Identify Your Mineral Treasures

Part Four: Chemical Mineralogy

Testing Techniques

Over the past several centuries, researchers have learned a great deal about the chemical nature of the minerals found on Earth, many of which mankind has exploited since prehistoric times. Through patient determination and painstaking dedication to discovery and knowledge, their investigations have led to the development of numerous chemical techniques employed to identify the elements and compounds that have become so necessary to modern civilization.

To be sure, such techniques now seem quite primitive by today's technological standards, and have been supplanted by state-of-the-art machinery to accomplish the task at hand in a fraction of the time and personal effort. But such technology is certainly far beyond the means and financial resources of any private researcher outside of government or academic environments. And it's also nowhere near as fun!

A major part of the allure for amateur and independent mineralogists—even average collectors can count themselves among such ranks—is the hands-on discovery and identification of a valuable find. And let's face it, all finds that result from personal effort and appreciation instantly attain some degree of value the moment they are picked up, dug out, or simply acquired at a yard sale intended as a throwaway of useless and unwanted possessions!

Though antiquated, such wet testing techniques have withstood the test of time. Minerals today are the same as they were millions of years ago, therefore their reaction to chemical testing will be the same regardless of the procedure employed, whether by technologically advanced equipment or simple lab methods. Thus, such simplistic wet tests remain a valid and reasonably accurate means of determining the chemical composition—and hopefully the identity—of unrecognized mineral specimens.

While many mineral samples can be identified rather confidently by physical means alone (such as crystal structure, geologic environment, hardness, luster, etc.) through experience and knowledge, the chemical composition of a mineral is still nonetheless of fundamental importance. After all, the classification of minerals is based upon their chemistry therefore the final proof of identity of a given mineral often lies in the determination of its chemical nature by means of various wet/dry tests.

GML Publishing

a division of the

Mojave Natural Resources and Lithologic Survey

Las Vegas, NV

www.discover-minerals.com

gmileslehman@gmail.com

Discover Minerals

a mineralogy journal reviewing the mines, mineral resources, and geological history of the Mojave Desert region

Regular Components:

Features

Mine of the Month

Element of the Month

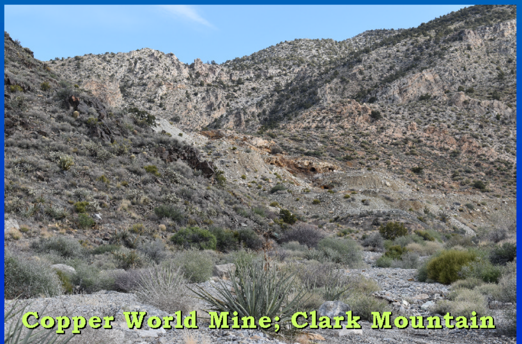
Mineral Showcase

Articles

Discover Minerals Field Trips

Publisher

G. Miles Lehman



Copper World Mine; Clark Mountain

Consequently, mineral chemistry is the single most important division of mineralogy, and even a beginning collector should be at least familiar with basic chemical information to fully appreciate a specimen's unique value to civilization and standing in Nature.

To this end, the previous issue of Discover Minerals addressed the essentials of commencing low-tech chemical research, reviewing the equipment and reagents needed for the endeavor. Having acquired such, we are ready to begin chemical analysis of mineral samples. In this regard, it is always best to first practice on known specimens in order to get the feel of the testing procedures, and to become familiar with the inevitable and expected results.

A good place to start would be to determine whether of not the substance in question is water soluble. In this regard, the easiest of all techniques is a simple taste test, which can be performed in the field. With a modicum of experience, tasting often provides accurate identification without any need of further testing. Salty (halite), bitter (epsomite), astringent (borax), metallic (chalcanthite), and cooling (niter) are just a few examples of the most likely indications to discern. If you experience any sensation at all, the substance is water soluble (at least to some degree).

A word of caution: some water-soluble minerals, for instance chalcanthite mentioned above, are poisonous! However, to say such is a bit misleading…*all* chemicals are poisonous at specific dosages—even oxygen and water! The tiny ingestion of chalcanthite to make a taste test is insignificant and harmless; applied sparingly, the experience is valuable and indelible. Nature is not for the squeamish!

These specimens are representative of water-soluble minerals that will render some kind of sensation when tested with the tongue. Niter provides a cooling sensation; epsomite is distinctly bitter; halite elicits a pleasant and familiar saltiness; and chalcanthite presents a rather unpleasant, but memorable metallic taste.

If the taste test fails to give results, the task at hand requires more involved chemical testing; samples must be collected to take back to the lab. But once there, where to start? The immediate goal should be to determine the likely candidates in order to whittle the possibilities down to a few contenders, otherwise much time, effort, and expense will be wasted performing an entire litany of unnecessary rote tests.

This can be accomplished by administering knowledge gained by studying and understanding the physical attributes that all minerals possess, and the geological environment/s they customarily occur in (most of which has already been covered in previous issues).

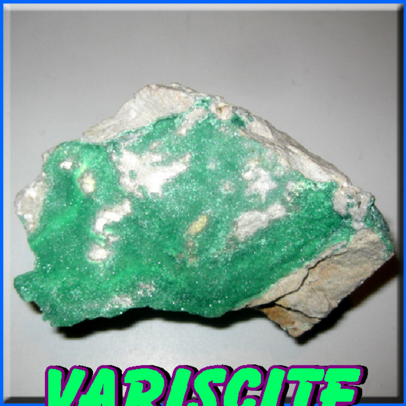
To review, physical attributes include such traits as hardness, luster, color, streak, cleavage, fracture, etc. In addition, even with a specimen that was not personally collected, a good guess can be made by recognizing the geological environment from which it derived, and knowing what minerals it is usually associated with. It is precisely this information that makes a matrix specimen so much more valuable than simply a loose crystal or clump of massive material.

The first step then should be conducting the simplest and least destructive tests. Try to determine the specimen's hardness by attempting to scratch a clean, unweathered, discrete surface with a knife blade (don't risk ruining a good specimen by marring a conspicuous surface). If it *cannot* be scratched, it is likely a silicate (although there are some hard oxides). If it *can* be scratched, and looks like it might possess a rhombohedral cleavage, it is likely to be a carbonate; test this by applying a drop of acid (e.g. HCl, H_2NO_3, even vinegar). Bubbling proves it to be a carbonate (some carbonates will only present bubbles in warm or hot solution, such as dolomite). If no bubbling is produced, suspect a sulfate first and limit testing to determining the presence of sulfur in the specimen.

If it is very colorful, it may be a phosphate, vanadate, or arsenate. Roast on charcoal or fuse in forceps; an odor reminiscent of garlic is produced by minerals containing arsenic (note that P and As readily substitute for one another, therefore even a phosphate can produce this effect). If no such odor, the specimen may be a vanadate.

PHOSPHATES

Dissolve sample in dilute nitric acid, then add a few drops to a *warm* excess ammonium molybdate solution; a canary-yellow precipitate of ammonium phosphomolybdate forms if phosphous is present in the mineral; ppt is soluble in ammonium/sodium hydroxide.



VANADATES

Dissolve sample in acid, then add a few drops of hydrogen peroxide to the solution; if vanadium is present, the solution will assume a red-brown color due to the formation of pervanadic acid. Test is simple and sensitive.

ARSENATES

Dissolve sample in dilute nitric acid, then add a few drops to a *hot* excess ammonium molybdate solution; a canary-yellow precipitate of ammonium arsenomolybdate forms if arsenic is present in the mineral; ppt is soluble in ammonium/sodium hydroxide.

Minerals with a metallic luster are either native elements or sulfides. Many metal elements are malleable, thus easily deformed by pressure (if available, pound a non-display-worthy sample with a hammer, or poke with a pointed object to produce an indentation). Metallic sulfides are brittle and will be crushed to a dark powder.

Frequently, secondary minerals contain water in the form of either *water of crystallization* (H_2O) or *hydroxyl ions* (OH). Heat a small sample in a test tube and note if liquid condenses in the tube; if so, the specimen is either a hydroxide or a hydrous member of one of the other groups already mentioned.

Silicates are the most difficult to test, because most are infusible and insoluble, thus do not easily give up their secrets. Start by fusing a small powdered sample in sodium carbonate, then dissolve in acid (formation of a gel upon cooling proves presence of silica), test for suspected elements, and see what happens.

By reviewing and becoming dependably familiar with the characteristics of minerals in each chemical class (review **Volume 1 Issue 2 pages 4-5**), understanding the environments they customarily occur in, and gaining valuable experience along the way, you will undoubtedly develop a personalized analytical strategy that will enable you to identify almost any specimen you acquire. Be aware, however, that Nature rarely does anything in purity; confusing results will ocassionally be obtained, making identification even more difficult. Do not be dismayed at the prospect—it happens to every experimenter eventually. It's acceptable to make a best guess and live with it until another clue is discovered sooner or later (sometimes even years later)!

Once simple lab equipment and basic reagents are procured (review **Volume 2 Issue 1 pages 2-5**), practice the preliminary tests covered in the previous issue to gain hands-on experience for recognizing typical results that can be encountered. Then refer to specific test procedures presented in the Chemical Identification Digest included in Appendix 3 of this special edition. Conduct the tests on known specimens first (use samples collected or acquired specifically for this purpose, rather that potentially damaging or destroying intended display specimens) and store or photograph the results for reference to use to compare against the results performed on unknown minerals.