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Letter

Effects of small crystallite size on the thermal infrared (vibrational) spectra of minerals

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Abstract

The thermal infrared (TIR, or vibrational) emission spectra of a suite of synthetic Mg-Fe olivines exhibit notable differences from their natural igneous counterparts in terms of their band shapes, relative depths, and reduced shifts in some band positions with Mg-Fe solid solution. Comparable reflectance spectra acquired from olivine-dominated matrices and fusion crusts of some carbonaceous chondrite meteorites exhibit similar deviations. Here we show that these unusual spectral characteristics are consistent with crystallite sizes much smaller than the resolution limit of infrared light. We hypothesize that these small crystallites denote abbreviated crystal growth and also may be linked to the size of nucleation sites. Other silicates and non-silicates, such as carbonates, exhibit similar spectral behaviors. Because the spectra of mineral separates are commonly used in the modeling and analysis of comparable bulk rock, meteorite, and remote sensing data, understanding these spectral variations is important to correctly identifying the minerals and interpreting the origin and/or secondary processing histories of natural materials.

Keywords: Spectroscopy, olivine, carbonate, crystallinity, metamorphism, meteorites, mineral synthesis, carbonaceous chondrites