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FOSSIL WOODS SUPPLEMENT KNOWLEDGE OF THE SUCCOR CREEK FOSSIL FLORA

By Wallace Eubanks*

The name Succor** Creek implies an area rich in fossil flora. It is, of course, the name of a drainage which arises partly in Idaho, flows in a northerly direction along the state line in Malheur County, Oregon, and finally crosses into Owyhee County, Idaho, where it empties into the Snake River (figure 1). The name Succor Creek also carries with it the association of other names such as Rockville School, McKenzie Ranch, Specimen Ridge, Fenwick Ranch, and Owyhee Reservoir, which in the past have been landmarks for the important fossil beds.

The Succor Creek Formation

The areas mentioned above are located within Miocene lake-bed sediments which crop out all along Succor Creek and are wide spread in the general area. These beds were named the Payette Formation by Lindgren (1900), and they retained this name for many years, but they are now referred to as the Sucker (Succor) Creek Formation (Kittleman, 1962; Kittleman and others, 1966; Baldwin, 1964; and Corcoran, 1965). This is the oldest Tertiary rock unit exposed in these parts of Oregon and Idaho.

The Succor Creek Formation consists of a thick series of tuffaceous sediments which are principally fine grained, thin bedded, and nearly white. In some areas, coarser tuffs of brown, yellowish, or greenish color are common. Basalt and rhyolite dikes and flows, also present within the series, evidently poured out during the deposition of the lake beds.

The age of the Succor Creek Formation is considered to be middle to late Miocene on the basis of fossil plants and vertebrates. Chaney and Axelrod (1959) and Graham (1962) correlate the leaves, fruits, and pollen

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** Phil Brogan, Chairman of the Oregon Geographic Names Board, reports that "Succor" Creek is now official. Action reversing the earlier official spelling, "Sucker" Creek, was taken by the U.S. Board on Geographic Names in the spring of 1966 on recommendation of the Oregon Geographic Names Board, following considerable historical research. The reversal was one of the few ever made by the national board.

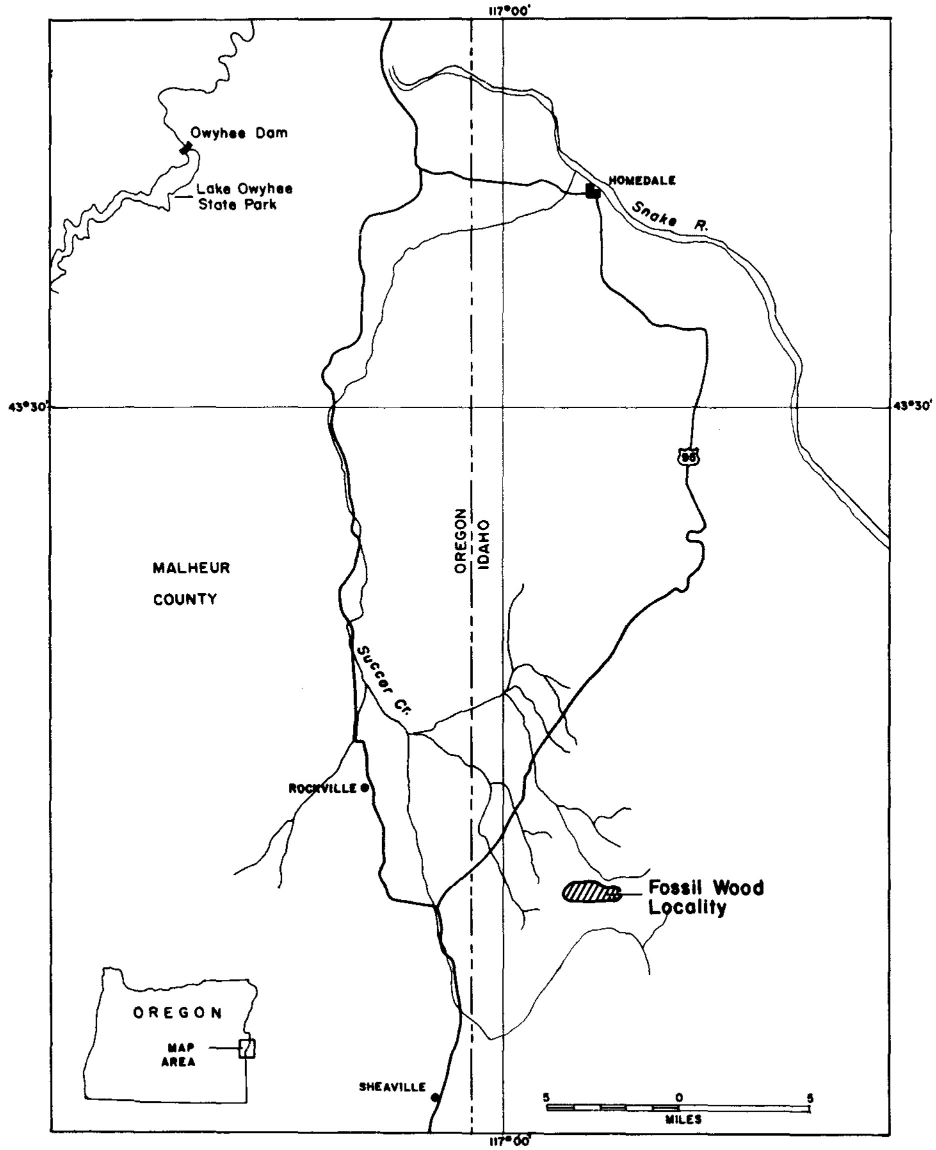

Figure 1. Index map of the Succor Creek area, Oregon-Idaho, showing fossil wood locale from which specimens were collected for study.

with those of the Mascall Formation of middle to upper Miocene age. Scharf (1935) concludes that the fossil vertebrates found in the lake beds are also generally equivalent to those in the Mascall Formation, and he assigns the strata to the middle Miocene or perhaps the early part of the late Miocene.

Studies of the Fossil Plants

Flora of the Succor Creek area first became known through Knowlton's study of Lindgren's collections (Lindgren, 1900). In Lindgren's report (p. 97-98), Knowlton lists more than a dozen types of fossil leaves. Since that time Chaney (1922), Berry (1932), Brooks (1935), Arnold (1936, 1937), and Smith (1938, 1940) gathered material from various parts of the Succor Creek area and analyzed it. A more recent work by Chaney and Axelrod (1959) presents a systematic study and correlation of the Miocene fossil floras of the Columbia Plateau, including the Succor Creek flora.

The most recent and the most comprehensive study of the Succor Creek flora is by Alan Graham (1962) for a doctoral dissertation. Graham gathered new specimens and analyzed them along with the previous collections and conclusions made by earlier workers. In addition to work with leaves, flowers, and fruits he made use of many thousands of pollen and spores to aid in identifying the various plants. As a result of this study, several plant types were renamed and new ones were added to the list. The trees and shrubs totaled 47 genera with 67 species. In addition several herbs, grasses, and ferns were found in the flora.

A summary of the tree and shrub genera from Graham is given below, with common names in parentheses. Some Asiatic forms have no common names in English.

- Abies (white fir)
- Acer (maple)
- Alnus (alder)
- Ailanthus (tree of heaven)
- Amelanchier (serviceberry)
- Arbutus (madrone)
- Betula (birch)
- Castanea (chestnut)
- Carya (hickory)
- Cedrela (cedar)
- Crataegus (hawthorn)
- Cornus (dogwood)
- Diospyros (persimmon)
- Ephedra
- Fagus (beech)
- Fraxinus (ash)
- Ginkgo (ginkgo)
- Glyptostrobus
- Gymnocladus (coffee tree)
- Hydrangea
- Ilex (holly)
- Juglans (walnut)
- Lithocarpus (tanbark oak)
- Mahonia
- Magnolia (magnolia)
- Nyssa (gum)
- Oreopanax
- Ostrya (hop hornbeam)
- Pinus (pine)
- Platanus (sycamore)
- Populus (cottonwood)
- Ptelea
- Picea (spruce)
- Pterocarya
- Persea (avocado)
- Pyrus (pear)
- Quercus (oak)
- Sassafras (sassafras)
- Symphoricarpus (snowberry)
- Shepherdia
- Salix (willow)
- Thuja (cedar)
- Tilia (basswood)
- Tsuga (hemlock)
- Ulmus (elm)
- Zelkova

These genera are represented by living trees and shrubs of three separate geographic regions. The principal group is found in the Appalachian Mountains of the eastern United States. Genera such as Carya, Fagus, Gymnocladus, Ostrya, Tilia, and Ulmus are now living in the eastern forests. Another group is represented by trees growing along the western slopes of the Cascade Mountains. This group includes Abies, Pinus, Quercus, Lithocarpus, and Picea. The third group is made up of plants currently found in Asia, such as in certain provinces of China. Examples are Ginkgo, Glyptostrobus, Ailanthus, and Zelkova.

These plant associations reveal the fact that the fossil flora of this period grew in locations which ranged from swamp to rocky mountain sides with considerable difference in elevation, and in a climate which varied from a winter low of 30° to summer highs of about 90°. Annual rainfall was probably on the order of 50 to 60 inches and well distributed throughout the year. The trees such as Cedrela and Oreopanax show that subfreezing temperatures occurred rarely.

Analysis of Succor Creek Woods

A study by the author in 1960-1961 of fossil wood structure and identification of woods from one portion of the Succor Creek area was made in order to supplement the knowledge of the flora as determined previously from leaves and fruit. Specimens were gathered at the head of a branch of Succor Creek at a spot in Idaho about one mile southeast of the crossing of U.S. Highway 95 with the state border (see figure 1).

This particular area has been the source of black, opalized wood encased in a white matrix. Rockhounds have mined several acres of the deposits in search of the material. However, miscellaneous pieces of wood not suitable for the collectors' purpose were more satisfactory for the study of wood structure. These pieces ranged in size from several hundred pounds to pieces of perfectly preserved twigs only an eighth of an inch in diameter. Wood structure of many specimens is excellently preserved, even to the details which are visible only at 200 magnification and greater.

The study of Succor Creek woods revealed that there is a considerable correlation between the genera identified from the leaves and fruits and genera identified from the wood structure. The wood, of course, did not yield all the different genera represented by the leaves, perhaps because the wood was more difficult to preserve than the leaves and perhaps because the wood sampled is not representative of as wide an area as the leaves, which could have been carried by the wind and water for long distances. One outstanding lack of wood genera is the oak or Quercus. Usually a fossil wood locality will yield oak if it is at all present. Perhaps it was just a quirk of fate that the author did not find a piece in that particular location.

Genera established through study of wood structure are as follows:

Acer (maple)
Alnus (alder)
Arbutus (madrone)
Betula (birch)
Castanopsis (chinquapin)
Celtis (hackberry)
Evodia
Fraxinus (ash)
Pinus (pine)
Platanus (sycamore)
Populus (cottonwood)
Prunus (wild cherry)
Sequoia (redwood)
Ulmus (elm)
Umbellularia (laurel)

Of these the Castanopsis, Celtis, Evodia, Prunus, Sequoia, and Umbellularia do not correspond to the genera named from the studies by Chaney and Axelrod (1959) and Graham (1962). However, all of these except Evodia are found in other portions of fossil forests of the Miocene epoch in Oregon.

It is not possible to determine species through fossil wood structure as it is from leaves and fruit or pollen, because many species of one genera having quite different leaves and fruits will have wood structure so similar that it is not practical to distinguish between them in the fossils. Consequently, in the above list only the genera are given. Woods not identifiable were also found in this location and perhaps future study will add to the list.

It is interesting to note that trees of past geological ages were also infected with insects, borers, and fungi as evidenced by the work of all three found in the fossil samples.

Method for Identifying Fossil Wood

Identification of trees by consideration of the wood is achieved through study of the cellular composition and arrangement within the wood. To the casual observer, or even to the cabinet maker and others familiar with the use of wood, it appears to be only a solid mass of fibres. With live woods the qualities of hardness, color, odor, and pattern of grain are apparent and are the means by which many people distinguish different kinds of wood.

Actually, wood is made up of many types of cells in many variations of arrangement. It is the systematic classification and knowledge of these variations that enable the identification of trees to be made through the structure of wood. This information concerning structure has been set up in the form of keys and lists for many of the trees and larger shrubs of the world. However, no such listing is available for fossil woods alone. Fossils are usually identified by relating them to living plants. By correlating the structure of fossil plants with the structure of living plants which are classified and named under uniform international rules, it is possible to achieve identification of the fossils even though they are several million years old.

In working with woods from the Oligocene, Miocene, and more recent epochs, it is not difficult to correlate the structure with present-day live

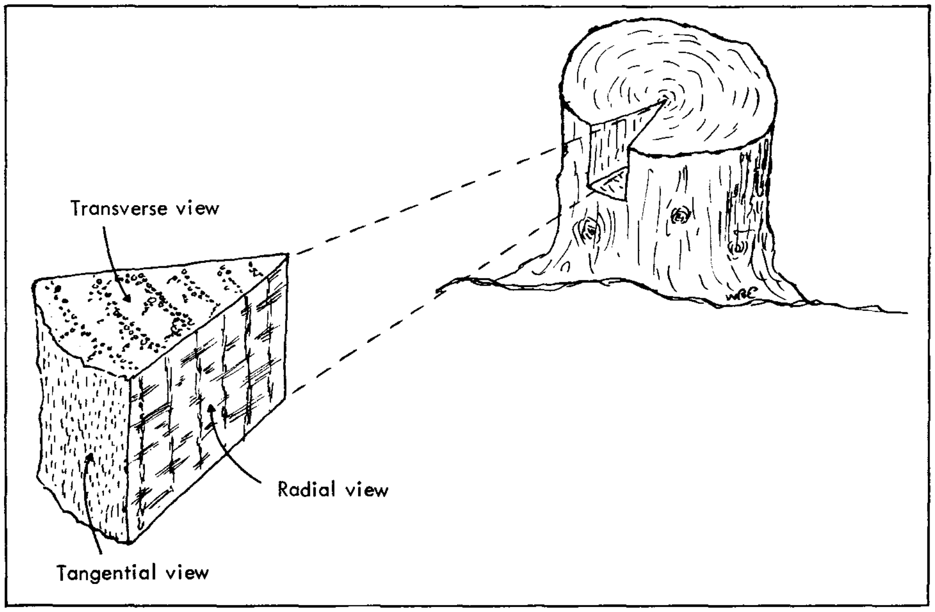

Figure 2. Sketch of tree stump and enlarged wedge of wood removed from it to show proper orientation of sections for microscopic identification.

woods. With wood from older geological periods, however, difficulty is experienced with correlation because of the greater changes in the plant structures during those millions of years.

Study of the minute structure of fossil woods from the Succor Creek area was made with polished pieces and by thin sectioning. Thin sections are made from the fossils by cutting very thin slices -- a sixteenth of an inch in thickness or less -- from properly oriented faces of the piece (figure 2). These slices are then polished on one side, fastened to a micoscope slide glass, and ground on a small lap or by hand until the light passes through the material and the cell structure becomes visible through the microscope. This technique is fairly simple for the hard, opalized or agatized woods but other techniques must be employed for the soft carbonized material.

By using the hand lens and microscope, the cell structure of the woods can be studied and the characteristics listed by standard definitions and terminology set up by the International Association of Wood Anatomists. After listing the characteristics of anatomy of each of the woods, a search is made of classified characteristics of live woods to find a correlation of live to fossil. The woods are considered to be similar if most characteristics correspond and none of the most important ones disagree.

An example may be made of the wood, Prunus -- one of the types found in the Succor Creek area. The thin section of this wood was made to show the tangential, radial, and transverse views of the structure (figure 3). Upon study of the wood by microscope, the following characteristics were listed:

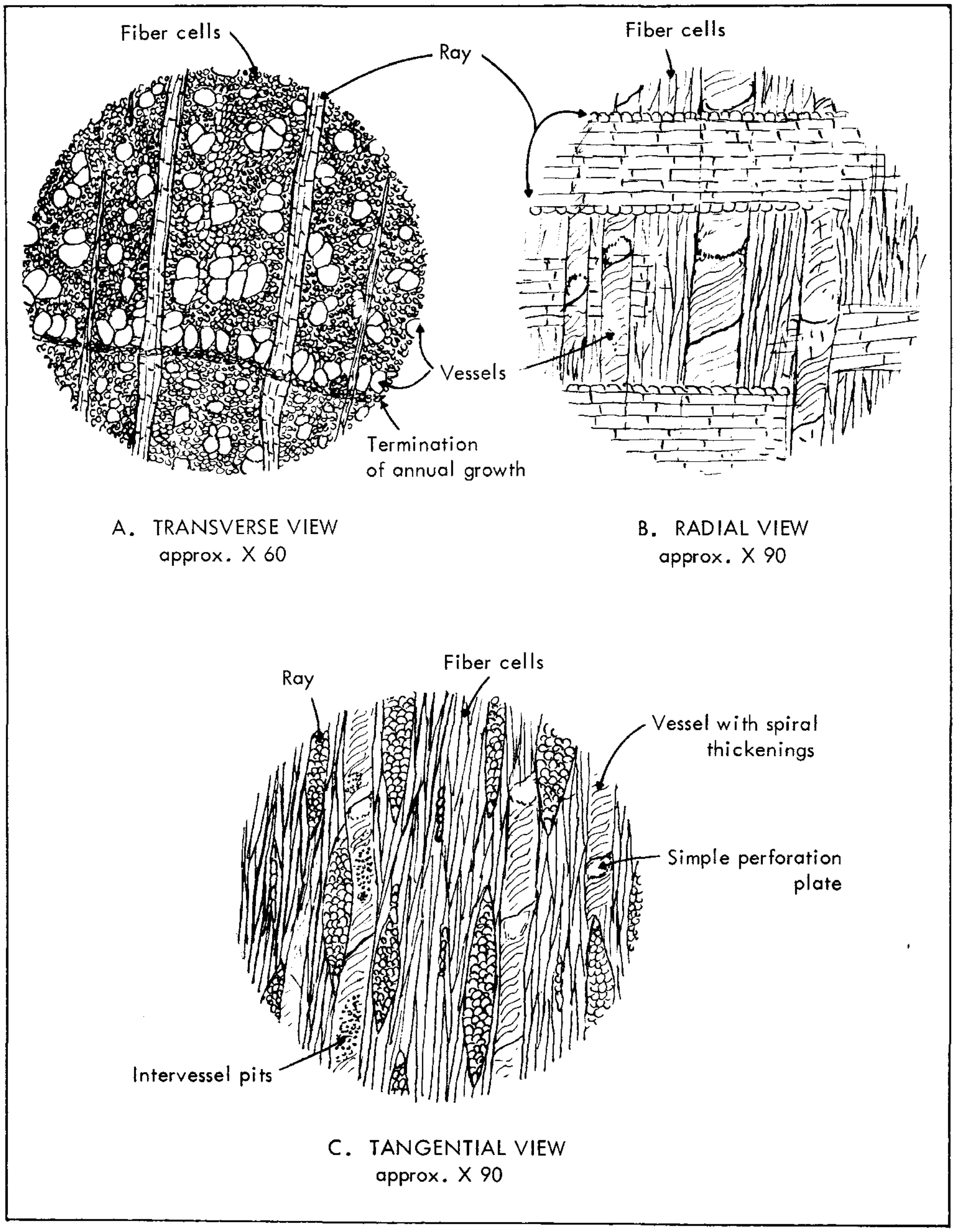

Figure 3. Microscopic structure of fossil Prunus from Succor Creek area.

Transverse view (figure 3-A)

Pore arrangement diffuse to semi-diffuse with pores small and indistinct to the naked eye. Those at the beginning of the growth season slightly larger than the late-year pores and aligned in a more or less uniseriate row, otherwise fairly evenly distributed. Growth rings are fairly distinct.

Parenchyma is not visible. Rays are plainly visible to the naked eye, are as wide as the vessels and occasionally wider. This piece of wood had traumatic resin ducts in a long, tangential string which did not show in the particular thin section.

Tangential view (figure 3-B)

Rays not storied, 2 to 4 seriate, mostly 3 seriate, homogeneous to heterogeneous type III; spiral thickening present in vessels; intervessel pits very small, crowded, orbicular; fibres not storied, not septate.

Radial view (figure 3-C)

Perforation plates simple; rays verified as to type; presence of spiral thickening in vessels verified.

A systematic check of these characteristics with the keys showed that the fossil wood agreed closely with the living Prunus, especially the North American representative of the genera. No significant differences between the fossil and live wood structures could be determined.

Summary

The writer has studied fossil woods from lake beds in the Succor Creek Formation and has added six genera of trees to the Succor Creek flora list. Previous workers based their studies on leaves, fruits, and pollen. Identification of the wood was done by examining thin sections under high magnification and comparing growth structures with those of living woods.

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REDRILL PERMIT ISSUED

The Department issued a permit on October 24, 1966, to Ivan J. Vojvoda of Los Altos, Calif., for the redrilling of Linn County Oil & Development Co. "Barr 1." Vojvoda will cut a window in the $5\frac{1}{2}$-inch casing, which was placed in the hole for testing purposes by Linn County Development Co. After the window is made, the new permittee will set a whipstock and redrill to a depth between 3,000 and 4,400 feet. Oil shows were reported in the original drilling, but subsequent testing resulted in only a small flow of gas.

Vojvoda is associated with the Supreme Oil & Gas Corp., Mountain View, Calif., and Ken Sills, geologist, who was the drilling contractor on the first hole. The official designation for the new permit is: Ivan J. Vojvoda "Madonna 1" (Linn County Development Co. Barr 1 Redrill, Permit 58 RD), located in the NW$\frac{1}{4}$ sec. 32, T. 11 S., R. 1 W., Linn County.

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BROKEN TOP BREAKS: FLOOD RELEASED BY EROSION OF GLACIAL MORAINE

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A torrential flash flood swept $5\frac{1}{2}$ miles down the east and south sides of Broken Top Mountain on October 7, 1966. Flood waters carried mud, logs, and bouldery debris from this High Cascades peak west of Bend, Oregon, across the Cascade Lakes Highway into Sparks Lake meadow (figure 1). The highway was temporarily blocked, and irrigation structures and timber were damaged along the course of the unexpected deluge.

First reports blamed a cloudburst for the sudden surge of flow along the lower part of Soda Creek. However, Phil F. Brogan of the Bend Bulletin correctly inferred that the source of the flood lay in a high glacial lake. Forest Ranger David Rasmussen traced the route of the flood backward to its head in a small unnamed lake, 11 acres in extent, at an elevation of 8,000 feet on the east side of Broken Top Mountain.

This seldom-visited lake lies at the foot of Crook Glacier*, and also receives melt water from a part of Bend Glacier. A very recently abandoned terminal glacial moraine, averaging 100 to 150 feet high, acts as a gravity dam (figure 2). This moraine is built of unconsolidated sand, gravel, and boulders deposited by previous glacial action and now ponding runoff from these melting glaciers. The exact cause of the flood is uncertain, but Rasmussen suggests that sudden breaking off of glacial ice into the lake may have created a wave which overtopped the lake outlet, rapidly increasing downcutting by the outlet stream (figure 3). It is possible that little or no extra impetus was necessary to breach the moraine, and that slow but persistent headward erosion by the steep outlet stream cut this natural dam until it could no longer hold back the lake.

Whatever the triggering action, within a short time (probably a few hours) the lake level dropped $14\frac{1}{2}$ feet (figures 4 and 5), releasing about 50 million gallons of water into the small stream channel below the lake (figure 6).

* Use of the name Crook Glacier is unclear. Older maps of the U. S. Geological Survey and current maps of the U.S. Forest Service apply the name Crook Glacier to the field of snow and ice on the east side of Broken Top. The 1959 U.S.G.S. 15-minute sheet applies the name Crook Glacier to the ice field on the south side of Broken Top, at the head of Crater Creek. This report follows the older U.S.G.S. usage.

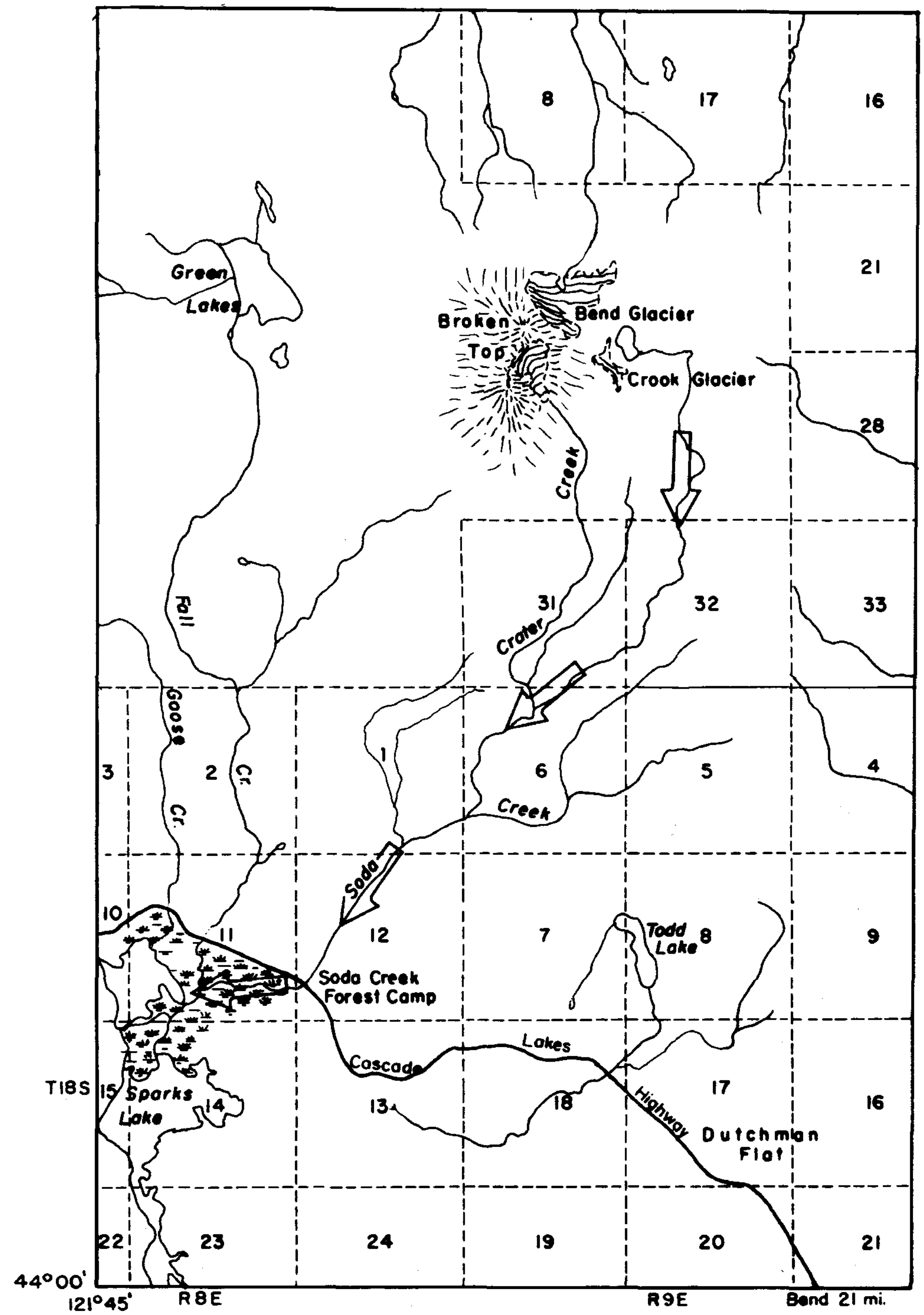


Figure 1. Map of the Broken Top area, showing location of the glacier, lake, and route of the flood waters (arrows).

Figure 2. East side of Broken Top, showing the terminal moraine which impounds the lake. Note the gap in the moraine, and boulders in the foreground which have been carried by flood water.

Figure 3. Outlet stream cutting through the moraine. The pre-flood level of the outlet was approximately at the shoulders of the notch, about 15 feet above the small waterfall.

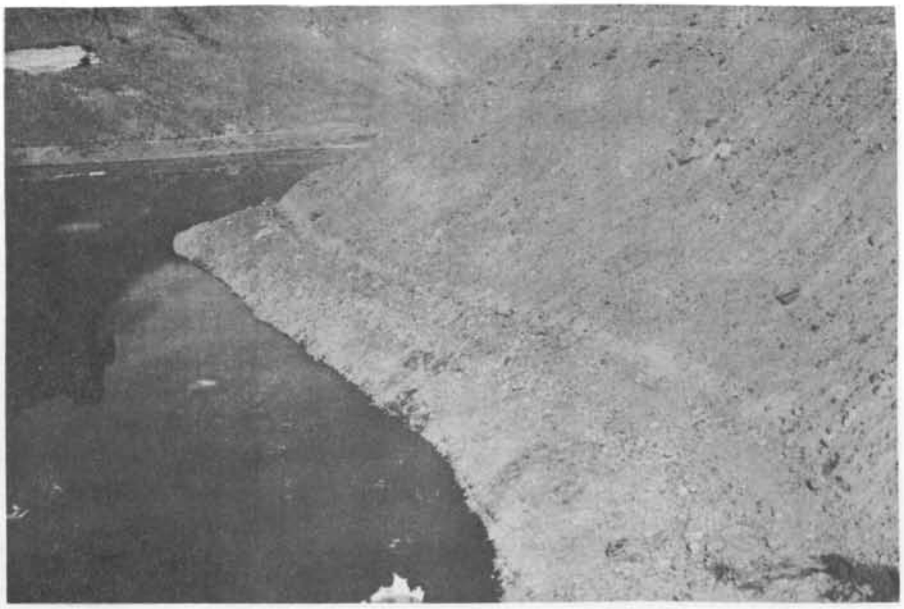


Figure 4. View to the north-northwest along the east shore of the unnamed lake, showing the old shoreline on the moraine, and in the lower right corner a part of the new outlet cut.

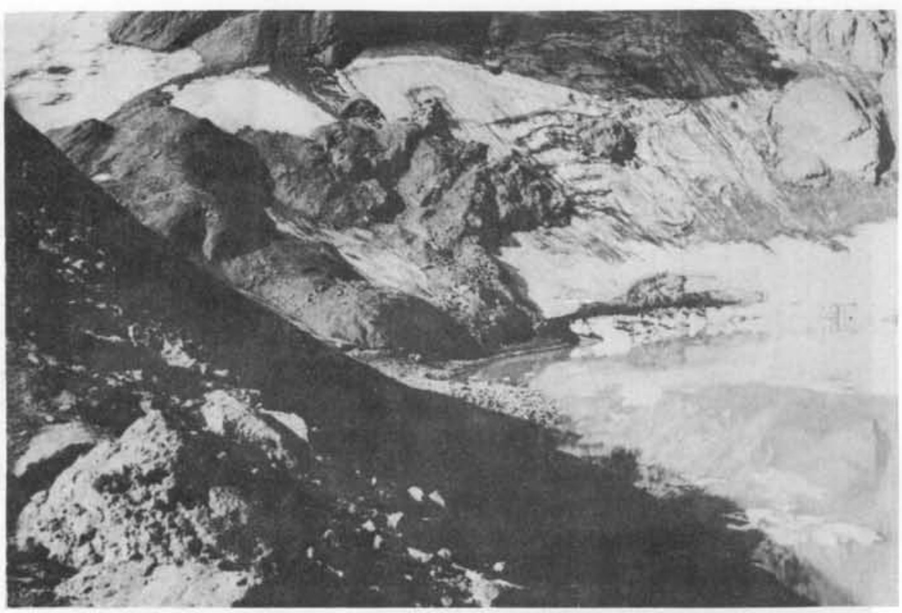


Figure 5. View along the southeast lakeshore, showing the old water line and part of the snow and ice of Crook Glacier.

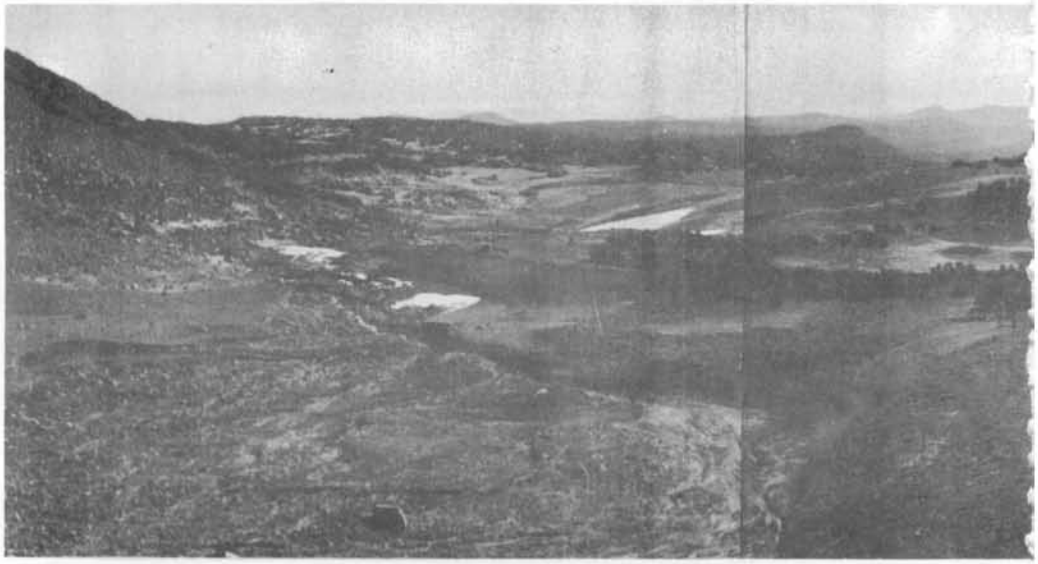


Figure 6. Panorama looking east and south from the moraine down the path of the and back to the right in front of Ball Butte.

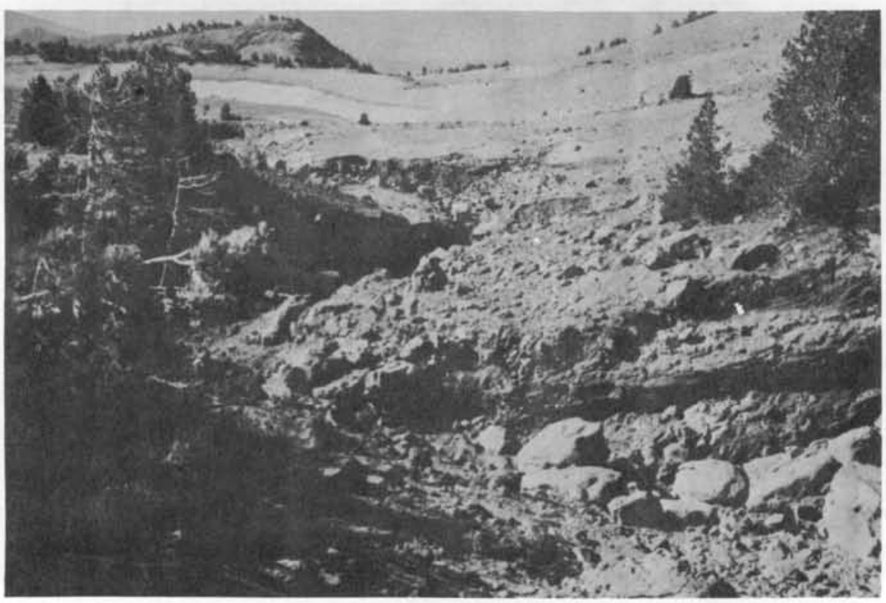
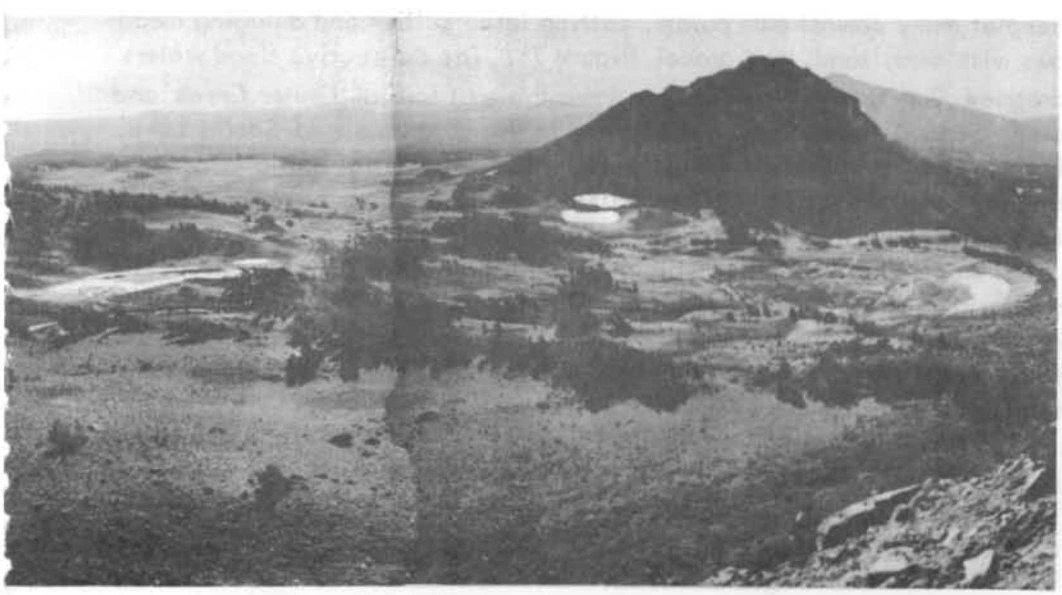


Figure 7. Typical erosion by the flood, approximately one mile down stream from the lake.



flood. The stream channel flows left around an old terminal moraine (with trees),

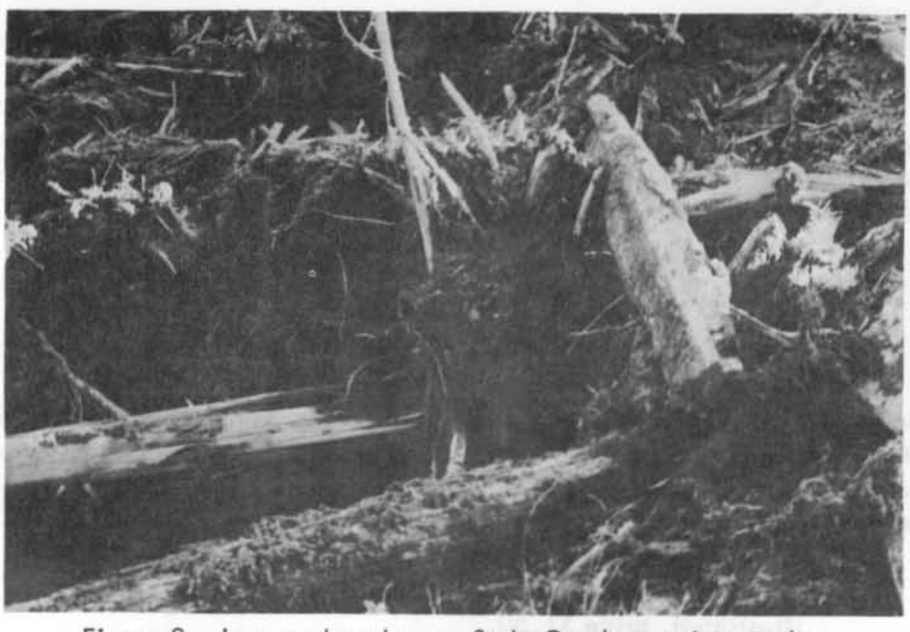


Figure 8. Logs and mud near Soda Creek crossing on the Cascade Lakes Highway.

The water line left by the flood indicates that flow was 10 to 15 feet deep at many downstream points, cutting large gullies and deluging meadows with mud, sand, and gravel (figure 7). The destructive flood waters dropped 2,600 feet in elevation down the east fork of Crater Creek and along Soda Creek before spreading out in the broad basin of Sparks Lake. Forest officials estimated that 35 percent to 45 percent of Sparks Lake meadow was covered by silt. At least 10,000 to 20,000 tons of sediment were carried into the lake and meadow by this flood (figure 8).

Floods of this sort are typical of alpine terrain. Mr. Brogan recalls similar and even larger floods in the Oregon Cascades, one of which swept down the north side of Mount Jefferson more than 35 years ago. Another famous alpine flood originated in a glacial lake near North Sister and reached the McKenzie River.

The author has studied similar flows of muddy debris in the Wallowa Mountains in northeastern Oregon. It is estimated that in the Wallowas the present rate of denudation by mudflows alone, averaged over the entire range, is between 10 and 16 inches per thousand years, considerably greater than the total rate in gentle terrain.

The small lake on Broken Top was only partly drained by the flood of October 7, and the moraine still impounds a large volume of water. Similar floods could occur again with rapid erosion of the moraine. An older, larger moraine, completely dissected by stream action, stands less than a quarter of a mile down stream from the one which impounds the lake.

Acknowledgments

The generous assistance of Phil F. Brogan and that of the personnel of the U.S. Forest Service, especially David Rasmussen, and of the Oregon Department of Geology and Mineral Industries is gratefully acknowledged in compiling this report. All photographs are by David Rasmussen.

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U. of O. MUSEUM ISSUES NEW BULLETIN SERIES

University of Oregon's Museum of Natural History, under the directorship of J. Arnold Shotwell, is now publishing a bulletin series, the first two numbers of which may be obtained, at the prices designated, from the Museum of Natural History, University of Oregon, Eugene, Oregon 97403:

Bulletin 1: Cenozoic stratigraphy of the Owyhee region, southeastern Oregon, by L. R. Kittleman and others; 45 pages, illustrated, price $1.50.

Bulletin 2: Notes on some upper Miocene shrews from Oregon, by J. H. Hutchison; 23 pages, illustrated, price $1.25.

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