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Light Plains in the South-Pole Aitken Basin: Surface Ages and Mineralogical Composition

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We studied light plains in the north-eastern South-Pole Aitken basin to investigate their origin, ages, and mineralogical composition. Light plains, also known as the Cayley Formation, occur on the near- and farside of the Moon. Due to their smooth texture, lower crater densities, and occurrence as crater fills, they were thought to be of volcanic origin [e.g., 1]. However, Apollo 16 samples of light plains deposits were in fact highly brecciated rocks [2]. Therefore, the Imbrium and Orientale impacts were thought to have formed light plains because they reshaped the surface thousands of kilometers from their impact sites. Subsequent studies revealed varying surface ages of light plains [e.g., 3] and different mineralogical compositions, which are in some cases more highland-like and in others more mare-like. Hence, an origin solely from the Imbrium and/or Orientale impacts is unlikely. Thus, the question whether light plains formed due to large impacts or regional cratering, or through endogenic processes remains open.

We performed crater size-frequency measurements [e.g., 4] on Lunar Reconnaissance Orbiter Wide Angle Camera images and obtained absolute model ages between 3.43 and 3.81 Ga. We observed neither a distinctive peak of light plains ages nor clustering of similar ages in any specific regions of the studied area. Due to the fact that the derived ages vary as much as 380 Ma, an origin by a single event seems unlikely. Moreover, some ages even post-date the Imbrium and Orientale impacts, and thus an origin related to those impacts is not likely.

Examination of multispectral data from Clementine [5] shows that the Ti abundances vary between 0.2 and 3 wt % and Fe abundances between 12.5 and 19 wt %. We observed a regional difference in distribution: light plains units within the Apollo basin have lower Fe and Ti values and are more highland-like, whereas light plains outside the Apollo basin show higher Fe and Ti values and are more mare-like. Furthermore, M^3 spectra from small impact craters on light plains show characteristic absorption bands for pyroxene.

We conclude that light plains are unlikely to have formed by the Imbrium and Orientale impacts due to the range of surface ages and the compositional differences. Nevertheless, these impacts together with secondary cratering and sedimentation from regional and local impacts may have played an important role in forming these plains. An endogenic origin can still not be excluded due to the mare-like composition of some light plains.

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