TYCHO CRATER: A POTENTIAL LANDING SITE TO STUDY A DIVERSITY OF REGOLITH PROCESSES AND SPACE WEATHERING. A. Przepiórka[1], S. Crites[2], S. Quintana[3], C. Santiago[4], T. Trabucchi[5], D. A. Kring[6]; [1]Space Research Centre of the Polish Academy of Sciences, Warsaw, Poland, aprzepiorka@cbk.waw.pl; [2]University of Hawai'i, Honolulu, HI; [3]Brown University, Providence, RI; [4]University of Texas at El Paso, El Paso, TX; [5]University of New Brunswick, New Brunswick, Canada; [6]Lunar and Planetary Institute, Houston, TX.

Introduction: The lunar regolith is a scientifically-rich geologic unit. This was first demonstrated with the Apollo 11 sample return mission when small particles of anorthosite in the regolith quickly led to the lunar magma ocean hypothesis [1]. It is also a critical interface for any future exploration efforts that will need to accommodate and potentially utilize this surface material. These and other facets of the regolith were captured by the National Research Council (NRC) in its 2007 report about *The Scientific Context for Exploration of the Moon* [2]. That report specifically identifies four types of regolith studies needed for future missions. A global survey of the Moon was conducted to identify lunar surface locations where those goals can be addressed [3]. In this paper, we describe one of those sites, Tycho Crater, and how all four goals can be accommodated at that site.

Tycho region characteristic: Tycho is a young Copernican age crater (~110 Ma [4]) with a diameter of ~85 km [4]. Continuous ejecta extends to a distance of ~110 km [5] beyond the crater rim and distinctive crater rays, visible from Earth, extend to distances of 2,000 km [4].

The suggested landing site is located at ~41.4° S and 11.8° W, which is ~20 km northwest of the Tycho crater rim.

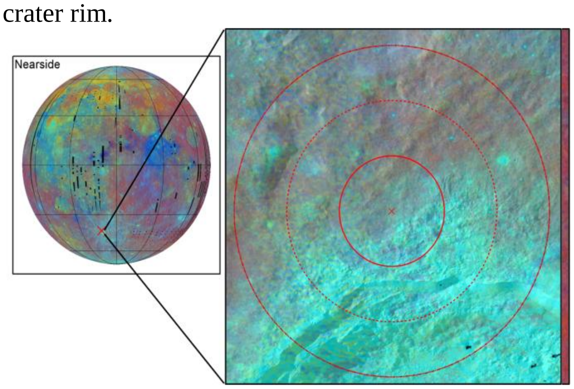

Figure 1: Clementine mosaic showing the nearside hemisphere and a zoomed view of the Tycho landing site. The region has material of two different compositions, and both are accessible from our proposed landing site.

This site is attractive for several reasons: it provides a sharp contrast between regolith formation on an impact melt-rich pond and on coarse, granular ejecta; between older highland regolith and young regolith of a suspected and easily verifiable age; between regolith formation on units of different chemical and mineralogical compositions as implied by the Clementine UVVIS instrument (Fig. 1); and between different ejecta deposits that vary in composition with radial distance from the crater rim. Furthermore, the slopes in the proposed region range from 4.5 to 8° [6], which are accessible to both human and robotic explorers. We now evaluate each of the NRC goals [2] and describe how they can be accommodated within this region.

Science goal 7a: Search for and characterize ancient regolith: The landing site is located on the continuous ejecta blanket of Tycho, ~20 km from the crater rim (Fig. 2). Ancient regolith may be exposed in layered depoits that are visible in the crater rim.

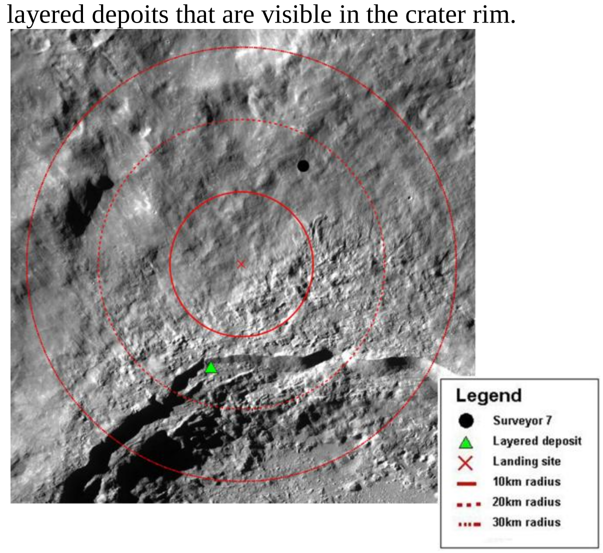

Figure 2: WAC mosaic of the Tycho landing site, denoted by a red "x" with circles denoting ranges of exploration. The inner circle is 10 km in radius, followed by 20 km and 30 km.

Tycho Crater was excavated from a highlands terrain of pre-Imbrian age, so any paleoregolith layers in Tycho's walls will also have a pre-Imbrian age. Preserved pre-Imbrian regolith should also occur beneath Tycho's continuous ejecta blanket. However, no smaller craters penetrate the ejecta and expose that older regolith. Thus, Tycho's crater walls are the best target for sampling. Slopes for the upper edges of Tycho's rim exceed 25º in only a few locations; a navigable route to access layered deposits can probably be found.

Science goal 7b: Determine the physical properties of the regolith at diverse location of expected human activity: Although any activity within the area may be limited to a few tens of kilometers, that will still provide access to diverse regolith deposits that can serve as proxies for other areas of the Moon. The site provides access to regolith produced from substrates of different compositions (Fig. 1), of different material properties (e.g., coherent melt pond vs. rubbly ejecta), and in a highlands area far from PKT mare-rich regions sampled by Apollo. We also note that Apollo 17 landed near one of the crater rays ~2000 km from Tycho and Surveyor 7 landed on the ejecta blanket ~30 km north of Tycho's rim. Thus, we can leverage these previous missions to compare the properties of regolith of the same age formed from different types of ejecta deposits

Science goal 7c: Understand regolith modification processes (including space weathering), particularly deposition of volatile materials: Remote sensing maturity maps developed by Lucey et al. 2000b [7] suggest the landing site contains both very immature and intermediately mature soils, providing an opportunity to see the evolution of space weaterhing processes. Furthermore, the Surveyor 7 spacecraft, which is ~20 km from the landing site, provides an opportunity to study the effects of space weathering on a known surface for a known amount of time (currently 44 yrs), a goal that is specifically stated in the NRC 2007 report. Because Surveyor 7 is located ~20 km from the proposed landing site, it should not suffer the 'sandblasting' effects that undermined similar measurements of Surveyor 3, which was 'sandblasted' by the descent engine of the Apollo 12 LM landing just 183 m away [8]. Surveyor 7 should, therefore, provide a more pristine sample of space weathering. Finally, the Tycho landing site is not near a lunar magnetic anomaly, so all space weathering processes are expected to be normal and representative of the lunar highlands. Solar-wind production of volatiles can also be nicely calibrated here, because the exposure age (100 Ma) is known and the orbital relationship between the Moon and the Sun has not changed significantly over that period [8].

Science goal 7d: Separate and study rare materials in the lunar regolith: Rare materials refer to the meteoritic material, *i.e.*, meteoritic fragments of a few millimeters in diameter. Because the landing site provides access to regolith of different ages, one has the potential of identifying relicts of projectiles that hit the Moon at different times [9]. It is also possible that chemical traces of the projectile that produced Tycho Crater can be found in the melt-rich rocks at the landing site.

Rare can also refer to lunar material from a distant region. Tycho Crater is, however, a relatively young crater, so the new surface created by its ejecta blanket will not have been contaminated by material deposited by large, distant impact events.

Conclusions: The proposed landing site provides an opportunity to sample material that addresses all four of the goals outlined by the NRC [2] for understanding the lunar regolith and the processes that modify that type of material on the Moon and other airless bodies. Tycho also provides an opportunity to study many other scientific issues. The impact event, for example, exhumed material from depth and deposited it in the region of the landing site. It also melted material in the lunar crust, providing a chemical signature of units from an even deeper interval. Thus, Tycho Crater is one of those locations on the lunar surface where multiple NRC [2] concepts and objectives can be addressed.

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