MARE AUSTRALE: NEW RESULTS FROM LUNAR ORBITER AND CLEMENTINE UV/VIS IMAGERY

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Introduction:

Mare Australe is an old lunar impact basin which is visible in its entire shape only in spacecraft images but not from Earth. We used Lunar Orbiter IV images as well as Clementine UV/VIS images acquired in 1994 in order to study basalt ponds of the Mare Australe basin. We performed crater counts, measured the size of the basalt ponds and the nearest neighbor distance and compared our results for Mare Australe to previously published results for the Mare Orientale region and the South Pole-Aitken basin.

Mare Australe is an 880 km wide pre-Nectarian impact basin located near the southeastern limb of the Moon. The basin has been intensively reworked by impact cratering prior to the extrusion of basaltic material. In contrast to the large nearside basins, the Australe basin is not completely filled with basalts. In Mare Australe the basalt eruptions mostly cover the interior of smaller craters and some intercrater regions. Therefore the appearance of Mare Australe is more like that of the South Pole Aitken basin or the Mare Orientale area than that of the nearside basins. Data for Mare Orientale and the South Pole-Aitken basin to which we refer are published by Yingst and Head [1]. Whitford-Stark [2] mapped about 248 single basalt ponds in the Mare Australe region. We used high resolution Lunar Orbiter images as well as Clementine UV/VIS images in order to derive the surface area of about 169 ponds and to determine the surface ages of 14 of such ponds. Our crater counts reveal generally Imbrian ages for the basalt extrusions. At the present state the results of our crater counts do not reflect the annular occurrence of basalt extrusions of four different ages, with the youngest basalts exposed near the outer edge of the basin, as proposed by Whitford-Stark. However, as we have only little data from specific ponds we cannot exclude the posssibility of such a circular age structure. Compared to existing crater counts for Mare Orientale and the South Pole-Aitken basin, our data may suggest that the basaltic volcanism lasted longer in Mare Orientale than in Mare Australe and in the South Pole-Aitken basin. Investigation of the morphology in the lava ponds generally reveals a paucity of all kinds of morphological features. Compared to Mare Orientale where over one-fourth of the ponds [1] have associated sinuous rilles, Mare Australe exhibits an unusual low number of morphological features. We identified only 3 sinuous rilles in the 196 observed ponds and 19 wrinkle ridges which are restricted to ponds larger than 330 km^2. Actually, only one wrinkle ridge (=5%) occurs in a pond less than 500 km^2 in size and only 3 wrinkle ridges (=16%) are found in ponds with less than 1000 km^2 size, whereas 15 wrinkle ridges (=79%) appear in ponds larger than 1000 km^2. Taking into account Whitford-Stark´s proposed annular surface age distribution, we found that 68% of the wrinkle ridges appear in ponds which are filled with the youngest basalts. 21% of the wrinkle ridges appear in ponds filled with second youngest basalts, 11% in ponds flooded with older basalts and no wrinkle ridge was detected in the oldest basalt ponds. The sizes of the ponds vary from 2 km^2 to 30000 km^2 with 30% of the ponds having less than 100 km^2 spatial extension. According to the mode of occurrence we found that 29% of the ponds outside the actual basin structure represent crater floors and about 4% are intercrater regions. Inside the Australe basin 40% of the ponds are mapped as crater floors and 27% as intercrater regions. It is obvious that the basalt flooding of intercrater regions as well as the basalt filling of crater floors are more abundant inside the basin structure. The mean pond size is about 1100 km^2 and very similar to the mean pond size of Mare Orientale, whereas the mean pond size of the South Pole Aitken basin is nearly twice as large (2000 km^2). On the other hand, the nearest-neighbor distance is 36 km for Mare Australe ponds but 160 km for Mare Orientale and South Pole-Aitken ponds,

respectively. The Clementine data indicate, that Mare Australe is a relativly shallow basin (4 km deep, referring to the mean datum of r=1738 km) compared to the South Pole-Aitken basin (13 km deep) and the Orientale basin (5-6 km deep). The crustal thickness derived from Clementine altimeter and gravity data [3] indicate a very solid crust of 45-70 km in the Australe area but a thinner crust for the South Pole-Aitken basin (20-60 km) and Mare Orientale (4-80 km). Assuming a diameter of 2500 km for the South Pole-Aitken basin, of 930 km for Mare Orientale and of 880 km for Mare Australe, the surface areas covered by ponds correspond to 2%, 6% and about 40% of the total basin surface, respectively.

	South Pole Aitken	Mare Orientale	Mare Australe
Mean diameter [km]	2500	930	880
Surface area [km^2]	4908738	679291	608212
Number of ponds	52	34	248
Mean basin pond density [km^2/pond]	94399	19979	2452
Mean pond size [km^2]	2000	1100	~1100
Mean pond volume [km^3]	1088	237	t.b.d
Depth of basin [km]	13	5-6	4
Nearest neighbor distance [km]	160	160	36
Pond surface ages [Ga]	3.63-3.64	2.49-3.8	3.26-3.81
Crustal thickness [km]	20-60	4-80	45-70
Pond surface/total basin surface [%]	2	6	~40

Tab.1: Ponds of Mare Australe compared with the results of Yingst and Head (1995) for Mare Orientale and the South Pole-Aitken basin.

References:

[1] YINGST R. A., HEAD J. W. III, (1995). Volumes of individual eruptive episodes on the Moon: Implications for eruption conditions, crustal transport mechanisms and magma source regions. Submitted to : Planetary and Space Science

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[3] ZUBER M. T., SMITH D. E., LEMOINE F. G., NEUMANN G. A., (1994). The shape and internal structure of the Moon from the Clementine mission. Science, vol. 266, 1839-1843