Surface Ages and Mineralogy of Lunar Light Plains in the South-Pole Aitken Basin. F. Thiessen[1], H. Hiesinger[1], C.H. van der Bogert[1], J.H. Pasckert[1]. M.S. Robinson[2], [1]Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Fiona.Thiessen@uni-muenster.de, [2]Arizona State University, Tempe, AZ, USA.

Introduction and Background: Light plains - also known as the Cayley Formation – cover about 5 % of the lunar surface [1] and are widely distributed on the near- and farside of the Moon. They show some mare-like features such as their smoothness, occurrence as crater fills, and lower crater densities. However, light plains are highland-like due to their geological setting and their relatively high albedo in comparison to mare basalts.

Before the Apollo 16 mission, light plains were thought to be volcanic in origin due to their smoothness and their appearance in craters and other topographic lows [e.g., 2]. The Cayley Formation was chosen as landing site for the Apollo 16 mission, partly to confirm the volcanic origin of light plains. However, the returned samples turned out to be impact breccias [3]. Thus, an impact-related origin was considered and due to the widespread occurrence of light plains, they were thought to have formed contemporaneously by one single event [4]. The last two basin forming impacts, Orientale and Imbrium, are good candidates because they had the ability to reshape the lunar surface thousands of kilometers away from their impact sites. However, some subsequent studies indicated that some light plains lie outside the continuous deposits of Imbrium and Orientale. Other impact-related models for the origin of light plains have been suggested, e.g. mixing of ejecta from big basins and local materials [5]. Even an endogenic origin was proposed again for some light plains due to age determinations giving varying surface ages and in some cases even younger ages than Orientale [e.g., 6]. These units therefore cannot solely be correlated to the Imbrium or Orientale impacts. Thus, many questions about origin, mode of emplacement, composition, and ages of light plains still remain open. To answer some of these questions, ages for light plains in the central farside of the Moon were derived and spectral data of light plains were analyzed to gather information about their mineralogical composition.

Datasets and Methods: The investigation area is situated at the north-eastern edge of the South-Pole Aitken basin. The most prominent features in this area are the Apollo and Oppenheimer craters.

To determine the ages of light plains, images from the Lunar Reconnaissance Orbiter Camera (LROC) were used. Crater counts were performed on both NAC (Narrow Angle Camera) and WAC (Wide Angle Camera) images. While NAC images have a pixel scale of about 1m/pixel, WAC images have a scale of ~100 m/pixel. [7]. In order to obtain absolute model ages of light plains, we performed crater size-frequency distribution (CSFD) measurements [e.g., 8].

To investigate the mineralogical composition of the selected area, multispectral data from Clementine were studied. In particular, we used maps of FeO and TiO_2 [9]. Additionally, M³ data were used to obtain spectra of the selected areas for a better understanding of the mineralogy of light plains.

Fourteen light plains units were mapped (Fig. 1) on the basis of the geological map of Stuart-Alexander (1978) [10]. Crater counts were made using Crater Tool [11] in ArcGIS, and CSFD were plotted and fit using Craterstats [12]. For every counted area on the WAC-mosaic, corresponding NAC images were selected and crater counts were performed on subsets of the NAC images. Because the light plains units are all Imbrian-aged, some surfaces have been heavily modified and/or resurfaced. We paid particular attention to avoid counting secondary craters.

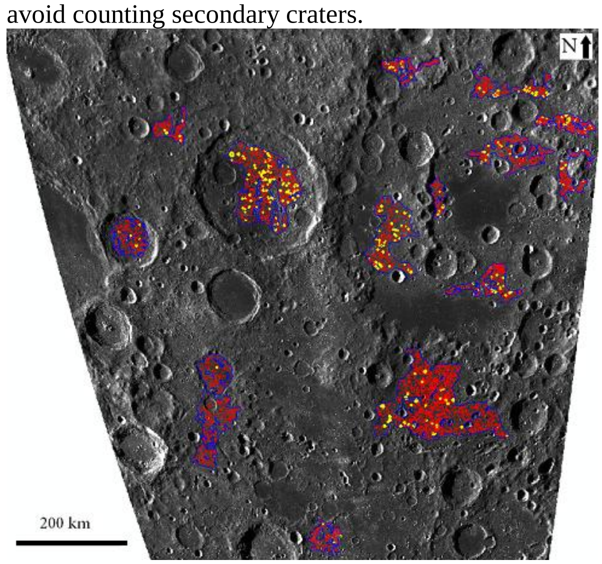

Figure 1: *Crater counts performed on WAC mosaic (100m/pixel) from the Lunar Reconnaissance Orbiter Camera (LROC). Red marked craters were included in age determinations, yellow marked craters are likely secondary craters and were excluded.*

Results:

Surface Ages: Crater counts on the WAC mosaic yielded absolute model ages between 3.43 (+0.07/-0.15) and 3.81 (+0.06/-0.11) Ga. Ages could not be derived from the NAC counts, because the surfaces have reached equilibrium at the smaller crater diameters seen in NAC images.

The following observations can be made: (1) in total the ages of light plains vary by 380 Ma and therefore an origin by one single event can be excluded. (2) The oldest age determined is 3.81 Ga, which post-dates the Imbrium and Orientale impacts, which formed ~3.92 Ga and ~3.84 Ga, respectively [13]. Hence an origin solely from those large basin-forming impacts is also less likely. Other big basins, such as Mare Humorum or Mare Australe, which also are located close to the investigation area, pre-date the formation of light plains as well and thus can be excluded. (3) We did not observe a distinctive peak of light plains ages, nevertheless, six units formed in a relatively close interval - between 3.69 and 3.75 Ga. (4) No clustering of similar ages in specific regions of the investigated areas, e.g. within the Apollo basin, was observed.

Clementine and M³data: Multispectral data from Clementine were used to estimate the FeO and TiO_2 abundances (Fig. 2). The Ti content varies in total between 0.2 and 3 wt %. The Ti content of light plains in the Apollo basin (0.2-1.2 wt %) is lower than that of all other investigated light plains. The same observation can be made for the Fe content, which varies in total between 12.5 and 19 wt %. Within the Apollo basin the Fe content is concentrated around 11-13 wt %; all other light plains units have slightly higher Fe contents. Basalts in the investigated area have Ti values between 4 and 8 wt % and Fe values between 18 and 21 wt %.

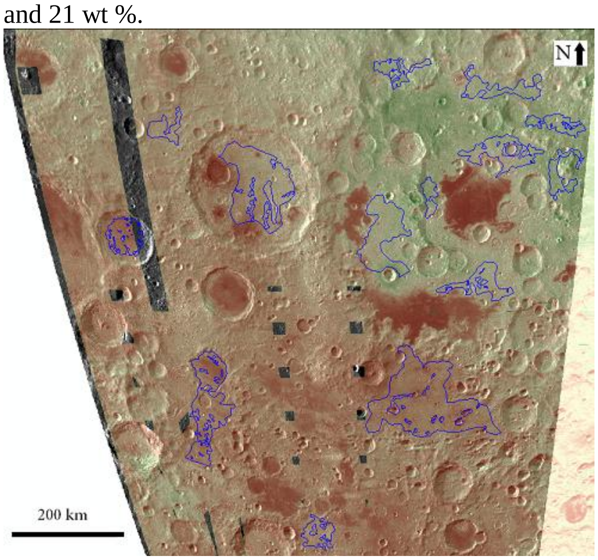

Figure 2: *FeO abundance: red colored areas represent higher Fe contents, green color areas lower Fe contents; investigated light plains units are outlined in blue.*

Spectra from small impact craters on different light plains units show characteristic absorption bands for pyroxene [e.g., 14]. However, in comparison to basalts in the studied area, light plains show less distinctive absorption bands (Fig. 3). Light plains units outside the Apollo basin show mare-like characteristics and units inside the Apollo basin are more highland-like. Thus, light plains outside the Apollo basin are more likely to have an endogenic origin. Alternately, the basalt-like spectra could represent cryptomare units hidden by light plains materials.

Conclusions: Based on the fact that the derived surface ages for light plains deposits vary in total by 380 Ma, an origin solely related to the Imbrium or Orientale impact can be excluded. Nevertheless, secondary cratering and sedimentation from regional impacts probably was quite important in forming these plains. Also an endogenic origin of light plains in this area cannot be excluded due to the fact that some light plains units show mineralogical compositions that are mare-like. This could also be a hint that cryptomare lies beneath the light plains. However, an extensive cryptomare body under all light plains units could not be identified.

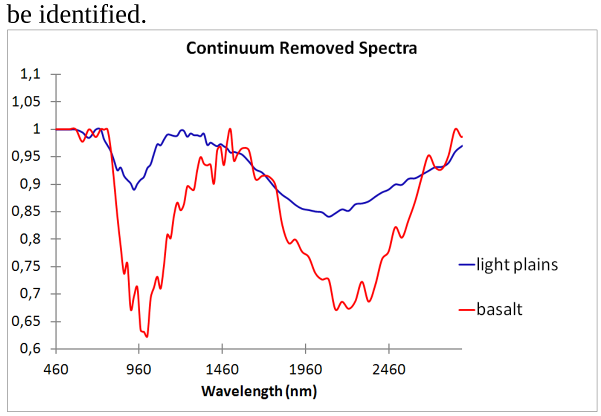

Figure 3: *Example of a M³ spectrum of light plains in comparison to a basalt unit; both spectra were obtained within the Apollo basin. The 1 and 2 µm absorptions are indicative of pyroxene.*

References:

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