RARE-EARTH INFORMATION CENTER NEWS

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Underwater Work For Rare Earths

More than just academic interest has stimulated research on the rare earth element concentration in ferromanganese nodules and other marine phases located in the Pacific Ocean according to D. Z. Piper [*Geochim. Cosmochim. Acta* **38,** 1007-22 (1974)]. The high metal content has raised the question of the economic feasibility of recovering the metal values from these underwater sources. Rare earth elements are also present in high concentrations and may prove useful in deciphering the origin of the nodules. Researchers first assume that rare earth content in the different marine phases represents a fractionation process from an initial shale pattern. Then RE content of various phases is compared and conclusions are drawn on the method of formation and the rate of accumulation of the various phases.

RE concentrations were measured in nodules from 31 different locations in the Pacific and Indian Oceans. Analysis of the samples showed a marked division according to rare earth content. Specimens taken from a depth of less than 3500 feet had a different rare earth pattern (enriched in ytterbium and lutetium relative to samarium, europium and terbium) than samples taken from a depth greater than 3500 feet (depleted in ytterbium and lutetium). Reasons for this difference may be related to a change in the mineralogy of manganese and/or the transport of rare earth elements to deep ocean by particulate matter.

Are You Contaminated?

Researchers at the U.S. Army Mobility Equipment Research and Development Center recently analyzed supplies of rare earth compounds in chemistry and glass polishing laboratories for radioactive thorium [R. C. McMillan, H. E. Horner, S. A. Horne, *Health Physics* **28,** 628-30 (1975)]. Thorium, a natural constituent of monazite ore from which the rare earths are also largely extracted, was discovered in compounds of La, Nd and especially Ce. Samples of CeO_2, used extensively for glass polishing, were found to contain up to ten times the minimum concentration allowed by rules and regulations set up by the U. S. Atomic Energy Commission. For the protection of rare earth users, additional watchfulness and improved separation of thorium from rare earth compounds may be warranted.

SINGLE CRYSTAL LASER FIBER

Preparation of single crystal fibers of neodymium-doped yttrium aluminum garnet (Nd:YAG) has been reported by C. A. Burras and J. Stone [*Appl. Phys. Letters* **26,** 318-20 (1975)]. Using a modified zone melting technique, fibers with 50 μm diameters have been grown and smaller diameters can be attained. With this technique the fibers are produced without grinding or polishing.

Optical properties of the single crystal fibers are essentially identical to the original larger rods. Room temperature cw laser action has been obtained in fibers 0.5 to 1 cm in length. The fiber dimensions and low threshold of Nd:YAG give this material a wide range of applications, particularly in optical communications.

RIC BENEFACTORS

Since the Information Center operates on a July 1 through June 30 fiscal year, we begin acknowledging our current benefactors with this issue of the *RIC News*. As we go to press we have received contributions or pledges from the twelve companies listed below (the number given in parentheses indicates the number of years the company has supported RIC):

American Metallurgical Products Co., U.S.A. (7)
Atomergic Chemetals Co., U.S.A. (4)
BBC Brown, Boveri & Company, Limited, Switzerland (4)
Th. Goldschmidt AG, Germany (7)
Kolon Trading Co., Inc., U.S.A. (3)
Leico Industries, Inc., U.S.A. (7)
Mitsubishi Chemical Industry Co., Ltd., Japan (3)
Molycorp, Inc., U.S.A. (8)
Rare Earth Products Limited, England (4)
Reactor Experiments, Inc., U.S.A. (6)
Ronson Metals Corporation, U.S.A. (8)
Treibacher Chemische Werke AG, Austria (4)

Considering the world-wide economic conditions we are grateful to acknowledge that several of the companies have increased their contribution and the others have continued their support at the same level as last year. However, we can see some effect of the adverse business conditions, in that the number of companies informing us of their decision to support the Center at press time is the lowest it has been for many years (the number has

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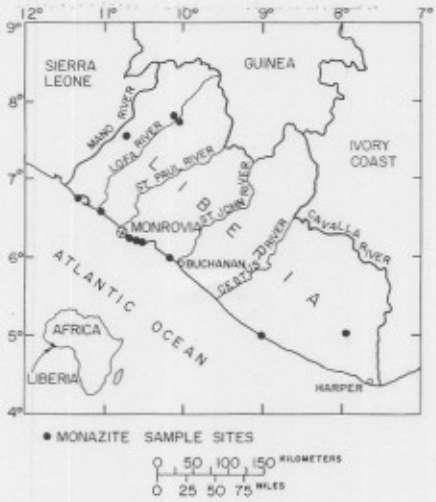
New Source of Monazite?

Liberian coastal sands may contain sufficient amounts of monazite to make their extraction practicable and profitable according to researchers for the U. S. Geological Survey and the Liberian Geological Survey [S. Rosenblum, *J. Res. U.S. Geol. Survey* **2**, 689-92 (1974)]. X-ray fluorescence of monazite samples revealed rare earth concentrations similar to those from other parts of the world with a slight enhancement of cerium. Other possible deposits are also indicated by radioactive anomalies in the area.



Crystal Field Conference Proceedings

The Proceedings of the First Conference on Crystalline Electric Field Effects in Metals and Alloys has been published in a limited edition. The Conference was held June 1974 at the University of Montreal. Together the 25 papers presented attempted to summarize the developments in crystal fields in metals and alloys to date. Nearly all of the papers are concerned with rare earth metals and their alloys and compounds.

Free copies of the 541 page, paperbound conference proceedings are available while they last by writing to:

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Contrast Enhanced

Contrast enhancement of a narrow-line emitting, cathodoluminescent phosphor, ZnS: Er, Cu, is the subject of a study made by E. Schlam, J.J. Pucilowski and I. Reingold [*J. Electrochem. Soc.* **122**, 655-9 (1975)]. The need for displays which have a high degree of viewability even when located in areas with high ambient lighting provided the stimulus for this investigation.

To improve the contrast the authors attempted to match a narrow-line emitting phosphor with a spectral filter. The filter selectively excludes ambient light which is not in the spectral region of the phosphor emission. The contrast was improved by a factor of 10 when the phosphor was used with the filter compared to the phosphor without the filter. The authors note that this type of system can be improved by achieving a closer match-up of the filter bandpass with the spectral emission of the phosphor. When compared with a commercial phosphor it was shown that the luminescence efficiency requirement for the narrow-band phosphor was much less than the commercial phosphor while still providing the same degree of viewability.

Lanthanide Inorganic Chemistry Reviewed

University instructors, research workers, industrial scientists, engineers, and undergraduates will be interested in the publication of *Inorganic Chemistry Series Two: Vol. 7, Lanthanides and Actinides*, K.W. Bagnell, ed., Butterworth & Co., Ltd. London (1975). This single volume contains 329 pages, has a subject index and costs $37.50.

Series Two was prepared in an attempt to keep inorganic chemists informed of the many advances that have occurred since publication of Series One in 1972 and provides a critical survey of work which has been published.

Topics reviewed include rare earth borides, carbides, carboxylates, mixed oxide systems, nitrates, silicides, oxidation states and structural chemistry.

RE Volcanoes

The origin of seamounts and volcanic chains has frequently been linked to the evolution of mid-ocean ridges. In the Pacific Ocean, seamounts appear to grow gradually as they drift away from the East Pacific Ridge (EPR), but the source of lava has not previously been specified.

According to J.-G. Schilling and E. Bonatti [*Earth Planetary Sci. Lett.* **25**, 93-102 (1975)], the rare earths are aiding geologists in their attempts to trace the origin of both oceanic ridge and seamount magma chambers. Their analyses of rare earth content in basaltic samples dredged from various locations on the EPR and the neighboring Nazca Plate (located generally between the Galapagos and Easter Islands) support earlier petrochemical data which indicated a common source of lava for both. However, due to their much younger geologic age, the seamount basalts are not remnants of a single volcano originating at the crest of the ridge.

From the rare earth data compiled by Schilling and Bonatti, both oceanic ridge and seamount lavas appear to derive from intraplate volcanism rather than from the lithosphere or the deeper asthenosphere as proposed by others. The low concentration of light rare earths in the sampled basalts indicates that the magma chambers are located in a world circling upper mantle—the depleted low velocity layer—which is characteristically depleted in these elements.

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MEETING

CFE IN METALS & ALLOYS

A conference on the crystal field effects (CFE) in metals and alloys will be held September 1-4, 1976 in Zürich, Switzerland. This date was chosen so that the conference would occur immediately before the International Magnetism Conference in Amsterdam and the Third European Crystallographic Meeting in Zürich.

The CFE Conference is sponsored by the Swiss Federal Institute of Technology (ETH) and will consist of invited and contributed papers from all branches of science involving crystal field effects in metals and alloys. The abstract deadline is May 1, 1976 and the application deadline is June 1, 1976.

For more information contact:
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Permanent Magnet Workshop

Excerpts from a final report on the 1974 International Workshop on Rare Earth Permanent Magnets have been published in *Cobalt* **1975,** [2] 29-31. No proceedings were published from that workshop.

The Second International Workshop on Rare Earth-Cobalt Permanent Magnets will be held June 1976 in Dayton, Ohio, U.S.A. Topics to be covered include technological and economic developments in raw materials and magnet alloys, advances in magnet research and production, commerical availability, engineering design of rare earth magnets, and their application in devices and machines. The emphasis will be on engineering design and applications.

Persons interested in attending the conference should contact K. Strnat, School of Engineering, University of Dayton, Dayton, Ohio 45469. Comments and suggestions concerning a published proceedings or possible topics for the workshop are welcomed.

PIONEER RE'er DIES

RIC received word in July of the death of pioneer rare earther Professor Olavi Erämetsä on January 3, 1974. Prof. Erämetsä was one of the first researchers to use complexing agents in the chromatographic separation of rare earths and is especially noted for the separation of naturally occurring promethium from apatite in 1965.

Born October 10, 1906 in Lahti, Finland, Prof. Erämetsä attended the Helsinki University of Technology receiving a Master of Science degree in 1934 and his Doctor of Technology in 1938. He was appointed as lecturer in analytical chemistry at Helsinki University from 1940-1946 and then as professor of inorganic chemistry from 1947 until his retirement in 1973. His main interests in rare earth research were in the occurrence and separation of the elements. Many of his 120+ publications dealt with the rare earths. Active research on the rare earths initiated by Professor Erämetsä is still being carried on.

During his lifetime Erämetsä was a member of the Finnish Academy of Sciences and the Academy of Technical Sciences in Finland. He was the recipient of several domestic and international awards including Gold Medal and Special Award of the City of Brussels at the Salon Internationale des Inventeurs in 1966 for the development of Neodymlite (Neolux) lamps.

RIC *(cont. from page 1)*

averaged about 19 for the last five years). We are hopeful that as the year progresses that we will hear from our past benefactors, and perhaps from new companies who are expanding into the rare earth field.

RIC financial projections, which take into account the economic turn-down and the inflationary increase of expenses, indicate a large deficit at the end of the current fiscal year. If your company is new in the rare earth field and/or has expanded its product line, perhaps it is time for you to join RIC's benefactors by writing to the Director, Dr. Karl Gschneidner, Jr. expressing your interest to help.

RE's in the News

PLZT NUMBERS

Sandia Laboratories have developed a PLZT ceramic device which could be useful in numeric display applications. The solid state, seven segment device uses a fringe field effect and can work in either a transmission or a reflective mode. Advantages offered by the ceramic over conventional materials include long life, fast switching, high contrast ratio; stability over a wide range of temperatures and they do not require sustaining power for display.

FLEXIBLE MAGNET MATERIALS

Magnet Polymers, Ltd. has announced the commercial availability of HERA, a flexible, polymer-bonded rare earth-cobalt permanent magnet. Properties include good resistance to chipping, a linear demagnetization curve, the highest maximum energy product for polymer-based materials, a low reversible temperature coefficient and adequate mechanical properties. HERA combines the magnetic characteristics of sintered rare earth-cobalt magnets and simplified manufacturing techniques. This allows a wide variety of shapes and gives the highest magnetic energy per unit cost.

PLANT EXPANSIONS

Molycorp, Inc. is implementing a 50% increase in the capacity of its chemical plant at Mountain Pass, California. The expansion will cost $1 million but will enable 15,000 tons of rare earth oxides to be processed per year.

The Rare Earth Metals Co. of America (Remcoa) has successfully completed a pilot plant stage production of rare earth metals using a rare earth fluoride bath method. Construction of a full scale demonstration unit is underway which will have a capacity of 114 tons of metal per year.

Cu DIFFUSION

D. B. Butrymowicz, J. R. Manning and M. E. Read have authored a survey and critical analysis of published data concerning diffusion in copper alloy systems entitled "Diffusion in Copper and Copper Alloys Part III. Diffusion in Systems Involving Elements of the Groups IA, IIA, IIIB, IVB, VB, VIB, and VIIB" [*J. Phys. Chem. Ref. Data* **4**, 177-248 (1975)].

The types of diffusion covered include volume diffusion, surface diffusion, grain boundary diffusion, tracer diffusion, alloy interdiffusion, electromigration, thermomigration, dislocation-pipe diffusion and diffusion in molten metals.

The types of alloy systems surveyed include all diffusion situations between copper and each metal. Therefore the system Cu-M encompasses diffusion of Cu in M and any binary or higher-component alloy that contains M; diffusion of M in Cu or any alloy containing Cu; and diffusion of any element in an alloy containing both Cu and M. The rare earths reported on are Ce, Eu, La, Lu, Pm, Pr, Tb and Tm.

The data is presented in figures and tables, and is discussed in the text. An extensive bibliography is also included.

REers on the Move

R. E. Sievers, formerly at the Aerospace Research Laboratories, Wright-Patterson A. F. B., Ohio has been appointed Professor of Chemistry at the University of Colorado, Boulder, Colorado.

R. L. Stone, formerly a vice-president with W. R. Grace and Co., has formed a new company, the Valumet Processing Corporation, which deals with the recovery and marketing of metals from minerals/chemical/metallic residues, compounds, and waste by-products. Mr. Stone was instrumental in arranging for industrial contributions to RIC in 1968, when we lost our support from the U.S. Atomic Energy Commission. We wish him the best in his new endeavor.

M. M. M.

The proceedings of the 20th annual M^3 conference held in San Francisco, December 3-6, 1974, are available as the *AIP Conference Proceedings No. 24, Magnetism and Magnetic Materials—1974.* Edited by C. D. Graham, Jr., G. H. Lander and J. J. Rhyne, this clothbound single volume contains 792 pages, measures 8¼ in. by 11¼ in. and costs $30.00.

Approximately 40% of the 381 papers presented deal with the rare earths. Topics included valence, volume and crystal field effects, rare earth chalcogenides, amorphous magnetic materials, spin waves, magneto optics, magnetoelastic and anisotropy effects, exchange, hyperfine fields, band structure, singlet ground states, phase transitions, critical phenomena, metals and alloys, preparation of new materials, bubble devices and materials, and rare earth permanent magnets.

In addition a special tutorial session was included for non-specialists in the areas of magnetic bubbles, magnetic impurities, phase transitions and critical phenomena.

The Age of Discovery

The rare-earth elements were discovered over a 160 year period dating from 1787 to 1947. The most complex element hunt in the history of science began in 1787 when Lt. C. A. Arrhenius stumbled on a unique black mineral near a quarry in Ytterby, Sweden, and was culminated in 1947 with the discovery of promethium.

RE STARS

Hypotheses on the origin of the overabundance of rare earths in Ap type stars have been challenged recently by the spectroscopic discovery of anomalous rare earth distributions [S. J. Adelman, S. N. Shore and M. F. Tiernan, *Astrophys. J.* **186**, 605-9 (1973) and T. J. Jones, S. C. Wolff and W. K. Bonsack, *Astrophys. J.* **190**, 579-83 (1974)].

One mechanism which had been proposed to explain the overabundance of rare earths involved spallation on magnetic A type stellar surfaces. This model predicted an odd-even distribution of rare earths similar to solar abundances (where ions with even atomic numbers are more predominant than those with odd numbers). However, Adelman *et al.*, in their investigations of Ap star βCrB, have noted that the most abundant rare earth present is Eu^{2+}, an odd numbered ion. Also, Jones and coworkers have shown that in the peculiar Ap star HD 51418, the odd numbered ion, Ho^{2+}, is dominant.

Other hypotheses have suggested that ions are selectively diffused by radiation pressure or distributed by magnetic-accretion. These mechanisms predict approximately equal abundances for all of the 4*f* elements and thus are not compatible with the marked enhancement of certain rare earths. Nor can they account for the absence of some of the heavier rare earths (e.g. Tb and Er) as observed by both groups of researchers.

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