

A Cr³⁺ luminescence study of natural topaz Al₂SiO₄(F,OH)₂ up to 60 GPa

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ABSTRACT

Topaz [Al₂SiO₄(F,OH)₂] is a subduction-related mineral that is found in metasediments and has a large pressure and temperature stability field. Here, we use luminescence spectroscopy of Cr³⁺ to probe the Al site in topaz at pressures up to ~60 GPa, which corresponds to a depth of ~1400 km in the Earth. This technique allows us to probe all three unique Al environments (i.e., [AlO₄(OH)₂]⁷⁻, [AlO₄(F)₂]⁷⁻, and [AlO₄OH,F]⁷⁻) simultaneously under high pressure. We find that the R-line luminescence from all three Al environments shift linearly to longer wavelength to ~40 GPa. Above ~40 GPa, they shift nonlinearly and begin to flatten out at ~48 GPa, with a pressure shift of ~0 cm⁻¹/GPa from ~48–55 GPa. Our results, combined with previous high-pressure single-crystal X-ray diffraction studies to ~45 GPa, strongly indicate that there is a change in the compression mechanism in topaz above ~40 GPa. Our high-pressure room-temperature results show that the metastable persistence of topaz on compression represents one of the most extreme cases among tetrahedrally coordinated silicates.

Keywords: Topaz, high pressure, Cr³⁺ luminescence, nesosilicates