The Alexandrite Effect

"The term alexandrite effect refers to the apparent change of color in certain minerals from blue-green or greenish violet in daylight to red or reddish violet in incandescent light. It has been determined that the absorption spectrum of all alexandrite-like minerals is characterised by transmission maxima in the blue-green and red regions and by a transmission minimum in the yellow region. The color of minerals with two such regions of transmission is determined in daylight (richer in blue and green) by the position of the transmission maxima and in incandescent light (richer in red) by the ratio of transmission in the red and transmission in the blue-violet sections of the visible spectrum."

E. Gübelin and K. Schmetzer

Alexandrite is the variety of chrysoberyl which changes color from green or blue-green in daylight to red, purple/red, or raspberry red under incandescent light. Chemically, alexandrite can be differentiated from normal chrysoberyl by the presence of chromium. Alexandrite is defined by its color change and only chrysoberyl that displays a distinct change of color should be referred to as alexandrite.

The origin of this color change is often attributed to dichroism, but simple observation shows that the change depends chiefly on the nature of the incident light. In antiquity this change was from sunlight to candlelight and this exhibition is still used today by many gemologists and jewelers. Careful study of the color changes in chromium compounds by means of tristimulus analysis proves that the color change is due to the response of the human eye and brain and not to any unexpected changes in the properties of the stone. As the chromium composition moves from those values which yield green compounds to those values which yield pink compounds, the interband minimum in the spectrum moves from near 525mp toward shorter wavelengths. The human eye is very sensitive to green light and is less sensitive to red and

See Alexandrite Tsarstone collectors guide, The Alexandrite Effect, http://www.alexandrite.net/viewpage.html?id=ALXS-002-00008 (Discussion about the alexandrite effect as a non-color-constancy phenomenon from the color theory perspective) (as of).

blue so it responds most strongly to the green light and the compound appears green. As the light passed by the interband minimum becomes more blue and the light passed by the long wavelength minimum becomes brighter red, the eye shifts its response from predominantly the green stimulus to a mainly red stimulus with some blue component. The gemstone now appears reddish.

Phenomenon of the alexandrite effect

Alexandrite under candlelight	Alexandrite under mixed light	Alexandrite under daylight
		
Fig. 13.: Incandescent lighting contains a higher balance of red light and alexandrite appears red to the human eye.	Fig. 14.: Alexandrite effect phenomenon of an observed color change from greenish to reddish with a change in source illumination.	Fig. 15.: Daylight contains high proportions of blue and green light and the stone appears green to the human eye.

Alexandrite Effect is the phenomenon of an observed color change from greenish to reddish with a change in source illumination due physiological response of the human eye in a particular part of the visible spectrum. Daylight contains high proportions of blue and green light and incandescent lighting contains a higher balance of red light. When the light is balanced (daylight), the stone is green but when the light source is reddish (incandescent), the stone appears red. Human vision is more sensitive to green light. Alexandrite reflects both green and red light. In daylight, a greater proportion of green light is reflected so we see green. Conversely, under incandescent light more red light is reflected so we see red.

Since the alexandrite effect is shown to be due only to critical wavelength minima in the absorption spectrum, there is no reason why this effect should be limited to chromium compounds. Indeed, several other well known gemstones, including sapphire, garnet, and spinel may also change color as a function of the prevailing light, but the color change of top

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alexandrites is distinctive and attractive under any light conditions. Sapphires rarely display a strong color change but there are some stones from a deposit in Songea, Tanzania that show a change similar to alexandrite and they are known as "alex type sapphires". The change in color change garnets can be outstanding but unlike alexandrites, they often already appear red in normal daylight so a fluorescent light is required to highlight the change. A few spinels from Sri Lanka have been known to exhibit exceptional blue to red color changes but stones like these are extremely rare and most color change spinels only show a small color shift. In any color change stone, the more dramatic and complete the color change, the more rare and valuable the stone.

Edwin Streeter wrote of alexandrite in "Precious Stones and Gems": *"The wonderful alexandrite is an emerald by day and an amethyst at night. The most sensational feature about this stone, however, is its surprising ability to change its color. Green or bluish-green in daylight, Alexandrite turns a soft shade of red, purplish-red or raspberry red in incandescent light. This unique optical characteristic makes it one of the most valuable gemstones of all, especially in fine qualities."*

The pioneering gemmologist Max Bauer, writing in 1904, described the Uralian Alexandrite as "*an emerald by day and an amethyst by night..."*. He also describes the daytime color as: *"grass-green to emerald green"* and the night time color as *"columbine red inclined to violet"*.

The strength of color described by Bauer is rarely seen and most stones show either a strong red or purple red or a strong green but usually not both. The older gemological literature is full of references in praise of the beautiful Russian Alexandrites but few of these stones have been seen in the West since the Russian Revolution in 1917. We know that the colors of the original Uralian material represented the Russian Imperial military colors of red and green. However with so few Russian stones available anywhere, we cannot really compare them with alexandrites from more recent discoveries.

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