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Possible compositional stratification of the ancient lunar crust: evidence from geological study of the northern portion of the SPA basin

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A region between 10-60° S and 125-175° W encompasses the northern portion of the South Pole-Aitken (SPA) basin. We conducted a detailed photogeological/stratigraphic analysis of this area and compiled a geological map for this region based on LROC WAC mosaics and LOLA topography. We analyzed the FeO abundancies in units of different ages using the Clementine FeO abundance map.

The crater-related landforms include the following stratigraphic units. Copernican craters with prominent rays and ejecta (Cc), Eratosthenian sharp-crested craters without rays (Ec), and large craters with ejecta and surrounding fields of secondary craters. Determination of the absolute model ages of these craters shows that they vary in age from the Lower to Upper Imbrian (LIc, UIc) epochs. Additional crater-related units include: Ejecta from the Orientale basin of the Lower Imbrian age (LIo) and Nectarian-pre-Nectarian craters with complete rims but without ejecta (NpNc). Also present are massifs of the Apollo (pNrnAPL) and SPA (pNrnSPA) basin rims of the pre-Nectarian age. Finally, strongly degraded crater materials of the pre-Nectarian age occur within the SPA floor (pNmSPAf) and rim (pNmSPAr). They predate unit NpNc, and show no lower stratigraphic limit. We interpret these units as those formed due to the SPA event.

Plains-forming units include dark and light plains of the Upper Imbrian age (UIdp, UIlp) and low-relief rugged terrain. This unit occurs in two areas where it has different ages. Near the SW corner of the map area, this unit is of the Lower Imbrian age (LIlr), associate with the other plains-forming units and likely represent older volcanic plains. Within the Apollo basin, this unit (pNlrAPL) has the same age as the basin itself and probably represents its impact melts

The oldest materials on the basin floor (pNmSPAf) have typical Fe content of ∼11-13.5 wt %, which accounts for the absolute majority of the SPA iron anomaly; materials on the basin rim are significantly Fe-poorer. The large difference in the Fe abundance between the SPA floor and rim primordial materials suggests that by the time of the SPA event the lunar crust was stratified in respect to the iron content. The oblique SPA impact likely stripped away the upper (Fe-poorer) portion of the crust, the materials of which were re-deposited in the SPA rim, and exposed the lower (Fe-richer) portion of the crust on the basin floor. The characteristic difference between the SPA topographic domains (∼8.5 km) provide the upper estimate of the thickness of the upper, Fe-poorer portion of the crust.

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