COMPTON-BELKOVICH VOLCANIC COMPLEX. B. L. Jolliff[1], M. Zanetti[1], K. A. Shirley[1], N. J. Accardo[1], C. Lauber[1], M. S. Robinson[2], and B. T. Greenhagen[3], [1]Dept. of Earth & Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, One Brookings Drive, St. Louis, MO 63130; [2]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287; [3]Jet Propulsion Laboratory, Pasadena, CA 91109 (blj@wustl.edu).

Introduction: We previously reported on the small, 25x35 km, volcanic terrain [1] that lies at the center of the Compton-Belkovich thorium anomaly [2]. Here we refer to this volcanic terrain as the Compton-Belkovich Volcanic Complex (CBVC). The CBVC forms a low topographic rise (Fig. 1) located along the second ring of Humboldtianum basin, and just east of the rim of the 214 km diameter Belkovich Crater. Domical morphologies seen in LRO Narrow Angle Camera (NAC) and Wide Angle Camera (WAC) images indicate the presence of constructional volcanic features. Relatively high reflectivity, coupled with spectral evidence from Diviner on LRO, indicate relatively silicic compositions [1,3]. Steep slopes on some of the volcanic constructs coupled with compositional data, including model Th concentrations as high as 40-55 ppm [4] lead us to conclude that rhyolitic material similar to known lunar granite/felsite in Apollo samples is exposed at the CBVC. In this abstract, we discuss several elements of the CBVC including timing of its formation, and petrogenesis of the volcanic features.

Timing: In a companion abstract [5], we present results of crater counts at the CBVC and surrounding regions to address the timing of volcanism. NAC images of flat parts of the CBVC reveal a paucity of small impact craters in the ~100-500 m size range (*e.g.*, Fig. 2), which makes the terrain appear relatively young compared to typical lunar volcanism that occurred mostly 3-4 BY ago. The crater size-frequency distributions appear to be "stepped" with specific size intervals reflecting model ages less than 1 BY, some significantly so. We do not yet understand these apparent model ages, but there is an indication in these data that the CBVC involved resurfacing that erased or greatly subdued certain crater size populations within the past billion years. A key constraint on timing may come from the Copernican-age Hayn Crater, 87 km diameter, located ~180 km NW of the CBVC. Several small chains and clusters of secondary craters, apparently from Hayn, lie on parts of the CBVC, although not in its central region. NW-SE trending grooves and lineations are prominent on the NE "peninsula" of the CBVC (Figs. 1,2). Crater counts using NAC images of parts of Hayn's continuous ejecta deposits indicate an age in the range 800-1100 MY [5]. Crater counts on areas within the CBVC suggest some form of resurfacing event at ~ 260 Ma [6].

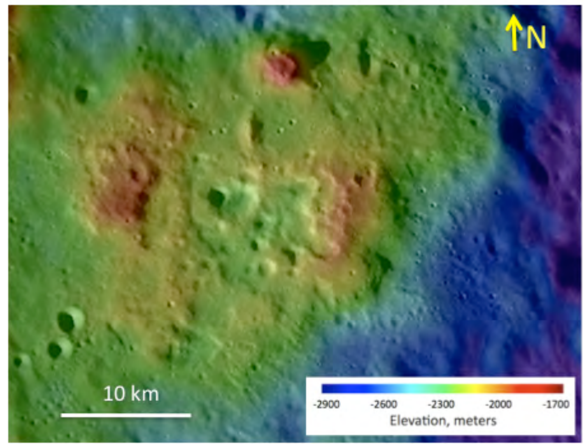

Figure 1. CBVC Topography. WAC GLD100 [7] draped over WAC visible image.

Irregular Depressions: In addition to positive-relief volcanic features, the CBVC includes several irregular depressions that we interpret to be collapse features. likely associated with the extrusion of lava along the eastern and western flanks of the CBVC and via the large dome to the north (Fig. 3). These features involve elevation changes of order 50-100 m, they are irregular in planform, and they do not all have continuous rims. From the irregular shapes we infer that the underlying, near-surface magma chamber was also irregular or consisted of some number of lobes that were perhaps dictated by the presence of preexisting structures associated with large impacts and megaregolith.

Petrogenesis: We consider the formation of the CBVC to have occurred in six stages: *Stage 1 - Melt production.* We infer the source most likely to have been at the base of the crust. A fertile source region such as a pocket of "urKREEP" melted by a deep thermal plume is one possibility, especially if melting occurred as late as the Copernican. The CBVC is ~ 900 km from the Procellarum KREEP Terrane and is completely isolated from other silicic volcanic occurrences. Moreover, no large craters in the vicinity exhumed similar material. *Stage 2 – Transport through the crust.* Models indicate the crust is relatively thin (~50 km) [8] in this region, and the surface lies ~2 km below the lunar mean radius. Lithostatic pressure in a layered crust, with an anorthositic upper crust overlying a gabbroic lower crust, is sufficient to raise a KREEP-basalt or basaltic andesite magma to within a few km of the

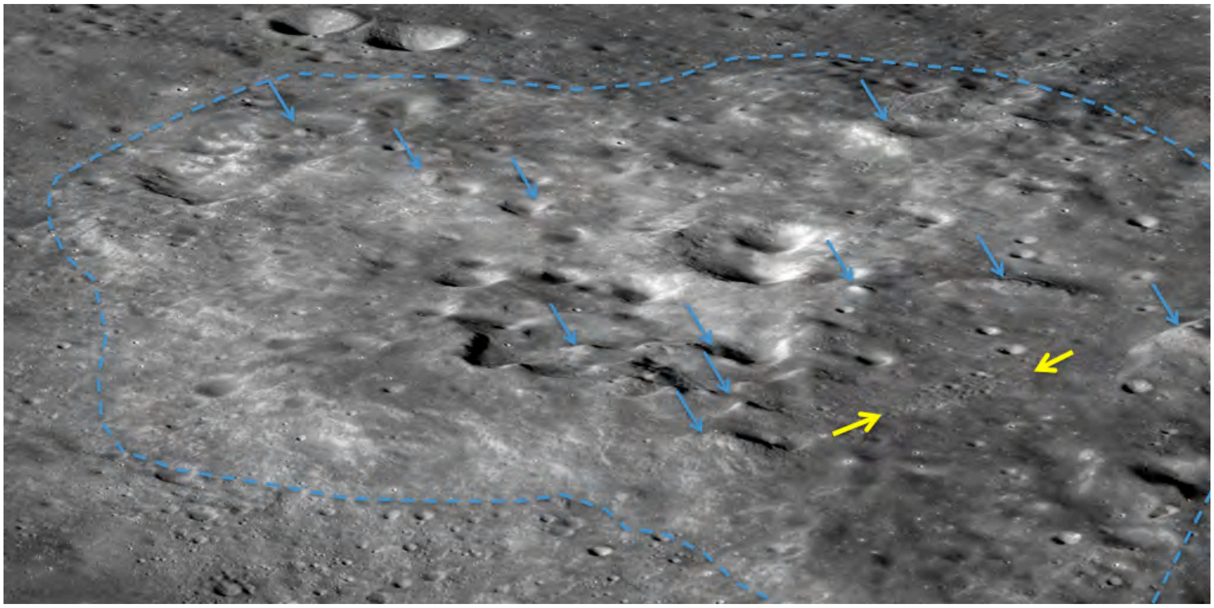

Figure 2. Oblique NAC image (M174549036), with positive relief volcanic features shown at blue arrows. Large α-dome off image to right. Small crater abundance greater outside dashed line. Yellow: secondary crater cluster possibly from Hayn.

surface. *Stage 3 – Inflation.* Megaregolith would provide a strong density contrast and a likely boundary for the lateral spread of magma from its conduit, accompanied by inflation over the magma chamber. *Stage 4 – effusive eruption.* Fracturing associated with inflation and exploitation of preexisting weaknesses led to eruption of lavas of KREEP-basalt-like [or some similarly (or more) evolved] composition. At the CBVC, we envisage such activity, coupled with broad doming, to have formed the eastern and western flanks. The large alpha dome to the north appears, by the slopes of its flanks, to have formed from a relatively evolved (more silicic) lava, perhaps an intermediate to late-stage melt composition. *Stage 5 – Collapse.* As a result of effusion of lava from the flanks, several regions of the magma chamber (or individual, irregular chambers) experienced mild collapse, forming the irregular depressions now observed at the CBVC. *Stage 6 – Magma end-stage differentiation and production of silicic domes and bulges.* Extended differentiation, either by fractional crystallization or silicate-liquid immiscibility, produced small rhyolitic bodies that rose just enough to break the surface. Some of these are associated with old crater rims where mobility may have been enhanced by structural weaknesses associated with the craters. Much of the CBVC appears to be mantled by high reflectance material, which extends up to 7 km beyond the topographic expression of the CBVC to the east. We suspect that these materials originated by pyroclastic activity, producing a veneer of late-stage, rhyolitic material that contributed to the orbital signature of silica and thorium enrichment.

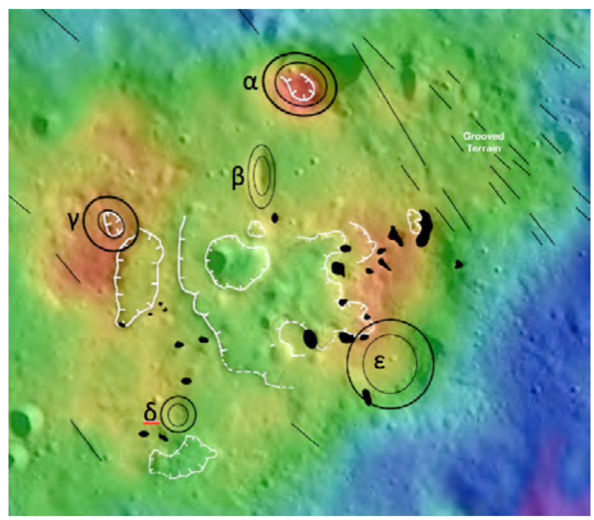

Figure 3. Locations of large (ovals) and small (black, solid fill) volcanic constructs, irregular depressions, and prominent lineations at the CBVC.

References: [1] Jolliff B. L. et al. (2011) *Nature Geosci*. **4**, 1151–1154. [2] Lawrence D. et al. (1999) *Geophys. Res. Lett.* **26**, 2681-2684. [3] Glotch T. et al. (2010) *Science*, **329**, 1510-1513. [4] Lawrence D. et al. (2003) *J. Geophys. Res* **108**, 6-1-6-25. [5] Shirley K. A. et al. (2012) *LPS* **43**, this vol. [6] Shirley et al. (2012) this Conf. [7] Scholten F. et al. (2012) *J. Geophys. Res.,* revised. [8] Wieczorek et al. (2006) *New Views of the Moon, RiM-G* **60**, Plates 3.5, 3.6.

Acknowledgements: We are ever grateful to the LROC Science & Operations Team and to NASA for support of the LRO project.