17. Special Effects

To earn this badge, you'll need to learn about what causes certain "special effects" in some rocks and minerals. For instance, what causes "cat's eye" effect and what rocks or minerals typically exhibit that effect? These are fun rocks to share with friends, so you should also start a collection of these special minerals and maybe hold an Amazing Mineral Magic Show!

Activity 17.1: Magnetism.
What is magnetism and what causes it? Name the two basic types of magnetism, and name at least three magnetic minerals. Provide a demonstration of magnetism.

Activity 17.2: Triboluminescence.
Learn to pronounce the long word "triboluminescence" and explain what it means. Demonstrate triboluminescence in a darkened room with two quartz crystals and with Wint-o-Green Life Savers candy.

Activity 17.3: Birefringence, or double refraction.
What is birefringence and what causes it? Name one common mineral that causes birefringence, or double refraction, and provide a demonstration of it to your fellow club members.

Activity 17.4: Chatoyancy: cat's eye and asterism.
What causes chatoyancy? Explain it to your fellow club members and show them how it works with a common spool of sewing thread under a bright light. Name at least three minerals that are often cut into cabs exhibiting cat's eye and/or asterism.

Activity 17.5: Natural fiber optics, or "TV stone."
A mineral called ulexite, when cut and polished on top and bottom, can magically lift words from a page and display them on its surface. How does it do that? Amaze your friends by demonstrating this for them.

Activity 17.6: Phantoms and inclusions.
Explain how phantoms and inclusions form. What is an enhydro? Show your fellow club members an example of a crystal with a phantom or inclusion.

Activity 17.7: Other special effects.
Learn about other special effects not listed above. How many others can you name and explain?

Activity 17.8: The amazing mineral magic show!
Either with fellow club members or on your own, host a "magic show" at one of your meetings to highlight special effects of some of these amazing minerals.

17. Special Effects

□ 17.1 Magnetism

□ 17.2 Triboluminescence

□ 17.3 Birefringence, or double refraction

□ 17.4 Chatoyancy: cat’s eye and asterism

□ 17.5 Natural fiber optics, or “TV stone”

□ 17.6 Phantoms and inclusions

□ 17.7 Other special effects

□ 17.8 The amazing mineral magic show!

To earn your Special Effects badge, you need to complete at least 3 of the 8 activities. Check off all the activities you’ve completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

______________________________ ______________________________
My signature Youth leader’s signature

____
Name of my club

Leader’s preferred mailing address for receiving badge:

____

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<u>Back-up page 17.1: Magnetism</u>.

We've all had fun with magnets: those little bars that stick to refrigerators and pick up paperclips. Place one near an iron or steel surface, and it will literally jump out of your hand and stick to the surface. They also attract and repel other magnets, letting you flip and push one around with another without them touching. Magnets perform these fun stunts because they produce a field of force—a magnetic field—caused by movement of electrons.

Some minerals react when placed near a magnetic field. Such minerals are referred to as **magnetic minerals**. They have one common denominator: **iron**. A simple test will help you identify a magnetic mineral. Pass it over a compass, and the compass needle will move.

Magnetic minerals come in two basic sorts. Most common are those attracted to a magnet, either strongly or weakly. The most strongly magnetic is magnetite (iron oxide), but there's also pyrrhotite (iron sulfide), ilmenite (titanium-iron oxide), hematite (another iron oxide), and franklinite (zinc-iron oxide). Some, such as limonite (hydrated iron oxide) or siderite (iron carbonate), may become weakly magnetic if heated.

A second sort of magnetic mineral is one that is naturally magnetized. That is, it's a magnet itself, generating a magnetic field that will attract iron to it. There's just one mineral of this sort, a specific variety of magnetite called lodestone.

You can enjoy fun activities with kids seeing how lodestone picks up paperclips or how magnets stick to magnetite and other magnetic minerals. For another fun activity, fill a plastic tub with **black sand** (often found in association with placer deposits while gold panning) and drop in a few strong magnets. Magnetic minerals in the black sand will clump around the magnets like frizzy hair on a bad hair day.

Magnetism has long fascinated people. For centuries, ships carried lodestones to magnetize compass needles for navigation. Magnetism has helped prospectors distinguish iron ore look-alikes; for instance, magnetite and chromite are outwardly similar, but magnetite is much more strongly magnetic.

The word "magnet" comes from Magnesia, an area in Greece where lodestone was discovered long ago. It was called *magnítis líthos*, or "magnesian stone." According to another, more interesting legend, a Greek shepherd boy named Magnes discovered lodestone when iron nails in his shoes stuck to a rock. Sounds like a good excuse for being late to school!

Back-up page 17.2: Triboluminescence.

Triboluminescence is quite a word! Kids (and adults!) may need help pronouncing it: tri´-bō-lu-mə-nə´-səns. The ***tribo*** part comes from the Greek word meaning **"to rub."** ***Luminescence*** is derived from the Latin word for **"light"** and is defined as low-temperature emission of light. Thus, triboluminescence is low-temperature light produced between two materials rubbed together.

In a darkened room, triboluminescence can take the form of tiny spark-like flashes observed in some minerals, like sphalerite or corundum, when a hard point is dragged across the surface. It can also occur when a mineral (or other material, like hard sugar or Wint-o-Green Life Savers) is crushed, ripped, scratched, or rubbed. Scientists still haven't fully explained this optical phenomenon, but they believe it to be caused by separation and reunification of electrical charges at a molecular level when bonds are broken by the rubbing or scratching. (Note that this is different from the high-temperature sparks generated when rocks and minerals like flint or pyrite are struck.)

Triboluminescence has been observed by diamond cutters, who sometimes see a diamond begin to glow while a facet is being ground. Since diamonds can be a little hard to come by, you may want to demonstrate the effect by rubbing together two large quartz crystals in a darkened room. This works best with pretty big, palm-sized specimens. You can simply rub two faces together or, to produce more light, rub the prism edge of one crystal back and forth along the prism face of the other crystal. (A prism face is one of the flat sides of the quartz crystal; the prism edge is where two flat sides come together.)

Interestingly, flashes of light have sometimes been observed during earthquakes. Some believe these "earthquake lights" may be related to triboluminescence when rocks high in quartz content get rubbed and rendered apart during the quake.

Back-up page 17.3: Birefringence, or double refraction.

Birefringence is one long, fancy word! A simpler term is **double refraction**. Take a piece of paper and draw a single line on it. Place a certain kind of clear crystal over the line, gaze through the crystal, and you'll see two lines! How does that happen?

When we direct our eyes at a line on a piece of paper, light is bouncing off the paper and into our eyes, allowing us to perceive the line on the paper. When light travels through certain crystals, the structure of the crystal causes the light to split into two rays traveling in slightly different velocities. When they bounce into our eyes, we perceive a double image. What is actually a single line, when viewed through the stone, appears as two lines.

Refraction, by the way, can occur in air when its density varies. You may have noticed this when gazing down a roadway on a hot summer day or across the basin of a desert, where hotter, less dense air radiates off the surface beneath somewhat cooler, denser air above. Light is refracted. The result? A mirage! Or, something your eyes see, even though your mind knows it's not really there.

The mineral most commonly associated with double refraction is **calcite**, particularly clear rhombohedral calcite crystals known as **Iceland spar**. Nice specimens from Mexico are on sale at nearly every gem and mineral show and are also often sold in museum gift shops.

Back-up page 17.4: Chatoyancy: cat's eye and asterism.

Cat lovers should enjoy **chatoyancy**. It's from a French word, *chatoyer*, meaning to shine like a cat's eye. Chatoyancy is commonly called **cat's-eye effect**. In bright light, a cat's pupil narrows to a vertical slit. When some gemstones are rounded and polished, bright light will be reflected as a single thin ray, looking very much like a cat's eye.

Chatoyancy is caused by inclusions, or minerals enclosed within another mineral. Light entering the host mineral reflects off included minerals. When inclusions are fibrous and run parallel to one another, they produce a single line of reflected light running perpendicular to the direction of the fibers. You can illustrate this effect for kids using a spool of sewing thread. Hold it under a light, and they'll see a vertical line running perpendicular to the wound thread. Chatoyancy is enhanced if the stone is rounded into a cabochon or sphere, concentrating the light, just as with our rounded spool of thread.

Chatoyancy can be produced by many minerals and inclusions. Yellow cymophane, or chrysoberyl containing rutile or tube-like cavities, is highly valued. A golden cat's-eye quartz contains rutile, while a gray-green variety contains amphibole asbestos. A gray-blue quartz containing partially silicified crocidolite (blue asbestos) is called hawk's eye. The popular tiger's eye quartz forms when crocidolite fibers are replaced by silica along with iron oxides, producing a silky golden color. Then there's actinolite, apatite, beryl, tourmaline, scapolite, moonstone, and more. You can even observe chatoyancy with common, non-precious minerals such as satin-spar gypsum or ulexite.

Minerals producing a chatoyant effect are found worldwide, but some places are especially famous: Sri Lanka and Brazil for cat's-eye chrysoberyl and quartz; South Africa and Australia for tiger's eye; California, for cat's-eye tourmaline. In addition to appreciating the beauty of cat's-eye gemstones, some cultures consider them good-luck charms with the ability to counteract an "evil eye."

The Greek word *aster* means "star," and **asterism** refers to a luminous star-like figure appearing on the face of a gemstone as a result of reflected light. Asterism is similar to cat's eye. Like cat's eye, it's caused by included fibers that run parallel to one another, producing a single line of reflected light. If bundles of such fibers are oriented in two directions, they'll produce two intersecting eyes, resulting in a four-rayed star. Oriented in three directions at 120 degrees to each other, as may happen within hexagonal crystals of corundum or quartz, rutile bundles will create three eyes, or a six-rayed star.

Cabbing focuses and concentrates light to produce the star effect, but much can go wrong in the process. The gem cutter must orient the base of the stone parallel to the plane of the inclusions, or the star may be off-centered. Another decision: how high to dome the stone? A higher dome channels light more effectively, creating a sharper star. But if the dome is too steep, rays get cut off and don't wrap around the surface of the dome. A dome cut too flat produces a fuzzy, ill-defined star. Gemstones most associated with asterism are star rubies and sapphires. However, Idaho produces star garnets. Quartz, diopside, and spinel can also exhibit asterism.

Back-up page 17.5: Natural fiber optics, or "TV stone."

Near the town of Boron, California, is an immense open-pit mine where truckload after huge truckload of borate minerals have been dug for generations for commercial applications; for instance, to produce borax for laundry detergent. These minerals were concentrated in a closed basin as ancient lakes dried up in the desert. One of those borate minerals is call **ulexite**, for the German chemist who first discovered it in the 1800s, Georg L. Ulex.

Ulexite is composed of long, thin crystals that might grow as fluffy, cotton-like puffballs or, more commonly, as compact, blocky masses of fibrous veins, with crystals tightly aligned side-by-side. The fibrous crystal bundles give blocky masses of white ulexite a soft, satin luster.

To demonstrate a truly neat special effect, use a rock saw to cut a chunk of ulexite perpendicular to those crystal bundles at top and bottom. Then polish both top and bottom. (You can often find small specimens of ulexite in rock shops and museum gift shops already cut and polished.) Now have your kids place that chunk onto the words in a book or atop a colorful drawing on the comics page of the Sunday newspaper. The words or picture will seem to be sucked up and will appear at the top surface of the ulexite, just like an image on a television screen!

The individual crystals making up the block of ulexite act like fiber-optic cables. Each transmits light from the bottom surface of the stone to the top surface, thus producing the unique optical property that earned ulexite its nickname of **"TV stone."**

Back-up page 17.6: Phantoms and inclusions.

We're all familiar with quartz crystals that appear clear through-and-though, like clean window glass. But sometimes when you look into a quartz crystal, you might see the clear or fuzzy outline of another quartz crystal! This crystal-within-a-crystal is referred to as a **phantom**. A phantom is created when crystal growth is interrupted and later resumes. It's similar to looking at the rings of a tree trunk, which record periods of active growth and dormancy. Essentially, when looking at a phantom, you're seeing a smaller, younger version of the bigger crystal you're holding.

Phantoms can be seen in almost any type of mineral that produces a transparent or translucent crystal, such as quartz, calcite, fluorite, or tourmaline. But the phantoms you see most commonly sold on the market are in quartz. With quartz, you may see nearly clear, almost indistinguishable phantoms from different growth phases. But many times, between growth phases, the crystal termination faces may be lightly etched or may collect gas or liquid bubbles. When that happens, the phantoms are a ghostly white. Other times, the termination faces may be lightly dusted by a coating of a different mineral, creating phantoms of different colors. Green phantoms are created by thin layers of chlorite, reddish-brown phantoms from iron minerals like hematite, and blue phantoms result from the mineral riebeckite.

Phantoms are found in many quartz crystal deposits. The Brazilian gemstone districts are especially famous for them. Arkansas has yielded its fair share of white phantoms, and Peterson Peak (or Hallelujah Junction) on the border between California and Nevada is famous for its smoky quartz phantoms. Crystals containing phantoms are also called "shadow crystals," "ghost crystals," or "specter crystals." While the names may sound like something from a spooky nightmare, the effects are like a beautiful dream!

In addition to phantoms, you occasionally see **inclusions** in quartz crystals or other mineral crystals. An inclusion may be any material—solid, liquid, or gaseous—found inside a mineral. I mentioned light dustings of chlorite that might form in a quartz phantom. Sometimes rather than just a light dusting, a larger mineral crystal will form and will then get engulfed in the growing quartz crystal. In my collection, I have quartz crystals containing tiny garnets and others containing tiny pyrite crystals. Clusters of needlelike rutile crystals frequently appear as inclusions in minerals like quartz or corundum. A variety of gypsum known as "hourglass selenite" from Oklahoma is well known for inclusions of clay and sand in the form of an hourglass figure.

One really cool type of inclusion is when an air pocket forms within a crystal and contains a little drop of water. Tilt the crystal this way and that way, and you'll see the water droplet move up and down, as with a carpenter's level. Such a crystal is referred to as an **enhydro**.

Back-up page 17.7: Other special effects.

Here, in brief, are a few other special effects not already described that some of your juniors may wish to explore. See if they can discover the reasons behind one or more of these special effects:

- *Opalescence, fire-and-flash, or play-of-color*. These terms all describe the vivid multicolored dance you see in an opal as you twist and turn it under the light.

- *Adularescence*. When turned in the light, minerals like labradorite and moonstone feldspars exhibit a milky, bluish luster that's been compared to the moon's reflection on water. This is also sometimes called "moonstone effect."

- *Iris or rainbow effect*. Some banded agates, when sliced thin and held to the light, exhibit all the colors of the rainbow in a gorgeous, iridescent display.

- *Phosphorescence*. Some fluorescent minerals momentarily holding a faint glow after a fluorescent lamp has been switched off, with the glow gradually fading away in the dark. It's especially noticeable in pink calcite rhombs from Nuevo Leon, Mexico. This also sometimes is called "afterglow. (See the back-up page for Activity 18.6.)

- *Thermoluminescence*. This is a faint glow, similar to phosphorescence, created when a mineral like fluorite is just mildly heated, well below the point of incandescence.

- *Pleochroism or change-of-color*. "Pleochroism" means "many colored." Some minerals (alexandrite, sapphire, tourmaline, benitoite, etc.) may change colors when viewed from different angles. For instance, some benitoite crystals may be blue viewed from above yet colorless viewed from the side. Dichroic minerals will show two colors; trichroic minerals show three.

- *Tenebrescence*. Some minerals, like hackmanite, change color after exposure to ultraviolet light, then fade under daylight, only to regain brighter colors with a little more UV exposure. This property of reversing color with changes in light radiation is called tenebrescence. (See the back-up page for Activity 18.6.)

- *Shooting sparks*. Striking a pyrite or flint against a piece of steel will create sparks. It's thanks to this that our caveman ancestors were able make fire to stay warm!

- *Aventurescence and schiller*. Particularly when polished, aventurine (massive quartz or feldspar filled with tiny plate-like inclusions of mica, rutile, or hematite) glistens as if filled with metallic confetti frozen in mid-air.

- *Floating rocks.* Obsidian and pumice are both volcanic glass, but one sinks in water while the other floats. Ask you kids why. Give them magnifying glasses to look closely at the structure of pumice and all those tiny holes that were created by gas bubbles when the pumice was a hot, frothy lather.

- *Singing rocks.* Zeolite minerals have microscopic pore spaces. This makes them highly effective for water filtration and purification and other industrial and medical uses. It also makes them great singers! When placed in a bowl with a little water, chunks of rocks containing certain zeolite minerals like clinoptilolite crackle, hum, and soon begin to whine. If the pieces you use are small, you'll need to hold the bowl close to your ear. After a while, the rocks become waterlogged and need to be dried to sing another day. Tiny pea-sized pebbles of clinoptilolite are sold with aquarium supplies as an ammonia remover in fish tanks. I was also able to secure gravel-sized pieces via eBay. These produced much better effects although I still needed to hold the bowl close to my ear.

- *Fizzing & bubbling rocks.* Carbonated beverages release bubbles of carbon dioxide. Similarly, carbonate rocks like limestone (calcium carbonate) fizz and release carbon dioxide when you put a drop of acetic acid (vinegar) on them. This is known as ***effervescence.*** To help enhance the fizzing, scratch the limestone with a nail to create a little heap of limestone dust before applying the acid.

- *Expanding minerals.* Vermiculite is a layered mica-like mineral. Water resides between the layers and, when the mineral is heated, that water converts to steam and vermiculite expands—just like popcorn. This is called ***exfoliation.*** You can find vermiculite in a gardening store since it's often used in hydroponics and as a soil amendment to help retain moisture and improve aeration; however, the bag I bought didn't really produce good results. The vermiulate was chopped fine and it had already been thoroughly dried. To be successful with this demo, you apparently need to secure big "fresh" pieces.

Most popular guidebooks about rocks and minerals, aimed at kids and adults, have a section or chapter devoted to special effects. For example, here are a few I know about:

- Bonewitz, *Smithsonian Rock & Gem*, 2005.
- Farndon, *The Complete Guide to Rocks & Minerals*, 2006. See the section "Mineral Properties: Optical."
- Symes, *Eyewitness Rocks & Minerals*, 2004.
- Ward, *Phenomenal Gems*, 2008. This great little book is filled with colorful photos showing gems that glow, shimmer, and change color, along with explanations.

Steer kids to books like these and have them explore even more special effects above and beyond those listed here.

Back-up page 17.8: The amazing mineral magic show!

For a presentation at one of your society's monthly meetings, help your kids host "The Amazing Mineral Magic Show!" They can demonstrate many of the effects described in this unit, as well as others they might discover by reading on their own. For instance:

- Lodestone magnetite can be used to show a rock that pushes magnets around, flips them over, and picks up paperclips. When placed alongside "black sand" or iron filings, you have a rock that suddenly grows "hair." Put filings into a plastic pan, hold your lodestone under the pan, and you can pull the filings all around.

- Transform ugly, dull fluorescent rocks and minerals into ones that turn bright, vivid colors and suddenly glow from within when you turn out the lights and turn on an ultraviolet lamp.

- Turn out the lights, turn on a UV lamp over a piece of fluorescent calcite from Mexico, then switch off the lamp to show a fluorescent mineral that holds a glow for awhile, before gradually fading to black.

- With the lights still out, show how two pieces of quartz can create spark-like flashes of light when simply rubbed together.

- Keep those lights out to show rocks that shoot real sparks by striking steal against chunks of flint or pyrite.

- Illustrate how ulexite is a "TV stone" that can "lift" images from printed pages.

- Reveal how a calcite rhomb doubles an image by holding it over a piece of white cardboard that has a single black line drawn down the middle.

- With a slice of iris agate and a flashlight, show how a rock can capture a rainbow.

- Show how a domed cab of Idaho garnet, rose quartz, ruby, or sapphire can capture a star, or how domed tiger-eye quartz or satin-spar gypsum winks like a cat's eye.

- Drop a piece of volcanic glass (obsidian) into a clear container of water to show how—as we all know—rocks are heavy and sink. Then, take a piece of volcanic glass known as pumice and drop it in to show a rock that floats!

What other magic effects can your kids come up with? This can be a presentation that's great fun for the entire club. In fact, the kids might ask the adults to come prepared to bring a "magical" rock or two of their own to join in the show. One club's kids hosts a booth at their annual show to demonstrate special effects to visitors throughout the day.

Note: *Kids can use this activity to satisfy requirements toward earning the Communication badge simultaneously (Activity 7.1).*