ALPHONSUS DARK-HALO CRATERS: IDENTIFICATION OF ADDITIONAL VOLCANIC VENTS.

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Overview: Dark-halo craters located along fractures in the floor of Alphonsus crater (108 km dia.; ~13ºS/357ºE) are considered type localities of small lunar pyroclastic deposits based on association of dark mantling material with likely cone-shaped source vents. Much of our understanding of the physical processes involved in smaller pyroclastic eruptions on the Moon comes from morphometric analyses of deposit volumes in Alphonsus crater performed by Head and Wilson [1]. These authors used high-resolution photographs and topographic maps to map the distribution and measure volumes of materials in the pyroclastic cones. They identified juvenile materials in all but one of the “dark halo” crater deposits. This study presents evidence for at least two previously unrecognized vents in the floor of Alphonsus crater. Results suggest that many such features and associated pyroclastic deposits are likely to be identified with the wealth of new lunar remote sensing data [e.g., 2, 3, 4].

Geologic Setting: Alphonsus is a Lower Imbrian-age crater located in the highlands east of the Upper Imbrian-age Mare Nubium [5]. The crater has a ~flat, cratered floor, a central peak, and a broad rim (***Figure 1***). Numerous linear rilles dissect the crater floor and dark-halo craters are located along and adjacent to the rilles, suggesting that the fractures provided preferential pathways for dike emplacement, volatile accumulation and subsequent pyroclastic eruption.

Eleven dark-halo craters were mapped previously within Alphonsus [1]; ten of these are located within 25 km of the basin rim. These dark-halo craters are characterized by non-circular rims <2 km in diameter, low-albedo deposits or “haloes” that extend up to 6 km from the crater center. Head and Wilson modeled the formation of the Alphonsus pyroclastics as vulcanian-style volcanic eruptions, with accumulation and intermittent explosion of volatiles that collected above rising magma confined in dikes below the fractures [1, 6].

Additional information on the nature of the magmatic or juvenile components at Alphonsus has come from Earth-based spectral data, which indicated that these deposits were compositionally diverse and that several of the pyroclastic cones may have olivine components [5, 7]. More recent results based on Clementine UVVIS data were less conclusive, supporting the existence of compositional diversity among the Alphonsus and other pyroclastic deposits but not clearly identifying an olivine component [8, 9].

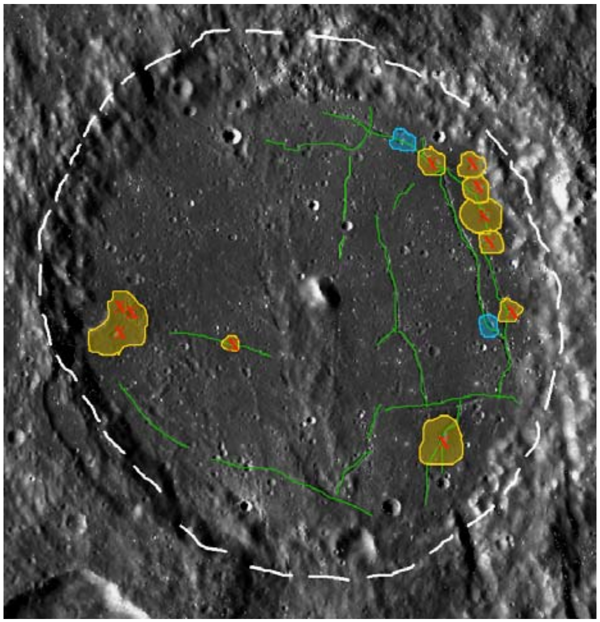

Figure 1. Alphonsus crater (108 km. diam.) and the locations of major floor fractures (green), 11 dark-halo craters (after 1]), and two newly identified vents. Kaguya Terrain Camera evening mosaic.

Analysis: Because of their iron-rich compositions, the volcanic deposits within the floor of Alphonsus crater are highlighted as bright in FeO maps derived from Clementine UVVIS data [10]. Examination of these data (***Figure 2***) reveals obvious iron-rich materials in association with the 11 previously recognized vents, but at least two additional sites are also highlighted (arrows). To examine these sites in more detail, we used data from the Lunar Reconnaissance Orbiter (LROC) Narrow Angle Cameras (NAC) [2; ~0.5 m/p] and the JAXA SELENE/Kaguya Terrain Camera [3; ~10 m/p].

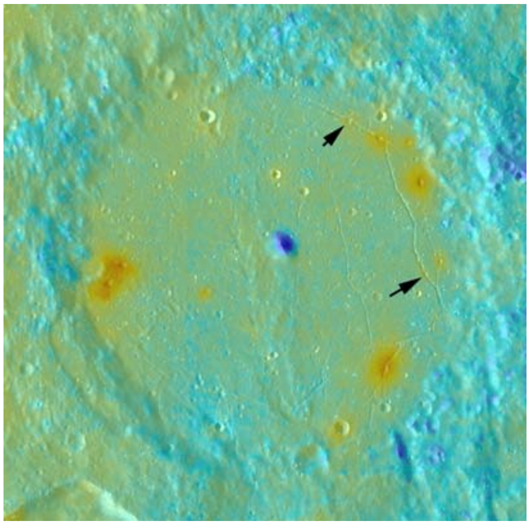

Figure 2. Alphonsus crater viewed by a Kaguya Terrain Camera evening mosaic with superimposed false-color Clementine derived FeO [10]. Yellow tones show enhanced iron content. Arrows mark the sites of two possible newly identified pyroclastic deposits.

The northeastern feature is centered on a group of irregular depressions (***Figure 3a***) located along a rille NW of Ravi cone [1], a previously recognized pyroclastic deposit. The northeastern deposit has a moderate albedo, extends ~4 km across, and has occasional darker portions that drape and mantle the margins of the host depressions (***Figure 4***). The east-central deposit (***Figure 3b***) is centered on a small depression west of deposit 6 of [1], has an even higher albedo, and extends ~2 km across. Both possible vent depressions straddle linear rilles. These characteristics resemble those of other nearby deposits and support a pyroclastic origin for these features.

Summary: Two possible newly identified pyroclastic deposits have been recognized in the floor of Alphonsus crater. The moderate albedoes of these deposits and their small size likely precluded earlier identification. New high-resolution image data [2, 3] allow more detailed analysis of the lunar surface and will likely support identification of many such features [e.g., 4]. These results suggest that pyroclastic deposits are likely to be even more widespread than previously recognized [e.g., 8, 9].

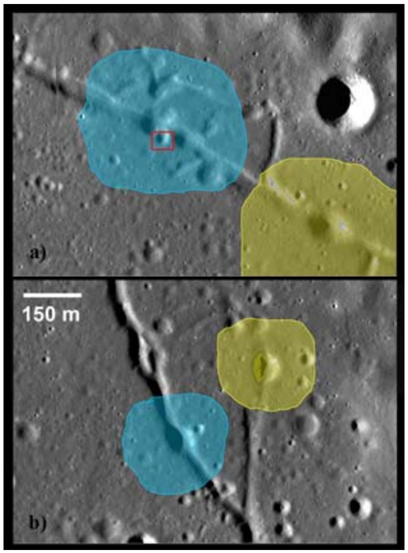

Figure 3. Possible newly identified “dark halo” deposits (blue) in (a) northeastern and (b) eastern floor of Alphonsus crater. Both are near previously recognized deposits (yellow). Box in a) marks location of Figure 4 view. Views from the Kaguya Terrain Camera evening mosaic at same scale; north is up.

Figure 4. LROC NAC frame (M111613281L, 0.54 m/p, 30° inc.) showing dark, drapey deposits along the margin of an irregular depression associated with the possible newly identified “dark halo” deposits in the northeastern floor of Alphonsus crater. North is up, view is ~17 m across.

References: [1] Head and Wilson (1979) PLPSC 10th, 2861. [2] Robinson et al., 2010, Space Sci. Rev, 150, 81-124. [3] Haruyama et al., 2008, Adv. Sp. Res. 42, 310-316. [4] Gustafson et al., 2011, this volume. [5] Hawke et al., 1989, PLPSC 19th, 255. [6] Head and Wilson, 1989, JVGR 37, 261-271. [7] Coombs et al., 1990. PLPSC. 20th, 339. [8] Gaddis et al., 2000, JGR, 105, 4245. [9] Gaddis et al., 2003, Icarus 161, 262. [10] Lucey et al., 2000, JGR 105, 20,297.