Earth Sciences Workshop

Rocks and Minerals

Mineral Identification

What is a mineral? There are 5 characteristics that a substance must have in order to be considered a mineral. Those characteristics are:

1. It must be naturally occurring (found in nature, not man-made).
2. It must be inorganic (not made from or by a living organism like a tree or animal).
3. It must be (usually) solid at room temperature (no liquids or gasses)
4. It must have a defined internal atomic structure which typically forms crystals (a pattern in the building blocks)
5. It must have a defined chemical composition (with some small variation) that is consistent across all occurrences of the substance.

What does this all mean? Let's look at some substances that are minerals and some that are not.

Quartz is a common and popular mineral. Quartz occurs naturally in the world, it is not organic in origin, its solid at room temperature, it has a defined crystal pattern that it grows into, and it has a consistent chemical formula of SiO_4.

Steel is not a mineral. It does not naturally occur in the world, being that it is man-made, and therefore does not have the first characteristic of a mineral.

Pure gold or copper, which can be found and mined in veins, are also minerals. Ice is a mineral as well, being that it has a defined structure and chemical composition. Other gem-like materials, like pearls, amber, or fossils, are not minerals because they are all organic, having come from living or once-living things.

Questions

1. Is plastic a mineral?

2. Is native silver a mineral?

3. Is rubber a mineral?

4. Is Calcite a mineral?

Now that we know what a mineral is, we can move on to identifying each individual mineral. Every mineral has certain properties to it, which we can test, and these tests will help us to identify whether the mineral is Quartz or Magnetite or Calcite or any of the over 3000 minerals.

The first test we can do is the scratch test to see how hard the mineral is. In geology, hardness does NOT mean how strong it is overall, but rather whether or not the mineral can be scratched by something. We use the Mohs hardness scale to rank our minerals, and it goes from 1-10, with 1 being the softest and 10 being the hardest. Certain minerals, like Quartz, Diamond, and Calcite, are considered to be the representative mineral for a hardness. For instance, Quartz is exactly a 7 on the hardness scale and is what is used in hardness testing kits. Similarly, Diamond is 10, Calcite is 3, and Corrundum (raw ruby) is 9. The hardness test itself is very easy. Geologists test hardness by trying to scratch an unknown mineral with something of a known hardness to see if it is harder or softer. In addition to the 10 type minerals that correspond to a known hardness, we also use fingernails (2-2.5), a penny (3), an iron nail (4.5), a steel knife (5-6.5), a piece of glass (5), and a piece of porcelain (5.5-6.5). By scratching an unknown mineral with these items, we can make assumptions about the hardness of the mineral. For instance, if the mineral is scratched by something with a 6 hardness, but not by a 5, we can assume that it is between 5 and 6 on the scale, probably a 5.5. Minerals of the same hardness can scratch each other but it might be a light scratch, so keep that in mind.

Questions

5. A mineral is scratched by a nail, but not a penny, how hard is it?

6. A mineral scratches glass, but not porcelain, how hard is it?

7. A mineral is not scratched by any of the minerals or tools in the kit (up to 9), how hard is it?

Other tests that we can perform are the streak test, magnetism test, and the fluorescence test. We can take a mineral and scrape it along a piece of rough porcelain to see if it leaves behind a streak, like scraping chalk along the sidewalk. The mineral can potentially be identified by what color streak it leaves behind. **Many minerals have a distinctive streak color, but others just streak white, so you have to use the streak color in addition to other tests.**

Some minerals are magnetic and others glow under a blacklight, which can further help identify them. We can also identify minerals by their crystalline shape, also called crystal habit, and by their cleavage, the way that they break. Some minerals break into little cubes or sheets, other minerals don't break in any particular way, and others have conchoidal fracture and break like glass.

We can identify them by their luster, which can be shiny, dull, or transparent, among other lusters.

We use all of these tests to try to pinpoint which mineral a specimen is. For instance, Quartz is a mineral with a hardness of 7, with a white to clear streak (if it leaves one at all, Quartz is harder than porcelain), a non-metallic glassy luster, that breaks with conchoidal fracture like glass, and has a prismatic crystal habit.

You don't always have to perform all the tests on a sample, usually just looking at the sample, measuring its hardness, and taking a streak are enough to identify most hand samples in a class.

However, it is good to know about all of the tests in case you run into something you haven't seen before or a mineral that looks different than you are used to.

Questions

8. You hit a random mineral you find with a hammer and when it breaks it looks like broken glass. What kind of test is this?

9. There are many minerals you can tell what they are just by looking at their shape and their shine in a hand sample. What two properties are you seeing with this?

10. Even though you can sometimes tell what a mineral is just by looking at it, color is not a test we use to identify a mineral. Why is that?

Rock Identification

Now that we know what a mineral is, we can move on to rocks. Rocks are made of minerals, just like a cake is made of ingredients. Rocks are an aggregation of different minerals that grow together. While you can find large, lumpy hunks of minerals that look like a rock, a rock must have multiple minerals in it. Unlike minerals, rocks have no defined chemical composition or structure. Because they are a collection of minerals, they do not have a crystal shape or a defined hardness. Different parts of the rock would have different streak colors, hardness, and properties depending on what mineral makes up that local section. As such, we grade rocks by a different set of standards.

There are three large-scale categories that all rocks fit into, they are either Igneous rocks, Sedimentary rocks, or Metamorphic rocks. Each of these categories have their own sorting system, but all rocks will fit into one of these three categories.

Questions

11. You find a sample that has many colors running through it, but it seems to have a uniform hardness and a crystal shape. Is it a rock or a mineral?

12. You find a sample that crumbles easily and seems to have different hardness in different areas and also glows under a black light in some areas, but not all. Is it a rock or a mineral?

The first category of rock is igneous. Igneous rocks form when magma or lava cools and hardens. Magma is molten rock that is still underground, lava is molten rock that has come to the surface. Igneous rocks have the most crystals in them of any of the three categories, since they let the minerals crystalize out of the magma, like salt out of cold water. Igneous rocks are judged by two main factors, composition and texture. The mineral composition is fairly easy to see because the minerals are either light or dark. This means we can judge igneous rocks by their color, which we cannot do with minerals. The texture of an igneous rock means how big or small the crystals are. Granite has a light composition and a coarse-grained (large crystals) texture. Basalt has a dark composition and a fine-grained (small crystals) texture. Obsidian is unique because it has no composition but it has a smooth, glassy texture. There are variations in between the fine and coarse textures and between the light and dark compositions, but in general igneous rocks are defined base off those two features.

The second category is sedimentary. Sedimentary rocks are formed from sediment, which is basically broken rock material. Rocks of all time erode and weather, breaking into smaller and smaller chunks, which we call clasts. Clasts can be any size, from a watermelon-sized chunk to sand to clay. These clasts can get moved around from one place to another by water. Eventually, these clasts can be glued together and turned into a rock, like making natural concrete. The sedimentary rocks can be glues with different types of natural cement that is usually present in the water system. They can also be made by light pressure, like burying clay deep underground in a swamp. Sedimentary rocks are judged mostly by their texture, which in this case means clast size. They are also judged by composition and size sorting, but those are not as important. Sedimentary rocks are usually the only

rocks with layering in them, since they are made by water bringing layers of clasts and setting them down. Rocks like sandstones, siltstone, and shale are sedimentary.

The final category is metamorphic. Metamorphic rocks are rocks that were igneous, sedimentary, or even another metamorphic rock that changed in some way. A good example is marble, which occurs when a limestone (sedimentary) is buried deep underground and is subjected to immense pressure and heat. This changes the rock, both in texture and potentially in composition, as some minerals might change into other ones when subjected to heat or pressure. The calcite in the limestone changes and fuses together in new ways, forming a marble rock. Most metamorphic rocks are named depending on what type of metamorphic process they go through and to what extent they change.

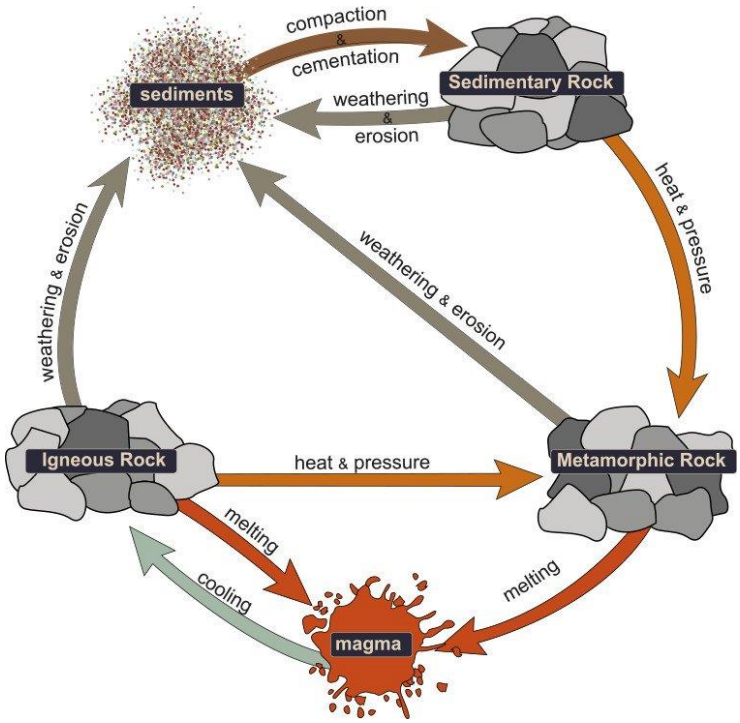
Questions

13. You find a rock that looks like it is made of crushed rock pieces. What kind of rock is it?

14. You find a rock with crystals that look like they've been crushed and compacted into forming bands. What kind of rock is this?

15. You find a black rock with large crystals in it near a volcano. What kind of rock is it?

Rocks are constantly being created, destroyed, and changed in a cycle we call the rock cycle. The rock cycle starts with magma that cools into igneous rocks. The igneous rocks break down into sediment, which then can be lithified into sedimentary rocks. Those sedimentary rocks can be subjected to metamorphic processes and turned into a metamorphic rock. Now, any rock can basically go to any stage. An igneous rock can be metamorphosed, eroded and lithified, or melted and recrystallized into igneous rocks. The same goes for sedimentary rocks and metamorphic rocks. Below is an idealized rock cycle that shows how any type of rock may turn into any other type of rock.



Questions

16. A metamorphic rock gets smashed to bits. What type of rock will it become?

17. An igneous rock gets so hot it melts and turns to magma. What type of rock will it become?

18. A sedimentary rock gets buried deep underground and gets really hot but doesn't melt. What type of rock will it become?