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Brumalia Tholus: Magmatic Intrusion on Vesta?

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Geologic mapping of Vesta was based on Dawn spacecraft Framing Camera (FC) images and compositional data from the Visible & Infrared Spectrometer (VIR). Mapping reveals that while the equatorial region of Vesta displays numerous wide, flat-floored troughs [1], these troughs do not cut the Vestalia Terra plateau (VT) [2]. However, three large pit crater chains are observed on the VT surface [2,3]. Pit crater chains are hypothesized to form when dilational motion on buried normal faults causes overlying material to collapse into the opening portions of the buried fault [4]. The merged pits of the VT pit crater chains show signs of collapse but distinct fault faces can also be observed [3]. It has thus been suggested that the VT pit crater chains are representative of subsurface faulting of the plateau [2].

The pit crater chain Albalonga Catena phases from being a topographically low feature of merged pits into being the topographically high Brumalia Tholus, an elongate hill. If Albalonga Catena represents a buried normal fault, then the topographic high that emerges along its length could have been formed by a magmatic intrusion utilizing the subsurface fracture as a conduit to the surface. Brumalia Tholus should thus be comprised of diogenite, a plutonic vestan material.

Teia crater impacts Brumalia Tholus and likely samples Brumalia's core material. FC data indicates that Teia ejecta have a smeared, flow-like texture and a distinct compostion. VIR analysis has shown that while background VT material is howarditic [5], these Teia ejecta are more diogenitic. VIR also detected small diogenite deposits on top of Brumalia Tholus. The identification of diogenite on the top of Brumalia Tholus and in the Teia ejecta is consistent with the hill being the surface representation of a magmatic intrusion.

We present a possible sequence of events. Global equatorial fracturing and faulting occurred, resulting in sub-surface faulting of VT. The surface of VT was covered by Rheasilvia ejecta. As this loose regolith material col-lapsed into dilational openings along the sub-surface faults, pit crater chains formed on the VT surface. Meanwhile, the subsurface fracture beneath Albalonga Catena served as a conduit for diogenitic mantle or lower-crustal material to move toward the surface, forming Brumalia Tholus due to dike injection. The Teia impact event then occurred, incorporating the diogenitic dike material into its ejecta.

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References: [1] Jaumann et al. (2012) Science doi:10.1126/science.1219122 [2] Buczkowski et al. (2012) GRL doi:10.1029/2012GL052959 [3] Buczkowski et al. (2011) LPSC abs. 2263 [4] Wyrick et al. (2004) JGR doi:10.1029/2004JE002240 [5] DeSanctis et al. (2012) Science doi:10.1126/science.1219270.