

Title : Gemological Characteristics and Chemical Composition of Color-Change Garnet claimed to be from Tanzania

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ABSTRACT

Color-change garnet, one of the high-value gem varieties of garnet, from Tanzania, belongs to the silicate mineral crystallized in the isometric crystal system and represents an intermediate composition between pyrope and spessartine. Its chemical formula is $(\text{Mg,Mn})_3\text{Al}_2(\text{SiO}_4)_3$. The cause of the change of color was previously reported due to trace elements of chromium (Cr^{3+}) and vanadium (V^{3+}) within the crystal structure. When observed under different light sources, the samples display a purple color under daylight and change to an orange-red color under incandescent light. This study aimed to investigate the gemological characteristics, internal inclusions, causes of color, and chemical composition of twenty round brilliant-cut, color-change garnets claimed to be from Tanzania. The studied samples ranged from 0.037 to 0.072 ct. and were classified into four groups based on their apparent colors: green (2 samples), light blue (6 samples), yellowish green (6 samples), and bluish green (6 samples). The specific gravity ranged from 3.34 to 4.36. The refractive index could not be determined because it was beyond the upper limit of the tools. All samples were inert under both short-wave and long-wave ultraviolet radiation. Microscopic examination revealed healed fractures as the main internal inclusions. Eight samples (2 green, 2 light blue, 2 yellowish green, and 2 bluish green) were selected to further analyze using UV-

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Vis-NIR spectroscopy in the wavelength range of 300 to 1100 nm. The obtained spectra showed an absorption band at approximately 410 nm, which was associated with Mn^{2+} , V^{3+} , and Cr^{3+} . Absorption bands at 460, 484, and 506 nm were related to Fe^{2+} and Mn^{2+} . Absorption bands at 569 and 574 nm corresponded to electronic transitions of V^{3+} and Cr^{3+} . Chemical compositions of the selected samples were analyzed using Energy-Dispersive X-Ray Fluorescence (EDXRF). Most samples showed magnesium contents ranging from 8.05-12.03 wt%, calcium 2.22-4.68 wt%, aluminum 17.53-18.61 wt%, silicon 34.2-35.58 wt%, titanium 0.02-0.35 wt%, manganese 26.54-31.71 wt%, iron 3.05-3.66 wt%, chromium 0.14-0.29 wt%, and vanadium 0.29-0.81 wt%. From this study, it can be concluded that chromium and vanadium detected tend to play significant roles in the color-change phenomenon of the Tanzanian color-change garnet samples.

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