Earth Science Questions and Answers for Teachers Teaching Grade 4

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What are the key diagnostic properties of the following minerals (as listed in the *Science Framework*)?

Quartz – is a hard mineral made of SiO_2. It has a hardness of 7 out of 10 on the Mohs Hardness Scale. It can have a distinctive growth pattern of 8-sided crystals, but it does not have cleavage, so it would break randomly in curved fractures called conchoidal fracture. There are several versions of quartz, including smoky quartz, rose quartz, and amethyst quartz. Several kinds of rocks are made of quartz, including chert, quartzite, and quartz sandstone.

Calcite – is a relatively soft mineral made of $CaCO_3$, and easily distinguished from other minerals because it will fizz in dilute hydrochloric acid or HCl. Calcite has three cleavages that give it the look of a squashed rectangle, or a parallelogram. It has a Mohs hardness of only 3, which makes it just slightly too hard to scratch with a natural fingernail. Calcite is the major mineral in limestone, and is also the building block of the shells of clams and snails, and also the skeletons of corals and other marine life.

Feldspar – is the most common mineral on Earth, because it is so common in igneous rocks. One version of feldspar is pink-colored and is called potassium feldspar, or K-spar. The letter K is the chemical symbol of potassium. The other common version of feldspar is called plagioclase feldspar, and it is often milky white in color. A distinctive feature of plagioclase feldspar is the tiny striations and are found on cleavage surfaces, like the furrows in a newly-plowed farm field.

Mica – is a group of minerals that are typically flat, with just one cleavage direction. One version of mica is called biotite and it has a dark green to black color. Another version of mica is called muscovite and it has a transparent color of tan or light gray. A thin sheet of either type of mica is flexible and will bend and return to its original flat shape. This ability to bend and be flexible is called being elastic.

Hornblende – is a dark black mineral that is common in rocks like granite and diorite. In those types of rocks, hornblende is the black specs one sees. One version of hornblende is called amphibole and is common in dark basalt lava rocks, or other rocks that generally have a dark color, such as gabbro.

Galena (lead) – is a mineral made of lead and sulfur, leading to its chemical formula of PbS, with Pb being the symbol for lead and S being the chemical symbol for sulfur. Galena is characterized by being very heavy, as it is made of lead. Holding galena to the nose and smelling it reveals a smell like firecrackers or gunpowder, which is from the sulfur smell that the mineral gives off. Galena is a metallic mineral, with a natural piece of it having the color of lead.

Hematite (iron) – is iron oxide and is mined as iron ore. It often has a reddish, or rusty red, color, which is from the iron having "rusted" or oxidized. Hematite can also have a metallic gray color, in which case it is called specular hematite, and is often used in jewelry in this form. All forms of hematite have a rust-red streak when streaked on an unglazed porcelain plate, so this can be a diagnostic feature of hematite. Rouge is a powdered form of hematite.

Copper – is rare as a mineral and often occurs as pure metal copper, in which case it is called native copper. A blue or green color often results when copper is found with other minerals, such as in turquoise used in jewelry. Copper is a good conductor of electricity, thus we see it used commonly in electrical wires.

How did iron oxide end up in beach sand?
Iron oxide in beach sand is grains of minerals that are left over from the erosion of other rocks, such as granite located high in the Sierra Nevada Mountains. The iron oxide sand grains on a California beach have traveled from high in the mountains down to the coastal beach. The iron oxide grains are resistant to breaking down and they are heavy, so they accumulate together and will sometimes occur as black areas on a beach, or on a sand dune in the desert.

What is the difference between magnetic north and true north?
When we buy a compass, we expect it to tell us which way is north. This is true of a pocket compass with a needle, or a digital compass as commonly found in automobiles. The needle on a pocket compass is painted either white or red and points toward north. But the "north" the compass points toward is not the actual "candy cane" north pole. That north pole is the axis that the Earth spins on, like a classroom globe with two points that allow the globe to spin. The compass needle is actually pointing to the north magnetic pole, which is slightly different than the geographic north pole (the candy cane). The difference between the geographic north pole and the magnetic north pole changes from year to year. The geographic north pole does not really change (it is the rotating axis of the Earth), but the magnetic north pole does "wander" around from year to year. When using a pocket compass to find our way in the woods, or a compass in a car to find our way on city streets or back roads, the difference between the two north poles does not really matter. Both are "up toward the north" and they differ by a few degrees, but not by enough to keep us from finding our way home again.

How were the Earth's poles magnetized in the first place?
The poles are not magnetized, as a magnet is magnetized. Rather, the Earth's poles (north and south) are the extension of the magnetic field in the core of the Earth. If the core is like a big magnet, then the north and south magnetic poles are the extensions of the invisible lines of force that come out of a magnet, like the iron filings that will line up on a magnet when the filing are sprinkled over a magnet.

How is a magnet made? How are N and S divided?
A magnet is made by subjecting iron-based material to a temperature higher than the Curie Point, which is really hot, over 700 degrees Centigrade or 1300 degrees Fahrenheit (recall our kitchen ovens really can't get much hotter than about 500 degrees Fahrenheit). Once the iron metal is hotter than the Curie Point, it will loose all magnetic properties. Then if it is cooled down inside a magnetic field, it will take on magnetic properties. North and south are not so much "divided," but rather are opposites in a magnetic field. You could not have a north without a south, and vice versa. So north and south are the result of a magnetic field and we think of them as pointing in opposite directions.

How can I explain to my students that the N on a magnet stands for north-seeking rather than the north pole of the magnet?
The best way to think of this is the common idea that "opposites attract" and this works with magnets as well. The north end of a magnet, or the north end of a magnetized needle in a pocket compass, points toward the north pole. But really it is a case of opposites attract, and it is really the south end of the magnet that is attracted to, or points toward, the north pole. We just paint a big "N" on the part of the compass needle that points north, but that is actually the south end of the needle or magnet, thus we are fooling ourselves a little bit so that the compass needle works the way we want it to.

What is stronger, Earth's gravitational pull or the Earth's magnetic field?
The Earth's gravitational pull is stronger than the Earth's magnetic field. Think about how much energy is needed to launch a rocket into space to overcome the Earth's gravitational field. But on the other hand, the Earth's magnetic field is very weak, and will move the needle of a pocket compass, but it would not stop a rocket from going into outer space.