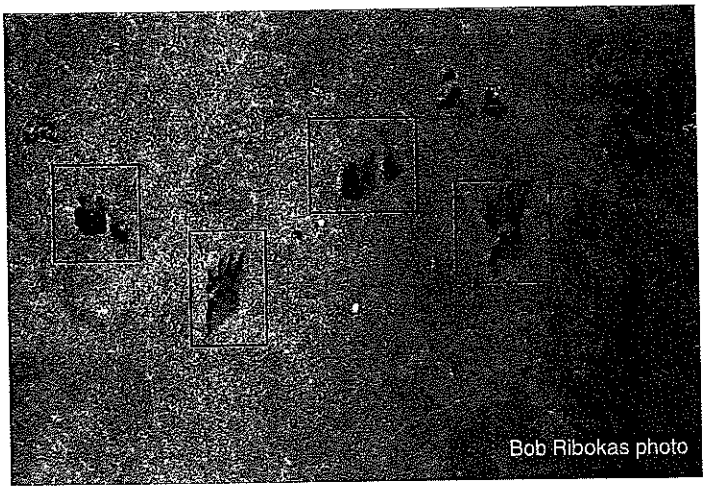
Crossbeds in Coconino Sandstone

The sand particles that make up the Coconino Sandstone also contain clues to its origin. The sand is mostly quartz, a very hard mineral. Other softer minerals have worn away totally. Viewed under a microscope, the quartz grains are **frosted,** giving them a foggy surface. Frosted surfaces suggest that the particles collided with each other as they were blown around by wind. Stream-eroded sand is usually polished and clear.

Geologists see the same crossbeds in sand dunes found in the Sahara Desert in Africa and White Sands National Monument in New Mexico. To a geologist, "the present is the key to the past." This is the **principle of uniformitarianism.** Geologists assume that the processes of erosion and deposition that they see happening *today* worked exactly the same way throughout geological time. They study the landforms, like beaches, sand dunes, and deltas, that result from these processes. Thus, when they see landforms preserved in rock layers millions of years old that are similar to landforms they see today, they can infer what the environment was like and what forces were at work when the sediments were deposited long ago. That is how geologists came up with the idea that the environment was dry and windy when the Coconino Sandstone sediments were laid down in the form of crossbedded dunes. How old is the Coconino Sandstone?



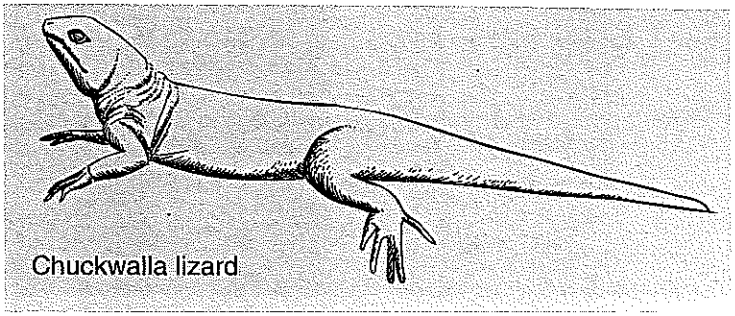
Geologists say that its average age is about 265–270 million years. That means it was deposited during the Permian period. Figuring out how old rocks are is part of the work of **paleontologists,** the scientists who study fossils. In places where the surface of the Coconino Sandstone has been exposed by erosion, they have found what they think are tracks of prehistoric animals. The tracks look like the ones in this photo.



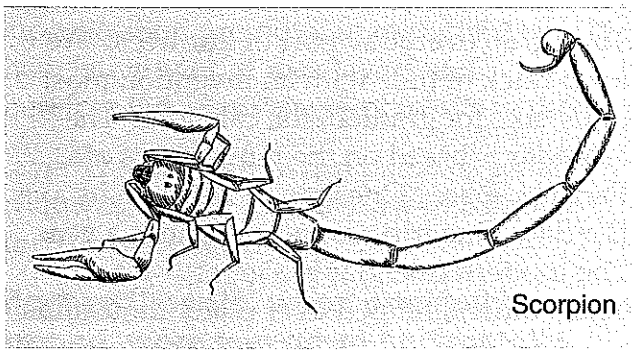
Bob Ribokas photo

The tracks might look like holes or dents in the rock to the casual observer, but to a paleontologist these holes are evidence that an ancient animal traveled over the prehistoric sand dunes. To the paleontologists the big questions are "What types of creatures could have made these tracks?" and "How were the

tracks preserved as fossils in what was probably a prehistoric sand dune?"


Chuckwalla lizard

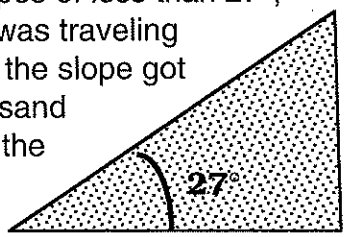
One scientist who worked on these questions was E. D. McKee. In 1940 he conducted experiments to duplicate the Coconino tracks. He filled a long trough with sand and propped it up on an angle, creating a model of a sand dune. He then encouraged a number of small animals, both vertebrate and invertebrate, to walk up and down the slope. The animals made tracks similar to the tracks in the Coconino Sandstone.


Scorpion

McKee tested two variables, the slope of the dune surface and the moisture content of the sand. He had the animals walk on dry sand, damp sand, very wet sand, and sand that was soaked and then dried.

McKee found that only the largest animals, the chuckwalla lizards, made tracks in the wet or crusted sand. But their tracks were not as clear as when they walked on the dry sand. Smaller animals, such as scorpions, didn't leave tracks in wet sand. They could only leave tracks in dry, loose sand.

McKee found that tracks were most likely to be preserved on slopes of less than 27°, whether the animal was traveling uphill or downhill. If the slope got any steeper, sliding sand would often destroy the tracks.



McKee concluded that the tracks in the Coconino Sandstone were probably formed in loose, dry sand. The sand was dampened by mist or fog before it was covered with another layer of sediment. Fogs and mists frequently cover areas of coastal sand dunes, so he thought the same thing might have happened in the Coconino environment.

Think Questions

1. Write a summary of E.D. McKee's study, including
   - What he knew before he started the investigation.
   - What he was trying to find out.
   - A description of his investigation.
   - His results.
   - His conclusions and inferences.

2. Consider the conclusions that McKee came to from his investigations.
   - Do you think his conclusions were good ones? Why or why not?
   - What other conclusions could you support with McKee's evidence?

3. Other scientists continue to study the Coconino tracks today. They have suggested that the tracks were made by animals walking on sandy surfaces covered by standing water.
   - What do you think?
   - How would you set up an investigation to provide evidence to support or disprove this conclusion?