The Fossil Trees of Specimen Ridge

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In 1872 congress set aside land to create Yellowstone, our first national park. The land making up this national park is distributed across three states with 96% in Wyoming, 3% in Montana, and 1% in Idaho. Yellowstone is a Hot Spot, a volcano produced by a plume of magma that "punches" through the Earths' crust. The current Yellowstone Caldera was created by a massive eruption 640,000 years ago. Major eruptions occur at 600,000 to 900,000 year intervals. Yellowstone National Park is well known for its wildlife and geothermal features. Today, the forests of Yellowstone help to define a Subalpine Ecosystem. Lodgepole Pine makes up 80% of the forested areas. Engelmann Spruce, Douglas-fir, Subalpine Fir, Whitebark Pine, and Quaking Aspen are also common. Petrified wood deposits found in Yellowstone reveal a past environment and ecosystem very different from the one we enjoy today.

In Yellowstone, remnants of 27 fossil forests are embedded within 366 m of sediment (Kenrick & Davis, 2004, p. 61). Clusters of fossilized trees, exposed at Specimen Ridge, represent a succession of over a dozen of these forest remnants (Yuretich, 1984, p. 159). Many trees are preserved in their original growth position (Fritz, 1980, p. 313, Retallack, 1981, p. 52, Yuretich, 1984, p. 161).

The hike to Specimen Ridge begins at a pullout on the south side of the road 5.3 miles east of Tower Junction in the Lamar Valley. The 1.5-mile hike to the trees has a gain of 1,200 feet. The round trip is 3 miles and takes 2 to 3 hours. The hike is very strenuous.

The fossil plant deposits were formed during the Eocene by periodic volcanic activity some 48 million years ago as indicated by radiometric dating and biostratigraphic correlation (Fritz, 1984, p. 638). During the Eocene two northwest trending subparallel volcanic chains formed the Western and Eastern Absaroka Belts. The Absaroka eruptive centers were 25 to 60 km apart with a narrow intermontane basin in-between them. The Larmar River Formation petrified wood deposits are found between these two volcanic chains (Fritz, 1980, p. 312).

During volcanic eruptions mud flows and braided streams originating on surrounding stratovolcanic peaks of the Absaroka Volcanic Supergroup transported plant parts from higher to lower elevations as well as buried plants in place. Transported trees were stripped of bark, branches, and roots (Fritz, 1980, p. 312). Fossil trees preserved *in situ* have bark and intact root systems penetrating the substrate (Fritz, 1981, p. 54).

Stumps at specimen ridge are rooted in fine-grained tuffaceous sandstone that represents immature soils. Conglomerates that overlie these root-zone sandstones formed from volcanic sediments that flowed around and buried the trees where they grew (Yuretich, 1984, p. 161). The burial of these plants by intermittent volcanic sediment flows occurred in localized areas (Fritz, 1980, p. 312, 1984, p. 638). During quiescent times, new soil layers formed and a new forest would grow. Growth rings suggest that some of the forests grew for 500 years.

The tree composition of these ancient forests was typical of warm temperate to subtropical floras. This contrasts with today's Subalpine Ecosystem. More than 80 kinds of trees, shrubs, and herbs are known. Redwoods, maples, oaks, chestnuts, magnolias, walnuts, persimmons, dogwoods, laurels, and bays are some of the more common trees. The flora also contained some exotic trees whose relatives are now found in East Asia. Fossil woods reported from Specimen Ridge include: pine, fir, redwood, cypress, oak, beech, sycamore, willow, and laurels (Beyer, 1954, p. 567).

Trees buried in Quaternary fluvial volcaniclastic sediments and lahars at Mount St. Helens in Washington serve as a modern analogue for the Eocene aged volcanic deposits found in Yellowstone. Karowe and Jefferson (1987) examined trees buried in lahars and fluvial sediments by the 1980 eruption of Mount St. Helens. Trees buried in lahars or mudflows dated at 1885, A.D. 1450-1550 and 36,000 years B.P. were also investigated. Characteristics of trees buried *in situ* or in place were compared with those buried during transport (allochthonous burial).

Trees transported by fluvial volcaniclastic sediments at Mount St. Helens are poorly preserved and damaged by abrasion. Most trees transported by fluvial sediments were in a horizontal or inclined position, with many forming log jams. Although rare, trees transported upright were found to have a height no greater than 2 m with broad root mats measuring 1.5 m wide. These dimensions made them stable for being transported upright. The roots of trees transported upright are encased within mudflow matrix, thus they are not in a layer representing soil (Karowe & Jefferson, 1987, p. 197).

Trees buried in mudflows were found to be well preserved. Mudflows encased both transported trees as well as trees buried in place. The 1980 eruption produced mudflows that exposed trees buried by an 1885 lahar. The exhumed trees measured up to 7 m tall and 1 m in diameter. The tops of these trees are near the surface level of the 1885 mudflow, exhibit poor preservation and are covered with root systems from plants that grew after the eruption. Root systems of the upright trees penetrate a finer-grained matrix below the mudflow deposit that is laterally continuous, representing a soil-like layer and indicating *in situ* burial. Horizontal trees uprooted or snapped off and subsequently transported by the 1980 mudflow were deposited alongside the 1885 upright trees. At another site, root systems embedded in undisturbed layers provided evidence for trees buried *in situ* during a 1482 eruption. Trees buried in a mudflow dated at 36,000 years B.P. were found to have excellent preservation, showing that wood can be buried in lahar deposits for thousands of years without substantial decay (Karowe & Jefferson, 1987, pp. 192-196).

Trees buried *in situ* at Mount St. Helens share similar characteristics with fossil trees exposed at Specimen Ridge. Upright trees at Specimen Ridge are tall, with their sheared off tops coinciding with the upper surface of the mudflow units in which they were encased. The upper portions of the trees were poorly preserved. The root systems of the fossil trees penetrate a finer-grained matrix that is laterally continuous for many meters and positioned below the volcanic sediments (Karowe & Jefferson, 1987, pp. 201 & 202). The fine-grained matrix in which the roots are found is interpreted as a palaeosol. Thus, evidence at Mount St. Helens and at Specimen Ridge supports an *in situ* burial model for the upright trees of Yellowstone.

The cyclic nature of mudflow deposits through time at Mount St. Helens illustrates how successive lahars can bury and preserve portions of forests representing different ages. Species of fossil wood that, today, exhibit different climatic tolerances are found at

Yellowstone. Climatic changes occurring between mudflows of different ages could help to explain how tree species exhibiting different climatic tolerances can be found in the same location.

Will trees buried in these lahar deposits eventually become petrified? Karowe & Jefferson (1987) examined the wood found at Mount St. Helens for the initial stages of silicification. Wood buried in the 1980 eruptions showed no significant silica deposition. Wood buried in 1885 and A.D. 1450-1550 exhibited silica deposition on cell walls along with some decomposition. In wood dated at 36,000 years B.P. silica had penetrated cell walls. Break down of cell walls had also occurred. Karowe and Jefferson (1987) concluded that the increase in silica deposition as well as decay associated with trees buried in mudflows at Mount St. Helens supported the currently accepted theory of silicification (p. 203). The apparent increase in silica deposition over time was an exciting find. However, researchers at the University of Bonn were unable to reproduce the results of Karowe and Jefferson even when using specimens prepared from the same trees (Hellawell, Gee, Ballhaus, Clynne, and Sander (2011). Perhaps Karowe and Jefferson were looking at an instrumental artifact. Scientists at the University of Bonn are currently working on a paper that will explore the results of their study in more depth.

It is clear that many petrified wood deposits, such as those found in Yellowstone, are associated with ancient volcanic mudflows. George Mustoe from Western Washington University has examined many Holocene wood specimens from mudflows and has found no evidence of silicification (Mustoe, written personal communication, 2012). Read our article Petrified Wood: The Silicification of Wood by Permineralization to explore possible pathways and the time needed to form petrified wood.

Click on this picture to take a virtual hike up Specimen Ridge

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