RARE-EARTH INFORMATION CENTER NEWS

ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE
IOWA STATE UNIVERSITY AMES, IOWA

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China = Rare Earths!

It is clear from what we see and hear that the Chinese will have a significant impact on the commercial, industrial, and technical aspects of rare earths in the 1980's, and by 1990 they will be making important contributions to the science of rare earths in many fields. The People's Republic of China has the world's largest reserves of rare earths, estimated to be 36 x 10^6 tons, which are thought to be more than the rest of the world combined. When their ore bodies become more viable and their processing plants fully operational the Chinese are expected to have a financial impact on the prices of raw and partially refined materials.

Although the Chinese have other metals whose ores are more than adequate, chromium and cobalt appear to be in short supply and high on their list of strategic metals. China's metallurgists seem uncertain about the quantity and quality of their chromium ores, even though major chromite deposits have been reportedly discovered and even some ore exported.

Substitution and conservation studies emphasize the use of China's most abundant resources, especially for items manufactured in large tonage amounts. Nodular iron parts are produced using Fe-Si-rare earth (RE) alloys, instead of magnesium, since China has virtually no magnesium production. Boron steels are used in place of chromium steels for structural components and gears. The addition of rare earths to these boron steels is said to improve the quality of the steel markedly. Gears manufactured from rare earth, boron steel are cheaper and last much longer than gears made from 18-chrome-manganese-titanium or 22-chrome-manganese-moly steel.

New Staffer

The Rare-Earth Information Center is pleased to announce the appointment of Jennings M. "Cap" Capellen as an Assistant Chemist II. Cap Capellen replaces Mr. Bernie L. Evans, who has left the Center to take a position elsewhere. Mr. Capellen has been associated with one of the Ames Laboratory Analytical Groups that is primarily concerned with mass spectrometry and gas chromatography. While working in these areas, part of Cap's duties insolved maintaining literature files and compiling bibliographies on mass spectrometry.

We know that those rare earthers who met and interacted with Bernie Evans over the past 7 years will miss him. We wish him luck in his new endeavors.

The improvement of steel by addition of rare earths is due to two separate effects. First the rare earths change the morphology of the sulfide inclusions from the elongated stringers into spherical rare earth sulfide (RE_2S_3) or oxysulfide (RE_2O_2S), which improves the transverse ductility and the toughness of the steel. The second effect is the conversion of aluminum oxide or aluminum compounds, which have higher hardness, to a rare earth aluminum compound with a lower hardness. This second process increases the fatigue strength of the gears.

A news item from *Russ. Met.* 1981 [1], 194 reports that during 1982, 30 new brands of steel are to be developed and priority will be given to

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THANKS

This year eight companies earned star billing and our heartfelt thanks for their tenth year of support. The companies earning their place on the honor roll and a place along side the previous honorees are given below.

Honor Roll

Allied Chemical Corp.
Atomergic Chemetals Corp.
Denison Mines, Limited
Foote Mineral Company
GTE Laboratories, Inc.
GTE Sylvania, Inc.
Rare Earth Products, Ltd.
Treibacher Chemische Werke

$$ Help $$

The 1982 fiscal year has ended with some bad news and some good news. The bad news is that six companies either dropped out of the rare earth business or did not renew their support of the center for the 1982 fiscal year. The good news is that four new companies joined our family and two previous benefactors renewed their support, leaving the number of companies the same as last year—45. Let's see if we can get all the old family members back next year and

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Let Your Light Shine

Come on, all you knowledgeable experts, don't hide your light under a basket but take it out and let it shine. The Rare-Earth Information Center (RIC) receives a number of inquiries seeking the names of persons or consultants to help solve problems or to provide information or expertise which the center does not possess. In the past, we have supplied names of people or companies that in our opinion could provide the services, information, assistance, or expertise as needed. In order to improve our services to the rare earth community RIC is compiling a list of persons who would be willing to answer questions or consult with those people making the inquiries. RIC would supply the names of the persons we have on file, whom we believe can provide the service or information needed. Any financial arrangements, or other agreements, would be made by the two parties involved and would not include RIC. As always, all information inquiries will be kept confidential.

The RIC would like to receive the following information from any person or company that would like to share their light with those in the dark.

1. Area(s) of expertise
2. Name and complete address
3. Phone numbers
4. Telex

Send the information to:
Rare-Earth Information Center
EMRRI
Iowa State University
Ames, Iowa 50011

Seltene Erden

Ekkehard Greinacher and Klaus Reinhardt have co-authored a review paper on the rare earths. It is in German and appears as pp. 678-707 in *Chemische Technologie Volume 2, Anorganische Technologie I.*, K. Winnacker and L. Kuchler, eds. Carl Hansen Verlag (Munich 1982). The review covers the following areas: the rare earths and their properties; the rare earth industry; ores; beneficiation of the ores; separation of the rare earths; production of the metal; and applications. A bibliography of 86 references opens the door to more detailed information.

RE's In The News

Cash Boost

French chemical giant Rhone-Poulenc hopes to increase its financial base by nearly a third of a billion dollars. It hopes to raise some $135 million through a new bond issue. The bonds will have a floating rate of interest keyed to that of French government backed bonds. This will be the first time that a newly nationalized French industry has gone to the bond market. Rhone-Poulenc will receive another $135 million from Proctor and Gamble for its 20.3 percent share holding in Morton-Norwich Products of Chicago. In addition, the French government will inject $1.6 billion cash into several of the companies nationalized earlier this year and Rhone-Poulenc will be one of the recipients.

New Deposits

In a report entitled "A Preliminary Review of Niobium—Tantalum/Rare Earth Deposits in British Columbia," Dr. E. W. Grove, of E. W. Grove Consultants, Ltd., describes the location, history, make-up, and commercial potential of several mineral deposits. The report was compiled for W. G. Heyman, Bristol Resources Corporation and Whitesail Ventures Corporation. We thank E. W. Groves and W. G. Heyman for their permission to use the information in the *RIC News*.

The area of interest had been explored several times since World War II, primarily for uranium deposits. Although the presence of some rare earth minerals was noted in at least one survey, most assays did not mention the rare earth content. Mineral deposits were noted to occur as placer material, hydrothermal products, pegmatites, and carbonatites.

Samples analyzed for this report were taken from four carbonatite deposits in southern British Columbia. They were analyzed for seven rare earths. The rare earths and their range of concentration in ppm are La (120-470), Ce (190-800), Nd (90-450), Sm (14-74), Eu (4-22), Tb (1-7), and Yb (1-5).

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Nd:Glass Lasers

D. C. Brown of University of Rochester's Laboratory for Laser Energetics has authored Volume number 25 in the Springer Series on Optical Sciences. The title is "*High-Peak-Power Nd:Glass Laser Systems*" and was published by Springer-Verlag, Berlin-Heidelberg in 1981. The book contains 286 pages and costs $38.20 (DM 84.). Dr. Brown's initial plan was to edit the book but, with some urging, he agreed to write the entire book. This led to a consistency of notation, a logical order of presentation, and a lack of duplication and overlap that is hard to achieve in edited books. The subjects covered include the following: glass laser physics; the optical and physical properties of laser glasses; amplified spontaneous emission and parasitic oscillations in Nd:glass amplifiers; and optical-pump sources for, amplifiers for, damage effects in, nonlinear effects in, and the design of high-peak-power Nd:glass laser systems. The references, in a listing at the end of the book, number 262. The book will be useful to the graduate student or engineer new to the field and could be used as a text in a graduate course in solid-state laser engineering.

Magnetic Properties Conference

An International Symposium on Magnetic Properties of Rare-Earth Alloys is to be held October 4-6, 1982 in Varna, Bulgaria. It is organized jointly by the Institute of Solid State Physics of the Bulgarian Academy of Sciences and the Department of Physics of Sofia University.

The scientific program will cover current topics on the technology, experiment, application, and theory of rare-earth alloys in ordered and disordered state, including hydrides.

The deadline for submitting papers was April 30, 1982 but this information reached *RIC News* too late for inclusion in the March issue. For more information on the symposium please contact.

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Magnetic Refrigeration

First predicted by Debye in 1926 and then by Giauque in 1927 and actually achieved by Giauque and MacDougall in 1933, magnetic cooling by adiabatic demagnetization has long played an important role in physics.

According to a paper by T. Hasimoto, T. Numasawa, M. Shino, and T. Onada [*Cryogenics*, **21**, 647-53 (1981)] three areas need to be investigated to make magnetic refrigeration practical in the home. The three areas are 1) new magnetic refrigerants, 2) the most appropriate magnetic refrigeration cycle, and 3) methods of achieving heat exchange in the cycle.

The authors chose to study the first area—the characteristics of useful magnetic refrigerants in the temperature range from room temperature to 4.2 K. By using the molecular field approximation, the magnetic entopy $S_M(T,H)$ as a function of temperature and field strength was calculated for a typical three dimensional ferromagnet. The dependence of $S_M(T,H)$ on such ferromagnetic properties as spin value, molecular field coefficient, and Curie temperature is made clear. The lattice entropy $S_L(T)$ as a function of the Debye temperature and temperature was also calculated. The total entropy of a typical ferromagnet is then the sum of $S_M(T,H)$ and $S_L(T)$.

In order to test the validity of the assumptions and methods used to obtain the calculated values, the magnetocaloric effects of Gd, Cr_3Te_4, and Ni were obtained experimentally and compared to the calculated values. The results were in good agreement. Other ferromagnets mentioned were Gd_3Al_2, Gd_5Si_4, Y_2Fe_{17}, MnAs, MnP, and CrTe.

From a theoretical point of view a magnetic refrigerant needs a large density of magnetic entropy and a small lattice entropy but from a practical point of view one must also consider economy, mechanical properties, and the eddy current loss of solids. Perhaps by the 1990's our home refrigerators or freezers may be powered by a magnetic refrigeration cycle.

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New Facility on Stream

In a news release dated March 24, Molycorp, Inc., a wholly-owned subsidiary of Union Oil Company of California, announced the start of production of high-purity oxides from a new $15 million separation plant at its Mountain Pass complex in eastern San Bernardino County, California. This is the sixth major expansion of the physical plant since 1966. The Mountain Pass facility is the world's largest rare earths mine and chemical complex.

The new plant uses a unique solvent extraction technology developed by Molycorp and will increase the company's production of high-purity rare earths by more than 35 percent. The new separation circuits will produce samarium and gadolinium oxides initially. The new separation circuits also have the capability to produce oxides of lanthanum, praseodymium, and neodymium to supplement existing production at other Molycorp plants.

Raw material for separations is supplied from the company's bastnasite mineral deposit at Mountain Pass. The ore is treated by milling and flotation in a mill with capacity to produce 45,000 tons per year of bastnasite concentrate. The concentrate is then processed into mixed rare earth chemical compounds which are the feedstock for the solvent extraction circuits in the new separation plant. The Molycorp process uses a series of tanks that separate specific rare earth elements from aqueous solutions by using selective organic solvents.

Catching the Sun

"Luminescent Solar Concentrators for Energy Conversion" is the title of a review paper by R. Reisfeld and C. K. Jorgensen [*Structure and Bonding*, **49**, 1-36 (1982)].

Luminescent solar concentrators (LSC) consist of a series of glass plates or organic films that act as planar luminescent concentrators. The basic principle is that light entering the concentrator with the correct energy is absorbed by a fluorescent species. The light subsequently emitted is then trapped by total reflection and concentrated at the edges of the plane where a mirror or some light converting device is located. The main advantages of LSC are reported to be:

1. High concentration of light without tracking.
2. High collection efficiency of diffuse light.
3. Good heat dissipation from large areas of the LSC plate in contact with air.
4. Choice of the luminescent species allows optimization of the concentrated light to the maximum spectral sensitivity of the light converting device (in this case, a specific photovoltaic cell).
5. The relatively low efficiency of solar cells exposed to white light can be circumvented by using LSC as beam splitters and coupling them to photovoltaic cell with optimum sensitivities in different spectral ranges, and hence using the solar spectrum in a more efficient fashion.

The luminescent species can be organic dyes in plastic film or inorganic glasses containing ions that fluoresce. Included in the ions that can be incorporated into the glasses either singly or in combinations, are the trivalent rare earths. One of the glasses in which Mn^{+2} can be incorporated is made from P_2O_5, Al_2O_3, and La_2O_3.

The review describes the general operation and parameters of a LSC, then discusses the fluorescent material in detail. A figure of interest plots the energy levels of 11 trivalent lanthanides below 4300 cm^{-1}. The review ends with suggestions for hybrid systems and a discussion of some shortcomings of present LSC systems and possible improvements in the future.

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high strength, corrosion-resistant, and low-alloy steels, alloyed with vanadium, tungsten, molybdenum, niobium, and rare-earth metals. Among new alloys developed in 1981 were rare-earth cobalt alloys for permanent magnets.

In another rare earth related story from China we have reference to award winning photos from the Second Metallographic Exhibition sponsored by the Chinese Society of Metals. It was first held in Shenyang in October, 1980 and then it went on tour of the country. More than 2,000 optical and electron photomicrographs were submitted from 90 institutes and laboratories of 18 provinces, municipalities, and autonomous regions. The exhibit consisted of 813 photos selected from those submitted. The optical micrographs include cast iron and carbon steel, alloys, stainless steel, superalloys, nonferrous metals, inclusions in steel, weld-structure, etc. The electron micrographs were taken by replica, metallic foil or scanning electron microscopy. The judging panel gave awards to 73 photos with 5 first awards, 18 second awards, and 50 third awards. One of the first awards is a micrograph of a 68Ag-28Cu-4Ce alloy entitled "Silver Flowers Blossom in a Riot of Beauty." The alloy was vacuum melted then etched with $FeCl_3$ in ethyl alcohol. In addition to the one first place award, micrographs of alloys containing rare earths won six third place awards. All the award winning photos were published in *Acta Metallurgica Sinica*, **17** No. 5 and 6, (October and December 1981).

We are indebted to Allen G. Gray, Publisher of *Metal Progress* and Technical Director of American Society for Metals for some of the above information. He visited China in late 1981 and attended the First China-U.S.A. Bilateral Metallurgical Conference in Beijing (Peking), China. He brought back informational bulletins and made some of them available to the Rare-Earth Information Center. While he was in Beijing he attended an exhibit which was devoted exclusively to rare earth materials. The products, materials, etc. were contributed from many areas of the People's Republic of China. The sleeping giant is awaking!

Analytical Chemistry

The RIC recently received volume 1 of a 2 volume treatise entitled *Analytical Chemistry of the Rare Earths*. The authors are Jai-kai Cheng, Yung-ao Tseng, and Quing-yao Luo. The book, in Chinese, was published by Science Press, Beijing, China. It contains 499 pages and is well referenced. The references are in Chinese, English, or Russian.

The chapter headings are as follows: 1) Introduction; 2) Properties of Rare Earths and Its Compounds; 3) Complexes of the Rare Earths; 4) Precipitation and Gravimetric Analyses; 5) Liquid-Liquid Extraction; 6) Liquid Chromatography in Columns; 7) Paper Chromatography and Multistage Chromatography; 8) Volumetric Analysis; 9) Spectrophotometry; and 10) Emission Spectrometry.

New Deposits
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The presence of stratiform carbonatite deposits with interesting niobium, tantalum, and rare earth contents has been established in three separate areas within the Omineca Tectonic Belt of British Columbia. In the northern location near Manson Creek only one deposit of significance has been found. In the other two, in the Blue River and Revelstoke areas of southern British Columbia, a fairly large number of occurrences have now been confirmed within areas that have good access or are close to ground access.

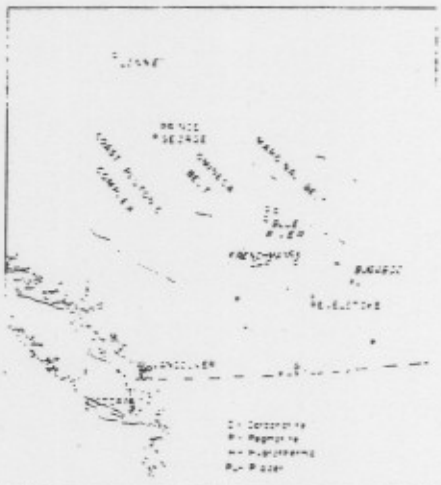
A map showing the location of some of the deposits is reproduced below.

$$ Help $$
(continued from page 1)

make it a banner year.

The 12 companies who contributed this last quarter are listed below. The number in parentheses is the number of years that company has supported the RIC.

Aldrich Chemical Company, Inc., U.S.A. (3)
Bose Corporation, U.S.A. (5)
Cometals, Inc., U.S.A. (5)
General Electric Company, U.S.A. (7)
GTE Sylvania, Inc., U.S.A. (10)
Hitachi Magnetics Corporation, U.S.A. (8)
Industrial Minera Mexico, S.A., Mexico (8)
Middlewest Investment Company, U.S.A. (4)
Rare Earth Products Limited, England (10)
Reactor Experiments, Inc., U.S.A. (12)
Wako Bussan Company, Limited, Japan (13)
Yao Lung Chemical Plant, People's Republic of China (2)



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