

## **Hydrothermal synthesis of hematite spherules and jarosite: Implications for diagenesis and hematite spherule formation in sulfate outcrops at Meridiani Planum, Mars**

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### **ABSTRACT**

We synthesized hematite spherules whose mineralogic, chemical, and crystallographic properties are strikingly similar to those for the hematite-rich spherules in lag deposits on the surface and embedded in outcrops at Meridiani Planum, Mars. The spherules were synthesized in the laboratory along with hydronium jarosite and minor hydronium alunite from Fe-Al-Mg-S-Cl acid-sulfate solutions under hydrothermal conditions. The reaction sequence was (1) precipitation of hydronium jarosite; (2) jarosite dissolution and precipitation of hematite spherules; and (3) precipitation of hydronium alunite upon depletion of hydronium jarosite. The spherules exhibit a radial growth texture with the crystallographic *c* axis aligned along the radial direction, so that thermal emission spectra have no hematite emissivity minimum at  $\sim 390\text{ cm}^{-1}$ . Our experiments show that hydrothermal, acid-sulfate solutions are a pathway for formation of jarosite and the hematite spherules at Meridiani Planum, Mars.

**Keywords:** Hematite, jarosite, spherule, synthesis, diagenesis, Mars, hydrothermal, concretions, thermal emission spectroscopy, X-ray diffraction, Mössbauer spectroscopy, scanning electron microscopy, transmission electron microscopy