BRUMALIA THOLUS: AN INDICATION OF MAGMATIC INTRUSION ON VESTA? D.L. Buczkowski[1], M.C. DeSanctis[2], C.A. Raymond[3], D.Y. Wyrick[4], E. Ammannito[2], A. Frigeri[2], D. Williams[5], C.T. Russell[6]. [1]JHU-APL, Laurel, MD, USA; [2]INAF-IAPS, Rome, Italy; [3]JPL, California Institute of Technology, Pasadena, CA, USA; [4]SwRI®, San Antonio, TX, USA; [5]ASU, Phoenix, AZ, USA; [6]UCLA, Los Angeles, CA, USA

Introduction: NASA's Dawn spacecraft collected imaging, spectroscopic, and elemental abundance data during its one-year orbital mission. Geologic mapping of Vesta's surface was based on compositional data from the Visible & Infrared Spectrometer (VIR) and Framing Camera (FC) images obtained during the High-Altitude Mapping Orbit (HAMO) and the Low-Altitude Mapping Orbit (LAMO). Mapping of Vestalia Terra [1] resulted in the identification of an unusual hill, now named Brumalia Tholus. We here present our hypotheses that Brumalia Tholus represents a dike that formed due to magmatic intrusion into subsurface fractures under the Vestalia Terra plateau (VT).

Observations: The equatorial region of Vesta displays numerous wide, flat-floored troughs whose formation has been tied to the Rheasilvia impact event [2] but these troughs do not cut VT [3]. However, there are three long pit crater chains observed on the surface of the plateau whose orientation is consistent with the equatorial troughs [1,3]. A strong correlation between pit crater chains and fault-bounded graben has been observed on other planetary bodies [4]; pit crater chains are hypothesized to form when dilational motion on buried normal faults cause overlying material to collapse into the opening portions of the buried fault. Consistent with this hypothesis, the merged pits of the VT pit crater chains show signs of collapse but distinct fault faces can also be observed [1]. It has thus been suggested that the pit crater chains on VT are representative of subsurface faulting of the plateau [3].

As Albalonga Catena (Fig. 1), the pit crater chain located in eastern VT, progresses westward it phases from being a topographically low feature of merged pits into being the topographically high Brumalia Tholus (Fig. 2a), an elongate hill that is evident in both the photographic and topographic data of Vesta (Fig. 1a,b). Westward of the hill, merged pits are again visible in the slope data (Fig. 1c). If Albalonga Catena does represent a buried normal fault, then the topographic high that emerges along its length could have been formed as a magmatic intrusion utilizing the subsurface fracture as a conduit to the surface, intruding into and deforming the rock above it. The core of Brumalia Tholus should thus be comprised of a more plutonic rock, such as diogenite, than the basaltic eucrites and brecciated howardites that have been observed in the equatorial region of Vesta [5]. Teia crater impacts the northern face of Brumalia Tholus (Fig. 2) and thus its ejecta is likely sampling Brumalia's core material. Color data from Dawn's FC instrument indi-

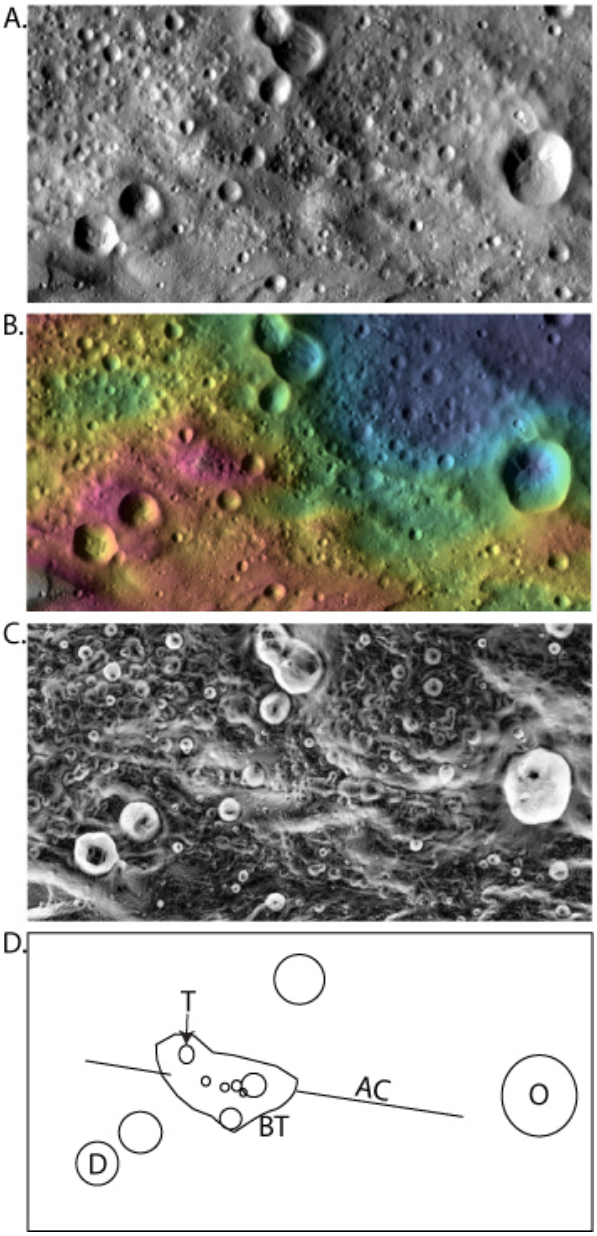

Figure 1. Eastern Vestalia Terra showing Albalonga Catena. A) FC HAMO mosaic. B) Topography overlying HAMO mosaic. C) Slope data. Albalonga Catena is distinctly visible in this data set. D) Sketch map of features in region. BT = Brumalia Tholus; AC= Albalonga Catena; O= Oppia crater; D= Drusilla crater; T= Teia crater. Some unnamed craters and the probable extension of Albalonga to the west of Brumalia are also drawn.

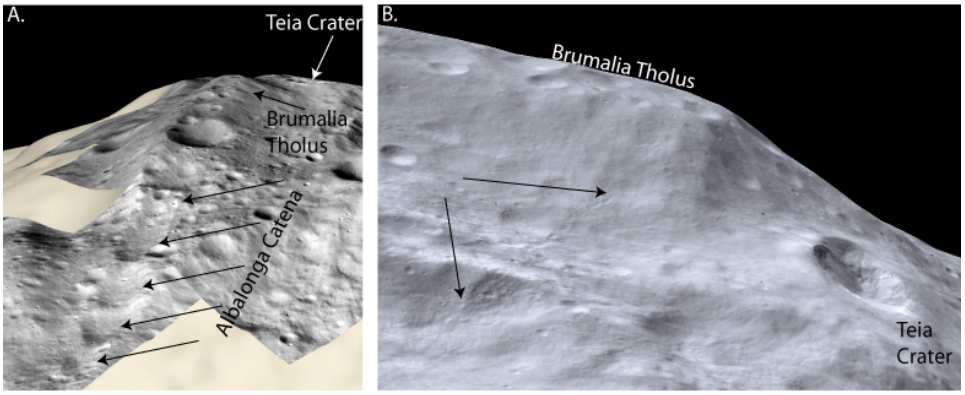

Figure 2. A) FC LAMO mosaic draped over Vesta shape model looking west along Albalonga Catena. Merged pits phase into Brumalia Tholus. B) The northern face of Brumalia Tholus. Albedo-bright deposits are Teia ejecta. Arrows point to linear arrangement of elongate pits that are associated with the FC false-color flow.

cates that ejecta from Teia have a distinct composition (Fig. 3). The false-colors orange and red correspond to the ratio of 749/438 nm and are observed to directly relate to ejecta material with a smeared and flow-like texture. Analysis by VIR has shown that while the background VT material is howarditic [5], these Teia ejecta are more diogenitic.

VIR also identified diogenite in small spots on the top of Brumalia Tholus. FC color data displays as the false-color red inside and along the small craters on the top of Brumalia Tholus and as false-color red flows travelling down its north face (Fig. 3). A potentially associated feature is a linear arrangement of elongate pits arranged down the tholus slope (Fig. 2b). If the false-color red on the slope represents a flow of diogentic material from the top of the tholus, then these linear pits may represent a collapsed lave tube. 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 the following possible sequence of events. Global equatorial fracturing and faulting occurred due to the Rheasilvia impact event. This faulting did not fault the surface of VT but did result in subsurface faulting. The surface of VT was then covered by Rheasilvia ejecta. As this loose regolith material collapsed 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 conduit for a diogenitic mantle or lower-crustal material to move toward the surface, forming Brumalia Tholus due to dike injection. Flows and at least one lava tube formed on the hill. The Teia impact event then occurred, incorporating the diogenitic dike material into its ejecta.

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

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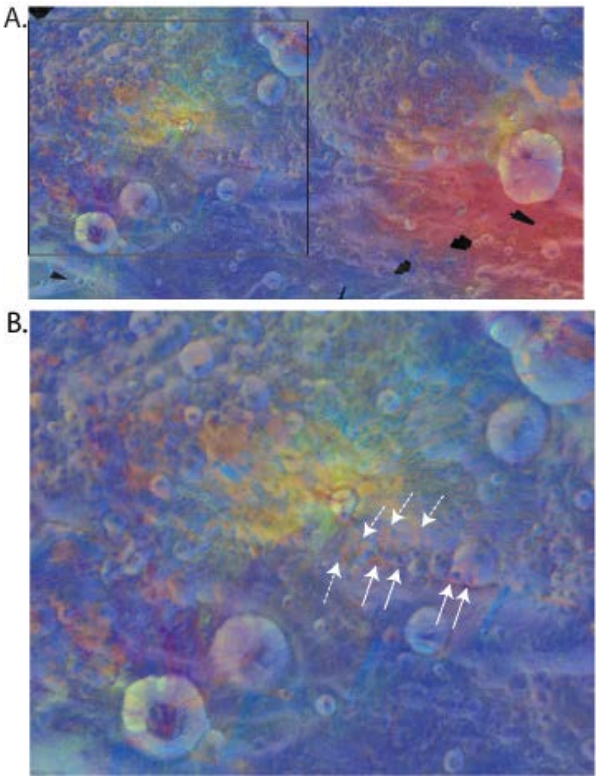

Figure 3. A) FC color data of region in fig. 1. Red =749/438 nm; Blue=749/917 nm; Green=438/749 nm. Box shows location of part b. B) Teia ejecta and the top of Brumalia Tholus. There is a close correspondence between false red/orange and the "glassy" ejecta. False-red flows down the north slope of Brumalia Tholus (white dashed arrows) while more false-red material is exposed near small pits (white solid arrows).