WASHINGTON GEOLOGICAL SURVEY

HENRY LANDES, State Geologist

BULLETIN No. 11

The Mineral Resources of Washington

WITH STATISTICS FOR 1912

By HENRY LANDES

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LETTER OF TRANSMITTAL.

Governor Ernest Lister, Chairman, and Members of the Board of Geological Survey:

GENTLEMEN: I have the honor to submit herewith a report entitled "The Mineral Resources of Washington, with Statistics for 1912," with the recommendation that it be printed as Bulletin No. 11 of the Survey reports. It is planned that this shall constitute the first of a series of annual reports dealing with the output of minerals and rocks that are of economic importance. In future bulletins it is expected that the various materials in turn will be more fully described, especially as to geological occurrence, methods of mining or of utilization, and value.

In this report the statistics for the years 1911 and 1912 were obtained by the State Geological Survey in cooperation with the United States Geological Survey, but for all years previous to 1911 the statistics were secured by the latter organization alone.

HENRY LANDES,
State Geologist.

University Station, Seattle, February 1, 1914.

TABLE OF CONTENTS.

	Page
Granite Quarries	7
Sandstone Quarries	10
Lime Kilns	13
Basalt Quarries	16
Sand and Gravel Pits	20
Coal Mining	24
Clay Plants	29
Cement Industry	35
Metal Mining	39
Mineral Waters	49

ILLUSTRATIONS.

Plate I. Map of Washington, showing location of Mines, Quarries, Limekilns, Clay and Cement Plants, and other Mineral Industries ..... Pocket

GRANITE QUARRIES.

GENERAL OCCURRENCES OF GRANITE.

Granite occurs very abundantly in Spokane, Pend Oreille, Stevens, Ferry, Okanogan, Chelan, Whatcom, Skagit, Snohomish and King counties. In these counties granite is usually found in broad areas rather than in detached outcrops. Small isolated occurrences of granite are noted in the basalt plateau of southeastern Washington, where erosion has removed the overlying rock. Instances of this are found along Snake River at several points. In the Cascades, granite is a common rock north of Snoqualmie Pass, but occurs very infrequently south of that point. It does not occur at all, except as glacial boulders, in the immediate vicinity of the Puget Sound basin, in the Olympic Mountains, or in the southwestern part of the state. Much of the stone is a true granite, but both granodiorite and syenite are quarried and sold under the name of granite.

QUARRY LOCALITIES.

Granite quarries have been opened up at several localities where a good quality of stone could be secured, on easy lines of transportation, and convenient to markets. Three quarries are in operation along the Great Northern Railway, in the vicinity of Index, Halford, and Baring. The rock is a granodiorite in which the feldspars have a pinkish tinge, giving a pleasing color effect. The material from the Great Northern quarry at Halford has been used almost entirely in the construction of the sea-wall from Everett to Seattle. The stone from the other quarries at Index and Baring is sold in Seattle and other cities on Puget Sound.

Spokane is another center of granite quarrying. Outcrops of this rock occur at many places east, west and north of the city. At the present time three quarries are in operation in the vicinity of Medical Lake, about 16 miles southwest of Spokane. Two quarries, located near together, are operated at a locality 12 miles north of Spokane and a third about six miles to the southeast of the city.

For some years a quarry was operated at Wawawai, on the

Snake River, in Whitman County, at a point about 14 miles from Pullman. The granite outcrops along the stream bank, convenient for transportation either by water or by rail. The chief market for the stone was in Portland. In late years the quarry has been inactive.

Near Electron, in Pierce County, the County Commissioners operated a quarry for some years, using the syenite therein obtained as crushed rock for road building.

GRANITE* QUARRIES NOW OR RECENTLY IN OPERATION.

Baring Granite Works, Baring, King County.

Pierce County Quarry, Electron, Pierce County.

Great Northern Railway Co., Halford, Snohomish County.

Index Granite Works, Index, Snohomish County.

Giles Granite Quarry, Medical Lake, Spokane County.

Medical Lake Granite Quarry, Medical Lake, Spokane County.

Washington Monumental & Cut Stone Co., Silver Lake, Spokane County.

Culver and Merwin, 12 miles north of Spokane, Spokane County.

East End Granite Quarry, 6 miles southeast of Spokane, Spokane County.

Washington Monumental and Cut Stone Co., 12 miles north of Spokane, Spokane County.

USES OF GRANITE.

The chief markets for Washington granite are in the growing cities, where the stone is used for street improvements and for building purposes. Of the stone quarried at Baring in 1912, 44 per cent. by value was sold for curbing; 33 per cent. was dressed for building purposes; 16 per cent. was made into paving blocks; and 7 per cent. was sold for monumental work. At the Index Granite Works over one-half the stone in value, in 1912, was dressed and sold for building purposes; about one-fourth was made into curbing, and the remainder was sold for paving blocks, monumental work, flagging, building pur-

*Includes granodiorite and syenite, as well as true granite.

poses, etc. The entire output for 1912 of the Great Northern Railway quarry at Halford was rubble, which was used wholly by the company.

The quarries near Spokane sell the larger part of their granite for monumental purposes. A smaller portion is used in buildings, as well as for paving blocks and curbing. Of the rock quarried in 1912 at Electron, in Pierce County, substantially all of it was used for macadamizing on the public roads, although a very small amount was used as riprap.

VALUE OF GRANITE* QUARRIED FROM 1901 TO 1912.

1901	$43,808	1907	$562,352
1902	147,273	1908	870,944
1903	209,095	1909	742,878
1904	422,508	1910	642,992
1905	681,730	1911	377,443
1906	459,975	1912	119,745

FUTURE DEVELOPMENT OF INDUSTRY.

The granite industry of Washington will doubtless increase in importance as the population multiplies, especially as the cities grow in number and expand in size. There is no question but what the increased use of cement has interfered somewhat with the normal growing demand for granite, but the latter stone has certain uses for which concrete is not accepted as a substitute. The fact that the value of the granite quarried in the state has increased four-fold in the last ten years is a reasonably sure indication of the continued development of the industry.

There is an abundance of granite of good quality easily accessible so far as transportation is concerned. At many places quarries may be developed convenient to markets and readily supplied with shipping facilities. This is particularly true along both the Great Northern and Chicago, Milwaukee and St. Paul railways within the Cascade Mountains, and at several localities about Spokane.

*From 1901 to 1910, inclusive, under granite is included, not only true granite, but basalt, andesite, diabase, syenite, granodiorite, and quartzite. For the years 1911 and 1912, the basalt production is not included under granite.

SANDSTONE QUARRIES.

GENERAL OCCURRENCES OF SANDSTONE.

The larger areas of sandstone are found between the western foothills of the Cascade Mountains and the Pacific Ocean. This rock also occurs within and to the eastward of the Cascades in more or less isolated localities. In the broad areas of southwestern Washington the sandstones are usually associated with shales, but sometimes with igneous rocks, mainly basalt. The bed-rock formations of this part of the state belong to the Tertiary age and represent both marine and brackish water sediments.

The sandstones of the northwestern part of Washington, to the eastward of the Puget Sound depression, as about Bellingham, belong to the Eocene time and represent sediments laid down in an ancient lake. The same thing is true of the extensive sandstone formations about Roslyn and Clealum in Kittitas County, and between Leavenworth and Wenatchee in Chelan County. In the lower Yakima valley the sandstones that outcrop on the flanks of many of the ridges belong to middle Tertiary time and also represent beds of sediments laid down in large fresh water bodies. At several places in Stevens, Ferry and Okanogan counties, small areas of sandstones have been found and in some instances the rock is being utilized. Not infrequently in the more mountainous parts of the state the sandstones have been so thoroughly indurated or hardened that they are now in the condition of quartzite.

QUARRY LOCALITIES.

Sandstone quarries have been operated in Washington for many years. The quarries have been located as near as possible to the markets and where the cheapest transportation was available. The principal localities in production have been the quarries on Chuckanut Bay, near Bellingham, and those at Tenino. The Chuckanut quarry was not in operation in 1912, but two of the Tenino quarries were producers throughout that year.

Several quarries have been opened in the sandstone beds of the coal measures, in the vicinity of Wilkeson and Spiketon (formerly Pittsburg), in Pierce County. The stone here is very conveniently situated for transportation and this locality has been a steady producer. In 1912 the only quarry operated was the one near Wilkeson, owned by the Bell-Scott Company.

A number of sandstone quarries have been opened on tidewater, about Puget Sound, where the stone could be easily transferred from the quarry floor to a scow moored alongside. This has been true at several localities among the San Juan islands, where cliffs of sandstone form the shores. The principal quarries operated in recent years have been on Waldron and Sucia islands. Similarly on the inlets about Bremerton, in Kitsap County, sandstone has been quarried at several places where loading on scows was easily accomplished. In 1912 the International Contract Company operated such a quarry at Waterman. Mention should be made here of the Fidalgo quarry, located on Fidalgo Island, at Deception Pass, and owned by the state, where a crushing plant has been installed and all the rock quarried is prepared for road use. The crushed rock is conveyed by scows to various points on Puget Sound where it is used in macadam construction. The rock is really a quartzite and not a sandstone, but it may be included here.

In eastern Washington small sandstone quarries have been opened at a number of places where there was a local use for the stone. This has been true at Republic, where two quarries have been worked intermittently and at several localities in the Yakima valley, as near North Yakima, Selah, and Prosser, where sandstone has also been quarried at various times.

QUARRIES NOW OR RECENTLY IN OPERATION.

Operator.	*Locality.*	*County.*
D. A. McGillis Quarry	Republic	Ferry
International Contract Co.	Waterman	Kitsap
Bell-Scott Company	Wilkeson	Pierce
Alaska Barge Company	Waldron Island	San Juan
Sucia Island Quarry Co.	Sucia Island	San Juan
Hercules Sandstone Co.	Tenino	Thurston
Tenino Stone Co.	Tenino	Thurston
Chuckanut Stone Co.	Bellingham	Whatcom
Howard Stone Quarry	Selah	Yakima

USES OF SANDSTONE.

For many years sandstone was commonly used in the construction of buildings in Seattle, Tacoma, Olympia, Bellingham, Everett and other cities of western Washington. In later years this material for structural purposes has been partially replaced by concrete, brick and terra cotta. With the decline of sandstone for building uses there has come an increased use of the stone for paving blocks, due to the rapid growth of the cities. It is also in much demand for rubble, mainly for riprap, because of the usual low expense of quarrying this rock. Of the sandstone quarried in the state during 1912, about 70 per cent. by value was used as riprap, 19 per cent. was sold as dressed stone for building purposes, and the remainder, or 11 per cent., was used for paving blocks.

VALUE OF SANDSTONE QUARRIED FROM 1901 TO 1912.

1901	$89,174	1907	$295,585
1902	30,725	1908	464,587
1903	47,430	1909	335,470
1904	88,135	1910	438,581
1905	124,910	1911	301,843
1906	169,500	1912	344,476

FUTURE DEVELOPMENT OF INDUSTRY.

Because of the many localities in the state where sandstone of good quality occurs it is probable that new quarries will be opened from time to time as demands for the stone arise in new districts or additional uses are found for it. It is unlikely that sandstone for structural purposes will achieve the relative importance it once had, because of the growing use of less expensive material. As the cities grow rapidly in number and size it is reasonable to suppose that paving blocks will be used in increasing quantities and other quarries will be opened where sandstone of sufficient hardness may be found. The use of sandstone for riprap along railway embankments, in jetties at the entrances of harbors, and in other lines of engineering, will induce an increasing, but more or less variable, demand.

LIME KILNS.

GENERAL STATEMENT

The chief uses of limestone in Washington are in the manufacture of lime and cement. In a minor way limestone is used as a flux in smelters, as a fertilizer, and as crushed rock for macadam construction. In 1912 eleven plants were in operation where ordinary lime was manufactured and one plant where hydrated lime was the chief output. The use of limestone in cement making is considered in another part of this bulletin.

DISTRIBUTION OF LIMESTONE.

The limestones of Washington are peculiar in that they do not ordinarily occur in broad areas of thick beds, but rather in isolated lens-like deposits of variable size. The lenses as originally made on the sea-floor were roughly circular in outline, but the accumulation of organic matter was far greater at the center than elsewhere. The resultant lens-like bodies had lateral diameters which exceeded from 3 to 10 times the vertical thickness at its maximum point. In practically every instance the rocks containing the limestone deposits have been tilted and partially eroded, with the result that the lenses now outcrop in variable positions and sizes. Usually the limestone mass is comparatively thick at the center and tapers to nothing when followed along the strike in either direction. Similarly the limestone thins out with depth and this lack of continuance has made the tonnage of rock which could be secured somewhat uncertain. As a rule the lenses outcrop in considerable number in any general locality where limestone occurs at all, so that for the same manufacturing plant the stone from several deposits may be used.

Another peculiarity about Washington limestones is the fact that they are limited to the northern counties of the state. From east to west the counties containing limestone bodies of workable size are Pend Oreille, Stevens, Ferry, Okanogan, Chelan, Whatcom, Skagit, Snohomish, King, and San Juan. The

above counties contain all the economic deposits so far discovered, except the limestone at one locality near Anatone, Asotin County. Over a very large portion of the state limestones are either unknown or of rare occurrence. Over the great lava areas of southern and southeastern Washington a veneer of limestone occasionally covers the basalt, where thermal waters have brought the calcium carbonate from below and deposits have been made on the surface. Sometimes these spring deposits are buried under a mantle of soil and at other times are exposed along stream banks or are found in well sections. At a few places, as in Klickitat County, the quantity of limestone of spring origin has warranted the erection of kilns where small amounts of lime have been burned.

A third peculiarity about the limestones of the state is the fact that in western Washington they are all very high in calcium carbonate, while east of the Cascades the lime is frequently largely replaced by magnesia, forming a dolomite rather than a pure limestone. The western deposits are all suitable for lime burning, as far as quality is concerned, but they are often small in size; while the deposits of the eastern part of the state are generally large and quantitatively are of economic value, except they are frequently unsuited for quick lime because of their magnesia content.

LOCATION OF KILNS.

San Juan has always been the principal lime producing county of the state. This is due to the fact that several large bodies of excellent limestone are located on the shore-line, near good harbors, very convenient for cheap transportation to neighboring markets. Recently a large plant has been placed in operation in Whatcom County, a few miles east of Sumas, where the lime is prepared and sold in the hydrated condition.

In eastern Washington, Stevens has been the largest producer of lime of any county. Formerly other kilns were operating besides those now in use at Evans, but because of the high percentage of magnesia in the limestone, and for other reasons, they are now out of commission.

At several localities the kilns are not operated all the time, but with a large amount of irregularity—no more lime being burned than that necessary to supply a small local demand. It sometimes happens that a kiln may lie idle for a good many months so that the list of producers varies somewhat from year to year. The list below includes not only those kilns that were producing in 1912, but those that had been in operation within the two or three previous years.

LIST OF LIME KILNS.

Operator.	*Locality.*	*County.*
F. B. Wuelfinger	Lake Chelan	Chelan
James O'Laughlin	Lake Chelan	Chelan
Wenatchee Lime Co.	Wenatchee	Chelan
Republic Lime Co.	Republic	Ferry
John Nopp	Chesaw	Okanogan
Okanogan Lime Co.	Okanogan	Okanogan
Oroville Lime Quarry	Oroville	Okanogan
Preston Hanley	Twisp	Okanogan
H. L. Martin	Metaline Falls	Pend Oreille
Henry Cowell Lime and Cement Co.	Deer Harbor	San Juan
Orcas Lime Co.	Deer Harbor	San Juan
Langdon Lime Co.	East Sound	San Juan
Henry Cowell Lime and Cement Co.	Friday Harbor	San Juan
J. A. Soderberg	West Sound	San Juan
Tacoma & Roche Harbor Lime Co.	Roche Harbor	San Juan
Idaho Lime Co.	Evans	Stevens
International Lime Co.	Sumas	Whatcom

QUANTITY AND VALUE OF LIME (EXCLUSIVE OF HYDRATED) FROM 1904 TO 1912, INCLUSIVE.

Year	*Amount in Short tons*	*Value*
1904	41,626	$216,454
1905	27,935	160,985
1906	59,094	347,924
1907	35,913	238,568
1908	32,343	228,353
1909	39,270	282,628
1910	35,540	267,735
1911	35,094*	228,933*
1912	32,372*	234,832*

*Includes hydrated lime.

BASALT QUARRIES.

GENERAL OCCURRENCES OF BASALT.

It is safe to say that there is more basalt in Washington than any other single variety of rock. More than one-quarter of the state is embraced in the Columbia lava plains of southeastern Washington, where the bed-rock is almost exclusively basalt. Along the Snake River the basalt cliffs frequently rise above the water's edge to heights of 2,500 feet or more. The same statement holds for several localities along the Columbia between its mouth and the junction with Spokane River.

Beyond the borders of the lava plain above mentioned, in the northern and western parts of the state, basalt is of frequent occurrence. Sometimes it is found in irregular areas where it has outflowed as molten lava, but oftener where it has been forced into the neighboring rocks as dikes or sills. Usually the basalt is harder than the associated rocks, so that in the process of weathering and erosion it is more resistant and hence today stands somewhat higher above the general level of the country than is true of other formations. In some parts of the state, as in southwestern Washington, it is frequently true that the higher hills and ridges are made up wholly or largely of basalt, and a study of the topography of the country is therefore helpful in locating this rock.

In Bulletin No. 2, entitled "The Road Materials of Washington," basalt is described from 35 counties of the state. Of the 171 tests made on samples of rock believed to be suitable for use in road building, 81 of these were from outcrops of basalt. In some counties basalt is virtually the only rock which may be found; and it is a safe assumption that in all the remaining counties of the state it occurs in quantity and quality desirable for macadam construction or for concrete.

LOCALITIES OF QUARRIES.

Since basalt is so widely distributed about the state, it is natural that many quarries should be opened up to secure this

rock for various uses. The majority of the quarries are small and are worked intermittently; only a few of the larger ones are regular producers and are never closed down.

The quality of the rock has always been an important factor in selecting a site for a quarry. Much of the basalt of the state is porous and in this respect every condition may be found between pumice and an extremely compact rock. As a rule, there is an abundance of good rock with a minimum of porosity, so that it is not necessary to seek very far for material of sufficient quality. Another factor in selecting a quarry has been the desirability of obtaining the rock as convenient as possible to the place where it is to be used. This has led to the frequent development of small quarries where enough stone was taken out for a particular utility and then the quarries abandoned. In opening a quarry for road purposes the topography has often been taken into account, whereby a cliff of sufficient height has been selected so that the rock could be handled by gravity from the quarry floor through the crusher and screens to the bunkers below.

Since basalt is so much used in road and street work it has followed that quarries and crushing plants have been put in operation by the state as well as by many counties and municipalities. The state is preparing basalt for macadam uses at its quarries at Meskill, Selah, Dixie, and Marshall. Several quarries, some publicly and others privately owned, have been operated in late years within and about Spokane. Basalt quarries are of common occurrence in the immediate neighborhood of many of the towns and cities of eastern Washington; there are several of them along the lower Columbia River; and at many convenient points for shipping in western Washington similar quarries are in operation.

QUARRIES NOW OR RECENTLY IN OPERATION.

Operator.	*Locality.*	*County.*
Sittke's Quarry	Asotin	Asotin
Benton County Quarry	Prosser	Benton
City of Hoquiam	Hoquiam	Chehalis
Northern Pacific Ry. Co.	Oakville	Chehalis

QUARRIES NOW OR RECENTLY IN OPERATION—Continued.

Operator.	*Locality.*	*County.*
Columbia Contract Co.	Camas	Clarke
Secor Brothers	Kelso	Cowlitz
Star Sand Company	Ladu	Cowlitz
Northern Pacific Ry. Co.	Olequa	Cowlitz
City of Seattle (Park Dept.)	Franklin	King
King County	North Bend	King
Riverside Stone Company	Riverton	King
Northern Pacific Ry. Co.	Veazie	King
Independent Asphalt Paving Co.	Charleston	Kitsap
Secor Brothers	Goldendale	Klickitat
Washington State Quarry	Meskill	Lewis
Pacific County Quarry	South Bend	Pacific
Washington State Quarry	Fidalgo	Skagit
Washington State Quarry	Marshall	Spokane
Empire Stone Quarry	Spokane	Spokane
Northern Pacific Ry. Co.	Gate	Thurston
Wahkiakum County Quarry	Cathlamet	Wahkiakum
Wahkiakum County Quarry	Skamokawa	Wahkiakum
Washington State Quarry	Dixie	Walla Walla
A. L. Smith	Colfax	Whitman
Wilson & Bailey Constr. Co.	Colfax	Whitman
Frank Hanlan	Garfield	Whitman
Whitman County Quarry	Oakesdale	Whitman
A. R. Boyd	Pullman	Whitman
Spokane Asphalt & Paving Co.	Pullman	Whitman
W. J. Donahue	Rosalia	Whitman
J. G. Hardesty	Rosalia	Whitman
Yakima County Quarry	Cowiche Canyon	Yakima
P. L. Zirkle	North Yakima	Yakima
Washington State Quarry	Selah	Yakima
Yakima County Quarry	Selah	Yakima

USES OF BASALT.

Since basalt is generally regarded as about the best rock to be had for macadam construction, it is natural that most of the quarries have been opened up to furnish material for road use. Crushed basalt is generally used for surfacing the permanent highways. In some portions of the state gravel for road building may be had so cheaply that this material is generally used as a substitute for basalt.

While by far the larger number of basalt quarries have been developed to supply road material, yet this rock is used in large amounts in other lines, as in jetty work at the mouth of the

Columbia, entrance to Grays Harbor, and elsewhere. Basalt is also used as riprap along railway and highway embankments, in concrete, as railroad ballast, and to a limited degree as a foundation stone in buildings.

VALUE OF OUTPUT.

In the statistics heretofore collected the value of the basalt output has been included with that of certain other rocks under the general head of granite. In examining the returns submitted by producers for 1912 we know definitely that the basalt production amounted to $689,456. Similarly it has been determined that the output for 1911 was $968,108.

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Fire tests: Humphreys; U. S. Geol. Surv., Bull. 370, 1909.

Building stones of Washington: Shedd; Wash. Geol. Surv. Vol. 2, 1902.

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Road materials of Washington: Landes; Wash. Geol. Surv., Bull. 2, 1911.

Limestone—See references under cements.

SAND AND GRAVEL PITS.

GENERAL OCCURRENCE OF SAND AND GRAVEL.

Sand and gravel in quantity and quality for ordinary uses may be found almost everywhere throughout the state. There are very few localities where it is necessary to transport these materials any considerable distance. It so happens that in the more thickly populated districts both sand and gravel may be had easily and cheaply and this is a prominent factor in construction work.

In the northern counties of the state and about Puget Sound, both sand and gravel occur in unlimited quantities. This holds true throughout the glaciated areas. Beyond the limits of the former ice invasion gravels and sands are found in broad plains which represent an outwash from the ice front. In the southern parts of Washington, beyond the reach or influence of glaciation, sand and gravel may be had in the terraces and bars along the larger streams. The Columbia, Snake, and Yakima, in eastern Washington, and the Cowlitz, Chehalis and other streams in western Washington, are usually bordered with workable deposits of sand and gravel which may be readily obtained for various utilities. Practically the only localities in the state where any difficulty is ever encountered in securing the necessary sand and gravel for usual purposes are on the higher plateaus of southeastern Washington, or on the hills and ridges of the southwestern part of the state.

LOCALITIES OF PITS.

The factors which usually prevail in opening sand and gravel pits are the quality of the material, nearness to market, and low cost of transportation. These conditions are all fulfilled immediately about Puget Sound and it is in that part of the state, therefore, that the largest number of productive pits is found. The sands and gravels are glacial in origin, and are almost always composed of unweathered material which is not

only hard and resistant but very clean as well. They are usually stratified, often alternating in position, and frequently make up the cliffs which rise from 100 to 300 feet above the shores of the sound. The usual method is to remove the sand and gravel from the pit by hydraulicking, the water for that purpose being either secured from a stream on the upland above, or is pumped and direct pressure used. Through troughs or chutes the sand and gravel is carried to the screens where it is sized before dropping into the bunkers. The scows, which are loaded directly from the bunkers, are then towed to the neighboring cities where the materials are to be used. Where gravity cannot be employed the sands and gravels are elevated from the pit to an ample height and then screened and stored in bunkers preparatory to loading on scows, cars, wagons or other methods of haulage to the place of use.

In both Seattle and Tacoma sands and gravels occur abundantly and are often well exposed in street grading. This has led to the development of many small pits where the materials are taken out and used locally. Similarly the Spokane Valley, within and about that city, contains many terraces and other deposits of sand and gravel which have been freely drawn upon at many points for various uses.

In the glaciated parts of the state, where banks of gravel are usually of very frequent occurrence, this material is very commonly employed in surfacing the roads. The pits are opened up at frequent intervals so that the length of haul will not be great. The era of road building on a large scale now beginning will see the use of gravel for this purpose increased many fold.

The fact that both sand and gravel are widespread in occurrence has led to the opening of a very large number of local pits of which we do not have any record. The statistics so far compiled for Washington show a production much below what would be true if all the producers were included. For 1912 the production from six counties only is given. In the future a

strong effort will be made to secure the returns from all the productive pits of the state.

NAMES OF PITS AND OWNERS.

Operator.	*Locality.*	*County.*
August Rutz	Ritzville	Adams
John Knappland	Prosser	Benton
Independent Sand & Gravel Co.	Aberdeen	Chehalis
Grays Harbor Construction Co.	Melbourne	Chehalis
Eagle Transfer Co.	Wenatchee	Chelan
Samuel Loney	Pasco	Franklin
Whidbey Island Sand & Gravel Co.	Whidbey Island	Island
Michaels & Blackwell	Bothell	King
Cedar Mountain Coal Co.	Cedar Mountain	King
Lake Gravel Co.	Buffalo	King
Lake Gravel Co.	Redmond	King
Lake Gravel Co.	Renton	King
Elliott Cedar River Gravel Co.	Elliott	King
Richmond Beach Sand & Gravel Co.	Richmond Beach	King
Edgewater Sand & Gravel Co.	Seattle	King
Green Lake Gravel Co.	Seattle	King
Springs Gravel Co.	Seattle	King
Vashon Sand & Gravel Co.	Vashon Island	King
Parker Asphalt Paving Sand Co.	Creosote	Kitsap
J. R. Jacobson	Ellensburg	Kittitas
Pioneer Sand & Gravel Co.	Steilacoom	Pierce
Tacoma Sand & Gravel Co.	Steilacoom	Pierce
Atlas Sand & Gravel Co.	Tacoma	Pierce
Harrison Brothers Co.	Tacoma	Pierce
J. Cunningham	Spokane	Spokane
Spokane Sand & Gravel Co.	Spokane	Spokane
Lind Gravel Company	Bellingham	Whatcom
Whidbey Island Sand & Gravel Co.	Lummi Island	Whatcom
W. J. Aumiller	North Yakima	Yakima
Yakima County	Sunnyside	Yakima

USES OF SAND AND GRAVEL.

In a study of the data submitted by producers we find that in 1912 substantially all of the gravel was used in making concrete. Of the sand produced in that year, 62 per cent. was used for building purposes, 33 per cent. in paving, and the remainder for molding, for engine use, and otherwise. Of the sand and gravel used in road surfacing we do not have any record, but we

know that much is used in those sections of the state where such materials are of common occurrence. The increasing use of concrete in general, the erection of more permanent buildings, the street paving and other engineering work in our rapidly growing cities, and the highway improvements now getting under way will all conspire to greatly accelerate the production of sand and gravel.

QUANTITY AND VALUE OF OUTPUT FROM 1906 TO 1912, INCLUSIVE.

	Quantity of sand and gravel together, in short tons.	*Value of gravel.*	*Value of sand.*	*Total value.*
1906	293,571	$92,052	$52,673	$144,725
1907	403,960	108,625	71,175	179,800
1908	654,995	159,543	101,988	261,531
1909	1,253,632	252,786	170,639	423,425
1910	1,575,289	186,242	295,327	481,569
1911	1,121,832	202,326	117,434	319,760
1912	1,020,841	226,180	119,109	345,289

COAL MINING.

GENERAL STATEMENT.

The coals of Washington are limited to four rather scattered areas in the western half of the state. The coal-bearing areas have been named as follows: the North Puget Sound field, including the mines of Whatcom and Skagit counties; the South Puget Sound field, comprising the counties of King and Pierce; the Roslyn field, in Kittitas County; and the Southwestern field, including the counties of Thurston, Lewis and Cowlitz.

Although thus limited in distribution, the coals vary greatly in composition. Anthracite has been reported from Whatcom County and semi-bituminous, bituminous and sub-bituminous coals are mined in King, Pierce, and Kittitas counties. In the Southwestern field there is noted a complete gradation in composition, lignites occurring in the western part of the area, with sub-bituminous, bituminous and anthracite as the mountainous region is approached. Coking coals of good grade, the only coals of this character mined on the Pacific coast in the United States, are taken from the Wilkeson-Carbonado field in Pierce County and from the North Puget Sound field. At present coke is made only in the former district, where, on account of the high content of ash, the coal is usually washed before coking. The smelter at Tacoma takes most of the coke from this field. The sub-bituminous coals of the Renton and Newcastle districts are of quite uniformly high grade and well suited to domestic use.

In King County the coal mines are located in the vicinity of the following places: Bayne, Black Diamond, Cumberland, Franklin, Grand Ridge, Issaquah, Kummer, Newcastle, Ravensdale, Renton, Snoqualmie and Taylor. In Kittitas County the operations are conducted near the towns of Clealum, Roslyn, and Taneum. Coal mining in Lewis County is carried on near Centralia, Chehalis, Divide, East Creek, Kopiah, and Mendota.

Burnett, Carbonado, Melmont, Spiketon, and Wilkeson, in Pierce County, are centers for coal mining operations, while in Thurston County the towns of Bucoda, Rainier, Tenino and Tono are to be mentioned.

COAL MINES.

Operator.	*Locality.*	*County.*
Carbon Coal & Clay Co.	Bayne	King
Occidental Coking Coal Co.	Bayne	King
Pacific Coast Coal Co., No. 11	Black Diamond	King
Pacific Coast Coal Co., No. 14	Black Diamond	King
Pacific Coast Coal Co. "B"	Black Diamond	King
Deep Lake Coal Co.	Cumberland	King
Independent Coal & Coke Co.	Cumberland	King
A. W. Lambert	Cumberland	King
Hyde Coal Co.	Cumberland	King
Pacific Coast Coal Co., Gem	Franklin	King
Central Coal Co.	Grand Ridge	King
Issaquah & Superior Coal Mines Co.	Issaquah	King
Denny-Renton Clay & Coal Co.	Kummer	King
Pacific Coast Coal Co.	Newcastle	King
Northwestern Improvement Co.	Ravensdale	King
Denny-Renton Clay & Coal Co.	Renton	King
May Creek Coal Co.	Renton	King
Puget Sound Trac., Light & Power Co.	Taylor	King
United Collieries Co.	Snoqualmie	King
Denny-Renton Clay & Coal Co.	Renton	King
American Canadian Fuel Co.	Clealum	Kittitas
Inland Improvement Co.	Clealum	Kittitas
Northwestern Improvement Co.	Clealum	Kittitas
Northwest Coal Company	Roslyn	Kittitas
Busy Bee Mining Co.	Roslyn	Kittitas
Northwestern Improvement Co., No. 3	Roslyn	Kittitas
Northwestern Improvement Co., No. 5	Roslyn	Kittitas
Northwestern Improvement Co., No. 6	Roslyn	Kittitas
Northwestern Improvement Co., No. 7	Roslyn	Kittitas
Roslyn-Cascade Coal Co.	Roslyn	Kittitas
Roslyn Fuel Co., Beekman Slope No. 1	Roslyn	Kittitas
Roslyn Fuel Co., Beekman Slope No. 2	Roslyn	Kittitas
Yakima-Roslyn Coal Co.	Roslyn	Kittitas
Carothers Brothers	Taneum	Kittitas
Centralia Coal Co.	Centralia	Lewis
Fords Prairie Coal Co.	Centralia	Lewis
Gibson Coal Co.	Centralia	Lewis
Sunshine Coal Co.	Centralia	Lewis

COAL MINES—Continued.

Operator.	*Locality.*	*County.*
Wilson Coal Co.	Centralia	Lewis
Chehalis Coal Co.	Chehalis	Lewis
Coal Creek Coal Co.	Chehalis	Lewis
Sheldon Coal Co.	Chehalis	Lewis
Superior Coal Co.	Chehalis	Lewis
Pennsylvania Coal Co.	Divide	Lewis
East Creek Coal Co.	East Creek	Lewis
Kopiah (Wilson Coal Co., Operator)	Kopiah	Lewis
Mendota Coal & Coke Co.	Mendota	Lewis
Pacific Coast Coal Co.	Burnett	Pierce
Carbon Hill Coal Co.	Carbonado	Pierce
Northwestern Improvement Co.	Melmont	Pierce
American Coal Co.	Spiketon	Pierce
Gale Creek Coal Mines Co.	Wilkeson	Pierce
South Willis Coal Co.	Wilkeson	Pierce
Wilkeson Coal & Coke Co.	Wilkeson	Pierce
Graham Bros.	Bucoda	Thurston
Majestic Coal Co.	Near Rainier	Thurston
Black Bear Mine	Tenino	Thurston
Washington Union Coal Co.	Tono	Thurston
Whatcom County Coal Co.	Lake Whatcom	Whatcom

PRODUCTION.

The highwater mark in the production of coal in Washington was reached in 1910, with a total of 3,911,899 short tons. A total of 3,572,815 short tons was mined in 1911, as compared with 3,360,932 in 1912. The decrease in amount from 1911 to 1912 was about 6 per cent., while the decrease in value was not so great, being only 1.6 per cent. But two counties, Pierce and Thurston, did not show a decreased production, the increase in the former being due to the greater production of coke, and in the latter to an increased domestic consumption, for which use that coal is mainly mined.

While other counties have augmented the production in certain years, the bulk of the tonnage has come from the counties of King, Kittitas, Lewis, and Pierce. The table for the production of the various counties for the decade ending with 1912 is here appended.

PRODUCTION OF COAL BY COUNTIES—1903-1912.

COUNTY	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Cowlitz	.....	1,800	* 3,706	* 3,523	* 7,424	.....	.....	.....	.....	.....
King	1,229,560	1,219,230	1,099,163	1,310,530	1,445,633	931,643	1,216,012	1,242,340	1,259,521	1,063,110
Kittitas	1,369,716	1,340,400	1,280,845	1,422,612	1,524,887	1,414,621	1,550,539	1,661,650	1,256,745	1,237,427
Lewis	1,410	1,335	1,300	25,880	103,539	73,675	121,573	179,484	172,734	128,377
Pierce	572,800	531,589	479,912	513,639	572,169	551,678	609,467	786,096	783,196	788,293
Skagit	19,115	10,650	.....	.....	.....	.....	.....	.....	.....	.....
Whatcom	672	1,837	.....	.....	.....	.....	.....	.....	.....	.....
Other counties	.....	30,840	.....	.....	26,880	53,326	† 104,672	42,329	‡ 100,619	‡ 143,725
Total	3,193,273	3,137,681	2,864,926	3,276,184	3,680,532	3,024,943	3,602,263	3,911,899	3,572,815	3,360,932
Total value	$5,380,679	$5,120,258	$5,141,258	$5,908,434	$7,679,801	$6,690,412	$9,158,999	$9,764,465	$8,174,170	$8,042,871
Average price per ton	$1.685	$1.63	$1.79	$1.80	$2.40	$2.21	$2.54	$2.50	$2.29	$2.39

* Includes Whatcom county.
† Includes small mines.
‡ Includes Thurston and Whatcom counties.

PRODUCTION OF COAL IN WASHINGTON, 1860 TO 1911.

Given in short tons (2,000 pounds).

1860	5,374	1887	772,601
1861	6,000	1888	1,215,750
1862	7,000	1889	1,030,578
1863	8,000	1890	1,263,689
1864	10,000	1891	1,056,249
1865	12,000	1892	1,140,575
1866	13,000	1893	1,208,850
1867	14,500	1894	1,131,660
1868	15,000	1895	1,163,737
1869	16,200	1896	1,202,534
1870	17,844	1897	1,330,192
1871	20,000	1898	1,775,257
1872	23,000	1899	1,917,607
1873	26,000	1900	2,418,034
1874	30,352	1901	2,464,190
1875	99,568	1902	2,690,789
1876	110,342	1903	3,190,477
1877	120,896	1904	2,905,689
1878	131,660	1905	2,846,901
1879	142,666	1906	3,290,523
1880	145,015	1907	3,722,433
1881	296,000	1908	2,977,490
1882	177,340	1909	3,590,639
1883	244,990	1910	3,979,569
1884	166,936	1911	3,546,322
1885	380,250	1912	3,360,932
1886	423,525		

REFERENCES ON COAL.

Coal areas of United States (Maps): Parker; U. S. Geol. Surv., Mineral Resources, Part II, 1910.

Origin and classification: Clarke; U. S. Geol. Surv., Bull. 491, 1911.

Coals of Washington, analyses: Smith; U. S. Geol. Surv., Bull. 474, 1911.

Coal areas of Washington: Landes; Wash. Geol. Surv., Vol. II, 1902.

Coals of King county: Evans; Wash. Geol. Surv., Bull 3, 1912.

CLAY PLANTS.

GENERAL STATEMENT.

The clay industry in the State of Washington is not confined to any one locality, but is widespread. A study of the map published with this bulletin shows that clay plants are in operation in all sections of the state. Few counties, if any, but are supplied with clay of suitable grade and in sufficient quantity to warrant the establishment of clay plants as the growth of the state provides new and larger markets.

Most of the clay products are made from sedimentary clays of Tertiary age. To what extent this situation obtains is not entirely known, but certainly nearly all the refractory and vitrifying clays are of this origin. Many plants, especially those confining their activity to the production of common brick, utilize other clays, especially alluvial or glacial deposits of Quaternary age.

As is to be expected, the wide range of origin and location of the clays leads to an even wider range in composition and character. While analyses vary greatly even for the same bed of clay, the following will give an idea of the approximate composition of clays that are used commercially in Washington:

TABLES OF CHEMICAL ANALYSES OF WASHINGTON CLAYS, SHOWING COMPOSITIONS OF CLAYS USED FOR VARIOUS PRODUCTS.

	CITY	COUNTY	OPERATOR	Silica SiO_2	Alumina Al_2O_3	Ferric oxide Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Titanium TiO_2	Moisture H_2O	Combined water. Ignition	Miscellaneous	Total
			BRICK AND TILE—												
1	Chelan.....	Chelan....	H. E. Dunham.....	59.84	16.40	4.10	5.84	0.36	1.62	2.84	1.20	0.74	5.51	1.32	99.77
2	Taylor.....	King.....	Denny-Renton Clay & Coal Co.....	72.27	16.16	1.56	.....	0.29	2.90	1.68	0.68	1.20	3.58	.....	100.32
3	Seattle.....	King.....	Seattle Brick & Tile Co.....	58.96	16.57	6.10	2.37	2.97	0.83	3.24	1.15	3.58	3.36	0.65	99.78
4	Chehalis....	Lewis.....	Chehalis Brick & Tile Co.....	58.75	18.27	3.86	0.86	1.68	2.18	1.53	0.85	2.12	8.66	1.20	99.96
5	Baker.....	Skagit....	Washington Portland Cement Co.....	58.75	25.94		* 4.66	† 4.47	1.48		.....	.....	4.60	.....	99.90
			SEWER PIPE—												
6	Kummer....	King.....	Denny-Renton Clay & Coal Co.....	61.58	17.46	6.69	0.40	1.37	2.80	0.78	0.65	1.16	7.00	.....	99.89
7	Mica.....	Spokane..	Washington Fire Brick Co.....	75.04	19.18	0.76	.....	.....	0.45		0.15	0.36	4.54	.....	100.48
8	Mica.....	Spokane..	American Fire Brick Co.....	72.68	13.15	2.01	0.59	1.21	0.34	1.51	.....	8.49		.....	99.98
9	Chester.....	Spokane..	Bergman Clay Mfg. Co.....	76.96	16.39	0.31	0.40	0.08	0.20	trace	0.44	0.29	5.48	.....	100.55
10	Freeman....	Spokane..	Washington Brick, Lime & Mfg. Co.....	59.92	16.65	8.25	2.22	3.71	2.14	2.02	.....	5.19		.....	100.10
			STONEWARE—												
11	Auburn.....	King.....	Auburn Pottery Co.....	62.80	23.04	1.14	0.40	0.51	3.84		.....	1.65	6.58	.....	99.76
12	Clayton.....	Stevens...	Spokane Pottery Co.....	65.66	21.98	1.92	.....	0.90	0.80		.....	1.68	6.66	.....	99.60
13	Clayton.....	Stevens...	Spokane Pottery Co.....	61.64	24.20	2.10	0.30	0.78	2.38	0.16	0.50	0.52	7.56	.....	100.14
14	Palouse.....	Whitman.	Palouse Pottery Mfg. Co.....	58.77	30.28	1.60	0.34	trace	0.08		.....	0.88	8.44	.....	100.39
15	Palouse.....	Whitman.	Palouse Pottery Mfg. Co.....	53.16	30.08	1.83	0.43	0.24	1.50	0.09	1.50	1.70	9.76	.....	100.29
			PAVING BRICK—												
16	Renton.....	King.....	Denny-Renton Clay & Coal Co.....	62.11	17.59	4.77	1.53	2.26	2.30	1.65	0.51	1.63	5.60	.....	99.95
17	Taylor.....	King.....	Denny-Renton Clay & Coal Co.....	56.60	20.46	6.42	1.30	1.03	1.48	0.66	0.47	1.50	9.90	.....	99.82
			TERRA COTTA—												
18	LaGrande...	Pierce. ...	Denny-Renton Clay & Coal Co.....	67.24	19.23	2.50	0.34	0.49	0.88	.....	0.25	2.12	6.66	.....	99.79
19	Clayton.....	Stevens...	Washington Brick, Lime & Mfg. Co.....	53.64	31.96	1.82	.....	trace	1.17		.....	1.66	10.06	.....	.....
20	Clayton.....	Stevens...	Washington Brick, Lime & Mfg. Co.....	51.36	33.09	2.39	.....	0.78	1.08		.....	2.12	10.54	.....	.....
			FLINT FIRE CLAY—												
21	Kummer....	King.....	Denny-Renton Clay & Coal Co.....	40.37	38.57	3.43	0.67	0.45	0.08	0.22	.....	1.56	15.30	.....	100.65
22	Kummer....	King.....	Denny-Renton Clay & Coal Co.....	40.26	35.84	3.20	0.40	0.26	.....	trace	2.38	1.75	15.21	0.70	100.00
23	Kummer. ..	King.....	Denny-Renton Clay & Coal Co.....	33.44	45.23	1.57	1.60	3.61	1.44		.....	.....	16.44	.....	103.33
			PORTLAND CEMENT CLAY—												
24	Bellingham.	Whatcom.	Olympic Portland Cement Co., Ltd.....	58.20	18.17	6.95	3.47	3.28	.....	.....	.....	.....	6.00	3.93	99.80
25	Concrete....	Skagit....	Washington Portland Cement Co.....	57.06	16.16	8.30	5.96	3.20	2.22		.....	.....	6.22	.....	99.12

* —5— $CaCO_3$. † —5— $MgCO_3$.

Nos. 1-23 from Clays and Clay Industry of Washington, Shedd, 1910. Nos. 24-25 from Bulletin 4, Washington Geological Survey, Shedd, 1913.

LIST OF CLAY PLANTS IN THE STATE.

County	Locality	Company	Products in 1912
Benton	Hanford	S. Garsi	Idle.
Benton	Kennewick	Twin City B. & T. Co.	Common brick.
Chelan	Chelan	H. E. Dunham	Common brick.
Chelan	Leavenworth	Leavenworth Brick Co.	Common brick.
Chelan	Wenatchee	Hobson Brothers	Common brick.
Clarke	Image	Columbia Clay Co.	Drain tile, sewer pipe and fireproofing.
Clarke	Vancouver	Carson Brothers	Common brick.
Clarke	Vancouver	Hidden Brothers	Common brick.
Douglas	Waterville	Frank Malfa	Common brick.
King	Auburn	Northern Clay Co.	Terra cotta.
King	Bayne	Standard Clay Co.	Vitrified brick.
King	Kummer	Denny-Renton C. & C. Co.	.....
King	Pontiac	Pontiac Brick & Tile Co.	Common brick.
King	Renton	Denny-Renton C. & C. Co.	Common, vitrified and front brick.
King	Seattle	Abrahamson Brick Co.	Common brick.
King	Seattle	Builders Brick Co.	Common brick and fireproofing.
King	Seattle	Harper-Hill Brick Co.	Common brick.
King	Seattle	Lake Union Brick Co.	Common brick.
King	Seattle	Lohse Brick Co.	Common brick.
King	Seattle	Seattle Brick & Tile Co.	Common brick.
King	Seattle	Washington Brick & Tile Co.	Common brick.
King	Taylor	Denny-Renton C. & C. Co.	Paving, front and firebrick; drain tile, sewer pipe, con duits, tile, terra cotta.
King	Van Asselt	Denny-Renton C. & C. Co.	Drain tile, sewer pipe, terra cotta, fire brick.
King	Woodinville	Superior B., T. & P. Co.	Common brick.
Kitsap	Harper	Harper-Hill Brick Co.	Common brick.
Kittitas	Clealum	O. K. Brick & Tile Co.	Common brick.
Klickitat	Goldendale	N. B. Brooks	Common brick.
Lewis	Centralia	Centralia B. & T. Co.	Common brick.
Lewis	Chehalis	Chehalis B. & T. Co.	Common brick and drain tile.
Lewis	Little Falls	Standard Clay Co.	Drain tile, sewer pipe, building tile, stove lining, etc.
Pierce	Clay City	Far West Clay Co.	Common brick, drain tile, fireproofing and fire clay.
Pierce	Jovita	Jovita Brick Co.	Common brick.
Pierce	Tacoma	F. H. Goss Brick Co.	Common brick.
Skagit	Bay View	Farmers B. & T. Co.	Common brick and tile.
Skagit	Tiloh	Knapp Brick & T. Co.	Common brick and drain tile.
Snohomish	Everett	Everett Brick Co.	Common brick.
Spokane	Cheney	Cheney Brick Co.	Common brick.
Spokane	Chester	Bergman Clay Co.	Fire brick.
Spokane	Freeman	Wash. Brick, Lime & Sewer Pipe Co.	Drain tile, sewer pipe, common brick.
Spokane	Mead	J. T. Davie Brick Co.	Common brick.
Spokane	Mica	American Fire Brick Co.	Common, front, fire brick; fireproofing, drain tile, sewer pipe.
Spokane	Spear	Wash. Brick, Lime & Sewer Pipe Co.	Drain tile and sewer pipe.
Spokane	Spokane	A. T. Dishman	Common brick.
Spokane	Spokane	Pioneer Brick Co.	Common brick.
Stevens	Bossburg	P. R. Fitzgerald	Common brick.
Stevens	Chewelah	Chewelah Brick & L. Co.	Common brick.
Stevens	Clayton	Wash. Brick, Lime & Sewer Pipe Co.	Front and fire brick, terra cotta.
Stevens	Colville	Roman Stone & Mfg. Co.	Common brick.

LIST OF CLAY PLANTS IN THE STATE—Concluded.

County	Locality	Company	Products in 1912
Stevens.....	Kettle Falls..	Kettle Falls Brick Co.....	Common brick.
Thurston....	Olympia.....	Burtchett & Baker.....	Common brick.
Walla Walla.	Walla Walla.	Walla Walla Constr. Co.....	Common brick.
Whatcom....	Bellingham..	J. R. Headrick & Co.....	Common brick.
Whatcom....	Bellingham..	J. F. Miller & Bros.....	Common brick.
Whatcom....	S.Bellingham	Coast Clay Co.....	Front brick and fire clay.
Whitman....	Colfax.....	Easum Brothers	Idle.
Whitman....	Garfield.....	Garfield Brick Co.....	Idle.
Whitman....	Uniontown...	George Herboth	Common brick.
Yakima.....	Granger.....	Granger Brick & T. Co.....	Common brick and drain tile.
Yakima.....	Toppenish...	Toppenish Brick & T. Co.....	Common brick.

PRODUCTION.

A wide variety of clay products is manufactured at the many clay plants within the state. Besides common brick and vitrified brick and block, the list includes front brick, drain tile, sewer pipe, conduits, architectural terra cotta, fire proofing, fire brick, pottery and miscellaneous clay products.

The apportionment of these totals among the various clay products has been carried out as far as possible and the table below shows the value of each product for each year, since 1905. The table shows plainly that common brick, vitrified brick and sewer pipe make up a large percentage of the total. While common brick has decreased since 1909, vitrified brick and block seem to have gained. It is to be noted, however, that the total value has declined since 1909. The number of operating firms shows similar variation, although the rank of the state in the nation was maintained quite uniformly until 1912, when it fell from eleventh to fifteenth.

The decreased value is not to be regarded as indicating a proportionate decrease in production since a general lowering of prices has accompanied, if not caused, the lessened manufacture of clay products. Thus the average price of common brick in 1912 was less than 85% of the price in 1907 and was $.55 lower than in 1909.

It should be noted that although one of the principal clay products of the state is vitrified brick, the lack of more than two producers makes it impossible to include these figures for some years in the statistical tables.

VALUE OF CLAY PRODUCTS MANUFACTURE IN WASHINGTON, 1905-1912.

PRODUCT		1905	1906	1907	1908	1909	1910	1911	1912	Total
Brick—										
Common	Quantity	81,022,000	99,788,000	101,905,000	107,638,000	143,198,000	130,634,000	99,588,000	78,000,000	
	Value	$566,385	$708,968	$846,971	$817,962	$1,081,579	$956,510	$695,100	$547,061	$6,220,536
	Average price	$6.99	$7.10	$8.31	$7.60	$7.55	$7.32	$6.98	$7.01	
Vitrified	Quantity	9,763,000	9,609,000	(a)	(a)	(a)	(a)	40,291,000	(a)	
	Value	$143,702	$156,476	(a)	(a)	(a)	(a)	$743,352	(a)	$1,043,530
	Average price	$14.72	$16.28	$18.22	$19.82	$18.72	$18.87	$18.45	$16.88	
Front	Quantity	3,304,000	4,439,000	4,539,000	4,011,000	7,802,000	5,570,000	5,224,000	6,881,000	
	Value	$86,388	$122,770	$127,245	$112,749	$153,600	$124,952	$118,615	$146,265	$994,584
	Average price	$26.15	$27.66	$28.03	$28.11	$19.94	$22.43	$22.71	$21.26	
Fancy	Value	$5,425	.....	.....	.....	.....	.....	(a)	.....	.....
Fire	Value	$24,699	$46,525	$43,940	$42,045	$103,531	$25,017	$63,654	$34,293	$383,704
Drain Tile	Value	$11,153	$13,057	$17,025	$28,551	$18,495	$34,128	$29,314	$24,676	$176,399
Sewer Pipe	Value	$242,245	$313,880	$482,870	$493,165	$737,847	$817,086	$738,473	$496,500	$4,322,066
Arch. Terra Cotta	Value	(a)	(a)	$94,795	$171,845	$206,324	$198,358	$283,608	$365,109	$1,320,039
Fireproofing	Value	(a)	$15,405	(a)	$45,205	$71,067	$114,501	$153,180	$163,077	$562,935
Tile, not drain	Value	.....	(a)	.....	.....	.....	.....	.....	(a)	.....
Pottery	Value	$41,100	$41,560	$30,695	(a)	(a)	(b)	(b)	(b)	$113,355
Miscellaneous	Value	$53,935	$80,743	$278,393	$390,317	$686,043	$753,302	$758,428	$611,889	$3,613,050
Total	Value	$1,175,032	$1,499,884	$1,921,934	$2,104,289	$3,060,486	$3,023,486	$2,840,372	$2,388,870	$18,014,353
No. of operators		72	61	63	67	65	65	55	50	.....
Rank of state		25	24	17	13	12	11	11	15	.....

(a) Included in "Miscellaneous."
(b) Value of pottery products in Washington for 1910, 1911 and 1912 could not be included in the state totals without disclosing the operations of individual establishments.

REFERENCES ON CLAYS.

Occurrence, properties, and uses: Ries; Wiley and Sons, 1908.

Clay deposits of Washington: Landes; U. S. Geol. Surv., Bull 260, pp. 550-558, 1905.

Clays of Washington: Shedd; Wash. State College, Pullman, 1910.

Short papers—Transactions American Ceramic Society, Vols. 1-12.

See references on Cement.

THE CEMENT INDUSTRY.

GENERAL STATEMENT.

The cement industry has been established for a long period of time in the United States and has had a remarkably rapid growth. At the present time, however, the Pacific Coast field is the only one that is extending very rapidly. In the 29 years since the industry was begun on this Coast it has grown from a single plant with a capitalization of $50,000 and a capacity of 100 barrels a day, to a total of 13 plants, capitalized at nearly $25,000,000, with a total output of approximately 40,000 barrels per day.

The first step in Washington toward the making of cement was taken in 1904, in Pend Oreille (then a part of Stevens county). A small plant for the manufacture of natural hydraulic cement was established and run for a short time. It was the intention of the operators to construct a Portland cement plant later but this plan was never carried out.

"The first Portland cement made in Washington was by the Washington Portland Cement Company, at Concrete, on the Skagit river, in Skagit county. Work was started on this plant June 1, 1905, and the first cement was made in May, 1907. The plant to start with had two kilns, each 7½ feet in diameter and 100 feet long, and a capacity of 900 barrels per day. In the spring of 1911 two additional kilns, each 8 feet in diameter and 125 feet long, were installed. This increased the capacity 1,700 barrels a day, making the total capacity of the plant 2,500 barrels per day.

The next cement plant to be built in Washington was the Superior Portland Cement plant, located at Concrete, just across the Baker river to the west of the Washington plant. This was built soon after the Washington plant, and for a number of years these were the only Portland cement plants in operation in Washington.

In June, 1910, work was started on the plant of the Inland Portland Cement Company, at Metaline Falls, and April 1, 1911,

it was completed. The construction of a plant at this point involved also the development of a large water power and this was not completed until August, so that the plant was not in operation until this time.

The plant of the International Portland Cement Company, which is located in Irvin, nine miles east of Spokane, was begun in January, 1912, and the first cement manufactured one year later.

The Olympic Portland Cement Company, Limited, at Bellingham, was the first plant in Washington to use the wet process in the manufacture of Portland cement. The work of building this plant was begun in the fall of 1911, and it has been in operation for some time now.

In the fall of 1912 work was begun on the plant of the Idaho Portland Cement Works, at Asotin, Washington, and it should not be long now before this plant will be manufacturing cement."*

Clays of suitable character are sufficiently abundant in Washington, but the lack of extensive deposits of limestone is a serious handicap to the industry. Although commonly reported that limestone suited to the manufacture of Portland cement is to be found only in the northern counties of the state, the recently utilized deposit in Asotin county is an important exception.

In addition to the general discussion of limestones of Washington presented in the chapter on lime kilns of this bulletin, the following notes may be of interest: The deposits at Roche Harbor, San Juan county, are advantageously located at tidewater adjacent to some clay beds exceptionally free from grit. Deposits of slate, which are available for cement manufacture, are near at hand also. Whatcom county is well supplied with both clays and limestone, especially in the vicinity of Kendall. This limestone is for the most part remarkably pure, ranging from 97.5 per cent. to nearly 99 per cent. calcium carbonate. Drilling

*Cement Materials and Industry in the State of Washington, S. Shedd, Washington Geological Survey, Bulletin 4, pp. 72-73, 1913.

has shown certain of the clay beds to be 50 feet thick. In Skagit county what is probably the most favorably located deposit of limestone is on the Baker river near its junction with the Skagit. Near the limestone there are silt clays averaging 165 feet in thickness. Snohomish county has several good limestone areas of unknown extent. In each case the limestone is associated with slates and schists. These metamorphic rocks of Whatcom and Snohomish counties extend down into King county, which is rich in clays of excellent quality. The prospecting in Okanogan county has revealed many limestone areas, some of which, in the western part of the county, cover several square miles. A long, narrow belt of crystalline limestone is found in Ferry county. Nearby are beds of clay and argillaceous limestone, which might be of use in Portland cement manufacture. Large deposits of limestone and slates are found in Stevens county, but many of these are high in their content of magnesia and the extent and location of the more desirable high calcium deposits is not at present known.

For a very complete description of the deposits of cement materials throughout the state with analyses showing their chemical composition, the reader is referred to Bulletin No. 4 of the Washington Geological Survey, by S. Shedd.

The uses of Portland cement in cement work are multitudinous and great extension of the field is yet anticipated. One of the later developments is the construction of concrete pavements and roads. The use of concrete in the construction of heavy masonry, such as wharves, tunnels, viaducts, dry docks, and retaining walls, is well established. Another promising field, as yet but slightly developed, is the use of cement in art and architectural work.

The production of cement in Washington in 1912 amounted to 1,438,137 barrels, having a value of $2,012,785.

LIST OF CEMENT PLANTS.

Operator.	*Locality.*	*County.*
Inland Portland Cement Co.	Metaline Falls	Pend Oreille
Superior Portland Cement Co.	Concrete	Skagit
Washington Portland Cement Co.	Concrete	Skagit
International Portland Cement Co.	Spokane	Spokane
Olympic Portland Cement Co.	Bellingham	Whatcom

REFERENCES ON CEMENT.

Cements, limes and plaster: Eckel, 1907; Wiley and Sons, New York.

Tests of mortars and concrete: Humphrey; U. S. Geol. Surv., Bulls. 331 and 344.

Manufacture of hydraulic cement: Bleininger; Ohio Geol. Surv., 4th Series, Bull. 3, 1904.

Uses of hydraulic cement: Eno; *idem*, Bull 2, 1904.

Cement materials of Washington: Landes; U. S. Geol. Surv., Bull 285, 1906.

Cement materials of Washington: Shedd; Wash. Geol. Surv., Bull. 4, 1914.

METAL MINING.

GENERAL STATEMENT.

Taken as a whole Washington is a state in which most of the metalliferous ores mined are of the base or refractory grade. That is to say, there is but little free-milling ore and only a small part of the output is taken from placer mines. This means that the majority of the mines are compelled to depend upon the transportation and custom-smelting companies. To be profitably worked, the mines must be located reasonably near a railway line, or a navigable waterway. In addition to this, the ore must be of a comparatively high grade, or else the charges for freight and treatment must be very low; unless the mine be an extensive one and able to operate its own transportation lines and its own smelting plants.

As is well known, these conditions are met with in but few of the metal-mining districts of the state. In fact many of the important mineral-bearing counties have a small railway mileage and it so happens that the ores of many of the camps are such that a high charge for treatment is necessary. In spite of the very serious difficulties encountered, the mining industry has been pushed by a large and increasing number of operators so that in the decade ending with 1912 the total production of the precious and semi-precious metals has been kept up in a satisfactory manner.

The production of gold for this period has been largely from Ferry and Stevens counties. Only once, 1904, did the production of another county exceed each of them, and for six of the ten years Ferry County was in the lead with a total production far in excess of that of any other county. Ferry and Stevens counties were in the lead also in the production of silver, but the excess of production of Ferry County was not so great as in the case of gold.

The copper produced has come almost entirely from four counties, Ferry, Okanogan, Snohomish and Stevens, the last named having produced more than 57 per cent. of the total for

the state during the decade 1903-12. In 1912 this county produced over 92 per cent. of the state's copper.

In lead ores Stevens County has been the only steady producer, no other county contributing in 1904, 1906, 1907 or 1912. The small amount of lead produced makes this item of relatively little moment. Only a little over eight and a quarter million pounds was mined in the decade 1903-1912; of this amount about 99 per cent. came form Stevens County.

In considering the total production for the decade in gold, silver, copper and lead, the apportionment among the counties shows a greater range. Combined percentages of the total are herewith shown:

County	*Amount produced.*	*Per cent. of total.*
Chelan	$190,029	2.9
Ferry	3,432,747	52.3
King and Kittitas	165,455	2.5
Okanogan	227,594	3.5
Snohomish and Skamania	364,035	5.5
Stevens	1,819,491	27.8
Whatcom	345,617	5.3
Others*	11,671	.2
Total	$6,557,639	100.00

A glance at the above tabulation shows that over 80 per cent. of this total has come from two counties and over 65 per cent. of this amount from one.

There is added below a complete set of tables of production of gold, silver, copper and lead for each county during the decade, 1903-1912, inclusive. These were compiled from the Mineral Resources published annually by the United States Geological Survey. It is to be noted that in every case the figures taken represent mine production only, since this is considered to be the most accurate when all factors are taken into account.

*"Others" includes Asotin, Benton, Clark, Clallam, Franklin, Lewis, Lincoln, Pend Oreille, Pierce, Skagit and Whitman counties.

TOTAL VALUES OF THE PRODUCTION OF GOLD, SILVER, COPPER AND LEAD, BY COUNTIES, FOR THE PERIOD 1903 TO 1912, INCLUSIVE.

COUNTY	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Total
Asotin	$696	.....	$1,030	$995	.....	.....	.....	$68	.....	.....	$2,789
Chelan	80,080	$21,196	13,010	291	$2,801	$3,681	$4,293	6,941	$22,100	$35,636	190,029
Clarke	.....	.....	100	100	.....	.....	.....	.....	.....	.....	200
Clallam	.....	.....	.....	.....	.....	3,629	39	.....	.....	257	3,925
Ferry	368,861	144,290	107,160	88,482	39,830	21,674	238,439	814,913	896,848	712,250	3,432,747
King *	1,604	6,327	* 19,494	* 22,442	10,698	13,933	10,887	21,118	13,099	9,419	* 165,455
Kittitas	4,441	2,721	.....	.....	8,755	6,029	5,876	3,619	2,830	2,163	.....
Lewis	.....	.....	.....	.....	.....	.....	.....	.....	447	.....	447
Okanogan	71,917	24,218	8,779	17,895	17,015	29,050	14,415	14,894	11,191	18,220	227,594
Pend Oreille	.....	.....	.....	.....	.....	.....	.....	.....	† 3,248	.....	3,248
Pierce	50	.....	.....	.....	.....	.....	.....	241	.....	.....	291
Skagit	1,161	.....	.....	.....	.....	.....	.....	5	13	.....	1,179
Snohomish	139,305	42,475	‡ 72,747	32,971	73,268	1,300	708	105	435	721	364,035
Stevens	75,412	147,430	212,523	148,849	217,348	293,104	173,747	106,319	105,412	339,347	1,819,491
Whatcom	48,418	129,371	91,338	38,508	28,920	6,083	562	26	190	2,201	345,617
Whitman	.....	.....	.....	.....	.....	312	.....	.....	204	.....	516
Other counties	36	.....	19	.....	.....	21	.....	.....	.....	.....	76
Totals	$791,991	§ $518,028	$526,200	$350,533	$398,635	$378,816	$448,966	$968,249	$1,056,017	$1,120,214	$6,557,649

* Includes Kittitas county.
† Includes zinc—20,590 lbs.; value, $1,174.
‡ Includes Skamania county.
§ Includes $9.00 in platinum.

PRODUCTION OF LEAD BY COUNTIES, IN POUNDS AND VALUES—1903-1912.

COUNTY	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Total
Ferry	.....	.....	.....	.....	.....	.....	.....	128 lbs $5	.....	.....	128 lbs $5
King	.....	.....	.....	.....	.....	3,500 lbs $147	.....	.....	.....	.....	3,500 lbs $147
Okanogan	6,300 lbs $252	.....	200 lbs $9	.....	.....	.....	23 lbs $1	248 lbs $11	.....	.....	6,771 lbs $273
Pend Oreille	.....	.....	.....	.....	.....	.....	.....	.....	11,982 lbs $539	.....	11,982 lbs $539
Skagit	8,400 lbs $252	.....	.....	.....	.....	.....	.....	40 lbs $2	.....	.....	8,440 lbs $254
Snohomish	1,200 lbs $48	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,200 lbs $48
Stevens	389,512 lbs $15,523	1,760,309 lbs $69,937	604,843 lbs $28,428	926,100 lbs $52,787	820,035 lbs $43,462	1,146,929 lbs $48,171	288,677 lbs $12,413	1,321,871 lbs $58,162	836,602 lbs $37,647	127,381 lbs $5,732	8,222,259 lbs $372,262
Totals	405,412 lbs $16,075	1,760,309 lbs $69,937	605,043 lbs $28,437	926,100 lbs $52,787	820,035 lbs $43,462	1,150,429 lbs $48,318	288,700 lbs $12,414	1,322,287 lbs $58,180	848,584 lbs $38,186	127,387 lbs $5,732	8,254,280 lbs $373,528

PRODUCTION OF COPPER BY COUNTIES, IN POUNDS AND VALUES—1903-1912.

COUNTY	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Total
Ferry	75,471 lbs $10,000	77,548 lbs $8,948	.....	52 lbs $10	131,731 lbs $26,346	1,144 lbs $151	606 lbs $79	61 lbs $8	161,158 lbs $20,145	77,968 lbs $12,865	525,739 lbs $78,552
King	.....	.....	.....	.....	.....	1,689 lbs $223	.....	.....	.....	.....	.....
Kittitas *	.....	329 lbs $46	* 2,008 lbs $313	.....	.....	.....	.....	.....	.....	.....	* 5,026 lbs $582
Lewis	.....	.....	.....	.....	.....	.....	.....	.....	3,425 lbs $428	.....	3,425 lbs $428
Okanogan	113,207 lbs $15,000	.....	.....	24,363 lbs $4,702	26,200 lbs $5,240	57,000 lbs $7,524	29,405 lbs $3,822	24 lbs $3	.....	966 lbs $159	251,165 lbs $36,450
Pend Oreille	.....	.....	.....	.....	.....	.....	.....	.....	411 lbs $51	.....	411 lbs $51
Pierce	.....	.....	.....	.....	.....	.....	.....	1,770 lbs $224	.....	.....	1,770 lbs $224
Skagit	.....	.....	.....	.....	.....	.....	.....	.....	101 lbs $13	.....	101 lbs $13
Snohomish †	292,863 lbs $38,720	77,850 lbs $8,991	† 91,252 lbs $14,235	138,802 lbs $26,692	74,837 lbs $14,967	3,765 lbs $497	4,977 lbs $647	.....	.....	.....	684,346 lbs $104,749
Stevens	19,038 lbs $2,522	194,320 lbs $25,803	15,449 lbs $2,410	72,313 lbs $13,956	65,044 lbs $13,009	248,432 lbs $32,793	220,146 lbs $28,619	85,063 lbs $10,803	153,112 lbs $19,139	1,007,076 lbs $166,168	2,079,993 lbs $315,222
Totals	500,579 lbs $66,242	350,047 lbs $43,788	108,709 lbs $16,958	235,030 lbs $45,360	297,812 lbs $59,562	312,030 lbs $41,188	255,134 lbs $33,167	86,918 lbs $11,038	318,207 lbs $39,776	1,086,010 lbs $179,192	3,551,976 lbs $536,271

* Includes King county.
† Includes Skamania county.

PRODUCTION OF SILVER BY COUNTIES, IN VALUE—1903-1912.

COUNTY	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Total
Chelan	.....	.....	$370	$1	$35	$51	$61	$74	$254	$506	$1,352
Ferry	$83,464	$22,085	21,107	17,730	9,452	4,190	27,921	100,092	98,177	93,687	477,905
King.*	20	.....	* 524	* 614	353	918	385	1,698	1,854	1,708	.....
Kittitas *	7	.....	.....	.....	69	58	46	30	29	22	* 8,335
Okanogan	20,656	6,152	6,457	4,394	2,384	13,528	1,689	1,792	6,468	14,759	78,279
Pend Oreille	.....	.....	.....	.....	.....	.....	.....	.....	851	.....	851
Skagit	865	.....	.....	.....	.....	.....	.....	2	.....	.....	867
Snohomish †	29,876	7,133	† 18,087	3,406	12,797	28	12	17	2	4	71,362
Stevens	54,865	40,090	15,822	4,269	11,286	28,247	11,217	7,172	21,552	143,624	388,144
Whatcom	12,030	14,371	13,355	312	161	38	3	.....	1	15	40,286
Other counties	6	.....	5	12	.....	18	.....	9	16	1	67
Totals	$201,789	$89,831	$75,727	$30,738	$36,537	$47,076	$41,334	$110,886	$129,204	$254,326	$1,017,448

* Kittitas included with King for 1905-1906.
† Skamania included with Snohomish for 1905.

GOLD PRODUCTION BY COUNTIES, IN VALUES—1903 to 1912.

COUNTY	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Total
Adams	$690	.....	$1,025	$983	.....	.....	.....	$68	.....	.....	$2,766
Chelan *	80,090	* $21,187	12,640	290	$2,766	$3,630	$4,232	6,867	$21,846	$35,130	188,678
Calrke	.....	.....	100	100	.....	.....	.....	.....	.....	.....	200
Ferry	275,397	113,257	86,053	70,742	4,032	17,333	210,437	714,808	778,526	605,698	2,876,283
King †	1,584	6,327	† 18,657	† 21,828	10,345	12,645	10,501	19,420	11,245	7,711	.....
Kittitas †	4,434	2,675	.....	.....	8,686	5,971	5,829	3,589	2,801	2,141	156,389
Okanogan	36,009	18,066	2,313	8,799	9,394	7,998	8,907	13,088	4,723	3,302	112,599
Pend Oreille	.....	.....	.....	.....	.....	.....	.....	.....	633	.....	633
Snohomish ‡	70,661	25,351	‡ 40,425	2,873	45,504	775	49	88	433	717	186,876
Stevens	2,502	11,600	165,863	77,837	149,588	183,893	121,498	30,182	27,074	23,823	793,860
Whatcom	36,388	115,000	77,983	38,196	28,759	6,045	559	26	189	2,186	305,331
Whitman	.....	.....	.....	.....	.....	309	.....	.....	203	.....	512
Clallam	.....	.....	.....	.....	.....	3,614	39	.....	.....	256	3,909
Other counties	130	.....	19	.....	.....	21	.....	9	4	.....	183
Totals	$507,885	$314,463	$405,078	$221,648	$259,074	$242,234	$362,051	$788,145	$847,677	$680,964	$4,628,219

* Chelan includes Asotin and Clarke for 1904.
† Kittitas included with King for 1905 and 1906.
‡ Snohomish includes Skamania for 1904.

THE METAL MINING INDUSTRY DURING THE DECADE 1903-1912.

It will be instructive to trace the development of the metal mining industry during this period and to note the factors which have from year to year been important in advancing or hindering the state's production.

A total of over eight hundred mining properties were reported in 1903 but of this number less than eight per cent. were productive, the remainder being in the course of development. In spite of this fact, the production of 1903 was a decided increase over that of 1902. The doubling of the number of mines reporting production of the precious metals probably accounts for the apparent excess in output.

The idleness of several mines in Chelan, Ferry, Okanogan and Snohomish counties in 1904 caused a decrease in the gold production from that of 1903. The proportion of producing to non-producing mines remained about the same for the quartz mines, which were the source of about 97 per cent. of the gold. The lack of transportation and the fact that nearly all the ore required smelting accounted to a large extent for the relatively few producing mines.

In 1905 there was no abnormal change. Of the four counties showing decreases in 1904 but one, Snohomish, gained in 1905. In addition to that, the increase in production was from Stevens, King and Kittitas counties.

The figures for 1906 show a peculiar change in production. With an increase of over 100 per cent. in the production of copper and over 65 per cent. in lead, there was a decrease of about 50 per cent. in gold and nearly as much in silver, as compared with the production of 1905. Some of the mines in Chelan, Ferry, King, Okanogan, Snohomish, Stevens and Whatcom counties did no work for that year, while others held back their ores for a cheaper means of transportation. The decrease was due almost entirely to the smaller quantities of siliceous ores treated, the falling off in that class being 29,042 tons. The increase in copper ores brought little gold or silver and the lead ores treated were non-argentiferous.

The production for 1907 showed an increase in gold, silver and copper, while lead decreased slightly. Snohomish and Stevens counties showed substantial increases in gold and silver production. Ferry County produced nearly 45 per cent. of the copper while the total output of lead was from Stevens County.

In 1908 the total value of metals mined in Washington decreased from that of 1907. Although both silver and lead increased in value of production, the smaller tonnage of ore and the reduction of the value of copper were sufficient to bring down the year's total production.

In 1909, although there was a decrease of 12 per cent., 20 per cent. and 74 per cent. in silver, copper and lead, respectively, from the production of 1908, the substantial increase in gold kept the total gain above 18 per cent. The great increase in gold and silver, due to development in the Republic district in Ferry County, was the most notable feature of the year's activity.

The year 1910 was a banner year in the metal mining industry in Washington. The mine production of gold, silver, copper and lead showed an increase of nearly 116 per cent. in spite of a decrease in the copper production. The Republic district, in Ferry County, continued its rapid development and was largely responsible for the great increase in both gold and silver.

The total production for 1911 was still greater than in 1910, although copper was the only ore showing any decided advance. The percentage of gain or loss as compared with 1910 is as follows, values only being considered:

Gold	+ 11 per cent.	Copper	+ 250 per cent.
Silver	+ 16 per cent.	Lead	— 34 per cent.

Total + 9 per cent.

The increase in gold was credited mainly to Ferry County and slightly to Chelan County. Although Ferry County produced most of the silver, the greatest increase was in Okanogan with 255 per cent. and in Stevens with 200 per cent. The copper output was the greatest since 1904 and was about equally divided between Ferry and Stevens counties, while 98 per cent. of the state's product in 1910 was from Stevens County. A

few trial shipments, the first shipped from the state, were obtained from lead-zinc ore mined at Metaline, Pend Oreille County.

In 1912 the value of the output of gold, silver, copper and lead was only slightly in advance of that of 1911. In fact, totals for 1910, 1911 and 1912 have varied but little, although there has been considerable variation in the output of the different metals. A falling off of 22 per cent. marked the gold production, which was due largely to conditions at Republic, Ferry County, where cyanide mills were being installed. The increase of 96 per cent. in silver had its source in the increased copper ore shipped, mainly from Stevens County. The activity in development of the Chewelah district in Stevens County was a feature of the mining industry for 1912.

METAL MINES NOW OR RECENTLY IN OPERATION.

Mine	*Location.*	*County.*
Belcher	Belcher	Ferry
Napoleon	Boyds	Ferry
Ivanhoe	Covada	Ferry
Silver Leaf	Covada	Ferry
Lone Star & Washington	Danville	Ferry
Shawnee	Danville	Ferry
Little Giant	Orient	Ferry
Swamp King	Orient	Ferry
Ben Hur	Republic	Ferry
Black Tail	Republic	Ferry
Insurgent	Republic	Ferry
Knob Hill	Republic	Ferry
Lone Pine	Republic	Ferry
Pearl	Republic	Ferry
Quilp	Republic	Ferry
Republic	Republic	Ferry
San Poil	Republic	Ferry
Snowstorm	Republic	Ferry
South San Poil	Republic	Ferry
Surprise	Republic	Ferry
Phil Sheridan	Sheridan	Ferry
Apex	Berlin	King
Butcher Boy	Chesaw	Okanogan
Gold Axe	Chesaw	Okanogan
Apache	Nespelem	Okanogan
Double Header	Nespelem	Okanogan
Hoyt and Miller	Nespelem	Okanogan
Dividend	Oroville	Okanogan

METAL MINES NOW OR RECENTLY IN OPERATION.

Mine	*Location.*	*County.*
Golden Chariot	Oroville	Okanogan
Lakeside	Oroville	Okanogan
Bodie	Wauconda	Okanogan
Duluth Toroda	Wauconda	Okanogan
Liberty	Blue Creek	Stevens
Bonanza	Bossburg	Stevens
Clugston	Bossburg	Stevens
Jarvis and Jarvis	Bossburg	Stevens
O. P. Nestos	Bossburg	Stevens
Young America	Bossburg	Stevens
Amazon	Chewelah	Stevens
Blue Star	Chewelah	Stevens
United Copper	Chewelah	Stevens
Paul Laplant	Evans	Stevens
Ben Venue	Kettle Falls	Stevens
Sunday Star	Kettle Falls	Stevens
Cleveland	Springdale	Stevens
Deer Trail No. 2	Turk	Stevens
Legal Tender	Turk	Stevens
Banshee	Valley	Stevens
Seattle-St. Louis	Glacier	Whatcom
Blinn	Blewett	Chelan
Golden Eagle	Blewett	Chelan
Washington Meteor	Blewett	Chelan
Wenatchee Gold Mining Co.	Entiat	Chelan
Cougar	Liberty	Kittitas
Gold Hill	Liberty	Kittitas
Hope	Liberty	Kittitas
Phoenix and Little York	Liberty	Kittitas
Wolf	Liberty	Kittitas

REFERENCES ON METAL MINING.

Ore deposits: Clarke; U. S. Geol. Surv., Bull. 491, pp. 599-681, 1911.

Mining districts of western United States: Hill; U. S. Geol. Surv., Bull. 507, p. 279-288, 1912.

Metalliferous resources of Washington: Landes; Wash. Geol. Surv., Vol. I, pt. 2, 1901.

Metaline district: Bancroft; U. S. Geol. Surv., Bull. 470, pp. 188-200, 1911.

Monte Cristo district: Spurr; U. S. Geol. Surv., 22nd Ann. Rept., pt. 2, pp. 785-865, 1901.

Republic district: Umpleby; Wash. Geol. Surv., Bull. 1, 1910.

Myers Creek and Oroville districts: Umpleby, *idem*, Bull. 5, 1911.

Blewett district: Weaver; *idem*, Bull. 6, 1912.

Index district: Weaver; *idem*, Bull. 7, 1912.

Covada district: Weaver; *idem*, Bull. 16, 1913.

MINERAL WATERS.

GENERAL STATEMENT.

The mineral springs of the state are numerous but so far they have been but little developed. No detailed study or examination of the various water supplies has been made, so that only a meager and general account is possible at this time.

The mineral waters are of several types. Some are characterized by differences in temperature as well as in the amount and kind of dissolved mineral matter. The variation in temperature is not great, but there is a great range in the quantity of dissolved matter. To the average consumer a water that is sold in limited quantities for either table or medicinal use is classed as a mineral water, even though the quantity of inorganic matter contained in solution is smaller than that in many city water supplies.

Springs are supplied by rainfall and since rainwater, when formed, is practically pure, it follows that whatever mineral matter is in the spring water must have been introduced after the water reached the ground. Percolating through the rocks and soils of the earth these underground waters come in contact with many soluble substances from which they obtain various amounts of inorganic matter. Obviously, the range of possibilities in the amount and kind of mineral matter so taken into solution is very great and cannot even be indicated here.

The mineral waters which have attained commercial importance are not confined to any one part of the state and their wide distribution indicates that many others of value for medicinal or table use may be discovered. In 1912 waters were on the market from the following counties: Clallam, Grant, King, Klickitat, Skamania, Thurston, and Yakima.

LIST OF PRODUCERS.

	Locality.	*County.*
Soap Lake Mineral Water Co.	Soap Lake	Grant
Diamond Mineral Spring Water Co.	Auburn	King
Scenic Hot Springs	Scenic	King
Klickitat Mineral Springs Co.	Klickitat	Klickitat
Collins Hot Springs	Collins	Skamania
Table Rock Mineral Water Co.	Stevenson	Skamania
Olympian Hygeian Spring Co.	Olympia	Thurston
Artesian Water Co.	North Yakima	Yakima
Yakima Soda Springs	North Yakima	Yakima
Sol Duc Hot Springs	Sol Duc	Clallam

In character these waters vary considerably. Some are strictly bathing waters, such as Soap Lake in Grant County, and Scenic Hot Springs in King County. Others are used mainly for table or medicinal purposes, and at least one is used largely in the manufacture of soft drinks. Analyses of most of these waters are not available at this time, but those for Soap Lake, Diamond and Artesian waters are given below:

SOAP LAKE MINERAL WATER.

	Parts per thousand.
Total solids	28.2669
Volatile solids	0.62503
Non-volatile solids	27.64186
Silica	0.12816
Alumina and iron oxide	Trace
Calcium sulphate	Trace
Calcium carbonate	Trace
Magnesium sulphate	0.39099
Sodium sulphate	6.34872
Sodium chloride	5.81384
Sodium carbonate	14.08901
Potassium carbonate	0.51177
Lithium sulphate	Trace
Phosphorus pentoxide	0.12018
Carbon dioxide (semicombined)	1.37034
Borax	None
Iodine	None
Free ammonia	.03400
Albumenoid ammonia	1.1060
The specific gravity	1.0260

Analysis made by H. G. Knight.

ANALYSIS OF DIAMOND MINERAL SPRING WATER.

	Parts per hundred thousand.
Total solids	363
Chlorine	195.9
Sodium	119.5
Calcium	9.2
Magnesium	3.9
Combined carbonic acid	13.7
Silica	18.0
Sulphuric acid	Trace
Iodine	Faint trace
The above constituents are probably combined in the water as follows:	
Sodium chloride—common salt	304.
Magnesium chloride	15.4
Calcium carbonate—limestone	23.0
Silica, free	18.0
Sulphuric acid	Trace
Iodine	Faint trace

ANALYSIS OF ARTESIAN WATER, NORTH YAKIMA.

	Grams in 10 liters	*Per cent of total*
Silica	0.2279	9.54
Ferric Oxide	.0060	.25
Lime	.0285	1.19
Magnesia	Trace	Trace
Sodium	0.9615	40.23
Chlorine	Trace	Trace
Sulphuric acid	.0170	.50
Lithium	Trace	Trace
Carbonic acid	1.1400	47.70
Potassium	0.0115	.50

Analysis made by Prof. Elton Fulmer, State Chemist, Pullman, Wash.

The small number of producers has been an important factor in determining the amount of mineral water sold and used. The production from 1903 to 1910, inclusive, averaged a little over 40,000 gallons annually. In 1911 there was a large increase in production and in 1912 a still greater quantity was marketed. In fact the production for 1911 and 1912 is nearly 50 per cent. of that for the whole decade, 1903-1912.

The wide variation in value of the product has served to make the total annual value more nearly constant, yet there is to be noted a steady incresae from $10,550 in 1903 to $17,542 in 1912.

PRODUCTION OF MINERAL WATERS FOR THE DECADE 1903-1912.

Year	*Quantity in gallons*	*Value*	*Average price per gallon*
1903	55,000	$10,550	$.19
1904	24,900	10,580	.42
1905	30,000	10,101	.33
1906	38,500	10,800	.28
1907	68,400	10,820	.16
1908	38,900	13,650	.35
1909	39,260	15,958	.40
1910	31,200	12,571	.40
1911	148,800	14,654	.10
1912	156,171	17,542	.11
Total	631,131	$127,226	

MINERAL PRODUCTION OF WASHINGTON FROM 1903 TO 1912, INCLUSIVE.*

NON-METALLIC PRODUCTS	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Coal	$5,380,679	$5,120,931	$5,141,258	$5,908,434	$7,679,801	$6,690,412	$9,158,999	$9,764,465	$8,174,170	$8,042,871
Clay products	928,265	1,200,919	1,175,032	1,499,884	1,921,934	2,104,289	3,060,486	3,023,854	2,861,758	2,388,870
Portland cement	.....	.....	.....	.....	† 214,500	† 396,000	767,195	1,031,704	1,496,807	2,012,785
Granite	209,095	442,508	681,730	459,975	562,352	870,944	742,878	642,992	1,345,551	809,201
Sandstone	47,430	88,185	124,910	169,500	295,585	464,587	335,470	438,581	301,843	344,476
Limestone	75,649	71,857	52,470	49,192	62,317	31,660	38,269	36,186	32,478	20,370
Marble	40,117	23,098	60,000	59,985	.....	.....	.....	.....	.....	.....
Lime	222,$52	216,454	160,985	347,924	238,568	228,353	282,628	267,735	228,933	234,832
Mineral waters	10,550	10,508	10,101	10,800	10,820	13,650	15,958	12,571	14,654	17,542
Sand and gravel	.....	.....	.....	144,725	179,800	261,531	423,425	481,569	319,760	345,289
Totals	$6,913,837	$7,174,460	$7,406,486	$8,650,419	$11,165,677	$11,061,426	$14,825,308	$15,699,657	$14,775,954	$14,216,236
METALLIC PRODUCTS										
Gold	$507,885	$304,640	$405,078	$221,648	$262,300	$253,700	$362,051	$788,145	$847,677	$680,964
Silver	201,789	89,831	75,727	30,738	55,400	46,400	41,334	110,886	129,204	254,326
Copper	66,242	43,786	16,958	45,360	24,453	21,411	33,167	11,038	39,776	179,192
Lead	16,750	69,937	28,437	52,787	29,786	32,844	12,414	58,180	38,186	5,732
Totals	$792,666	$508,196	$526,200	$350,533	$371,939	$354,355	$448,966	$968,249	$1,056,017	$1,120,214
Grand totals	$7,706,503	$7,682,656	$7,932,686	$9,000,952	$11,537,616	$11,415,781	$15,274,274	$16,667,906	$15,631,971	$15,336,450

* Compiled from Mineral Resources U. S. Geological Survey.
† Approximate production.

INDEX.

	Page
Analyses of clays	30
Analyses of mineral waters	50-51
Basalt, general occurrences of	16
Basalt output, value of	19
Basalt quarries, location of	16
Basalt, references on	19
Basalt, uses of	18
Cement industry, progress of	35
Cement plants, list of	38
Cement production, value of	37
Cement, references on	38
Cement, uses	37
Clay, chemical analyses of	30
Clay plants, list of	31
Clay, production of	32
Clay products, value of	33
Clay, references on	34
Coal mines, list of	25
Coal mines, location of	24
Coal mines, production of	26-28
Coal output, value of	27
Coal, references on	28
Copper	39
Copper, value of output	43
Diamond Mineral Spring water, analysis of	50
Gold	39
Gold, value of output	44
Granite, general occurrences of	7
Granite industry, future development of	9
Granite quarries	7
Granite, references on	19
Granite, uses of	8
Granite output, value of	9
Lead ores	40
Lead output, value of	42
Lime kilns, location of	14
Lime kilns, list of	15
Lime, value of output	15
Limestone, distribution of	13
Limestone, references on	38
Limestone, uses	13
Metal mines, list of	47-48
Metal mines, output of	40
Metal mines output, value of	41
Metal mining	39
Metal mining industry	45
Metal mining, references on	48
Mineral production of Washington	52
Mineral water producers, list of	49
Mineral waters, analyses of	50
Mineral waters, production of	51
Mineral waters, types of	49
North Yakima artesian water, analysis of	51
Portland cement, uses	37
Quarries, basalt	16
granite	7
sandstone	10
References on cement	38
clay	34
coal	28
metal mining	48
stone	19
Sand and gravel, general occurrences	20
Sand and gravel output, value of	23
Sand and gravel pits, list of	22
Sand and gravel pits, location of	20
Sand and gravel, uses of	22
Sandstone, general occurrences	10
Sandstone industry, future development	12
Sandstone output, value of	12
Sandstone quarries	10
Sandstone references	19
Sandstone, uses of	12
Silver output, value of	44
Soap Lake mineral water, analysis of	50

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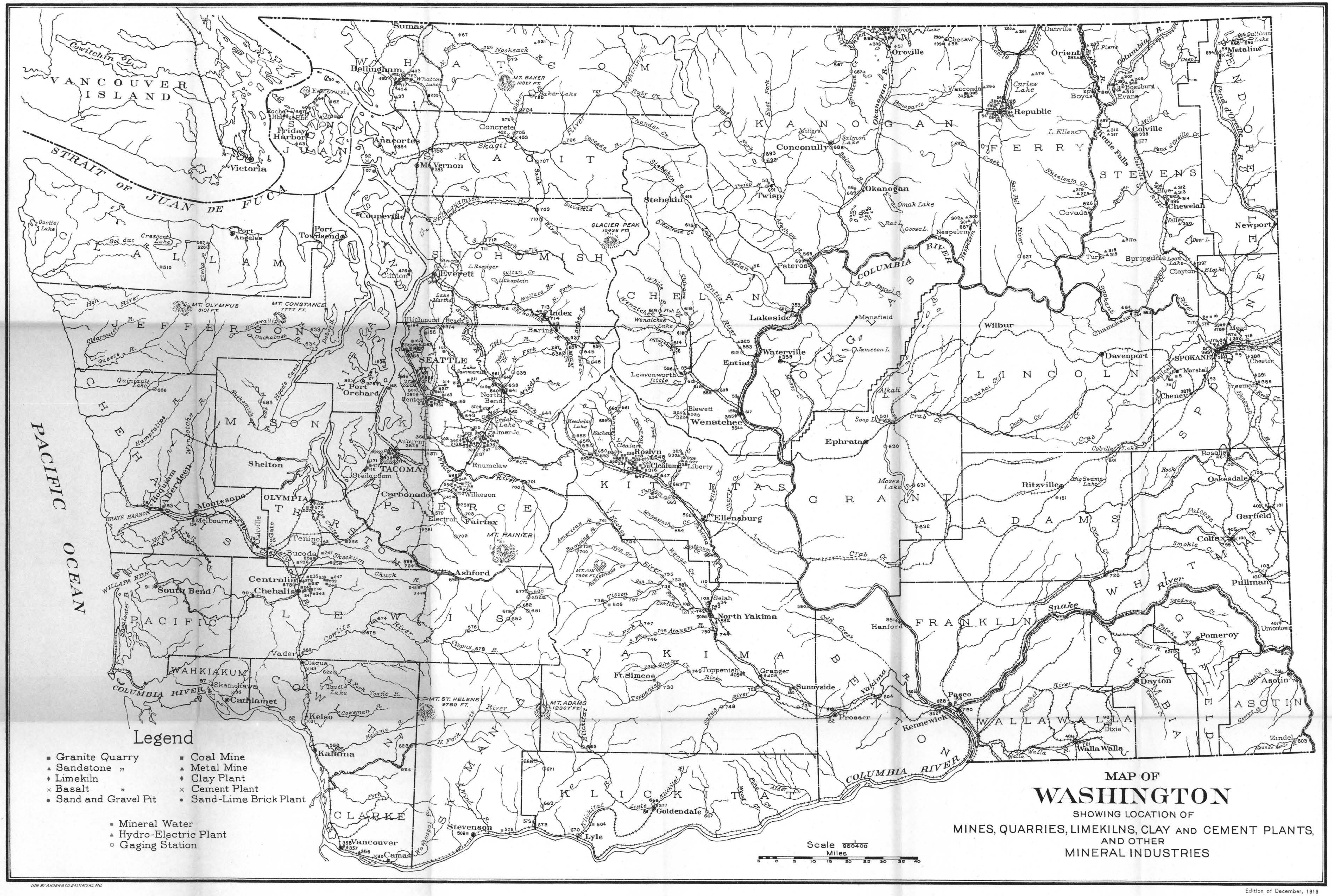

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Edition of December, 1913

GRANITE QUARRIES

		LOCALITY	COUNTY
1	Baring Granite Works	Baring	King
2	Pierce County Quarry	Electron	Pierce
3	Great Northern Railway Co.	Halford	Snohomish
4	Index Granite Works	Index	"
5	Giles Granite Quarry	Medical Lake	Spokane
6	Medical Lake Granite Quarry	"	"
7	Wash. Mon. & Cut Stone Co.	Silver Lake	"
8	Culver and Merwin Quarry	Spokane	"
9	East End Granite Quarry	"	"
10	Wash. Mon. & Cut Stone Co.	"	"

SANDSTONE QUARRIES

26	D. A. McGillis Quarry	Republic	Ferry
27	International Contract Co.	Waterman	Kitsap
28	Bell-Scott Company	Wilkeson	Pierce
29	Alaska Barge Company	Waldron Island	San Juan
30	Sucia Island Quarry Co.	Sucia Island	"
31	Hercules Sandstone Co.	Tenino	Thurston
32	Tenino Stone Co.	"	"
33	Chuckanut Stone Co.	Bellingham	Whatcom
34	Howard Stone Quarry	Selah	Yakima

LIME KILNS

51	F. B. Wuelfinger	Lake Chelan	Chelan
52	James O'Laughlin	" "	"
53	Wenatchee Lime Co.	Wenatchee	"
54	Republic Lime Co.	Republic	Ferry
55	John Nopp	Chesaw	Okanogan
56	Okanogan Lime Co.	Okanogan	"
57	Oroville Lime Quarry	Oroville	"
58	Preston Hanley	Twisp	"
59	H. L. Martin	Metaline Falls	Pend Oreille
60	Henry Cowell Lime and Cement Co.	Deer Harbor	San Juan
61	Orcas Lime Co.	" "	" "
62	Langdon Lime Co.	East Sound	" "
63	Henry Cowell Lime and Cement Co.	Friday Harbor	" "
64	J. A. Soderberg	West Sound	" "
65	Tacoma & Roche Harbor Lime Co.	Roche Harbor	" "
66	Idaho Lime Company	Evans	Stevens
67	International Lime Co.	Sumas	Whatcom

BASALT QUARRIES

76	Sittke's Quarry	Asotin	Asotin
77	Benton County Quarry	Prosser	Benton
78	City of Hoquiam	Hoquiam	Chehalis
79	Northern Pacific Ry. Co.	Oakville	"
80	Columbia Contract Co.	Camas	Clarke
81	Secor Brothers	Kelso	Cowlitz
82	Star Sand Company	Ladu	"
83	Northern Pacific Ry. Co.	Olequa	"
84	City of Seattle (Park Dept.)	Franklin	King
85	King County	North Bend	"
86	Riverside Stone Company	Riverton	"
87	Northern Pacific Ry. Co.	Veazie	"
88	Independent Asphalt Paving Co.	Charleston	Kitsap
89	Secor Brothers	Goldendale	Klickitat
90	Washington State Quarry	Meskill	Lewis
91	Pacific County Quarry	South Bend	Pacific
92	Washington State Quarry	Fidalgo	Skagit
93	Washington State Quarry	Marshall	Spokane
94	Empire Stone Company	Spokane	"
95	Northern Pacific Ry. Co.	Gate	Thurston
96	Wahkiakum County Quarry	Cathlamet	Wahkiakum
97	Wahkiakum County Quarry	Skamokawa	"
98	Washington State Quarry	Dixie	Walla Walla
99	A. L. Smith	Colfax	Whitman
100	Wilson & Bailey Constr. Co.	"	"
101	Frank Hanlan	Garfield	"
102	Whitman County Quarry	Oakesdale	"
103	A. R. Boyd	Pullman	"
104	Spokane Asphalt & Paving Co.	"	"
105	W. J. Donahue	Rosalia	"
106	J. G. Hardesty	"	"
107	Yakima County Quarry	Cowiche Canyon	Yakima
108	P. L. Zirkle	North Yakima	"
109	Washington State Quarry	Selah	"
110	Yakima County Quarry	"	"

SAND AND GRAVEL PITS

151	August Rutz	Ritzville	Adams
152	John Knappland	Prosser	Benton
153	Independent Sand & Gravel Co.	Aberdeen	Chehalis
154	Grays Harbor Construc'n Co.	Melbourne	"
155	Eagle Transfer Co.	Wenatchee	Chelan
156	Samuel Loney	Pasco	Franklin
157	Whidbey Island Sand & Gravel Co.	Whidbey Island	Island
158	Michaels & Blackwell	Bothell	King
159	Cedar Mountain Coal Co.	Cedar Mountain	"
160	Lake Gravel Co.	Buffalo	"
161	" " "	Redmond	"
162	" " "	Renton	"
163	Elliott Cedar River Gravel Co.	Elliott	"
164	Richmond Beach Sand & Gravel Co.	Richmond Beach	"
165	Edgewater Sand & Gravel Co.	Seattle	"
166	Green Lake Gravel Co.	"	"
167	Springs Gravel Co.	"	"
168	Vashon Sand & Gravel Co.	Vashon Island	"
169	Parker Asphalt Paving Sand Co.	Creosote	Kitsap
170	J. R. Jacobson	Ellensburg	Kittitas
171	Pioneer Sand & Gravel Co.	Steilacoom	Pierce
172	Tacoma Sand & Gravel Co.	"	"
173	Atlas Sand & Gravel Co.	Tacoma	"
174	Harrison Brothers Co.	"	"
175	J. Cunningham	Spokane	Spokane
176	Spokane Sand and Gravel Co.	"	"
177	Lind Gravel Company	Bellingham	Whatcom
178	Whidbey Island Sand & Gravel Co.	Lummi Island	"
179	W. J. Aumiller	North Yakima	Yakima
180	Yakima County	Sunnyside	"

COAL MINES

201	Carbon Coal & Clay Co.	Bayne	King
202	Occidental Coking Coal Co.	"	"
203	Pacific Coast Coal Co., No. 11	Black Diamond	"
204	" " " " No. 14	" "	"
205	" " " " "B"	" "	"
206	Deep Lake Coal Co.	Cumberland	"
207	Independent Coal & Coke Co.	"	"
208	A. W. Lambert	"	"
209	Hyde Coal Co.	"	"
210	Pacific Coast Coal Co., Gem	Franklin	"
211	Central Coal Co.	Grand Ridge	"
212	Issaquah & Superior Coal Mines Co.	Issaquah	"
213	Denny-Renton Clay & Coal Co.	Kummer	"
214	Pacific Coast Coal Co.	Newcastle	"
215	Northwestern Improvement Co.	Ravensdale	"
216	Denny-Renton Clay & Coal Co.	Renton	"
217	May Creek Coal Co.	"	"
218	Puget Sound Trac., Light & Power Co.	"	"
219	United Collieries Co.	Snoqualmie	"
220	Denny-Renton Clay & Coal Co.	Taylor	"
221	American Canadian Fuel Co.	Clealum	Kittitas
222	Inland Improvement Co.	"	"
223	Northwestern Improvement Co.	"	"
224	Northwest Coal Company	Roslyn	"
225	Busy Bee Mining Co.	"	"
226	Northwestern Improvement Co. No. 3	"	"
227	Northwestern Improvement Co. No. 5	"	"
228	Northwestern Improvement Co. No. 6	"	"
229	Northwestern Improvement Co. No. 7	"	"
230	Roslyn-Cascade Coal Co.	"	"
231	Roslyn Fuel Co., Beekman Slope No. 1	"	"
232	Roslyn Fuel Co., Beekman Slope No. 2	"	"
233	Yakima-Roslyn Coal Co.	"	"
234	Carothers Brothers	Taneum	"
235	Centralia Coal Co.	Centralia	Lewis
236	Fords Prairie Coal Co.	"	"
237	Gibson Coal Co.	"	"
238	Sunshine Coal Co.	"	"
239	Wilson Coal Co.	"	"
240	Chehalis Coal Co.	Chehalis	"
241	Coal Creek Coal Co.	"	"
242	Sheldon Coal Co.	"	"
243	Superior Coal Co.	"	"
244	Pennsylvania Coal Co.	Divide	"
245	East Creek Coal Co.	East Creek	"
246	Kopiah (Wilson Coal Co., Operator)	Kopiah	"
247	Mendota Coal & Coke Co.	Mendota	"
248	Pacific Coast Coal Co.	Burnett	Pierce
249	Carbon Hill Coal Co.	Carbonado	"
250	Northwestern Improvement Co.	Melmont	"
251	American Coal Co.	Spiketon	"
252	Gale Creek Coal Mines Co.	Wilkeson	"
253	South Willis Coal Co.	"	"
254	Wilkeson Coal & Coke Co.	"	"
255	Graham Bros.	Bucoda	Thurston
256	Majestic Coal Co.	Near Rainier	"
257	Black Bear Mine	Tenino	"
258	Washington Union Coal Co.	Tono	"
259	Whatcom County Coal Co.	Lake Whatcom	Whatcom

METAL MINES

276	Belcher	Belcher	Ferry
277	Napoleon	Boyds	"
278	Ivanhoe	Covada	"
279	Silver Leaf	"	"
280	Lone Star & Washington	Danville	"
281	Shawnee	"	"
282	Little Giant	Orient	"
283	Swamp King	"	"
284	Ben Hur	Republic	"
285	Black Tail	"	"
286	Insurgent	"	"
287	Knob Hill	"	"
288	Lone Pine	"	"
289	Pearl	"	"
290	Quilp	"	"
291	Republic	"	"
292	San Poil	"	"
293	Snowstorm	"	"
294	South San Poil	"	"
295	Surprise	"	"
296	Phil Sheridan	Sheridan	"
297	Apex	Berlin	King
298	Butcher Boy	Chesaw	Okanogan
299	Gold Axe	"	"
300	Apache	Nespelem	"
301	Double Header	"	"
302	Hoyt and Miller	"	"
303	Dividend	Oroville	"
303a	Golden Chariot	"	"
304	Lakeside	"	"
305	Bodie	Wauconda	"
305a	Duluth Toroda	"	"
306	Liberty	Blue Creek	Stevens
307	Bonanza	Bossburg	"
308	Clugston	"	"
309	Jarvis and Jarvis	"	"
310	O. P. Nestos	"	"
311	Young America	"	"
312	Amazon	Chewelah	"
313	Blue Star	"	"
314	United Copper	"	"
315	Paul Laplant	Evans	"
316	Ben Venue	Kettle Falls	"
317	Sunday Star	"	"
317a	Cleveland	Springdale	"
318	Deer Trail No. 2	Turk	"
319	Legal Tender	"	"
320	Banshee	Valley	"
321	Seattle-St. Louis	Glacier	Whatcom
322	Blinn	Blewett	Chelan
323	Golden Eagle	"	"
324	Washington Meteor	"	"
325	Wenatchee Gold Mining Co.	Entiat	"
326	Cougar	Liberty	Kittitas
327	Gold Hill	"	"
328	Hope	"	"
329	Phoenix and Little York	"	"
330	Wolf	"	"

CLAY PLANTS

		LOCALITY	COUNTY
351	S. Garsi	Hanford	Benton
352	Twin City Brick & Tile Co.	Kennewick	"
353	H. E. Dunham	Chelan	Chelan
354	Leavenworth Brick Co.	Leavenworth	"
355	Hobson Brothers	Wenatchee	"
356	Columbia Clay Co.	Image	Clarke
357	Carson Brothers	Vancouver	"
358	Hidden Brothers	"	"
359	Frank Malfa	Waterville	Douglas
360	Northern Clay Co.	Auburn	King
361	Standard Clay Co.	Bayne	"
362	Denny-Renton Clay & Coal Co.	Kummer	"
363	Pontiac Brick & Tile	Pontiac	"
364	Denny-Renton Clay & Coal Co.	Renton	"
365	Abrahamson Brick Co.	Seattle	"
366	Builders Brick Co.	"	"
367	Harper-Hill Brick Co.	"	"
368	Lake Union Brick Co.	"	"
369	Lohse Brick Co.	"	"
370	Seattle Brick & Tile Co.	"	"
371	Washington Brick & Tile Co.	"	"
372	Denny-Renton Clay & Coal Co.	Taylor	"
373	" " " " " "	Van Asselt	"
374	Superior Brick, Tile & Pottery Co.	Woodinville	"
375	Harper-Hill Brick Co.	Harper	Kitsap
376	O. K. Brick & Tile Co.	Clealum	Kittitas
377	N. B. Brooks	Goldendale	Klickitat
378	Centralia Brick & Tile Co.	Centralia	Lewis
379	Chehalis Brick & Tile Co.	Chehalis	"
380	Standard Clay Co.	Little Falls	"
381	Far West Clay Co.	Clay City	Pierce
382	Jovita Brick Co.	Jovita	"
383	F. H. Goss Brick Co.	Tacoma	"
384	Farmers Brick & Tile Co.	Bay View	Skagit
385	Knapp Brick & Tile Co.	Tiloh	"
386	Everett Brick Co.	Everett	Snohomish
387	Cheney Brick Co.	Cheney	Spokane
388	Bergman Clay Mfg. Co.	Chester	"
389	Wash. Brick, Lime & Sewer Pipe Co.	Freeman	"
390	J. T. Davie Brick Co.	Mead	"
391	American Fire Brick Co.	Mica	"
392	Wash. Brick, Lime & Sewer Pipe Co.	Spear	"
393	A. T. Dishman	Spokane	"
394	Pioneer Brick Co.	"	"
395	P. R. Fitzgerald	Bossburg	Stevens
396	Chewelah Brick & Lime Co.	Chewelah	"
397	Wash. Brick, Lime & Sewer Pipe Co.	Clayton	"
398	Roman Stone & Mfg. Co.	Colville	"
399	Kettle Falls Brick Co.	Kettle Falls	"
400	Burtchett & Baker	Olympia	Thurston
401	Walla Walla Construction Co.	Walla Walla	Walla Walla
402	J. R. Headrick & Co.	Bellingham	Whatcom
403	J. F. Miller & Bros.	"	"
404	Coast Clay Co.	South Bellingham	"
405	Easum Bros.	Colfax	Whitman
406	Garfield Brick Co.	Garfield	"
407	George Herboth	Uniontown	"
408	Granger Brick & Tile Co.	Granger	Yakima
409	Toppenish Brick & Tile Co.	Toppenish	"

CEMENT PLANTS

451	Inland Portland Cement Co.	Metaline Falls	Pend Oreille
452	Superior Portland Cement Co.	Concrete	Skagit
453	Washington Portland Cement Co.	"	"
454	International Portland Cement Co.	Spokane	Spokane
455	Olympic Portland Cement Co.	Bellingham	Whatcom

SAND-LIME BRICK PLANTS

476	Sandstone Brick & Lime Co.	Clinton	Island
477	Chamber's Creek Brick Works	Steilacoom	Pierce
478	Spokane Pressed Brick Co.	Mead	Spokane

MINERAL WATERS

501	Soap Lake Mineral Water Co.	Soap Lake	Grant
502	Diamond Mineral Spring Water Co.	Auburn	King
503	Scenic Hot Springs	Scenic	"
504	Klickitat Mineral Springs Co.	Klickitat	Klickitat
505	Collins Hot Springs	Collins	Skamania
506	Table Rock Mineral Water Co.	Stevenson	"
507	Olympian Hygieana Spring Co.	Olympia	Thurston
508	Artesian Water Co.	North Yakima	Yakima
509	Yakima Soda Springs	" "	"
510	Sol Duc Hot Springs	Sol Duc	Clallam

HYDROELECTRIC PLANTS

551	Lewiston-Clarkston Co.	Asotin Cr.	Asotin
552	Pacific Power & Light Co.	Yakima R., Prosser	Benton
553	Wenatchee Valley Gas & Elec. Co.	Entiat R., Entiat	Chelan
554	Wenatchee Valley Gas & Elec. Co.	Quiltoc R.	"
555	Wenatchee Valley Gas & Elec. Co.	Wenatchee R., Dryden	"
556	Great Northern Railway Co.	Wenatchee R., Leavenworth	"
557	Olympic Power Co.	Elwha R., Port Angeles	Clallam
558	Washington-Oregon Corporation	Kalama R., Kalama	Cowlitz
559	Pacific Power & Light Co.	Tucannon R., Pomeroy	Garfield
560	City of Seattle	Cedar R., Cedar Lake	King
561	Puget Sound Trac., Light & Power Co.	Snoqualmie R.	"
562	City of Ellensburg	Yakima R., Ellensburg	Kittitas
563	Washington Water Power Co.	Spokane R., Long Lake	Lincoln
564	" " " "	Spokane R., Little Falls	"
565	Methow Power Co.	Methow R., Pateros	Okanogan
566	North Washington Power Co.	Similkameen R., Oroville	"
567	Palmer Mountain Tunnel Co.	Toats Coulee Cr.	"
568	Inland Portland Cement Co.	Sullivan Cr.	Pend Oreille
569	City of Tacoma	Nisqually R.	Pierce
570	Puget Sound Trac., Light & Power Co.	Puyallup R., Electron	"
571	Puget Sound Trac., Light & Power Co.	White R., Dieringer	"

HYDROELECTRIC PLANTS *(Continued)*

572	Superior Portland Cement Co.	Bear Creek	Skagit
573	Northwestern Electric Co.	White Salmon R.	Skamania
574	City of Spokane	Spokane R.	Spokane
575	Washington Water Power Co.	Spokane R., Spokane	"
576	Spokane and Inland Empire R. R.	Spokane R.	"
577	Stevens County Light & Power Co.	Colville R.	Stevens
578	Olympic Light & Power Co.	De Chutes R.	Thurston
579	Puget Sound Trac., Light & Power Co.	North Fork Nooksack	Whatcom
580	Pacific Power & Light Co.	Columbia R., Priest Rapids	Yakima
581	" " " "	Naches R., Naches	"
582	" " " "	Yakima R., North Yakima	"

GAGING STATIONS

	STREAM	LOCALITY	COUNTY
601	Cow Creek	Keystone	Adams
602	Snake River	Clarkston	Asotin
603	Grand Ronde River	Zindel	"
603a	Asotin Creek	Asotin	"
604	Yakima River	Kiona	Benton
605	" "	Richland	"
606	Quinault Lake	Quinault	Chehalis
607	Chelan Lake	Chelan	Chelan
608	" River	"	"
609	Wenatchee River	Cashmere	"
610	" "	Leavenworth	"
611	" "	Dryden	"
612	Entiat River	Entiat	"
613	Icicle Creek	Leavenworth	"
614	Chiwaukum Creek	Chiwaukum	"
615	Railroad Creek	Lucerne	"
616	Stehekin River	Stehekin	"
617	Columbia River	Wenatchee	"
618	Chiwawa River	" Lake	"
619	White River	" "	"
620	Elwha River	Port Angeles	Clallam
621	Tucannon River	Pomeroy	Columbia
622	Toutle River	Castle Rock	Cowlitz
623	Lewis River (upper)	Cougar	"
624	" " (lower)	"	"
625	Kalama River	Kalama	"
626	Hall Creek	Inchelium	Ferry
627	San Poil River	Keller	"
628	Columbia River	Pasco	Franklin
629	Upper Crab Creek	Adrian	Grant
630	Middle " "	Ephrata	"
631	Moses Lake	Neppel	"
632	Lower Crab Creek	Warden	"
633	Dosewallips River	Brinnon	Jefferson
634	Duckabush River	Duckabush	"
635	Miller River	Berlin	King
636	" " (W. Fork)	"	"
637	Skykomish R., (S. Fork)	"	"
638	Snoqualmie R., (N. Fork)	North Bend	"
639	" " "	" " (upper)	"
640	" " (S. Fork)	" "	"
641	" " (Middle Fork)	" "	"
642	Tokul Creek	" "	"
643	Cedar River	Ravensdale	"
644	Snoqualmie (S. Fork Upper)	Rockdale (Alice Creek)	"
645	Foss River	Skykomish	"
646	" " (E. Fork)	"	"
647	Teanaway (lower)	Clealum	Kittitas
648	" (upper)	"	"
649	Yakima River	"	"
650	Kachess River	Easton	"
651	" Lake	"	"
652	Cabin Creek	"	"
653	Yakima River	"	"
654	Manastash Creek	Ellensburg	"
655	Keechelus Lake	Martin	"
656	Yakima River	"	"
657	Clealum Lake	Roslyn	"
658	" River	"	"
659	" " (W. Fork)	"	"
660	" " (Middle Fork)	"	"
661	" " (N. Fork)	Galena	"
662	Swauk Creek	Clealum	"
663	Taneum Creek	Thorp	"
664	Yakima River	Umtanum	"
665	Klickitat River	Glenwood	Klickitat
666	Little Klickitat River	Goldendale	"
667	Rock Creek (W. Fork)	"	"
668	Trout Creek	Guler	"
669	White Salmon River	Husum	"
670	Klickitat River	Lyle (Wals Ferry)	"
671	White Salmon River	Trout Lake	"
672	" " "	Underwood	"
673	Chehalis River	Chehalis	Lewis
674	Cowlitz River	Mossy Rock	"
675	" "	Mayfield	"
676	" "	Randle	"
677	Ohanapecosh River	Lewis	"
678	Cispus River	Randle	"
679	Cowlitz River	Lewis	"
680	" (Clear Fork)	"	"
681	" (Upper Lake Creek)	"	"
682	" (Lake Creek)	"	"
682a	Coal Creek	"	"
683	Johnson Creek	"	"
684	Spokane River	Long Lake	Lincoln
685	Skokomish River (N. Fork)	Hoodsport	Mason
686	Salmon Creek	Conconully	Okanogan
687	Nespelem River	Nespelem	"
687a	Sinlahekin Creek	Night Hawk	"
688	Similkameen River	Oroville	"
689	Okanogan River	Okanogan	"
690	Methow River	Pateros	"
691	Twisp River	Twisp	"
692	Methow River	Winthrop	"
693	" " (E. Fork)	"	"
694	Clark's Fork	Metaline	Pend Oreille
695	Sullivan Creek	"	"
696	" Lake	"	"
697	Clark's Fork	Newport	"
698	Nisqually	Ashford	Pierce
699	White River	Buckley	"
700	" (Upper Sta.)	Enumclaw	"
701	Greenwater River	"	"
702	Puyallup River	Electron	"
703	Carbon River	Fairfax	"
704	Nisqually River	La Grande	"
705	Baker River	Concrete	Skagit
706	Cascade River	Marblemount	"
707	Sauk River	Sauk	"
708	Skagit River	Sedro-Woolley	"
709	Sauk River	Darrington	Snohomish
710	Clear Creek	"	"
711	Stilaguamish R., (S. Fork)	Granite Falls	"
712	" " (Canyon Cr.)	" "	"
713	Skykomish R., (N. Fork)	Index	"
714	" " (S. Fork)	"	"
715	Stilaguamish River (S. Fork)	Silverton	"
716	Skykomish River	Sultan	"
717	Little Spokane River	Spokane	Spokane
718	Spokane River	"	"
719	" "	Trent	"
719a	Kettle River	Marcus	Stevens
720	Snake River	Burbank	Walla Walla
721	Mill Creek	Walla Walla	" "
722	Whatcom Creek	Bellingham	Whatcom
723	" Lake	"	"
724	Baker River (Upper Sta.)	Concrete	"
725	" Lake	"	"
726	Nooksack River (N. Fork)	Glacier	"
727	Skagit River	Marblemount	"
728	Palouse River	Hooper	Whitman
729	Toppenish Creek	Alfalfa	Yakima
730	" "	Fort Simcoe	"
731	Simcoe Creek	" "	"
732	Yakima River	Mabton	"
733	Naches River	Naches	"
734	" (Upper Sta.)	Nile (Anderson Ranch)	"
735	" " "	Naches (Oak Flat)	"
736	Tieton River (Lower Sta.)	" (Cobb's Ranch)	"
737	" " (Middle Sta.)	Naches (Headworks)	"
738	" " (Upper Sta.)	Naches (McAllisters Mdws)	"
739	Bumping River	Nile	"
740	" Lake	"	"
741	American River	"	"
742	Naches River	North Yakima	"
743	Yakima River	" "	"
744	" "	Yakima City	"
745	Atanum Creek	Tampico	"
746	" " (S. Fork)	"	"
747	" " (N. Fork)	"	"
748	Satus Creek	Toppenish	"
749	Toppenish Creek	White Swan	"
750	Atanum Creek	Yakima	"