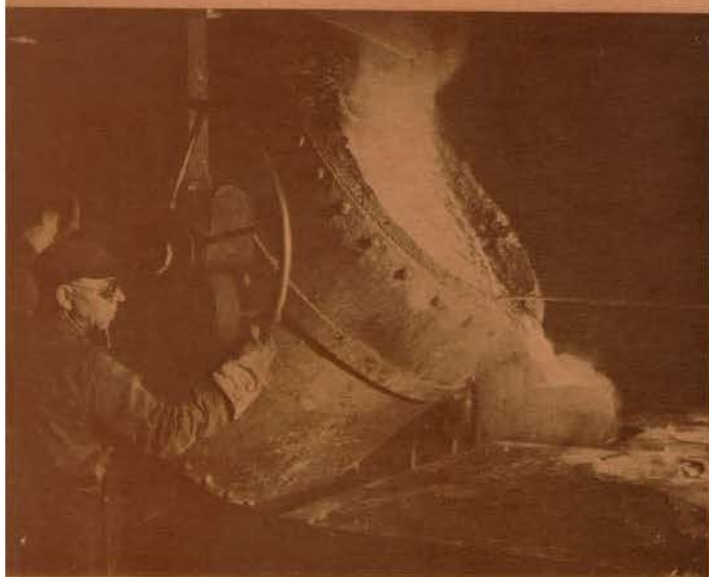


GEOLOGY IS FOR EVERYONE

For Planning



For Industry

For Recreation

BULLETIN 59

State of Oregon Department of Geology
and Mineral Industries



FOREWORD

"Geology is for Everyone" is well displayed in this, the Fifteenth Biennial Report of the Department, which briefly reviews the activities of the State of Oregon Department of Geology and Mineral Industries for the period 1964-1966.

From the grade school student who wrote us saying: "Could you possibly send me a sample of red obsidian which is a type of rock? Please! I need it cause I have to have a science project or I die," to the private organizations who are considering Oregon's geothermal potential or our offshore oil and hard-mineral possibilities -- geology is a serious business. It is serious, also, to the mining companies investigating Oregon for quicksilver, gold, chrome, and other metallic minerals on shore and to the land owner or industrial concern who wants to know what and where the geologic hazards are or whether the ground is adaptable to the building of a swimming pool or can support a large structure. Geology is not so serious -- in fact it is fun -- to the intellectual recreationist interested in the "why" of the scenery of our State Parks or to the outdoor hobbyist, "rockhound," and amateur geologist.

All of these interests are covered in the investigations and reports of the Department this past biennium. In addition, the Department served as a source of geologic information for other State departments and for municipalities and counties of the State. To obtain the information needed, the Department does basic geologic mapping; makes resource studies; conducts geologic engineering investigations (now centered in the Willamette Valley); analyzes terrain unique to the State for special development (central Oregon is an astronaut training ground); and makes reconnaissance geochemical examinations of large areas to pinpoint more closely mineralized areas. In addition, the Department maintains a free assaying service, a spectrographic laboratory, a library on geology and mining subjects, a museum for public enjoyment, and provides a limited speakers' bureau.

This brief biennial review of the Department's activities should lay to rest the archaic view that geology is useful only to the mining and oil industries and demonstrate that geology is truly for everyone.

Hollis M. Dole
State Geologist

BULLETIN 59

FIFTEENTH BIENNIAL REPORT OF THE STATE GEOLOGIST

1964 - 1966



STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

STATE GOVERNING BOARD

Frank C. McColloch, Chairman	Portland
Harold Banta	Baker
Fayette I. Bristol	Grants Pass

Hollis M. Dole
State Geologist



A pen set made from the new state rock in the outline of the State of Oregon was presented on March 29, 1965, to Governor Mark O. Hatfield. This was the pen that was used by Senate President Harry Boivin and House Speaker F. F. Montgomery to sign the resolution. On the Governor's desk are a number of other thunder eggs, some sawed open and others uncut. Standing behind Governor Hatfield from left to right are: Rep. Sam Johnson, Sen. Harry Boivin, Rep. William Gallagher (hidden), Sen. R. R. Raymond, Rep. L. B. Day, Rep. G. W. Detering, Sen. Ed Ahrens, Sen. Glen Stadler, Mr. Ed Nichols, Sen. Gordon McKay, Mr. Marion Cady, and Mr. Al Keen. (Photograph by Joseph V. Tompkins)

GOVERNING BOARD
FRANK C. MCCOLLOCH, CHAIRMAN, PORTLAND
HAROLD BANTA, BAKER
FAYETTE I. BRISTOL, ROGUE RIVER



FIELD OFFICES:
2033 FIRST STREET
BAKER
239 SOUTHEAST "H" STREET
GRANTS PASS

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1069 STATE OFFICE BUILDING
PORTLAND, OREGON 97201

To His Excellency, The Governor
of the State of Oregon
and to
The Fifty-fourth Legislative Assembly of the State of Oregon

Sirs:

We submit herewith the Fifteenth Biennial Report of
the Department of Geology and Mineral Industries, covering
activities of the Department for the period from July 1, 1964,
to and including June 30, 1966.

Respectfully,


Frank C. McColloch, Chairman


Harold Banta, Member

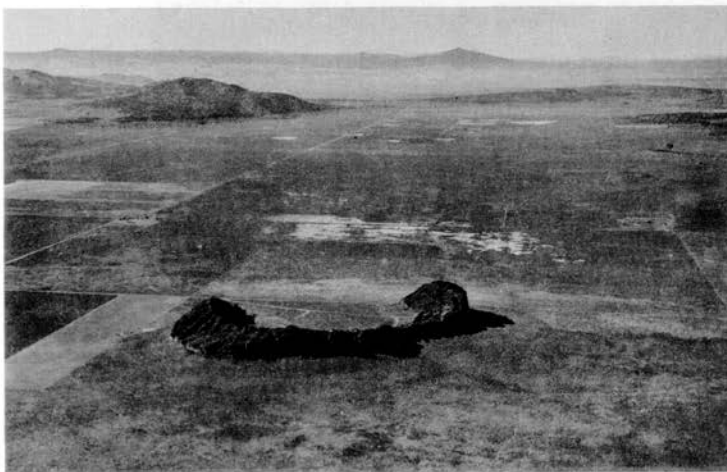

Fayette I. Bristol, Member

Portland, Oregon
January 20, 1967

GEOLOGY IS FOR EVERYONE

TABLE OF CONTENTS

	<u>Page</u>
For Land Development:	1
Land Development in the Willamette Valley	1
Land Use on the Oregon Coast	2
Utilization of Volcanic Terrain.	4
For the Recreationist:	6
Oregon's State Rock -- A Rockhound's Prize	6
Geology of State Parks Program	7
Photographs of Cape Lookout and Cape Arago State Parks	8
Sketch Maps of Park Areas Studied	9
Department Museum Draws Many Visitors	10
For the Student:	11
The Library	11
Publications	11
Mineral Sets	11
Speaker and Letter Service	12
For Children:	13
For the Mineral Investigator	14
Status of Geologic Map Project - Eastern Oregon	14
Geophysical and Geochemical Program	16
For Industrial Development	17
Geothermal Energy in Oregon	17
Oregon's Mineral Industry	18
The Search for New Mineral Wealth	20
Petroleum in Oregon	21
Department Organization	25



Fort Rock, looking south. Erosional remnants of the rims of a large tuff ring that once projected as an island above ancient Fort Rock Lake in Lake County. The steep, wave-cut cliffs of Fort Rock display the initial dips of thin layers of palagonite tuff that accumulated when exploded debris settled around a broad crater.

GEOLOGY IS FOR LAND DEVELOPMENT

LAND DEVELOPMENT IN THE WILLAMETTE VALLEY

Large-scale urbanization in the United States began in the latter part of the 19th century, and migration from rural to urban areas has continued to increase. Since 1940, metropolitan areas (major city centers and their environs) have nearly doubled in number. The urban areas account for the growth, while the centers of the metropolitan areas are declining in population.

A group of connected metropolitan areas, sometimes termed a "megalopolis," already exists in several parts of the nation. Within the next few decades the Willamette Valley is destined to become a megalopolis made up of merging urban areas extending all the way from Portland south to Eugene and laterally between the foothills of the Coast Range and Cascade Mountains.

In order to develop these urban areas to the best advantage, a detailed knowledge of the ground conditions should be a prime consideration. Planners will need the facts geologists and engineers can provide on bedrock, soils, and ground water. It is this kind of information that can make the task of urban planning meaningful.

To further the compiling of this record, the Department is engaged in a detailed study and mapping of the geology of urban areas in the Willamette Valley. The work is being carried out under "Project of the Planning Agency under Urban Grant No. Oregon P-45."

Since the fastest growing portion of the Willamette Valley region is the Tualatin Valley, this area is the first to undergo investigation in the Department's long-range study. Information will soon be published for the Tualatin Valley on the character of the bedrock and unconsolidated deposits, on the distribution of surface and underground water, on the location of potentially valuable minerals and construction materials such as sand and gravel, and on the environment of hazards such as floods, landslides, and soft ground. Engineering problems related to these geologic factors have been analyzed, and this information should serve as a guide for those making detailed, on-the-site investigations.

Following publication of the maps and text on the geology and engineering characteristics of the Tualatin Valley, the study will be extended into the Salem region and other rapidly developing portions of the Willamette Valley. It is the Department's sincere belief that investigations of this type can lay the foundation for safe and effective development of urban land.



View of Onion Flat area, showing urban growth and local source of sand for construction

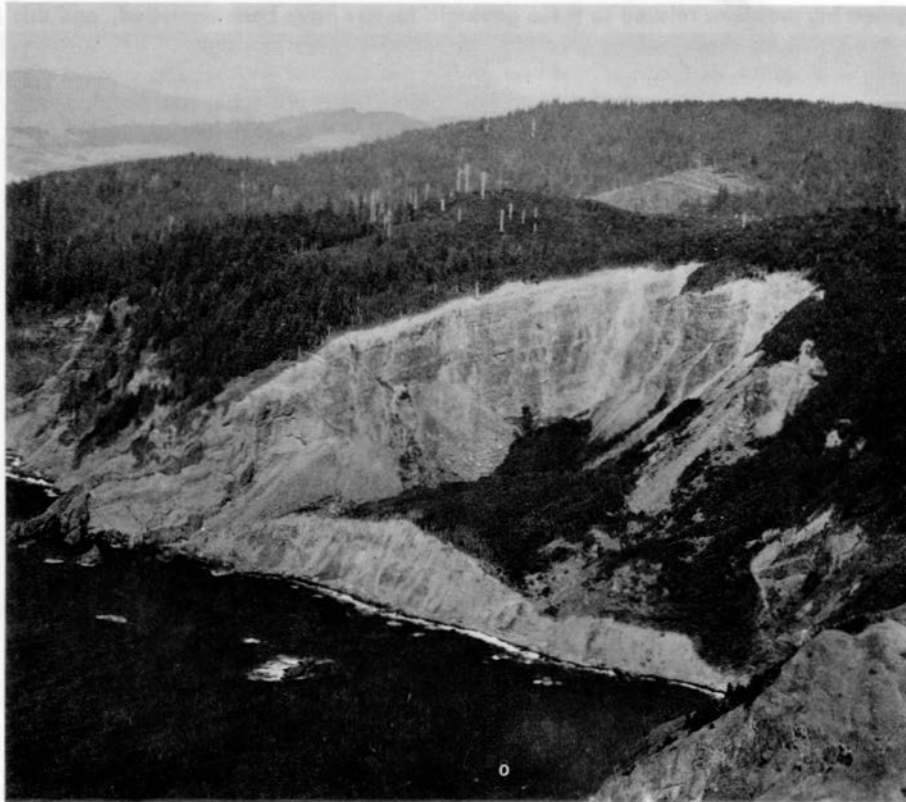
LAND USE ON THE OREGON COAST

The increased development of the Oregon coast for homes, recreation, and industry makes it economically important to understand processes of coastal erosion and deposition. Of all the erosional processes, landsliding is undoubtedly the most important. In the November 1965 issue of *The ORE BIN*, Dr. John V. Byrne describes and illustrates landslides along the northern Oregon coast. He points out that this type of erosion is active along 70 of the 150 miles from the Columbia River to Florence.

In the past, investigations of coastal landslides have followed mainly a reactionary approach. Only after property has been damaged or rendered valueless have detailed studies been made to determine causes of the movements and the feasibility of preventive measures.

Landslides are produced by the force of gravity and can occur in any type of weakened material where slopes are steep. Both consolidated rock and unconsolidated sediments can be affected. Frequency of landsliding on the coast appears to be correlated with high winter waves and increased precipitation. Property losses have been extensive in sparsely populated areas such as Ecola Park and Cascade Head (see photograph). Severe damage to buildings, roads, and utilities has occurred in the village of Cope Meares and in the city of Newport as the result of sea-cliff recession (see sketch maps).

Total prevention of coastal landslides is an expensive undertaking well beyond the means of the average property owner. However, where limited steps have been taken to retard small, but economically damaging, slides the results appear to be well worth the effort. Future planning and development of land along the Oregon coast should be preceded by careful analysis of the underlying geologic materials to ensure safe foundation conditions.



Rock-terrace slump which has destroyed 20 acres of land on Cascade Head.

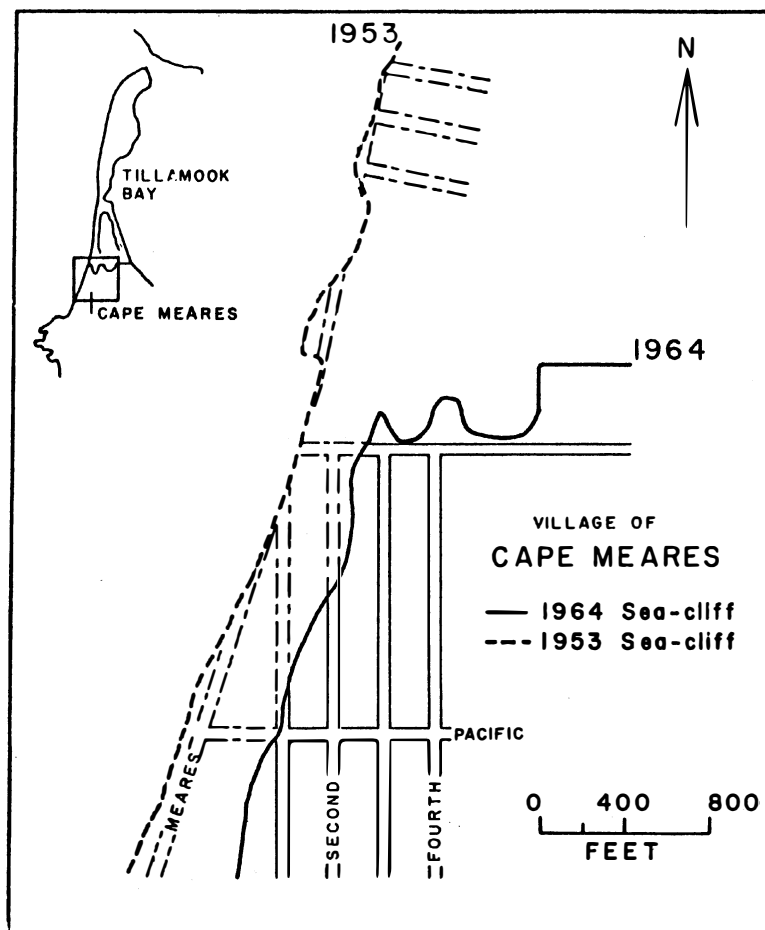


Figure A. Coastal retreat at Cape Meares, 1953 to 1964.

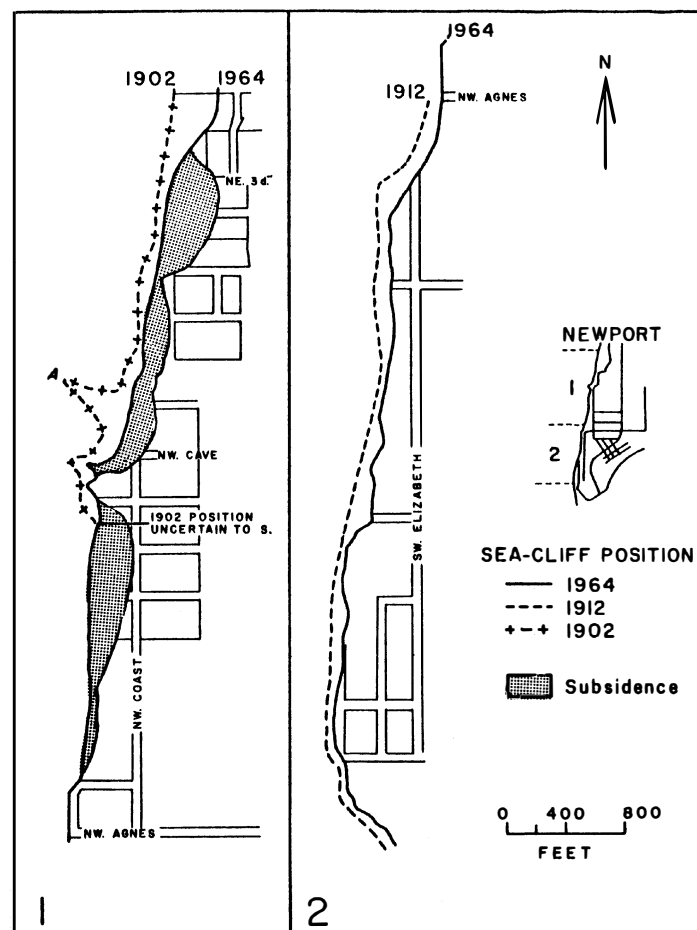


Figure B. Coastal retreat at Newport, 1902 and 1912 to 1964.

UTILIZATION OF VOLCANIC TERRAIN

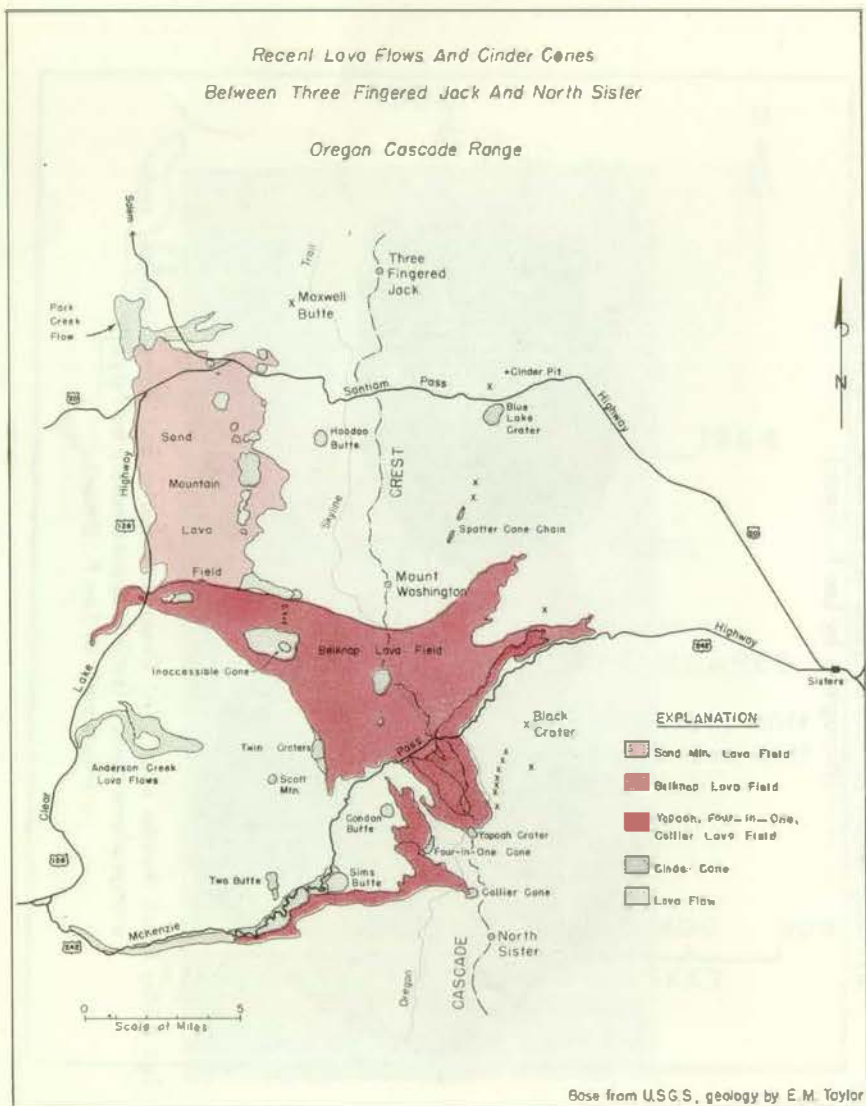
There are large areas around Bend, Oregon, where Recent lavas have poured out over the land and completely destroyed the vegetation. These volcanic features are so young that there has not been sufficient time for any soil horizon to develop on them and thus they provide little grazing for cattle or wildlife.

The Department has investigated these barren lava surfaces over the past several years in order to determine whether they could be used as a lunar test site. Scientists and engineers have been encouraged to visit the Bend area to see at first hand the great variety of volcanic rocks and surface features that are found in this region. An International Lunar Geological Field Conference was held at Bend in August, 1965. Since that time, representatives from the National Aeronautics and Space Administration and from several companies involved in space research and development have shown considerable interest in Oregon rocks. For example, 15 tons of porous basalt, most of it in large blocks measuring two or three feet on a side, were taken from a flow near Lava Butte and shipped to Black & Decker Corp. in Baltimore, Md., for use in the testing of a lightweight lunar core drill. Samples of volcanic ash from a deposit near Bend were heated in an electric furnace built by the Department to demonstrate that quantities of chemically combined water in these rocks could be distilled and collected. Its use as a source of water for astronauts based on the moon was shown on a nationally broadcast lunar exploration television program. NASA has sent teams of astronaut trainees to the Bend area in order to acquaint them with the type of volcanic terrain which they may encounter when they land on the moon. With the establishment of the new Center for Volcanology at the University of Oregon, there is certain to be more field research on Oregon's rocks in the future.

The publicity that Oregon's "moon country" has been receiving from the various news media has resulted in an increased number of visitors to the Bend district. These people want to see for themselves what the moon will look like to the first men when they make their landing.



Conference group listens intently as Dr. Haroun Tazieff of the University of Brussels, Belgium, describes the operation of a portable volcanic gas analyzer at the East Lake Hot Spring in Newberry Crater.



Recent volcanism in the Oregon Cascade Range visible from well-traveled highways.

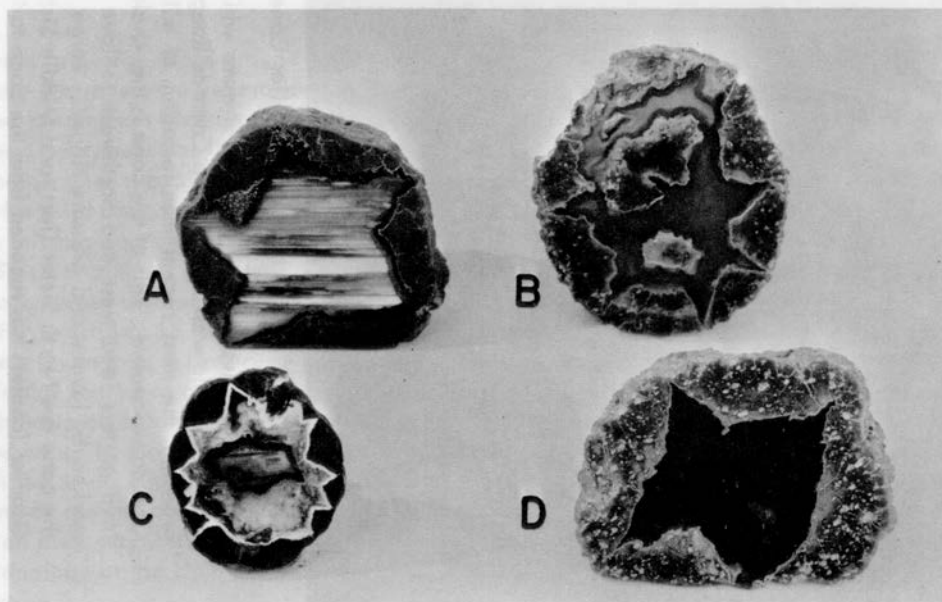


Lava flows from Collier Cone

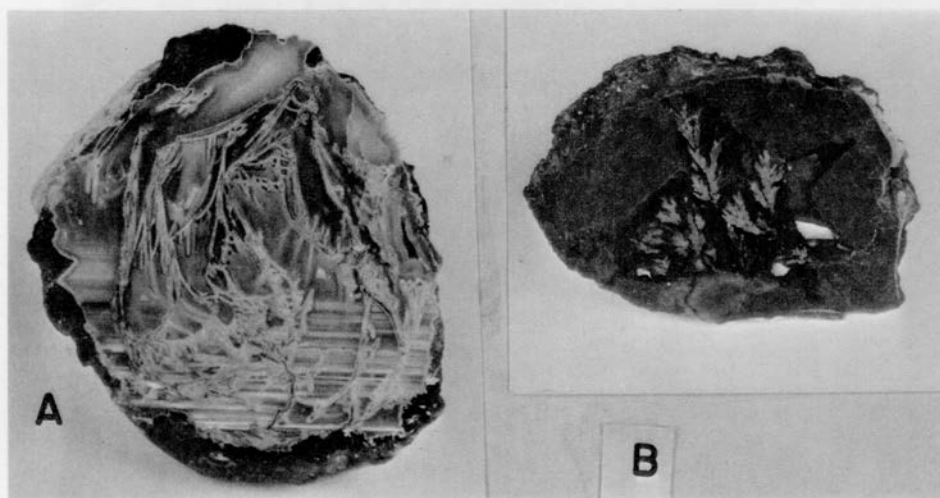
Collier Cone (upper left) and lava streams which spread from its crater down the west slope of the Cascade Range (foreground), are probably the most recent manifestation of millions of years of Oregon volcanism. Left of the cone is the Aholapom Cinder Field; lava gutters lead west and northwest to lava lobes which are marked by levees and pressure ridges. Large volcanoes behind the cone are North Sister (left) and Middle Sister (right). Collier Glacier (center) has receded from the cone to its present position in only 40 years. In the background are Broken Top (left) and South Sister (right). Four-in-One Cone and lavas are visible at lower left. (Delano Aerial Oblique No. 631234)

GEOLOGY IS FOR THE RECREATIONIST

OREGON'S STATE ROCK - A ROCKHOUND'S PRIZE



Cut and polished thunder eggs from four localities (each is approximately half size):
(A) Priday Ranch; (B) Sucker Creek; (C) Buchanan; and (D) Ochoco.
(Photograph by Lea F. Simon)



Two Priday Ranch thunder eggs: (A) Green moss agate; and (B) red, yellow, and orange plume agate (each is approximately half size).
(Photograph by Leo F. Simon)

GEOLOGY OF STATE PARKS PROGRAM

During the summer of 1966, the Department and the State Parks Division shared in an experimental program to produce geologic information on some of the major state parks. Under this program the State Parks Division paid for the salaries of the two geologists who did the work, and the Department financed their field expenses, supervision, and the cost of publication of their reports. The aim of the project was to analyze the geology of these parks and present it in ways that would make it interesting and understandable to the general public. Information of this type has long been needed.

To accomplish this work, the Department hired two graduate women geology students -- one from each of the state universities. Their work was supervised by a Department staff member. Each woman selected a park area where geologic processes are the direct cause of a variety of scenic features. The two park areas worked on during the summer were: 1) Cape Arago near Coos Bay, which includes Arago, Shore Acres, and Sunset Bay State Parks; and 2) Cape Lookout near Tillamook, which includes Cape Lookout and Cape Meares State Parks. At both locations picnic grounds and overnight camping facilities draw numerous visitors throughout the summer.

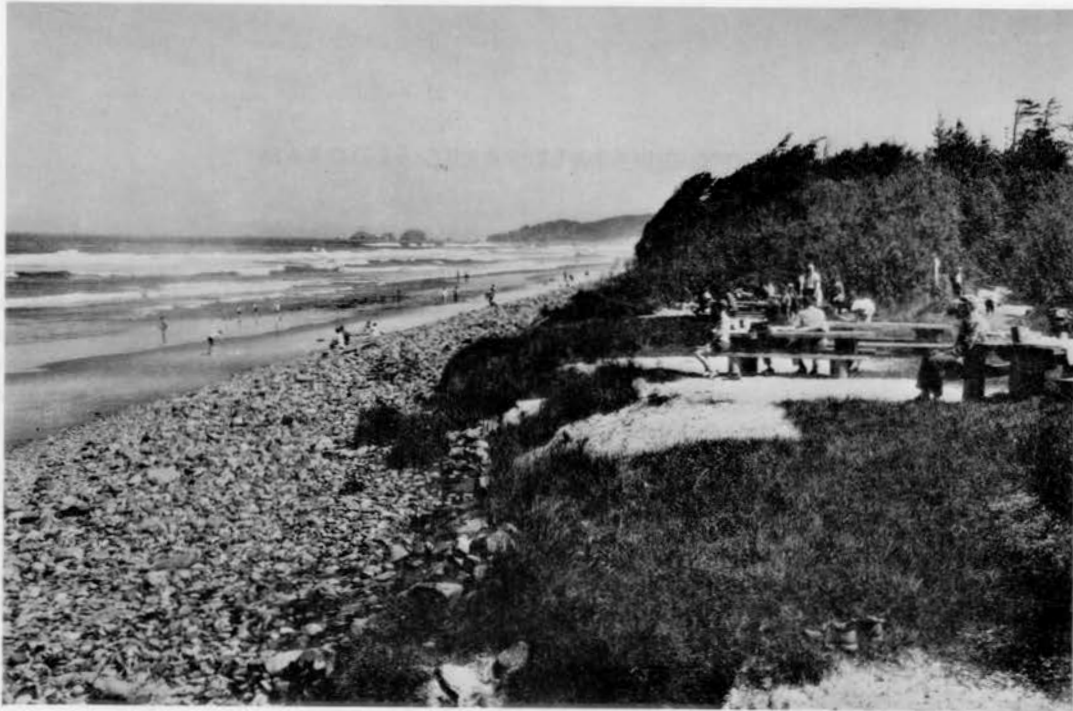
Each of these park areas owes its scenic beauty to the erosive powers of streams, ocean currents, and pounding surf gradually wearing away the weaker rock and leaving the harder materials standing in relief. Although both groups of parks have been subjected to similar erosive processes, the scenery is entirely different. This is due to the dissimilarity of the rock formations underlying the two regions. The parks to the south are in an area where alternating promontories and narrow embayments have developed in upturned and faulted beds of marine sandstone of varying hardness. The parks to the north are in an area where bays and long sand spits have formed between basaltic headlands that originated from ancient submarine volcanoes.

The main goal of the summer's field work is a report on each area written in non-technical language and illustrated by simple geologic maps, photographs, and sketches -- to be published in *The ORE BIN* during the spring of 1967. These reports will then be at the disposal of the Parks Division for adaptation to descriptive brochures. In addition, the project calls for suites of colored slides of natural features in the parks, together with explanatory texts that can be used by park personnel. Other aspects of the project include making collections of typical rocks and fossils for future display, and outlining suggestions for greater utilization of the natural features of the area.

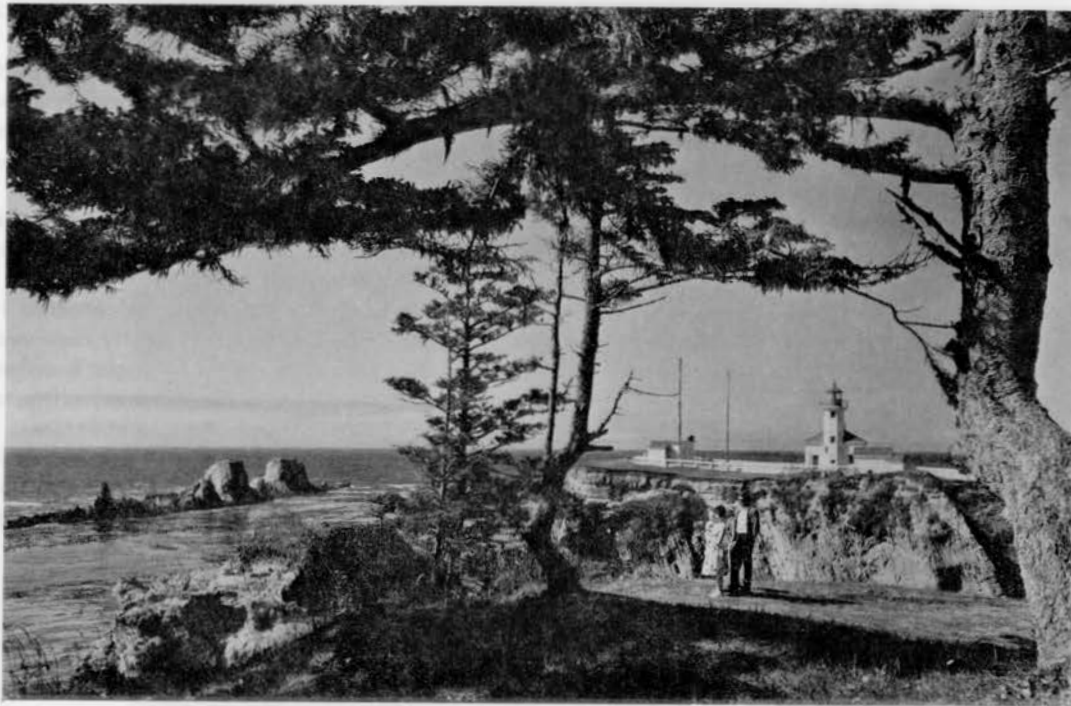
After publication of the reports forthcoming from this pilot program, the Department and the State Parks Division will review the summer's project and determine whether or not the program should be continued.

During the course of their summer field work the two geologists, both of whom volunteered their services in the parks on a number of occasions, found that their presence was enthusiastically received by employees and visitors alike. Park employees welcomed assistance of someone with geologic knowledge to present evening slide programs. Visitors, curious about what they saw along the beaches, cliffs, and trails, were delighted to obtain first-hand explanations about rocks, fossils, and geologic structures.

The public's expressed desire for information about the natural background of the parks shows that endeavors such as this are well worth the investment, especially if such programs can help develop public appreciation for the intrinsic value of one of Oregon's most important natural resources -- its scenic geology.

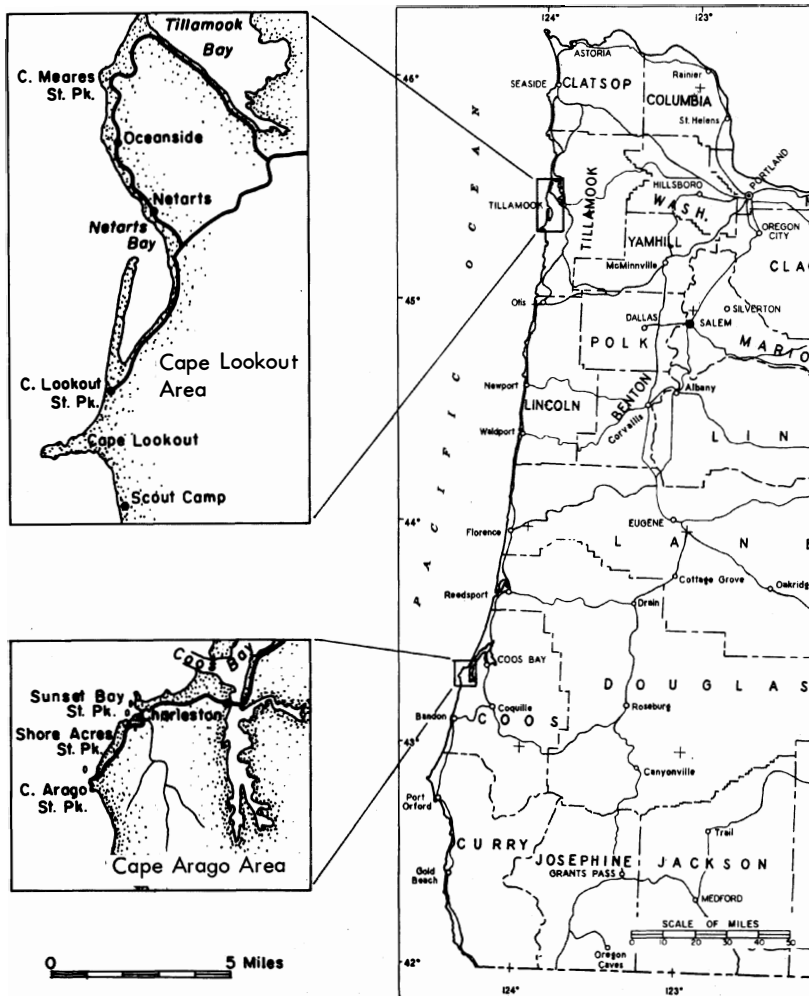


In addition to picnic and camping facilities, fun at Oregon's rugged Cape Lookout State Park includes a visit to a marine garden and hiking miles of trails through a primitive rainforest. In the background are Three Arch Rocks, site of a notional sea lion and bird refuge, and Cape Meares, with its 1890 lighthouse. (Oregon State Highway Department photograph No. 6782)



Sunset Bay State Park on the southern Oregon coast offers a close view of the Cape Arago lighthouse along with other seascapes, picnic areas, boat launching site, sandy beaches, and overnight camping facilities. (Oregon State Highway Department photograph 7071)

SKETCH MAPS OF PARK AREAS STUDIED



Cape Lookout on the northern Oregon coast and Cape Arago in the southern region were the popular and scenic sites of last summer's field studies.

DEPARTMENT MUSEUM DRAWS MANY VISITORS



A thunder-egg exhibit is part of the Department's permanent museum collection. The "eggs" were donated by 35 Oregon rock clubs soon after legislative action made this agate-filled nodule the official State Rock. The natural habitat of thunder eggs is in siliceous lava flows in central and southeastern Oregon. At one time thunder eggs were easy to find, and in some places lay scattered about on the ground where they had weathered out of their volcanic matrix. Now they are becoming scarce and are much sought after. The beauty of their agate-filled interiors makes them highly prized by rock hounds, who come from all over the nation to hunt for them. No two eggs are entirely alike and their origin, although given much thought by the experts, is still something of a mystery.

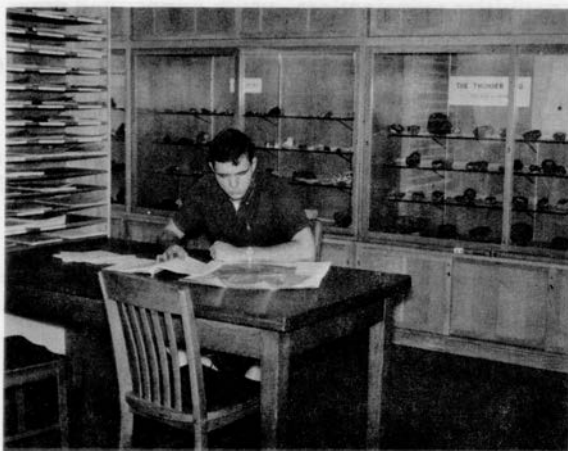


Bones of extinct animals, sea shells on mountain tops, and leaf imprints of tropical plants are some of the treasures to search for and find in the fossil beds of Oregon. Fossils tell a story of by-gone mammals that preceded present-day types, of ancient seas that once covered the state, and of luxuriant forests growing where now there is nothing but sagebrush. Fossil hunting is a favorite hobby for thousands of Oregonians and of visitors from out of state who spend weekends and vacations digging in rock outcrops for choice specimens.

GEOLOGY IS FOR THE STUDENT

THE LIBRARY

For lack of space, the Department's many thousands of volumes and pamphlets are crammed into shelves between offices and along the aisles. Our library consists strictly of geologic subjects in technical volumes, especially United States Geological Survey and United States Bureau of Mines publications, and in an assortment of professional journals and trade magazines. The remainder of the library is made up of exchange material from other Geological Surveys; both federal agencies and those of other states produce much material of general interest applicable to work in Oregon. Most valuable to serious students of Oregon geology and to geologists concerned with the State Geologic Map Project is the collection of theses on Oregon geology; 16 theses written by graduate students were added during the biennium.



A college research project.

One purpose of the library is to concentrate within the Department a single reference collection for both students and representatives of industry interested in the state's geology. Portland State College geology students find a ready source of information here, and during vacation periods students from the two universities use it a great deal. High school students find material for their science projects here.

Industries in Portland and the surrounding area frequently call on the library for general as well as local geologic information. Most mineral and oil and gas investigations in Oregon start with careful perusal of published and unpublished reports housed in the Department's library.

PUBLICATIONS

The ORE BIN, monthly publication of the Department, is widely known for dispensing information on subjects of current concern, such as location of the epicenter of a recent earthquake; the chance of tsunamis striking the coast; the means of avoiding or limiting damage from landslides or earthquakes; the explanation of a sudden flood from a glacial lake on a Cascade peak; the historical record of a meteorite fall; the description of fossil localities and identification of the fossils found therein; short illustrated articles on eye-catching geologic features along the state's highways; news of new mining activities and current legislation affecting mining; and an annual survey of the state's mineral industry. The ORE BIN is mailed to more than 1900 individuals, private business concerns, educational institutions, and government agencies.

In addition, the Department has issued during the past biennium Bulletin 35 (rev.), "Geology of the Dollos-Valsetz quadrangles, Oregon," originally issued in 1948; Bulletin 57, "The Lunar Geological Field Conference guide book"; Bulletin 58, "Geology of the Suplee-Izee area, Crook, Grant, and Harney Counties, Oregon"; Transactions of the Lunar Geological Field Conference [in cooperation with the State of Oregon Division of Planning and Development]; and the following Miscellaneous Papers: No. 6, "Oil and gas exploration in Oregon," revised 1965; a supplement to No. 7 entitled "Bibliography of theses on Oregon geology," extending the record to December 1965; and No. 10, reprints from The ORE BIN headed "Articles on Recent volcanism in Oregon."

MINERAL SETS

Another service provided for the student is the loan of rock and mineral sets to Oregon schools. Each rock and mineral set consists of 60 typical specimens, together with information on how to identify them.

SPEAKER AND LETTER SERVICE

The Department attempts to respond to every request for a speaker, whether the talk is to be given before a third-grade class interested in Oregon fossils, or to a professional symposium on vulcanology. Requests come from service groups, church gatherings, activities organizations, youth camps, and professional societies. In addition there are numerous, growing demands from students ranging from the lower grades through college. The Department maintains a large library of colored slides which are of great help in giving talks to audiences having little or no background in earth science. The slides are taken during the course of regular field work by staff members.

Increasing use of the Department's staff is being made by local television and radio stations. Each year the Department tapes a 15-minute radio program on safety with respect to rockhounding and mineral collecting. The tape is recorded and distributed through the state-owned station, KOAP.

The answering of letters occupies an increasing amount of staff time. Mail comes from students, prospectors, hobbyists, land- and home-owners, mining companies, and geologists. Many of the requests can be fully answered by sending reprints from issues of *The ORE BIN*, the Department's monthly newsletter. Some of the leaflets on fossil hunting have been reprinted repeatedly and thousands have been mailed.

from around Oregon. Someday
I plan to be a professional baseball
player and a half time Geologist.
My friend Brad Shubert and I
plan to start a junior geology
club. So if possible please send
me some rocks for our club. There
are some rocks I'd like if
possible. Ordovician, Permian,
Basalt, Lignite and Triassic.
If any cost please tell me if
any cost thank you
Sincerely

Dear Sir: I just want to write and note to tell you
I received the six mineral samples today-wish
every state would do what you do. Such nice samples
and every one just what I wanted.

Thank you very much for sending them-I really
appreciate it.

Sincerely,
Jody Winston
9060 Textile Rd.

Our school is having
rock collections. The rocks
from your state are needed
desperately. These collection
are to be displayed in our
school Science Fair. I have
been appointed to represent
your state. We would appreciate
any and all the rocks you can
possibly send.
Thank you.

Well I got an A on the
paper, and I never could
have done it with out your
fast, and friend lay help.
I just wanted to tell
you how very much I
appreciate your help.

Dear Sirs:

Please tell me how
you now which rock
is which.

Thank you
Sherrice Roper

Dear Sirs,

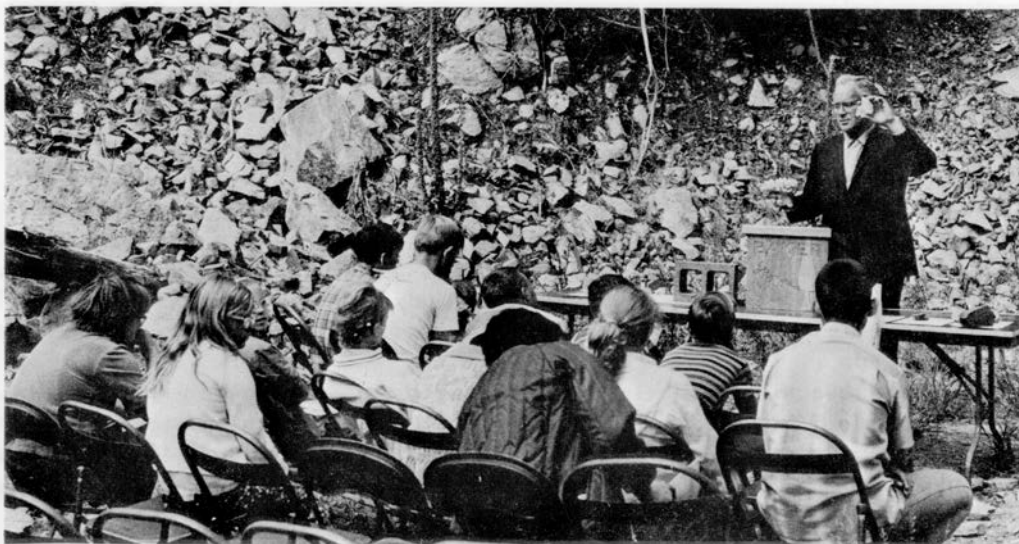
Could you please send me a few
samples of rocks or mineral. I have
a big collection but I'm hungry for
more.

Thank you,

Dear Sirs:

Could you possibly send me a sample
of Ordovician which is a type of rock?
Please - I need it cause I have to have
a science project on I die.

GEOLOGY IS FOR CHILDREN



In class groups of 15 to 20 students, 342 sixth-grade Baker County students attended the Baker Kiwanis Club's third annual Natural Resource Appreciation Tour at Marble Creek in September, 1966. Howard Brooks, Department geologist, is pictured conducting a class on geology and minerals to a group from the Huntington Grade School. (Photograph courtesy Baker Democrat-Herald.)



In western Oregon, too, grade school students are intrigued by geology. Shown is a group from McMinnville Grade School at a Natural Resources Retreat held at Trestle Glen on the Clackamas River in October, 1965. With the students is R. S. Moson, mining engineer for the Department.

GEOLOGY IS FOR THE MINERAL INVESTIGATOR

Status of Geologic Map Project

EASTERN OREGON

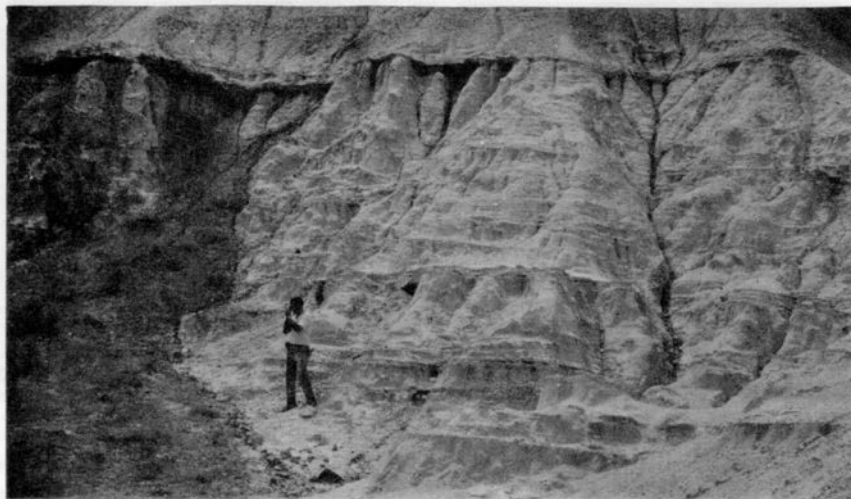
The most important areal geology project being conducted in Oregon at the present time is the State Geologic Map. The geology of the western half of the state was completed and published in 1961. Since that time the Department, in cooperation with the U.S. Geological Survey and aided by university professors and graduate students, is continuing this study in the eastern part of the state. The accompanying map shows the quadrangles that have been published and the progress being made in other areas still to be completed.

For the past several years, H. J. Buddenhagen, consulting geologist for the Department, has been working on the pre-Tertiary geology of the Suplee-Izee area of east-central Oregon. It is in this part of the state that the oldest known fossilized rocks have been found, approximately 400,000,000 years in age. Field work in the Suplee-Izee is now essentially complete and Mr. Buddenhagen is writing a report to accompany his map.

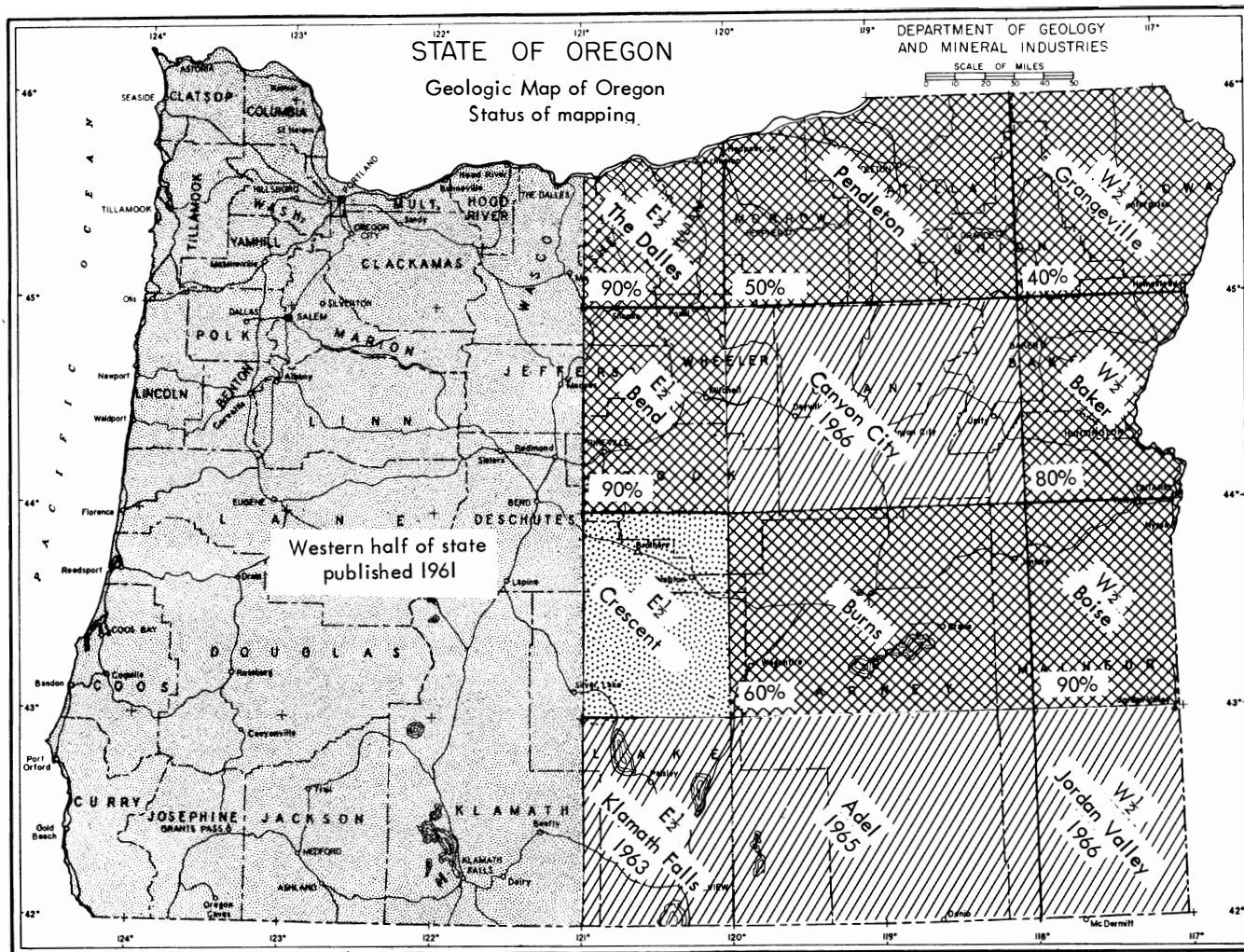
The region in the general vicinity of Baker and the Wallowa Mountains eastward to the Snake River Canyon is one of the most geologically complex in the entire state. Understanding the structure and the areal relationships of these rock units is important for future development of economic mineral deposits and delineation of the basement geology of Oregon. The rocks are fairly old and they have been considerably folded and faulted since the time they were first deposited. Howard Brooks, district geologist in the Baker field office, has spent parts of several summers in the Snake River Canyon between Richland and Huntington, unravelling this structural puzzle. Graduate students and professors from Oregon State University, University of Oregon, and Stanford University have carried on field investigations in other parts of this same area. All of the work will be incorporated in the final geologic map of the Baker quadrangle.

The Department also has field parties in the high desert plateau area, which includes the Harney Basin centering around the town of Burns, in cooperation with the U.S. Geological Survey. Now that work is nearing completion in both the Burns and adjoining Boise quadrangles, the geology of the entire southern portion of the eastern half of the state will be available to the public.

It is hoped that the field work for the remainder of the state will be finished and ready for publishing within the next five years. Preliminary maps will be distributed for critical review to all who have been associated with the project, and suggested corrections or revisions will be made at that time. The final map of eastern Oregon will then be assembled for publishing at the same scale (1:500,000) as the western half.



Mapping of tuffaceous rocks near Adrian in Malheur County.



Geologic mapping completed and date of publication

Geologic mapping completed and in process of being published

Geologic mapping in progress showing percentage of area completed

Geophysical and Geochemical Program

GEOPHYSICAL WORK

The Department is participating in geophysical work directly and indirectly. We have made gravity surveys in southeastern Oregon as part of a study of potential geothermal power sites, and have cooperated with the Department of Oceanography at Oregon State University in the preparation of a state gravity map. Other geophysical studies concern the use of electrical resistivity as a prospecting tool for geothermal sites, for prospecting for bauxite, and for the mapping of near-surface rocks.

We are indirectly participating in some of the spectacular activities of federal agencies and private corporations that involve air-borne and satellite-borne remote sensing, photography, and measurement. Assistance in this line has mostly been in an advisory capacity, showing researchers in these fields the ground accessible points that contain some physical feature analogous to what their instruments (heat, radar, magnetic, radiation, or photographic) are seeking. In addition to working with researchers on the ground, Department personnel have made over-flights with many of the groups so they could photograph and measure the analogs from the air. As an offshoot of this activity, the Department has assembled a library of aerial photographs of Oregon volcanic features that may be similar to some of the phenomena seen on the moon. Because of the striking similarity of many of these Oregon photographs to lunar scenes they have been requested by many of the branches of the National Aeronautics and Space Administration and by contractors working on the Lunar program. As a result of the availability of these aerial photographs, other groups have come to Oregon to study.

GEOCHEMICAL WORK

The program of sampling stream sediments in Oregon has been under way since 1963. A total of about 4000 samples has been collected so far, mostly from Josephine, Jackson, and Curry Counties. Analysis has been done in the Portland geochemical laboratory for copper, zinc, molybdenum, and mercury. Publication of geochemical maps of southwestern Oregon on a scale of 1:250,000 (1 inch to 4 miles) is anticipated during the next biennium. In addition to making the information available for possible mineral development in the areas sampled, the library of samples we have collected is valuable for future reference and study.

Possibly the greatest use of the sample library will be in the future as newer instrumental analytical techniques increase the speed and lower the costs of analysis. It will then be possible to analyze for whatever elements our expanding technology demands. This information could be handled by automatic data processing and would, in a short period of time, turn out computer-drawn maps of the element desired.

GEOLOGY IS FOR INDUSTRIAL DEVELOPMENT

GEOHERMAL ENERGY IN OREGON

The need for collecting and exchanging data on "New Sources of Energy," including geothermal energy, was emphasized by an international conference sponsored by the United Nations in 1961. The western United States is experiencing increasing interest in the exploration and exploitation of natural steam and hot waters as an energy source.

There is a definite association of near-surface heat anomalies with Late Tertiary and Quaternary volcanic activity. Oregon's extensive Pliocene, Pleistocene, and Recent volcanism, and the fault structures associated with this volcanism, indicate an excellent potential for large local concentrations of heat near the surface.

The Department has designated 10 general areas in the Oregon Cascades and in south-central and eastern Oregon where surface displays such as hot springs, fumaroles, and geysers, recent volcanic eruptions, or structural conditions indicate possible geothermal potential. None of these areas has been explored thoroughly, and preliminary geologic studies are proposed to determine the best possibilities for large geothermal reservoirs. The first of these studies made during the 1966 field season of the Klamath Falls area indicates a near-surface thermal zone at least half a mile wide and traceable for several miles. The geology appears favorable for a large geothermal reservoir. Klamath Falls residences, schools, and industrial buildings have utilized hot water and steam from this reservoir for heating for more than 50 years. Further geophysical tests and deep drilling will be needed to assess the total potential.



Steam well on Hillside Avenue in Klamath Falls residential district. The well is 100 feet deep in the hottest area.

View looking north across Main Street in Klamath Falls, showing hot water waste flowing into storm sewers.



OREGON'S MINERAL INDUSTRY

During the biennium the mineral and metallurgical industries in the state produced an estimated \$154,596,000 worth of minerals and metals. This is equivalent to \$87.40 for every man, woman, and child living in Oregon. More importantly, these basic industries reached into every community to furnish raw materials for construction and development. During the past 10 years, the value of raw minerals and metals produced in the state has increased 157 percent. This dollar increase has been due almost entirely to growth in production rather than to escalation of unit values. The mineral industry in the state is unique in that prices for its principal commodities -- stone, sand and gravel, and lime -- did not advance significantly during the biennium and, in fact, held steady during 1966.

The geographic diversity of the mineral industry in the state is perhaps best shown on the accompanying chart. During the past year, 16 counties each produced more than \$1,000,000 worth of raw minerals and metals. Values of all minerals are quoted at the pit. The value of these same minerals at the point of ultimate use would be many times the quoted figures. Douglas County, for the second year in a row, held the top spot in county mineral production with \$9,804,000. Contributing to this total were nickel, sand and gravel, stone, mercury, gold and silver, and minor commodities. Newcomers to the "Million Dollar Club" included the following counties: Morrow, \$1,821,000; Jefferson, \$1,253,000; and Josephine, \$1,217,000. The six counties of Baker, Clackamas, Douglas, Jackson, Lane, and Multnomah have been members of the club since 1964. Dropped from last year's list were Umatilla and Wasco Counties.

Relative rank of counties producing at least \$1,000,000 of mineral wealth for the years shown between 1954 and 1964.

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Baker	4	3	4	4	4	4	3	4	5	4	6
Clackamas	1	1	1	1	1	1	4	3	3	2	2
Clatsop							8				
Coos			7								
Deschutes			8	9	7	8	7				
Douglas	6	5	2	2	2	2	2	2	2	1	1
Gilliam										11	5
Jackson	2	2	3	5	5	5	6	5	4	6	7
Jefferson											11
Josephine											13
Klamath										9	12
Lane	5	6	6	6	3	3	1	1	1	3	4
Linn						7			8	8	14
Malheur		9				10					16
Marion				8	8						15
Morrow											9
Multnomah	3	4	5	3	6	6	5	6	6	5	3
Sherman		8								7	8
Tillamook									9		
Umatilla					9	9	9		7	10	
Wasco				7						12	
Washington		7					10	7			10
Number of Counties	6	9	8	9	9	10	10	7	9	12	16

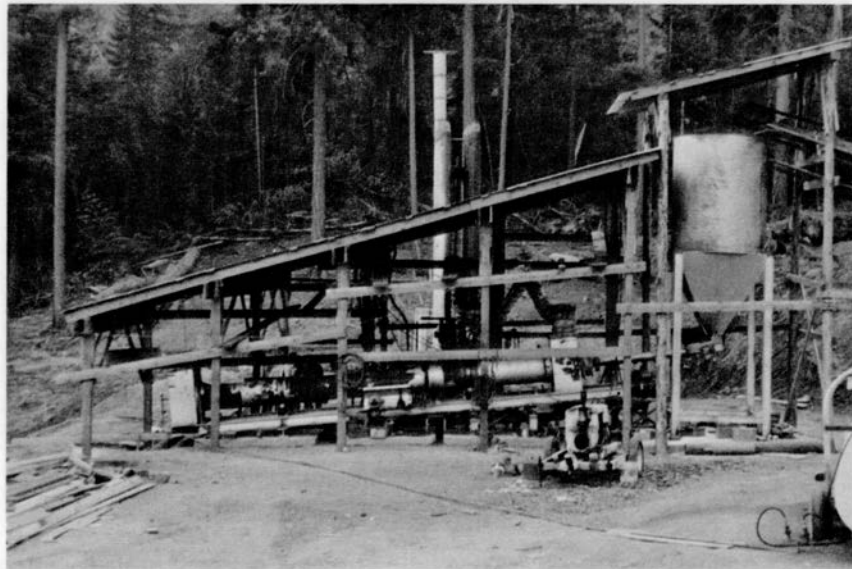
Fifteen counties reported increased mineral production over that of the previous year.

A large proportion of Oregon's mineral production is accounted for by the "growth minerals" such as stone, sand and gravel, and lightweight aggregates that go into the building of highways, buildings, and dams. The state is noted for being the only producer of nickel and one of the few in the United States that mines cinnabar, the ore of mercury. Minor amounts of platinum are recovered from gold placers. Oregon ranks among the top states in the Union with respect to semiprecious gems. Conservative estimates place the value of these eagerly sought-after stones at \$1,000,000 annually. Tourists, attracted to the numerous "rockhounding" areas in the state, are numbered in the tens of thousands each year.

Oregon's metallurgical industry furnishes such diverse products as burnt lime, calcium carbide, cement, expanded shale, steel, columbium, tantalum, titanium, tungsten, and zirconium. Use of these commodities spans a wide range of history. Burnt lime dates back to pre-Roman times; titanium and the other "space-age" metals have been produced commercially for only a few years and their metallurgy is still under rapid development. Oregon is an important center for the reduction, purification, and fabrication of the space-age metals. Several secondary plants have been located in the area to further fabricate some of the semi-finished products. These industries are characterized by an almost total lack of industrial pollution of either air or water. They also produce a relatively high-value product per acre of land and have attracted staffs and crews that are unusually skilled.

A considerable portion of the Department's energies is directed toward the search for areas in which there is the best chance for the discovery of economic mineral deposits. A first step in this work usually involves basic geologic mapping, with geophysical and geochemical surveys used to supply more detailed information. Geologic mapping provides information on the distribution and age of the various rocks. These maps help in the discovery of minerals having current economic potential and will serve equally well in the future when uses are found for minerals presently considered to be worthless. Geologic mapping can also provide information on subsurface conditions of interest to civil engineers responsible for designing foundations for buildings, the location of highways and reservoirs, and the platting of residential developments.

Employment in the mining industry during the biennium increased 21.5 percent, with a total of approximately 1700 men employed on a full-time basis. The production of primary metals increased 14 percent, with 6500 employees. The mineral and metallurgical industries characteristically have little seasonal fluctuation. This adds a much-needed stabilization to an economy with a high percentage of employees affected by periods of unemployment.



Oregon is one of the few states that produces mercury. High in the Jackson County hills this new mill roasts cinnabar in a rotary furnace and distills the volatilized mercury in the vertical condensers behind the mill building. The furnacing of mercury ores is the oldest metallurgical process known, dating back to pre-Roman times.

The Search for New Mineral Wealth



Most mineral prospects start out looking like this. A driller and a Department field geologist look over an old excavation to determine where the first diamond-drill hole should go. The Department assists many mining companies by providing basic geologic data, but does not perform any exploratory work. Assays and old mine maps, stored in the Department's files, often supply vital information for planning exploration and development work.



A diamond-drill rig making hole at a gold prospect in southwestern Oregon's Josephine County. Deep drilling helps to determine the approximate size and location of an ore body, and assays of the drill cores indicate the grade of the ore. Whenever possible the Department obtains copies of drilling maps, assays, and mine plats prepared by mining companies. Much of this information is held confidential for a period of time and then placed on open file.

PETROLEUM IN OREGON

Petroleum Engineering

Statutes regulating oil and gas exploration were passed in 1923 by the Oregon Legislature. Since that time many refinements and additions have been made in the law, with the result that responsibilities required the addition of a petroleum engineer to the staff in 1957. The principal duties of the petroleum engineer are to regulate exploratory drilling, collect information, and initiate studies related to the petroleum geology of the state.

In the summer of 1964 the Department employed as many as six inspectors to observe offshore core-drilling operations. The men were employed through a cooperative arrangement with the Washington Division of Mines and Geology, since operations alternated between both states. The salaries of the observers were met through assessments to the oil companies. Observers functioned under state supervision on federal submerged lands as well as within the territorial waters of the states through joint agreement between the bordering states and the U.S. Geological Survey.

Casing programs, plugging procedures, and installation of blow-out-prevention equipment are all a part of the regulations covering drilling in the state. The Department has taken legal measures to bring about proper plugging of 11 test holes. In three instances it had to foreclose on drilling bonds and supervise the abandonments. Proper plugging of holes is necessary to prevent contamination of ground water, since most marine sands, the target for oil and gas explorations, contain brine or brackish water.

During the biennium 18 loans of drill samples were made to oil companies and consultants. Samples are loaned with the proviso that any microfossils found in them must be set aside to enhance the research value of the drill cuttings and cores. As a result of this policy, many foraminiferal slides have been accumulated. Presently the Department has on file samples from 40 deep-test drillings totaling 217,000 feet of hole.

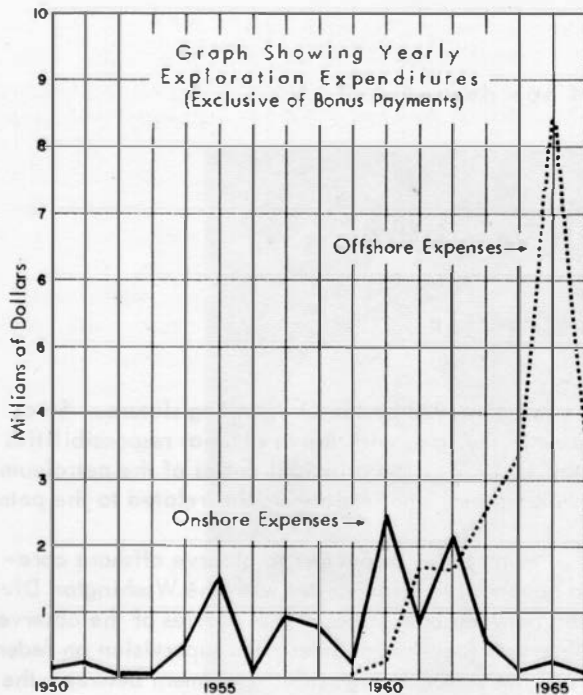
One oil and gas publication was revised and republished in the biennium: "Oil and Gas Exploration in Oregon," Miscellaneous Paper 6. The paper lists 176 oil and gas drillings in the state and gives pertinent facts on each. Progress was made on another publication which is to cover results of the extensive Willamette Valley exploration of 1962-63. To date, the Department has published four oil and gas papers and one bulletin. These publications maintain current data on petroleum explorations and expedite future search.

Cooperative studies include: a bibliography of saline water occurrences for the research committee of the Interstate Oil Compact Commission (Oregon has been an associate member since 1954), and an oil-shale sampling project with the U.S. Bureau of Mines Petroleum Research Laboratory. Besides these studies, the Department provided data or gave advice to: State Water Resources Board, State Corporation Department, Planning and Development Division, State Land Board, and the State Engineer and to the U. S. Geological Survey (one project consisted of providing basalt cores for chemical analyses).

Future projects will relate to areal geologic studies of petroleum prospects, pilot computer studies, and up-grading of the sample collection.

Oil and Gas Exploration

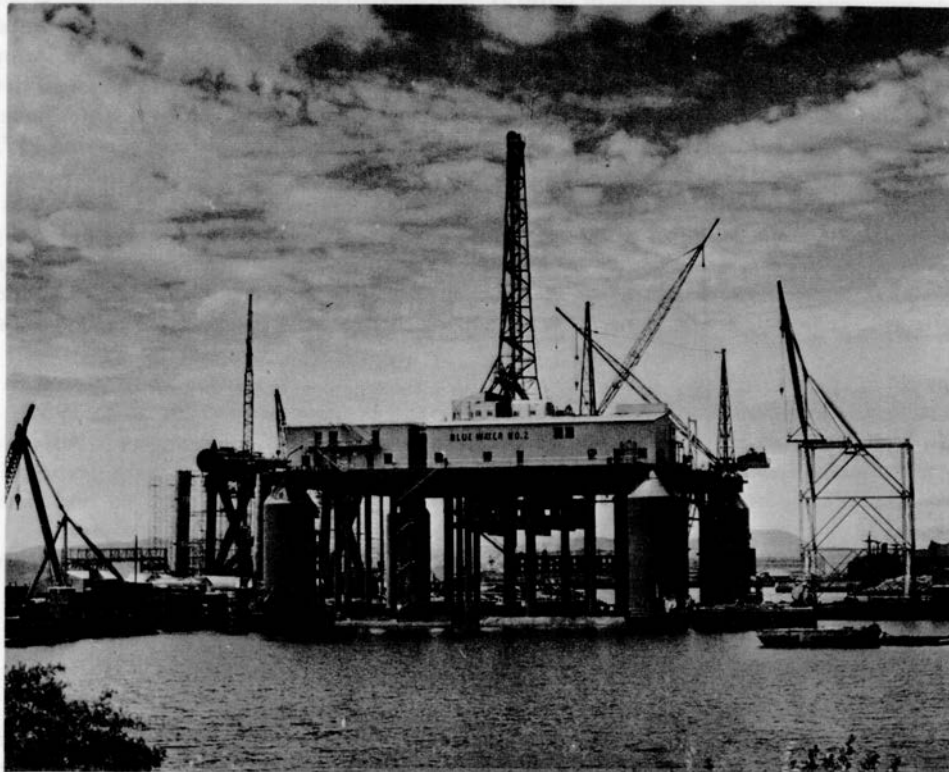
The search for petroleum in the state has continued over the past 60 years because of favorable geologic factors. Sedimentary marine rocks, the most likely hosts for oil and gas accumulations, cover an area of approximately 15,000 square miles in western Oregon and 8,000 square miles in central Oregon. No commercial amounts of oil or gas have been found in the 180 drillings thus far, but several eastern Oregon ranches utilized natural gas for domestic purposes in the early 1900's.



Until 1945, most drilling was done by small, venturesome groups, referred to in the industry as wildcatters. Scientific methods were not employed in most early enterprises and holes were frequently drilled because the scenery resembled a distant oil-producing region or on advice of a clairvoyant. Scientific methods have been utilized to a much greater extent recently so that future projects should have a better chance of discovering petroleum than the majority of those in the past.

Wildcatters generally do not spend a great deal on their ventures, so that exploration expenditures before 1945 do not comprise a significant portion of the total.

No more than 39 deepholes which employed modern scientific procedures have been drilled in Oregon. The accompanying graph shows yearly exploration expenditures for 1950 through 1966. Area under the curves represents a total of \$33 million spent on oil and gas exploration for the 16-year period. This is exclusive of the bonus and rentals paid for offshore leases. The total, including bonus and rental payments, is approximately \$70 million.



Blue Water II of the Santo Fe Drilling Co. Used to drill five holes off the Oregon coast, 1965-66. Derrick had to be dismantled to allow passage under the Golden Gate Bridge. Picture taken at San Francisco when the equipment was constructed.

Offshore developments

During the 1964-1966 biennial period, continental shelf exploration went from the geological study phase to the drilling phase. Leases had to be obtained before drilling could proceed offshore, and this was accomplished by bidding late in 1964. Five deep holes were drilled off the Oregon coast and one off the Washington coast in the two years covered in this report. No discoveries were announced.

Offshore Drilling, 1964-66

Company	Federal Tract	Location	Water Depth	Depth
Shell Oil	43	20 miles seaward from Yachats	320'	3,348'
Shell Oil	43	20 miles seaward from Yachats	325'	8,306'
Union-Standard-Pan Am., et al.	57	18 miles seaward from Seal Rock	195'	10,010'
Standard-Union	74	12 miles seaward from Cape Foulweather	425'	12,628'
Shell Oil	18	22 miles seaward from Gearhart	470'	8,220'

Onshore developments

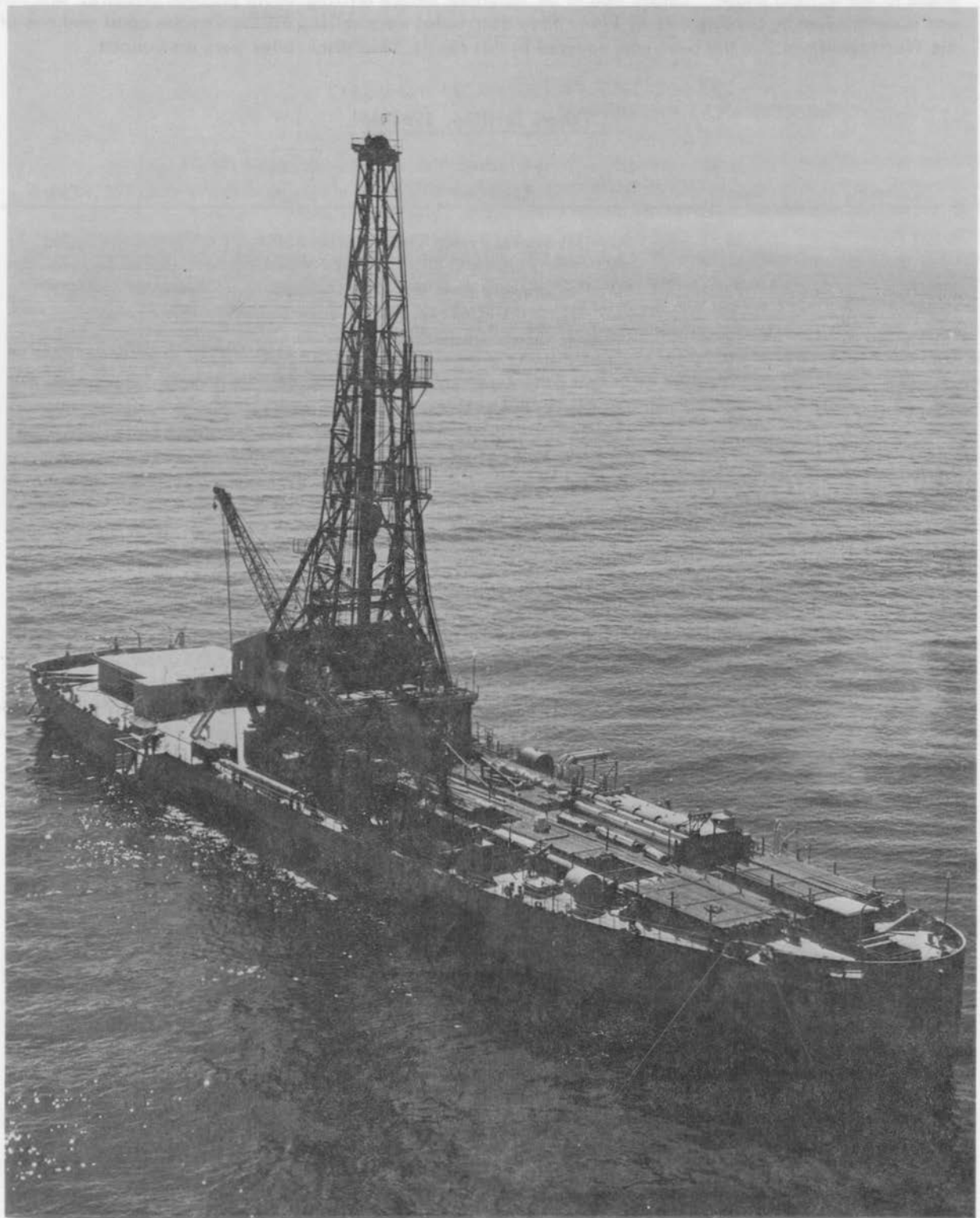
Little exploration was done onshore in Oregon in 1964 to 1966. Only two shallow wildcats were drilled in this time. Marvin Lewis of Salem drilled out the abandonment plugs of the Reserve Oil & Gas "Bruer 1" near Rickreall to retest sands that registered gas shows during the original drilling. The work failed to find commercial amounts of oil or gas. Butte Oil of Oregon drilled a shallow hole 5 miles south-east of Forest Grove. The firm planned to test Oligocene sands below the Columbia River Basalt. At the close of the biennium, they were fishing for drill pipe left in the hole as a result of a twist-off.

The last work done in the state by major oil firms took place in the Willamette Valley in 1962-63, when four deep holes were drilled. No production resulted and the companies moved to the continental shelf area.

Onshore Drilling, 1964-66

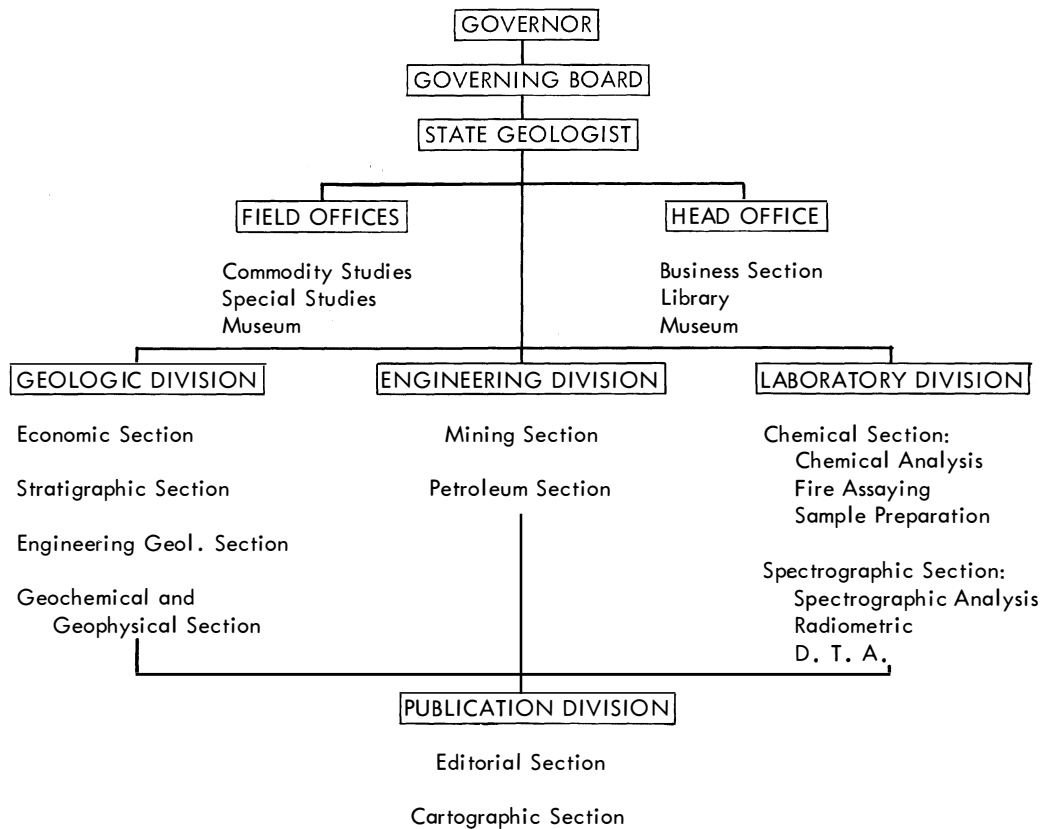
Permit No.	Company	Well	Location	Depth	Status
52PB	M. Lewis	Crossley-Jennings 1 (Reserve O&G Bruer 1)	NE $\frac{1}{4}$ sec. 31, T. 6 S., R. 4 W. Polk County	5,549'	Abandoned June 30, 1965.
54	J. T. Miller	Ray Adams 2	SW $\frac{1}{4}$ sec. 11, T. 8 S., R. 5 W. Polk County	622'	Abandoned Feb. 15, 1966. Small flow of gas encountered.
55	Butte Oil of Oregon, Inc.	Cowan 1	NW $\frac{1}{4}$ sec. 8, T. 1 S., R. 3 W. Washington County	959'	Suspended temporarily.

* * * * *



Western Offshore Drilling & Exploration Co. Barge No. 3 (365 feet long).
Used to drill Standard-Union Tract 74 and Union-Standard-Pan American group Tract 57.

DEPARTMENT ORGANIZATION



DUTIES OF THE DEPARTMENT

Conduct geological and mineral resource studies (ORS 516.030 [1]).
 Carry out economic studies pertaining to utilization of mineral raw materials (ORS 516.030 [2]).
 Cooperate with Federal and quasi-public agencies in studies of value to the state (ORS 516.030 [3]).
 Serve as a bureau of mineral and geological information, compile and keep up to date a mines catalog,
 prepare and publish reports of investigations and mineral statistics (ORS 516.030 [4]).
 Collect specimens and develop a museum (ORS 516.030 [5]).
 Collect a mining and geological library (ORS 516.030 [6]).
 Make qualitative examinations of rocks and minerals (ORS 516.030 [7]).
 Study minerals and ores and treatment processes (ORS 516.030 [8]).
 Make quantitative determinations of ores and minerals (ORS 516.040).
 Make spectrographic analyses (ORS 516.050).
 Serve on the Dredge Mining Consulting Committee (ORS 517.700).
 Serve on the Committee of Natural Resources (ORS 184.410).
 Advise other agencies on mineral leases (ORS 517.410).
 Administer Oil and Gas Act (ORS 520).
 Participate in administration of Tide and Submerged Lands Act (ORS 274).
 Establish unit operations for oil and gas development (ORS 520.260).

COMPARATIVE STATEMENT OF EXPENDITURES

	1963-1965 Total Expenditures 7/1/63-6/30/65	1965-1967 Estimated Expenditures 7/1/65-6/30/67	1967-1969 Funds Requested 1967-1969
<u>Personal Services:</u>	<u>\$316,896.91</u>	<u>\$391,837.00</u>	<u>\$413,336.00</u>
<u>General Operating & Maintenance:</u>	<u>\$ 70,139.64</u>	<u>\$ 72,646.00</u>	<u>\$ 78,100.00</u>
Office Supplies	2,251.29	2,400.00	2,400.00
Telephone & Telegraph	4,359.03	4,200.00	4,200.00
Postage, Freight, Express	2,525.11	3,000.00	3,000.00
Printing	9,561.44	12,500.00	14,000.00
Rents	25,306.00	19,660.00	21,820.00
Premiums & Assessments	397.51	500.00	500.00
Auditing	1,073.15	1,100.00	1,200.00
Industrial and Laboratory	4,504.80	3,800.00	3,800.00
Heat, Light, Power	995.42	1,300.00	1,300.00
Library	798.18	800.00	900.00
Laundry	97.50	96.00	100.00
Photos and Blueprints	2,057.26	2,000.00	2,100.00
Gas & Oil Well Law Administration	268.26	1,400.00	1,500.00
All Other	78.00	500.00	500.00
Building and Ground	123.23	250.00	250.00
Travel Expenses: In State	14,150.56	17,140.00	18,230.00
Travel Expenses: Out of State	<u>1,592.90</u>	<u>2,000.00</u>	<u>2,300.00</u>
<u>Capital Outlays:</u>	<u>\$ 3,091.75</u>	<u>\$ 7,573.00</u>	<u>\$ 17,835.00</u>
Office Furniture & Equipment	1,418.52	2,848.00	4,305.00
Motor Vehicles	1,190.65	1,600.00	3,570.00
Laboratory & Field	<u>482.58</u>	<u>3,125.00</u>	<u>9,960.00</u>
<u>Special Requests:</u>	<u>\$ 14,974.08</u>	<u>\$ 15,000.00</u>	<u>\$ 15,000.00</u>
State Geological Survey	<u>14,974.08</u>	<u>15,000.00</u>	<u>15,000.00</u>
Total Expenditures	\$405,102.38	\$487,056.00	\$524,271.00

Summary

	Expended 1963-1965	Appropriated 1965-1967	Requested 1967-1969
Personal Services	\$316,896.91	\$391,837.00	\$413,336.00
General Operating & Maintenance	70,139.64	72,646.00	78,100.00
Capital Outlays	3,091.75	7,573.00	17,835.00
State Geologic Map	<u>14,974.08</u>	<u>15,000.00</u>	<u>15,000.00</u>
TOTAL	\$405,102.38	\$487,056.00	\$524,271.00

THE APPROPRIATION

(1965 - 1967 FISCAL BIENNIUM)

Salaries and Wages	\$ 391,837.00	80.30 percent
General Operating & Maintenance	72,646.00	14.90
Capital Outlays	7,573.00	1.60
State Geologic Map	15,000.00	3.20
	<hr/>	<hr/>
TOTAL	\$ 487,056.00	100.00

AND WHAT IT PAID FOR

(1964 - 1966 REPORTING PERIOD)

825 Square miles geologically mapped	1,378 Spectrographic analyses
100 Field investigations	659 Petrographic examinations
31 Oil and Gas Act inspections	160 Talks
68 Cooperative projects with other agencies	15 Field trips for groups
7 Informational leaflets	6 Office tours
7 Major publications issued	26,208 Pieces of mail sent (excludes bulk mail)
65,525 Copies of The ORE BIN	30,879 Pieces of mail received (Portland)
379 Mineral sets	8 Television and radio appearances
13,961 Visitors	13 Exhibits judged
1,764 Mineral identifications	4 Expert witness in court
4,080 Chemical analyses	3 Bathymetric models
1,964 Radiometric determinations	