Identify Your Mineral Treasures

Part Three: Physical Mineralogy

Picking up where we left off last issue, determining as best as possible the physical characteristics of your recently collected or acquired specimen will help to narrow the field of likely candidates. Having a firm appreciation for the attributes and vicissitudes of Color, Luster, Diaphaneity, and Streak, we conclude our discussion of Physical Mineralogy with the remaining significant characteristics of minerals.

Hardness, Tenacity, Fracture...

Familiarity with the physical properties of mineral specimens is a valuable aid in the rapid identification of unknown samples. With experience, a few observations or simple tests can often be all one needs to resort to in order to make a reasonable conclusion.

In previous issues, such obvious characteristics as color, luster, diaphaneity, and streak were considered in making preliminary identifications. Often, these can be enough to at least narrow the list of likely contenders. To make a final determination, the various species also possess many other qualities that, together, are uniquely characteristic for each individual member of the mineral world.

Cleavage

When a mineral consistently breaks in a way that it yields definite planal surfaces, it is said to exhibit **cleavage**. Such smooth surfaces are always parallel to crystal faces, and usually to the crystallographic axes. Cleavage is closely related to the mineral's crystal structure—the arrangement of atoms in the internal lattice producing symmetry—which is weaker in some directions and stronger in others.

Thus, cleavage is a directional property; any plane parallel to it through the crystal is a potential cleavage plane. In describing cleavage, one must consider quality, crystallographic direction, and ease of production.

Quality is expressed as *perfect* (e.g. micas), *good* (cerussite), *fair* (olivine), *poor* (beryl), *obscure* (apatite), and even *none* (spinel). The quality of the cleavage may even vary along different axes. A mineral, therefore, may have a perfect cleavage along one plane, and a poor one along another.

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Direction is noted by the indices which the cleavage parallels in regard to dimensions in space, that is, length, width, and height. Direction is also expressed by the name of the form which the cleavage parallels, such as *basal*, *prismatic*, *pinacoidal*, *rhombohedral*, *cubic*, and so on. By convention, these axes are labeled A, B, and C. A system (Miller Index) has been devised tp describe crystal faces and cleavages that cross these axes. Thus, the notation {100} means that the face or cleavage crosses the plane of the A axis, but not B and C *(a more thorough explanation of these indices and forms will be addressed in a future issue that will focus on crystallography)*. Cleavage is not always easily produced, but when it is, it can serve as an excellent diagnostic criterion.

Lepidolite

Perfect Micaceous Cleavage

Calcite

Rhombohedral Cleavage

Franklinite

No Cleavage

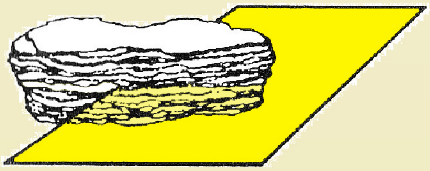
Parting

While cleavage is always consistent with the symmetry of a crystal, **parting** differs in that it expresses itself only along certain parallel, spaced planes. When subjected to pressure, some samples develop planes of structural weakness along which they may break.

The phenomenon is not necessarily characteristic of a specific mineral, but rather of the specific specimen—regardless of species—that had been twinned or subjected to the proper pressure. Even in such a specimen, there are only so many planes in a given direction along which it will break.

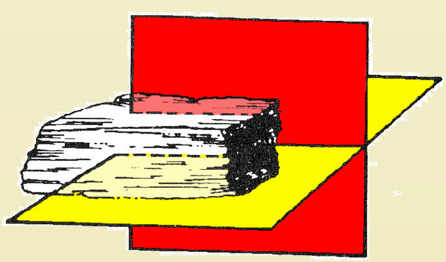
It should be duly noted that parting is present only in *some* specimens, and never occurs between random atom planes. While cleavage is diagnostic of *all* specimens of a particular mineral, parting is produced in individual specimens, and cannot be relied on for identification purposes.

EXAMPLES OF CLEAVAGE



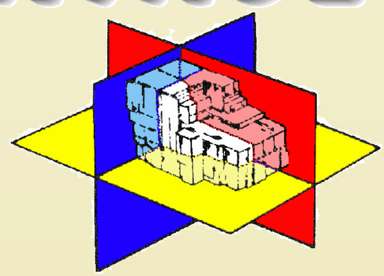
One Plane

e.g. Biotite



Two Planes

e.g. Orthoclase



Three Planes

e.g. Galena

Fracture

Unlike displaying predictable cleavage or elusive parting, minerals often show a tendency to break along surfaces other than cleavage planes. The character of such a broken surface is called **fracture**.

Some minerals, or those that occur in various habits, may break in such a way as to produce fibers or splinters (*fibrous* and *splintery*, respectively), such as the satin spar variety of gypsum, or the asbestiform habit of serpentine called chrysotile. Metals often break with a jagged, sharp-edged fracture called *hackly*.

Since most minerals show either an *uneven*, irregular, break, or a curvy, shell-like one called *concoidal*, fracture is not very useful in narrowing a long list of candidates that display similar breakage. However, used in conjunction with other identifying attributes, fracture can play a pivotal role in a final determination.

Hardness

The resistance that a smooth surface of a mineral offers to scratching is called its **hardness**. The degree of hardness is determined by observing the comparative ease or difficulty with which one mineral is scratched by another, or some other tool to make such a determination, such as a knife or file.

A series of ten common minerals (and various substitutes) has been arbitrarily chosen by mineralogists throughout the past to serve as a reference scale to compare the relative hardness of one specimen to another. These minerals (see sidebar) comprise what has become known as the *Mohs Scale of Hardness*.

With a little practice, the hardness of minerals under 5 can be quickly estimated by the ease with which they can be scratched by a pocket knife. Anything harder than a knife is either a silicate or hard oxide (of which there are few and are readily identified by other means).

It should be noted that the degree of hardness is not necessarily of equal extent one number to the next, as diamond is many more times harder than corundum, as corundum is over topaz! The differences are *relative*, not absolute.

In order to make a determination of hardness using this scale, it is necessary to find out which of these reference minerals can or cannot scratch your unknown specimen. When performing the test, certain precautions must be observed.

First, portions of a harder mineral may leave a mark on the surface of the softer mineral being tested. Similar to a streak test, such a mark can be rubbed off, whereas a true scratch will remain. Secondly, one must take care to test a fresh, unaltered surface, as weathering will often produce material that can be much softer than the original mineral. Thirdly, the inherent physical nature of the specimen may interfere with determining a correct hardness; for instance, it may be pulverulent, granular, or splintery, which can result in the tested material being simply broken down rather than scratched, thus giving an apparent hardness.

Finally, it should be noted that only within relatively wide limits can one definitively determine hardness with any degree of exactness. One must be particularly attentive when resorting to a scratch test to determine a specimen's hardness.

Mohs Scale of Hardness

Relative Scale	Natural Example	Artificial Example
1	Talc	
2	Gypsum	
		Fingernail ~2.5
3	Calcite	Copper Coin
4	Fluorite	
5	Apatite	Knife Blade
		Glass ~5.5
6	Microcline	
		Steel File ~6.5
7	Quartz	
8	Topaz	
9	Corundum	
10	Diamond	

Specific Gravity

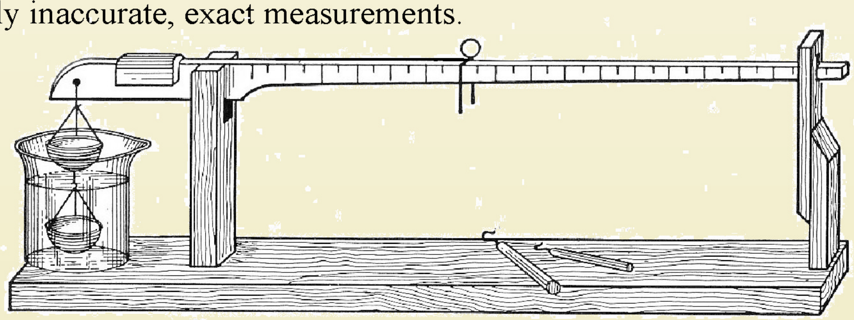
The ratio between the weight of a mineral specimen and the weight of an equal volume of water at 4º C is called its **specific gravity**. If that number is two, for instance, that means that the specimen weighs twice as much as the same volume of water. Notice it is a relative term that does not require a unit measurement (e.g. ounces, pounds, degrees, etc.).

For practical purposes, there is a serious drawback to determining specific gravity—one needs a *pure* specimen to conduct the experiment. As we all likely know, this condition is difficult to fulfill, as purity is rarely met in nature! There are other requirements as well. The specimen in question must also be compact with no cracks or cavities that can trap bubbles or films of air. Additionally, the specimen should be large enough to reasonably measure, a volume of at least a cubic inch. Since all of these conditions combined are seldom attainable, determining specific gravity by any rapid and simple method available to the average collector will inevitably be inaccurate and useless.

On the other hand, an equally valuable substitute for a mineral's actual specific gravity is its **heft**, a quality easily determined in the field. People naturally develop a sense of the relative weight of objects they're familiar with in normal life. A tennis ball *feels* lighter than a solid rubber ball of the same size. A box of nails is distinctly heavier to pick up than the same sized box filled with rubber bands. What this means is, one has developed an idea of an average specific gravity, or a feeling of what something of a given size should weigh.

With a little practice the same sense can be developed in regard to minerals. The average specific gravity of the Earth's upper crust is between 2.65 and 2.75. This is because the most common and abundant non-metallic minerals, quartz (2.65), feldspar (2.6 to 2.75) and calcite (2.71), fall within this range. By contrast, many minerals are much heavier. Pyrite, for instance, has a specific gravity of 5; gold, about 19.

If you were blindfolded, and a number of mineral specimens of equal size were placed before you—only one of which had a high specific gravity—you could immediately determine with absolute certainty which one it was just by picking up each sample in turn. With a little practice, one can become expert enough to distinguish comparatively small differences in specific gravity between mineral specimens without having to resort to time consuming, and usually inaccurate, exact measurements.



Armed with a fundamental understanding of the many characteristics that define the thousands of known minerals, combined with and honed by valuable experience, most of the more common minerals—and many uncommon ones as well—can be identified with reasonable accuracy simply by utilizing the most basic of testing techniques.

Even when this fails (as it inevitably will), the pursuit and enjoyment of discovery by employing more involved techniques, which will be addressed in future editions of Discover Minerals, provides emotional and intellectual benefits that will reward the geologist and rockhound alike with a lifetime of incomparable gratification.