The Ore Bin

Vol. 35, No. 1
January 1973

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

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2033 First Street, Baker 97814

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

Subscription rate - $2.00 per calendar year
Available back issues $.25 each

Second class postage paid
at Portland, Oregon

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

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OREGON'S MINERAL AND METALLURGICAL INDUSTRY IN 1972

Ralph S. Mason
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The year 1973 can be tagged as the year of "Enhanced Environmentalism" which follows hard on the heels of 1972 which saw "Enforced Environmentalism" become a reality with the inception of the Mined Land Reclamation Act on July 1. Enhancement will become increasingly apparent in the years ahead as pits are reclaimed upon abandonment. In addition to the environmental considerations, the enforcement of the Act has already developed one spin-off benefit in the form of an apparent two-fold increase in the number of known operating pits and quarries in the state. This should eventually result in a substantial increase in the total reported production of sand and gravel and stone.

Preliminary figures for mineral production in Oregon for 1972 show an increase of 2.5 percent, to $79,800,000. This is a preliminary figure and is based largely on the pit price for the principal commodities, sand and gravel and stone. No figures for the metals produced in the state are available but would exceed $700,000,000 in all probability.

Environment --- Economy

The gulf between the two disciplines, ecology and economics, has always been wide, but there are signs that it may now be narrowing. The adoption of the Mined Land Reclamation Act last July opened the door which will lead to the eventual determination of the cost of environmentally acceptable practices which must be followed by the extractive industry. The impact of the required reclamation work which must be performed by industry when it abandons a worked-out pit will not become apparent for several years. The reclamation work will be an added charge to the operation and this charge will, as always, be passed on to the customer.

Environmental concerns were expressed in several other areas during the year. The Department of Environmental Quality imposed pollution standards, including noise levels for Wildernesses, including the Rock Mesa area in the Three Sisters Wilderness. Rock Mesa contains a large reserve of block pumice. Exploratory drilling for oil and gas on Federal lands was delayed pending preparation of environmental impact statements and no Federal leases for geothermal energy drilling have been granted because of environmental requirements.

SOME OF OREGON'S MINERALS AT A GLANCE

Mineral	1970	1971
Clays	$ 180,000	$ 255,000
Copper	W	3,000
Diatomite	5,000	1,000
Gem stones	750,000	755,000
Gold (recoverable content of ores)	9,000	10,000
Lime	1,777,000	1,989,000
Mercury	112,000	W
Nickel	W	W
Pumice and volcanic cinder	1,221,000	1,239,000
Sand and gravel	25,978,000	28,707,000
Silver (recoverable content of ores)	6,000	6,000
Stone	20,948,000	26,708,000
Value of items that cannot be disclosed: Bauxite (1970), cement (portland and masonry), clay (fire) (1970), talc, tungsten (1971), and values indicated by symbol W	17,095,000	18,212,000
Total	$68,081,000	$77,885,000

The Metals

Oregon's foremost metal-mining operation, the Hanna Mining Company's nickel mine at Riddle, Douglas County, was in production throughout the year. The mine and smelter constitute the only nickel production in the United States.

Gold production continued at a very low ebb during the year. Cornucopia Minerals, Inc. opened up the old deep placer ground on Pine Creek in northeastern Baker County in midyear and continued until shut down by weather. Although good values were known to exist in the creek, the presence of large boulders and the great depth to bedrock prevented mining for many years until heavy equipment was available. Nuclear Exploration and Development Corporation shipped gold ore from the old Bald Mountain mine in the Cracker Creek district of Baker County. The mine and the adjacent Ibex mine are located on the same vein. The two properties have a production history extending back almost 75 years.

Almost in inverse ratio to commercial gold production has been the interest and activity by the non-professional gold hunter, skin diver and rockhound in looking for "colors" in Oregon's gold-bearing streams. "Gold and Silver in Oregon," a 350-page bulletin describing all known gold deposits and mines in the state was primarily designed to provide information to the professional community. Currently, however, the bulletin is of interest mainly to the non-professional since it serves as an excellent guidebook to several hundred mines and, perhaps, artifacts left behind a century ago.

Mercury production nose-dived to the near zero point in hot pursuit of an equally rapidly declining market price. Environmental concern over the role of mercury wastes and emissions was largely responsible for the sharp drop in use. Although world prices for the metal strengthened late in the year, the prospects for mercury mining in the state remained dim.

Aluminum production returned to normal late in the year when Reynolds Metals reopened potlines at its Troutdale plant, which had been cold for a year. Production at the Harvey Aluminum plant at The Dalles was continuous during 1972.

Industrial Minerals

Production of sand and gravel in the state increased 6 percent in volume over the previous year. The unit price reported also increased 6 percent over 1971. Details of quantity and value are shown in the accompanying table. As noted in the introductory box, these figures are expected to change significantly in the future as the canvass by the Department proceeds. The sand and gravel industry, local and state governments, and the consuming public are involved in a diversely developing dilemma. Producers of the constantly diminishing, non-renewable reserves of this prime construction material are faced with ever-increasing demands by the consumer on the one hand and ever more stringent restrictions on production by regulatory agencies on the other.

Projections made by the Department indicate that known sand and gravel resources in the Willamette Valley will be exhausted by about the year 2010; this date is also predicted for depletion of sand and gravel in western Washington. Clearly every effort must be made <u>now</u> to ensure that maximum protection of this critical material for future use is achieved.

Crushed and dimension stone production declined 6 percent from 1971. Unit value increased approximately 2 percent. Sand and gravel and stone accounted for 78 percent of the non-metals produced in Oregon in 1972.

Natural lightweight aggregates such as pumice, volcanic cinders, and scoria were produced from pits in central Oregon. Quantity increased 22 percent while unit value remained unchanged from the previous year. Expanded shales were processed at a plant operated by Empire Building Materials in Washington County. The brick and tile industry continued production in much the same manner that it has for many years.

* * * * *

GEOTHERMAL ACTIVITY IN 1972

Richard G. Bowen
Economic Geologist, Oregon Dept. of Geology and Mineral Indus.

Leasing for geothermal investigations continued on private lands in Oregon during the year. Gulf Oil Company extended its acreage, and Anadarko Petroleum picked up leases in the Alvord Lake area (Figure 1, page 9). The work on the lease blocks by exploration parties was mostly related to geologic research, but some geophysical studies consisting of seismic ground-noise, microearthquake, and electrical resistivity measurements were also made. Pacific Power and Light and Weyerhaeuser Timber Companies have continued geologic reconnaissance, airborne infrared mapping, and geochemical analysis of waters in Lake and Klamath Counties in an effort to target areas for more intensive exploration. Eugene Water and Electric Board financed some geophysical studies by the Geology Department of the University of Oregon. The Geophysical Research Group, Department of Oceanography, Oregon State University is making magneto-telluric, microearthquake, and ground-noise studies in the Klamath Falls region.

The Department of Geology and Mineral Industries was able to continue geothermal studies with a grant from the U.S. Bureau of Mines. The results of the geothermal gradient and heat-flow measurements made thus far by the Department are described in another section of this issue. A more detailed outline of the exploration plan appears in the July 1972 ORE BIN.

Late in the year, Magma Energy Company applied for a permit to drill a 6000-foot geothermal test on land which it had leased for several years near Vale. A permit to drill has been granted by the Department of Geology, but as yet the company has not received a solid-waste permit from the State Department of Environmental Quality.

Outside of Oregon, on areas of privately owned land, activity continued at a high level during the year. At The Geysers field in northern California units 7 and 8 were completed and placed on line during the summer and fall, bringing the installed capacity of the field to 302 megawatts. Construction is underway on units 9 and 10, which are scheduled for operation later this year. Unit 11 has been ordered and site preparation is underway for its installation; operation is expected in 1974. Unit 11, a 110-megawatt installation, will be the largest geothermal turbo-generator set in the world. Present turbo-generator sets are 55 megawatt, with two installed in each plant. Construction of the larger unit allows some economies of scale and will reduce the present low capital costs even more. It is interesting to note that new geothermal installations during the year cost about $122/kw, while base-load fossil fuel plants were between $200 and $250/kw and nuclear plants ordered were between $400 and $475/kw.

The Union-Magma-Thermal partnership drilled 10 new wells in The Geysers area in 1972 to supply steam for the new plants under construction by Pacific Gas and Electric. Pacific Energy Corporation drilled 3 wells along the south side of the field during the year and is now negotiating with Pacific Gas and Electric for construction of a power plant on those leases.

In the Imperial Valley area, Magma Energy drilled five wells and is working with San Diego Gas and Electric to construct a binary fluid "Magmamax" power plant which is expected to be in operation in 1973.

Although Congress passed the law to allow geothermal exploration on Federal lands two years ago, implimentation of the Federal leasing regulations is still delayed. Most of the steps required by Congress and by the National Environmental Protection Act before leasing can take place have been done. Preliminary draft of the leasing regulations and of the environmental impact statement were published and public hearings were held for comment; revised regulations were published in November 1972. After allowing time for public comment, the Secretary of Interior can place the regulations in force. However, actual leasing cannot take place until the final environmental impact statement has been completed and approved by the Secretary of the Interior.

It appears that Federal lands will be available for geothermal exploration in 1973. But the very restrictive regulations and onerous terms of the leases make it very doubtful that there will be much exploration on Federal lands. The Interior Department has not followed the mandate of Congress to "encourage the development of this resource;" it has instead made every effort to maximize the revenues from the leasing. These regulations have made exploration for geothermal resources more costly and more difficult than if the developer were looking for oil or gas, uranium, coal, or other leasable or claimable minerals.

* * * * *

UNUSED WELLS NEEDED FOR TEMPERATURE LOGGING

In order to extend its geothermal study program in Oregon, the Department needs to know the location of all unused wells that are suitable for temperature measurements. To give a valid reading, the well must be one that has not been pumped for at least 6 months in western Oregon and 3 months in eastern Oregon. Depths should be greater than 500 feet for wells in the western part of the state and 300 feet in the eastern part. If you own such a well or know where one is located, please notify the Department.

GEOTHERMAL GRADIENT AND HEAT FLOW MEASUREMENTS
BAKER AND MALHEUR COUNTIES, OREGON

Locality	North Lat.	West Long.	Depth meters	Elev. meters	Rock type	Average Gradient °C/km	K mcal/cm sec °C	Heat flow cal/cm^2 sec
Chalk Butte								
19-45S11	43°55'	117°10'	65	835	Tuffaceous sandstone	185±2	3.0±.2	5.7±.2
19-45S14	43°54'	117°10'	135	910	"	174±2	3.0±.2	5.4±.4
19-45S22	43°53'	117°11'	115	843	"	110±2	3.0±.2	3.3±.4
19-45S25	43°53'	117°09'	70	813	"	232±7	3.0±.2	6.9±.4
19-45S26	43°52'	117°10'	175	822	"	119±2	3.0±.2	3.6±.4
20-45S6	43°51'	117°15'	135	823	"	74±2		
20-45S10	43°50'	117°12'	135	780		114±2		
Grassy Mountain								
21-43S36	43°41'	117°23'	76	995	Tuffaceous sandstone	54±1	2.9±.2	1.5±.1
21-44S28	43°42'	117°20'	30	1000	"	106±1		
Willow Creek								
16-43S10	44°11'	117°26'	115	758		75		
16-43S13	44°10'	117°24'	170	768		*(20-130) 50 *(130-170) 90		
16-43S15	44°10'	117°26'	230	758		*(25-100) 35 *(100-230) 75		
16-43S23	44°09'	117°25'	170	749		*(20-110) 50 *(110-170) 90		
17-44S11	44°06'	117°17'	370	722		86±2		
17-44S31	44°02'	117°23'	70	819		86±2		
18-44S21	43°59'	117°20'	85	795		67±2		
18-41S35	43°51'	117°38'	45	887		44±6		
Alvord								
39-34S2	42°17'	118°41'	380	1498	Altered basalt	61±.4	3.7±0.2	2.3±0.2
Powder River								
8-42S24	44°51'	117°31'	70	835		40±4		
9-41S7	44°47'	117°44'	25	1131	Silicified gabbro	45		
Huntington area								
14-43S13	44°21'	117°24'	280	1174	Graywacke & phyllite	32±1		
15-45S7	44°16'	117°15'	170	857	Tuffaceous sandstone	*(20-90) 62±2 *(90-170) 30		
Thomas Creek								
37-19S30	42°20'	120°31'	135	1823		59±1		
37-18S14	42°22'	120°27'	75	1804	Tuff breccia	140±3	2.5±0.2	3.2±0.2
Drew								
32-2S4	42°49'	122°56'	215	931	Schist	20±1		

*Two gradients are reported for these wells. This variation may be caused either by water movements in the aquifer or by difference in thermal conductivity of the bedrock at the depths measured.

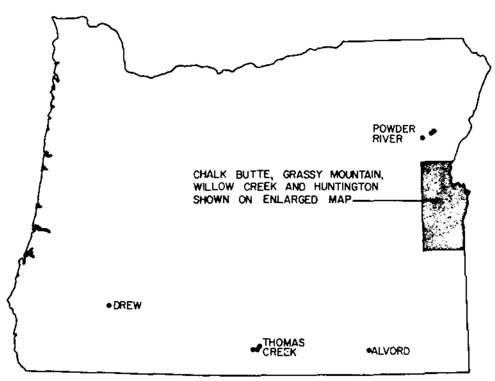
PROGRESS REPORT ON GEOTHERMAL MEASUREMENTS IN OREGON

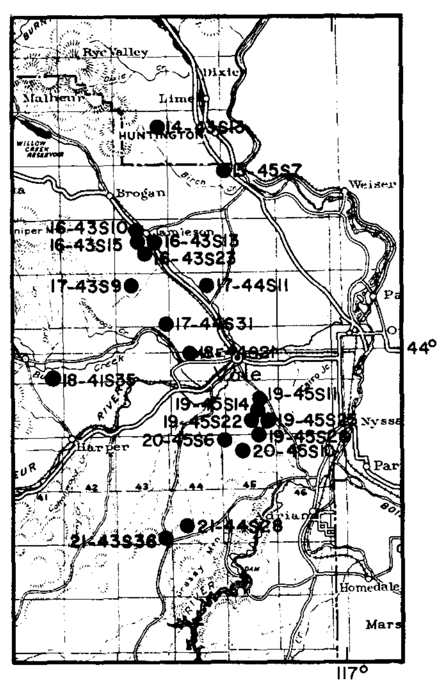
The accompanying list of geothermal gradients and heat-flow measurements is published here as a progress report on the geothermal study being conducted by the Oregon Department of Geology and Mineral Industries under the direction of R. G. Bowen. Cooperating in the study is Dr. David Blackwell of the Geology Department of Southern Methodist University, Dallas, Texas, who provided the heat-flow determinations. Funds for the program are provided by the U.S. Bureau of Mines.

The goals and methods of the Department's geothermal study were outlined in the July 1972 ORE BIN, following publication of some preliminary temperature gradient measurements in the April issue.

During the summer of 1972, a concentrated effort was made to locate pre-drilled holes and make temperature gradient measurements. The data for 25 holes are presented in the list. Included in the list are temperature gradients for five of the holes reported on in the April 1972 ORE BIN (locality nos. 19-45S22, 19-45S26, 19-45S25, 20-45S10, and 39-34S2).

Preliminary heat-flow measurements are given for eight of the holes. These measurements are based on thermal conductivity determinations of cuttings and cores that the Department was able to obtain on some of the wells for which gradients had been measured. More refined heat-flow determinations will be published at a later date, after corrections for radioactivity and topography have been made; however, it is probable that the presently determined values will be only slightly altered by the correction.





Index maps showing sites of temperature-gradient and heat-flow determinations.

OIL AND GAS EXPLORATION IN 1972

Vernon C. Newton, Jr.
Petroleum Engineer, Oregon Dept. Geology and Mineral Industries

No drilling was done in Oregon during 1972, but leasing activity continued at a high level for this area (Figure 1). Environmental concern delayed the start of a wildcat by Standard Oil of California in the remote southeastern corner of the state. For those unfamiliar with drilling success in Oregon, we should remark that the state is still without a single commercial discovery of oil or gas.

In spite of the lack of discovery, the geology of Oregon is not entirely discouraging to oil companies; five large firms prepared to launch exploration ventures during the year. The widespread volcanic history in Oregon has complicated the interpretation of the geology and has been a prominent factor in retarding wildcat drilling. Although no significant surface seeps of petroleum are known in the state, minor shows of hydrocarbons have been found in several wells, and sands which would make suitable reservoir rock for petroleum have been encountered.

Petroleum geology

Tertiary marine sedimentary rocks ranging in thickness from a few thousand feet to more than 10,000 feet cover an estimated 11,000-square-mile area of western Oregon. Nearly as large an area of similar rocks, but of greater thickness, occurs on the bordering continental shelf. In this 20,000-square-mile region, a total of 25 deep test holes have been drilled both on-shore and offshore, but many more holes are needed to evaluate its potential more thoroughly. The cost of such additional exploration is estimated to be nearly $100 million (Figure 2).

Marine rocks in central Oregon are covered for the most part by thick deposits of comparatively young volcanic rocks (see Figure 3), but beneath a large area of central Oregon lies a great thickness of Mesozoic and Paleozoic marine sedimentary rocks. Little is known about these formations at depth.

There are more than 600 square miles of Quaternary to Tertiary lacustrine rocks in the eastern part of the state, where the thickness measures several thousand feet. Numerous gas shows found in this area indicate that commercial amounts of natural gas may occur in a few of these fresh-water basins. The presence in the sedimentary section of a few fairly thick lava flows results in poor seismic records.

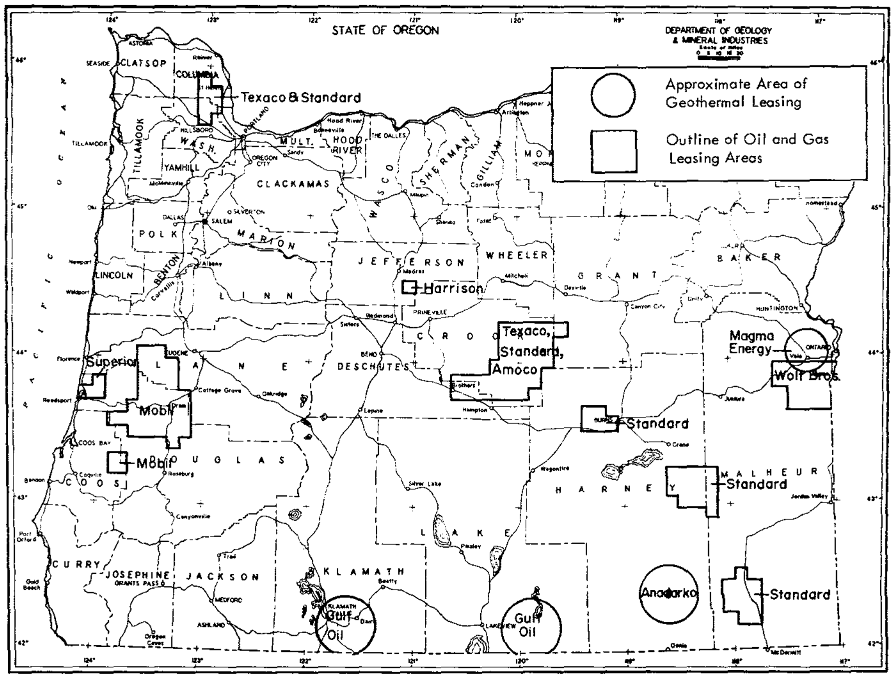


Figure 1. Map of Oregon showing location of petroleum and geothermal leases (effective December 1972).

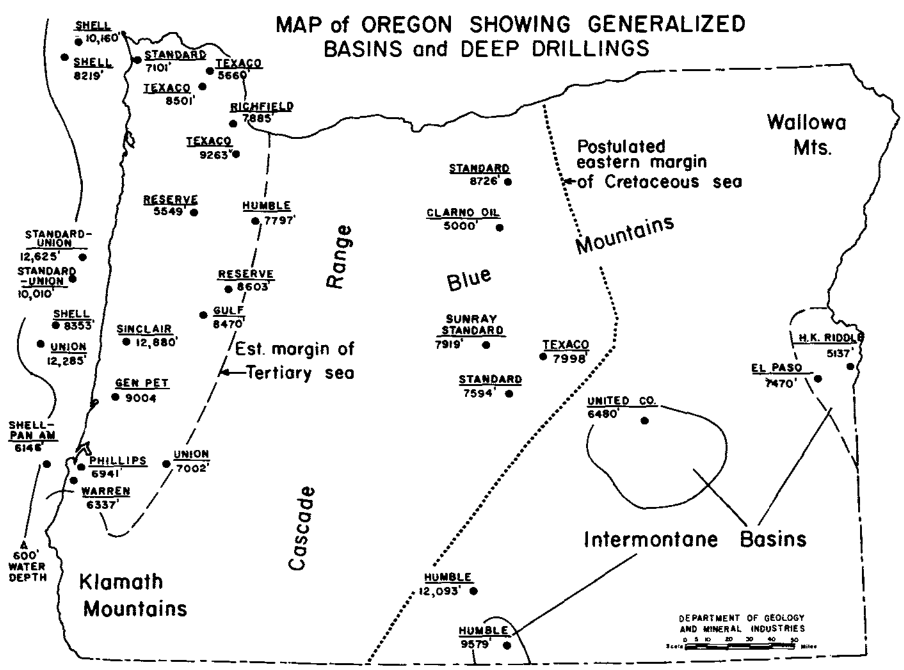


Figure 2. Map of Oregon showing generalized basins and deep drillings.

Environmental problems

In October 1971, the State Department of Environmental Quality asked the U.S. Bureau of Land Management to file a full impact statement for a wildcat hole being drilled by Texaco in central Oregon. No drilling has been done in the state since that time. However, Standard Oil of California was successful in obtaining clearance from DEQ and BLM for an exploratory hole in southeastern Oregon on a Federal lease unit after several months of delay. The U.S. Bureau of Land Management agreed to prepare a statewide impact report for oil and gas leasing. Companies wishing to drill wildcats in Oregon must obtain waste disposal permits from DEQ in order to dispose of drill cuttings and mud wastes. Standard Oil is expected to begin drilling its Blue Mountain Federal unit by early spring.

Leasing and exploration

More than 300,000 acres of Federal oil and gas leases were pending action by the Bureau of Land Management at the end of 1972 (Table 1). Applications for some of the acreage were submitted more than a year ago. Leases will not be issued until the statewide impact report for Federal leases in Oregon is completed. After its issuance, separate environmental analyses will be made for each new location. In the event of an oil or gas discovery, an impact statement will be required for each new field. Effect on the environment can best be determined when the size of the field and the probable extent of development operations are known.

Loss to county school and road funds resulting from delays in issuing Federal leases amounted to more than $55,000 by the end of 1972.

Field studies

One major oil company had a geological field party working in western Oregon during the year, and two large firms did limited geological studies in eastern Oregon. Several companies used the Department's sample library to assist with their geological investigations.

Non-explosive seismic studies were conducted in the Willamette Valley and in southwestern Oregon during 1972, and explosive seismic surveys were run in the Quaternary-Tertiary lake basin in Malheur County.

Future exploration

The emphasis on the need for new energy supplies will accelerate the search for petroleum in Oregon for the next few years. A map of Oregon offshore geology by the U.S. Geological Survey and the Oceanography Department at Oregon State University, scheduled to be published in 1973, should help to renew interest in petroleum prospects in this region.

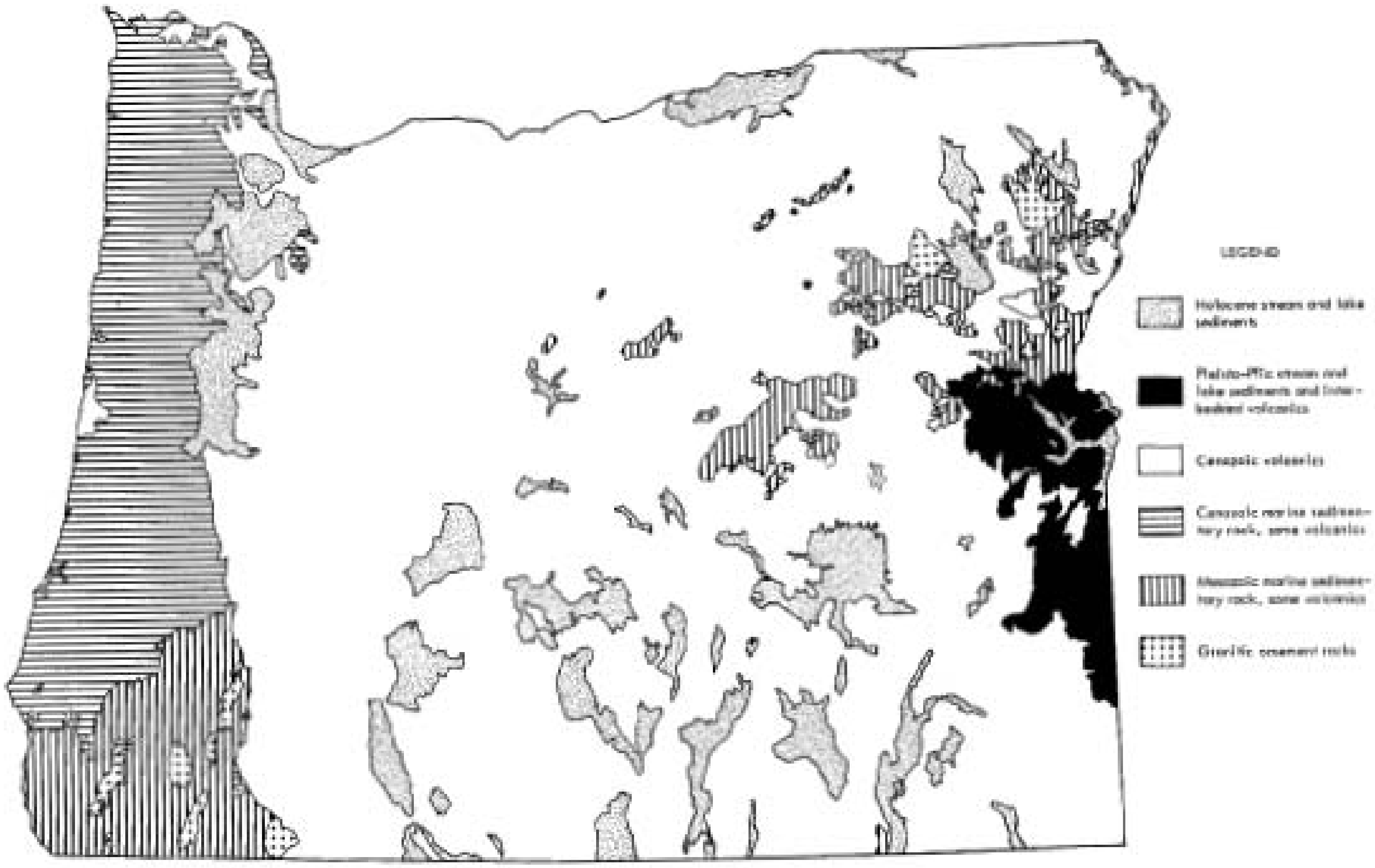


Figure 3. Map of Oregon showing exposures of major rock types.

Table 1. Oil and gas leases during 1972

Company	County	Est. total	Status
Standard Oil of California	Columbia Crook Harney Malheur Washington	300,000 acres	Active
Mobil Oil Co.	Coos Douglas	120,000 acres	Most pending approval by BLM
Texaco, Inc.	Columbia Crook	235,000 acres	Approx. 30,000 acres pending approval
Amoco	Crook Malheur	70,000 acres	Pending approval by BLM
Superior Oil Co.	Douglas	40,000 acres	Active
Wolf Bros., Denver	Malheur	145,000 acres	Pending approval by BLM
Harrison, Seattle	Jefferson	10,000 acres	Active

Environmental controls have delayed activity in Oregon as well as in other parts of the United States, particularly in offshore regions. Drilling on the continental shelf will eventually be done when the need for petroleum becomes critical. A good example of the urgency for offshore drilling can be seen in the present North Sea operations. Drilling and development in this very difficult environment was stimulated by the need for energy supplies, and government officials in Great Britain, Holland, and Scandinavian countries are delighted to have the 30 or more underwater oil and gas fields to add to national resources.

* * * * *

NORTH SEA OIL

Reserves are mounting in the newly found petroleum province underlying the North Sea. Fifteen oil fields and eight gas fields were discovered in this region last year. Proven reserves are now estimated to be 7 billion barrels of oil and 60 trillion cubic feet of gas. More than 20 oil fields and as many gas fields have been found since development began in the North Sea 5 or 6 years ago. Huge drilling rigs are being assembled which will be able to operate year-round in the ocean environment. Water depth ranges from 250 feet to 500 feet over most of the sea. (Oil and Gas Jour. Jan. 1973)

* * * * *

FIELD WORK IN OREGON DURING 1972

John D. Beaulieu
Stratigrapher, Oregon Dept. Geology and Mineral Industries

During the 1972 field season at least 130 geologic field studies were conducted in the state of Oregon. The list below includes those of which the Oregon Department of Geology and Mineral Industries is aware. For convenience the state is roughly divided into six sections and the studies are grouped according to location.

The list is probably not complete, and the Department would appreciate receiving information about other studies in progress in this state. Resumés received thus far have been invaluable in completing this list and the Department expresses its gratitude for these contributions. Unless stated otherwise, no reports on the following studies are available through this Department.

Northwestern Oregon

1. Recent sedimentation in Tillamook Bay: Gennaro Avolio, graduate student, PSU
2. High Cascades-Western Cascades contact: Brian Baker, Professsor, U of O
3. Environmental Geology of upland Tillamook and Clatsop Counties: John Beaulieu, DOGAMI
4. Biostratigraphy of the type Nestucca Formation: A. D. Callender, Jr., graduate student, PSU
5. Gravity survey of part of northeast Portland: Dan Cash, professor, PSU
6. Geology near Oswald West State Park: Frank Cressy, master's candidate, OSU
7. Oligocene cetacean, "Butte Creek beds": John Falhaber, master's candidate, U of O
8. Ground water in the Harrisburg-Halsey area: F. J. Frank, USGS (Portland) in coop. with Oregon State Engineer
9. Water resources in central Lincoln County: F. J. Frank and A. Laenen, USGS (Portland), in coop. with Oregon State Engineer
10. Thermal surveillance of volcanoes: J. D. Friedman, USGS
11. Biostratigraphy of the type Yamhill Formation: L. R. Gaston, graduate student, PSU
12. Surf transformation near Newport: Mike Gaughan, master's candidate, oceanography, OSU
13. Eocene pleurotomariid gastropods: Carole S. Hickman, Adj. Res. Associate, Swarthmore College, Swarthmore, Pennsylvania
14. Lower Oligocene molluscan fauna: Carole S. Hickman, Adj. Res. Associate, Swarthmore College, Swarthmore, Pennsylvania

15. Bauxite deposits in northwestern Oregon: Ron Jackson, master's candidate, PSU
16. Soil and geology of part of the Western Cascades: Harold Legard, soils scientist, U.S. National Forest Service
17. Ground water of north Clackamas County: Al Leonard, USGS (Portland), in coop. with Oregon State Engineer
18. Coastal landforms: Ernest Lund, professor, U of O
19. Reconnaissance mapping of the Tillamook Uplands: Norman S. MacLeod, USGS
20. Radiometric dating of igneous rocks: Alexander McBirney, professor, U of O, and J. Sutton, professor, Ohio State U.
21. Engineering geology of part of coastal Lincoln County: Kent Mathiot, master's candidate, PSU
22. Contact of the Tyee and Yamhill Formations: Robert McWilliams, professor, Miami U., Hamilton, Ohio
23. Micropaleontology of the continental shelf: Greg Miles and Steven Conley, graduate students, U of O
24. Stratigraphy of parts of northwestern Oregon (for GSA Guidebook): Alan Niem, professor, OSU; Robert Van Atta, professor, PSU; Vaughan Livingston and Weldon Rau, Wash. Div. Mines & Geology
25. Environmental geology of the Portland area (for GSA Guidebook): L. Palmer, professor, PSU, and Roger Redfern, master's candidate, PSU
26. Radiometric dating: Donald Parker, doctoral candidate, OSU
27. Geology near Onion Peak: Tom Smith, master's candidate, OSU
28. Geodimeter study of Cascade volcanoes: D. A. Swanson, USGS
29. Gales Creek planktonic foraminifers: Dick Robertson, master's candidate, U of O
30. Geology and geomorphology of part of the Blue River drainage: Fred Swanson and Mike James, graduate students, U of O
31. Environmental geology of Marquam Gulch, Portland: Roger Redfern, master's candidate, PSU
32. Environmental geology of coastal Tillamook and Clatsop Counties: Herb Schlicker, John Beaulieu, and Gordon Olcott, DOGAMI, and Robert Deacon, Shannon and Wilson
33. Environmental geology of Lincoln County: Herb Schlicker, John Beaulieu, and Gordon Olcott, DOGAMI, and Robert Deacon
34. Geology of the central Oregon Coast: Parke D. Snavely, Jr., Norman S. MacLeod, and Holly C. Wagner, USGS
35. Geophysics of the continental margin: Parke D. Snavely and Norman S. MacLeod, USGS
36. Upper Eocene petrochemistry and magmatic history: Parke D. Snavely and Norman S. MacLeod, USGS
37. Coastal processes between Netarts and Nehalem Bay: Tom Terrich, graduate student, oceanography, OSU

38. Volcanic and intrusive geology of the central Oregon coast (for GSA Guidebook): Parke D. Sna ely and Norman S. MacLeod, USGS
39. Post-Sardine volcanic centers of the Western Cascades: Craig White, graduate student, U of O
40. Portland seismic study: Paul White, graduate student, PSU
41. Cenozoic floras: J. A. Wolfe, USGS

Southwestern Oregon

1. Miocene sequence in the Floras Lake-Cape Blanco area: Warren Addicott, USGS
2. Plio-Pleistocene molluscan paleoecology at Coos Bay and Cape Blanco: John M. Armentrout, professor, U of O
3. Oligocene mollusca of the Tunnel Point Formation, Coos Bay, Oregon: John M. Armentrout, professor, U of O
4. Glacial and neo-glacial geology of the Mountain Lakes area: Gary Carver, graduate student, U of W
5. Mineral potential of the Illinois River drainage: Terry Close, US Bur. Mines (Spokane)
6. Black sands: Ed Clifton, USGS
7. Galice-Rogue-Dothan relationships: Henry Dick, graduate student, Yale U, and Len Ramp, DOGAMI (Grants Pass)
8. Jurassic of North America: Ralph Imlay, USGS
9. Quaternary sedimentation and coastal terraces: R. J. Janda, USGS
10. Sedimentation of the Sixes River estuary: Charles Jones, professor, Chadron State College, Chadron, Neb., and Sam Boggs, professor, U of O
11. Cretaceous of Oregon and California: D. L. Jones, USGS
12. Crabs from the middle Eocene Umpqua Formation: Marilyn Kooser, graduate student, U of O
13. Geothermal gradients: Arthur Lachenbruch, USGS
14. Josephine peridotite and Vulcan Peak peridotite: Robert A. Loney, USGS, and Glen R. Himmelberg, professor, U of Missouri
15. Microfossils of central and southwestern Tertiary formations: Daniel R. McKeel, U. Cal. Davis
16. Micropaleontologic sampling: Mobil Oil Co.
17. Geology of the Dutchman Butte quadrangle: Ranau Perttu, master's candidate, PSU
18. Mineral survey of Douglas County: Len Ramp, DOGAMI (Grants Pass)
19. Ground water in the Sutherlin area: J. H. Robison, USGS (Portland) in coop. with Douglas County
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5. Sampling of volcanic peaks: Gary L. Millhollen, professor, U of South Carolina
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5. Authigenic lacustrine cherts near Rome: Richard Sheppard and A. J. Gune, III, USGS
6. State map of Oregon: George Walker, USGS
7. Geothermal exploration: George Walker, USGS

* * * * *

CHARLTON RETIRES FROM MEI

Dr. David B. Charlton, Staff Consultant for Metallurgical Engineers, Inc., retired Dec. 29, 1972, after a distinguished career in chemistry and microbiology. He operated an independent analytical laboratory in the Portland area for 40 years, during which time he played a leading role in advocating better control of the nation's air, water, and natural resources.

* * * * *

USES FOR WASTE GLASS DISCOVERED

The U.S. Bureau of Mines laboratory in Tuscaloosa, Alabama, has been doing some interesting experiments in recycling waste glass from municipal incinerator residues. Three Report of Investigations (R.I. 7605, R.I. 7701, and R.I. 7708) indicate that it is economically feasible to use waste glass for making building brick, as a flux for clay products, and for producing glass wool.

According to the Bureau, about 15 million tons of glass is discarded in municipal wastes annually. Of this, about 2 million tons pass through incinerators and can be recovered by ore-processing techniques developed by the Bureau. Operating at a feed rate of 1,000 pounds per hour, the plant can recover 578 pounds of cullet-grade glass (material suitable for recycling into new glass) and 414 pounds of waste glass per ton of residue. The waste material used in the Bureau's experiments was the type worthless for cullet.

Results of the first phase of the investigations (R.I. 7605) indicate that face brick of good color and high quality can be produced using waste glass as the principal component. A second experiment (R.I. 7701) shows that waste glass reduces firing temperature and firing time significantly when used as a flux in common-brick clays. A third experiment (R.I. 7708) resulted in the production of glass wool that meets the commercial standards for wall and ceiling insulation.

* * * * *

U.S. DEPENDENT ON MINERAL IMPORTS

Hollis M. Dole, Assistant Secretary of the Interior for Mineral Resources, recently outlined the degree to which the United States is becoming dependent on foreign supply sources for its mineral requirements. Speaking at a recent AIME meeting, Dole said, "The gap between our supply and our demand (for minerals) has risen from $2 billion in 1950 to $8 billion in 1970, and is projected to increase to $31 billion in 1985 and $64 billion in the year 2000." He based these figures on Interior's first annual report under the Mining and Minerals Policy Act of 1970. Among the problems that prevent the full potential of the nation's resources from being realized, Dole stated, are environmental constraints that have forced the closing of almost half the nation's zinc refining capacity; the loss of markets by coal which is unable to meet sulphur content limitations; the denial of access or withdrawal from development of mineralized lands; and competition from other nations for access to foreign supplies.

(Nevada Mining Association News Letter, Nov. 15, 1972

* * * * *

BULLETIN ON DOUGLAS COUNTY AVAILABLE

The latest bulletin (No. 75) to be issued by the Department is "Geology and Mineral Resources of Douglas County, Oregon," by Len Ramp, geologist at the Grants Pass Field Office. The 106-page publication contains information compiled from all available published and unpublished reports and mine-file records.

Main topics include the general geology of the county, the history of its mining and mineral production, summaries of the metallic mineral deposits with short descriptions of known mines and prospects, and a review of the industrial minerals and rocks and the mineral fuels.

Douglas County is famous for having the only nickel mine in the United States. The mine and smelter, situated near Riddle and operated by the Hanna Mining Co., have produced continuously since 1954. This mine puts Douglas County at top of all counties in value of mineral production.

Other metallic minerals with past production and possible potential include gold, copper, silver, mercury, and chromite. Among the non-metallic minerals, sand, gravel, and crushed rocks, the basic materials for construction, are in ample supply at the present time. Fairly large reserves of sand and gravel occur along the Umpqua River, but demand for these materials is rapidly growing with increased population and development.

Some of the other non-metallic mineral deposits include limestone, silica, asbestos, emery, olivine, sulfur, and talc and soapstone. Small deposits of coal are known, and geologic conditions are favorable for oil and gas and geothermal energy resources.

The bulletin is illustrated by numerous photographs and maps and is accompanied by a multicolored geologic map showing distribution of rocks ranging from Triassic to Quaternary. A glossary of technical terms is also included. Bulletin 75 is for sale by the Department at its offices in Portland, Baker and Grants Pass. The price is $3.00.

* * * * *

ORE BIN RENEWAL NOTICE

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The Ore Bin

Vol. 35, No. 2
February 1973

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin

Published Monthly By

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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 229 - 5580

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Available back issues $.25 each

Second class postage paid
at Portland, Oregon

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The ORE BIN
Volume 35, No. 2
February 1973

THE MINERAL INDUSTRY AND THE ENVIRONMENT

John D. Beaulieu, Stratigrapher
Oregon Dept. of Geology and Mineral Industries

"Americans want electricity without nuclear plants; they want low cost and low sulphur fuel, but they don't want ships, pipelines, oil imports or offshore exploration and rigs. They want more coal, but they don't want strip mining." They are, in a sense, "spoiled rotten." This is the opinion of C. Howard Hardesty, vice president of Continental Oil Company (quoted in article by John Chamberlain, Oregon Journal, Nov. 22, 1972).

Are we really "spoiled"? Do we want the material comforts without the labor, equipment, and possible pollution required? Since it is no longer questioned that the environment is worthy of our concern, what policies and programs are most viable in terms of 20th century American life?

What about the environment?

Only recently have we begun to realize the delicate balances among all parts of the natural machinery around us. In addition to being necessary to our survival, environmental preservation is fitting from a purely esthetic standpoint as well. How then do we equate our need for production with our need to preserve the environment?

The answers to this question are, of course, far more complex than can be handled here. Nevertheless, a few observations are pertinent. First, we need knowledge. We need to know more about nature, about ourselves, about the mechanics of our society. In addition, this knowledge must be quantified so that it can be dealt with in a precise fashion. We must know, for instance, the precise environmental cost of a certain operation, but we must also be able to balance this in precise terms against the benefits of the operation to society. Some basic needs can only be supplied with a certain definite amount of change in the physical environment.

Second, we need the kind of common sense that reminds us that nature pollutes, too. The eruptions of Krakatoa (1883), Mount Katmai (1912), and Hekla (1947) blew more particulates into the atmosphere than has all man's activities before or since. We must realize that nature, as well as man, degrades the environment.

We need critical thought rather than catchy phrases and indignation. We need the kind of critical thought that examines individual issues on an individual basis. We need to realize, for instance, that although DDT may be overused in this country, in India alone it is saving more than 750,000 lives a year by reducing malaria, and thanks largely to it the Green Revolution was made possible.

If we are to clean up the environment we need responsible action. We need the money, labor, and equipment that only a thriving economy can provide. We need these things to recycle the metal, to dredge the sludge, and to overcome the pollution that we are creating. We need balanced legislation to deal with specific polluters in a realistic way which does not overly threaten the economy. We may even need to redirect our mode of life. If we find, for instance, that in terms of environmental costs many of our conveniences are really luxuries beyond the cost we wish to pay, appropriate taxations and price structures may be called for.

Is technology to blame for our pollution?

Where there is production of goods there very commonly is pollution. It is around our factories, cities, mines, and smelters that the landscape is often scarred and the streams commonly run foul. It is along our crowded freeways that the air pollution creeps beyond acceptable levels. The list of contributors to pollution could be extended almost endlessly. Not surprisingly, then, technology is sometimes viewed as the culprit behind the environmental dilemma in which we find ourselves.

In pursuing the idea that we cannot survive without a clean environment, however, it would also be wise to remember that we cannot survive in our present numbers without technology. We sometimes forget that we are ill-equipped to deal with nature except with our heads; that we do, in fact, rely on technology for our very survival. How long would 3 billion people survive without the technology needed to produce their food, to fabricate their shelters, and to manufacture the equipment needed for everything from medicine to large-scale transportation?

Our society is basically a highly complex and sophisticated mechanism which enables far larger numbers of people to survive than would otherwise be possible. Therefore, while we recognize the shortcomings of technology we should also give due consideration to its benefits.

The way out of our environmental dilemmas is, of course, far more complex than can be handled here. We would, however, like to explore the problems and the benefits of one segment of our technological society, a segment often accused of polluting but seldom recognized as one of the most basic industries needed in our technological economy - the mining industry.

Do we really need mined materials?

Currently there is animosity toward the mining industry for digging holes and in other ways fouling the environment. Some of this attitude may be deserved. Careless strip mining operations, for example, left scars on both the land and the people that will be a long time healing. For one concerned with the environment a sensible starting point in assessing the situation is to ask if we need mines. The extremist does us all a disservice, however, when he assumes the answer is "No."

Part of the extremist's approach is rooted in the fact that few people are readily able to relate their everyday living to mining. Actually, our way of life is founded on the use of a variety of mined materials. The following list, taken from Virginia Minerals, v. 18, no. 4, November, 1972, well illustrates that mining is fundamentally essential to our economy:

Metal or Mineral	Common Uses
Aluminum	Beverage and food cans; lawn chairs; building roofs and siding; electric appliances; air conditioners; canoes, ships, automobiles, trucks, airplanes and other transportation equipment; cooking utensils; aluminum foil for packaging and kitchen use; high-voltage power transmission lines
Asbestos	Construction cements, floor tile, paper products, brake linings, and clutches for all transportation equipment, textiles, paints, power lines, electric roofing and siding for buildings
Barite	Mud for drilling oil wells and in glass, paints, rubber and paper
Copper	All electric appliances, telephones, radios, TV sets, automobile radiators and electric systems, motors for all purposes, ornamental items made of brass and bronze, plumbing pipes, pennies, and roofing
Feldspar	Glassware, pottery, enamel and scouring powders
Fluorspar	Refrigerants for refrigerators and air conditioning equipment, steel making, refining of aluminum, manufacturing of nuclear fuels, propellants for spray paints, cosmetics and insecticides

Gypsum	Plaster, plaster board, cement, binders for orthopedic and dental casts, fertilizer, and in crayons
Iron Ore (steel)	Electric household appliances, automobiles, beverage and food cans and other containers, tools, farm and factory machinery, transportation equipment of all types; buildings
Lead	Storage batteries, gasoline additives, red lead for coating construction steel, lead foil for toothpaste tubes, solder for cans and containers, type metal for printing, radiation shielding, and sound proofing for rooms and machinery
Mercury	Electrical batteries, lamps, switches, paints, plastics, medicines, dental tooth fillings, and in the manufacture of chlorine for chemical plants
Molybdenum	Automobiles, airplanes, machine tools, pipes and tubing, catalysts to make pigments and refine petroleum in automobile greases and oils, fertilizers, welding rods, in electrical and electronic equipment, and in stainless steels
Nickel	Automobiles, airplanes, transportation equipment, household appliances, electrical machinery, ships and boats, coinage, and numerous ornamental and utilitarian alloys
Phosphate rock	Fertilizers, soap and detergents, plating and polishing, feed for animals and fowl
Platinum	Industrial chemicals, petroleum refining, glassware, telephones, dental equipment, and jewelry
Potash	Fertilizers, soap and detergents, plating and polishing soap, glass and chemicals.
Salt (sodium chloride)	De-icing agents for roads and streets; food preparation and home cooking; a source of chlorine used to make paper, plastics,

Salt (cont'd)	solvent fluids for automobiles; sprays to kill pests; and sanitation purposes
Silver	Photographic films and print paper, silverware, jewelry, industrial refrigerators, coinage, batteries, electric switches, all electronic equipment such as radios, TVs, etc.; solder in aircraft
Sulfur	Fertilizers, pigments for paints and plastics, rayon, explosives, manufacture of steel, petroleum refining, alcohols, pulp and paper, refining of many metals
Tin	Tin-coated cans, solder, pewter ware, in bronze and brass, in electrical equipment and supplies, in pigments for paints and plastics and in dry-cell batteries
Titanium and Titanium Oxide	Brilliant white pigments in paints, paper, and plastics; floor tile; printing ink; fiberglass; ceramics; and metal in jet plane turbines and structures
Zinc	Galvanized roofs, siding, fences, auto bodies; zinc die castings for carburetors, automobile grills and trim, home appliances, door handles; zinc oxide for auto tires and paints; rolled zinc in dry-cell batteries; and brass and bronze ornamental and utilitarian objects

We might add sand and gravel to this list since it is a principal mineral commodity in many states including Oregon. Some of its uses are listed in The ORE BIN, November 1972, p. 196.

As long as the American people directly or indirectly demand the products in the right hand column in the above list, we will need to mine the minerals on the left. One might ask the extremist which of the products on the right he is in all honesty willing to do without.

Must we mine in such great quantities?

Well-meaning people often suggest that perhaps we consume too much. It follows that if we reduce our consumption we can correspondingly reduce mining, industry, and pollution. Many people are trying to consume less and are actually living up to this ideal. Admirable though this may be, however, it does not represent national trends.

With their actions, the American people daily reaffirm their commitment to a high standard of living on the private, corporate, and public level. As long as consumption continues to climb, mine production must also climb. Per capita consumption continues to escalate as the following table shows:

PER PERSON USE OF RESOURCES IN THE UNITED STATES*
(in tons)

Resource	1950	1969
Fuel	7.2	7.5
Building materials . . .	5.4	5.8
Agricultural supplies . .	2.1	2.3
Metallic ores	2.55	2.65
Food	0.75	0.75
	18.00	19.00

* Clapp, 1972

Why more mines? Can't we rely solely on the mines now in operation?

"America is the land of plenty." Surely here we can pick and choose between those mineral deposits we develop and those we leave untouched. This is a prevalent attitude in the minds of many, but unfortunately it is not supported by the facts. Leith (1972) presents a chart showing the small size of known mineral reserves both in the United States and the world at current minable grades and rates of consumption (Figure 1). He also describes in realistic terms this country's posture in terms of mineral wealth:

> "The flush of discovery in the United States is passed.... Reserves can be approximately measured. Discovery has not stopped, but the rate has been slowing down for a considerable time. Of 33 metal-mining districts that have yielded the greatest wealth to date, only five have been discovered since 1900 and none at all since 1907. The coal and iron fields are pretty thoroughly mapped. The chance of finding another Mesabi Range or another Pittsburgh coal field is small indeed. The rate of discovery of oil and gas still continues high, but the geological limitations are pretty well understood, and the chances of finding another East Texas or Kettleman Hills are not promising.
>
> "Finally, the United States leads the world in the speed with which it is exploiting and exhausting its resources. For the metals and fuels, despite a magnificent endowment, depletion is further advanced than even mining men generally realize. In gold, the peak of American production was passed

in 1915, and despite the enormous stimulus of falling commodity prices and devaluation of the dollar, production today is still far below the pre-war level. In silver, also, we seem to have passed the peak. The copper mines of Michigan have gone a mile below the surface, by far the deepest copper mines in all the world, and at those depths, despite the ablest of engineering, they are quite unable to compete with many low-cost districts here and abroad. Mining at Butte has reached deep levels and has long since passed its peak. The great tri-state zinc district of Missouri, Oklahoma and Kansas is no longer expanding, and no notable geographic extensions are in sight. In the oil industry the glut produced by east Texas makes us forget the hundreds of dead or dying pools in other areas. The Southwest gas production hides the decline of many eastern districts and the death of the Indiana gas belt. Even in coal, one of the most abundant of our resources, it is estimated that the anthracite fields of Pennsylvania are 29 percent exhausted. While the total supply of bituminous coal is huge, the exhaustion of the best of the bituminous beds is well advanced. About half of the known high grade iron ore of the Lake Superior region has been produced."

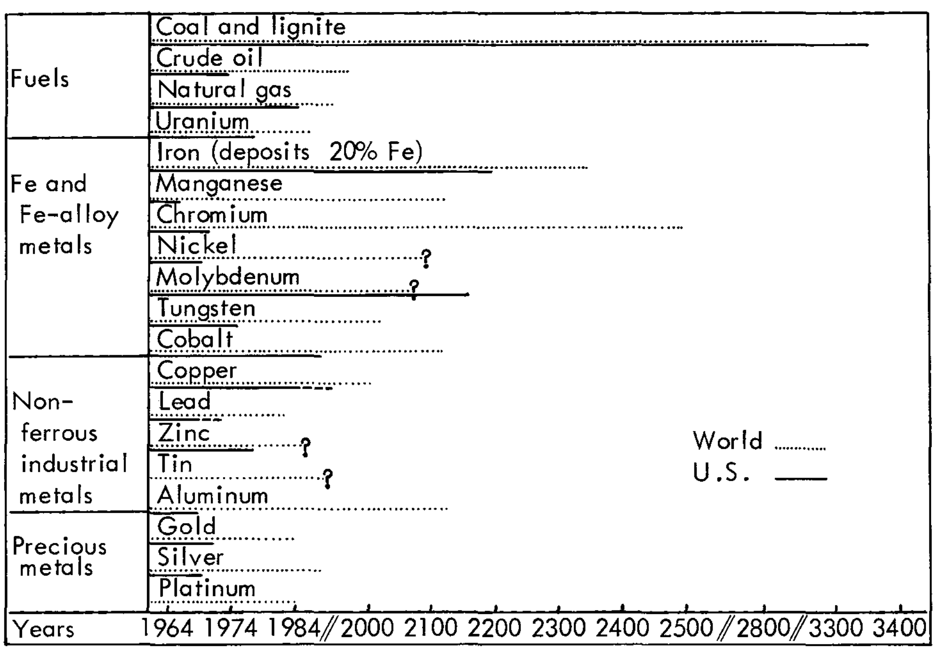

Figure 1. Lifetimes of estimated recoverable reserves of mineral resources at current minable grades and rates of consumption.

Summing up the situation, Mr. Johnson of the U.S. Department of the Interior stated that our mineral production, once the envy of the world,

> "has deteriorated over the past 20 years at an accelerating pace, and we have reached an alarming point of dependency on uncertain foreign sources for a substantial part of our mineral needs. As far as mineral needs are concerned, we have permitted ourselves to become a 'have-not' nation. ... This has not come about because we lack resources. ... We have, in fact, effectuated national policies that have discouraged development of mineral resources. So, whatever has been done to us, we have done it to ourselves."*

Can we get the needed minerals from other countries?

Since the beginning of civilization man has engaged in trade - the exchange of surplus goods on the one hand for those that are lacking on the other. At present, daily trade provides us with a partial answer to mineral needs, including oil. It is easy to think increased trade in the future will continue to supply our increasing demand. However, in trading its natural resources a nation trades a piece of its national security, a share of its monetary stability, and a say in its national destiny. The balance of trade is threatened by excessive United States imports, and the price is paid in terms of added inflation. Although free exchange of materials between nations is good, we cannot begin to supply all our natural resource needs through trade. The quantities are too great and the price in terms of national independence is too high.

In ethical terms, there is a more basic issue involved as well. A way of life which demands both high mineral consumption and a well-scrubbed environment but which, in effect, denies this to a trading foreign country is inconsistent. Other nations are already reacting to our shortsighted views. According to Leider (1962),

> "The evident hypocrisy of subjecting other nations to the depredations of bulldozers, power shovels, and chain saws, so as to spare one's own land from the machines, causes intense animosity and resentment. Few factors provide more fuel to Canadian nationalism than the vision of a future as a raw material reservoir for the U.S. consumer appetite. Public attitudes are hardening on the sale of oil, natural gas, and minerals to the United States. Bringing American investments to a halt and talk of expropriation have become popular political issues. To escape, Canada may turn in new directions to join different partners."

* David A. Loehwing, To have or have not, Barron's, September 25, 1972, p. 7-8.

We cannot ask other countries and other peoples to bear the burden of supplying our way of life. Moreover, by taking the resources of underdeveloped countries now, we are forever removing a portion of whatever future betterment their land may hold for them. If human environment is a legitimate concern, then human squalor surely must also be. In honesty we cannot consciously trade one for the other anywhere else in the world to supply our particular wants.

If we need new mines, can't we locate them out of sight?

Mining is thought of as dirty business. It often involves heavy equipment, noise, and large-scale earth movement. Although it would be desirable to keep it out of sight, economic geology tells us this is an unrealistic expectation. Cloud (1972) points out,

> "Economics and technology play equally important parts with geology itself in determining what deposits and grades it is practicable to exploit. Neither economics, nor technology, nor geology can make an ore deposit where the desired substance is absent or exists in insufficient quantity."

Any ore, like gold, is where you are lucky enough to find it. This is one basic fact we cannot ignore. Criticizing the location of gravel pits and metal mines in sight of freeways as we speed by in our automobiles is not a rational mode of behavior.

Is our mineral posture equally as grim as our environmental situation?

With the realization that there are no panaceas for the problems arising from our material consumption, we as a nation must objectively look to the future in anticipation of what it holds for us. Where do we get the needed minerals? What do we do about the environment? Must we pit one against the other?

From the preceding graph of the known national and world mineral reserves, page 27, total depletion of our mineral wealth may lie only a short distance ahead. A critical factor must not be overlooked, however. The estimated reserves are based on deposits of current minable grades. Man's capacity to make lower-grade deposits profitable is a key with which we can extend our known reserves almost indefinitely.

Eugene Holman, President of Standard Oil Company of New Jersey, approaches the concept thus:

> "Archaeologists have shown us that prehistoric men used axes, drills, and other implements made of flint and other hard stone. With these tools they were able to create simple societies,

which, in turn, made possible the accumulation of knowledge about the natural world.

"The Stone Age developed both the instruments and the knowledge which enabled men to use certain of the softer metals, especially copper and tin. Humanity then stepped up to the Copper and Bronze Age. Now man had more tools and more serviceable ones. He could fell trees faster and thus have more buildings for shelter and more vehicles for transport. He could move more widely than before over the earth.

"As the men equipped with bronze tools learned more and more about the world, humanity stepped up again--this time to an age of Iron. Now man began fashioning a really formidable array of tools. He had new power to cut, grind, hammer, and otherwise work materials. He could handle masses of material with stronger levers, wedges, pulleys, gears, hooks, eyes and pincers.

"In modern times the age of Iron has given way to the Steel Age. And within our own liftimes there has been superimposed on the Steel Age what we may call the age of lightweight metals, plastics and atomic fission."

Holman emphasizes that our progress has been geometric, with each successive stage opening broader horizons for us, that each stage has been dependent on the one before it, and that man's ingenuity has been instrumental in his profitable use of the resources around him.

Increasing knowledge has allowed us to discover new sources of raw materials, to extract resources from lower and lower tenor ores, to develop more efficient methods of use and to develop more uses for previously unused materials. It has been through the use of our resources, rather than non-use, that we have acquired the knowledge so essential to our sophisticated development. The oil industry provides us with an informative example of how this process operates in the present day.

"By producing and using oil we have built a dynamic oil industry and have accumulated the means, both financial and technical, to find more oil. We have developed methods for locating and mapping structures with greater speed and accuracy. We can select where to drill a structure with better odds of success. We can reach deeper strata. As a result, in the United States alone, there has been produced since 1938 as much oil as was known to exist in the country at that time. And despite that great withdrawal, the domestic industry's proved reserves are at an all-time high level. It's as though we started out with a tank of oil, used it all up, and had a bigger tankful left.

"...The idea of a storehouse--or at least, a single-room storehouse--does not correspond with reality. Instead, the fact seems to be that the first storehouse in which man found himself was only one of a series. As he used up what was piled in that first room, he found he could fashion a key to open a door into a much larger room. And as he used the contents of this larger room, he discovered there was another room beyond, larger still." (Holman 1972)

The march of progress from storehouse to storehouse has depended in large part on scientific knowlege and furthered by industrial aggressiveness; both, in turn, have been aided by favorable political and social conditions. Unrealistic repressive conditions in the social and political realm could ultimately halt our forward progress in mineral production.

Mining is directly responsible for a very small percentage of this nation's pollution. Yet it provides us with all the natural resources upon which our society, our survival mechanism, depends. It makes little sense then to translate one's concern for the environment into a "shut 'em down" approach toward the mining industry.

We simply must go forward. The storehouses behind us are empty. Our mineral posture is as grim or as promising, therefore, as we choose to make it. Now, in the 20th century with 3 billion lives at stake and accumulated ingenuity beyond early man's wildest dreams, we can ill afford to turn our backs on that simple lesson, nor do we need to.

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* * * * *

JACKSON INTRODUCES SURFACE MINING BILL

Sen. Henry M. Jackson has introduced a surface mining reclamation bill (S. 425) to "counteract the environmental abuses of surface mining, while recognizing the critical dependence of the nation on its products."

The bill would place primary responsibility for regulation with the states, subject to federal review and preemption; a $100 million fund to reclaim abandoned strip mine lands would be established; requirements of the legislation would be applied to all commercial surface mining operations, public corporations and utilities, and federal and Indian lands.

The five major goals of the Jackson bill are (1) prohibition of strip mining when full reclamation is impossible; (2) national standards to reduce inequities among states and to protect the national interest if a state fails to act; (3) imposition of social and environmental costs such as erosion, slope failures, and water pollution on the mining companies; (4) return of all areas to a condition capable of supporting at least pre-mining uses, and (5) administrative procedures which are fair and flexible enough to cope with unique conditions in various regions of the country.

The bill also requires: administration by a new Interior Department office without mineral development or promotion duties; Federal coal regulations within 90 days and all others within one year; a moratorium on all new strip mines pending issuance of states' permits; an acceptable applicant reclamation plan and bond adequate to pay reclamation costs; bond money returned on fulfillment of reclamation plan; individuals and companies hurt by the new regulations get first chance at strip mine reclamation contracts; Federal grants for state land-use planning involving designation of parks, streams, and other public areas as unsuitable for strip mining; and special Presidential exemption for national emergencies.

Jackson said slope limitations included in the House strip mine bill, passed last fall, would effectively ban most coal surface mining. "In the rush to pass the legislation before adjournment the House members, in my judgment, did not strike a proper balance between our energy and environmental needs. Strong actions are imperative to protect us from the specter of a ravaged land. Yet, we must also produce the energy needed for our homes, farms, and factories," he said.

A Council on Environmental Quality study of the effects of the House ban has been requested by Jackson. Preliminary findings will be presented during hearings on the Senate bill to be held in late February and early March. As introduced, the Senate bill requires mine operators to meet tough reclamation goals and performance standards but does not impose an arbitrary slope limitation.

Representatives of mining companies, conservation organizations, individual mine operators, reclamation experts, mine workers, local citizens, and consumers will testify during the Interior Committee hearings.

American Mining Congress News Bulletin

* * * * *

OREGON'S MILLION-DOLLAR-A-YEAR CLUB, 1971

County	Mineral production	County	Mineral production
Baker	$ 8,249,000	Lincoln	1,033,000
Clackamas	12,495,000	Malheur	1,360,000
Douglas	10,294,000	Marion	1,120,000
Grant	1,011,000	Multnomah	7,940,000
Jackson	1,700,000	Umatilla	2,008,000
Josephine	2,076,000	Union	1,676,000
Klamath	2,228,000	Washington	2,131,000
Lane	5,288,000		

In addition to the values shown, there was a total of $11,746,000 which could not be assigned to specific counties. Furthermore, production figures for Clatsop, Columbia, Curry, Gilliam, Harney, Hood River, Jefferson, Morrow, and Wasco Counties were concealed by the U.S. Bureau of Mines to avoid disclosing individual company confidential data.

* * * * *

PRIVATE GOLD POSSESSION BAN MAY BE LIFTED

The law which prohibits private possession of gold by American citizens should be repealed after international monetary reforms become effective. That is the recommendation made by the Joint Economic Committee's subcommittee on international exchange and payments.

The prohibition against the private possession of gold for any but ornamental or industrial purposes has existed since 1933, when the United States partially abandoned gold as the sole backing for its currency.

"As soon as the international monetary reform that is currently being negotiated is achieved, all prohibitions on the purchase, sale and holding of gold by American citizens should be promptly abolished," the subcommittee recommended.

Such a move, it said, would be a step "toward removing the mystique from gold and making it a commodity that is traded in the same manner as other metals."

The subcommittee called for reforms which would enhance the role of special drawing rights (SDR) in international monetary affairs and downgrade the role of gold.

Special drawing rights, commonly known as "paper gold," are an artificial reserve asset created in 1968 by the International Monetary Fund (IMF) and distributed to its members in proportion to their economic importance in the world economy. SCR's are used in the same fashion as gold, dollars or other currencies to settle debts between nations.

Under reforms now under discussion, the subcommittee said, "SDR's should be acceptable in lieu of gold in all transactions between the IMF and its member countries."

The subcommittee called for continuing existing agreements under which the world's central banks are prohibited from purchasing gold in the free market or directly from South Africa.

But it said the current agreement committing the IMF to purchase gold from South Africa under specified conditions should be terminated when it expires in two years.

When reforms make SDR's the chief international reserve asset, the subcommittee said, gold will become just another metal with its value determined by the economics of mining and refining and the demand for artistic and industrial uses.

GOLD IN DECEMBER

The average price for gold, as reported by E&MJ, for December 1972 was \$63.909 for London bullion buyers and \$64.311 for the Engelhard selling price. The London price is based on a 1000 fine troy ounce, the Engelhard on 99.95 percent pure gold in 400 ounce bars.

HELP FOR GOLD HUNTERS

According to a U.S. Geological Survey geologist, "a sort of old-fashioned gold fever seems to strike many people in the late spring and summer; requests for maps and reports that describe the known deposits of gold in the country -- particularly in the west -- mount rapidly." To help answer the many inquiries, the Survey has prepared three companion-piece nontechnical leaflets entitled: 1) GOLD, 2) PROSPECTING FOR GOLD, and 3) SUGGESTIONS FOR PROSPECTORS. Single copies of each of these three leaflets may be obtained upon request from the Information Office, U. S. Geological Survey, Washington, D.C. 20242.

The Oregon Department of Geology and Mineral Industries has published information on gold in Oregon: history, mines, production figures, deposits, and prospecting and panning methods. Obtainable from its three offices in Portland, Baker, and Grants Pass are the following: "Gold and Silver in Oregon," a 337-page, illustrated, bulletin which sells for $5.00; "Lode mines in the central part of the Granite mining district, Grant County" ($1.00); "The Almeda mine, Josephine County," ($2.00); "Oregon's gold placers," (25 cents); Oregon mineral deposits map and key (45 cents).

* * * * *

WASHINGTON DIVISION OF MINES ISSUES NEWSLETTER

The Washington State Division of Mines and Geology has joined the club of state geologic surveys that issues a periodical. "Washington Geologic Newsletter," the name of the Division's new endeavor, is a quarterly publication and the realization of a long-time hope. As stated in the opening paragraph:

> For years the Division of Mines and Geology has considered the possibility of publishing a quarterly news report on geologic happenings in the state. Now, after much thought, the quarterly newsletter has become a reality. Through it, we hope to keep the people of Washington abreast of events that are of geologic significance in our state.

Volume 1, no. 1, January 1973, is an $8\frac{1}{2}$ by 11 pamphlet of seven pages containing short articles on history and goals of the Division, news on environmental geology, land reclamation, metal production, geologic studies in the Olympic Peninsula, and a report from the State Geologist, Vaughn E. Livingston, Jr. Included is a map showing the new location of the Division's offices east of the State Capitol in Olympia. Persons interested in subscribing to the Newsletter are invited to write to the Department of Natural Resources, Division of Mines and Geology, Olympia, Washington 98504.

* * * * *

GEOLOGICAL SOCIETY OF AMERICA TO MEET IN PORTLAND

The Cordilleran Section of The Geological Society of America will meet March 22, 23, and 24, 1973, at Portland State University in Portland. Hosts for the meeting will be the Department of Earth Sciences, Portland State University, and the Oregon Department of Geology and Mineral Industries. Meeting jointly with the Cordilleran Section will be the Pacific Coast Section of the Paleontological Society.

The meetings will be held in Cramer Hall, Portland State University. There will be a registration fee for those who attend the scientific sessions and additional fees for the individual field trips.

Scheduled for the program are 250 papers in 20 categories as follows:

- Pre-Tertiary Evolution of the Pacific Northwest, 17 papers, all day Wednesday
- Biostratigraphy, 8 papers Thursday a.m., 7 papers Friday a.m.
- Economic and Engineering Geology, 10 papers Thursday a.m.
- Geomorphology, 8 papers Thursday a.m.
- Mineralogy and Petrology, 10 papers Thursday a.m.; 10 papers Friday a.m.; 11 papers Friday p.m.
- Structure and Tectonics, 9 papers Thursday a.m.; 9 papers Friday a.m.; 8 papers Friday p.m.; 7 papers Saturday a.m.
- Marine Geology, 7 papers Thursday p.m.
- Paleontology, 5 papers Thursday p.m.; 8 papers Friday p.m.
- Sedimentary Petrology, 6 papers Thursday p.m.
- Ignimbrites and Volcanoclastics, 11 papers Friday a.m.
- Urban and Environmental Geology, 12 papers Friday a.m.
- General Geology, 11 papers Friday a.m.
- Heat Flow, 10 papers Friday p.m.
- The Nasca Lithospheric Plate, 12 papers Friday p.m.
- Stratigraphy, 11 papers Friday p.m.
- Stratigraphy of the Columbia River Basalt, 10 papers Saturday a.m.
- Geochemistry and Geochronology, 12 papers Saturday a.m.
- Pleistocene Geology, 8 papers Saturday a.m.
- Sedimentology, 12 papers Saturday a.m.
- West Coast Mesozoic Micropaleontology, 8 papers Saturday a.m.

Detailed programs and abstracts will be handed out with Registration, beginning Wednesday, March 21 at 2:00 p.m.

Six field trips are scheduled for the periods before and after the meetings: 1) North-central Oregon; 2) Central Coast Range; 3) Northwestern Oregon and southwestern Washington; 4) Columbia River Gorge; 5) Portland area; and 6) Pasco Basin, Washington. A field trip guidebook, included in cost of trips, will be for sale for $5.00 for those who may wish to make self-guided tours later. The guidebook, published by Oregon Dept. of Geology and Mineral Indus. as Bulletin 77, will also be for sale in the Department's offices after the close of the GSA meetings.

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-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 suppl.) geology and mineral resources of Oregon, 1947: Allen. . 1.00
35. Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin. . . . 3.00
36. Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 1 $1.00; vol. 2 1.25
39. Geology and mineralization of Morning mine region, 1948: Allen and Thayer . . 1.00
46. Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey 1.25
49. Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch . . . 1.00
52. Chromite in southwestern Oregon, 1961: Ramp 3.50
57. Lunar Geological Field Conf. guidebook, 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 Tualatin Valley region, 1967: Schlicker and Deacon . . . 5.00
61. Gold and silver in Oregon, 1968: Brooks and Ramp 5.00
62. Andesite Conference Guidebook, 1968: Dole 3.50
64. Geology, mineral, and water resources of Oregon, 1969 . . . . 1.50
66. Geology, mineral resources of Klamath & Lake counties, 1970: Peterson & McIntyre 3.75
67. Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts 2.00
68. The Seventeenth Biennial Report of the State Geologist, 1968-1970 . . . . . . 1.00
69. Geology of the Southwestern Oregon Coast, 1971: Dott 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
72. Geology of Mitchell Quadrangle, Wheeler County, 1972: Oles and Enlows . . . 3.00
73. Geologic formations of Eastern Oregon, 1972: Beaulieu 2.00
74. Geology of coastal region, Tillamook Clatsop Counties, 1972: Schlicker & others 7.50
75. Geology, mineral resources of Douglas County, 1972: Ramp 3.00
76. Eighteenth Biennial Report of the Department, 1970-1972 . . . . 1.00
77. Geologic field trips in northern Oregon and southern Washington, 1973 . . . in press

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck 2.15
Geologic map of Oregon (12" x 9"), 1969: Walker and King 0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bulletin 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 portion of High Cascade Mtns., 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 and others . . 1.50
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka . . . 1.50
GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: Berg and others
[sold only in set] flat $2.00; folded in envelope 2.25
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess 1.50

OIL AND GAS INVESTIGATIONS SERIES

1. Petroleum geology, western Snake River basin, 1963: Newton and Corcoran . . . 2.50
2. Subsurface geology, lower Columbia and Willamette basins, 1969: Newton . . . 2.50

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18. Radioactive minerals prospectors should know, 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
24. The Almeda mine, Josephine County, Oregon, 1967: Libbey	2.00

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
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5. Oregon's gold placers (reprints), 1954	0.25
6. Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton	1.50
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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: Lewis	0.30
14. Thermal springs and wells, 1970: Bowen and Peterson	1.00
15. Quicksilver deposits in Oregon, 1971: Brooks	1.00

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Geologic time chart for Oregon, 1961	Free
The ORE BIN - available back issues, each	0.25
Postcard - geology of Oregon, in color	10¢ each; 3 - 25¢; 7 - 50¢; 15 - 1.00

The ORE BIN - annual subscription	2.00

The Ore Bin

Vol. 35, No. 3
March 1973

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin

Published Monthly By

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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
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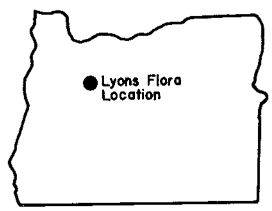
The ORE BIN
Volume 35, No. 3
March 1973

THE OLIGOCENE LYONS FLORA OF NORTHWESTERN OREGON

Herb Meyer
Student, Portland State University

The purpose of this study of the Lyons flora is to determine the age and paleoecology of the flora through the examination and identification of the fossil plant species of the flora.



The plant fossils comprising the Lyons flora were collected from a locality in the upper Thomas Creek area, 5 miles southeast of the town of Lyons, Oregon.

Geologic Occurrence

The beds from which the Lyons flora was obtained are part of the Little Butte Volcanic Series of Oligocene and early Miocene age described by Peck and others (1964). Stratigraphically below the fossil deposit, the Little Butte Volcanic Series is characterized by a pumiceous tuff-breccia which contains blocks and fragments of a volcanic flow rock. This exposure, the base of which is not exposed, underlies the fossil deposit for a thickness of more than 400 feet.

The deposit containing the fossil leaves is composed of a thinly laminated tuffaceous material which has been silicifed to varying degrees. These beds may have been deposited in a shallow, quiet body of water. Lacustrine deposition is suggested by the stratification of the beds, the abundant presence of fossil leaves, and the presence of one water plant in the fossil record.

Composition of the Lyons Flora

Twenty-four identified fossil plants represent the Lyons flora as it is known at this point in the study. Twelve have been identified to species and twelve have been identified only to genus (Table 1).

Ed. note: Herb Meyer was an OMSI student research worker and a winner in the 1972 Westinghouse Science Talent Search.

Table 1. Systematic list of species

GYMNOSPERMAE

GINKGOALES
- GINKGOACEAE
  - *Ginkgo biloba* L.

CONIFERALES
- PINACEAE
  - *Abies* sp.
- TAXODIACEAE
  - *Cunninghamia chaneyi* Lakhanpal
  - *Metasequoia occidentalis* (Newberry) Chaney
  - *Sequoia affinis* Lesquereux
- CUPRESSACEAE
  - *Chamaecyparis* sp.

ANGIOSPERMAE

GLUMIFLORAE
- CYPERACEAE
  - aff. *Cyperacites* sp.

JUGLANDALES
- JUGLANDACEAE
  - *Pterocarya mixta* (Knowlton) Brown

FAGALES
- BETULACEAE
  - *Alnus* sp. 1
  - *Alnus* sp. 2
- FAGACEAE
  - *Castanopsis longifolius* Lakhanpal

ROSALES
- SAXIFRAGACEAE
  - *Hydrangea* sp.
- HAMAMELIDACEAE
  - *Exbucklandia oregonensis* (Chaney) Brown

ANGIOSPERMAE, continued

ROSALES, continued
- PLATANACEAE
  - *Platanus condoni* (Newberry) Knowlton
- ROSACEAE
  - *Rosa hilliae* Lesquereux

SAPINDALES
- ACERACEAE
  - *Acer* sp.
- SABIACEAE
  - *Meliosma* sp.

MALVALES
- TILIACEAE
  - *Tilia* sp.

MYRTIFLORAE
- NYSSACEAE
  - *Nyssa* sp.
- ALANGIACEAE
  - *Alangium thomae* (Chaney and Sanborn) Lakhanpal

ERICALES
- CLETHRACEAE
  - Clethra sp.

CONTORTAE
- OLEACEAE
  - *Fraxinus* sp.
- GENTIANACEAE
  - *Nymphoides circularis* (Chaney) Brown

TUBIFLORAE
- VERBENACEAE
  - *Holmskioldia speirii* (Lesquereux) MacGinitie

Growth habit

The following conclusions regarding the growth habit of the Lyons species have been made through comparisons with the similar living species.

Trees

Ginkgo biloba	Exbucklandia oregonensis
Abies sp.	Platanus condoni
Cunninghamia chaneyi	Acer sp.
Metasequoia occidentalis	Tilia sp.
Sequoia affinis	Nyssa sp.
Chamaecyparis sp.	Fraxinus sp.
Castanopsis longifolius	

Low Trees and Shrubs

Pterocarya mixta	Meliosma sp.
Alnus sp. 1	Alangium thomae
Alnus sp. 2	Clethra sp.
Rosa hilliae	

Vines

Hydrangea sp.	Holmskioldia speirii

Herbs

aff. Cyperacites sp.	Nymphoides circularis (aquatic)

Although this information would seem to indicate that trees comprised most of the vegetation, it should be considered that this type of vegetation is more readily preserved in the fossil record. The larger stature of trees and the greater quantity of their leaves would, as discussed by Lakhanphal (1958), increase the probability of their preservation.

Paleoecology

The interpretations of the paleoecology of the Lyons flora are based upon comparisons with the similar living species and their climatic distribution and upon the analysis of physiognomic leaf characters.

Distribution of similar living species

Table 2 shows the similar living species of the Lyons plants identified to species and the geographical distribution of each. Those plants known only to genus have not been included since most of them have widespread geographical distribution.

The following species, as judged by their similar living species, were typically subtropical: Ginkgo biloba, Castanopsis longifolius, Exbucklandia oregonensis, Platanus condoni, Alangium thomae, and Holmskioldia speirii.

Typically temperate species include the following: Metasequoia occidentalis, Sequoia affinis, Pterocarya mixta, and Rosa hilliae. Cunninghamia chaneyi is both subtropical and temperate. Many genera not included in Table 2 (i.e., Abies, Chamaecyparis, Alnus, Acer, Tilia, and Fraxinus) are predominantly temperate plants, while Meliosma is predominantly subtropical.

Analysis of leaf characters

Certain physiognomic characters of the leaves present information which can be used as an indication of the paleoclimatic conditions under which a flora lived. The analysis of such characters for several floras are shown in Table 3, by percentage.

The length of the leaves has been measured and recorded in two categories: those 10 cm and under and those over 10 cm. Marginal characteristics have been distinguished as entire or non-entire. Entire includes those leaves with no regular indentations along the margin, whereas non-entire includes margins which are lobed, toothed, or have other regular indentations. The occurrence of an abrupt, elongate apex confirms the presence of a dripping point. The texture of the leaves of a species has been determined either as thick or thin.

Large leaves are frequently predominant in the tropical and subtropical floras; smaller leaves occur more frequently in the cooler floras. Leaves with entire margins are typical of climates that are physiologically arid for the plant during part or all of its growing season (i.e., tropical, non-humid

Table 2. Distribution of similar living species

Fossil species	Living species	East Asian	American East	American West
Ginkgo biloba	G. biloba	X		
Cunninghamia chaneyi	C. lanceolata	X		
Metasequoia occidentalis	M. Glyptostroboides	X		
Sequoia affinis	S. sempervirens			X
Pterocarya mixta	P. paliurus	X		
Castanopsis longifolius	Castanopsis spp.	X		
Exbucklandia oregonensis	E. populnea	X		
Platanus condoni	Platanus spp.		X	X
Rosa hilliae	R. palustris		X	
Alangium thomae	A. chinense	X		
Holmskioldia speirii	H. sanguinea	X		
	Total	8	2	2

Table 3. Percentage of leaf characters

Flora	Length over 10 cm	Length under 10 cm	Margin entire	Margin non-entire	Dripping point present	Dripping point absent	Texture thick	Texture thin
Lyons	35	65	40	60	10	90	30	70
Bridge Creek	30	70	25	75	10	90	55	45
Muir Woods modern forest	27	73	23	77	9	91	64	36
Scio	33	67	33	67	33	67	44	56
Goshen	53	47	61	39	47	53	98	2
Panama modern forest	56	44	88	12	76	24	98	2

temperate, and arctic climates). Leaves with non-entire margins are more characteristic of humid climates which are not physiologically arid for the plant. Dripping points are usually present only in the large, entire margined leaves of tropical and subtropical floras. Leaves with thick textures are also typical of tropical and subtropical species.

Comparisons with the other floras in Table 3 indicate that the Lyons flora is unlike the subtropical Goshen flora and the more tropical Panama modern forest. A closer similarity to the temperate Bridge Creek and Muir Woods floras is apparent. The Lyons species are quite similar to the Scio species in size, textural, and marginal characteristics. The Scio flora is apparently a semi-subtropical coastal flora, although it has few species in common with the Lyons flora.

Paleoecological conditions of the Lyons flora

The comparison with modern species and the analysis of leaf characters indicate that the Lyons flora contained plants which were both subtropical and temperate, although the temperate species were predominant. Since the Lyons flora grew near the margin of the Oligocene sea, the occurrence of both subtropical and temperate species in the flora can be attributed to the moderate climatic conditions which resulted from the influence of a marine climate. Under such moderate conditions, subtropical species which were typical in the Eocene and early Oligocene floras had survived into the middle Oligocene.

The Lyons flora probably represents a forest which grew near a coastal environment which had a warm temperate climate with mild, moderate temperatures.

Age and Correlation of the Flora

The Tertiary of western North America experienced a climatic cooling trend as this period progressed. Eocene and early Oligocene floras contain typically tropical or subtropical plants. Beginning in the middle Oligocene and continuing through the middle Miocene, climatic changes gave rise to temperate hardwood-conifer forests. Cool temperate floras became

Table 4. Distribution of Lyons species in other Tertiary floras

	Oligocene							Miocene				Pliocene
	Early		Middle				Late	Early	Middle		Late	Early
Fossil species	Comstock	Florissant	Goshen	Scio	Rujada	Bridge Creek	Weaverville	Eagle Creek	Latah	Mascall	Stinking Water	Troutdale
Ginkgo biloba								X	X	X		
Cunninghamia chaneyi					X							
Metasequoia occidentalis				X	X	X	X					
Sequoia affinis		X			X							
Pterocarya mixta					X				X	X	X	
Castanopsis longifolius					X							
Exbucklandia oregonensis					X	X		X	X			
Platanus condoni					X	X						
Rosa hilliae		X				X						
Alangium thomae			X	X	X	X						
Nymphoides circularis						X						
Holmskioldia speirii		X	X			X						
Species in flora	0	3	2	2	8	7	1	2	3	2	1	0
Species in sub-epoch	3		11				1	2	3		1	0

Table 5. Distribution of Lyons genera in other Tertiary floras

Fossil genera	Oligocene							Miocene				Pliocene
	Early		Middle				Late	Early	Middle		Late	Early
	Comstock	Florissant	Goshen	Scio	Rujada	Bridge Creek	Weaverville	Eagle Creek	Latah	Mascall	Stinking Water	Troutdale
Abies		X			X	X				X	X	
Chamaecyparis		X										X
Alnus					X	X		X	X	X	X	X
Hydrangea		X	X			X	X		X	X	X	
Acer		X				X		X	X	X	X	X
Meliosma			X									
Tilia		X				X	X	X	X			
Nyssa						X	X	X	X	X		
Clethra												
Fraxinus				X	X	X				X		X
Genera in flora	0	5	2	1	3	7	3	4	5	6	4	4
Genera in sub-epoch	5		8				3	4	7		4	4

predominant by the Pliocene. As these climatic changes occurred, the plant species, and often genera, would change accordingly. Therefore, the plant species from any one sub-epoch are somewhat distinctive from those of any other.

The age of the Lyons flora is based upon comparisons made with the distribution of the same plant species in other Tertiary floras, as shown in the correlation charts (Tables 4 and 5). It is most probable that the age of the Lyons flora is equivalent to the age of those floras which contain the largest number of species in common with it.

Table 4 shows the distribution of the Lyons plants identified to species; Table 5 shows the distribution of the plants identified only to genus. Those plants known to species are most useful for age determination, whereas those known to genus actually reveal little infomation about age. This is due to the fact that many of the genera are widely distributed throughout the Tertiary epochs, while species are more limited to a single epoch or sub-epoch.

The table showing the distribution of plants identified to genus is included primarily to show their distribution in other floras.

The correlation of those twelve plants identified to species (Table 4) indicates a close resemblance to middle Oligocene floras. Representation of Lyons species in the subtropical early Oligocene floras is less prominent. Cool temperate floras that are younger than late Oligocene age also show little similarity to the Lyons flora. Resemblance to the middle Oligocene Bridge Creek and Rujada floras of Oregon on the basis of species is noteworthy. The Lyons plants bear eleven species in common to the floras of this sub-epoch; seven species are common to the Bridge Creek flora and eight are common to the Rujada flora. This evidence would indicate that the Lyons flora is of middle Oligocene age.

As pointed out, generic comparisons have a limited value when used in age determination. However, the information from Table 5 confirms the placement of the Lyons flora in the middle Oligocene to Miocene group. The abundance of genera in common with the early and middle Miocene floras does not contradict the middle Oligocene placement of the Lyons flora; many of the Oligocene genera survived into the early and middle Miocene.

Holmskioldia speirii, a species abundant in the Lyons flora, is not known regionally in floras younger than middle Oligocene age. It can, therefore, be used as an indication of pre-late Oligocene age in a flora. Accordingly, its presence in the Lyons flora confirms the pre-late Oligocene age of the flora.

The close resemblance of the Lyons flora to the Bridge Creek and Rujada floras and the pre-late Oligocene age indicated by Holmskioldia speirii indicate that the age of the Lyons flora is middle Oligocene.

Acknowledgments

The author wishes to express his gratitude to the following persons who have assisted with this project:

Dr. Jack A. Wolfe, U.S. Geological Survey, for helpful discussion and aid with identifications of fossil plants.

Mr. Howard Schorn, University of California, Berkeley, for helpful discussion, aid with identifications, and granting the author access to the type collections at the Museum of Paleontology.

Mrs. Eleanor Gordon Thompson, Salem, for allowing use of her private collection of plant fossils from the Lyons flora.

Dr. Paul Hammond, Portland State University, for aid in interpretation of geologic problems.

Oregon Museum of Science and Industry, for provision of facilities.

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Explanation of plates

PLATE I.

Figure 1. *Ginkgo biloba* L.
Figure 2. *Cunninghamia chaneyi* Lakhanpal
Figure 3. *Metasequoia occidentalis* (Newberry) Chaney
Figure 4. *Sequoia affinis* Lesquereux
Figures 5, 6. *Pterocarya mixta* (Knowlton) Brown
Figure 7. *Hydrangea* sp.

PLATE II.

Figure 1. *Castanopsis longifolius* Lakhanpal
Figure 2. *Alnus* sp. 2
Figure 3. *Alnus* sp. 1
Figure 4. *Alnus* "cones"
Figure 5. *Chamaecyparis* sp.
Figures 6, 7. *Exbucklandia oregonensis* (Chaney) Brown

PLATE III.

Figure 1. *Platanus condoni* (Newberry) Knowlton (Reduced X 2/3)
Figure 2. *Rosa hilliae* Lesquereux
Figures 3, 4. *Holmskioldia speirii* (Lesquereux) MacGinitie

PLATE IV.

Figure 1. *Meliosma* sp.
Figure 2. *Tilia* sp.
Figure 3. *Nyssa* sp.
Figure 4. *Fraxinus* sp.
Figure 5. *Acer* sp.

PLATE V.

Figures 1, 3. *Alangium thomae* (Chaney and Sanborn) Lakhanpal
Figure 2. *Clethra* sp.
Figure 4. *Nymphoides circularis* (Chaney) Brown

All figures are natural size unless otherwise noted.

PLATE I

fig. 1

fig. 2

fig. 3

fig. 4

fig. 5

fig. 6

fig. 7

PLATE II

fig. 1

fig. 2

fig. 3

fig. 4

fig. 5

fig. 6

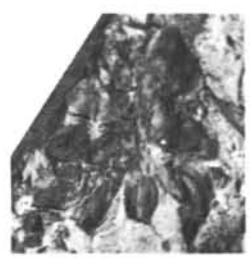

fig. 7

PLATE III

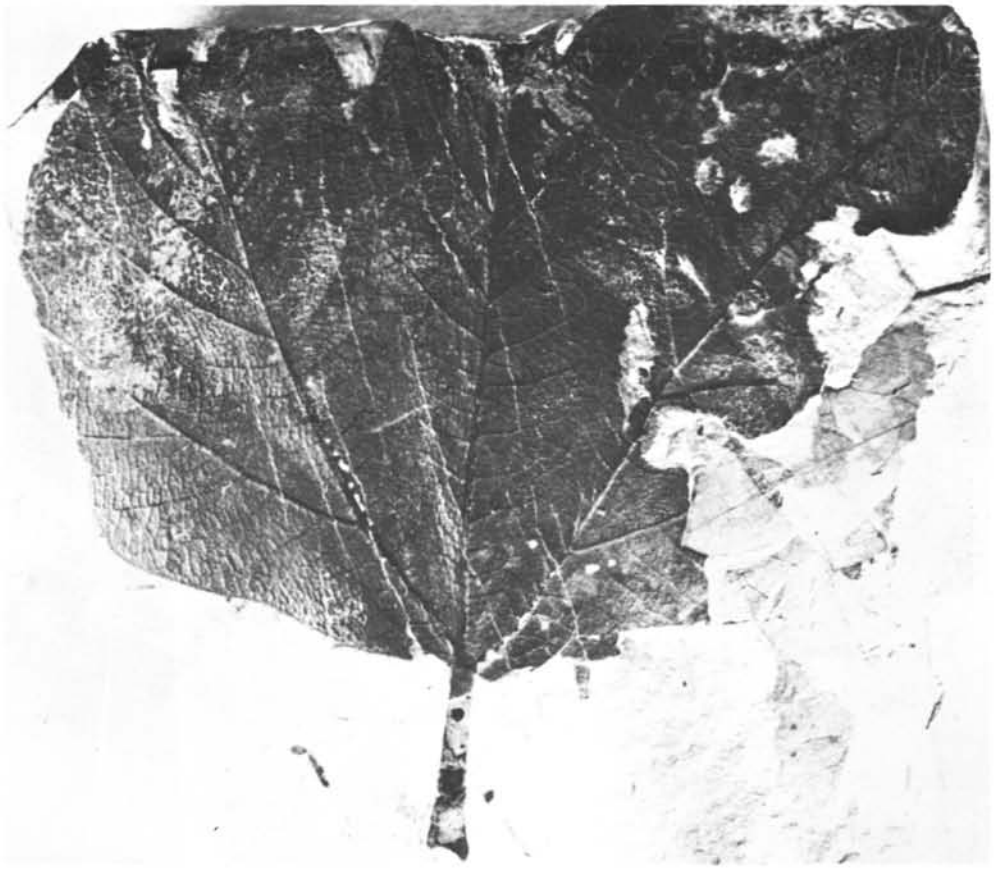

fig. 1

fig. 2

fig. 3

fig. 4

PLATE IV

fig. 1

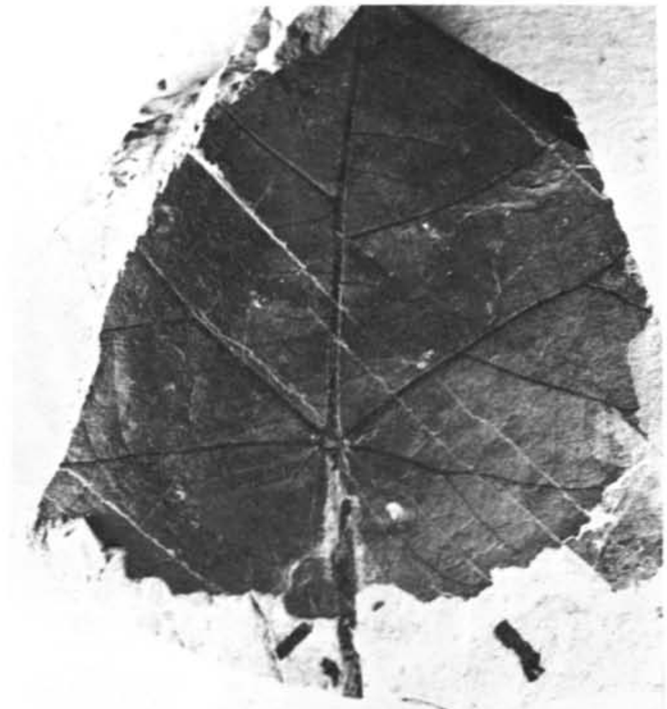

fig. 2

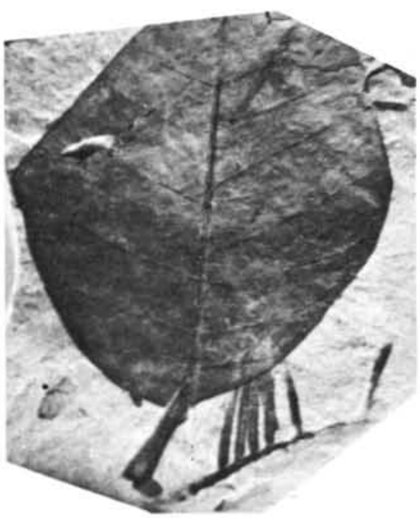

fig. 3

fig. 4

fig. 5

PLATE V

fig. 1

fig. 2

fig. 3

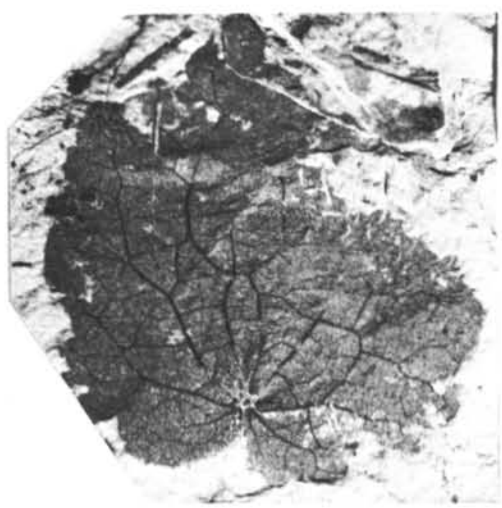

fig. 4

THESES ON OREGON GEOLOGY ADDED TO LIBRARY

The following unpublished master's theses and doctoral dissertations on the geology of Oregon have been added to the Department's library:

Armentrout, John M., 1967, The Tarheel and Empire Formations; geology and paleontology of the type sections, Coos Bay, Oregon. Univ. Oregon master's thesis.

Bloomquist, R. Gordon, 1970, A partial review and an analysis of the use of grain-size parameters, percentage of heavy minerals, and particle shape in the determination of depositional environment of ancient sediments on southwest Oregon coast. Univ. Stockholm Sweden, master's thesis.

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Trost, Paul B., 1970, Effects of humic-acid-type organics on secondary dispersion of mercury. Colorado School of Mines doctoral dissertation.

Utterback, William C., 1972, The geology and mineral deposits of Eden Valley-Saddle Peaks and vicinity, southeastern Coos and northeastern Curry Counties. Oregon State Univ. master's thesis.

Van Atta, Robert O., 1971, Sedimentary petrology of some Tertiary formations, upper Nehalem River basin, Oregon. Oregon State Univ. doctoral dissertation.

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COPPER FROM CANS

The copper mining industry is a big consumer of old steel cans. U.S. mining companies buy millions of them from municipal waste-separating facilities for use in a process that accounts for nearly 15 percent of the nation's copper production. When shredded and mixed with certain chemicals, the reclaimed steel helps to leach copper from low-grade ore. A large part of the cans is recovered from city garbage by magnetic separation. An American Iron and Steel Institute estimate for 22 cities shows 2.25 billion steel cans extracted from waste using magnetic separation in 1972.

(Compressed Air, v. 78, no. 2, Feb. 1973)

* * * * *

AN ACRE IS MORE THAN JUST 43,560 SQUARE FEET

Land-use planning is here to stay; it is here now and it looks as though it will be with us for the long pull. However, one gets the distinct impression that to many people, including planners, land is only a surface, sometimes flat, sometimes hilly. It may be low and swampy or dry and high. Land-use planners talk about these surfaces in terms of so many people per square mile, so much runoff per drainage basin, so many tons of fallout per acre, and so on. But they talk only about the surface. The unit of surface is the acre, roughly equal to an average city block or, more precisely, 43,560 square feet.

Geologists take a different view of "land." First, they view it as a three dimensional block of the earth's crust. Each block is unique in many ways though its surface may appear to be identical to adjoining parcels. What lies immediately below the surface is much like the mythical Pandora's Box, which loosed many ills and blessings when opened. Lurking beneath an innocent looking land surface may be a plague of geologic hazards or a wealth of mineral resources which may be set free if the surface land cover is removed and the "box" opened. Geologic hazards lying beneath the surface may go unnoticed for centuries. Landslides, subsidence, changes in water table, contamination of potable water, and destruction of natural springs are some of the geologic hazards which may become all too apparent when the land is disturbed.

Mineral resources that may be underlying the land surface include such things as sand and gravel, crushable rock, dimension stone, jetty rock, fill material, ground water, oil and gas, coal, metallic ores, and industrial minerals.

To a geologist, "land" is the basis for economic opportunity. For example, communities rely on abundant and nearby sources of aggregate in the form of sand and gravel or crushable rock. A century ago these materials were readily available on or near the surface in certain areas. Today these easily mined deposits are largely gone and only the buried reserves are left. Unfortunately, land-use planning often fails to recognize that mineral wealth may lie hidden beneath the surface and much zoning has effectively prohibited the development of these resources.

Here is an example of how good land-use planning can provide for utilization of the entire block of land. A deposit of sand and gravel 27 feet deep underlying one acre of land will produce 43,560 cubic yards of highly useful material, which if sized and screened will "swell" in volume when sand is separated from gravel and then gravel is screened from boulders. All of these products are normally salable and under present market conditions should realize about $2.00 per cubic yard as they leave the plant. This is roughly $87,000 per acre. In the construction industry, its worth increases with use; if the aggregate is in a concrete structure the value is approximately 100 times greater than the original pit price.

After the sand and gravel, or other mineral, has been extracted, the mined area may serve a variety of useful purposes if properly handled. Such pits may become solid waste landfill sites, "instant basements," or recreational sites with ready-made lakes. If used for solid waste landfill, the acreage of surface is again available to the planner for a variety of other commercial uses.

Small wonder then that geologists are concerned when poor land-use planning ignores the mineral wealth hidden beneath the land surface. We are running out of natural resources, and future needs must be considered in current land-use planning. We must start thinking of an acre as being more than just 43,560 square feet of surface.

* * * * *

DOLE TO HEAD OIL SHALE PROJECT IN COLORADO

Former Oregon state geologist Hollis M. Dole, Assistant Secretary of Interior during Nixon's first term, has been named to head an oil shale development program in western Colorado. The Interior Department announced that he will become senior executive in charge of the jointly sponsored oil shale development program of the Atlantic Richfield Co. and the Oil Shale Corp., with headquarters in Denver.

Dole, assistant secretary for mineral resources since March 1969, had major responsibility for federal policies and programs related to energy and mineral resource development and was among the first of the Administration officials to alert the country to the energy crisis. Dole was instrumental in securing passage of the Mining and Minerals Policy Act and the Geothermal Steam Act, and was interested in upgrading the capabilities of mineral science colleges and increasing the number of their graduates. He was head of the Oregon Department of Geology and Mineral Industries from November 1954 until March 1969.

* * * * *

DONALD McGREGOR

Donald G. McGregor, resident of Grants Pass, Oregon, and the most recently appointed member of the Department's Governing Board, died February 15 at the age of 70. Mr. McGregor was appointed to the Board by Governor Tom McCall in August 1972 and would have served in this capacity until March 1976 (see August 1972 ORE BIN). During his short term of office he became particularly interested in the development of Oregon's potential for geothermal power.

* * * * *

CHINA DEVELOPING GEOTHERMAL RESOURCES

Before 1949, the geothermal resources of China were used only in treatment of certain skin diseases, for pleasure bathing, and as oral medication in curing certain illnesses. The potential for agricultural and industrial use went unrecognized.

With the increased geological surveying of the country, additional sources of geothermal energy have been discovered, and the exploitation of these resources for industrial, agricultural and household uses is increasing. In 1958 generation of electric power with geothermal energy was started, and since that time investigations into development of this resource have expanded. Such energy is now recognized by China as being relatively abundant in reserve, low cost in exploitation, and unpolluting to the human environment.

At present, geothermal energy in the form of natural steam, warm and hot water springs is being used for generation of electricity in a number of locations. In some urban areas natural hot water has been piped for heating purposes and for industrial production, especially in industries which require large supplies of hot water, such as dyeing, paper manufacturing, chemical production. In rural areas, warm and hot springs have been channeled for irrigation of nursery crops and of paddy fields to shorten the growing period. Also, water from hot springs is used in greenhouses, poultry and fish hatcheries, fermentation processes, and for steaming and drying foodstuffs.

(from Geothermics, v. 1, no. 3, Sept. 1972)

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BIBLIOGRAPHY OF ALASKAN GEOLOGY

The Alaska Geological Survey has published two new bibliographies on Alaskan geology, each with subject index. The volumes cover the years 1965-1968 and 1969-1971, and are fifth and sixth respectively in a series on Alaskan geology covering literature published since 1831. The bibliographies are designed for geologists and others who seek information on the geology of Alaska. As stated in the introduction, the data for Alaska were compiled from Abstracts of North American Geology, published by the U.S. Geological Survey, and from Bibliography and Index of Geology, published by the Geological Society of America. The volumes are available by writing to Alaskan Department of Natural Resources Division of Geological Survey, College, Alaska. Each publication is $1.00.

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AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-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 suppl.) geology and mineral resources of Oregon, 1947: Allen. .	1.00
35. Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin. . . .	3.00
36. Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 1 $1.00; vol. 2	1.25
39. Geology and mineralization of Morning mine region, 1948: Allen and Thayer . .	1.00
46. Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25
49. Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch . . .	1.00
52. Chromite in southwestern Oregon, 1961: Ramp	3.50
57. Lunar Geological Field Conf. guidebook, 1965: Peterson and Groh, editors . . .	3.50
58. Geology of the Suplee-Izee area, Oregon, 1965: Dickinson and Vigrass	5.00
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The Ore Bin

GOLD!
SPECIAL ISSUE

OREGON

Vol. 35, No. 4
April 1973

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin
Published Monthly By

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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
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The ORE BIN
Volume 35, No. 4
April 1973

GOLD

The price of gold has risen from $60.35 per ounce in mid-November, 1972, to $91.25 per ounce in mid-April, 1973. The present high price has caused considerable speculation as to the underlying reasons for the sudden increase and what effect it may have on the international monetary situation. This precious metal has been eagerly collected and mined for more than 6,000 years because of its desirable physical qualities and its relative scarcity. Although some economists refer to it as a "barbaric metal," the expanding use of gold in the electronics industry attests to the fact that it is an important contributor to our modern technological society. Because of the present great interest in gold, this issue of The ORE BIN features a wide variety of information on gold, with contributions by mining engineers, economists, and Department staff.

Sources of Gold

Gold is widely distributed in the rocks of the earth's crust but generally in very minute quantities. It can be mined profitably only where it is present in unusual concentrations.

The three principal sources of gold are: gold in placers, gold ore in lodes, and base-metal ores in which gold is a by-product.

Gold placers

Most gold placers are formed by the erosion of a surface which has outcrops of gold ore (lode gold). Weathering decomposes the rock; runoff water carries the disintegrated rock down the ravines and gullies to the creeks and down the creeks to the rivers. In the process, the rock is ground to sand and gravel.

Gold, which is resistant to chemical attack, is freed by weathering from the rock. Since its specific gravity is many times greater than that of the associated minerals, it sinks in running water and lags behind in the bed of the stream while the greater part of the sand and gravel is swept on. Thus the gold is concentrated and a placer deposit is formed.

Placer deposits are most likely to occur where the carrying power of the stream is reduced, as in sand and gravel bars or in low points or pockets in the stream bed. Irregular surfaces of bedrock beneath the stream flow aid in trapping gold particles. Fine particles of gold are carried out to ocean beaches at the mouths of streams where the combination of stream washing and wave action settle out the tiny gold fragments.

A few unusually heavy and resistant minerals commonly accumulate with gold. Magnetite is the most common. Other heavy minerals that may be present in Oregon placers are chromite, ilmenite, zircon, garnet, and a very minor amount of platinum.

Lode gold

Lode gold originates from great depth in the earth's crust. It is carried, along with other minerals, by rising hot waters emanating from a source such as a cooling magma. Under pressure, the hot solutions follow cracks or fractures formed by earth movements and travel upward until they encounter cooler rocks. Here, where temperatures and pressures are less, the minerals crystallize out of the solutions and accumulate along fracture surfaces and in voids along fractures to form veins.

Commonly the principal constituents of a fracture-filling or vein are quartz or quartz and calcite, but the vein material generally contains some copper, lead, iron, and other metal-bearing compounds. In many veins, brass-like iron sulfide or pyrite is abundant. Pyrite and iron-stained mica are sometimes mistaken for gold, hence the name "fool's gold."

The deposition of the gold is rarely uniform but varies from rich to lean. The form of deposition may be in bands, in a series of lenses separated or connected, in irregular shapes like splashes of ink on blotting paper, or at vein intersections. Visible gold is not common in an average ore, and it is necessary to sample and assay frequently and to plot the gold assays on an accurate mine map to guide the mining of the deposit.

Lode gold deposits are difficult to discover and the history of gold mining is full of the element of luck, the fortuitous circumstances which have led to the discovery of most of our famous gold-mining districts. Lode deposits do not always crop out, or only a small area may be exposed and that hard to distinguish from the surrounding rock. The presence of placer gold in a stream bed usually indicates a source in a vein or lode deposit in the vicinity.

The rarity of important finds is clearly reflected in the records of gold production; pulsations or surges are evident whenever great new gold-mining districts have been opened.

By-product gold

More than one-third of the gold produced in the United States is a by-product from mining other metallic ores. Where base metals, such as copper, lead, and zinc, are deposited either in veins or as scattered mineral grains, minor amounts of gold are usually present. Deposits of this type are mined for the predominant metals, but during processing of the ore the gold is also recovered.

Some deposits of base metals, such as disseminated or porphyry-copper deposits, are so large that even very minor amounts of gold per ton of ore will total a substantial amount. Gold recovered from copper ore mined at the vast open-pit mine at Bingham, Utah, for example, almost equals the amount of gold produced from the largest gold mine in the United States.

The Scarcity of Gold

Gold has been sought and mined for more than 6,000 years, not just by individuals but by kings, governments, conquerors, adventurers, and corporations. All five continents and many of the world's islands have been searched and mined. The airplane, helicopter, four-wheel-drive automobile, and the shallow-draft motorboat have opened the wilderness and made it easy of access. Scarcely any virgin land or unexplored areas where gold might be found remain, except the sea floor, and it is receiving increasing attention. Gold never was plentiful in the past nor is it plentiful today.

The scarcity of gold is a continuing fact which the monetary authorities refuse to recognize. In spite of statements to the contrary, the world has never suffered from a surplus of gold, even when the discovery of great bonanzas doubled the gold stocks.

Discoveries and Production

Gold is not linked to supply and demand the way most metals are. The supply is limited and the demand unlimited. Gold production rises and falls in a series of irregular waves, depending upon the discovery of new deposits. This is a matter of historical record. If the production of the important individual gold-mining districts in the United States is plotted separately, the waves take shape and coincide with the ups and downs of the overall production. These waves are of variable magnitudes and are a function of the geology of the mining district and of the ore occurrence. The policy of gold miners is to get out the gold from a new discovery as rapidly as is consistent with maximum profit, and this policy governs production. ("What price gold," by Pierre R. Hines)

The Need for Gold

The intrinsic value of gold has always been recognized, even before gold was used in coinage, and it remains the only universally recognized standard of value in international monetary exchange. Most of the world's refined gold is absorbed by governments and central banks to provide stability for paper currency, but the amount of gold used in the arts and industry is increasing. In addition to its use for jewelry, decorative finishes, and dentistry, its special properties have led to numerous applications in modern science and technology. Surface coatings of gold protect earth satellites from heat and corrosion, and certain electrical components and circuits of spacecraft are made of gold when extreme reliability is required.

Effect of Price Controls

In the United States, the Federal Government has long controlled the price of gold -- first by establishing its coinage value and then, in 1934, by withdrawing it from circulation as a medium of exchange and eliminating the right of citizens to buy or sell refined gold without a license.

In 1792 the U.S. Treasury price for gold was set at $19.39 per ounce. In 1834 it was raised to $20.69 and three years later it was lowered slightly to $20.67, where it remained for nearly 100 years. In 1934 various government decrees and legislation led to the establishment of a price of $35.00 per ounce. As a result of the 1934 legislation, gold was withdrawn from circulation in the U.S. and it has since been unlawful for any unlicensed person or group to buy, sell, or transport gold except in its natural state.

The depression of the 1930's and the increase in the price of gold to $35 resulted in a peak output of 4.9 million ounces of gold for the U.S. in 1940. At the beginning of World War II, however, production began to decrease because of high wages and scarcity of materials. In 1942, War Production Board Order L-208 forced all gold mines to close. Although L-208 was rescinded in 1945, most of the mines that had been productive in pre-war years could not reopen. The fixed price of gold, the high cost of materials and labor, and the prohibitive expense of rehabilitating plants and workings that had lain idle were the immediate reasons. Marginal gold mining firms that did open up went out of business eventually because of the rising costs in labor, supplies, equipment, capital, management, and taxation.

Meanwhile, the needs of the industrial sector were increasing. In 1971, industrial consumption of gold in the U.S. was up an estimated 10 per cent over the previous year. Nearly 7 million ounces of gold were imported into the U.S. in 1971 while less than 1.5 million ounces were produced in the U.S.

Soaring prices of gold on the free world market have stirred up considerable interest among prospectors and mining companies. However, it is believed by those experienced in the mining field that significant increases in production cannot be achieved unless the free market price exceeds $100 per ounce and remains at that price.

* * * * *

Generalized Map of Placer Mining Areas in Oregon

The Armstrong nugget, found in 1913 in a placer mine near Susanville, Grant County, Oregon, weighs 80.4 ounces. As a nugget it is worth many times the value of the metal. Scale is in inches.

Gold and the International Monetary System

by Ted E. Slanker, Jr., T. E. Slanker Co., Portland

The international monetary crisis has gripped the jugular of the business world and thrown the politicians, bankers, economists, and speculators into a state of confusion.

One constantly hears these questions:

Why did the currency system break down?

Have the recently made changes solved the problem for the long term?

Has gold moved into greater or lesser importance?

Where will we go from here?

This article will attempt to answer these questions, place the monetary muddle into its proper perspective, and gaze into the future and attempt to pick out tomorrow's trend.

Why?

Money and credit is the medium which business must have to efficiently trade its products. Either man trades on the simultaneous exchange of goods or money, or he depends upon the integrity of the other party to return equal value in the future on the receipt of goods today.

Real money is a direct extension of virtually any part of the commodity system. Historically, this extension is an element from the metals group and most commonly it is gold.

Credit consists of any promissory note and, in some cases, just a verbal declaration.

For a currency (credit) structure to be valid, it must be secured by a reserve asset not only to define the currency instrument but to limit the growth of the credit structure. Under a gold standard, the currency in circulation is backed in two ways: 1) Gold is held as a reserve to redeem the currency on demand in order not only to define the currency, but to limit the quantity that can be issued; 2) The currency can be created only when gold is deposited in the reserve or when secured by good inventory loans.

In today's world, most countries, including the U.S., have reserve bases to support their currencies which consist of some gold and large volumes of credit instruments. In other words, most of the free world countries have based their currency systems on foreign currencies and the debt obligations of their own or other governments.

The failure of the currency system is occurring because man has forgotten the basic principles of money and credit. He has come to the belief that the credit system can be fine tuned to provide for perpetual prosperity. This is a myth! No "politician" has ever lived who had the courage to discipline the structure in order to make it work. Many politicians have made attempts toward discipline but they or their successors have never followed through. It is this human element which continues to unwind all of the good intentions of today's romantic economists.

Even in the present world credit structure, inflation is still being defined by Webster's dictionary as the excessive creation of credit in relation to the creation of goods. Since 1914, the supply of currency and bank demand deposits in the U.S. have been growing substantially faster than industrial production. (It has been growing twice as fast since 1967 alone.) This has been due to the Federal Reserve Board creating deposits to purchase government bonds and the relaxing of reserve requirements to allow credit instruments to act as reserves for the issuance of more credit in the domestic banking system.

Therefore, the value of the currency must decline in relation to the value of goods and in the process the holder of credit instruments of the U.S. is being cheated by the loss in their purchasing power.

The foregoing is the basis behind the continual monetary crisis the world has been witnessing for the past 16 years.

Solutions?

The recent suggestions offered by the members of the International Monetary Fund (IMF) to stabilize the crisis are: to align the currencies (devalue the dollar in relation to other currencies of the world); to have a joint float of a block of European currencies against the dollar and other currencies of the world; and to put greater emphasis on replacing dollars as reserves in the system with additional issues of the Special Drawing Rights. (SDR's are credit instruments issued by the IMF).

Not one of these suggestions grapple with the basic causes for the breakdown of the system. In fact, due to the floating nature of the system, roots have been planted for an acceleration of the basic cause for further breakdown. When one currency floats against another, the country which refrains from inflating will be the most competitive and therefore its currency will appreciate in value, thus putting its industry in a non-competitive position. Therefore, for the sake of business and full employment, the major nations of the world will try to inflate at a rate equal to the fastest inflating rate of its major trading partners. This could lead to world-wide hyperinflation.

The trend toward currency breakdown will be further emphasized by the suggestion to increase SDR's. This is just a continuation of the present trend to have reserves consisting of credit and will also lead to more inflating.

Gold?

Gold has made big headlines recently with its meteoric rise from $60 to the $90 per ounce level in just the last few weeks. Many people have claimed that gold is returning to its rightful place as the only reserve asset of the international monetary system. In other words, a return to convertibility of currency into gold could be at hand.

But will our present type of government, which has fought gold and discipline since 1932, welcome its return? Probably not, for politicians want to control the expansion and contraction of currency to manipulate our financial destiny. No evidence exists that politicians are ready to give up control of the credit system without a desperate fight.

The current appreciation in the price of gold is not due to a return to gold as an official standard of value but as a barometer reflecting the rise and fall in the level of confidence the citizens of the world have for the paper currency system. Thus, the role of gold, while actually lessening officially, is in an unofficial capacity gaining more new admirers daily.

Future?

The future should bring a continuation of the past trend of government manipulation but in a much more amplified tone. The governments will continue to cycle from contraction to expansion of the credit structure in order to control the course of business, employment, and prosperity. But due to the incredible overextension of debt presently existing in the system, the government will find that its options are few because any slight slowdown may precipitate a crushing depression, while a continuation of credit expansion threatens to become a hyperinflationary spiral.

The die is cast. The world is on a one-way street to a monetary hell. Unless there is a miraculous return to reality by the politicians, economists, and bankers, the role of gold and the honest extension of credit will not come until the present system has run its course to complete destruction.

* * * * *

Current Gold Problem Reviewed*

by D. H. McLaughlin, Chairman of Executive Committee
Homestake Mining Company

Gold is an important part of the monetary reserves of every country. Until 1971 the United States stood by its obligation to redeem dollars held by foreign central banks in gold at the then official rate of $35 per ounce. By that time, however, claims in dollars in foreign hands had amounted to $60 to $70 billion and the gold stock pledged to their redemption had declined to less than $9 billion, making it apparent that the United States could not meet its obligation to pay its creditors in gold. Consequently, in August 1971 the gold window was shut. This unavoidable move was not

* Reprinted from American Gold News, v. 40, no. 3, April 1973

unlike a declaration of bankruptcy. The dollar, though still defined in gold, could no longer be converted into gold, even by foreign banks. Citizens in the United States, of course, have not had the right to redeem their dollars in gold or even to own gold since 1934.

The demand for gold that determines its worth arises from: 1) its qualities that make it uniquely valuable for many special purposes, 2) its function as a means of storing wealth, and 3) its worldwide acceptance as the basic money commodity.

The amount of gold needed each year to meet the first two demands is now approximately equal to the entire current production from the mines of the non-communist world (i.e., about 40 million ounces). Under present conditions, practically no new gold is going into the monetary reserves.

In the United States, the consumption of gold for industrial and similar non-monetary purposes is nearly four times the production from domestic mines (about 1.7 million ounces). The balance has to be imported, thereby adding something over $486,000,000 at today's price of gold to the deficit in our balance of payments.

With the repudiation of the obligation to redeem dollars in gold, the dollar become simply another fiat currency -- i.e., a currency or paper money that has no gold backing and derives its value as money from the edict of a government or international agencies that it must be accepted by its citizens in payment of debt. Our green-backs used to have a statement on them that they were redeemable in lawful money, which by definition would be gold. Those now issued state only that "This note is legal tender for all debts public or private."

Gold alone now commands worldwide confidence as money, which is revealed by the tenacity with which all governments hold onto their gold reserves and endeavor to meet their obligations in currencies or some related device. This behavior is in accord with Gresham's Law--viz, bad money drives good money out of circulation.

The world is not likely to regain sound money again until the dollar and other currencies are redefined in gold and made convertible into gold. This cannot be done with gold at $35 per ounce or $42.22 per ounce, the present official price. It would require a reduction of the gold content of the dollar to at least one third of that in 1934, which would mean a so-called price of gold at $105. This would just about match the depreciation of the dollar that has occurred in the last forty years.

With inflation continuing on a worldwide basis, any delay will make it necessary to put the "price" of gold still higher. $105 per ounce may already be too low.

With such a write-up in the value of gold in the monetary reserves, it would be possible to re-establish convertibility of the dollar into gold and to offer to redeem in gold a significant part of the huge overhang of dollars that now menaces the monetary system of the world. Utilization of this write-up in value of gold reserves to redeem debt would keep this move from being inflationary -- and, on the other hand, the increase in liquidity would make it possible to initiate steps to check inflation without creating a depression and unemployment on such a scale as to be socially and politically disastrous.

A bold revaluation of gold -- or in other words, a devaluation of the dollar in terms of gold -- may well be the only means our country has of checking inflation without a depression.

The market -- restricted as it is -- has already demonstrated that gold, quite apart from its monetary function, commands a substantial price. If its monetary value were re-established at a much higher level in terms of the dollar -- and the dollar made convertible -- this would amount to fixing the price for all uses of gold at the new monetary rate. An official monetary price far below the market rate is meaningless, except possibly as an artificial basis for comparison of currencies, but there will be no transactions in gold at such levels. At a properly high monetary price with governments ready to buy and sell at this rate, economies in the non-monetary use of gold would result, some gold would move out of private stock into monetary reserves, and production from mines would gradually be stimulated as existing operations were enlarged and exploration for new deposits was undertaken more intensely. With the "price" right, there would be enough gold to augment official reserves at a rate adequate to provide the world with the monetary liquidity needed for growth.

* * * * *

Government Regulations On Gold

The Department of Geology and Mineral Industries continually receives inquiries about gold regulations. The following summary of U.S. Treasury regulations, supplied by the Arizona Department of Mineral Resources, is here presented to explain the often misunderstood rules.

1. Gold may be bought and sold at any price agreed upon between the buyer and seller (usually the free market value for refined gold) provided the buyer and seller meet certain legal requirements, outlined below.
2. The United States Mint no longer buys gold (by amendment to Gold Regulations, March 17, 1968).
3. Gold may be mined without a Treasury Department license.
4. "Gold in its natural state" is defined in the Treasury Gold Regulations as being gold recovered from natural sources, which has not been melted, smelted or refined, or otherwise treated by heating or by a chemical or electrical process. Gold in its natural state may be held, purchased, sold and transported without a Treasury license regardless of the amount.
5. Gold amalgam results from the addition of mercury to gold in its natural

state for the purpose of recovering the gold. Gold amalgam produced from domestic sources may be dealt with in the same manner as gold in its natural state. In addition, gold amalgam may be heated to a temperature sufficient to separate the mercury from the gold (but not to the melting temperature of the gold), producing a material known as retort sponge, without a license by the person who recovered the gold from natural deposits in the United States.

6. Gold in its natural state and gold amalgam may not be melted, smelted, leached or refined or otherwise treated by heating or by a chemical or electrical process except for the heating of amalgam as explained above, without a Treasury Department license regardless of the quantity.
7. Up to 200 fine troy ounces of retort sponge (amalgam cake) resulting from the heating of amalgam may be held and transported by the person who mined or panned the gold, without a license. Retort sponge produced by a miner or panner may be sold to a person holding a Treasury Department license authorizing the purchase of such gold or to an unlicensed person, provided such unlicensed person does not hold at any one time over 200 fine troy ounces of gold.
8. Persons other than the miner or panner who acquire retort sponge may sell the gold only to the holder of a Treasury Department license. An unlicensed person may not retort gold purchased by him from miners or other persons.
9. Gold in a melted or treated form (except gold amalgam and retort sponge) may be sold or disposed of only by persons and concerns operating under a Treasury gold license authorizing the disposition of gold in such form.
10. Any person regularly engaged in an industry, profession, or art, who requires gold for legitimate, customary and ordinary use may, without a Treasury license, acquire gold in any form from any person authorized to hold and dispose of gold, hold, transport, melt and treat such gold and furnish melted and/or unmelted scrap to licensed scrap handlers. The maximum quantity of gold that can be so held or processed is limited to 50 fine troy ounces at any one time and 350 fine troy ounces in any one month. The Treasury gold regulations exclude the miner and panner from those persons who are regularly engaged in an industry, profession, art, etc., unless that person is the same person who produces the final industrial, professional, or art object. Example: a gold jeweler can mine and refine gold and construct gold jewelry without a license subject to the above mentioned quantities.

Additional regulations cover gold coins, gold certificates, speculative gold markets, gold securities and gold art objects.

Gold Mining in Oregon

Shortly after the discovery of gold in California in 1848, rich deposits were found at several places in southwestern and northeastern Oregon. The impact of these discoveries on the state was immediate and profound. Prior to the discovery of gold, the state lacked two necessary ingredients for development -- an abundance of wealth and an infusion of settlers who could be gainfully employed in large numbers. Gold mining stimulated every level of business activity, from basic farming to lumbering and transportation. The gold "rush" in Oregon never reached the great intensity of that in California, which in eight years established that state in a dominant position still retained today. Oregon's gold rush quickly became a way of life for many Oregonians in the southwestern counties of Jackson, Josephine, Coos, Curry, and Douglas, and the northeastern counties of Baker, Grant, Malheur, Union and Wallowa. This pattern persisted for nearly 90 years until it was extinguished by wartime directive in 1942. Since that time, gold mining has steadily waned as a commercial activity, and the fortunes of these two areas of the state have likewise suffered.

The discovery of gold in Oregon brought the first semblance of law and order to hitherto rough outposts of civilization. Each mining camp, through sheer necessity, quickly established its own laws and enforced them with alacrity. Water was vital to gold mining and water laws largely stem from those established in the early mining camps. The "miners inch," a unit for measuring flowing water in ditches and flumes, is still in use and mining districts created in the nineteenth century are still in existence in the twentieth. Along with the need for laws came the desire for culture and every mining camp worthy of the name had its opera house and knew the great and near great of the theater and entertainment world.

At first, all of the gold found in Oregon came from the stream beds. Later rich deposits of gold and platinum were found in the beach sands along the southern Oregon Coast. Eventually the gold placers were largely exhausted and miners traced the gold to outcrops in the hills. Underground mining gave the state a second economic shot in the arm, since this type of mining required vast economic expenditures in the form of shafts and tunnels, concentrating mills and smelters, and in many cases the construction of complete towns.

Today the gold camps have all but disappeared and the mines are idle. Until very recently the price for gold was far too low to generate any real interest by mining companies which, having been shut down during World War II, moved on to other fields as the cost of doing business climbed but the price of gold remained fixed by government order. It is too early to accurately assess what the high price of gold will do to the gold mining industry. It is quite possible that some old mines will be reopened and exploration for new ones will be conducted. The industry is greatly concerned over environmental considerations and the restrictions that have been

This bucket line gold dredge mined gravels along the John Day River between the towns of John Day and Mount Vernon from 1937 to 1942.

Old wooden water wheel on Salmon Creek in Baker County was used to power the Dixon gold arrastra in the early days of gold mining.

imposed by state and federal agencies. The easily mined gold has been largely worked out. New mines will be hard to find and costly to outfit and operate. Many companies have found it to be more rewarding to operate in foreign, undeveloped countries where the need for capital and job opportunities overshadows other considerations.

Quite apart from the commercial aspects of gold mining is the rapidly expanding interest by the general public in recreational gold panning and nugget hunting. Oregon has a wide variety of places where gold can be recovered in small amounts if large amounts of effort are expended. Gold has a peculiar allure for nearly everyone and the hope of finding some is strong. There is always the hope that one might just strike it rich, since great wealth can be found if one is only lucky.

Questions and Answers for the Weekend Gold Miner

For many people in Oregon, gold mining has become a recreational pursuit to be enjoyed on weekends and vacations. Answers to questions most frequently asked of the Department by "weekend miners" are given below.

The Department maintains offices at 1400 S.W. 5th Avenue, Portland, and field offices at 521 N.E. "E" Street, Grants Pass, and 2033 First Street, Baker. You are invited to visit the field offices to obtain detailed information on local gold diggings. Geologic maps, topographic maps, and a wide variety of bulletins are sold at all three of the Department's offices.

1. <u>Where can I look for placer gold?</u> The southwestern and northeastern corners of the State are the best, although other minor areas have some possibilities. Much of the land in these two areas is public domain and can be entered freely. The publications listed below under item no. 7 will be very helpful.
2. <u>How do I learn to use a gold pan?</u> Detailed directions are given in the Department's publication "Oregon's Gold Placers," which sells for 25 cents.
3. <u>Where can I get information on skin diving for gold?</u> Information on equipment for mining, regulations, safety factors, and where to look are given in the Department's publication "Skin Diving for Gold," which sells for 25 cents.
4. <u>What are the rules and regulations for gold placers?</u> The Department has available a short summary of mining law and also sells copies of the State Mining Code for $1.25; the U.S. Bureau of Land Management distributes without charge "Staking a Mining Claim on Federal Lands." Most gold panners, however, are not interested in locating a mining claim and desire only to do some recreational panning at varied places. No permits are required and unless you unduly muddy the waters in a stream there will be no problems. Care must be taken

not to trespass on valid mining claims or private property. Good outdoor manners and a concern for the environment are essential.

5. Suppose I find some gold, what then? Placer gold is yours to keep, give away, or sell. There is no limit to the amount, but it must not be melted down (see section on "Where to Sell Gold").
6. Where can I get my samples assayed for gold? The State Department of Geology and Mineral Industries has an assay service at its Portland headquarters. Samples of black sand concentrates, raw bank run sand and gravel, or ore specimens should weigh at least one pound for best results. The charge for assaying a sample for gold and silver is $4.00 (payment must accompany the samples). There is no charge for identifying rocks and minerals unless special tests are required. Simple tests for gold are contained in "Oregon's Gold Placers" listed below.
7. Where can I get information on old gold mines and maps of gold producing areas? Here are some selected Department publications:

Gold and Silver in Oregon, a 337-page bulletin plus maps	$5.00
Oregon's Gold Placers, 14 pages	0.25
Oregon Mineral Deposits Map and Key, 18 pages plus map	0.45
Detailed topographic maps, 1"= 1 mi., most areas available	1.00

(See also Suggested References below)

Where to Sell Your Gold

1. Raw placer gold may be sold to any willing buyer at an agreed upon price. Placer gold, if in large flakes or nuggets, usually commands a premium price, depending on size. Rock shops and manufacturing jewelers buy placer gold. Telephone directory "yellow pages" often list gold, silver, and platinum buyers.
2. Gold amalgam, or the "sponge" remaining after the mercury has been removed by retorting, is normally salable to some person or firm possessing a gold buyer's license.
3. Gold ore from quartz mines must be sent to a smelter for treatment. Smelters pay for all metals specified in their schedule. Smelter charges and freight are deducted from payments.
4. Gold jewelry and other objects containing gold, if melted down, must be sold to persons or firms possessing a gold buyer's license. Gold in this form is often heavily discounted by the buyer.
5. Gold is no longer purchased by the U.S. Mint.

Suggested References

Basic placer mining, Calif. Division of Mines, Mineral Information Service, Dec. 1963.

The elephant as they saw it (history of Calif. gold rush, contemporary writings) E. L. Egenhoff, assembler, Calif. Division of Mines, 1949.

Exploration and development of small mines, Arizona Bur. Mines, Bull. 164, 1966. $.25

Geology of placer deposits, Olaf P. Jenkins, Calif. Div. Mines, Mineral Information Service, Jan., Feb., Mar., April, May, June, Aug., Sept. 1964. (excellent set of articles)

Gold and money session, 1960 Pacific Northwest Metals and Minerals Conf., Amer. Inst. Mining, Metal. and Petrol. Eng., 57 p. [out of print]

Gold and money session, 1963 Pacific Northwest Metals and Minerals Conf., 52 p. $2.00 [for sale by the Department]

Gold and money session, 1967, Pacific Northwest Metals and Minerals Conf., 76 p. $2.00 [for sale by the Department]

Gold and Oregon's settlement, Helen B. Rand, The ORE BIN, v. 21, no. 5, May 1959. [out of print]

Gold and silver, in Mineral and water resources of Oregon, Oregon Dept. Geol. and Mineral Indus., Bull. 64, 1968. $1.50

Gold and silver in Oregon, H. C. Brooks and Len Ramp, Oregon Dept. Geol. and Mineral Indus., Bull. 61, 337 p., illus., maps, 1968. $5.00

Golden years of eastern Oregon, Miles Potter and Harold McCall, The ORE Bin, v. 30, no. 6, 14 p., June 1968. [out of print]

Gold placer mining in southwestern Oregon, Len Ramp, The ORE BIN, v. 22, no. 8, 5 p., Aug. 1960. $.25

Highlights in the history of gold production in the United States, Pierre R. Hines, The ORE BIN, v. 21, no. 4, 6 p., April 1959. $.25

Lest we forget (history of gold mining in southwest Oregon), F. W. Libbey, The ORE BIN, v. 25, no. 6, 17 p., June 1963. $.25

Operating ideas for small mines, Montana Bur. Mines and Geol., Misc. Contr. 14, 1956. $1.00

Oregon's gold placers, Oregon Dept. Geol. and Mineral Indus., Misc. Paper 5, reprinted 1973, 14 p. $.25

Oregon State Mining Code (copy of pertinent sections of Oregon Revised Statutes) 12 p. $1.25

Prospecting and developing a small mine, Idaho Bur. Mines and Geol., Bull. 20, 1961. $1.00

Skin diving for gold, R. S. Mason, The ORE BIN, v. 23, no. 4, 7 p., April 1961. $.25

Timbering and support for underground workings for small mines, Idaho Bur. Mines and Geol., Bull. 21, 1962. $1.00

U.S. Geological Survey Information Office, Washington 20242, has following brochures for distribution without charge:

Gold   Prospecting for gold   Suggestions for prospectors

What price gold?, Pierre R. Hines, The ORE BIN, v. 28, no. 2, 23 p., Feb. 1966. $.25

* * * * *

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-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 suppl.) geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin	3.00
36.	Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 1 $1.00; vol. 2	1.25
39.	Geology and mineralization of Morning mine region, 1948: Allen and Thayer	1.00
46.	Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	3.50
57.	Lunar Geological Field Conf. guidebook, 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 Tualatin Valley region, 1967: Schlicker and Deacon	5.00
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	5.00
62.	Andesite Conference Guidebook, 1968: Dole	3.50
64.	Geology, mineral, and water resources of Oregon, 1969	1.50
66.	Geology, mineral resources of Klamath & Lake counties, 1970: Peterson & McIntyre	3.75
67.	Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts	2.00
68.	The Seventeenth Biennial Report of the State Geologist, 1968-1970	1.00
69.	Geology of the Southwestern Oregon Coast, 1971: Dott	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
72.	Geology of Mitchell Quadrangle, Wheeler County, 1972: Oles and Enlows	3.00
73.	Geologic formations of Eastern Oregon, 1972: Beaulieu	2.00
74.	Geology of coastal region, Tillamook Clatsop Counties, 1972: Schlicker & others	7.50
75.	Geology, mineral resources of Douglas County, 1972: Ramp	3.00
76.	Eighteenth Biennial Report of the Department, 1970-1972	1.00
77.	Geologic field trips in northern Oregon and southern Washington, 1973	5.00
78.	Bibliography (5th suppl.) geology and mineral industries, 1973: Roberts, et al.	in press

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck	2.15
Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bulletin 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 portion of High Cascade Mtns., 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 and others	1.50
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka	1.50
GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: Berg and others [sold only in set] Flat $2.00; folded in envelope	2.25
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess	1.50

OIL AND GAS INVESTIGATIONS SERIES

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2.	Subsurface geology, lower Columbia and Willamette basins, 1969: Newton	2.50

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24. The Almeda mine, Josephine County, Oregon, 1967: Libbey 2.00

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
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
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11. A collection of articles on meteorites, 1968, (reprints, The ORE BIN) 1.00
12. Index to published geologic mapping in Oregon, 1968: Corcoran. 25
13. Index to The ORE BIN, 1950-1969, 1970: Lewis 0.30
14. Thermal springs and wells, 1970: Bowen and Peterson 1.00
15. Quicksilver deposits in Oregon, 1971: Brooks 1.00

MISCELLANEOUS PUBLICATIONS

Landforms of Oregon: a physiographic sketch (17" x 22"), 1941 . . . . 0.25
Geologic time chart for Oregon, 1961 . . . . Free
Postcard - geology of Oregon, in color . . . . 10¢ each; 3 - 25¢; 7 - 50¢; 15 - 1.00

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The Ore Bin

COASTAL
SAND DUNES
ISSUE

Vol. 35, No. 5
May 1973

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

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Available back issues $.25 each

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The ORE BIN
Volume 35, No. 5
May 1973

OREGON COASTAL DUNES
BETWEEN COOS BAY AND SEA LION POINT

Ernest H. Lund
Department of Geology, University of Oregon

Sand dunes that have formed since the end of the Ice Age, or within the last 10-15 thousand years, occupy approximately 140 of Oregon's 310 miles of coast. Dune areas vary in size from small patches a few hundred feet across to stretches tens of miles long. With the exception of Curry County south of Port Orford, dunes are a common landform along the Oregon coast.

Older dunes that were formed during the Pleistocene Epoch are now perched on Pleistocene marine terraces well above sea level. The original form of these dunes has been destroyed by erosion, and a soil layer that has developed on the sand supports a forest of large trees and dense brush; hence, this ancient dune terrain is not recognizable by surface configuration. The sand can be identified, however, by its soil zone and its cross-stratification, visible in many roadcuts along the coast highway.

This study is concerned with the post-Ice Age (Holocene) dunes in the coast segment between Coos Bay on the south and Sea Lion Point on the north (see accompanying maps). This is the longest strip of dunes along the Oregon coast and extends for a distance of about 55 miles. It is divided into three segments by the Siuslaw and Umpqua Rivers and is interrupted by numerous smaller streams that cross it. The strip has a maximum width of nearly 3 miles at Florence. At places it narrows to less than half a mile, but most of it is more than 2 miles wide. The area where the dunes attain their greatest size, abundance, and variety has been designated the Oregon Dunes National Recreational Area, an administrative division of the Siuslaw National Forest.

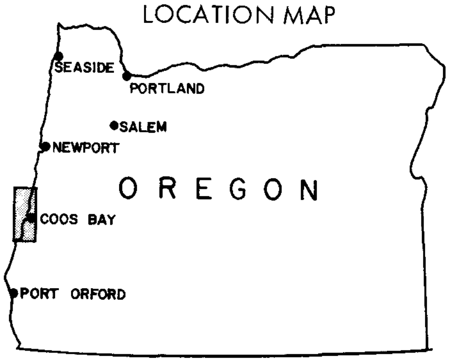
A definitive study of this dune strip was made by Cooper (1958) in his investigation of the coastal dunes of Oregon and Washington, and his work was a useful guide in the preparation of this article. The writer is grateful to Wilbur Ternyik, Chairman of the Oregon Coastal Conservation and Development Committee, for helpful information about the dunes and changes in the dune belt and to John Czemerys, Recreational Assistant, and Ed Whitmore, Planning Leader, of the Oregon Dunes National Recreational Area, who made aerial photographs of the Area available for study and offered helpful information about the dunes.

OREGON COASTAL DUNES BETWEEN

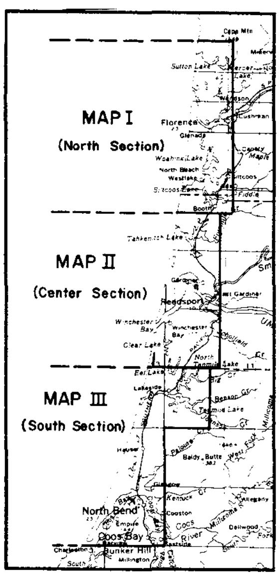
COOS BAY AND SEA LION POINT

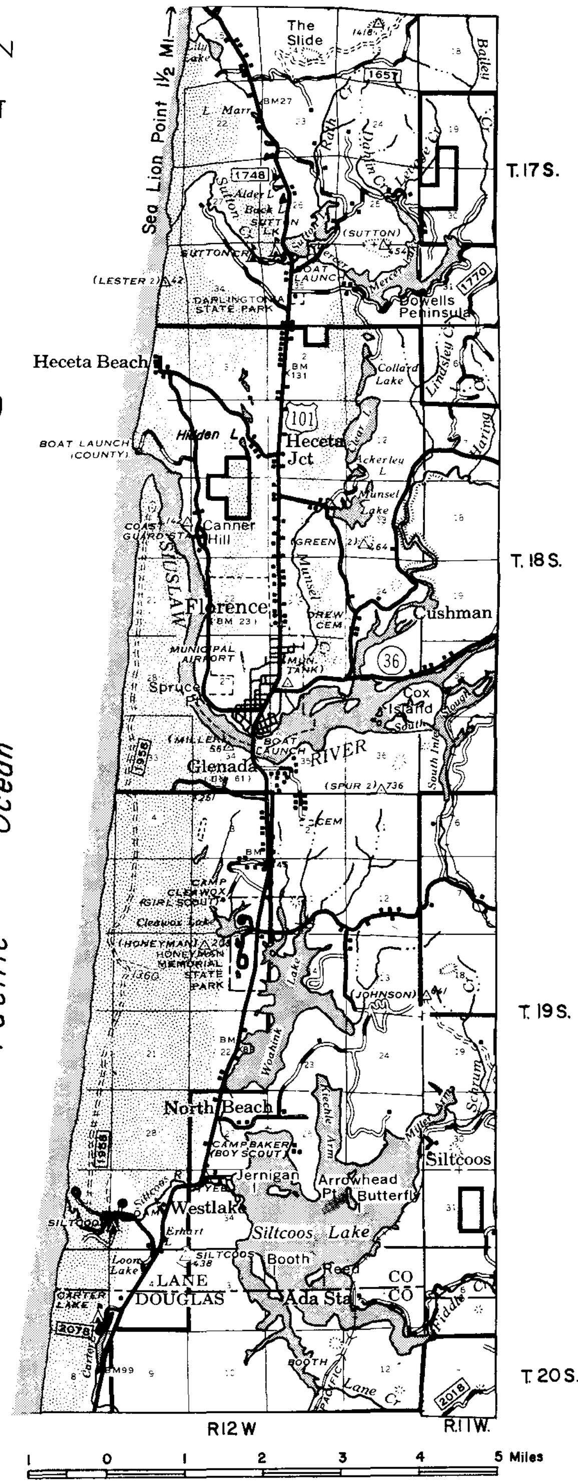
MAP I. NORTH SECTION

LOCATION MAP



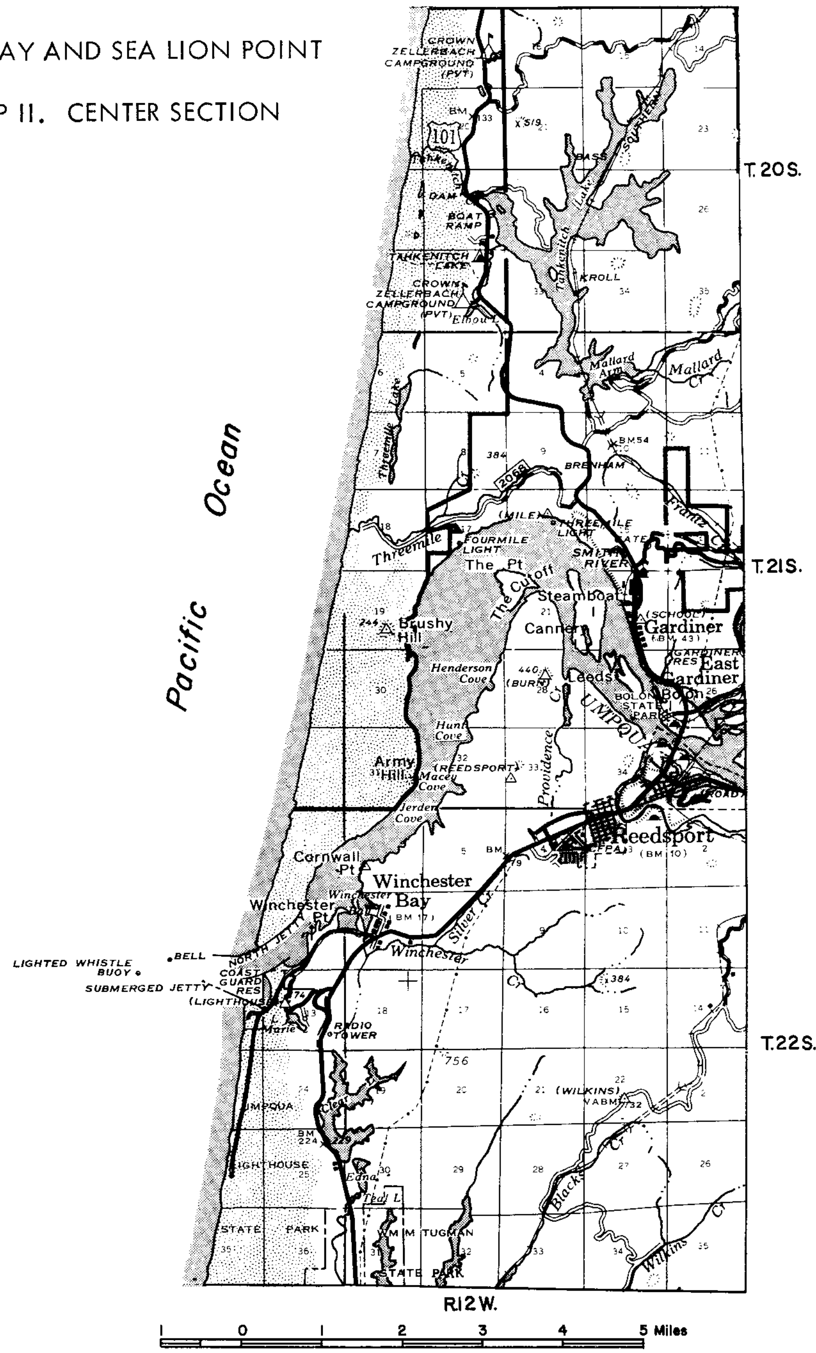
INDEX MAP





OREGON COASTAL DUNES BETWEEN COOS BAY AND SEA LION POINT

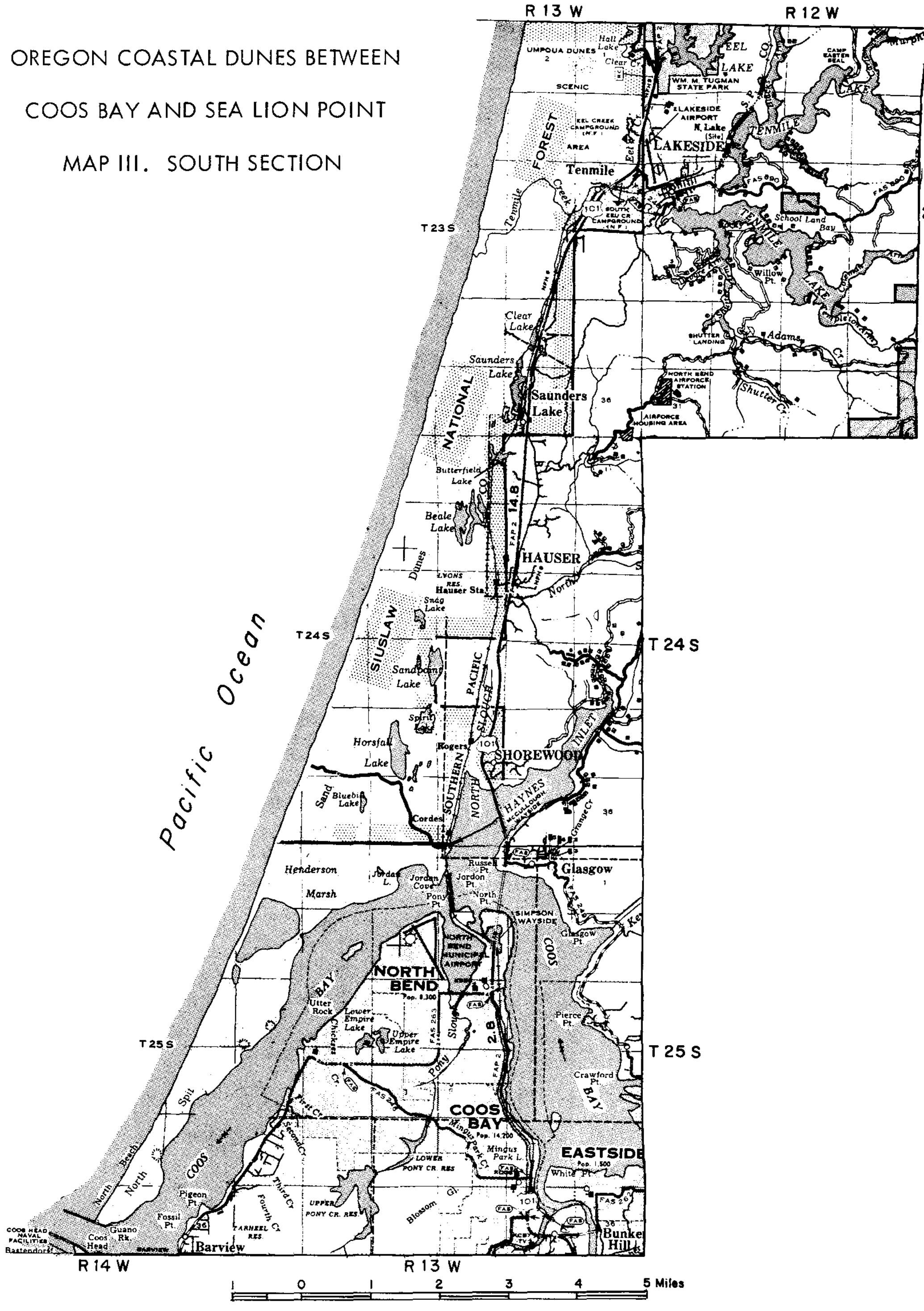
MAP II. CENTER SECTION



OREGON COASTAL DUNES BETWEEN

COOS BAY AND SEA LION POINT

MAP III. SOUTH SECTION



Conditions and Setting

The essential ingredients in dune formation are abundant loose sand, wind, and a favorable terrain. Other factors that play significant roles in the dune-forming processes are water and vegetation. To the extent that his activities affect the dune setting, man also has an influence on these processes.

Sand

The immediate source of sand for the coastal dunes is the beach, and the beach, in turn, receives its supply from the currents that move along the shore. These currents, that flow northward in winter and southward in summer, acquire their sand load by direct erosion along the shore and from sediment transported to the shore by streams. An ample supply of sand for dune building is available along the coast, and wherever the terrain is receptive to wind-blown sand, dunes have formed.

Wind

Winds along the Oregon coast have marked seasonal changes. The strongest summer winds come principally out of the sector between north and northwest; the strongest winter winds come from directions between south and southwest. Fall and spring are transitional periods when the wind comes from both southerly and northerly directions.

No quantitative data are available on which to base a comparison of the effectiveness of the summer and winter winds in moving sand. Cooper (p. 54), however, by applying the principle of parallelogram of forces in which mean winter and summer wind directions and velocities of 16 miles per hour and greater are the force vectors, concludes, "...the competency of the summer wind in transport of sand is thus about twice that of the winter wind." Conversely, Ternyik (oral communication) and others who have observed the dunes over a period of years believe that more sand is moved by southerly winds than by those out of the north. The writer favors the latter view, that winds from the south are the more effective and bases his opinion partly on the shape of the large dune ridges. These ridges are asymmetrical (Figure 1), with the steeper slope on the north side, and characteristically the steeper slope of a dune ridge is on the leeward side. If the gross form of the dune is determined by the southerly winds, the conclusion is drawn that they also move the greatest amount of sand. The southerly winds have the advantage of more time, for the period of south and southwest winter winds is considerably longer than the period of north to northwest summer winds. Further, the winter storms are of longer duration and their winds reach higher velocities.

Figure 1. Oblique dune ridges south of the Umpqua River. Black patches in the dune area are remnants of older, forest-covered dunes. Tenmile Lake is in the upper left-hand corner of the photograph. View is to the south. (Oregon State Highway Div. photo)

Figure 2. Oblique dune ridges and Cleawox Lake south of the Siuslaw River. Small, dark areas on the dunes are patches of wet sand. (Oregon State Highway Div. photo)

Terrain

A favorable terrain for dune formation is one that permits the movement of sand, ideally over a level surface; vertical surfaces are prohibitive. Some surface irregularity is tolerable, for if the sand can move around obstacles it will eventually create its own surface by deposition and adjustment of slopes to local wind conditions. Much of the Oregon coast is not receptive to dune formation because it is bounded by sea cliffs composed of basalt or other hard rock masses. Where the coast is most receptive, the bedrock along it is composed of easily eroded sedimentary material.

During periods of higher sea level in the Pleistocene Epoch, indentations were formed in the coastline along areas of sedimentary bedrock, and a wave-cut platform or bench was eroded on the rock. A thin layer of sediment was deposited over the platform, and subsequent changes in sea level allowed these areas to be exposed as low, narrow coastal plains that sloped gently from the upland front to the sea's edge.

The lowland strip of coast between Sea Lion Point and Coos Bay is underlain along most of its length by the Eocene Tyee Formation, a sandstone. At the southern end, similar but somewhat younger rocks of the Coaledo Formation make up the bedrock. Bedrock is exposed in roadcuts where U.S. Highway 101 turns inland and passes over a hilly terrain between Tahkenitch Lake on the north and Clear Lake, south of Winchester Bay, on the south. Bedrock crops out in a single known shore locality near the base of the peninsula north of Winchester Bay.

The dune belt occupies most of this low coastal region. Landward the dunes lap onto terrace deposits and older dune sands. In places where the terrace is missing, they lap onto Tertiary bedrock. The coast highway is on the Pleistocene terrace and follows along the edge of the dune belt almost continuously from Honeyman State Park to Tahkenitch Lake.

Water and vegetation

Water and vegetation reduce the rate at which sand shifts about. In summer, a thin outer layer of dry sand covers the dune, but windstorms may lay bare wet sand on the windward side of the dunes and in interdune valleys (Figures 2, 8). In winter, most of the sand movement is over a moist surface; cohesion between grains on a wet surface greatly reduces the erosion effect of the wind, but unless the sand is completely saturated with water, particles will be jarred loose and a sheet of sand set in motion over the surface. The wet sand lends itself to wind-sculpturing into weird and interesting forms.

Where deflation (removal of loose particles by wind) lowers the land surface to the summer ground-water level, erosion stops and vegetation soon moves in (Figure 3). Among the first plants to get established on the deflation surface are the yellow monkey flower and marram grass, the beach grass

Figure 3. Vegetation encroaching on the deflation surface that lies along the active dunes south of the Siuslaw River. View is to the northeast.

Figure 4. Lobe on one of the oblique dunes near Cleawox Lake in Honeyman State Park. Marks of sand streams that have corrected an oversteepened summer slipface are visible. (Oregon State Highway Div. photo)

introduced from Europe to stabilize dunes on the West Coast. Where this happens along the western edge of the active dune belt, it usually marks the end of dune activity, and a plant succession begins that culminates in a conifer forest of shore pine and spruce.

Where stabilization is required, marram grass is planted because of its resistance to the abrasive effects of moving sand, ability to withstand burial, and high rate of reproduction. This grass survives and propagates itself so well it now grows profusely in dune areas all along the Oregon coast and has brought about marked changes in these areas.

Dune Forms

Oblique ridge

The dominant dune form of the area included in this study is the oblique ridge (Figure 1). It is a large northwest-trending, asymmetrical feature that lies at an angle to the shoreline and also to both the southwest winds of winter and the northwest winds of summer. In cross section, the steepest side is generally on the north, and, although the surface configuration changes from season to season, the ridge itself does not migrate. The oblique dunes create a pattern of more or less parallel ridges, and they occur in Oregon only in this segment of the coast.

The oblique dune ridges vary considerably in both height and length. They are largest and most numerous between the Siuslaw and Siltcoos Rivers and between the Umpqua River and Tenmile Creek, where they present an impressive expanse of bare, rolling terrain. The highest lie between the Umpqua River and Tenmile Creek; one is more than a mile long. Cooper reports the average length of ten major ones is 1250 meters (about eight-tenths of a mile) and the highest 112 meters (about 367 feet) above sea level and 56 meters (about 185 feet) above its base. Most ridges increase in height landward.

During the summer the northwest winds sweep sand up the north slope of the dune ridge without appreciably changing the slope angle. The sand moves over the crest, part of it accumulating on the slipface, a steep surface that is developed on the leeward side of the dune. A sharp break in the slope marks the upper edge of the slipface, and on many oblique dunes this coincides with the dune crest.

The rate of accumulation on the slipface is greatest along the upper edge, which causes oversteepening of the slope. This unstable condition is corrected from time to time by sand flowage, in which sand streams down the slope until the stable angle of repose (about 30° to 35°) is restored (Figure 4). Because this manner of slope adjustment is possible only when the sand is dry, it is mainly a summer phenomenon. The summer slipface may attain a height of 40 feet or more along the highest parts of the dunes. At the seaward ends, the oblique dune ridges merge with the transverse dunes described in the following section.

Figure 5. Slump area about 50 feet wide on leeward side of oblique dune west of Honeyman State Park. Slumping corrects oversteepened slopes in winter.

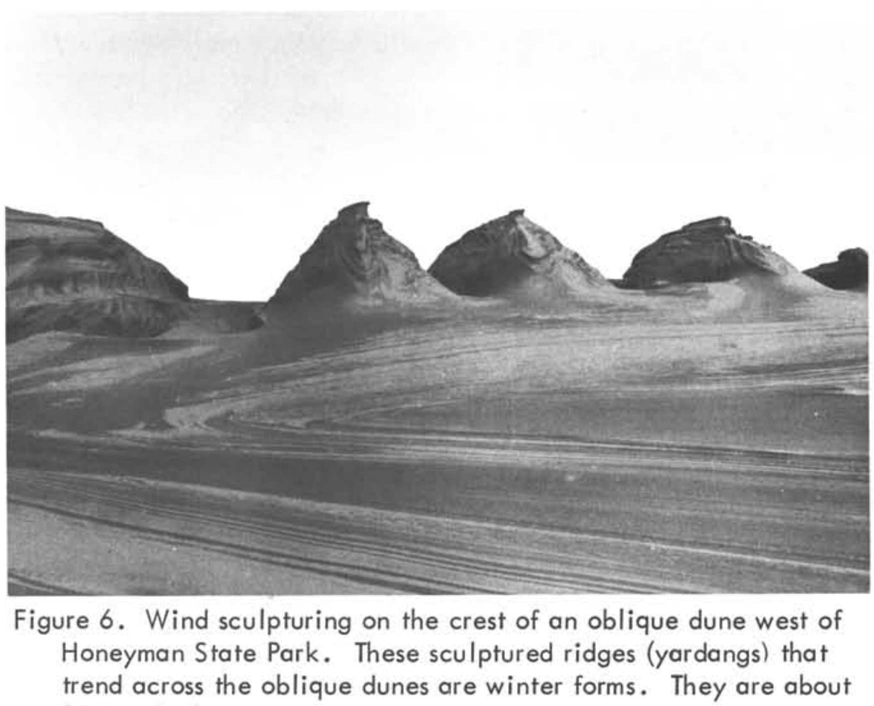


Figure 6. Wind sculpturing on the crest of an oblique dune west of Honeyman State Park. These sculptured ridges (yardangs) that trend across the oblique dunes are winter forms. They are about 15 feet high.

During the winter the slipface shifts to the north side of the dune. The summer accumulation on the south side is largely removed and transferred to the north side. This transfer of sand is well under way by mid-November. Adjustment of oversteepened slipfaces in winter is by a slumping action: a mass of sand breaks loose and moves slowly down the slope as a unit (Figure 5).

Winter wind erosion performs considerable sculpturing along the dune crest, and in places cuts the crest into short segments separated by troughs. These crest remnants, known as yardangs, reach heights as much as 15 feet above the bottom of the adjacent troughs (Figure 6). Sand removed between the yardangs accumulates in tongues downwind from the troughs, imparting an undulating pattern.

Because both the winter and summer winds have a landward component, the edge of the oblique dune system is migrating landward several feet a year by the accumulation of sand along a slope on the inner boundary of the active dune belt. Cooper applied the name "precipitation ridge" to this feature where sand is encroaching onto a forest (Figure 7). A precipitation ridge from an earlier dune-building episode lies just west of the highway along much of the distance between Woahink and Elbow Lakes, and active slipfaces on precipitation ridges can be seen from the highway at many places between the Siuslaw River and Coos Bay. As the dune belt migrates landward, forested patches of older dunes become isolated and surrounded by active dunes; they are referred to as "islands" (Figures 1,17).

Transverse dunes

Transverse dunes (Figure 8) are somewhat sinuous ridges that lie approximately at right angles to the summer wind directions. Their growth and migration take place only during the summer months. During the winter they are either completely obliterated or greatly subdued.

Prior to the introduction of marram grass and the formation of a grass-covered ridge along the shore, transverse dunes extended from the beach into the lower part of the oblique ridge system. Their area has been greatly reduced in the past 30 years and continues to shrink; however, they still cover large areas on the sand peninsulas and low areas in from the shore where deflation has not yet reduced the surface to the lower limit of wind erosion. They form in the interdune valleys and on the gentle south slopes of the oblique dunes. Active dunes north of the Siuslaw River are mostly transverse.

Transverse dune ridges lie approximately parallel to each other, but they commonly run together. Their length varies greatly, and a single ridge may be more than half a mile long. The ridge crests are not uniform in height, but, rather, form a succession of high and low places. On their leeward sides are slipfaces with slope angles of about 30 degrees. At the high places in the ridge the slipface is concave; at the low places it is

Figure 7. Sand encroaching on the forest along a precipitation ridge at Carter Lake.

Figure 8. Transverse dunes west of Honeyman State Park. Dark area in the lower part of the photograph is a smooth surface on wet sand.

Figure 9. Cross-bedding exposed in a yardang on the crest of an oblique dune. Hat shows scale.

Figure 10. Cross-bedding on a horizontal surface at the western edge of the active dunes west of Honeyman State Park. Dark spot is 2-inch lens cap.

convex. On the windward sides the transverse dunes have long gentle slopes inclined generally less than 10 degrees.

As the transverse dune migrates forward, it moves into the area formerly occupied by the dune ahead of it. Layers of sand that are deposited on the slipface of the advancing dune make an angle with the layers that remain from the windward part of the dune ahead. This produces a bedding pattern known as cross-bedding, and because of the sinuosity of the dune ridges, the undulations on the windward surfaces, and the irregularities along the dune front, the cross-bedding may be very complex. Cross-bedding can be exposed in cross section where there has been wind sculpturing in set sand (Figure 9) or on horizontal surfaces where deflation has occurred (Figure 10).

A minor feature associated with the transverse dunes is a small ridge on the lee side of the dune. It begins in the concavities along the ridge and terminates against the windward slope of the dune ahead. Cooper names these small ridges "lee projections" and attributes them to local conditions in the wind pattern.

Blowouts and parabolic dunes

A blowout is a more or less elongate deflation basin or trough in a sand area. An individual blowout may be no more than a few feet across and 10 to 15 feet long, or it may be hundreds of feet across and more than a mile long. Small blowouts are very common in areas that are only partly stabilized by grass, and in places the direction of the influencing wind is clearly shown by the pattern of the blowouts and grass clumps (Figure 11).

The large blowouts are along the eastern edge of the active dune belt, where they project into forested, hilly terrain. There are two localities where one can see excellent examples. One is west of Tahkenitch Lake and north of Elbow Lake, where several blowouts have been shaped by northwest winds. The other is west of Clear Lake south of Winchester Bay; there several blowouts are influenced by southerly winds (Figures 12, 13). The westernmost is the longest and extends for a distance of about a mile in an almost due north direction. At one place, the narrow ridge that separates it from the active dune strip behind the shore has been breached, and at the lower end of the blowout the substratum of Pleistocene sand over which the post-Ice Age dune sand was deposited has been exposed.

Sand removed from a blowout area accumulates at the downwind end in a U-shaped mass referred to as either a U-shaped dune or a parabolic dune. The greatest accumulation is at the end, and from there the limbs of the U extend along the sides of the blowout (Figure 12). As a blowout grows longer, the sand that accumulates along its edges forms long ridges. This is the origin of a series of forested ridges that trend obliquely to the beach in a southeast direction north of Heceta Beach community.

Figure 11. Aligned hillocks in the dunes along the north end of Heceta Beach reflect the influence of the northwest winds. Small blowouts lie between grassy hillocks. (Oregon State Highway Div. photo)

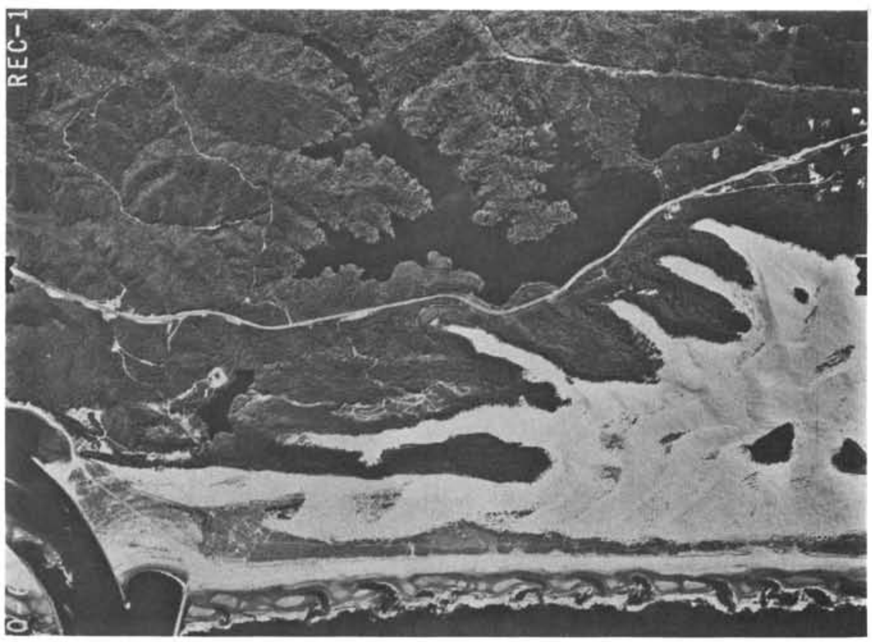


Figure 12. Large blowouts penetrate forested hills south of Umpqua River. The sand is blown out around edges in U-shaped parabolic dunes. Irregular-shaped Clear Lake was formed where dunes dammed a creek. (U.S. Forest Service aerial photo)

Hillocks and the foredune

Where sand moving across a smooth surface meets an obstruction, eddy currents and turbulence in the air behind the obstruction cause sand to be deposited (Figure 14). This can be seen in summer at many places along the dry sand part of the beach where a log or some other object checks the wind. Logs and native plants have always stopped enough sand to create a low beach ridge, but much of the sand was able to move past the ridge and enter the dune-building activity behind the shore. However, with the introduction of European beach grass on the West Coast, the conditions along the shore underwent a pronounced and rapid change, and in the past 25 or 30 years a foredune has built up along the shore that has effectively shut off movement of sand from the beach at all but a few places along the Oregon coast.

Marram and other beach grasses can survive burial, and as sand builds up around them, new roots and growth come out at the joints. Marram apparently has survival qualities that make it superior to native beach grasses, for it has been much more effective in sand stabilization. As sand accumulates around it, the mound gets higher and the grass adds on a new "story" at the same time the cluster gets larger. The mound thus increases in height and girth until it becomes a small hillock. With a steady sand supply, the hillock gets larger and soon merges with other hillocks to form an area that is completely stabilized with grass and other types of vegetation that can grow once the sand stops moving.

The foredune (Figure 15) is a ridge of coalesced hillocks superimposed on an earlier, low beach ridge. The hillocks nearest the beach stop most of the sand and continue to grow while the ones farther from the beach stay about the same size or grow slowly. During winter storms, waves reach the base of the foredune ridge and erode it back to an abrupt edge (Figure 16). Thus in places, banks several feet high are formed which become an additional obstacle to the shifting sand, increasing the effectiveness of the foredune as a barrier.

The foredune has now completely cut off the supply of sand to the dunes along most of the Oregon coast and the interior dunes are now "feeding on themselves." The inland advance of the dune is thus at the expense of the western part of the strip behind the foredune (Figure 3). The body of sand in the dune strip is roughly wedge-shaped in cross section, with the thick edge of the wedge on the landward side. Hence for every foot of advance made by the front, the thin western edge must recede several feet. The dune strip is thereby becoming narrower. As the dune strip narrows, the zone where deflation has reached base level (lower limit of erosion) widens and the belt of vegetation increases in width accordingly. In places, strips of open sand have narrowed by nearly half in the past 30 years.

Figure 13. Large blowout south of the Umpqua River.

Figure 14. Sand accumulating around a clump of marram grass on a deflation surface west of Honeyman State Park.

Figure 15. Foredune ridge along the beach formed by the coalescing of grass-stabilized hillocks. (U.S. Forest Service photo)

Figure 16. Bank along a foredune formed by wave erosion. (U.S. Forest Service photo)

Most of the lakes that lie in and along the dune strip owe their origins to the dunes. Exceptions are several small bodies of water that occupy abandoned river channels, the largest an oxbow lake in an abandoned meander loop of the Siltcoos River at the Siltcoos Forest Camp.

Only a few of the lakes impounded by dunes are entirely within the dune strip. The largest of these are on deflation plains, and smaller ones are in interdune valleys and low areas around the edges of "islands."

Horsefall, Spirit, Sandpoint, and Beale Lakes north of Coos Bay are broad shallow bodies of water occupying low places on a deflation plane where a rise in ground-water level has created an area of lakes and marshland. Beale Lake is at a little higher elevation than the others and appears to be partly on a deflation surface and partly in interdune valleys.

Adjacent to the "islands," usually on the west side, are narrow crescent-shaped valleys. Most of these valleys hold shallow bodies of water during the wet season, and a few have ponds that survive the summer, small though they may be by the end of the dry season (Figure 17).

Figure 17. Small crescent-shaped lake partly encircles an "island" south of Honeyman State Park. The lake lies in a depression between migrating dunes and an isolated remnant of an older forested dune.

Interdune lakes in this dune belt are few and small. Some valleys between the oblique ridges hold shallow ponds during the wet season, but these dry up in the summer. Numerous small, shallow water bodies occupy interdune troughs in the stabilized part of the dune area north of the Siuslaw River, but they usually dry up or are reduced to marshland during the summer. Hidden Lake, which lies west of Heceta Junction and north of Heceta Beach Road, maintains sufficient depth through the year to support fish.

The lakes along the margin of the dune strip are impounded on or against either Pleistocene terrace sandstone or Tertiary bedrock. Carter and Threemile Lakes, long narrow bodies of water between Siltcoos and Umpqua Rivers, lie between the inner dune ridge and the terrain on Pleistocene sediments. The southern part of Sutton Lake at the north end of the dune strip, Cleawox (Figure 2) and Woahink Lakes south of the Siuslaw River, and Saunders Lake north of Coos Bay are on the terrace sediments. Siltcoos, largest of the lakes, is partly on Pleistocene terrace sediments and partly on Tertiary bedrock. The large branching lakes, such as Mercer Lake at the northern end of the dune strip, Tahkenitch Lake between Siltcoos and Umpqua Rivers, and Clear (Figure 12), Eel, and Tenmile (Figure 1) Lakes south of the Umpqua River, occupy the flooded lower ends of stream systems. Elbow Lake, a small lake west of Tahkenitch, is also of this origin. Numerous other lakes, such as Clear and Munsel Lakes north of the Siuslaw River, occupy low areas in the erosional surface on Tertiary bedrock.

The large lakes that are in the flooded stream valleys and the bays at the mouths of Coos, Umpqua, and Siuslaw Rivers have a point in common with respect to origin. All are related to the post-Ice Age rise in sea level. There are numerous indications along the coast that the sea rose to a level somewhat higher than the present, and although it has dropped below its maximum, the level is still high enough that the ocean encroaches on the rivers to form estuaries, the bays at the river mouths.

The larger rivers have sufficient volume to maintain sea-level channels through the dune strip to the ocean, and the impounded and enlarged water bodies at the "drowned" lower ends are subject to the inflow of salt water from the sea. The smaller streams, on the other hand, are incapable of maintaining a sea-level channel across the dune strip and so become dammed up behind the sand barrier. Fresh-water lakes are thereby formed at their "drowned" lower ends.

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The Ore Bin

Vol. 35, No. 6
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The Ore Bin

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The ORE BIN
Volume 35, No. 6
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IF MOUNT HOOD ERUPTS

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Volcanism at several sites around the world in recent years has shown that a number of volcanoes considered "dead" were only dormant and that renewed activity is an ever-present possibility. Many geologists anticipate that within their lifetime one of the sleeping Cascade volcanoes will erupt. After all, Mounts Baker, Rainier, and St. Helens erupted several times in the 1800's, Mount Lassen in the early 1900's, and today Mount Rainier, Mount St. Helens, Mount Adams, and Mount Hood have active fumaroles and hot spots.

Every year more people move toward the foothills and slopes of the Cascade Mountains for summer and winter recreation, or they migrate up the stream valleys that lead toward the mountains to occupy seasonal or permanent homes. An eruption of one of the dormant volcanoes could endanger the lives of thousands of these people.

Dr. Paul E. Hammond, author of this imaginary story, is a geologist and an authority on the Cascade Range and its volcanoes. His vivid interpretation of what might happen if Mount Hood should erupt is based on his intimate knowledge of volcanic processes and the evidence for repeated eruptions in relatively recent time. As well as telling a story, he gives careful thought to ways Oregonians can be prepared to meet the hazards of a volcanic eruption. Ed.

This story was written not by an alarmist but by a geologist with an avid interest in Cascade volcanoes. It is not a story of when Mount Hood will erupt but how it could erupt. Geologists are fully cognizant of the processes of change on earth, from some imperceptibly slow to those which can relentlessly wash out beach homes, to others violently catastrophic such as earthquakes. Processes of change are inevitable. Man cannot stop them, but he can be prepared to meet them. That is the purpose of this story.

A news agency article in the Oregonian, April 22, relates that on April 21 a small earthquake, magnitude 3.8, occurred near Mount Hood. Seismologists at Oregon State University are quoted as saying the quake occurred at 10:43 a.m. PST, lat 45°27' N., long 121°37.5' W., near the northeastern base of Mount Hood, at a focal depth of about 40 km.

On May 4 another communication reports a quake at 2:10 p.m. PST, magnitude 3.2, at lat 45°24.0' N., long 121°53' W., north of Rhododendron, with a focal depth of about 16 km.

Again an earthquake is reported at 9:18 p.m. PST, May 9, magnitude 2.5, focal depth 10 km, at lat 45°24' N., long 121°47' W., also north of Rhododendron. Residents of upper Hood River and Sandy River valleys are alarmed.

Repetition of earthquakes near Mount Hood, each decreasing in focal depth, indicate that magma may be rising from a source along a conduit leading to the volcano. Volcanologists concur that an eruption of Mount Hood may well be pending. On May 10, personnel at Timberline Lodge report feeling small tremors, rattling of dishes, and the creaking of the structure, which they believe to be the aftershocks of the May 9 quake. Observers of the mountain report seeing light-colored clouds, either as steam or dust, rising from the snow-clad summit. The State Emergency Services Division, Salem, after consultation with the U.S. Geological Survey, the State Geologist, and the center of Volcanology at Eugene, requests daily air observation of the peak.

In the morning of May 11, after the first flight, aerial observers report no unusual features on the mountain top. Visitors at Timberline Lodge report an increasing number of tremors, most of which are felt as "rolls." The Governor's Office, Salem, calls for a Volcano Alert of all Cascade volcanoes, with particular attention to Mount Hood.

On May 12, after the second morning's flight, in which infrared photographs are taken, there is no report of a visible change in Mount Hood from the previous day. Observers at Timberline Lodge, with clear sky as background, report seeing well-defined steam plumes rising from the Crater Rock area at the summit. Microseismic activity continues; the number of tremors exceeded 100 on May 11. Plans are made to evacuate Timberline Lodge and Mount Hood Meadows. All guests are requested to leave by noon and most employees to leave by 6:00 p.m. of the next day. The State Police assume patrol of U.S. Highway 26 and Oregon Highway 35. Hood River and Clackamas County Sheriffs' offices establish a Volcano Watch in cooperation with the State Emergency Services Division. A 24-hour watch is set up at Multorpor Lodge, near Government Camp, and on Middle Mountain in the upper Hood River Valley. The State Office also requests 10- and 20-day meteorological forecasting in the event of extensive volcanic ash eruptions, which are typical of the Cascade peaks.

Although clouds enshroud the peak all day, precluding any observations of steam activity, the third set of infrared aerial photographs, taken in the early morning hours of May 13, shows increased thermal activity at the fumaroles around Crater Rock. Microseismic activity continues at about the same rate as the previous day. Staff members remaining at Timberline Lodge report two sharp quakes, one at 10:37 p.m. and the other at 11:15 p.m. Strong winds and heavy rains have obscured the peak since mid-day.

In the morning of May 14, adverse weather prevents infrared aerial photography of the peak. United Air Lines flight 482 bound for Portland from San Francisco reports seeing a dark billowy cloudmass among storm clouds in the vicinity of Mount Hood at 9:12 a.m. At the same time, the skeleton staffs remaining at Timberline and Mount Hood Meadows report continuing tremors and an unusually dark cloud amidst the storm. The rain is muddy! They are advised to leave immediately. Thereafter the Timberline road is closed to general traffic. A 10:00 a.m. surveillance flight by the volcano watch crew reports seeing a low dark ash cloud over Mount Hood, confirming earlier reports. The State Police immediately set up check points on U.S. Highway 26 and Oregon Highway 35, warning motorists. State offices at Salem and Portland and the news agencies issue periodic radio warnings and advise on conditions. County Sheriff offices warn residents in the valley bottoms at the foot of Mount Hood as far west as Brightwood to prepare to evacuate at a given radio signal.

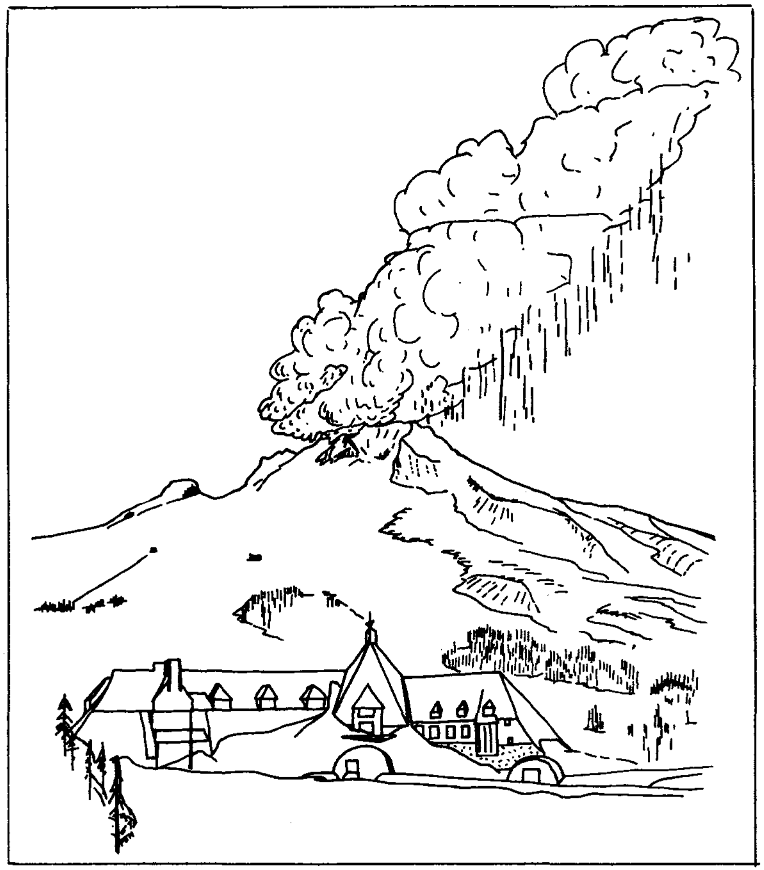
The storm continues unabated all day, obscuring efforts to see the shape and size of the ash cloud and exact position of the erupting vent.

Aerial surveillance that afternoon reports that a large dark cloud of ash is rising to about 17,000 feet altitude to the northeast from Mount Hood. The sheriff of Hood River County reports that evening that about a quarter of an inch of fine mud is accumulating on county roads. Ash is also reported to be falling on Interstate Highway 80N in the Gorge between Hood River and The Dalles. Another report that night, made after completion of an aerial surveillance for infrared photography, indicates that a greatly enlarged "hot spot" is centered about 1,000 feet west of the summit of Mount Hood and north of Crater Rock at an elevation of about 10,500 feet. Fearing the worst, the State Police close U.S. Highway 26 between Cherryville and Wapinitia Junction and Oregon Highway 35 south of Parkdale at 11:00 p.m., and residents are warned to be prepared to evacuate.

River watchers, assigned to the forks of the Hood, White, Zigzag, and Salmon Rivers, report during the night that waters are rising as expected after the two days of heavy rain and moderating temperatures. The waters are colored gray by the admixture of ash. The volcano watchers at Multorpor telephone that no glow is visible at night but audible booms of the eruption can be heard above the diminishing wind.

Dawn flights on May 15 reveal a giant pluming dark-gray cloud rising rapidly above Mount Hood to about 25,000 feet altitude and trailing northeastward in a broad dark band about 60 miles.

Observations continue. At 11:00 a.m. Mount Hood is emitting a



Sketch of Timberline Lodge showing how Mount Hood might look during the eruption. Billowy cloud of ash trails to the northeast on the prevailing wind.

steadily increasing volume of ash. The size and elevation of the ash cloud is increasing and accompanied by sporadic lightning. The sound of the explosive eruptions is intensifying. There is now the possibility of large mudflows originating on the slopes of the volcano, in view of the magnitude of the eruption and melting of the glaciers and snowpack. All people in the valleys are warned to leave immediately in anticipation of these mudflows. Those communities affected are in the Hood River valley, along the Zigzag, Salmon, and Sandy Rivers downstream to Cherryville, and along the White River valley to Tygh Valley. Residents on the lower Sandy River, including Troutdale, as well as those in Hood River, are warned of the possibility of mudflows.

At 12:00 noon, Timberline road is reported impassible to motorized wheeled travel; up to six inches of gray ash and small rocks cover the road. The State Police warn motorists on Interstate 80N between Cascade Locks and Biggs Junction of obscured visibility and recommend only essential traffic be permitted. The Wasco County Sheriff at The Dalles reports that the ash fall there is 3 inches deep, exceeding the deposits of the Mount St. Helens eruption of 1842.

At 2:00 p.m. reports indicate that river waters continue to rise steadily; their particle content has increased substantially. The stream flow in the upper Hood River is reported to resemble a slurry and there is flooding locally. Explosive eruptions are increasing in volume and tumult. The ash fall appears to contain a greater pumice and rock content than initially. Up to six inches of ash reportedly cover stretches of Oregon Highway 35 in the upper Hood River Valley. State Emergency Services Division declares that mudflows are imminent and calls for evacuation of all threatened low-lying areas. Remining residents and personnel at Government Camp and Parkdale are ordered to evacuate. At 4:00 p.m. the State Police close U.S. Highway 26 at Sandy and Oregon Highway 35 south of Hood River. The ash is clogging air intakes on the State Highway vehicles, causing frequent breakdowns and thereby preventing police from clearing the highway.

At 8:00 p.m. aerial surveillance reports that the ash cloud has risen to 47,000 feet altitude and extends eastward about 150 miles. The State Police warn motorists on I-80N of greatly obscured visibility between The Dalles and Pendleton; all vehicles must be driven with lights on.

During the night the volcano watchers report a vivid glow at the vent. In addition, there are noted increased intensity of explosions and strong microseismic activity, exceeding the activity prior to the eruption. Watchers along Hood and Sandy Rivers report increased flooding by muddy water - the Sandy downstream from Wemme, the Zigzag River above Rhododendron, and the East Fork of Hood River above Parkdale.

In the pre-dawn hours of May 16 the watchers report that at least four glowing balls of fire, accompanying strong explosions, rose from the vent, perhaps signifying the degassing stage of the eruptive cycle. Aerial flights, which continue to monitor the activity, report at dawn that the ash cloud column now rises to at least 72,000 feet altitude and extends eastward about 250 miles and north-south about 80 miles as a tabular blanket. Although the observers are not able to fly into the dense clouds, they note through breaks in the clouds that the landscape on the eastern slopes of the volcano is barren. A black carpet covers the terrain. Trees are either defoliated or bowed under the weight of the moist ash. The lodges at Timberline and Mount Hood Meadows are mantled by an estimated 6 inches of ash on top of snow. A lava flow is seen advancing slowly down the west flank of Mount Hood onto the Reid Glacier in the upper headwaters of the Sandy River. Sizable mudflows can be expected to descend the Sandy River valley within hours. By 7:00 a.m. Sheriff's patrols are ordering residents in the lower Sandy River valley near Troutdale to leave.

At 9:00 a.m. the Portland Water Bureau reports that very fine volcanic ash is entering the drinking water system on Bull Run River and discoloring the water. Bonneville Power Administration reports that The Dalles dam has trimmed the flow through the turbines in order to prevent corrosion by ash-laden waters. Restricted use of electrical power may be required. Portland General Electric reports that a power line is down near Lolo Pass on the northwest side of Mount Hood, probably due to the weight of accumulated mud-caked ash. The U.S. Geological Survey, Washington, D. C. releases to the news media the communication that a major volcanic eruption is underway at Mount Hood, Oregon, located 50 miles east of Portland. This is the second eruption in the Cascade Range in this century, the first being the 1912-17 activity at Mount Lassen in northern California.

At 11:00 a.m. the Governor, from his temporary office in Portland, declares a state of emergency in Clackamas and Hood River Counties and requests emergency funds from the President to (1) maintain radio communication in the disaster area and coordinate surveillance by military helicopter flights; (2) provide temporary food and housing for evacuated citizens, reportedly about 5,000; and (3) augment the efforts of the Highway Division, State Police, and County Sheriffs' offices to rescue persons trapped by the accumulating ash and to clear some highways as soon as possible.

Public officials now feel that water and power supplies to Portland are imperiled. There is considerable concern about the possibility of a shift in the upper atmospheric wind pattern which could bring the ash cloud toward Portland. Reportedly the Governor of Washington and officials of Vancouver and Clark County are keenly watching developments.

At noon the State Highway Division closes I-80N between Hood River and Pendleton and U.S. Highways 197 and 97 between I-80N and Madras to non-commercial traffic because of extremely poor visibility, in places reduced to less than a quarter of a mile.

At 2:00 p.m. the Bonneville Power Administration halts power output at Bonneville, The Dalles, and McNary dams because of the high ash content in the Columbia River water. Industries in northwestern Oregon and southwestern Washington are to cut their power consumption to just 10 percent. Many industries are reportedly closing temporarily. Households in the Portland-Vancouver area are asked to limit power consumption. Portland Water Bureau warns citizens to store water - fill bathtubs, washing machines, bottles, etc. - in the event the Bull Run water supply is shut off or impaired. The tap water has become increasingly cloudy, producing a "run on the market" for bottled distilled water. The City Council is considering temporarily closing the Bull Run water supply and seeking alternative sources from the Willamette River, upstream from its confluence with the Clackamas. Fortunately Portland's water supply is not nested on the flank of Mount Hood, where the facilities could be devastated by mudflows or lava flows.

At 4:00 p.m. the helicopter observer, dispatched just minutes before to survey the western slope of the volcano, reports that the snout of the lava flow has descended to the middle portion of the Reid Glacier, and large incandescent blocks are dropping from the lava front down the icefall on the glacier between the 7,500- and 8,000-foot elevations. As he is radioing his report, a huge mass of snow and ice suddenly projects outward from the icefall, carrying with it most of the lava flow, and surges down the steep slope to the Sandy River. A churning mass of ice blocks, rocks, and broken trees descends the river in less than 5 minutes, bursts from the narrow defile near Ramona Falls as a wall 500 feet high, and spreads across the valley floor above Old Maid Flat. Trees are severed at mid-heights, debranched, and uprooted in one sweeping movement. The mudflow slams into the southeastern base of Last Chance Mountain and surges up the mountainside almost 800 feet, sweeping it clean of trees. Continuing down-valley the flow surmounts Cape Horn and moves relentlessly onward, the velocity and height of the front decreasing, due in part to the huge, wildly flailing matchstick-like mass of entwined trees in front. In twenty minutes the mudflow reaches Zigzag River, its front less than 100 feet high. The flow quickly spreads out, part surging up the Zigzag River into Faubion and Zigzag. A large mass flows over the Sandy River bank just upstream of Wemme, overwhelms the town, and continues across the terrace separating the Salmon and Sandy Rivers. Part of the mudflow is dissipated in the timber atop the terrace, but two streams continue down-valley, joining at Brightwood about 20 minutes later into a single mass 50 feet high. The flow widens, thins, and slows considerably in the broad valley below Brightwood. It flows over the diversion dam near Cherryville and surges almost to the top of the terrace at Roslyn Lake. From there down-valley the mudflow is confined to the steeper canyon walls of the Sandy River. Forty minutes later the Sheriff reports the flow passing Dodge Park; its front is now only 20 feet high, and it clears the three water pipes from Bull Run to Portland.

Minutes after helicopter surveillance reports the collapse of Reid Glacier all bridges across the Sandy River are barricaded in anticipation of the surging wave of debris which may ram the bridges aside. The bridge on Highway I-80N is no exception. In the almost two hours since the mudflow began, hundreds of spectators crowd the high banks of the Sandy River near Troutdale to await its arrival. Fifty minutes later the flow front, a 10-foot wall of foam, debris and mud, passes beneath the Crown Point highway bridge and a minute later beneath the I-80N bridge.

By dusk May 16 observers note the mudflow has deposited a sheet of dark-gray mud, sand, and boulders more than 100 feet into the Columbia River beyond the mouth of the Sandy River; the Columbia River is carrying a gray streak along its south shore downstream to the Interstate Bridge. The level of the mudflow has subsided but considerable fresh debris lines the banks, and rafts of branches and bark float in the dark water of the Sandy River. By now the State Highway Division and State Police, in communication with volcano observers and the State Emergency Services office at Portland, consider that the mudflow and the surging flows in the aftermath of the main mass are abating and I-80N can be reopened to traffic to Hood River.

The last May 16 daylight observance by helicopter of the vent area on Mount Hood seems to indicate that the rate of lava outpouring is increasing and that fresh lava is steadily flowing into the void created by the melted Reid Glacier. Returning to Troutdale airfield over the Sandy River valley the observer reports that the valley is now a swath in which streams are winding among boulders and mud. Vast numbers of trees and debris of smashed houses and bridges, pushed to the edge of the swath, now lie tens of feet above the muddy water's surface.

Several volcano observers, including the Clackamas County Sheriff, note that the ash cloud above the volcano has diminished both in height and density. The explosive activity is also lessening. During the night a bright glow can be seen near the summit and a narrow ribbon of lava streams westward downslope from the spot.

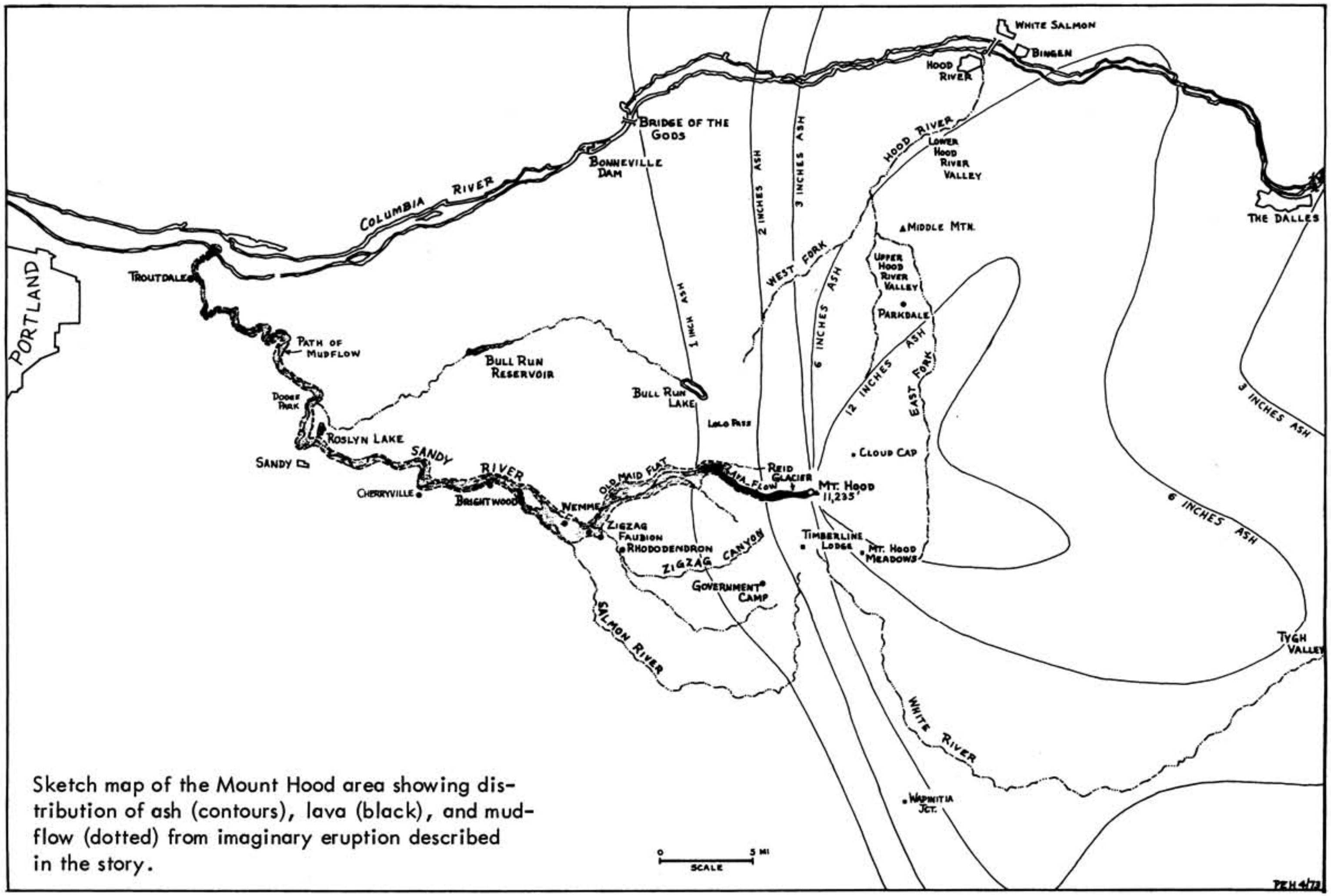
By mid-morning May 17 it is obvious that the amount of ash fall from the volcano is greatly reduced. Reports from The Dalles and points east on I-80N indicate improved visibility, and the State Police are permitting normal traffic flow. Snow plows are assigned to remove drifted ash.

With favorable reports coming in, the State Emergency Services Division personnel in Portland begin to relax. The Portland Water Bureau believes the Bull Run water supply may survive but the water in the reservoirs will be murky for a year until after the next years' runoff. Bonneville Power Administration announces that reduced power output will continue for at least another five days. No power is being generated at the lower Columbia dams. There is hope that if the eruption is diminishing, the ash being carried into the Columbia by Mill Creek and other creeks near The Dalles and by the Hood and Deschutes Rivers will decrease substantially within the next 5 days and settle in the Columbia River reservoirs, provided a heavy rain storm does not strike on the heels of the eruption.

The major fear now is that (1) a meteorologic storm could cause a number of devastating mudflows in all valleys around the volcano; and (2) volcanic activity could be renewed, with new ash and lava eruptions; and as a remote possibility, (3) the lava flow might extend to Zigzag and form a barrier across U.S. Highway 26.

A check of Portland hotel and motel facilities by the newspapers indicates that most are booked solid by sightseers, many of them Californians, and a lesser number of Seattleites, to witness the eruption and follow its activity. Fortunately the State Police have closed U.S. Highway 26 at Sandy to prevent sightseers from interfering with the rescue operations to restore communications and travel within the devastated Sandy River valley.

Assessment of the damage of the Sandy River mudflow and the eastward ash-fall are now being reported to the Governor's office and released to the news services. At least $9 million damage has occurred along the Sandy and Zigzag River valleys; bridges between Dodge Park and Zigzag have been smashed or lifted from their foundations. In addition, buildings along the valley floor between Alder Creek and Zigzag have been destroyed



Sketch map of the Mount Hood area showing distribution of ash (contours), lava (black), and mudflow (dotted) from imaginary eruption described in the story.

or extensively damaged. Fortunately the wind has blown nearly constantly eastward during the eruption and has carried the ash away from the orchards of Hood River valley, although some severe leaf and bud damage is reported to trees in the upper valley. Damage to timber and logging operations in the area east of Hood River is not considered to be extensive.

Throughout the entire eruption, up to 4:00 p.m. May 17, not one death has been reported. Thanks to the speedy efforts of the State Emergency Services Division, the Sheriffs, and the State Police, and the immediate establishment of observers in constant radio communication from vantage points and from the air, residents and motorists have been forewarned and prepared for evacuation. Most fortunately, the volcano this time underwent a gradual buildup of activity, allowing time for nearby persons to evacuate.

May 26: The eruption of Mount Hood has continued for eight more days but is subsiding. This afternoon's helicopter surveillance reports that no lava can be seen issuing from the vent, that the vent is only smoking, and that there is no longer a glow within it. The lava flow has reached the upper part of the Old Maid Flat in the upper Sandy River valley and is cooling and congealing rapidly on the surface.

May 27: The State Police, Sheriffs' deputies, and employees reach Timberline Lodge and Mount Hood Meadows from the south and begin the dusty job of shovelling and bulldozing aside nearly 6 inches of ash and pumice, cleaning out pipes, and airing the rooms.

Portlanders are thankful that this century's eruption of Mount Hood was relatively mild, not nearly as catastrophic as the past eruptions of Mount Mazama and other Cascade volcanoes.

Addendum

Any similarity to dates, times, places, and persons in this story is purely coincidental. Mount Hood did not erupt but it <u>will probably erupt</u> sometime in the future, and the eruptive episode may be similar to the story. Preliminary observations of the volcanic deposits in the neighborhood of Mount Hood reveal that in times past mudflows larger and thicker than the one described have descended Sandy River as well as Hood and White Rivers.* And a large thick avalanche deposit, representative of one of the most recent events at Mount Hood, blankets the southwestern flank of the mountain from Crater Rock to Multorpor Mountain.

As stated in the first paragraph, mankind cannot stop geologic processes, but man can be prepared for a catastrophe.

* * * * *

* Wise, W. S., 1968, Geology of the Mount Hood volcano, *in* Andesite Conference Guidebook: Oregon Dept. of Geol. and Mineral Indus. Bull. 62, p. 81-98.

GEOTHERMAL AND PETROLEUM DRILLING REGULATIONS EXPANDED

In an effort to accelerate exploration for geothermal and petroleum resources and, at the same time, minimize hazards to the environment, an agreement between the Department of Geology and Mineral Industries and the Department of Environmental Quality is published below. In essence, the agreement spells out the DEQ restrictions on the drilling of wells; these regulations now become part of the permit-to-drill issued by the Department of Geology and Mineral Industries. It is hoped that the agreement will simplify procedures and avoid duplication for those applying for permits.

1. If geothermal activity of commercial interest is discovered, no drilling of additional wells or operations in connection therewith shall commence until an Environmental Impact Statement has been prepared for utilizing and developing the resource.

2. Prior to commencement of any construction or drilling activities, detailed plans and specifications shall be submitted to and approved by the Department of Environmental Quality for collection and disposal of drill cuttings and mud, and other potential waste materials.

3. A contingency plan shall be submitted to the Department of Geology and Mineral Industries prior to any drilling activities outlining the following information and procedures:
    a. Measures taken to prevent emergency conditions or unplanned discharges, such as blowouts.
    b. A description of preventive facilities to contain or treat unplanned discharges.
    c. The reporting system to be used to alert facility management and appropriate legal authorities.
    d. A list of personnel and equipment available to respond to emergency conditions.

4. Upon determination of the Director of the Department of Environmental Quality or the Director of the Department of Geology and Mineral Industries that any activities conducted by the permittee in relation to its drilling operations or activities may tend to or will cause damage, hazards, pollution or risk to the environment of Oregon or may violate any conditions of permits issued by the aforementioned departments, the permittee shall when notified either orally or in writing by the Director of either department immediately cease and desist its drilling operations or activities until the problem has been corrected.

5. All drilling processes and all waste mud and waste waters collection, treatment and disposal facilities shall be operated and maintained at

all times in a manner which will prevent a direct discharge or indirect discharge of any waste mud and waste waters to the waters of the state.

6. All waste mud and waste waters are to be discharged into self-contained, non-overflow holding ponds for which construction plans have been approved by the Department of Environmental Quality.

7. All access roads, trails, drainage systems and the drilling site shall be constructed and maintained to minimize soil disturbances, control erosion and prevent channeling.

8. All refuse shall be disposed of at a refuse site which has a valid permit from the Department of Environmental Quality except as permitted in Condition 9.

9. Nonputrescible combustible wastes such as paper bags and brush may be burned. All open burning must be carried out in compliance with Oregon Administrative Rules Chapter 340, Subdivision 3, OPEN BURNING, Sections 23.005 through 23.020 and all other applicable Federal, state, and local burning regulations.

10. No geothermal waters or other waters or substances which might cause the Water Quality Standards of the State of Oregon to be violated shall be discharged or otherwise allowed to reach any of the waters of the state unless a permit for the discharge has been issued by the Department of Environmental Quality.

11. Sanitary wastes shall be disposed of in chemical or gas-fired toilet facilities which have been installed in accordance with the recommendations of the Oregon State Health Division and the local county health department or by other approved means.

12. In the event a breakdown of equipment or facilities causes a violation of any of the conditions of this permit or results in any unauthorized discharge, the permittee shall:
    a. Immediately take action to stop, contain and clean up the unauthorized discharges and correct the problem.
    b. Immediately notify the Department of Environmental Quality and the Department of Geology and Mineral Industries so that an investigation can be made to evaluate the impact and the corrective actions taken and determine additional action that must be taken.
    c. Submit a detailed written report describing the breakdown, the actual quantity and quality of resulting waste discharges, corrective action taken, steps taken to prevent a recurrence and any other pertinent information.

13. Compliance with these requirements does not relieve the permittee from responsibility to maintain continuous compliance with the conditions of this permit or the resulting liability for failure to comply.

14. Authorized representatives of the Department of Environmental Quality or the Department of Geology and Mineral Industries shall be permitted access to the premises of all facilities owned and operated by the permittee at all reasonable times for the purpose of making inspections, surveys, collecting samples, obtaining data and carrying out other necessary functions related to this permit.

* * * * *

GEOTHERMAL ENERGY POTENTIAL OF DEEP SEDIMENTARY BASINS

As a part of its research to identify energy resources of the United States, the U.S. Geological Survey has undertaken a study of geothermal resources. To date nearly all of these studies have been concentrated in areas of visible thermal manifestations such as volcanoes, hot springs, and fumaroles--the type of areas of the world where geothermal power is currently being utilized. A new dimension has been added to the understanding of geothermal resources by the work of Paul H. Jones, U.S.G.S. hydrologist, who studied the potential for geothermal development of the northern Gulf of Mexico basin. Jones' report, given at the Pisa Symposium on the Development and Utilization of Geothermal Resources in 1970, shows that large areas of the Gulf Coast are underlain by water at temperatures as high as 500°F at pressures as great as 15,000 pounds per square inch. Jones' paper has stimulated more study of geothermal resources in sedimentary basins, and a preliminary report (U.S.G.S. 1972) discussing the geothermal energy potential from this source follows:

> The geothermal energy potential of deep sedimentary basins has been examined by B. F. Grossling (1971). In appraising the long-range prospect of geothermal energy, it is necessary to consider these deep basins because of their large masses of stored water and heat. The total amount of energy that can be recovered without regard to costs can surpass, by way of comparison, the heat of combustion of the oil and gas resources of those basins. The bulk of the waters, however, are low in enthalpy (temperature<150°C), and only a fraction are high in enthalpy (temperature >150°C). The latter may be the more important for electric power generation, depending on costs of drilling, power-generation technology, and other factors.
>
> The size of these high-enthalpy hydrothermal resources in sedimentary basins of the United States hinges on a number of

unresolved questions: (1) Volumes of high-enthalpy waters that may be retrieved by wells, (2) average temperature of these waters, and (3) economics. Porosity, permeability bed thickness, lateral continuity, and other factors determine the amount of water that may be retrieved by wells. These quantities are not well known, especially for the deepest parts of sedimentary basins which may be the most important. The simple projection of near-surface temperature gradients in sedimentary basins, according to Grossling, generally underestimates the temperatures in the deeper parts of the basins where surface gradients are depressed because of subsidence and sedimentation. The economics of the exploitation of the high-enthalpy water would depend on the depth range of the wells, production characteristics of the wells, and the nature of the solids dissolved in the waters.

The sedimentary basins of the conterminous United States have a total area of about 4.9×10^6 km^2, which is about 60 percent of the total area. Moreover, the total sedimentary volume is on the order of 33×10^6 km^3. The maximum depth to basement may be as high as about 18 km. Of the total volume, perhaps about 2.1×10^6 km^3 lies below 4 km depth, and about 30.9×10^6 km^3 lies above it. Assuming that the pore space is filled with water at a mean temperature of 150°C (≈300°F) and that porosity is 5 percent, averaged throughout the total thickness, the total in situ heat of the interstitial water below 4 km is 1.6×10^{22} cal. The considerable magnitude of this total can be appreciated by comparing it with the heat of combustion of 1 million barrels of oil, which is about 1.4×10^{15} cal. That is, the total sensible heat stored in interstitial waters of sedimentary basins of the United States below depths of 4 km may be on the order of the heat of combustion of 10 trillion barrels of oil. The figures for the low-enthalpy waters above 4 km are nearly an order of magnitude greater. The amount of recoverable heat is obtained by multiplying the above in situ figures by a factor which may range as high as 10^{-2} to 10^{-1}. Thus the recoverable amounts are still considerable.

A particularly important objective is finding sedimentary basins with large volumes of interstitial waters in their deep parts, which overlie areas with an abnormally high temperature at the mantle-crust boundary. The Gulf Coast geosyncline and the Imperial Valley - Mexicali Valley area are perhaps the two most important exploration targets in the United States in this respect. For instance, for an area of 100 x 100 km underlain by a layer within the sedimentary column containing permeable beds with an average porosity of 5 percent, a thickness of 1 kilometer, and an average temperature of 250°C, the heat of the water above surface temperature is on the order of 10^{20} cal; this value is equivalent to the heat of combusion of 90 billion barrels of oil. Thus, even if only a small fraction of the water could be retrieved, still the magnitude of the recoverable energy is considerable.

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Grossling, B. F., 1971, An appraisal of the prospects of geothermal energy in the United States (a preliminary report): Natl. Petroleum Council, U.S. Energy Outlook, open-file report, 28 p.

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U.S. Geological Survey, 1972, Geological Survey research, 1972: U.S. G.S. Prof. Paper 800A, p. A10-A11.

* * * * *

GULF OIL PLANS OREGON GEOTHERMAL DRILLING

Gulf Oil Company filed applications with the Department for permits to drill two deep exploration holes for geothermal resources in Lake and Klamath Counites. One hole is proposed to be drilled 6 miles northeast of Klamath Falls and the other deep test is to be drilled 2 miles northwest of Lakeview. Hot water and steam occur at several locations in both of these areas. Details concerning proposed exploratory wells are:

Gulf Oil Company	"Meadow Lake Inc. 1-ST"	6,000' depth
NE¼, sec. 19, T. 38 S., R. 10 E.		
Gulf Oil Company	"Farell-Utley 1-ST"	6,000' depth
NE¼, sec. 5, T. 39 S., R. 20 E.		

The firm is expected to begin drilling in Oregon by mid-summer after completing its exploratory program in northern California.

* * * * *

EASTERN OREGON GEOLOGIC MAP ISSUED

A preliminary uncolored edition of the long-awaited geologic map of eastern Oregon (companion to the western Oregon geologic map published in 1961) is now available as U.S. Geological Survey Miscellaneous Field Studies Map MF-495. The map, prepared in cooperation with the Oregon Department of Geology and Mineral Industries and compiled by George W. Walker, is for sale by the U.S. Geological Survey, Distribution Section, Federal Center, Denver, Colorado 80225. The price is $1.00.

* * * * *

TEN-YEAR BIBLIOGRAPHY SUPPLEMENT PUBLISHED

The fifth supplement to the "Bibliography of the Geology and Mineral Resources of Oregon" has been published by the Department as Bulletin 78. This 200-page bulletin, which includes a comprehensive subject index, covers published and unpublished materials on the geology and mineral resources of the state released during the ten-year period January 1, 1961 to December 31, 1970. This includes master's theses and doctoral dissertations known to the Department from all universities, and because of their inclusion in this publication, no further supplements to Misc. Paper no. 7, "Bibliography of Theses on Oregon Geology," will be issued.

Bulletin 78 can be purchased from the Department's offices at Baker, Grants Pass, and Portland for $3. Still available are the first supplement, Bulletin 33, for $1.00, and the fourth, Bulletin 67, for $2.00.

* * * * *

VAN GORDON BECOMES DEPARTMENT BOARD MEMBER

H. Lyle Van Gordon of Grants Pass has been appointed to the Department's Governing Board to succeed Donald McGregor, who died in February.

Van Gordon was born in Cove, Oregon, but spent his early years in Nevada. He attended the University of Nevada, gained experience in lead, silver, and gold mines, and during World War II was with the War Manpower Commission in magnesium research and process control. He moved with his family to Grants Pass in 1944 and in 1950 joined Pacific Power and Light Co., doing construction, marketing and customer relations work; he now is Customer Representative. He has been active in local civic groups and regional organizations and received the Grants Pass Distinguished Citizen Award for 1965. Of his recent appointment, he states, "This is the finest and will be the most interesting and rewarding opportunity to serve."

* * * * *

NEVADA PLACER GOLD DEPOSITS SUMMARIZED

The U.S. Geological Survey has published "Placer Gold Deposits of Nevada," by Maureen G. Johnson, as Bulletin 1356. The publication describes 115 placer districts which produced gold between 1849 and 1968. History, production, and possible lode source are given together with location and access.

The 118-page bulletin is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Price - $2.00.

* * * * *

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-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 suppl.) geology and mineral resources of Oregon, 1947: Allen . . 1.00
35. Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin 3.00
36. Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 1 $1.00; vol. 2 1.25
39. Geology and mineralization of Morning mine region, 1948: Allen and Thayer . . 1.00
46. Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey 1.25
49. Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch . . . 1.00
52. Chromite in southwestern Oregon, 1961: Ramp 3.50
57. Lunar Geological Field Conf. guidebook, 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 Tualatin Valley region, 1967: Schlicker and Deacon . . . 5.00
61. Gold and silver in Oregon, 1968: Brooks and Ramp 5.00
62. Andesite Conference Guidebook, 1968: Dole 3.50
64. Geology, mineral, and water resources of Oregon, 1969 . . . . 1.50
66. Geology, mineral resources of Klamath & Lake counties, 1970: Peterson & McIntyre 3.75
67. Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts 2.00
68. The Seventeenth Biennial Report of the State Geologist, 1968-1970 . . . . . . 1.00
69. Geology of the Southwestern Oregon Coast, 1971: Dott 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
72. Geology of Mitchell Quadrangle, Wheeler County, 1972: Oles and Enlows . . . 3.00
73. Geologic formations of Eastern Oregon, 1972: Beaulieu 2.00
74. Geology of coastal region, Tillamook Clatsop Counties, 1972: Schlicker & others 7.50
75. Geology, mineral resources of Douglas County, 1972: Ramp 3.00
76. Eighteenth Biennial Report of the Department, 1970-1972 . . . . 1.00
77. Geologic field trips in northern Oregon and southern Washington, 1973 . . . . 5.00
78. Bibliography (5th suppl.) geology and mineral industries, 1973: Roberts, et al. . . in press

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck 2.15
Geologic map of Oregon (12" x 9"), 1969: Walker and King 0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bulletin 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 portion of High Cascade Mtns., 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 and others . . 1.50
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka . . . 1.50
GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: Berg and others
[sold only in set] flat $2.00; folded in envelope 2.25
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess 1.50

OIL AND GAS INVESTIGATIONS SERIES

1. Petroleum geology, western Snake River basin, 1963: Newton and Corcoran . . . 2.50
2. Subsurface geology, lower Columbia and Willamette basins, 1969: Newton . . . 2.50

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24.	The Almeda mine, Josephine County, Oregon, 1967: Libbey	2.00

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
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
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11.	A collection of articles on meteorites, 1968, (reprints, The ORE BIN)	1.00
12.	Index to published geologic mapping in Oregon, 1968: Corcoran	.25
13.	Index to The ORE BIN, 1950-1969, 1970: Lewis	0.30
14.	Thermal springs and wells, 1970: Bowen and Peterson	1.00
15.	Quicksilver deposits in Oregon, 1971: Brooks	1.00

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Geologic time chart for Oregon, 1961	Free
Postcard - geology of Oregon, in color	10¢ each; 3 - 25¢; 7 - 50¢; 15 - 1.00

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The Ore Bin

Vol. 35, No. 7
July 1973

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

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The ORE BIN
Volume 35, No.7
July 1973

ARCHAEOLOGICAL EVIDENCE OF LAND SUBSIDENCE ON THE NORTHWEST COAST

Emory Strong*

The determination of changes in sea level is a tedious process, requiring world-wide instrumentation and time measured in decades or centuries. Yet in many areas archaeological sites provide a ready-made indicator for regional fluctuations. For instance, N.C. Flemming (1969), in a monumental survey of 179 ancient towns on the Mediterranean, found that land elevations had changed as much as 56 feet during the last 2,000 years. Prehistoric residents of the Northwest Coast, enjoying a prosperous marine and riverine economy, lived in shoreside villages, and their ruins, like those towns on the Mediterranean, show substantial sea-level changes.

Melting ice sheets of the last glacial period have raised sea level as much as 100 feet, but the rate of rise has sharply decreased in the past 6,000 years and has amounted to only about 5 feet in the past 2,000 years (Shepard, 1964). If recent sea-level changes are as slight as most scientists believe (Butzer, 1971), then it would appear that some regions in the Pacific Northwest are subsiding.

I first became aware of this geological phenomena while searching the banks of the Columbia River for Indian artifacts. I located all the old villages in the Portland vicinity and, when the spring flood waters were receding, hunted as many as I could in my boat to see what prizes erosion had uncovered. Most of the sites were completely submerged by even a normal freshet, and in order to rescue the relics before they were washed away (or before someone else got them) I kept a record of the normal river stage for the first and subsequent visits.

The flooded sites puzzled me. There seemed to be no acceptable reason to have a village where every spring it must be abandoned, especially as there was usually higher ground nearby. The Indians built their houses of planks, fashioned with great labor, over a pit 3 or 4 feet deep, so it is very doubtful they would have built on flood-prone land. Had they

* Mr. Strong is a retired engineer, archaeologist by avocation, and author of two books and a number of articles on early man in the West.

done so, they would have had to remove the valuable planks before the flood and afterward clean the pits of silt before rebuilding their houses. Although most sites show occasional flooding, the stratification indicates a time interval of centuries.

There are about a dozen archaeological sites in the vicinity of Portland that are covered by high water, but the most revealing one is on Lake River near Felida, Washington, about 8 miles northwest of Vancouver. On their return trip up the Columbia in 1806, Lewis and Clark recorded, "we set out and had not proceeded far before we came to a landing place (outlet of Shillapoo Lake) where there was several large canoes hauled up, and sitting in a canoe appearantly awaiting our arival with a view to join the fleet an indian who was then alongside of us. this man informed he was a Shoto and that his nation resided a little distance from the river. we landed and one of the indians pointed to the Shoto village which is situated back of a Pond (Shillapoo Lake) which lies parallel with the river on the NE. side nearly opposit the Clannahquah village."

When I hunted there many years ago, the outlines of the old houses were plainly visible (Figure 1). From 1964 to 1966 the Oregon Archaeological Society completely excavated the site, which lies at an elevation of 16 to 21 feet above sea level. Because of spring flooding, no work could be done until about the middle of July (Figure 2). Plank outlines of the houses were found and many storage pits. The floors of the houses were about 30 inches deep, and the depth of midden in their vicinity varied considerably.

Near the shore, where the eroded bank was steep, excavation had to be abandoned because the permanent water table was reached at a depth of 8 feet, although the midden extended to an unknown depth. It was evident that the houses being excavated were much younger than the old and deep midden. No C-14 dates could be obtained because of contamination from Hanford, but judging by other sites nearby, this one is not more than about 1,000 years old. Since few trade goods were found, the town was probably abandoned during the Great Pestilence of 1830-1835 -- perhaps even earlier, for no other journals mention the site.

In 1971, crews from the University of Washington excavated another site on the left bank of Lake River a short distance below Shoto. Their excavation also approached the permanent water table; when their report is released it may provide some relative or absolute dating.

Examples of drowned archaeological sites have been noted at a number of places in the Pacific Northwest. In 1938 Dr. Philip Drucker (1943) made an extensive survey of the Northwest Coast,and several of the sites to the north of Vancouver Island showed considerable wave erosion. In one of them, where the midden was 18 feet deep, it was necessary to abandon a test pit 7 feet below high tide line because of seepage, although the midden still continued. Dr. Drucker thought there might have been sudden submergence of the area.

Figure 1. Shoto Village site showing house outlines. Lake River on left.

Figure 2. University of Washington crew working site on Lake River. Dark area is damp from nearness to water table.

In reply to a letter asking for C-14 dates on drowned sites, Dr. Richard D. Daugherty of Washington State University said, "It appears that on the Washington Coast the situation varies from south to north. I noticed back in 1947 when I was surveying the Washington Coast that around Willapa Bay there was abundant evidence of recent submergence, but on the northern coast the evidence is that of recent emergence. I don't have any C-14 dates that relate directly to the problem."

George Gibbs, early ethnologist and geologist, also noted changes on Willapa Bay. In 1865 he wrote (Clark, 1955), "At Shoalwater Bay, where evidence of elevation and depression of the land, apparently at no very ancient date, are visible, the Chinooks, it is said, have traditions of earthquakes that have shaken their houses and raised the ground, but I could not learn whether any superstitions were connected with the occurrence."

Petroglyphs abound on the Northwest Coast. Edward Mead (1971) wrote: "That many petroglyphs are extremely ancient is indicated by the fact that the majority are located on beaches at half to low tide levels. In most places a difference in tide level of at least twelve feet would be required to allow the carvings to stand above high tide mark."

Lambert Florin, Portland author, in a letter to me commented, "My publisher showed me the site of Oleman House near Agate Point (on Puget Sound). There are some middens around there, and some foundation poles still show at extreme low tides. The water comes in further now than then." Concerning the same site, Warren Snyder (1956) says, "The most plausible explanation of the presence of chipped stone points on the beach and their absence in the site is that an earlier site once existed on this sandspit and was destroyed by wave action just as the present site is now being destroyed."

I have found only one usable C-14 date relating to land submergence but it is most interesting. Dr. Thomas M. Newman in 1956 to 1959 conducted extensive excavations in an ancient village on Netarts sandspit in Tillamook County (Figure 3). Quoting from his report (Newman, 1959): "Of special interest is the position of this stratum in relation to the present fresh water table and sea level. At the time of excavation, during the late summer, the fresh water table beneath the surface of the site is at its lowest point. At this low point the fresh water table still bisected the lowest occupation. A winter visit to the site revealed that at that time of the year this occupation was covered by the water table to the depth of 0.5 meters or slightly more....It is quite clear that occupations of this stratum did not take place under conditions existing today. Both sea level and the water table must have been substantially lower to permit occupation. Similar conditions are reported by Drucker (1943)."

Dr. Newman postulated that the lowest occupation level should have been at least 2.5 meters (8.2 feet) higher than present for comfortable living, since the site appeared to have been directly on the beach when first occupied. Radiocarbon samples from the lower level gave a date of about 1400 A.D. The rise in sea level (or land subsidence) would then be approximately 18 inches per century.

Figure 3. Excavation in Tillamook site showing permanent water table. Photo courtesy of Dr. Thomas Newman.

The Shoto village near Felida, Washington was occupied in 1806. Although Lewis and Clark did not visit the village itself, they show it on their map and record it in their ethnology report as "Shoto Tribe, No. of Houses or Lodges 8, Probable No. of Souls 460." If this estimate includes the three other towns in the vicinity, it reasonably agrees with the evidence. Land submergence in that area must have been quite rapid in the past 150 years, for the site is now flooded every year. On May 23, 1953, I wrote in my diary, "Water at 19.5 feet (Vancouver Gauge). All Shillapoo camps completely covered." And on June 7, "Water at 17.5. Camps on Shillapoo just out of water."

The examples cited here are but a few of many. The "Village Chinook"near McGowan, Washington, home of the famous Chief Concomly, is now completely washed away, as is the great Namuit village on Sauvie Island. Along the banks of the Columbia and its sloughs, old fire lines can frequently be seen deep beneath the surface, visible only at extremely low water.

The many illustrations of drowned archaeological sites along the coast and in tidal bays and rivers of the Pacific Northwest provide evidence for land subsidence within the past few centuries. Although submergence of sites may reflect a slight world-wide rise in sea level, local downwarping appears to play the dominant role.

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FIELD TRIP GUIDEBOOKS STILL AVAILABLE

Copies of the field-trip guidebook prepared for the Geological Society of America meetings at Portland State University in March, 1973, are still available. The publication, issued as Bulletin 77 by the Oregon Department of Geology and Mineral Industries, is entitled "Geologic Field Trips in Northern Oregon and Southern Washington." It presents seven self-guiding tours to see the geology of the Coast Range in Oregon, the Columbia River Gorge, the lower Columbia River region and northern Oregon coast, the north-central Oregon region, the Pasco basin in Washington, a lava tube on the flank of Mount St. Helens in Washington, and the urban environmental geology of the Portland area.

The guidebook can be purchased from the Department at its Portland, Baker, and Grants Pass offices. The price is $5.00.

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METEORITES OF THE PACIFIC NORTHWEST

Erwin F. Lange
Portland State University

Nineteen meteorites have been recovered from the vast territory comprising Alaska, British Columbia, Idaho, Nevada, Oregon, and Washington. By contrast, 22 meteorites have been recovered from California, 26 from Arizona, and about 120 from Texas. In general, more have been found across the southern part of the United States and Mexico than across Canada and the northern part of this country.

Although approximately 40 percent of the world's 2,000 known meteorites were observed falls, only three or four of the meteorites of the Pacific Northwest were seen falling. Most of the Northwest meteorites can be considered as finds, and the following account indicates that meteorites have been found in a variety of ways associated with man's activities. Since so few meteorites have been discovered in such a large area, it is probable that many others exist and could be found if more people frequenting the outdoors became familiar with meteoritic properties. It is also quite likely that some people treasure unreported and undescribed meteorites among their possessions. Since meteorites are of most value as objects of scientific study, such unreported specimens should be described in the scientific literature.

Alaska

Only three meteorites have been found and described in the scientific literature from Alaska, a state larger than Texas.

The first meteorite from Alaska became known about 1881 when the California State Mining Bureau purchased a 94-pound iron from Indian Chief Donawack or "Silver Eye." The chief reported that the meteorite had been seen to fall at Chilkoot Inlet, Portage Bay, about a hundred years before by the father of one of the oldest members of the tribe. This iron, known as the Chilkoot meteorite, is now on display amid a large mineral collection in San Francisco at the California Division of Mines and Geology.

In 1921 the U.S. National Museum (Smithsonian Institution) received a 40-gram and a 280-gram specimen of a pallasite meteorite which had been found on top of a mountain about three miles west of the trading post at Cold Bay on the Alaskan Peninsula. The two fragments of the Cold Bay meteorite were badly rusted, resembling terrestrial limonite, but the interior revealed an irregular sponge of shiny metal with interstices of yellow olivine characteristic of pallasite meteorites.

On August 11, 1942, a gold dredge uncovered a 95-pound iron meteorite from 12 feet underground along Aggie Creek on Seward Peninsula about 90 miles southeast of Nome. The operator, on hearing the thump of something very heavy hit the dump plate, shut down the dredge to investigate more carefully. At first he thought he had hit real gold because of the weight and color of the heavy rock, but after scratching the surface with a file he found to his disappointment a silver-colored metal. This fine meteorite is displayed at the University of Alaska.

British Columbia

Two stony meteorites, both observed falls, have been reported from British Columbia. Data regarding the falls are very scanty.

The first observed fall in the Pacific Northwest occurred on May 26, 1893, after many persons had heard the noise of a passing meteor. Two masses weighing 5 and 25 pounds respectively fell near Beaver Creek, a few miles north of the American-Canadian boundary and about ten miles above the point where Beaver Creek flows into the Columbia River. Fragments of these two specimens have become widely distributed in the world's important meteorite collections. The largest extant piece, weighing about 6.5 pounds, is in the meteorite collection of the American Museum of Natural History in New York; a smaller piece, weighing about 4.5 pounds, is in the Field Museum of Natural History in Chicago.

A brilliant fireball crossed British Columbia on March 31, 1965, and after a search was carried out two very small fragments of a stony meteorite weighing about 1 gram were recovered. These specimens were found about 38 miles northwest of Revelstoke, the name by which this meteorite is now known.

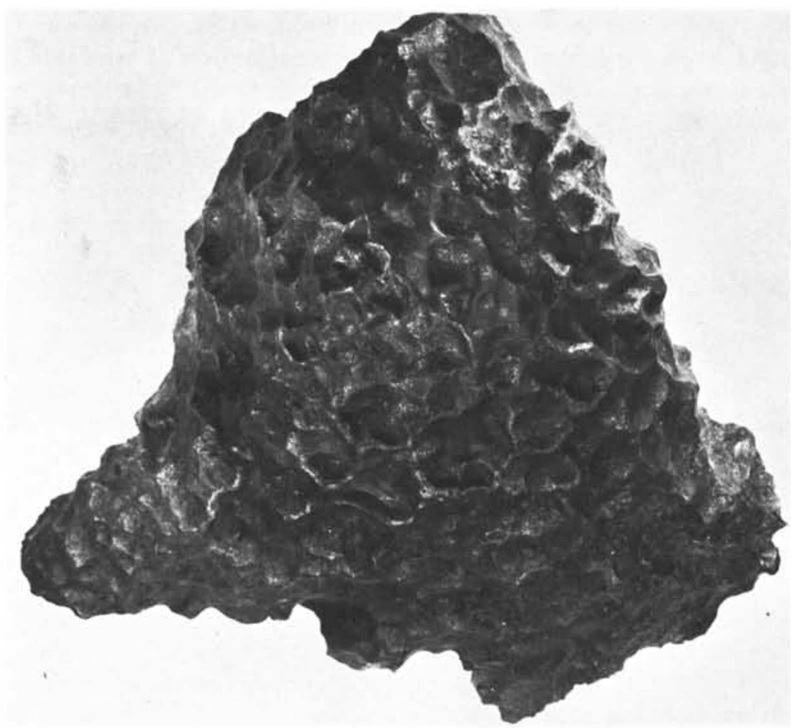
Idaho

Three meteorites are known from Idaho. The first, a small $9\frac{1}{2}$-ounce iron, was found sometime before 1895 by a gold prospector at the bottom of a 12-foot shaft on Hayden Creek. For weeks the prospector pounded on the small iron with a sledge hammer, thinking the object was gold. When he finally succeeded in breaking it in two he was greatly disappointed at the shiny silver-white interior. The two pieces were cut up further so that specimens of this meteorite are in many meteorite collections.

Idaho's largest meteorite, the 260-pound Oakley iron, was found in May 1926 by two teenage boys who were cutting cedar posts in the hills a few miles east of Oakley. As the axe struck the iron the boys were startled by a ringing sound. After the meteorite was displayed in Oakley, it was purchased by the Smithsonian Institution for its collection of meteorites.

In 1954 a 15-pound stony meteorite was found in Jerome County. No details of this find are known.

The Chilkoot meteorite, a 94-pound iron found by Indians at Chilkoot Inlet, Alaska, about 200 years ago.



Idaho's largest meteorite, the 260-pound Oakley iron.

Nevada

Four meteorites, all irons, have been found in Nevada. One of these was a small 10.6-pound iron discovered near Quartz Mountain in central Nevada in 1935. It lay under rocks and debris and was covered with a layer of reddish-brown iron oxide, indicating an old fall. The meteorite was presented to the University of Nevada at Reno where the specimen is on display in the Mackay Museum.

An unknown prospector discovered one of the West's great meteorites in 1908 on the western slope of the foothills of the Quinn Canyon Mountain range about 90 miles due east of Tonopah. The meteorite, shaped like a giant turtle, weighed 3,275 pounds and required the use of a heavy freight wagon with six horses, a crew of three men, a derrick, cables, and pulleys in order to move it to Tonopah, the nearest rail center. The moving took eight days.

This meteorite has a fine low-cone shape due to its oriented attitude in flight through the atmosphere. In flight the apex of the cone is forward. This has resulted in a series of furrows and channels from atmospheric shaping. The Quinn Canyon, like many large iron meteorites, also has many pits or holes which penetrate the mass for several inches. The openings of nearly all the holes are smaller in diameter than the cavities. The Quinn Canyon iron is the largest specimen in the meteorite collection of the Field Museum of Natural History in Chicago.

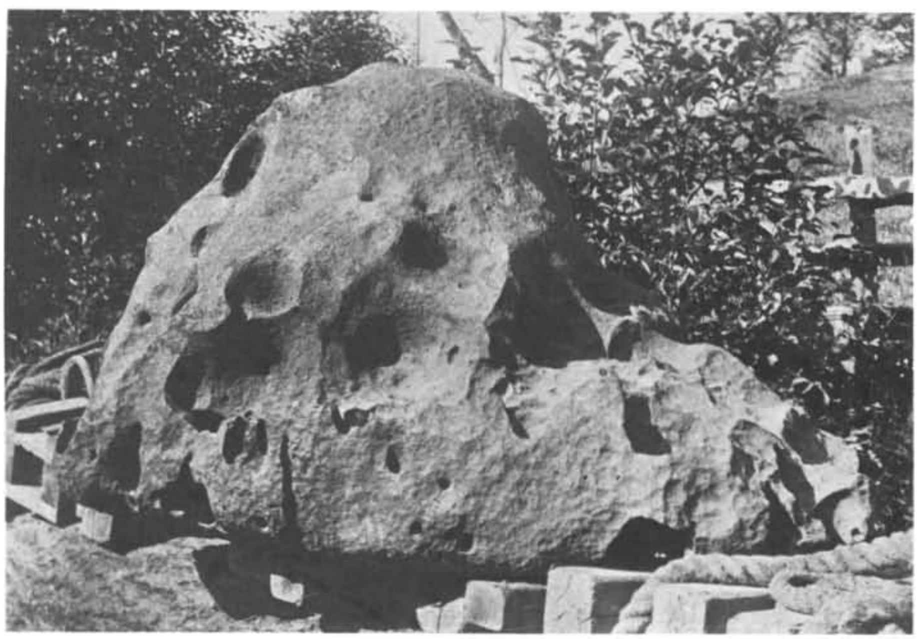
Two other irons, of which little is known, have been found in Nevada. One was a mass of unknown weight discovered in 1930 about 30 miles north of Las Vegas. A specimen of about 6.5 pounds of the Las Vegas meteorite is in the U.S. National Museum. Another meteorite of unknown weight was found near Tonopah sometime before 1947; a small 33-gram piece is in the U.S. National Museum.

Oregon

Four meteorites have been authenticated from Oregon. A piece weighing about one ounce in the U.S. National Museum and a still smaller fragment in the Natural History Museum in Vienna are the only evidence of the lost Port Orford pallasite meteorite reportedly found by Dr. John Evans about 1856 on the western face of Bald Mountain. When Dr. Evans died any further knowledge of the site of discovery was lost. The Port Orford meteorite is estimated to weigh ten to eleven tons. A feature article in Argosy, March 1963, called "The Treasure From Outer Space," pointed out that $2,200,000 awaited the finder of the great meteorite. This fantastic claim has excited many searchers each year.

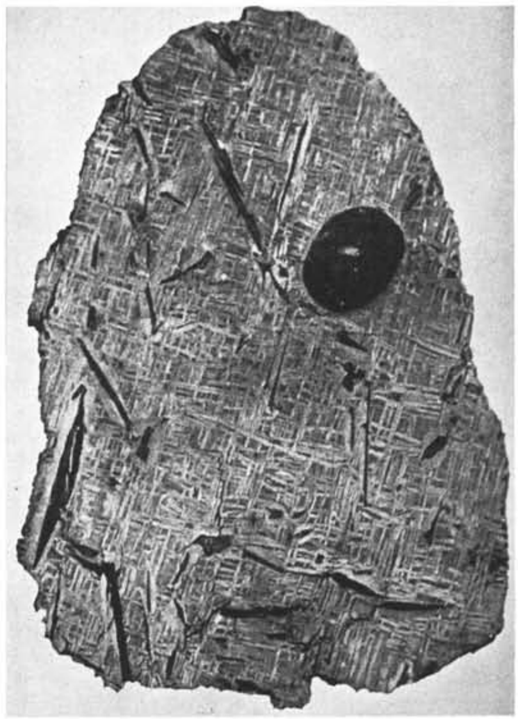
In 1894 a 15-pound iron meteorite was found near the community of Sams Valley, north of Medford. About 1914 the specimen was sold to the

One of the largest meteorites of the West, weighing 3,275 pounds, found near Quinn Canyon Mountain, Nevada. (Courtesy of Chicago Natural History Museum)



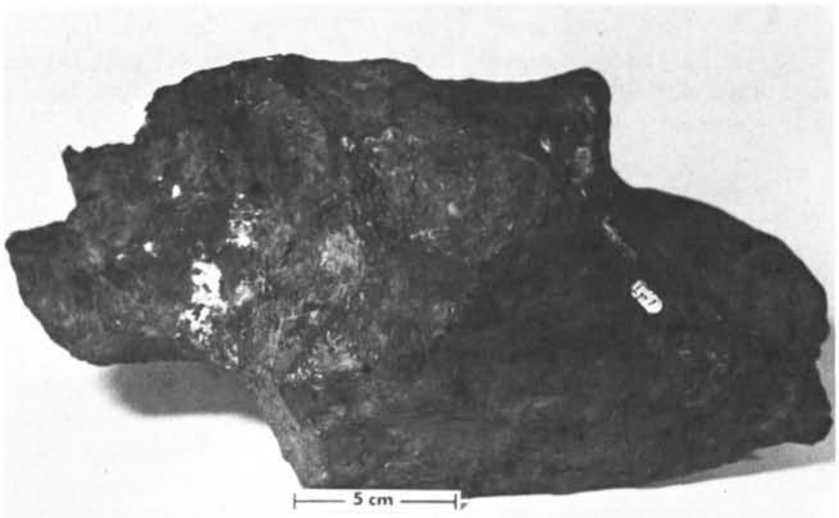
The famous $15\frac{1}{2}$-ton Willamette iron, largest meteorite ever found in the United States, discovered in 1902 near Willamette, Oregon. (Oregon Historical Society photograph)

Foote Mineral Company, which had it cut into a number of pieces for distribution to various collections. Over the years several smaller specimens were found in the same area, giving evidence that the Sams Valley fall was a meteoritic shower. Pieces of the Sams Valley iron are in the Natural History Museum of the University of Oregon and the Jacksonville Museum.

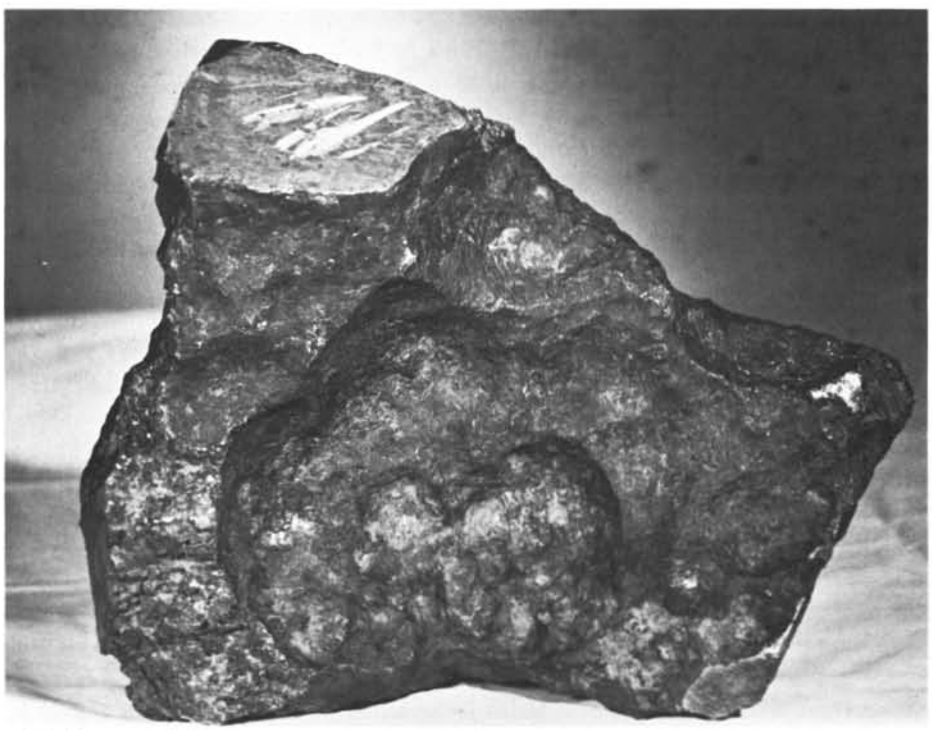


A slice of the 15-pound iron meteorite from Sams Valley, Oregon. (From Foote, 1915) Approx. $\frac{1}{2}$X

One of the most interesting and majestic meteorites found any place on earth is the 15$\frac{1}{2}$-ton Williamette iron, the largest meteorite ever found in the United States. It was discovered in 1902 by Ellis Hughes on land belonging to the Oregon Iron and Steel Company in the hills near Willamette, now a community in the city of West Linn. The ownership of this great meteorite involved Indian rituals and two court cases. Both the circuit court in Oregon City and the State Supreme Court ruled in favor of the Oregon Iron and Steel Company, a decision which embittered Mr. Hughes the rest of his life. After the meteorite was on display at the Lewis and Clark Exposition in Portland in 1906, it was sold to the American Museum of Natural History in New York. There it is prominently displayed in the hall of the Hayden Planetarium along with the great Greenland irons brought to the United States by Admiral R. E. Peary.



The Klamath Falls iron meteorite weighing 37.5 pounds found in 1952.



Washington's largest meteorite, weighing 75 pounds, found near Waterville about 1927. (Jay McMullen Photography)

After 50 years without new meteorite finds in Oregon, the 37.5-pound Klamath Falls iron was discovered in 1952 by Jack Halsell, at that time a logger for Ellingson Lumber Company. The mass was sold to the Institute of Meteoritics at the University of New Mexico in Alburquerque, where it is now on exhibition.

Washington

The three Washington meteorites are of interest in that all have remained in collections in the Pacific Northwest.

The largest Washington meteorite is the 75-pound iron found by Fred Fachnie while harvesting wheat on his farm about 16 miles northwest of Waterville in central Washington. The exact date is not known but it is assumed that the discovery was made in 1927. The specimen was first displayed in a local hardware store and then loaned to the Washington Historical Society, where for many years it was exhibited amid a mineral collection in the Society's Tacoma Museum. In 1962 it was returned to Waterville, where it is now exhibited in the local historical museum. A second Waterville meteorite, an iron weighing 19.5 pounds, is also on display. This Waterville meteorite has been of particular interest to science because of the rich abundance of troilite (iron sulfide) nodules scattered through its mass.

On Sunday morning, July 2, 1939, a brilliant fireball passed over Portland, Oregon, shortly before 8:00 a.m. Just east of Portland the meteor exploded, shaking many buildings in the city and surrounding areas. The fireball, called the Portland meteor, proved to be exceptionally newsworthy and was reported in newspapers from coast to coast. In August of 1939 a small meteorite was found by Jerry E. Best of Washougal, Washington, who sent the specimen to J. Hugh Pruett in Eugene. Today the Washougal stone is in the Natural History Museum of the University of Oregon. It is about the size of a tennis ball and weighs about half a pound. It has a smooth, black fusion coat formed by its fiery passage through the atmosphere. Small particles of nickel-iron are distributed throughout its light-gray interior.

Washington's most recent meteoritic fall is very controversial. Between January 17 and 20, 1955, several Seattle and nearby Kirkland newspapers reported on two small iron meteorites coming through the dome of an observatory belonging to an amateur astronomer. Although the fall received unusual publicity, it was not investigated by scientists from the Seattle area. However, in 1960 Dr. W. F. Read of Lawrence College, Wisconsin, came to Kirkland to investigate the unusual occurrence. He found two small iron specimens which someone had badly mutilated with acid but which were true meteorites. He also found two holes in an aluminum panel of the dome of the observatory. The holes appeared to have been made by melting rather than rupture by a projectile. Several meteoritic scientists have considered the event a hoax. The two meteorites, along with the aluminum panel, are on display in the Waterville Historical Museum with the Waterville meteorites. The Kirkland irons are now referred to in the scientific literature as a very doubtful fall.

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WASHINGTON DIVISION OF MINES ISSUES OPEN-FILE REPORT

A preliminary geologic map of the Southern Cascade Range, Washington, has been released for public inspection and reproduction. The report, prepared for the Division by Dr. Paul E. Hammond of Portland State University, is a part of the geothermal energy research program of the Washington Department of Natural Resources.

Hammond's report consists of a geologic map with cross sections that covers an area from Stevens Pass to Vancouver and from Puget Sound east to Yakima, a detailed geologic map of the area between Mount Adams and Mount St. Helens, a chart showing the chronologic relationships of volcanic eruptions, and a brief explanation.

Copies are available for inspection at the Division of Mines and Geology in Olympia, Washington, the California Division of Oil and Gas in Sacramento, California, and the Oregon Department of Geology and Mineral Industries in Portland. Reproductions are available at Ivor McCray's Copy Center, 121 W. Legion Way, Olympia, Washington 98501.

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THOMS TO HEAD EARTH SCIENCES DEPARTMENT AT PSU

Richard E. Thoms has been elected chairman of the Department of Earth Sciences of Portland State University. John Eliot Allen, who has been chairman and head of the Department since its formation in 1956, retired from administration July 1. He will continue to teach during the coming year.

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U.S.G.S. ISSUES NEW JOURNAL OF RESEARCH

"Journal of Research of the U.S. Geological Survey," is the outgrowth of the Survey's 13-year series of professional papers entitled "Geological Survey Research," also known informally as the "annual review" series. The Journal is published 6 times per year for the purpose of making the Survey research more readily available to readers. It contains papers by members of the Geological Survey on geologic, hydrologic, topographic, and other scientific and technical subjects.

For sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D. C., 20402. Current annual subscription rate is $15.50. Single copies are $2.75.

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The Ore Bin

Vol. 35, No. 8
August 1973

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
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The ORE BIN
Volume 35, No. 8
August 1973

FOSSIL BIGHORN SHEEP FROM LAKE COUNTY, OREGON

Richard E. Thoms* and Harold Cramer Smith**

In the first week of October, 1972, Roy Collier, a bulldozer operator for the MC ranch at Adel, Oregon, bulldozed up a skull from the gravels near the mouth of Twentymile Creek. The locality is in the South Warner Valley, Lake County, Oregon, in the NW¼, sec. 19, T. 40 S., R. 24 E., W. B. & M. Subsequent examination of the skull indicated that it represents a specimen of *Ovis catclawensis* Hibbard and Wright, an extinct Pleistocene species of bighorn sheep known only from the Great Basin. A "battered cobble" of basalt, possibly representing human occupation of the stream bank or its vicinity, was found in association with the skull.

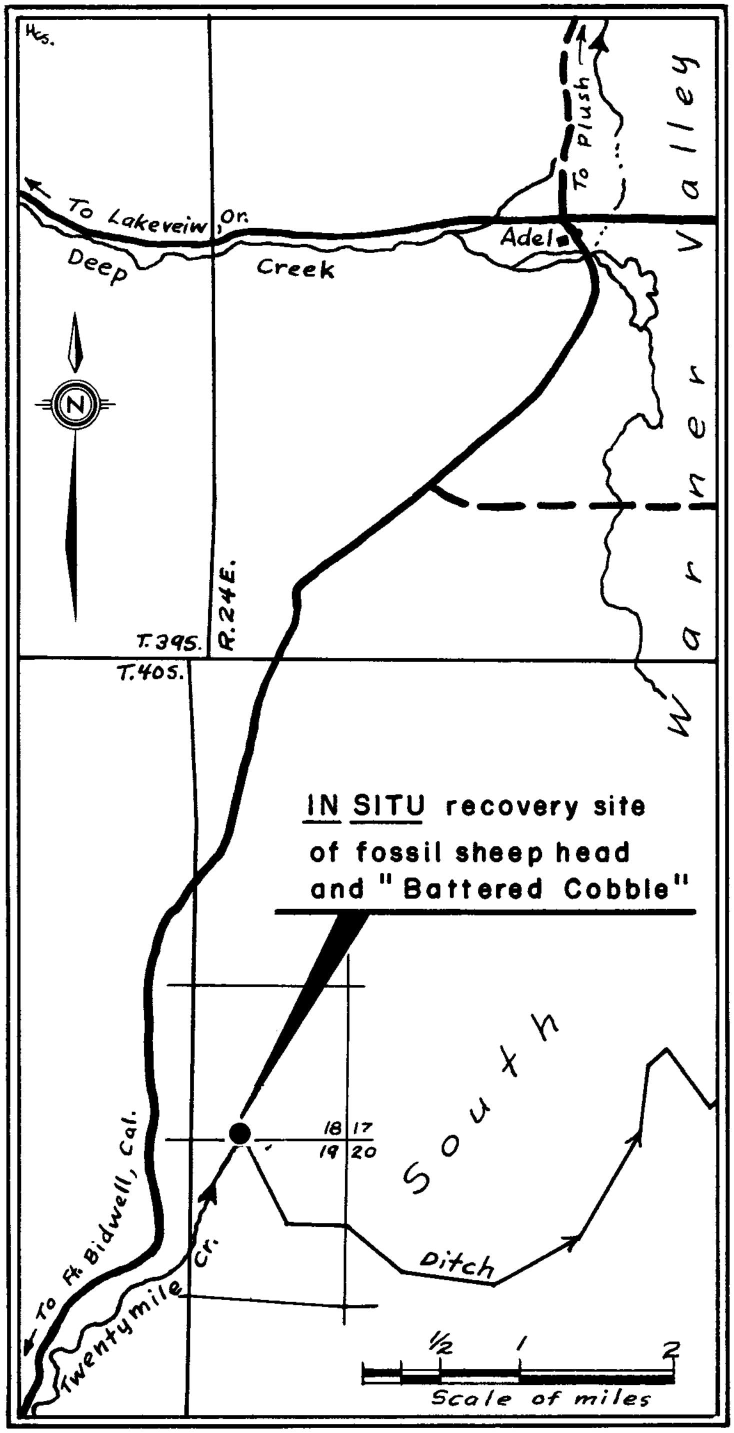
Previous Studies on Fossil and Living Bighorn Sheep From North America

For a thorough treatment of the various studies which have been made on the descriptions, distributional patterns, and evolution of fossil and recent bighorn sheep in North America, the reader is referred to the paper by Stokes and Condie (1961). The following section, a review of the historical record of bighorn sheep in the Oregon country, is offered for the reader to better understand the rugged and limited conditions under which the modern analog of *Ovis catclawensis* now survives in a portion of the Great Basin.

Historical Record of Bighorn Sheep (*Ovis canadensis*) in the Oregon Country

The story of the decline of bighorn sheep in Oregon parallels the decline of other wilderness species that could not compete with the coming of the white man and his "civilization."

*Chairman and Associate Professor of Geology, Department of Earth Sciences, Portland State University
**Wildlife artist, Information and Education Department, State of Oregon Game Commission



Map showing location of fossil sheep skull.

The bighorn is strictly a wilderness animal, intolerant of heavy hunting and competition with domestic livestock, elk, and deer. At one time much more numerous than today, bighorn sheep were widespread over the West wherever rugged terrain provided desired habitat. As the white man turned livestock onto accessible ranges and extensively hunted the bighorns, they retreated to the most inaccessible, wildest, and highest peaks of the Rockies and to the deserts of the Southwest. All this happened quickly in the last half of the 1800's.

Distribution in North America

Two distinct species of wild mountain sheep evolved in North America since Pleistocene times, according to Cowan (1940). They are the thinhorn sheep (*Ovis dalli*) with three races or subspecies, and the bighorn sheep (*Ovis canadensis*) with five races.

Distribution in Oregon

Two types of bighorns were originally native to Oregon: the California bighorn (also called the rimrock or lava beds bighorn), and the Rocky Mountain bighorn. Bighorns generally have more massive, close, heavier horns than do the northern thinhorns, with usually blunt, broomed tips as compared to the sharper, wider spread point of the Dall and Stone sheep. The Rocky Mountain bighorn, "Emah-ki-kini" of the Blackfeet Indians, held to the relatively small area of the northeast corner of the state, including the Wallowas and part of the Blue Mountains. Old timers reported the Rocky Mountain bighorn as far south as the Strawberry Mountains in Grant County and over to the high breaks along the Snake River Canyon. U.S. Forest Service reports indicate a remnant of these sheep as late as 1933 in the high Wallowas.

The California bighorn ("Tsnoon" of the Warm Springs Indians, and "Quoipa" of the Piutes) ranged from the Cascades east through central and southeastern Oregon. Early explorers such as Peter Skene Ogden gave accounts of the lava beds sheep near the Deschutes River in the area south of The Dalles, which is still known as the "Mutton Mountains." From locales such as this, the sheep ranged eastward through Hart Mountain and the Steens Mountains to Idaho and Nevada. One authentic report places these sheep as far southwest as the Siskiyou Mountains along the California-Oregon border.

Survival

Several theories are advanced as to the cause of the extinction of this species in Oregon. Schnabel in 1916 wrote that disease in the winter of 1884-1885 killed most of the sheep in the desert country. However,

FOSSIL BIGHORN SHEEP SITES REPORTED IN WESTERN NORTH AMERICA

LEGEND FOR NUMBERED SITES

1. Two remains in Alaska-Kowak clays
2. Canada - Last Chance Creek - Yukon Territory
3. Washtucna Lake (Old Washington Lake) - Franklin County, Washington
4. Mouth Twentymile Creek, Lake County, Oregon
5. Willow Creek Canyon - near Winnemucca, Nevada
6. Danger Cave, Utah
7. Hardman Gravel Pits - Salt Lake City, Utah
8. Gypsum Cave, Nevada
9. Catclaw Cave, Mohave County, Arizona
10. River gravels near Bloomfield, New Mexico

parasites from domestic sheep appear to be the greatest decimating factor. Huge flocks of domestic sheep covering much of the high desert range near and after the turn of the century contaminated nearly all parts of both summer and winter range. The scab mite supposedly caused loss of hair and undercoat so that the wild sheep perished from exposure during the winter. This theory is questioned by some authorities. In 1914, a Mr. Tillford of Fort Klamath stated that close grazing of bighorn winter range by domestic flocks resulted in heavy winter die-off in the winter of 1879-1880. Other eastern Oregon rangers corroborated the starvation theory.

In Oregon, the Steens and Hart Mountains appeared to be the last stronghold of the California bighorns. The last records of wild sheep in these areas was an account, by Goldman, of one or two rams seen on Hart Mountain in 1912. By 1916 the California bighorn had disappeared from the state.

In 1939, a group of Lakeview sportsmen, with the aid of the U. S. Biological Survey, released 23 Rocky Mountain bighorns on Hart Mountain. This transplant was unsuccessful.

In 1954, the Oregon Game Commission, in cooperation with the British Columbia Game Department, trapped 20 sheep in British Columbia and released them in Oregon. Again the Hart Mountain area was chosen as a good site. They were released into a 34-acre pen and held there while a 600-acre holding pen was constructed on the west face of Hart Mountain. The large pen was started in March, 1955, and completed in July of that year. It consisted of over 4½ miles of fence constructed under adverse conditions and on very difficult terrain.

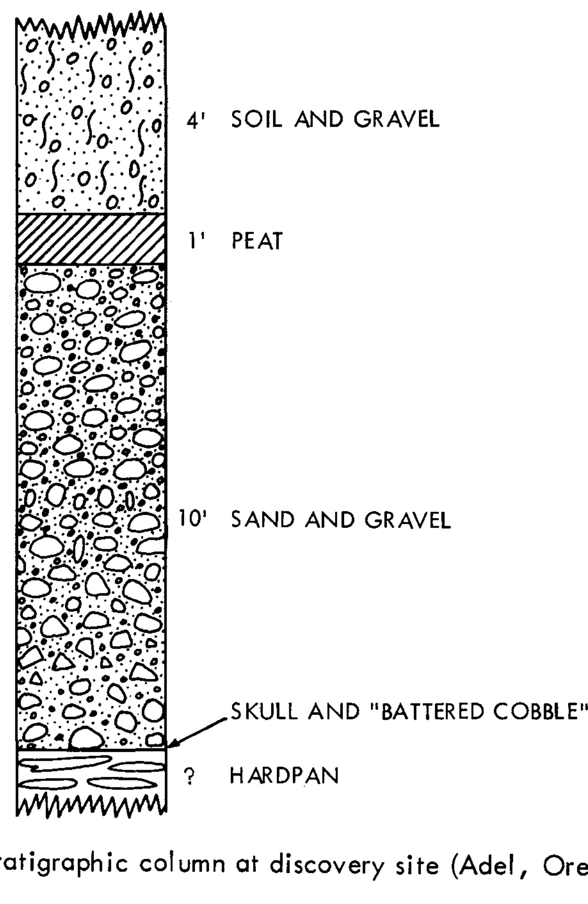
The sheep quickly adapted to life in the 600-acre pen. The first release from the pen was made in June, 1957, when 18 sheep were allowed to escape from the pen at the west face of the mountain. Since that time a few sheep have liberated themselves by breaking through the fence. An attempt has been made each year to tally as many sheep as possible both inside and outside of the pen. By 1960, the known population was over 64 animals, including animals both in and out of the enclosure. In 1960 four sheep were caught and moved to Steens Mountain, a distance of about 70 airline miles, and in 1961 an additional seven sheep were moved to that site.

In November of 1965, 17 sheep were transplanted from the Hart Mountain herd to the Owyhee Canyon country. In 1971, 21 Hart Mountain sheep were released in the Strawberry Mountains area south and east of John Day and Prairie City. Also in 1971, 40 sheep from Jasper National Park were released on two different sites in the Snake River country, 20 head below Hells Canyon Dam, and 20 head on the lower Lostine River. To date, some of the transplants have been sufficiently successful to allow limited permit hunting.

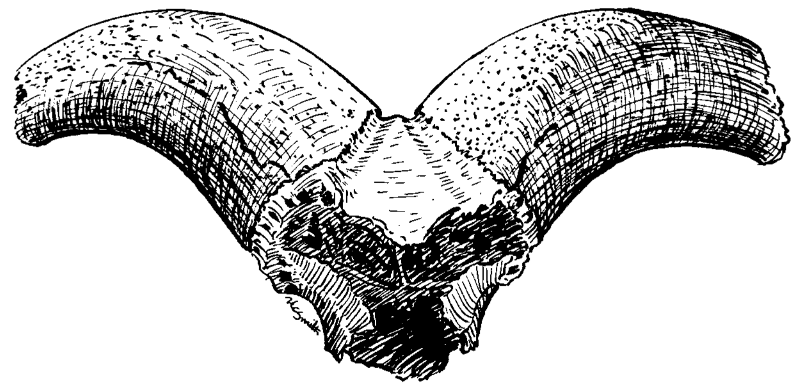
Stratigraphy

The skull and "battered cobble" were found about 5 feet apart on the south side of the creek bed, lying on the hardpan layer beneath the oldest deposit of sand and gravel exposed in the bed of Twentymile Creek. The sand and gravel was previously about 8 to 10 feet thick, but was partially cleared away about 10 years ago. The bed of Twentymile Creek is artificially altered by continual construction of revetments and digging in the channel for agricultural purposes. Thus, the specimens were covered by only about 4 feet of the deposit. They were obviously associated with the sand and gravel and not with the hardpan. A layer of peat, about 1 foot thick, overlies the sand and gravel, and this in turn is covered by about 4 feet of mixed soil and gravel.

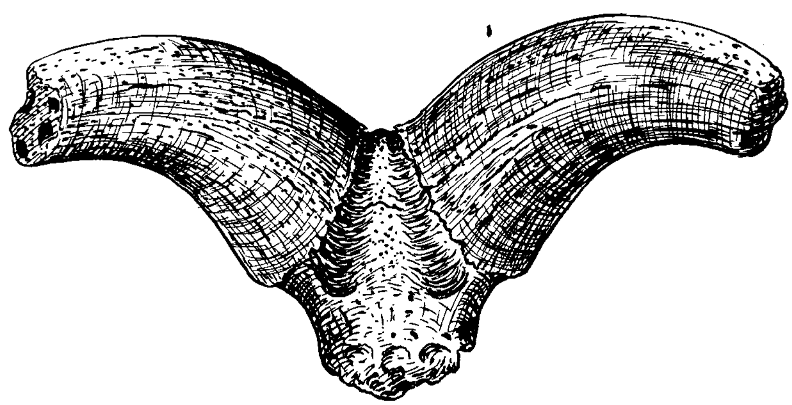
Across the channel on the north side, about 5 to 10 yards from the bank, is a promontory where the wind has blown away the soil in places, exposing numerous artifacts. This may represent an old campsite, and thus a human origin for the "battered cobble" is made more probable.



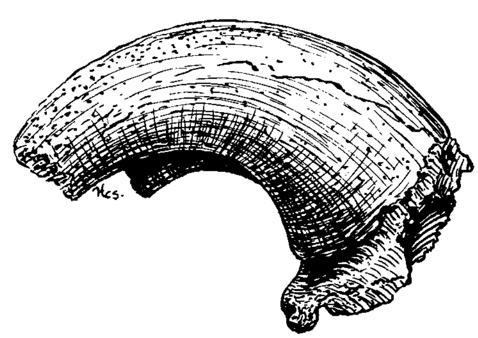
Stratigraphic column at discovery site (Adel, Oregon)



Front View



Rear View



Side View

Three views of partial skull and attached horns of Ovis catclawensis from Adel, Oregon.

Description and Comparison of the Adel Specimen

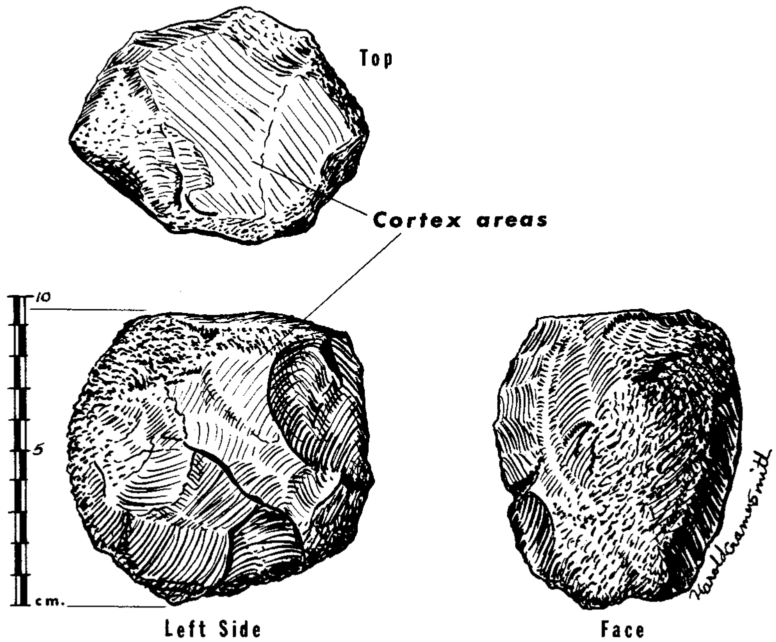
The accompanying table summarizes the measurements which could be made on the specimen, a partial skull with attached horn cores. These measurements compare favorably with those made by Stokes and Condie (1961) on fourteen specimens of _Ovis catclawensis_ from several localities in the Great Basin. However, the partial nature of the Adel specimen permitted only one of Stokes and Condie's "most significant measurements" -- the maximum core circumference -- to be compared. Comparison of illustrations from Stokes and Condie with the specimen shows many similar features. In addition, comparison of the Adel specimen with specimens and measurements of the modern _Ovis canadensis canadensis_ and _Ovis canadensis californiana_ do not warrant inclusion in either of these subspecies. The Adel specimen possesses the robust features of a mature male, with the fused condition of cranial sutures characteristic of an individual of 10 years or more in age.

Horn core and skull measurements of the Adel specimen

Maximum diameter at base of horn cores:	left	116 mm
	right	115 mm
Minimum length of horn cores:	left	179 mm
	right	179 mm
Circumference of horn cores at base:	left	336 mm
	right	337 mm
Minimum angle between horn cores:	90°	

Conclusions

The discovery of the Adel specimen extends the known range of _Ovis catclawensis_ into the northwestern-most part of the Great Basin. Although a precise date for the locality has not yet been established, all heretofore known occurrences of this species are Pleistocene, and the majority of these are from the Alpine Formation of the Bonneville Lake basin. The association of skull and "battered cobble" in proximity to a living site suggests that _Ovis catclawensis_ was contemporaneous with early man in at least part of its stratigraphic range. This association, as well as the geographic distance of the find from those of the Bonneville basin, should spur interest in this fascinating part of Oregon's Pleistocene record.



"BATTERED COBBLE"

Possible artifact from mouth of Twentymile Creek in South Warner Valley. (Found in association with sheep skull.)

Description: Approximately cobble size, some cortex* (20%) remains, both areas of cortex on opposite ends of object.

Appears to have been battered over 60% of surface, quite a number of hinge-flake scars visible in one area. Spalls and other flake scars over much of remainder of surface. Little indication of mechanical transportation subsequent to manufacture is present. It was apparently deposited at site of find or nearby. An in situ circumstance is indicated.

Conclusion: Quite high probability that this object represents human (cultural?) modification, but it is not a standard artifact form. Other associations and data needed to confirm. I would call it a "battered cobble."

Dr. Tom Newman
Department of Anthropology
Portland State University

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*Natural, unflaked surface of the basalt cobble

Acknowledgments

The assistance of several persons who have aided in the preparation of this report is hereby acknowledged. First of all, Roy Collier, of Adel, Oregon, whose sharp eye and steady hand first brought the specimen to light and whose generous loan of the specimen made its careful study possible. Next, Dr. Tom Newman of the Department of Anthropology, Portland State University, who analysed the "battered cobble;" and finally, David Taylor, who made the measurements of the skull in the Earth Sciences Museum, Portland State University.

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THE BALANCED ROCKS OF THE METOLIUS

Phil Brogan
Bend, Oregon

John Strong Newberry, physician, naturalist, and geologist, was nearing the end of an historic exploration of the upper Deschutes country in the late summer of 1855 when he discovered a strange formation in the Metolius River canyon.

His observation concerned a group of balanced rocks visible today on the north-facing slope of the Metolius River canyon where the rocky wall of the Metolius sharply slopes to the man-made lake behind the Round Butte Reservoir. This reservoir is Lake Billy Chinook, named for an Indian Scout of pioneer days.

In 1855, Dr. Newberry, for whom Mount Newberry was named years later, was physician for the Williamson Railroad Survey party, which was assigned the task of locating a possible route for a railroad between the Sacramento Valley of California and the Columbia River basin.

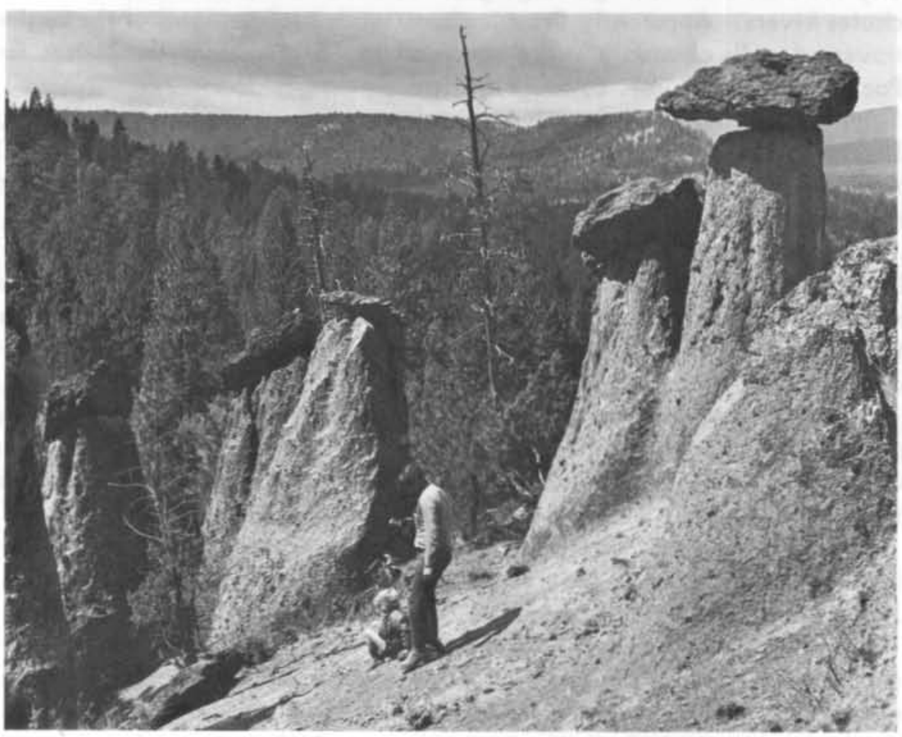
Members of the railroad survey party, headed by Lt. R. S. Williamson, moved northward from Klamath Basin toward Fort Dalles; their route eventually took them into the grand gorges of the Metolius, Crooked, and Deschutes Rivers. Apparently Dr. Newberry made profuse notes of the region traversed. His observations are recorded in "Explorations for Routes for Pacific Railroad," vol. 6, pt. 2, 1855.

After leaving the party's base camp near the present site of Sisters, Dr. Newberry and his group rode toward Mount Jefferson. He noted, "On the side of Mount Jefferson was plainly discernible a stream of black and rugged lava which had descended nearly to the Metolius River."

From this point of observation, the explorers followed the Metolius River downstream some 20 miles. Newberry wrote, "The canyon walls on either side continued as high as where we struck it until we emerged from the hills which form the eastern base of Mount Jefferson." There the party came to the plateau of the Deschutes.

Near the head of a dry canyon, Dr. Newberry suddenly came on a spectacular group of perched rocks. He wrote, "This canyon, where it cuts through the hills, exposes nothing but volcanic rock, generally dark, vesicular trap [basalt], with sometimes volcanic conglomerate.

"In some places where this formed the north wall of the canyon, the fragments which it included were of large size, cemented by a tufaceous [tuffaceous] base which was readily eroded by the action of the weather. The portions of this material which here underlie these larger masses of enclosed trap were protected by them from the erosion which wore away the surrounding rock, and they were left perched on pinnacles 20 or 30 feet in height, and having a less diameter at the summit than the rock they sustain."



Dr. Newberry also noted a marked change in walls of the Metolius River canyon as he moved downstream. He wrote:

"The precipices, composed of trap and volcanic conglomerate which with a height of nearly 2,000 feet had enclosed it for twenty miles, were here succeeded by strata of tufas [probably tuffs]. These formed walls perhaps 2,000 feet in height, capped by a thick layer of columnar trap [basalt]."

It is apparent that at this point Dr. Newberry was referring to The Dalles Formation, also known as the Deschutes or Madras strata, which is composed of layers of water-laid tuffaceous siltstone, sandstone, and conglomerate interbedded with basaltic lava flows and ash-flow tuffs.

Although Dr. Newberry obviously was intrigued by the giant, perched rocks, flat and slightly tilted, he did not show these in the big 1855 railroad survey volume, which holds a number of sketches of prominent landmarks.

Not far from the balancing slabs of volcanic debris is another "garden" of balancing rocks. These are not as massive, nor as high as the familiar balancing rocks. The second group has been named Button Head Rocks.

The balanced rocks illustrated in the accompanying photographs are at the head of a small canyon south of the Metolius River about 9 miles north of the Fly Lake Guard Station. Information relative to reaching the site can be obtained at Lake Chinook Village. This service area is near the top of the west grade out of the Crooked River Canyon in Cove Palisades State Park.

For more information about the geology and history of the region, see the references listed below:

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* * * * *

LAND USE PLANNING

A. J. Teske, executive secretary of the Idaho Mining Association, said recently that any land use planning approach which fails to take into consideration subsurface mineral potential will severely reduce the nation's capability to meet future mineral requirements.

Speaking at the Inland Empire Chapter of the Society of American Foresters' annual meeting in Spokane, Teske said most of the land use policy proposals presented to date seem to discard the multiple use management principle in favor of identifying lands for their dominant use.

He said that more often than not superficial appraisals and personal value judgments are the determining factors, not actual resource values.

Teske noted that only a fraction of western public land has been seriously explored and evaluated for mineral potential.

"If at this time, a land use plan is adopted preventing mineral exploration and development because the land is committed to specific surface uses, the importance for mineral purposes will never be known," he said.

"The mining industry recognizes that there are certain land areas of unusual and unique value which may justify preservation," Teske said. "But, as a general policy, lands valuable for a particular surface use should not be closed to the evaluation of their importance for mineral purposes."

Citing substantial projected increases for mineral demand in the years ahead, Teske said the domestic mining industry must continue to have reasonable access to the public lands under land use policies which recognize certain basic facts about the needs of the industry.

Among those facts: (a) Most of the mineral deposits for future requirements are still undiscovered, (b) it will require extensive and expensive exploration to find these deposits, and (c) minerals can be mined only where they exist - not where they are environmentally acceptable.

(Amer. Gold. News., v. 4, no. 6, p. 7, 1973)

* * * * *

BERKLUND NAMED DIRECTOR OF BUREAU OF LAND MANAGEMENT

Curtis J. (Curt) Berklund, 43, of Cottonwood, Idaho, has been appointed Director of the Bureau of Land Management. Berklund succeeds Burt Silcock, who is now Federal Co-Chairman of the Joint Federal-State Land Use Planning Commission for Alaska. Berklund has held several jobs in the Department of the Interior prior to his appointment as Director. Before entering government he was an executive with resource industries, basically lumbering and ranching in Idaho.

* * * * *

Book Reveiw: GEOTHERMAL ENERGY, Resources, Production, Stimulation
Edited by Paul Kruger and Carel Otte

This book, released by Stanford Press in July of this year, is recommended to any serious student of geothermal energy, and because of its broad treatment of the entire field, would make an excellent textbook.

Papers presented at the special symposium held by the American Nuclear Society in June of 1972 have been enlarged and thoroughly edited for technical content by the original symposium participants. Individual papers discuss available and potential resources throughout the world, methods of exploration and evaluation, geological and geochemical character of the resource, problems in developing the several types of resources, the current status of geothermal energy production in the United States and elsewhere, potential methods for more efficient production, the impact on the environment, and possible uses as a water resource. Six papers are devoted to the possibilities of stimulating resources by underground explosion or other fracturing methods, either to generate steam or to release existing fluids from otherwise sealed aquifers.

Of special benefit to students are the extensive bibliographies that accompany most of the articles.

The book is available from Stanford University Press, Stanford, California, 94305, for $17.50.

* * * * *

MORE NATURAL GAS TO BE FOUND IN U.S.

Undiscovered gas resources in the United States are estimated by the Potential Gas Committee to be 50 times the present annual use. In other words, these supplies, plus existing reserves, could meet the nation's gas needs for the next 60 years. Future gas supplies will cost more to find and develop than the earlier supplies since they will come from offshore wells, wells located in the Artic, or from wells onshore at depths of 15,000 feet or more below the earth's surface. The future potential supply of natural gas in the United States, according to the committee, is 1,146 trillion cubic feet. Current proved reserves in the United States total 266 trillion cubic feet and present annual use is 22.5 trillion cubic feet.

The Potential Gas Committee consists of 150 scientists and engineers from industry, universities, and governmental agencies under the direction of the Colorado School of Mines. The School of Mines has endeavored to establish the independence and absolute freedom of the Committee from industry or political influence. The Oregon Department of Geology and Mineral Industries has contributed data to the study for the past six years.

* * * * *

PENDLETON QUADRANGLE MAP PUBLISHED

"Reconnaissance geologic map of the Pendleton quadrangle, Oregon and Washington," has been published by the U.S. Geological Survey as Miscellaneous Geologic Investigations Map I-727. The map and accompanying text are by George W. Walker. The Pendleton quadrangle map, at a scale of 1:250,000, covers a large region of northeastern Oregon between 118° and 120° lat. and 45° and 46° long. It includes a large part of the Columbia River Plateau and the northern edge of the Blue Mountains. The region is occupied mainly by basalts of the Columbia River Group, but includes in its southern part rocks as old as Paleozoic. Map I-727 is on one sheet, together with explanation of units, a brief text, a tectonic map, and a list of references. The map is for sale by the U.S. Geological Survey for 75 cents.

* * * * *

GOLD AND SILVER ASSAY CHARGE RAISED

The Governing Board of the Department of Geology and Mineral Industries, at its August 10 meeting, determined that increased costs of laboratory materials and supplies make it necessary to raise the charge for combined gold and silver assays from $4.00 to $5.00. Assays for either gold or silver alone will remain at $3.00.

* * * * *

WASHINGTON MINES AND GEOLOGY DIVISION RENAMED

Geology and Earth Resources Division is the new name recently given the Mines and Geology Division of Washington's Department of Natural Resources. It was announced that the new title is more consistent with the Division's objectives and services in relation to present-day technology. No staff changes will be made, and V. E. (Ted) Livingston, Jr., who supervises the Division, continues as the State Geologist. The Division remains at the same location. Mail address is: Department of Natural Resources, Geology and Earth Resources Division, Olympia, Washington 98504.

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The Ore Bin

Vol. 35, No. 9
September 1973

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

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The ORE BIN
Volume 35, No. 9
September 1973

PLATINUM IN OREGON

Steven R. Munts*

The platinum-group metals have been the subject of considerable discussion in the news media over the past few months, particularly because of their projected use as catalysts in automobile engines. Metals Week of August 27 shows that platinum commands a price of $176.00 per ounce, as compared to $150.00 per ounce last May.

Oregon's platinum production has been tied closely to its gold placer mining activities; therefore, little production has been recorded since 1942 when Executive Order L-208 closed down practically all of the gold mines in the country. The future potential of platinum production in Oregon is difficult to predict. The present high price of both gold and platinum should certainly act as a stimulus for exploration, particularly if the prices remain at their present level or go even higher.

This issue of The ORE BIN discusses the properties of the platinum-group metals and describes areas in the state where platinum is known to occur. We hope this information will encourage new exploration efforts in Oregon.

Introduction

Platinum is classified as one of the "precious metals," although not too long ago it had little value. At the turn of the century, for example, it was considered only a nuisance when found in gold placer deposits. Platinum-group metals are well known, but their occurrence in Oregon is seldom mentioned.

Over 60 percent of the platinum or platinum-group metals consumed in the United States are used in the production of jewelry, electrical contacts, and chemicals. The newest demand for platinum is by the automotive industry for use in catalytic exhaust emission devices.

* Private geologist, Sweet Home, Oregon

Platinum was first discovered by the Spaniards in Colombia, South America, in 1735, where the metal was collected and taken back to Spain. In Spain, the new metal was named platina, from the Spanish word plata for silver.

Physical Properties

The platinum group of metals comprises six elements: platinum, iridium, osmium, ruthenium, rhodium, and palladium. Platinum, iridium, and osmium have the greatest density, and iridium is now recognized as the heaviest element that occurs in nature. Densities of ruthenium, rhodium, and palladium average only 55 percent as great. Thus, these six elements are divided by their densities into two sets, which are analogous to gold and silver, and just as native gold is invariably alloyed with silver, so all six of these elements are invariably present as native alloys of the platinum metals.

The platinum metals are slightly magnetic as opposed to gold and silver, which are non-magnetic. Palladium has the greatest and osmium the smallest magnetic susceptibility. Palladium has a higher magnetic susceptibility than any other non-ferromagnetic element so far determined.

The natural alloys of the platinum metals occurring in black sand placer deposits are handled differently by producers than the natural alloys of gold and silver. Since native gold is non-magnetic, most of that found in the black sand which is not removed by washing can be reclaimed by magnetic separation of the other minerals, such as magnetite, chromite, and ilmenite. Native platinum cannot be handled by this method. Since the platinum metals are slightly magnetic and a part of the alloys may be ferromagnetic, not all the other minerals of the black sand can be separated magnetically from the platinum.

The usual method for extracting platinum from black sands requires several steps. Crude placer platinum is first separated from the black-sand concentrates by the use of a concentrating table, such as a Wilfley. Screening of the dried metals and magnetic separation, so far as permitted, are then employed. This product is then either further refined by blowing it from a vibrating hopper, as employed by the Goodnews Bay Mining Company, Alaska, or it may be sent directly to the smelter.

Chemical Properties

Pure platinum is not attacked by the common inorganic acids, but is dissolved, though less readily than gold, by aqua regia, from which it can then be precipitated with the addition of ammonium chloride. The precipitate will give platinum metal when heated. Potassium iodide may also be used as a precipitating agent.

On the other hand, pure iridium and rhodium are not appreciably attacked by aqua regia or other inorganic acids, and osmium and ruthenium are quite insoluble in such acids. Palladium is dissolved not only by aqua regia but also by hot nitric or hot sulfuric acid. This vulnerability of paladium to acids is reflected in its inferior ability to withstand the effects of weathering and consequently by its greater tendency to form natural mineral compounds.

Mineralogy

The platinum metals occur in nature in two forms: first, as natural alloys and in intergrowths of alloys; and second, as chemical compounds in which the platinum metals function as cations. The alloys have as wide ranges in composition as their crystallography and other factors permit. The chemical compounds also have variable compositions but within smaller limits, as these are controlled by substitutions of cations and anions requiring comparable radii. Wright and Fleischer (1965, p. A5-A6) have tabulated as compounds, or mineral species, the platinum metals known to be chemically combined with oxygen, sulfur, arsenic, antimony, bismuth, tin, or tellurium, if these elements function as anions. They point out, however, the uncertainty in classifying platinum metals, and suggest that a few of the so-called alloys may be partly or wholly minerals and vice versa.

Alloys and compounds of platinum metals are too numerous to list here, but they are tabulated by Wright and Fleischer (1965) and also by Mertie (1969). The alloys are referred to in terms of their mixtures and intergrowths with other elements, for example "cuproplatinum" or "ferroplatinum." The compounds, in contrast, are given specific names ending in "ite" denoting a mineral species, for example "sperrylite." A number of the platinum alloys and minerals are unnamed.

Sperrylite ($PtAs_2$) is the most common of the platinum minerals; it is a tin-white, brittle, cubic, has a black streak, a hardness of 6-7, and a specific gravity of 10.58.

Geologic Occurrence

Platinum rarely forms compounds and occurs in basic and ultrabasic rocks, where it has been concentrated by magmatic processes. These magmatic concentrations are subdivided into two groups by Bateman (1942): the early magmatic phase, and the late magmatic phase. In the early magmatic phase, platinum occurs as sparse disseminations with chromite in dunites. The erosion of such deposits yields platinum placers such as are found in the Ural Mountains of Russia, Alaska, and Colombia. Platinum may also be concentrated in this stage by segregations or fractional crystallization. Such deposits include those at Merensky Reef, Rustenburg, South Africa.

In the late magmatic phase, platinum concentration can occur as immiscible liquid segregations, as is found at Vlackfontein, South Africa. Concentration may also occur as an immiscible liquid injection. Deposits at the Frood mine at Sudbury, Ontario, may have formed in this manner. Platinum can also occur in contact metasomatic deposits, as in Tweetfontein, South Africa, or as hydrothermal deposits, as at Sudbury, Ontario (Bateman, 1942).

Platinum often occurs as a mineral constituent of peridotite, serpentine, dunite, norite, olivine gabbro, and of less importance, in pyroxene, especially olivine pyroxenites. Platinum is commonly associated with olivine, chromite, pyroxene, magnetite, and nickel.

Platinum, as sperrylite, is present in some high-temperature sulfide deposits. Chalcopyrite, pyrrhotite, and quartz veins may contain varying amounts of the platinum-group metals. Replacement ores of copper and gold and some base-metal veins may also contain the platinum-group metals.

Classification

The classification of platinum deposits is best described by Mertie (1969) as follows:

"The platinum metals occur in workable deposits mainly as platinum minerals in nickel-copper and copper lodes and as platinum alloys in placers, but they occur also in other environments that are of more scientific than economic interest. The principal workable lodes are in Ontario and Manitoba, Canada, in the central Transvaal, Republic of South Africa, and in several areas of northwestern Siberia, U.S.S.R. To these should be added the lithified placers of the Witwatersrand, Republic of South Africa. Most of the workable lodes are characterized by platinum and palladium minerals, but some of them, notably in the Transvaal, also yield small amounts of the native metals or alloys.

LODES

"The platinum metals occur as lodes in several different environments. The more significant deposits are related to the basic or ultrabasic rocks, but these metals are also found in ores that are related to granitic rocks, as shown in the following classification:

Classification of platinum lodes

"A. Platinum-bearing nickel-copper, copper, or copper-cobalt sulfides that are related genetically to basic or ultrabasic rocks, commonly the former, but are not magmatically segregated ores. The workable lodes occur principally as secondary concentrations of ore minerals rather than as magmatic minerals in situ, though the secondary ores appear to grade into disseminated ore minerals in the associated igneous rocks. The ore bodies occur either along the contact of the basic intrusives with country rock, or at variable distances up to 5 miles from the basic intrusives. These ores may or may not be associated with igneous rocks, of which some are considered to be related genetically to the parent basic rocks. By some geologists, the sulfides of these secondary deposits are thought to have originated as immiscible fluids of magmatic character; by others, these sulfides are considered to be epigenetic hydrothermal deposits. The ores of the Sudbury district, Ontario, exemplify such deposits. Native platinum metals or their alloys are commonly absent from deposits of this type.

"B. Platinum-bearing nickel-copper ores that are magmatically disseminated or concentrated in gabbroic and ultrabasic rocks. Pyroxenite and anorthosite the principal source rocks are commonly associated with norite and all of these may have the outlines of dikes, sills, pipes, lenses, or schlieren. These rocks are petrographically homogeneous along their major structures for long distances, but they vary locally and produce layers and lenses of peridotite and chromite. The platinum metals occur mainly in sperrylite, cooperite, and other platinum and palladium minerals, but smaller amounts of the native platinum metals or alloys are commonly present. The platinum minerals occur in the sulfides and in lesser amounts in the silicates and may be sufficiently plentiful to constitute the principal value of the ores, with byproducts of nickel copper, and other metals. The Merensky zone, in the Bushveld igneous complex of the Transvaal, illustrates this type of deposit. The ratios of platinum to palladium are significantly greater in the ores of class B than in those of class A.

"C. Native alloys of the platinum metals that are magmatically disseminated in peridotites, less commonly in perknites, and rarely in gabbros. If concentrated, they are commonly intergrown with chromite. Most of these deposits are in dunites, which range in composition from hortonolite dunite to olivine dunite. The dunites at some localities may be partly or wholly altered to serpentinite. The platiniferous hortonolite or iron-rich dunites are exemplified by the Onverwacht and Mooiheep properties in the Bushveld igneous complex of the Transvaal. Platiniferous dunites, perknites, and their alteration products are the sources of the Uralian placers; dunite and serpentinite are the sole sources of the placers of the Goodnews Bay district, Alaska; and so far as known, similar peridotites and perknites are the sources of most placers that are known in the world. Platinum and osmiridium lodes have been discovered in dunite or serpentinite, principally in the Urals and in South Africa, but generally they have proven to be either too small or too low grade for profitable mining. Some masses of chromite, however, have been found in dunite that had high tenors in the platinum metals.

"D. Platinum minerals or native platinum alloys in copper and related ores indigenous to contact metamorphic and other types of ore bodies, including vein systems.

"E. Native platinum metals in the gold ores of quartz veins and in other ores of free gold.

"F. Platinum-bearing meteorites.

"G. Secondary platinum metals:

1. Recovered in purification of blister copper and copper mattes that produced on a large scale.
2. Recovered at the U.S. Mint and other mints, in the refining of metallic gold. The U.S. Mints make no payment to the producers of gold bullion for such platinum metals, claiming them as seignorage.
3. Recovered from industrial wastes and from jewelry.

PLACERS

"Platinum placers consist of alluvial deposits that contain in workable amounts the alloys of the six platinum metals, and it is worthy of note that no analagous deposits of platinum minerals have ever been found. The platinum metals occur commonly in two alloys of variable composition, of which one consists dominantly of platinum with varying amounts of the other five elements, whereas the other consists dominantly of iridium and osmium, less ruthenium, still smaller amounts of platinum and rhodium, and with little or no palladium. Much of the placer platinum consists of two intergrown or intermixed alloys, each of variable composition, as exemplified by the product recovered in the Goodnews Bay district....

"Some of the alluvial platinum comes from placers that yield both gold and platinum. The stream placers of Colombia and of California,... are excellent examples. Commonly the gold and platinum are separate alloys, one of gold and silver and the other of five or six platinum metals. This fact is not generally clarified by analyses of placer platinum, as small amounts of gold are reported merely as a part of the contained precious metals. Hence such analyses, in order to be comparable with others which show no gold, have to be recomputed free of gold as well as free of "impurities." Examples will later be given, however, of placer gold with which small amounts of the platinum metals are alloyed.

"The densities of the platinum alloys found in placers and the sizes of their grains are generally similar to those of alluvial gold; hence, the geologic classification of platinum placers is exactly like that of the gold placers, as heretofore used by the writer:

A. Residual and eluvial placers.

B. Stream placers.

1. Present stream valleys.
2. Older stream valleys.
    a. Terrace deposits.
    b. Buried deposits.

C. Beach placers.
  1. Present beaches.
  2. Ancient beaches.
    a. Elevated beach deposits.
    b. Buried beach deposits.
D. Deltaic and outwash deposits.
E. Glaciofluvial (glaciofluviatile) deposits.
F. Aeolian deposits.
G. Lithified placers.

"Placers of the platinum metals are commonly derived from dunite or serpentinite, less commonly perknite, in which these metals are sparsely and irregularly distributed. In nonglaciated regions, it may be inferred that the original lodes could be discovered by tracing the alluvial deposits upstream. Commonly the general country rock may thus be recognized, but workable lodes can rarely be located. This may result from one or more of the three following causes:

1. The original rocks from which the placers were derived may have been completely eroded, so that no platiniferous source rocks remain in the area.
2. The present country rock may be platiniferous, but may represent the uneroded low-grade roots of lodes that were much richer in their apical horizons.
3. All the original source rocks may have been of extremely low grade, and the placers may have been concentrated from such sources over a very long period of time. Under such circumstances, representative source rocks, even if preserved, would not constitute workable lodes and are not likely to be discovered.

"The formation of placers is possible under any of these conditions. But workable lodes can rarely be located in placer fields, and it is therefore concluded that the platinum metals in placers have been concentrated generally from source rocks wherein these metals were sparsely and widely disseminated.

"Heavy metals, such as platinum or gold, rarely migrate far downstream from their bedrock sources, unless they are so fine grained as to be moved by swift water or floated by surface tension. Flour gold, for example, may move downstream for many miles, in fact to the ocean. Generally, however, ordinary detrital grains of platinum or gold work rapidly downward through alluvial deposits, and come to rest either near, on, or within bedrock. If the bedrock has a well-developed cleavage or fracture, the precious metals may penetrate 10 feet or more. Only very high water that cuts to bedrock, or rejuvenation of a stream, will again move these metals, and even under these conditions, their downstream migration is not great. Hence, excepting some special environment, such as glaciation, placers of the precious metals may be assumed to lie within a few miles of their bedrock sources. If placer paystreaks are very long, it may be suspected either that several bedrock or proximate sources are present in a valley, or that the metals have been distributed downstream by repeated lowering of the base level of erosion or as result of glaciation."

Platinum in Oregon

The occurrence of platinum in Oregon is thoroughly discussed by Mertie (1969), from which the following is quoted:

"The platinum metals found on the beaches of Oregon and California appear to have originated in bodies of peridotite and serpentinite. The great dike of serpentinite that crops out in the valley of the Applegate River, a north-flowing tributary of the Rogue River, and continues northward may be such a source rock. Platinum was located in the Highland mine, about 12 miles south of Gold Hill, in the Gold Hill quadrangle, Oregon. According to Kellogg (1922, p. 1000), this metal was finally traced to a bluish quartz that was taken from the 100-foot level of the Gold Hill mine. The tenor in platinum, as given by smelter returns, was 0.32 ounce per ton of ore. Serpentinite, however, is probably the major source.

PLACERS

"Platinum-bearing gold placers have been found and mined at three localities in Oregon. The most important of these was the Takilma-Waldo district, in Josephine County, about a mile northeast of Waldo and about 30 miles southwest of Grants Pass. Gold was discovered in 1853 on Althouse Creek and thereafter was mined for many years, particularly before 1917 but also up to 1930. A second but less important site was on Applegate River, about 25 miles northeast of Waldo. The third locality consisted of the Pacific beaches of Curry and Coos Counties, which were discovered in 1852 and were worked intermittently for many years. According to Shenon(1933, p. 179), the minimum production of the platinum-bearing gold placers of the Takilma-Waldo district up to 1930 was $4 million, but no estimate is available for Applegate River and its tributaries. No record was kept of the early production of gold and platinum from the ocean beaches of Oregon, but according to Pardee (1934, p. 26), quoting from the U. S. Bureau of Mines, the production of gold between 1903 and 1929 was about $60,000, of which about $2,000 was platinum.

"The production of platinum from Oregon in the period 1880-1903, with 9 years not recorded, is given by Quiring (1962, p. 254) as 675 troy ounces, with a maximum output in 1895 of about 130 ounces. Using a gold-platinum ratio of 100:1 for the Takilma-Waldo district, and rating platinum at twice the value of gold at that time, this district may have produced about 1,000 ounces. An unknown part of this output should be added to that given by Quiring for the period 1880-1903, so that the production of platinum metals from Oregon may have been as much as 1,500 ounces.

Takilma-Waldo district

"The deposits of the Takilma-Waldo district include both Tertiary and Quaternary placers. The Tertiary placers, which are in Tertiary conglomerate, are composed of large, greatly altered, boulders of greenstone, granite, argillite, and other rocks in a well-indurated sandy matrix. Gold and platinum are distributed throughout the conglomerate and are only slightly concentrated near bedrock, which suggests local sources. Well-known deposits in the Tertiary conglomerate that were worked at a profit were the High Gravel, Cameron, and Platerica mines. The ratio of gold to platinum is reported to have ranged from 75:1 to 100:1, but no assays or analyses of the platinum appear to have been made. The principal heavy and semi-heavy minerals recovered with the precious metals were chromite, magnetite, limonite, hematite, ilmenite, epidote, and zircon.

"The more valuable deposits of the Takilma-Waldo district were gravel deposits on terraces or in the present valley floors. One of the best known properties of this group was the Logan mine, later known as the Llano de Oro mine, but best known perhaps as French Flat. This was a terrace from 15 to 20 feet high, on the west side of the East Fork of the Illinois River, about a mile northeast of Waldo. The deposit consisted of imperfectly sorted gravel, sand, and clay ranging in thickness from a foot at its outer edge up to 50 feet. The gold was angular and was associated with chromite, magnetite, ilmenite, hematite, limonite, epidote, and zircon. The ratio of gold to platinum was reported to have been about 50:1. According to Shenon (1933, p. 187), a sample of the platinum was analyzed by E. T. Erickson, of the U.S. Geological Survey, who reported that it consisted largely of platinum and ruthenium, less iridium and osmium, and very small amounts of palladium and rhodium. This analysis differs from any other known to the writer, and if reliable, is indeed unique.

"Other deposits worked in the Takilma-Waldo district were the Deep Gravel mine, and those on Fry, Waldo, Allen, Butcher, and Sailor Gulches. These properties were mainly in the valley floors of the present streams and were concentrated from the Tertiary conglomerate, which constituted a proximate source rock. Platinum was undoubtedly recovered from these deposits but its presence was not mentioned either by Horner (1918) or by Shenon (1933).

Applegate district

"Applegate River is a northwest-flowing tributary of Rogue River. Mining was carried on in the Applegate district for years after mining ceased in the Takilma-Waldo district. A nonfloating dredge, probably mounted on skids and moved by a caterpillar, was operated on the Applegate River in 1944, and two others were operated in the Applegate drainage. In addition, some mining was in progress on Forest and Poorman Creeks, tributaries of the Applegate River. The following analysis of platinum, made by the Wildberg Smelting and Refining Co. of San Francisco, was given to the writer by an operator on the Applegate River: platinum 29.70, iridium 31.96, osmium 25.56, ruthenium 12.78, rhodium not determined, total 100 percent. This is clearly a mixture of osmiridium with ordinary platinum, wherein osmiridum is a major component.

Pacific beaches

"The beach deposits of Oregon have been well described by Pardee (1934). In Curry County the principal localities, named from south to north, were the mouth of Chetco Creek, Ophir Creek, the mouth of Pistol River, Gold Beach at the mouth of the Rogue River, Eucher Creek, Port Orford, and Cape Blanco near the mouth of the Sixes River; in Coos County, Bandon at the mouth of the Coquille River, Old Randolph on South Slough, and Coos Bay at the mouth of Coos River. These deposits were discovered in 1852, and those of higher grade were soon exhausted, yet many of them were worked intermittently for years afterwards.

"The coastal ranges of Oregon are bounded on the west by a narrow Pacific coastal plain that ranges in width from a quarter of a mile to 4 miles and in altitude from sea level to 100 feet, with numerous low marine terraces. There are also higher terraces at or about 170 feet above sea level and one higher terrace at an altitude of 800 feet. Deposits at the 170-foot level were worked at two mines east of Cape Blanco and at four mines north of Cut Creek. The Peck mine, at an altitude of 800 feet, was on a spur north of the Sixes River, and still other terraces up to an altitude of 1,500 feet are present, though none of these was mined. The terrace deposits, however, proved not to be as high grade as those in the coastal plain or low terraces. Probably the richest deposits were found south of Coos Bay, but the beaches at Whisky Run, Cape Blanco, Port Orford, and Gold Beach were also remunerative.

"The platinum metals and the gold are extremely fine, rounded, flat grains from 0.8 to 0.05 millimeter in diameter and from 0.05 to 0.005 millimeter in thickness, but range downward to grains of microscopic size. The ratio of gold to platinum varied from 100:1 to 160:1. The heavy and semi-heavy minerals on the Port Orford and adjacent beaches were found to be mainly magnetite, chromite, ilmenite, garnet, and olivine. Some zircon and monazite were also found at Coos Bay.

"Two chemical analyses, which are believed to represent the platinum of the littoral deposits, have been published and are presented in Table 43. It may be assumed that most of the "osmium plus iridium" recorded in Table 43 is iridium, but these analyses, owing to the high percentage of

Table 43. Analyses, in percent, of platinum metals from Pacific beaches of Oregon
(N.D., no data)

	A	B
Platinum	53.37	57.20
Iridium	.42	.45
Osmium	N.D.	N.D.
Osmium plus iridium	38.69	41.46
Ruthenium	N.D.	N.D.
Rhodium	.67	.72
Palladium	.16	.17
Iron	4.46	N.D.
Copper	2.23	N.D.
Total	100.00	100.00

A. Deville and Debray (1859); republished by Kemp (1902, p. 19)
B. Deville and Debray (1859)

platinum, do not represent osmiridium alone. On the other hand, the high tenors in osmium plus iridium indicate that much osmiridium is present. If these analyses represent an alluvial mixture of two alloys, as may well be true, they suggest that the ratio of osmiridium to platinum is high. Owing to the low percentage of rhodium, these two analyses do not correspond closely with any of those recorded for California.

"Platinum metals have been found, generally as traces, in many other counties of Oregon, and from Baker County there was a small production in 1925. Platinum has been identified in Jackson, Douglas, Lincoln, Linn, Clatsop, Washington, and Multnomah Counties, in the western part of the State; Wheeler and Grant Counties, in the central part; and Union County, north of Baker County, in the eastern part of the State."

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MORTON NAMES DAY AS MESA CHIEF

Secretary of the Interior Rogers Morton has appointed James M. Day, director of Interior's Office of Hearings and Appeals since its creation in 1970, to be administrator of the new Mining Enforcement and Safety Administration (MESA), effective immediately.

"Mr. Day's excellent legal training, his keen knowledge of mining issues and mine safety, and his exceptional administrative talent are prime qualifications for this new assignment," the Secretary said. "He has demonstrated outstanding competence in the area of mine safety enforcement."

Morton pointed out that Day had conducted public inquiry into general problems of coal mine health and safety on the Secretary's behalf, and also had conducted a comprehensive investigation into the cause of the disaster which claimed 91 lives at the Sunshine Silver Mine in Idaho.

MESA's responsibilities include enforcement of the Federal Coal Mine Health and Safety Act and the Federal Metal and Nonmetallic Mine Safety Act. Mine health and safety, assessment and compliance, education and training functions were transferred to MESA from the Bureau of Mines in May.

Day, 43, whose selection concludes an exhaustive search for the best qualified person to head the new agency, was a private attorney in Washington, D.C. before his 1970 appointment to the Interior post. Donald P. Schlick, acting administrator, will remain as depty administrator.

* * * * *

OUR OTHER MINERAL RESOURCES ARE ALSO SCARCE

For many months we have been hearing reports on an energy crisis - and there really is one, as the demand for energy of all sources continues to grow faster than the supply of energy from all sources. Now, a new threat to the strength of our economic society has been highlighted as the U.S. Geological Survey has released a comprehensive report showing that for most of our mineral needs the United States already is a major importer and faces further critical shortages in the next twenty years.

U.S. Geological Survey Professional Paper 820, "United States Mineral Resources" reviews more than 60 mineral commodities which are essential resources in our industrial society and finds that we possess less than half a dozen commercial minerals in major quantities. For the rest, we face fast increasing shortages which will call for (1) even more imports than we have now, (2) revised industrial technology, (3) developing substitutes, (4) increased recycling, (5) intense new exploration, and (6) improved mining and mining technology.

As one looks ahead in the energy "crisis," solutions appear on the horizon in various forms, such as: new oil discoveries, coal liquifaction and gasification, oil shale development, tar sands development, acceptable nuclear energy, geothermal energy, etc.

Ironically, with much less fanfare and ballyhoo about our other minerals shortages, they may actually be more serious to our society, inasmuch as realistic solutions to their shortages are not on the horizon. Among our existing critical shortages are ores of aluminum, chromium, manganese, mercury, silver, tungsten, asbestos, and nickel. But joining the critical list soon will be lead, zinc, titanium, uranium, barite, high-quality clays, and many others.

While most people can translate energy shortages into person impacts such as lack of heat or transportation fuel, most persons don't relate to a widespread industrial minerals shortage. Yet the impact of such shortages will be tremendous, ranging from high-priced imports which will seriously affect our balance of payments, to a need to alter and even curtail our voracious, mineral-consuming technology as we find ourselves running short of one item after another.

The U.S. Geological Survey has done a real service in highlighting the problem of mineral shortages in Professional Paper 820, "United States Mineral Resources." This 722-page report is available from U.S. Government Printing Office, Washington, D.C. 20402 for $9.15. A 19-page summary is available free from the U.S. Geological Survey, Washington, D.C. 20244; it is listed as Geological Survey Circular 682, "Summary of the U.S. Mineral Resources."

(By Arthur A. Socolow, in Pennsylvania Geology, v. 4, no. 3, 1973)

* * * * *

GEODETIC SURVEY MAP SHOWS CRUSTAL MOVEMENT

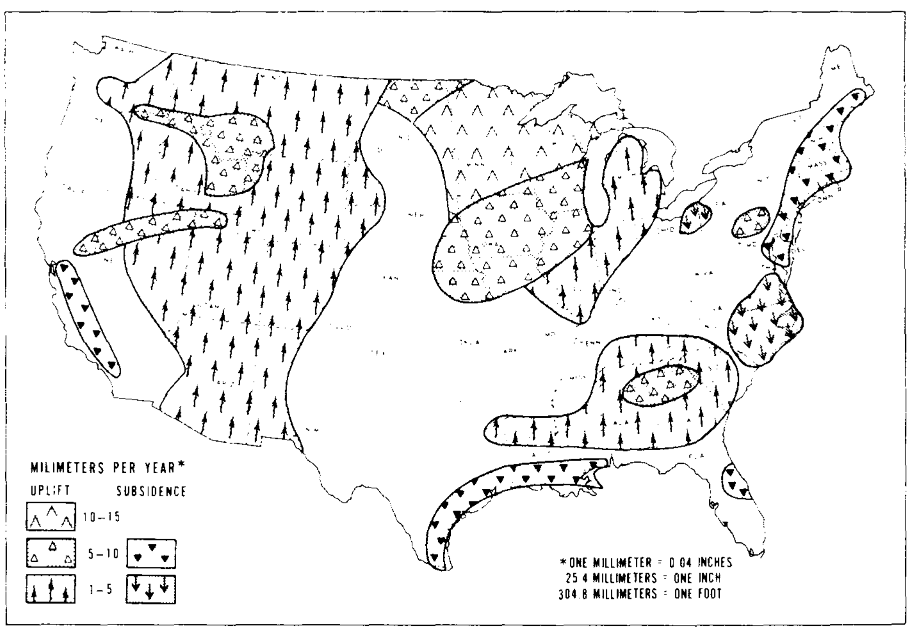
A new map of the United States showing vertical movements of the earth's crust indicates that the land in much of the country is slowly rising or falling and that very few really stable areas exist.

The first compilation of its kind for the United States, the map reveals probable annual rates of crustal movement over large regions.

The map is based on measurements made over the past 100 years by surveyors and geodesists of the National Geodetic Survey. Only the larger areas of land subsidence and uplift are shown on the map; much of it is based on interpolation between widely-spaced lines of elevation that have been measured by geodetic field parties.

Some of these movements are minute, detectable only by painstaking and repeated measurements over a period of years. Others are large enough to be of concern in the design and maintenance of engineering structures, and in some areas land subsidence is sufficiently rapid to cause alarm. Samuel P. Hand, Chief of the National Geodetic Survey's Vertical Network Division, which developed the map, cited as one example of this the Houston-Galveston area in Texas which has subsided as much as 5 feet in 20 years. In the New Orleans area, a subsidence of more than 1 foot has been detected in a 25-year period.

These cities lie in a large area of subsidence which extends along the entire coastal plain of Texas and Louisiana. Hand said this rapid subsidence,



CRUSTAL MOVEMENT MAP SHOWING PROBABLE VERTICAL MOVEMENTS OF THE EARTH'S SURFACE and subsidence of the Central Valley in California, are largely the result of the removal of underground resources.

The NOAA geodesist pointed to Terminal Island at Long Beach, Calif., as an outstanding example of large-scale subsidence. Subsidence there reached more than 25 feet before it was checked by the injection of fresh water.

In such flat coastal areas, subsidence increases drainage problems and the danger of storm inundation. Among other areas so affected are the eastern shores of Delaware, Maryland, and Virginia, and the vicinity of Atlantic City, N.J.

Whereas some subsidence is caused by man, widespread vertical movements are due to natural internal forces which are forcing the earth's crust up or down.

(NOAA, v. 3, no. 1, p. 55, Jan. 1973)

* * * * *

COOS COUNTY BULLETIN AVAILABLE

Specialists in several fields have collaborated in producing the Department's newest bulletin, no. 80, "Geology and mineral resources of Coos County, Oregon." Ewart M. Baldwin, University of Oregon, and John Beaulieu of the Department's staff authored the sections on geology and geography. Mineral and fuel resources were the responsibility of staff members Len Ramp, Jerry Gray, Vernon C. Newton, Jr., and Ralph S. Mason.

The descriptions of more than 20 geologic units and their map distribution are the product of many years of geologic mapping in southwestern Oregon by Dr. Baldwin and graduate students working under his direction. Such comprehensive coverage has not previously been available for this area, which is the most complex geologically of the Oregon Coast.

Mineral production has not been as important economically in Coos County as elsewhere in the state, but metallic minerals in the black sands deposits and the coal deposits are of interest. Lists of mines and prospects are included. Twelve wildcat holes have been drilled in the search for oil, several of which had gas shows.

The 82-page bulletin is illustrated by numerous photographs; a three-part multicolored geologic map and a mineral resource map accompany the report. This report and its maps should serve as a useful guide for intelligent land-use planning and zoning in this region during the coming years.

Copies of Bulletin 80 are available from the Department offices in Portland, Baker, and Grants Pass and sell for $5.00.

* * * * *

DEEP WELL INFORMATION RELEASED

Two new publications recently added to the Department's Oil and Gas Investigations series (O&G 3 and O&G 4) provide fossil information and age of sediments on two deep wells drilled by oil companies in western Oregon. The author is Weldon W. Rau, geologist with the Washington Geology and Earth Resources Division.

"Preliminary identifications of foraminifera from General Petroleum Corp. Long Bell No. 1 well" (O&G No. 3) contains identifications of fossils found at depths ranging from 4,500 to 9,000 feet in the Douglas County well; age range is from middle to lower Eocene; Ulatisian to Penutian stages.

"Preliminary identifications of foraminifera from E. M. Warren Coos County 1-7 well, Oregon" (O&G No. 4) covers samples found at depths of 100 to 6,400 feet and of late Eocene age.

Each of the new reports is a two-page chart showing depths at which the particular specimens were found and whether their occurrence was rare, few, or common. Copies are available at the Department's offices at Portland, Baker, and Grants Pass for $1.00 for either O&G 3 or O&G 4.

* * * * *

WASHINGTON ISSUES COASTAL GEOLOGY REPORT

"Geology of the Washington Coast between Point Grenville and the Hoh River," a new publication published by the Washington Geology and Earth Resources Division, reviews the geologic processes which formed the rock formations and scenic features along one section of the Washington coast. The author is Weldon W. Rau.

The report is divided into two parts: Part I covers rock formations and their geologic history, and Part II gives geologic observations and interpretations of the four coastal segments. Most of the features described are accessible by roads and trails. The oldest rocks found in the area of the study are middle Eocene volcanics formed 45 to 50 million years ago, which were dated from microfossils contained in interbeds of marine siltstone. The youngest are Pleistocene sand and gravel and present-day beach deposits.

Photographs, both black and white and colored, liberally illustrate the report, and small maps locate the areas described in Part II. Copies of the report, Bulletin 66, are available from the Geology and Earth Resources Division, Department of Natural Resources, Olympia, Washington for $3.00.

* * * * *

Notice: The ERTS (Earth Resources Technology Satellite) map of Oregon reproduced in color with geographic overlay and explanatory text will be available from the Department's offices late in November. The price will be announced.

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-print, will be mailed)

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The Ore Bin

"Special Subscription Issue"

Vol. 35, No. 10
October 1973

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
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Subscription rate - $2.00 per calendar year
Available back issues $.25 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 35, no. 10
October 1973

MINING COMMUNICATIONS 70 YEARS AGO

Norman S. Wagner *

"MANESIS" or, if you prefer, "28585," meaning, "It is not advisable that this should be published" is part of an elaborate mining code in use early in the century when the telegraphic key was the foremost means of communication.

Creator of the code was Bedford McNeill, Associate of the Royal School of Mines in England. McNeill's Code, consisting of 45,000 words, was designed to cover the whole field of mining activities from claim staking to smelting. Each code word was accompanied by a corresponding five-digit number that could be substituted for it. Several pages of the 807-page code book are reprinted here.

Published in 1899, the code was "extensively adopted in all the more important mining centres throughout the world, including Australia, India, South Africa, and the United States." Since our western frontier abounded with persons engaged in some aspect of mineral development at the turn of the century, McNeill's Code is a part of the history of those times.

The versatility of McNeill's Code was limitless. A scout sent out to the frontier in search of promising mining investments could use it to dispatch a 67-word message to his associates at the expense of only 11 telegraphed words. For example, MANESIS BALANZON 28019 RINOMABILE LOSBRECHEN decodes to read, "It is not advisable that this should be published, but the general opinion of all who have visited the property is that the property is well placed for economic development and working." Add to this HOPLITES IMBAGNATO TRAMITELO and the message continues "Would suggest that you make an offer to option for 30 days." To advise the need for fast action, add ALEMA HOMEBRED LOWERMOST and urge, "Consider it very desirable at once to cable terms of offer. Delay on your part is dangerous; the property should not be lost."

Not only did this ingenious code provide a great saving in cost of sending messages, it also served as a protection of private business secrets, unless, of course, one's competitors also had copies of McNeill's Code. A section at the back, however, listed many extra and substitute code words

*Resident Geologist, Department of Geology and Mineral Industries, Field Office, Baker, Oregon so the user could record additional or secret meanings of his own devisement to further protect his information transmission.

In addition to the financial aspects of mining transactions, the code applied to rocks, minerals and ores, milling, smelting, machinery, repair and replacement, transportation, accidents, and all possible considerations even including the weather. Thus, PIANIST means "Shipments stopped as teams cannot haul on account of road." PORFIA explains further, "The roads are impassible from snowslides." And PORPORATO TRAITABLE adds the warning, "Shall probably be snowed up for another four weeks."

Some examples of the way McNeill's Code could be adapted to mining operations are given as follows:

Geology

DISIMULO IMPROBULUS SWINISHLY DIXIEME MAZZERO. The general geological conditions are such that I can confirm the statement made, i.e., as depth is obtained the ore bodies are more solid and continuous with visible free gold uniformly disseminated through the quartz.

Prospecting

SOLVIENTE TUSILAGO BALANZON SOMBROUSLY. The vein can be traced at the surface for a distance of 750 feet but it is a very irregular one both in width and value.

Lode mining

MANTENERSI TRAPECIO BALANZON EINFORMIG STOP REGRESSION. We will probably be able to sink 100 feet additional with the present pump but we have not sufficient boiler power for hoisting. Can you find competent man as surveyor who can also make assays.

Placer Mining

DIVULGETER BALANZON EMBOUCHURE TRISTESSE TRAINOIL. The gold is coarse and readily amalgamated but we have 460 feet of ditch to make, requiring 3 days, before we commence hydraulicing.

Surveying

PUPITRE TRINCAFIER STUPIDITY STOP PECIENTO FOXDOG REGNICOLA. We have holed through to the 400 foot level from the stope below during the past week. Will send map as soon as we have finished surveying.

McNEILL'S CODE.

Arranged to meet the Requirements of

MINING, METALLURGICAL AND CIVIL ENGINEERS; DIRECTORS OF MINING, SMELTING AND OTHER COMPANIES; BANKERS; STOCK AND SHARE BROKERS; SOLICITORS, ACCOUNTANTS, FINANCIERS AND GENERAL MERCHANTS.

SAFETY AND SECRECY.

BY

BEDFORD McNEILL, Assoc. M. Inst. C. E.

Associate of the Royal School of Mines;
Member of the Institution of Mining and Metallurgy and of the North of England Institute of Mining and Mechanical Engineers; Fellow of the Geological Society,
&c., &c.

London:
PRINTED AND PUBLISHED BY WHITEHEAD, MORRIS & CO., LIMITED,
Chief Offices:—9 & 10, Fenchurch Street, E.C.; and Caxton House, Westminster, S.W.
Branches:—Cape Town, Johannesburg, Cairo and Alexandria.

New York:
THE SCIENTIFIC PUBLISHING COMPANY,
253, Broadway.

Australia:
E. S. WIGG & SON,
Adelaide, Perth, Broken Hill.

Cape Town:
WHITEHEAD, MORRIS & Co. (SOUTH AFRICA), LD.,
32, St. George's Street.

1899.

Entered at Stationers' Hall.] *Price: One Guinea.*

PREFACE.

In the present volume the Author has endeavoured to include the technical terms and sentences required by the Mining, Metallurgical and Civil Engineer, by the Mine Director, and by those connected with the direction or management of Mining and Smelting Companies. Particular attention has also been paid to the financial part of mining, needs of Financiers generally, negotiations for effecting the sale or purchase of mineral and other properties, as well as to the requirements of Stock Exchange transactions. Legal, Banking and General Phrases are also largely included.

The Code is alphabetically arranged, with but one exception, viz. :—
"Sundry Weights and Measures" on pages 774-775.

On pages 373-376, under the word "Mineral," will be found a list of the more commonly occurring Minerals; and on pages 533-535, under the word "Rock," will be found a similar list of Rocks. Both "Minerals" and "Rocks" are arranged alphabetically.

The Cipher Words have been carefully selected with a view of eliminating such as may be identical in their telegraphic signals, or otherwise liable to error in transmission. On the next page will be found General Suggestions as to the use of the Code, also for securing accuracy in messages received, for the prevention of errors in transmission, and for deciphering mutilated words when such occur.

The First Part contains over forty-four thousand Mining, Legal and General Phrases; while the Second Part includes Numerals, Measurements, Weights and Currencies.

A Schedule embracing the phrases required when surveying or reporting upon a mineral property is also added.

Any suggestions will be most cordially received.

BEDFORD McNEILL.

Apunchar ...	02988	No assay office is available
Apuntado ...	02989	From the assay results
Apuntalar	02990	Vein matter assays
Apunto ...	02991	The outcrop assays
Apuracion	02992	The ore streak assays
Apuradero	02993	The drill core(s) assay(s) [telegraph results
Apurativo ...	02994	Send duplicate samples to nearest government assay office, and
Apurement	02995	From the assay it looks as if sample(s) has (have) been salted
Apurrir ...	02996	The following are the assay results of the duplicate samples
Apyrexia ...	02997	Pulp assays at mill average
Aquagium	02998	Pulp assays at —— mill average per ton
Aquarelle ...	02999	Tailing assays average —— per ton
Aquarium ...	03000	Control assay
Aquatico	**03001**	Have made control assay which gives
Aquatique	03002	Wait for cable giving results of assays
Aquatoris ...	03003	Better wait for results of assays
Aquejar ...	03004	Assay of samples from —— to-day gives
Aquel ...	03005	Assays for the week do not show any improvement
Aquende ...	03006	I (we) believe the ore will assay at least —— ozs. to the ton
Aquestar ...	03007	Why do you not report assays
Aquidoccio	03008	What is the assay value
Aquiducum	03009	What is the assay value for silver per ton of ore
Aquietar ...	03010	What is the assay value for gold per ton of ore
Aquifolia ...	03011	Assay value —— per ton
Aquilatar ...	03012	Assay value for gold per ton
Aquilea ...	03013	Assay value for silver per ton
Aquilentam	03014	Telegraph the result of assays from
Aquilifero	03015	Are the assays absolutely reliable
Aquilino ...	03016	Assays are absolutely reliable
Aquilonal ...	03017	Sample assays gold ——, silver —— per ton of 2,240 lbs.
Aquilotto ...	03018	Sample assays gold ——, silver —— per ton of 2,000 lbs.
Aquitibi ...	03019	Sample assays silver —— ozs., lead —— per cent., copper ——
Arabescato	03020	Sample(s) to be assayed for [per cent.
Arabesco ...	03021	Has (have) forwarded duplicates of samples for assay
Arabesque	03022	Average assay of ore milled last month is gold ——, silver ——
Arabian ...	03023	Average assay of ore milled for month of —— is gold ——, silver—
Arabiga ...	03024	—— Carload assays silver —— ozs. per ton, copper —— per
Arachidnam	03025	Cable assay results of stuff from [cent., lead —— per cent.
Arador ...	03026	Results of assays will follow; have not yet received
Aradorcico	03027	Average assay of ore is
Aradura ...	03028	Average assay value of the ore in the mine is ——
Aragnoides	03029	Average assays for last month are
Aragonesa	03030	Average assays for last week are
Araignee ...	03031	**Assayed**
Arambel ...	03032	Not yet assayed ——
Aramento ...	03033	Some of it assayed as much as
Aranata ...	03034	**Assayer**
Arancel ...	03035	Employ as assayer ——
Aranciato ...	03036	Competent assayer should be sent out as soon as possible
Arandano ...	03037	Can you secure services of reliable and competent assayer
Arandela ...	03038	Send duplicate samples to nearest reliable assayer, and tele-
Araneas ...	03039	**Assent** [graph results
Araniego ...	03040	Shall I (we) assent
Arapende ...	03041	To assent
Aratoire ...	03042	Do you (they) assent
Aratura ...	03043	Do not assent
Arazzeria ...	03044	You have my (our) assent
Arbalete ...	03045	Cannot give my (our) assent
Arbeiten ...	03046	Cannot obtain ——'s assent
Arbeitsam	03047	Has (have) obtained ——'s assent

Dizain ...	15572	Can pan out gold
Dizionario	15573	—— gold from each pan
Dizziness ...	15574	Have made many pannings and have always found gold
Dobblone ...	15575	Value for gold and silver
Dobladilla	15576	Gold and silver
Doblado ...	15577	Gold, silver and copper
Dobladura	15578	Gold, silver and lead
Doblar ...	15579	Have saved —— per cent. of the gold
Doblegable	15580	Little or no gold present
Doblegar ...	15581	Must be paid in gold coin
Doblemente	15582	Pennyweights of gold per ton of 2,240 lbs.
Dobleria ...	15583	Prevents us recovering a fair proportion of the gold
Doblete ...	15584	On account of the gold being associated with
Doblonada	15585	I apprehend difficulty in treating the gold
Docciatura	15586	Gold is very fine and will present great difficulty in treatment
Docetur ...	15587	Gold is very rusty, and I (we) apprehend difficulty in treatment
Dochleas ...	15588	Gold extracted since the mine was commenced is valued at
Docht ...	15589	Gold and silver are in about equal proportions
Docidium ...	15590	What is the fineness of the gold
Docientos ...	15591	Gold is —— fine
Docilidad ...	15592	Gold is increasing in fineness
Docility ...	15593	The gold is associated with
Docilmente	15594	Gold is associated with iron pyrites
Docimastic	15595	Gold is associated with arsenical pyrites
Docketing	15596	The gold is associated with black iron sand
Dockyards	15597	Ore contains no visible gold
Doctificam	15598	Ore contains visible gold
Doctissime	15599	There is no visible gold
Doctorando	15600	Gold is very fine and most difficult to save
Doctorar ...	15601	Have found a nugget of gold weighing —— ozs.
Doctorate ...	15602	Owing to reputed find of nuggets of gold
Doctoribus	15603	Nuggets of gold are occasionally found
Doctress ...	15604	Washing for gold
Doctricem...	15605	Gold is mainly in the free state and coarse
Doctrinal ...	15606	The gold is mainly in the free state but very fine; apprehend [considerable difficulty in saving a fair proportion
Doctrinero	15607	The gold is entirely alluvial
Doctrino ...	15608	The gold occurs in
Documento	15609	The gold is very base
Dodder ...	15610	The gold contents is increasing
Doddering	15611	The gold contents is diminishing
Dodecaedro	15612	The gold contents has become practically *nil*
Dodecagon	15613	The yield amounts to —— ounces of retorted gold
Dodgingly	15614	An average assay for gold gave —— per ton of 2,240 lbs.
Dodicina ...	15615	An average assay for gold gave traces only
Dodliner ...	15616	An average sample assayed, gold *nil*
Dodrante ...	15617	The quartz carrying the gold is
Doffing ...	15618	The paystreak carrying the gold is
Dogana ...	15619	A paystreak —— inches wide, full of visible gold
Doganiere...	15620	Samples can be found showing free gold but the average is low
Dogaresse...	15621	We shall then materially increase the amount of gold saved
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PORTLAND CHAMBER OF COMMERCE ISSUES MINERAL RESOURCES POLICIES

The Portland Chamber of Commerce recently issued the following statement on the development of mineral resources in Oregon:

The Chamber vigorously supports development of Oregon's mineral resources as consistent with maintaining quality of life and a healty economic climate. We recognize that all resources must be responsibly managed, for they are finite.

We strongly feel excesses have been committed in the name of environmental protection, and these excesses are now throttling our nation and threatening its very foundation. Needless proliferation of controls and restrictions on legitimate business engaged in mining and exploration contribute to shortages, and in a very real sense, to a higher cost of living.

The Chamber is concerned that mining, and particularly the sand and gravel industry, is increasingly the target of prohibitionists. This industry, a cornerstone of construction and the largest dollar volume producer of all Oregon's mineral industries, is threatened by urbanization and other factors which will lock away the resource forever. We must insure that remaining deposits are fully utilized, whether located on land or in waterways.

Land use planning should recognize mining and exploratory drilling as the "highest and best use" in many areas of Oregon, and these operations should be entitled to equal consideration with urban development, agriculture and recreation.

Mineral industries are closely allied in many segments with energy supply. Uranium, fossil fuels, and geothermal deposits all have their role to play in alleviating the nation's energy crisis. The Chamber, therefore, strongly supports development of Oregon's potential in these areas.

Oregon's historic role as a storehouse of vitally needed materials in the national interest, as a major regional power producer, and as the most liveable of states, can be continued. This concept requires responsible management of our minerals, and we believe private industry can best provide that management.

* * * * *

NORTHWEST MINING ASSOCIATION TO MEET

The 79th annual convention of Northwest Mining Association will be December 7-8, 1973, at Davenport Hotel, Spokane. Program will include new legislative actions, exploration activities, and outlook for regionally-produced commodities. Authors of papers and those wishing information may write: Program Committee, N.M.A., W. 522 First Ave., Spokane, WA 99204.

* * * * *

EARTHQUAKE INFORMATION SERVICE SHIFTED TO USGS

The National Earthquake Information Service, formerly a component of the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, has now been shifted to the U.S. Geological Survey, Department of the Interior.

The quake information group, located in Boulder, Colorado, receives and analyzes worldwide seismic data, determines earthquake epicenter locations, collects earthquake damage data, and makes the data available through publications. The group also provides assistance to other Federal agencies concerning studies such as seismic effects of nuclear blast testing, building vibration studies, and nuclear power-plant siting.

The move of the earthquake information facility from NOAA to the USGS is part of a series of actions taken to consolidate the Federal program in solid-earth physics that began last May when seismological and geomagnetic research groups were moved from NOAA to the USGS. Details of completion of the entire consolidation - involving about 175 scientists, engineers and technicians, as well as property and equipment at laboratories, offices, and observatories located in nine states and in Guam and Puerto Rico - will be announced shortly.

The National Earthquake Information Service was established in 1966 in order to refine and expand the presentation of seismic data to the scientific community and the general public.

According to Dr. Arthur C. Tarr, geophysicist, and Acting Chief of the Service, "our major function is to provide scientists, the public, and disaster-relief agencies with timely data on important earthquakes that occur in the United States and worldwide. Although originally a basic data-processing operation, the addition and expansion of communications and computer systems has transformed our operation into an information-centered one. Continuous data coming in from several lines linked to a worldwide network give us the capability to locate any destructive earthquake within 30 minutes to an hour."

The operations room of the Service is banked by instruments providing continuous visual recordings of incoming signals, and devices which automatically convert seismic signals into photographic seismic records. A teletypewriter circuit connects the Service with other operators, worldwide. Seismic information is received over this circuit from hundreds of USGS-managed and independent stations around the globe.

"An alarm system in the instrumentation," Tarr said, "alerts duty seismologists when an earthquake of Richter magnitude 5 or greater is detected in the United States, and 6.5 or greater elsewhere in the world."

The earthquake information number in Boulder is 303 - 444-1139. After hours (5:00 p.m. to 8:00 a.m., Mountain Time) callers will hear a recorded voice identifying the duty geophysicist and how to reach him, if it is an emergency. The voice also lets callers leave a recorded message for seismologists to answer when they return during normal duty hours. The mailing address of the Service is:

National Earthquake Information Service
U.S. Geological Survey
RIO/S
Boulder, Colorado 80302

* * * * *

SILVER SHORTAGE

An immense shortage of silver is developing all over the world, according to the latest E. George Scheafer letter. Silver users are dipping into their inventories as more silver is being used than is being mined. Schaefer cannot see why the U.S. government put a ceiling price of $2.716 an ounce on silver because there is no restriction on selling silver to foreigners, who will pay higher prices while U.S. silver users suffer. He notes that Handy and Harman, the world's largest silver dealer, says that Phase IV leaves it unable to sell any silver to U.S. silver users, and concludes:

"The chickens are coming home to roost. For so many years, both the Silver Users Association and the government have said there is plenty of silver. Therefore, the price declined and the silver mining industry has not been able to expand, as needed, for our growing economy. The price of silver has been entirely too low to encourage expansion and exploration of the mines. Now, suddenly, a silver shortage and explosion in price. As I see it, there is plenty of silver to be mined at a much higher price for silver. The same applies to gold. But the government does not want to relax the rules, so shortages and more inflation are most likely to develop in the future."

(Alaska Mines Bulletin, v. 22, no. 10)

* * * * *

TEMPERATURE GRADIENT INFORMATION AVAILABLE

The U.S. Geological Survey has released on open file "Temperature Gradients in Harney County, Oregon," by J. H. Sass and R. J. Munroe. The report provides additional data supplementing that published by the Department in the April 1972 The ORE BIN. Copies of the open-file report are available at various Survey offices and also at Oregon Department of Geology and Mineral Industries library in Portland. Material from which copy can be made at private expense is obtainable in the USGS library at Menlo Park, California.

* * * * *

DESCHUTES COUNTY SOIL MAP PUBLISHED

"General Soil Map, with Soil Interpretations for Land Use Planning, Deschutes County, Oregon," has been published by the U.S.D.A., Soil Conservation Service, in cooperation with the Oregon Agricultural Experiment Station.

The Deschutes soils have developed from a variety of rock types including wind and water deposited sands and gravels in the eastern part of the County and pumice, ash, and glacial till in the western and southern parts. The characteristics of the soil units and their suitability for a number of particular uses are tabulated. A copy of the publication can be seen at the Oregon Department of Geology and Mineral Industries library.

* * * * *

COPPER AND TIN RECOVERED FROM SCRAP

Research chemists at the Bureau of Mines' Albany Metallurgy Research Center in Albany, Oregon, have demonstrated that it is possible to recover copper and tin from the ferrous fraction of municipal incinerator residues. The techniques developed are important for two reasons: from a conservation standpoint, valuable and perhaps strategically needed metals can be recovered, and secondly, these impurity metals can be removed from the ferrous scrap being recycled by the steel industry. The methods developed by the Albany Center are described in RI 7776, "Reducing copper and tin impurities in ferrous scrap recovered from incinerated municipal refuse," available from Publications Distribution Branch, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213. Copy may be consulted in the library at Oregon Department of Geology and Mineral Industries, Portland.

* * * * *

USGS WESTERN REGION DIRECTOR NAMED

Joel M. Johanson, 53, has been named Assistant Director for the Western Region, U.S. Geological Survey, Department of the Interior. He assumes his new post after serving 7 years as Assistant Director for Programs, USGS. With offices at the Survey's Menlo Park, California field center, Johanson will be the personal representative of the Director of the Geological Survey. He will provide policy guidance and coordination of Survey activities, and liaison with Federal, State, and local agencies in the States of Washington, Oregon, Idaho, Nevada, California, Arizona, Alaska, and Hawaii.

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U.S. MINERAL DEVELOPMENT LAGGING, INTERIOR REPORT SAYS

Improved technology is urgently needed to bolster the mineral productivity of the United States, according to a report released recently by Secretary of the Interior Rogers C. B. Morton.

Noting that the country's mineral resource position is still basically sound, the report states, however, that "development of our domestic resources is not keeping pace with needs." For example:

The U.S. trade deficit in minerals totaled $6 billion in 1972, and could reach $100 billion by the year 2000.

Domestic mineral exploration continues a downward trend.

Some forms of energy are in short supply.

Even with domestic oil wells producing at full capacity, 29 percent of the nation's petroleum came from foreign countries in 1972.

Domestic petroleum refining capacity cannot meet the country's current demand, and increasing amounts of refined petroleum products are being imported.

Over 17 million tons of foreign steel was imported last year.

The document, titled "Mining and Minerals Policy--1973," is the Interior Secretary's second annual report under the Federal Mining and Minerals Policy Act of 1970. It says that to improve productivity in the domestic mining, minerals, mineral-reclamation, and energy industries, better technology needs to be introduced rapidly for all phases of mineral industry operations, including exploration, mining, processing, use, recovery, recycling, and oil and gas production. The kind of technology needed, Secretary Morton said, must also safeguard the health and safety of mineral industry employees and protect the environment from pollution associated with mineral operations.

The report supports several legislative proposals being considered by the Congress, including creation of a U.S. Department of Energy and Natural Resources, overhaul of the Federal mineral leasing laws, and environmental regulation of surface mining activities. It also calls for cooperative research on mineral technology, involving companies, universities, and government agencies, and recommends a review of the U.S. tax structure to seek new incentives for mineral producers.

Library copies of the report can be consulted at the following places in Oregon: Bureau of Mines State Liaison office, Salem; Bureau of Mines in Albany; and Oregon Dept. of Geology and Mineral Industries, Portland. Copies can be purchased from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, as follows:

Mining and Minerals Policy, 1973, No. I-1.96/3:973	$1.25
Mining and Minerals Policy, 1973, Appendices, No. I-1.96/3:973/Pt. 2	$5.30

* * * * *

INLAND TILLAMOOK AND CLATSOP COUNTIES STUDY PUBLISHED

"Environmental Geology of Inland Tillamook and Clatsop Counties, Oregon" is the latest of the Department's bulletin series to come off the press. Its author is John D. Beaulieu, Department stratigrapher. The new publication, designated Bulletin 79, is a companion to Bulletin 74, which dealt with the coastal region of Tillamook and Clatsop Counties.

The inland portions of Tillamook and Clatsop Counties lie in the northwestern corner of the Coast Range, a mountainous region drained by Columbia, Nehalem, Wilson, Trask, and Nestucca Rivers. These five valleys are the routes of highways and sites of a growing number of uses. The very nature of the topography and bedrock make much of the area unsuitable for development unless approached wisely with adequate knowledge of the ground conditions. The Bulletin describes the various geologic units and discusses the related geologic hazards present in each of the five river basins.

Bulletin 79 has 65 pages, numerous photographs and diagrams, and is accompanied by a folder containing 12 geologic and hazard maps in color covering 6 quadrangles. The Bulletin and its maps can be obtained from the Oregon Department of Geology and Mineral Industries at its offices in Portland, Baker, and Grants Pass. The price is $6.00.

* * * * *

EUGENE AREA GROUND WATER RESOURCES PUBLISHED

"Ground Water in the Eugene-Springfield Area, Southern Willamette Valley, Oregon," by F. J. Frank, has been published as U.S. Geological Survey Water-Supply Paper 2018. The report presents geologic and hydrologic information on an area covering approximately 450 square miles where rapid population growth and progressively greater volumes of ground water are being required. The 65-page report includes a geologic map in color, a water-level map, and geologic sections based on well data.

Water-Supply Paper 2018 is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The price is $2.75. Stock Number 2401-00277.

* * * * *

COOS BAY-MEDFORD AEROMAGNETIC MAP ISSUED

The U.S. Geological Survey has released in open file "Aeromagnetic Map of Parts of Coos Bay and Medford 1° by 2° quadrangles." Copy available for inspection (or for sale at $2.00) in Department's Portland office.

* * * * *

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79. Environmental geology inland Tillamook Clatsop Counties, 1973: Beaulieu	6.00
80. Geology and mineral resources of Coos County, 1973: Baldwin and others	5.00
81. Environmental geology of Lincoln County, 1973: Schlicker and others	in press

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Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck	2.15
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Vol. 35, No. 11
November 1973

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The ORE BIN
Volume 35, no. 11
November 1973

STRATIGRAPHIC AND BIOSTRATIGRAPHIC RELATIONSHIPS OF THE TYEE AND YAMHILL FORMATIONS IN CENTRAL-WESTERN OREGON

Robert G. McWilliams
Miami University, Hamilton, Ohio 45011

Introduction

The Yamhill Formation was defined by Baldwin and others (1955) as the "sequence of marine sedimentary rocks that overlies the Siletz River Volcanic Series." The type area was designated as the exposures of mudstone and siltstone along Mill Creek, south of Sheridan in northwestern Oregon. The name Yamhill has since been applied to the succession of black mudstone and siltstone interbedded with minor sandstone overlying the Tyee Formation and the Siletz River Volcanics in central-western Oregon and the "volcanics and sediments undifferentiated" (Schlicker and Deacon, 1967) in the hills bordering the west edge of the Willamette Valley. Baldwin (1964b, p. 19) defined the Rickreall Limestone in the type area near Buell as a lower member of the Yamhill Formation He interpreted it to lie above the contact with the Siletz River Volcanics.

The lower part of the Yamhill Formation has been generally interpreted as equivalent to the upper Tyee and to interfinger with the Tyee where the two formations are in contact (Snavely and Wagner, 1964, p. 9; Baldwin, 1964a, p. 7). This interpretation is based on four considerations: (1) The mudstone and siltstone interbeds of the Tyee and the dominantly siltstone upper members of the Tyee (Lorane Siltstone, Elkton Siltstone, and Sacchi Beach) closely resemble rocks of the Yamhill Formation. (2) The Yamhill Formation is said to interfinger with the Tyee near Falls City (Baldwin, 1964a, p. 12). (3) Foraminifera from the type Yamhill Formation were used (Baldwin and others, 1955; Stewart, 1957) to correlate the Yamhill Formation with the Sacchi Beach member of the Tyee. (4) The stratigraphic position of the Yamhill above the Siletz River Volcanics in northwestern Oregon is similar to that of the Tyee Formation in southwestern Oregon.

Previous Work

Portions of the area shown in the geologic map (Figure 5) have been mapped by Baldwin (1947, rev. 1964b), Baldwin and Roberts (1952), Baldwin and others (1955), and MacLeod (1969). Owing to the exploratory nature and geographic separation of their work, the Yamhill and Tyee Formations were not continuously distinguished and mapped throughout this area. Therefore, the primary concern of the writer in remapping the geology and studying the foraminifera of this area was to produce a consistent regional map and to determine the stratigraphic relationship between the Yamhill Formation and Tyee Formation. The writer recognizes the essential accuracy of most of the earlier work and strongly recommends them to the reader for comparison and particularly for additional structural and petrologic details.

Lithologic Discrimination of the Tyee and Yamhill Formations

The Tyee Formation was distinguished from the Yamhill Formation in the map area by the presence of sandstone interbeds greater than 6 inches thick and by the more fissile siltstone and mudstone (Figures 1 and 2).

The sandstone beds of the Tyee range from 6 inches to 10 feet thick, consist of lithic to arkosic micaceous wacke, and are rhythmically interbedded with shale. The sandstone beds contain current markings and sedimentary structures described in detail by Snavely and others (1964).

The mudstone and siltstone layers of both Tyee and Yamhill contain abundant mica and carbonized fragments of fossil plants. Sandstone interbeds are scarce in the Yamhill but where present include arkosic and basaltic wackes.

Although defined as a member of the Yamhill Formation, the Rickreall Limestone is characteristic of neither the Yamhill nor the Tyee Formations. In the area studied, the Rickreall Limestone occurs within or at the top of the Siletz River Volcanics. In addition, the foraminifera and other fossils of the Rickreall Limestone are known to occur in the Siletz River Volcanics but not in the Tyee or Yamhill Formations. Therefore, the Rickreall Limestone is shown as part of the Siletz River Volcanics on the map.

Stratigraphic Relationships of Tyee and Yamhill Formations

The geologic map shows that where the Yamhill occurs in depositional contact, as for example in the area 4 miles south of Grand Ronde, it overlies the Tyee. In most cases, however, the contact is located at normal and reverse faults and the Tyee and Yamhill are restricted to separate fault blocks. This indicates a layer-cake rather than interfingering relationship between the formations (Figure 3). Where the contact occurs along a fault, the Yamhill is always found on the downthrown block and the Tyee on the upthrown block, indicating the Yamhill is younger than the Tyee. This is particularly significant at the long east-west trending fault located 2 miles south of Grand Ronde. There the sense of displacement of the fault has been

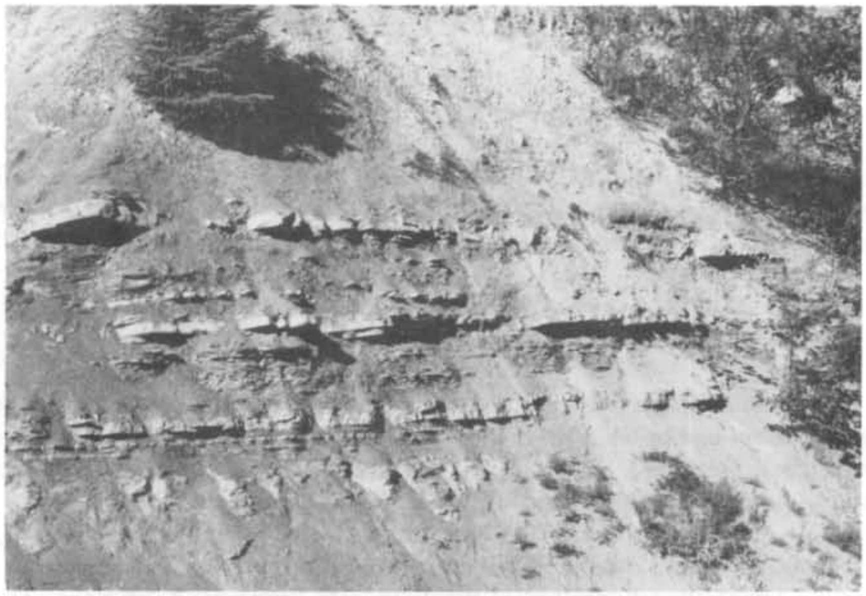

Figure 1. Typical weathered exposure of Tyee Formation showing resistant character of outcrops and the presence of sandstone beds 6 inches thick and greater. Hammer in lower center provides scale. Located center sec. 2, T7S, R8W, Valsetz quad.

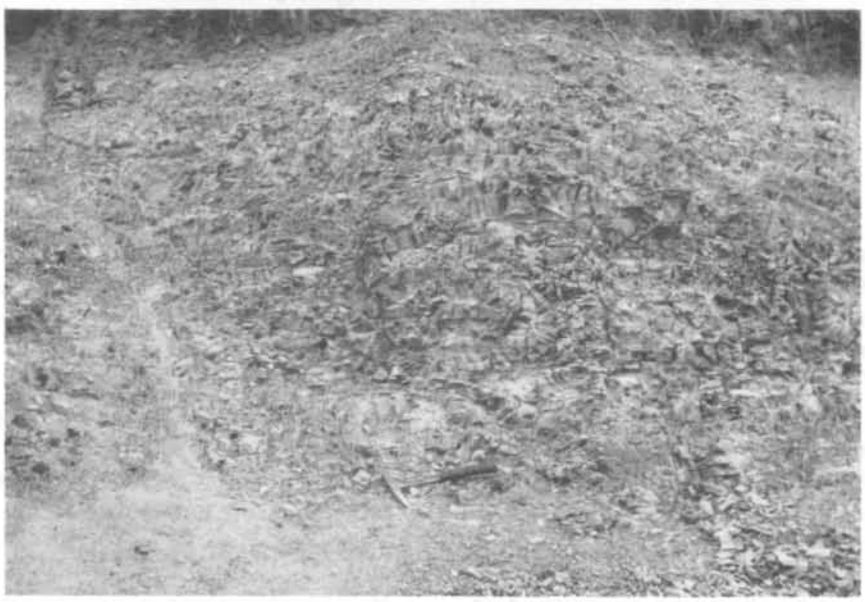

Figure 2. Typical weathered exposure of Yamhill Formation showing generally non-resistant character of outcrops and the absence of sandstone beds greater than 6 inches thick. Hammer in lower center provides scale. Located sec. 35, T6S, R8W, Grand Ronde quad.

independently determined by Baldwin and Roberts (1952) and MacLeod (1969), and the Yamhill side is downfaulted. The apparent interfingering reported by Baldwin (1964a) near Falls City was not observed. In a later publication, Baldwin (1964b) indicates, as does the map accompanying this article, (Figure 5), that the contact is located 3 to 4 miles south of Falls City. There the Yamhill overlies the Tyee Formation and is separated from it by a sill.

Biostratigraphic Relationships of the Tyee and Yamhill Formations

Fossil mollusks from the type Yamhill (Baldwin and others, 1955) indicate a Tejon age or what has been long regarded as upper Eocene age on the West Coast (Weaver, 1944). Fossil mollusks of the Tyee outside of the map area indicate a Domengine or middle Eocene age (Turner, 1938).

In apparent contradiction with this age distinction, Stewart (1957, p. 11; Baldwin and others, 1955) correlated the type Yamhill Formation and the Sacchi Beach member of the Tyee with Laiming's B-1A zone. Stewart (1957, p. 11) stated:

> ...the Yamhill-Sacchi Beach-lower McIntosh fauna is distinguished by the common and restricted occurrence of *Amphimorphina californica* Cushman and McMasters, which is Laiming's marker for the upper Domengine B-1A zone in California.... It appears to mark the upper range limits of a few middle Eocene species including *Nodosaria latejugata* Gumbel and *probably* [italics mine] *Amphistegina californica* Cushman and M. A. Hanna, *A. simiensis* (Cushman and McMasters) and *Pseudophragmina psila* (Woodring).

More recent information shows this correlation to be in error, however. Although *Amphimorphina californica* and *Nodosaria latejugata* are present in the Yamhill, the other species are not reported in Stewart's check lists (in Baldwin and others, 1955) and are not present in my collections of the Yamhill Formation along Mill Creek and elsewhere in the map area (Tables 1-5 and 7).

Amphimorphina californica and *Nodosaria latejugata* have recently been reported in definite Narizian assemblages by Rau (1964, p. 4, 7; 1966, Fig. 5) and with other species restricted to the Narizian in the type Yamhill by Stewart himself (Baldwin and others, 1955) and this author (Table 2). Therefore, these species can no longer be considered to be restricted to the Ulatisian or the B-1A zone.

The Tyee does not contain foraminifera diagnostic of age in the map area. Available data from the Tyee elsewhere in Oregon indicate it is no younger than Ulatisian (Stewart, 1957, p. 13; Snavely and others, 1964, p. 465; Thoms, 1965; and Bird, 1967). The Siletz River Volcanics (including

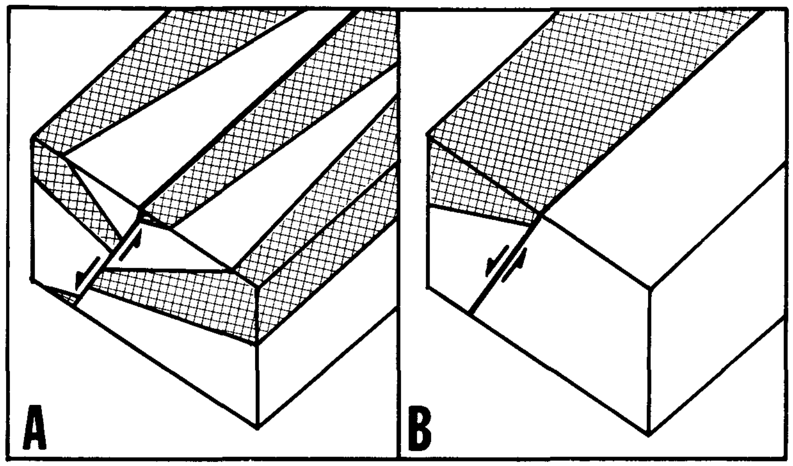

Figure 3. A. Effect of block faulting and erosion on interfingering stratigraphy. Note each facies, denoted by pattern, is found on each side of the fault.

B. Effect of block faulting and erosion on layer-cake stratigraphy. Note upper layer found only on down-thrown block.

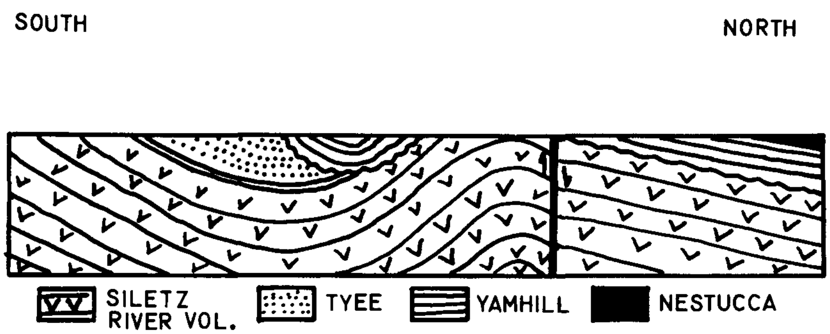

Figure 4. Generalized cross section showing angular unconformity between Yamhill and older formations. South end of section located near intersection of the southern boundary of the geologic map (Figure 5) and the Luckiamute River. North end of section located near Sheridan.

the Rickreall Limestone member) contains species indicative of the Ulatisian stage (Tables 1, 2, 5, 6, 8). In summary, present knowledge of the range of benthonic foraminifera indicate the Yamhill is Narizian and therefore younger than any of the Tyee and that correlation or interfingering of the two formations is not possible.

Stratigraphic Relationships of the Siletz River Volcanics and Yamhill Formation

The Yamhill Formation overlies the Tyee Formation in the southern and western portions of the map. Elsewhere in the map area it overlies volcanics mapped as Siletz River. This relationship is depicted in the cross section (Figure 4) as an angular unconformity. This interpretation requires deformation, uplift, and erosion of both the Tyee Formation and the Siletz River Volcanics prior to deposition of the Yamhill Formation. The type Siletz River Volcanics was defined by Snavely and Baldwin (1948) as underlying the Tyee and is lower Eocene in age. The Siletz River Volcanics underlying the Tyee south of the map area in the vicinity of Marys Peak contains fossils in the upper part indicative of Capay or lower Eocene age (Baldwin, 1955).

The rocks mapped as "Siletz River" underlying the type Yamhill along Mill Creek in the northern part of the map contain foraminifera whose joint occurrence indicate an upper middle Eocene age (at the Ulatisian-Narizian boundary). Elsewhere in the map area in the sub-Yamhill "Siletz River" is Ulatisian or middle Eocene (Tables 1, 2, 5, 6, 8). Apparently two volcanic units are involved although they have not been shown separately on the map. The type "Siletz River Volcanic Series" is one unit, and a younger volcanic sequence beneath the Yamhill Formation is the other. In addition, available biostratigraphic data suggest the sub-Yamhill "Siletz River" may even be young enough to be post-Tyee in age. Because of these and other difficulties, the writer has proposed to explain the relationship of the Yamhill to the underlying rocks in terms of the plate tectonics model (McWilliams, 1972, 1973).

Conclusions

(1) Field mapping and biostratigraphic data indicate that the Yamhill Formation overlies and is younger than the Tyee Formation; interfingering of the two formations is not indicated. (2) Stewart's correlation of the Yamhill Formation with the Sacchi Beach member of the Tyee was based on incomplete knowledge of the range in time of key species. Presently available information rules out age equivalence of the two units. (3) Available biostratigraphic data suggest that the sub-Yamhill "Siletz River" is younger than the sub-Tyee Siletz River and may even be post-Tyee in age.

Fossil localities indicated by number in Tables 1-8 are shown on the geologic map (Figure 5) and described in the "Register of Localities."

Table 1. Check list of foraminifera from the Rickreall Creek section

/ 1 SPECIMEN
X 2-5 SPECIMENS
◢ 6-15 SPECIMENS
■ 16 SPECIMENS AND ABOVE

	ULATISIAN			?	NARIZIAN						
	SILETZ RIVER VOLCANICS										
					YAMHILL FM.						
	1	2	3	4	5	6	7	8	9	10	11
AMMODISCUS INCERTUS D'ORBIGNY		/									
AMPHIMORPHINA JENKINSI (CHURCH)								X	◢		X
ANOMALINA DANVILLENSIS HOWE & WALLACE			X								
ANOMALINA PACKARDI BANDY		X									
ASTERIGERINA SIMIENSIS C. & MCMASTERS	■	■									
BATHYSIPHON SP.					/			/			
BULIMINA CORRUGATA C. & SIEGFUS					X						
BULIMINA OVATA VAR. COWLITZENSIS BECK					■	◢		■	■	/	
CIBICIDES HAYDONI (C. & SCHENCK)					◢						
CIBICIDES NATLANDI BECK					◢	/					
CIBICIDES SPIROPUNCTATUS GALLOWAY & MORREY		X									
CIBICIDES SP.		X	X								
CHILOSTOMELLA CYLINDROIDES REUSS					■						
CHILOSTOMELLA CF. C. OVIFORMIS SHERBORN & CHAPMAN			/								
CHILOSTOMELLA SPP.					/						
DENTALINA COMMUNIS D'ORBIGNY		◢			X	/			/		X
DENTALINA PAUPERATA (D'ORBIGNY)											/
DENTALINA SPP.									/		
DISCOCYCLINA SP.		/									
DYOCIBICIDES SP.			X								
EPONIDES DORFI TOULMIN		X									
EPONIDES MEXICANA (CUSHMAN)						X					
EPONIDES SP.			/								
GLOBIGERINA SPP.			■								
GUTTULINA IRREGULARIS (D'ORBIGNY)									/		
GUTTULINA OREGONENSIS BANDY		/									
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN		X	/		◢						
HAPLOPHRAGMOIDES OBLIQUICAMERATUS MARKS					X						
HÖGLUNDINA EOCENICA (C. & HANNA)			/								
LENTICULINA WASHINGTONENSIS BECK											/
LENTICULINA SP.											/
NODOGENERINA LEPIDULA (SCHWAGER)		/		/							/
NODOGENERINA SPP.		X			X				◢	/	
NODOSARIA CF. N. LONGISCATA D'ORBIGNY					■						
NODOSARIA PYRULA D'ORBIGNY					X						
NODOSARIA SPP.				/	X				X		
PLECTOFRONDICULARIA OREGONENSIS C., STEWART & STEWART					X						
PLECTOFRONDICULARIA PACKARDI VAR. MULTILINEATA C. & SIMONSON						/		X	/	/	
PLECTOFRONDICULAIRA PACKARDI VAR. PACKARDI C. & SCHENCK									/		
PSEUDOGLANDULINA CF. P. INFLATA (BORNEMANN)						X					
PSEUDOPHRAGMINA SP.		◢									
PULLENIA BULLOIDES D'ORBIGNY			/								
QUINQUELOCULINA GOODSPEEDI HANNA & HANNA							/				
QUINQUELOCULINA SPP.	/										
ROBULUS ALATO-LIMBATUS (GUMBEL)			◢	/	■	◢		◢			
ROBULUS CHIRANUS C. & STONE					◢						
ROBULUS COALEDENSIS? DETLING									X		
ROBULUS INORNATUS D'ORBIGNY	/	■		/	X	X		/			
ROBULUS SP.									/		
TEXTULARIA SP.		/									
UVIGERINA GARZAENSIS C. & SIEGFUS								X	◢		/
UVIGERINELLA SP.									X		
VAGINULINOPSIS MEXICANA VAR. KELLEYI MARTIN			X								
VAGINULINOPSIS MEXICANA VAR. NUDICOSTATA (C. & HANNA)		X	/								
VAGINULINOPSIS MEXICANA VAR. VACAVILLENSIS (HANNA)		X									
VAGINULINOPSIS SAUNDERSI VAR. LEWISENSIS BECK									X		
VAGINULINOPSIS SP.		◢									
VALVULINERIA COOPERENSIS (CUSHMAN)		X									
VALVULINERIA TUMEYENSIS C. & SIMONSON					X			/	■		
VULVUINA CURTA C. & SIEGFUS		◢			X						

Table 2. Check list of foraminifera from the Mill Creek section

/ 1 SPECIMEN
X 2-5 SPECIMENS
◢ 6-15 SPECIMENS
■ 16 SPECIMENS AND ABOVE

	18	19	20	22	23	24	25	26	28	29	30	31	32	33	34	35
	ULAT.-NARIZ.		NARIZIAN													
	SILETZ RIVER VOLCANICS		YAMHILL FM.												NESTUCCA FM.	
ALABAMINA WILCOXENSIS VAR. CALIFORNICA MALLORY	◢	X														
AMMOBACULITES SP.															/	
AMPHIMORPHINA BECKI MALLORY			◢													
AMPHIMORPHINA CALIFORNICA C. & MCMASTERS									◢				■			
AMPHIMORPHINA JENKINSI (CHURCH)								X			■					
AMPHIMORPHINA IGNOTA C. & SIEGFUS			/				■	◢		■		■				
BATHYSIPHON EOCENICA C. & HANNA			■				◢	◢	■	X						
BOLIVINA BASISENTA VAR. OREGONENSIS C., STEWART & STEWART													/			
BULIMINA CORRUGATA C. & SIEGFUS			X			X	X		■	X						
BULIMINA JACKSONENSIS VAR. WELCOMENSIS MALLORY						◢		■								
BULIMINA CF. B. OVATA D'ORBIGNY									◢				X		X	
BULIMINA PUPOIDES D'ORBIGNY			X			◢	X	X			◢				◢	
BULIMINA PYRULA D'ORBIGNY															X	
BULIMINA SCULPTILIS VAR. LACINATA C. & PARKER			◢			/	◢	■	◢	◢	■	/	◢		◢	
CASSIDULINA GLOBOSA HANTKEN			/					◢		X			◢		/	
CERATOBULIMINA SP.			/													
CHILOSTOMELLA MEXICANA VAR. CHIRANA C. & TODD			◢						X		■					
CIBICIDES HODGEI C. & SCHENCK	X															
CIBICIDES LOBATULUS (WALKER & JACOB)							/	/								
CIBICIDES MCMASTERSI? BECK			X	X				X								
CIBICIDES NATLANDI VAR. OLEQUAHENSIS BECK			/													
CIBICIDES WARRENI C., STEWART & STEWART			◢			◢	/	X	■				◢		/	
CYCLAMMINA PACIFICA BECK			X	/		◢	X	X	/	X	/	◢	/			/
DENTALINA CF. D. APPROXIMATA REUSS			/	X						X						
DENTALINA COLEI C. & DUSENBURY							X		X	X		X				
DENTALINA COMMUNIS D'ORBIGNY	X	/	/													
DENTALINA DUSENBURYI BECK		/														
DENTALINA CF. D. MULTILINEATA BORNEMANN															X	
DENTALINA CF. PAUPERATA D'ORBIGNY											◢					
DISCORBIS SP.			/													
EGGERELLA ELONGATA BLAISDELL								/					/			
EPONIDES MEXICANA (CUSHMAN)	■	X														
EPONIDES UMBONATA REUSS			X			◢										
GLOBIGERINA SPP.								X			X		/		X	
GLOBOBULIMINA PACIFICA CUSHMAN																◢
GLOBOBULIMINA CF. G. PACIFICA CUSHMAN								X		◢	◢	◢				
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN			X	/		■	X	◢	X	■	X				/	
GYROIDINA PLANULATA C. & RENZ													/			
HAPLOPHRAGMOIDES OBLIQUICAMERATUS MARKS				/		X	◢			■			X			
HAPLOPHRAGMOIDES SP.				X												
?KARRERIELLA SP.												/				
LAGENA AMPHORA VAR. PAUCICOSTA FRANKE			■													
LAGENA VULGARIS ?WILLIAMSON			/				/									
LENTICULINA WASHINGTONENSIS BECK		/														
NODOGENERINA CF. N. ADOLPHINA (D'ORBIGNY)						/			X		X	/				
NODOGENERINA CF. N. KRESSENBERGENSIS (GÜMBEL)						X										
NODOGENERINA SPP.	X	X														
NODOSARIA ARUNDINEA SCHWAGER												/			X	
NODOSARIA LATEJUGATA GÜMBEL	X															
NODOSARIA LONGISCATA D'ORBIGNY			X				◢		X	◢		/			/	
NODOSARIA MACNEILI CUSHMAN															/	
NODOSARIA CF. N. PYRULA D'ORBIGNY			/												/	
NODOSARIA SPP.				◢					X		/	X			X	
NONION PLANATUM C. & THOMAS	/														/	
PLECTOFRONDICULARIA SACATENSIS HORNADAY			X			■										
PLECTOFRONDICULARIA VOKESI C., STEWART & STEWART								X								
PSEUDOGLANDULINA NALLPEENSIS RAU	/		/													
PULLENIA SALISBURYI STEWART & STEWART															/	
QUINQUELOCULINA CF. Q. PAYNEI BECK									/							
ROBULUS ALATO-LIMBATUS (GÜMBEL)	■	◢														
ROBULUS CHIRANUS C. & STONE			/								X	X				
ROBULUS COALEDENSIS DETLING											/					
ROBULUS CF. R. DEFORMIS (REUSS)									/							
ROBULUS INORNATUS D'ORBIGNY			◢	X	◢	◢	■	/	■	■	/	X	■	/	◢	
ROBULUS WELCHI CHURCH							?									
SARACENARIA HANTKENI CUSHMAN															/	
SIGMOILINA TENUIS (CZJZEK)							/	X								
TROCHAMMINA SP.							/		/							
UVIGERINA GARDNERAE CUSHMAN							X									
UVIGERINA GARZAENSIS C. & SIEGFUS							X				◢					
UVIGERINA GARZAENSIS VAR. NUDO-ROBUSTA MALLORY								■	X							
VAGINULINOPSIS MEXICANA VAR. NUDICOSTATA (C. & HANNA)	◢	X														
VAGINULINOPSIS SAUNDERSI (HANNA & HANNA)	■	X														
VALVULINERIA JACKSONENSIS VAR. WELCOMENSIS MALLORY			/						◢	◢	◢				X	
VULVULINA SP.									/							

Table 3. Check list of foraminifera from the Rowell Creek section

Legend: 1 = 1 SPECIMEN; 2-5 = 2-5 SPECIMENS; 6-15 = 6-15 SPECIMENS; 16 = 16 SPECIMENS AND ABOVE

	?NARIZIAN YAMHILL FM.			
	36	37	38	39
?ASTACOLUS BARKSDALEI BECK	6-15			
BATHYSIPHON SP.				1
BIFARINA NUTTALLI C. & SIEGFUS	6-15			
BULIMINA MACILENTA C. & PARKER				1
BULIMINA OVATA VAR. COWLITZENSIS BECK	16	1	16	16
BULIMINA SCULPTILIS VAR. LACINATA C. & PARKER		6-15		
BULIMINELLA SUBFUSIFORMIS CUSHMAN	6-15			2-5
CIBICIDES HODGEI C. & SCHENCK	2-5			
CIBICIDES MCMASTERSI BECK		1		
CHILOSTOMELLA CYLINDROIDES REUSS	1			
CHILOSTOMELLA MEXICANA VAR. CHIRANA C. & TODD	2-5	1		
DENTALINA COMMUNIS D'ORBIGNY	2-5		2-5	
DENTALINA SP.	2-5			
EPONIDES MEXICANA (CUSHMAN)		1		
GLOBIGERINA SPP.	6-15			
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN		2-5		
HAPLOPHRAGMOIDES OBLIQUICAMERATUS MARKS	2-5	2-5	1	
NODOGENERINA LEPIDULA (SCHWAGER)	1			
NODOGENERINA SPP.	6-15	2-5	16	
NODOSARIA CF. N. ARUNDINEA SCHWAGER	2-5			
NODOSARIA LATEJUGATA GÜMBELL	1			
NODOSARIA CF. N. LONGISCAIA D'ORBIGNY			16	
PSEUDOGLANDULINA NALLPEENSIS RAU	2-5			
ROBULUS CHIRANUS C. & STONE	2-5			
ROBULUS INORNATUS D'ORBIGNY		2-5		
VALVULINERIA JACKSONENSIS VAR. WELCOMENSIS MALLORY	6-15	2-5	6-15	16
VALVULINERIA TUMEYENSIS C. & SIMONSON				16

Table 4. Check list of foraminifera from the Rock Creek section

Legend: 1 = 1 SPECIMEN; 2-5 = 2-5 SPECIMENS; 6-15 = 6-15 SPECIMENS; 16 = 16 SPECIMENS AND ABOVE

	NARIZIAN YAMHILL FM.										
	40	41	42	43	44	45	46	47	48	49	50
AMPHIMORPHINA JENKINSI (CHURCH)						2-5					
BATHYSIPHON EOCENICA C. & HANNA			6-15	6-15	6-15	6-15	2-5	1	16	2-5	
BATHYSIPHON SP.			2-5	1				1			
BIFARINA NUTTALLI C. & SIEGFUS			2-5								
BULIMINA CORRUGATA C. & SIEGFUS			2-5								
BULIMINA LIRATA C. & PARKER			1								
BULIMINA OVATA D'ORBIGNY									6-15		
BULIMINA OVATA VAR. COWLITZENSIS BECK	6-15	2-5	16	2-5	1	16	6-15			6-15	6-15
BULIMINA SCULPTILIS VAR. LACINATA C. & PARKER											
BULIMINELLA SUBFUSIFORMIS CUSHMAN						1					
CHILOSTOMELLA HADLEYI KEIJZER	2-5		2-5							1	
CHILOSTOMELLA MEXICANA VAR. CHIRANA C. & TODD			16								
CHILOSTOMELLA SPP.											1
CIBICIDES HODGEI C. & SCHENCK			2-5		1						2-5
CIBICIDES MCMASTERSI BECK				1				1			
CIBICIDES NATLANDI BECK				1		1		1			
CIBICIDES SPIROPUNCTATUS GALLOWAY & MORREY								6-15			
CYCLAMMINA SAMANICA BERRY		1	2-5								
CYCLAMMINA CF. C. PACIFICA BECK										2-5	
DENTALINA COMMUNIS D'ORBIGNY		6-15	2-5	?	1		1				
DENTALINA EOCENICA? CUSHMAN						6-15					
EGGERELLA ELONGATA BLAISDELL									2-5		
EPONIDES MEXICANA (CUSHMAN)								1			
EPONIDES UMBONATUS (REUSS)			2-5								
GAUDRYINA SP.							1				
GLOBIGERINA SPP.		6-15	6-15		2-5	2-5		2-5			
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN			2-5			1			1	2-5	
GYROIDINA CF. G. FLOREALIS WHITE									1		
HAPLOPHRAGMOIDES OBLIQUICAMERATUS MARKS			16	1						2-5	
KARRERIELLA WASHINGTONENSIS RAU						1					
MARGINULINA SUBBULLATA HANTKEN											6-15
NODOGENERINA SP.						1					
NODOSARIA CF. N. ARUNDINEA SCHWAGER			6-15		2-5	2-5		2-5			2-5
NODOSARIA CF. N. LONGISCATA D'ORBIGNY							16			2-5	
NODOSARIA PYRULA D'ORBIGNY	?										
NODOSARIA SPP.			2-5				1				
PLECTOFRONDICULARIA PACKARDI VAR. MULTILINEATA C. & SIMONSON							6-15		2-5		
PLECTOFRONDICULARIA PACKARDI VAR. PACKARDI C. & SCHENCK						1					
PLECTOFRONDICULARIA VAUGHANI CUSHMAN							2-5				
PLECTOFRONDICUALRIA VOKESI C., STEWART & STEWART	1										
PSEUDOGLANDULINA CF. P. NALLPEENSIS RAU			2-5	1			2-5	1			
ROBULUS ALATO-LIMBATUS (GÜMBEL)			1	6-15	2-5						
ROBULUS CF. R. ARCUATA-STRIATUS VAR. CAROLINIANUS CUSHMAN							1				
ROBULUS COALEDENSIS DETLING	2-5										6-15
ROBULUS CHIRANUS C. & STONE			2-5			1					
ROBULUS INORNATUS D'ORBIGNY			6-15	6-15	2-5	2-5	6-15	6-15	6-15	2-5	
SPIROLOCULINA WILCOXENSIS C. & GARRETT							1				
?TEXTULARIA SP.											1
UVIGERINA GARZAENSIS C. & SIEGFUS				1		2-5					
VALVULINERIA JACKSONENSIS VAR. WELCOMENSIS MALLORY	1	2-5				2-5					
VALVULINERIA TUMEYENSIS C. & SIMONSON						2-5					

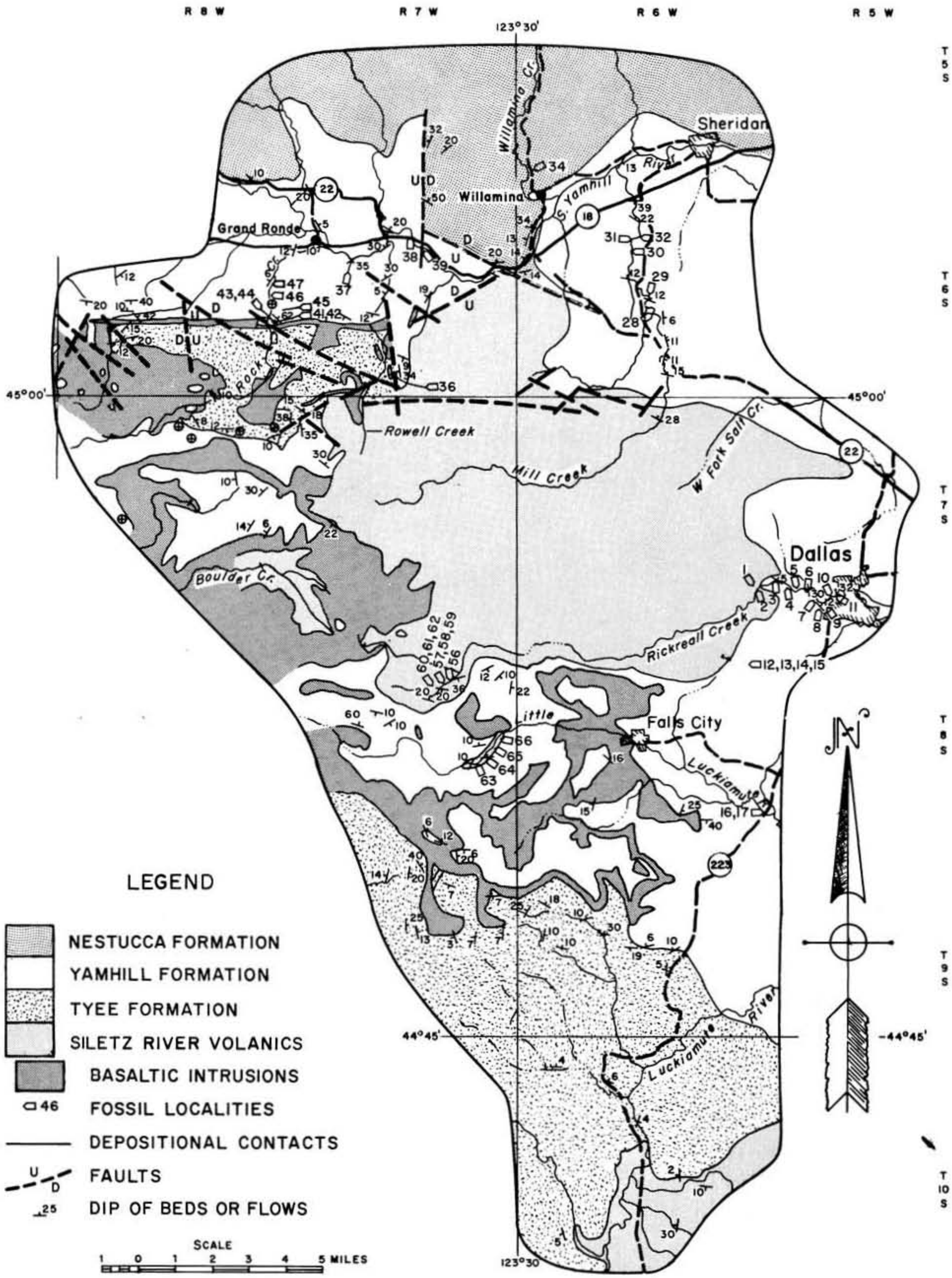

Figure 5. Geologic Map of the Dallas - Grand Ronde, Oregon

Table 5. Check list of foraminifera from the Oakdale School section

/ 1 SPECIMEN
X 2-5 SPECIMENS
◢ 6-15 SPECIMENS
■ 16 SPECIMENS AND ABOVE

	ULATISIAN	NARIZIAN				
	SILETZ RIVER	YAMHILL FM.				
	12	13	14	15	16	17
AMPHIMORPHINA JENKINSI (CHURCH)					■	
ANOMALINA DANVILLENSIS HOWE & WALLACE				/		
ASTERIGERINA SIMIENSIS C. & MCMASTERS	■					
BATHYSIPHON EOCENICA C. & HANNA				/		
BULIMINA OVATA D'ORBIGNY					■	
CIBICIDES HAYDONI (C. & SCHENCK)				X		
CIBICIDES NATLANDI BECK		X		X		
CIBICIDES PSEUDOUNGERIANUS VAR. EVOLUTUS C. & HOBSON						/
CIBICIDES SPIROPUNCTATUS GALLOWAY & MORREY						/
CHILOSTOMELLA CF. C. OVIFORMIS SHERBORN & CHAPMAN						/
CHILOSTOMELLA SPP.						/
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN		X		/		
HAPLOPHRAGMOIDES OBLIQUICAMERATUS MARKS		X		◢		
HÖGLUNDINA EOCENICA (C. & HANNA)						/
NODOGENERINA SPP.						/
NODOSARIA CF. N. ARUNDINEA SCHWAGER		■				
PLECTOFRONDICULARIA GARZAENSIS C. & SIEGFUS						X
PLECTOFRONDICULARIA PACKARDI VAR. PACKARDI C. & SCHENCK					◢	
QUINQUELOCULINA SPP.	X					
ROBULUS ALATO-LIMBATUS (GUMBEL)	/	◢	/	X		
ROBULUS CHIRANUS C. & STONE				X		
ROBULUS INORNATUS (D'ORBIGNY)					◢	
VALVULINERIA TUMEYENSIS C. & SIMONSON					X	
VULVULINA CURTA C. & SIEGFUS				/		

Table 6. Check list of foraminifera from the South Fork Rickreall Creek section

/ 1 SPECIMEN
X 2-5 SPECIMENS
◢ 6-15 SPECIMENS
■ 16 SPECIMENS AND ABOVE

	ULATISIAN						
	SILETZ RIVER VOLCANICS						
	56	57	58	59	60	61	62
ALABAMINA WILCOXENSIS VAR. CALIFORNICA MALLORY	/	/					
ANOMALINA PACKARDI BANDY		X			X		
ANOMALINA SP.					/		
ASTERIGERINA SIMIENSIS C. & MCMASTERS					■	■	?
BULIMINA OVATA D'ORBIGNY	◢	◢	◢	◢	■	■	■
BULIMINA OVATA VAR. COWLITZENSIS BECK					X		
CHILOSTOMELLA HADLEYI KEIJZER				X			
CHILOSTOMELLA MEXICANA VAR. CHIRANA C. & TODD	X	X	◢	X	/	■	◢
CHILOSTOMELLA CF. C. OVIFORMIS SHERBORN & CHAPMAN	◢	◢		X	◢	■	◢
CHILOSTOMELLA SPP.	X	X				X	
CIBICIDES CF. C. BEATUS MARTIN							X
CIBICIDES AFF. C. HODGEI CUSHMAN & SCHENCK					◢	X	
CIBICIDES MCMASTERSI BECK					/		
CIBICIDES PSEUDOWVELLERSTORFI? COLE		X			/		
CIBICIDES SP.	/				X		
DENTALINA COMMUNIS D'ORBIGNY		X			X	X	
DENTALINA EOCENICA? CUSHMAN	X	◢					
DYOCIBICIDES SP.	/	X					
EPISTOMINA CF. E. PARTSCHIANA (D'ORBIGNY)	X	X	/	/			
EPONIDES DORPI TOULMIN						X	
EPONIDES LODOENSIS MARTIN	/						
EPONIDES MEXICANA (CUSHMAN)						/	
EPONIDES UMBONATUS (REUSS)					/		
EPONIDES SP.			/				
GLOBIGERINA SPP.	/	◢				X	
GUTTULINA IRREGULARIS (D'ORBIGNY)					/		
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN	/	/			/		
GYROIDINA SP.				/			
HÖGLUNDINA EOCENICA (C. & HANNA)	/	/			/	■	X
LAMARKINA RUGATINA BANDY						/	
LOXOSTOMIUM APPLINAE (PLUMMER)			/				
MARGINULINA CF. M. ADUNCA (COSTA)					/		
NODOGENERINA SPP.					/		
NODOSARIA LATEJUGATA GUMBEL	/	X	/			X	
NODOSARIA CF. N. ARUNDINEA SCHWAGER	◢	/			/	/	
NONION APPLINAE HOWE & WALLACE		/					
NONION PLANATUM C. & THOMAS		/					
PLECTOFRONDICULARIA GARZAENSIS C. & SIEGFUS	X		/				
PLECTOFRONDICUALRIA KERNI COOK	X						
PSEUDOGLANDULINA CF. P. INFLATA (BORNEMANN)	X	X					
PSEUDOGLANDULINA NALLPEENSIS RAU	/					X	
PYRGO SP.					/		
QUINQUELOCULINA SPP.					X		
ROBULUS ALATO-LIMBATUS (GUMBEL)				X	◢		
ROBULUS INORNATUS D'ORBIGNY	X	◢	◢	X	X	■	◢
ROTORBINELLA COLLICULUS BANDY		/			X	◢	
SIGMOILINA TENUIS (CZJZEK)					/		
VALVULINERIA JACKSONENSIS VAR. WELCOMENSIS MALLORY	X				/	X	
VAGINULINOPSIS MEXICANA VAR. NUDICOSTATA C. & HANNA	X		X	/	X	◢	/
VAGINULINOPSIS SAUNDERSI (HANNA & HANNA)		?					
VULVULINA CURTA C. & SIEGFUS	/						

Table 7. Check list of foraminifera from the Salmon Creek section

- / 1 SPECIMEN
- X 2-5 SPECIMENS
- ◢ 6-15 SPECIMENS
- ■ 16 SPECIMENS AND ABOVE

	NARIZIAN — YAMHILL FM.				
	51	52	53	54	55
?ASTACOLUS BARKSDALEI BECK	?				
ALABAMINA WILCOXENSIS VAR. CALIFORNICA MALLORY			X		X
BATHYSIPHON EOCENICA C. & HANNA	X	/		■	/
BATHYSIPHON SP.			X	X	
BOLIVINA KLEINPELLI BECK	X				
BULIMINA OVATA VAR. COWLITZENSIS BECK	X	/	X	■	X
BULIMINA SCULPTILIS VAR. LACINATA C. & PARKER	/				
CERATOBULIMINA SP.			/		
CHILOSTOMELLA CYLINDROIDES REUSS	X				
CHILOSTOMELLA CF. OVIFORMIS SHERBORN & CHAPMAN			X		
CHILOSTOMELLA SPP.			/		X
CIBICIDES HAYDONI (CUSHMAN & SCHENCK)	/				
CIBICIDES MCMASTERSI BECK				/	
CIBICIDES NATLANDI BECK	/	/		X	/
CIBICIDES SP.	/				
CYCLAMMINA CF. C. PACIFICA BECK				/	
DENTALINA COMMUNIS D'ORBIGNY	/				/
DENTALINA SP.	/				
EGGERELLA ELONGATA BLAISDELL				◢	■
EPONIDES MEXICANA (CUSHMAN)	X	/	X	X	
GLOBIGERINA SPP.	/		/	X	
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN	X		/	◢	/
HAPLOPHRAGMOIDES OBLIQUICAMERATUS MARKS		/	?	◢	■
MARTINOTIELLA EOCENICA C. & BURMUDEZ	X		/		?
NODOGENERINA SPP.			X		/
NODOSARIA CF. N. ARUNDINEA SCHWAGER		X		◢	X
NODOSARIA CF. N. LONGISCATA D'ORBIGNY			◢		
PELOSINA SP.					■
PLECTOFRONDICULARIA PACKARDI VAR. PACKARDI C. & SCHENCK	X				
PLECTOFRONDICULARIA VAUGHANI CUSHMAN	/				
PLECTOFRONDICULARIA VOKESI C., STEWART & STEWART			/		
PSEUDOGLANDULINA CF. P. NALLPEENSIS RAU.				/	
PSEUDOGLANDULINA CF. P. INFLATA (BORNEMANN)				X	
QUINQUELOCULINA CF. Q. IMPERIALIS HANNA & HANNA	/		X	/	
ROBULUS ALATO-LIMBATUS (GUMBEL)	X				
ROBULUS INORNATUS D'ORBIGNY		/			

Table 8. Check list of foraminifera from the Little Luckiamute River section

- / 1 SPECIMEN
- X 2-5 SPECIMENS
- ◢ 6-15 SPECIMENS
- ■ 16 SPECIMENS AND ABOVE

	?ULATISIAN — SILETZ RIVER VOLCANICS		ULATISIAN — SILETZ RIVER VOLCANICS	
	63	64	65	66
ASTERIGERINA SIMIENSIS C. & MCMASTERS				/
BATHYSIPHON EOCENICA C. & HANNA	■			
BIFARINA NUTTALLI C. & SIEGFUS	/			
BULIMINA MACILENTA C. & PARKER		X		/
BULIMINA OVATA D'ORBIGNY		X	X	◢
BULIMINA OVATA VAR. COWLITZENSIS BECK		X		
CHILOSTOMELLA MEXICANA VAR. CHIRANA C. & TODD		/		
CHILOSTOMELLA CF. C. OVIFORMIS SHERBORN & CHAPMAN		X		
CIBICIDES CF. C. BEATUS MARTIN		X		/
CIBICIDES CF. C. MARTINEZENSIS VAR. MALLORYI SMITH		◢		/
CIBICIDES SP.			/	
DENTALINA COMMUNIS D'ORBIGNY		/	X	?
DENTALINA EOCENICA? CUSHMAN		X	■	
DYOCIBICIDES SP.			/	
EPISTOMINA CF. E. PARTSCHIANA (D'ORBIGNY)		X		
EPONIDES DORFI TOULMIN		/		/
EPONIDES MEXICANA (CUSHMAN)		X		
EPONIDES UMBONATUS (REUSS)				X
GLOBIGERINA SPP.		■		◢
GLOBOROTALIA SP.		/		
GYROIDINA ORBICULARIS VAR. PLANATA CUSHMAN		◢		/
HÖGLUNDINA EOCENICA (C. & HANNA)				/
LOXOSTOMIUM APPLINAE (PLUMMER)			/	/
MARTINOTIELLA EOCENICA C. & BURMUDEZ		/		
MARGINULINA SUBBULLATA HANTKEN				/
PSEUDOGLANDULINA NALLPEENSIS RAU		/		
PULLENIA SALISBURYI STEWART & STEWART		/		
QUINQUELOCULINA SP.		X		
ROBULUS ALATO-LIMBATUS (GUMBEL)		◢		
ROBULUS INORNATUS D'ORBIGNY	/	X		X
SIGMOILINA TENUIS (CZJZEK)				/
?STICHOCASSIDULINA THALMANNI STONE				/
TRITAXILINA COLEI C. & SIEGFUS		/		
VAGINULINOPSIS ASPERULIFORMIS? (NUTTALL)		/		
VALVULINERIA JACKSONENSIS VAR. WELCOMENSIS MALLORY				/

Register of Localities*

Locality
No.

1. Ellendale quarry, NW$\frac{1}{4}$ sec. 36, T7S, R6W, Dallas 15' quad. Sample collected at top of quarry in basaltic ss. on south side.
2. North bank Rickreall Cr. about 400 feet south of north boundary sec. 36, near Ellendale quarry, T7S, R6W, Dallas 15' quad.
3. Intersection of sec. 25 and 30 and Rickreall Cr. T7S, R5 and 6W, Dallas 15' quad.
4. Intersection of Rickreall Cr. and second "l" in "Ellendale" SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 30, T7S, R5W, Dallas 15' quad.
5. In Rickreall Cr., immediately below the "i" in "Rickreall" SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 31, T7S, R5W, Dallas 15' quad.
6. In Rickreall Cr. immediately below second "l" in "Rickreall", NE$\frac{1}{2}$ NE$\frac{1}{4}$ sec. 31, T7S, R5W, Dallas 15' quad.
7. Just inside sec. 31 near boundary with sec. 32 in Rickreall Cr., T7S, R5W, Dallas 15' quad.
8. In Rickreall Cr. about 400 feet east of west boundary of sec. 32, T7S, R5W, Dallas 15' quad.
9. In Rickreall Cr. about 1,200 feet east of west boundary of sec. 32, T7S, R5W, Dallas 15' quad.
10. In Rickreall Cr. about 2,000 feet east of west boundary of section in SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 32, T7S, R5W, Dallas 15' quad.
11. In Rickreall Cr. about 3,000 feet east of west boundary of sec. 32, T7S, R5W, Dallas 15' quad.
12. In quarry floor NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 12, T8S, R6W, Dallas 15' quad.
13. In black mudstone 6 feet above contact with underlying basalt at north end of quarry NW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 12, T8S, R6W, Dallas 15' quad.
14. In black mudstone 12 feet above contact with underlying basalt at north end of quarry in NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 12, T8S, R6W, Dallas 15' quad.
15. In black mudstone 18 feet above contact with underlying basalt at north end of quarry in NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 12, T8S, R6W, Dallas 15' quad.
16. In Luckiamute River about 500 feet SE of State Highway 223 in NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 36, T8S, R6W, Dallas 15' quad.
17. NW side of bridge on Little Luckiamute River NE$\frac{1}{4}$ sec. 36,T8S, R6W, Dallas 15' quad.
18. On east side Mill Cr. next to NE support of bridge NE$\frac{1}{4}$ sec. 4, T7S, R6W, Dallas 15' quad.

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* Localities are shown on the geologic map (Figure 5).

19. In Mill Cr. at east footing of bridge in NE$\frac{1}{4}$ sec. 4, T7S, R6W, Dallas 15' quad.
20. On west bank of Mill Cr. about 200 feet north of bridge NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 4, T7S, R6W, Dallas quad.
21. No fossils collected.
22. On east bank of Mill Cr. approximately 400 feet south of section line, NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 4, T7S, R6W, Dallas quad.
23. On west side of Mill Cr. about 600 feet north of section line SE$\frac{1}{4}$ sec. 75, T6S, R6W, Sheridan quad.
24. In Mill Cr. about 600 feet west of section line SE$\frac{1}{4}$ sec. 52, T6S, R6W, Sheridan quad.
25. On NW bank of Mill Cr. about 200 feet west of section line NE$\frac{1}{4}$ sec. 52, T6S, R6W, Sheridan quad.
26. 800 feet north of section line in Mill Cr. SW$\frac{1}{4}$ sec. 54, T6S, R6W, Sheridan quad.
27. No fossils collected.
28. In middle of Mill Cr. about 200 feet upstream from intersection of 320-foot contour and stream, NE$\frac{1}{4}$ sec. 43, T6S, R6W, Sheridan quad.
29. 100 feet north of section line in Mill Cr. SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 41, T6S, R6W, Sheridan quad.
30. 600 feet south of section line in Mill Cr. NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 41, T6S, R6W, Sheridan quad.
31. 300 feet north of south section line on west bank of Mill Cr. S$\frac{1}{2}$ sec. 39, T6S, R6W, Sheridan quad.
32. 1,000 feet north of section line in Mill Cr. SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 39, T6S, R6W, Sheridan quad.
33. 100 feet south of section line in Mill Cr. NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 38, T6S, R6W, Sheridan quad.
34. On east side of road in quarry about 75 feet north of road intersection sec. 36, T6S, R6W, Sheridan quad.
35. In quarry on east side of road, 300 feet east of section line sec. 1, T6S, R6W, Sheridan quad.
36. In Rowell Cr. at bend about 1,900 feet south of north boundary sec. 32, T6S, R7W, Grand Ronde 15' quad.
37. In South Yamhill River at south extremity of bend in river near south corner of sec. 57, T6S, R7W, Grand Ronde 15' quad.
38. On east bank South Yamhill River about 500 feet south of fork in E$\frac{1}{2}$ sec. 9, T6S, R7W, Grand Ronde 15' quad.
39. In South Yamhill River on north bank, about 2,500 feet NW of BM 272 in sec. 46, T6S, R7W, Grand Ronde 15' quad.
40. In Rock Cr. about 500 feet south of fork in creek, in N$\frac{1}{2}$ sec. 26, T6S, R8W, Grand Ronde 15' quad.
41. In Rock Cr. 75 feet north of locality 40, N$\frac{1}{2}$ sec. 26, T6S, R8W, Grand Ronde 15' quad.

42. In Rock Cr. 125 feet north of locality 40, N$\frac{1}{2}$ sec. 26, T6S, R8W, Grand Ronde 15' quad.
43. In Rock Cr. located 50 feet north of Siletz River outcrop in Yamhill Fm. at bend in creek, about 250 feet north of south boundary, sec. 23, T6S, R8W, Grand Ronde 15' quad.
44. In Rock Cr. at west extremity of bend in creek, about 600 feet north of south boundary, sec. 23, T6S, R8W, Grand Ronde 15' quad.
45. In Rock Cr. about 100 feet SW of right angle turn in creek near center S$\frac{1}{2}$ sec. 23, T6S, R8W, Grand Ronde 15' quad.
46. In Rock Cr. about 1,900 feet south of north boundary sec. 23, T6S, R8W, Grand Ronde 15' quad.
47. In Rock Cr. at boundary between sec. 14 and sec. 23, T6S, R8W, Grand Ronde 15' quad.
48. In Rock Cr. NE$\frac{1}{4}$ sec. 14, T6S, R8W, at north extremity of bend in creek about 1,000 feet south Salmon River Highway, Grand Ronde quad.
49. In Rock Cr. extreme NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 13, T6S, R8W, about 500 feet west of road crossing Rock Creek, Grand Ronde 15' quad.
50. In Agency Cr. beneath bridge along state route 22, NW$\frac{1}{4}$ sec. 1, T6S, R8W, Grand Ronde 15' quad.
51. In Salmon River 1,200 feet north of south boundary, sec. 24, T6S, R9W, Grand Ronde 15' quad.
52. In Salmon River about 1,600 feet SE of fork in NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 24, T6S, R9W, Grand Ronde 15' quad.
53. In Salmon River about 1,200 feet SE of fork in sec. 24, T6S, R9W, Grand Ronde 15' quad.
54. In Salmon River at fork near center sec. 24, T6S, R9W, Grand Ronde 15' quad.
55. In Salmon River about 1,500 feet NW of fork in N$\frac{1}{2}$ sec. 24, T6S, R9W, Grand Ronde 15' quad.
56. In South Fork Rickreall Cr. in NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 10, T8S, R7W, Valsetz 15' quad. about 1,000 feet east of west boundary sec. 10.
57. In South Fork Rickreall Cr. about 985 feet east of west boundary of sec. 10, T8S, R7W, Valsetz 15' quad. 15 feet south of locality 56.
58. In South Fork Rickreall Cr. about 965 feet east of west boundary sec. 10, T8S, R7W, Valsetz 15' quad. 25 feet south of locality 56.
59. In South Fork Rickreall Cr. about 805 feet east of west boundary sec. 10, T8S, R7W, Valsetz 15' quad. 195 feet south of locality 56.
60. In South Fork Rickreall Cr. about 635 feet west of east section boundary in SE$\frac{1}{4}$ sec. 9, T8W, R7W, Valsetz 15' quad.
61. In South Fork of Rickreall Cr. about 425 feet west of east section boundary in SE$\frac{1}{4}$ sec. 9, T8S, R7W, Valsetz 15' quad.
62. In South Fork Rickreall Cr. at intersection with south boundary of sec. 9, T8S, R7W, Valsetz 15' quad.

63. In Luckiamute River about 1,100 feet west of east boundary sec. 22, T8S, R7W, Valsetz 15' quad.
64. In Luckiamute River at intersection of boundary between secs. 22 and 23, T8S, R7W, Valsetz 15' quad.
65. In Luckiamute River at intersection with creek SW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 23, T8S, R7W, Valsetz 15' quad.
66. In Luckiamute River about 1,100 feet south of north boundary sec. 23, T8S, R7W, Valsetz 15' quad.

Acknowledgments

I wish to recognize the help of Professor V. S. Mallory of the Department of Geology and the Burke Museum, University of Washington, under whose guidance and with whose help this work was begun in 1967. I am also greatly indebted to Dr. John Beaulieu, Oregon Department of Geology and Mineral Industries, for sharing with me his extensive knowledge of the stratigraphy of the Pacific Northwest. Financial support for this work was provided by the Miami University Faculty Research Committee and by a Penrose Grant from the Geological Society of America. I accept full responsibility, however, for the data and interpretations proposed.

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GEOTHERMAL DEVELOPMENTS OUTSIDE THE UNITED STATES

Many countries of the world are recognizing the usefulness of geothermal resources for supplementing, and in some cases surplanting, the conventional energy systems. The following notes from various journals give an indication of these activities.

Italy

In March 1973, the total generating capacity of geothermal plants in Italy was increased to 405.6 MW. The average production per plant was 2.5 billion kw hr/yr. Drilling activity has been fruitful in the Travale-Radiocondoli area 20 km east-southeast of Larderello. Well 22, completed this year, produced 326,000 kg/hr of 180°C steam; shut-in pressure is 60 bars.

Monti Volsini is a new field 80 km northwest of Rome. A well completed in August produced steam at 300,000 kg/hr and had a shut-in pressure of 33 bars. Two wells have been drilled in the Viterbo-Monti Cimino hot-water system 50 km northwest of Rome. The wells are now being tested for production and reinjection in a zone below 700 m.

Exploration for geothermal resources is continuing in a 30,000 km^2 area along the west coast of Italy and on the islands of Sicily and Sardinia. The geothermal prospect area represents 10 percent of the Italian territory. (P. Ceron, *Geothermal Hot Line Newsletter*)

New Zealand

Development drilling has begun at the Broadlands field in New Zealand after several years of delay. The discovery of large reserves of natural gas in offshore fields caused delay in the development of the Broadlands field as new power plants utilizing the natural gas were considered. The government energy policy now is to utilize the geothermal resources more extensively and to reserve natural gas for higher quality uses than boiler fuel. (*Geothermal Hot Line Newsletter* and *Electrical World*)

Iceland

Considerable exploration and drilling has taken place in Iceland during the last 3 or 4 years. Most of this has concentrated on developing new sources of hot water and steam for space and process heating in order to reduce the island's dependency on imported oil. (*Geothermics*)

Japan

The Japan National Natural Resources Committee reported on May 5, 1973 that Japanese scientists and experts have estimated that it is possible to develop geothermal energy in Japan in a range between 30,000–50,000 MW and perhaps up to 60,000–140,000 MW.

In addition to the presently operating fields at Matsukawa and Otake, four other fields are under development. Near Hachimantai-Onuma, a 10 MW turbine-generator set is now being installed and is expected to be in operation in December 1973. At Onikobe, ten successful dry-steam wells have been drilled, and construction of an initial 25 MW plant is underway. At Katsukonda, construction is underway, with initial plans to install 200 MW in increments of 50 MW each. At Hatchobaru, Kyushu Electric Power Co. is developing an initial 50 MW geothermal unit scheduled for operation in 1975, with possible expansion to 200 MW. (Geothermics)

Phillipine Islands

Three successful geothermal wells have been drilled in the Tiwi area of southern Luzon and developmental drilling is continuing. The United States has just announced a loan of $4.2 million to the Phillipine National Power Corporation for the construction of a 10 MW electric generating plant and necessary transmission facilities. (Geothermal Hot Line Newsletter)

* * * * *

Page 1

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5. LOCATION OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS *(Not printers)*: 1069 State Office Bldg., Portland, Multnomah, Oregon 97201
6. NAMES AND ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR

PUBLISHER *(Name and address)*: R. E. Corcoran, State Geologist, Oregon Dept. of Geology and Min. Indus., 1069 State Office Bldg., Portland, OR 97201

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The Ore Bin

Vol. 35, No. 12
December 1973

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The Ore Bin
Published Monthly By

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The ORE BIN
Volume 35, no. 12
December 1973

LANDFORMS ALONG THE COAST OF SOUTHERN COOS COUNTY, OREGON

Ernest H. Lund
Department of Geology, University of Oregon

A marine terrace (Figure 1) borders the shore of Coos County for much of the distance between the entrance to Coos Bay and the Curry County line, and erosion along this terrace has produced a shore with varied and magnificent scenery. Different degrees of resistance to erosion have allowed the waves to sculpture the terrace into sharp points of land, reefs, islands, secluded coves, and a myriad of smaller forms. Rocks on which the terrace was formed differ along the shore, and this is reflected in a variation in shore features from one segment of the Coos County coast to another.

Figure 1. Rugged coastline and marine terrace at Shore Acres State Park. (Oregon State Highway Division photo)

Figure 2. Shore between Cape Arago and Coos Bay. Middle Cove is in foreground. (Oregon State Highway Division photo)

Between the Coos Bay entrance and Cape Arago, the terrace is on a sequence of Tertiary sedimentary rocks that are inclined steeply towards the east and cut by numerous fractures. The edges of these beds are exposed to wave attack along a southwest trending coast. Erosion, directed along soft sedimentary layers and fractures, has shaped a shore that is distinctly different from that of any other part of the Oregon coast (Figure 2). South of Cape Arago, where the trend of the coast is more nearly parallel to the trend of the Tertiary sedimentary strata, the shoreline is much more regular. The terrace is missing for about 2 miles and the shoreline is at the base of a high cliff along a stretch of rugged terrain (Figure 3). Except for the small projection and sea stacks at Fivemile Point, the shore along the terrace between Sacchi Beach and the Coquille River is regular and with wide beaches (Figure 4 and 21).

Figure 3. Shore along Seven Devils south of Cape Arago. (Oregon State Highway Div. photo)

Figure 4. Sacchi Beach. (Oregon State Highway Division photo)

Figure 5. Shore south of Bandon. Coquille Point is in upper left and Grave Point in foreground. (Oregon State Highway Division photo)

Along the shore from the Coquille River southward for about 3 miles, the terrace is on Jurassic rocks of varied composition and hardness. The shore along this stretch is irregular and rugged but in a different way from that north of Cape Arago (Figure 5). Along the remaining 9 miles, from about Crooked Creek to the county line, the shore is bordered by a low, wide coastal plain with sand dunes along the outer edge (Figure 6).

Geologic investigations of this part of the state go back to about the turn of the century when Diller (1901) mapped and described the geology of the Coos Bay quadrangle. Coal in the Tertiary sedimentary rocks around Coos Bay and other minerals of potential economic importance in this region have stimulated much of the investigation. An article of popular interest with emphasis on the state parks at Cape Arago was prepared by Ehlen (1967). A recent work by Baldwin and others (1973) is a comprehensive study of the geology and mineral resources of Coos County and contains an extensive bibliography of earlier geologic works dealing with this part of the state.

The writer wishes to express his appreciation to Dr. Ewart M. Baldwin, professor of geology at the University of Oregon, for his critical reading of the manuscript and helpful suggestions and to Ward Robertson of Coos Bay for air photographs used in this article.

Figure 6. Shore at Bandon State Park and southward. Bradley Lake in upper left. (Oregon State Highway Division photo)

Bedrock

Pre-Tertiary rocks

Pre-Tertiary rocks along the Coos County coast are sedimentary and metamorphic types of Jurassic age. Rocks of Late Jurassic age are assigned to the Otter Point Formation and are a complex mixture of types that include graywacke sandstone, greenstone, and chert. Isolated bodies of blueschist embodied within the formation became incorporated in it from an outside source during a time of intense deformation. The rock that was quarried from what was known as Tupper Rock for use in construction of the jetty at Bandon is blueschist. Jurassic rocks are exposed in the sea cliffs and in the knobs, sea stacks, and larger islands along the shore south of the Coquille River.

Tertiary rocks

Roseburg Formation: Rhythmically bedded turbidites, which are alternating thin beds of sandstone and shale thought to have been deposited under conditions of turbidity on the sea floor, are exposed at Fivemile Point.

Elkton Siltstone: Beds of mica-bearing siltstone and thin-bedded sandstone that crop out at Sacchi Beach are assigned to the Elkton Formation of Eocene Age.

Coaledo Formation: The Coaledo Formation is exposed along the shore from the north end of Sacchi Beach to the south end of Bastendorff Beach. This Eocene Formation consists of approximately 6,000 feet of sandstone, siltstone, and shale. It has been subdivided into three members, principally on the basis of the amount of silt and clay in the strata. The middle member has more of these finer sediments than the upper and lower members, which are mostly sandstone and are coal-bearing. The middle member has no coal. The contacts between members are gradational, and their boundaries are arbitrarily defined.

Thickness of beds in the Coaledo Formation ranges from a fraction of an inch in the thin shale laminae to tens of feet in the massive sandstone beds. The massive sandstone offers the greatest resistance to wave erosion and the shale and siltstone layers the least, a condition that is one of the main reasons for the great irregularity along the shore between Bastendorff Beach and the tip of Cape Arago.

A striking feature of the Coaledo Formation is the abundance of large concretions, some having a diameter of more than 2 feet. These structures were formed in the sandstone by a cementing process after the sand was deposited. Initially a small particle of shell or other substance in the sand acted as a nucleus around which calcium carbonate (calcite) precipitated from water percolating through the porous sand. As precipitation continued, the concretion grew, incorporating the surrounding sand into a calcite-cemented sandstone body of more or less spheroidal shape. Because the sandstone in the concretions is harder than that surrounding them, they stand out in positive relief on an eroded surface (Figure 7).

Bastendorff Formation: The Bastendorff Formation lies behind the beach between Yoakam Point, known locally as Mussel Reef, and Tunnel Point. This formation, of upper Eocene and lower Oligocene age, consists of about 2,900 feet of shale that overlies the Coaledo Formation. The shale of the Bastendorff Formation is easily eroded; consequently, where it occurs along the shore, there is an indentation in the coastline.

Tunnel Point Formation: The Tunnel Point Formation is exposed in a point of land that projects onto the beach about half a mile south of the south jetty at the Coos Bay entrance. This formation of Oligocene age consists of 800 feet of fine-grained, massive sandstone that overlies the Bastendorff Formation. It is similar to sandstone beds of the Coaledo Formation and erodes in a similar way.

Figure 7. Concretions in lower member of Coaledo Formation (diameter about 2 feet).

Figure 8. South Slough and Coos Bay entrance. Bastendorff Beach left of jetty and tip of Coos Bay sandspit in upper right. (Photo by Ward Robertson)

Empire Formation: The Empire Formation of Pliocene age extends from its contact with the Tunnel Point Formation eastward and is the bedrock on both sides of the South Slough. Baldwin (1966) reports an outcrop at the mouth of China Creek 3 miles south of Bandon.

Pleistocene sediments

Coquille Formation: The Coquille Formation, described and named by Baldwin (1945), is composed of bay sediments deposited during late Pleistocene at the mouth of the Coquille River when its channel was north of its present position. These sediments consist of loosely consolidated conglomerate, sandstone, and mudstone containing stumps, logs, and smaller pieces of wood. The beds are exposed in the sea cliff between Whisky Run Creek and Cut Creek and are the source of the petrified wood and varieties of quartz found on the beach between these creeks.

Terrace sediments: Terrace sediments were formed at different times during the Pleistocene and are at different altitudes. The youngest and lowest was named the Whisky Run terrace by Griggs (1945). Because of warping in the earth's crust, its height above sea level is different at different places. Baldwin (1945) reports an altitude of 125 feet at Cape Arago and a decrease to about 25 feet at Fossil Point on the east side of the bay just north of the mouth of South Slough. The highest terrace in the Cape Arago vicinity is at about 600 feet and tilts in the direction of South Slough.

The 125-foot altitude of the Whisky Run terrace is within the range of sea level fluctuation during the Pleistocene Ice Age and was formed during an interglacial stage when sea level stood higher than it does now. The altitudes of the older terraces, however, are far greater than the highest level of sea during the interglacial stages, and their positions are attributed to upward movement in the earth's crust.

Terrace sediments consist principally of weakly consolidated sand. In places the sand overlies conglomerate that rests on the bedrock, but conglomerate is usually absent where the bedrock is sandstone or less durable rock.

Dune sand: Wherever the shore is bordered by a coastal plain, wind has blown sand off the beach to form a belt or area of sand dunes. The most extensive of these is along the southern part of the Coos County coast. Dunes are also a prominent feature on the plain at the mouth of the Coquille River (Figure 21).

Structure

The sedimentary formations in the area around South Slough have been bent downward into a trough-like structure referred to as the South Slough syncline. A low in the topography, a former stream valley, coincides with the low part of the syncline and is occupied by South Slough (Figure 8). The sedimentary formations on either side are inclined towards the slough,

Figure 9. Tilted beds of Coaledo Formation overlain by horizontal terrace sand at Shore Acres State Park.

Figure 10. Fault cutting rock in the wave-cut bench in Sunset Bay.

and so all the strata between it and Cape Arago tilt downward towards the east. This is remarkably well displayed along the shore where the edges of the beds are exposed in the sea cliffs (Figure 9).

The stresses in the earth's crust that formed the syncline also fractured the rock in numerous places. Movement along many of the fractures caused faults along which strata were displaced (Figure 10). Displacement is only inches along some faults but many tens of feet along others. In some the displacement was along a single surface, and in others it was distributed along zones of varying width. Rock in the fault zones is badly shattered and therefore very susceptible to erosion.

Landforms

Along most of the shore between Coos Bay and the Curry County line, a beach of sand or mixed rock and sand forms a thin veneer over a wave-eroded surface. In places the beach lies at the foot of a sea cliff composed of terrace sediments, bedrock, or, most commonly, bedrock overlain by terrace sediments. Where there is no sea cliff and the terrain is low, a foredune ridge lies behind the beach.

Where waves are working against terrace deposits or other Pleistocene sediments only, the shore has little irregularity. Where they are eroding bedrock, the shore varies from regular to extremely irregular depending upon structural characteristics and hardness of the rocks under attack.

Between the Coos Bay entrance and Sunset Bay, the shore has a general southwest trend that is diagonal to the trend of the South Slough syncline (map). With strata exposed along the shore in cross section, wave erosion can take maximum advantage of differences in rock hardness. Between Sunset Bay and the end of Cape Arago, the shore is more nearly parallel to the trend of the sedimentary beds, but the rock is cut by numerous faults. Erosion is directed along soft strata and fault zones where the rock has been weakened by shattering. The Coos County coast has its greatest irregularity between Coos Bay and Cape Arago (Figure 2).

Bays, coves, and indentations

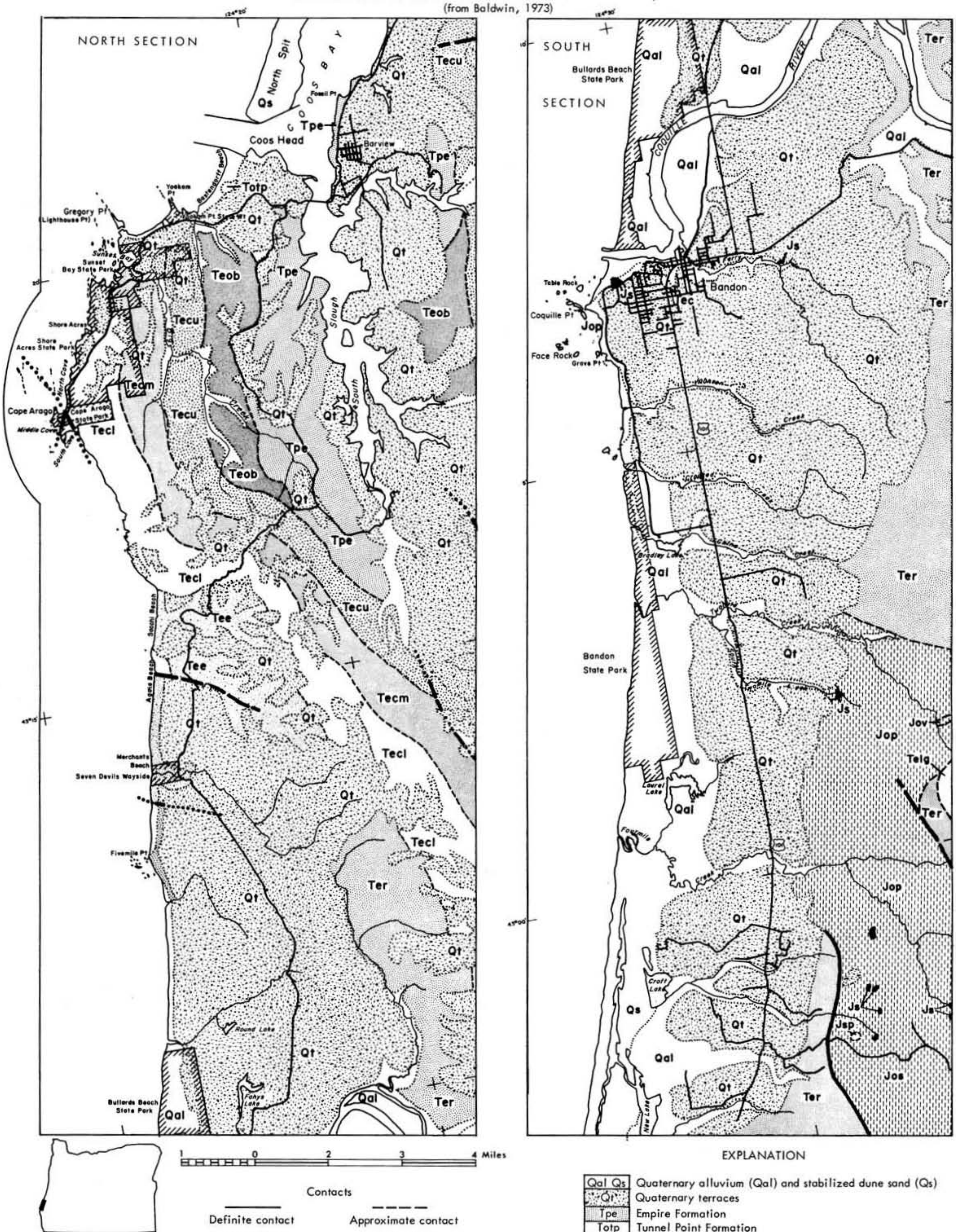
Bays, coves, and indentations are variations of the same general shore form, differences being mainly in size and shape. Bays and coastal re-entrants that are related to rivers do not belong in this category.

Two broad indentations, one between Tunnel Point and Yoakam Point and the other between Yoakam Point and Lighthouse Point (shown on the map as Gregory Point), are at places where there is a thick sequence of weak beds. Between Tunnel Point and Yoakam Point, the rock is shale of the Bastendorff Formation. Prior to the construction of the south jetty, Bastendorff Beach was limited by these two points. After the jetty was built, sand filled in, causing the shore to shift seaward and extending Bastendorff Beach

Figure 11. Lighthouse Beach with points of land on hard units of middle member of Coaledo Formation. (Photo by Ward Robertson)

Figure 12. Sunset Bay, Lighthouse Point, Squaw Island, and reefs. (Oregon State Highway Division photo)

GEOLOGIC MAP OF THE COAST OF SOUTHERN COOS COUNTY, OREGON
(from Baldwin, 1973)



Contacts

Definite contact	Approximate contact
Inferred contact	Concealed contact

Faults

Definite fault	Approximate fault
Inferred fault	Concealed fault

EXPLANATION

Qal Qs	Quaternary alluvium (Qal) and stabilized dune sand (Qs)
Qt	Quaternary terraces
Tpe	Empire Formation
Totp	Tunnel Point Formation
Teob	Bastendorff Formation
Tecu	Coaledo Formation: upper member
Tecm	middle member
Tecl	lower member
Tee	Elkton Formation
Ter	Roseburg Formation
●-Js	Otter Point (Jop) and blueschist (Js)
Jop	
Jsp	Serpentinite

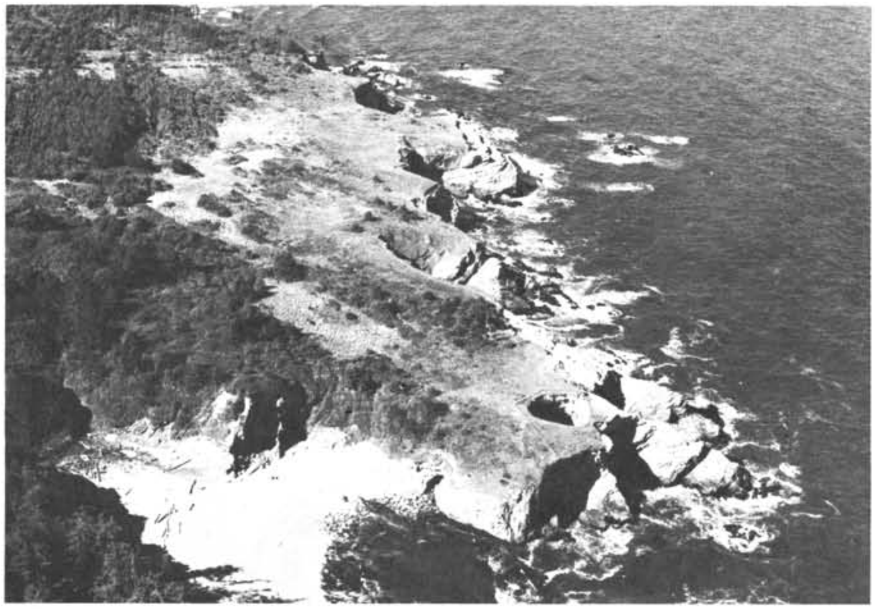


Figure 13. Round hole in terrace at Shore Acres State Park is a collapse in the roof of a sea cave.

Figure 14. Chasm at Yoakam Point (Mussel Reef).

to the jetty (Figure 8). This extension of the beach has somewhat obscured the natural boundaries of the indentation.

The concavity between Yoakam Point and Lighthouse Point is against the middle member of the Coaledo Formation. Although this member has a greater amount of shale and siltstone components than the lower and upper members, it has some massive sandstone beds. These units form points that project onto Lighthouse Beach, and small indentations lie between them (Figure 11).

Between Sunset Bay and the tip of the cape, the shore is against the lower member of the Coaledo, and the trend of the shore is nearly parallel to the trend of the strata. Most of the irregularities in this stretch are related to faults, though differences in rock hardness play an important role in shaping the coves.

Sunset Bay (Figure 12), largest of the coves, lies partly in the lower member and partly in the soft middle member of the Coaledo. At this locality, numerous faults cut through the rock nearly at right angles to the shore. The forming of the bay occurred when erosion, guided by these faults, breached the lower member and scoured out the softer rock behind the constricted entrance. The lobe at the southern end of the bay is an extension along the valley of Big Creek.

The cove south of the view house at Shore Acres State Park (Figure 13) and numerous smaller ones along this part of the shore are somewhat similar to Sunset Bay in origin, though their enlargement was in softer strata of the lower member and not in the middle member of the Coaledo.

North, Middle,and South Coves (Figures 2 and 3) at the outer lobe of Cape Arago are in the lower Coaledo and owe their origin in part to difference in rock hardness and in part to structure. The Cape Arago fault crosses the "neck" of the lobe in an approximate north-south direction. A local wrinkle in the strata called the Cape Arago anticline is associated with the fault and also has a north-south trend. It is likely that the coves formed where fracturing of the rock along these structures created zones of weak rock.

Points, reefs, and islands

As the weaker rock is worn away by waves, various forms emerge where the rock is more resistant to erosion. The sandstones and metamorphic rocks of the pre-Tertiary formations and the massive sandstones of the Tertiary formations are the most durable types and the ones that make up the points, reefs, islands, and miscellaneous smaller rock masses that lie along the shore.

Coos Head is supported by the Empire Formation, Tunnel Point by the Tunnel Point Formation, Yoakam Point and Lighthouse Point by massive sandstone units of the upper and lower Coaledo respectively, and Cape Arago by lower Coaledo sandstone. Numerous sandstone units in the middle Coaledo support smaller, unnamed promontories (Figure 11). Shale and siltstone in

Figure 15. Yoakam Point between Bastendorff Beach on upper right and Lighthouse Beach on lower left. (Oregon State Highway Division photo)

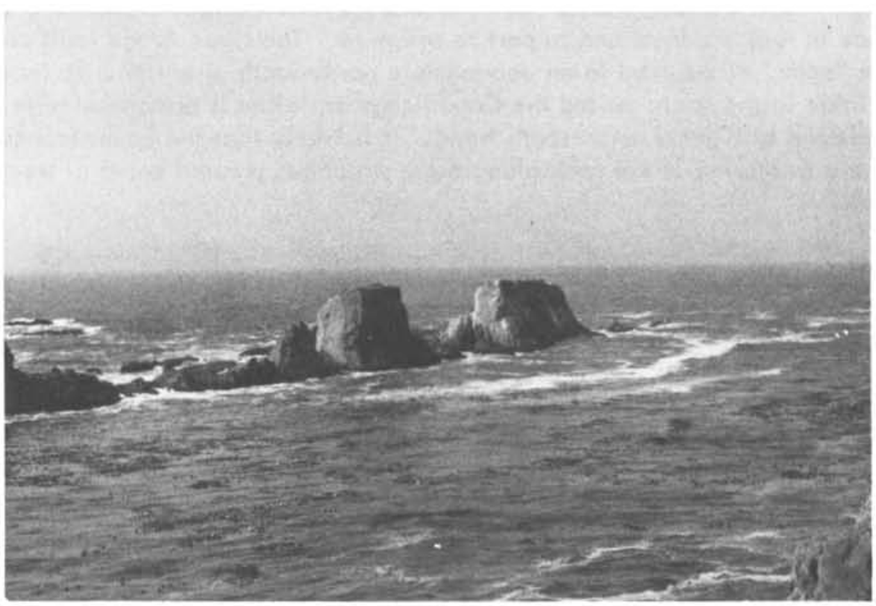


Figure 16. Sea stacks along a reef west of Lighthouse Point.

the upper and lower Coaledo permit deep penetration of erosion with the development of second order points on these members. Yoakam Point and the point of land at Lighthouse Point are forked where chasms have been eroded in weak rock between resistant sandstone units (Figure 14).

Fivemile Point (Figure 4), south of Cape Arago, is a well-indurated mass of interlayered sandstone and shale of early Eocene age. Coquille Point (Figure 21) and the point at Bandon Beach Wayside (Figure 5) south of Bandon are of lightly metamorphosed graywacke sandstone of Jurassic age.

Reefs at Yoakam Point (Figure 15) and aligned rock masses off the tip of Lighthouse Point are erosional remnants of points of land. Several groups of aligned rock masses that lie west of Lighthouse Point (Figures 12 and 16) are reefs and are probably remnants of a much larger promontory that included Lighthouse Point ages ago.

Simpson's Reef is on massive sandstone units of the lower Coaledo. The outer reef (Figure 17) is mostly a continuous spine developed on a single rock unit, and the inner reef is a cluster of rocks in parallel groups aligned along several sandstone units. That the reefs are remnants of the mainland that extended farther to the north and west in the distant past is a plausible assumption. It is likely that all or part of the inner reef was once a point of land that projected northward from the outermost part of the Cape.

Along the shore at Shore Acres State Park, a sloping wall of rock is separated from the terrace by a trench cut along a weak layer (Figure 9). With continued widening of the trench, the wall will become more distinctly a reef. This mode of origin offers a possible explanation for the origin of the outer reef north of the Cape.

The numerous islands, stacks, and associated smaller rock knobs along the shore near Cape Arago and south of Bandon are terrace remnants; where erosion has not removed it, terrace sediment caps a body of bedrock. Where the terrace sediment is still intact, the top of the stack or island is at the same level as the terrace on the nearby mainland (Figure 18).

Squaw Island, just off the entrance to Sunset Bay, is only a "part-time" island, for at low stages of the tide it can be reached by a bedrock connection with the mainland. This natural causeway is improved by a tombolo, a deposit of sand that links an island to the mainland or another island. Bedrock also extends to the reef just west of the island (Figure 12). These connections joining the reef, the island, and the mainland owe their origin to local wave refraction. Part of a wave moving towards the entrance of Sunset Bay may be refracted in such a way that it moves northward towards the island. Part of a wave moving towards Lighthouse Point may be refracted southward towards the island. When the water level is high enough that the island is completely surrounded, waves from the north and waves from the south neutralize each other. Consequently, erosion at this place is considerably diminished, and at times sand is deposited. When the island is not continually surrounded by water, waves wash up onto the tombolo, bringing sand from both directions (Figure 19). At times during winter storms, large

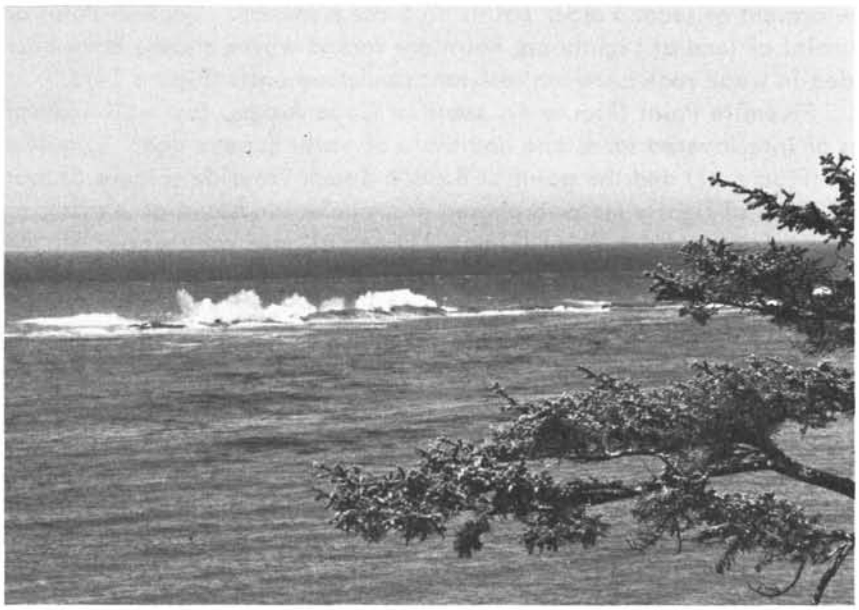


Figure 17. Outer reef of Simpson's Reef. (Oregon State Highway Division photo)

Figure 18. Stacks and islands off Coquille Point. (Oregon State Highway Division photo)

waves rush through the gap between the island and the mainland, sweeping the bedrock clear of sand.

The part of Lighthouse Point on which the lighthouse sits is separated from the mainland by a chasm that was formed by erosion along a fault. This part of the point is technically an island, and it is the largest in the Cape Arago locality.

The largest islands and the greatest number of islands and stacks are south of Bandon along a stretch of the shore that extends from Coquille Point southward to Bandon State Park, a distance of about 3 miles. The largest are off Coquille Point (Figure 18). The large number of stacks and islands and their size can be attributed to the durability of units in the Jurassic rock along this part of the coast.

Trenches, chasms, and tunnels

Trenches and chasms are considered here to be the same type of feature, differing only in size. Some are formed along weak rock layers and others along fractures in the rock. There are many of the former between Yoakam Point and Shore Acres, and remarkable examples can be seen at Yoakam Point (Figure 14) and Lighthouse Point. Trenches and chasms related to faults are common between Sunset Bay and the tip of Cape Arago. A good example of this variety shows up on the wave-cut bench in Sunset Bay at low tide (Figure 10). Several trenches related to fractures cut across the rock apron that fringes the northern part of the lobe at the tip of Cape Arago.

Some trenches and chasms end in caves (Figure 20). At Cape Arago at least two of the trenches terminate in caves that penetrate into the sea cliff several tens of feet.

At Shore Acres State Park, caves have formed in weak rock layers, and towards the rear of one of them the roof has collapsed, leaving a natural bridge (Figure 13). This feature is much like the famous Devil's Punch Bowl at Otter Rock in Lincoln County, Oregon.

Tunnel Point gets its name from a tunnel that passes through it near the tip. Prior to the building of the south jetty, the tunnel was awash during high tide, but the sand deposition that followed jetty construction moved the beach line away from the point, and the tunnel has been partly filled.

Sandspits

At the mouths of Coos River (Figure 8) and Coquille River (Figure 21), sandspits have grown from the north and have pushed the rivers against bedrock along their south banks. During the summer, northwest winds form longshore currents that flow southward, and during the winter southwest winds form northward flowing currents. Cape Arago to the south of Coos River and Coquille Point to the south of Coquille River cut off most of the supply of sand from the south so at both of these rivers the longshore currents from the north are more influential in building the sandspits.

Figure 19. Squaw Island and tombolo connecting it to the mainland.

Figure 20. Trench and cave along a fault at Cape Arago.

Figure 21. Sandspit at the mouth of Coquille River. (Oregon State Highway Division photo)

Dunes and lakes

A low, narrow strip of dunes lies behind Bastendorff Beach and is the only one between the jetty and the end of the Cape. The dunes have been stabilized by dune grass, allowing little shifting of sand by wind.

Dunes border most of the shore from Whisky Run Creek southward into Curry County. Between Whisky Run and Cut Creeks they rest on the Whisky Run terrace, which in turn rests on the Coquille Formation. A sea cliff along the shore between these two creeks prevents any new sand from moving into the dunes, and they are stabilized by a forest cover. From Cut Creek southward to the Coquille River is a strip of active dunes behind the shore, and inland from it is a half-mile-wide strip of stabilized dunes. A foredune ridge along the shore is stabilized with beach grass, and very little new sand is reaching the active strip behind it. These dunes are on a low area where the Coquille River removed a segment of the terrace.

From Bandon south to Crooked Creek stabilized dunes occupy a position at the edge of the terrace. Because of the sea cliff, no sand is being added from the beach. South of Crooked Creek a low area between the beach and the terrace is receptive to wind-blown sand, and a strip containing active dunes extends southward into Curry County; this strip widens to the south. A stabilized foredune ridge is almost continuous along the shore, and little new sand is moving over it. Consequently, as in other dune belts along the Oregon coast, the area covered by active dunes is decreasing and the area of vegetated dunes increasing.

Where dunes increase in size until they block a creek's drainage to the ocean, a lake may be formed. Round Lake and Fahys Lake, north of the Coquille River, lie behind an older stabilized dune ridge. Bradley Lake (Figure 6), Laurel Lake, Croft Lake, and New Lake, south of the Coquille River, are behind the active dune belt.

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TEXACO RECORDS RELEASED

Well records on Texaco "Federal No. 1" well were released from the Department's confidential file on Nov. 22, 1973, 2 years after date of abandonment. The 8,000-foot test hole was drilled in sec. 31, T. 17S., R. 23 E., in Crook County. No oil shows were found, but noncommercial gas shows were encountered between depths of 1,700 and 3,500 feet. The well is believed to have bottomed in Jurassic volcaniclastic rocks.

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ERTS MAP OF OREGON PUBLISHED

The ERTS (Earth Resources Technology Satellite) map of Oregon is now in print. The map is reproduced in shades of green at a scale of approximately 1:1,000,000 with names of the main geographic features overprinted in red. Both map and text were prepared by the Environmental Remote Sensing Applications Laboratory at Oregon State University. The publication, Miscellaneous Paper 16, is published by the Oregon Department of Geology and Mineral Industries and is for sale at its Portland, Baker, and Grants Pass offices. The price is $2.00.

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