Mineralogical and morphological characterization of a suspected lunar silicic construct: The Wolf crater

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The Wolf crater is an irregularly shaped crater situated within the central part of Mare Nubium in the southern hemisphere on the lunar near side (16.573°W, 22.904°S). With an approximate diameter of about 25 km, this crater has been recently suspected to be a lunar silicic construct, hinting at a felsic composition that is more silicic than pure, immature anorthite. These suspicions have mainly been triggered by the high thorium anomaly in this region, and Christiansen Feature (CF) and Concavity Index (CI) mapping using Diviner multispectral data from the Lunar Reconnaissance Orbiter (LRO) mission. Many areas in the Wolf crater show CF values lower than 7.84 µm (CF for pure, immature anorthite). This study adopts a more holistic approach by studying the mineralogical composition and morphology of this crater complex using Moon Mineralogy Mapper (M³) data for mineralogical analysis and LROC WAC (wide angle camera) and NAC (narrow angle camera) data for morphological analysis. The whole complex can be divided into two parts—highland massif and mare basalt regions. CSFD analyses show that the outer part of the massif is older than the mare basalt, whereas the inner part have relatively younger surfaces. Analysis of the M³ data reveals the presence of pyroxene exposures on the massif as well as the mare basalt. However, their compositions are distinctly different, the massif pyroxenes being low-Ca pyroxene while the mare pyroxenes are High-Ca pyroxenes in composition. It can be inferred that the pyroxene exposures on the massif are not related to any ejecta deposits from the mare basalts. The highly silicic compositions implied by the CF and CI maps are limited to only certain parts of the massif, indicating a compositional heterogeneity in the massif region as well. Morphologically, the highland massif shows an extremely knobby structure which surrounds the mare basalt in a topographically depressed central part. The massif is discontinuous and the mare-highland boundary is very irregular, suggesting that the central depression is not of an impact-related origin. Extensional deformation features near the mare-highland boundaries also support this. In some parts, dome like features can be identified, with fresh rock fragments being visible on the surface. The rock fragments seem to be of two different tones— one very bright tone, and another comparatively darker tone. These rock fragments cannot be related to any nearby cratering activity, and they seem to be embedded in their locations. Pyroclastic deposits can also be identified around some of these domes, by their characteristic low albedo and smooth appearance. Overall, the Wolf crater complex shows signatures of non-mare volcanic activity and
can be of non-impact related volcanic origin.