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The 823rd Meeting of The Mineralogical Society of Southern California

"Meteorites and Asteroids"

by Dr. Alan Rubin

Friday, September 8, 2006, at 7:30 p.m.

Geology Department, E-Building, Room 220
Pasadena City College
1570 E. Colorado Blvd., Pasadena

Inside this bulletin:

September Meeting Features "Meteorites and Asteroids"

Dr. Alan Rubin will speak on "Meteorites and Asteroids" with mineral collectors in mind on Friday, September 8, at 7:30 p.m. His talk will include historic and modern information about these space rocks. Eighteenth Century scientists were skeptical about the existence of extraterrestrial rocks. For every report of rocks falling from the sky, there were other reports of falling paper, wool, flesh, money and blood. It was a difficult task to sort out the real from the fabulous. But at the end of the 18th and beginning of the 19th Century, a series of events led to the recognition of the meteorite phenomenon: an influential monograph was published showing the compositional similarity of different meteorites, several well-documented meteorite falls occurred, and asteroids were discovered. This discovery laid to rest the Newtonian notion that the cosmos was essentially empty of non-luminous bodies.

Ten essential links between meteorites and asteroids show that most meteorites come from these bodies. The meteorites have been dubbed the "poor man's space probe" because they come to us for free. They provide a great wealth of information about the origin and evolution of the solar system, but they have a dark side. They can also kill us. The ubiquitous craters on the Moon and the buried impact craters on Earth testify to the bombardment inner-solar-system bodies received. There are some new ideas about how to mitigate the asteroid hazard, some more promising than others.

Dr. Rubin received his B.S. in Astronomy from the University of Illinois in Urbana in 1974, an M.S. in Geological Sciences from the University of Illinois-Chicago in 1979, and a Ph.D. in Geology from the University of New Mexico in 1982. He was a Post-doctoral Fellow at the Smithsonian Institution's Department of Mineralogy for one year (1982-1983), and then went to UCLA in 1983. He is currently a Research Geochemist here. Dr. Rubin has published about 140 peer-reviewed scientific papers on meteorites (mainly mineralogy and petrology), and about 25 popular articles on space science. In 2002, his book, Disturbing the Solar System, was published by Princeton University Press. Asteroid 6227 was named Alanrubin in 2002.

Minutes of the August 13, 2006, Meeting

The 822nd meeting of the Mineralogical Society of Southern California, the club's annual summer picnic, was held on Sunday, August 13, 2006, at the home of Paul and Janet Gordon. The event was held from approximately 2:30 p.m. until 6:00 p.m.

In addition to the potluck picnic, a successful silent auction of member-provided mineral specimens was conducted. Walt Margerum reported that $336.00 in much needed funds was raised. The star of the auction was a ferroaxinite crystal donated by Bill Moller. Herman Ruvalcaba narrowly outbid Rock Currier for the specimen. Mr. Margerum was impressed by the quality of the donated minerals, and expressed his thanks to all participants, particularly the donors. He proposed that silent auctions be included in more events, and offered the suggestion that a single specimen be auctioned at each monthly meeting.

Further, Dr. Janet Gordon, Professor Emeritus of Geology at Pasadena City College, provided a presentation entitled: "Exploring North Carolina Minerals and Mines." Dr. Gordon recently attended the 42nd Forum on the Geology of Industrial

Minerals in Asheville, North Carolina. An open, international forum is conducted each year for the purpose of promoting interest in industrial mining. She related that attendees of this year's forum were fortunate enough to visit a number of mining districts in western North Carolina on a chartered train. Among the minerals and gems observed were marble, olivine, quartz, feldspar, sheet mica and emeralds. It was surprising to learn that marble was actually crushed to make sand due to the lack of aggregate at that locale. It was also noted that a North Carolinian mine operator's ability to process ultra pure quartz adversely affected certain Brazilian mining operations. Dr. Gordon additionally described mineral museums in the area, and accompanied her presentation with numerous photographs taken by Paul Gordon.

Respectfully submitted,
Pat and Geoff Caplette

Micro-Mount Conference Needs Your Help!

Walt Margerum reports that Julie Steele is unable to continue as chair of the Pacific Micro-mount conference due to family problems. The MSSC needs someone to volunteer for this position. Walt is willing to assist, but he cannot take the chairmanship because his duties as Treasurer will keep him especially busy from October through January with dues, year end budget, new budget, etc. He has temporarily assumed a role as the contact person for the conference.

It is suggested that the tasks of putting on the conference are divided into the following categories: chair, speakers (partially done), badges and door keeper (Al Wilkins last year), field trip (Bob Housley last year), auctions & emcee (society president), pictures of specimens (Sugar White has done this in the past), food (Annie Meister has volunteered), etc.

The event is scheduled for January 26-28, 2007, at the San Bernardino County Museum. This is an important event that gets national, and international recognition. It would be a shame if we let it die! Please contact Walt immediately if you can help.

Help Teachers Learn about Rocks and Minerals

Future and present teachers enrolled in "Earth Science for Teachers" at Cal State, Dominquez Hills could use some mineral specimens to study according to a request for help from their instructor, Judy King. She explains, "These classes are required for all future elementary school teachers and consist of two hours of lecture and three hours of lab each week. We spend fully 1/3rd of the semester on learning the properties of rocks and minerals and how to identify them. The great majority of my students claim that this hands-on lab time with their mineral trays is the best time they have all semester. They are sad when we move on.

"I would appreciate it if your members would donate hand-size rock forming minerals, shiny ore specimens, and/or fossils and crystals. Hopefully they will be labeled specimens that I can give to these future teachers to use in their own science lessons in the future. It is always my hope that they go on to teach their students a love of rocks and minerals! Most of CSUDH's liberal studies students already have children and many are working to support their families and themselves. Most are first-generation college students and many minorities are represented. This course is their first introduction to the Earth Sciences and they truly enjoy it."

If you have some appropriate specimens to contribute, please bring them to the September meeting and give them to John Moore who has volunteered to be the contact with Ms. King. This sounds like a great way to make a little more space in the garage and introduce new teachers to minerals.

Basic Concepts about Ore Deposits (That Every Mineral Collector Should Know) Part 1

by Janet Gordon

Most mineral specimens are extracted from ore deposits, and a basic understanding of ore deposit formation enhances the collector's appreciation of the specimens we enjoy. The simplest definition of an ore is rock from which materials can be extracted for a profit. It is true that what was profitable yesterday might not be profitable today, but that is not our concern here. Also, fossil fuels are not generally considered to be ores; they are referred to as energy resources.

Implicit in our definition of ores is the fact that they represent unusual concentrations of desired materials. Ores may be as mundane as pure quartz sandstone for glass making or as romantic as crystals of gold in a vein. Ore deposits are generally divided into metallic and non-metallic groups. Metallic deposits are concentrations of desirable metals such as copper, silver, and platinum. Non-metallic deposits include sedimentary deposits of gypsum, borates, limestone, and the like.

The geological processes that produce these concentrations are varied and still not understood in every detail, but useful generalizations can be made which have led to various classifications of ore deposits. For convenience, let's group ore deposits into 5 categories, and as with all attempts to classify natural phenomena, be warned that there is some overlap between the groups. To start the discussion the categories are:

1. Magmatic deposts have desirable materials that have separated directly from a magma.
2. Hydrothermal deposits have material concentrated by hot water solutions.

3. Sedimentary deposits precipitate from lake or sea water.

4. Placer deposits involve the mechanical separation of materials by flowing water.

5. Residual deposits are the products of extreme weathering, such as bauxite.

After discussing these 5 categories, we'll consider some of the secondary processes by which the original deposits can be enriched.

1. Magmatic deposits:

Magma is more than simply melted rock. Most magma contains some percentage of crystals either from the original rock that was melted or new crystals that are growing as the physical and chemical conditions of the magma change. Magma also contains a highly variable amount of volatile ingredients, such as H2O, CO2, and HF. These are dissolved in the magma when it initially forms at great depths, but they can be liberated during magmatic processes much the way CO2 bubbles separate from the liquid when a can of soda is opened.

The magmatic ore deposits of most interest are (a.) pegmatite deposits, (b.) concentrations in mafic layered intrusions, and (c.) products of immiscible magmas.

a. Pegmatite deposits:

Pegmatites are basically igneous rocks with extra-large crystals. Many of them form in dikes or as pods in larger plutonic igneous rock bodies. They are the products of water-rich magmas. Although pegmatites can form from magma of a variety of compositions, those familiar to most mineral collectors are produced by granitic magmas. These magmas initially contain several weight percent of H2O.

Small (20 cm wide) simple pegmatite dike containing alkali feldspar and riebeckite on the north shore of Lake Superior, Canada. Abundant water in the magma when it intruded into the crack permitted the growth of large crystals instead of creating a fine-grained dike that a more ordinary magma would produce in this setting. Janet Gordon photo.

To understand pegmatites, consider a simplified view of what happens when a large body of granitic magma is crystallizing at depth. Most of the magma will be consumed by crystallizing quartz and feldspar because the magma's main chemical ingredients are Si, O, Al, Na, K, and Ca. But the magma also contains trace amounts of interesting elements such as Li, Be, Cu, Ag, Au, Pb, and rare earth elements. As the quartz and feldspar crystals grow they consume Si, O, Al, Na, K, and Ca, but they exclude H2O and those interesting elements that don't fit into the structures of these minerals. As more and more quartz and feldspar grows, the residual magma becomes proportionally richer and richer in H2O and trace elements. For some magma compositions minerals such as muscovite, biotite, and hornblende crystallize early and consume water as they grow. This inhibits the production of water-rich magmas and helps explain why many igneous intrusions do not have associated pegmatites.

However, when a water-rich magma is produced, it is more fluid and less dense than normal magma. It can rise within the large crystallizing body to form pods, and it is easily injected into cracks to form dikes. Increased concentration of H2O in the magma greatly lowers the freezing (crystallization) temperature of most minerals, especially feldspar. Therefore, water-rich magmas are still fluid at relatively low temperatures. Also, water in magmas promotes the growth of large crystals because it aids the transport of chemical elements and makes nucleation of silicate minerals more difficult. The few crystals that are nucleated have the opportunity to grow large.

As crystallization continues in this water-rich magma or as it rises to locations of lower pressure, the volatile components can separate out in the form of supercritical fluids or gases. Consequently vug formation and gas explosions are a normal part of pegmatite evolution.

What about the tourmaline, beryl, topaz, and other minerals from pegmatites that collectors prize? If their ingredients, such as Li, Be, and B were in the original magma in trace amounts and have eschewed being included in the common minerals, they can be concentrated enough in the last remains of the water-rich magma to make a few crystals.

Pegmatite deposits are wide spread around the globe. Californians are proud of the San Diego County tourmaline-rich pegmatites. Black Hills deposits contain rose quartz and 40-foot long spodumene crystals. Colorado is known for small pegmatites of amazonite and smoky quartz. Mount Apatite put Maine on the map with large apatite crystals. North Carolina has emeralds and high-tech industrial minerals. Brazil appears to have an endless supply of gems from pegmatites. Afghanistan has flooded the market with aquamarines. Ethiopia has amazonitebearing pegmatites, and the list goes on.

b. Concentrations in mafic layered intrusions.

Mafic layered intrusions are fascinating large bodies of igneous rock that belong in the gabbro family. They have been important sources of platinum group metals, chrome, vanadium, and other commodities. The layers can be extremely thick to almost microscopically thin, and they can extend for many miles. They range in composition from pure plagioclase feldspar to combinations of olivine, pyroxene, and metallic minerals including magnetite, ilmenite, and sulfides. Historically the layering has been attributed to crystal settling and/or repeated injections of new magma, but some layers may actually be the result of immiscible magmas (which will be discussed in the next section). However they form, these bodies are of tremendous economic importance.

Dark layers of chromite alternate with plagioclase layers in a portion of the Bushveld Complex in South Africa.
Janet Gordon photo.

The most famous mafic layered intrusion of them all is the Bushveld Complex in South Africa. It is the source of most of the world's chrome and platinum. The huge complex is about 500 km across and produces tons of platinum annually plus impressive amounts of chrome and vanadium. The platinum is concentrated in the sulfide minerals found in an olivine and pyroxene layer. Other layers are nearly pure chromite. The nearby Great Dyke of Zimbabwe also has valuable chromite layers and some platinum concentrations.

Closer to home, the Stillwater Complex in Montana has economically viable platinum-rich layers, and southern California's San Gabriel Anorthosite Complex is also layered. There mining operations have produced Ti and P from pods of ilmenite and apatite, but no platinum.

c. Immiscible magma deposits

Immiscible magmas are coexisting magmas that cannot be mixed together just as the oil and vinegar of Italian salad dressing can be shaken together, but they remain immiscible. The magmas can separate as discrete drops of one within the other, or, as in the case of the Italian dressing that have been on the shelf for a while, they can separate completely into two distinct liquids.

Perhaps the best-known deposits in this category are carbonatites. One rarely thinks of carbonate minerals coming from magmas, but these rare magmas have been observed in the act of erupting, so it's hard to dispute their existence. Typically the carbonate magmas (which produce carbonatites) separate from alkalic felsic magmas (granites and syenites). For example, the Mountain Pass Mine, just north of Interstate 15 near the California-Nevada border, is an important producer of rare earth elements from a carbonatite body. The rare earth elements were probably concentrated by stages of magmatic evolution, the last of which was the separation of a carbonate magma from a syenite magma. The rare earth elements had a strong preference for the carbonate magma and left the silicate magmas as they evolved.

Another important deposit formed by immiscible magmas is the nickel-rich zone of the Sudbury Intrusion of Sudbury, Ontario, Canada. For many years it dominated the world market as the source of Ni. In this unusual deposit, a meteorite impact caused a large portion of the mantle to melt. The majority of magma produced was gabbroic, but a small amount of sulfide magma separated from the gabbo taking with it the Ni that would normally be dispersed in the gabbro in non-economic concentrations.

In the Kingston Range of eastern California, it appears that an iron-oxide-rich magma separated from a quartz monzonite magma to produce a small commercial iron deposit. The iron-oxide-rich magma was injected between layers of surrounding sedimentary rocks to produce a sill that is mostly magnetite. Very unusual!

As a final example, a number of geologists have suggested that the pods of ilmenite, chlorite and apatite in the San Gabriel Anorthosite are the result of immiscible magmas. The pods may represent blobs of iron-oxide rich magma that coalesced within the host magma that became the anorthosite.

The next issue will continue with Part 2 and a discussion of hydrothermal mineral deposits.

2006 Calendar of Events

September 16-17, Paso Robles, Santa Lucia Rockhounds, Pioneer Park and Museum, 2010 Riverside Ave., Hours: 10-5 both days, Joyce Baird 805-462-9544.

liljoysee@charter.net.

September 22-24, San Bernardino, Orange Belt Mineralogical Society, 6th Annual Rock, Gem, & Jewelry Tailgate: Ball Park, 6707 Little League Drive, Hours: Fri./Sat. 9-6, Sun. 9-4, Mike Woolery (909) 882-6806, Al Carrell (951) 961-5988.

September 23-24, Carmel, Carmel Valley Gem and Mineral Society, Monterey Fairgrounds, 2004 Fairgrounds Road, Hours: Sat. 10-6, Sun. 10-5, Sky Paston 831-755-7741, sky@familystones.net, www.cvgms.org.

September 23-24, Downey, Delvers Gem and Mineral Society, Woman's Club of Downey, 9813 Paramount Blvd., Hours: Sat. 10-6, Sun. 10-4, Teresa Widdison (562-867-1521, twiddison72@aol.com.

September 23-24, San Diego, San Diego Lapidary Society, Bernardo Winery, 13330 Paseo Del Vernao Norto, Rancho Bernardo, Hours: 10-4 both days, Kim Hutsell 619-294-3914 info@sandiegolapidarysociety.org.

October 1, Fallbrook, Fallbrook Gem & Mineral Society, 123 W. Alva (FGMS Headquarters), Hours: 10-4, www.fgms.org, Janice Bricker (760) 728-1333.

October 14-15, Grass Valley, Nevada Co. Gem & Mineral Society "Earth's Treasures," Nevada Co. Fair Grounds, 11228 McCourtney Rd., Hours: 10-4 both days. Cliff Swsenson, 530-272-3752.

October 14-15, Trona, Seales Lake Gem & Mineral Society "Gem-O-Rama" Searles Lake Gem & Mineral, 13337 Main St., Hours: Sat. 7:30-5, Sun. 7:30-4. Bonnie Fairchild 760-372-5356, jbfairchild@verizon.net. Field trips: Mud Trip on Sat. at 9 a.m.; Blow Hole on Sat. at 2:30 p.m., Pink Halite on Sun. at 9 a.m. Additional community events and food available. More information at www1.iwvisp.com/tronagemclub/.

October 21-22, Anderson, Shasta Gem & Mineral Society, Shasta District Fairgrounds, Hours : Sat. 10-5, Sun. 10-4, Alex Stoltz 530-474-4400.

October 28-29, Vista, Vista Gem & Mineral Society, Brengle Terrace Recreation Center, 1200 Vale Terrace, Hours: Sat. 10-5, Sun. 10-4, Mary Anne Mital 760-758-4599.

November 4-5 Lancaster, Palmdale Gem & Mineral Club, "Rock n Gem Roundup," Antelope Valley Fairgrounds, 2551 West Ave. H, Hours 9-5 both days, Susan Walblom 661-943-1861.

November 4-5, San Diego, San Diego Mineral & Gem Society, Al Bhar Shrine Center (behind Hampton Inn) 5440 Kearny Mesa Rd., Hours: St. 9:30-5, Sun. 10-4.