

The Biennial Report

OF THE

BOARD OF GEOLOGICAL SURVEY

OF THE

STATE OF WASHINGTON

FOR THE TERM

1911-13



OLYMPIA, WASH.:

F. M. LAMBORN  PUBLIC PRINTER

1913

LETTER OF TRANSMITTAL.

To the Legislature of the State of Washington:

The board of geological survey transmits herewith its biennial report for the term 1911-13, as required by statute.

Respectfully submitted,

M. E. HAY, *President;*

J. G. LEWIS, *Secretary;*

T. F. KANE,

E. A. BRYAN.

Olympia, December 15, 1912.

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BIENNIAL REPORT OF THE BOARD OF GEOLOGICAL SURVEY

GENERAL PURPOSES OF SURVEYS.

TOPOGRAPHICAL SURVEYS.

The Topographical Map.—A topographical map is designed to represent the form and slope of the surface of the land and the elevation of all points above sea level. The positions of streams, lakes and ponds, public and private roads, towns and railroads, are shown in their correct relative positions. The map indicates boundaries of counties and the position of section lines wherever there have been land surveys. In the making of the necessary surveys for such maps permanent marks, consisting of iron posts, copper bolts or tablets, are set at frequent intervals to mark the exact elevation above sea level to serve as datum points for further spirit level work, for engineering investigation, and for such public works as canals, water supply, railway and other public or private surveys.

The topographical map is made with such accuracy and in such detail that it is useful to almost every citizen. In a new state that is inviting immigration, the map is valuable in order to show the location of desirable farm lands and the general character of the country. From it the positions of streams and lakes may be seen and the possibilities of these for purposes of water power or irrigation may be largely determined. The topographical map facilitates the construction of railroads and wagon roads, since upon it available routes and grades may be laid out without the preliminary surveys ordinarily necessary for improvements of this kind. In our public schools such a map is indispensable in that it places before the children truthful maps of our commonwealth, instead of those that are glaringly inaccurate.

In the making of topographical maps the areas selected for survey are defined by lines of latitude and longitude and are called quadrangles. Each quadrangle, and the topographic map which represents its features, is designated by the name of the most prominent place or topographic feature included within it. The scale generally used in map construction is about two miles to the inch, and on this scale the area embraced in a quadrangle is about eight hundred square miles. In Washington the topographic map when completed will comprise, in round numbers, ninety sheets, complete and fractional, of which about thirty-two have already been surveyed.

HYDROGRAPHICAL SURVEYS.

A hydrographical survey is an examination of the water resources of the state or parts thereof, in order to determine the possible supplies of water suitable for domestic purposes, power plants, or for use in irrigation. The water supply of the state is of more importance to the life and pursuits of the people than any other natural resource, as the health and economic development of every community are directly dependent upon the character and volume of the available supply.

Hydrographical surveys have to do with both the surface and underground waters of the state. The rivers are used for domestic and industrial supplies, power purposes, navigation and irrigation. In order that there may be no useless expenditures in the development of these resources, studies are made to determine the amount of water that is available throughout the various seasons of the year and throughout a series of years. Along the principal streams of the state gaging stations are maintained in order to secure records of flow which indicate the fluctuations that might be expected in the quantity of the water. Profiles or level lines along the rivers are run in order to determine the possibilities of storage, and to secure data for the determination of available water power.

Investigation of underground water supplies is equally as important as in the case of surface waters. This work includes a determination of the areas that are underlaid by water-bear-

ing strata, of the depths at which these strata occur, and of the amount and quality of water that may be obtained. A knowledge of the existence of water-bearing strata is very necessary, not alone for the purpose of irrigation, but in some parts of Washington settlement is well-nigh impossible because not even enough water for domestic purposes has as yet been obtained

GEOLOGICAL SURVEYS.

Geological surveys have been organized in nearly all the states of the Union, and in some of the older states they have been continuously active for over fifty years. In most states they are regular departments of the state government, and receive definite financial support in the way given to every other bureau or department. They are usually in charge of a board of three or five men, who direct the work of the survey, and who are responsible for its management.

The general purpose of a geological survey is to disclose and make known the mineral resources of a state. Under such heading would naturally come the metalliferous deposits, coal fields, iron ores, building stones, soils, clay beds, road materials, water power, and kindred subjects. The field work of a survey consists in mapping accurately the locations of all such valuable products as those just mentioned, and determining the areal extent and quantity of each. The office work consists of careful tests and analyses of all samples collected in the field, and the preparation of reports which describe fully the mineral resources under investigation. The reports and maps when published are valuable alike to the citizens of the state and to outside capitalists and investors. Surveys examine and test those minerals, ores and rocks that are but little known and determine whether or not they are of economic value. They also suggest ways of preventing wastes in mining operations, and assist in all ways to conserve the natural resources. Surveys are potent factors in making available valuable information regarding the mineral resources of the state, which knowledge may be utilized by the poorest citizen as well as the wealthiest corporation.

PRINCIPAL FEATURES OF STATE LAWS PROVIDING FOR SURVEYS.

The law establishing a state geological survey was passed by the legislature at the session of 1901. As set forth in the various sections of the law, the principal objects of the measure are as follows: An examination of the economic products of the state, such as gold, silver, copper, lead, and iron ores, as well as building stones, clays, coal, and all mineral substances of value; an examination of the soils, road-building material, water supplies, artesian wells, water power, etc.; an examination of the physical features of the state with reference to their practical bearing upon the occupations of the people; the preparation of special geographic and economic maps to illustrate the resources of the state; and the publication from time to time of the results of the work of the survey in reports and bulletins, and the dissemination of these among the people.

At the session of 1903 the legislature amended the above law, by providing for co-operative work between the federal and the state bureaus engaged in geological survey work. The amendment authorized the state board of geological survey to make provisions for topographic, geologic, and hydrographic surveys of the state, in co-operation with the United States geological survey, in such manner as would be of the greatest benefit to the agricultural, industrial and geological requirements of the state. The amendment carried a proviso that the director of the United States Geological Survey should agree to expend on the part of the United States upon such surveys a sum equal to that expended by the state.

At the session of the legislature for 1909 the work of the state geological survey was provided for by a law having these provisions:

SECTION 1. In order to complete the topographical map of the State of Washington, and for the purpose of making more extensive stream measurements, and otherwise investigating and determining the water supply of the state, there is hereby appropriated the sum of thirty thousand dollars (\$30,000), for cooperation with those branches of the United States Geological Survey engaged in this work. This appropriation, however, shall be contingent upon, and not become available

unless the United States government apportion an equal amount to be expended for similar purposes within the state. The board of geological survey is hereby authorized and directed to enter into such agreements with the director of the United States Geological Survey as will insure that the said surveys and investigations be carried on in the most economical manner, and that the maps and data be available for the use of the public as quickly as possible.

SEC. 2. In order to enable the board of geological survey to carry on investigations authorized by law, there is hereby appropriated the sum of twenty thousand dollars (\$20,000) for the use of said board in the geological and other investigations provided for in chapter 165 of the Session Laws of the State of Washington for 1901, and as amended in chapter 157 of the Session Laws of 1903.

SEC. 3. In order to carry out the purposes of this act, all persons employed hereunder are authorized to enter and cross all lands within the state: *Provided*, That in so doing no damage is done to private property.

SEC. 4. The sum of fifty thousand dollars (\$50,000) herein appropriated for the purposes specified in this act shall be available in the following manner: One-half during the first twelve months after this act takes effect, and the unexpended balance during the second twelve months after this act takes effect.

At the session of the legislature for 1911 the work of the geological survey was provided for in the general appropriation bill, wherein \$37,500 were appropriated for topographic and hydrographic surveys (conditioned upon a similar sum being expended by the United States Geological Survey), and \$20,000 were appropriated for geological surveys.

REPORT FOR 1911-13.

ORGANIZATION.

At the call of the governor, the State Board of Geological Survey met at Olympia on March 29, 1911, with all the members present as follows: Governor Hay, State Treasurer Lewis, President Kane of the State University and President Bryan of the State College. Governor Hay was authorized to sign the necessary agreements with the director of the United States Geological Survey, arranging for cooperative work in topography and hydrography, as provided by law. The work for the biennium was outlined, and the State Geologist directed to carry on the different investigations and surveys that are described below.

TOPOGRAPHICAL SURVEYS.

The accompanying progress map indicates the locations of the quadrangles surveyed, during this biennium, as well as during the United States Geological Survey, during this biennium, as well as during 1909-11. In selecting quadrangles for survey it has been the policy of the board to choose those areas where the demand for the maps is very great and where they are most likely to be used to advantage.

In central Washington, immediately east of the Columbia River, and lying between the Great Northern and Chicago, Milwaukee & Puget Sound Railways, an area of 1,025 square miles has been surveyed within the past four years and the maps engraved. In this area there are five quadrangles, viz.: Quincy, Winchester, Moses Lake, Beverly and Red Rock. Each quadrangle was mapped on a scale of one mile to an inch, with contour intervals or level lines every twenty-five feet. During the present biennium surveys have been continued on neighboring quadrangles to the northwest of the Quincy quadrangle, and the Palisades quadrangle has been one-third completed, the Malaga quadrangle entirely finished, and the Wenatchee quadrangle about two-thirds surveyed. These quadrangles are

located in arid Washington, where irrigation must be followed to insure the greatest agricultural development. Topographic surveys were made as the first necessary step to secure the reclamation of this dry belt by irrigation.

The survey of the Cedar Lake quadrangle (immediately east of the Tacoma quadrangle) was begun in 1910 but was not completed until the summer of 1911. It is now being engraved on a scale of two miles to an inch, with contour intervals or level lines every one hundred feet. The board chose this quadrangle for survey in order to assist in the development of the great water resources of the area which will be invaluable for municipal and power purposes to the growing cities of Puget Sound.

Topographic surveys were carried on during the summers of 1911 and 1912 in the region about Grays Harbor. This will be styled the Grays Harbor special map and it will be engraved after a little more field work has been done. During the summer of 1912 topographic mapping was under way in the Chehalis quadrangle, which may be completed in one more year. This quadrangle is being mapped preparatory to a survey of the extensive coal fields which occur within the area.

Copies of all engraved topographic maps may be purchased of the United States Geological Survey, Washington, D. C., at ten cents each.

HYDROGRAPHICAL SURVEYS.

The water resources of the state have been investigated jointly by the federal and state surveys, each party assuming one-half of the expense. The chief object has been to obtain accurate information regarding the amount of water that could be depended upon for irrigation and for power purposes. All of the water that can be secured by storage that is tributary to arid Washington will soon be needed for irrigation. The rapid industrial development of Western Washington demands the continued utilization of the available water power. The detailed investigations have been along two lines, viz., establishment of gaging stations, and running of surveys for the determination of river profiles.

Gaging Stations.—As shown on the progress map, gaging stations are in operation upon a large number of streams of the state. At each station the daily discharge of the stream is obtained and the amount of water available for any purpose made known. The gage readings are particularly valuable at the times of minimum flow, which occur on some Washington streams in mid-winter and upon others in mid-summer.

River Profiles.—During the past four years an investigation has been carried on of the water power of the Cascades, beginning at the southern end of the range in Washington, along the Columbia river. Along the principal streams level lines have been run and profiles made from the mouths to a point near the headwaters where the volume of water has become too small to be considered for power purposes. Topographical maps have been made, using 5-foot contour lines, of the country immediately adjoining each bank of the stream. In this way not only has the exact drop of the stream per mile and fraction thereof been determined but also the storage opportunities have been fully shown. The discharge data of the streams, obtained at the gaging stations during previous years, when used with the measured fall of the streams, give the total horsepower which is afforded.

The first report was called "Water Powers of the Cascade Range, Part I, Southern Washington," and was issued in 1910. It described the water powers along the Klickitat, White Salmon, Little White Salmon, Lewis and Toutle rivers, with some of their principal tributaries.

The second report is known as "Water Powers of the Cascade Range, Part II," and describes the following streams and their tributaries: Cowlitz, Cispus, Nisqually, Puyallup, White, Green and Cedar rivers. This report has been printed and is now about ready for distribution.

The third report is styled "Water Powers of the Cascade Range, Part III, and involves Yakima River with its several important tributaries. The data for this report has been accumulating for a number of years, in great detail, and all

calculations have been very accurately made. Part III is now in the printer's hands and it will be ready for distribution early in 1913.

All the field work for Part IV has been done, which includes the drainage basins of the Wenatchee, Chelan and Methow rivers. The office work on this report is now being done and the printed report will not appear until the close of 1913.

GEOLOGICAL SURVEYS.

Mineral Resources.—The State Geological Survey, since 1911, has co-operated with the United States Geological Survey in the collection of statistics regarding the mineral production of Washington. It is a matter of great importance to the state that such statistics be secured covering accurately the entire mineral output, because of the bearing this must have upon the establishment of industrial enterprises. The accompanying table gives a summary of the principal mineral products of Washington for the ten-year period from 1902 to 1911, inclusive. While the production is already large, and constantly growing, it is capable of a very much greater extension when the economic minerals are investigated and made better known.

MINERAL PRODUCTION OF WASHINGTON FROM 1902 TO 1911, INCLUSIVE (a)

NON-METALLIC PRODUCTS.	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911
Coal	\$4,572,295	\$5,339,679	\$5,120,361	\$5,141,258	\$5,906,434	\$7,679,801	\$6,690,412	\$9,158,969	\$9,764,465	\$8,174,170
Clay products	905,231	928,265	1,200,919	1,175,062	1,469,884	1,621,664	2,104,289	3,060,486	3,023,854	2,861,768
Portland cement						(b) 214,500	(b) 396,000	767,195	1,031,704	1,496,807
Granite	147,273	209,095	442,508	681,730	459,975	562,352	870,944	742,878	642,992	1,345,551
Sandstone	39,725	47,430	88,185	124,910	169,500	295,585	464,587	385,470	488,581	301,843
Limestone	27,744	75,049	71,857	52,470	49,192	62,317	31,660	88,269	36,186	32,478
Marble	61,176	40,117	23,068	60,000	59,985					
Lime	186,070	222,052	216,454	169,985	347,924	238,568	228,353	282,628	267,785	228,933
Mineral waters	9,300	10,550	10,568	10,101	10,800	10,820	13,650	15,968	12,971	14,654
Sand and gravel					144,725	179,800	261,581	423,425	481,569	319,760
Totals	\$5,989,314	\$6,913,897	\$7,174,460	\$7,406,486	\$8,650,419	\$11,165,677	\$11,061,436	\$14,825,308	\$15,689,657	\$14,775,954
METALLIC PRODUCTS.										
Gold	\$272,200	\$507,885	\$304,640	\$405,078	\$321,648	\$262,300	\$283,700	\$362,051	\$788,145	.....
Silver	328,070	201,789	89,831	75,727	39,738	55,400	46,400	41,334	110,896	.....
Copper .....	.....	66,242	43,788	16,968	45,360	24,453	21,411	33,167	11,088	.....
Lead .....	.....	16,750	69,337	28,437	52,787	29,786	32,844	12,414	68,180	.....
Totals	\$600,270	\$792,666	\$508,196	\$526,200	\$350,533	\$371,989	\$354,355	\$448,966	\$908,249	.....
Grand totals	\$6,540,984	\$7,706,563	\$7,682,656	\$7,932,686	\$9,000,952	\$11,537,616	\$11,415,781	\$15,274,274	\$16,697,906	.....

(a) Compiled from Mineral Resources U. S. Geological Survey.

(b) Approximate production.

Surveys of Coal Fields.—In the past four years coal surveys have been made in King, Pierce and Kittitas counties. The work has been carried on with great thoroughness and the plan has been to make the surveys in such detail that they would not need to be repeated for many years. In King and Pierce counties the field work was greatly retarded because of the deep soil covering as well as heavy forest growth under which the coal seams are concealed. By going over the ground with great care and using all possible sources of information, the detailed structure of the coal formation has been accurately made out.

It has been the plan to publish ample descriptive matter describing the results of the field examinations. Maps are made which show accurately (1) the boundaries of the developed fields, (2) the limits of the probable workable fields, (3) the locations of the fields where coal outcrops occur but where the coal is not believed to be commercially valuable, and (4) those localities underlaid by formations other than coal measures and where coal is an impossibility.

The report on King county has been published as Bulletin No. 3 of the State Geological Survey reports. The field work has been practically completed in Pierce and Kittitas counties and a portion of the office work done in the preparation of the reports for the printer. In both of these counties advance copies of the geological maps have been made, showing the areal distribution of the coal beds.

In cooperation with the United States Geological Survey the state survey collected about two hundred and twenty-five samples of coal, from all the commercial seams of the state, and these were analyzed and their heating values determined. The results have been published in Bulletin 474 of the United States Geological Survey, and in Bulletin No. 3 of the state survey reports.

Investigation of Materials for Portland Cement.—Because of the rapidly growing demand for Portland cement in Washington, it was deemed wise to have a report prepared, giving the quantity and quality of the materials known to be available for its manufacture. Proper materials for the manufacture

of a high grade of Portland cement are comparatively rare in this state and it is desirable that a thorough search be made for them. All parts of the state have been examined where the necessary limestone and clay deposits were regarded as likely to be found. It was thought wise to examine and report upon all the limestone deposits, regardless of the small size of some of them, because of the necessity for the use of such material in the manufacture of quick lime, in fertilizers, as a flux, for use in paper making, etc., apart from its utilization in the making of cement. This report, which will contain over 250 pages of descriptive matter, besides the numerous maps and illustrations, is now in manuscript form and ready for the printer.

Reports on Metal Mining Districts.—In the past four years reports have been made upon the metal mining districts in and about Republic, Myers Creek, Oroville, Blewitt and Index. It has heretofore been the policy to select comparatively small areas and work out with much detail the extent, quality and other characteristics of the ore bodies. Four reports upon the metal mining districts have been published, containing geologic and topographic maps, as well as ample descriptions of the ore deposits, the amount of development work, and the methods of mining and ore reduction.

Soil Surveys.—Extensive soil surveys have been made under a cooperative arrangement with the Bureau of Soils, United States Department of Agriculture. Under this plan the latter bureau agreed to assume the major portion of the expense of the field work, and all the expense of printing the reports. In these surveys the various kinds of soil are studied with care, and they are classified into types based upon origin, texture, depth, agricultural value and topography. Maps are prepared in colors, showing the character of the soils which occur in every locality embraced by the surveys. All the factors that have a bearing upon the utility of the soils, such as topography, drainage, climate, etc., are investigated and the conclusions set forth in detail in the reports.

The soil surveys have been carried on mostly in Western Washington and have had to do with the logged-off lands. As a result of the surveys a land classification map is prepared in colors, showing the extent of the logged-off lands, the areas still covered by virgin forests, the tracts which have been developed agriculturally, and the swamp or marsh lands. The lands surveyed are further classified into different groups, and these are shown on the land classification map by means of symbols. Some of the principal groups are as follows: Lands adapted to general farming and justifying immediate agricultural development; lands which are capable of being developed agriculturally and are adapted to intensive farming, fruit growing and pasturage; lands which can be utilized for orchards and pasturage, but not well adapted to farming; non-agricultural lands, suitable for reforestation only; and areas of forests, unclassified.

Two soil reports have been printed, viz.: "Reconnaissance Soil Survey of the Eastern Part of the Puget Sound Basin," and "Reconnaissance Soil Survey of the Western and Southern Parts of the Puget Sound Basin." A third report entitled "Reconnaissance Soil Survey of Southwestern Washington," has been printed and is now about ready for distribution.

A fourth soil survey report is now about ready for distribution and is entitled "Reconnaissance Soil Survey of the Quincy Area." It embodies about 1,100 square miles in Grant and Adams counties, immediately east of the Columbia River, in the most arid part of the state. The soil survey was made as one of the necessary steps looking toward the reclamation of this desert area by irrigation.

Geology of Western Counties.—So much inquiry has been made concerning the bedrock geology of that part of the state between the western foothills of the Cascades and the Pacific Ocean that a reconnaissance survey has been made of this region. The chief question has been in regard to the probable occurrences of gas and oil, mainly in the counties immediately adjacent to the ocean. The prevailing formations have been found to be

sedimentary strata, mainly sandstones and shales, with occasional indications of oil and less frequently of gas. Enough field work has been done to secure the data for a geological map, giving the boundaries of the different formations, and sufficient cross-sections to show the folded condition of the strata. A large amount of information has been obtained regarding the most likely ground for oil and gas prospecting, which will undoubtedly mean a great saving of money in future drilling operations. This report is now about ready for the printer.

Report on the Glaciation of the Puget Sound Region.—This report, which was secured at a merely nominal cost to the Geological Survey, is a very accurate account of the geological history of the country around Puget Sound, especially with regard to the story of glaciation. The glacial formations, in their influence on the kind and character of the soil, the clay, sand, gravel and other things of economic value, are fully described. The report, containing several maps and other illustrations, is now ready to be printed.

FINANCIAL STATEMENT.

Topographical and Hydrographical Surveys.

U. S. Geological Survey:	
Allotment for cooperation 1911-1913.....	\$37,500 00
Expenditures to December 1, 1912.....	29,756 28
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Balance on December 1, 1912.....	\$7,743 72
State Geological Survey:	
Appropriation for 1911-1913.....	\$37,500 00
Expenditures to December 1, 1912.....	31,548 17
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Balance on December 1, 1912.....	\$5,951 83

Geological Surveys.

State Geological Survey:	
Appropriation for 1911-1913.....	\$20,000 00
Expenditures to December 1, 1912:	
Printing of Reports	\$4,272 92
Coal Surveys:	
Pierce County	5,228 13
Kittitas County	1,239 40
King County	696 56
Investigation of cement materials.....	2,126 89
Soil Surveys	1,523 40
Investigations for oil	1,607 93
Surveys of metal mining districts.....	181 10
Report on geology of Puget Sound region.	225 00
Clerical work	686 77
Instruments and filing cabinets.....	564 71
Office supplies, express charges and in-	
cidental	564 16
Traveling and field expenses of State	
Geologist	806 38
Per diem paid State Geologist	230 00
Expenses of Board of Geol. Survey.....	11 98
	<hr/>
Total.....	\$19,965 33
	<hr/>
Balance on December 1, 1912.....	\$34 67
U. S. Department of Agriculture, Bureau of Soils:	
Expenditures for field-work in cooperation, Soil Surveys	\$4,550 25

RECOMMENDATIONS.

APPROPRIATIONS REQUESTED.

For topographical and hydrographical surveys (conditioned upon a similar sum being expended in the state by the United States Geological Survey).....	\$35,000
For Geological Surveys	20,000

TOPOGRAPHICAL SURVEYS.

The following areas or quadrangles, which are now partly surveyed, may be completed in one more field season, viz.: Grays Harbor, Chehalis, Wenatchee and Palisades. In addition there is an urgent and imperative demand for topographic maps in the arid districts of the state where the land may be reclaimed only by irrigation. Topographical surveys should be continued at once in Franklin, Adams, Grant, Benton, Yakima and Kittitas counties.

In the past four years level lines or profiles have been run along all the streams of the eastern Cascades, and along all the streams of the western Cascades south of Snoqualmie Pass. This has been done as a necessary part of the problem of determining with accuracy the total hydro-electric power of the rivers of the Cascade Mountains. It is very desirable that this work should be continued, and it can be carried to completion in two more field seasons.

HYDROGRAPHICAL SURVEYS.

As indicated on the Progress Map accompanying this report, gaging stations are maintained on a large number of the rivers where information is very necessary as to the total amount of water available for municipal supplies, irrigation and power. The gaging records are of the greatest value only when they are kept continuously for a series of years. It is recommended that the usual appropriation for this work be made so that co-operation with the Federal government may be continued.

GEOLOGICAL SURVEYS.

The sum of twenty thousand dollars, the same amount as appropriated by the legislatures of 1909 and 1911, is requested

for geological surveys, in order that certain lines of work now under way may be completed and some new work may be begun.

Printing. Six bulletins or reports are now ready for printing. The field-work necessary for some of these reports has extended over three or four years and many thousands of dollars have been expended in securing the valuable and important information now ready for publication. These bulletins should be printed and distributed as soon as possible after the necessary appropriation has been made. The bulletins of the geological survey are sold to the public and the receipts therefrom are paid into the general fund.

Surveys of Coal Fields. In addition to those already made, coal surveys are urgently requested in Whatcom and Lewis counties. In the former an area of semi-anthracite coal has recently been discovered, the boundaries of which are unknown, and the economic value of the field should be investigated and publication be made concerning it. In Lewis County also the boundaries of the coal fields have never been accurately ascertained and the quantity and quality of the coal satisfactorily determined.

Soil Surveys. Soil surveys have been requested by different organizations in Stevens, Franklin, Grant, Chelan and other counties. In this work cooperation is afforded with the United States Bureau of Soils, the Federal bureau usually assuming about three-fourths of the expense of the field work, besides all the cost of printing.

Surveys of Metal Mining Districts. In addition to the detailed surveys already made of the best known districts, there are many requests for reconnaissance surveys of the scattered mining sections, whereby the varieties of bed-rock, the important minerals, and the character of the ore deposits may be determined and described. It is also hoped that in this connection samples from low grade ore bodies may be secured and tests made to ascertain the best treatment to employ in separating out the metals.

General Reconnaissance Surveys. Large areas of Washington are unknown from a geological standpoint, and as rapidly as possible surveys should be made to determine in a general way the character of the rock formations of such districts and their mineral resources. There has long been a demand for a geological map which would represent by a scheme of colors the general rock formations of the state. Such maps have been made in nearly all the states, and the facts are being rapidly secured for the construction of such a map for the State of Washington.

PUBLICATIONS
OF THE
WASHINGTON GEOLOGICAL SURVEY.

Volume 1.—Annual Report for 1901. Part 1, Creation of the State Geological Survey, and An Outline of the Geology of Washington, by Henry Landes; part 2, The Metalliferous Resources of Washington, Except Iron, by Henry Landes, William S. Thyng, D. A. Lyon and Milnor Roberts; part 3, The Non-Metalliferous Resources of Washington, Except Coal, by Henry Landes; part 4, The Iron Ores of Washington, by S. Shedd, and the Coal Deposits of Washington, by Henry Landes; part 5, The Water Resources of Washington, by H. G. Byers, C. A. Ruddy and R. E. Heine; part 6, Bibliography of the Literature Referring to the Geology of Washington, by Ralph Arnold. Out of print.

Volume 2.—Annual Report for 1902. Part 1, The Building and Ornamental Stones of Washington, by S. Shedd; part 2, The Coal Deposits of Washington, by Henry Landes and C. A. Ruddy. Postage 20 cents. Address, State Librarian, Olympia, Washington.

Bulletin 1.—Geology and Ore Deposits of Republic Mining District, by Joseph B. Umpleby. Bound in cloth; price, 35 cents. Address, State Librarian, Olympia, Washington.

Bulletin 2.—The Road Materials of Washington, by Henry Landes. Bound in cloth; price, 60 cents. Address, State Librarian, Olympia, Washington.

Bulletin 3.—The Coal Fields of King County, by Geo. W. Evans. Bound in cloth; price, 75 cents. Address, State Librarian, Olympia, Washington.

Bulletin 4.—The Cement Materials of Washington, by S. Shedd and A. A. Hammer. In preparation.

Bulletin 5.—Geology and Ore Deposits of the Myers Creek and Oroville-Nighthawk Districts, by Joseph B. Umpleby. Bound in cloth; price, 50 cents. Address, State Librarian, Olympia, Washington.

Bulletin 6.—Geology and Ore Deposits of the Blewett Mining District, by Charles E. Weaver. Bound in cloth; price, 50 cents. Address, State Librarian, Olympia, Washington.

Bulletin 7.—Geology and Ore Deposits of the Index Mining District, by Charles E. Weaver. Bound in cloth; price, 50 cents. Address, State Librarian, Olympia, Washington.

Bulletin 8.—Glaciation of the Puget Sound Region, by J. Harlen Bretz. In preparation.

Bulletin 9.—The Coal Fields of Kittitas County, by E. J. Saunders. In preparation.

Bulletin 10.—The Coal Fields of Pierce County. In preparation.

Bulletin 11.—The Mineral Resources of Washington, with statistics for 1912, by Henry Landes. In preparation.

Bulletin 12.—Bibliography of Washington Geology and Geography, by Gretchen O'Donnell. In preparation.

Bulletin 13.—A Preliminary Report on the Tertiary Formations of Western Washington, by Charles E. Weaver. In preparation.

Bulletin 14.—The Quincy Valley Irrigation Project, by Henry Landes, A. W. Mangum, H. K. Benson, E. J. Saunders, and Joseph Jacobs. Bound in paper, price 20 cents. Address, State Librarian, Olympia, Washington.

Bulletin 15.—A Preliminary Report on the Tertiary Paleontology of Western Washington, by Chas. E. Weaver. Bound in paper, price 20 cents. Address, State Librarian, Olympia, Washington.

PUBLICATIONS OF THE U. S. GEOLOGICAL SURVEY, IN CO-OPERATION WITH THE WASHINGTON GEOLOGICAL SURVEY.

(For copies of these publications address the Director, U. S. Geological Survey, Washington, D. C.)

Topographic Maps of the Following Quadrangles: Mount Vernon, Quincy, Winchester, Moses Lake, Beverly and Red Rock. Price, 10 cents each.

Water Supply Paper No. 253: Water Powers of the Cascade Range, Part I, Southern Washington.

Water Supply Paper No.—: Water Powers of the Cascade Range, Part II. In preparation.

Water Supply Paper No.—: Water Powers of the Cascade Range, Part III. In preparation.

Water Supply Paper No. 272: Results of Stream Gaging in Washington for 1909.

PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS, IN CO-OPERATION WITH THE WASHINGTON GEOLOGICAL SURVEY.

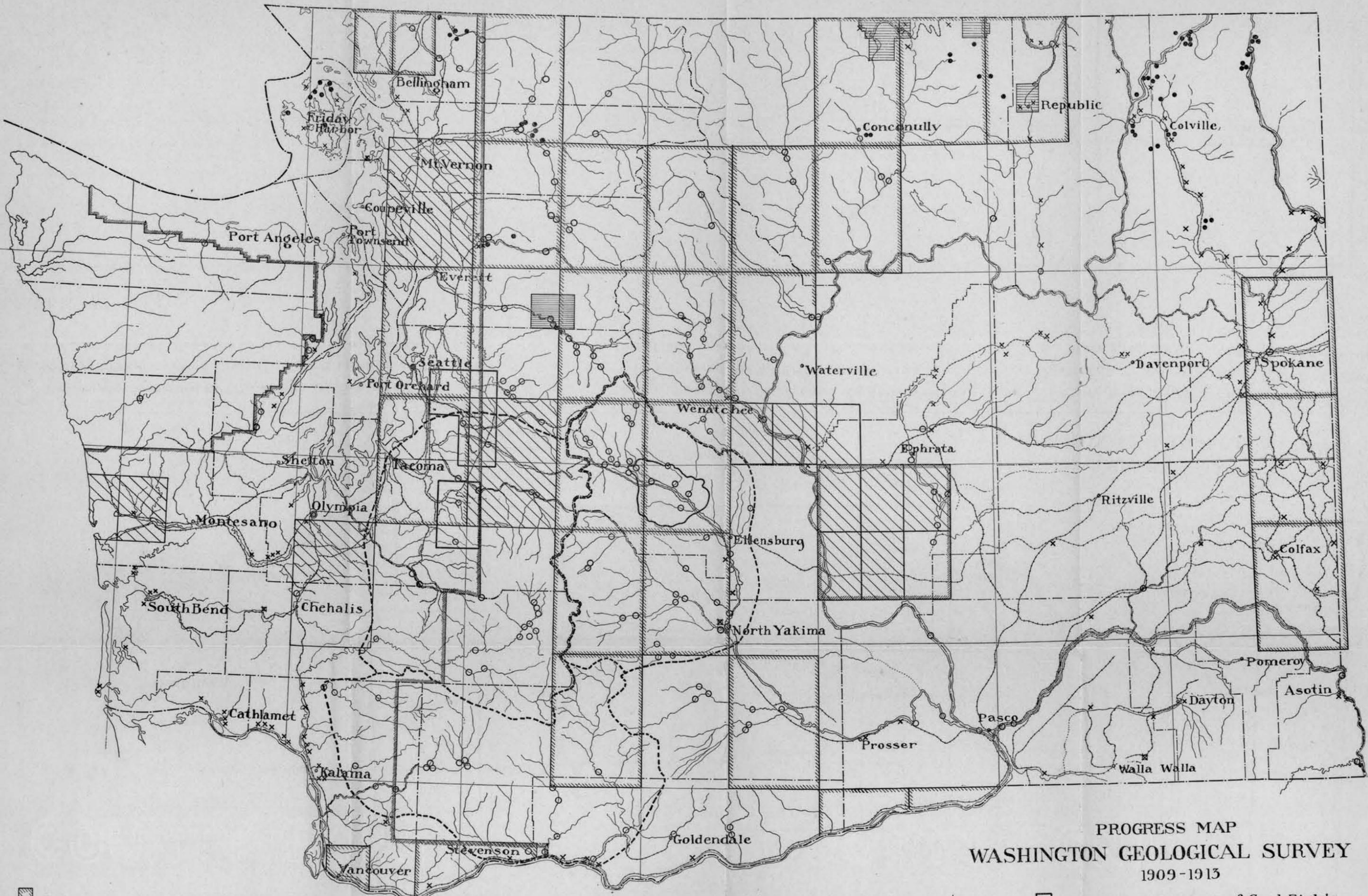
(For copies of these publications address one of the members of congress from Washington.)

Reconnaissance Soil Survey of the Eastern Part of the Puget Sound Basin.

Reconnaissance Soil Survey of the Western and Southern Parts of the Puget Sound Basin.

Reconnaissance Soil Survey of Southwestern Washington.

Reconnaissance Soil Survey of the Quincy Area.



PROGRESS MAP
 WASHINGTON GEOLOGICAL SURVEY
 1909-1913

- Quadrangles surveyed by U.S. Geological Survey previous to 1909.
- Quadrangles surveyed under co-operation during 1909-13.
- Locations of rock deposits tested for use in road building.
- Gauging stations for stream measurements.
- Areas covered by Water Power Reports.
- Locations of materials tested for making cement.
- Completed Surveys of Coal Fields.
- Metal Mining Districts.
- Soil Surveys.
- State quarries located for road building.

TOPOGRAPHY

STATE OF WASHINGTON
M.E. HAY, GOVERNOR
HENRY LANDES, STATE GEOLOGIST
(Quincy)

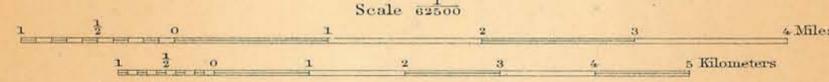
WASHINGTON
BEVERLY QUADRANGLE

U.S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR



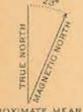
120°00' R.23 E. 55' 50' R.24 E. 119°45' (Winchester)
T.17 N. 47°00'
T.16 N. 55'
T.15 N. 46°45'
ENGRAVED APRIL 1912 BY U.S.G.S.
R.23 E. 55' 50' R.24 E. 119°45'

Eberly
B



Contour interval 25 feet.
Datum is mean sea level.

Edition of June 1912.



BEVERLY, WASH.

SURVEYED IN COOPERATION WITH THE STATE OF WASHINGTON.

R.B. Marshall, Chief Geographer.
T.G. Gardine, Geographer in charge.
Topography by A.O. Burkland and C.F. Eberly.
Control by R.B. Robertson and C.H. Semper.
Surveyed in 1909-1910.

DESCRIPTION OF THE TOPOGRAPHIC MAP OF THE UNITED STATES

The United States Geological Survey is making a topographic map of the United States. This work has been in progress since 1882, and more than one-third of the area of the country, excluding outlying possessions, has been mapped. The mapped areas are widely scattered, nearly every State being represented, as shown on the progress maps accompanying each annual report of the Director.

This great map is being published in atlas sheets of convenient size, which are bounded by parallels and meridians. The four-cornered division of land corresponding to an atlas sheet is called a *quadrangle*. The sheets are of approximately the same size: the paper dimensions are 20 by 16½ inches; the map occupies about 17½ inches of height and 11½ to 16 inches of width, the latter varying with latitude. Three scales, however, are employed. The largest scale is 1:62500, or very nearly one mile to one inch; i. e., one linear mile on the ground is represented by one linear inch on the map. This scale is used for the thickly settled or industrially important parts of the country. For the greater part of the country an intermediate scale of 1:125000, or about two miles to one inch, is employed. A third and still smaller scale of 1:250000, or about four miles to one inch, has been used in the desert regions of the far West. A few special maps on larger scales are made of limited areas in mining districts. The sheets on the largest scale cover 15' of latitude by 15' of longitude; those on the intermediate scale, 30' of latitude by 30' of longitude; and those on the smallest scale, 1° of latitude by 1° of longitude.

The features shown on this map may, for convenience, be classed in three groups: (1) *water*, including seas, lakes, ponds, rivers and other streams, canals, swamps, etc.; (2) *relief*, including mountains, hills, valleys, cliffs, etc.; (3) *culture*, i. e., works of man, such as towns, cities, roads, railroads, boundaries, etc. The conventional signs used for these features are grouped below. Variations appear in some maps of earlier dates.

All water features are shown in *blue*, the smaller streams and canals in full blue lines, and the larger streams, lakes, and the sea by blue water-lining. Certain streams, however, which flow during only a part of the year, their beds being dry at other

times, are shown, not by full lines, but by lines of dots and dashes. Ponds which are dry during a part of the year are shown by oblique parallel lines. Salt-water marshes are shown by horizontal ruling interspersed with tufts of blue, and fresh-water marshes and swamps by blue tufts with broken horizontal lines.

Relief is shown by contour lines in *brown*. Each contour passes through points which have the same altitude. One who follows a contour on the ground will go neither uphill nor downhill, but on a level. By the use of contours not only are the shapes of the plains, hills, and mountains shown, but also the elevations. The line of the seacoast itself is a contour line, the datum or zero of elevation being mean sea level. The contour line at, say, 20 feet above sea level is the line that would be the seacoast if the sea were to rise or the land to sink 20 feet. Such a line runs back into the valleys and forward around the points of hills and spurs. On a gentle slope this contour line is far from the present coast line, while on a steep slope it is near it. Thus a succession of these contour lines far apart on the map indicates a gentle slope; if close together, a steep slope; and if the contours run together in one line, as if each were vertically under the one above it, they indicate a cliff. In many parts of the country are depressions or hollows with no outlets. The contours of course surround these, just as they surround hills. Those small hollows known as sinks are usually indicated by hachures, or short dashes, on the inside of the curve. The contour interval, or the vertical distance in feet between one contour and the next, is stated at the bottom of each map. This interval varies according to the character of the area mapped; in a flat country it may be as small as 5 feet; in a mountainous region it may be 200 feet. Certain contours, usually every fifth one, are accompanied by figures stating elevation above sea level. The heights of many definite points, such as road corners, railroad crossings, railroad stations, summits, water surfaces, triangulation stations, and bench marks, are also given. The figures in each case are placed close to the point to which they apply, and express the elevation to the nearest foot only. The *exact* elevations of bench marks and

their descriptions, as well as the descriptions and geodetic coordinates of triangulation stations, are published in the annual reports and bulletins of the Survey. The publications pertaining to specified localities may be had on application.

The works of man are shown in *black*, in which color all lettering also is printed. Boundaries, such as State, county, city, land-grant, reservation, etc., are shown by broken lines of different kinds and weights. Houses are shown by small black squares which in the densely built portions of cities and towns merge into blocks. Roads are shown by fine double lines (full for the better roads, dotted for the inferior ones), trails by single dotted lines, and railroads by full black lines with cross lines. Other cultural features are represented by conventions which are easily understood.

The sheets composing the topographic atlas are designated by the name of a principal town or of some prominent natural feature within the quadrangle and the names of adjoining published sheets are printed on the margins. They are sold at five cents each, when fewer than 100 copies are purchased, but when ordered in lots of 100 or more copies, whether of the same or of different sheets, the price is three cents each.

The topographic map is the base on which the facts of geology and the mineral resources of a quadrangle are represented. The topographic and geologic maps of a quadrangle are finally bound together, accompanied by a description of the district, to form a folio of the Geologic Atlas of the United States. The folios are sold at twenty-five cents each, excepting that such as are unusually comprehensive are priced accordingly.

Applications for the separate topographic maps or for folios of the Geologic Atlas should be accompanied by cash—the exact amount—or by post-office money order, and should be addressed to—

THE DIRECTOR,

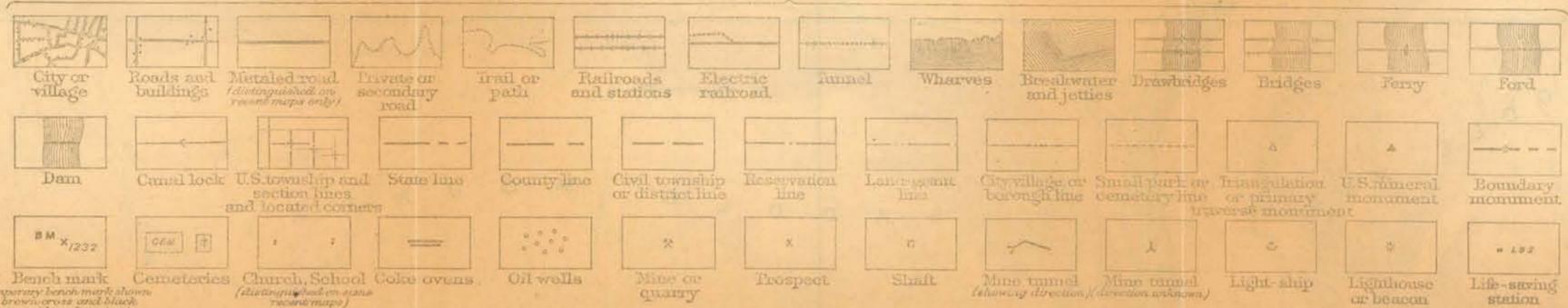
United States Geological Survey,

Washington, D. C.

February, 1911.

CONVENTIONAL SIGNS

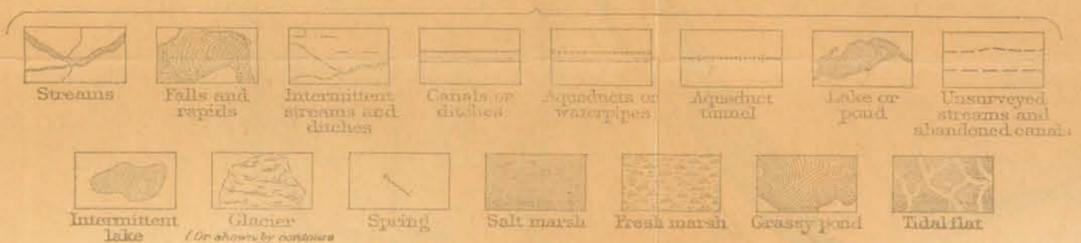
CULTURE (printed in black)



RELIEF (printed in brown)



WATER (printed in blue)



WOODS (when shown, printed in green)