Absolute Model Ages of Light Plains in the Southern Lunar Hemisphere. H. Hiesinger[1], C. H. van der Bogert[1], F. Thiessen[1], M. S. Robinson[2], [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (hiesinger@uni-muenster.de), [2]Arizona State University, Tempe, AZ, USA.

Introduction: Lunar light plains cover ~5% of the lunar surface and are widely distributed on both the nearside and farside [1]. They are characterized by relative smoothness and lower crater densities (compared to the highlands), and their occurrence as crater fills. However, they also exhibit highland-like characteristics such as high albedos (in comparison to mare basalts) and their geological and stratigraphic setting. Light plains not only occur on the Moon, but are also important geologic units on other planetary bodies, including Mercury. Originally light plains were interpreted as products of volcanic ash flows due to the mantled appearance and a noticeable thickness of the material [2]. Alternatively, light plains were interpreted as effusive flows because they often occur as smooth deposits in crater interiors and other topographic lows, and embay, bury, and cross-cut older landforms [3]. Light plains, i.e., the Cayley Plains were chosen as landing site for the Apollo 16 mission, which returned ~95 kg of samples [4]. Surprisingly, a large number of rock samples turned out to be light-colored plagioclase-rich breccias instead of volcanic rocks. Consequently, several impact-related models of the origin of light plains were proposed, including (1) ejecta of large basins, particularly Imbrium and Orientale [e.g., 5,6,7], (2) a mixture of material from local and regional craters in addition to basin ejecta [8], and (3) in-situ formation by impact melt from large events [9]. Crater size-frequency distribution (CSFD) measurements demonstrated that at least some light plains post-date the Imbrium and Orientale impacts. Hence, for those light plains an endogenic origin was proposed [e.g., 10,11]. The different volcanic-related theories include: (1) unknown form of highland volcanism [e.g., 12] (2) KREEP volcanism [e.g., 13], and (3) cryptomaria [e.g., 14].

In summary, despite the long history of investigating light plains, there are still numerous open questions concerning their mode of emplacement, their mineralogical composition, their ages and their origin.

Data and Methods: For this study we performed new crater size-frequency distribution measurements of 16 light plains located in the southern lunar hemisphere, both within and outside the South Pole-Aitken basin. We used ISIS [15] to process a global mosaic of LRO wide-angle camera (WAC) images with a pixel scale of 100 m/pixel. Within ArcGIS, we used CraterTools [16] to perform our crater counts. The count areas were primarily defined on the basis of morphology. The CSFDs were plotted with CraterStats [17]. We used the production function (PF) and the lunar chronology of [18]. A detailed description of the technique of CSFD measurements is given by [e.g., 18-21].

Results: We dated 16 occurences of light plains with CSFDs. All dated regions were previously identified as light plains and either mapped as smooth light plains (Ip) or light plains with undulatory surface (INp) in the geologic maps [1, 22-25]. The investigated light plains are located both inside and outside the South Pole-Aitken (SPA) basin within a latitudinal band between ~-36° and ~-75°. In particular, we investigated the following smooth light plains: Janssen (40.82°E, -44.96°; Ip [1]), Nishina (-170.8°E, -44.57°; Ip [22]), South of Nishina (Ip [22]), Obruchev (162.43°E, -38.67°; Ip [22]), Oresme (169.22°E, -42.61°, Ip [22]), Schrödinger (132.93°E, -74.73°; Ip [23]), Nearch (39.01°E, -58.58°; Ip [23]), Nasmyth (-56.39°E, -50.49°; Ip [23]), Manzinus (26.37°E, -67.51°; Ip [23]), Klaproth (-26.26°E, -69.85°; Ip [23]), Phocylides (-57.31°E, -52.79°, Ip [23]), Buffon (-133.53°E, -40.64°; Ip [24]), Roche (136.54°E, -42.37°; Ip [25]). We also dated the following light plains with undulatory surfaces: Koch (150.33°E, -42.13°; INp [22]), Garavito (156.78°E, -47.21°; INp [22]), Eötvös (134.43°E, -35.61°; INp [25]). Our CSFD measurements yield absolute model ages of 3.71 to 4.02 Ga for all studied light plains, thus confirming the Imbrian and/or Nectarian ages of the geologic maps [1,22-25]. While we only dated three INp light plains, they appear to have ages that are close to the upper limit, i.e., 3.96-4.02 Ga (Tab. 1; Fig. 1). However, further studies of INp light plains are necessary to support this preliminary finding. Our new absolute model ages are generally similar to model ages derived for light plains north of Mare Frigoris, which vary between 3.65 to 4.0 Ga [11], light plains within the

SPA basin (3.43-3.81 Ga) [26], and light plains in the surroundings of the Orientale and Imbrium basins (3.8-4.3 Ga) [10]. Not only are the ages similar, they also show similar ranges. While our model ages vary by about 300 Ma, model ages of [11,26] exhibit a range of ~350 Ma and ~380 Ma, respectively. A somewhat wider range of ages of ~500 Ma has been documented by [10].

Ip Light Plains	**Age**	**Error**
Nishina	3.71	+0.02/-0.03
S of Nishina	3.72	+0.01/-0.01
Oresme	3.87	+0.01/-0.01
Buffon	3.88	+0.01/-0.01
Phocylides	3.88	+0.01/-0.01
Obruchev	3.89	+0.02/-0.03
Schrödinger	3.90	+0.01/-0.01
Nasmyth	3.90	+0.01/-0.01
Roche	3.91	+0.01/-0.02
Nearch	3.91	+0.01/-0.01
Janssen	3.96	+0.02/-0.02
Klaproth	3.96	+0.00/-0.01
Manzinus	4.00	+0.01/-0.01
INp Light Plains	**Age**	**Error**
Garavito	3.96	+0.02/-0.02
Eötvös	4.01	+0.01/-0.02
Koch	4.02	+0.02/-0.02

Tab. 1 Ages of all investigated light plains.

Discussion: One of the key scientific questions concerning light plains is their origin. Previous studies [10,11,26] have come to the conclusion that the range in ages of several hundreds of millions of years is inconsistent with the formation of the light plains by a single event (i.e., Orientale or Imbrium) and that at least some of the light plains might be volcanic in origin. While this might be plausible for light plains close to mare areas, especially on the lunar nearside, we did not observe any morphologic evidence that would support a volcanic origin such as flow fronts, volcanic vents, domes or dikes. We also did not observe characteristic morphologies typical for impact melt deposits, including dark albedos, cooling cracks, and flow features [27]. However, for several billion years the surface has been subjected to intense impact bombardment, which likely destroyed or obscured the original small-scale volcanic or impact melt morphologies and caused lateral mixing to change the albedos. Alternative to the volcanic and impact melt origin, the light plains might be ponded fluidized impact breccia deposits [5].

On the basis of radiometrically dated lunar samples the ages of the Imbrium and Orientale basin are not very well constrained [28]. Carefully reviewing the available radiometric ages, [28] concluded that Imbrium might be 3.77 or 3.85 Ga old, depending on the interpretation of the lunar samples. Similarly, Orientale might either be 3.72-3.75 Ga or 3.72-3.85 Ga old. Consequently, only the youngest light plains could be related to these basin forming events, whereas the older light plains either require a formation by older basins, local craters or a mixture of both. We are investigating compositional differences of light plains using spectral data to supplement our morphologic studies and age determinations.

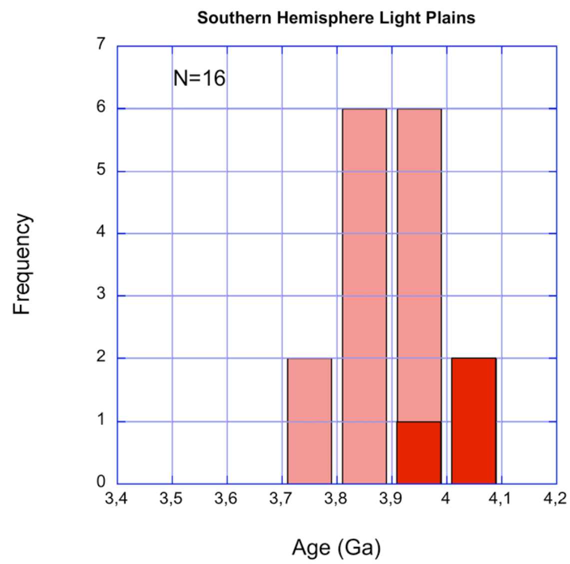

Fig. 2 Distribution of ages of all investigated light plains (Ip and INp). Highlighted in dark red are INp light plains.

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