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**DIVISION OF MINES AND GEOLOGY**


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MARSHALL T. HUNTTING, Supervisor

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**BIENNIAL REPORT NO. 9****PART I****ADMINISTRATION**

The following report applies to the organization and activities of the Division of Mines and Geology, Department of Conservation, for the period July 1, 1960 to June 30, 1962.

**STAFF**

Marshall T. Huntting.....	Supervisor
Weldon W. Rau.....	Geologist V
W. A. G. Bennett.....	Geologist IV
Vaughn E. Livingston.....	Geologist III
Wayne S. Moen.....	Geologist III
William H. Reichert.....	Geologist II
Gerald W. Thorsen.....	Geologist II
Nancy Maschner.....	Cartographer
Dorothy Rinkenberger.....	Secretary-Editor
Gloria DeRossitt.....	Secretary
Sandra Anderson.....	Clerk-Typist

In order to staff the new geologic and mineral-resource investigations projects included in the Department budget for which funds were appropriated by the 1961 Legislature, one new full-time geologist, Dr. Weldon W. Rau, was hired at the beginning of the biennium. Part-time geologists who were hired for 3 months each in the summer of 1960 to head field parties to examine and report on the limestone deposits of the State are Dr. Joseph W. Mills, chairman, Department of Geology at Washington State University, and Dr. W. R. Danner, professor of geology at the University of British Columbia. Dr. Mills was hired for 3 months again in 1961 to examine the geology and mineral deposits in an area in Stevens County. Temporary field or laboratory assistants who worked for short periods during the biennium are Frank Kistner, Herbert Bradshaw, Keith Ikerd, and John Braislin.

The present technical staff of 6 geologists compares with a total of 4 geologists and 1 mining engineer comprising the Division staff 14 years ago, at a time when the demands for services were substantially less than they are now.

## HISTORY OF THE DIVISION

Geologic investigations as a function of the State Government were established by the first State Legislature and began with the appointment of George A. Bethune as State Geologist in 1890, with office in Tacoma. After 2 years this early work was discontinued for lack of further appropriation. It was resumed in 1901 with the establishment of the Board of Geologic Survey and the appointment, by the Board, of Henry Landes as State Geologist. For 20 years the office of the Washington Geological Survey was maintained at the University of Washington, Seattle. On April 1, 1921, the Administrative Code was adopted by the Legislature, and the duties and functions of the Board of Geologic Survey devolved upon the Director of the Department of Conservation and Development, the activities to be carried on by the Division of Geology. The first supervisor of this newly formed Division was Solon Shedd. He retired in 1925, to be succeeded by Harold E. Culver, but throughout the whole 24-year period from 1921 to 1945 the Divisional office was maintained at the State College of Washington, Pullman.

In 1935 the Legislature passed the Mines and Mining Act, whereby the Director of the Department of Conservation and Development was given the duty, through an appointed supervisor, of carrying on what, in effect, were nearly the identical activities of the original State Geologic Survey and its successor agency the Division of Geology. The first supervisor of the Division of Mines and Mining was Thomas B. Hill; the office was in the quarters of the Department of Conservation and Development, Olympia. In 1941 he was succeeded by Sheldon L. Glover, formerly the assistant supervisor of the Division of Geology, and the Olympia office and staff were enlarged to carry on the activities specifically authorized by the Mines and Mining Act.

For four years thereafter (from November 1, 1941 to October 1, 1945) these two divisions of the Department of Conservation and Development were concurrently engaged in the investigation of the State's mineral resources, studying all phases of geology that were prerequisites to a proper understanding of our mineral deposits, preparing reports for publication, and aiding in every possible way in the development and utilization of these natural resources. Through careful collaboration and coordination of activities the two supervisors prevented a duplication of field investigations and a waste of funds. However, it was impossible to operate the separate offices without considerable duplication in the matter of files, records, library, and laboratory facilities, and without some inconvenience to the public who were unaware of which office had the particular data desired.

On October 1, 1945, therefore, the two divisions were combined by administrative order. All files, records, field notes, reports, maps, library volumes, and bulletins of the Division of Geology were moved to Olympia and there added to the similar material of the Division of Mines and Mining. The supervision of the combined Division of Mines and Geology was given to Sheldon L. Glover. Upon Mr. Glover's retirement in February 1957, Marshall T. Hunting was appointed supervisor.

## **DUTIES OF THE DIVISION**

The Division of Mines and Geology is a service agency that has the responsibility of compiling and distributing information on mineral resources, mineral industries, and geology of Washington. Regulatory activities of the Division are limited to those in the field of oil and gas exploration and production as required under the Oil and Gas Conservation Act of 1951 (RCW 78.52.001 to 78.52.550).

The Division has the following duties and responsibilities as set out in RCW 43.21.070 and 43.92:

- (1) To examine the metallic and nonmetallic mineral deposits of the State.
- (2) To prepare and distribute, at cost of printing, geologic and mineral-resource reports and maps.
- (3) To collect, compile, publish, and disseminate statistics and information about mining, milling, and metallurgy.
- (4) To collect and assemble an exhibit of mineral specimens.
- (5) To assemble a library pertaining to mining, milling, metallurgy, and geology.
- (6) To make determinative examinations of ores, minerals, and rocks for the public.
- (7) To administer the Oil and Gas Conservation Act, regulating drilling and production of oil and gas.
- (8) To cooperate with the U. S. Geological Survey in making topographic and geologic maps and to cooperate with the U. S. Bureau of Mines and with all departments of the State Government.

## **ACTIVITIES OF THE DIVISION**

The Division is engaged in fundamental and applied research, the purpose of which is to serve the mineral industries and the public in developing a better knowledge and understanding of the geology and a more complete utilization of the mineral resources of the State.

The statutory duties are broadly defined, providing the flexibility necessary for the proper functioning of the Division in accordance with changing economic conditions, new trends in minerals utilization, and changing demands for mineral-resource and geologic information. In formulating plans for the Division's investigative programs, it is always helpful to have the suggestions and recommendations of professional and technical people in the minerals industries. Especially valuable during the past biennium have been the recommendations of the Industrial Raw Materials Advisory Committee to the Washington Department of Commerce and Economic Development. Some of the recommendations of this committee, although directed to the Commerce Department, were for mineral resource surveys, which are a function of the Division of Mines and Geology of the Department of Conservation. A program that was proposed by the committee and was carried on by the Division during the biennium was that of mapping and sampling to determine the location, size, and quality of high-purity limestone deposits in the State.

The activities of the Division in fulfilling its statutory duties are described in the following paragraphs.

### **MINERAL DEPOSIT EXAMINATIONS**

Division geologists during the biennium continued to acquire information on the metallic and nonmetallic mineral deposits in the State. Field studies were made of known mineral deposits, new deposits were sought out, and reported occurrences were investigated. Field examinations were made of deposits of copper, gold, iron, lead, mercury, nickel, uranium, zinc, barite, bauxite, black sand, clay, coal, diatomite, limestone, olivine, peat, pumice, saline compounds, sand and gravel, and silica. Most field studies served the dual purpose of adding to our fund of information on the State's mineral resources and aiding the prospector or owner of the claim on which the mineral deposit was located. Most of the examinations were of a preliminary nature, but some were in more detail. In examining mineral deposits at the request of their owners, Division geologists take great care not to encroach upon the field of the consulting engineer or geologist. In accordance with this policy, oral advice is given but written reports are not made for individual claim owners.

### **MINING AND MILLING STATISTICS**

The Division cooperates with the U. S. Bureau of Mines in collecting production data on all minerals produced in Washington. These data are published in the annual Minerals Yearbooks of the Bureau of Mines. Preprints of the Washington chapter on mineral production are available from the Bureau.

At least once in each 2 years, Division geologists visit the State's active mining operations—metallic, nonmetallic, and sand and gravel—in order to compile the Directory of Washington Mining Operations. These directories are among the most popular reports published by the Division.

### **MINERAL EXHIBITS**

A rather complete labeled collection of all the metallic and nonmetallic minerals of known economic importance is maintained in the Division office for the use of prospectors, miners, and industrialists. Also included in the display are mineral substances that may have future value but that are not now being mined.

Characteristic samples from mineral deposits and geologic formations throughout the State are collected during the course of field work. In the office they are classified and added to an extensive collection of several thousand specimens that is maintained for staff reference and for the use of visiting geologists who may be working in the State. An attractive collection of fluorescent minerals and a small collection of agates and other specimens of interest to hobbyists are on display for anyone wishing to refer to them. A special display of uranium minerals is maintained. Two sets of minerals and rocks are kept in special traveling cases for occasional display at expositions or to illustrate talks made before various groups and organizations. A supply of bulk minerals and rocks is used to fill requests for samples.

During the biennium an elaborate display was built for use at conventions and other organizational and public meetings. This display features a 5- by 8-foot colored relief map of the State, on which the locations of the principal

occurrences of 28 different mineral commodities are shown by more than 900 tiny colored lights. The lights are automatically controlled to show each of the minerals in sequence. The display features also the new State Geologic Map and lighted photographs of some of the larger mining and metallurgical plants in the State.

Samples of cuttings and cores from oil and gas test wells are collected, examined, labeled, and added to an extensive collection of similar materials maintained for study and reference. These samples are of particular value to the geologists of companies exploring for oil in the State.

### **LIBRARY**

A fairly large, specialized, reference library of approximately 13,000 publications is maintained for the use of the staff, other State agencies, and for public reference. It includes authoritative texts on mining, metallurgy, mineral resources, and geology, and nearly complete collections of the reports of the U. S. Geological Survey and U. S. Bureau of Mines. Included also are pertinent reports of the U. S. Atomic Energy Commission and other Federal agencies, as well as the publications of Canadian and other foreign geological surveys and the reports of other state geological surveys and mining bureaus. The U. S. Geological Survey and the U. S. Bureau of Mines place unpublished reports on Washington areas and mineral deposits on open file for public inspection in the Division library. The Division subscribes to a number of geology, mining and metallurgy, and oil periodicals to assist staff members in keeping informed of current developments in those fields and for the benefit of anyone else who may wish to consult the publications in the Division offices.

Full sets of all topographic maps of Washington are maintained for the use of the staff and for public reference. Similarly available are aerial mosaics, planimetric maps, special geologic maps, mine maps, and various other maps. The Division's map collection is constantly being enlarged.

Most of the library material is acquired without cost on an exchange basis from other State and Federal agencies and from educational institutions. A few volumes are acquired by private donations, and a few texts and reports of especial interest are purchased through limited funds available for the purpose. Library acquisitions are increasing rapidly as a result of increased mineral-resource exploration activity nationally and publication of the results of these studies, and as a result of greatly increased numbers of publications distributed by the Federal agencies and other state geological surveys.

### **MINERAL IDENTIFICATION SERVICE**

The Division provides a free mineral identification service for the public. Samples of ores, rocks, minerals, and clays from Washington localities are examined and identified. The senders are advised of the possible value of submitted samples, and suggestions are given for further prospecting or analysis whenever such action appears warranted. Through this service new occurrences of potential value are occasionally found and brought to the attention of those who are seeking new sources of mineral raw materials in the State. Sample identification does not include assays or quantitative chemical analyses, as these services are available from commercial concerns.

During the biennium the Division of Mines and Geology received and reported upon 1,800 samples. This is 50 percent more sample examinations than were made during the preceding 2-year period. This indicates a very large interest in Washington's mineral resources and shows increased public dependence upon help and advice from the Division in developing these resources.

The laboratory of the Division is equipped for most of the mineralogical studies required. Equipment consists of a diamond saw and laps for making thin sections and polished sections of rocks and ores; binocular, petrographic, and metallographic microscopes; a small laboratory electric furnace for high-heat tests; an electric drying oven; a spectrograph and densitometer for qualitative and quantitative examinations of rock and mineral specimens; blow-pipe equipment for qualitative tests; sieves for making screen analyses of sands; laboratory crusher and grinder; a Superpanner; Geiger counters and a scintillation detector for radiometric tests of uranium-bearing samples; ultra-violet lamps for fluorescence tests; and a high-intensity magnetic separator.

### OIL AND GAS

In July 1957 oil was discovered in quantity thought to be commercial in a well at Ocean City in Grays Harbor County. This discovery set off the biggest boom of oil and gas exploration and leasing activity ever experienced in the State. For months the Division of Mines and Geology was flooded with telephoned, written, and personal requests for information on the geology and oil and gas exploration history and potential of the State.

Since the early 1930's the Division has collected and cataloged all available information on the progress and results of oil and gas test drilling. These data are on open file for all geologists and oil men who desire to see or copy them.

In 1951 the Oil and Gas Conservation Act was passed by the Legislature. The Act and the rules and regulations drawn up under its authority govern the drilling, testing, and other operations that comprise exploration and production of oil and gas in Washington. In January 1954 the Oil and Gas Conservation Committee appointed the Supervisor of the Division of Mines and Geology to be Oil and Gas Supervisor for the State and gave him the duty of administering the Act.

From January 18, 1954, through June 30, 1962, a total of 172 drilling permits were issued, of which 26 were issued during the 1960-62 biennium. This is an increase of more than 50 percent over the preceding biennium.

The Oil and Gas Conservation Act and rules and regulations require that all logs, drilling histories, cuttings and core descriptions, and records of tests that are made for each well must be filed with the Oil and Gas Supervisor (who is Supervisor of the Division of Mines and Geology) within 30 days after completion or abandonment of the well (6 months are allowed for filing electric logs). These logs are kept confidential for a period of 1 year after the filing deadline, after which they are released for public inspection.

No new personnel were hired when the administration of the Oil and Gas Conservation Act was turned over to the Division in 1954. In order to provide some of the greatly increased services demanded by oil and gas exploration groups, the Division needed funds to set up a micropaleontological laboratory

and to hire a geologist to operate the laboratory, do field geologic mapping, and help in the issuance of drilling permits and the collection of data required by law. Some of the needed equipment was acquired during the biennium, and a biostratigrapher was hired at the beginning of the new 2-year period. Further funds are needed to complete the micropaleontologic laboratory.

### REPORTS PUBLISHED

Geologic investigations are of little value to the public unless the results are made easily available. The demand is increasing each year for information on geology, mineral resources, and the status of the mining industry of Washington. This information is dispensed through office and field conferences, by correspondence, and, most effectively, through distribution of published reports. Most of the Division's reports are written by staff geologists, but some manuscripts are obtained free or are purchased from specialists outside the staff. As required by law, the entire cost for printing of reports will eventually be returned to the State's General Fund through income from sale of the reports.

During the biennium the following reports were published and made available for distribution:

Geologic Map of Washington, by Marshall T. Huntting, W. A. G. Bennett, Vaughn E. Livingston, Jr., and Wayne S. Moen. Scale 1:500,000. Sheet size 52 in. by 74 in. Available either folded or rolled, \$3.00.

Inventory of Washington Minerals: Nonmetallic Minerals, by Grant M. Valentine, revised by Marshall T. Huntting, Bulletin 37, Part I, Second Edition, 258 pages, 39 plates. Price per set (2 volumes—text and maps) \$3.00.

Coal Reserves of Washington, by Helen M. Beikman, Howard D. Gower, and Toni A. M. Dana, Bulletin 47, 115 pages, 62 figures, \$1.75.

A Stratigraphic Section in the Yakima Basalt and the Ellensburg Formation in South-Central Washington, by J. Hoover Mackin, Report of Investigations 19, 45 pages, 9 plates, 4 figures, 75¢.

Geological Interpretation of Airborne Magnetometer and Scintillometer Survey, Mt. Bonaparte, Bodie Mountain, Curlew, Aeneas, and Republic Quadrangles, Okanogan and Ferry Counties, Washington, prepared by Hunting Geophysical Services, Inc., Report of Investigations 20, 34 pages, 25 plates, 2 figures, \$1.50.

Stratigraphy of Eocene Rocks in a Part of King County, Washington, by James D. Vine, Report of Investigations 21, 29 pages, 3 figures, 50¢.

1960 Directory of Washington Mining Operations, by Gerald W. Thorsen, Information Circular 35, 84 pages, 2 maps, free.

Mineral Rights and Land Ownership in Washington, by Wayne S. Moen, Information Circular 36, 23 pages, 1 plate, 2 figures, free.

Geology of the Jumbo Mountain Nickel Deposit, Snohomish County, Washington, by Joseph W. Mills, Reprint No. 6, reprinted from Mining Engineering, March 1960, 3 pages, 2 figures, 25¢.

A publications list is available from the Division. Listed are all the Bulletins, Reports of Investigations, Information Circulars, administrative reports, and Reprints that have been published by the Division of Mines and Geology and its predecessor agencies.

## PROJECTS IN PROGRESS

During the biennium the following projects were in progress and reports on most of these were in preparation:

- Limestone in Washington—an investigation to determine the size and quality of stone available in the largest and most accessible deposits in both eastern and western Washington. The deposits are concentrated in the northern tier of counties from San Juan to Pend Oreille. Two geologists and five field assistants were assigned to the job. The western Washington survey was supervised by Dr. W. R. Danner, professor of geology at the University of British Columbia, and the eastern Washington survey by Dr. Joseph W. Mills, Chairman, Department of Geology at Washington State University. Topographic and geologic maps of the best deposits were made. About 750 samples were taken for complete chemical analysis. Field work was done in 1959 and was continued and completed in the fall of 1960. The results of the survey will be published in two reports. The first of these reports, "High-Calcium Limestone in Eastern Washington," by Joseph W. Mills, Bulletin 48, 268 pages, 7 plates, 64 figures, \$4.00, was sent to the printer before the end of the biennium and was ready for distribution early in the following 2-year period. The western Washington report is in preparation and should be ready to print some time in 1963.
- Saline Lake Deposits in Washington, by W. A. G. Bennett, Bulletin 49, 129 pages, 35 figures, \$1.50. This report was completed by the end of the biennium. It was sent to the printer and was ready for distribution early in the following biennium.
- Geology and Mineral Deposits of the North Half of the Van Zandt Quadrangle, Whatcom County, Washington, by Wayne S. Moen, Bulletin 50, 129 pages, 4 plates, 41 figures. Refractory clays have been mined from this area in the past, and substantial clay reserves were found to remain in the ground. Limestone is quarried here, and minor occurrences of silica, iron ore, and chromite were examined. The field work on this project was completed in 1959, and the report was ready to be sent to the printer soon after the close of the biennium. It should be ready for distribution early in 1963.
- Preliminary Geologic Map of the Hobart and Maple Valley Quadrangles, King County, Washington, by James D. Vine (U. S. Geological Survey), Geologic Map GM-1, 75¢. The first of two maps, which are the product of a cooperative project with the U. S. Geological Survey described on pages 61 and 62, was completed late in the biennium and was sent to the printer. The map and brief report were ready for distribution late in 1962.
- Preliminary Geologic Map of the Cumberland Quadrangle, King County, Washington, by A. A. Wanek and H. D. Gower (U. S. Geological Survey), Geologic Map GM-2. The second map in a series of two, mentioned above, was in preparation and should be ready for publication early in 1963.
- Ferruginous Laterite in the Kelso-Cathlamet Area, by Vaughn E. Livingston, Jr. A mineral resource not now being utilized but having very great potential value is the iron-rich bauxite that occurs in northwestern Oregon and in the Kelso-Cathlamet area in Washington. Geologic mapping to outline the areas that are favorable for the occurrence of this material was conducted during the biennium, and ten core holes were drilled in the fall of 1961.

Introduction to Washington Geology and Resources, by Charles D. Campbell, Information Circular 22R, 44 pages, 5 figures, 25¢. This circular, first published by the Division in 1953 as a reprint of a Research Studies of the State College of Washington report, was very popular and soon went out of print. The author made some slight revisions, and the Division printed the revised Information Circular 22R late in 1962.

Geology and Mineral Resources of the South Half of the Colville Quadrangle, Stevens County, Washington, by W. A. G. Bennett. Field work for this study was essentially completed during the last biennium. A small amount of additional field work was accomplished during this biennium. It is expected that the geologic map and report will be completed and published during the next two years.

Bibliography and Index of the Geology and Mineral Resources of Washington, 1957-1962, by William H. Reichert. This is part of a continuing project to maintain an up-to-date bibliography and index to articles, both published and unpublished, on geology and mineral resources of the State. This report will be completed and published during the next 2 years.

Black Sand at Grays Harbor, by Gerald W. Thorsen. Numerous inquiries about black sands, both as a possible source of iron and as a source of titanium, have emphasized the need for detailed information on the mineralogic composition of these sands. Laboratory analyses of samples from the mouth of Grays Harbor have been completed, and a report is in preparation.

Geology of the Northern Cascade Mountains, by Peter Misch, professor of geology at the University of Washington. Dr. Misch, in a period of about 20 years, has mapped, almost singlehandedly, an area of more than 2,000 square miles in the northern Cascades, the most rugged and inaccessible terrain in the State. The Division is pleased to have arranged to publish his maps and a report describing the rocks in this area. The report and maps are in preparation and should be ready for publication some time during the 1962-64 biennium.

Geology and Mineral Resources of the Methow Quadrangle, Okanogan County. Dr. Julian D. Barksdale, professor of geology at the University of Washington, has devoted many years to the study of the geology of a large area in Okanogan County, including the area within the Methow quadrangle, and the Division has made arrangements to publish his geologic map and report on the geology of the area. In 1959, G. W. Thorsen examined most of the known mineral deposits in the area, and the results of his examinations also will be published. The U. S. Bureau of Mines has cooperated by compiling a record of production for all the mines in the area.

Barite in Washington, by Wayne S. Moen. The demand for barite in the Northwest has increased greatly during the past few years as the result of greatly increased oil-well drilling activity in Alaska. A complete survey of the barite resources of the State was completed during the biennium, and a report was being prepared for publication some time in 1963.

Geology of the Wynoochee Area, Grays Harbor County, Washington, by Weldon W. Rau. Field and laboratory studies of the rocks and their contained

fossils were continued throughout the biennium. A geologic map and report should be ready for publication in 1963.

Geology and Mineral Resources of the East Half of the Kettle Falls Quadrangle, Stevens County, Washington, by Joseph W. Mills. Field work was commenced in 1961 and continued in 1962. Additional field work will be required during the following 2-year period.

Road Log of the Snoqualmie, Swauk, and Stevens Pass Highways. A geologic road log, originally prepared by members of the staff of the Department of Geology at the University of Washington, was revised and supplemented by Vaughn E. Livingston, Jr., and is to be published in 1963.

## COOPERATIVE PROJECTS

### Topographic Mapping

The Division continued to cooperate with the U. S. Geological Survey in topographic mapping within the State. The mapping is conducted by the Survey, the State contributing half of the funds through a cooperative, matching agreement. Additional topographic mapping is carried on and paid for solely by the Federal agency.

The first topographic quadrangle map in Washington was published in 1895 by the U. S. Geological Survey. In order to speed up the mapping program, the State Legislature of 1903 authorized expenditure of State funds on a 50-50 matching basis, and the Legislature of 1909 appropriated \$10,000 for this purpose. Since that time the State has provided matching funds almost every year. The total amount expended from 1909 through 1961 is \$414,717, and 75 quadrangle maps have been completed or are in progress under this cooperative program. In spite of greatly increased mapping in recent years by the U. S. Geological Survey independent of the cooperative program, there still remain large areas in the State for which no topographic maps are available, and there are other large areas for which the available maps are of inadequate scale or accuracy.

The Industrial Raw Materials Advisory Committee has pointed out that topographic maps are an indispensable tool for the development of Washington's natural resources and are an important aid in overall economic development in the State. These maps are required by planners, builders, engineers, geologists, foresters, farmers, soil conservationists, hydrologists, river-resource developers, and hunters and fishermen. The committee has recommended that greatly increased funds be made available to augment the cooperative program so that topographic mapping of the State may be completed in the next 10 years.

Through the courtesy of Mr. Robert O. Davis, Pacific Region Engineer, Topographic Division, U. S. Geological Survey, Menlo Park, California, the following data on progress of mapping in Washington during the biennium have been supplied:

- 42 new triangulation stations were established and monumented.
- 1,826 square miles of photography were completed.
- 3,135 square miles were compiled by photogrammetry and field surveys.
- 1,807 square miles controlled by 2nd and 3rd order triangulation.
- 17 new 15- and 7½-minute quadrangles were published.

Quadrangles worked on and financed as cooperative projects between the State of Washington and the U. S. Geological Survey are:

<i>Names of quadrangles</i>	<i>Counties in which located</i>	<i>Estimated publication date</i>
Bandera (Cedar Lake 1).....	King .....	①
Mount Si (Sultan 4).....	King .....	①
Doe Mountain .....	Okanogan .....	1964
Mazama .....	Okanogan .....	1964

① Published during the biennium.

Also during the biennium, the following quadrangles were completed and published by the U.S. Geological Survey using Federal funds only. They are 15-minute quadrangles unless marked 7½-minute. Names used while work was in progress are shown in parentheses.

<i>Names of quadrangles</i>	<i>Counties in which located</i>
Aberdeen (7½') (Aberdeen NE) .....	Grays Harbor
Boylston .....	Kittitas
Camas (7½') .....	Clark
Cle Elum (Mount Stuart 3) .....	Kittitas
Ediz Hook (7½') .....	Clallam
Fort Simcoe (White Swan 2) .....	Yakima
Morse Creek (7½') .....	Clallam
Mount Tabor (7½') .....	Clark
Orchards (7½') .....	Clark
Port Angeles .....	Clallam
Port Angeles (7½') .....	Clallam
Sauvie Island (7½') .....	Clark
Steilacoom (7½') .....	Pierce
Washougal (7½') .....	Clark
Yakima West (7½') (White Swan 2).....	Yakima

### Coal Investigations

During the previous biennium a 2-year investigation of the coal reserves of Washington was completed. The work was done by the Fuels Branch of the U. S. Geological Survey, and the cost was shared equally by the State and the Federal Government. During the biennium covered by this report the Division published the results of this study, a comprehensive report on "Coal Reserves of Washington." This report tabulates the amounts of coal present in each township in each coal field in the State. With these data available, anyone who may be interested in coal in the Northwest will be able to make preliminary appraisals of Washington's coal resources for any possible industrial use.

In July 1960 the second year of a 2-year cooperative project was continued with the Fuels Branch of the U. S. Geological Survey to map the geology and investigate the coal and clay resources of an area in King County com-

prising the following 7½-minute quadrangles: Maple Valley, Hobart, and Cumberland. Some of the most productive coal mines and refractory clay pits in King County are in this area, and it is expected that detailed geologic mapping will furnish a guide for exploration and development of new reserves of both of these commodities. The principal results of this work will be published late in 1962 and early in 1963 as geologic maps and brief texts, "Preliminary Geologic Map of the Hobart and Maple Valley Quadrangles, King County, Washington," and "Preliminary Geologic Map of the Cumberland Quadrangle, King County, Washington." As a byproduct of this study, the Division published during the biennium Report of Investigations 21, "Stratigraphy of Eocene Rocks in a Part of King County, Washington."

#### Other Cooperative Projects

Cooperation is maintained with the U. S. Bureau of Mines in the collection of mineral production statistics in Washington. Information on mining operations and mineral producers, obtained separately by the Bureau and the State Division of Mines and Geology, is exchanged in the interest of complete coverage. Assistance is given the Bureau in exchange for copies of detailed production records. The Bureau has tested samples of clay and bauxite collected by Division geologists in conjunction with geologic mapping projects described on previous pages.

The Division cooperates with the U. S. Coast and Geodetic Survey by maintaining in Olympia for the Survey a strong-motion accelerograph. Periodic checks are made to be sure that the instrument is in good operating condition and to determine whether or not the instrument has recorded any strong-motion earthquakes.

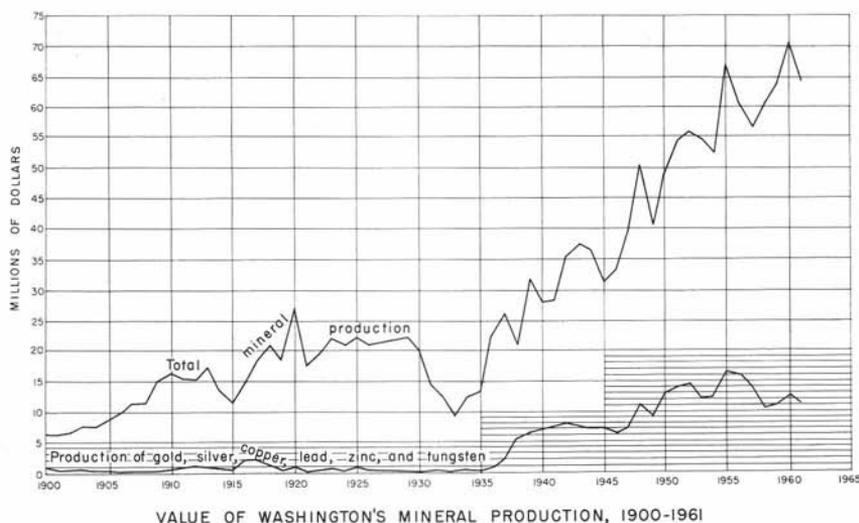
Cooperation with the U. S. Atomic Energy Commission is maintained through distribution of A. E. C. literature by the Division. The A. E. C. has provided the Division with a "radiometric assayer" instrument for the purpose of making quantitative analyses of uranium ores.

During the past biennium the Division has had occasions to provide information and be of assistance to the U. S. Forest Service and other Federal agencies as well as such State agencies as the Department of Commerce and Economic Development, Department of Highways, Commissioner of Public Lands, Pollution Control Commission, Department of Employment Security, Tax Commission, and Department of Licenses.

PART II  
MINERAL INDUSTRY OF WASHINGTON

VALUE OF MINERAL PRODUCTION

The mineral industry of Washington comprises an important part of the overall economy of the State—more important than is generally recognized. In comparison with the other extractive industries in the State, mining in 1961 produced minerals having a raw product value of \$64,527,000,<sup>①</sup> which is more than one-tenth of the value of unprocessed agricultural products for that year, about one-fourth of the value of the logging industry's output, and more than three times the value of the products of the commercial fisheries. Likewise, the value of mineral production in Washington is larger in comparison with that for the adjacent states of Idaho, Oregon, and Alaska than most people realize. Washington's mineral production for 1961 exceeded that of two of these three neighbors. Figures supplied by the U. S. Bureau of Mines show Washington's production to have been slightly less than Idaho's figure of \$68,846,000, more than Oregon's \$51,730,000, and almost double Alaska's production of \$34,708,000. During the past 10 years (1952-1961) mineral production in Washington had a total value of \$614 million, an increase of more than \$150 million over the previous 10 years. With minor fluctuations, the State's mineral production has been steadily increasing since the depression year of 1933, when it was valued at just over \$9 million.



King County had the highest mineral production value, followed by Pend Oreille, Stevens, Pierce, and Spokane Counties. Columbia was the only county that had no reported mineral production.

<sup>①</sup> All mineral production figures in this report were compiled by the U. S. Bureau of Mines.

The tabulation of production statistics for the years 1954 through 1961 as shown on pages 68 and 69 gives the relative value of the mineral products of Washington. Totals for some of the major products, such as gold, silver, portland cement, and magnesite, cannot be published but must be lumped together under "Miscellaneous" in order to protect confidential data of individual companies. This tabulation, along with the graph on page 63, shows the trend of the State's mineral industry over the years.

Minerals are divided into two broad groups: metallic and nonmetallic. The metallic minerals are mined for the metals that can be extracted from their ores. The nonmetallic, or industrial, minerals are not commonly mined for their elemental content but rather for some quality that they have in their natural state or acquire through beneficiation or treatment. The metallic minerals gold, silver, copper, lead, zinc, uranium, and tungsten accounted for approximately 20 percent of the State's mineral production value in 1961. This is a 2-percent increase over 1959. This relationship is shown graphically one page 63.

VALUE OF MINERAL PRODUCTS BY COUNTIES<sup>①</sup>  
[Thousand dollars]

<i>County</i>	1960	1961	<i>Minerals produced in 1961 in order of value</i>
Adams .....	\$ 396	\$ 455	Stone, sand and gravel
Asotin .....	②	23	Sand and gravel
Benton .....	125	179	Stone, sand and gravel
Chelan .....	②	1,254	Gold, sand and gravel, stone, silver, pumice, copper
Clallam .....	88	163	Sand and gravel, stone, gold
Clark .....	608	2,306	Recycled lime, stone, sand and gravel, clays
Cowlitz .....	371	②	Recycled lime, stone, sand and gravel
Douglas .....	849	237	Stone, sand and gravel
Ferry .....	②	②	Gold, silver, sand and gravel, stone, copper
Franklin .....	1,838	1,508	Stone, sand and gravel
Garfield .....	51	118	Do
Grant .....	1,043	1,242	Diatomite, stone, lime, sand and gravel
Grays Harbor ..	394	389	Sand and gravel, stone, petroleum
Island .....	220	47	Sand and gravel
Jefferson .....	457	1,023	Recycled lime, stone, sand and gravel
King .....	7,805	8,578	Cement, sand and gravel, stone, coal, clays, peat
Kitsap .....	282	269	Sand and gravel, stone, peat
Kittitas .....	1,071	1,002	Coal, stone, sand and gravel, gold, silver
Klickitat .....	2,828	1,560	Stone, sand and gravel, carbon dioxide
Lewis .....	654	466	Stone, sand and gravel, coal, clays
Lincoln .....	484	315	Stone, sand and gravel
Mason .....	②	17	Sand and gravel, stone
Okanogan .....	238	495	Sand and gravel, stone, gypsum, epsomite, silver, copper, gold
Pacific .....	171	1,053	Stone, sand and gravel
Pend Oreille ....	10,194	8,417	Zinc, lead, cement, stone, sand and gravel, silver, copper, barite

VALUE OF MINERAL PRODUCTS BY COUNTIES<sup>①</sup>—Cont.  
[Thousand dollars]

County	1960	1961	Minerals produced in 1961 in order of value
Pierce .....	3,290	4,719	Sand and gravel, recycled lime, stone, clays, peat, lead, gold, silver, coal
San Juan .....	156	176	Sand and gravel
Skagit .....	3,053	2,794	Cement, stone, olivine, sand and gravel, talc and soapstone
Skamania .....	188	160	Stone, sand and gravel
Snohomish .....	1,938	3,780	Sand and gravel, stone, recycled lime, peat, clays, copper, gold, silver
Spokane .....	3,872	4,481	Cement, sand and gravel, stone, clays, tungsten, uranium
Stevens .....	5,093	5,163	Uranium, magnesite, stone, barite, sand and gravel, lead, zinc, gold, silver, grinding pebbles
Thurston .....	267	228	Stone, coal, sand and gravel, peat
Wahkiakum .....		②	Stone, sand and gravel
Walla Walla ...	6,486	1,925	Recycled lime, stone, sand and gravel
Whatcom .....	②	②	Cement, stone, sand and gravel, clays
Whitman .....	190	304	Stone, sand and gravel
Yakima .....	1,290	1,630	Sand and gravel, stone, pumice, lime, clays
Undistributed③.	16,415	9,969	
Totals④ ...	70,485	64,527	

① No production reported in Columbia County.

② Figure withheld to avoid disclosure of individual company confidential data; included with "Undistributed."

③ Includes value of some stone, sand and gravel, and gem stones that cannot be assigned to specific counties and values indicated by footnote 2.

④ Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime—1960 total revised.

## MINING OPERATIONS

Minerals or mineral aggregates, including sand, gravel, and common stone, are produced from all counties in the State except one. Commercial minerals other than sand, gravel, and common stone are produced from 18 counties. Metallic minerals are mined in 10 counties.

### METALLIC MINING

The value of the products of metallic mining decreased about \$1 million from the 1960 total, to \$14.6 million in 1961.

**Zinc and lead**—Zinc production, valued at \$4.65 million for 1961, led that of all other metals. This represents a decrease of almost \$1 million from 1960. Lead, with a total value of \$1.66 million, dropped \$150,000 below 1960. Only two large zinc properties were in operation—Pend Oreille Mines & Metals Company's Pend Oreille mine and American Zinc, Lead & Smelting Company's Grandview mine, both in Pend Oreille County. In Washington, lead has been produced mainly as a byproduct of the big zinc operations. Only a few small properties were operated exclusively for their lead value.

**Gold and silver**—Gold production decreased 7 percent and silver production remained about the same as in 1960. As in past years, Knob Hill Mines,

Inc., in Ferry County, and Lovitt Mining Co., in Chelan County, were the principal gold and silver producers. Four other lode properties and three placer operations reported gold production; however, they contributed only a very small part of the total production. During the year a 300-ton flotation mill was put into operation at the Lovitt mine. The mine and mill are operated jointly by Lovitt Mining Co. and Day Mines, Inc. Lead-zinc producers recovered an average of 5.45 ounces of silver per ton of lead produced in 1961.

**Uranium**—Uranium concentrate ( $U_3O_8$ ) production in 1961 was up about 2 percent over 1960. Total value, however, was up about 10 percent. Dawn Mining Company continued to be the principal producer.

**Copper**—Copper production decreased 15.4 percent compared with 1960. In 1961 only \$40,000 in copper was produced. More than half of this was a byproduct from lead-zinc operations. Only two properties, the Kromona mine of Kromona Consolidated Mines, Inc., in Snohomish County, and the Paymaster mine of Paymaster Mines, Inc., in Okanogan County, mined ore primarily for its copper content.

**Aluminum**—One aluminum company continued exploration and research work on the ferruginous bauxite deposits in Cowlitz and Wahkiakum Counties during the biennium. These deposits conceivably may be the State's best iron ore reserve. The aluminum and iron content of these deposits is low, but the fact that these metals occur together may give the deposits enough value to render them economically workable.

**Tungsten**—Tungsten concentrate was produced by Silver Hill Mines, Inc. from an open-pit mine and mill a few miles south of Spokane. Development work continued at the Chief Jo tungsten property in Okanogan County.

### NONMETALLIC MINING

Production of industrial minerals was valued at \$49.9 million in 1961. This was a decline of approximately \$6 million from 1960. Sand and gravel production dropped appreciably, as did coal, stone, cement, magnesite, and clay. Production of pumice and olivine each nearly doubled over the values of 1960. Olivine production has had a spectacular rise in value during the past few years. Since the first reported production, in 1955, its value has increased by a factor of about 50.

Coal operators, despite a steadily dwindling demand for their product, are hopeful that large-scale steam-electric generation will be started in the State soon, thus establishing an important new coal market. Experimentation with hydraulic mining of coal has given great promise for decreased mining costs.

Under the stimulus of the demand resulting from increased oil-well drilling in Alaska, barite production in Washington rose sharply over 1960. Eight properties, seven in Stevens County and one in Pend Oreille, produced during 1961. The crude barite was ground at Clear Lake and was loaded on barges at Anacortes for shipment to Alaska.

Talc and soapstone production increased in 1961 in terms of tonnage by 22 percent over the previous year. Value of production increased by 87 percent.

All lime production in Washington is for captive markets. Two sugar refineries calcine limestone to make lime, and some limestone is converted to lime at pulp mills. A substantial amount of lime is recycled at pulp mills.

#### **PETROLEUM AND NATURAL GAS PRODUCTION**

Crude oil production from the State's only commercial well, the Sunshine Mining Co.-Medina No. 1, was suspended in 1960.

Exploration drilling was carried out during the biennium in Clallam, Grays Harbor, Island, King, Lewis, Lincoln, Pierce, and Whatcom Counties. Nineteen wells were drilled, with a total footage of 77,569 feet.

WASHINGTON MINERAL PRODUCTION<sup>①</sup>—1954 THROUGH 1961

PRODUCT	1954		1955		1956		1957	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clay (except for cement) <sup>②</sup> .....short tons	261,328	\$318,560	365,331	\$411,807	319,988	\$439,461	297,069	\$488,071
Coal.....short tons	619,269	4,478,127	609,790	4,263,030	472,620	3,432,127	390,336	2,790,505
Copper.....short tons	3,636	2,145,240	3,958	2,925,668	2,926	2,487,100	1,700	1,023,400
Gold.....troy ounces	66,740	2,335,900	74,360	2,692,000	70,669	2,473,415	③	③
Lead.....short tons	9,588	2,723,012	10,340	3,081,320	11,657	3,696,298	12,734	3,641,924
Peat.....short tons	43,134	153,058	④	④	37,043	128,964	39,364	153,274
Pumice.....short tons	④	④	④	④	5,291	14,757	④	④
Sand and gravel.....short tons	16,644,687	13,595,014	21,645,161	19,350,682	16,841,792	15,037,128	20,414,748	17,509,821
Silver.....troy ounces	313,735	283,946	436,248	394,917	448,442	465,863	④	④
Stone.....short tons	5,366,890	9,596,534	6,568,212	10,579,631	8,057,338	11,669,568	8,807,340	11,645,317
Tungsten ore (10% conc.).....short tons	18	65,812	12	43,349	⑤	⑤	⑤	⑤
Zinc.....short tons	22,304	4,817,664	29,536	7,265,856	25,069	7,016,866	24,000	5,568,000
Miscellaneous <sup>③</sup> .....	.....	16,366,850	.....	19,765,194	.....	17,811,369	.....	19,049,703
Total.....	.....	\$53,300,000	.....	\$67,334,000	.....	\$81,723,000	.....	\$90,471,000

WASHINGTON MINERAL PRODUCTION<sup>①</sup>—1954 THROUGH 1961—Continued

PRODUCT	1958		1959		1960		1961	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Barite .....	②	②	②	②	②	②	②	②
Clay (except for cement)④.....	195,000	\$183,000	180,000	\$171,000	169,000	\$163,000	5,100	\$42,000
Coal .....	252,000	1,968,000	242,000	1,841,000	228,000	1,721,000	145,000	138,000
Copper .....	52	27,000	49	30,000	78	50,000	191,000	1,381,000
Lead .....	9,020	2,111,000	10,310	2,371,000	7,725	1,808,000	8,053	40,000
Peat .....	34,642	116,000	32,884	124,000	27,770	121,000	55,543	1,659,000
Pumice .....	②	②	②	②	②	②	②	②
Sand and gravel.....	24,389,000	20,086,000	21,360,000	18,576,000	25,594,000	19,459,000	18,994,000	16,145,000
Stone .....	7,837,000	9,991,000	12,278,000	13,587,000	13,807,000	15,796,000	11,464,000	14,758,000
Tyale and soapstone.....	②	②	②	②	②	②	②	②
Uranium ore .....	②	②	②	②	171,255	3,223,000	175,327	3,582,000
Zinc .....	18,797	3,835,000	17,111	3,433,000	21,317	5,500,000	20,217	4,650,000
Miscellaneous⑤ .....	②	②	②	②	②	②	②	②
Total.....	.....	\$90,897,000	.....	\$63,894,000	.....	\$70,485,000	.....	\$64,527,000

① Compiled by State Division of Mines and Geology from statistics obtained in cooperation with U. S. Bureau of Mines and, in part, published in Minerals Yearbook.  
 ② Included in "Miscellaneous."  
 ③ Includes items indicated by ④ above; also in various years the following: Abrasive stone, carbon dioxide (natural), chromite, diatomite, epsomite, gem stones, gold, gypsum, iron ore, lime, magnesite, manganese, olivine, portland cement, quartz, silver, strontium, talc and soapstone, tungsten, uranium, and other mineral commodities.  
 ④ Incomplete total, fire clay included with "Miscellaneous."  
 ⑤ Miscellaneous.