The Ore Bin

Vol. 31, No. 6
June 1969

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin

Published Monthly By

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 226 - 2161, Ext. 488

FIELD OFFICES

2033 First Street	521 N. E. "E" Street
Baker 97814	Grants Pass 97526

Subscription rate $1.00 per year. Available back issues 10 cents each.

Second class postage paid
at Portland, Oregon

The ORE BIN
Volume 31, No. 6
June 1969

THE GEOLOGY OF CEDAR BUTTE NORTHERN COAST RANGE OF OREGON

By
Dennis O. Nelson* and Gerald B. Shearer**

The following article on the Cedar Butte area in Oregon's northern Coast Range was written originally as a term paper by the authors at the time they were undergraduate students in geology under Dr. Paul Hammond at Portland State University. Although their period of field work was brief and their mapping of a reconnaissance nature, the authors were able to extract enough information to write a report which has considerable merit as a basis for further study.

The northern Coast Range has received little attention geologically, and mapping has been limited to the broad, generalized picture. And yet, here is a region right at Portland's back door that begs to be studied. Its complex history of Tertiary volcanism, marine deposition, folding, and faulting offers many areas for research in stratigraphy, petrology, paleontology, and structure.

A further inducement is the abundance of outcrops in the Tillamook Burn. This rugged area of some 550 square miles, including Cedar Butte, was once covered by a nearly impenetrable forest. In 1933, 1939, and again in 1945 devastating fires swept across the region, destroying the timber and leaving behind a desolate terrain of scorched soils and barren rock. A new forest is springing up as the result of the State Department of Forestry's rehabilitation program. But opportunely for the geologist, the rocks are still fairly well exposed in most places, and numerous logging roads, built for salvage and reforestation purposes, make the area easily accessible.

It is hoped that this paper by Nelson and Shearer will encourage others to select localities for geologic research in this much neglected portion of the Coast Range. - Editor

Introduction

Cedar Butte is situated in the Tillamook Highlands, a mountainous region in the northern Coast Range of Oregon (figure 1). The butte rises to 2907

* Graduate student, Dept. of Geology, University of North Carolina.
** Graduate student, Dept of Geology, Ohio State University (now with 548th Engr. Bn., Fort Bragg, N. C.)

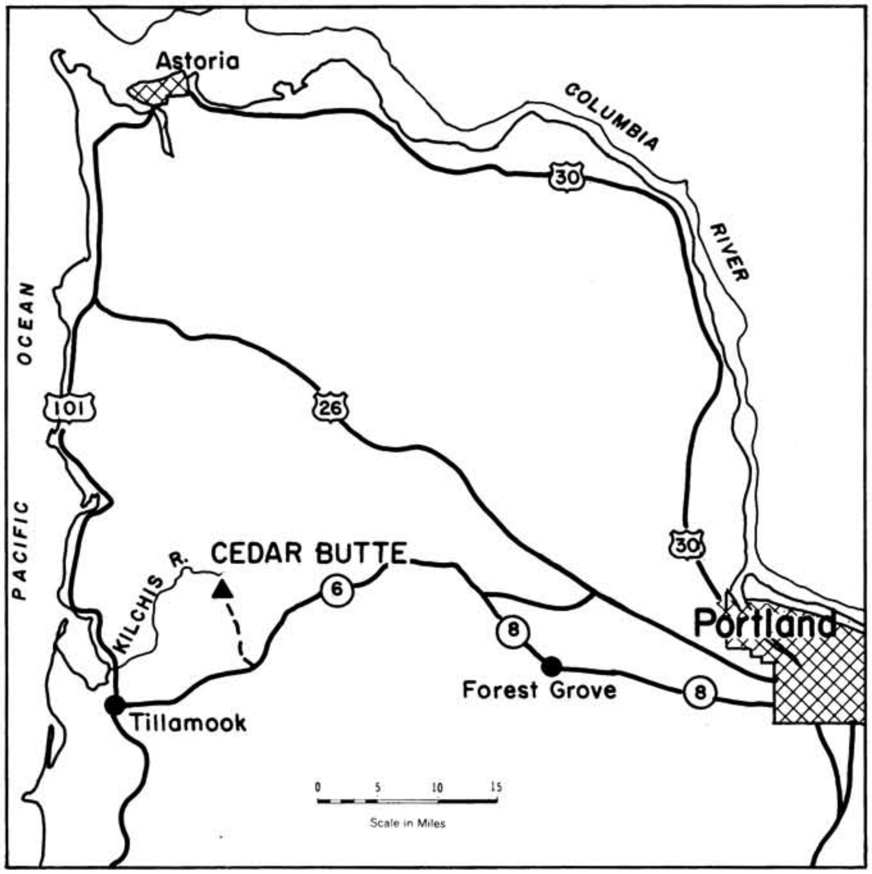


Figure 1. Index map of northwestern Oregon showing location of Cedar Butte.

feet above sea level in the NW$\frac{1}{4}$NE$\frac{1}{4}$ sec. 10, T. 1 N., R. 8 W., Tillamook County (figure 2). The area is readily accessible by car in good weather and is reached by way of Oregon Highway 6 (Wilson River Highway) and logging roads.

The purpose of this paper is to describe the various rock units found in the Cedar Butte area, to present specific data to supplement the more general knowledge concerning the igneous and sedimentary rocks of the northern Coast Range, and if possible to stimulate further interest so that more detailed work might be done by others.

Because of limited time, we restricted the area of study to approximately 15 square miles within the 15-minute Enright quadrangle. A detailed geologic map (plate 1) was made of the immediate vicinity of Cedar Butte. The emphasis was on field relationships, supplemented by limited petrographic studies of some units. Field work for this report was done in the fall of 1966 and spring of 1967, while we were undergraduates at Portland

State University.

We were first introduced to the Cedar Butte area during a collecting trip to the "augite locality" (figure 3). Our study of the "augite" crystals indicated that they are probably members of the diopside-hedenbergite compositional series. They occur in a thick unit of crystal vitric tuff which is highly weathered and very friable (figure 4). Single crystals can be found at the surface, and more can be obtained with only minor digging, using a rock hammer. Because of the friable state of the tuff, individual crystals can be removed easily and without being damaged. Both single and twinned crystals can be found, almost all perfectly euhedral and generally showing no visible alteration.

The crystals occur throughout the unit, but the best location for collecting is on the south side of Cedar Butte (see plate 1). Roads leading to Cedar Butte are shown on the 15-minute Enright quadrangle and State Forest maps of the area, both of which are readily available. It is suggested that anyone planning to collect in this area should carry one of these maps, since the maze of winding roads can be confusing. Additional information can be obtained from the State Forestry Headquarters at Forest Grove.

Regional Geology

The northern Coast Range in Oregon has been mapped on a regional basis by Warren, Norbisrath, and Grivetti (1945); Wells and Peck (1961); and Snavely and Wagner (1964). The following discussion of the regional geology is summarized chiefly from Snavely and Wagner (1964).

The northern Coast Range is part of an anticlinorium extending northward from the Klamath Mountains to the Columbia River in western Oregon. Minor anticlines trending east-west and northwest lie across the regional grain. The faults follow northeasterly and northwesterly trends. The stratigraphy consists of the Eocene Tillamook Volcanic Series overlain by Eocene to early Miocene eugeosynclinal sediments which, in turn, are overlain by Miocene basalt flows.

Uplift and erosion of rocks in the northern Coast Range have produced the Tillamook Highlands, a topographically rugged region underlain primarily by the Tillamook Volcanic Series (figure 5). From early Eocene time to possibly late Eocene this region was a center of volcanism, largely submarine, where basaltic pillow lavas and breccias, along with some interbedded sediments, accumulated to an estimated thickness of 20,000 feet. Tuffaceous marine sediments were deposited around the margins of the volcanic center. They interfinger with the lavas and thicken away from the locus of volcanic activity. Rocks overlying the Tillamook Volcanic Series on the margins of the Tillamook Highlands are mapped as undifferentiated marine tuffaceous siltstone and sandstone of late Eocene to middle Miocene age. They include also basalt and andesite flows, breccia, and pyroclastic rocks of late Eocene age south of the Tillamook Highlands.

Description of the Units

The stratigraphic sequence consists of tuffaceous shales and volcanic sandstones overlain unconformably by volcanic rocks, dominantly pillow basalts and submarine breccias. Capping these rocks is a series of basalt flows fed by a number of small dikes.

To avoid confusion in the literature, the formations have not been named and will be referred to in more general lithologic terms. The units are described below, from oldest to youngest (see table 1).

Olivine basalt porphyry

Although not exposed in the mapped area, olivine basalt porphyry occurs as xenoliths in several of the described units. This rock apparently underlies the lowest exposed sequence in the area.

The material is greenish black, amygdaloidal, holocrystalline, fine grained allotriomorphic granular and porphyritic, having 35 percent phenocrysts whose average size is 2.5mm. Of these phenocrysts, 15 percent are augite and 85 percent are Mg-olivine. The groundmass is composed of 20 percent plagioclase, probably labradorite (An_{60}); 30 percent augite (40 percent Ca)*; 40 percent titaniferous(?) magnetite; and 10 percent alteration minerals of which 5 percent are antigorite and 5 percent calcite.

Tuffaceous shale and volcanic sandstone

The oldest unit exposed within the map area is a sequence of interbedded, sparsely fossiliferous, tuffaceous, siliceous shale and volcanic sandstone. Thin layers of ash can readily be found throughout the entire formation. The base is not exposed, but the unit is at least 250 feet thick and is probably very much thicker. It strikes northwest with a moderate northerly dip. The best section within the mapped area crops out along the south fork of the Kilchis River (plate 1). Similar sediments crop out along Cedar Butte road south of the mapped area (figures 6 and 7).

The shale members of this formation are dark gray, weathering to light brown. The rock is extremely fine grained, and is composed primarily of silt- and clay-size particles with a few small subangular sand grains firmly bound by a siliceous cement. Minerals recognized are quartz, feldspar, and a small amount of authigenetic mica. The shale exhibits good bedding-plane fracture.

Of special significance is the fact that fossil leaves of conifers and deciduous trees are present in this shale. These indicate a temperate climate and a shallow-water environment of deposition.

---

* Value estimated from 2V.

Figure 2. (Top) View of the top of Cedar Butte from its south flank. The "augite" locality is to the left of the photograph.

Figure 3. (Bottom) "Augite" locality on the southwest side of Cedar Butte. Part of the butte is visible in the background. Crystal-bearing vitric tuff unit dips northeasterly. Attitude of the beds is assumed to represent initial dips or cross-bedding.

Table 1. Stratigraphic column of the Cedar Butte area.

Lithologic Name	Thickness (feet)	Description
Basalt flows	400+	Dense, black amygdaloidal basalt flows capping Cedar Butte; cliff former.
(Disconformity [?])		
Upper submarine breccia	100-150	Fine-grained, dark, massive breccia containing pillows and stringers of basalt; cliff former.
Interlayered basalt flows and breccias	300-325	Interlayered thin-bedded dark, massive fine-grained olivine basalt and dark, massive submarine breccias; cliff former.
Crystal vitric tuff	100-400	Green-black to red-brown massive, fine- to medium-grained crystal vitric tuff; contains pyroxene crystals.
(Disconformity)		
Palagonitic pillow breccia	320-450	Interstratified palagonitic pillow breccia and lensoidal masses of basalt; breccia composed of basalt pillows in red-brown tuffaceous matrix.
Lower submarine breccia	100	Gray-brown, massive submarine breccia composed of fragmented volcanic rocks in a fine-grained matrix; contains moderately to well-developed pillows; cliff former.
(Angular unconformity)		
Tuffaceous shale and interbedded volcanic sandstone	250+	Dark-gray to light-brown fine-grained tuffaceous siliceous shale, containing fossil leaves and exhibiting good bedding-plane fracture; interbedded with gray to red-brown volcanic sandstone; cliff former.

Figure 4. (Top) Weathered vitric tuff at "augite" locality shows abundance of crystals in talus; scale is compared to a dime.

Figure 5. (Bottom) Rugged topography typical of the Tillamook Burn region is illustrated by this view looking northwest down the Kilchis River from the Cedar Butte area.

Interstratified with the shales are beds 1 to 3 feet thick of coarse-grained sandstone(?), consisting of angular fragments of shale, pyroxene, and dark glass, cemented with silica.

The volcanic sandstone members are composed of ferruginous, argillaceous, silty wacke of a gray to grayish-brown color, weathering to dark reddish brown. Thicknesses of beds range from 5 to 60 feet. The sandstone is massive, fine to medium grained, and poorly sorted. It is composed of subangular grains of quartz, plagioclase, lithic fragments, and clay firmly bound together with a siliceous cement. The sandstone members are prominent cliff formers.

No microfossils were observed when representative samples of this sedimentary sequence were disaggregated and studied under a binocular microscope to determine mineralogical composition.

Lower submarine breccia

The tuffaceous shale and volcanic sandstone is overlain unconformably by massive cliff-forming submarine breccia, which has a uniform thickness of about 100 feet. It is grayish brown, composed of angular fragments of poorly sorted volcanic rocks in a fine- to medium-grained matrix consisting of quartz, zeolites, minor olivine, and unidentified accessory or alteration minerals firmly cemented with silica.

An outcrop along the north fork of the Kilchis River contained a pelecypod, possibly a Unio(?).

The submarine origin of the breccia is suggested by moderately to well-developed pillow structures. Massive, fine-grained breccia exposed on slopes south of Cedar Butte has the appearance of pavement (figure 8).

Palagonitic pillow breccia

The submarine breccia is overlain conformably by 320 to 450 feet of interstratified palagonitic pillow breccia and lensoidal masses of basalt. The breccia consists of whole or fragmented pillows of fine-grained basalt, set in a yellow to reddish-brown tuffaceous matrix and containing blebs of sideromelane partly altered to palagonite. Xenoliths of olivine basalt porphyry occur throughout the unit.

This unit was apparently formed by the flowing of basaltic lava into water.

Crystal vitric tuff

Overlying the palagonitic pillow breccia with a disconformity is a crystal-vitric tuff (figures 3 and 9). It is greenish black, weathering to reddish brown, massive, fine to medium grained, poorly sorted, and is composed of pyroxene crystals, glass, and iron-bearing clay.

Studies of optical properties and crystal morphology gave ambiguous results as to the identity of the crystals. X-ray diffraction was employed and all the peaks on the resulting graph indicated that the mineral was in the diopside-hedenbergite solid solution series. The following lattice planes were identified for the mineral: (220), $(\bar{2}21)$, (310), $(\bar{3}11)$, $(1\bar{3}1)$, $(\bar{5}31)$, and $(\bar{2}23)$. It should be noted that all of the members of the diopside-hedenbergite series have similar diffraction patterns with respect to the major peaks. Mineral analysis performed by the State of Oregon Department of Geology and Mineral Industries gave the following average:

SiO_2	50.0%
Al_2O_3	7.0
Fe_2O_3	6.5
CaO	19.5
MgO	17.5
	100.5%

Comparison of these average analyses with those given by Deer, Howie, and Zussman (1965, v. 2, p. 47-55) indicates that the mineral may be a variety of salite, a member of the diopside-hedenbergite compositional series.

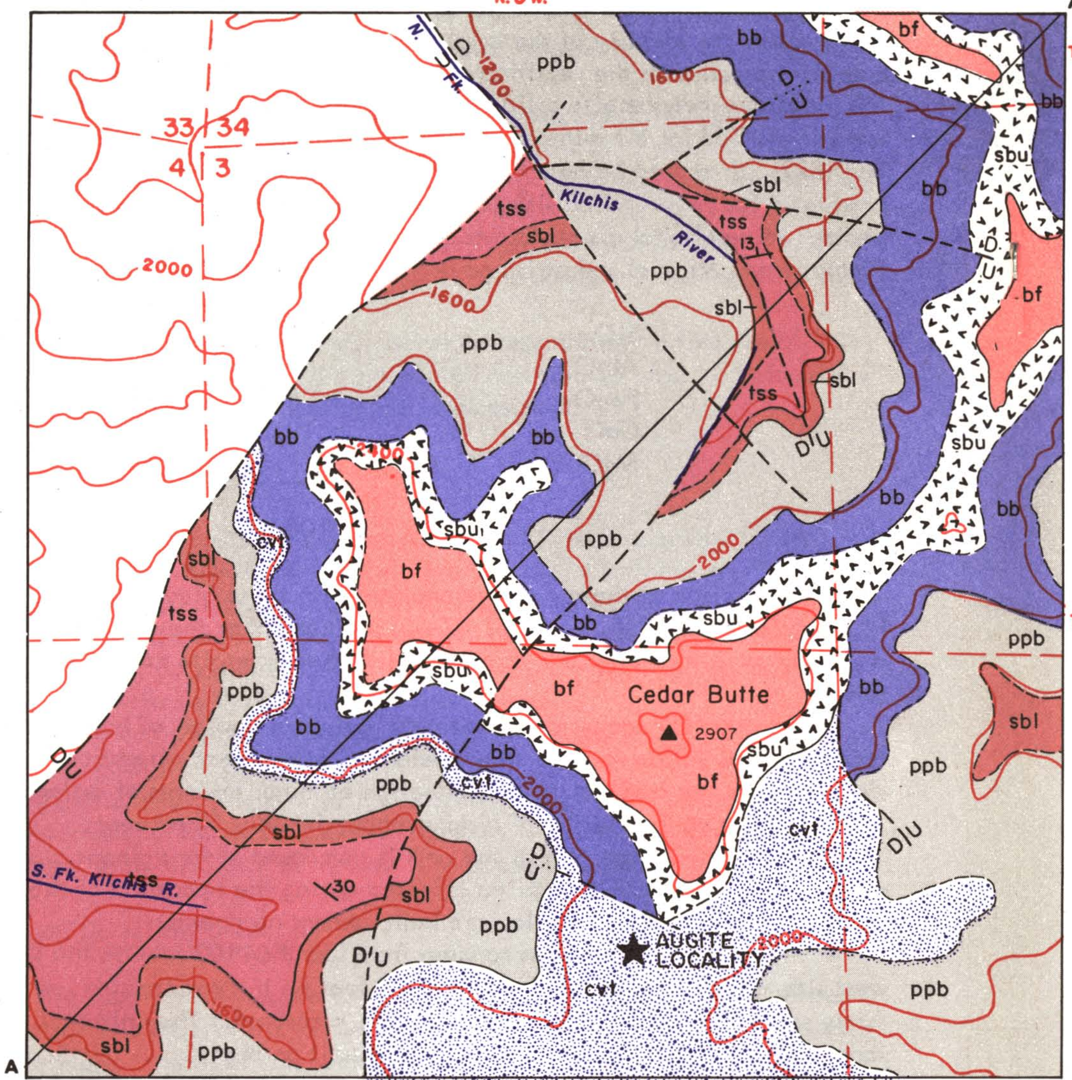
The glass is opaque to transparent, being composed of both black tachylyte and yellow-orange sideromelane. Subsequent alteration of the sideromelane has resulted in the formation of minor amounts of palagonite(?). The concentration of glass is approximately 50 percent.

The remaining portion of the unit is composed of ferruginous clay and minor amounts of secondary silica released during the hydration of the sideromelane. The silica and clay are both cementing agents.

The unit has a thickness ranging from less than 100 feet on the southwest side of Cedar Butte to more than 400 feet on the eastern side, where fairly steep easterly dips in cross beds were measured. The unit contains laminar bedding and xenoliths of olivine basalt porphyry.

The very thin-bedded character, the size, and areal extent, suggest an airborne deposit into shallow water. Pelecypods are reported to have been found in the unit, supporting the belief that the unit was deposited in water (R. E. Corcoran, personal communication). The advancement of a basaltic ash flow into water has also been suggested (P. E. Hammond and R. E. Corcoran, personal communications). Ash-flow tuffs, however, generally consist of unsorted pyroclastic debris that would include vesiculated rock fragments. Ross and Smith (1960, p. 18) report that generally in subaerial ash flows the most important criterion for recognition of ash-flow tuffs is the presence of these pyroclastic rock fragments. The absence of such debris and the moderate degree of sorting suggest to the present authors that the unit was not an ash-flow tuff.

Plate 1 GEOLOGIC MAP OF CEDAR BUTTE



Base map modified from USGS Enright Quad.

0 1000 2000 3000 4000 FEET

EXPLANATION

Miocene(?)	bf	Basalt flows
Eocene–Oligocene(?)	sbu	Submarine breccia (upper)
	bb	Interlayered basalt flow and flow breccia
	cvt	Crystal vitric tuff
	ppb	Palagonitic pillow breccia
	sbl	Submarine breccia (lower)
Eocene	tss	Tuffaceous shale and sandstone
		Unmapped

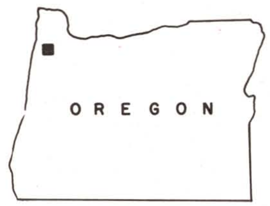
Contour lines — Definite Contact

Fault (approximate) — Approx. contact

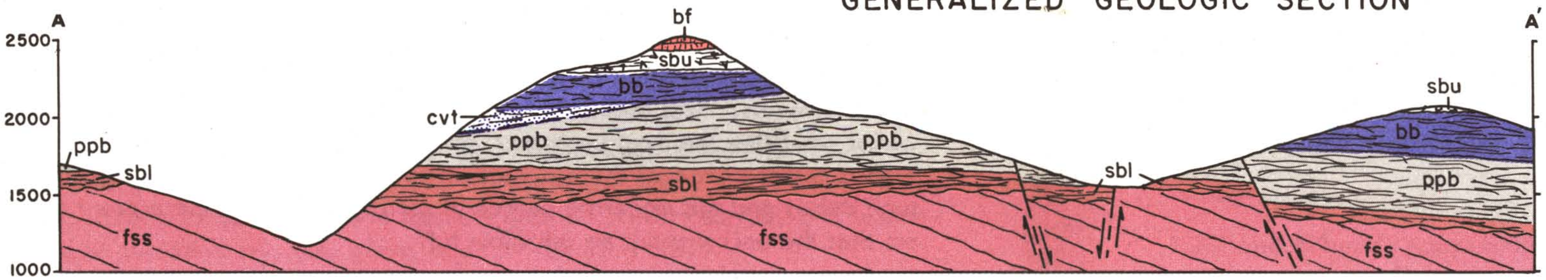
Fault (inferred) — Attitude of beds

Section lines

Index map showing approximate location of area of study.



GENERALIZED GEOLOGIC SECTION



Interlayered basalt flows and flow breccias

Overlying the crystal-vitric tuff is a sequence of interlayered basalt flows and submarine flow breccias 300 to 325 feet thick. The basalt flows are olivine basalt, very dark, massive, fine grained, and composed of plagioclase, pyroxene, lesser olivine, and interstitial glass. Individual flows are about 8 to 10 feet thick and have irregular columnar and vertical jointing.

The flow breccias are dark brown to black, massive, and fine grained. They contain angular fragments of basalt, ranging in size from one to four centimeters and similar in composition to the flows. Minor alteration has resulted in the formation of zeolites. The flow breccias range in thickness from 15 to 100 feet.

The basalts of this sequence are massive, hypocrystalline, aphanitic, with a trachytic to pilotaxitic texture, and are composed of plagioclase, pigeonite, olivine, magnetite, glass, and chlorite. Of the rock, 40 to 45 percent is plagioclase, occurring both as phenocrysts and microlites. The phenocrysts, most of which are albite twinned, are zoned, ranging from An_{75} at the core to An_{50} at the rims. The microlites are all albite twinned and have a composition of An_{50}.

The pyroxene, making up 30 to 35 percent of the rock, occurs both as phenocrysts and in the groundmass. Some crystals are twinned, and minor zoning is present. A large portion of the pyroxene shows alteration to chlorite. Interference figures gave a positive 2V of approximately 15 to 20 degrees and it is probably pigeonite (18 percent Ca). Olivine occurs in the groundmass and as phenocrysts, making up 10 to 15 percent of the rock. Optical properties indicate the olivine is Mg-rich. Alteration to serpentine with subsequent magnetite dust is common. Minor amounts of glass (3 to 5 percent) occur as irregular veins and between grains of pyroxene, olivine, and plagioclase, suggesting rapid cooling after prolonged crystallization. Opaque minerals compose 5 to 8 percent of the rock. Alteration minerals, consisting of chlorite and iddingsite(?), constitute 5 percent of the rock.

Upper submarine breccia

Conformably overlying the basalt flow and flow-breccia sequence is a fine-grained, dark, massive breccia containing pillows and stringers of basalt with well-developed columnar jointing. The rock is well indurated and consists of 50 percent lithic fragments, 25 percent glass, 15 percent magnetite, 5 percent pyroxene, and 5 percent olivine bound by a siliceous cement. The unit ranges from 100 to 150 feet in thickness and forms cliffs exposed near the summit of Cedar Butte.

Basalt flows capping Cedar Butte

Amygdaloidal basalt flows overlie the breccia with a depositional contact. They are dense and black, with poorly developed primary jointing and intensive fracturing. The units have an exposed thickness of more than 400 feet, with the individual flows ranging from 60 to 100 feet. They form a resistant cap on Cedar Butte, and weather to form steep cliffs.

Microscopically, the basalt is hypidiomorphic granular, and has a composition of 50 percent plagioclase, 25 percent augite, 7 percent magnetite, and 18 percent alteration minerals, primarily chlorite and an unidentified mineraloid. The plagioclase is highly zoned and ranges from An_{40} in the rims to An_{70} in the cores of the phenocrysts. The microlites have a composition of An_{40}. The pyroxene, occurring primarily in the groundmass, is lime-rich augite (47 percent Ca)*.

Basaltic dikes

The rocks of the Cedar Butte area are cut by several dikes of basaltic composition (not mapped) (figure 9). In general, these intrusive bodies trend northwesterly and dip steeply northeast, and are probably small feeder dikes to the overlying cap rocks.

The specimen of dike rock studied in this section is a porphyritic olivine basalt. It is holocrystalline, fine to medium grained, hypidiomorphic granular, pilotaxitic and porphyritic. It contains augite, 40 to 45 percent; labradorite, 35 to 40 percent; Mg-olivine, 8 to 10 percent; magnetite, 5 percent; and alteration minerals, 3 to 5 percent. The plagioclase phenocrysts have a composition of An_{64}. The microlites are only slightly less calcic, having a composition of An_{56}. The pyroxene has a positive 2V of 56° and is probably augite (45 percent Ca)*. A greater percentage of the pyroxene occurs in the groundmass, and many crystals are twinned along the b-axis parallel to (010)*. The olivine is generally euhedral and occurs only as phenocrysts. Optical properties indicate a Mg-rich variety. Alteration has resulted in the formation of serpentine and magnetite. Magnetite occurs as both a primary and a secondary mineral.

Composition of the Basalts

Determining whether a particular flow is a tholeiitic or an alkali-olivine basalt by means of petrographic data alone may yield results somewhat less than satisfactory, but such a study may serve, at least, to indicate compositional varieties.

Probably the most reliable petrographic criteria for establishing the

---

* 2V and twinning data obtained from measurements on the universal stage.

Figure 6. (Top) Thick sedimentary series below the volcanics is exposed along the road to Cedar Butte.

Figure 7. (Bottom) Close-up view of weathered shale and sandstone of figure 6.

various types of basalts are modal percentage and mode of occurrence of the olivine, and the Ca-content of the pyroxenes (Wilkinson, 1967).

In an alkali-olivine basalt, olivine percentage is high, with olivine generally occurring both as phenocrysts and in the groundmass. Coexisting pyroxene is usually Ca-rich (Ca percentage $>$45). In a tholeiitic basalt, olivine percentages are low and the mineral generally occurs only as phenocrysts. Pyroxene in such a basalt would be Ca-poor (Wilkinson, 1967).

The previously mentioned data for the basaltic rocks described earlier are listed in table 2.

Table 2. Data for compositional character of basalts of the Cedar Butte area.

Unit	Vol. % olivine	Mode of occur. of olivine	% Ca in pyroxene
1	30	P & G	~ 40
2	23	P & G	~ 18
3	8-10	P	~ 45
4	0	-	~ 47

P = Occurs as phenocrysts
G= Occurs in the groundmass

Unit 1. Olivine basalt porphyry; oldest unit, probably underlying mapped area.
Unit 2. Basalt from the basalt flow - flow breccia sequence.
Unit 3. Basalt from dike intruding unit 2.
Unit 4. Basalt from youngest flows capping Cedar Butte.

From the data presented, no confident conclusions can be drawn. The results are somewhat ambiguous and sometimes conflicting. Unit 1, however, does seem to approximate the characteristics of an alkali-olivine basalt, while the modal percent and mode of occurrence of olivine in units 3 and 4 may indicate a tholeiitic character similar to that of Columbia River Basalt.

More reliable results could be obtained through wider and more systematic sampling, and detailed chemical and petrographic analysis. It is hoped that in the near future such a study will be undertaken.

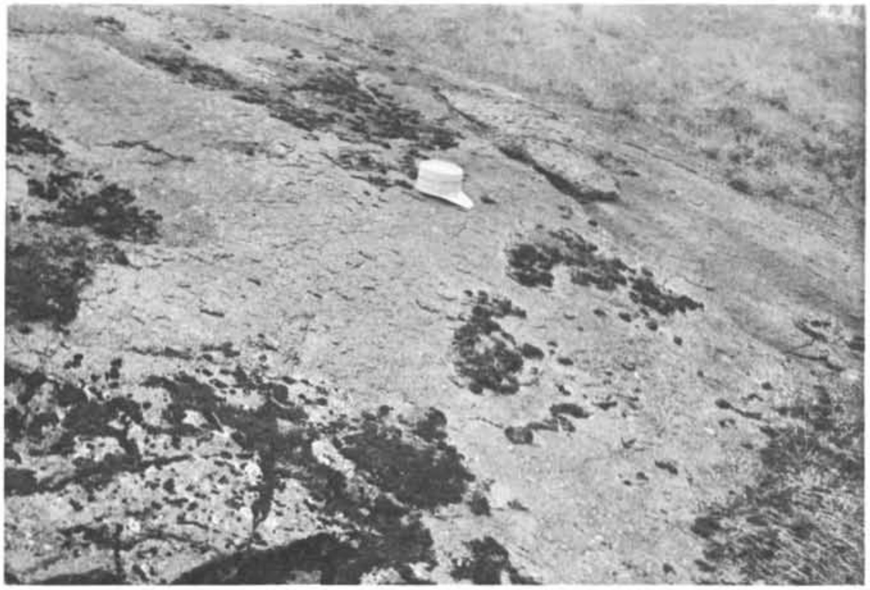


Figure 8. (Top) Fine-grained volcanic breccia forms massive pavement-like outcrops south of the mapped area.

Figure 9. (Bottom) Small basalt dike which marks minor offset in the vitric tuff bed was probably one of the feeders for the basalt cap on Cedar Butte.

Structural Geology

The most significant structural feature of the Cedar Butte area is the angular unconformity between the older sedimentary sequence and the overlying volcanic rocks. The older sedimentary sequence strikes northwesterly and dips variably to the northeast. The younger volcanic rocks are nearly horizontal or are dipping gently to the west-northwest (plate 1).

The rocks are complexly faulted in both northeast and northwest directions. The faults in general are high-angle normal ones with small to moderate displacement; some strike-slip movements were also interpreted. Mapping was on too small a scale to detect the large-scale regional folding noted by Snavely and Wagner (1964).

Summary and Conclusions

Cedar Butte, located in the northern Coast Range of Oregon, consists of a sequence of basalt flows, basaltic pillow lavas and submarine breccias, unconformably overlying sparsely fossiliferous tuffaceous shales and volcanic sandstones. The leaf fossils within the sedimentary rocks indicate a temperate climate and a shallow-water environment of deposition. The sedimentary rocks appear to have been derived from volcanic rocks. Later volcanism is indicated by basalt flows, flow breccias, and a crystal-vitric tuff. Pillow lavas, pillow palagonite breccias, palagonitic breccias, and submarine breccias indicate the volcanism was dominated by submarine activity. It is probable that the sedimentary sequence is part of the Tillamook Volcanic Series of middle to late Eocene age.

The presence of the angular unconformity between the Eocene sedimentary sequence and the younger volcanic sequence, and the possible tholeiitic character of the younger basalts suggest to the authors that these basalts may be related to the Columbia River Basalt of Miocene age.

Acknowledgments

We wish to express our appreciation to Dr. Paul E. Hammond and to other members of the Department of Geology at Portland State University for their helpful suggestions during the preparation of this report.

References Cited

Deer, W. A., Howie, R. A., and Zussman, J., 1965, Rock-forming Minerals, vol. 2, Chain Silicates: New York, John Wiley & Sons.

Ross, Clarence S., and Smith, Robert C., 1960, Ash flow tuffs: their origin, geologic relations and identification: U.S. Geol. Survey Prof. Paper 366.

Snavely, P.D., Jr., and Wagner, H.C., 1963, Tertiary geologic history of western Oregon and Washington: Washington Div. Mines and Geology Rept. Invest. 22.

__________________, 1964, Geologic sketch of northwestern Oregon: U.S. Geol. Survey Bull. 1181-M.

Warren, W.C., Norbisrath, Hans, and Grivetti, R.M., 1945, Geology of northwest Oregon west of Willamette River and north of latitude 45°15': U.S. Geol. Survey Map OM 42.

Wells, F.G., and Peck, D. L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geol. Survey Map I-325.

Wilkinson, J. F. G., 1967, The petrography of basalts, in Hess, H. J., and Poldervaart, A., eds., Basalts: the Poldervaart Treatise on Rocks of Basaltic Composition: Interscience Publishers, v. 1, p. 163-214.

* * * * *

DATE OF MARMES MAN CONFIRMED

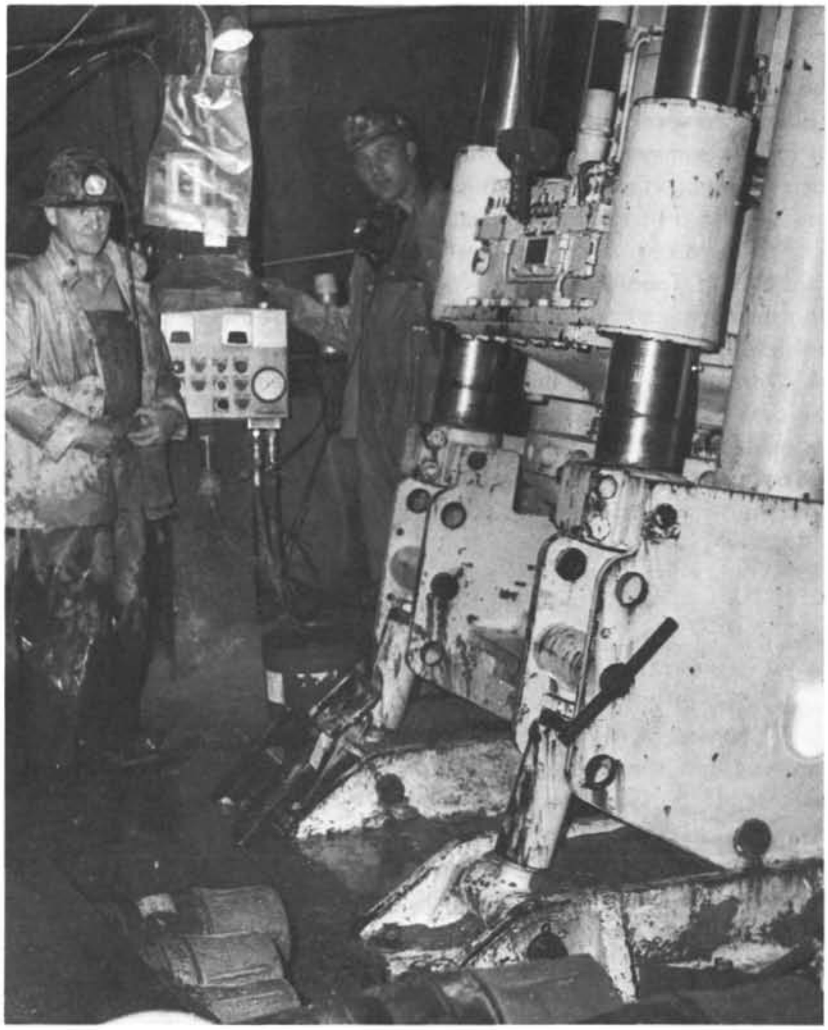
Ancient human remains at the Marmes rockshelter site in the southeastern part of Washington are now established as about 10,000 years old, according to scientists of the U.S. Geological Survey and Washington State University. Confirmation of the dating was announced recently by Dr. Meyer Rubin, head of the U.S. Geological Survey Radiocarbon Dating Laboratory in Washington, D.C., and by Professor Roald Fryxell of Washington State University's Laboratory of Anthropology.

Samples of bone from skulls, charcoal from firepits, and residue from decayed vegetation that grew at the excavation site were analyzed. Age of the specimens was determined by using the radiocarbon method. An additional check was provided by Dr. Minze Stuiver, head of Yale University's Radiocarbon Laboratory, who analyzed samples of shells from freshwater molluscs which lived in the nearby Palouse River shortly after the occupation of the Marmes site, and also shells discarded on the floor of the site.

The Marmes site has attracted international attention since the discovery of skull remains in 1965, not only because of the great age of the human skeletal remains, but also because of the unique sequence of these remains, artifacts, fossil animal bones, and geological record from the site, ranging in age from the 10,000-year-old skeletons in the lowest layer to remains of an individual who died only 2000 years ago. Hopes of preserving the site were set back in February, 1969, when a protective levee failed to save it from water backing up behind Lower Monumental Dam on the Snake River in Washington.

The dating of the Marmes site corresponds fairly closely with that assigned to the Fort Rock sandals (9050 B.P.) in northwestern Lake County, Oregon. The sandals, discovered about 30 years ago by Dr. Luther Cressman, head of the Department of Anthropology at the University of Oregon, represent the oldest known artifacts in North America.

* * * * *



OMEGA MINES USES BORING MACHINE

Pictured above is the raise boring machine used recently by Omega Mines in the drilling of a 4-foot-diameter interconnection between levels on the company's property at Bourne, Baker County, Oregon. Ted Corcoran (left) is superintendent of the mine; Alf Madson (right) is operator of the equipment.

Machines of this type first drill a pilot hole between levels and then, with the reamer bit attached, enlarge the hole from the bottom up. The raise now completed by Omega was bored over a distance of 150 feet for the dual purpose of enhancing subsurface ventilation and providing an emergency alternate escapeway for safety purposes. (Continued on page 132)

Insofar as is known, this is the first time a raise has been bored by a machine of this type and size in any mine in Oregon. This particular project represents only part of Omega's continuing program of developing and appraising ore reserves on their extensive holdings in the Bourne area. Plans for the summer include a massive diamond-drilling effort from both surface and subsurface locations and the driving of a considerable footage of new workings in the form of both drifts and crosscuts.

The more noteworthy properties now part of Omega's holdings include the old E & E, Tabor Fraction, North Pole, Golconda, and Columbia mines. During the fore part of the century these properties were operated as individual mines under separate ownership and management; however, all properties overlie portions of the outcrop of what is believed to be the longest and widest continuous gold-bearing shear zone in Oregon. Omega's program for exploring and developing this lode therefore rates as a truly major project of far-reaching significance. (Photograph by Jerry Herman, courtesy of the Democrat-Herald, Baker, Oregon.)

* * * * *

MINERALS YEARBOOK AVAILABLE

The U.S. Bureau of Mines has issued its MINERALS YEARBOOK for 1967. The four-volume statistical publication is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Volumes I and II (under one cover), priced at $6.25, summarize all metals, minerals, and fuels; Volume III, at $5.25, contains the domestic area reports; and Volume IV, at $5.25, has the international area reports. All of the volumes are clothbound.

* * * * *

WILLAMETTE VALLEY SOILS DESCRIBED

"Geomorphology and soils, Willamette Valley, Oregon," by C. A. Balster and R. B. Parsons, has been published as Special Report 265 by the Oregon State University Agricultural Experiment Station in cooperation with the Soil Conservation Service of the U.S. Department of Agriculture. The 31-page publication, including a geomorphic-soils map, is available from the Agricultural Experiment Station, Oregon State University, Corvallis, Oregon 97331. There is no charge for single-copy orders.

The report demonstrates the time sequence of landscape development and establishes the relation of the soils of the valley to the geomorphic units.

* * * * *

AVAILABLE PUBLICATIONS

(Please include remittance with order. Postage free. All sales are final and no material is returnable. Upon request, a complete list of the Department's publications, including those no longer in print, will be mailed.)

BULLETINS

2.	Progress report on Coos Bay coal field, 1938: Libbey	$ 0.15
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.	(1st vol.) Five papers on Western Oregon Tertiary foraminifera, 1947: Cushman, Stewart, and Stewart	1.00
	(2nd vol.) Two papers on Western Oregon and Washington Tertiary foraminifera, 1949: Cushman, Stewart, and Stewart; and one paper on mollusca and microfauna, Wildcat coast section, Humboldt County, Calif., 1949: Stewart and Stewart	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Allison	0.75
46.	Ferruginous bauxite deposits, Salem Hills, Marion County, Oregon, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining dist., Grant County, Ore., 1959: Koch	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	3.50
53.	Bibliography (3rd supplement) of the geology and mineral resources of Oregon, 1962: Steere and Owen	1.50
56.	Fourteenth biennial report of the State Geologist, 1963-64	Free
57.	Lunar Geological Field Conference guide book, 1965: Peterson and Groh, editors	3.50
58.	Geology of the Suplee-Izee area, Oregon, 1965: Dickinson and Vigrass	5.00
60.	Engineering geology of the Tualatin Valley region, Oregon, 1967: Schlicker and Deacon	5.00
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	5.00
62.	Andesite Conference Guidebook, 1968: Dole, editor	3.50
63.	Sixteenth Biennial Report of the State Geologist, 1966-1968	Free

GEOLOGIC MAPS

Preliminary geologic map of Sumpter quadrangle, 1941: Pardee and others	0.40
Geologic map of the St. Helens quadrangle, 1945: Wilkinson, Lowry & Baldwin	0.35
Geologic map of Kerby quadrangle, Oregon, 1948: Wells, Hotz, and Cater	0.80
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
Geologic map of Lebanon quadrangle, Oregon, 1956: Allison and Felts	0.75
Geologic map of Bend quadrangle, and reconnaissance geologic map of central portion, High Cascade Mountains, Oregon, 1957: Williams	1.00
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
Geologic map of Oregon west of 121st meridian: (over the counter) folded in envelope, $2.15; rolled in map tube, $2.50	2.00
Gravity maps of Oregon, onshore and offshore, 1967: [Sold only in set]: flat folded in envelope, $2.25; rolled in map tube, $2.50	2.00

[Continued on back cover]

Printed by Duplicating Systems, Inc.

State of Oregon
Department of Geology & Mineral Industries
1069 State Office Bldg., Portland, Oregon 97201
POSTMASTER: Return Requested

The Ore Bin

⚒ ⚒ ⚒ ⚒ ⚒ ⚒ ⚒ ⚒

Available Publications, Continued:

SHORT PAPERS

2.	Industrial aluminum, a brief survey, 1940: Leslie L. Motz	$ 0.10
18.	Radioactive minerals the prospectors should know (2nd rev.), 1955: White and Schafer	0.30
19.	Brick and tile industry in Oregon, 1949: Allen and Mason	0.20
20.	Glazes from Oregon volcanic glass, 1950: Charles W.F. Jacobs . . .	0.20
21.	Lightweight aggregate industry in Oregon, 1951: R. S. Mason	0.25
23.	Oregon King Mine, Jefferson County, 1962: F.W. Libbey and R.E. Corcoran	1.00
24.	The Almeda Mine, Josephine County, Oregon, 1967: F.W. Libbey . . .	2.00

MISCELLANEOUS PAPERS

2.	Key to Oregon mineral deposits map, 1951: R. S. Mason	0.15
3.	Facts about fossils (reprints), 1953	0.35
4.	Rules and regulations for conservation of oil and natural gas (rev. 1962) .	1.00
5.	Oregon's gold placers (reprints), 1954	0.25
6.	Oil and gas exploration in Oregon, rev. 1965; Stewart and Newton . . .	1.50
7.	Bibliography of theses on Oregon geology, 1959: H.G. Schlicker . . .	0.50
7.	(Supplement) Bibliography of theses, 1959 to Dec.31, 1965: M. Roberts .	0.50
8.	Available well records of oil & gas exploration in Oregon, rev. '63: Newton	0.50
10.	Articles on Recent volcanism in Oregon, 1965: (reprints, The ORE BIN) .	1.00
11.	A collection of articles on meteorites, 1968: (reprints, The ORE BIN) . .	1.00
12.	Index to published geologic mapping in Oregon, 1968: R. E. Corcoran .	Free

MISCELLANEOUS PUBLICATIONS

Oregon mineral deposits map (22 x 34 inches), rev. 1958	0.30
Oregon quicksilver localities map (22 x 34 inches), 1946	0.30
Landforms of Oregon: a physiographic sketch (17 x 22 inches), 1941	0.25
Index to topographic mapping in Oregon, 1961	Free
Geologic time chart for Oregon, 1961	Free

OIL and GAS INVESTIGATIONS SERIES

1.	Petroleum geology of the western Snake River basin, Oregon-Idaho, 1963: V. C. Newton, Jr., and R. E. Corcoran	2.50