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New Crater Counts of the South Pole-Aitken Basin

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Lunar Reconnaissance Orbiter Camera (LROC) images allow us to perform detailed crater size-frequency distribution (CSFD) measurements of the SPA basin to derive absolute model ages of the basin itself as well as several superposed impact structures. The SPA basin is of interest because (1) it might have penetrated the entire lunar crust and exposed lower crustal or upper mantle material, (2) it did not reveal KREEP-rich rocks in contrast with the Imbrium basin, and (3) its age will shed light on the plausibility of a terminal cataclysm [e.g., 1]. Such a cataclysm was proposed to explain the large number of ~3.9 Ga impact ages of the Apollo and Luna samples [e.g., 2]. Provided the age of the SPA basin is close to 4 Ga, this would support the lunar cataclysm hypothesis [3]. Our CSFD measurements indicate that the SPA basin is ~4.26 (±0.03) Ga old (N(1)=3.70x10-1), similar to the ages of ancient samples from the Apollo 16 and 17 landing sites, and the farside meteorites Dhofar 489 and Yamato 86032, which were interpreted to indicate the formation of the SPA basin at 4.23 Ga [4]. We also find that the craters Planck and Oppenheimer formed about the same time as each other, i.e. ~4.09 (+0.02/-0.03; N(1)=1.11x10-1) and ~4.04 Ga (±0.01; N(1)=8.43x10-2) ago. Schrödinger is younger with absolute model age of ~3.92 Ga (±0.02; N(1)=3.74x10-2). Both Planck and Schrödinger are characterized by underlying older surface ages of 4.26 (+0.07/-0.18; N(1)=3.70x10-1) Ga and 4.19 Ga (+0.08/-0.24; N(1)=2.26x10-1), which is close to the age of SPA. We conclude that (1) SPA is significantly older than 4 Ga; (2) this age is consistent with radiometric ages of Apollo 16 and 17 samples, as well as lunar farside meteorites, (3) the absolute model age of SPA is too old for a sharply spiked lunar cataclysm at 3.9-4.0 Ga; (4) some of the younger impacts such as Schrödinger and Planck only incompletely resurfaced the SPA basin as they exhibit underlying older ages that are similar to the age of SPA; (5) to unambiguously determine the age of SPA and excavation depth of material exposed at the surface a dedicated sample return mission is required.

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