# Evidence of differentiated near-surface plutons on Vesta in integrated Dawn color images and spectral datasets

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Introduction: Recent analyses of Visible and Infrared Mapping Spectrometer (VIR) data from the Dawn mission [1] revealed isolated areas on the asteroid (4) Vesta that contain enhanced abundances of olivine [2,3]. However, this olivine component is only subtly expressed in the VIR data, superimposed on spectrally dominant pyroxene absorptions. The highly "mixed" nature of these spectra is likely due, in part, to the relatively coarse spatial resolution of VIR (∼190 m/pixel in HAMO-2) [4], which averages the spectral characteristics of potentially heterogeneous meter-scale outcrops. The capability to resolve the olivine-enhanced regions at a finer scale may reveal a spectrally-dominant olivine component that would facilitate characterization of 1) the distribution and context of the olivine-enhanced exposures, and 2) the spectral properties of the olivine component, providing clues to mineral composition.

In order to access finer spatial scales while preserving the detailed mineralogic information offered by the hyperspectral VIR instrument, we use an approach developed for the Moon by [5] that is based on an inversion of the Spectral Mixture Analysis (SMA) framework [6]. Here, we project the VIR data onto co-located, multispectral Framing Camera (FC) data with a spatial resolution of ∼50 m/pixel (HAMO-2) [7]. The analysis was carried out using georeferenced VIR and FC calibrated mosaics for the olivine-enhanced region containing Bellicia and Arruntia craters in the northern hemisphere of Vesta. The approach produces a set of four calculated VIR end members, as well as a projected image cube that contains a calculated VIR spectrum for each FC pixel in the scene. An important advantage of this approach is that it can be applied to co-located multi- and hyperspectral datasets on other planetary bodies.

Initial Results: We find that VIR observations for diverse areas across the scene are well described by the following hyperspectral end members: two spectra resembling pyroxenes, one of which has a subtle ∼600-nm absorption; one spectrum that resembles a pyroxene but displays a somewhat distorted 1000-nm band shape that may be indicative of residual calibration issues in the VIR data; and one spectrum strongly resembling a pure olivine. The olivine-like calculated end member spectrum provides important validation of the interpretation that the spectral character of VIR data in the Bellicia/Arruntia region is due to the spectral influence of an olivine component. In addition, the ∼600-nm feature in one of the calculated pyroxene end members is an unexpected and compelling result. Coordinated petrologic and spectral analyses of unbrecciated eucrites by [8] indicate that a similar ∼600-nm absorption is observable in relatively primitive, Cr-rich pyroxenes. This observation suggested that the presence of a ∼600-nm absorption in remote-sensing data for Dawn may be a straightforward indicator of the presence of primitive materials – a prediction that is borne out in these results.

Evaluation of the hyperspectral projected cube reveals that discrete regions of spectrally pure olivine are indeed present throughout the walls of Bellicia and, to a lesser extent, Arruntia. Spectra of the Arruntia ejecta in the projected cube contain less of an olivine component than the walls, but important spatial variations are apparent. In particular, the proximal Arruntia ejecta ($< 1$ crater radius) appear to contain very little olivine, whereas spectra of the more distal ejecta ($> 1$ crater radius) do display an apparent olivine component. This observation strongly suggests that the Arruntia impact has revealed a compositionally stratified subsurface, with an enhanced olivine component occurring at slightly deeper levels. Projected spectra displaying pyroxene bands with a superimposed ∼600-nm feature occur primarily on crater walls, often in association with olivine- dominated spectra. The co-occurrence of Cr-rich pyroxene and olivine in this unique region of Vesta suggests that a primitive lithology is locally exposed at the surface. We interpret these observations as indicating the presence of one or more differentiated plutons in the Bellicia/Arruntia region.

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