Effects of secondary material on thermal emission spectra of primary minerals in controlled mixing experiments

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Thermal infrared (TIR) spectroscopy is a technique by which the surface mineralogy of Mars has been investigated, using data from the TES, THEMIS, and mini-TES experiments. We are interested in how secondary weathering material affects TIR spectra. In previous work, we analyzed TIR spectra of weathered basalts to understand how secondary materials affect these spectra. To further test how secondary materials affect primary mineral spectra, we performed a set of controlled mixing experiments.

We coated grains of pyroxene, plagioclase, or a 50:50 wt% ratio of pyroxene to plagioclase with either montmorillonite or amorphous silica. We varied the amount of secondary material present in the mixtures: 2.5, 5, 10, and 20 wt% abundances and analyzed the mixtures as pelletized and loose particulates through laboratory TIR spectroscopy.

Linear deconvolution is a method to model mineral abundances in spectra assuming linear mixing of mineral spectra in proportion to their areal abundances. Linear deconvolution of our mixtures correctly identifies the primary minerals, but an increasing amount of secondary material decreases the accuracy of the modeled abundances. Additionally, some linear deconvolution models incorrectly identify materials, such as basaltic glass, that are not in the physical mixtures. The identification of basaltic glass is independent of the type or abundance of secondary material in the mixture, but pyroxene in the mixture tends to increase the modeled basaltic glass abundance. Some mixtures with small amounts of secondary material model basaltic glass over the stated detection limit (10-15%).

The type and amount of secondary material in the 50:50 wt% pyroxene-to-plagioclase mixtures affects the modeled abundances of primary minerals: Montmorillonite increases the modeled pyroxene-to-plagioclase ratio, while amorphous silica decreases this ratio. This suggests that modeled primary mineral abundances depend on the type of secondary material present.

Small amounts of weathering products on the Martian surface are likely to affect deconvolved primary mineral abundances, and may overestimate the abundance of other materials, such as basaltic glass.