



Friends of Mineralogy, Colorado Chapter Newsletter – January 2013

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)

An informal talk on X-ray Diffraction and X-ray Crystallography by Professor Joseph Smyth

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](#)

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

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From the editor;

I hope everyone had a wonderful holiday season and that Santa put nice mineral specimens in everyone's stockings. I find myself examining many of my specimens that have been in some cabinet or drawer just to remind myself to check documentation on each of them. Cleaning house for the holidays often finds me dusting off many of my cabinet or larger specimens and gives me a chance to reminisce on the occasion by which I find them in my possession. Many I have field collected but some I have bought. My son had a chance to dig for emeralds in NC over the holidays and it just lights a fire in me to research a new area to see if some information might lead to a better chance of finding that elusive crystal. Hopefully someday I will make it out there. I have not heard from any of my usual sources for parts of the newsletter so there is no current news from the School of Mines Museum or from our historians, Jeff Self and Donna Ware. I understand they are preparing for Tucson and that is keeping them busy. I am looking forward to this upcoming meeting to review my knowledge on X-ray crystallography and I hope to see many of you there.

Home
About FM
Objectives
Bylaws
Chapters
Upcoming Symposia
Newsletters
State Mineral Index
Letter from the president of FM
Links
Membership Application
Contact Us



Welcome to FM

Friends of Mineralogy

Upcoming National and Chapter Symposia

Members belong to the Friends of Mineralogy either through one of its several regional chapters or as a national member. Most of the chapters hold or co-sponsor annual symposia.

Listed chronologically below are symposia that should be of interest to many FM members.

The 34th Annual FM-MSA-TGMS Tucson Mineral Symposium

Fluorite, A Rainbow of Color

Saturday, February 16, 2013
Tucson Convention Center

10 AM to 3 PM
Crystal Ballroom
Symposium Agenda

10:00 to 10:05 AM	Welcome and Introductory Remarks	Julian Gray
10:05 to 10:30 AM	The Emerald green Fluorites and the Golden Calcites of the Malmberget Mine, Gällivare, Lappland, Sweden	Peter Lyckberg

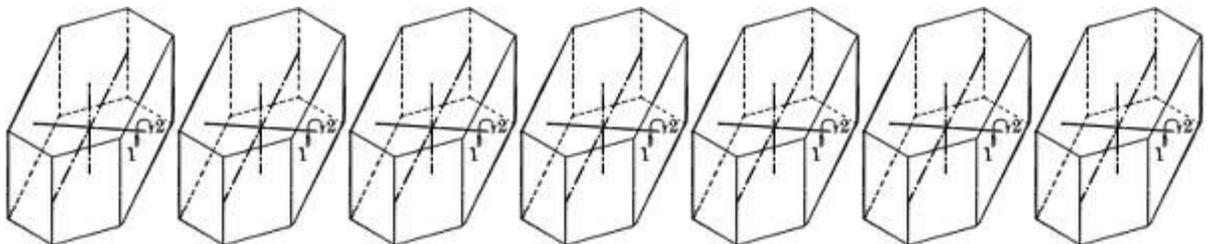
10:30 to 11:00 AM	Fluorite: A Favorite of Mineral Collectors	Arvid Pasto
11:00 to 11:30 AM	Fluorite in Granitic Pegmatites	Mark Ivan Jacobson
11:30 AM to 12:00 PM	New Mexico Fluorite - Over 10 million years of mineralization that continues today	Virgil W. Lueth
12:00 to 1:30 PM	Lunch Break	
1:30 to 2:00 PM	Fluorine and Fluorite in Mississippi Valley-Type (MVT) Deposits	John Rakovan
2:00 to 2:30 PM	The North Pennines Orefield, England - a Classic Fluorine-Enriched Mississippi Valley-Type Deposit	Jesse Fisher
2:30 to 3:00 PM	The Weardale Giant - a Large Fluorite Specimen Recovered from the Rogerley Mine, England in July 2012	Jesse Fisher

The thirty-fourth annual Friends of Mineralogy symposium will be held in conjunction with the Tucson Gem and Mineral Show and will take place on Saturday, 16 February 2013. In addition to the Friends of Mineralogy, the symposium is sponsored by the Tucson Gem and Mineral Society and the Mineralogical Society of America. The theme is the same as the show theme: **Fluorite, A Rainbow of Color**. Presentations on descriptive mineralogy, classic and new localities, and related subjects are welcome. An audience of amateur and professional mineralogists and geologists is expected.

Friends of Mineralogy is affiliated with *The Mineralogical Record Magazine*, The Mineralogical Society of America(MSA), the American Geological Institute(AGI), and *Rocks & Minerals* magazine.

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Web page updated December 2012.



Collecting in the Cold

*The ground, hard and unforgiving
reluctantly gives up it's hold
Your heart and mind reliving
the pocket, worth it's weight in gold.*

*Winter gear protects the body
from the freezing wind and snow.
What made us choose this hobby
as we dig the ground below?*

*Aching muscles and wind burnt faces
test our resolve to keep going
to add to our mineral cases
even as the snow starts blowing.*

*To study facets of crystalline structure
to understand their atomic scale
to analyze a specimen cluster
from pocket to lab as we drink ale.*

*What insanity has grasped us?
a kind of undiagnosed pathology?
What mental condition makes us cuss?
This thing called.... mineralogy.*

W. H. Hutchinson 2013

CRYSTAL STRUCTURE

The aspects of crystallography most important to the understanding and basic interpretation of XRD data are:

- conventions of lattice description, unit cells, lattice planes, d-spacing and Miller indices,
- crystal structure and symmetry elements,
- the reciprocal lattice

Description of the Crystal Structure

A crystal structure is like a three-dimensional wallpaper design in that it is an endless repetition of some motif (i.e., a group of atoms or molecules). The process of creating the motif involves point-group operations (rotation, reflection, and inversion) that define it. The process of creating the wallpaper involves translation (with or without rotation or reflection) to create the complete structure (which we call the lattice). Real-world crystalline structures may be simple lattice structures, or combinations of lattices to make complex crystalline molecules. As long as the structure is repetitive, its structure may be discovered with the application of x-ray diffraction.

Symmetry

The repetition of the arrangement of atoms (or motif) in a crystal structure is what produces the diffraction pattern, thus a large part of X-ray crystallography is discerning the motif by “solving” the diffraction pattern. If there is no repetition (as in truly amorphous materials) there is no diffraction pattern. Repetition of the motif in a lattice defines its symmetry.

A symmetry operation may be thought of as moving a shape-object in such a way that after the movement, the object appears exactly the same as it did before the movement.

An alternative way to view symmetry is as a series of replication operations on one surface of a shape-object by which the entire object may be generated. Crystal structures are defined based on the symmetry operations used to replicate (or create) the structure.

All symmetry operations may be defined by several basic movement operations described below:

Rotation (Symbols used: **1,2,3,4,6**. Indicates the number of times the form is replicated during one 360° rotation. As an example, in 4-fold rotation, it takes four rotational movements of the form to return to the original position, and the form is identically repeated at each of the four rotational stages.)²

Reflection (Symbol used: **m**. Form is replicated by mirror reflection across a plane.)

Inversion (Symbol used: **i**. Form is replicated by projection of all points through a point of inversion; this point defines a center of symmetry.)

Rotation-Inversion (Symbol used \bar{n} : for single rotation/inversion. May be combined with rotational operations, i.e. $\bar{3}$, = 3-fold rotation w. inversions at each rotation.)

Translation (A lateral movement which replicates the form along a linear axis)

In general, rotation, reflection and inversion operations generate a variety of unique arrangements of lattice points (i.e., a shape structure) in three dimensions. These translation-free symmetry operations are called **point-group elements**.

Translations are used to generate a lattice from that shape structure. The translations include a simple linear translation, a linear translation combined with mirror operation (glide plane), or a translation combined with a rotational operation (screw axis). A large number of 3-dimensional structures (the 230 Space Groups) are generated by these translations acting on the 32 point groups as discussed in the next section.

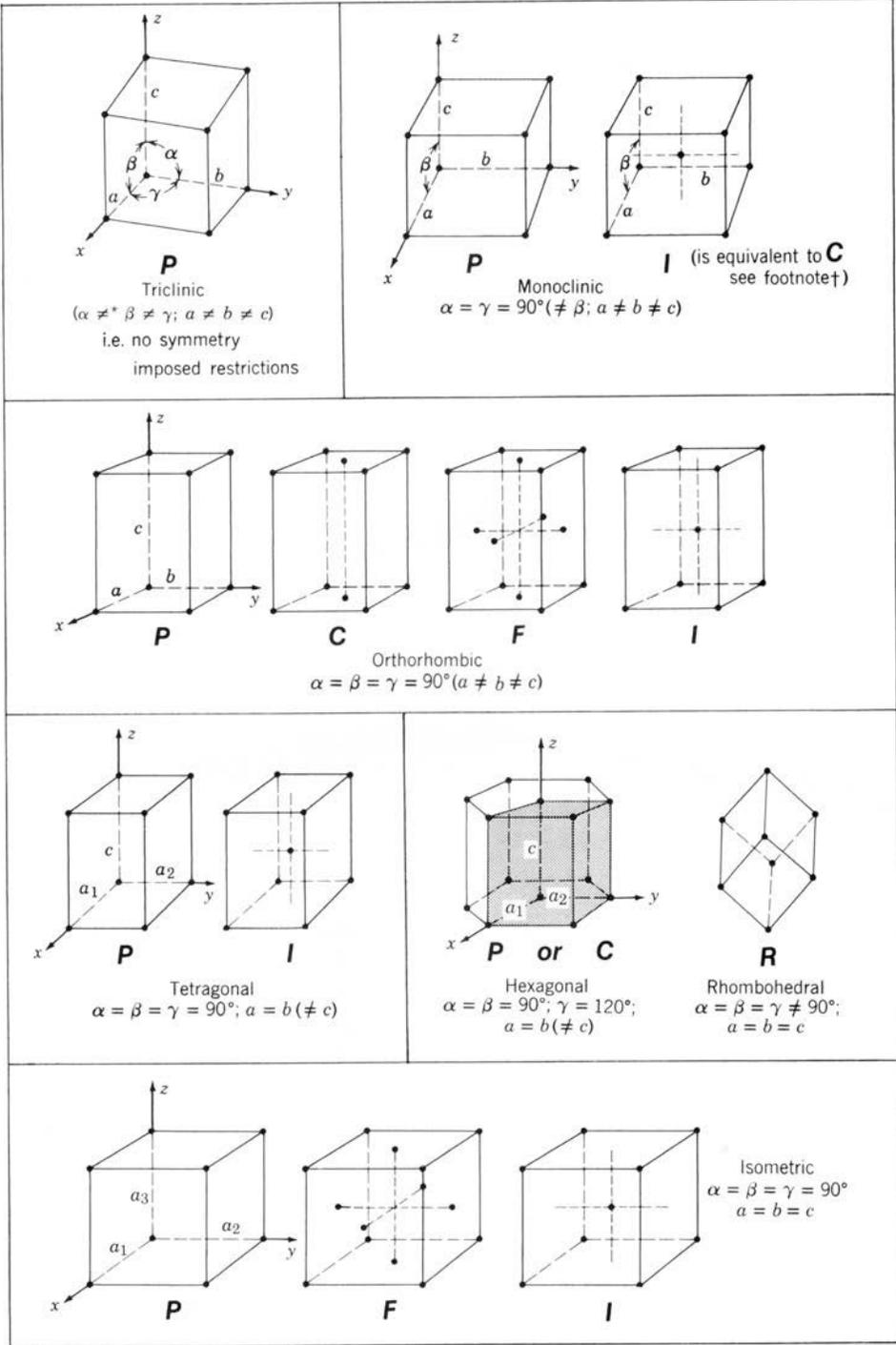
The repetitive nature of crystal structures results in the presence of stacks of planar arrays of atoms. Repeating, equidistant planar elements (d-spacings) are present in all crystals. The measurement of these d-spacings and the variations in intensity of the diffractions caused by them can be used to uniquely “fingerprint” the crystal studied. This is the basis of x-ray crystallography.

Elementary Crystallography for X-Ray Diffraction (prepared by James R. Connolly, for EPS400-002, Introduction to X-Ray Powder Diffraction, Spring 2012)

The six crystal systems (table on following page) are defined by relationships between unit cell edge lengths and the angles between those edges. The combination of centering and relationship between the angles between lattice directions and axis length define the 14 lattice types within the 6 crystal systems. In the primitive lattice (P) all atoms in the lattice are at the corners. In the body centered lattices (I) there is an additional atom at the center of the lattice. There are two types of face centering, one in which the atoms are centered on a pair of opposing plane lattices (C) and another in which an atom is centered on each face (F).

System	Type	Edge - Angle Relations	Symmetry
Triclinic	P	$a \neq b \neq c \alpha \neq \beta \neq \gamma$	$\bar{1}$
Monoclinic	P (b = twofold axis) C	$a \neq b \neq c \alpha = \gamma = 90^\circ \neq \beta$	2/m
	P (c = twofold axis) C	$a \neq b \neq c \alpha \neq \beta = 90^\circ \neq \gamma$	
Orthorhombic	PC (or A, B) IF	$a \neq b \neq c \alpha = \beta = \gamma = 90^\circ$	mmm
Tetragonal	PI	$a_1 = a_2 \neq c \alpha = \beta = \gamma = 90^\circ$	4/mmm
Hexagonal	RP	$a_1 = a_2 \neq c \alpha = \beta = 90^\circ, \gamma = 120^\circ$	m 6/mmm 3
Cubic	PI F	$a_1 = a_2 = a_3 \alpha = \beta = \gamma = 90^\circ$	m3m

The following is from Klein, 2002 shows the 14 unique Bravais lattices. These are defined by translation of the two-dimensional lattices in the third dimension combined with placement of presence atoms in addition to those at the lattice corner(P). These atoms can be body-centered (I) or face-centered (F) in the lattice.



MINERAL ANNOUNCEMENTS:

Denver Gem & Mineral Show Mini Report January 2013

Planning is already underway for the 2013 Denver Gem & Mineral Show. The dates are September 13 – 15, 2013. The featured mineral is tourmaline. As everyone knows, tourmaline is a beautiful mineral with such variety including colors of pink, blue and green. Wait until you see the poster for the show. It is spectacular! There will also be small flyers in a new format for advertising the show. One side will be a small poster, featuring a tourmaline specimen, with usual show information on the reverse side. The Show Chair remains Larry Havens. This is Larry's third year as Show Chair and he has done a superb job. If you have any questions, concerns or ideas for the show, contact Larry at lwrnchavens@comcast.net or 303-757-6577.

The show is sponsored by the Greater Denver Gem & Mineral Council, which is made up of the eight local gem, mineral and fossil clubs. These clubs are: Colorado Mineral Society, North Jeffco Gem & Mineral Club, Flatirons Mineral Club, Littleton Gem & Mineral Club, Denver Gem & Mineral Guild, Mile Hi Rock and Mineral Society, Friends of Mineralogy Colorado Chapter, and Western Interior Paleontological Society. All the planning and operation of the show is done by the Show Committee, which consists of volunteers from these clubs. 2013 is the 46th annual show. Forty-six years is a long time for an annual show which is put on by all volunteers. Plus the show keeps getting better every year. The Show Committee meets at the Denver Museum of Nature & Science the first Tuesday every month of the year except for December, February and July. To keep the show a great show year after year takes commitment by the members of the Show Committee. New members are always needed and welcome on the Show Committee. If you enjoy the show and would like to become more of a part of it, consider joining us. There are probably several members of your club who are already members of the Committee. Talk to them about their experiences and reasons for being on the Committee. Come with them to a meeting to see what it is all about. You will meet people from the other clubs and make new friends. The show is a great way to enjoy the gem, mineral, and fossil hobby. Respectfully submitted, Judy Knoshaug, Secretary

Upcoming events;

Tues., Jan. 15, Potential links between climate change and water quality degradation in a mineralized watershed, by Andrew Manning, USGS, Denver. *Please email me (pmodreski@usgs.gov) for a complete list of all our USGS seminars scheduled through May 28.*

Fri-Sat-Sun, Feb. 22-24, Gem and Mineral Show, Jefferson County Fair Grounds, Exhibits Building; sponsored by the Denver Gem and Mineral Guild. Free admission & parking; hours 10-6 Fri. & Sat., 10-5 Sun. For more info see <http://denvergem.org/Shows.html> .

Sat-Sun, Mar. 16-17, Western Interior Paleontological Society (WIPS) Symposium, Ice Worlds and Their Fossils; "Discover how glacial climates & life interact to shape evolution and the biosphere". At the Green Center, CSM campus, Golden. See http://www.westernpaleo.org/symposiums/pages_2013/2013.php for full information. (early registration - \$10 discount- runs through Jan. 7). These symposia, held every other year by WIPS, are GREAT!

Fri-Sat-Sun, Mar. 22-24, Fort Collins Rockhounds Gem and Mineral Show, McKee 4-H Building at The Ranch (Larimer County Fairgrounds), Loveland, CO; at I-25 exit 259; 4-8 p.m. Fri., 9-6 Sat., 10-5 Sun. Admission, adults \$4/day or \$7/3-day pass, students age 12-18 with student ID \$1, children under 12 free with adult. See <http://www.fortcollinsrockhounds.org/> .

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SCIENCE FOR A CHANGING WORLD
<http://www.usgs.gov> <http://ask.usgs.gov>

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.

Your newsletter editor encourages all FMCC members to send your email address so that you will receive the newsletter electronically. The email version of the newsletter is in color; the paper version will have none. Please send your email address to Editor Bill Hutchinson at wmhutchi5@g.com. Also if you only want a paper newsletter but are presently receiving an email newsletter, please let your editor know.

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