STATE OF WASHINGTON
ARTHUR B. LANGLIE, Governor

Department of Conservation and Development
JACK V. ROGERS, Director

BIENNIAL REPORT NO. 3
of the
DIVISION OF MINES AND GEOLOGY
For the Period Commencing October 1, 1948 and Ending September 30, 1950

by
SHELDON L. GLOVER
Supervisor

OLYMPIA, WASH.
STATE PRINTING PLANT
1951
DIVISION OF MINES AND GEOLOGY

BIENNIAL REPORT NO. 3

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GENERAL STATEMENT

The following report applies to the organization and activities of the Division of Mines and Geology for the period October 1, 1948 to September 30, 1950.

The technical staff consisted of:
Sheldon L. Glover, Supervisor, B. S. and M. S. in Geology, University of Washington, Registered Mining Engineer
W. A. G. Bennett, B. S. and M. S. in Geology, State College of Washington, Ph. D., University of Chicago
Grant M. Valentine, B. S. and M. S. in Geology, State College of Washington
Marshall T. Huntting, B. S. and M. S. in Geology, State College of Washington, Registered Mining Engineer
C. Phillips Purdy, Jr., S. B. in Geology, Harvard College, postgraduate in mining geology, Massachusetts Institute of Technology
Stephen H. Green, Mining Engineer, who was on leave of absence without pay during the early part of the biennium and then retired, and whose vacant position on the staff has not been filled
Robert H. Stebbins, B. S. in Geology, Massachusetts Institute of Technology, who filled the position left vacant when Grant Valentine resigned toward the end of the biennium to enter the employ of the Shell Oil Company

The clerical staff consisted of Dorothy Rinkenberger, B. A., State College of Washington, and an assistant—first Ruth Johnston; then Darlene Tilley; and, near the end of the biennium, Sandra Burdick.

Temporary additions to the staff for special projects were George B. Rigg, Professor Emeritus, Botany Department, University of Washington, in charge of a peat investigation, and C. S. Leuthy, F. A. Nave, and E. M. Woodruff, field assistants.

Activities, as usual, were confined almost exclusively to economic aspects of the state’s mineral resources. During the biennium much information was gained through continued geologic investigations in the field to supplement the results of similar work conducted by the Division and its predecessor agencies since 1901. All this fund of data is readily available and is constantly used in answering inquiries regarding the mineral occurrences of the state—questions involving: the kinds and varieties of metallic and industrial minerals, their locations, extent, and accessibility; uses to which the materials are adapted; markets; and sources of supplies for industry, both here and out-of-state.
STATUS OF MINERAL PRODUCTION IN WASHINGTON

Mining during the biennium has been particularly active and has contributed markedly to the wealth of the state. Just how important the industry is may best be realized by considering the mineral statistics for the past decade. The total production of all minerals and aggregates from 1939 to 1948, inclusive, was approximately $353 million—far more than for any previous 10 years in the state's history. In fact, each year of that decade exceeded in value of production any year previous to that period since mining began in Washington. The average annual output during the 10 years was $35½ million. Of this, the metallic minerals—chiefly gold, silver, copper, lead, and zinc—had an average annual value of about $73½ million, or 23 percent of the total; while the industrial minerals—portland cement, coal, sand and gravel, stone, magnesite, clay products, and other materials of lesser importance—had an average annual value of about $27½ million, or 78 percent of the total. This relationship between value of output of the metallic and the industrial minerals is not generally realized by those unconversant with the details of our mineral industry.

![Graph showing Value of Washington's mineral production, 1900-1948](image)

Again considering production during the past decade, the average annual value for that period was exceeded not only during the war years of 1942-44, as would have been expected, but also during 1947 and 1948, when curtailed production certainly would have been expected. Actually, the 1947 production exceeded that of any previous year in the state's history, and the 1948 production exceeded that of 1947 by $10½ million, reaching the phenomenal all-time high of $50½ million.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>1941</th>
<th>1942</th>
<th>1943</th>
<th>1944</th>
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<tbody>
<tr>
<td>Clay and clay products</td>
<td>short tons</td>
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<tr>
<td>Coal</td>
<td>short tons</td>
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<tr>
<td>Coke</td>
<td>short tons</td>
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<tr>
<td>Copper</td>
<td>short tons</td>
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<tr>
<td>Gold</td>
<td>Troy ounces</td>
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<tr>
<td>Iron ore</td>
<td>long tons</td>
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<td>Lead</td>
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<td>Lime</td>
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<tr>
<td>Manganese ore</td>
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<tr>
<td>Flint</td>
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<td>Pumice</td>
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<td>Sand and gravel</td>
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<tr>
<td>Silver</td>
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<tr>
<td>Stone</td>
<td>short tons</td>
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<tr>
<td>Talc and soapstone</td>
<td>short tons</td>
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<tr>
<td>Tungsten ore (60% conc.)</td>
<td>short tons</td>
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<tr>
<td>Zinc</td>
<td>short tons</td>
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<td>Miscellaneous</td>
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① Compiled by State Division of Mines and Geology from statistics of U. S. Bureau of Mines, as published in Minerals Yearbook, 1941 and later years.
② Not included in state total, in order to avoid duplication.
③ Included in "miscellaneous."
Total Mineral Production
1939-1948

<table>
<thead>
<tr>
<th>Year</th>
<th>Metallic minerals</th>
<th>Industrial minerals</th>
<th>Total</th>
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<tbody>
<tr>
<td>1939</td>
<td>$6,739,467</td>
<td>$24,850,556</td>
<td>$31,590,023</td>
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<tr>
<td>1940</td>
<td>7,018,812</td>
<td>21,071,376</td>
<td>28,090,188</td>
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<tr>
<td>1941</td>
<td>7,571,856</td>
<td>20,631,596</td>
<td>28,203,452</td>
</tr>
<tr>
<td>1942</td>
<td>8,372,609</td>
<td>27,486,534</td>
<td>35,859,143</td>
</tr>
<tr>
<td>1943</td>
<td>7,638,012</td>
<td>29,754,988</td>
<td>37,393,000</td>
</tr>
<tr>
<td>1944</td>
<td>7,195,136</td>
<td>29,287,864</td>
<td>36,483,000</td>
</tr>
<tr>
<td>1945</td>
<td>7,140,242</td>
<td>24,150,788</td>
<td>31,291,025</td>
</tr>
<tr>
<td>1946</td>
<td>6,886,748</td>
<td>26,189,352</td>
<td>33,076,098</td>
</tr>
<tr>
<td>1947</td>
<td>7,339,489</td>
<td>32,584,511</td>
<td>39,923,999</td>
</tr>
<tr>
<td>1948</td>
<td>11,171,715</td>
<td>39,326,285</td>
<td>50,498,000</td>
</tr>
<tr>
<td>Totals</td>
<td>$77,377,116</td>
<td>$275,344,520</td>
<td>$352,721,636</td>
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</tbody>
</table>

The year 1948 is the latest for which complete statistics of the state’s mineral production are available. As yet, there is very little upon which to base estimates of the 1949 and 1950 output. However, it is probable that some drop in the value of production took place in those years, though the totals for each year may be expected to materially exceed the $35½ million annual average of the 1939-48 decade.

PRESENT MINING ACTIVITY

In the latter part of each year the Division canvasses the mining concerns throughout the state to determine who is operating, where, and on what mineral substances. This is done by actually visiting the operators, thus obviating the necessity of adding to the number of questionnaires that are so disliked by industry. The results are published as early as possible in the following year as an annual “Directory of Washington mining operations,” and are given wide circulation, not only within the state but quite generally over the country, supplying desired information to the mining industry, to the users of minerals and aggregates, and to the companies that furnish materials and equipment to operators.

The 1949 and 1950 directories give the status of mining within the state during the present biennium. A summation based on the 1950 report shows that 85 metallic mining properties were actively in production, had been in production within the past year or two and could be expected to resume production, or were under development with expectation of active production in the near future. This, compared with 107 properties figured on the same basis in 1949, is a decrease of 22 operations. Stevens County led in 1950 with 32 operations, followed by Ferry County with 12, Okanogan County with 10, Snohomish County with 7, and 8 other counties with from 1 to 6 operations each. Among the various metallic minerals involved, gold-silver headed the list with 34 operations. Lead-zinc was next with 27, then copper with 15, lead-silver with 12, and finally antimony, iron, molybdenum, and tungsten with from 1 to 3 operations each.

Using the same 1950 basis with regard to the industrial minerals and disregarding the very numerous operations involving sand, gravel, and common stone, 26 counties had producing properties. King County led with 50 operations, followed by Snohomish County with 14, Stevens County with 13, Spokane County with 12, Lewis County with 11, and 21 other counties with from 1
to 10 operations each. Some 26 industrial minerals were produced. Leading
the list in number was coal with 35 operations. This was followed by clay pits
and plants with 29 operations, peat with 26, limestone with 14, stone (other
than common) 12, and 21 other nonmetallic minerals and aggregates with
from 1 to 8 operations each.

CONTINUING ACTIVITIES OF THE DIVISION

An industry as important to the state as mining is entitled to all possible
state support, consideration, and assistance. It is the function by law of the
Division of Mines and Geology to aid the mineral industry to the end that re-
liable information will be available on mineral resources, both to those who
are developing mineral deposits and to those who are using or wish to use the
products of the mines. Care is taken to avoid infringing on the activities of the
professional consulting geologists and mining engineers or the commercial
analysts and assayers. Rather, aid is given to the prospector and small operator
who might not be able to afford other assistance, and this is always done with
the idea of demonstrating the need and advantage of using the services of
commercial consultants and laboratories when at all possible.

In supplying this aid, it is of foremost importance to investigate the de-
posit in the field, ascertain the geology of the mineral occurrence, and obtain
samples for laboratory study. Such work fits in very well with the special
projects that the Division always has underway and which are described later
in this report. In the interest of economy, special trips are rarely made, but
when regularly scheduled field investigations take a staff member into a cer-
tain region, the prospectors and small miners of that region are contacted and
their mineral deposits are examined.

Mineral Identification Service

A well-equipped laboratory is maintained by the Division in which sam-
plels, taken in the field, are studied in connection with the preparation of the
regular published bulletins and reports. This same equipment is, of course,
available for any other research that comes within the field of geology. One
supplementary use made of these facilities is in the identification service car-
ried on for prospectors, miners, or the general public. By this means, samples
or specimens of minerals and rocks are examined without charge, identified,
and the sender advised of possible value and market use. During the past
biennium 525 samples were submitted and received attention. They covered
a surprising range of both metallic and nonmetallic materials, and the work on
them, aside from satisfying the needs (or sometimes mere curiosity) of the
sender, occasionally provided valuable information to the Division on new oc-
currences of minerals.

Mineral Exhibits

A small, compact collection of economic minerals is maintained in the
Divisional office for the use of prospectors, miners, and industrialists. A char-
acteristic specimen or two of every metallic and nonmetallic mineral known to
occur in the state is housed in a well-lit cabinet, so as to be readily ac-

ccessible for reference. These materials are particularly useful when callers
request information on prospecting techniques and locations and when users
of industrial minerals wish to consider state sources of required materials.
Other collections include portable exhibits for use at expositions and to illus-
trate talks made before various groups and organizations; a small collection of fluorescent minerals and local gem stones; considerable bulk minerals and rocks of various kinds for filling certain requests for samples; and the filed and catalogued cuttings and core samples from nearly all oil and gas prospecting wells drilled here since 1934.

Cooperation

A valuable part of the work of the Division is in cooperation with other state agencies and with branches of the Federal government. In this way the Division has engaged for many years in a topographic mapping program with the U. S. Geological Survey. Biennial Report no. 1 provided full details of this program and the accomplishments up to September 1946. Cooperation is also maintained with the U. S. Bureau of Mines in the collection of statistics of mineral production, and, on occasion, with other government agencies in matters concerning which the Division could be of assistance. During the past biennium the Division has been glad to provide information and be of assistance to the State Department of Highways; Commissioner of Public Lands; Department of Health; Pollution Control Commission; Department of Licensees; Department of Employment Security, Research and Statistics Section; Board of Education; and Mine-to-Market Road Commission.

Topographic Mapping

Topographic mapping continued as usual during the biennium, both as cooperative work between the state and the Federal government and as work sponsored solely by the Federal government. Through the courtesy of Mr. C. A. Ecklund, Pacific Region Engineer, Topographic Division of the U. S. Geological Survey, Sacramento, California, the following information on topographic mapping has been compiled:

195 linear miles of levels were run.
39 new permanent bench marks were established.
1,175 square miles were covered by triangulation of second and third order.
134 new triangulation stations were established.
3,148 square miles of mapping was done by multiplex and field surveys.
13 new 15-minute quadrangles were published.

Quadrangles worked on and financed in cooperation between the state and the Federal government included the Deer Park and Freeman, in Spokane County; the Lake Annun, in Okanogan and Ferry Counties; the Keller and Twin Lakes, in Ferry County; and the Penawawa, in Whitman and Garfield Counties.

During the biennium, the following quadrangle maps were published which were financed by Federal funds:

The Brothers, in Jefferson and Mason Counties
Mount Steel, in Jefferson and Mason Counties
Mount Christie, in Jefferson and Grays Harbor Counties
Lucerne, in Chelan County
Holden, in Chelan County
Hunters, in Stevens and Ferry Counties
Wilmont Creek, in Ferry and Stevens Counties
Turtle Lake, in Stevens and Lincoln Counties
Lincoln, in Lincoln, Ferry, and Stevens Counties
Wilbur, in Lincoln and Ferry Counties
Grand Coulee Dam, in Lincoln, Okanogan, and Douglas Counties
Starbuck, in Whitman and Columbia Counties
Haas, in Franklin and Walla Walla Counties

SPECIAL PROJECTS AND INVESTIGATIONS

Inventory of Washington Minerals

When "Inventory of Washington minerals, Part I, Nonmetallic minerals" was published late in 1949 as Bulletin 37, the commendatory response was most gratifying and exceeded all expectations. (See Biennial Report no. 2, 1948, p. 9.) It became obvious, however, that there is an equal or greater demand for the proposed Part II of this report, which is to list, locate, and briefly describe all known and reported occurrences of metallic minerals in the state. Although the preparation of Part I was laborious and time-consuming, it was simple compared to the work involved in preparing Part II. A considerable part of the needed data on metallic minerals has been undergoing collection for the past 40 years or so. This has been supplemented by detailed research during the past year, and most of the material is now on some thousands of 4- by 6-inch cards. Yet there remain many references to be consulted before the card index is complete; and matters of evaluation, form of presentation, and drafting have yet to be arranged and completed. Every effort is being made to expedite the work, but a year or two may elapse before the report can go to the printer.
Antimony

The field work involved in the investigation of the state's antimony deposits was completed in the preceding biennium. (See Biennial Report no. 2, 1948, p. 8.) During the past two years the office and laboratory work have been finished, and the manuscript is now nearly ready to go to the printer. It is expected that this report will be available for distribution late this year.

Perlite and Other Volcanic Glasses

The field investigation of perlite and related volcanic glasses was completed during the preceding biennium. (See Biennial Report no. 2, 1948, pp. 8, 9.) Early in the present biennium the office and laboratory work were finished, and the resultant findings were published as Report of Investigations no. 17.

Saline-lake Deposits

Continued delay has been experienced in the completion of this project dealing with state resources of sodium sulphate, sodium carbonate, and magnesium sulphate. (See Biennial Reports no. 1, 1946, pp. 12, 13; and no. 2, 1948, p. 10.) Field work, laboratory work, and all but a minor amount of office work are now finished, so, depending on available funds, it should be possible to have the report through the printer's hands in the near future.

Peat

A new project started in the 1949 field season was the investigation of the principal peat occurrences of the state. The Division was fortunate in interesting Dr. George B. Rigg, Professor Emeritus, Botany Department, University of Washington, in taking charge of this work. Dr. Rigg is a well-recognized authority on peat and has spent many years in the study of the deposits of the Northwest. The field work, occupying two seasons, will probably be finished this fall (1950). In all, 210 peat bogs were examined and measured, some 12,204 feet of drilling was done, and scores of representative samples were taken for chemical and physical analyses. The State Department of Agriculture, through the courtesy of its Director, Sverre N. Omdahl, supplied the funds for the analytical work that was desirable in order that the project would be complete and well-rounded. It is believed that the resultant report will fill a decided need, giving excellent information on a little-known resource that is becoming of increasing commercial value.

Molybdenum

It has been said for many years that Washington has valuable resources in molybdenum, an alloying element used in the manufacture of steel. Two or three molybdenite deposits were well known, and geologic information on them was available. Some 20 others were reported without substantiation, and whether they had economic value or not was entirely unknown. During the 1950 field season, all these known and reported occurrences were investigated, so that as complete information as possible would be available in case changing economic conditions or a new war emergency should place molybdenum on the critical list. Field work on this problem, just completed, proved to be disappointing. Some molybdenite could be produced, and a few deposits probably have some commercial importance, but most of the occurrences, though showy in part, are too small to deserve consideration. These findings will be published in the coming year as a Report of Investigations.
Chromium

Chromite, the ore of the important plating and steel-alloying element, chromium, occurs here in a considerable number of deposits. Most of these are relatively small, pod-like masses that are of fairly high quality but incapable of producing much tonnage. Nevertheless, under ordinary conditions, and particularly when a war emergency exists, the mineral is valuable and much sought after. The Division has investigated one deposit or another at various times since attention was first directed to specific needs before World War I, but there has been no effort to study consistently all occurrences; and published information that is available to the public has been very sparse. To overcome this lack, and in anticipation of renewed interest, all known and reported deposits have now been examined, and the results of this work will be published as another paper in the series of Reports of Investigations.

Talc and Soapstone

Talc and soapstone are found in scattered occurrences in seven counties of the state. These materials have been mined in considerable amount at times, particularly from deposits in Skagit County, and their value as industrial minerals should increase with the general economic development of the Northwest. Mention is made of talc and soapstone in several reports of the Division as well as in other publications, but for some time it has appeared desirable to bring these accounts up to date and publish a more complete, inclusive bulletin that would answer the inquiries that are so commonly received by the Division. Accordingly, all deposits were investigated during the 1950 field season, and as full information as possible was obtained on the extent, grade, and marketability of these nonmetallic minerals.

Asbestos

During the present biennium, some attention has been given to reported occurrences of various asbetiform minerals. So far, the investigations have not demonstrated the existence of material of particular economic importance, but, as time permits, the examination of deposits will be continued and efforts will be made to find the vaguely rumored occurrences that are mentioned in old reports. The work is well justified, judging by the inquiries from industry. These are not too numerous, but they have had a definite persistence that indicates a sustained interest in new sources of asbestos of one variety or another for industrial use.

Oil and Gas Legislation

No regulations exist in Washington concerning the prospecting for oil and gas except where the work is done on State-owned lands. As by far the larger part of such prospecting is on land other than that owned by the State, it permits an unfortunate situation to exist whereby the State has no control or jurisdiction whatever over methods employed in drilling and abandoning of holes, in the saving of invaluable geologic data, or, in the event of commercial production, in the development, without waste, of oil and gas.

All producing states have such regulations, as do a large number of states where, as in Washington, commercial production is to be expected. The legitimate prospecting concerns do not object to conservation measures; in fact, they prefer to work under known and definite regulatory procedures. They
well realize that a conservation measure will be forthcoming if commercial oil
or gas is discovered, and they prefer to know what such regulation involves
prior to committing themselves to what may be a large investment of funds.
If the state had had a regulatory law years ago, valuable records of former
drilling would now be available instead of being lost to all future operators,
and we would not have the incidents of salt-water contamination of farm
lands and of fresh-water aquifers that have occurred in Whatcom County.

With the objective of improving the existing situation, a special committee
was appointed in 1949 by Mr. Jack V. Rogers, Director, Department of Con-
servation and Development, and Mr. Jack Taylor, Commissioner of Public
Lands, to develop an oil and gas conservation bill that could be submitted to
the 1951 Legislature for its approval. On the committee were representatives
of the Department of Conservation and Development, Department of Public
Lands, Association of County Commissioners, Northwest Mining Association,
West Coast Mineral Association, Standard Oil Company of California, Union
Oil Company of California, Shell Oil Company, Harmony-Pacific Oil Company,
and private land and lease holders.

The Committee held several meetings, studied laws of other states, re-
ceived comments and suggestions from interested parties, and finally arrived
at and gave unanimous approval to a bill that should be entirely adequate for
the state. The proposed measure places a minimum of hampering restrictions
on drilling concerns, yet provides for all foreseeable contingencies in matters
of prospecting, development, and production. In fact, it is based on and closely
follows the model law entitled “A form for an oil and gas conservation statute”
proposed after years of study by the Interstate Oil Compact Commission.

It is sincerely hoped by all concerned with the orderly and proper develop-
ment of what is confidently expected will some day be major resources of this
state—oil and gas—that this bill will receive the favorable attention of the
Legislature and will be enacted into law.

The Place of Steam-electric Generating Stations in the
Orderly Program of Electric Power Development
in the Pacific Northwest

For a number of years the Division has been concerned over the almost
constant decrease in production from the state’s coal mines. Available records,
starting in 1860, show that the coal production in that year amounted to 5,374
tons, and that the annual production increased almost steadily, year by year,
until 1918, when a peak of 4,128,424 tons was reached. From 1918 forward the
production has shown a general, though sometimes interrupted, decline until
1949, when 907,915 tons were mined, the least in any year since 1887. This
decline is due to various factors—for instance, the greatly increased use of
fuel oil, both for industrial fuel and power and for domestic heating; the in-
creased use of electricity and gas for domestic heating and cooking; and, in
considerable measure, changes in economic conditions. Despite the current
trend, it is probable that, of all the state’s mineral resources, metallic or non-
metallic, coal has a greater potential value than any single material.

Various steps and possibilities have been considered whereby the coal
industry might benefit. One result was the survey made in 1946 and 1947 of
Washington’s fuel requirements and supplies by the Battelle Memorial In-
stitute of Columbus, Ohio, work done at the request of, and paid for by, the
Department of Conservation and Development. (See Biennial Report no. 2,
pp. 7 and 8.) Another possibility became apparent when, during the past two
or three years, a shortage of electric power was experienced throughout the
Northwest. Recognizing this, Governor Arthur B. Langlie called a conference in 1949 to explore the feasibility of using our local coal in steam-electric generating plants to supplement hydroelectric power.

A preliminary consideration of the various factors involved in this use of coal indicated that a thorough study should be made of all phases of the problem—the present hydroelectric system, the ultimate development of hydroelectric energy under present plans, latest developments in fuel-burning electric-generating plants, competitive fuels, costs, and all related matters. Only then could proper conclusions be reached. Mr. Jack V. Rogers, Director, Department of Conservation and Development, and Mr. Owen Clarke, Chairman, Public Service Commission, were given the direction of the study.

Through the courtesy of Mr. Clarke, it was arranged that the analysis should be made by Mr. Holland H. Houston, an electrical engineer who for several years has been with the Public Service Commission and who has had long experience in both public and private power organizations and is well qualified by training and experience to make the study. Mr. Houston completed the work on the project in 1950 and made his report to Messrs. Rogers and Clarke, and they, in turn, transmitted the results to Governor Langlie.

It was obvious that Mr. Houston's report could not possibly serve its best purpose unless it were published and made available to all who are interested in power development and in the place properly occupied by fuels in the generation of electric power. Accordingly, it was decided that the Division of Mines and Geology should publish the report as one of its regular series of bulletins and handle the distribution.

**Publications**

The following reports were published and made available for distribution during the biennium, or are now in preparation and nearly ready for publication. Copies of the published reports were sent to all the principal libraries in Washington, to the larger libraries throughout the United States, and, on an exchange basis, to Federal agencies and to the geological surveys of other states. These reports may be consulted at any of these libraries and offices, or may be purchased from the Department of Conservation and Development, Olympia, for a small charge that covers the cost of printing. Some of the less expensive reports (mostly mimeographed) are distributed without charge.

- **Saline-lake deposits of Washington**, by W. A. G. Bennett. (In preparation.)
- **Antimony occurrences of Washington**, by C. Phillips Purdy, Jr. (In preparation.)
- **The place of steam-electric generating stations in the orderly program of electric power development in the Pacific Northwest**, by Holland H. Houston. (In preparation.)