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How old is Autolycus crater?

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Accurately determining the lunar cratering chronology is prerequisite for deriving absolute model ages (AMAs) across the lunar surface and throughout the Solar System [e.g., 1]. However, the lunar chronology is only constrained by a few data points over the last 1 Ga and there are no calibration data available between 1 and 3 Ga and beyond 3.9 Ga [2]. Rays from Autolycus and Aristillus cross the Apollo 15 landing site and presumably transported material to this location [3]. [4] proposed that at the Apollo 15 landing site about 32% of any exotic material would come from Autolycus crater and 25% would come from Aristillus crater. [5, 6] proposed that the ^{39}Ar-^{40}Ar age of 2.1 Ga derived from three petrologically distinct, shocked Apollo 15 KREEP basalt samples, date Autolycus crater. Grier et al. [7] reported that the optical maturity (OMAT) characteristics of these craters are indistinguishable from the background values despite the fact that both craters exhibit rays that were used to infer relatively young, i.e., Copernican ages [8, 9]. Thus, both OMAT characteristics and radiometric ages of 2.1 Ga and 1.29 Ga for Autolycus and Aristillus, respectively, suggest that these two craters are not Copernican in age. [10] interpreted newer U-Pb ages of 1.4 and 1.9 Ga from sample 15405 as the formation ages of Aristillus and Autolycus. If Autolycus is indeed the source of the dated exotic material collected at the Apollo 15 landing site, than performing crater size frequency distribution (CSFD) measurements for Autolycus offers the possibility to add a new calibration point to the lunar chronology, particularly in an age range that was previously unconstrained. We used calibrated and map-projected LRO NAC images to perform CSFD measurements within ArcGIS, using CraterTools [11]. CSFDs were then plotted with CraterStats [12], using the production and chronology functions of [13]. We determined ages of 3.72 and 3.85 Ga for the interior (Ai1) and ejecta area Ae3, which we reject because our CSFDs show evidence of secondary craters. Areas Ae1 and Ae2 show very young AMAs ($<\sim$0.5-0.6 Ga), which are too young, considering the fact that Aristillus superposes Autolycus and the results of OMAT studies [7]. Areas Ae4 and Ae5 yielded ages of 3.20 and 3.45 Ga, respectively. Although these ages are least affected by secondaries from Aristillus, they are much older than the 2.1 Ga sample ages that were linked to the formation of Autolycus crater [5, 6]. This either implies that the dated samples are not related to Autolycus or that the CSFD measurements are so heavily affected by resurfacing and secondary cratering from Aristillus that they do not represent the formation age of Autolycus. In either case, because of these uncertainties Autolycus can not currently be used as a calibration point for the lunar chronology function. A dedicated mission to either sample terrains with ages of 1-3 Ga or in situ dating such surfaces is of high priority to further constrain the lunar chronology.

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