"Minerals that do things…"

Hands-on demonstrations of mineral properties

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Scratch & Sniff Minerals

Object: Students will experience minerals and rocks via their sense of **smell**. Smell tells you that something important is happening when you scratch a rock or mineral. Smelly minerals can indicate the presence of tiny invisible ***fluid inclusions*** in minerals and rocks and give clues to their compositions.

Procedure description: Students scratch minerals or rocks with nail or metal file or knock them together, then sniff them. While many rocks and minerals will give off some odors when scratched, fetid barite is called "fetid" precisely because it smells really bad – with a very strong odor of rotten eggs.

Most students will react strongly to the smell of some of mineral or rock samples. (Note that in order to get a strong smell it may be necessary to chip a fresh surface on specimens that have already been heavily scratched by previous students.) Compare the smell of the pyrite and the fetid barite with that of the sulfur; how does the petroliferous limestone compare? Can you tell them apart?

Specimens to test: "Fetid" barite (available from various locations including Frystown, in Berks County, Pennsylvania – the local Amish call them "stink stones"); sulfur chunks; pyrite; marcasite; petroliferous limestone; arsenopyrite; white quartz pebbles; Herkimer "diamonds" (quartz from Herkimer, NY).

Equipment needed: Large nails or coarse metal files. A short file works well – you can take old worn-down metal files and break them into 4- to 6-inch pieces.

Scientific discussion: Scratching fetid barite breaks open microscopic *fluid inclusions* caught up in the crystal when the crystal was forming. Breaking open these tiny pockets of fluid releases some very minor amounts of hydrogen sulfide (H_2S) – a gas to which your nose is very sensitive (you can detect it at the parts per billion level).

Fluid inclusions in minerals are typically microscopic – smaller than 0.01 mm across – and there may be billions of inclusions in a crystal that is only a few centimeters across. Fluid inclusions are really small preserved samples of the fluid from which the crystal precipitated when it was forming. Scientists study fluid inclusions in minerals such as quartz, calcite, barite, sphalerite, and other minerals. Fluid inclusion studies are one way to study how minerals form. For instance, they allow us to determine the temperature of formation. Most of the fluid in a fluid inclusion is just salt water, but gases such as carbon dioxide and hydrogen sulfide may also be trapped.

Pyrite and petroliferous limestones have similar odors. Pure sulfur smells slightly different. Some students will describe the odor as that of "rotten eggs," "sulfur," "garlic," or "natural gas," or describe the smell as similar to that of the hot springs at Yellowstone. Native sulfur is just pure sulfur (S); rotten eggs give off hydrogen sulfide (H_2S). Methane (CH_4 – the major component of natural gas) is naturally odorless, but we mix into natural gas a small amount of a very smelly chemical called methyl mercaptan (CH_3SH) so that you can smell the gas if a leak occurs. Notice that all three compounds contain sulfur – the root of their bad smells. Petroleum (oil) can also be trapped in fluid inclusions. Hydrogen sulfide frequently accompanies natural gas and petroleum – hence the smell of petroliferous limestone, although you may notice an oily smell, too.

Additional possibilities: It is possible to obtain quartz crystals with large visible inclusions (with fluids, gases, and/or solids). Herkimer "diamonds" – quartz crystals from Herkimer, NY – often show solid black inclusions of a material called anthraxolite (which is an amorphous organic material). Part of the sparkle of Herkimers is due to the fact that they frequently have large interior flaws – some of these flaws are large empty fluid inclusions (small cracks can allow fluids to escape). Some quartz crystals can also be found with large visible fluid inclusions; these inclusions often contain gas bubbles (which may include water vapor, methane, or carbon dioxide) that can be seen to move when you tip the crystal back and forth.

Quartz nodules called "enhydros" may also be obtained. These are essentially geodes that contain water. By careful cutting and polishing, a lapidary can work the nodule to the point where one side is thin enough that it is possible to see the water sloshing around inside, but the nodule still remains sealed. Enhydros and crystals with large visible inclusions can be used to show students that fluid-filled inclusions are real.

Marcasite – an iron sulfide mineral – like some pyrites – will smell sulfurous, especially if it is falling apart. (We call the tendency of pyrite, marcasite, and other sulfide minerals to decompose and crumble "pyrite disease.") Other sulfide minerals such as sphalerite or galena may also give off a sulfurous odor when scratched. Arsenic minerals may give off an odor more like "garlic" – the smell of arsenic.

By the way, I've also noticed that some water-rounded white quartz pebbles sold as landscaping rocks will, when knocked together, give off a sulfurous odor. This is probably due to a slight amount of hydrogen sulfide in their fluid inclusions, too.

One may find other smelly rocks and minerals. Clay minerals, such as kaolinite, will have an earthy or clayey smell when damp. Experiment with other minerals and rocks – strongly-smelling specimens are usually found associated with sedimentary rocks.

Notes for demo tables: If you are doing demonstrations for large numbers of visitors (such as at a booth at a trade show), I've found that fetid barite and sulfur work best. It is simplest to have the test specimens in pairs. Ask your visitors to rub two pieces of fetid barite together, and then take a big whiff.

One should note that different people have sharper or duller senses of smell. Thus, most people will react strongly to fetid barite while some others will barely smell it. Kids often have keen senses of smell. Older adults, on the other hand, may have lost much of their sense of smell.