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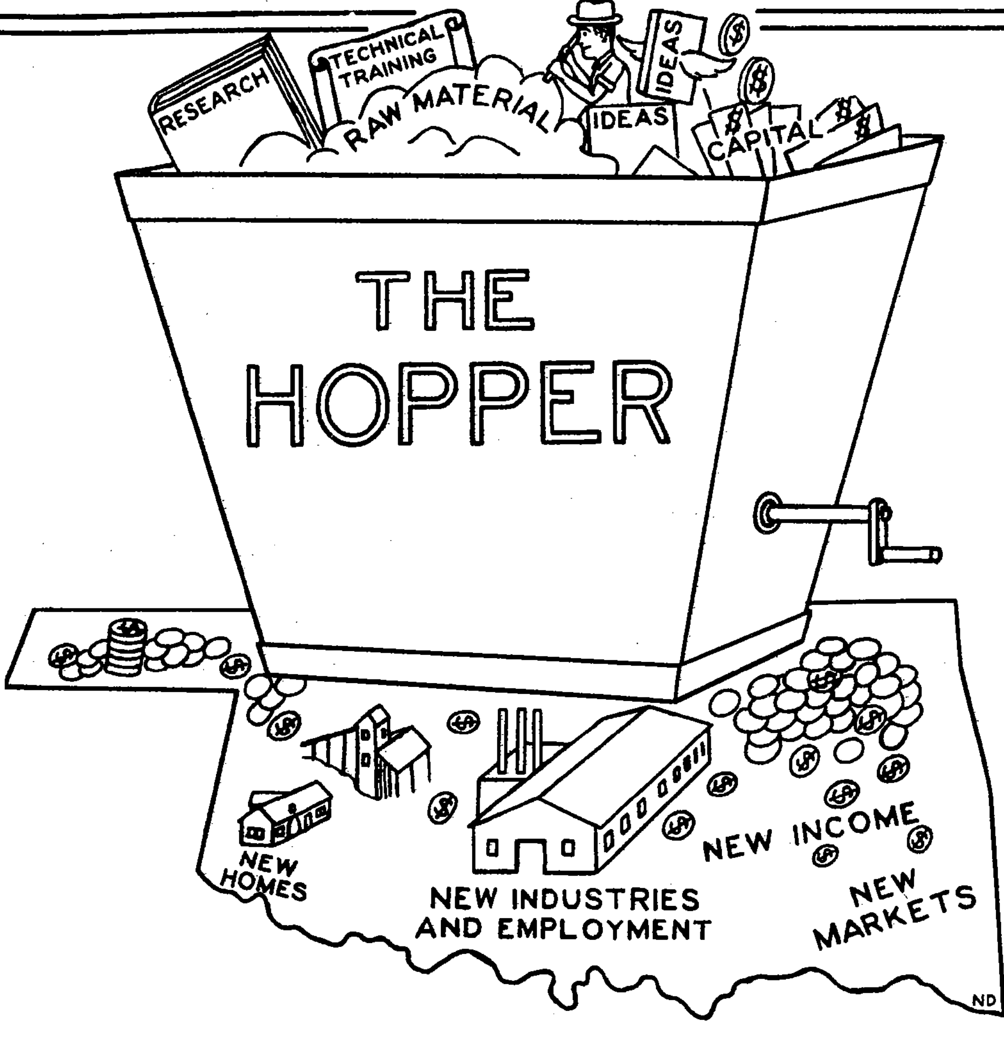

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BLUE CHIP METALS

(The first section of the following article appeared in the February issue of the ORE-BIN, a publication comparable to THE HOPPER. It is published by the Oregon State Department of Geology and Mineral Industries, Portland, Oregon. The article appeared to us to be a rather good discussion of current trends in new developments pertaining to some of the less commonly known mineral materials. Some of these are pertinent to Oklahoma.

The second section dealing particularly with Oklahoma's position in regard to some of the new possibilities was prepared by Mr. A. L. Burwell, Industrial Chemist of the Oklahoma Geological Survey.)

This atomic age is dependent on metals, and their importance is constantly being brought home to us. This is a development hastened by war and war preparation, but in any case, seemingly, it is an industrial evolution along the course set by the demand for more and improved machines and the inventions of new and more intricate instruments. A greater quantity of the common metals is continually demanded; and "new" metals - new in their practical applications - are becoming increasingly necessary in the ever-expanding industrial field. Cobalt, titanium, columbium, tantalum, germanium, and the so-called rare-earth metals are among those which have become essential to modern industry. Because of price, domestic needs, and metallurgical characteristics, they are the "blue chips" of present-day metallurgy.

Cobalt is one of the most useful of the new-old metals. Nearly everyone is familiar with the beautiful cobalt blue color which comes from some cobalt salts, and the main use for the metal for many years was in the arts. Cobalt metal had very little application as a metal until research point-ed to cobalt alloys having outstanding characteristics. It was found that cobalt when alloyed with other metals such as nickel, chrome, tungsten, and some others, takes on incomparable qualities, one of which is withstanding elevated temperatures and this quality is now utilized in jet engines. Cobalt forms nearly indispensable alloys for permanent magnets and magnetic steels. Some other industrial uses, besides ceramic, are in forming high speed and other steels, cemented carbides, and hard facing welding rods. Our needs have expanded tremendously in the past few years. Consumption in 1950 was 8,283,408 pounds compared to about 2,893,000 pounds in 1941. Price of the metal is now about $2.40 per pound compared to $1.50 in 1941. Up to the present we have been dependent on imports, principally from the Belgian Congo and Northern Rhodesia. However, one mine in central Idaho owned by Howe Sound Mining Company is now getting into production and will reportedly have a capacity of about 3 million pounds of metal annually. The old silver district of Cobalt, Ontario, is taking a new lease on life and can produce a substantial amount of cobalt along with the silver. If the large demand continues and the market price provides sufficient incentive, new domestic deposits will probably be found and developed.

Titanium is best known in oxide form for use in pigments. However, titanium metal is becoming more and more in demand because of a very desirable combination of qualities of strength and light weight. The application of titanium to aircraft is a natural development and will probably find an expanding demand as the metal becomes cheaper and more available. Because of chemical characteristics, reduction to metal from titanium compounds is attended with much difficulty, hence the current high market price of about $5 a pound. If the history of production of titanium metal runs true to form, and it surely will, there will be a progressive reduction in cost of production which will mean a wider use in industry.

Columbium and tantalum, usually closely associated in nature, are in strong demand for specialized uses, many of which are for military needs. The principal use of columbium is not as a metal by itself but rather in improving the quality of stainless steels and in giving superior strength to alloys used in jet engine and gas turbine construction. Because our own production of columbium is inconsequential and imports are insufficient for our actual and potential needs, concentrated efforts have been made with some success to develop substitutes. However, under present conditions columbium is in insufficient supply to meet both defense and civilian needs and we are trying to increase imports and develop domestic sources.

Tantalum is used mainly as a metal in which form it has a variety of valuable uses. It is corrosion resistant, has a high melting point, and is readily worked. It is used for many surgical supplies and for electronic tube parts. Tantalum carbide is a component of some cutting tools, and cemented carbides of tantalum and columbium have special uses.

U.S. Bureau of Mines <u>Minerals Yearbook</u> reports that in 1949 imports of columbium ores for consumption largely from Nigeria amounted to 1,557,479 pounds valued at $561,945, a large reduction compared to 1,973,728 pounds in 1948 and 2,821,634 pounds in 1947. The decline in columbian production has been due to the exhaustion of the richer tin placers of northern Nigeria from which the bulk of columbite production has been derived. Imports of tantalum ores mostly from Belgian Congo amounted to 136,664 pounds valued at $237,292 in 1949, 127,688 pounds in 1948, and 418,753 pounds in 1947.

Germanium is another metal which has been brought into the industrial limelight during the past few years because of unique qualities. These qualities have caused a great increase in the demand for the metal in the electronics field. A "transistor" has been developed by Bell Laboratories for use in long-distance circuits and rectifiers. The "transistor" is a minute object, smaller than a pea, which operates like a vacuum tube. The rectifying characteristics of germanium have led to the development of a germanium diode, a very small compact device which has allowed construction of tiny wrist-watch type radios having no glass tubes. Many other interesting things about germanium are being developed. Germanium is produced from zinc ores of the Tri-State district which contain 0.01 to 0.1 percent Ge. The market price of germanium is reported to be about $180 a pound.

The rare-earth metals were interestingly described by Barnett Ravits in Barron's, December 17, 1951, and the following is abstracted from his article:

Today the rare-earth metals are increasingly in the news because of their use in atomic energy developments and to a limited extent in the metallurgy of high quality steels and light metal alloys. In order of their relative abundance rare-earth minerals include: cerium (31%); neodymium (18%); lanthanum, samarium, dysprosium, ytterbium, and gadolinium (7% each); erbium (6%); praseodymium (5%); lutecium (1.5%); terbium, holmium, and thulium (1% each); and europium (0.2%).

The main derivative of rare earths is misch metal (mixed metal), consisting mostly of cerium. Misch metal (flints) is the essential element in cigarette lighters, but it also has a number of other uses. It adds intensity and brightness to miners' lamps, gas mantles, carbon arcs for searchlights and motion picture projectors. It is an important ingredient of flashlight powder. Manufacturers of stainless and super-alloy steels employ misch metal to prevent flakes (fine internal cracks) and to remove oxygen and other gases, thereby creating denser steels with improved rollability when heat treated.

Current prices reflect the varying availability of the rare-earth metals. Fairly pure cerium, for instance, is valued at around $50 per pound. Lanthanum, neodymium, and praseodymium fetch prices of $175, $200, and $750 per pound, respectively. High-purity europium oxide and thulium oxalate bring the extremely high prices of about $700 and $1,500 a gram, respectively. Misch metal, the crude and presently main commercial form of the rare-earth metals, currently sells for around $4.50 per pound.

Up until recently, the major raw material from which the rare earths are derived was monazite sand. Low-grade monazite is found in Idaho, Florida, and North Carolina, but these deposits are uneconomic at current domestic prices. Monazite's scarcity has shot import prices up from $245 a ton in 1949 to $360 a ton at present - when it can be obtained.

Recently the Molybdenum Corporation acquired an acreage of several square miles in California containing an exceptionally large and rich deposit of bastnäsite, a new source of rare earths. Drilling on 50 percent of the property already has outlined about 1 billion pounds of the rare-earth minerals. At depth, the company estimates that its deposit contains 3 billion pounds.*

Despite the commercial strides made in the use of the rare earths, the metallurgy and chemical separation and purification of rare-earth metals are still in their infancy. The Atomic Energy Commission is undertaking a most intensive investigation into the history of these minerals and the scientific problems surrounding them, especially in its Ames Laboratory at Iowa State College.

Similar experiments are being conducted at the University of Idaho.

From what has been revealed about the AEC's work on and interest in the rare earths, the results of its research mark a considerable advance in knowledge of separating the difficult-to-isolate component metals, and thus stand to enhance their future industrial consumption.

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*E&MJ Metal and Mineral Markets for" December 20, 1951, reports that a deposit of bastnasite owned by William Heim in the Callinas district of New Mexico is being developed by Lindsay Light & Chemical Company and General Chemical Company. The deposit, discovered by Heim while mining fluorspar in 1950, contains 14 rare-earth minerals. Current production amounts to several carloads of concentrate a month. Ed.

F.W.L.

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The foregoing quotation from the ORE-BIN, February, 1952, issue, published in Oregon, should serve to focus attention on Oklahoma "blue-chip" raw materials. It is doubtful that Oklahoma citizens appreciate what we have within our State in the way of "blue-chips" several of which have greater intrinsic value than the gold and silver for which the early pioneers searched so diligently and unsuccessfully. Certain of these "blue-chip" materials are already in commercial production in Oklahoma and several others appear as something more than possibilities. All should have our attention.

Germanium and its properties have been described in the ORE-BIN article. In spite of the publicity given to the subject through the technical journals and by means of motion picture film, it is not generally known that this "blue-chip" metal is being produced in Oklahoma. The recovery of germanium as a by-product of zinc smelting is founded on one of the most interesting research and development accomplishments of recent years. The Eagle-Picher smelter at Henryetta recovers germanium, gallium, and cadmium. The National Zinc Company smelter at Bartlesville recovers germanium dioxide only. This recovery is from ore so lean in germanium that its presence is hardly detectable. It is reported that important discoveries of renierite, a germanium sulfide mineral, in the Belgian Congo carry as much as 7.8 percent metal. Such concentration is exceptional and interest has been shown in material carrying relatively minor amounts such as certain bituminous coals and shales. Investigations in West Virginia prove the presence of germanium in some of that state's coal seams. It is interesting to note that the germanium occurs not in the ash but in the bitumen itself, where it has been concentrated from circulating ground water apparently, since the metal is in the upper or lower three inch layer of the seam and is not present elsewhere except in minor amounts. The method of identification and assay in West Virginia was by means of the spectrograph. A question naturally arises as to whether or not germanium is present in Oklahoma bituminous coal. If it occurs in some of our thin-bedded shallow seams that are not presently economically feasible sources of fuel it might prove them to be highly valuable.

Gallium is being produced in Oklahoma but the uses of this metal have not materialized in a manner comparable to germanium. Gallium is priced in the range of $2.50 to $5.00 per gram, certainly a "blue-chip" if produced and sold.

Cadmium should also be included in any list of "blue-chip" material being produced in Oklahoma. Any metal that brings $2.00 per pound is a "blue-chip" in our book. It is being recovered as a by-product in zinc smelting at Henryetta and Bartlesville. The principal use for cadmium is in plating iron and steel, yielding a film possessing certain desiral le corrosion-resisting properties.

Indium is still another "blue-chip" metal being producing in Oklahoma. Indium occurs in only trace amounts in some zinc, lead, tin, tungsten, and iron ores. Its production is strictly a by-product operation. The fact that the world production of indium is shown in troy ounces indicates its scarcity and justifies the price of better than $20.00 per ounce that the metal brings. Indium "finds its most important use as an unexcelled final plating for high-quality composite engine bearings, especially where high-bearing loads, elevated operating temperatures, and severe conditions of lubricant corrosion are encountered." Several alloys and solders containing indium have been made to serve for special purposes.

There are several metallic minerals occuring in Oklahoma which will fall in the catalogy of "blue-chip" materials if and when located in sufficient concentration and quantity to justify commercial exploitation. Included in such a list are minerals carrying berylium, thorium, zirconium, vanadium, chromium, and titanium. The titanium ores have been investigated by members of the staff of the Oklahoma Geological Survey. THE HOPPER, issue of February, 1952, carries an article by Gerald Chase of the Survey staff which indicates that the production of titanium-bearing ore in Oklahoma should be an actuality within a short time, removing that metallic material from the possibility classification to one of commercial production.

Berylium occurs in Oklahoma but to date only one occurrence has been reported. An examination of an old prospect-pit in the Wichita Mountains was made in 1945, and material from the dump was found to contain the mineral helvite, a berylium mineral. Unfortunately the old shaft is now filled and the samples from the dump show the presence but nothing of the extent of the Berylium-bearing material. The report from the United States Bureau of Mines laboratory at Rolla, Missouri, reads: "The sample was composed of an orthoclase-magnetite rock containing sphalertite, galena, magnetite, feldspar, and about 3 percent helvite." "A chemical analysis showed that the sample contained 6.88 percent lead, 9.25 percent zinc, 16.15 percent iron, and 0.35 percent beryllia." Not much beryllium to be sure, but berylium does not occur in high concentration. As a matter of fact, the world production of beryllium ore amounted to less than 5,000 metric tons of concentrates carrying 10 to 12 percent BeO. The most important use for berylium is in alloys with copper to yield castable, ductile, machinable metals capable of function at moderately elevated temperature, and at the same time conduct electricity. These alloys are of great commercial and strategic significance. The classifying of berylium as "blue-chip" metal appears well justified when one considers that the addition of 4 percent beryllium increases the value of copper, nominally worth 23 to 24 cents per pound, to about $2.50 per pound. The commercial alloys, as a rule, contain from 0.25 to 2.85 percent berylium.

Thorium as a commercial metal has had its ups and downs. The fact that it is next to uranium in the intensity of its radio activity has focused the limelight on this metal and its ores. Thorium metal powder, in 1949, in lots of 1,000 grams was priced at 25 cents per gram. The monazite sands of the Carolinas, Idaho, and California, have been the usual source of thorium minerals, but more recently thorium minerals have been a by product from the Florida titanium-mineral operations. In addition to its use based on radio activity, thoria is recognized as a special-purpose refractory.

Zirconium is also important in the preparation of refractories. Both thorium and zirconium have been found, but so far not in commercial concentration, in the pegmatite rock in certain parts of the Wichita Mountains, especially at the so-called "zircon mine." The present commercial source of zirconium minerals is also from the ilmenite-rutile mining operations in Florida. Strange as it may seem, this by-product recovery of zircon from the titanium mining operations has made the United States self-sufficient as regards this "blue-chip." Zircon (65 percent ZrO) has been quoted in the last two years in the range from $40 to $48 per ton. This chip is not as blue as some of the others but there is more of it available.

The use of vanadium and chromium in steel, where they impart very important properties to the alloy, is a matter generally known by users of steel and steel fabrications. Both vanadium and chromium have been isolated from magnetite iron and titanium ores of the Wichita Mountain area. Vanadium has been found in the ash from Impsonite of the Ouachita Mountains, and in certain asphalts of the state. It is thought that investigations of Oklahoma shales may show the presence of vanadium in some of them. It seems reasonable that if vanadium and chromium, or either one of them, if produced in Oklahoma will come as by-product from iron, titanium, or other metal recovery, but should Oklahoma shales carry an appreciable amount, even as little as 1 to 1.5 percent vanadium oxide, we might see a "blue-chip" operation for itself alone.

This lists only a few of the "blue-chip" possibilities of Oklahoma. New ones may show up at any time. Strange as it may seem, some of our lowly "dirt" may change character rather rapidly. Nature is slow to disclose some of her secrets.

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