Executive Summary

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Presentation Title

Science Criteria for Lunar Outpost Site Selection and an Example

Summary

Science criteria for a lunar outpost site are dominated by lunar and planetary science objectives, but also include consideration of other NASA science endeavors such as astrophysics, heliophysics, earth science, planetary protection, and environmental characterization. Some of the objectives relate purely to science, whereas others relate integrally to exploration. Many can and should be done at any outpost location.

Key lunar and planetary science objectives relate to (1) the impact record over the Moon's history as a record of Solar System events, (2) the internal structure and dynamics of the Moon, (3) composition and evolution of the lunar crust and mantle, (4) nature and history of solar emissions, galactic cosmic rays, and local interstellar medium through investigation of buried layers within the lunar regolith, and (5) investigation of polar volatile deposits.

The first phase of Lunar Architecture development focused on a polar outpost site (South Pole, rim of Shackleton Crater). In this presentation, the Aristarchus region will be presented as an example of a non-polar, potential outpost site. Briefly, the Aristarchus region includes the Aristarchus crater, which appears to have excavated material significantly different from the Apollo and Luna sites. The region includes a large pyroclastic deposit that differs from the volcanic glass deposits of Apollo 15 and 17, and thus provides a key new capability to probe the deep lunar interior. The region includes a variety of volcanic features such as the prominent Valles Schröteri lava channel, Cobra Head vent, and compositionally different and distinctive basalts of western Oceanus Procellarum. Also located nearby are large craters spanning a range of ages that could be dated to help calibrate lunar chronostratigraphy (Aristarchus, Herodotus, Prinz). Key scientific targets lie within range of long-distance rovers from an Aristarchus outpost location. Young basalts to the northwest, near Lichtenberg Crater, could be sampled and dated to constrain lunar volcanic history. To the N-NE of the Aristarchus Plateau lie volcanic domes, including the Rümker Hills, Mairan Domes, and Gruithuisen Domes. These volcanic constructs differ spectrally and compositionally from materials sampled by Apollo and Luna, and may represent an important phase of lunar volcanic activity that is as yet little known. Long-distance traverses to access these geologic sites could serve also to place geophysical stations (seismic, heat flow nodes) as part of a regional network. Heat flow and subsurface structure are key to testing hypotheses about the Procellarum KREEP Terrane.

For Astrophysics, access to the radio-quiet environment of the lunar far side lies just over 1000 km to the west of Aristarchus; however, a retroreflector or transponder network deployed from an Aristarchus outpost could help to achieve new tests of gravitational theory. The site has a view of Earth, so high-priority observations and long-term monitoring of Earth and Sun-Earth interactions could be done from this location. Direct observations of the Sun from this location could be carried out during the daytime. Because Aristarchus is a volcanic terrain, access to paleoregolith as a record of solar activity and radiation history would be available through impact crater ejecta, rille walls, or local excavation and drilling.

For the eventual development of lunar resources, the site is located near vast expanses of ilmenite-bearing basalt. Thus an outpost site in this region could eventually be developed for large-scale regolith mining for oxygen, metals, and solar-wind volatiles.