ESTABLISHING A PRECISE ABSOLUTE CHRONOLOGY OF THE MOON – A NEED FOR ROBOTIC MISSIONS.

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Introduction: Establishing a precise absolute chronology is one of the highest priority goals listed by the National Research Council in "The Scientific Context for Exploration of the Moon" [1]. It is therefore necessary to determine the absolute ages of numerous craters and maria (representatively distributed temporally and geographically) that have well detemined relative ages (particularly those that definine or fall close to the chronological boundaries) by returning samples from their surfaces to Earth for radioisotope dating. The number of features that need to be dated is much greater than the number of locations that can be realistically visited by manned missions in the initial phase of exploration. Robotic sample return missions have been successfully used in the past with the Luna 16, 20 and 24 missions [2]. Samples from Luna 16 allowed the age of a section of Mare Fecunditatis to be established as 3.41 Ga; dating samples from Luna 24 established the age of part of Mare Crisium as 3.4 - 3.6 Ga [3].

Proposed approach: Robotic sample return missions could be used to establish the absolute ages of selected surfaces and features in order to establish a precise absolute chronology. Compared to manned landings on non-complex surfaces (which can play a crucial role in establishing a precise lunar chronology), they are more cost effective. Surfaces that could be dated through robotic landings should be selected based on the following criteria: 1) their relative age (younger surfaces are better), 2) surface roughness (smoother and flatter surfaces are preferred), 3) the predicted ease with which a particular sample can be linked to the specific lunar surface feature (the "linkage potential"), 4) size of selected unit (large enough to allow high quality crater counting).

Although it is sufficient to merely sample the selected surfaces and return the samples to Earth in order to establish an absolute chronology, the mission payload should include additional instruments for other scientific goals. These could include: panoramic camera, microscopic imager, spectrometers, seismometers, ground penetrating radars [4]. The landing site selection process should be preluded by an orbital reconnaissance mission that includes; high-resolution imaging (for crater counting and terrain roughness) and mineralogical mapping (in order to determine between melt deposits basalt or regolith).

Proposed landing sites: There are two types of localities which could be selected as landing sites for these robotic sample return missions:

1) Mare surfaces with relative ages (based on crater counting) between 3 and ~1 Ga [5]. At least a few points from this time range are required in order to calibrate impact flux curves [3]. Landing at a few sites within Oceanus Procellarum [5] should be sufficient to fulfill this aim. Selecting a landing site on the boundary between different lava flows or on the rim of small craters (located on the younge flow and with an excavation depth sufficient to penetrate beneath the flow) should allow multiple surfaces to be dated during a single mission.

2) Craters with easily visible (and therefore accessible) large melt sheets or ponds. Most craters younger than ~3 Ga and larger than 30 - 50 km in diameter [6] contain such units. An example of such a locality is King crater (5.0 N, 120.5 E) (Figure 1). It is one of the largest Copernican-aged craters and is located on the far side, is therefore a good candidate for a robotic sample return mission [7]. King has an extensive melt pond (~285km^2) located on the north rim of the crater that could be a convenient landing site.

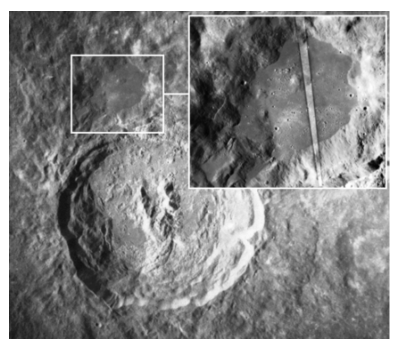

Figure 1 Melt pond on the northern rim of the King crater. AS16-M-1580, AS16-P-5000 and 4998.

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References:

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