EARTH

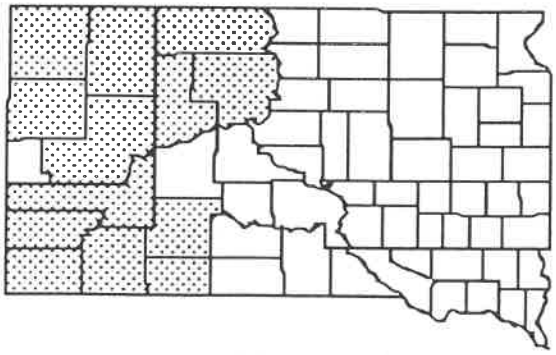
Fossils: Plants

PETRIFIED WOOD OF SOUTH DAKOTA

What Is Petrified Wood?

The word, to petrify, literally means, "turn to stone." Petrified wood, then, is wood that has turned to stone. The English word is similar to the Greek (piedra) and Latin (pietra) words for stone.

Petrified wood is a fossil of a woody plant preserved by *permineralization* through time by chemical and physical processes. In some cases, fossilized wood is readily identifiable. Generally, the species can be determined by examining thin slices of the fossil under a microscope. The microscopic structure of the fossilized wood is then compared to the cellular structure of living species.



Counties With Petrified Wood

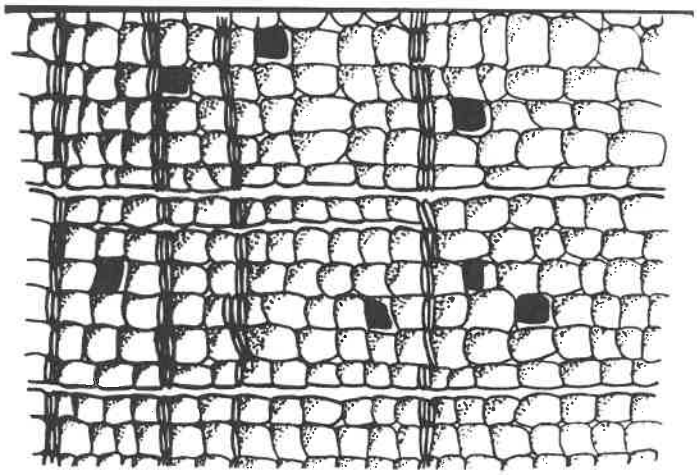


Figure 1. Microscopic Cross-section Of Petrified Wood (Bald Cypress) Showing Individual Cells.

Where Is Petrified Wood Found In South Dakota?

The early *Cretaceous* Lakota Sandstone deposits, which are found on the outside edge of the Black Hills, probably contain the oldest petrified wood specimens in the state. These fossils formed between 120 and 130 million years ago. Species in these deposits include bald or white cypress, several species of palm, and several species of *cycadeoids*.

Fossil wood is frequently encountered in the Hell Creek Formation that also con-

tains the last dinosaurs that lived at the end of the *Cretaceous*. These woods have not been studied but appear to include bald cypress-like trees. The Hell Creek Formation is found in the northwestern part of South Dakota.

Petrified wood from *Paleocene Epoch* deposits can be found on the prairies of western South Dakota, especially in the mid-northwest tier of counties and in the Badlands. These *Paleocene* fossils are younger than those found in the *Cretaceous* deposits. They began forming between 65 million and 38 million years ago. These younger fossils include *conifer* species, such as woodworthia, metasequoia, sequoia, hemlock, yew, and pine. Broadleaf species in *Paleocene* deposits are oak, poplar, sycamore, elm, willow, and hackberry.

How Does Petrified Wood Form?

The process of petrification is not completely understood because researchers have not been able to duplicate the process in the laboratory, where it can be observed and measured. But, certain conditions that must have existed for petrification to occur are known. Oxygen, which causes oxidation or rotting of all types of materials, would have to have been kept away from the dead plant material to prevent it from decaying before it was preserved. Most likely, the dead plant material was deprived of oxygen by being buried by sediments settling in water covering the plants. Much of the fossil wood found today is a product of ancient river and flood plain environments.

After rapid burial, the tree reacts to percolating water. Three things may happen. The log may disintegrate and not be fossilized. The log may be reduced by compression to a coal or it may become petrified. If petrification takes place, minerals from percolating water are deposited in fluid-filled openings in the wood. This process is called *permineralization* and it preserves the tissues of the wood! In some situations minerals may also substitute for the woody tissues of the log. This process is called *replacement*. Most petrified woods are *permineralized*. The entire process is not fully understood but is being actively studied.

The final condition, necessary for petrification, is time. The mineral *replacement* process is very slow, probably taking millions of years.

What Minerals Are In Petrified Wood?

The mineral content of petrified wood is easily identified using a *mass spectrometer* or *X-ray diffraction* technology. Silica, in the form of silicon dioxide (SiO_2), commonly known as quartz, is the most common *replacement* mineral. Often traces of other minerals give petrified wood its unique color and characteristics. Iron oxide will cause reds, browns, yellows and earth tones. Copper and chrome oxide create greens, silicates of aluminum produce whites, and manganese dioxide makes black.

Why Does South Dakota Have Such Different Fossil Species?

The phenomenon of *plate tectonics*, or continental drift, helps to answer this question. Although continental land masses appear to be solid and stable, they, in reality, are part of massive plates that are moving very slowly. The location of South Dakota today is not the same as it was during the *Cretaceous Period*. During the early *Cretaceous*, the entire North American continent was located much farther south. The area, now called South Dakota, was a few degrees to the south of our present latitude and was much closer to sea level. Also, at that time, there were no Rocky Mountains. The combined effects of these geographical differences resulted in an entirely different climate and air mass circulation patterns. Apparently, during the

Cretaceous Period, what is now South Dakota experienced higher average temperatures and greater precipitation than occur here today. Over the great expanse of geologic time, the North American plate acted as a huge barge, carrying the fallen trees that were buried under sediments. As the land mass gradually moved north and west, petrification of the trees occurred.

Conservation Measures

Often, petrified wood is found in large accumulations where the trees evidently grew, died and later petrified. These *in situ*, (in place), assemblages of petrified wood are called petrified forests. Usually, they are managed by either the Federal Government, (i.e. the Petrified Forest of Arizona), or State Government, (i.e. the Ginkgo Petrified Forest in Washington state). Some privately owned forests exist, such as one at Flora Mississippi. The Black Hills Petrified Forest in South Dakota near Piedmont is another example of a privately owned petrified forest. The address of this site is listed in the resource section below.

A petrified garden or park is a display of petrified wood probably not *in situ*. The Badlands Petrified Gardens are located near Kadoka. The city of Lemmon has a public park displaying fossil wood characteristic of the northwest part of the state.

As with all fossils, petrified wood is a limited resource that reveals a great deal about life in this area millions of years ago. People are encouraged to participate with museums in protecting South Dakota's fossil heritage. Fossil collectors must have permission from landowners in order to look for and collect specimens from private lands. It is illegal to collect fossils from Tribal lands without permission from Tribal authorities. Regulations on public lands vary, therefore, people always should contact the land manager before disturbing geological formations.

Glossary

Conifer - trees, such as pines and spruce. with needle-like leaves and reproduction through the development of cones.
Cretaceous Period - the period of geologic time between 144 and 65 million years ago.
Cycadeoid - a cycad-like plant common during the age of dinosaurs. Cycads are cone-bearing, tropical (or subtropical) plants with palm-like leaves.
Mass spectrometer - an instrument used to identify a substance by measuring the mass of an individual molecule.
Paleocene Epoch - that division of geologic time between 65 and 55 million years ago, after the dinosaurs became extinct.
Permineralization - the addition of minerals to spaces in an organic structure producing a fossil.
Plate tectonics - the scientific theory that explains the movement, through geologic time, of large land masses called plates, to which the continents are attached . The plates of land "float" very slowly on the mantle of molten rock inside the earth. The continents are passive passengers on the plates.
Replacement - the substitution of one mineral for materials in an organic structure producing a fossil.
X-ray diffraction - a technology used to identify the molecular structure of materials by bombarding them with x-rays and measuring the angle at which the rays are bent.

References

Stanley, Steven, 1989. Earth and Life Through Time, 2nd Edition, W.H. Freeman and Co.
Tidwell, W.D., 1975. Common Fossil Plants of Western North America, Brigham Young Press, Provo, Utah.

Selected Resources For Teachers

Black Hills Petrified Forest, HC-80, Box 766, Piedmont, SD 57769. The facilities are open to the public May 1 through October 1 with displays and sales of fossils and rocks.

Written by:
Gerald E. Teachout, Black Hills Petrified Forest, Piedmont, S.D. 57769. © 1995.

Reviewed by:
Dr. Philip Bjork, Museum of Geology, S.D. School of Mines and Technology, Rapid City, SD. 57001
Dr. James Martin, Museum of Geology, S.D. School of Mines and Technology, Rapid City, SD 57001

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