"Minerals that do things…"

Hands-on demonstrations of mineral properties

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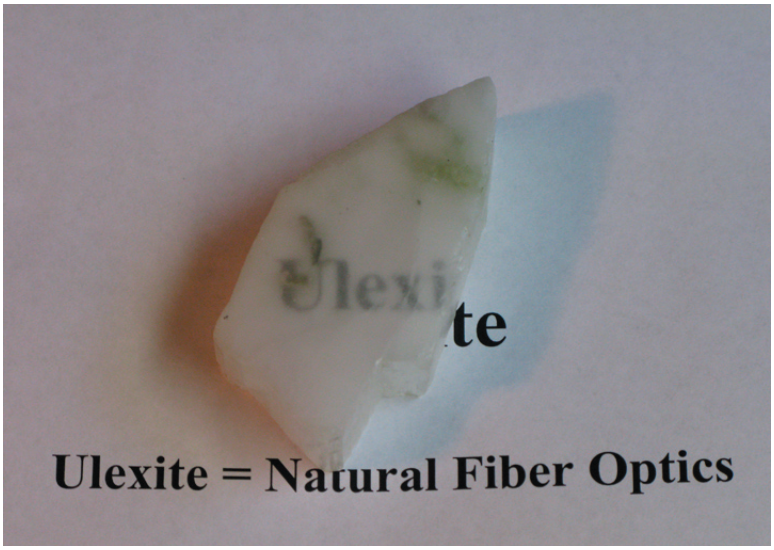
Light Pipes and Frosted Rocks



Object: **Fiber optic** technology is the basis of our modern computer and telephone networks. Few people know that natural fiber optic materials occur in the mineral kingdom. Students can observe the fiber optic effect in minerals such as ulexite ("T.V. Stone"). This effect depends upon the phenomenon of total internal reflection. Students use a point light source and a frosted piece of quartz to observe total internal reflection.

Procedure description: Students place a piece of a fiber optic mineral such as ulexite on a white piece of paper. Use a cut and polished slab of ulexite. Words written on the paper will appear to jump up to the upper surface of the ulexite. Move the specimen across the page – notice how the text appears to stay still while the specimen moves. Put the stone on a colored image. Note that the stone also transmits color to its upper surface.

Students also place a piece of frosted quartz on a point light source. The entire frosted surface of the quartz appears to glow.

Specimens to test: For fiber optic effect: fibrous ulexite (also known as "T.V. Stone"); fibrous gypsum; fibrous trona. Flat surfaces, perpendicular to the fiber direction, must be cut in these minerals. Polishing the surfaces is very helpful. Cutting and polishing these minerals is difficult because they are all water-sensitive. Cut and polished specimens of ulexite are available from mineral dealers and science supply houses.

For total internal reflection: a piece of quartz (single crystal) with a frosted exterior surface works well. Frosted quartz can be made by taking chunks of clear single crystals and tumbling them in a rock tumbler with coarse grit. This will eliminate any sharp edges and give the crystals a milky white appearance. Then chip or polish a small window in the surface. This window should be just sufficient to allow light from your light source into the crystal.

Equipment needed: Paper with crisp clear black on white lettering (larger lettering is best), paper with clear colored figures or images. A small point source of light. A pen light that uses a single LED (light emitting diode) is a good source of light. Colored LEDs are most impressive.

Scientific discussion: Light that enters a transparent mineral reflects off the inside of the mineral's surfaces again and again, bouncing around the entire inside of the crystal. If the exterior of the crystal is frosted, the entire surface will glow uniformly and some of the light leaks out.

If light enters a long skinny transparent fiber, it will ricochet back and forth off the inside walls as it travels down this light pipe. We rely upon this effect to transmit pulses of light down great lengths of optic fibers.

The fiber optic effect can occur in ulexite, gypsum, and trona because these minerals grow in long thin fibers. Light passes though the natural fibers in the same manner as it travels through a synthetic optical fiber: it bounces off the interior of the sides. If the fibers are aligned parallel to each other in sufficiently large clusters, the cluster can transmit an image that is larger than any given fiber.

Additional possibilities: It is possible to acquire synthetic fiber optic material for demos. Rough chunks of fiber optic material are sold to lapidaries. This synthetic material is dyed (red, yellow, green, blue, etc.) and cut into the form of spheres, eggs, and other shapes for sale. It is easy to identify the orientation of the fibers and use these materials to demonstrate the fiber optic effect.

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 it is simplest to use a light source made from one of the LED-illuminated display stands used for laser-etched glass paperweights. Some of these display stands have multiple colors of LEDs and cycle through them. Take the paperweight off the stand and use black electrical tape to mask off all but a small hole through which light from the LEDs can shine. When you place the polished window of your frosted quartz directly over the light hole, the entire stone will glow with the colors of the LEDs. You can just place the frosted quartz on the masked stand, turn on the LEDs, and let the demonstration operate by itself.