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Visible to near-infrared optical properties of pure synthetic olivine across the olivine solid solution

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Abstract

Olivine exhibits highly diagnostic absorption features across visible to near-infrared (VNIR) wavelengths due to electronic transitions of Fe^{2+} in its crystal structure. The properties of these absorptions vary with composition, enabling compositional analysis of olivine through VNIR spectroscopy, both in the laboratory and through remote sensing. Previous analyses of these trends have relied on natural olivine samples, which are influenced by the presence of minor cations that can affect the diagnostic absorptions. We conduct a systematic analysis of a suite of synthetic (pure Mg/Fe) olivine samples with VNIR (300–2600 nm) reflectance spectroscopy and quantitative spectral deconvolutions. From the full suite of samples described and characterized by Dyar et al. (2009), we identify a small suite of well-characterized and chemically pure olivine samples that demonstrates consistent and reliable spectral reflectance properties across visible to near-infrared wavelengths. This suite covers the stoichiometric olivine solid solution from x = Mg/(Mg+Fe) = 0 to x = 70 (Fo_0 to Fo_{70}). Because of their tight compositional control, these synthetic samples improve on previous analyses of natural samples. The results of this study provide a new standard for spectral reflectance properties of olivine across visible to near-infrared wavelengths for the compositions present in the suite. We present updated data on the trends in olivine band position as a function of olivine composition, which are the basis for remote compositional evaluation of olivine with visible to near-infrared reflectance spectroscopy. For these reasons, these improved olivine band position trends are of major importance to remote compositional analyses of terrestrial planets.

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