DEPARTMENT OF THE INTERIOR
HUBERT WORK, SECRETARY
NATIONAL PARK SERVICE
STEPHEN T. MATHER, DIRECTOR

THE PETRIFIED FOREST NATIONAL MONUMENT ARIZONA

Sections of petrified trees

RULES AND REGULATIONS

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1925

THE NATIONAL MONUMENTS AT A GLANCE

Administered by National Park Service, Department of the Interior

[Number, 32; total area, 3,681 square miles, or 2,356,044.31 acres; chronologically in order of creation]

Name	Location	Area (acres)	Special characteristics
Devils Tower	Wyoming	1,152	Remarkable natural rock tower, of volcanic origin, 1,200 feet in height.
Montezuma Castle.	Arizona	[1] 160	Prehistoric cliff-dwelling ruin of unusual size situated in a niche in face of a vertical cliff. Of scenic and ethnologic interest.
El Morro	New Mexico	240	Enormous sandstone rock eroded in form of a castle, upon which inscriptions have been placed by early Spanish explorers. Contains cliff-dweller ruins. Of great historic, scenic, and ethnologic interest.
Petrified Forest	Arizona	25,625	Abundance of petrified coniferous trees, one of which forms a small natural bridge. Is of great scientific interest.
Chaco Canyon (chä'kō).	New Mexico	[1] 20,629	Numerous cliff-dweller ruins, including communal houses, in good condition and but little excavated.
Muir Woods [2] (mūr).	California	426.43	One of the most noted redwood groves in California, and was donated by Hon. William Kent, ex-Member of Congress. Located 7 miles from San Francisco.
Pinnacles	do	2,980.26	Many spire-like rock formations, 600 to 1,000 feet high, visible many miles; also numerous caves and other formations.
Natural Bridges	Utah	[1] 2,740	3 natural bridges, among largest examples of their kind. Largest bridge is 222 feet high, 65 feet thick at top of arch; arch is 28 feet wide; span, 261 feet; height of span, 157 feet. Other two slightly smaller.
Lewis and Clark Cavern. [2]	Montana	160	Immense limestone cavern of great scientific interest, magnificently decorated with stalactite formations. Now closed to public because of depredations by vandals.
Tumacacori (tū-mä-kä'-kō-rē).	Arizona	10	Ruin of Franciscan mission dating from seventeenth century. Being restored by National Park Service rapidly as funds permit.
Navajo (năv'á-hō).	do	[1] 360	Numerous pueblo, or cliff-dweller ruins, in good preservation.
Shoshone Cavern (shō-shō'nē).	Wyoming	210	Cavern of considerable extent, near Cody.
Gran Quivira (grän kē-vē'rä).	New Mexico	[1] 560	One of the most important of earliest Spanish mission ruins in the Southwest. Monument also contains pueblo ruins.
Sitka	Alaska	[1] 57	Park of great natural beauty and historic interest as scene of massacre of Russians by Indians. Contains 16 totem poles of best native workmanship.
Rainbow Bridge	Utah	160	Unique natural bridge of great scientific interest and symmetry. Height 309 feet above water, and span is 278 feet, in shape of rainbow.
Colorado	Colorado	13,883	Many lofty monoliths, and is wonderful example of erosion, and of great scenic beauty and interest.
Papago Saguaro (pä'pä-gō ság-wä'rō).	Arizona	1,940.43	Splendid collection of characteristic desert flora and numerous pictographs. Interesting rock formations.
Dinosaur (dī'nō-sôr).	Utah	80	Deposits of fossil remains of prehistoric animal life of great scientific interest.
Capulin Mountain (kăpū'lĭn).	New Mexico	681	Cinder cone of geologically recent formation.
Verendrye (vér-rōn-drē).	North Dakota	253.04	Includes Crowhigh Butte, peculiar mountain formation, from which Explorer Verendrye first beheld territory beyond Missouri River.
Casa Grande [3] (ka'sä grän'dá).	Arizona	480	These ruins are one of the most noteworthy relics of a prehistoric age and people within the limits of the United States. Discovered in ruinous condition in 1694.
Katmai (kăt'mī)	Alaska	[1] 1,087,990	Wonderland of great scientific interest in the study of volcanism. Phenomena exist upon a scale of great magnitude. Includes "Valley of Ten Thousand Smokes."
Scotts Bluff	Nebraska	1,893.83	Region of historic and scientific interest. Many famous old trails traversed by the early pioneers in the winning of the West passed over and through this monument.
Yucca House [2] (yŭc-cä).	Colorado	9.6	Located on eastern slope of Sleeping Ute Mountain. Ruins of great archeological value, relic of prehistoric inhabitants.
Fossil Cycad	South Dakota	320	Area containing deposits of plant fossils.
Aztec Ruin [2]	New Mexico	4.6	Prehistoric ruin of pueblo type containing 500 rooms.
Hovenweep	Utah-Colorado	285.8	Four groups of prehistoric towers, pueblos and cliff dwellings.
Pipe Spring	Arizona	40	Old stone fort and spring of pure water in desert region serves as memorial to early western pioneer life.
Carlsbad Cave	New Mexico	719.22	Limestone caverns of extraordinary proportions and of unusual beauty.
Craters of the Moon.	Idaho	24,960	Weird volcanic region containing remarkable fissure eruption together with its associated volcanic cones, craters, lava flows, caves, natural bridges, and other phenomena.
Wupatki	Arizona	2,234.10	Prehistoric dwellings of ancestors of Hopi Indians.
Glacier Bay	Alaska	1,164,800	Contains tidewater glaciers of first rank.

[1] Estimated.

[2] Donated to the United States.

[3] From Mar. 2, 1889, until Aug. 3, 1918, classified as a national park.

THE
PETRIFIED FOREST NATIONAL MONUMENT

ARIZONA

INTRODUCTION

The deposits called the Petrified Forests of Arizona extend over an area of more than 100 square miles and present great variety both in structure of the log-bearing strata and in characteristics of the petrified wood.

The Arizona fossil forest surpasses in extent, in number of petrified trunks, in richness of coloring and in profusion of variegated chips any other deposit of this kind in the world. The rainbow hues seen in the cross sections of logs and in the fragments that glisten in the sun are responsible for the name by which this tract is best known, the Rainbow Forest.

AREA, LOCATION, AND ACCESSIBILITY

Owing to wanton destruction and the carting away of beautiful specimens it became necessary to put this forest under Federal protection, and about 90 square miles of this region were set aside as a national monument by presidential proclamation in 1906. In 1911 the reserve was reduced to its present size, 25,625 acres (about 40 square miles.) Thus great quantities of petrified wood are to be found outside of the monument boundaries.

Its location is in northeastern Arizona (Apache and Navajo Counties) on the south side of the Atchison, Topeka & Santa Fe Railway, and not far from the junction of the two branches of the National Old Trails Road at Holbrook (see maps). People traveling by rail can leave the train either at Adamana or Holbrook, where motor transportation to the monument can be secured. (For rates, see p. 9.)

Motorists coming over the north branch of the National Old Trails Road may take the road through Adamana and the forest to Holbrook going west, or detour at Holbrook through the forest to Adamana going east. Traveling over the south branch of the National Old Trails Road there is a convenient detour 1½ miles long and well marked with signs, 77 miles from Springerville and 18 miles from Holbrook.

The winters are generally mild and this monument may be visited any day in the year.

NOTE.—When heavy rains occur in this region the flood waters of the Rio Puerco may make the approach through Adamana temporarily impassable.

GEOLOGIC HISTORY: PROCESS OF FOSSILIZATION

The term "petrified forest" has occasioned much misunderstanding. Many persons having heard vaguely of such a forest, but not having had opportunity to see pictures of it or read articles thereon, expect to see a large group of standing petrified trees, more or less intact, or at least standing trunks or stumps as they occur in the Yellowstone petrified forest. No such thing can be seen in this locality; the petrified tree trunks, more or less fractured, dismembered, and lacking the branches, all lie prostrate on or in the ground. True, there are a few upright stumps, but they belonged originally to horizontally bedded trunks and have only tipped to their present standing position. This region may be more properly described as an eroded deposit of petrified drift logs, or the buried, petrified, and resurrected remains of a forest that grew somewhere else millions of years ago.

Yet no one need suffer any disappointment because the trees are not standing. Nature in its process of fracturing, dislocating, and shattering these logs has shown us that part which is perhaps the most interesting and startling, the interior with its multitude of colors.

As stated above, these trees did not grow at or even very near the place where they are now found. Every fossil log is stripped of its branches and roots, and the bark is seldom found; they all bear unmistakable signs of having been carried by water for great distance, and thus only the stoutest parts of the trunks survived.

From the relations of the stratum in which these trees are entombed, it is known that they grew in the Triassic period, several million years ago. The formation containing them is the Shinarump conglomerate and the overlying clays are the Chinle formation. Microscopic examination of the fossil wood discloses the fact that most of the logs in this region belong to an extinct species of cone-bearing tree, described by Dr. F. H. Knowlton as *Araucarioxylon arizonicum*. Doubtless extensive groves of these trees existed during the Triassic age in various areas in Arizona, and were the source of the logs.

The principal features in the history of the petrified trees are the sinking of a water-logged trunk, its rapid entombment in sediments and subsequent petrifaction. The trunks were carried by streams which at one time covered this region with a wide mantle of sand and conglomerate (now the Shinarump). They accumulated and sank in ponds or bayous and were rapidly buried by a thick deposit of clay. The illustrations show how the petrified forest region is made up of these sedimentary deposits. During part of late Mesozoic time which followed, the entire region was submerged by the sea and the tree-bearing deposit was deeply buried. At this stage the pressure at the lower levels became enormous, and the sands hardened to sandstone and the clays to shale. That the petrifaction began at some early time during the process of burial and was completed before the logs were deeply buried is shown by the fact that the logs are not materially flattened. The particles of wood decaying by slow oxidation were replaced by silica (quartz) from underground water, by a chemical process of substitution not

FIG. 1.—Large, well-preserved petrified tree in the Third Forest. Erosion has dealt gently with this log, and with the exception of the transverse cracks there has been no disturbance of its form since petrifaction

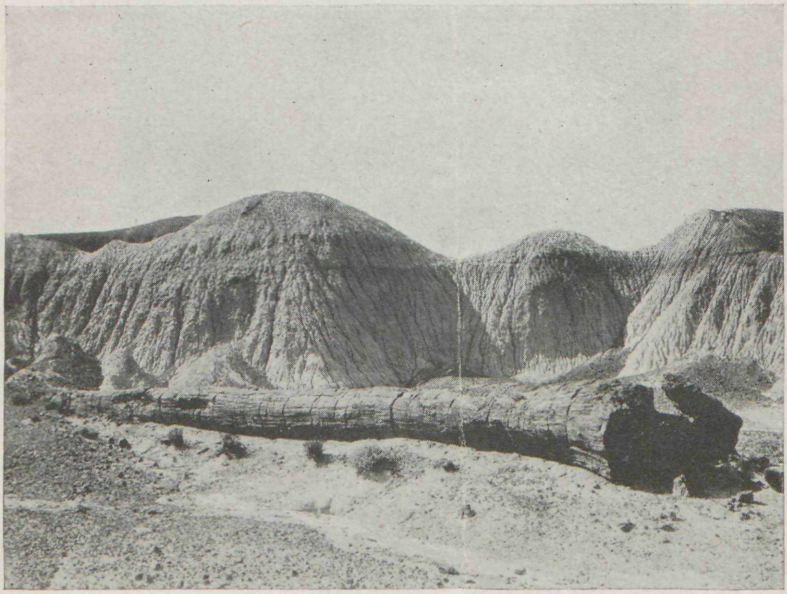


FIG. 2.—Large tree in Third Forest; not entirely uncovered. The small "wash" in the foreground has caused a weakening of the soil in the log. Hence the transverse fractures are opening up, and later erosion will effect a separation of the section

fully understood. The replacement of every tiny particle of the wood material was as a rule carried out with the greatest fidelity, so that some of the material shows today under the microscope all the cell-structure of the original wood, even to its minutest details (see fig. 3). As no two species of trees have exactly the same cellular structure in detail it is possible to determine through microscopic examination the species which are represented in this forest.

Had silica alone effected the petrifaction the resulting "stone trees" would have been white or gray as is generally the case in the petrified wood deposits of Montana, Wyoming, South Dakota, Colo-

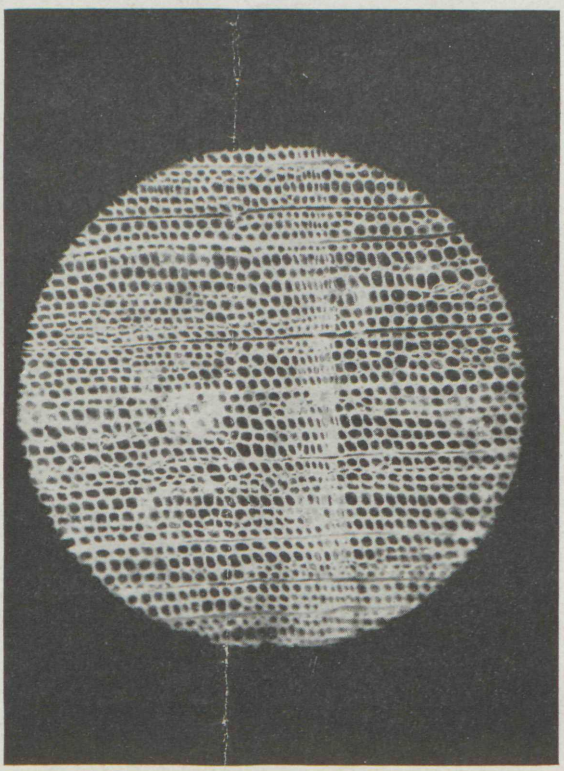


FIG. 3.—Photomicrograph of fossil wood from the Rainbow Forest. Section shows the ending of one season's growth (where small cells are closely grouped) and the large cells that mark the renewed growth in the spring. Growth rings (annular rings) are not visible to the unaided eye in the Arizona fossil wood; the "rings" so often seen in cross sections are merely more or less regular, concentric bands of differently colored petrifactions, due to zonal segregation of various minerals

rado, Nevada, and California. Fortunately, however, certain small amounts of iron and manganese were present and combined with the silica to form the highly colored chalcedony that constitutes the major portion of the Arizona fossil forest.

After the petrified trees had been deeply buried there followed a period of slow upheaval, and the erstwhile area of deposition became a high plateau, with its layer of petrified logs deeply buried. The Petrified Forest now lies at an altitude of approximately 1 mile

above sea level. During later ages the tooth of erosion, gnawing with varying intensity, removed thousands of feet of the superimposed layers of sandstone and clays and finally exposed the one that contained the logs, trenching deeply here and there, with the result shown in the illustrations.

The above is merely a skeletonized outline of the process, for the discussion of minor details is not within the scope of this pamphlet.

GENERAL DESCRIPTION

The reservation contains three principal districts, called the First, Second, and Third Forests. Geologically they belong to the same layer, but erosion has produced different results in the three areas; also does the color and texture of the wood vary considerably, so that a visit to each place is well worth while.

The First Forest, the smallest of the three, contains sections and fragments of logs that were once bedded in the upper layers of clay and sandstone which have now crumbled away with the exception of some knolls and spurs. Enough of the sandstone capping remains to indicate the continuity of the original mesa in which the logs were entombed. In this cap rock can be seen many remnants of logs still firmly held in place, awaiting the erosion of coming milleniums, while their ends, divided in many sections, adorn the furrowed slopes below. The fantastically carved escarpments, with banded colors, form a picturesque setting for this deposit.

The Natural Bridge (fig. 7) is found about one-half mile to the east. It is a log about 100 feet long, originally incased entirely in sandstone. The crumbling of this stone has exposed the largest part of the trunk and, beginning with a small channel under the central portion, has carved an arroyo under the log, so that the latter now forms a bridge of about 50-foot span. The length of the span and the immense weight of the trunk made it necessary (in 1917) to place a reinforced concrete beam as a support under this log.

It should not be supposed that this tree grew on the rocky ledge, fell across the arroyo, and petrified. Such is far from the truth. Instead, picture this region as the center of a vast basin overflowed by running water and gathering silt and gravel from surrounding higher elevations. Then imagine this very tree, water-logged and no longer able to float, descending through the water and settling to its resting place on a sand bar, next being covered with more sand and pebbles that formed sandstone and "covered by thousands of feet of clay and sand," then subjected to the ages upon ages of the chemical action we call petrifaction, which changed it from a wooden trunk to a mass of agate and carnelian without affecting its shape. Then picture the slow upheaval that drained the water from this basin; the gnawing of erosion through many thousands of years to remove the layers above this trunk; and the final crumbling, in spots, of the immediately surrounding sandstone to expose the log and form the gulley. Such, in short, is the story of this natural bridge.

The Second Forest lies about 2 miles south and a little to the east of the first one. In visiting it one makes a side trip from the main road (see maps). This district contains, in addition to the chips

FIG. 4.—Group of logs in Third Forest showing how erosion of soil causes separation of sections

FIG. 5.—Scene in First Forest showing advanced stage of erosion. The petrified wood occurs here as sections and fragments of logs

and scattered sections that are everywhere abundant, some rather well-preserved logs, a few of which are not entirely uncovered. The striking feature here is a number of logs of yellowish gray color and dull texture, quite a contrast to the more flinty and brightly colored specimens that prevail in the First Forest. This gray petrifaction shows under the microscope the minutest details of the original wood, and the grain can be readily recognized, even with the naked eye. In fact, it often looks remarkably like ordinary dry wood, and even at a short distance the appearance is deceptive.

The Third Forest lies about 6 miles south and west of the first one; it surpasses by far the first two deposits both in size, number of logs, and brilliancy of coloring. Here are found hundreds of logs in a good state of preservation. The picture on the front page as well as Figures 1, 2, 4, and 6 were taken in this locality. The illustrations show clearly the general appearance of the petrified trees. Stripped of branches, roots, and most of their bark, these huge trunks lie in great profusion, pointing in all directions, mute witnesses of conditions at a very remote period. Many exceed 100 feet in length. If the missing tops were reconstructed they would indicate that the trees in their growth often reached 200 feet or more. The outer surface is generally a reddish brown, while the cross sections reveal every tint of the rainbow.

The west portion of the Third Forest is the place which was directly responsible for the name Rainbow Forest. Here the colors of the wood reach their greatest intensity. The cap rock was partly worn away in the early stages of erosion and many deep ravines trenched through this bed of logs, after which the destructive agencies of weather through many thousands of years have reduced these trees to piles of fragments. The ground in every direction is literally paved with chips of agate, onyx, carnelian and jasper.

It may here be mentioned that part of the Third Forest extends beyond the west boundary of the reserve, so that vistors may there obtain samples of the petrified wood.

FOSSIL ANIMALS

In the Petrified Forest region there are many fossilized skeletons of extinct animals belonging to the later Triassic age. They consist mostly of scattered pieces of bones and teeth, but some complete skulls have been unearthed, proving these animals to be reptiles, specifically a Phytosaurus named *Machaeroprosopus validus*. The bones are, as a rule, of bluish-gray color, the teeth generally dark brown.

PREHISTORIC INDIAN LIFE

Signs of early Indian life are abundant through this district. Ruins, inscriptions, shards of pottery, stone hammers, and arrowheads (the latter made from petrified wood) are found in many places. In a few instances the Indians used blocks of petrified wood in the construction of the walls of their huts, and while the walls have tumbled long ago the rectangular outline of the foundations may still be seen. The Indians did not build houses of wooden logs which afterwards petrified, as some writers of magazine articles have claimed.

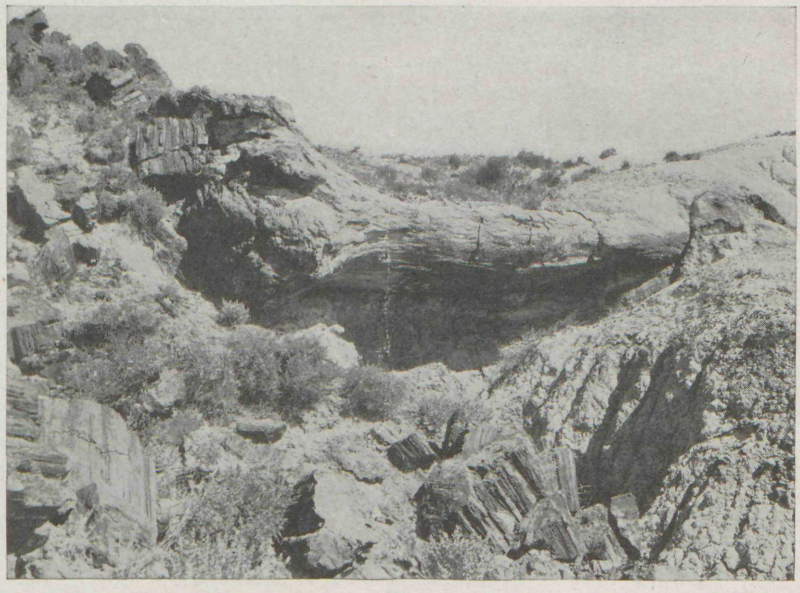


FIG. 6.—Large log in Third Forest being slowly undermined by erosion; illustrating the early stages of a "natural bridge" formation

FIG. 7.—The Natural Bridge. Here the erosion of thousands of years has so exposed this log that its central portion spans an arroyo about 50 feet wide, while both ends still remain bedded in sandstone. Now strengthened by a reinforced concrete beam, seen in picture as a dark band under the log

BLUE FOREST; PAINTED DESERT

These two districts, both containing petrified wood but not included in the monument, are very interesting and well worth visiting. The Blue Forest lies about 4 miles southeast of Adamana. Its blue-gray marl hills are quite picturesque, and it contains large quantities of petrified wood similar to that within the reserve.

The Painted Desert, near the north branch of the National Old Trails Road about 9 miles north of Adamana, is a district of highly colored marl hills and contains numerous petrified trees. The petrifactions here lack the bright colors of the Rainbow Forest, the wood being mostly dark and some of it jet black. This area should not be confused with the Painted Desert region east of the Grand Canyon.

ADMINISTRATION; BUILDINGS

The Petrified Forest National Monument is under the jurisdiction of the Department of the Interior, National Park Service, and is in charge of a custodian who resides in the Third Forest.

A small museum, housing some of the most rare and remarkable specimens, has been built in the Third Forest. A number of these specimens have been polished, and they exhibit in the greatest possible degree the wonderful coloring of the wood. No visitor should neglect the opportunity to see this collection. There is no charge for admission. A book for registration of visitors' names is kept here.

Camp ground, water supply, and lunch room are within a short distance of the museum.

The water supply depends on the yearly rainfall, which is scant, and can not fully take care of the demands made upon it by the great number of visitors. Tourists who intend to camp in the monument should preferably beforehand fill their canteens at Holbrook, Hunt, or Adamana.

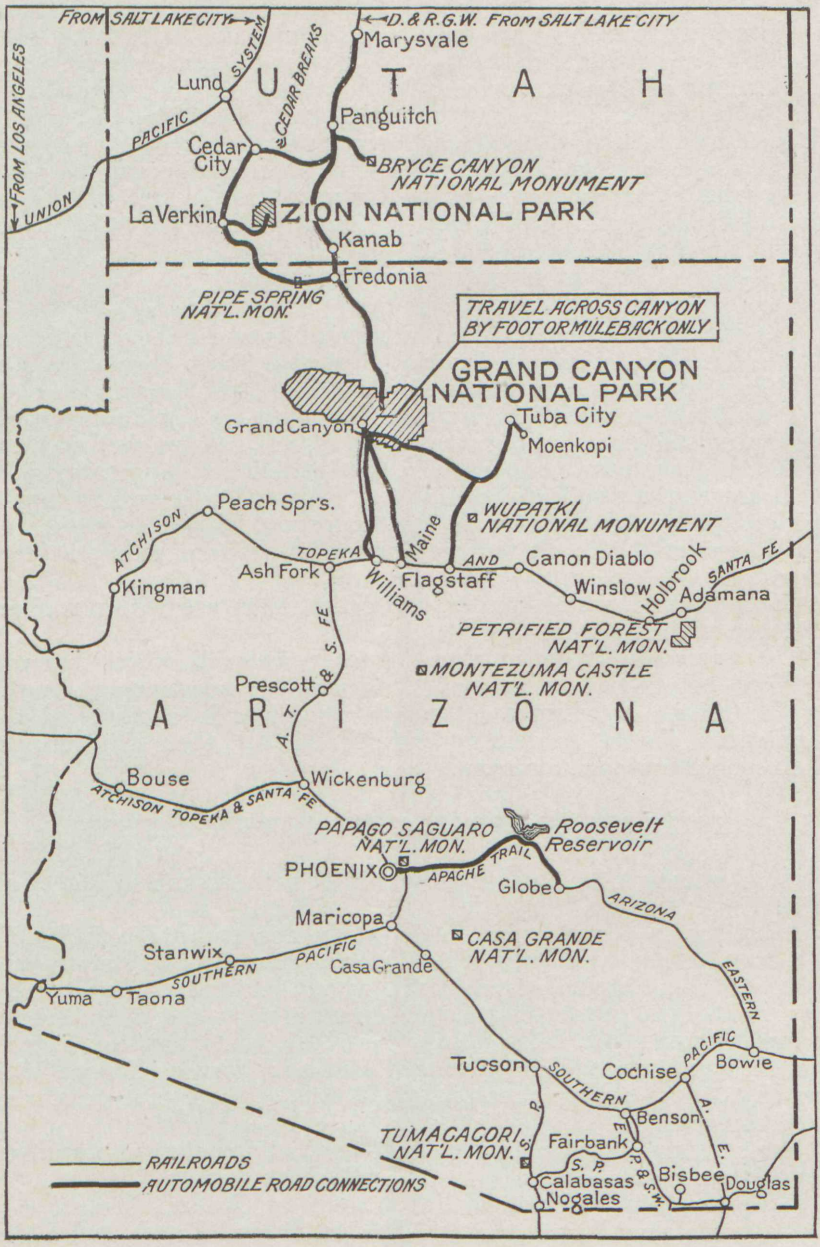
HOTEL AND TRANSPORTATION ACCOMMODATIONS

Hotel accommodations are available at both Adamana and Holbrook.

Adamana is a small place close to the forests on the Santa Fe Railway, consisting chiefly of hotel, post office, railway station, and a store. The Petrified Forest may be visited from Adamana any day in the year, except when flood waters make the streams temporarily impassable. The Forest Hotel at this point has electric lights, sanitary plumbing, and hot and cold water. Rates: $5.50 per day, American plan; meals only, $1 each. Thirty-five guests can be accommodated.

From Adamana the following automobile trips at rates approved by the service are made:

1. To the First and Second Forests and the Natural Bridge.
2. To the First Forest, Natural Bridge, Second Forest, and Third Forest.
3. To the Blue Forest.
4. To the Painted Desert and the Black (or North) Forest.



Map showing railroad connections to Petrified Forest National Monument

The round-trip fare from Adamana for either of trips Nos. 1, 3, or 4 is $5 for one person, $3 each for two persons, and $2.50 each for three or more persons. Round-trip fare for trip No. 2 is $10 for one person, $6 each for two persons, and $5 each for three or more persons. About one-half day is allotted to each trip, although three trips can be made in one day.

Holbrook, the county seat of Navajo County, and about 18 miles from the forests on the Santa Fe Railway, has several hotels and

Map showing principal automobile routes in Colorado, Utah, Arizona, and New Mexico

restaurants. Mr. C. B. Campbell, of Holbrook, furnishes taxi Service to the forests at the following rates approved by the service:

1. Trip to Third Forest: One passenger, $7.50; two passengers, $3.75 each; three or more passengers, $2.50 each.

2. Trip to First, Second, and Third Forests, $15 minimum; three passengers or more $5 per person.

3. Trip to Painted Desert, $10 for party of one, two, or three persons.

4. Round trip through First, Second, and Third Forests, the Blue Forest, and the Painted Desert, $20 minimum; $7.50 per passenger for three or more.

RULES AND REGULATIONS (BRIEFED)

The following briefed sections of the rules and regulations which are the law of the monument should be kept in mind and faithfully observed:

It is unlawful to injure, destroy, or appropriate specimens of petrified wood, of any size whatsoever, found within the monument boundary, and violators will be prosecuted to the full extent of the law. Penalty, up to $500 fine or 6 months imprisonment, or both.

At first glance it may seem that this law is quite drastic, because the fragments and chips are so abundant within the monument. But it should be remembered that we have now nearly 50,000 visitors a year; that it is most important to keep the *reserved* area intact, and that we may under the law supply specimens only to museums and scientific institutions.

Attention is called again to the fact that areas outside of the reserve contain great quantities of petrified wood, and the visitor may there obtain samples for souvenirs. These areas are: The Black Forest (in the Painted Desert), the Blue Forest, and that part of the Third Forest lying west of the boundary line. These places are indicated on the map. The spots where the boundary line of the reserve crosses the roads are conspicuously marked with signs.

Hunting or shooting within the monument is prohibited.

Do not leave rubbish without burying it.

Transportation of passengers for pay within the monument without permit from the National Park Service is prohibited.

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