Petrifying Wood

I had the pleasure last spring of visiting Arizona's Petrified Forest. What an amazing site! Acres of huge logs, now made of quartz, weathering out of the hill-sides, piling up in the washes, and paving the ground with bits of agate. Such details of preservation! The wood grains, rings, knots and cell structures all still visible. One wonders about the geologic conditions that could form such a deposit.

The geological setting is fortunately well-explained to the general public in the Park's literature. During the Triassic Period, about 200 million years ago, the area was a complex of swamps, lakes and rivers. An active volcano belt to the south regularly showered the area with ash. The mud, sand and ash covered ancient log jams of conifers and cycads as well as other plants and animals that lived there.

But how did the logs get converted to agate? Where did the silica come from? Why was it deposited? How did it so delicately preserve the wood's structure? Why is it so colorful? Answers to these questions can be drawn from the work of Anne Sigleo, who studied on the geochemistry of the petrified wood while she was at the University of Arizona in Tucson.

Where did the silica come from? It came out of the volcanic ash. The ash, originally a glass, weathered easily to clays such as montmorillonite. The weathering released silica in a form which is soluble in ground water. The ground water percolating through the sediment brought the silica to the logs.

Why was the silica deposited? Decaying logs form a local area relatively low in oxygen. Ordinarily, ground water is at least slightly oxygenated. When it reaches an area of low oxygen content, it changes chemically and deposits the silica.

How did the silica so delicately preserve the wood's structure? There are two possibilities. Either the silica replaced the wood chemically, atom by atom, or else it filled in the pores between the wood particles, a process called permineralization. Sigleo's work supports permineralization as the dominant process at work on the Petrified Forest. Her evidence was the details of texture seen under the scanning electron microscope and the discovery that original woody material (now degraded to lignin compounds) is still in the logs. The fact that wood is full of open pores is known to anyone who slaps paint on a fresh piece of wood. The woody porous structure thus served as template guiding the details of silica precipitation.

What gives the petrified wood such an array of color, with regions of pink, tan, purple, yellow, brown and black? The same processes that freed, transported and deposited the silica also applied to chemicals such as iron, manganese, uranium and antimony. The varying concentrations of these trace elements from place to place colors the wood.

Thus, Arizona's Petrified Forest resulted from a happy combination of circumstances beginning with the deposition and preservation of log jams in stagnant lakes and swamps later covered by volcanic ash. Normal chemical breakdown of the ash and movement of the chemicals by ground water into the wood's pores did the rest. Knowing this does not dim the appreciation of the startling vistas of agate-rich logs resting on Arizona badlands. We can all be grateful for the foresight of people like John Muir and Theodore Roosevelt that allowed these features to be protected so that all may enjoy them.

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References:

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