MICROMOUNTERS OF NEW ENGLAND

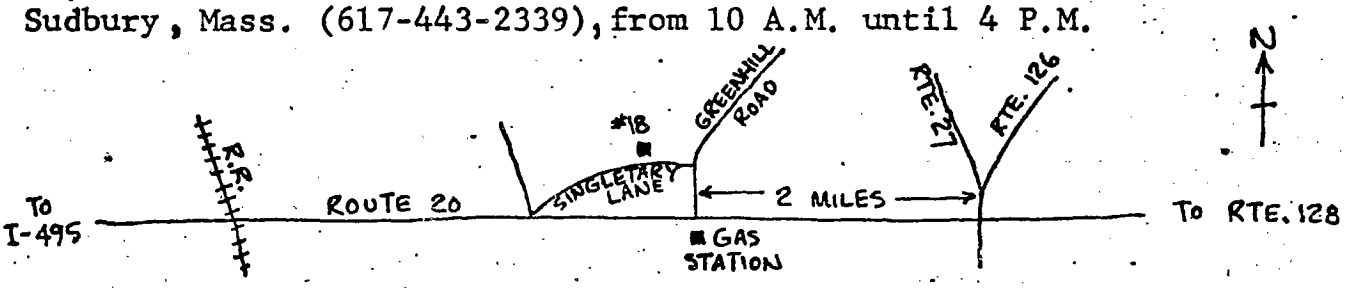
PRESIDENT AND BULLETIN EDITOR — John Anderson, 17 Ginley Road, Walpole, MA 02081, 617-668-2008

VICE PRESIDENT — Norman Biggart, 4 Baron Park Lane, Burlington, MA 01803, 617-272-1537

TREASURER AND SECRETARY — Ralph Carr, Jr., 25 Farnum Road, Warwick, RI 02888, 401-467-3823

NEWSLETTER #38 SEPTEMBER 1, 1977

The next regular meeting will take place on Saturday -September 24, 1977 at the home of Janet and Steve Cares on Singletary Lane in Sudbury, Mass. (617-443-2339), from 10 A.M. until 4 P.M.



There will be discussion of heavy liquids, conducted by Janet Cares and a homemade goniometer, conducted by John Anderson. This will be the first in a series (hopefully) of discussions, by members on micromount related topics. Also, a calendar of events will be presented at the meeting.

It is with sorrow and deep regret that we report the death of fellow member Bob Eldridge, of Penacook, N.H. The sympathy of our members is extended to the Eldridge Family.

Saco Valley Gem and Mineral Club Micromounters Roundup
Saturday September 17, 1977
Kenneth A. Brett School in Tamworth, NH 9AM to 6PM
(on route 113, just north of route 25)

5
35
175

.175
.05
8.75

#38

THE USE OF HEAVY LIQUIDS FOR DETERMINING SPECIFIC GRAVITY OF MINERALS

Specific gravity (G or S.G.), the ratio of the weight of a mineral (or other solid) to an equal volume of water, is a valuable property for differentiating minerals when used in conjunction with other methods of identification. With large pieces of pure mineral, various weighing methods may be used, but they are seldom sensitive enough for the micromounter. Heavy liquids, on the other hand, can be utilized with only small chips of a mineral, however the useful range is limited to the specific gravity of the heaviest liquid available. The method is based on the principle that a piece of pure mineral, regardless of size, will float on a liquid of higher specific gravity than itself, or sink in a lighter one. A mineral will remain suspended in a liquid when both have the same gravity.

Three commonly used organic solvents and their specific gravity are:

Bromoform	2.89
Acetylene tetrabromide	2.96
*Methylene iodide	3.32

Organic solvents such as these may be subject to decomposition, and should preferably be stored in air-tight brown glass bottles away from light. A few small pieces of clean copper wire placed in the bottles will aid in preventing decomposition. These liquids are volatile, and all have some degree of toxicity, particularly by inhalation, so should not be used for long periods of time, and then only in a well-ventilated area. They are not flammable, though it is inadvisable to smoke while using, as very toxic breakdown products may be produced by the heat of the burning tobacco, and inhaled directly into the lungs. They are not miscible with water, so other organic liquids must be used if dilution is desired. Denatured alcohol is suggested as it is readily available and has a gravity of approximately 0.8.

The heaviest liquids which are most practical to use are compounds of thallium as shown with their specific gravities:

Thallous formate	3.4
*Thallous malonate-formate (Clerici solution)	4.0 - 4.25

These liquids are not only heavier than the organic solvents but may be readily diluted with distilled or deionized water to give a wide range of gravities. Since they are not volatile at room temperature, there is little or no hazard from inhalation, but they are poisonous if swallowed, and are the basis of depilatories, so it is important to thoroughly wash hands, containers, or other surfaces with which they have been in contact in order to avoid transfer, especially to mouth or eyes.

Although there are other ways of applying heavy liquids, this discussion will be based on the comparison of minerals with liquids of known gravity. A satisfactory set of liquids may be made up in small plastic-capped glass vials which may be available from pharmacies or laboratory supply houses. (Clear plastic containers may be softened or dissolved by organic liquids). The lowest practical gravity is 2.0, since few minerals are lighter, and of those, most are water-soluble, and would require organic liquids. A gravity difference of 0.2 between each liquid is accurate enough for most work. A mineral may vary by this amount, so that extreme accuracy is of doubtful

---

*The cost of methylene iodide is about 4 times that of acetylene tetrabromide and about 2½ times that of bromoform on a weight basis. Clerici solution is roughly 3 times the cost of methylene iodide.

value. Impurities and air trapped within a mineral can alter the gravity, so it is important that the piece selected for testing be as clear as possible, and free from inclusions, surface coatings, or cracks which could trap air.

Ideally, dilutions should be prepared with accurate measuring devices such as pipettes or burettes, however good results may be obtained with more readily available tools. (This will be discussed at the meeting). To determine the amounts necessary for a certain gravity, the following formula may be used:

$$G \text{ of Mixture} = \frac{(\% \text{ heavy liquid} \times G) + (\% \text{ light liquid} \times G)}{100}$$

Obviously the percentages of the two liquids must add up to 100. This formula may be readily plotted on graph paper for convenience. (G of water = 1).

It is important to remember that water used for diluting thallium compounds may evaporate, and that mixed organic solvents may evaporate at different rates, so that the gravity of a liquid may change over a period of time. Whenever an unknown mineral is checked, a solid of known gravity (see table) should be placed in the liquid for confirmation. If loss by evaporation has taken place, water (or solvent) may be added a drop at a time until the proper gravity is reached, as checked by a known solid.

Work should preferably be carried out near a sink, using a tray to prevent contamination of table tops and to contain spills if they should occur.

To carry out a determination, a practical method is to prepare a series of thallous malonate-formate solutions with gravities from 2.0 up to the highest value obtainable, in increments of 0.2. One pure heavy organic liquid is helpful, as it will retain the same gravity, even though it may evaporate. Bromoform is most stable, but acetylene tetrabromide is useful as the 3.0 liquid (actual G = 2.96), which is about halfway between the highest and lowest of the liquids prepared. A clean, dry chip or crystal of unknown gravity is placed in this liquid and its action noted. Tweezers should be used for handling, and magnification may be necessary for very small pieces. To avoid confusion it is advisable to write down the effect at each gravity, using symbols such as S (specimen sinks), F (specimen floats), and = (specimen is suspended in liquid).

If the specimen floats, the vial should be swirled gently to insure that no air is trapped in the specimen, and that it is completely wet with liquid. If it still floats, it should be removed with tweezers, dipped in alcohol to rinse, and allowed to dry thoroughly. Since its behavior indicates that its gravity is less than 3.0, it is next placed in a lighter liquid such as 2.4. If it sinks, it is cleaned, dried, and placed in a liquid of higher gravity. This process is repeated until it sinks in one liquid and floats on the liquid of next higher gravity. The gravity of the specimen is then between that of the two liquids. If it remains suspended in a liquid, it has the same gravity as the liquid.

With practice the gravity may be more closely estimated. A specimen having a gravity just higher than the liquid will sink rather slowly, and can be temporarily resuspended by swirling the vial. If it is only slightly lower than the liquid, it may sink slightly when swirled, then return to the surface.

When an unknown is suspected of being one of two minerals of differing specific gravity, such as calcite (G = 2.7) or aragonite (G = 2.9) only one determination will be necessary. If the specimen is placed in a liquid of 2.8 G, pure calcite will float and pure aragonite will sink.

The usefulness and accuracy of determining specific gravity of minerals with heavy liquids is up to the individual and his or her care in preparation, application, and constant checking of liquids with known specimens.

Janet W. Cares

#38

building a one-circle optical goniometer

William A. Henderson, Jr.

Most micromounters do not realize that they possess two of the three components needed to make a one-circle optical goniometer. Moreover, the third component is by far the cheapest. The three are: a light source, a telescope or microscope, and an arrangement for rotating a crystal and measuring the angle of rotation. Only the last is not at hand, and that is easily constructed.

But why would anyone want a goniometer? As any mineral book will explain, a goniometer is used to measure the angles between faces on a crystal. An optical goniometer is used to measure the angles between the faces on very small crystals, and to do it accurately. Such measurements are very useful for two reasons. First, they can be used to determine what crystal forms are present on the crystal. Second, they can be used as a check on the identify of minerals.

Micromounters, who suffer frequently from lack of sufficient material for testing, are again lucky that identification by this technique does not destroy the specimen even to the extent of necessitating the removal of the crystal from the matrix (most of the testing I have done has been on specimens still in their micromount boxes). Moreover, the small crystals of micromount size are more perfectly developed and show a greater variety of forms for investigation than larger specimens.

Do you want to try your hand at it? You will only need to make the device for holding and rotating the crystal or micromount box. I made my first one by mounting a wooden dowel through close fitting holes in two blocks of wood so it could rotate. On one end of the shaft, I glued a small wooden tray to hold the specimen. In it I put a lump of roofing compound (clay will do) which can be molded to hold the crystal in the right position. On the other end of the shaft, I glued a fairly large, clear plastic protractor (available from stationery stores for a dime or so) so that its center coincided with the center of the goniometer's shaft. The protractor rotates past a marker line drawn on the goniometer base. The goniometer is mounted on three legs (faucet washers) for greater stability. About 12 inches long, the only critical dimensions on the goniometer are enough height for the shaft to clear the microscope base and enough length for the shaft to bring the sample holder under the microscope optics. Figure 1 shows the goniometer in front and end views.

Several steps are necessary in using the goniometer in order to get good results. The sequence is as follows:

1. To get a smaller light source, stop the regular microscope light source down by putting a piece of aluminum foil pierced by a half inch hole over the front of it.

2. Arrange the light so it is pointing steeply down from above the scope. The light should be perhaps eight inches above the goniometer shaft and about four inches in front of the microscope optics, directly in front of the scope. Either a monocular or binocular microscope can be used, although a monocular microscope is better. I use my binocular microscope, but only one ocular.

3. Set up the goniometer under the 'scope so that its shaft is perpendicular to the line between the 'scope and the light.

4. Stick the specimen in the clay and arrange the crystal so it is exactly in line with the shaft. That is, sighting along the shaft, it must point directly at the crystal.

5. Wiggle the crystal about and mold the clay so that the edge between the two crystal faces you want to work on is exactly coaxial with the shaft. That is, the crystal edge must be pointing in the same direction as the shaft and be in line with the center of the shaft. Focus the microscope on the crystal edge. When this is properly done, rotation of the shaft without moving the microscope, goniometer base or light will make each of the crystal faces in turn reflect light strongly through the microscope. All that should be necessary is a very slight adjustment of the microscope focus.

6. Turn off all other lights to avoid unwanted reflections.

7. Rotate the shaft so the first face reflects through the 'scope as strongly as possible. Record the angle reading on the goniometer, estimating to the nearest tenth of a degree. Rotate the shaft so the second face reflects. Record the second angle. Repeat the process four or five times and find the average difference between the readings on the two faces. This is the angular relationship between the two faces. A sample of the calculations performed on octahedron faces of fluorite is as follows:

#38

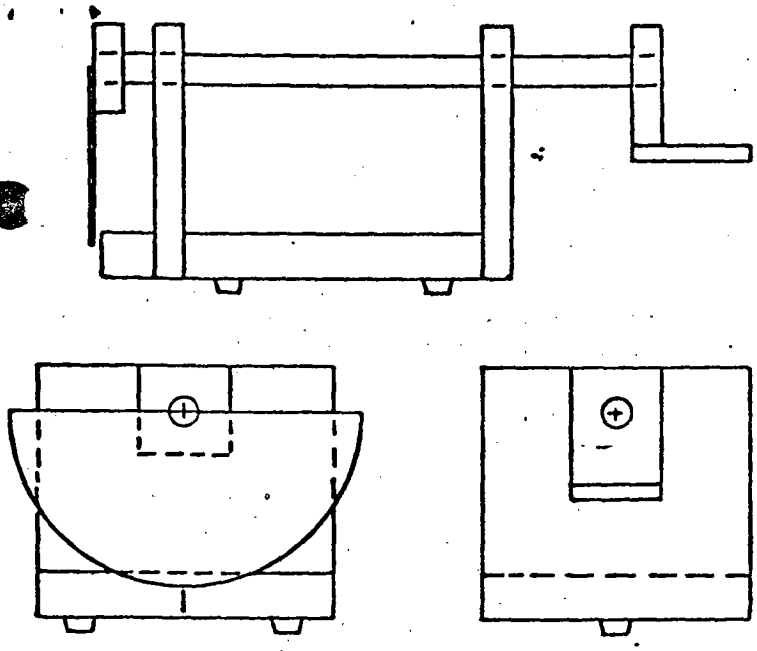


Fig. 1. Front and end views of a one-circle optical goniometer, showing location of axle, protractor and sample holder.

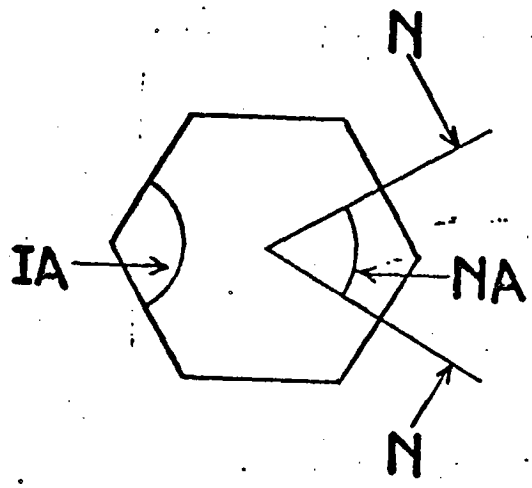


Fig. 2. This shows the relationship between the interfacial angle (IA) and the normal angle (NA) of the faces of a hexagonal prism.

First angle	Second angle	Difference	
123.9	53.8	70.1	
124.2	53.8	70.4	
123.0	53.0	70.0	
123.2	53.4	69.8	
123.7	53.6	70.1	
		70.1	Average difference

This average difference of 70.1° is about 70°6′ (70 degrees 6 minutes) and compares favorably with the literature value of 70°31′ for the angular relationship between octahedron faces.

The above is the angle between the *normals* to the two faces, not the angle between the faces themselves. A normal is a line drawn perpendicular to a face. The relationship between the two for the prism faces of a hexagonal crystal is given in Figure 2. The normals to two faces are designated by the letter N. The interfacial angle (IA) is 120°. The normal angle (NA) is 180° less the interfacial angle or 60°. This relationship that NA plus IA is equal to 180° is true for any pair of faces of any crystal.

A listing of the angles between the various faces on a crystal is only of value to collectors when it can be compared to literature values or used in calculations based on literature values. Sinkankas' superb book *Mineralogy for Amateurs* makes excellent use of interfacial angles drawn on each crystal diagram. *Dana's Textbook of Mineralogy* gives polar or normal angles for the more common crystal forms of minerals. *Dana's System of Mineralogy* uses a third type of notation which is too complex to describe here.

Angles between faces are usually given in a form such as *ao*, (100)^(111) = 54°44′. This means that the polar angle between the *a* of cube face and the *a* or octahedron face of an isometric mineral is 54 degrees and 44 minutes.

To check the accuracy of the homemade goniometer, I measured the angles between different faces on several micro garnet specimens. In all cases but one, the angles measured between the dodecahedron, trapezohedron and other faces of garnets were within one degree of the literature values. In most cases, they were within a half a degree. Thus, it was possible to identify exactly the crystal forms present and, in the process, to confirm the identification of the crystals as garnet.

One group of crystals sight identified as garnet gave angles which did not fit for an isometric mineral, thus illustrating the value of the optical goniometer as a tool for mineral identification. The story of this case of mistaken identify will be told in a subsequent article.

References

FORD, W. E. (1958) Dana's Textbook of Mineralogy, 851 p.

PALACHE, C., H. BERMAN and C. FRONDEL (1944) Dana's System of Mineralogy, Volumes I & II.

SINKANKAS, J. (1964) Mineralogy for Amateurs, 585 p. □

AUGUST FIELD TRIP REPORT

Saturday, August 20th found the Grandys, Webers, Tofts, VanIderstines, Vecchairellis, Charmans, Ed Hooghkirk, Earle Sullivan, Irv Stolberg and Joel Yancey at Mt. Sunapee State Park for the Annual Show of the Capital Mineral Club. The cooler temperatures made for a pleasant day of walking through the show, seeing the displays and micromount tables. It was real cool for the outside traders. We also enjoyed mine owner Bob Whitmore's talk and slides on the Palermo Mine and some of its micro-minerals!

Sunday was another beautiful day; clear, sunny and not too hot. Bob Whitmore came up from the Sunapee Show to spend some time with us, giving us a tour of the mine, showing us the work that had been done and where the various minerals were found, both in the past and the present.

Kaj Toft and Howard VanIderstine worke for several hours in Pod #1 and succeeded in pounding out a fair size chunk of scorzalite for their efforts. In doing so they found several green micro crystals in white matrix. They are not identified at this writing.

Marcelle, Charlie, Jim, Ed. Earle, and Joel divided their time between looking through the newly added dump material (from the bulldozing out of the pit) and the new pit itself, as well as looking around the area near Pod #1 and hard rock mining in Pod #3. Later in the day, after another couple who were there left, Jim climbed up to a precarious perch over the chimney where they had been and whacked out several specimens of whitlockite. These were among the best specimens of the day. This spot is Bob Whitmore's recently opened Pod #4 and, in addition to numerous whitlockite xls, contains siderite, rockbridgeite, strunzite, laueite, meeselite, fairfieldite, mitridatite, jahnsite (?), fluor-apatite, carbonate-apatite, quartz, childrenite, heterosite, and diadochite, an amorphous yellowish, brownish, reddish, glassy material. And so the day was ended on a positive note.

A day's rapid scanning of the Palermo material turned up nothing new. In small pieces of siderite, picked up in the vicinity of Pod #1, xls of ludlamite, vivianite, pyrite, laueite, jahnsite, and dark brown phosphoferrite are present.

It's hard going in Pod #3--the rock is tough and you stand on the surface you want to work. However, there is a ready supply of palermoite xls still available as well as goyazite in silky-lustered cubes, apatite, childrenite, laueite, struzite, and what appears to be bjarebyite in glassy green xls (this mineral was found in this pod). Roscherite has been found here, too, and there are several as yet unidentified minerals. It is to be understood, of course, that these are all micro.

Ed was collecting autinite in the pit, Charlie found some small quartz crystals and Jim has some micro smokeys, but the brazilianite which has been found there was not collected, to our knowledge. The dump was not particularly productive, either. There were a few phosphates around, and some quartz xls, as well as matrix with "eyes" of uranium sec-

(Continued page 6, column 2)