50¢

THE STORY OF THE

Petrified Forest

GINKGO STATE PARK, WASHINGTON

FOSSIL TREE TYPES

Found in Ginkgo Petrified Forest State Park Area

Over 200 species of trees, representative of more than 50 genera, have been identified from an unlimited number of specimens uncovered in this area.

Among the genera positively identified, according to Prof. George Beck of Central Washington College, are true fir (Abies), sandarac tree (Callitris), ginkgo (Ginkgo), spruce (Picea). Douglas fir (Pseudotsuga), pine (Pinus), redwood (Sequoia), dawn redwood (Metasequoia), swamp cypress (Taxodium), yew (Taxus), maple (Acer), buckeye (Aesculus), alder (Alnus), birch (Betula), hickory (Carya), katsura (Cercidiphyllum), persimmon (Diosypros), beech (Fagus), ash (Fraxinus), bay (Gordonia), witch hazel (Hamamelis), walnut (Juglans), red gum (Liquidambar), mountain ash (Sorbus), sour gum (Nyssa), sycamore (Platanus), cottonwood (Populus), chinese "walnut" (Pterocarya), oak (Quercus) and elm (Ulmus).

THE STORY OF THE Petrified Forest

GINKGO STATE PARK, WASHINGTON

By C. FRANK BROCKMAN

INTRODUCTION

The Ginkgo Petrified Forest State Park embraces one of the most unique fossil forests in the world. A vast number of species, representative of numerous genera, are found here. Many have been positively identified (see inside front cover). No other fossil forest approaches this in number of species! Here, unlike most other petrified forests in the world, the trees were entombed and petrified in once-molten lava! And, while fossil leaves of the ginkgo have been discovered in many places, this is the only known location where petrifed wood of that tree has been found!

Why does a petrified forest exist here? The answer to this and many related questions lies rooted in an understanding of the geological story of central Washington — a story that carries one back to Miocene times, more than 15 million years ago.

A VARIED, DIVERSIFIED FOREST ONCE FLOURISHED IN THIS REGION

More than 15 million years ago the topography of central Washington was vastly different from the present terrain. The Cascade Range was, as yet, unborn. The Columbia River followed a different course, uncharacterized by the great arc which encloses the area now known as the "big bend country." Between the present location of the Coulee Dam and the southern part of the state there existed a greatly dissected basin, surrounded by mountains — the southern extension of an ancient land mass now represented by the Okanagan highlands. Through this region, from their sources in the northern mountains, flowed the tributaries of the Columbia — the upper portions of which are represented by streams which we know by such names as Wenatchee, Methow, and Okanagan.

As may well be imagined, the climate here at that time was equally different. Then central Washington was a more humid region. Considerably more moisture was deposited by winds which swept inland from the Pacific, unimpeded by the barrier of the Cascades which today cause the greater part of this moisture to fall upon their western side. In addition, most of the rainfall apparently fell during the summer rather than the winter, as it does today. Because of this, central Washington, in that ancient day, supported a rich and diversified forest typical of the varying conditions of climate and soil at different elevations.

Upon the upper levels of the northern highlands, in what is now northern Washington and British Columbia, flourished a forest composed primarily of cone-bearing trees such as sequoias, pines, firs, and spruces. Upon the lower slopes of adjacent foothills, grew a variety of broadleaved trees such as oaks, maples, sycamores, beeches, hickories, chestnuts, and the like. In the lower valleys, some of which were characterized by bordering river swamps not unlike the lower Mississippi today, grew cypress, water tupelo, and other trees which preferred the moist habitat of such an area.

It is significant that, while many of these hardwoods and a few of the conifers have counterparts in present-day American forests, few exist in this part of Washington today. In addition to those trees mentioned, one would have found others which are now extinct, or nearly so, such as the ginkgo — "sacred tree of the Orient".

THE FIRST LAVA FLOWS TRANSFORMED CENTRAL WASHINGTON INTO A LOW, SWAMPY BASIN

Thus the stage was set for a series of cataclysmic occurrences which were to modify greatly the appearance and the climate of central Washington, and give us the petrified forest which we find here today.

The first in ths series of events took place some ten to fifteen million years ago. At that time lava flows, welling up quietly from fissures in the earth, invaded this region. Relentlessly pushing northward, this lava eventually over-ran the basin previously characteristic of this area. The original valleys were filled with lava, and even the tops of the ridges and low mountains were deeply buried. As a result of the leveling-off process of these flows, the previously well-dissected basin was transformed into a relatively flat area.

Here the progress of the swift mountain streams of the northern highlands was arrested. Dallying slowly across the broad, flat basin, they formed swamps, lakes, and other expanses of quiet water; and in this environment there developed extensive forests of swamp-loving trees. Except for their greater extent, these were much like the river-bordering swamp forests of a former time — consisting of cypress, water tupelo, and similar species. Higher levels not inundated by the lava continued to support forests of broadleaved trees. Likewise, still higher elevations in the more distant mountains continued to foster forests dominated by conifers.

LOGS, TRANSPORTED TO THIS AREA BY STREAMS, ACCUMULATED IN THE SWAMPS AND LAKES

With the passing of time many of the trees of the upland forests — conifers which grew in the high, northern mountains as well as boradleaved trees of adjacent foothills — completed their life span and fell to earth. By various means they were "worried" down the slopes to turbulent steams, which eventually transported the fallen logs to the more quiet waters of the lowland swamps. There, scoured of limbs and bark, these miscellaneous logs mingled with the trees of the swamplands as heterogeneous rafts upon the surface of the calm waters.

THE SWAMPY BASIN WAS REPEATEDLY COVERED BY LATER LAVAS

Volcanic activity continued to play a dominant role in the modification of this region. Throughout a long period of time following the development of the broad, swampy basin, this area was repeatedly over-run by later lavas which, like the previous flows, welled quietly from fissures in the earth. The trees here — both those growing in the swampy soils and those which, as logs, had been carried down from the northern highlands — were engulfed by these molten masses.

Surface vegetation was destroyed by the accompanying heat and flame. Likewise, floating logs and those covered by only a few feet of water were destroyed.

Lava which cooled slowly upon the surface formed dark, granular material known as basalt — which ordinarily takes the form of four to six-sided columns. When it poured into deep water the lava cooled rapidly into a sticky mass of rounded "pillows". The resulting yellowish to glassy lava rock is known as palagonite.

Previous to these lava flows many of the logs had become water-logged and lay submerged in the lakes and swamps. Amply protected by deep water, they were surrounded by the "pillows" of lava. Thus, those deeply submerged logs were sealed in a relatively undamaged condition for an eternity. Silica and other minerals, probably derived from the lavas, were forced through these logs by accompanying steam and gases. These minerals impregnated the open pores and surrounded or replaced the cell walls of the wood, which eventually became petrified.

Numerous such lava invasions, interspersed by long periods of quiet, occurred over a period of several million years. In time, as each of these lava invasions spent its force, cooled, and solidified, the lakes, swamps, and streams again assumed dominance over the land. Consequently the original forests were repeatedly able to re-establish themselves here. But with each impact of later lava these re-established forests were destroyed again, and a new layer of logs was engulfed and preserved.

Approximately fifty lava flows inundated this region, accumulating to a thickness of thousands of feet. Eventually they forced the great Columbia River to its present course, and in so doing, the lower portions of its tributaries were completely obliterated. Today only the northern extensions of these streams — the Methow, Wenatchee, Okanagan, and others — remain as indicators of the former pattern of drainage.

THE CASCADE UPLIFT CHANGED THE CLIMATE OF CENTRAL WASHINGTON

Concurrent with the latter stages of these lava flows came a great uplift to the west. This eventually evolved into the Cascade Range, which formed a barrier to the free passage of moisture-laden winds from the Pacific to the inland areas. Such winds lose much of their

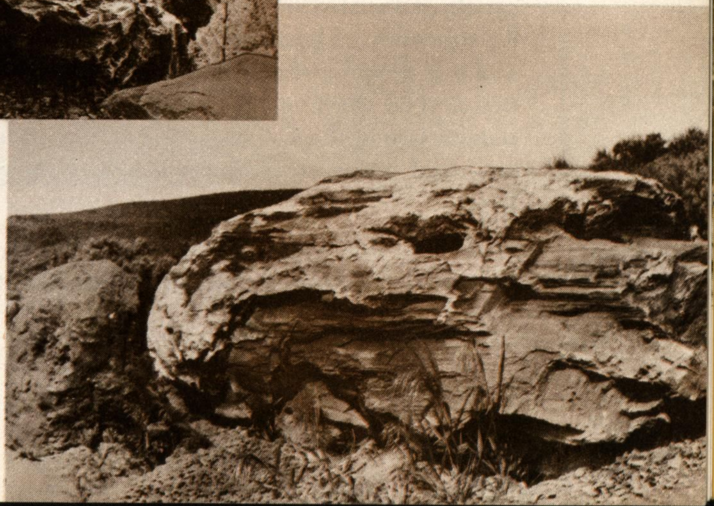
moisture as fog, rain, or snow when they rise into the higher and cooler air strata in passing over the Cascades. This accounts for the present moist, humid climate of western Washington and the more arid conditions to the east.

Thus, when the Cascades were formed, the lush, humid forests characteristic of eastern Washington in pre-historic times were doomed. Another highly important factor in the decline of these forests was the change in the seasonal pattern of rainfall — from summer to winter — which occurred at about the same time. The forests could not maintain themselves here as they had in the past. In time they were replaced by plants of different species adapted to a more arid climate.

THE BURIED, PETRIFIED LOGS WERE EXPOSED BY EROSION

The uplift of the Cascades had a profound effect in other ways; ways that determined why we may see many of these logs which were engulfed and preserved in lava millions of years ago.

Examples of petrified logs, Ginkgo Petrified Forest State Park, Vantage, Washington.



These logs were once living trees in a pre-historic forest of central Washington.

Co-incident with the formation of the Cascades came a general uplift of the great lava plain to the east. As this land was slowly raised, accelerated erosion stripped away much of the surface. Streams, glaciers of the ice age, torrential waters from melting ice as the glaciers receded, wind, frost action, and many other factors played their part. The lava basin with its successive layers of lava and petrified logs, was dissected into a mass of deep canyons, channels, and gullies interspersed by hills, ridges, and minor mountains. By such action many of the buried petrified logs were destroyed, but many others were exposed or rendered more easily accessible to those seeking them beneath the relatively shallow surface.

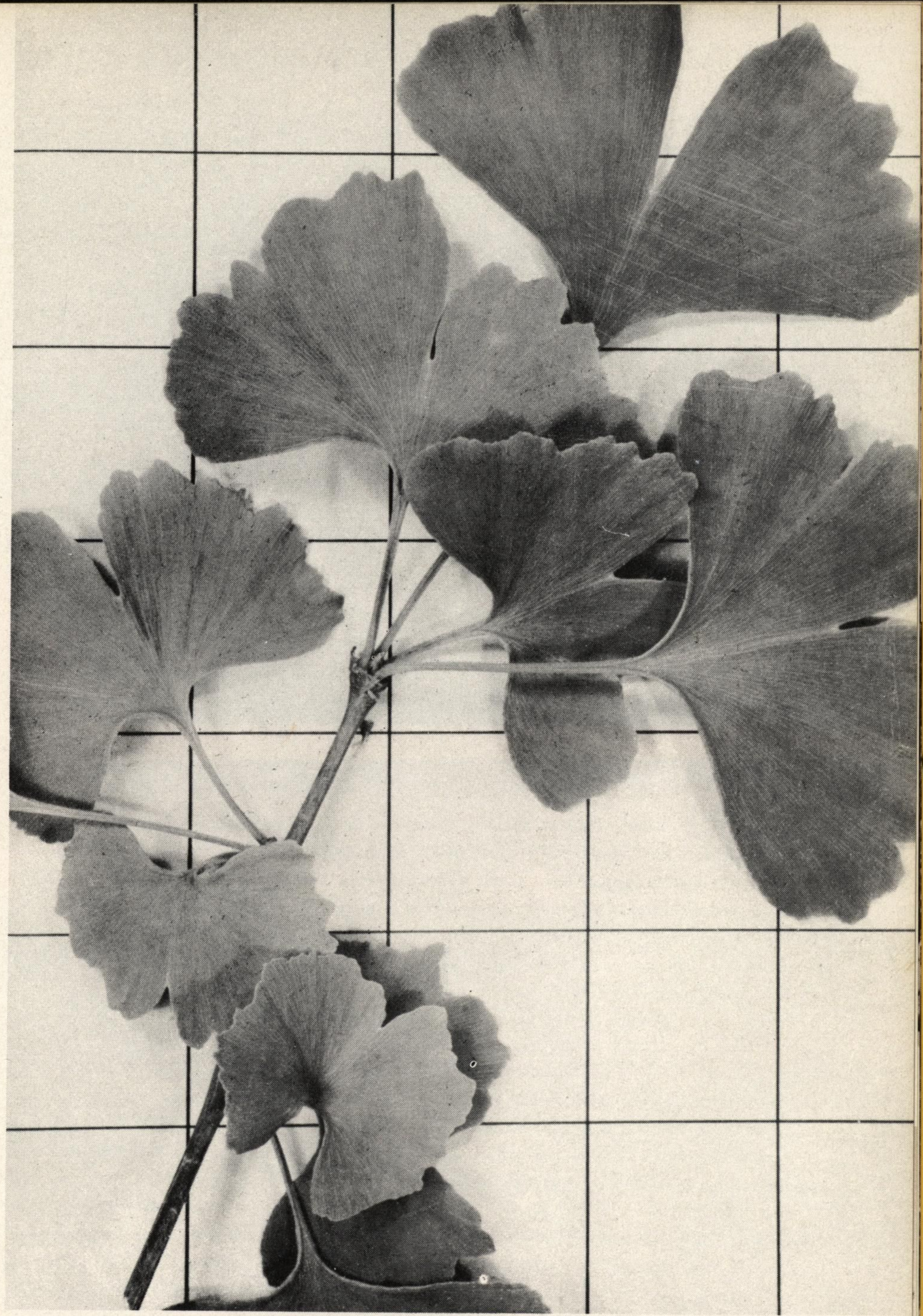
In such places — upon the upper portions of ridges and hills in this region — they remain today mementoes of a distant past, preserved in lava as symbols of the forest wealth of this region in yesteryear.

THE GINKGO TREE

The modern ginkgo (Ginkgo biloba) is often referred to as a "living fossil". It is the only survivor of a family of trees (Ginkgoaceae), once widely distributed over the temperate regions of both the northern and southern hemispheres, which existed at a time when such pre-historic animals as the dinossaurs and peridactyls roamed the earth. Many fossil ginkgoes have been described from ancient rocks in the United States, Canada, Great Britain, Greenland, China, Japan, Franz-Joseph-Land, Siberia, and even Australia.

Very likely the disappearance of the ginkgo throughout much of its original natural range resulted from effects co-incident with the approach of the ice age. However, in the Orient, where the effects of the ice age were not so severe, it survived. Yet even there it does not exist in the wild state today. It is found only as a planted tree, usually associated with religious buildings, tombs, palaces, and similar structures. About such places it has been cultivated for centuries, and it is probably due to this fact that it owes its existence in modern times. The exact reason for the disappearance of the ginkgo as a natural tree in the Orient, where many fossils indicate former abundance and where no obvious reasons for its elimination exists, is unknown.

The earliest known record, in books, of the ginkgo is contained in a Chinese volume on agriculture which dates from the eighth



The foliage of the ginkgo (Ginkgo biloba) is fan-like with an irregularly incised apex. The size of the leaves is indicated by inch squares on the background.

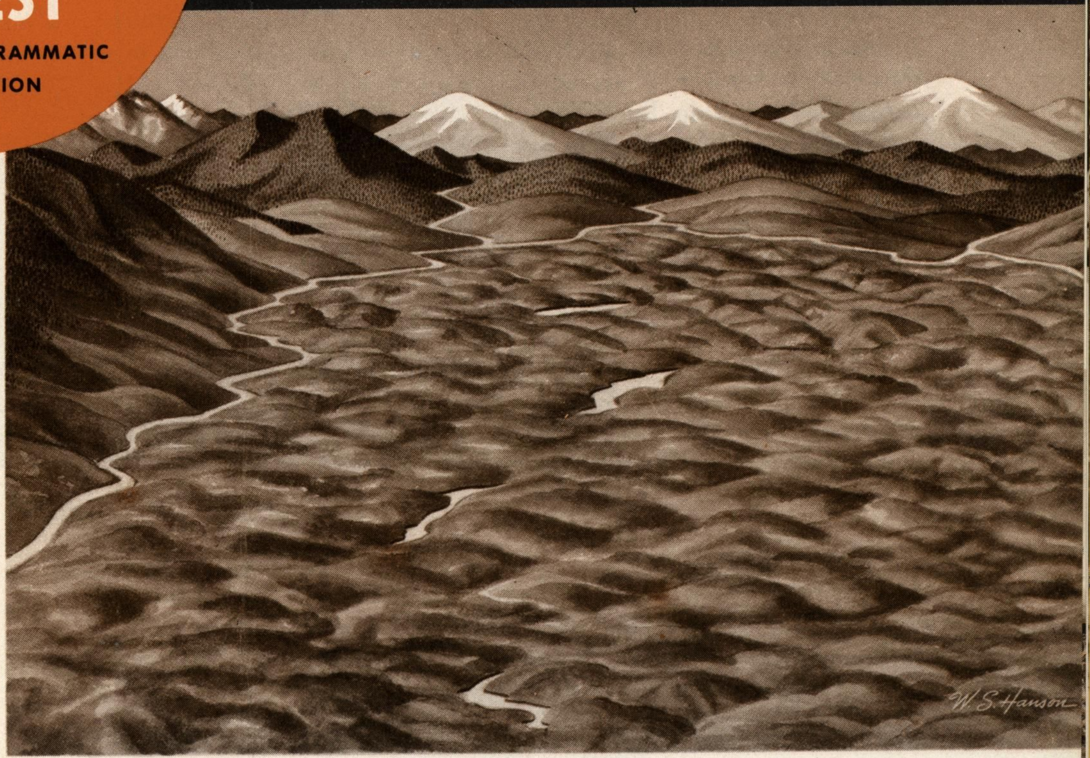
EVOLUTION OF THE PETRIFIED FOREST

ARTIST'S DIAGRAMMATIC CONCEPTION

STAGE NO. 1

STAGE NO. 2

STAGE NO. 3



STAGE NO. 1. MORE THAN 15 MILLION YEARS AGO the Cascade Range was not in existance and the Columbia River followed a much different course. The Central Washington area was a low, greatly dissected basin bordered by foothills and mountains where grew a great variety of trees supported by the moist, humid climate typical of this region in that day. Many of the trees of the foothills and mountains, falling to earth after completing their life span, were carried by streams to the lowlands. There they mingled, as floating or submerged logs, with water-loving species growing in river-bordering swamps. (See page 1).

STAGE NO. 2. ABOUT 10 TO 15 MILLION YEARS AGO lava, welling quietly from fissures in the earth, began to invade this area. Layer upon layer, a series of flows eventually inundated much of the original terrain to a depth of thousands of feet. Each flow was followed by a long period of quiet during which native vegetation re-developed and the streams, flowing slowly across a more level surface, formed extensive lakes and swamps characterized by accumulations of logs carried in by streams from higher ground. In turn, each of these forests were engulfed by later lavas. Surface vegetation was destroyed but submerged logs, protected by deep water, were sealed by the lava and became petrified. (See page 2).

STAGE NO. 3. FOLLOWING THE LAVA INVASIONS, tremendous upheavals formed the Cascade Range, which intercepted the moisture-laden winds from the Pacific. Thus the climate of this inland area became more arid and the lush forests of earlier times could not re-establish themselves. At the same time, accelerated erosion began dissecting the lava plain, eventually transforming it into its present day character. Although erosion undoubtedly destroyed many of the petrified logs, numerous others were exposed or made more readily accessible beneath a relatively shallow surface. (See page 4).

century of the Christian era. Later, in 1578, a published account of this tree refers to it as Ya-chio-tzu (the tree with leaves like a duck's foot). More modern Chinese names are Yin-kou-tsu (silver nut-tree) and Pai-kou-tsu (white nut-tree). In Korea and Japan it is known by translations of its Chinese name, ginkgo being merely a Japanese transposition of the Chinese, yin-kou.

The slender-stalked leaves are roughly fan-like in shape, narrow at the base and widening toward the broad, irregularly incised apex. There is no mid-rib; instead numerous branching, parallel veins characterize the leaves, which are somewhat leathery in texture. Bright green when newly formed, they are darker at maturity In autumn, before falling to the ground, they take on a bright yellow hue — a feature which makes the ginkgo very attractive in the fall. The fan-like foliage of this tree is possessed by no other flowering plant, and because of its similarity to the leaflets of the maidenhair fern it is often referred to as the "maidenhair tree".

The ginkgo, like the willow and cottonwood, bears staminate and pistillate flowers on different trees. In the spring, before the appearance of the leaves, the staminate or pollen-bearing flowers grow in stout catkins, while the pistillate or fruit-producing flowers appear as small knobs at the ends of specially developed stems. The fruit is orange-yellow in color, plum-like in form, and about one inch in diameter. It consists of a pointed, oval, smooth, white-shelled nut surrounded by a thin, fleshy covering which emits an offensive odor, not unlike rancid butter, upon ripening. The white nuts, cleaned of their malodorous pulp, are roasted and eaten in the Orient.

Young ginkgo trees are characterized by a central trunk and sparsely branched, spire-like crown. At maturity their form is usually broadly conical. Exceptional trees have been reported to be as much as 100 feet in height and eight feet in diameter.

The ginkgo was introduced into Europe in 1730, Great Britain in 1754, and the United States about 1780. Today it is a common ornamental tree in this nation for it is adapted to a wide range of soil, moisture, and climatic conditions.

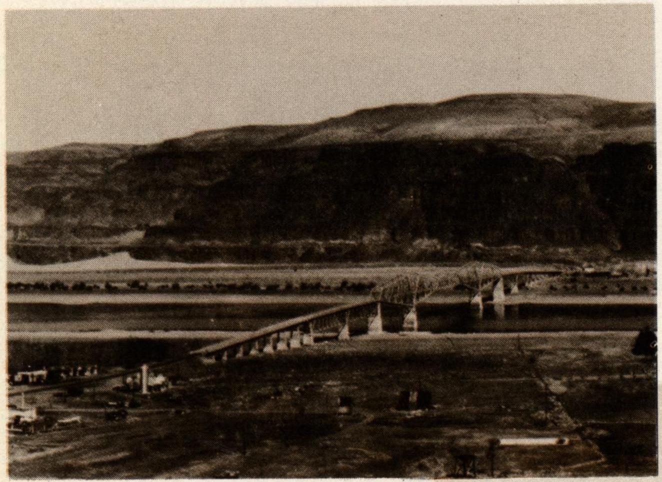
OTHER NOTED PETRIFIED FORESTS

The fossil forest of this park is but one of several known areas of similar character in central Washington. Though less extensive in size, all the others have a like geological background. This was

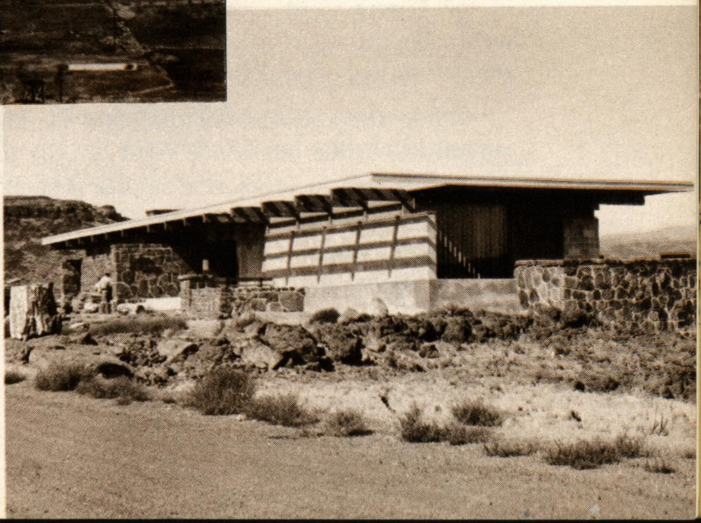
selected as a state park for three primary reasons — (1) the size and abundance of its finely preserved logs. (2) the exceptional number of petrified species, and (3) the fact that it is adjacent to a major highway and therefore is readily accessible to the public.

While petrified wood is occasionally found in many scattered localities, the other most noted fossil forests of the United States are found in the Petrified Forest National Monument of Arizona; in Yellowstone National Park, Wyoming; near Calistoga in northern California; in the Black Hills of South Dakota; and in east-central Oregon.

With the exception of some of those in east-central Oregon, all are of a character much different from the Ginkgo Petrified Forest. The petrified forests of east-central Oregon repose in lavas which are part of the same extensive lava plateau typical of eastern Washington. This great plateau is of interest in its own right, since it covers over 250,000 square miles throughout eastern Washington and Ore-



View of the Columbia River and the Vantage Bridge from the Ginkgo museum.



Ginkgo Petrified Forest Museum Vantage, Washington gon, southern Idaho, and parts of northern Utah and Nevada, and northwestern California. It is the second largest area of its kind in the world, being outranked only by the Dekkan Plateau of India.

The petrified forest of Yellowstone National Park, although found in volcanic materials, is different from this one at Vantage. In Yellowstone National Park, standing trees were buried by volcanic ash. Today their petrified remains are found as erect rather than prostrate trunks, but the species represented are fewer — restricted to a single stand of trees.

The petrified forest at Calistoga has been preserved in volcanic mud flows.

Perhaps the best known fossil forest in the United States is in the Petrified Forest National Monument of Arizona. Like petrified forests generally it is found in sedimentary rather than volcanic rocks, and consequently it has a much different geological background. Although far fewer species are represented in Arizona than at Ginkgo, the logs are remnants of a more ancient forest. None of the petrified logs found there have counterparts among species in modern forests of the United States. Generally, they were derived from trees, now extinct, which are related to the Araucarias (monkey tree) of the southern hemisphere.

EVIDENCES OF PRE-HISTORIC ANIMAL LIFE

One might readily imagine that the animal life in this region fifteen million years ago was as unique and varied as were its forests. However, with the exception of one particularly interesting find, fossilized remains indicative of the presence of such animals is lacking. The exception referred to is evidence of an aquatic, short-legged rhinoceros (Aphelops) which was discovered in 1935 near Blue Lake in the Grand Coulee country. Except for a number of bone fragments, the carcass of this animal had been consumed; but the impression of its body was left as a mold within the lava.

While there exists few tangible manifestations of pre-historic animal life in the immediate Ginkgo area, paleontological investigations elsewhere in rocks of a similar geological age indicate that, in addition to the rhinoceros, at least several other species of pre-historic animals probably roamed the central Washington region during Miocene times. Included was a tiny, three-toed horse (Merychippus)

about the size of a shetland pony; an antelope-like creature with four horns upon its head (Syndoceras) which was about the size of a small deer; an animal no larger than a gazelle, but resembling a llama (Stenomylus); the ferocious bear-dog (Daphaenodon); a bizzare beast with clawed feet (Moropus), related to the modern horse; a huge, pig-like brute (Dinohyus) about the size of a buffalo; and a small four-tusked mastodon (Trilophodon).

Specific evidence of their presence here is lacking since it is likely that these pre-historic animals either were driven from the area by the lava flows or, if trapped, were destroyed along with surface vegetation, by the heat and flame.

EVIDENCE OF INDIAN ACTIVITY

Also of interest in the Ginkgo Petrified Forest State Park are a number of petroglyphs (picture writings) found on the basaltic cliffs bordering the Columbia River. These, about a mile upstream from Vantage, may be reached by means of a trail which starts a short distance west of the bridge.

The Columbia River served as a natural thoroughfare for the aboriginal peoples of this region and, in addition, furnished them fish and other foods. It is logical, therefore, that such evidence of the presence of these early inhabitants should be found along the cliffs of the mighty river which was so important in their lives.

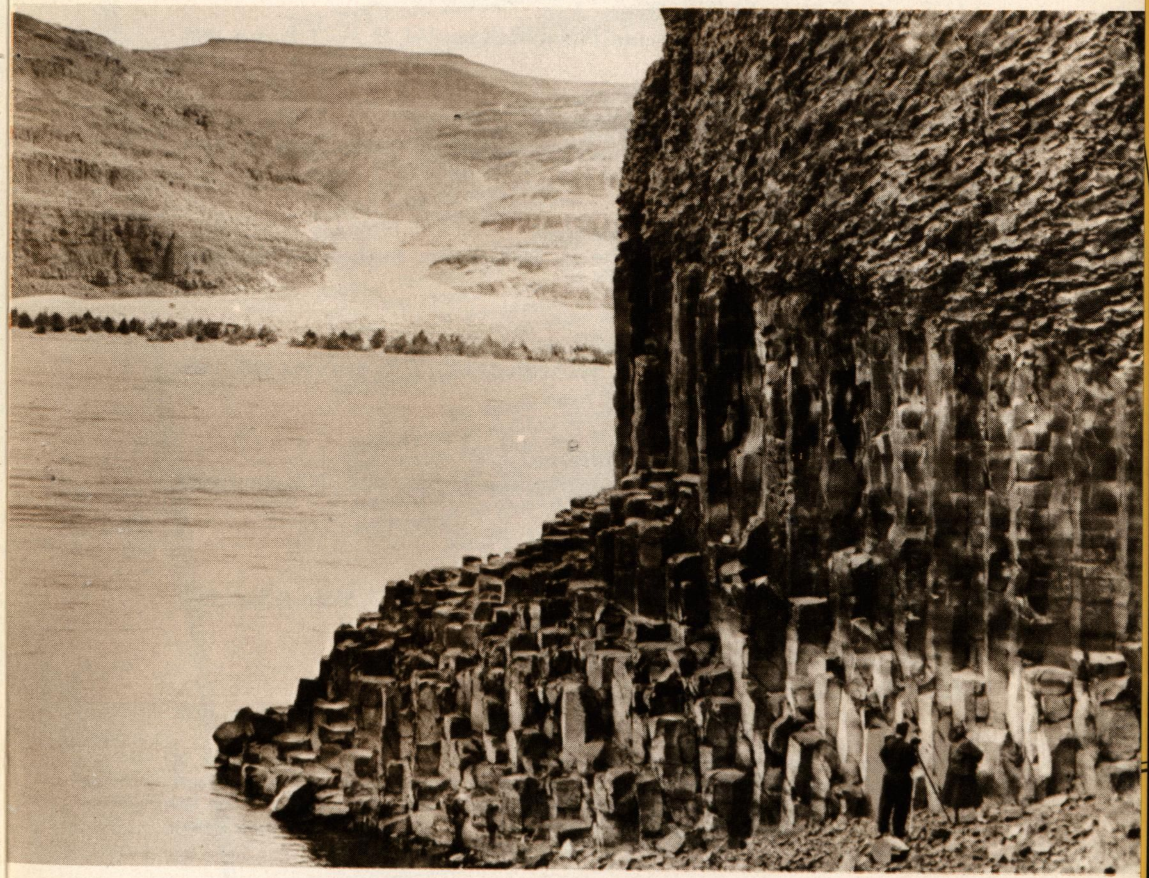
These petroglyphs are similar to many others found along the Columbia, and these, in turn, resemble others found in many places throughout western North America. Although their meaning is unknown even to modern Indian tribes, they are generally interpreted as records of the hunt, meetings with other tribes, or expressions of religious experiences.

Examples of petroglyphs found on basaltic cliffs bordering the Columbia River.

It is also evident that the aborigines utilized certain accessible petrified logs in the manufacture of spear and arrow points. Numerous such artifacts have been found throughout the Columbia basin. Several partly excavated logs — surrounded by chips and thus obviously the work of Indians — have been found.

DISCOVERY OF THIS FOSSIL FOREST; ESTABLISHMENT OF GINKGO PETRIFIED FOREST STATE PARK

The fossil forest included within this state park was discovered in 1931 by Professor George F. Beck of Central Washington College. The Ginkgo Petrified Forest State Park was established by the Legislature of the State of Washington in 1935.



Basaltic cliffs, approximately one mile upstream from Vantage, where petroglyphs are found.

SELECTED REFERENCES

Material in this booklet is a mere digest of the interesting story of this region. Should anyone wish to read further about the various ramifications of its highly significant background, the following publications will serve as a basis:

GEO. F. BECK
Ancient Forest Trees of the Sagebrush Area in Central Washington.
Journal of Forestry, Vol. 43, No. 5; May 1945.

G. H. COLLINGWOOD AND W. D. BRUSH
Knowing Your Trees.
Washington, D. C., American Forestry Assn., 1947.

EDWIN H. COLTON
Nebraska Fifteen Million Years Ago.
Natural History Magazine, Vol. 35, No. 1, January 1935.

LYMAN H. DAUGHERTY
The Upper Triassic Flora of Arizona.
Washington, D. C., Carnegie Institution; 1941.

F. O. JONES
Grand Coulee from Hell to Breakfast.
Portland, Ore., Binsfords and Mort; 1947.

F. H. KNOWLTON
The Fossil Forests of the Yellowstone National Park.
Washington, D. C., U. S. Gov't Ptg. Off., 1921.

F. B. LOOMIS
Physiography of the United States.
Garden City, N. Y., Doubleday, Doran & Co., 1937. (Chapter XXIII).

C. R. LONGWELL, A. KNOPF, AND R. F. FLINT
Physical Geology.
N. Y. C., Wiley & Sons, 1939.

CHAS. SCHUCHERT AND C. O. DUNBAR
Historical Geology.
N. Y. C., Wiley & Sons, 1933.

The author, C. FRANK BROCKMAN, is associate professor of forestry at the College of Forestry, University of Washington. For twenty years he was associated with the National Park Service as park naturalist of Mount Rainier and Yosemite National Parks. He has authored a number of publications of this type relative to the natural and human history of those areas.

Published by
NORTH PACIFIC BANK NOTE CO.
Tacoma, Washington

N.P. BANK NOTE CO.
TACOMA

STATE OF WASHINGTON

ARTHUR B. LANGLIE
GOVERNOR

JOHN R. VANDERZICHT
DIRECTOR

COMMISSIONERS
DR. FRANK F. WARREN, CHAIRMAN
RUTH E. PEELER, VICE CHAIRMAN
EMIL H. MILLER, SEC. TREAS.
JOHN M. McCLELLAND, JR.
HERBERT J. OLSON
ARTHUR H. MORGAN
JOHN E. BLUME

THE SEAL OF THE STATE OF WASHINGTON 1889

State Parks and Recreation Commission

100 DEXTER AVENUE
SEATTLE 9, WASHINGTON
ELLIOTT 2248

This Booklet Is Officially Authorized

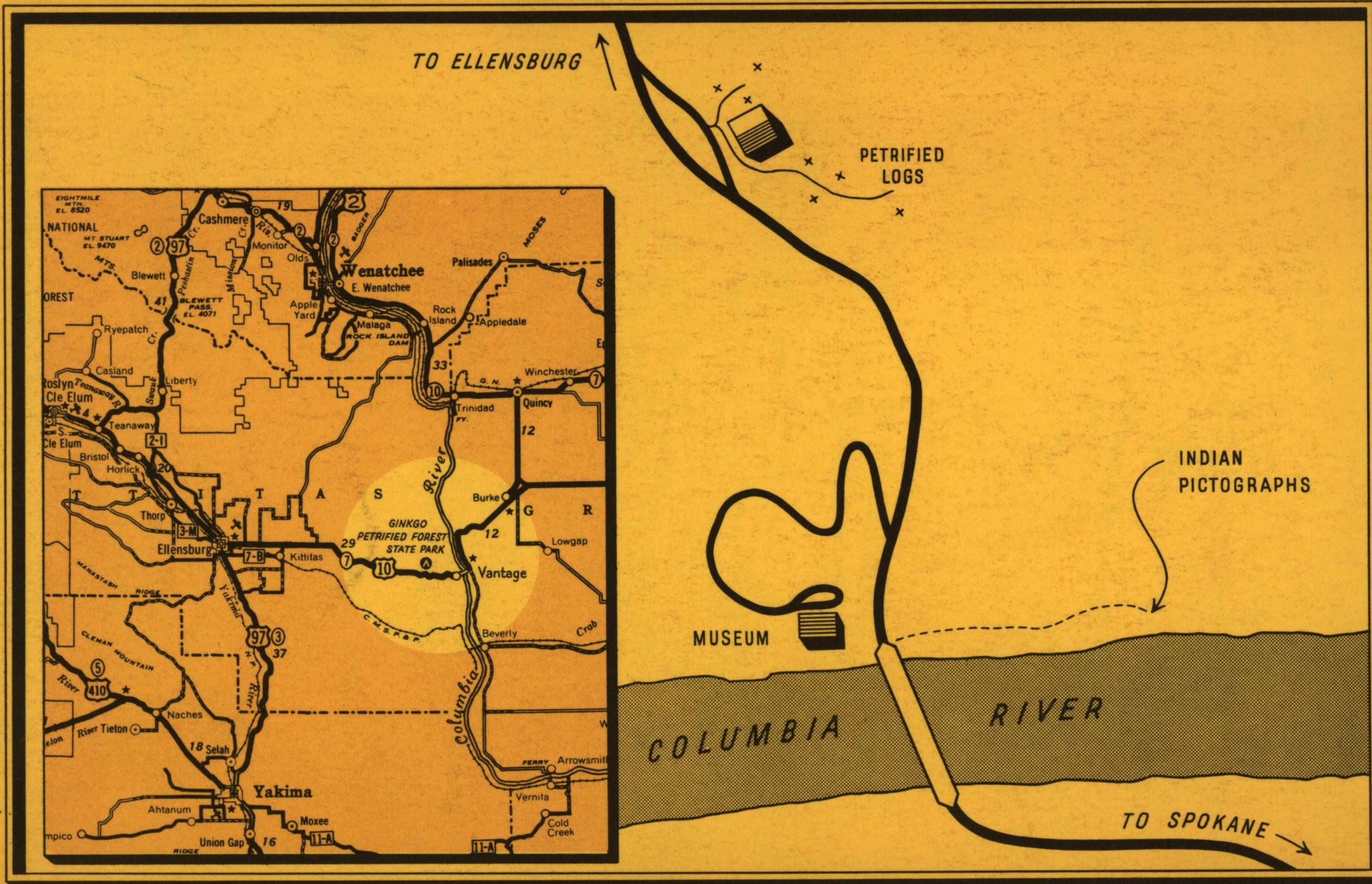
By The State Parks and Recreation Commission

The many Washington State Parks provide for a wide variety of outdoor recreational interests. Each park has its own particular charm, but some have special significance which makes them unique in their field. The latter can most properly be used, appreciated, and enjoyed only if park visitors have an understanding of the basic reasons for their unique character.

Ginkgo Petrified Forest State Park is one of these significant areas. The reasons for the existence of a state park here may be obscure until the dramatic story of this region's geologic past is brought into focus. It is the purpose of the museum and this small booklet to interpret this fascinating story in a brief, interesting, and understandable fashion so that visitors may really see this area, and may appreciate the existence here of this unique fossil forest.

The State Parks and Recreation Commission hopes that the publication of similar booklets dealing with other significant Washington state parks may some day be possible, thus enabling both residents of this state and visitors from other sections of the country to become familiar with the varied aspects of the geology, biology, history, and archaeology of Washington.

John R Vanderzicht
John R. Vanderzicht, Director
State Parks and Recreation Commission



TO ELLENSBURG
PETRIFIED LOGS
INDIAN PICTOGRAPHS
MUSEUM
COLUMBIA RIVER
TO SPOKANE
GINKGO PETRIFIED FOREST STATE PARK
Cashmere
Wenatchee
E. Wenatchee
Monitor
Olds
Apple Yard
Malaga
ROCK ISLAND DAM
Rock Island
Appledale
Palisades
Blewett
BLEWETT PASS EL. 4071
MT. STUART EL. 9470
EIGHTMILE MTN. EL. 8520
NATIONAL
OREST
Ryepatch
Casland
Liberty
Roslyn
Cle Elum
S. Cle Elum
Teanaway
Bristol
Horlick
Thorp
Ellensburg
Kittitas
Vantage
Trinidad
Winchester
Quincy
Burke
Lowgap
Beverly
Naches
Tieton
Selah
Yakima
Ahtanum
Moxee
Union Gap
Vernita
Cold Creek
Arrowsmith
FERRY
Columbia River
Yakima River
MANASTASH RIDGE
CLEMAN MOUNTAIN
MOSES
Crab
BADGER