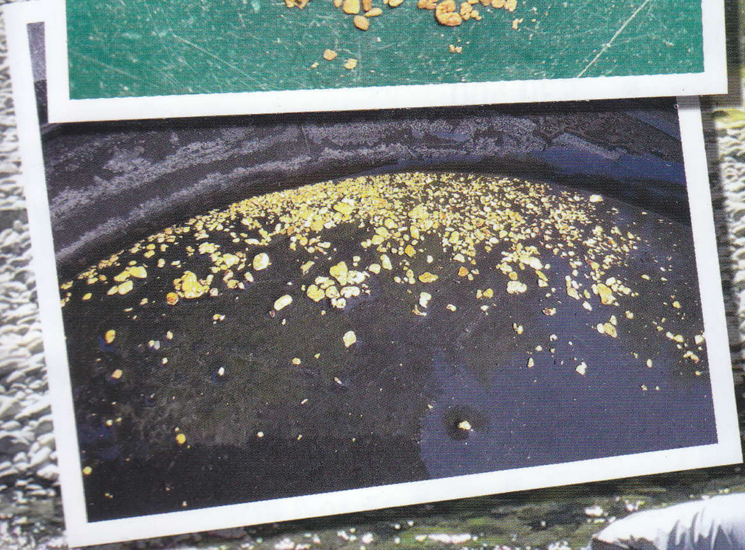
ICMJ's

PROSPECTING and MINING JOURNAL

Volume 90, Number 1
September 2020
$3.75

Celebrating Our 90th Year



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FLUORESCENT MINERAL PROSPECTING

by John Norman

Most readers of the *Mining Journal* are familiar with tools for locating gold deposits—metal detectors, pinpointers, gold pans, magnifiers and more. In this article, we will cover another type of instrument suitable for locating minerals. This is the ultraviolet light or "geologist's lamp."

Background

Color is an important characteristic for identifying any type of mineral. When we make an inspection under regular light, we are seeing the wavelengths of light that the specimen rock is able to reflect back to our eyes in the visible light range.

When we view the same rock under a "black light," we are actually doing something completely different. Unlike visible light, light from a well-filtered UV lamp is not visible at all to the human eye. Its wavelength is shorter (less than 400 nanometers vs. 400-770nm) and it is much more energetic than visible light. Ultraviolet light is divided into three levels, labeled A, B and C depending on the wavelength, with C having the shortest wavelength and the most energy. The more energetic range of ultraviolet is sometimes called shortwave ultraviolet.

When ultraviolet light strikes certain materials, it "excites" them into producing their own light. This "fluorescence" effect is caused by high-energy photons from the UV light source striking molecules of the target and knocking their outer electrons into a higher, unstable energy state. When they fall back down, photons are released in the form of longer wavelength visible light. Fluorescent minerals have been studied since 1819, when fluorite was found to have this property. And it turns out that the type of UV light that the rock will respond to and the colors emitted are a very accurate predictor of what it contains, though the element causing the fluorescence may be present in only small amounts.

Safety

Ultraviolet light, particularly UV-C can cause skin burns and damage your eyes. This is the same type of light that causes sunburn and skin cancer outdoors and eye injury to welders. Avoid exposing your skin to any UV-C lamp, keep these devices away from children, and always make sure everyone in the area is wearing a pair of standard polycarbonate plastic safety glasses when operating a UV source. Polycarbonate and similar plastics used in safety glasses are known to block nearly 100% of UV radiation. (Another important safety point is that most scorpions will fluoresce and are easily visible while hunting minerals at night.)

Fluorescent Minerals

A variety of minerals can be identified and/or collected using a geologist's UV lamp. Whether you are looking to add some stunning samples to your collection or identify a valuable deposit, the idea is the same. A dark area is a must, so you will want to wait until nightfall, preferably on a low-moon night, and then go over

A commercial SW/LW lamp with portable power pack. (Photo by John Norman.)

rock outcroppings, mine dumps and similar with your lamp. Haul roads from old mining areas are another good bet, as material falls off trucks. A few of the more common minerals you can spot this way include:

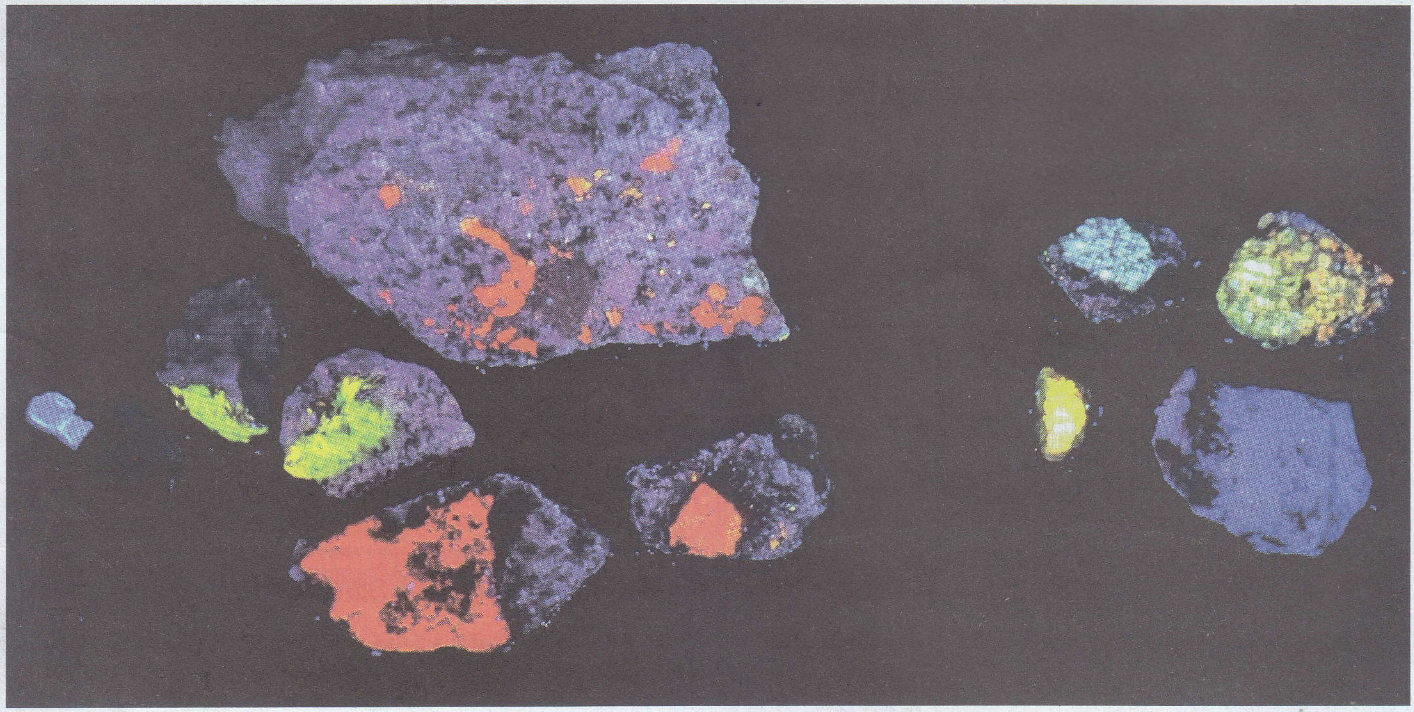
1. Tungsten Group Minerals—Scheelite ($CaWO_4$) is perhaps the best-known example of a UV fluorescent mineral. This primary ore of tungsten glows a bright white-blue under shortwave ultraviolet light, often showing up as "pinpoints" or white glowing spots. Unless the ore is very high grade, a large glowing mass is probably calcite or similar. Calcite will often fluoresce in another color rather than the blue/white of scheelite.

2. Uranium minerals such as autuntite and carnotite glow a nice yellow-green under long and shortwave UV. The darker uranite or pitchblende ores will fluoresce if a drop of nitric acid is placed on the sample. Uranium-doped glass (also known as "depression glass") will also glow vividly under long or shortwave UV.

3. Fluorite (CaF_2) will glow an intense blue under just about any black light. Since it was mined as a commodity for steel making, it is typically easy to find at many abandoned mine sites.

4. Calcite ($CaCO_3$) will glow various colors, depending on wavelength

A selection of UV finds, including caliche and reactive glass. (Photo by James Rice.)



Same samples, under shortwave UV light. (Photo by James Rice.)

and what impurities it contains. Expect to see a pink tone under longwave UV and reds or blues under shortwave. An orange coating that lights up under all wavelengths is probably caliche, a shallow ground water mineral deposit closely related to calcite.

5. Silicates—A bright green shortwave-only activation often indicates one of many SiO_2 minerals, (hyalite, chalcedony, quartz, agate), with a trace of uranium as an activator.

6. Gemstones—A variety natural gemstones such as diamonds, rubies and topaz may be fluorescent. This is highly dependent on the area and what impurities are present, like chromium for rubies or emeralds. Very pure lab-grown stones and gem-quality diamonds may not fluoresce at all.

Types of Lamps

There are two primary types of UV lamps used in geology—longwave and shortwave. Different minerals react to one or both, and the colors they emit can be different when exposed to each type.

A "longwave" UV lamp is the type most utilized and is what we are used to seeing. It uses a small fluorescent tube with a dark-purple tint or an array of LEDs to produce light from 365-385nm. An LED "scorpion light" flashlight or a 4-watt fluorescent lamp will run on batteries and allow you to see rocks that fluoresce in this type of light up to around 3' away in a dark area. For best results when prospecting, the light should have a ZWB2 or similar UV-A filter, so that all visible light is blocked out. A regular fluorescent light can be fitted with a "UV-A" tube, and small filters suitable for UV-A flashlights are only a few dollars.

The "shortwave" type of UV lamp is more specialized. It uses a "germicidal" mercury bulb that produces 265nm light. This type of bulb also produces a large amount of unwanted visible light, and an expensive, specialized filter (Hoya U325C) is needed. Excluding the filter, a fluorescent lamp can be converted to UV-C by replacing the tubes with germicidal ones. To order one, change the "F" in the bulb number of the installed tube to a "G" and buy that one. Note that there are shortwave LEDs available, but they currently cost around $80/watt. Due to the COVID-19 situation

Samples of caliche (orange/red) and hyalite. (Photo by James Rice.)

and interest in UV sterilizers, you may see Chinese and other on-line sellers advertising cheap UV-C LED lamps for disinfection. These are not genuine UV-C sources and should not be purchased.

Portable UV-A lamps can be had starting at under $20, while the least-expensive UV-C lamps usually start at around $100. The small 4-watt units have a very short range, from basically 0-12" distance. The filter material for a real UV-C lamp is very expensive, however there are some ways to get this done affordably:

1. Look for used 110-volt "trans-illuminator" and "mineral lamps" on-line. These are typically 6-24W and can be powered from a cordless drill battery fitted with a 40-100W inverter from DeWalt, Ryobi, etc. If you already own a set of power tools, one of these used lab tools can get you into the game for under $100. Many come equipped with both a longwave and shortwave setting.

2. If you are handy with electronics, get a cheap flashlight head for your 12-18V cordless tool batteries and swap the bulb out for a UV LED array. The LED modules, power supply and filters for this type of conversion are available on-line from a variety of sources. With UV-C disinfection also becoming popular, there should be some new sources for portable fluorescent tubes, holders and power supplies available now.

3. If you can get your hands on a large tabletop-sized UV source at an auction, the UV-C filter can be salvaged for making portable units. Use a lapidary or tile saw to cut the filter glass into pieces that can be mounted in a portable fixture. These "transilluminators" are used in biology labs and often show up as surplus.

Various minerals from Doug Billing's collection. (Photo by Doug Billings.)

A variety of homemade lamps fabricated by James Rice. (Photo by James Rice.)

Quenchers, Activators and Pure Materials

Some minerals contain traces and small amounts of certain elements that make the minerals fluoresce. The florescence-promoting substances are known as activators. Fluorescence can also be caused by certain structural defects within the crystal lattice of the atoms in the crystal. However, there are also elements that "quench" or stop them from fluorescing. Iron is a well-known quencher, as is copper. The intensity of the fluorescent effect is a balance of the effects of the activators and the quenchers. Note that very pure mineral specimens—especially synthetic ones from a mill process or lab—may not be fluorescent at all; because of their high purity, they don't contain the activator elements. It's common that trace amounts of impurities are required for good fluorescence.

Conclusion

Like metal detecting, UV prospecting can be an excellent way to expand your five senses and discover mineral specimens that would otherwise escape detection. Just be careful with the energetic light output, watch where you step around old mine sites, and don't pick up any scorpions (they glow bright green).

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James and Allen Rice, UV collectors and lamp builders.