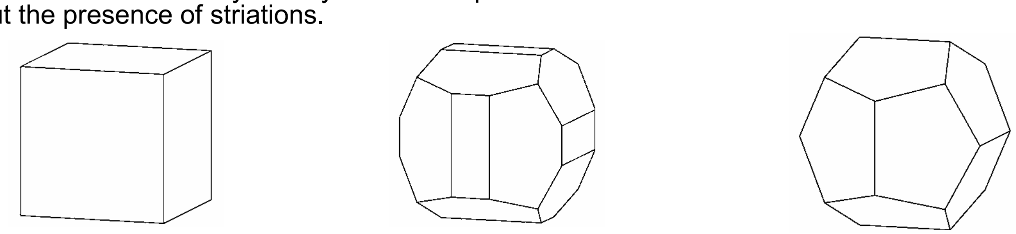
EARNING THEIR STRIPES – What striations can tell us about a mineral

by Julian C. Gray, GMS Member and Mineral Section Chair

Striations are those small parallel lines on some crystal faces of minerals. Mineral identification books often list these as a diagnostic property for either identification or for distinguishing between two similar minerals. For example, plagioclase feldspars are recognized by fine striations on one of its cleavage planes and this is one quick way to tell the difference between microcline (potassium feldspar) and plagioclase (Klein, 2002). But what exactly are striations? How do they form and what can they tell us, besides how to identify a mineral? Ernst Cloos, a famous structural geologist, once said "No structure [or feature] in a rock [or mineral] is insignificant, no matter how small or unimportant it first appears" (quoted in Rodgers, 1970). This is very true of mineral striations. So let's look at a few examples.

Probably the best known example of striations on crystal faces are those found on some faces of pyrite crystals. These little grooves are surprisingly complex. To understand their meaning, we need to do a little crystallography. The most common crystal forms of pyrite are the cube and the pyritohedron (Figure 1). The pyritohedron is also called a pentagonal dodecahedron – a polyhedron made up of twelve (do = two plus deca= ten) faces with five sides to each face (penta = five). The pentagons are not perfect pentagons, though. Look carefully at the length of edges on each face, four are the same length, but the fifth is longer. If you locate the longer edge on a pyritohedron face, you have located one of the crystal axes. Now rotate the crystal around that axis 180 degrees once, then once more. At each stop the pyritohedron looks the same; it is symmetric. The axes of a cube go right through the center of each of the six square faces. Since the faces are square, you can rotate the cube around one of its axes, stopping four times; once every 90 degrees. Do this with a cubic pyrite, a dice, or child's building block, anything that is a perfect cube. Now which crystal form is more symmetric, the cube or the pyritohedron? The cube, of course, because there are four positions where it looks the same when rotated rather than the two positions as with the pyritohedron. Mineralogists call these four-fold and two-fold axes of symmetry (Klein, 2002).

So what has all that got to do with striations? We know that striations are fine parallel grooves. Striations are caused by a crystal alternating between crystal faces as it grows. Crystals grow by adding tiny molecular building blocks of the chemicals of which it is formed. The final form may be very different from the unit cell building blocks. If the sharp corners of a pyrite cube are replaced by triangular faces then the crystal has grown mostly as a cube, but partially as an octahedron. If the edges of the cube are replaced by rectangular faces, then the cube has been modified by a dodecahedron – most likely a pyritohedron (Figure 1, center drawing). We have no problem understanding that a mineral can exhibit two or more crystal forms. It is also fairly common to see the faces of the cube modified by striations. These striations are produced when the pyrite grows with the cube as the most prominent form, but the cube faces alternate between a cube face and a pyritohedron face (Figure 2). Each striation is a tiny stair step: it alternates back and forth between cube face, pyritohedron face, cube face, over the whole striated face (Hurlbut and Sharp, 1998). I can prove this. If you have a cube with striations, place it on a table so that the striations on the top cube face are lined up left-right. The striations on the front and back face go from top to bottom and those on the left and right side go front to back. If the faces of the cube were smooth, you could rotate the crystal four times to a symmetrical position. The presence of striations reduces the symmetry of the pyrite to the point that you can only rotate the crystal two times to symmetrical positions. Sound familiar? The presence of the microscopic pyritohedron faces reduces the four-fold symmetry of the cube to two-fold symmetry of the pyritohedron. Although pyrite forms cubes, it does not have four-fold symmetry! This lower symmetry of the internal crystalline pyrite structure is revealed by the fact that it can grow into pyritohedrons, which have two-fold symmetry! And this profound observation of its structure is revealed from simple observations about the presence of striations.



Cube — Cube and Pyritohedron — Pyritohedron

Figure 1 - Common crystal habits of pyrite (*Drawings by Julian C. Gray using* SHAPE Software v.6.0).

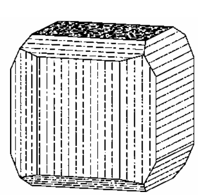


Figure 2 - Pyrite exhibiting combined cube and pyritohedron habit with striations. (*Drawing by Julian C. Gray using* SHAPE Software v.6.0).

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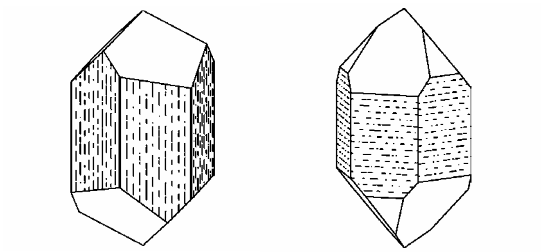
Another familiar example is quartz. Quartz crystals are made of a combination of two triangular prisms and two rhombic pyramids, which form the triangular faces of the terminations. The c axis of the crystal is vertical, going from point to point on a doubly-terminated crystal. Striations are common on the prism (side) faces of quartz (Figure 3). The striations are at a right angle to the edges of the prism faces (right angles to the c-axis of the crystal). This is a diagnostic property of quartz (Klein, 2002).



Phenakite with vertical striations — Quartz with horizontal striations

Figure 3 - Comparison of phenakite and quartz crystals (*Drawings by Julian C. Gray using SHAPE Software v.6.0*).

Phenakite is a rare and very valuable beryllium silicate found in pegmatites. The name for phenakite comes from the Greek words for deceiver for its similarity to quartz (Blackburn and Dennen, 1997). Phenakite occurs in crystals comprised of two triangular prisms and two triangular pyramids. It has a hardness of 7.5 to 8, is white or colorless, and has a vitreous luster; all of which sounds like quartz (Klein, 2002). So you are collecting in a pegmatite-rich area one day. How would you know if you are finding common (but cute) quartz crystals or the rare and valuable phenakite? Phenakite also has striations, but the striations are parallel to the edges of the prism faces or parallel to the c-axis (Jacobson, 1993)! Ah hah! So striations can be used to distinguish between quartz and phenakite. If the striations are vertical it is phenakite, if they are horizontal the mineral is quartz (Figure 3). No longer shall ye be deceived.

While we are discussing phenakite, I should also mention that it has one of the most fascinating twins. Phenakite forms a penetration twin that occurs when the second crystal is rotated 60 degrees around the c-axis (Figure 4). The end of the resulting twin looks like the point of a steel star drill bit. Therefore these crystals have been nicknamed drill-bit twins (Jacobson, 1993). Bet you won't confuse them with quartz!

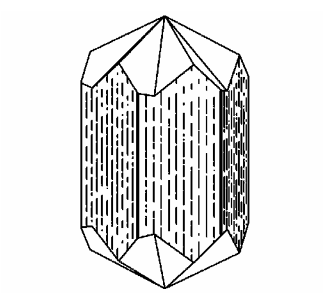


Figure 4 - Phenakite drill-bit twin with vertical striations *(Drawing by Julian C. Gray using SHAPE Software v.6.0)* .

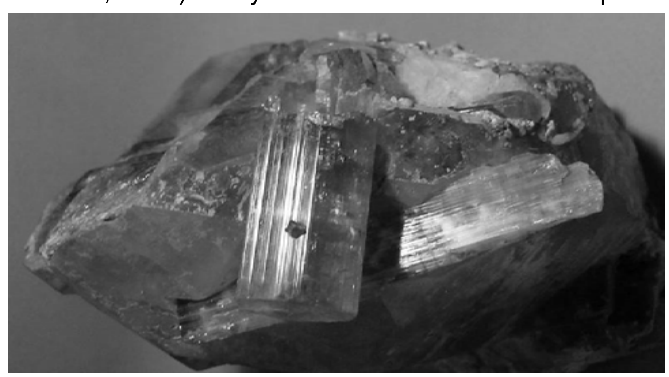


Figure 5 - Elbaite variety of Tourmaline (Himalaya Mine, CA) on Quartz. Light reflections on the two crystals in the center show the typical striation patterns exhibited by tourmaline (*photo by Doug Daniels; specimen owned by Doug and Carolyn Daniels*.)

Another common example of striations occurs in tourmaline (Figure 5). Alternating prism faces on tourmaline crystals that give it those distinctive and interesting vertical striations. Commonly the alternating forms distort the flat triangular cross section into the well-known curved triangular shape familiar to all (Hurlbut and Sharp, 1998).

Other examples of striations caused by alternating crystal forms abound. They add beauty to minerals, tell us about the crystal symmetry of minerals, and help distinguish between sometimes confusing similar species.

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LOUD & CLEAR
August 1, 2003

H.R. 2416 - Paleontological Resources Preservation Act

We all need to do some fast letter writing. Let me remind my mineral collecting friends who do not seem to be disposed to concerning themselves with rights to collect fossils, that the relevant agency rules lump minerals, rocks and invertebrate fossils together in their regulations.

The Senate companion bill to H.R. 2416 has already passed the Senate (S546). Here's what Washington Watch had to say about S546:

"Bad Bills"

S546 Anti-rockhounding bill titled the "Paleontological Resources Preservation Act" places severe penalties on recreational rockhounding, would permit only "experts" to disturb public land surfaces. Allows for seizure of private vehicles, camping equipment and anything else the government wants to grab for even minor violations. This bill assumes that big brother government has all the answers, even though some of the greatest discoveries of dinosaurs in pre-recorded history has been done by private individuals."

Frankly, I was surprised that the forfeiture provision for seizure of vehicle and property of the malfeasor is also provided for in the House bill H.R. 2416 even if the violation is characterized as a "civil penalty", i.e., does not rise to the level of a crime (misdemeanor or felony). The forfeiture provision would put erring fossil collectors in the same peril as drug dealers.

What else is wrong with H.R. 2416? Answer: a lot. In Section 15 of the bill entitled "Saving Provisions", Provision 3 specifies that the bill does not apply to amateur collecting of a rock, mineral or invertebrate or plant fossil that is not protected under this act." Yes, I know that this provision is no worse that the current BLM and Forest Service regulations which prohibit the collecting of vertebrate fossils. However, I would not like to see the vertebrate-invertebrate distinction codified by federal statute. As I have explained at length in previous columns, the little fossil collecting experience I have had has been mostly directed to vertebrate fossils, none of which were sufficiently unique or valuable to warrant special protection under the law.

I would like to challenge lawmakers to pick a vertebrate fossil I own (a rounded hunk of agatized bone) from among a group of rocks. At the minimum, they would have great difficulty. Yet this bill demands such skill of their constituents.

Section 9 "Prohibited Acts; Penalties -(B) False Labeling Offenses" provides "a person may not make or submit any false label or counter label for or any false identification of any paleontological resource excavated or removed from Federal lands. As I previously wrote, "pity the poor collector or curator, amateur or professional, who mistakes a psittacosaurus bone for a chasmosaurus bone." Such misidentification can make a criminal out of you. Thank god I only collect minerals which I all too often misidentify. On the bright side, this provision has the potential for placing all those pesky SVP members behind bars and thus out of our hair.

Another objection is that you would be prohibited from selling or exchanging fossils which you legally collect from Federal lands, e.g., a surface collected invertebrate or plant fossil. See Section 9(3). Why should fossils be different from minerals, gold nuggets, coins, etc., found on public lands?

Please immediately write your Congressman at:

Representative ________________
U.S. House of Representatives
Washington, D.C. 20515

Those Pesky Solicitors

Several nights ago I answered a knock at the front door of our home in Vienna, Virginia to find a beautiful young blond female on our threshold. Many years ago this would be the occasion of no small amount of excitement but not so now, especially so since my wife Karen beat me to the door. The young lady was soliciting memberships in some environmental group. I explained that I was opposed to some of what is being done in the name of environmentalism giving the example of road closures on public lands which restricted my access to rock collecting sites. The young lady assured me that her organization was only interested in suppressing particulate emissions from stack gases of coal-fired power generating plants. I was a definite no sale but in departing she left a brochure. In the first paragraph of that brochure I learned that the organization she represented took great pride in the "roadless rules" put into place during the Clinton administration. What her organization regarded as its major accomplishment was precisely what I had complained of. Be careful what you buy.

Please note my new e-mail address: gloud@comcast.net.
George Loud, Chair, AFMS Conservation Legislation Committee

Couple Fined for Digging on National Forest Land

An unnamed husband and wife, were cited and required to pay a $200 fine for digging large holes near an old amethyst mine in the Charlie's Creek area in towns County (GA). The old mine was abandoned years ago, yet people still continue to dig in the backfill looking for gems. "Chattahoochee-Oconee Law Enforcement Officer Stuart Delugach said, "The damage done by this digging is consistent with what would be done with a backhoe on a construction site. People digging for these minerals have little to no payoff for a tremendous amount of work." Delugach went on to say that the man said he had been coming to the old mine since he was a kid and didn't know he was doing anything wrong.

Delugach said that from an environmental perspective, officers are noticing evidence of erosion caused by digging. The eroded soil damages plant life and ends up in streams causing the buildup of sediment that can harm aquatic species.

"Restoration of these damaged sites is extremely expensive due to the remote nature of the place where the digging occurs," said Tallulah District Ranger Dave Jensen. "It is difficult to get equipment into some of these places to rehabilitate and repair the damage.

Forest Service employees ask visitors to remember to leave no trace when visiting the national forest. By leaving plants, animals and resources in the forest, they will be available for other visitors to enjoy. Individuals caught removing resources from national forest land can be arrested and receive a misdemeanor charge of up to $5,000 and or six months in jail.

From Hiawassee, Georgia, Towns County Herald, Vol. 74, Num. 32, Page 1, August 7, 2003

SFMS Member clubs:

This is the second or third set of rockhounds to be fined at the Charlie's Creek amethyst mine dumps in the last three months! This particular amethyst mine was abandoned over 70 years ago and has been a favorite collecting location for rockhounds and Georgia mineral clubs ever since. The Weinman Mineral Museum, located in Cartersville, GA, has a spectacular display of Charlie's Creek amethyst specimens and is probably a good reason why so many mineral collectors try to visit this area. (To find little success, I might add!...) This old mine is in a rather remote location and consists of several small (less than 1/4 acre) tree covered dumps that are a good distance up the mountain from the creek.

This like so many old abandoned mines in the National Forest have been dug by mineral collectors for so many years that the landscape begins to look like the surface of the moon. We need to help the Forest Service manage these sites! These old mineral locations have, in reality, become historic rockhounding areas and need to be protected and set-aside by the Forest Service specifically for mineral and fossil collecting. SFMS Gem and Mineral Societies need to start thinking about creating a dialogue with their local District Ranger office in an attempt to adopt important historic mines in your local National Forest and to help the Forest Service develop and manage them! A cooperative approach to this situation in our National Forests is what we need to strive for. In North Carolina, a number of interested mineral collectors and local rock clubs are currently working with the local district Forest Service to have the old Ray mine designated and set aside as a "historic rockhounding area". "Corundum Knob" on Chunky Gal Mountain in Western North Carolina is an example of a special "rockhounding area" designated by the Forest Service. The Chunky Gal corundum location is only a few miles from the Charlie's Creek amethyst mine but both are located in different Ranger Districts.

From my observations, it seems to me that each Ranger district chooses which of the National Forest Service regulations and policies to enforce and which ones not to enforce. This inconsistent enforcement has caused a lot of confusion among the rockhounding community. Each district Ranger office may even have additional published policies that they follow separate from the Ranger District next door. Until we can get the Forest Service to establish and designate special mineral and fossil collecting areas within the National Forest that are operated under a single set of guidelines, we will have to visit each individual Ranger District to determine what the local policies are for collecting in their particular jurisdiction.

Before selecting a site, rockhounds should check with the LOCAL District Ranger offices to determine the following:

- The location is on National Forest land.
- Rock hounding is permitted in the area.
- The mineral rights are not privately owned.

Jim Flora, SFMS Field Trip Committee Chair
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