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FERRUGINOUS BAUXITE IN WASHINGTON COUNTY, OREGON

by

F. W. Libbey*

Introduction:

So far as is now known, Oregon possesses the only bauxite in deposits of commercial size west of the Rocky Mountains. Although these deposits need considerable metallurgical research in order to determine most economical methods of treatment, their location, within 25 or 30 airline miles of aluminum reduction plants at Vancouver and Troutdale, makes them a potential source of alumina for these aluminum plants which now must haul alumina across the country from East St. Louis or Mobile. The factor of alumina supply is most important to postwar operation of these reduction plants and if Oregon bauxites prove to be economic, they may be the determining factor in producing the cheapest aluminum in the country.

The Oregon Department of Geology and Mineral Industries has been studying these deposits as time and personnel permitted since last April. Sixty-three auger holes have been put down and some pick and shovel work has been done in this exploration work. G.M.I. Short Paper No. 12 has been published as a preliminary report, and a supplemental report describing work done since No. 12 was issued is being prepared.

Location of Deposits:

These deposits so far explored are in northern Washington County, distributed over four townships, namely Tps. 2 and 3 N. and Rs. 2 and 3 W. Reconnaissance work has been done on similar deposits in Columbia County and it seems likely that material similar in grade to that in Washington County may occur in deposits of commercial size. Further investigations in both counties may show extensions of the ore-bearing areas known at present. Most of the exploration work of the Department has been done in two localities, one called the Hendrickson and the other has been given the general name of the Hutchinson locality. A few test holes have been drilled in other localities; especially noteworthy are results of samples obtained from the southern part of the area in the Helvetia locality.

Access:

The deposits are easily reached from Portland by several roads, mostly paved. The most direct route to the northern part of the area is by way of Skyline Boulevard to the Dixie Mountain road which extends south from Skyline through the eastern part of the area. The western part of the area is reached by way of the Pumpkin Ridge road from North Plains.

Columbia County deposits may be reached from U.S. 30, north and west of Scappoose.

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* Paper read at annual meeting of Oregon Academy of Science, Portland, January 13, 1944.

Description of the Deposits:

These deposits are flat-lying under an overburden of silt which ranges in thickness from a few inches to 40 or more feet. Ore so far investigated averages about 11 feet thick, and ratio of overburden to ore is moderate, probably less than 2 to 1, although definite statements may not be made for all the deposits because of the small amount of drilling work done, especially in the southern part of the area. Generally speaking, the ore varies in color from yellow to brown; it is of two kinds, hard and soft. Hard ore is, for the most part, oölitic and magnetic, due probably to residual magnetite. Some sections of the ore beds may be best described as pebbly or concretionary. The soft or clay-like ore usually contains small oölites in the clay-like matrix which in places contains bauxite minerals. The ore is underlain by clay and the contact is usually fairly sharp, although in places the change from ore to waste is gradational. It is believed that the ore is made up of an intimate mixture of hydrous aluminum and iron oxides, with a minor amount of titanium. No hercynite, iron aluminum oxide, has been found. In parts of both the Hendrickson and the Hutchinson deposits, probably mining could be accomplished without blasting. It is believed that mining conditions are particularly favorable for cheap operation. Usually, especially in the northern part of the area, the many gulches would provide adequate dumping space for disposal of overburden.

Quantity of Ore:

The work in the Hendrickson locality has indicated over 2,000,000 long tons of material which analyzes approximately as follows:

	%
Alumina	32
Iron	26
Silica	9
Phosphorus	0.14
Titania	4.5
Moisture	19
Ignition loss	18

In the Hutchinson locality, insufficient work has been done upon which estimates of tonnage may now be made. Indications are that tonnage so far explored in a preliminary way will be at least equal to that in the Hendrickson locality and although analytical results are incomplete, probably the grade will be about equivalent to that in the Hendrickson. Grade of ore in the Helvetia locality appears to be higher in alumina than in other places. Samples running up to 46 percent Al_2O_3 have been obtained on the Schmidt farm just north of Helvetia.

Origin of the Ore:

It is believed that these deposits are lateritic in origin and were formed subsequent to the last outpourings of the Columbia River lavas. Thus these ferruginous bauxites are later in age than the Scappoose limonites which have been found overlain by basalt. There is corroborative evidence of this at two localities in Washington County, one at the Berger place east of Helvetia and one in the Hutchinson locality in a gulch just east of the Hutchinson house. At both of these places, limonite in place is found stratigraphically below ferruginous bauxite. Since in all localities so far examined, the bauxite is overlain by silt only, it is believed that the ore was formed after the Columbia River basalts had been extruded in Miocene time and before the silt was deposited, largely by wind action, probably in Pleistocene time.

Possible Utilization:

Material similar in composition to the Washington County bauxites has been treated on a commercial scale in Norway by the Pedersen process. In this process French bauxite was mixed with Norwegian iron ore and smelted with lime in an electric furnace to produce both a high grade pig iron and a calcium aluminate slag. The slag was further treated by leaching with sodium carbonate solution, and precipitating the dissolved sodium aluminate with carbon dioxide to produce aluminum hydrate which was filtered and calcined to produce anhydrous alumina. Work by the U.S. Bureau of Mines on siliceous and ferruginous bauxites in this country indicates that the Pedersen process is applicable to Washington County ore.

The Bayer process, now the only method used for producing alumina in this country, involves treatment of low silica bauxite with sodium hydrate under both heat and pressure. The resulting solution contains the aluminum as aluminum hydrate, which is precipitated according to a method developed by the Aluminum Company of America, by means of which a "seed charge" of aluminum hydrate is added to the hot solution which is gradually cooled and at the same time agitated. This treatment allows the aluminum hydrate to be precipitated as a crystalline material which facilitates filtering. The aluminum hydrate is calcined to produce pure alumina. As sodium hydrate dissolves silica, bauxites amenable to the Bayer process must be low in silica, and formerly maximum allowable silica in bauxite used in the Bayer process was 7 percent. The maximum allowable now is somewhat higher but, of course, the more silica in the bauxite, the greater the cost of treatment. Iron in bauxite is unattacked by alkalies; therefore the iron content is not important in the economics of the Bayer process except that high iron means relatively low alumina. South American bauxites contain 50 percent or more of alumina and, of course, the higher the alumina, the lower the treatment cost per pound of alumina produced. In any event, as far as the analysis of the Washington County bauxites is concerned, the Bayer process or some modification of it could be used for treating these ores. The residue remaining after the alumina is dissolved out by the sodium hydrate would contain all the iron as a high grade "red mud". This "red mud" could probably be smelted in an electric furnace to produce pig iron for which there is a good demand in the Northwest. Part of the "red mud" might be utilized in making electrolytic iron, in demand for making shapes by powder metallurgy technique.

Conclusion:

It is believed that this bauxite ore which fortuitously occurs so close to present aluminum reduction plants is of much potential importance in the industrial picture of the Northwest, and it is also believed that further exploration work will show that a very large tonnage in millions of tons exists in Washington and Columbia Counties.

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REPORT ON HIGH ALUMINA CLAY DEPOSIT NEAR CASTLE ROCK, WASHINGTON

A preliminary report on the Castle Rock high alumina clay deposit, Cowlitz County, Washington, has been placed on open file at the Oregon State Department of Geology and Mineral Industries, Portland, by the U.S. Geological Survey. This report was prepared by Dr. Robert L. Nichols of the High Alumina Clay Division of the Survey, and describes geology and characteristics of the ore deposits, and gives an estimate of the reserves. The report is accompanied by maps, cross-sections, and columnar sections of the deposit. Copies of the report are also on open file at the Geological Survey offices at Washington D.C., Spokane, Washington, and Salt Lake City, Utah, as well as the Washington State Division of Mines, Olympia, and the Washington State Division of Geology at Pullman.

The Cowlitz County high alumina clay deposits were explored by the U.S. Bureau of Mines in cooperation with the U.S. Geological Survey. Results of the exploration show 8,634,000 dry tons of measured ore containing 30% available Al_2O_3 and 5.7% Fe_2O_3. In addition, it is estimated that the deposit contains 9,249,000 dry tons containing 29% available Al_2O_3 and 6.3% Fe_2O_3.

The report is available to persons interested in the development of the deposit.

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A HIGH-FLYING BIRD'S EYE VIEW OF PERMANENTE METALS CORPORATION MAGNESIUM AND ASSOCIATED PLANTS

by

John Eliot Allen*

On December 14, the writer had the privilege of spending a full day inspecting the various plants of the Permanente Metals Corporation, located about 15 miles west of San Jose.

The complexity and magnitude of these operations are awe inspiring, especially when one considers the short time in which they have been built and put into operation. Henry J. Kaiser's organization sponsored and built these two privately owned plants.

Magnesium is produced at Permanente by the carbothermic, or Hansgirg process; the metal being obtained from dolomite ($MgCO_3 \cdot CaCO_3$) and sea water in equal parts. The dolomite quarry is located at Natividad, about 8 miles northeast of Salinas, California, where the rock is mined by open cut quarry with electric dipper shovels and crushed and calcined at 2000° F. to the double oxide in two large rotary kilns of the cement calcining type. Calcined dolomite is trucked a distance of about 12 miles to the coast on Monterey Bay. Water is taken from the ocean at this Moss Landing plant at the rate of 6500 gallons per minute through a 5-foot diameter wood stave line and delivered to hydrotreator tanks where suspended solids and carbonates are precipitated. The treated sea water then flows through reactor tanks where the calcined dolomite, slaked to the hydroxide is introduced. Here the magnesium in the sea water, being higher in the electromotive series than the calcium in the dolomite, replaces it to produce magnesium hydroxide. This slurry is then thickened in four 250-foot thickeners and washed in a fresh-water flow of 1000 gallons a minute. The excess water is then removed in a battery of Oliver filters and the filter cake is conducted by a screw conveyor to another large rotary kiln where it is dehydrated at a temperature of 2300° F. This material, over 96 percent MgO, is trucked in large trailer trucks to the Permanente plant west of San Jose.

At Permanente the dehydrated MgO is mixed in molecular proportions with petroleum coke, and interground in a 26-foot ball mill. This material is briquetted in a series of presses and distributed to air-locked feed bins of the five 8000 KVA reduction furnaces. From this stage on until the finished metal comes out of the retorts, the process is conducted in an axygen free atmosphere. The reduction furnaces are approximately 16 feet high, and 16 feet in diameter and are heated by three electrodes coming in from the top, each electrode being 20 inches in diameter. The electrodes are fed automatically into the furnaces and are insulated against electricity, pressure, and heat. At the operating temperature of 2000° C the reaction $MgO + C \equiv Mg + CO$ takes place and the gaseous products come out a port in a side of the furnace where they are shock-chilled by jets of natural gas. The microscopic magnesium dust produced by this reaction and shock-chilling is removed from the gas by a battery of bag filters. When the plant was first put in operation it was found that carbon tended to build up in the discharge ports of the furnaces. An automatic reamer was then built, which periodically during the operation slides into the furnace and cleans out this port. The magnesium dust from the bag filters is conveyed to dust bins and from dust bins to gas-tight enclosed pelleting presses of special design. Pellets are loaded, still in a closed atmosphere of gas, into vertical air-tight retorts about 4½ feet in diameter and 20 feet high. These steel retorts are metalized with aluminum on the outside to retard their oxidizing under the heat of the electric resistance furnaces into which they are then lowered. The furnaces, heated by banks of nichrome wire coils, sublimate the magnesium metal at 1400° F. at an absolute pressure of 0.2 mm of mercury. In the upper condensing portion of the retort is a removable liner which during the 90 hours of heating collects the crystalline magnesium sublimate. The area over which

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* Geologist, State Department of Geology and Mineral Industries, on leave.

the retorts are prepared for loading, furnacing, cooling, and stripping, measures about 230 by 290 feet. The retorts, which weigh about ten tons loaded, are lifted and conveyed from place to place by two large gantry cranes. Loading is conducted on a rotating scale platform containing five retorts, which places each retort in turn beneath an automatic air-lock connected to pellet storage bins. Each retort must be completely purged of air before it is loaded. When the retorting is completed, the magnesium crystals are exposed to the air for the first time. They are cracked loose from the liners and routed to the ingot casting foundry where they are melted in gas-fired tilting furnaces. The crystals, which are over 99.99 percent pure, are alloyed in these crucible furnaces and cast into ingots to be used subsequently for sand castings, forgings, and extrusions. Sulfur and SO_2 gas are used for protecting the metal from burning during pouring.

Magnesium production is only one of the activities at Permanente. The original plant at this locality was erected by the Permanente Cement Company. The wet process is used and clinkering is done in four 364-foot kilns - the largest in the world. Limestone for the cement is mined in the hill above the plant from a great lens of dark-colored bedded limestone lying on the Franciscan series of Jurassic age. An altered volcanic rock nearby is used to furnish the siliceous and iron elements of the cement in proper amount. High-grade limestone is sold directly from the quarry and waste limestone is sold as commercial rock. The seven types of Permanente cement are sold in bags and in bulk, shipment being made by bulk-truck, box car, and company owned steamships.

The third separate and distinct operation on the property is the ferrosilicon plant. It consists of three 8000 KVA electric furnaces. Raw materials used are silica in the form of quartz, coke, and steel shavings. Quartz is mined at a company owned quarry near Merced, California, and coke is furnished by Fontana. The plant was brought into production about the middle of 1942 to furnish ferrosilicon for the Kaiser sponsored D.P.C. magnesium plant at Manteca, California. Magnesium was produced here using the silicothermic, or Pidgeon process. The government shut the Manteca plant down in 1944 and since then the ferrosilicon plant at Permanente has been supplying the ferroalloy to users throughout the country - principally steel producers.

Plants tributary to the magnesium plant include a nitrogen plant which produces an inert gas for some portions of the process. Here air and natural gas are introduced into retorts in which the oxygen is burned out of the air and the resulting nitrogen is cleaned of the other products in scrubbing towers. A Girbotol water-gas plant is operated to produce hydrogen which is used as an inert gas in portions of the process. A sand-casting plant produces magnesium castings which are going exclusively toward the war effort. A refractories plant utilizes magnesium oxide to produce periclase refractory brick for lining the cement kilns and open hearths at the Kaiser steel plant at Fontana and also for sale to other plants. A flux plant produces the various fluxes used in the foundry and also produces for sale on the outside market. Natural gas is dried and scrubbed in order to make it available for use. A complex system of piping of the various raw materials and products is spectacular in that each pipe is colored to indicate the material which it carries. Water pipes are painted black; natural gas, red; high vacuum, yellow; low vacuum, brown; high pressure, low pressure, nitrogen, hydrogen, magnesium dust, exhaust or vent pipes are all painted distinctive colors; and the complexity of various colored and sized pipes running through the pipe trenches and tunnels from plant to plant is interesting indeed.

By-products marketed by The Permanente Metals Corporation are numerous, the most important ones being:

Raw dolomite - used in open hearth steel furnaces.

Hydrated and processed) - used in the building trade, oil refining, and for
High magnesia lime) general commercial and chemical use.

Dead burned dolomite) - electric furnace and open hearth
and)
) bottom maintenance
Ramming mix)

Magnesium oxide (Various burns and compositions)	rubber compounding chemical uses basic brick (periclase) ladle and furnace linings (periclase)
Carbothermic magnesia (Residue from the carbothermic process	compounding neoprene and GR-S synthetic rubbers

The first four are more or less standard products and are produced and shipped direct from the Natividad or Moss Landing plants. Carbothermic magnesia is a special product produced from treating the residue obtained from the retorting step in magnesium production at Permanente. The special treating is done in a separate plant using a process developed by the research staff at Permanente.

Magnesium is the lightest metal in commercial use. It weighs only two-thirds as much as aluminum, one-fourth as much as steel, and one-fifth as much as copper. Some magnesium alloys have the tensile strength of structural steel. It can be machined faster than any other metal and can be fabricated into desired shapes by any method commonly used in making other metals. It can be sand-cast, die-cast, extruded, forged, or rolled into flat or tapered sheets. It may be rolled into sheets varying from 0.014 to 0.500 inch in thickness. Magnesium may be welded by the use of a special arc which is insulated from the air by a jet of helium or argon gas.

The writer wishes to express his appreciation to the Permanente Metals Corporation for the information in this sketch and for the courtesy extended during the visit.

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SILICONES

Within the past year technical literature has indicated a growing interest in the new series of chemical products called silicones. These products are a class of organic compounds in which the silicon (instead of the carbon) atom is joined in combination with other elements and radicals to oxygen atoms to form chemical ring and chain compounds. These materials have been a laboratory curiosity for some time but with the advent of the war their useful and unusual properties have placed them in commercial production. The research which developed silicones was a culmination of glass and plastic studies, heretofore considered quite unrelated fields. The Dow-Corning Company was formed in the latter part of 1943 to make these products available for war purposes. Press releases indicate that the General Electric Company is also engaged in the production of silicones.

The primary raw materials required for the preparation of silicones are sand, brine, coal, and oil. One or more hydrocarbon groups must be carried by the silicon atoms, and these groups have a great effect on the properties of the resulting compound. The process for the preparation of silicones is complex and involves many steps. A vast new field of research has been opened up in the study of these compounds.

Silicone compounds in the form of fluids, greases, resins, and lubricants are commercially prepared at the present time. Some of the properties which are peculiar to silicones and which make them of such great use are:

1. They are chemically inert to metals, resist oxidation, and are neutral in reactions.
2. They have a low surface tension which makes them useful in the preparation of water-repellent surfaces.
3. They are insoluble in water, although they are soluble in most organic compounds.
4. They have a low dielectric constant and power factor.
5. They exhibit little change in viscosity over a wide range of temperature.

Silicones find wide use in the field of electrical insulation due to their exceptional electrical properties which allow greater life and better operation of electrical equipment. Because of their unusual thermal properties, silicones are superior to previously known organic varnishes and resins. The low surface tension of certain silicones allows them to be easily applied to glass, Fiberglas, and asbestos surfaces. They find wide use in the rubber industry also.

There can be little doubt that silicones will become of great importance in the postwar world, and many products which are seemingly fantastic now will inevitably become everyday realities in the near future.

Esther W. Miller

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PAPERS PRESENTED AT GEOLOGY AND GEOGRAPHY SECTION OF OREGON ACADEMY OF SCIENCE, JANUARY 13, 1945

Warren D. Smith, Chairman

1. "An Unusual Example of Stream Capture near Lewiston, Idaho": Lloyd L. Ruff of the United States Engineers.
2. "A Preliminary Report on the Tertiary Foraminifera of the Coos Bay Area": Mrs. Mildred Reichers Detling of the University of Oregon.
3. "Ferruginous Bauxite Deposits of Washington County, Oregon": F. W. Libbey of the Oregon Department of Geology and Mineral Industries.
4. "Eugene Silica Foundry Sand": Wallace D. Lowry of the Oregon Department of Geology and Mineral Industries.
5. "Geologic and Geographic Work in the War Effort in Washington, D. C.": Warren D. Smith of the University of Oregon.
6. "A Summary of the Stratigraphy of the Coos Bay Area": John Eliot Allen and Ewart M. Baldwin of the Oregon Department of Geology and Mineral Industries.
7. "Wind Erosion Basins in Fort Rock Valley, Oregon": Ira S. Allison of Oregon State College.
8. "Chalcedony Filled Nodules": A. W. Hancock of Portland.
9. "Results of Geography Tests Given to University Students": James C. Stovall of the University of Oregon.
10. "A Geonomic Survey of the Rogue River Valley": Willis B. Merriam of the University of Oregon.
11. "Fossil Woods": George F. Beck.
12. "A New Fossil Plant Locality near Eugene": LeRoy E. Detling of the University of Oregon.

Symposium on early man in Oregon:

Dr. L. S. Cressman, principal speaker: "The Stratigraphic Record of Early Man in Oregon."

Dr. Ira S. Allison: "Clues from Pluvial Lakes."

Dr. Henry P. Hansen: "Postglacial Climates and Chronology."

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MERCURY IN NOVEMBER 1944

According to the U.S. Bureau of Mines monthly mercury report released January 3, 1945, production of mercury decreased to 2,300 flasks in November, or to the lowest rate since February 1940.

Consumption continued unmoved at the rate of 3,900 flasks reported for the 3 preceding months, the gains for some uses counteracting losses registered for others. Consumption may have been restricted in part by difficulties in obtaining metal. The situation regarding essential war needs promised improvement in December because of the Government's action in releasing metal from the stockpile for this purpose. Winter weather and labor difficulties contribute to the unfavorable outlook for noteworthy production gains in the near future. Total industry stocks declined further in November and prices continued the uptrend of recent months.

Salient statistics on mercury in the United States in 1939-43 and in January-November 1944, in flasks of 76 pounds each

Period	Production	Consumption	Stocks at end of period		Price per flask at New York
			Consumers and dealers 1/	Producers 2/	
	Average Monthly				
1939 . . .	1,553	3/ 1,742	12,600	376	$ 103.94
1940 . . .	3,148	2,233	14,100	607	176.87
1941 . . .	3,743	3,733	12,400	439	185.02
1942 . . .	4,237	4,142	10,700	1,377	196.35
1943 . . .	4/ 4,327	4,542	13,200	3,457	195.21
	Monthly				
1944:					
January .	4,400	3,400	11,300	5,459	151.60
February.	3,800	3,700	9,400	5,450	130.00
March . .	3,800	3,600	9,900	5,011	130.00
April . .	3,700	3,200	9,700	5,604	128.20
May . . .	3,400	3,100	8,900	6,171	115.54
June. . .	3,000	3,400	9,000	5,757	101.69
July. . .	2,700	3,000	9,300	4,025	100.56
August. .	2,500	3,900	9,100	2,252	104.04
September	2,500	3,900	8,400	1,936	104.28
October .	2,700	3,900	7,400	2,550	109.20
November.	2,300	3,900	7,800	2,094	116.30

1/ Largely excludes redistilled metal. 2/ Held by reporting companies. 3/ Apparent consumption. 4/ Based on final figures.

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