COMPTON-BELKOVICH VOLCANIC COMPLEX: NONMARE VOLCANISM ON THE MOON'S FAR SIDE. B. L. Jolliff,[1] S. J. Lawrence,[2] M. S. Robinson,[2] F. Scholten,[3] B. R. Hawke,[4] B. T. Greenhagen,[5] T. D. Glotch[6], H. Hiesinger[7], and C. H. van der Bogert[7], [1]Dept. Earth & Planetary Sciences & McDonnell Center for the Space Sciences, Washington University, One Brookings Drive, St. Louis, MO 63130; [2]School of Earth & Space Exploration, Arizona State University, Tempe, AZ 85287; [3]German Aerospace Center (DLR), Institute of Planetary Research, Berlin; [4]SOEST, University of Hawaii, Honolulu, HI 96822; [5]Jet Propulsion Laboratory, Pasadena, CA 91109; [6]Dept. of Geosciences, Stony Brook University, Stony Brook, NY 11794; [7]Institut für Planetologie, Westfälische Wilhelms Universität Münster, Germany; <blj@wustl.edu>

Introduction: Images from the Lunar Reconnaissance Orbiter Cameras (LROC), including digital terrain models derived from the LROC Wide and Narrow Angle Cameras, and mineralogical data from the Diviner Lunar Radiometer provide evidence that a small silicic volcanic complex lies at the center of the Compton-Belkovich "thorium anomaly," known from Lunar Prospector gamma-ray data [1,2,3,4]. The Compton-Belkovich volcanic complex forms a low, broad dome about 25×35 km across and ~1 km in elevation, although the central part of the dome is depressed (Fig. 1 and [1]).

Superposed on the broad dome are a range of volcanic constructs, from small, circular domes and "bulges" with ~500 m base diameters to intermediate-size, irregular domes up to several km in maximum dimension, to larger volcanic features, with up to 6 km basal diameter, with summit depressions and flank slopes to over 20 degrees (Fig. 2). Within central parts of the Compton-Belkovich volcanic complex are irregular depressions, which we interpret to have resulted from collapse of a near-surface magma chambers following flank eruptions.

The Compton-Belkovich volcanic complex is the only silicic, nonmare volcanic feature known on the Moon's farside, and it is located ~900 km distant from the Procellarum KREEP Terrane where all of the Moon's other known silicic volcanics occur.

Compositional and mineralogic data: Diviner data in the region of the Christiansen Feature show that the broad Compton-Belkovich volcanic complex corresponds to an area of relatively silicic composition [5,6]. Lunar Prospector gamma-ray thorium data, after accounting for the broad compositional response function of the gamma-ray spectrometer [2], are consistent with Th concentrations as high as those seen in small samples of lunar granite and felsite, known from Apollo samples [e.g., 7-13], i.e., 40-55 ppm.

Origin: We hypothesize that the volcanic complex formed by intrusion of a magma with a KREEP-like composition that was generated deep in the crust. The intrusion ponded near the surface, likely within megaregolith. A deep origin is indicated by the observation that large impact craters in the region did not excavate KREEP- or Th-rich material. Generation of a silicic lava, e.g., 65-75 wt% SiO_2, deep in the crust and

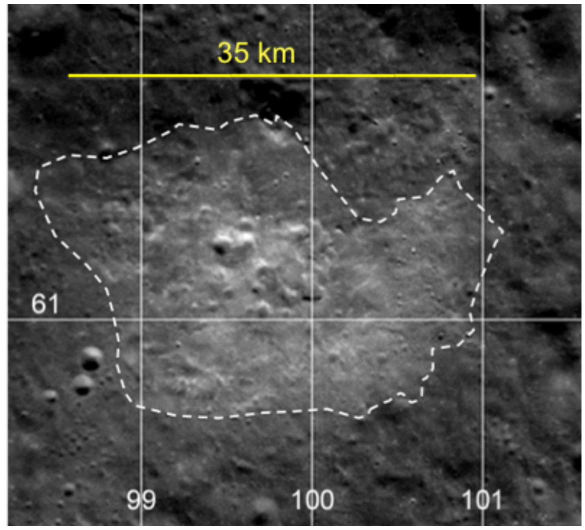

Fig. 1a. Wide-angle Camera (WAC) 604 nm [14].

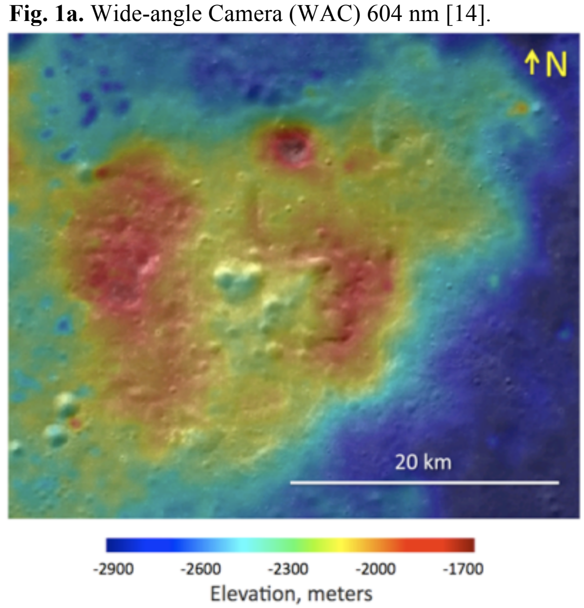

Fig. 1b. WAC digital terrain model (DTM) [15,16] draped over WAC image, 100 m/pixel.

transportation directly to the surface seems implausible owing to the high viscosity of dry (or even slightly wet) silicic lava compositions. The broad, low-relief topography of the Compton-Belkovich volcanic complex and the low slopes along the apparently constructional east and west flanks are more consistent with a

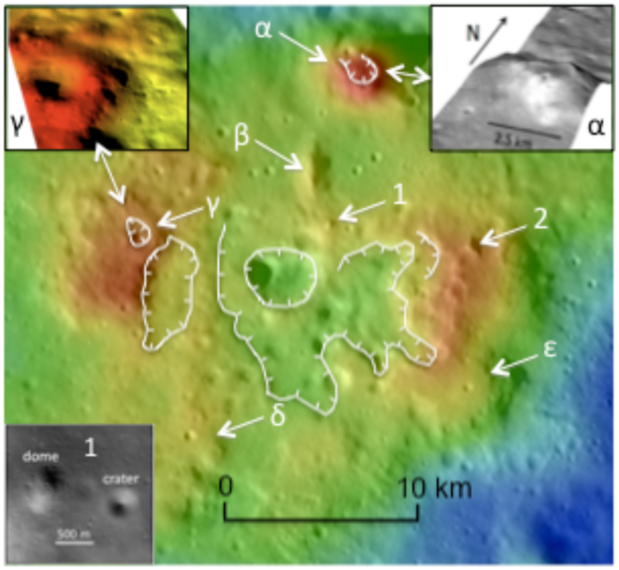

Fig. 2. Volcanic features in the Compton-Belkovich volcanic complex. Large cumulo-volcano structures, alpha and gamma, and small dome 1 shown in the corner insets.

lava of KREEP-basalt composition, i.e., SiO_2 ~50-52 wt% and viscosity some 3-5 orders of magnitude lower than rhyolite, even if it contained a small fraction of water [17].

We consider the emplacement to have occurred in four stages: (1) Melt generated deep in the crust or at the crust-mantle boundary intruded and ponded at the base of the megaregolith where there is a substantial density contrast with the anorthositic upper crust (Fig. 3). (2) The magma body inflated to form a broad, low dome, causing arcuate structural weaknesses in the uplifted megaregolith. (3) Lava exploited structural weaknesses and initially erupted at the surface, prior to extensive differentiation, producing volcanic constructs along the east and west sides of the complex, possibly concurrent with initial collapse in the central region. (4) Late-stage silicic derivative melts then extruded to form domes with a range of morphologies, including the large alpha dome to the north and smaller domes and bulges in the central region, especially along the flanks of the collapse scarps. The offset (or extension) of the Compton-Belkovich volcanic complex reflectance feature to the east-southeast of the topographic expression (as well as the asymmetric Th distribution in that direction) could result from pyroclastic dispersal preferentially on the eastern side of the complex. A combination of upward-enrichment of late-stage silicic differentiates and pyroclastic dispersal of silicic (rhyolitic) residual melt would have produced a veneer of silica and Th-rich material at the surface, masking the underlying megaregolith or KREEP-basalt/basaltic andesite intrusive.

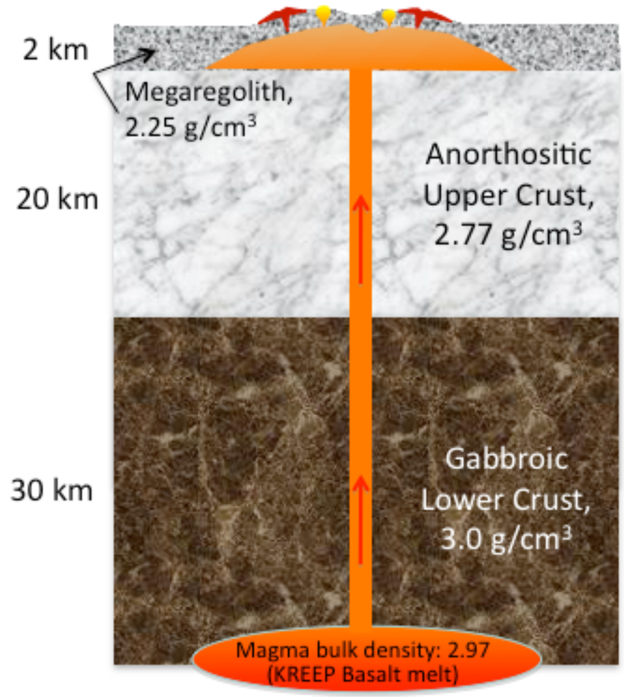

Fig. 3. Model for the origin of the Compton-Belkovich volcanic complex. Rise of magma in response to lithostatic pressure resulting from layered crust as shown (using methods in [18]). Assumed density of silicic melt (yellow, at surface) is 2.4-2.5 g/cm^3.

Acknowledgements: We thank the LROC science operations team and the Diviner and LRO Ops teams for their excellent work, and NASA for support of the LRO project.

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