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SEDIMENTARY PETROLOGY OF WHISKY RUN TERRACE SANDS, CAPE ARAGO, OREGON*

Carmen J. Rottman

Introduction

Plio-Pleistocene marine terraces are found intermittently along the entire western coast of the United States. Some of the best exposures of these wave- and surf-cut terraces and the overlying deposits of sand are those between Coos Bay and Bandon, Oregon (see Figure 1). Diller (1902) first described the four coastal terraces in this region and later examined the composition of the overlying sands (1914). Griggs (1945) investigated the heavy mineral content of black sand deposits within the terrace sands. Baldwin (1945) presented a chronology of Plio-Pleistocene geology and terrace formation. With the exception of these studies, there has been little work on the overall physical nature of the sands lying on the terrace surfaces. Hence, the present study defines the sands of the lowest surface with regard to grain size, grain shape, and heavy mineral composition and utilizes these variables to determine the probable sediment source and environment of deposition.

Setting

The lower member of the upper Eocene Coaledo Formation crops out along the coast south of Coos Bay from Sunset Bay State Park to Cape Arago State Park (see Figure 1). During the Holocene, the steeply dipping, interbedded sandstones and shales of this unit have been carved into vertical cliffs, jutting promontories, and a sea-level bench by the continuous action of the surf. Capping the prominent cliffs is a thin layer of limonitized sand, deposited on a terrace surface formed during an earlier stand of the sea (see Figure 2). This terrace surface, known as the Whisky Run Terrace, probably originated in a manner very similar to that which is forming the present coastal scenery.

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*Paper is based on a portion of Mrs. Rottman's doctoral dissertation, University of Oregon, 1970.

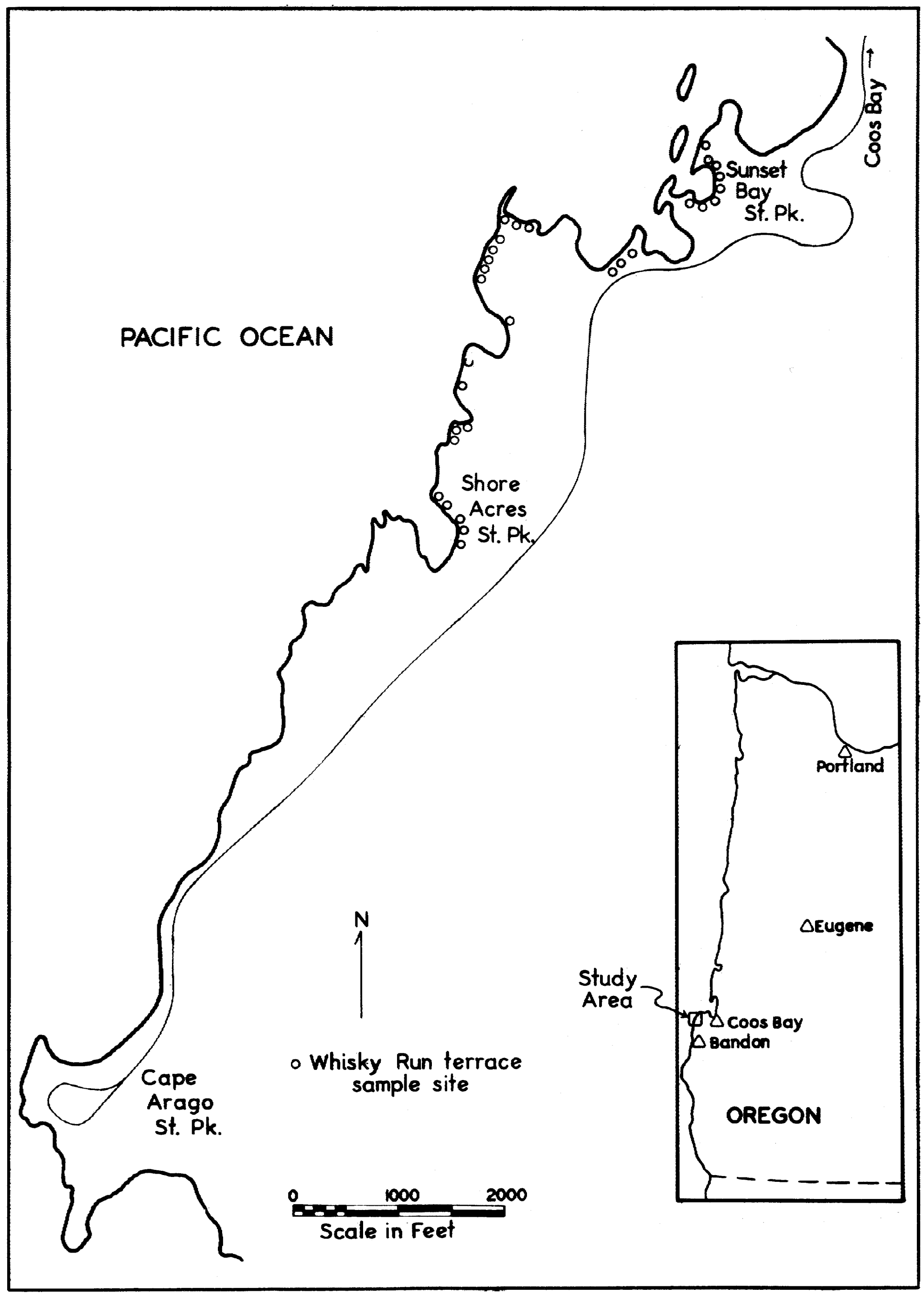

Figure 1. Map of Cape Arago study area with western Oregon reference map.

Method of Study

As part of a more comprehensive study (Rottmann, 1970), 30 samples of the Whisky Run terrace sands were gathered by channeling the rim of the seacliff at selected sites from Shore Acres State Park to Sunset Bay State Park (see Figure 1). Standard procedures of sedimentary petrology were used to prepare the sediment samples for size, shape, and composition analysis. These procedures included chemical disaggregation, combined washing and decantation, and size sieving through a standard sieve series.[1]

After sieving, sized fractions of the samples were given additional preparation for shape analysis and heavy mineral analysis. Measurement of quartz-grain shape, limited to 1.5Ø[2] (0.35mm) size fractions, was carried out by the method designed by Boggs (1967) (see Figure 3). Heavy mineral separates, obtained by gravity separation of 2.5Ø (0.177mm) and 3.5Ø (0.088mm) size fractions, were studied and identified under a petrographic microscope.

Raw data for size, shape, and composition measurements were programmed for statistical analysis on the University of Oregon Statistical Laboratory and Computing Center IBM System 360 computer. The refined data thus obtained was reprogrammed by the method of Wahlstedt and Davis (1968) to determine interdependence of the several different parameters measured.

Discussion

Grain size

Table 1 shows the average values and ranges of values for phi mean, phi standard deviation, and skewness.[3] These three grain size parameters were determined by two different statistical methods (Inman, 1952; Griffiths, 1967) for comparative purposes. The sediments are in the medium to very fine sand grades and range from well to moderately sorted.

Visher (1969) has defined a series of environmental sand types, based on the relative proportions of sand deposited under traction, saltation, or suspension conditons. When the grain size distributions for all terrace sand samples are analyzed by Visher's method, they fit into the beach and wave zone categories.

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[1]For detail on specific procedures see Rottmann (1970) or consult any handbook of sedimentary petrology, for example Müller, 1967.

[2]The Greek letter Ø (phi) is standard notation for grain size units. A phi unit equals the negative $\log_2$ of the size in millimeters (Krumbein, 1938).

[3]Mean - measure of average size; standard deviation - measure of uniformity of sorting; skewness - measure of asymmetry with respect to the mean.

Figure 2. Thin layer of Whisky Run terrace sand lying unconformably on steeply dipping Lower Coaledo bedrock, south side of Shore Acres State Park.

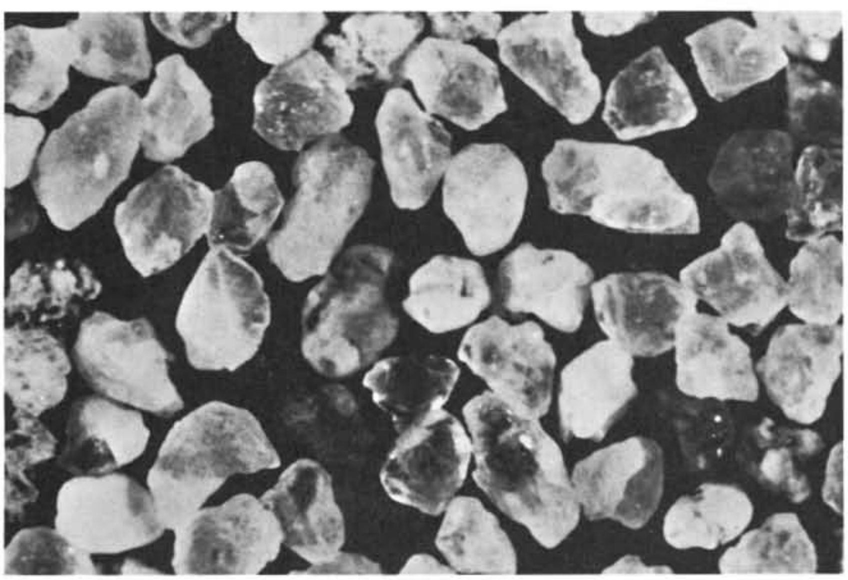

Figure 3. Photograph of quartz grains (white and clear) prepared for roundness and sphericity measurement by method of Boggs (1967); grains are 1.5∅ (0.35 mm) across the shorter projected diameter.

Table 1. Average grain size distribution values for Whisky Run terrace sands (30 samples).*

	Inman Statistics	
	Average	Range
Phi Mean Size	2.371	1.895 - 3.201
Phi Standard Deviation	0.482	0.306 - 0.846
Skewness	0.082	-0.141 - 0.398
	Moment Statistics	
	Average	Range
Phi Mean Size	2.3388	1.9184-2.8220
Phi Standard Deviation	0.5892	0.3685-1.0180
Skewness	0.7664	0.2932-1.1001

*See footnote 3 for definition of terms

Table 2. Heavy mineral composition of Whisky Run terrace sands.*

2.5Ø Separates		3.5Ø Separates	
Mineral	Percent	Mineral	Percent
Clinopyroxenes	21.6	Blue-green hornblende	21.9
Blue-green hornblende	19.4	Magnetite	17.2
Brown hornblende	14.2	Brown hornblende	16.0
Other amphiboles	12.6	Other amphiboles	14.0
Clear garnet	9.3	Clinopyroxenes	10.6
Hypersthene	5.5	Hypersthene	4.8
Magnetite	5.2	Clear garnet	4.7
Pink garnet	3.9	Epidote	2.6
Epidote	3.7	Clinozoisite	1.5
Biotite	1.3	Zircon	1.3
Minor constituents	3.3	Pink garnet	1.1
(glaucophane, enstatite,		Glaucophane	1.0
zircon, clinozoisite, olivine,		Ilmenite	1.0
sphene, kyanite)		Minor constituents	2.3
		(biotite, enstatite, olivine,	
		sphene, kyanite)	
Total	100.0	Total	100.0

*Averages based on 22 and 17 counts in excess of 100 grains for 2.5Ø and 3.5Ø, respectively

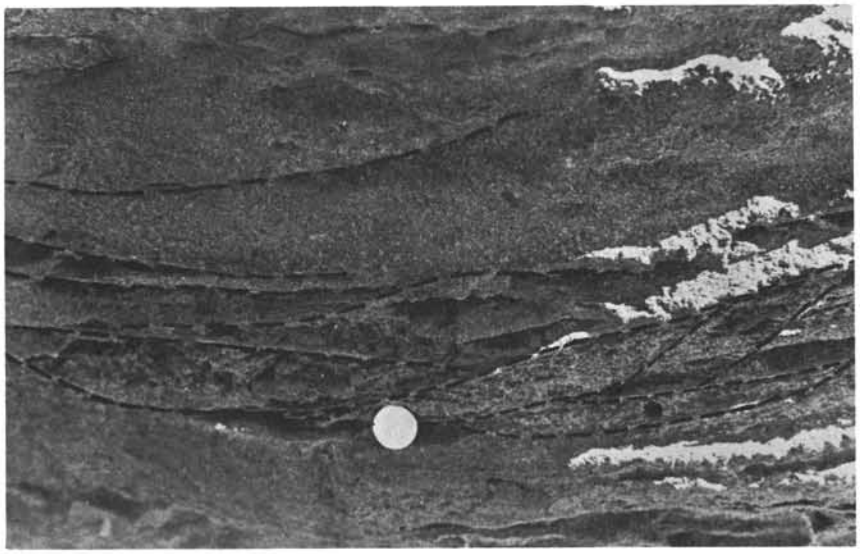

Figure 4. Detail of cross-bedded wave structures in outcrop of Whisky Run terrace sand at Shore Acres State Park; quarter coin for scale.

In addition, Inman and Chamberlain (1956) have shown that Holocene marine sands of similar mean size and sorting are deposited in zones of wave action, i.e., either beach or shallow offshore depositional environments.

These comparisons suggest that these sediments were deposited in a zone of wave action. In particular, the degree of sorting (standard deviation) reflects the winnowing produced by continuous wave action. Figure 4, a close-up of a terrace sand outcrop, shows current structures typically formed in a zone of to-and-fro wave action.

Roundness and sphericity

Figure 5 displays the results of measuring two grain shape parameters: roundness and sphericity.[4] The values for each sample were computed from a maximum of 100 quartz grains (a total of 2918 grains from 30 samples). The average mean roundness for all samples is 0.478 (subrounded class of the 1953 Powers' scale); average mean sphericity is 0.829.

Because of variation in methods of analysis, little comparative literature exists to relate these measured shape values with those ascribed to particular depositional environments. However, the larger investigation (Rottmann, 1970), which included the present study, does compare

[4] Roundness - particle angularity (i.e., smoothness of grain edges); sphericity - approximation of particle shape to shape of a perfect geometric sphere.

roundness and sphericity of Coaledo bedrock, Whisky Run terrace sand, and modern beach sand from the same area. Application of multi-variate analysis to the data of the same study indicates that the coastal outcrop of the Coaledo sandstones is and was the major sediment source for both the modern beach sands and the Whisky Run terrace sands of the Cape Arago area. The quartz grains of the terrace sediment are the most spherical of the three sediments, but are less rounded than those of the modern beach sand.

The relatively higher sphericity of the terrace sands suggests that the sands were transported only a short distance from the sediment source before final deposition. Several authors (Pettijohn and Lundahl, 1943; Russell and Taylor, 1937) have described naturally occurring reductions in sand grain sphericity as the distance from sediment source increases. MacCarthy (1933) has shown that longshore drift, which is mainly a suspension transport mechanism, carries grains of lower sphericity for greater distances. Because more spherical grains settle first from suspension transport (Krumbein, 1942), higher sphericity values are measured closer to the sediment source.

On the basis of the identification of the sediment source (Coaledo sandstones) and the greater roundness of quartz grains from the modern beach sands relative to those of either the Coaledo source or the terrace, Rottmann (1970) concludes that a measurable increase in grain roundness does occur in the zone of surf action (i.e., the beach). This conclusion suggests that the terrace sand is not a product of the beach depositional environment.

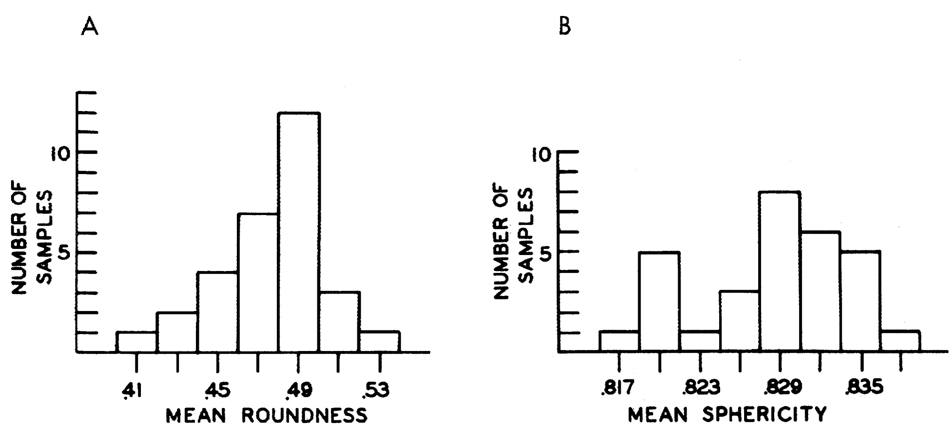

Figure 5. A. Mean roundness of 1.5Ø (0.35 mm) quartz grains from 30 terrace sand samples.

B. Mean sphericity of 1.5Ø (0.35 mm) quartz grains from 30 terrace sand samples.

Heavy minerals

Clinopyroxenes in the 2.5ø separates and blue-green hornblende in the 3.5ø separates are the most common heavy minerals (Specific gravity >2.96) in these terrace sands. Other commonly occurring heavies include brown hornblende, magnetite, garnet, hypersthene, and epidote. Table 2 lists the percentages of all heavy mineral species; the relative proportions of the major heavy mineral species are given in Figure 6.

This heavy mineralogy is very similar to that of the recent southern Oregon shelf sediments (Kulm, and others, 1968) and to that of the lower Coaledo (Rottmann, 1970). However, the latter does not contain glaucophane and kyanite, two minor minerals of the terrace sands. This similarity of mineralogy is additional evidence that the Coaledo was the probable major source of terrace sediment. Yet, the presence of additional minerals indicates one or more additional sources. The exposure to shelf currents of either an offshore or an open beach depositional environment would account for the minor occurrence of these minerals.

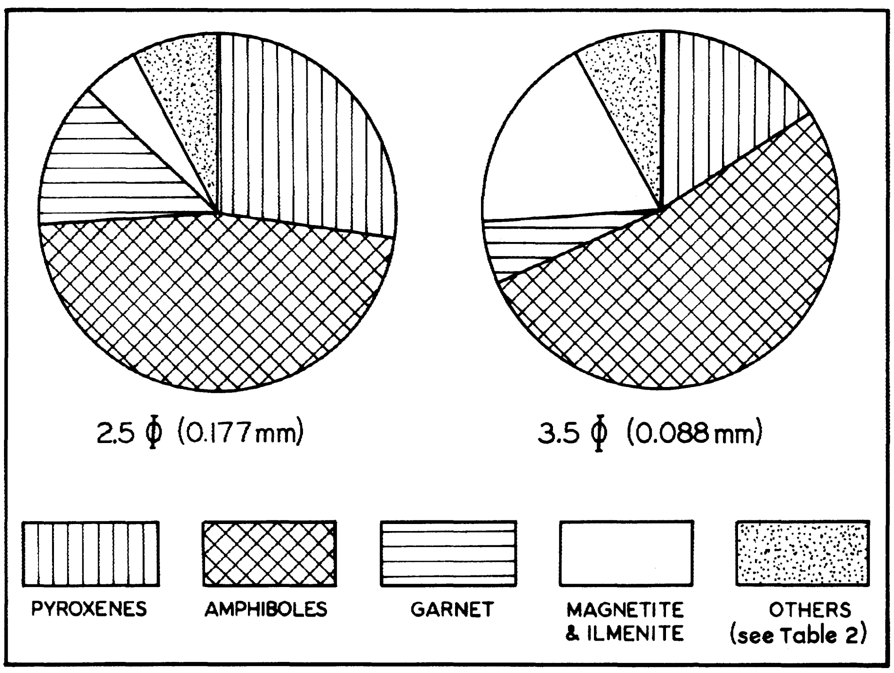

Figure 6. Heavy mineral composition of 2.5ø (0.177 mm) and 3.5ø (0.088 mm) size fractions of the Whisky Run terrace sand.

Summary and Conclusions

The Whisky Run terrace sands are of medium to very fine grain size, moderately well sorted, subrounded, of relatively high sphericity; they contain a heavy mineral assemblage similar to that of other Tertiary and Holocene deposits of southwestern Oregon. Multivariate analysis of the size, shape, and composition variables reveals that all samples of these sands are very uniform in these properties.

Comparison of the measured grain size parameters of these sands with those given in the literature indicates that the depositional environment was a zone of wave action. The heavy mineralogy shows a definite affinity with that of the bedrock cliffs. The roundness of quartz grains from the terrace sands indicates that the depositional site was not a beach at the foot of the cliffs; the sphericity suggests that the site was not a great distance from the sediment supply. Hence, it is postulated that the Whisky Run terrace sands were deposited in a shelf environment just seaward of the surf zone and that the Eocene Coaledo provided the major sediment supply to that site.

Acknowledgments

The writer wishes to thank Dr. Sam Boggs, Jr., for serving as advisor to the doctoral program which included this study. Dr. Boggs and Dr. E. M. Baldwin, both of the University of Oregon Geology Department, are acknowledged for their critical reading of the manuscript. The University of Oregon Geology Department provided financial aid for the duration of the study. I particularly want to thank my husband, Warren, for valuable assistance both in the field and in drafting and photographing the figures.

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SOUTH-CENTRAL OREGON LAKE STUDY PUBLISHED

"Hydrology and geochemistry of Abert, Summer, and Goose Lakes, and other closed-basin lakes in south-central Oregon" is the title of Professional Paper 502-B recently issued by the U.S. Geological Survey. Authors are Kenneth N. Phillips and A. S. Van Denburgh, who have brought together all of the available data on variations of water level, area, volume, and chemical character of the lakes. The 86-page report is illustrated by maps, diagrams, and photographs. For sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price is $1.75.

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A FOSSIL PINE FOREST IN THE BLUE MOUNTAINS OF OREGON

Irene Gregory*

Introduction

A petrified wood deposit in the Blue Mountains of northeastern Oregon appears to be the fossilized *in situ* remains of a pure stand of Western White Pine (*Pinus monticola* Dougl.) of probable Eocene age. Intensive search produced no additional species in the collecting area.

The fossil pine forest is in the Burnt River drainage basin at elevations between 4200 and 5000 feet. The wood occurs over a wide area both in place as low stumps and as scattered logs and chunks. Growing among the fossil material is a living forest of another species of pine, representing a difference in age of as much as 40 million years.

Geologic Relationships

The Burnt River fossil pine wood area is included in the geologic mapping of the Canyon City AMS quadrangle by Brown and Thayer (1966), who show the bedrock units in the vicinity of the wood locality to consist of the Clarno Formation of Eocene age overlain by the Strawberry Volcanics of Miocene-Pliocene age.

Because the locality appeared to be situated near the contact of these two formations of widely differing ages, a more detailed geologic survey was needed to determine the host rocks for the fossil wood. Howard Brooks, geologist at the Oregon Department of Geology and Mineral Industries field office in Baker, who was mapping Tertiary rocks in adjacent areas, kindly offered to investigate the locality. He reported as follows (written communication, November 26, 1971):

> "The slope on which the pine wood occurs is underlain chiefly by a gently dipping sequence of interlayered andesitic tuff breccias and tuffs that were at least partly waterlaid. Wood fragments up to 2 feet in diameter were found entirely as float, but the absence of any nearby exposures of younger rock units or gravels seemingly precludes the possibility of a source other than the underlying breccias and tuffs.
>
> "Pardee and others (1941) in mapping the Sumpter quadrangle included the andesite tuff breccias of this region in the lower

*Mrs. James M. Gregory is a fossil-wood anatomist, Hillsboro, Oregon.

Tertiary section. Brown and Thayer (1966) also regarded the andesite tuff breccias as lower Tertiary in age and mapped them as part of the Clarno Formation.
"James McIntyre and I found fossil wood and leaves in Clarno lithologies at several locations in this and adjacent areas. Dr. Jack Wolfe (written communication, July 22, 1971) assigned Clarno dates to the fossil leaf collections. Some of the fossil wood collections are being sent to you for identification."*

Prior to the present study, pine was not commonly recognized as a component of the Eocene forests of Oregon. The writer has found it to be in abundance not only in the Burnt River locality but also in nearly every Clarno wood locality investigated. It occurs in association with both subtropical and temperate types of fossil wood. Pines should thus be considered one of the typical Eocene trees of Oregon.

Description of the Pine Deposit

Wood

The fossil wood deposit represents a dense, unmixed stand of Pinus monticola; such pure stands are also a characteristic growth habit of the living P. monticola. Petrified trunks up to 5 feet in diameter, branches of many sizes, and the typical slender twigs of this species--all the component woody parts of complete trees including bark--are present. Although d.b.h. (diameter breast high--that is, measured at $4\frac{1}{2}$ feet above the ground) has been measured at a record of 8 feet in living specimens, more normally this is $2\frac{1}{2}$ to $3\frac{1}{2}$ feet. Most of the fossil trunk specimens are also 2 to 3 feet in diameter (Figures 1 and 2). Since none show tapering, they may be assumed to represent the middle portions of the tree, which in mature living specimens range from 150 to 180 feet in height. No root-wood has been observed; it presumably remains buried at depth in growth position. Any associated understory of shrubs or herbs of the time has been destroyed or is still buried; this is true also of cones and needles, which have not been found at this locality.

Bark

Fossil bark eroded from exposed trunk sections litters the area as in living pine forests, and some still adheres to the fossil trunks. The bark is often found broken into the peculiar small, square blocks that are

*All of the wood collections from the Clarno localities sent by Mr. Brooks were found to contain pine.

Figure 1. Exhumed trunks of *Pinus monticola* in Burnt River area.

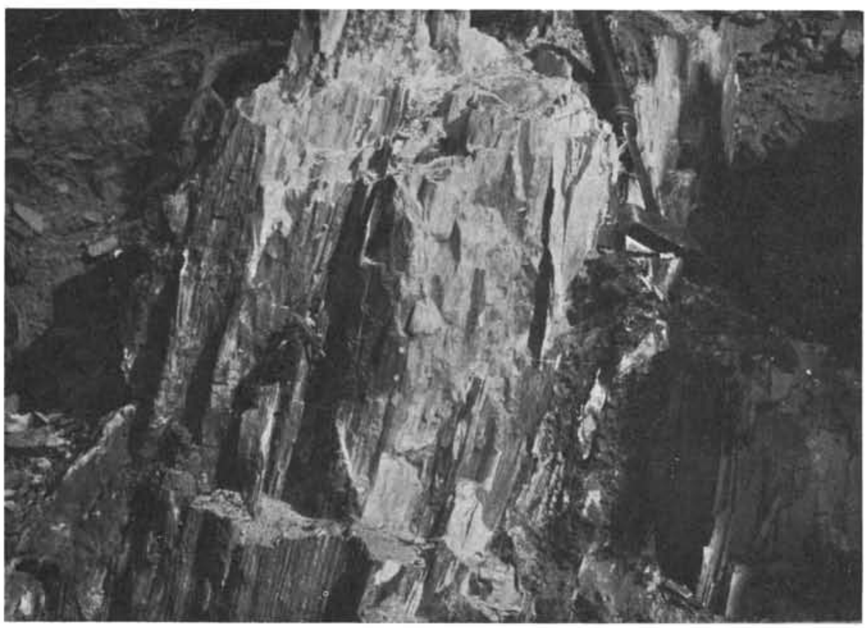

Figure 2. Gross structure of the pine wood is well preserved in this specimen. See pick for scale.

characteristic of living P. monticola after it reaches a trunk size of approximately 12 inches in diameter. Growth patterns of bark are quite constant within a genus, and some have characteristics unique to the species, as in P. monticola (Figure 3). Distinct microscopic structure of bark, particularly when combined with wood structure, can also be an important feature in identification (Chang, 1954).

Pitch (?)

Of frequent occurrence in the soil zone around the fossil stumps are masses of silicified material that look like pine pitch. Since none of the specimens found thus far are attached to the fossil wood, this identification is uncertain. However, Dr. Lloyd S. Staples, who examined some of the samples, suggested that although the material was completely silicified and lacked residual matter, it would be entirely possible for masses of pitch to become silicified in an environment so highly charged with silica (oral communication, November 29, 1971).

Methods of Identification

Pine is one of the few fossil woods that can be readily identified in the field by means of a hand lens. For more precise microscopic identification as to species, the wood must be exceedingly well preserved and be examined in thin-section views of transverse, tangential, and radial cuts. Much of the wood at the Burnt River locality is replaced by opaque jaspers with scattered pyrite, which obscure the minute details of structure. But some of the highly silicified specimens exhibit very well-preserved, anatomical details of cell structure. These have made it possible to identify this wood as to species, rather than to genus only, as is the case with most fossil woods.

Botanical Classification

Pines and other needle-trees are conifers. They belong to one of the main divisions of plants called Gymnosperms, meaning that they have exposed seeds which are usually borne in cones, as is denoted by their order name, Coniferales. Because of the comparative ease with which their wood is worked, they are classified also as "softwoods" in contrast to "hardwoods," a term which has come to include all dicotyledonous trees such as oak or maple; these belong to the other main plant division, Angiosperms, that have seeds enclosed in a fruit and bear true flowers. Each type of wood has its own structure; that of a typical softwood is shown in Figure 4, which is a diagram of the transverse view of white pine (P. monticola).

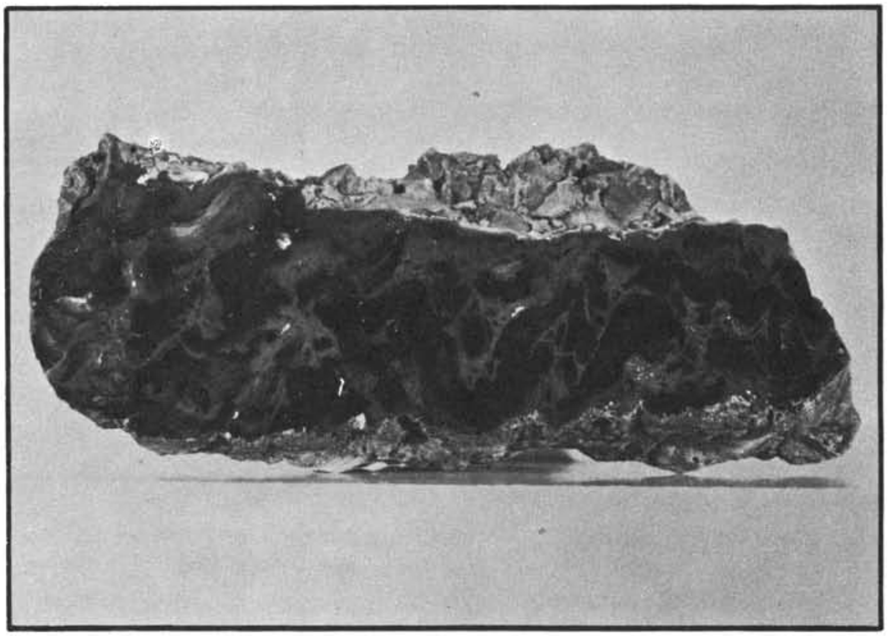

Figure 3. Petrified bark cut and polished to show pattern of structure.

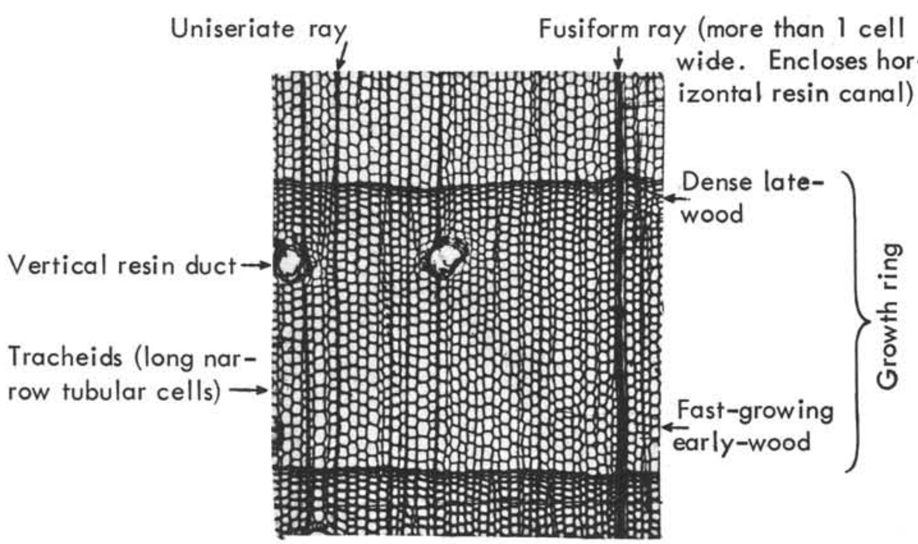

Figure 4. Anatomical features of _Pinus monticola_, a typical softwood; transverse view. Approx. 50X.

Systematic Description

Class	GYMNOSPERMAE
Order	CONIFERALES
Family	PINACEAE
Genus	PINUS Linnaeus

Pinus monticola Dougl.

(Figure 5A, B, C)

Anatomical description

Growth rings: Distinct. Marked by a narrow band of denser (slow-growing) late-wood at outer margin. Fast-growing (larger celled) early-wood takes up most of the ring. Transition from early-wood to late-wood is very gradual.

Tracheids: Arranged in definite radial rows. Up to 50, but average 35 to 45 microns in diameter; bordered pits in one row (sometimes 2) on radial walls. Pits to ray parenchyma windowlike and large; 1-2 (usually 1) per cross-field.

Longitudinal parenchyma: Not visible.

Rays: Very fine. Not visible to naked eye except those few larger that enclose a transverse resin canal. Of two types but mostly uniseriate, 1-10 cells high as seen on tangential. Also scattered fusiform rays enclosing horizontal resin canal; 2-3-seriate in thickened area, tapering to uniseriate above and below; up to 12 cells high. Ray tracheids present in both types of rays, non-dentate.

Resin Canals: Vertical: easily visible with lens. Numerous. Scattered through central and outer part of ring. Solitary. Rarely two or three side by side. Appear as vertical streaks or lines on tangential. Epithelium thin-walled. Often occluded with tylosoids. Average diam. 135-160 microns. Horizontal: inconspicuous. Rather sparse. On transverse appear as more prominent wood rays irregularly spaced. Scarcely visible with lens on tangential. Avg. diam. less than 60 microns.

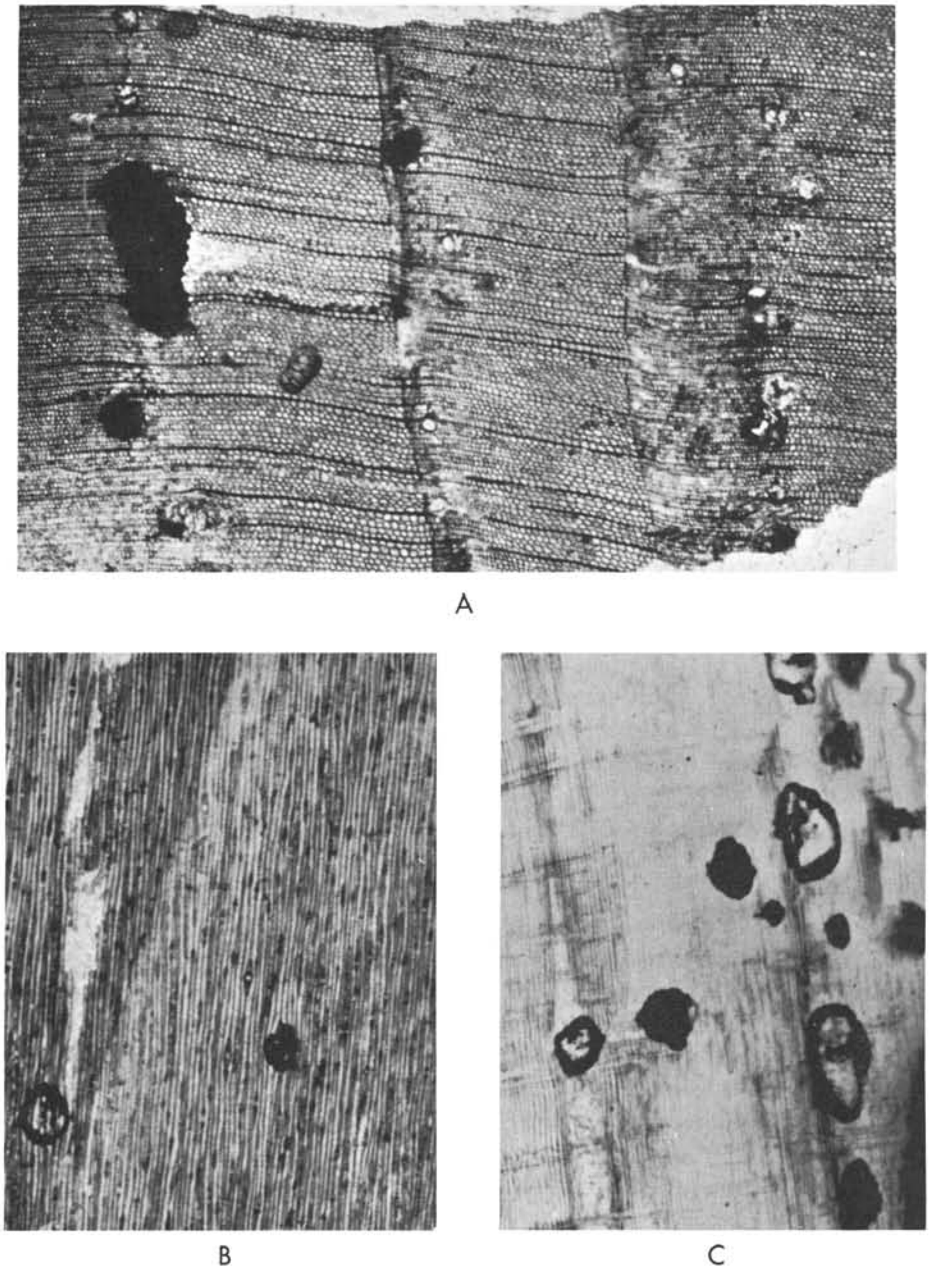

Figure 5. Photomicrographs of thin sections cut from fossil Pinus monticola from the locality in the Blue Mountains, Oregon. A. Transverse view; B. Tangential view; C. Radial view. (Photography by Thomas J. Bones, Vancouver, Washington.)

Discussion

Wood of the genus Pinus is easily distinquishable from other conifers because of its characteristic vertical resin ducts that can be plainly seen on the cross section with a hand lens; they appear as small rounded holes scattered about among definite, neatly arranged rows of cells (tracheids) of uniform size and approximate rectangular shape. Resin ducts are found also in other conifers such as spruce, larch and Douglas fir, but in these genera they are far less numerous and arranged in characteristic group patterns rather than scattered about as in pines. Vertical resin ducts are actually tubular intercellular spaces that carry resin in the sapwood; they are lined with a sheath of resin-secreting cells (epithelium). When using a high-power microscope, the thin walls of the epithelial cells of the resin ducts are the feature that serves to separate members of the genus Pinus from all other conifers. Horizontal resin ducts, inconspicuous and enclosed in rays, are also sparsely present in pines and may be seen under a microscope on the tangential surface.

All fossil pine wood has structures hardly distinguishable from similar pines living today; apparently pines adapted so successfully to climates of the time that only minute evolutionary changes have come about during the intervening ages. Consequently names of living pines can be applied to the fossil forms. That this also is true of the needles and seeds of pine is borne out by Wolfe (1964), who describes P. monticola parts from the Tertiary as being indistinguishable from similar specimens of extant P. monticola.

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* * * * *

CHROME MINER DIES

William Stanley Robertson, 79, prominent mining man in southern Oregon for more than a half-century, who died last December 9, had a strong role in the region's mining history. He was born May 31, 1893, in Portland.

In the same year that he was born his father moved the family to Sunny Valley, where the father went to work for L. A. Lewis as foreman at the Columbia Placer mine on Tom East Creek. Four years later, the family moved to Galice where his father was foreman of the Old Channel mine for many years.

Growing up in an era when mining was a key industry in Josephine County, it became a natural for him to enter the mining fields as an adult, fortified with knowledge gained from association with many persons active in mining. He and his brothers owned the Bunker Hill mine on Bear Camp Road above Galice and made their first big strike there in the early 1920's. They reportedly took out some of the richest gold ore mined in Josephine County and worked the mine until gold mining was shut down at the start of World War II and chrome mining became the big thing.

Undaunted by the change of events, Robertson became active in chrome mining both in California and southern Oregon. He headed a delegation to Washington, D.C. and was instrumental in getting the chrome program underway, a boon to Josephine County. He was one of the largest chrome producers in the United States, with operations at the Oregon Chrome mine on the Illinois River and at the Cyclone Gap mine in California.

He was highly respected by the industry for his keen knowledge of mines and mining, and frequently was consulted. His advice and help were freely given to many. (Grants Pass Courier)

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GROUND WATER GEOLOGY OF MEDFORD AREA PUBLISHED

"Availability and quality of ground water in the Medford area, Jackson County, Oregon," by J. H. Robison has been published by the U.S. Geological Survey as Hydrologic Investigations Atlas HA-392.

The Atlas consists of two sheets 26x36 inches, folded in an envelope. One sheet is a geologic map showing the rock units, thickness of the alluvium aquifer in Bear Creek Valley, and location of water wells. The other sheet presents a ground water availability map, chemical analyses of water from 76 wells, and information on chemical character of water from the various geologic formations.

Atlas HA-392 is for sale by the U. S. Geological Survey, Denver Center, Denver, Colorado, for $1.25.

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MARTYRING THE OTHER FELLOW

Although Arizona already has passed some of the most stringent air pollution laws in the nation, the majority of respondents to a recent research poll said that if business and industry do not meet the state's anti-pollution standards within one to two years, they should be shut down until they fulfill the requirements. But a more meaningful question, it seems to us, is how many Arizonans would themselves be willing to be unemployed to stop pollution.

It is painless to demonstrate one's environmental concern by threats to business and industry. We strongly oppose environmental irresponsibility by those who plunder resources with no thought of long-range detriment to the land and its people. But we also question the wisdom of "close it down" advocates.

However you look at it, compliance with the state's air quality requirements is going to be expensive, sometimes mighty expensive, for such Arizona businesses as the copper smelters, which have already spent $700 million in this line in the last six years.

If businesses were forcibly shut, the economic dislocation they'd suffer could be so severe that they would declare bankruptcy rather than finance anti-pollution measures.

And, even if the companies were not closed for good, their temporarily unemployed workers would be thrown wholesale onto the rolls for unemployment compensation.

When companies are already beginning to clean up the environment, we see no sense in raising the specter of putting them out of business and throwing employees out of work. To do so would be to fly from a lessening evil into the arms of a greater one. (From The Arizona Republic)

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OREGON ACADEMY OF SCIENCE PUBLISHES PROCEEDINGS

"Proceedings of the Oregon Academy of Sciences," volume 7, 1971, has been published by the Academy at Corvallis. The 99-page booklet includes symposium papers on "Approaches to the Population Problem," selected articles presented at the 29th meeting, and abstracts of papers given at the section meetings. The Geology Section is represented by abstracts of five papers. The Proceedings include memorial tributes and citations for outstanding achievement.

Copies of the 1971 Proceedings may be obtained from the OAS secretary, Dr. Courtland L. Smith, Dept. of Anthropology, Oregon State University, Corvallis, Oregon 97331, for $1.25.

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BULLETINS

8.	Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller	0.40
26.	Soil: Its origin, destruction, preservation, 1944: Twenhofel	0.45
33.	Bibliography (1st supplement) of geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin	3.00
36.	Vol. 1. Five papers on western Oregon Tertiary foraminifera, 1947: Cushman, Stewart, and Stewart	1.00
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68.	The Seventeenth Biennial Report of the State Geologist, 1968-1970 . .	Free
69.	Geology of the Southwestern Oregon Coast W. of 124th Meridian, 1971: R. H. Dott, Jr.	3.75
70.	Geologic formations of Western Oregon, 1971: Beaulieu	2.00
71.	Geology of selected lava tubes in the Bend area, 1971: Greeley . . .	2.50

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: (over the counter) . . . folded in envelope, $2.15	2.00
Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Preliminary geologic map of Sumpter quadrangle, 1941: Pardee and others . .	0.40
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bull. 37) .	0.50
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker . . .	1.00
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GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka . .	1.50
GMS-2: Geologic map, Mitchell Butte quad., Oregon: 1962, Corcoran et. al.	1.50
GMS-3: Preliminary geologic map, Durkee quad., Oregon, 1967: Prostka . .	1.50
GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: [Sold only in set] flat, $2.00; folded in envelope, $2.25; rolled in map tube . . .	2.50
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