



Friends of Mineralogy-Colorado Chapter  
P.O. Box 5276  
Golden, CO 80401-5276

## Friends of Mineralogy, Colorado Chapter Newsletter – November 2012

**Next meeting January 10th followed by March 14th, 2013 meeting at the Denver Museum of Nature and Science**

2001 Colorado Blvd., Denver, CO

Enter the museum via the staff/security entrance, to the left of the main entrance doors on the north side of the museum. Security staff will direct you to the Meeting Room

*(Board meeting 6:30-7:30)*

To be announced;

*All are invited to attend! If you need more information or directions, please contact Pete Modreski, chapter president, [pmodreski@usgs.gov](mailto:pmodreski@usgs.gov) or 303-202-4766*

### **2012 FMCC Board of Directors:**

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Editor, Bill Hutchinson, 303-452-9009  
  
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### **From the editor;**

The 2012 Denver gem and Mineral Show was a great success. Copper minerals lined the aisles and beautiful specimens abounded. The overall buzz was that most did well selling their ordinary fare as well as their prized mineral specimens. The weather was pleasant and attendance seemed in agreement. The theme of copper minerals was well represented and we all saw wonderful examples of native copper as well as copper oxides, sulfides etc. Thank you to all the volunteers that helped out at the show! While I was manning the ID booth some interesting rocks came by including a Leadville limestone sample that an owner had held on to for decades thinking it was valuable gold ore. Her interest in the mine that she had inherited was just beginning and I hope she finds that all elusive treasure trove of information she is seeking. Here is an article on the mining of copper ore I thought interesting.

# Copper Ore Types: Sulfides versus Oxides

Thursday April 21, 2011, 4:17pm PST

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By **Leia Michele Toovey**- Exclusive to [Copper Investing News](#)



Copper-containing rock hosts only a small percentage of copper. Most of the rock is unwanted material, typically referred to as gangue. Depending on to what minerals the copper is bound, the rock is processed in different ways in order to extract the valuable copper. There are two main copper ore types of interest, copper oxide ores and copper sulfide ores.

Both ore types can be economically mined, however, the most common source of copper ore is the sulfide ore mineral chalcopyrite, which accounts for about 50 percent of copper production. Sulfide copper ores are the most profitable ores because they have high copper content, and the copper can be more easily separated from the unwanted minerals. It is important to note that sulfide ores are not as abundant as the oxide ores.

## **Copper oxide ores**

Copper oxide ores are not as attractive of an exploration target as the copper sulfide ore types due to their lower grade, however low-grade copper oxide deposits can be economically extracted because they can be processed at lower cost than the copper sulfide ores. Oxidized copper ore bodies may be treated several ways, with [hydrometallurgical processes](#) used to treat oxide ores dominated by soluble minerals such as copper carbonate minerals. These oxide ores are usually leached by sulfuric acid to liberate the copper minerals into a solution of sulfuric acid laden with copper sulfate in solution. The copper sulfate solution (the pregnant leach solution) is then stripped of copper via a solvent extraction and electrowinning (SX-EW) plant. Alternatively, the copper can be precipitated out of the pregnant solution through a process called cementation, where the copper is contacted with scrap iron. Copper produced through the cementation method is usually less pure than SX\_EW copper.

## **Copper sulfide ores**

The method used to separate copper in copper sulfide ores depends on the concentration of the copper. Higher concentrated ores can be separated via smelting; lower concentrated ores are separated via hydro-metallurgical processes. Some supergene sulfide deposits can be leached using a bacterial oxidation heap leach process to oxidize the sulfides to sulfuric acid, which also allows for simultaneous leaching with sulfuric acid to produce a copper sulfate solution. As with oxide ores, solvent extraction and electrowinning technologies are used to recover the copper from the pregnant leach solution. Secondary sulfides formed by [supergene secondary enrichment](#) are resistant to sulfuric leaching. When rich enough, native copper ore bodies may be treated to

recover the contained copper via a gravity separation circuit. Supergene ores rich in sulfides may be concentrated using froth flotation.

### **Types of sulfide deposits**

Massive sulfide deposits are formed via the flow of heated fluids (usually seawater) through sedimentary and/or igneous rocks. The circulation of the fluids is generally driven by volcanic activity. Fluids drawn down through sediments or igneous rocks towards the earth's crust encounter rising temperatures. As these fluids are heated to become a hydrothermal fluid, any dissolved sulfates are reduced to sulfide or precipitated as calcium sulfate. As it is heated, the fluid also becomes depleted in magnesium, and this causes a drop in pH. What results is a heated, acidic fluid that reacts with the solid rocks in which it is contained. Various elements are leached from the rock and dissolved as complexes. This modified hydrothermal fluid rapidly reaches equilibrium with an assemblage of secondary minerals. The hot hydrothermal fluid becomes less dense and flows upwards. As it nears the earth's surface, most often a seafloor, it cools. This causes precipitation of minerals such as pyrite, chalcopyrite, sphalerite and galena that form massive sulfide deposits. The largest [volcanogenic massive sulfide deposits](#) are found in [greenstone belts](#) in Achaean cratons, such as those in South Africa and Canada. Massive sulfide deposits are a major source of many metals including [lead](#), [zinc](#), copper and [silver](#).

Sediment-hosted deposits are found in oceans where spreading centers are buried beneath sediments shed from the nearby continents. While the process of mineral deposition is similar to that mentioned in regards to massive sulfide deposits above, there is an important difference. Instead of the hydrothermal fluids flowing directly into sea water from the oceanic crust, they must first pass through an overlying layer of sediments. When passing through the sediments, the fluid's chemistry is substantially altered. Sediment-hosted massive sulfides have a wider range in mineralogy than volcanic-hosted deposits, reflecting the variation in the composition of sediments. When it comes to their mineral content, sediment-hosted massive sulfide deposits tend to have higher concentrations of lead, zinc and silver, and relatively smaller quantities of copper and [iron](#) than volcanic-hosted deposits. Two of the largest sediment-hosted massive sulfide deposits are the Sullivan in Canada and the Broken Hill in Australia.

**From <http://copperinvestingnews.com/6114-copper-ore-types-sulfides-versus-oxides.html>**

## **The coming of Winter**

**The onset of winter and the end of the year  
brings forth regret and some what of a tear  
that no great discoveries were found or uncovered  
though we dug with our hearts, our muscles, they suffered  
there is always next year with promise galore  
waiting for the thaw so to dig once more  
with our hopes and dreams driving us on  
the winter its seems wont be all that long.**

**W. H. Hutchinson 2012**

## January's talk will be on X-ray Diffraction

Professor Joseph Smyth of the University of Colorado Boulder Campus will present a talk on X-ray diffraction and X-ray crystallography.

Joseph Smyth is a professor in the [Department of Geological Sciences](#). With the help of graduate students, he operates the [Mineral Structures Laboratory](#) at the University of Colorado, Boulder. His research centers on the atomic structures of natural materials and how these structures control the physical properties and distributions of elements in the Earth. He teaches courses in mineralogy, crystallography, X-ray powder diffraction, and introductory geology.

He is actively collaborating with scientists at [Bayerisches GeoInstitut](#) in [Bayreuth, Germany](#). He spent Spring Semester, 1999 in Bayreuth. He also spent June, 2000 and June, 2001 there.

[Curriculum Vita](#).

[Full List of Publications](#)

[Mineral Structures Data Base](#)

[Rock Art Petrography](#)

## X-ray crystallography

From Wikipedia, the free encyclopedia

**X-ray crystallography** is a method of determining the arrangement of [atoms](#) within a [crystal](#), in which a beam of [X-rays](#) strikes a crystal and causes the beam of light to spread into many specific directions. From the angles and intensities of these diffracted beams, a [crystallographer](#) can produce a three-dimensional picture of the density of [electrons](#) within the crystal. From this electron density, the mean positions of the atoms in the crystal can be determined, as well as their [chemical bonds](#), their [disorder](#) and various other information.

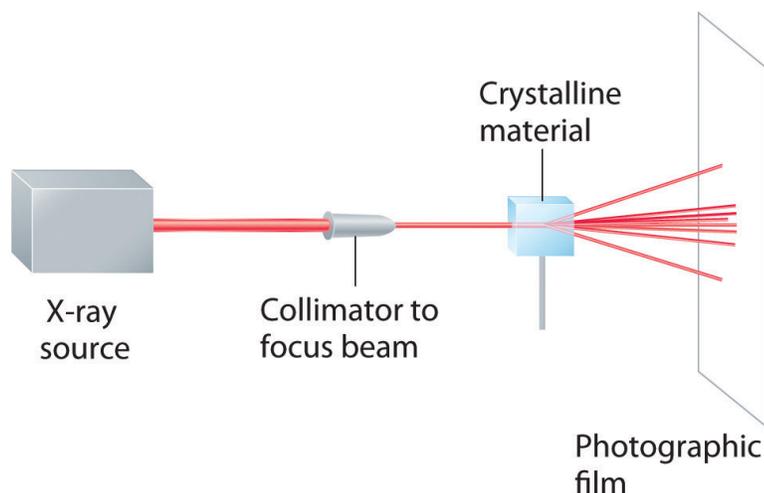
Since many materials can form crystals—such as [salts](#), [metals](#), [minerals](#), [semiconductors](#), as well as various inorganic, organic and biological molecules—X-ray crystallography has been fundamental in the development of many scientific fields. In its first decades of use, this method determined the size of atoms, the lengths and types of chemical bonds, and the atomic-scale differences among various materials, especially minerals and [alloys](#). The method also revealed the structure and function of many biological molecules, including vitamins, drugs, proteins and nucleic acids such as [DNA](#). X-ray crystallography is still the chief method for characterizing the atomic structure of new materials and in discerning materials that appear similar by other [experiments](#). X-ray [crystal structures](#) can also account for unusual [electronic](#) or [elastic](#) properties of a material, shed light on chemical interactions and processes, or serve as the basis for [designing pharmaceuticals against diseases](#).

In an X-ray diffraction measurement, a [crystal](#) is mounted on a [goniometer](#) and gradually rotated while being bombarded with X-rays, producing a diffraction pattern of regularly spaced spots known as *reflections*. The two-dimensional images taken at different rotations are converted into a three-dimensional model of the density of electrons within the crystal using the mathematical method of [Fourier transforms](#), combined with chemical data known for the sample. Poor resolution (fuzziness) or even errors may result if the crystals are too small, or not uniform enough in their internal makeup.

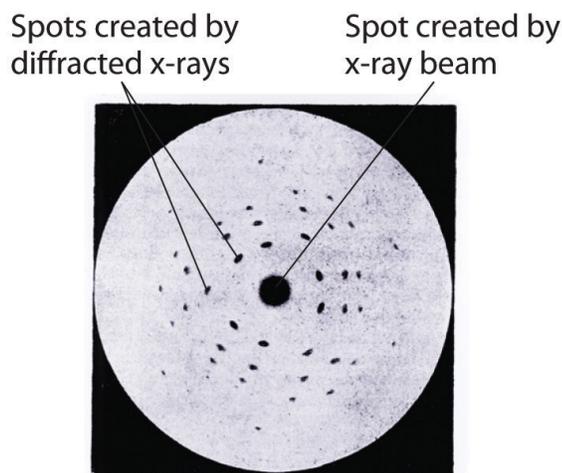
X-ray crystallography is related to several other methods for determining atomic structures. Similar diffraction patterns can be produced by scattering electrons or [neutrons](#), which are likewise interpreted as a Fourier transform. If single crystals of sufficient size cannot be obtained, various other X-ray methods can be applied to obtain less detailed information; such methods include [fiber diffraction](#), [powder diffraction](#) and [small-angle X-](#)

[ray scattering](#) (SAXS). If the material under investigation is only available in the form of nanocrystalline powders or suffers from poor crystallinity, the methods of [electron crystallography](#) can be applied for determining the atomic structure.

For all above mentioned X-ray diffraction methods, the scattering is [elastic](#); the scattered X-rays have the same [wavelength](#) as the incoming X-ray. By contrast, *inelastic* X-ray scattering methods are useful in studying excitations of the sample, rather than the distribution of its atoms. <sup>[[citation needed](#)]</sup>



(a) X-ray diffraction



(b) X-ray diffraction pattern captured on photographic film

## MINERAL ANNOUNCEMENTS:

**Nov. 16**, for science educators, the annual **Colorado Science Conference for Professional Development** will be held at the Denver Merchandise Mart. Workshop sessions, exhibitors, and featured speaker, **Dr. Kirk Johnson**; see <http://www.coloradoscience.org/> for full information

**Sat., Nov. 17**, annual Silent Auction of minerals, rocks, books, gems, jewelry, etc., held by the Littleton Gem and Mineral Club. All are welcome to attend; always a fun event, lots of interesting item at (perhaps?) bargain prices, and always great refreshments too! 12 noon to 5 p.m., at Columbine Hills Church, 9700

**Fri.-Sat.-Sun., Dec. 7-9**, **Flatirons Gem and Mineral Show**, at the Boulder County Fairgrounds, Exhibits Building; 9595 Nelson Rd. (Nelson & Hover), Longmont, CO; 10-6 Friday, 9-5 Saturday, 10-5 Sunday.

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**Meeting Dates for 2013**

The dates for our 2013 meetings will be Jan 10th, Mar 14th, May 9th Sept 5th, Nov 14th.

Membership in FMCC and National FM is \$13 for 2013.

Payment by check can be sent to our Treasurer or any Board member.

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