STATE OF WASHINGTON
ALBERT D. ROSELLINI, Governor

Department of Conservation
EARL COE, Director

BIENNIAL REPORT NO. 8
of the

DIVISION OF MINES AND GEOLOGY

For the Period Commencing July 1, 1958
and Ending June 30, 1960

By
MARSHALL T. HUNTTING
Supervisor

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DIVISION OF MINES AND GEOLOGY

MARSHALL T. HUNTTING, Supervisor

BIENNIAL REPORT NO. 8

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, 1958 to June 30, 1960.

STAFF

Marshall T. Huntting	Supervisor
W. A. G. Bennett	Geologist 4
Vaughn E. Livingston	Geologist 3
Wayne S. Moen	Geologist 3
William H. Reichert	Geologist 2
Gerald W. Thorsen	Geologist 2
Mark D. Haun	Cartographer
Dorothy Rinkenberger	Secretary-Editor
Gloria DeRossitt	Secretary
Jean Preston	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 1959 Legislature, two new full-time geologists and a clerk-typist were hired during the biennium. In addition, two other geologists were hired part-time for a special project. The new permanent staff geologists are William H. Reichert, who started to work October 20, 1958, and Wayne S. Moen, who joined the staff July 1, 1959. The new part-time geologists who were hired for 3 months each in the summer of 1959 to head field parties to examine and report on the limestone deposits of the State are Joseph W. Mills, professor of geology at Washington State University, and W. R. Danner, professor of geology at the University of British Columbia. Temporary field assistants who worked for short periods during the biennium are Charles E. Stearns, Clayton D. Rau, Thomas H. Cole, R. D. Shumway, Alder M. Rivisto, and Charles F. McKillop. Mavis Stuhr worked as a clerk-typist on a temporary basis from February 29, 1960 until June 3, 1960.

The present staff's combined experience and acquaintance with Washington geology and mineral resources and Division office and field procedures is an asset which is very valuable to the State and which should be retained and built up. This can only be accomplished by offering conditions of employment — salaries, equipment, and job security — which approach those in private industry and equal those in the Federal Government. The difficulties encountered in attempting to fill vacancies on the technical staff illustrate the need for improvement in all three categories.

The present technical staff of 5 geologists compares with a total of 4 geologists and 1 mining engineer comprising the Division staff 12 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. Huntting 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. Administrative activities of the Division are limited to regulatory functions 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 make archaeological surveys.

(9) 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 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. Three programs that were proposed by the committee and were initiated by the Division during the biennium are: a geophysical survey for iron ore and other minerals; geologic mapping to outline areas favorable for the occurrence of high-grade clays; and mapping and sampling to determine the location, size, and quality of high-purity limestone in the State.

These and other 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 lead, zinc, copper, gold, uranium, iron ore, black sand, limestone, silica, coal, and peat. 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.

Each year Division geologists visit the active mining operations—metallic, nonmetallic, and sand and gravel—in order to compile the annual 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 which may have future value but which are not now being mined. This collection is housed in a large well-lighted cabinet, so that all specimens are readily accessible for handling and detailed inspection. Two other lighted display cabinets house metallic and nonmetallic mineral collections. These materials are particularly useful when callers request information on Washington minerals and localities and when users of industrial minerals wish to consider State sources of required materials.

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.

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. Inadequate storage space for this material and increased demands for its use emphasize the need for providing special facilities for this "rock library" of samples of cuttings and cores from Washington oil and gas test wells.

LIBRARY

A fairly large, specialized, reference library of approximately 12,000 volumes 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. Increased library acquisitions and the need to systematize this library material made it necessary to hire a geologist who has had special training in library work; such a man was hired during the biennium.

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 1,203 samples. This is more than 50 percent more sample examinations than were made during the 2-year period 10 years earlier, in 1948-50. This indicates a greatly increased interest in Washington's mineral resources and shows increased public dependence upon help and advice from the Division in developing these resources. It also emphasizes the need for additional staff to handle the increased work load.

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; 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; ultraviolet 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, 1960, a total of 148 drilling permits were issued, of which 17 were issued during the 1958-60 biennium. The table on pages 10 and 11 lists and gives data on the wells drilled under these permits during the biennium and during the preceding months in the past biennium subsequent to the publication date of Division of Mines and Geology Information Circular 29, "Oil and Gas Exploration in Washington, 1900-1957."

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 arrangements were made to hire a biostratigrapher at the beginning of the new 2-year period. Further funds are needed to complete the equipment requirements and to purchase necessary catalogs and library reference publications.

ARCHAEOLOGY

In 1957 the Legislature appropriated money to the Division of Mines and Geology for the purpose of making archaeological surveys. With the advice and assistance of archaeologists from the University of Washington and the State College of Washington a program to include three projects was adopted and carried out in 1957. During the summer of 1958 an archaeological survey was made in the Sun Lakes area and a 244-page report of this work, "Archaeological Tests in the Lower Grand Coulee, Washington," was submitted to the Division. This report has been placed on open file and is available for inspection at the Division office.

Two archaeological reports were published during the biennium.

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:

Peat Resources of Washington, by George B. Rigg, Bulletin 44, 272 pages, 1 plate, 263 figures, $4.00. Peat has been found in 28 counties in Washington, and this State has been among the leaders in peat production

OIL AND GAS DRILLING PERMITS ISSUED SINCE SEPTEMBER 1957

Permit no.	Date issued	Company	Well name	Location and elevation	Spudded	Status
132	10-31-57	Sunshine Mining Co.	Minard No. 1	330 ft. N., 240 ft. W. of SE. cor. sec. 10, (17-12W). Elev. 13.2 ft. topo.	1-21-58	T.D. 5,038. Dry hole.
133	3- 5-58	Pleasant Valley Gas and Oil Co.	Guenther No. 1	900 ft. S. of center sec. 8, (12-1W). Elev. 520 ft. topo.	3-10-58	T.D. 8,015. Dry hole.
134	8- 5-58	McCulloch Oil Exploration Co. of Calif.	McCulloch-Krainick No. 1	493 ft. S., 642 ft. E. of NW. cor. sec. 10, (20-6E). Elev. 592 ft. K.B.	8-12-58	T.D. 5,069. Dry hole.
135	9- 5-58	Standard Oil Co. of California	Silvana-Community 12-1.	420 ft. S. and 1,345 ft. W. of E. ¼ cor. sec. 12, (31-4E). Elev. 29 ft. Gr.	9-10-58	T.D. 7,419. Dry hole.
136	10-22-58	Standard Oil Co. of California	Engstrom-Community No. 1	220 ft. S., 1,160 ft. E. of center sec. 17, (30-2E). Elev. 340 ft. topo.	11- 1-58	T.D. 7,353. Dry hole.
137	11-10-58	Sunshine Mining Co. (This is a deepening of the old T. T. Hawksworth-State No. 4 well)	Sampson Johns No. 1	663 ft. S., 1,408 ft. W. of center sec. 15, (18-12W). Elev. 10 ft. Gr.	1- 6-59	T. D. 4,522. Gas production potential.
138	1- 6-59	Adams-Benedict Oil Company, Inc.	Benedict No. 1	Center SE¼SW¼NE¼ sec. 21, (4-1E) Elev. 270 ft. topo.	1-14-59	T.D. 2,600±. Suspended.
139	5-18-59	Tideland Oil & Gas Corporation	Weyerhaeuser 7-11	1,920 ft. N., 1,150 ft. E. of S. ¼ cor. sec. 7, (11-10W). Elev. 30 ft. topo.	6- 2-59	T.D. 5,988. Dry hole.
140	7-20-59	Shell Oil Co.	Sturdevant No. 1	599.9 ft. S., 354.9 ft. W. of N. ¼ cor. sec. 27, (12-2W). Elev. 435 ft. Gr.	8- 5-59	T.D. 8,446. Dry hole.

OIL AND GAS DRILLING PERMITS ISSUED SINCE SEPTEMBER 1957—Continued

Permit no.	Date issued	Company	Well name	Location and elevation	Spudded	Status
141	7-22-59	Tideland Oil & Gas Corporation.....	Carlisle Estate No. 1....	350 ft. N., 540 ft. E. of center SE¼ sec. 23, (20-12W). Elev. 260 ft. Gr.	8-16-59	T.D. 3,596. Suspended.
124-A	7-29-59	Wn-Cal Exploration Co.....	Swanson 22-1	660 ft. S., 10 ft. E. of N. ¼ cor. sec. 22, (18-12W). Elev. 5 ft. topo.		
142	8-10-59	Russell Cobb, Jr.....	Merrill-Ring No. 1.....	950 ft. S., 525 ft. E. of NW. cor. sec. 4, (31-11W). Elev. 155 ft. topo.	12-28-59	T.D. 8,519. Dry hole.
143	8- 3-59	Shell Oil Co.....	Zion No. 1.....	420.9 ft. S., 3,407 ft. W. of NE. cor. sec. 15, (11-2W). Elev. 420 ft. Gr.	9-11-59	T.D. 6,560. Dry hole.
144	9-25-59	Shell Oil Co.....	Thompson No. 1.....	649.0 ft. N., 1,896.5 ft. E. of SW. cor. sec. 34, (12-1W). Elev. 366 ft. Gr.	10- 6-59	T.D. 10,820. Dry hole.
145	6- 9-60	Sunshine Mining Co. and Cascade Natural Gas Co.	Rayonier No. 1.....	660 ft. N., 860 ft. E. of SW. cor. sec. 24, (20-12W). Elev. 400 ft. topo.	6-16-60	T.D. 1,220. Crooked hole. Skidded rig to new location.
146	6- 9-60	Sunshine Mining Co. and Cascade Natural Gas Co. et al.	Oscar No. 1.....	660 ft. N., 1,980 ft. W. of SE. cor. sec. 15, (18-12W). Elev. 10 ft. topo.	8-14-60	

for many years. This comprehensive report describes in detail 350 of the known peat deposits.

Washington's Channeled Scabland, by J Harlen Bretz, Bulletin 45, 57 pages, 4 plates, 36 figures, 50¢. The Channeled Scablands of eastern Washington are unique—nothing like them exists elsewhere in the world. The Division was fortunate in obtaining the services of the foremost authority on them to write a description and explanation of their origin to be published as a bulletin. Because of the scablands' scenic attraction, the report will be of interest to tourists as well as to professional geologists.

Archeology in Washington, by Bruce Stallard, Information Circular 30, 64 pages, 1 plate, 34 figures, 50¢. This report was written as part of one of the archaeological projects sponsored by the Division during the previous biennium. It describes the science of archaeology and the work an archaeologist does, and the allied fields of anthropology; it gives a history of archaeological field investigations in Washington; it describes the early history of man in Washington as interpreted from archaeological evidence; and it includes a bibliography on Washington archaeology.

Prospecting in Washington, by Donald L. Anderson, Information Circular 31, 26 pages, 9 figures, free. Many requests for information are received from prospectors each month. The requests cover a wide range of subjects, many of which are not adequately covered in any other Division report now available. Donald L. Anderson, Professor of Mining Engineering at the University of Washington, was hired to write this information circular to answer most of the questions commonly asked by Washington prospectors.

Early Man in Washington, by Richard D. Daugherty, Information Circular 32, 66 pages, 28 figures, 50¢. One of the most fascinating areas of American archaeological research is the study of "Early Man," who lived here more than 5,000 or 6,000 years ago. The Division was fortunate in being able to obtain from Dr. Daugherty this manuscript describing his research at the Lind Coulee Site and on artifacts recovered there, indicating that man may have been hunting large game animals in Washington as early as 13,000 to 17,000 years ago.

Fossils in Washington, by Vaughn E. Livingston, Jr., Information Circular 33, 35 pages, 1 plate, 17 figures, 25¢. Many requests are received for information on fossils in the State. Although fossils are the subject of highly specialized studies by paleontologists, they also are interesting to many nonspecialists, beginning students, and amateurs, and it is for those persons that this report has been prepared.

1959 Directory of Washington Mining Operations, by Gerald W. Thorsen, Information Circular 34, 78 pages, 2 maps, free. This directory, like those in preceding years, lists all the known producers and the active developments on deposits of metallics, nonmetallics, and sand and gravel in the State. For each operation the directory lists the name, address, location, product, and status of activity.

Pleistocene Sequence in Southeastern Part of the Puget Sound Lowland, Washington, by D. R. Crandall, D. R. Mullineaux, and H. H. Waldron,

reprinted from American Journal of Science, Reprint 2, 14 pages, 1 figure, 25¢.

Tertiary Stratigraphic Papers, Southwestern Washington. Reprinted from The Bulletin of the American Association of Petroleum Geologists, Reprint 3, 45 pages, 22 figures, 25¢.

McIntosh Formation, Centralia-Chehalis Coal District, Washington, by P. D. Snavely, Jr., Weldon W. Rau, Linn Hoover, Jr., and Albert E. Roberts.

Lyre Formation (redefinition) Northern Olympic Peninsula, Washington, by R. D. Brown, Jr., P. D. Snavely, Jr., and H. D. Gower.

Twin River Formation (redefinition) Northern Olympic Peninsula, Washington, by R. D. Brown, Jr., and H. D. Gower.

Nickel-Gold Ore of the Mackinaw Mine, Snohomish County, Washington, by Charles Milton and Daniel J. Milton. Reprinted from Economic Geology, Reprint 4, 22 pages, 17 figures, 25¢.

What Are the Prospects in Washington State? by F. H. Wurden; and Puget Sound Area Has Several Prospective Oil and Gas Basins, by J. Q. Anderson, Reprinted from World Oil, Reprint 5, 9 pages, 5 figures, 25¢. The first of these two articles describes the geology of the Ocean City oil field in Grays Harbor County, and the second describes the Black Diamond-Enumclaw area in King County.

Gem and Ornamental Stones and Quartz Crystal, Plate 15 with brief text from Bulletin 37, pt. 1, free. This extremely popular map with brief text which shows the locations and describes the gem stone occurrences of the State was revised and reissued.

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:

Geologic Map of Washington. The entire remaining stock of the geologic map of Washington was quickly exhausted when uranium prospecting became active. This necessitated the immediate start on a complete revision of the state map—a meticulous, time-consuming, and expensive project that will require more than 3 years to complete. It is the most important new project scheduled by the Division. Geologic maps of all kinds have been acquired from government agencies, private companies, candidates for advanced college degrees, and other individuals. These maps have been reduced to the compilation scale of 1:400,000, necessary changes have been made, and the maps have been transferred to a manuscript copy of a single statewide map that will be redrafted and published at a scale of 1:500,000. The project has benefited greatly from the excellent cooperation extended by all who have made unpublished geologic maps available for use. Especially valuable has been the help of the U. S. Geological Survey, several oil companies, the University of Washington, and Washington State University. Although

the revised State geologic map will be largely a compilation of maps from other sources, some mapping has been done by Division geologists specifically for this map revision project. During the summer of 1958 some additional mapping was done in the southern Cascade Mountains by a Division geologist and a geologist of the U. S. Geological Survey under a cooperative agreement between the two agencies. The State map is scheduled for publication in 1961.

Inventory of Washington Minerals: Nonmetallic Minerals, by Grant M. Valentine, revised by Marshall T. Huntting, Bulletin No. 37, Part I, Second Edition, 175 pages, 39 plates, $3.00. The first edition of this report, published in 1949, was entirely exhausted in April 1956. As there is a continuous demand for data on the State's industrial minerals, the bulletin is being revised, brought up to date, and considerably enlarged for reprinting. The revised report is in press and should be completed and ready for distribution soon after the close of the biennium.

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 2 years.

Bibliography and Index of the Geology and Mineral Resources of Washington, 1937-1956, by William H. Reichert, Bulletin No. 46, 721 pages, $2.00. This report was originally compiled by Mr. Reichert as a Master of Librarianship thesis at the University of Washington. Upon receiving his degree Mr. Reichert was hired by the Division as a full-time staff member, and he has since enlarged and completely revised the report. It is in press and should be ready for distribution soon after the close of the biennium.

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 No. 20, 34 pages, 2 figures, 25 plates, $1.50. This project and the two described below were undertaken as the result of recommendations by the Industrial Raw Materials Advisory Committee to the Department of Commerce and Economic Development, and the latter department cooperated in this project by paying part of the cost of printing the report. The survey was completed in 1959, and the report and maps had been printed by the end of the biennium. They were scheduled for release July 1, 1960. Accompanying the report are five sets of maps for each of the five quadrangle areas (a total of about 935 square miles) covered. These maps show aeromagnetic and radiometric data on a planimetric base, the same data printed on translucent paper without a base map, for use as an overlay, and other overlay maps as follows: mineral commodity map showing mines and prospects and location of National Forest and State-owned lands; height of the survey aircraft above ground, shown by contours; and geologic interpretations.

Geology and Mineral Resources of the North Half of the Van Zandt Quadrangle, Whatcom County, by Wayne S. Moen. 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 a report is 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 have been assigned to the job. The western Washington survey is being supervised by Dr. W. R. Danner, Professor of Geology at the University of British Columbia, and the eastern Washington survey is by Dr. Joseph W. Mills, Professor of Geology at Washington State University. Topographic and geologic maps of the best deposits are being made. About 800 samples are being taken for complete chemical analysis. Field work was done in 1959 and was scheduled for completion in the fall of 1960. The results of the survey will be published in two reports.

Ferruginous Laterite in the Kelso Area, by Vaughn E. Livingston, Jr. A mineral resource not now being utilized but having very great potential value is the iron-rich bauxite which occurs in northwestern Oregon and in the Kelso area in Washington. Geologic mapping to outline the areas which are favorable for the occurrence of this material was conducted in 1959.

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 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 will be included in the report. The U. S. Bureau of Mines has cooperated by compiling a record of production for all the mines in the area. Dr. Barksdale is continuing his geologic mapping in 1960 and some additional mineral deposits will be examined this year also.

Coal in Washington. Two reports on Washington coal were in preparation by the U. S. Geological Survey in cooperation with the Washington Department of Conservation. These are described on page 19 of this report.

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 1959 is $389,771, 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 over-all 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:

11 new triangulation stations were established and monumented.
300 lineal miles of levels were run.
4,370 square miles of photography were completed.
3,595 square miles were compiled by photogrammetry and field surveys.
113 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:

Names of quadrangles	*Counties in which located*	*Estimated publication date*
Cedar Lake 1	King	December 1961
Sultan 4	King	December 1961
Doe Mountain	Okanogan	1964
Mazama	Okanogan	1964
Granite Falls (Stillaguamish 3)	Snohomish	①
Silverton (Stillaguamish 4)	Snohomish	①
Index (Sultan 1)	Snohomish and King	①
Monroe (Sultan 2)	Snohomish and King	①

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.

Names of quadrangles	*Counties in which located*
Aberdeen SE (7½′)	Grays Harbor and Pacific
Aeneas (Wauconda)	Ferry and Okanogan
Aeneas Valley (Osoyoos 4)	Okanogan
Badger Pocket (Yakima 2)	Yakima
Bay Center (7½′) (South Bend NW)	Pacific
Bellingham South (7½′) (Samish Lake NW)	Whatcom
Black Rock Spring	Yakima and Kittitas
Blaine	Whatcom
Bodie Mountain	Ferry and Okanogan
Bonneville Dam	Skamania
Bow (7½′) (Samish Lake SW)	Skagit
Brewster (Okanogan 3)	Okanogan
Bridgeport (Okanogan 4)	Okanogan
Cairn Hope Peak (7½′) (Priest Rapids SW)	Yakima
Cape Flattery	Clallam
Carlisle (7½′) (Moclips NE)	Grays Harbor
Clallam Bay (Clallam)	Clallam
Clear Lake	Snohomish and Skagit
Conconully (Chopaka 4)	Okanogan
Copalis Beach (7½′) (Moclips SW)	Grays Harbor
Copalis Crossing (7½′) (Moclips SE)	Grays Harbor
Cougar (Mount St. Helens 3)	Cowlitz
Destruction Island	Jefferson and Grays Harbor
Edmonds	Kitsap, Island, Snohomish, King
Elk Rock (Mount St. Helens 2)	Cowlitz and Lewis
Ellensburg (Ellensburg 15′)	Kittitas and Yakima
Ellensburg North (7½′) (Mount Stuart 4 SE)	Kittitas
Ellensburg South (7½′) (Ellensburg 1 NE)	Kittitas
Emerson Nipple (7½′)	Benton
Enumclaw (Cedar Lake 3)	King and Pierce
Everett	King and Snohomish
Ephrata	Grant
Forks	Clallam and Jefferson
Fort Simcoe (7½′) (White Swan 2 SE)	Yakima
Gig Harbor (7½′) (Gig Harbor SE)	King and Pierce
Goldendale	Klickitat
Grayland (7½′) (Grayland SE)	Grays Harbor and Pacific
Greenwater (Cedar Lake 4)	King and Pierce
Harrah (7½′) (White Swan 1 NE)	Yakima
Harrah SE (7½′) (White Swan 1 SE)	Yakima
Hembre Mtn. (7½′) (Zillah 2 SE)	Yakima
Hood River	Skamania and Klickitat
Hoquiam (7½′) (Aberdeen NW)	Grays Harbor
Horseshoe Basin (Chopaka 2)	Okanogan

Names of quadrangles	*Counties in which located*
Husum	Klickitat
Joyce (Port Crescent 15′)	Clallam
Klickitat	Klickitat
Kloochman Rock (Elk Park)	Jefferson and Grays Harbor
Lake Crescent	Clallam
Lake Pleasant (Pleasant Lake)	Clallam
La Push	Clallam and Jefferson
Lewiston Orchards	Asotin
Lewiston Orchards South (7½′)	Asotin
Loomis (Chopaka 1)	Okanogan
Loup Loup (Okanogan 2)	Okanogan
Lynden (Sumas)	Whatcom
Medicine Valley (7½′) (White Swan 2 NE)	Yakima
Moclips (7½′) (Moclips NW)	Grays Harbor
Morton	Lewis
Moses Lake	Grant
Mt. Bonaparte (Osoyoos 1)	Okanogan
Mount Olympus	Clallam and Jefferson
Mount St. Helens (Mount St. Helens 4)	Skamania
Mount Tom	Clallam and Jefferson
Naches (7½′)	Yakima
Nemah (7½′) (South Bend SW)	Pacific
North Cove (7½′) (Cape Shoalwater NE)	Pacific
North Nemah (7½′) (South Bend SE)	Pacific
Ohop Valley (Tanwax Lake)	Pierce and Thurston
Okanogan (Okanogan 1)	Okanogan
Olympia (Olympia SW)	Thurston
Orcas Island (East Sound)	San Juan
Oroville (Osoyoos 2)	Okanogan
Oysterville (7½′) (Cape Shoalwater SE)	Pacific
Ozette Lake	Clallam
Point Brown (7½′) (Grayland NW)	Grays Harbor
Priest Rapids (7½′)	Yakima and Grant
Pysht	Clallam
Richardson	San Juan
Salmon River (Queets)	Jefferson and Grays Harbor
Samish Lake	Whatcom and Skagit
Satus Pass (Goldendale 1)	Klickitat
Selah (7½′) (Ellensburg 4 NE)	Yakima
South Bend (7½′) (South Bend NE)	Pacific
Spirit Lake (Mount St. Helens 1)	Lewis and Skamania
Spruce Mountain	Clallam and Jefferson
Tenino (Tenino SE)	Thurston
Thorp (Mount Stuart 4)	Kittitas
Thorp (7½′) (Mount Stuart 4 SW)	Kittitas
Tiffany Mountain (Chopaka 3)	Okanogan
Tonasket (Osoyoos 3)	Okanogan
Toppenish (7½′)	Yakima
Toppenish Mtn. (7½′) (White Swan 1 SW)	Yakima

Names of quadrangles	*Counties in which located*
Toppenish SW (7½′) (Zillah 2 SW)	Yakima
Wapato (7½′) (Zillah 2 NW)	Yakima
Wasco	Klickitat
Western (7½′) (Aberdeen SW)	Grays Harbor
Westport (7½′) (Grayland NE)	Grays Harbor
Wheeler	Grant
White Swan (7½′) (White Swan 1 NW)	Yakima
Wiley City (7½′) (Ellensburg 4 SW)	Yakima
Wilkeson (7½′) (Lake Tapps SE)	Pierce
Willard (Hood River 1)	Skamania and Klickitat
Wilson Creek	Grant
Wind River	Skamania
Wishram	Klickitat
Yacolt	Clark
Yakima East	Yakima and Kittitas
Yelm	Thurston

Coal Investigations

At the end of the 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.

At the end of the first season's work a progress report was submitted, and upon completion of the investigations a final report was being made which tabulates the amounts of coal present in each township in each coal field in the State. The tabulation is subdivided to show the coal in each rank—lignite, subbituminous, bituminous, and anthracite. The data will also be broken down into 3 categories of thickness of coal seams (2½ to 5 feet, 5 to 10 feet, and more than 10 feet thick), 3 categories of thickness of overburden (0 to 1,000 feet, 1,000 to 2,000 feet, and 2,000 to 3,000 feet), and 3 categories of reliability and abundance of data (measured, indicated, and inferred reserves). 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.

The report on this work should be ready for publication early in 1961.

In July 1959 a 2-year cooperative project was initiated 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 comprising 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.

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 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.

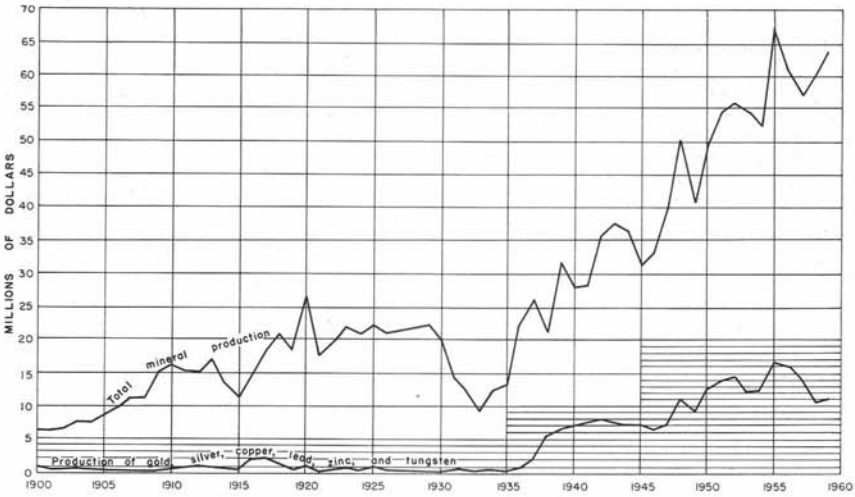
During the past biennium the Division has had occasions to provide information and be of assistance to the U. S. Forest Service and other Federal agencies as well as such State agencies as the Department of Commerce and Economic Development, Department of Highways, Commissioner of Public Lands, Pollution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

PART II

MINERAL INDUSTRY OF WASHINGTON

VALUE OF MINERAL PRODUCTION

Mineral production and processing constitute one of the major industries of the State. Only two extractive industries, agriculture and logging, have a greater value than mining. Most people probably view the mineral industry casually, little realizing that it comprises a substantial part of Washington's economy. During 1959, minerals worth $63,894,000① were produced in the State; this was a $3 million increase over 1958. During the past 10 years (1950-1959) mineral production had a total value of $577 million, an increase of more than $200 million over the previous 10 years. With minor fluctuations,



Value of Washington's mineral production, 1900-1959

the State's mineral production has been steadily increasing since the depression year of 1933, when it was valued at just over $9 million. This steady climb can be attributed to two factors: increase in the State's population, and improvement in prospecting, production, and extraction methods. Washington's 1959 mineral production was $7 million less than that of Idaho, one and one-third times greater than Oregon's, and three times that of Alaska.

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

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

VALUE OF MINERAL PRODUCTION BY COUNTIES①
[Thousand dollars]

County	*1958*	*1959*	*Minerals produced in 1959 in order of value*
Adams	$ 594	$ 1,239	Stone, sand and gravel
Asotin	42	②	Sand and gravel
Benton	344	256	Sand and gravel, stone
Chelan	1,250	1,749	Gold, stone, sand and gravel, silver, pumice
Clallam	516	109	Sand and gravel, manganese
Clark	382	890	Stone, sand and gravel, clays
Columbia	②	—	
Cowlitz	385	420	Stone, sand and gravel
Douglas	1,030	685	Sand and gravel, stone
Ferry	②	②	Gold, silver, sand and gravel, stone
Franklin	717	1,131	Stone, sand and gravel
Garfield	62	52	Stone
Grant	4,132	1,682	Sand and gravel, diatomite, stone
Grays Harbor	258	288	Sand and gravel, stone, petroleum
Island	114	236	Sand and gravel, stone
Jefferson	258	318	Stone, sand and gravel
King	8,864	10,000	Cement, sand and gravel, stone, coal, clays, peat
Kitsap	176	232	Sand and gravel, stone
Kittitas	1,416	1,214	Coal, sand and gravel, stone, gold, silver
Klickitat	345	1,692	Sand and gravel, stone, carbon dioxide
Lewis	475	668	Sand and gravel, stone, coal, clays
Lincoln	603	230	Sand and gravel, stone
Mason	②	②	Do
Okanogan	138	506	Sand and gravel, stone, gypsum, silver, gold, iron ore
Pacific	315	204	Stone, sand and gravel
Pend Oreille	②	②	Zinc, lead, cement, stone, sand and gravel, silver, copper, uranium, gold
Pierce	3,042	3,012	Sand and gravel, stone, clays
San Juan	—	120	Sand and gravel
Skagit	3,486	3,539	Cement, sand and gravel, stone, olivine, talc and soapstone, strontium, chromite
Skamania	257	703	Stone, sand and gravel
Snohomish	1,540	1,828	Sand and gravel, stone, peat, clays, copper, gold, silver
Spokane	4,715	4,980	Cement, sand and gravel, stone, clays, uranium
Stevens	3,357	3,391	Uranium, magnesite, stone, sand and gravel, iron ore, lead, barite, clays, silver, zinc, grinding pebbles
Thurston	204	588	Sand and gravel, stone, coal, peat
Walla Walla	1,483	1,547	Sand and gravel, stone
Whatcom	②	②	Cement, stone, sand and gravel, clays
Whitman	398	496	Stone, sand and gravel
Yakima	1,158	964	Sand and gravel, stone, pumice, clays
Undistributed③	20,486	20,861	
Total④	$60,896	$63,894	

① Wahkiakum County not listed because no production was reported.
② Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
③ Includes value of sand and gravel, stone, and gem stones that cannot be assigned to specific counties and value of minerals for counties indicated by footnote 2.
④ Adjusted to eliminate duplicating value of clays and stone; 1958 total revised.

The tabulation of production statistics for the years 1952 through 1959 as shown on page 26 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 21, 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, and tungsten accounted for approximately 18 percent of the State's mineral production value in 1959. This is a 2-percent increase over 1958. This relationship is shown graphically on page 21.

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 22 counties. Metallic minerals are mined in 10 counties.

METALLIC MINING

The number of metallic mining operations has remained practically unchanged during the past two years. In 1959 there were 66 properties reported as producing or being actively developed with the expectation of producing in the near future. In 1958 there were 65 such properties. The value of metallic mining increased about $500,000 over the 1958 total, to $12.5 million in 1959.

Zinc and lead.—Zinc production, valued at $3.9 million for 1959, led that of all other metals by over $1.5 million. This represents an increase of $100,000 over 1958. Lead, with a total value of $2.37 million, gained $200,000 over 1958. 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. An important zinc discovery was made by Goldfield Consolidated Mines Company on their Anderson mine property in 1959. A core drilling program undertaken during the summer months revealed hitherto unknown zinc reserves. It is reported that plans are now being made to return the property to production. Goldfield has been out of production since their Deep Creek mine was closed in 1956. In Washington, lead has been produced mainly as a byproduct of the big zinc operations. The Lucille, Gladstone, and Electric Point mines were the only properties that were operated exclusively for their lead value.

Gold and silver.—Gold production increased 5 per cent and silver production decreased 8 percent from 1958. 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. Five other lode properties and one placer operation reported gold production; however, they contributed less

than 1 percent of the State total. Lead-zinc producers recovered an average of 3.6 ounces of silver per ton of lead produced in 1959.

Uranium.—Uranium concentrate (U_3O_8) production in 1959 was up about 2 percent over 1958. Total value, however, was down slightly. Dawn Mining Company continued to be the principal producer. About 160,000 tons of ore was milled at their Ford plant, 130,000 tons of which came from the Midnite mine.

Copper.—Copper production fell off sharply with the closure of the Holden mine in 1957. In 1959 only $30,000 in copper was produced. Almost two-thirds of this was a byproduct from lead-zinc operations. Only one property, the Kromona mine of Kromona Consolidated Mines, Inc., in Snohomish County, mined ore primarily for its copper content.

Iron and aluminum.—The Kulzer mine in Stevens County was the State's only producing iron property during 1959. The ore was used as a cement additive rather than for its elemental content. There was considerable attention given the black sand deposits in Grays Harbor and near the mouth of the Columbia River by organizations both in and out of the State.

Two aluminum companies did 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.

United Pacific Aluminum Corporation has announced plans to construct an aluminum reduction plant at Longview in 1960 to handle foreign ore. This will bring the number of aluminum plants in the State to six.

NONMETALLIC MINING

Industrial minerals were valued at $51.4 million in 1959. This was a gain of approximately $2.5 million over 1958. Sand and gravel production dropped slightly, as did coal and clay. Stone, cement, magnesite, and olivine rose in production and value. Olivine has made a spectacular rise in value during the past few years. Since the first reported production, in 1955, its value has increased over 23 times.

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.

Of significance in the sand and gravel industry was the purchase of Pioneer Sand and Gravel Co. of Seattle by Ideal Cement Co., Klinker Sand and Gravel Co. of Seattle by the Boise Cascade Corp., and Ace Concrete Co. by Hecla Mining Co. This appears to indicate a shift to larger sand and gravel operations.

The future for silica looks bright with the opening of the Lane Mountain silica property in southern Stevens County. Lane Mountain Silica Company officials estimate that they have 100 million tons of high-grade silica reserves.

PETROLEUM AND NATURAL GAS PRODUCTION

Crude oil production from the State's only commercial oil well, the Sunshine Mining Co.-Medina No. 1, dropped sharply during 1959. Early in 1959, Sunshine Mining Co. deepened the old Tom T. Hawksworth Gas & Oil Development Co. and Associates-State No. 4 well under the new name of Sampson John Unit No. 1. The company announced that the well is capable of producing gas in commercial quantities. Lack of a market caused the well to be shut in.

Exploration drilling was carried out in King, Pacific, Grays Harbor, Lewis, Island, Snohomish, Clark, and Clallam Counties. Twelve wells were drilled with a total footage of approximately 72,000 feet.

SELECTED MINERAL PRODUCTION①—1952 THROUGH 1959

Product	1952		1953		1954		1955	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clay (except for cement).....short tons	225,000	$352,576	198,233	$312,141	261,328	$318,500	365,331	$411,807
Coal .....short tons	844,000	5,986,129	689,831	5,047,928	619,209	4,478,127	609,790	4,263,030
Copper .....short tons	4,357	2,108,788	3,740	2,146,760	3,636	2,145,240	3,958	2,925,668
Gold .....troy ounces	54,776	1,917,160	62,560	2,189,600	66,740	2,335,900	74,360	2,602,600
Lead .....short tons	11,744	3,781,568	11,064	2,898,768	9,938	2,723,012	10,340	3,081,320
Peat .....short tons	42,580	111,386	32,107	104,274	43,134	153,058	②	②
Pumice .....short tons	3,604	8,089	②	②	②	②	②	②
Sand and gravel.....short tons	13,322,000	9,422,117	11,182,835	9,317,793	16,044,687	13,595,014	21,645,161	19,350,682
Silver .....troy ounces	316,000	285,675	321,202	290,704	313,735	283,946	436,348	394,917
Stone .....short tons	4,591,000	5,491,525	4,438,259	5,890,849	5,366,890	9,526,534	6,593,212	10,579,631
Tungsten ore (60% conc.).....short tons	4	14,008	5	19,710	18	65,812	12	45,949
Zinc .....short tons	20,102	6,673,864	32,786	7,540,780	22,304	4,817,664	29,536	7,265,856
Miscellaneous③	.....	19,985,862	.....	18,817,913	.....	16,903,830	.....	19,765,194
Total.....	.....	$56,139,000	.....	$54,577,000	.....	$53,300,000	.....	$67,334,000

Product	1956		1957		1958④		1959④	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clay (except for cement).....short tons	319,988	$439,461	297,669	$488,071	⑤ 196,000	⑤ $183,000	⑤ 180,000	⑤ $171,000
Coal .....short tons	472,620	3,432,127	360,336	2,760,505	252,000	1,968,000	242,000	1,841,000
Copper .....short tons	2,926	2,487,100	1,700	1,023,400	52	27,000	49	30,000
Gold .....troy ounces	70,669	2,473,415	②	②	②	②	②	②
Lead .....short tons	11,657	3,660,298	12,734	3,641,924	9,020	2,111,000	10,310	2,371,000
Peat .....short tons	37,043	128,964	39,364	153,274	34,642	116,000	32,884	124,000
Pumice .....short tons	5,291	14,757	②	②	②	②	9,000	112,000
Sand and gravel.....short tons	16,841,792	15,037,128	20,414,748	17,509,821	24,389,000	20,086,000	21,360,000	18,576,000
Silver .....troy ounces	448,442	405,863	②	②	②	②	②	②
Stone .....short tons	8,057,338	11,659,598	8,897,340	11,645,317	7,837,000	9,991,000	12,278,000	13,587,000
Tungsten ore (60% conc.).....short tons	②	②	②	②	②	②	②	②
Zinc .....short tons	25,609	7,016,866	24,000	5,568,000	18,797	3,835,000	17,111	3,936,000
Miscellaneous③	.....	17,811,399	.....	19,049,703	.....	24,225,000	.....	25,077,000
Total.....	.....	$61,723,000	.....	$60,471,000	.....	$60,897,000	.....	$63,894,000

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 ② above; also in various years the following: carbon dioxide (natural), chromite, diatomite, epsomite, gem stones, gold, gypsite, iron ore, lime, magnesite, manganese, olivine, portland cement, quartz, silver, strontium, talc and soapstone, tungsten, uranium, and other mineral commodities.

④ Preliminary statistics, subject to revision.

⑤ Incomplete total, fire clay included with items that cannot be disclosed.