

Booming Beryllium

Utah Ore Discovery, New Processing Method May Cut Metal's Cost

Prospectors Crowd Topaz Mountain; Mining Firms Feud Over Land Rights

Boost for Polaris, Mercury

BY DANIEL M. BURNHAM

Staff Reporter of THE WALL STREET JOURNAL

JUAB COUNTY, Utah—At an isolated mining camp in the Topaz Mountain area south of Utah's Great Salt Lake Desert, sun-tanned Dr. Norman C. Williams, a geologist, stands in a shallow pit and displays a fistful of chalk-white rock.

"We don't know much about it," he says, "but this is what the furor is all about."

The rock contains a still undefined material which yields beryllium, a light, tough and currently expensive metal with a mounting number of space-age applications. In a five-square-mile area of rugged Utah land near the western slope of the grey-green Topaz, where swarms of prospectors dug for uranium in the early 1950's, geologists believe they have found an important new supply of the metal.

Dr. Williams and his colleagues don't know at this time precisely how much beryllium the Topaz Mountain deposit contains, nor do they know what it might cost to extract the metal. But on the basis of what they have learned so far, geologists seem reasonably sure it will prove a formidable competitor for African and South American suppliers of the mineral beryl, from which is extracted about 95% of the beryllium being consumed in the U.S. One striking statistic underlies this conclusion: While beryl is made up of only about 4% beryllium, geologists believe the Utah material may contain as much as 45% beryllium.

Lower Rate in Prospect

In any case, the Topaz Mountain discovery, coupled with new, cheaper methods being developed for extracting beryllium from beryl, promises to bring down the metal's price from a minimum of \$60 a pound—four times greater than silver—and consequently open new markets to the two main U.S. processors and fabricators of the metal, Beryllium Corp. of Reading, Pa., and Brush Beryllium Corp. of Cleveland.

"We've already cut some prices for beryllium and we figure we'll be able to cut them much further in the next two years," declares W. R. Lowry, president of Beryllium Corp.

So far the beryllium industry is a tiny one. Purchasers often buy the metal by the pound, even by the ounce. Although U.S. consumption of beryllium in 1959 jumped fourfold from 1954 and was a third greater than in 1958, it still came to only 8,100 tons. Nevertheless, where the metal is used, it is considered vital.

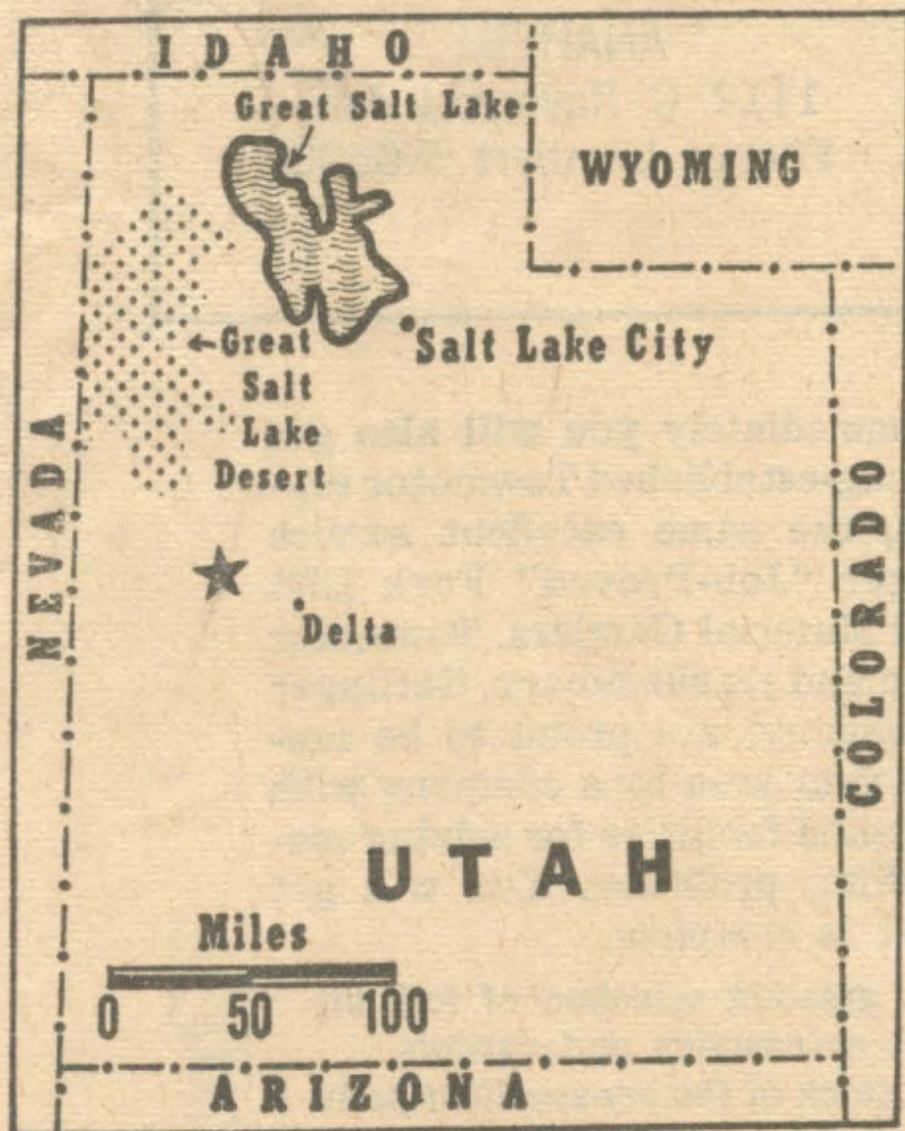
Because beryllium has a high melting point (2,342 degrees Fahrenheit), it is especially suited for missile nose cones, which must be able to withstand high friction-generated temperatures. Beryllium is used, for example, in the nose of the Polaris missile and is going into the Project Mercury capsule which is being designed to carry a man into space. Because beryllium uniquely resists neutron bombardments, it is being used as a structural material in most atomic reactors, including the reactor for the Air Force's atomic plane. Beryllium ranks as the second lightest metal (behind lithium) and weighs one-third less

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Rush of Prospecting

With the metal possessing such desirable properties, it is understandable that Utah's beryllium discovery has touched off a feverish rush of prospecting in the discovery area (marked by a star in the map below).



"There are so many jeeps and cars out on those hills a man has to look to the traffic or get killed," says George Spor, an auto dealer in Delta, the town nearest the discovery area. "Why," he adds with obvious awe, "we found one fellow who came all the way from Michigan."

Miss Josephine Kay, assistant recorder of Juab County, says that more than 500 mining claims were filed with her office in the first six months of this year, more than double the number filed in the comparable 1959 period for all minerals, including uranium and fluorspar.

A number of big-name corporations—DuPont Co., U.S. Steel Corp. and Food Machinery & Chemical Corp. among them—are known to have been looking around in the Topaz area, but so far most of the exploring has been done by two new mining subsidiaries of old line uranium companies. One, the firm for which Dr. Williams works is Beryllium Resources, Inc. It was formed last summer by Floyd Odum, then chairman and chief executive officer of Atlas Corp. of New York, a closed-end investment company. Beryllium Resources is owned jointly by Hidden Splendor Co. of Salt Lake City, a uranium company in which Atlas holds a 95% interest, and Federal Resources, Inc., also a Salt Lake City uranium

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concern, of which Mr. Odlum owns or controls about 40% of the common stock. Mr. Odlum retired from Atlas in May, but retains a large stock interest in the company. His son, Bruce Odlum, is president of Beryllium Resources.

Vitro Interest

The second company is Vitro Mineral Corp., owned half by Vitro Corp. of America, a New York engineering concern with big interests in minerals, and half by Rochester & Pittsburgh Coal Co., Inc., a mining company in Indiana, Pa. Vitro Mineral operates, among other properties, a uranium mill in Salt Lake City.

At the moment Beryllium Resources and Vitro are blasting away at each other for alleged spying and stealing credit for discovery of the lode, and are hotly disputing each other's claims to big hunks of what the companies believe is beryllium-rich land.

Vitro has attempted to gain prominence for its role in the discovery by naming the ore substance Vitrolite. According to Vitro's exploration manager, Cecil H. Smith, the discovery was made by four prospectors who had staked their own claims in the area and then brought ore samples in to both Vitro and Beryllium Resources.

Dr. Williams, chief geologist of Beryllium Resources, however, disputes this claiming he personally was first at the discovery area. Dr. Williams says his "discovery" was a logical progression from his findings of non-beryl ore containing beryllium in an abandoned uranium mine in New Mexico and later of a similar deposit in the Grant Mountain range in Utah, some 50 miles east of Topaz. Neither of these deposits contained heavy enough concentrates of beryllium to be of commercial value, but their placement in geological formations, he says, led him to believe there might be beryllium near Topaz.

Rights and Leases Acquired

Since the discoveries, in early January, Vitro has bought outright leases on some 3,200 acres in the Topaz area. Beryllium Resources, on the other hand, has confined itself to acquiring rights to explore some 2,700 acres, with the stipulation it will share with existing leaseholders any profits from the sale of beryllium mined on the property in the future.

Prospectors poking about these arid hills have been aided by an invention, called the Beryllometer, which merrily ticks away whenever it's near beryllium. The instrument costs about \$2,800 and functions in much the same way as the uranium prospector's Geiger counter.

Until the Topaz discovery, U.S. geologists did not know whether beryllium existed in a commercially significant form other than beryl. While much remains to be learned about the Utah material, Brush Beryllium already has successfully tested a process for extracting beryllium from the rock here. The company expects the first commercial shipments of ore may leave the Topaz area before the end of the year if all goes well.

Beryllium, which was discovered by French scientists in 1797, now is mined as beryl mainly in the mountains of Brazil and in the Union of South Africa. Natives in these lands hand chip about two tons of waste rock to get each ton of beryl, then cart the beryl to nearby ports. A number of deposits of beryl are known in the U.S., but no machinery has been developed to separate beryl from the rock in which it is found and high labor costs make hand-chipping methods impractical in this country. Some domestic beryl, however, is being purchased by the General Services Administration, which plans to stockpile 4,500 tons by 1962.

Grey-Brown Rock

new method of extracting beryl from the rock in which it is found.

The new process, developed by a Los Angeles chemical engineer, Edward Van Dornick, is backed by the two Odlums. In this case, Dynamic Metal Corp., a new firm set up to design and test the system, is owned 75% by Hidden Splendor and Federal Resources together, and 25% by Mr. Van Dornick. In the Van Dornick process, rock containing beryl is crushed to a fine powder, then mixed with a liquid reagent. When this mixture is shaken up, the reagent bubbles to the surface, picking up and carrying the beryl with it. Beryl is then skimmed off the surface. The same principle is used in the U.S. to mine low-grade copper ores and has been tried unsuccessfully with beryllium in the past by the U.S. Bureau of Mines. The key to the Van Dornick process is the reagent, but Dynamic Metal declines to describe it.

Should the Van Dornick process prove practical, idle deposits of beryl in New Mexico, South Dakota and New Hampshire might be profitably mined, geologists say. A pilot plant to test the process recently was completed in Los Angeles, although D. H. Hershberger, treasurer of Brush, believes the process already has been tested enough in the laboratory "to show very good signs of succeeding."

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CESIUM

Cesium, the heaviest and most reactive of the alkali metals, is currently receiving some of the attention that a few years ago was focused on uranium. This is because cesium is the most readily ionized of all the elements. The more exotic uses considered at present are as an ion motor fuel for rocket propulsion and the production of electricity directly from heat through thermionic conversion.

Press releases during the last year have disclosed that scientists are working on and have developed an ion motor using cesium, and it was made known in December that some 34 private concerns and universities are working under Government contracts for ion-stream studies and to develop cesium fuel as a booster for projectiles and satellites.

In April 1959, AEC scientists succeeded in generating direct current electricity from a plasma thermocouple using cesium vapor and enriched uranium. Then, at the beginning of this year, General Dynamics Corporation converted heat directly to alternating current in cesium cells.

Present uses of cesium also making use of its ionization potential are in photomultiplier tubes, infrared spectrometers, and scintillation counters.

Cesium is almost always found with rubidium, and the two follow and sometimes proxy for potassium. They resemble potassium chemically, but their atomic dimensions are greater. This large atomic diameter is responsible for their concentration in late crystallates, notably granite, and granite pegmatites. Cesium content in granites averages 40 parts per million, while igneous rocks in general average 7 ppm¹ of cesium.

¹ Rankama, K., and Sahama, Th. G.: Geochemistry, p. 437-440.

Pollucite, a hydrous cesium aluminous silicate, is the principle cesium mineral. It contains up to 42 percent Cs_2O . It is listed in Dana as isometric; often in cubes; also massive; $H = 6.5$, $G = 2.9$; colorless; $n = 1.525$. Because of its megascopic resemblance and association with quartz, it has been hard for prospectors and field geologists to identify.

The largest known deposit of pollucite is from a granite pegmatite at Bernic Lake, Manitoba, Canada, where reserves are estimated to be 150,000 tons of 25 percent Cs_2O ore. Other slightly smaller deposits are known in Southern Rhodesia and South-West Africa.

Other occurrences of cesium are in concentrations as high as 3.5 percent Cs_2O in lepidolite, microcline, biotite, and muscovite. The U. S. production of cesium by the American Potash & Chemical Corporation is as a by-product of the extraction of lithium from lepidolite and other lithium minerals. In the past, this and the African production have been sufficient for the minor amounts of cesium used.

Cesium is not presently on the OCDM list of critical and strategic minerals, but because of its rapidly increasing uses of a strategic nature it is receiving a lot of attention.

Prices are not quoted regularly on pollucite; however, in 1957 it was valued at about \$0.50 a pound of concentrate containing 25 to 30 percent Cs_2O .

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Report by: R. G. Bowen
February 26, 1960

Ralph

RARE EARTHS RARING TO GO

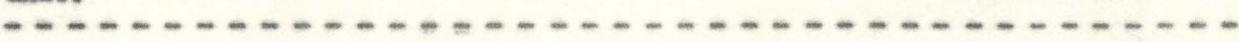
Rare earths seem to be over the hump - that difficult stage between basic research and large scale commercial production. Biggest immediate reason for the present boom in rare earth research and plant construction is demand created by the Atomic Energy Commission. Although companies now in the field are setting up their operations to fill AEC contracts, they feel that, once they are in the business, they will be in a good position to develop much larger commercial outlets.

Before AEC entered the picture, rare earth products found use in carbons for arc lighting, lighter "flints," glass coloring or decolorizing, glass polishing, and numerous minor outlets. Some applications require rare earth compounds, others like lighter "flints," use misch metal (mixture of rare earth metals) or cerium metal.

AEC is the biggest factor affecting today's rare earth market. First, its need for thorium has given the monazite processing industry a big push. Now it wants individual rare earths as well.

Thorium can be transformed into fissionable uranium-233 in an atomic pile. Plans are being made to use it in a "breeder" blanket in nuclear power reactors such as the one Commonwealth Edison is building near Chicago. The U²³³ will be removed periodically, and thus our supply of fissionable material will be increased.

Just how much thorium will be needed for reactors is a question which nobody can answer right now. Actually, calculations have not even yet been completed to show exactly how much will be needed in the Commonwealth Edison unit.



Demand for Individual Elements

It is not difficult to see why AEC is interested in individual rare earth elements. Some have thermal neutron capture cross-sections among the largest, and some among the smallest of the elements. There are nuclear applications for both types of material. This is why rare earths never before separated on a commercial scale are being sold today.

There are also potential new commercial demands for individual rare earths. Thulium, for example, can be made radioactive and serve in a portable x-ray device. Cost of irradiation is now quite high, but it is hoped that this can be lowered later to make the device economical.

The market for individual rare earths varies from week to week. Sudden and obscure demands throw everyone into a flurry of bidding. Rumors of tonnage demand for items now made by the pound breeze through the industry at short intervals. Demand for a single rare earth means that large storage facilities are needed for the partially processed cuts containing the unwanted elements. Producers hope this "unwanted" condition will be a temporary one for most rare earths but feel that some particular ones may glut the market for years. In spite of these difficulties and some price drops, companies separating rare earths are optimistic.

Mixtures Hold the Market

Although separation of rare earth mixtures into compounds of individual elements probably offers the greatest chance of future profits, the quantity of separated material is presently very small compared to that sold as mixtures. No dramatic increase is foreseen for mixtures in most applications, but metallurgy is an exception.

Not only are rare earths - as misch metal, or more recently as compounds - used in ferrous metallurgy, but they also are used with magnesium alloys.

Cerium, used in lighter "flints," is suffering somewhat from foreign competitors. Traditionally, a good deal of this has been exported, but now Europeans are producing more of their own. European atomic energy programs may possibly have an even greater effect in the future.

Research for New Markets

Research might open up entirely new markets for rare earths. Davison, for example, thinks they are worth investigating as catalysts. If separation processes are improved so that prices are lowered, then new markets will appear. A mixture of oxides naturally has a relatively low melting point but some individual oxides will make "beautiful" refractories, according to one manufacturer.

Physical data - such as melting points - are often unavailable. Probably there is much restricted data in existence, but if a company could offer engineers exact information about properties, it would be much easier for them to find new applications.

A few individual rare earths have been investigated for metallurgical uses, to see if they are more effective than mixtures. So far they do not, but this work is still in its early stages.

Ion-exchange processes are constantly being improved and are probably the most effective means yet developed for complete separation of rare earths.

However, this technique is most economical when it is desired to make a complete fractionation of pure rare earths at one time. It leaves something to be desired when just one element is wanted.

Solvent extraction has also been used, but the separation obtained is not so sharp. It may become useful for preliminary separations, or for "diving" for a particular rare earth. Of course, "pure" is a relative term. Sometimes a product assaying 95% is so designated and is effective in its application. Usually "pure" means 99% or better.

There has been no real breakthrough in producing rare earths in the metallic state in usable form. The heavier rare earth oxides are especially hard to reduce. Usual reducing agents lead to grossly impure products.

Spedding uses metallic calcium to reduce some of the metals. Lanthanum obtained in this way can be used to reduce heavier rare earth oxides, and the results mixture can be separated by sublimation.

Rare earths have never been too scarce, says Spedding; they just have not been developed. He believes they can be compared with aluminum which stood around on the shelf a long time before it came into production commercially. Present AEC demands may give rare earths the impetus they need to get them into tonnage production.

RARE EARTHS

What Companies in the Field Are Doing Today

Lindsay Chemical Co., West Chicago, Illinois, has been in the business of making thorium from monazite sand since World War I, when it was forced to acquire a new source of thorium for its gas mantle business (C&EN, Sept. 26, 1955, p. 4102). At first the rare earths were of no importance and were discarded, but later on uses were found for them and Lindsay became the leading producer. It still definitely holds the top position so far as volume of monazite derivatives is concerned. With the discovery that thorium could be converted into fissionable uranium-233, Lindsay's interest again shifted to thorium - this time for AEC.

Last year Lindsay set up an ion-exchange pilot plant, similar to the one F. H. Spedding, Jack Powell, and their co-workers developed at the Institute

for Atomic Research at Ames, Iowa. This enabled it to add almost all of the individual rare earths to its line, which previously had included only cerium, lanthanum, praseodymium, neodymium, and mixtures. The ion-exchange plant is now being doubled in size.

Lindsay, which on occasion has also processed bastnasite, gets most of its monazite from South Africa. It encourages the search for new sources, and last fall announced it had taken an option on a newly found deposit in Saskatchewan.

Maywood Chemical Co., Maywood, N. J., is also a long time producer of thorium and rare earths. It processes monazite, and sells individual rare earths separated by crystallization. It does not have an ion-exchange plant. Smaller than Lindsay in rare earths, Maywood is doing some expanding in this division.

Rare Earths, Inc., Pompton Plains, N. J., is the third processor of monazite ores presently operating. Rareox, optical quality cerium oxide polishing powder, thorium salts, and rare earth compounds have been the chief products of this eight-year-old company. Recently it was purchased by W. R. Grace, which is expanding in this field through its Davison Chemical Division (see below).

Molybdenum Corp., entered the rare earths business five years ago with its 18 million-ton reserve (rare earth oxide basis) of bastnasite at Mountain Pass, Calif. The company processes rare earths there and at Washington, Pa., to obtain compounds for the metallurgical industry. Bastnasite contains only a negligible quantity of thorium and it is not recovered.

Molybdenum's business is quite different from that of the monazite processors. Its refining operations are based on wet flotation processes. Product is sold in the form of patented "T-compounds" for improving the rolling qualities of stainless steels, and for other metallurgical uses. Production comes to a substantial total.

Davison Chemical Co., division of W. R. Grace, is installing (with Rare Earths, Inc.) a \$2 million monazite-processing plant at Curtis Bay, near Baltimore, Md. Completion date is set for some time early this year. Combined capacity of this plant and the Pompton Plains plant will be about 10,000 tons of monazite sands annually. This is estimated to be about 50% of the capacity of the entire monazite derivatives industry.

Davison, wanting to diversify into some phase of the atomic field, started by looking into the possibility of extracting uranium from its phosphate rock back in 1948. Continuing the search, Davison acquired Rare Earths, Inc., last August.

The Curtis Bay plant will have the advantage of developments made at Rare Earths, Inc. Yields are expected to be 70-6% thorium and 64% rare earths (which will not be separated into individual components at present). Rare Earths/Davison currently are making available purified rare earth elements and are actively developing improved methods of production.

Research Laboratories of Colorado, Inc., at Newtown, Ohio, has an ion-exchange plant for separating rare earths - not from monazite but from Norwegian gadolinite, and experimentally from concentrates of various kinds rich in the so-called yttrium group. Besides yttrium (which is not actually a rare earth, but is found associated with them) the group consists of the heavier rare earth elements such as thulium, ytterbium, and lutetium. Monazite yields the cerium group of lighter rare earths mostly, although Lindsay produces yttrium from it.

United States Yttrium Co., of Laramie, Wyo., expects to start production almost any day. It has an ion-exchange plant and will process thalenite, an yttrium silicate. Thulium will also be available.

Michigan Chemical at St. Louis, Mich., is engaged in research and pilot plant work. It is working on a number of concentrate bases and is interested in producing individual rare earth compounds.

Mallinckrodt's present output of rare earth products is limited to misch metal especially prepared for metallurgical uses, but it is believed to be interested in striking out in other directions too. Recently, Mallinckrodt became a subcontractor for a mining company, Porter Bros. Corp. of Boise, Idaho, for extracting niobium, tantalum, and uranium from euxenite. Since this mineral also contains rare earths, Mallinckrodt should be in a good position to produce rare earths from the euxenite residues.

Crane Co. has a subsidiary, Marine Minerals, Inc., dredging for monazite, zircon, rutile, and ilmenite near Aiken, S. C. It plans to have another subsidiary, Heavy Minerals, process the first two. The latter two are titanium minerals and will go to its Cramet subsidiary. It was the search for titanium ores that led to the monazite discovery. The company is keeping quiet about its plans but is widely thought in the industry to be considering going into rare earths in a fairly big way.

Vitro Corp., also is not too talkative at the moment except to say that it intends to go into thorium and rare earth production on a substantial basis.

Other companies are in various stages in developing rare earth programs. Horizons, Inc., of Cleveland is evaluating the field. Monsanto has some interest. So does Air Reduction. Union Carbide has been making rare earth metallurgical products and is rumored to be considering expanding. Mitten Chemical of Alma, Mich., is in the business.

Research Chemicals, Inc. of Burbank, Calif., has produced small quantities of rare earths for some time.

PROCESSORS OF RARE-EARTH CONCENTRATES

Davison Chemical Division
W. R. Grace and Company
Pompton Plains, New Jersey

Michigan Chemical Company
St. Louis, Michigan

Heavy Minerals Company
Chattanooga, Tennessee

Molybdenum Corp. of America
Pittsburgh, Pennsylvania

Lindsay Chemical Division
American Potash and Chemical Corporation
West Chicago, Illinois

Research Chemicals, Inc.
Burbank, California

Lunex Company
Pleasant Valley, Iowa

St. Eloi Corporation
Newtown, Ohio

Maywood Chemical Works
Maywood, New Jersey

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