MONONGAHELA ROCKHOUND NEWS

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A Pittsburgh Area Mineral, Fossil, & Lapidary Club

From the President

Hello and Happy April! I'm writing this earlier than usual and it's still March and cold and snowy. So, I hope by the time the April meeting takes place that we have a change into Spring.
My topic this month is the CLUB SHOW! This is a good opportunity to show off our hobby to the public and gather new members and make new rockhounds. So please patronize the show – don't forget there's a $5 coupon waiting at the door for every individual club membership (2-$5 coupons for a family membership). The coupon must be used at the show and food is not included ☺.
We still need volunteers to work at the door (2 hour time slots) and at the kids' activities. Working with the kids is the best way to generate new interest in the hobby.
Have you collected something or made something hobby related that you want to show off? Make sure to bring it to the show and we can put it in the club display case. Better yet, tell Bret ahead of time and he can print a nice tag for it to use in the display.
Please advertise the show and bring your friends. It's always a great weekend!

June

Our next Meeting will be held Saturday, April 7, 2018 at 7:30 pm, in the Munhall Borough Building.

- May meeting speaker will be Bret on Rare Earth Minerals
- Mineral for May – Heavy Metals
- Hosts for snacks for May Debbie B and Jim Walter

Look forward to seeing you there.

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Rare Earth Elements and Their Minerals

byBret Howard

What are the rare earth elements (REEs) and why would we even care? The rare earth elements are the group of 15 transition metals of the lanthanide series on the periodic table of the elements, Figure 1, - lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu). Yttrium (Y) and sometimes Scandium (Sc) are included since they are chemically similar. The reason we are interested in them is that they have unique and increasingly valuable applications in current technologies. They're used in smart phones, computers, magnets, catalysts, ceramics, lasers, batteries, phosphors in lights,… – a seemingly endless list! In fact, many items used in your everyday life depend on these elements. Most lapidarists, like many of us, are familiar with cerium oxide as a polishing agent and it is critical in the glass industry for polishing glass items. Powerful, light weight rare earth magnets are now used virtually everywhere from high-tech applications (computer disk drives, wind turbine generators) to low-tech applications (magnetic jewelry clasps, magnet toys). There are also new applications being developed. One that is potentially a giant technological advance is magnetic refrigeration which is based on new REE-

containing alloys. Magnetic refrigeration has advantages over current technologies and could replace them in the future. Because of the importance of the REEs, global production of the REE oxides has risen from essentially nothing in the 1950s to over 120 thousand tons currently. Due to the importance of these elements, they are now considered "critical materials" in the United States.

So why are they called "rare earth" elements? The name is linked to the fact that they're not well known and, due to their chemical characteristics, they tend not to be geologically concentrated into useful ore deposits. Their chemical characteristics also cause them to be extremely difficult to separate from each other on an industrial scale. The REEs are actually not all that rare in the earth's crust but because of their dispersion through the crustal rocks and the difficulty of chemically separating them, they were not recognized as a new element family until the late 1700s. Johan Gadolin realized that a new mineral (now called gadolinite) contained something different which he published in 1794. It took until 1828 for the first relatively pure REE, yttrium, to be isolated and another 80 years for the final one, lutetium, to be isolated. REEs are actually not all that rare in the earth's crust. They are just widely disseminated. For example, the more common REEs, La, Ce and Nd are found in approximately the same concentration in the crust as familiar elements such as Cu, Ni and Sn. Figure 2 shows a comparison of the relative elemental concentrations in crustal rocks. However the rarer and often technologically useful REEs are found at much lower concentrations similar to precious metal concentrations.

What minerals contain the rare earth elements? There are actually a large number of minerals that contain REEs as an essential component of their structure. Currently there are over 250 REE minerals known and new ones are being added to the list every year. However, most of these minerals are very rare and even the most serious collectors is not likely to recognize their names or actually have an example in their collection. These minerals typically don't occur as well formed crystals and usually are not all that attractive either! There are a few that are reasonably common and available to collectors including bastnasite, monazite, parisite and xenotime. Figure 3 shows a specimen of bastnasite and a faceted stone from Zagi Mountain, Pakistan. Table 1 lists some REE minerals and their compositions. There are several noteworthy locations that do produce attractive RE mineral specimens. These locations include Zagi Mountain, Pakistan, Mount Malosa, Malawi, Novo Horizonte, Bahia, Brazil and even a few locations in the US such as the Snow Bird Mine in Mineral County, Montana. Due to the chemical similarities of REEs, REE minerals tend to contain higher concentrations of the common REEs but also lower concentrations of the rest. The actual concentrations depend on the geochemical environment of their formation. Typically the dominant REE in a specific sample of a mineral will have that dominant REE appended to the name as in "monazite-(Ce)" for example. There are also many minerals that can contain REEs at appreciable concentrations as a structural substitution. These include apatite, zircon, titanite and eudialyte.

Where are REE minerals found? The answer is pretty much everywhere at low concentrations, often in secondary deposits such as heavy sands. The higher concentration, primary occurrences that offer economic potential are relatively rare. This is due to the geochemistry of REEs. They are unusual in that they have a large ionic radius and high charge so generally aren't compatible with typical mineral structures such as silicates. Therefore, they often are concentrated in less common geological environments. These include carbonatites, pegmatites, pegmatitic apatites, peralkaline granites and a few others.

Mining of REE minerals has been going on for over a century but at extremely low levels compared to today. In the late 1800s, the first successful commercial application of a REE was invented. It was found that adding thorium (Th) oxide mixed with some Ce oxide to a gas lamp mantel improved its brightness. (This application is still common today in camping lanterns but usually Y oxide is used due to the radioactivity concerns from the Th content.) Therefore, an inexpensive source of Ce and Th was now needed. It was found that monazite, which contains both Ce and Th, could be produced from placer deposits where it was concentrated due to its density. In the 1950's and 60's, the development of technological applications for REEs was accelerating so new, richer sources were needed. In the mid-1960s, a new deposit began production, the Mountain Pass Mine in California which exploited a large, rich bastnasite-containing carbonatite. Mountain Pass was the US's and the world's primary REE source until the mid-1980s when China began increasing production. Mountain Pass stopped production in 2002 due to competition and environmental concerns. Today, more than 95% of the worlds REE supply is mined in China, primarily from the Fe–REE–Nb deposit at Bayan Obo and the ion-exchanged clay deposits in southern China. Because of the current dependency on China's export of REEs,