FIELD EXPLORATION OF THE LUNAR SURFACE PURSUED AT REGIONAL SCALES. P.E. Clark, J. Bleacher, S. Mest, N. Petro, and L. Leshin, Catholic University of America (Physics Department), NASA/GSFC, Planetary Science Institute; all@NASA/GSFC, Greenbelt, MD 20771, Pamela.E.Clark@NASA.gov.

**Purpose:** We are responding to the need to provide science requirements for lunar surface system architecture and metrics for lunar surface system operations to the Constellation Program Office Lunar Surface Systems Element, and to address lunar science goals, as recently stated by both the NAC and NASA lunar science working groups [1]. Operations groups have already begun to use mathematical models for field operations to maximize ‘science return’ in terms of metrics like EVA time, samples collected, and distance covered. However, these approaches do not consider a real connection to the geology of a given site; thus, and the metrics generated do not maximize scientific significance of potential field excursions. In response, the Surface Scenarios Working Group (co-author Laurie Leshin is a co-chair of this group) of the NASA HQ Outpost Science and Exploration Working Group (OSEWG) is beginning to develop effective lunar surface science scenarios on a range of spatial scales. We have formed a small team of lunar geoscientists with combined expertise in planning and executing lunar field studies using surface exploration scenarios on scales ranging from contextual (100 km, weeks) to regional (1000 km, months) in order to achieve major science goals. Our intent is to produce regional traverse plans complementary to ongoing efforts towards local scale (10 km) exploration planning using the Apollo extended J mission model.

**Approach and Methodology:** NASA has considered a variety of exploration strategies for the return to the Moon, ranging from an outpost model that allows for progressively greater duration and mobility to shorter duration sorties to multiple sites that provide potential global scale access. Here, we will provide a study of the science activities and requirements for exploration at the 100 to 1000 km scales, beyond the local scale achievable at an outpost early on or at a single sortie landing site alone. These longer, larger scale efforts could occur either with longer range and duration mobility capability from an ‘outpost’, or as part of an extended sortie. In this case, the strategy and tactics for choosing temporary ‘field camps’ and logistical requirements to support such work will become important, as well as the optimal way of providing in situ or remote regional to global scale context. By providing contextual or regional scale field studies, we believe it will be possible to significantly enhance what is learned locally, while enhancing our ability to provide significant insight into major science questions using carefully selected sites.

We are planning extended field excursions with standard field methodologies used by geologists. Preliminary reconnaissance is based on assessment of digital remote data and interpretive maps, on hand and currently assembled at GSFC in an ArcGIS format, supported by hard copy, non-digital data products. Stations for study are located where the best indications of the stratigraphy (as surface or near-surface exposures), structure, and origin of a local feature (e.g., volcanic dome) or terrane (e.g., basin) are (a) most accessible and (b) best sampled and documented in situ using the least possible number of field camps or sites.

**Rules and Tools:** We assume Apollo ‘ground rules’ for crew safety (continuous EVA time (8 hours), walk back from any rover <10 km) and Apollo J mission logs to indicate reasonable mobility of a roving vehicle (average 5 to 10 km/hour, driven about half of the time during a multi-stop EVA). We also assume 2 rovers in the field, a minimum crew of 4, availability of Apollo geology/sample collection/documentation tools, plus audio/video feed to the ground and additional handheld, rover-mounted, and laboratory tools not available during the Apollo missions, ranging from simple field spectrometers to ground-penetrating radar. We will also consider the deployment of one or more automated science stations (ALSEP equivalent) at each site. Our time frames correlate with mobility capability as in the present lunar architectural models (100 km, up to weeks; 1000 km, up to months).

**Targets:** We have selected 3 representative targets for this study that vary in origin, represent a variety of geological processes displayed at different scales, and are each capable of addressing a number of science goals. Orbiter and Clementine image sequences, Apollo pan or metric camera imaging, geochemical remote sensing data, as well as interpretive geological maps are available for all three regions. The target we will focus on here is South Pole Aitken Basin, although we are also considering Aristarchus Plateau and Tsiolkovsky-Stark.

The largest and oldest confirmed basin on the Moon, SPA is the most prominent farside feature and gives access to volcanic basalt flows of distinctive composition and underlying farside stratigraphy, which could include deep crustal to upper mantle material. Thus, many of the science objectives could be
addressed here (Figure 1). Features of particular interest include (1) Olivine Hill [2], a feature apparently rich in Mg Suite materials near Bose crater in the center of the basin, (2) Oppenheimer-area pyroclastics [3] along the northern edge of the basin, (3) Mare Ingenii, with its magnetic swirl anomaly, in the northwest, (4) Schrödinger basin in the southwest, the basin structure itself including the inner ring, and (5) the South Pole. A contextual scale study is envisioned originating from the north-central part of SPA and traversing north toward the basin’s edge. A regional scale exploration could be envisioned as a series of trips originating in the same area, traversing north, northwest, or south/southwest, to the features of interest mentioned here, and beyond the edge of the basin.

Aristarchus is a premier site for illustrating the range of styles and sequencing of volcano-tectonic activity on the Moon, which includes the nature and timing of tectonic activity that led to the formation of the plateau. At Aristarchus, a contextual study could include the Plateau itself, a regional traverse across the surrounding range of volcanic extremes, including Lichtenberg for the youngest flows, the Marius Hills for volcanic domes, and the Reiner Gamma magnetic swirl anomaly.

Characterized by very distinctive and anomalous volcanic and impact features in a compact area, Tsiolkovskovsky Crater, set in the middle of the pre-Nectarian Tsiolkovskovsky-Stark basin, is arguably the best example of mare volcanism in the lunar farside highlands. A contextual level study would allow study within the crater, a regional study a traverse from the central peaks to the surrounding ancient basin edge.

**Issues:** We will consider what strategy works best for contextual or regional scale study, a series of focused visits to temporary field camps, closely spaced sites along traverses, or some combination, and how variations in the nature and scale of processes studied affect this strategy. We will also consider what level of effort, use of resources (e.g., EVA time, number of sites sampled), type of real-time interaction (i.e., the ability to upload data or retrieve mission-critical information), and tools, including lab facilities in the field, are essential for this work. Other considerations will be the facilitation of documentation and classification of samples, and the role for robotic support.


Figure 1. South Pole Aitken Basin with potential traverses A) locally in vicinity of landing site at Olivine Hill (1) [2]; and then progressively longer traverses from (1) to B) Oppenheimer (2) [3] and Apollo (6); D) Mare Ingenii (3); E) Schrödinger (4) and the South Pole (5).