MAUNDER CRATER: A CASE STUDY OF A LANDING SITE DESIGNED TO FULL-FILL MULTIPLE NRC [2007] SCIENCE OBJECTIVES. Z. E. Gallegos[1], P. Donohue[2] N. Hammond[3], R. W. K. Potter[4], D. A. Kring[5], [1]University of New Mexico, Albuquerque, NM, zackman@unm.edu; [2]University of Notre Dame, Notre Dame, IN, [3]University of California, Santa Cruz, CA, [4]Imperial College London, London, UK, [5]Lunar and Planetary Institute, Houston, TX.

Introduction: When the *National Research Council (NRC)* outlined science priorities for lunar exploration, it defined goals that (i) will clarify the origin and evolution of the Moon and (ii) will provide insights into processes that occur throughout the solar system [1]. With regard to (ii), the *NRC* pointed out that the Moon is an ideal laboratory for studying impact process and outlined four specific science objectives that will aid interpretations of similar structures on all planetary surfaces. We evaluated lunar surface sites where each of those objectives can be addressed and then integrated those results to find a subset of locations where all four objectives can be simultaneously addressed. We outline those objectives here, describe suitable landing sites, and then provide a case study of a single landing site where the objectives can be met.

Science Goals:
6a *Characterize the existence and extent of melt sheet differentiation*: Impact melt sheet differentiation has been a subject of debate in the past, particularly towards its existence on the Moon. Two primary analysis methods exist for assessing the hypothesis, both of which involve craters that have subsequently 'drilled' into an older, possibly differentiated melt sheet. The first is stratigraphic interpretation of uplifted central peak material from a subsequent impact. This can be accomplished by sampling along a traverse up or down a central peak or by sampling boulders that have rolled to the base of the peak. The second method is to test for chemical variability in melt samples that are excavated by later impact events. Radial sampling of those later ejecta blankets can be used to create a stratigraphic assessment of melt sheet differentiation with originally deep material concentrated in close proximity to the crater and originally shallow material ejected farther from the crater.
6b *Determine the structure of multi-ring impact basins*: Multi-ring basins are the largest observable impact structures in the Solar System yet their formation mechanisms and, therefore, their structure, are still debated. Two methods can be used to test current hypotheses and to determine multi-ring basin structure: geological sampling and geophysical data collection.
6c *Quantify the effects of planetary characteristics (composition, density, and impact velocities) on crater formation and morphology*: Crater formation and morphology varies as a result of unique physical and chemical characteristics of a specific target as well as the speed of the impactor. A range of craters must be studied and sampled to fully understand the effects of those variables.
6d *Measure the extent of lateral and vertical mixing of local and ejecta material*: Ejecta mixing ratios are poorly constrained due to limited well-studied, terrestrial analogues. Lunar craters with distinct ejecta blankets (*i.e.*, those with rays, high albedo or distinct compositions) are the best candidates for study. The method for accessing deep within the ejecta blanket, where ballistically ejected material mixed more thoroughly with local material, will rely on later impacts that, again, 'drill' into a larger craters ejecta blanket. To study the extent of this process, samples of the mixed ejecta blanket must be taken radially.

Case Study: We identified four localities on the

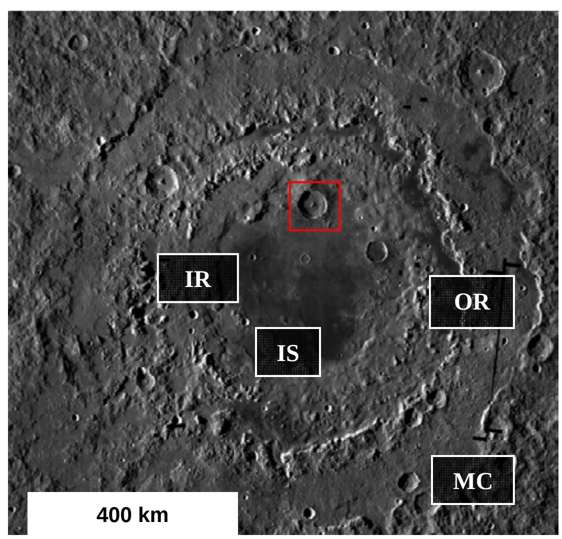

Figure 1: The location of Maunder Crater within Orientale Basin. IS = Inner Shelf Ring, IR = Inner Rook Ring, OR = Outer Rook Ring, MC = Montes Cordillera

Moon where all four of these goals can be addressed concurrently, including sites within the Humboldtianum, Mendel-Rydberg, Nectaris, and Orientale Basins. Directly east of Maunder Crater, (within Orientale Basin, **Figure 1**) is an area where all four science goals within Concept 6 can be addressed simultaneously. Outlined in **Figure 2** are the potential traverse areas, within 10 km and 20 km radii of a landing site, which are the current exploration limits for crew. Also shown is a traverse path with sampling sites from the rim of Maunder towards the Inner-Shelf Ring (**Figure 3**), the best path for assessing all goals of Concept 6. The slopes that rovers must traverse are ~ 4° for the rim of Maunder Crater and ~ 7° for the Inner-Shelf Ring, which are well within the current architectural limits. Tests of each science goal will be conducted using the methods described above.

With regard to 6a, there is a potential caveat. Because Maunder Crater is located just inside the edge of Orientale's proposed transient crater rim, the melt sheet of Orientale will be significantly thinner than near the basin's center. Thus, portions of Orientale's melt sheet that are excavated by Maunder may be undifferentiated, even if Orientale's central melt sheet is differentiated.

With regard to 6b, this landing site is particularly interesting. Although the Inner Shelf Ring is not as prominent a feature as the other rings within Orientale Basin, it provides a key test of different models that interpret it as either remnants of the transient crater melt lining, a block of upper crust that moved along a thrust fault, or the remnants of a collapsed central peak

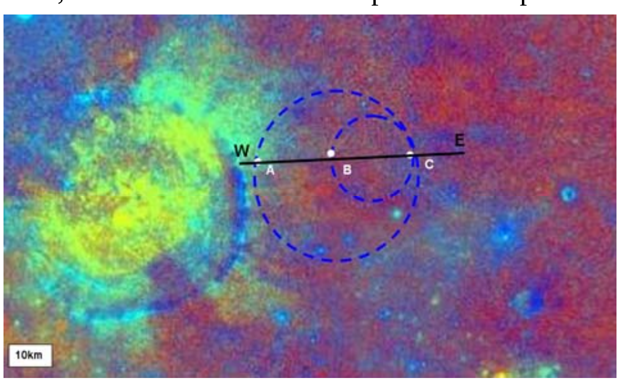

Figure 2: Clementine false color RGB image of Maunder Crater. The blue segmented circles show the extent of a 20 km and 10 km exploration radius. Sites **A**, **B** and **C** represent potential sampling sites along a roughly east to west transect.

that may (or may not) have an overturned sequence of lithologies.

With regard to 6d, spectral data from Maunder Crater suggests the impact excavated multiple lithologies. Depending on the complexity of those lithologies, that may make it easier (or more difficult) to evaluate mixing within the ejecta blanket.

The traverse distance will govern the amount of science accomplished. If the traverse is limited to a 10 km radius, then crew will have less distance over which to sample radially to address goals 6a and 6d; they would not have an opportunity to examine the interior of Maunder Crater and sample ejected Maunder melt, affecting our ability to address goal 6c. On the other hand, if the traverse limit was extended to 20 km from the lander, allowing travel over the entire 40 km-long path shown in **Figure 2**, then crew would maximize their ability to address all of the *NRC*'s Concept 6 goals and provide a series of benchmarks about impact cratering processes that can be applied to planetary surfaces throughout the solar system.

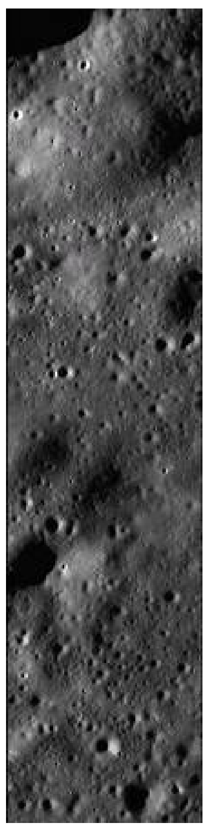

Figure 3: LROC NAC image M133431792LE (full width, top section); A potential area of study near the Inner Shelf Ring in the vicinity of site C (see **Figure 2**)

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References: [1] National Research Council (2007) *The scientific context for exploration of the Moon*, final report.