The Ore Bin

Vol. 33, No. 6
June 1971

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: 229 - 5580

FIELD OFFICES

2033 First Street
Baker 97814

521 N. E. "E" Street
Grants Pass 97526

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

Second class postage paid
at Portland, Oregon

State of Oregon
Department of Geology
and Mineral Industries
1069 State Office Bldg.
Portland Oregon 97201

The ORE BIN
Volume 33, No. 6
June 1971

EVIDENCE FOR THE PORTLAND HILLS FAULT

By J. H. Balsillie and G. T. Benson
Department of Earth Sciences, Portland State University

Introduction

Downtown Portland is bounded on the west by a broad, partly dissected ridge named the Tualatin Mountains on topographic maps and locally called the Portland Hills. The linear character of the east front of the hills strongly suggests faulting (fig. 1). For obvious practical reasons, the evidence for such a fault (commonly called the Portland Hills fault) deserves careful investigation.

The Portland Hills, which stand about 1,000 feet higher than the Willamette Valley to the east, are the physiographic expression of an anticline. The west limb and crest of the structure are adequately defined, but the east flank poses the immediate problem: It may represent a normal fold limb within the area of the hills; it may represent a normal fold limb east of the present front of the hills, which has been eroded and covered by Quaternary sediments; or it may represent a fault. These alternative hypotheses may be evaluated on the bases of structural data, geomorphic features, and seismic records. This paper is primarily concerned with the area northwest of Portland -- Forest Park in the hills, and along the west bank of the Willamette River from the south end of Suavie Island to about Vaughn Street-- where the evidence for the Portland Hills fault seems least equivocal.

Diller (1916) described the uplift of Portland Heights, but did not analyze the structure; he did, however, postulate northwest-trending faults between southeast Portland and Oregon City. Treasher (1942) noted the escarpment of the east front of the Portland Hills and considered it possibly indicative of faulting, but he excluded faulting from his interpretation for lack of direct evidence. Trimble (1963) did not show a fault at the east front of the hills on his geologic map and cross section of Portland, and he did not mention faulting as a possibility in his report. On the other hand, various authors, such as Schlicker and others (1964), have noted seismic

Figure 1. Oblique aerial view looking northwest over downtown Portland and along the east side of the Portland Hills. Photo by L. A. Palmer, prepared by T. R. Bessler.

events which would support the presence of a fault with a projected trace along the eastern foot of the hills. Schlicker and Deacon (1967) showed a segment of the inferred fault and described it as a major structural feature of the region. Thus there is disagreement among geologists who have studied the area as to the existence of the Portland Hills fault.

Rock Units

Stratigraphic units in the Portland area have been described by Treasher (1942) and Trimble (1963) among others. The following summary is based largely on published work and is simplified, omitting stratigraphic details which are not immediately pertinent. Units discussed are shown on the accompanying map (fig. 2) and cross sections (figs. 3A and 3B).

Columbia River Basalt (Tcr) underlies the whole area and is the oldest unit exposed, forming the core of the Portland Hills anticline (fig. 2). Fresh, dark gray to black, dense basalt, with well-developed columnar or close-cubic ("brick-bat") jointing, is exposed in roadcuts. Natural outcrops, however, are generally deeply weathered; the weathered zone (saprolite), up to 30 feet thick, consists of red to brown clay with fragments of decomposed basalt. Individual flows are 30 to 60 feet thick; weathered flow tops, and breccia and ash units have been recognized (Schlicker and Deacon, 1967). Although detailed petrographic studies were not made, the basalt is identified as Columbia River on the bases of stratigraphic position and gross lithologic similarity to the Columbia River Basalt in the Columbia Gorge.

In the Richfield Oil Co. "Barber no. 1" (sec. 23, T. 1, N., R. 1 W., near the top of the hills), Columbia River Basalt was encountered beneath mantle at 97 feet, and marine sedimentary rocks beneath the basalt at 803 feet (Hart and Newcomb, 1965). On the detailed cross section (fig. 3-B), the surface location of the well (elevation 1,047 feet) is shown approximately 200 feet below the projected top of the basalt. The pre-erosion top of the basalt may have been as little as 100 feet above the present surface at the well. This projection of the top of the basalt is important as it bears on the estimated throw of the fault.

In the subsurface beneath Portland, the Columbia River Basalt is overlain by the Sandy River Mudstone (Tsr on fig. 3-A). This unit is about 1,000 feet thick under east Portland (Trimble, 1963), but thins westward and is missing in wells immediately east of the front of the hills (Brown, 1963). The Troutdale Formation (Tt) of Pliocene age overlies the Sandy River Mudstone and the Columbia River Basalt (Hodge, 1938; Trimble, 1963). Isolated remnants of gravels of characteristic Troutdale lithology are mapped on the east side of the Portland Hills at elevations up to 600 feet. The Troutdale Formation has been recognized on the west slope of the hills and in the Tualatin basin to the west in finer-grained facies (Schlicker and Deacon, 1967). Distribution, thickness, and lithology of these units suggest that the Portland Hills structure has been developing, probably more or less

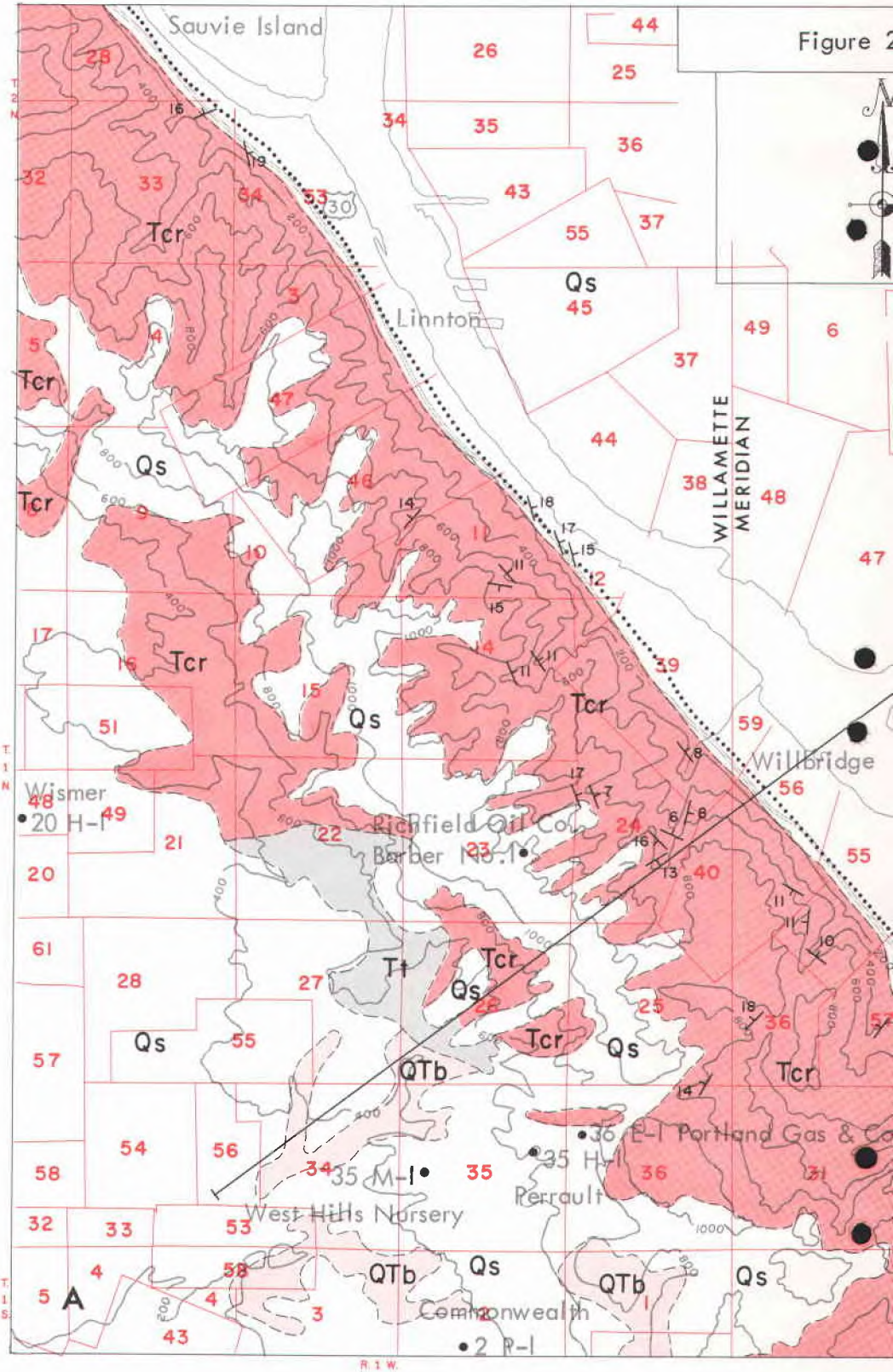


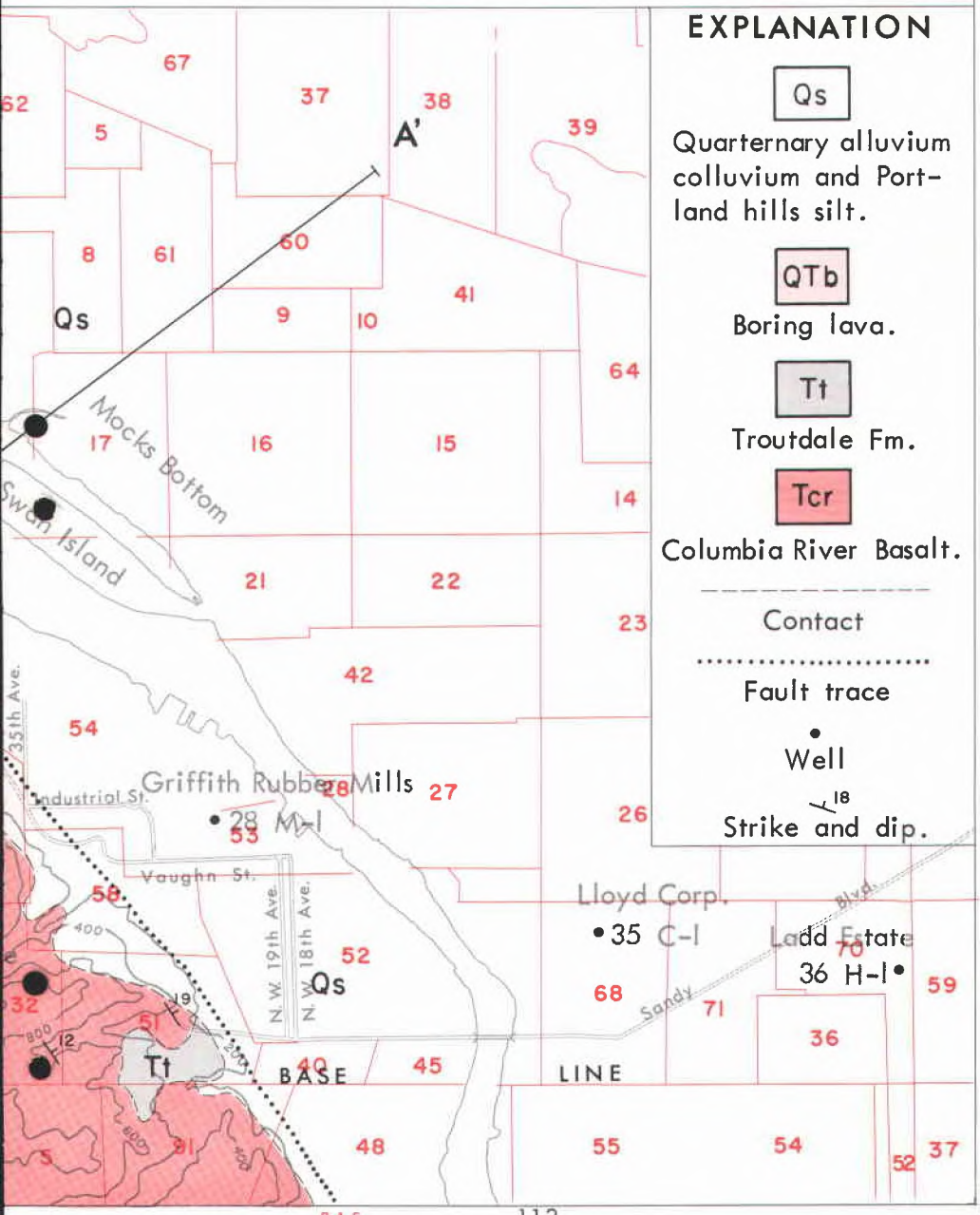
Figure 2
Sauvie Island
Linnton
Willbridge
Wismer
20 H-1
Richfield Oil Co.
Barber No. 1
35 M-1
West Hills Nursery
35 H-1
Perrault
36 E-1 Portland Gas & Co
Commonwealth
2 P-1
WILLAMETTE MERIDIAN
T. 2 N.
T. 1 N.
T. 1 S.
R. 1 W.
Tcr
Qs
Tt
QTb
A

SIMPLIFIED GEOLOGIC MAP OF NORTHWEST PORTLAND

Scale 1:62,500

1 .5 0 1 2

Contour interval 200 feet
Sources: Schlicker & Deacon, 1967
Trimble, 1963; Treasher, 1942



continuously, at least since Columbia River Basalt time.

Boring lava (QTb) of late Pliocene or early Pleistocene age is locally exposed on the crest and west slope of the Portland Hills. The Boring lavas are olivine basalt (or andesitic olivine basalt) distinguished by gray color, blocky or platy jointing, and diktytaxitic texture (Schlicker and Deacon, 1967). The thickness of the Boring is quite variable, depending on proximity to local vents. Various lines of Boring vents have been noted in the greater Portland area; one of these roughly follows the crest of the Portland Hills.

Quaternary sediments (Qs) deposited mainly in fluviatile environments cover the Portland and Tualatin basins. Where Boring lavas are missing, discrimination between Quaternary deposits and underlying Troutdale Formation in well records is difficult. Absence of Troutdale exposures in the cliff at Mocks Bottom indicates a thickness of at least 90 feet of Quaternary deposits in the vicinity of the Willamette River. A relatively thin mantle of buff colored, cohesive silt covers much of the upper part of the Portland Hills. This unit has been identified as Portland Hills Silt (Lowry and Baldwin, 1952), loess of Quaternary age (Trimble, 1963), and Upland Silt (Schlicker and Deacon, 1967).

Structural Evidence

As noted above, the Portland Hills (Tualatin Mountains) are the expression of an anticline with Columbia River Basalt exposed in the core. The Tualatin and Portland basins, to the west and east respectively, are synclinal and largely filled with younger deposits covering the basalt (fig. 2). The axis of the anticline trends north-northwest, generally following the crest of the hills, but the top of the structure is broad and crenulated (fig. 3A).

Detailed study of the structure is hampered by lack of readily measureable bedding attitudes; exposures of flow surfaces and interbeds in the Columbia River Basalt are relatively scarce. Columnar joints, however, are commonly well displayed in roadcuts. As these joint columns are primary structures formed perpendicular to cooling surfaces, planes normal to column axes may be taken as geometric approximations (phantoms) of flow surfaces. The Columbia River Basalt flows spread widely over fairly gentle slopes, and flow surfaces were presumably nearly horizontal. Thus, present orientations of column axes and deduced phantom flow surfaces should record post-cooling deformation. The problem of column fans and irregular flow surfaces is avoided by considering only continuous exposures of reasonable length and uniform column orientations. (Independent measurements suggested that magnetite in the basalt had little effect on compass strike readings.)

Orientations of 75 column axes were used to determine average phantom flow surface attitudes in 21 localities in Forest Park northwest of Portland. Phantom flow surface attitudes shown on the map (fig. 2) were projected

into the detailed cross section (fig. 3-B) as apparent dips. These dips were used to extend the projected top of the Columbia River Basalt eastward from the Richfield Barber well. The geometrically constructed cross section (fig. 3-B) is compatible with faulting. The top of the Columbia River Basalt immediately west of the projected fault is located approximately 700 feet above sea level; east of the fault it is placed at about sea level. Thus the dip-slip component of displacement on the fault is about 750 feet. Easterly dips, which are obvious along the highway at the foot of the hills, are not found at higher elevations (fig. 3-B), and these dips have little effect on the projection of the top of the basalt. The easterly dips could be attributed to drag adjacent to the fault.

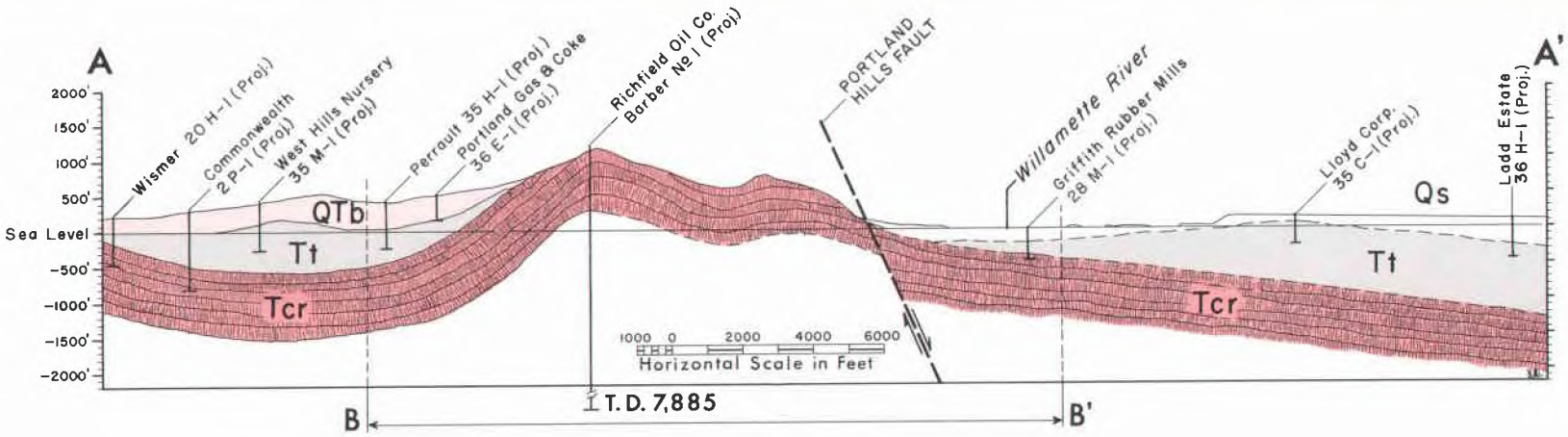
Geomorphic Evidence

Several physiographic features indicative of faulting along the east front of the Portland Hills are apparent on the Portland and Linnton 7 1/2' topographic quadrangle maps and on aerial photographs: 1) The eastern front of the hills is markedly linear. A straight edge can be placed along the break in slope on the map for as much as two miles; the break in slope lies within 250 feet of a line drawn from the intersection of NW. 35th and Industrial Streets in Portland to the highway at Linnton, five miles to the northwest. Segments of the line everywhere trend within 8° of N. 38° W. It seems hardly credible that the river could have cut such a straight valley side leaving no meander scars. 2) Spur ridges extending northeast from the crest of the hills terminate in aligned triangular facets. A straight edge can be used to follow the same contour from one facet to the next; breaks in slope at the tops of the facets are roughly aligned. The notable uniformity of facets may be accounted for in part by the uniform lithology and resistance to erosion of the Columbia River Basalt which forms them. 3) Cross profiles of canyons of northeast-flowing streams have wine-glass shapes, and long profiles of some of these streams show nick points; both features are indicative of local rejuvenation.

These physiographic features suggest not only that the eastern front of the Portland Hills is a fault-line escarpment, but also that movement on the fault has been relatively recent.

Anomalous benches low on facets in several localities are evident on aerial photographs (though not on topographic maps). At least one of these benches, just south of Willbridge, could not be a simple river terrace as it slopes gently southeast (upstream). Perhaps these benches are related to faulting, but this idea needs further investigation.

South of Vaughn Street, the physiographic front is less well defined, although it does continue and is generally linear. Contours on the top of the Columbia River Basalt beneath downtown Portland (based on data from Brown, 1963) suggest several steep zones in the subsurface east of the front of the hills. This raises the possibility of more than one fault in the area.



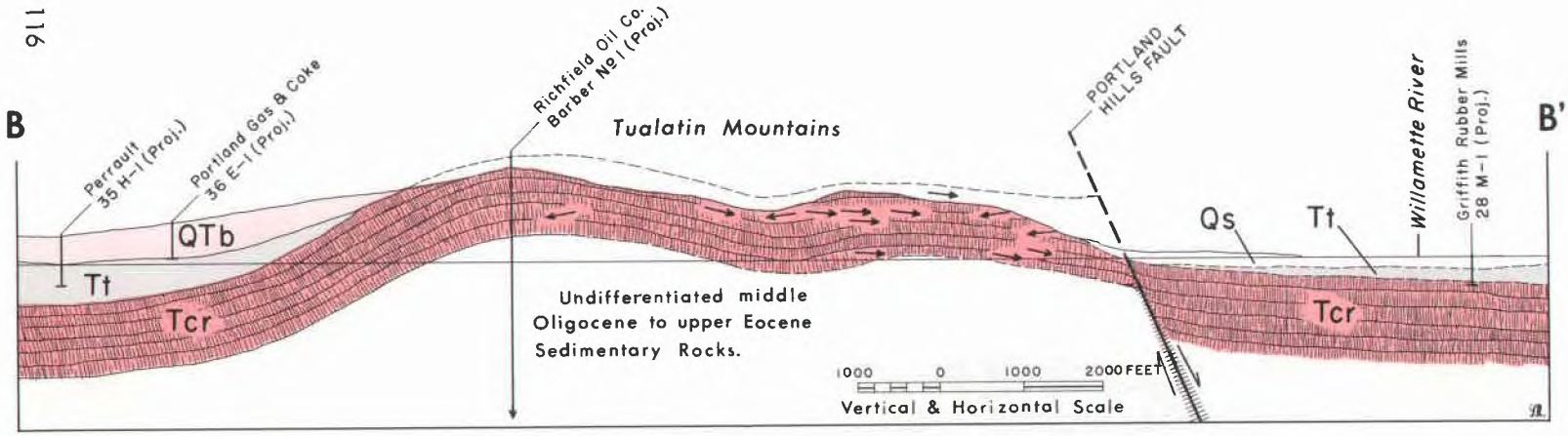


Figure 3 A & B. Geologic cross section. (Well data from Brown, 1963, Hart and Newcomb, 1965, and Hogenson and Foxworthy, 1965.)

Seismic Evidence

Of the 240 earthquakes felt in Oregon between 1841 and 1958, 51 were reported in the Portland area (Berg and Baker, 1963). Although this proportion may reflect population distribution in part, Portland is certainly among the more active seismic areas in the state. In the last few years about one shock has been felt in the Portland area per year. Some of these shocks have caused minor damage, but no ground breakage or other evidence of surface faulting has been reported.

The most useful seismic data obtained to date came from the earthquake of November 5, 1962 and its aftershocks (Dehlinger and Berg, 1962; Dehlinger and others, 1963). Based on revised travel-time curves, the epicenter of the principal event was placed at lat. 45° 36' N, long. 122° 40' W, between Portland and Vancouver, Washington. The depth of focus was estimated between 15 and 20 km (10 to 12 miles). This would be compatible with a normal fault having a surface trace at the eastern base of the Portland Hills and a northeasterly dip between 63° and 69° (shown as limits in fig. 3-B). Detailed studies related the aftershocks to the Portland Hills escarpment (Westphal, 1962).

Discussion

Of the alternative explanations of the eastern flank of the Portland Hills structure, a normal fold limb within the area of the hills is ruled out by structural data; there is simply not enough room to fit the fold limb. The possibility that the eastern limb of the fold has been eroded and buried cannot be eliminated owing to lack of attitudes in the Columbia River Basalt under the younger cover. Preference must be given to faulting as the explanation, however, on the basis of three separate lines of evidence--structural, geomorphic, and seismic.

The axiom of field geology, "when in doubt, don't map a fault," certainly has merit. But where several lines of indirect evidence suggest the presence of a fault, it should be mapped at least as inferred--particularly in a populated area. Here the fault should be carefully investigated and considered in urban planning and structural design. We must assume that the Portland Hills fault does exist and that it is active.

Acknowledgments

Kathleen Manning helped in all phases of this study. L. A. Palmer, R. J. Deacon, and P. E. Hammond read the manuscript and made valuable suggestions. Martha Appleman prepared the original drawings. Work was partly supported by Portland State University Research and Publications Fund Grant no. 493.

References Cited

Berg J. W., Jr., and Baker, C. D., 1963, Oregon earthquakes, 1841 through 1958: Seismol. Soc. Amer. Bull., vol. 53, p. 95-108.

Brown, S. G., 1963, Problems of utilizing ground water in the west-side business district of Portland, Oregon: U. S. Geol. Survey water-supply Paper 1619-O, 42 p.

Dehlinger, Peter, and Berg, J. W., Jr., 1962, The Portland earthquake of Nov. 5, 1962: Oregon Dept. Geology and Mineral Industries, The Ore Bin, vol. 24, no. 11, p. 185-188.

Dehlinger, P., Bowen, R. G., Chiburis, E. F., and Westphal, W. H., 1963, Investigations of the earthquake of November 5, 1962 north of Portland: Oregon Dept. Geology and Mineral Industries, The Ore Bin, vol. 25, no. 4, p. 53-68.

Diller, T. S., 1916, Guidebook of the western United States, Part D., The Shasta route and coast line: U. S. Geol. Survey Bull. 614, 146 p.

Hart, D. H., and Newcomb, R. C., 1965, Geology and ground water of the Tualatin Valley, Oregon: U. S. Geological Survey Water-supply Paper 1967.

Hodge, E. T., 1938, Geology of the lower Columbia River: Geol. Soc. Amer. Bull., vol. 49, p. 836-929.

Hogenson, G. M., and Foxworthy, B. L., 1965, Ground water in the east Portland area, Oregon: U. S. Geol. Survey Water-supply Paper 1793, 78 p.

Lowry, W. D., and Baldwin, E. M., 1952, Late Cenozoic geology of the lower Columbia River Valley, Oregon and Washington: Geol. Soc. Amer. Bull., vol. 63, p. 1-24.

Schlicker, H. G., and Deacon, R. J., 1967, Engineering geology of the Tualatin Valley region, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 60, 103 p.

Schlicker, H. G., Deacon, R. J., and Twelker, N. H., 1964, Earthquake geology of the Portland area, Oregon: Oregon Dept. Geology and Mineral Industries, The Ore Bin, vol. 26, no. 12, p. 209-230.

Treasher, R. C., 1942, Geologic history of the Portland area: Oregon Dept. Geology and Mineral Industries Short Paper 7, 17 p.

Trimble, D. E., 1963, Geology of Portland, Oregon and adjacent areas: U. S. Geol. Survey Bull. 1119, 119 p.

Westphal, W. H., 1962, Seismic aftershock investigations - Project Vela. Portland, Oregon, earthquake of 6 November 1962: Stanford Research Inst. Technical Report no. 1, 11 p.

* * * * *

OREGON EOCENE DECAPOD CRUSTACEA

By W. N. Orr and M. A. Kooser
Department of Geology, University of Oregon

Introduction

Although they are locally ubiquitous, fossilized crabs are seldom common in the Tertiary fossil record of the Pacific Northwest. Literature on this invertebrate group for the same area is limited to a few papers describing individual new species or faunal lists which include an occasional note on decapods. The most authoritative compendium at present on the fossil crabs of the west coast was produced by Mary J. Rathbun in 1926.

The present paper is to describe a particularly well-preserved assemblage of middle Eocene crabs found in association with a diverse invertebrate community in exposures of the Umpqua Formation in southwest Oregon.

Location

Collections described here were obtained from exposures of the Umpqua Formation in road cuts along road 3406 adjacent to Snout Creek in the N½, SW¼ sec. 9, T. 34 S., R. 11 W., between 2.5 and 3 miles east of Agness, Oregon (fig. 1). Most of the exposures along this road were found to be fossiliferous but the best single locality (U. of O. Locality no. 2594) is 3 miles east of Agness in the cut on the south side of the road. These sediments have been mapped and described by several authors but undoubtedly the most recent and continuing efforts in the area are by Baldwin (1961, 1963, 1964, 1965). According to that author [(1965) and oral communication], sediments in the area under study are from an interval in the upper half of the Umpqua Formation. Locally the sediments along Snout Creek dip gently to the west and are part of a syncline plunging to the northeast. The Umpqua Formation in the immediate vicinity consists of black to grey calcareous siltstones that weather yellow and tan upon oxidation of the iron content. Within the siltstone, calcareous concretions from 1 cm up to 10 cm are common and it is in these concretions that the best preserved invertebrate specimens are to be found. Calcite-filled fractures and small-scale slickensides within the siltstone suggest considerable movement and deformation of the sediments after consolidation.

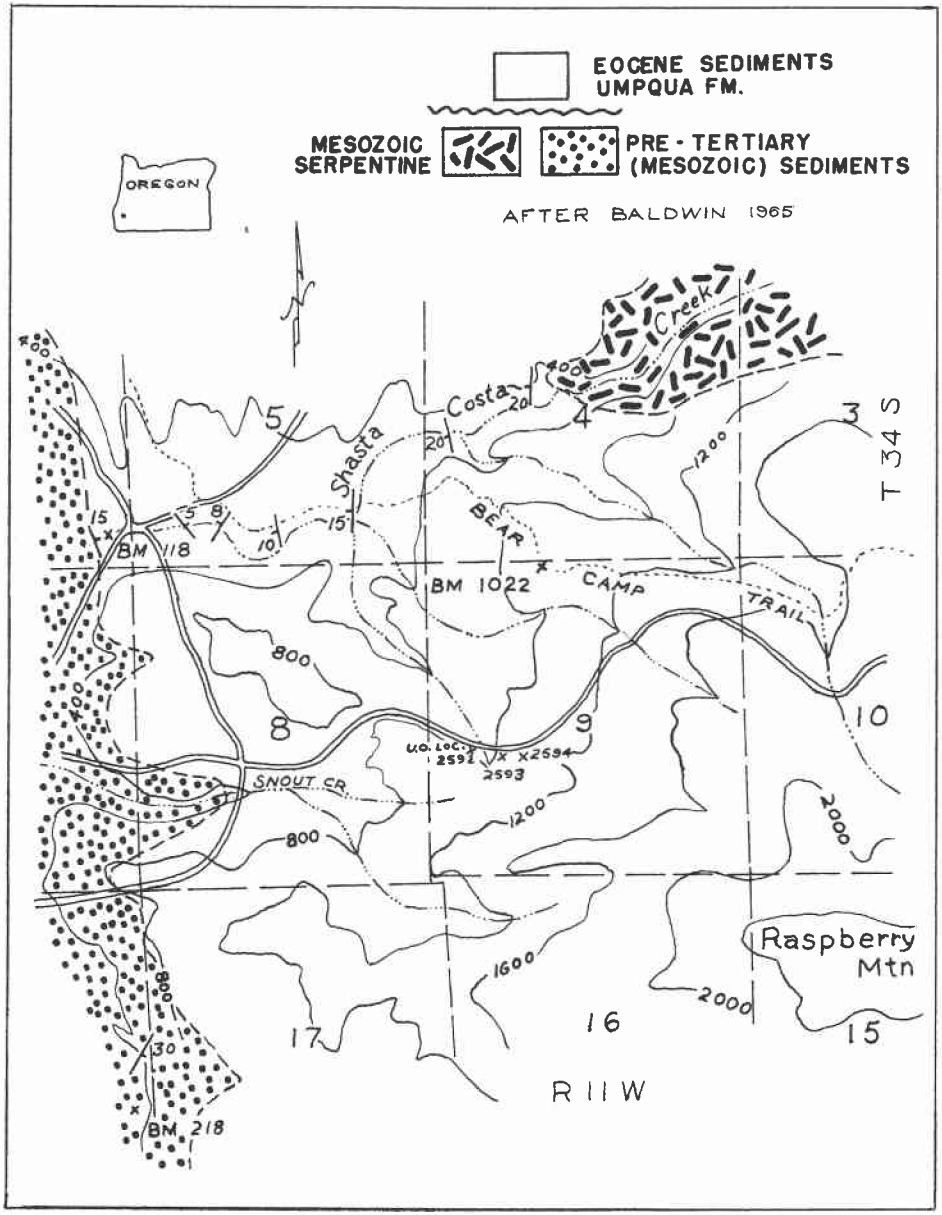


Figure 1. Geologic sketch map showing location of Univ. of Oreg. Mus. of Nat. Hist. Localities 2592, 2593, 2594. Geology from Baldwin [(1965) and oral communication].

Fossil Assemblage

Crabs

Fossilized crabs from these sediments are assigned to three genera and species including Raninoides washburnei Rathbun, Plagiolophus weaveri Rathbun and Cancer sp. The latter species is indeterminant and may be a new, as yet unnamed taxon.

By far the commonest species of crab recovered at any of the collecting sites was Plagiolophus weaveri. (figure 5A-I) This species is characterized by three prominent spines on the anterior periphery of the carapace and the large forward projecting orbits. Many of the living Pacific Coast crabs related to this species (family Goneplacidae) are burrowing types found in the mud flats of shallow bays and inlets. More than fifty complete carapaces of P. weaveri were recovered as well as several fragments sufficiently large for identification. This moderate number of whole specimens permits a simple analysis of growth in this species by plotting the width of the carapace against the length (fig. 2). With this type of graphic presentation, we are able to see that the ratio of width to length in the smallest individuals is very near one to one. Young adult specimens have a ratio of four to three whereas in mature adults the ratio is around three to two. A growth pattern of this type where the width increases at a more rapid rate than the length is not uncommon in decapods and is an expression of the rapid expansion of the branchial areas enclosing the gills within the lateral portions of the carapace. Males may be distinguished from females in this species by the slightly wider abdomenal segments in females (fig. 5E & 5F). The observed ratio of males to females in the P. weaveri population was around four to one. Plagiolophus weaveri has been reported by Rathbun (1926) from several Eocene localities in California. Many of the specimens of P. weaveri represented in this study were complete articulated specimens. This was particularly true of specimens preserved in concretions. The frequency of whole specimens here suggests that these organisms were buried in a quiet or low-energy environment in the Eocene ocean. Another explanation for their outstanding preservation as fossils might lie in their habitat as borrowing organisms.

Somewhat less common at these localities was the species Raninoides washburnei Rathbun (fig. 4D, E, G). This species belongs to a family (Raninidae) of crabs that once lived along the north Pacific Coast. At present they are more representative of tropical to subtropical waters from Mexico to Panama (Rathbun 1926). Although no articulated specimens of R. washburnei were recovered, we were fortunate enough to extract a small specimen on which the sternum plates are displayed (fig. 3C, 4F). R. washburnei is characterized by the coarse punctations on the carapace, the outward projecting lateral spine off the ovate carapace and the broad bispinous outer orbital spine. Specimens of Raninoides washburnei have been reported (Rathbun 1926) from Oligocene sediments near Eugene, Oregon as well as

from middle Eocene sediments exposed in Douglas County, Oregon.

The final decapod species recovered from the southwest Oregon locality has been assigned to the genus Cancer because of subelliptical carapace outline, small orbits and the rows of five tooth-like spines on the anterior lateral margins (fig. 4H, I). Only a very few specimens assignable to this taxon were recovered and most were fragments. The difficulty of assigning even whole specimens to a recognized species, however, suggests that they may belong to a new species. The genus Cancer is commonly represented by several species in the Tertiary fossil record of the Pacific Northwest (Nations 1969) and is known from rocks dating from the Paleocene to the Holocene.

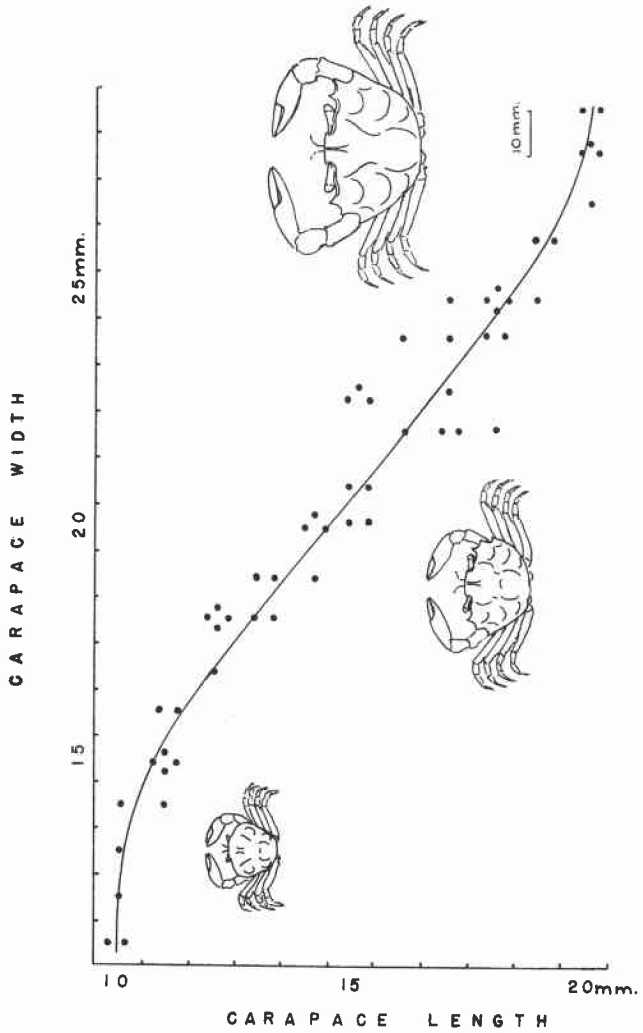


Figure 2. Length/ width distribution in the species Plagiolophus weaveri Rathbun.

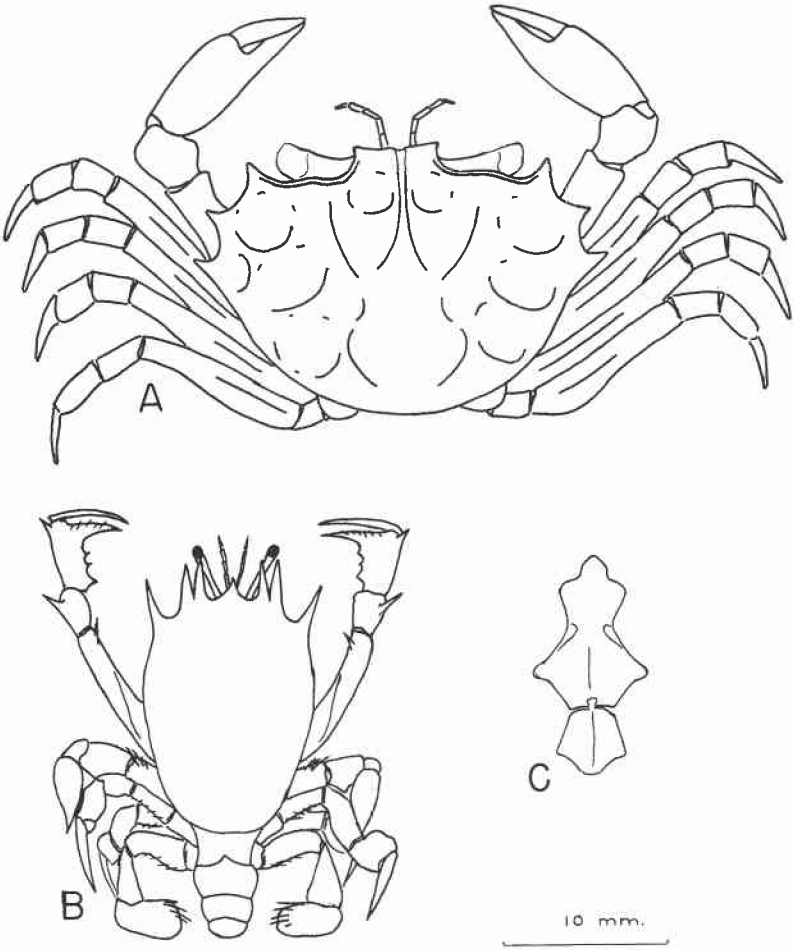


Figure 3. Reconstruction of Plagiolophus weaveri Rathbun (3A) and Raninoides washburnei Rathbun (3B), Sternum of Raninoides washburnei Rathbun (first and second segments and episternum) (3C). Details of reconstructed legs here as well as those on figure 2 are not precise (particularly those of R. washburnei) and are primarily to show the proportions of the carapace with respect to the entire body.

Echinoderms

Several specimens of irregular echinoids were recovered at the localities. Most of the specimens were small (2 cm dia. or less) and were considerably distorted. The specimens are characterized by well-defined, depressed

SPECIES LIST

MOLLUSCA

Pelecypods

Acila decisa (Conrad)

Anomia mcgoniglensis Hanna

Crassatella cf. uvasana mathewsoni (Gabb)

Glycimeris fresnoensis Dickerson

Nuculana gabbi (Gabb)

Ostrea sp.

Solena (Eosolen) cf. coosensis Turner

Tellina soledadensis Hanna

Gastropods

Fusinus merriami Dickerson

Homalopoma wattsi (Dickerson)

Mitra cretacea Gabb

Olivella mathewsoni umpquaensis Turner

Siphonalia cf. bicarinata Dickerson

Turritella buwaldana coosensis Merriam

Volutocorbis oregonensis Turner

Scaphopods

Dentalina sp.

FORAMINIFERA

Bathysiphon eocenica Cushman & Hanna

Dentalina jacksonensis (Cushman & Applin)

Haplophragmoides cf. scitulum (Brady)

Haplophragmoides obliquicameratus Marks

Haplophragmoides sp.

Lenticulina sp.

Lenticulina theta Cole

Marginulina subbulata Hantken

Nodosaria pyrula D'Orbigny

Pseudoglandulina ovata Cushman & Applin

Rhabdammina eocenica Cushman & Hanna

Robulus alato-limbatus Gumbel

Spiroplectammina richardi Martin

Textularia sp.

Trochammina sp.

EXPLANATION FOR FIGURES 4 AND 5

Figure 4. A, B, C, Chela and leg segments of Plagiolophus weaveri Rathbun

A University of Oregon Museum of Natural History hypotype No. 28220 Length 25 mm Loc. No. 2594

B U.O.M.N.H. No. 28221 Length 23 mm Loc. No. 2594

C U.O.M.N.H. No. 28222 Length 25 mm Loc. No. 2594

D, E, G, Raninoides washburnei Rathbun, carapaces

D U.O.M.N.H. No. 28223 Length 33 mm Loc. No. 2594

E U.O.M.N.H. No. 29224 Length 36 mm Loc. No. 2594

G U.O.M.N.H. No. 29225 Length 22 mm Loc. No. 2594

F Raninoides washburnei Rathbun, sternum (first and second segments and episternum) U.O.M.N.H. No. 28226 Length 19 mm Loc. No. 2594

H, I Cancer sp. ventral (H) and dorsal (I) views of male carapace U.O.M.N.H. No. 28227 Length 26 mm Loc. No. 2594

Figure 5. All specimens Plagiolophus weaveri Rathbun

A Juvenile, dorsal view of carapace U.O.M.N.H. No. 28228 Length 10 mm Loc. No. 2594

B Abdomen of small male U.O.M.N.H. No. 28229 Width 15 mm Loc. No. 2594

C Young adult, dorsal view of carapace U.O.M.N.H. No. 28230 Width 14 mm Loc. No. 2594

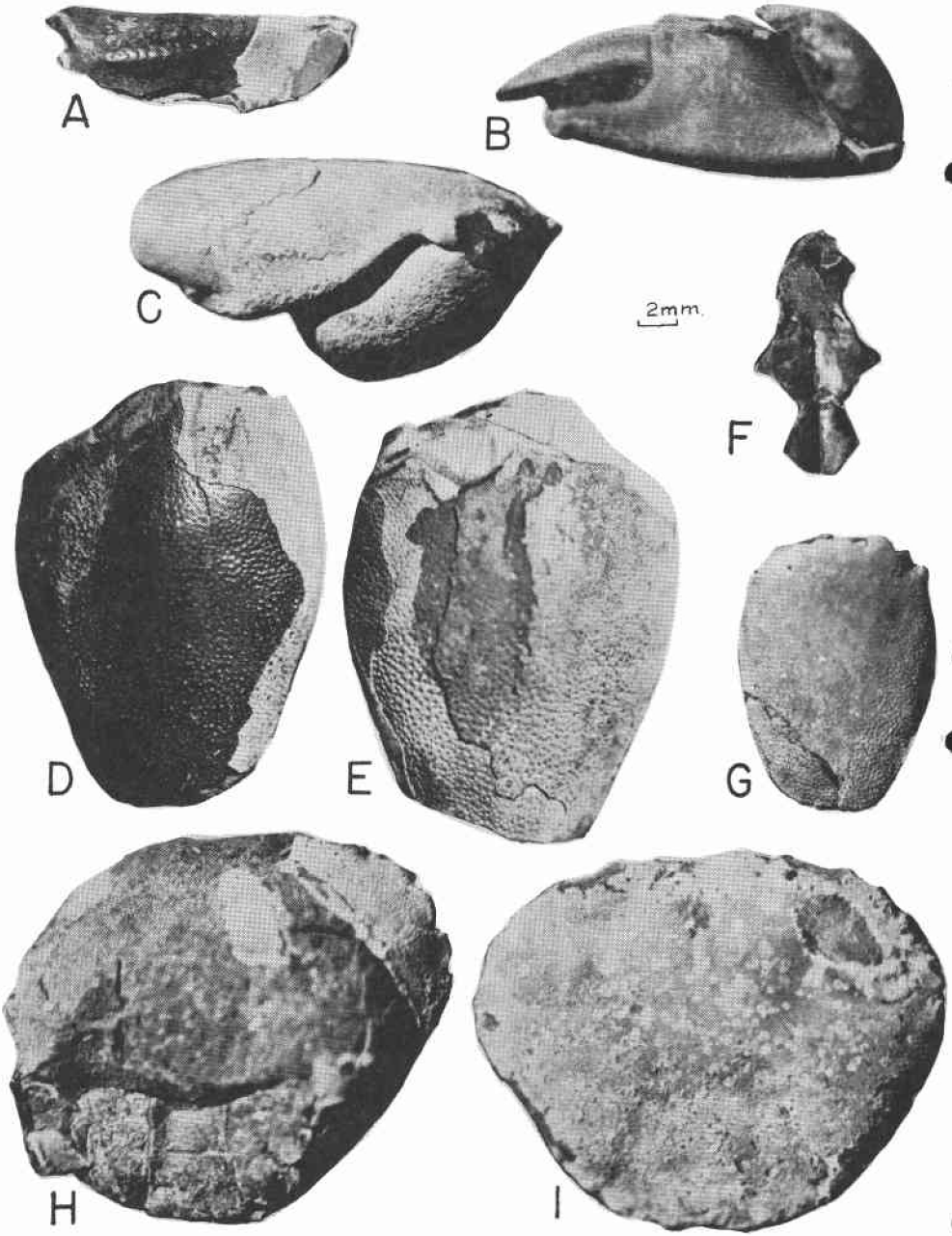
D Mature adult, dorsal view of carapace U.O.M.N.H. No. 28231 Width 24 mm Loc. No. 2594

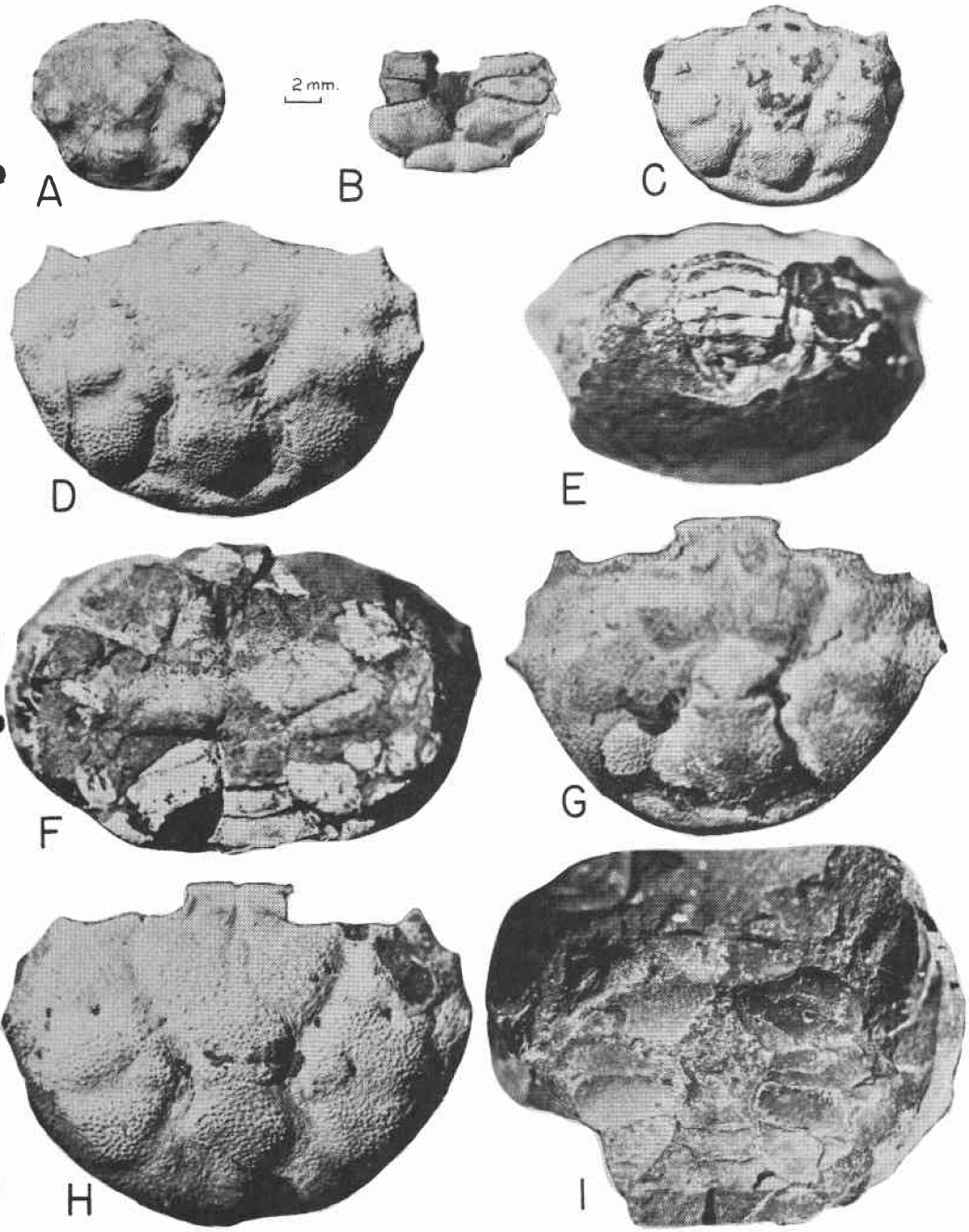
F Mature male, ventral view of carapace U.O.M.N.H. No. 28232 Width 28 mm Loc. No. 2594

E, G Posterior and dorsal views of carapace of a mature female U.O.M.N.H. No. 28233 Width 25 mm Loc. No. 2594

H Mature adult, dorsal view of carapace U.O.M.N.H. No. 28234 Width 28 mm Loc. No. 2594

I Adult male ventral view of carapace U.O.M.N.H. No. 28235 Width 20 mm Loc. No. 2594


A
B
C
2mm.
F
D
E
G
H
I


2 mm.
A
B
C
D
E
F
G
H
I

ambulacral areas divided by sharp ridges. Because of the distortion it was not possible to immediately identify these organisms. Echinoid spines from both sand dollar and urchin types of echinoids were among the more common components of the biogeneous portion of the sediments.

Molluscs

Associated with the decapods at every locality was a diverse and well-preserved molluscan fauna. The fauna is made up of nearly equal numbers of gastropods and pelecypods and a very few, small scaphopod specimens (see species list). All of the molluscan species identified have been previously reported from Eocene rocks by Turner (1938) and Thoms (1964). Upon initial examination it was noticed that almost every molluscan specimen recovered was remarkably small. As a working hypothesis, the possibility that we were collecting a dwarf or depauperate fauna was considered. After some time was spent preparing the fauna, however, the large number of broken fragments of larger pelecypods and gastropods led us to the conclusion that the "dwarfism" phenomena was largely a post-consolidation deformation product. Larger specimens of molluscs may then have been more easily fragmented than the smaller, compact, geometrically competent specimens. It is possible that this phenomena may have had a similar effect on the decapods.

Protozoa

The protozoa are represented in the Umpqua sediments here by several species and most specimens are well preserved. In addition to the smaller calcareous and arenaceous foraminifera (list below), several perfect specimens of the larger foraminifera Pseudophragmina psila Woodring were recovered. This species has been reported by Thoms (1964) in both of his "Upper" and "Lower" Umpqua members. Despite the fact that several species of smaller foraminifera were identified it is difficult to assign a definitive correlation for the sediments other than middle Eocene. Most of the calcareous species are of the family Lagenidae whereas the remainder are characterized by an arenaceous test. The latter group is abundant even today in shallow bays and estuaries. The apparent lack of other families of foraminifera , particularly the planktonic Globigerinidae, further implies (but does not necessarily confirm) a shallow-water origin for the sediments and faunas under consideration here. Like many shallow-water forms, the foraminifera listed here tend to be stratigraphically long ranging. This may be due to a true longevity of the species involved or to the lack of sufficient distinguishable morphology on their relatively simple tests making them difficult to subdivide into evolutionary series. Most of these species range through several Eocene foraminiferal stages (Mallory 1959) and it is impossible to restrict the fauna to a shorter interval than the Ulatisian to Bulitian stages.

The presence of Haplophragmoides obliquicameratus Marks suggests the Narisian stage, as it is known only from that stage in California (Mallory 1959). Thoms (1964), however, has indicated that this species probably has a longer stratigraphic range in Oregon than in California on the basis of his study of Umpqua biostratigraphy. Thoms (1965) further correlates sediments from what is apparently the same stratigraphic interval with the late Ulatisian to late Penutian stages of Mallory (1959). Stratigraphic evidence presented by Baldwin [(1965) and oral communication] largely corroborates Thoms' (1964) correlation.

Bibliography

Baldwin, E. M., 1961, Geologic map of the lower Umpqua River area, Oregon: U. S. Geol. Survey Map OM 204.

_____, 1963, Lower and middle Eocene formations of southwestern Oregon: Geol. Soc. Amer. Spec. Paper 76, p. 188-189.

_____, 1964a, Geology of Oregon: 2nd Edition, Eugene, Oregon, 165 p.

_____, 1964b, Thrust faulting in the Roseburg area, Oregon: Oregon Dept. Geology and Mineral Industries, The Ore Bin, vol. 26, pp. 176-184.

_____, 1965, Geology of the south end of the Oregon Coast Range Tertiary basin: Northwest Science, p. 93-103.

Laiming, Boris, 1940, Some foraminiferal correlations in the Eocene of the San Joaquin Valley, California: Proc. 6th Pac. Sci. Cong., vol. 2, p. 535.

Mallory, V. S., 1959, Lower Tertiary biostratigraphy of the California Coast Ranges: Am. Assoc. Petroleum Geol., Tulsa, Oklahoma, 416 p.

Nations, J. Dale, 1969, The fossil record of Cancer on the West Coast of North America: Abstract G.S.A. Cordilleran Section 65th Ann. Mtg.

Rathbun, Mary J., 1926, The fossil stalk-eyed Crustacea of the Pacific slope of North America: U. S. National Mus. Bull. 138, 155 p.

Thoms, R. E., 1964, Biostratigraphy of the Umpqua Formation, southwest Oregon: Univ. California doctoral diss. (unpub.) 215 p.

Turner, F. E., 1938, Stratigraphy and mollusca of the Eocene of western Oregon: Geol. Soc. Amer. Spec. Paper 10, 130 p.

Acknowledgements

The authors would like to express their appreciation to Dr. Ewart M. Baldwin for suggestions on the manuscript and to Michael E. Brownfield for help in photographing fossil specimens.

* * * * *

MINED LAND RECLAMATION BILL PASSES

House Bill 3013, popularly known as the "Mined Land Reclamation Bill," was approved by the state Senate on June 7, following earlier passage by the House. The measure becomes effective on July 1, 1972. All open pit mines and quarries which produce over 10,000 cubic yards per year will be subject to the provisions of the new law. Operations with excavations existing prior to the enactment of the law will not be required to reclaim worked-out areas, and operators having valid contracts with land owners as of January 1, 1971, are not subject during the life of the contract. This exemption does not apply after January 1, 1981, however.

Administration for the environmentally-oriented legislation rests with the State of Oregon Department of Geology and Mineral Industries. Funding will be derived solely from the $100 permits and $25 annual renewal fees. All operators, whether they have valid contracts or not, are subject to payment of the permit and annual renewal fees.

As stated in H.B. 3013, the purposes of the Act are:

a. To provide that the usefulness, productivity and scenic values of all lands and water resources affected by surface mining operations within this state shall receive the greatest practical degree of protection and reclamation necessary for their intended subsequent use.

b. To provide for cooperation between private and governmental entities in carrying out the purposes of this Act.

The Department of Geology intends to work closely with both industry and state and local government agencies in the preparation and administration of rules and regulations designed to permit the most economical extraction of mineral products while minimizing the adverse environmental effects both during the period of operation and afterwards.

* * * * *

DEPARTMENT ISSUES BULLETIN ON GEOLOGIC FORMATIONS

"Geologic Formations of Western Oregon," by John D. Beaulieu, has been published by the Department as Bulletin 70. The bulletin discusses all formations and units lying west of longitude 121°30', presenting pertinent data on distribution, lithology, contacts, structure, stratigraphy, and age. In compiling the information the author placed emphasis on the recent literature where possible. The publication includes correlation charts and an extensive bibliography. Bulletin 70 can be purchased from the Department's offices in Portland, Grants Pass, and Baker. The price is $2.00.

* * * * *

CONFERENCE ON GEOTHERMAL POWER HELD IN OLYMPIA

On May 21 the Washington State Department of Natural Resources held the "First Northwest Conference on Geothermal Power" in Olympia. About 250 people from electrical utilities, governmental agencies, petroleum companies, mining firms, and the interested public heard several speakers discuss various factors concerning this developing industry.

The papers presented covered such subjects as the engineering and economic aspects of The Geysers steam field in California; electric energy demands of the Pacific Northwest; highlights of the United Nation's Geothermal Conference in Pisa, Italy; environmental effects of producing geothermal power; implementation of the Federal Geothermal Steam Act of 1970; a history of geothermal developments in the United States; exploration techniques for geothermal resources; and prospects for geothermal energy in Washington.

A discussion period held at the end of the meeting was highlighted by a proposal by Joseph W. Aidlin, General Council for Magma Power Company, for the establishment of a western geothermal council. The purpose of this council, to be composed of representatives of government, industry, and utilities, will be to advance the orderly development of geothermal resources. Bert Cole, Washington State Commissioner of Public Lands, volunteered the services of his Department to organize such a group.

* * * * *

LEGISLATURE ENACTS GEOTHERMAL DRILLING REGULATIONS

A law authorizing the State of Oregon Department of Geology and Mineral Industries to supervise and regulate the drilling, redrilling, operation, and abandonment of wells for the production of geothermal resources was enacted during this session of the legislature. The Department felt this law was necessary because, starting during the summer of 1971, a major effort will be expended within the state to appraise its geothermal potential.

Only two wells have been drilled in the state specifically for the purpose of finding steam for the production of electric power. The first, drilled north of Adel in the Warner Valley, was abandoned after it failed to produce fluid of sufficiently high temperature. Shortly after abandonment the well erupted as a continuous geyser until it was plugged several years later. The second well, drilled north of Lakeview by the same company, was abandoned at a shallow depth because of drilling difficulties.

Because uncontrolled blowouts are an ever present danger when working with the high pressure steam found in geothermal reservoirs, and because the drilling equipment and techniques are similar to those used in oil and gas exploration, the Department of Geology requested that authority to regulate this drilling be added to its already existing oil and gas drilling regulations.

* * * * *

DEPARTMENT TO CHARGE FOR ASSAY SERVICE

By legislative action in the passage of House Bill 2060 by the 1971 session of the Oregon State Legislature, and by authority of the Governing Board of the State Department of Geology and Mineral Industries, a fee is to be charged for all assays and chemical analyses made on rocks and minerals submitted to the Department for that purpose.

This is to go into effect on all samples received or postmarked on or after July 1, 1971. The following is a list of fees to be charged:

Gold	$ 5.00	Iron	$ 7.50
Silver	5.00	Magnesium	7.50
Gold and Silver	6.00	Manganese	7.50
Copper	7.50	Mercury	7.50
Lead	7.50	Molybdenum	10.00
Zinc	7.50	Nickel	7.50
Copper-Lead-Zinc	15.00	Phosphorus	7.50
Lead-Zinc	12.00	Platinum Group	12.00 each metal
Alumina	10.00	Rare Earths	30.00
Antimony	10.00	Silica	7.50
Barium	8.0	Tin	15.00
Calcium Oxide	8.00	Titanium	10.00
Chromium	10.00	Tungsten	15.00
Cobalt	10.00	Uranium	15.00
Loss on Ignition	3.00	Vanadium	7.50

Drying wet samples $.75 per sample Prices for other analyses on request

There will be no limitation on the number of samples, and information concerning the legal description or ownership of the property will not be required. Fees for all analyses must accompany the samples. A convenient assay request blank will be provided upon request. Analytical results will be reported as promptly as possible after receipt of sample and fee.

* * * * *

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

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
	Vol. 2. Two papers on foraminifera by Cushman, Stewart, and Stewart, and one paper on mollusca and microfauna by Stewart and Stewart, 1949	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Allison	0.75
39.	Geology and mineralization of Morning mine region, Grant County, Oregon 1948: R. M. Allen & T. P. Thayer	1.00
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
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
62.	Andesite Conference Guidebook, 1968: Dole,	3.50
63.	Sixteenth Biennial Report of the State Geologist, 1966-68	Free
64.	Mineral and water resources of Oregon, 1969	1.50
66.	Reconnaissance geology and mineral resources, eastern Klamath County & western Lake County, Oregon, 1970: Peterson & McIntyre	3.75
67.	Bibliography (4th supplement) geology & mineral industries, 1970: Roberts	2.00
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

GEOLOGIC MAPS

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
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	2.00

folded in envelope, $2.15; rolled in map tube, $2.50

[Continued on back cover]

Mr. G. B. Burdwell
OSU Marine Science Center
Marine Science Drive
Newport, Oregon 97365

The ORE BIN
1069 State Office Bldg., Portland, Oregon 97201

The Ore Bin

POSTMASTER: Return postage guaranteed.

Available Publications, Continued:

SHORT PAPERS

2.	Industrial aluminum, a brief survey, 1940: 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
21.	Lightweight aggregate industry in Oregon, 1951: Mason	0.25

MISCELLANEOUS PAPERS

1.	Description of some Oregon rocks and minerals, 1950: Dole	0.40
2.	Key to Oregon mineral deposits map, 1951: Mason	0.15
	Oregon mineral deposits map (22" x 34"), rev. 1958 (see M. P. 2 for key)	0.30
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: Schlicker	0.50
7.	(Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts	0.50
8.	Available well records of oil & gas exploration in Oregon, rev. 1963: Newton	0.50
11.	A collection of articles on meteorites, 1968: (reprints, The ORE BIN)	1.00
12.	Index to published geologic mapping in Oregon, 1968: Corcoran	Free
13.	Index to The ORE BIN, 1950-1969, 1970: M. Lewis	0.30
14.	Thermal springs and wells, 1970: R. G. Bowen and N. V. Peterson	1.00

MISCELLANEOUS PUBLICATIONS

Oregon quicksilver localities map (22" x 34"), 1946	0.30
Landforms of Oregon: a physiographic sketch (17" x 22"), 1941	0.25
Index to topographic mapping in Oregon, 1968	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: Newton and Corcoran	2.50
2.	Subsurface geology of the lower Columbia and Willamette basins, Oregon, 1969: Newton	2.50