A Beginner's Guide to the Vreeland Spectroscope

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The Spectroscope is used to identify the different elements that can be present in minerals. Basically, it is an enhancement of the blowpipe in the sense that it uses a heat source to fuse minerals. There are many differences between the two apparatuses. First, the blowpipe gives off an inconsistent rate of heat because a human's breath is by no means constant. The spectroscope gives off a constant rate of heat, via the arc-flame between the carbon rods, so the results will have a smaller margin of error. A second difference is the heat index. The hottest part of a blowpipe flame has been known to reach about 1500° C. The spectroscope has a heat index that can range from about 2000° C to an intense heat of about 3000° C. This is very helpful because it causes the mineral to fuse faster, which in turn gives us better and quicker results. Also, the samples that are used in a Spectroscope are crushed into very small particles, this creates more surface area for the heat to interact with the mineral therefore causing the rate of fusion to increase. It would be hard to use crushed minerals with a blowpipe because you would just blow the sample away (blowing hot particles of rock is a major safety hazard).

What it does:

White light is composed of light of all colors of the visible spectrum. These colors differ from one another in wavelength. A spectroscope is an instrument, which separates these different wavelengths, or disperses them into a spectrum for visible observation. Different elements have different flame colors. The Spectroscope analyzes these colors by identifying the wavelengths producing them. In many cases color is found from the combination of several wavelengths. When atoms are heated their electrons are excited and rise to higher energy levels; the higher the temperature, the higher the state of excitement. When the electrons fall to lower energy levels the emission of radiant energy occurs. The energy difference between the two levels determines the wavelength of the emitted radiation. Since the electronic configuration of the atom is different for each element, every element has a characteristic spectrum.

Safety First:

Before even touching the Spectroscope, you should be aware of all dangers present in the device as well as the ways to safely avoid these dangers. This section tries to provide an exhaustive list of cautions, but is still liable to human error. Use your head and keep watch for dangers not described in this safety section.

- **Do not touch the arc.** Temperatures between 2000° C and 3000° C mean severe burns, you may even catch on fire.
- **Do not look at the arc.** The intense light will damage your eyes, just like looking at the sun. There is a mylar window on the right side of the chimney that will allow you to see the arc-flame without danger.

- **Do not touch the carbon rods or anything near them after use.** Surfaces near the carbon rods will stay hot enough to severely burn you even after turning off the power supply.
- **Do not touch the glowing cones.** These are parts of the power supply located just to the left of the viewing mechanism on the base of the Spectroscope under a protective guard. During and after operation the cones and the protective guard will both be hot enough to burn.
- **Do not look down chimney during operation.** Not only might harmful gasses be evolving from the burning sample, but also poorly crushed bits of sample might shoot up and into your eyes.

Personal Protective Equipment:

- **Eyes:** Welder's (mylar) goggles for looking into the flame. Safety glasses for general operation.

- **Skin:** Use tweezers or tongs to place/remove anything from the staging area.

- **Inhalation:** Always use the Spectroscope in a functional and operating fume hood. Some samples may evolve dangerous and/or stinky gasses.

Procedure:

1. Find a rock or mineral you would like to analyze for elemental contents. Then crush them with a mortar and pestle until it is a fine powder. Then lead a heaping quarter-teaspoon onto the tiny specimen dishes.
2. Make sure the power is off when coming anywhere near the electrodes. Put sample feeder all the way down and electrodes at least an inch apart. This makes placing the sample on the specimen hearth easy.
3. Push carbon rods together so that they are touching, make sure that their tangent point is directly above the center of the sample so when you feed the sample it is consumed directly in the electric current. Also with the rods centered, the light of the combustion is aligned perfectly with the Spectroscope's optics.
4. Push sample awning up to protect from harmful light and heat emission.
5. Turn on Spectroscope.
6. Fiddle with the carbon feed knob until you get an electric arc between rods, once this happens look into the welders glass only and separate rods to about 1/8th of an inch apart. This distance creates a good heat index.
7. While looking through welder's glasses slowly feed the sample up into the arc until you see the sample start to melt, or you see the arc-flame change its character.
8. Align the Spectrum films. There are a number of films one can use. There is one for each major terrestrial element. It would be a pain to check each against the short-lived sample so we recommend using film 20 on the right side as it allows quick identification of many elements.
9. No matter what film you use, it has a set of Sodium-D reference lines (they appear as strong double lines). Sodium always shows as it is in the electrodes. Looking through the eyepiece, align the double Sodium-D lines with those in the center spectrum of the Spectroscope.
10. Look into the eyepiece and slowly move the up and down without adjusting any of the film knobs. There should be bright horizontal lines connecting the two element films, these lines are indicators of the prominence of the element that they light up, the brighter the line, the more of the element in the mineral.

11. Try using the heat increase knob, this may brighten the lines and make them easier to see. Our suggestion is that you try both and not just one.
12. Record your results. If you didn't have enough time to get a good look at the whole spectrum, try it again! It doesn't take too long and you don't need much rock to make many samples.

Exciting Spectroscope Links:

www.spectrex.com
Spectrex, the maker of the Vreeland Spectroscope

Haiku inspired by the Spectroscope:

Vreeland Spectroscope
Burn my crush rock samples, burn
Many colored flame

Who are you rock friend?
Secrets now known by glowing
Rods of 'lectric truth

Old arc jump
Project due too soon
Cursed spark!

All information contained in this document was either gleaned from the circa 1974 user manual that came with our Vreeland Model 7A Spectroscope or from experience gained with the instrument by Franek Hasiuk and Adam Hoffman of the Geology Department University of Iowa.