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Geological and geochemical analysis of stratigraphic units in the South Pole - Aitken Basin

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The South Pole-Aitken (SPA) Basin, located on the Lunar far side, is one of the oldest and largest recognized impact structure in the solar system. This PreNectarian basin (>3.9 Ga) measures 2500 km in diameter with depths up to 13 km. A large mafic province was formed by the impact that effectively removed the upper crust [1]. Hence, deep-seated lower crustal and possibly even mantle materials are exposed in the severely modified Basin interior, providing the unique opportunity to probe and study the composition and structure of the Lunar interior. Consequently, the SPA Basin is a frequently proposed site for future sample return missions and detailed multispectral studies will required to aid landing site selection [2]. Previous studies on the multispectral dataset of Clementine (1994) by Pieters and Tompkins [1,3] revealed fresh mafic compositions of both low-Ca pyroxene or high-Ca pyroxene dominated rocks, referred to as norites and gabbros respectively. Some regions contained spectral features of olivine (troctolite), such as in Olivine Hill, which could suggest the presence of mantle derived deposits tapped during SPA impact.

Using an algorithm developed by Pieters et al. [1] we have produced images for three subregions, covering the central and northern part of the SPA Basin. The algorithm is based on three diagnostic features in the UV/VIS spectrum of Clementine's 11 band multispectral dataset. The parameters are assigned to an RGB composite and allow distinction between mature soils, anorthosite (blue), norite (pink) and gabbro/troctolite compositions (green). Furthermore, we have used Clementine's Near Infrared database to produce a NIR band ratio image (2000 nm/1250 nm), as a parameter to distinguish between olivine and pyroxene-rich materials where we aim to detect traces of excavated mantle material (modified from LeMoeulic et al. [4]).

Regretfully, we found that the NIR ratio method does not confirm olivine-rich material exposed in Olivine Hill as it shows no significant bright colors compared to the surroundings. This means that we have no firm evidence of mantle material being excavated during SPA impact. Instead, we have identified an overall noritic composition as the deepest stratigraphic unit exposed on the basin floor. Norite is found in nearly all central peaks of both small and large size and in large topographical structures that have punched through the upper, often gabbroic layer, such as in the Leibnitz and Apollo basins. This thin layer of gabbroic composition is distributed over large parts of the basin floor and presumably overlays the noritic basement of apparent lower-crustal origin. The origin of these high-Ca pyroxene dominated rocks emplaced on the basin floor could be attributed to several processes and possibly represent remnants of the SPA impact melt sheet; some form of cryptomare or cooled and exposed mafic plutons formed during crustal differentiation. We have combined the multispectral results with topographical Clementine LIDAR data and SMART-1 AMIE images containing additional morphological information, in order to produce geochemical-geomorphological maps which provide a clear geological overview of the rock types within the SPA Basin.

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