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AN ALUMINUM PRIMER

by

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1. Is aluminum an important metal?

Aluminum metal belongs to this modern age. Because it holds tenaciously to other elements with which it is associated in nature, it does not occur in nature as a metal, and therefore was not known to the ancients. In fact an economical method of production of aluminum metal is a relatively recent discovery. It was in 1886 that Charles Martin Hall discovered that he could reduce aluminum oxide to aluminum metal in a cryolite bath. From that discovery dates the United States aluminum industry which has grown in this century by leaps and bounds along with development of electric power, until now it is one of our basic industries. Without aluminum we could not successfully prosecute a war, or take part in modern peacetime industrial progress.

2. Is aluminum a rare element in rocks?

No, it is the most widely distributed of all the metals, but it is for the most part combined with silica to form silicates which have not been treated economically to produce aluminum in competition with bauxite, the impure oxide of aluminum. Bauxite occurs in many parts of the world, but is limited in quantity compared to aluminum silicate rocks.

3. What are the principal uses of aluminum?

Because of its light weight, conductivity, color, noncorrosiveness with acids, and strength of its alloys, aluminum has a great variety of industrial uses; its household use is universal. It is essential from a national defense standpoint because of its need in aircraft construction, in tank engines, and in naval vessels. The U.S. Bureau of Mines Minerals Yearbook for the year 1944 is authority for the statement that 96,369 planes of all types were delivered to the armed forces in 1944, and that 50 percent of the weight of these planes (average weight per plane 10,600 pounds) was aluminum or aluminum alloys. An aircraft carrier requires 1000 tons of aluminum; a battleship, 700 tons; a heavy cruiser, 300 tons; and so on down the line. The best known peacetime uses are in transportation equipment, including automobiles and trucks; electrical transmission cables and electrical appliances; household utensils, in steel making, in many machines other than automotive, in the chemical industry; and for miscellaneous uses such as foil, paint, and the like.

4. Why does aluminum appear to have great future importance?

The aluminum industry is youthful. It has had a remarkable growth during the present century, but because of the metal's peculiar properties it seems certain that the industry will continue to grow. We are entering an age of expanding air transportation.

To compete in this age, ground transportation will need to use increasing quantities of light metals in order to achieve maximum economy of operation. Aluminum will be used to an increasing extent in the construction industry.

5. <u>Why does aluminum appear to have special importance to Oregon and the Northwest?</u>

Before the war two privately owned aluminum reduction plants were built on the Columbia River at Vancouver, Washington, and Longview, Washington, respectively. During the war three additional reduction plants were built with Government funds at Troutdale, Oregon, Spokane, Washington, and Tacoma, Washington, respectively. In addition an aluminum sheet rolling mill was built by the Government at Spokane. When the war demand stopped there was a drastic reduction in operations at Government-owned plants. Finally these plants were closed down and later declared surplus property. It has been recently reported that the Spokane plants have been leased by the Government to the Kaiser interests, and that the Troutdale plant has been leased to the Reynolds Metals Company. Because of the production at the privately owned plants at Vancouver and Longview, and because of the probable future production of the Government-owned leased plants, the Northwest's share in the domestic aluminum industry is of major proportions. As a corollary, the aluminum reduction plants are a market for a large proportion of Bonneville Power, and this fact alone makes the industry important to the Northwest. Oregon has a particular stake in the industry because Oregon ore may be the principal future source of alumina for these plants.

6. <u>What are the materials required for making aluminum metal?</u>

Alumina, which is pure aluminum oxide; cryolite which is sodium aluminum fluoride with a strong solvent power for alumina; and carbon electrodes. Alumina, the primary raw material is obtained by the treatment of bauxite which is the only ore of aluminum at the present time. Cryolite occurs in nature in commercial quantity in only one place in the world, at Ivigtut, Greenland. There is no difficulty however in making synthetic cryolite. Carbon electrodes are made from a pure coke together with a binding agent. Petroleum coke makes a desirable electrode because of its low ash content.

7. <u>What are the steps in producing aluminum metal?</u>

a. Mining bauxite ore.

b. Treating bauxite to produce pure alumina (aluminum oxide).

c. Electrolysis of alumina to produce aluminum metal.

8. <u>Is the production of aluminum difficult compared to other common metals?</u>

Yes, the metallurgy of aluminum is much more complicated mainly because aluminum has such a strong affinity for oxygen.

9. <u>What is bauxite?</u>

Bauxite was named for a material found near Les Baux, southern France, in 1821 by the French chemist Berthier. This material was composed essentially of aluminum oxide, iron oxide, and water. For many years bauxite was considered to be a mineral. It was finally recognized that this substance, consisting of impure aluminum oxide combined with water, found in several parts of the world varied in petrographic characteristics, and that the name bauxite had come to be applied to a mixture of oxides rather than one particular aluminum oxide. These natural aluminum oxides, containing combined water are known as bauxite minerals, and the best known are gibbsite, boehmite, and diaspore. One or more of these oxides together with impurities makes up commercial bauxite.

10. <u>Has bauxite any uses other than production of aluminum?</u>

Yes, it is used in fairly large quantities for making chemicals, abrasives, high-grade refractories, and in oil refining. In the prewar year 1939, over 50 percent of domestic production of bauxite was used by industries other than the aluminum industry. This proportion of course does not give a true picture of the relative amount of bauxite going into aluminum production, as the large amount of imported bauxite is used for the most part in making aluminum metal.

11. <u>What process is now used to treat bauxite ore in order to obtain alumina?</u>

The ore is dried, ground, and treated with hot caustic soda solution under pressure. The aluminum goes into solution as sodium aluminate, and the impurities remain undissolved and may be filtered off. This residue is known as "red mud". The filtrate is cooled and agitated, and on the addition of a "seed" charge of aluminum hydrate, the aluminum is precipitated as aluminum hydrate in crystalline form. The hydrate is filtered and calcined to form pure aluminum oxide, or alumina. This method of treatment is known as the Bayer process.

Although the Bayer process is the only one used commercially, a procedure known as the Pedersen process was used formerly in Norway. The ore, relatively high in iron, was smelted in an electric furnace with lime and coke. The resulting products were pig iron and calcium aluminate slag which was ground and leached with sodium carbonate solution. The aluminum was thus combined with sodium to form sodium aluminate. Then on treatment with carbon dioxide gas, the aluminum was precipitated as aluminum hydrate which was filtered and calcined to alumina as in the Bayer process.

12. <u>Have clays been treated commercially to produce alumina?</u>

Not in the United States. During the war when enemy submarine activity in the Caribbean endangered our bauxite supply, the Government authorized construction of pilot plants to make large scale tests on high-alumina clays with the object of working out an economic process or processes to produce alumina from such material. These plants were located at Harleyville, N. C., Laramie, Wyoming, and Salem, Oregon. Although these plants, if allowed to work out processes thoroughly, will contribute very valuable information, it seems unlikely that clays will be able to compete successfully with bauxite in production of alumina.

13. <u>Why is Oregon especially interested in production of alumina?</u>

Extensive deposits of high-iron bauxite have been found in northwestern Oregon, and are being developed by Alcoa Mining Company. This ore is much lower in alumina than the bauxite being used in Bayer plants, but the Oregon ore is relatively high in iron, production of which will offset the lower alumina value. The Pedersen process, or some modification of it, would seem to be applicable to this ore. Alcoa is carrying on metallurgical testing work, and if an economical process can be worked out, a plant will be built to produce both alumina and pig iron from Oregon ore.

14. <u>How was Oregon ore formed?</u>

After Columbia River basalt had flowed over the country many millions of years ago, climatic conditions were right for intense weathering of this rock. The basalt is made up for the most part of aluminum and iron silicates, with small amounts of combined lime, magnesia, and titania. The weathering process, called laterization, resulted in breaking down of the silicates, and leaching of silica, lime, and magnesia, leaving behind and concentrating aluminum oxide, iron oxide, and titanium oxide. The aluminum oxide is present mainly as the mineral gibbsite - a bauxite mineral. The ore was thus formed by weathering, and in order to have it preserved, weathering had to proceed much faster than erosion. In many places erosion was effective, and the ore was removed.

15. What is the distribution of the Oregon ore?

Deposits have been found in Washington, Columbia, Multnomah, Clackamas, Polk, and Marion counties. So far as is now known, the most important deposits are in Washington, Columbia, and Marion counties.

16. Is there a variation in the character of the deposits?

Although in general the deposits are similar, those in Marion County are somewhat different from those in the other counties. Probably the Marion County area suffered somewhat greater erosion than the other areas so that a portion of the upper section of deposits has been removed. This resulted in a surface concentration of high-grade bauxite boulders left behind as float over the Salem Hills and to a less extent in the Eola Hills. Also the ore section in Marion County is thinner than in Washington and Columbia counties.

17. Is the high-grade bauxite in Marion County of importance commercially?

Insufficient work has been done on these deposits to determine their extent. Their wide distribution warrants exploration. Although the quantity of this material is probably small compared to the lower grade, high-iron bauxite in the several counties, the high-grade float may have industrial uses other than for producing aluminum.

18. What is the extent of reserves of Oregon ore?

Alcoa Mining Company has been sampling the deposits in Washington and Columbia counties for over a year. No tonnage figures have been made public, but reserves are in the order of many millions of tons. In the preliminary work of the State Department of Geology and Mineral Industries, auger-hole drilling[1] indicated over 5,000,000 long tons of ore in two deposits in Washington County only.

19. Do the Oregon deposits have good physical characteristics from a mining standpoint?

Yes, the deposits lie flat and generally have a moderate overburden of silt. The ore is for the most part soft, and little in the way of explosives will be required. The deposits could be mined cheaply by surface mining methods. Highly important is location of deposits so close to the aluminum plants on the Columbia River.

20. When will a decision be reached concerning commercial production of Oregon ore?

It seems likely that exploration and testing work now being done will allow a decision sometime in 1946.

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CURRENT MINING NOTES

Langdon Rand and associates, Baker, are working a drift placer on Connor Creek, Baker County.

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J. R. Davies, Boise, Idaho, is in charge of development work now underway at the Red Cloud quicksilver mine, northern Jackson County. Mr. Davies will do several thousand dollars worth of underground work according to an announcement by F. E. Hobson, consulting engineer.

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[1] Libbey, F.W., Lowry, W.D., and Mason, R.S., Ferruginous bauxite deposits in northwestern Oregon: Oregon Dept. Geol. and Min. Ind. Bull. 29, 1945.

Mason, R.S., Auger-hole prospecting: The Ore.-Bin, vol. 6 no. 12, 1944, Oregon Dept. Geol. and Min. Ind.

The Baker-Union Concrete Products Co., C. L. Lawton, manager, has built a plant at North Powder, Baker County, for making building blocks and concrete fence posts. Production has reached 700 blocks per day, according to a statement in the Baker Record Courier of March 14.

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L. A. Damon, Marial, Curry County, has driven 200 feet on his Golden Fraction claim tunnel on the west fork of Mule Creek. The tunnel is developing a vein 7 feet in width and having a high-grade streak 6 to 12 inches in width which contains iron and manganese oxides. Over 550 tons of ore on the dump is reported to assay $12 to $15 to the ton excluding the high grade. Damon and associates are also working the Brown Eagle claim in the same district. An open cut is being driven to crosscut a vein near the surface. Assays as high as $298 to the ton in gold and silver have been reported.

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W. P. Crowell, Medford, Oregon, has taken over the Golden Economy claim, formerly owned by Chas. M. Lewis, located near the head of Tiny H Creek, Curry County. A 26-inch vein containing copper, lead, and manganese has been encountered. Gold and silver values from $28 to $48 to the ton have been reported. A contract to sink a shaft on the Golden Economy claim has been let to Willis Ireland.

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USEFUL LITHIUM COMPOUNDS

Among the many wartime discoveries to enter the postwar world are lithium greases and waxes. Two recent articles[1,2] in Foote Prints, issued by the Foote Mineral Company, emphasize the importance of these new materials.

A lithium grease is a grease prepared from a lubricating oil of the vegetable or mineral type with a sufficient amount of lithium soap to thicken the oil. These greases are adaptable to many lubrication problems which other greases fail to solve. Lithium greases are easier to make and the manufacturing cost is no greater than that of other greases.

A lithium wax is a mixture of lithium stearate and a paraffin wax. Because of their superior properties these waxes find great use in improving such products as cosmetics, pencils, waterproof coatings, electrical insulation, sound recording disks, adhesives, paper coatings, etc.

It is believed that lower cost and superior properties will make lithium organics indispensable to the industrial progress of the future.

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1. Luckenbach, W.F., Jr. and Meyer, H.C., Jr., "The Effect of Fatty Acid Molecular Weight on Lithium Greases," Foote Prints, Vol. 17, No. 2, pp. 3-8, 1945.

2. "Lithium Organics," Foote Prints, Vol. 17, No. 2, pp. 22-23.

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CLEARING HOUSE

CH-86: For sale - unpatented placer claim in E½ NW¼ NE¼ sec. 5, T. 34 S., R. 7 W., 13 miles from Wolf Creek at the mouth of Rock Creek in Josephine County. The claim has first water right, 2 ditches, pipe line, and giant. There is a 4-room house and garage on good road. Four test holes reported to return 31 cents per yard. Price $1500 cash. After May 10 for 30 days address W. T. Tennison, Wolf Creek, Oregon.

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NEW FIELD GEOLOGIST

Elton A. Youngberg, Department field engineer stationed at Grants Pass, has resigned to take a position with Howe Sound Mining Company at the Holden Mine, Lake Chelan, Washington. Youngberg has been succeeded by Hollis M. Dole, until recently Navy lieutenant with over three years' service in the South Pacific. Dole majored in geology at Oregon State College and was doing graduate work in geology at University of California at Los Angeles when he entered the Navy.

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OREGON GEOGRAPHIC NAMES

The March 1946 issue of Oregon Historical Quarterly contains a list of Oregon place names compiled since the last installment in 1944. In this list Lewis A. McArthur, author of the invaluable volume on Oregon geographic names, has assembled basic information of 175 names of places not previously catalogued in all parts of the State, starting with Abberdeen in Linn County and ending with Yampo School in Yamhill County. Dr. McArthur seeks additional information on some of these names, and readers of the Quarterly are requested to send him anything specific in the way of explanation or clarification.

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NEW ENGINEERING EXPERIMENT STATION BULLETIN

The Engineering Experiment Station, Oregon State System of Higher Education, Oregon State College, has just issued a bulletin, No. 20, entitled The Fishes of the Willamette River System in Relation to Pollution. The authors are R. E. Dimick, Professor of Fish and Game Management, and Fred Merryfield, Associate Professor of Civil Engineering. This bulletin gives results of a survey of the Willamette River system in relation to the menace to fish life due to pollution by industrial and domestic wastes. The bulletin is sent free of charge to residents of Oregon.

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PUBLICATIONS

GEOLOGIC MAP SERIES

	Price postpaid
1. Geologic map of the Wallowa Lake quad., 1938: W.D.Smith & Others (also in Bull. 12)	$ 0.45
2. Geologic map of the Medford quadrangle, 1939: F.G.Wells & Others	0.40
3. Geologic map and geology of the Round Mountain quad., 1940: W.D.Wilkinson & Others	0.25
4. Geologic map of the Butte Falls quad., 1941: W.D.Wilkinson & Others	0.45
5. Geologic map and geology of the Grants Pass quad., 1940: F.G.Wells & Others . . .	0.30
6. Preliminary geologic map of the Sumpter quad., 1941: J.T.Pardee & Others	0.40
7. Geologic map of the Portland area, 1942: Ray C. Treasher	0.25
8. Geologic map of the Coos Bay quad., 1944: Allen & Baldwin (sold with Bull. 27) . .	----
9. Geologic map of the St. Helens quad., 1945: W.D.Wilkinson, W.D.Lowry, & E.M.Baldwin	0.30

MISCELLANEOUS PUBLICATIONS

The Ore.-Bin: issued monthly by the staff, as medium for news items about the Department, mines, and minerals. Subscription price per year	0.25
Oregon mineral localities map	0.05
Landforms of Oregon: a physiographic sketch, (17 by 22 inches) 1941	0.10
Index to geologic mapping in Oregon, 1944	Free
Index to topographic mapping in Oregon, 1945	Free

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