Gemological characteristics, inclusion investigation, and chemical compositions of gemstone trade named Super Seven claimed to be from Brazil.

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Abstract

The gemstone known as Super Seven is a type of Quartz often claimed to contain various internal mineral inclusions, resulting in unique characteristics in color, shape, and crystal structure. However, much of the information about Super Seven is commercial, based on beliefs and marketing naming rather than scientific data, leading to inaccuracies and misunderstandings about the gemstone's composition and characteristics. This project therefore focuses on systematically studying the types of internal inclusions using gemological and mineralogy principles to confirm or clarify scientific facts for use in explaining its properties and creating accurate knowledge about this gemstone.

Materials and Methods



The ten polished samples (Figure 1) were studied using standard gemological tools for gemological properties, Raman spectroscopy for inclusion determination, UV-Vis-NIR spectroscopy for cause of color, and micro-EDXRF for chemical compositions.

Figure 1. The studied ten samples of Super Seven Quartz.

Result

Geomological Properties

The specific gravity of the samples ranged from 2.64 to 2.66 and refractive indices were 1.540 to 1.559. they were inert under both SW- and LW-ultraviolet light. Under microscope, all samples showed red crystal inclusions, probably goethite and lepidochrocite, healed fractures and unhealed fractures (Figure 2).

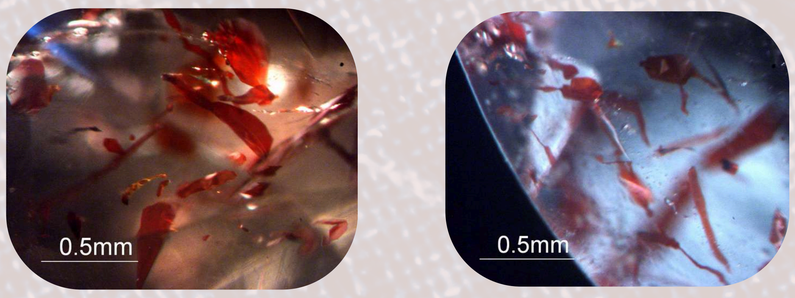


Figure 2. Red inclusions in the studied samples.

Raman Spectroscopy

Raman spectroscopic analysis revealed prominent peak signals at 223.6, 290.4, and 463.1 cm^{-1}, consistent with the characteristics of hematite (alpha-Fe_2O_3), which was the main inclusions found in the studied samples. The peak at 223.6 cm^{-1} exhibited the highest intensity, indicating the material's apparent crystallinity. Furthermore, a broad base peak at 1321.8 cm^{-1} was observed, resulting from secondary scattering of the iron oxide structure (Figure 3).

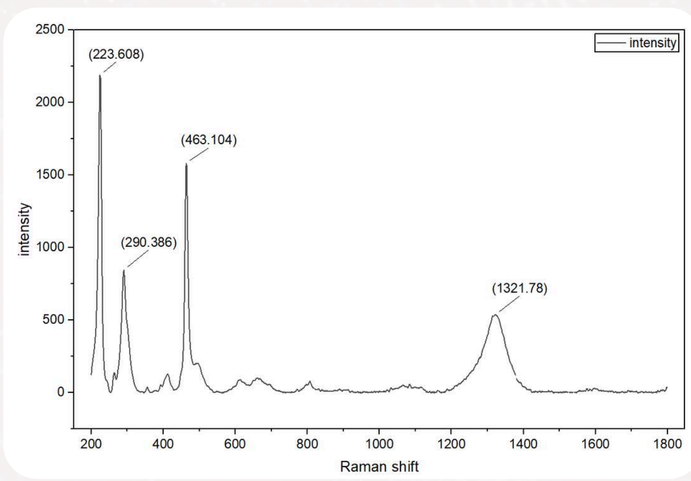


Figure 3. The representative Raman spectrum of the sample showing characteristic peaks of hematite (alpha-Fe_2O_3) at 223.6, 290.4, 463.1, and 1321.8 cm^{-1}.

Absorption Spectra

UV-VIS-NIR spectroscopy showed absorption bands between at 320-450 nm and 500-550 nm. was attributed to colour centres formed by Fe^{4+} activated by natural radiation, resulting in a purple to red coloration. The samples also revealed absorption bands associated with charge transfer between O^{2-} and Fe^{3+} within the quartz structure. The absorption range probably corresponded to the electronic transition of Fe_2O_3 in the mineral inclusions, goethite and lepidocrocite (Figure 4).

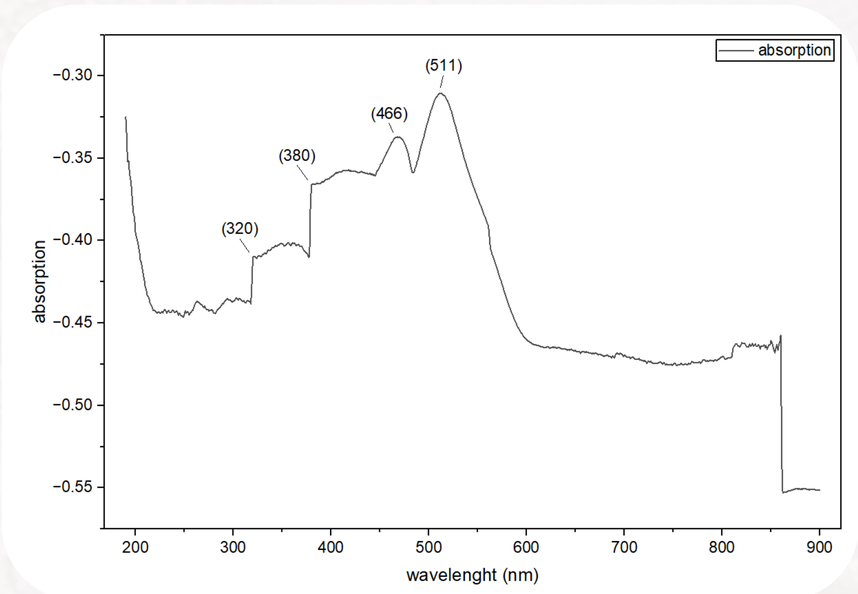


Figure 4. The representative UV-VIS NIR spectrum showing the absorption bands between at 320-450 nm and 500-550 nm.

Chemical Compositions

The chemical compositions of the studied samples at the inclusion area revealed that SiO_2 was the main compositions (86.80 wt.%) with high contents of iron (8.54 wt.%) and Al_2O_3 at 3.42 wt.%. Meanwhile, the host quartz consisted of nearly pure SiO_2 content (99.66 wt.%).

Conclusion

The sample exhibited refractive indices and specific gravity consistent with standard alpha-quartz. XRF results confirmed the purity of the host quartz (average SiO_2 99.66 wt%), but revealed a high iron oxide content of 8.54 wt% in impurity zones. Microscopic observation combined with Raman Spectroscopy confirmed that the red crystalline impurities were iron oxide minerals: Goethite, Lepidocrocite, and Hematite (alpha-Fe_2O_3), exhibiting distinctive peaks at 223.6, 290.4, and 463.1 cm^{-1}. UV-VIS-NIR data indicated that the purple-red coloration resulted from charge transfer between O^{2-} and Fe^{3+}, as well as the formation of color centers from naturally radioactive Fe^{4+}.

Acknowledgement

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