THE LUNAR SAMPLE ACQUISITION AND CURATION REVIEW RECOMMENDATIONS FOR HUMAN SURFACE SCIENCE CAPABILITIES DURING PLANETARY EXPLORATION

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The Lunar Sample Acquisition and Curation Review addressed the topic of crew skills and requirements for future human exploration and planetary surface operations. Here we review the recommendations that are to be made to NASA HQ. Crews must have a level of scientific training that is, at a minimum, comparable to the Apollo crews. We recommend that all astronauts be trained to the same scientific level regardless of their background or potential participation in sortie or outpost missions. It is reasonable to assume that crews will include science or curation leads or experts. Therefore, we recommend that each science mission includes at least one astronaut with background training (prior to astronaut science training) as a geology expert, and that outpost missions include at least one curation/inventory management expert.

The success of Apollo surface science operations was the result of the leadership of the Field Geology PI. Therefore, we recommend that a Lunar Surface Geology Principal Investigator (PI) position be established and filled as soon as possible to oversee all surface science operations on the Moon. As in Apollo, The PI will be responsible for directing the field training campaign for the astronauts, traverse design, and will make final decisions for most field operations. Under the guidance of the PI all astronauts should be trained for efficiency in: 1) fundamental field geology skills, 2) hand specimen petrography, 3) sample collection tool use and protocols, 4) science instrument use, 5) navigation and rover operation, 6) sample collection protocols, 7) outpost laboratory analytical capabilities, and 8) science support room interaction.

The astronaut training program must identify sites where personnel will be educated. As in Apollo, training can be broken down into three categories, 1) instrument/tool training, 2) basic geology training, and 3) integrated simulations. Equipment tests under conditions relevant to crew operations on the lunar surface need not require analogs in remote locations. Training the crew to use specific instruments or tools can be conducted in pressurized suits to simulate lunar conditions while at NASA field. Analog science curriculum will require geology and petrography classrooms in the field and therefore the identification of appropriate geologic sites. For each site a specific geologic problem should be clearly identified and the approach to teaching those geologic principles should be well drawn out. Integrated simulations of science traverses at relevant analog field sites will again require travel to the appropriate geologic sites, but must also include those team members who are to be trained for participation as science support room personnel.

Basic geologic training can occur over a number of sites, and advanced geologic training tied to specific mission plans will require unique sites to be identified. Thus, we recommend that once PI is identified, a training curriculum be established and the proper sites identified for all three training and teaching categories. Each analog site must have a well defined teaching/training goal. The cost/benefit balance of any potential site should be well established and should always be a critical factor in site selection. Efforts should be made now to revisit the Apollo sites to determine if they remain unmodified and appropriate.

Petrographic training of the Apollo astronauts relied not only on field trips, but class room activities introducing rock forming minerals and hand specimen petrography. The Apollo collections of minerals and rocks must be replenished and expanded to include more crustal lithologies and rock specimens. In this endeavor the lunar rock collection must be consulted extensively. Furthermore, astronaut science education and training during Apollo was essentially a collaborative effort between NASA MSC (JSC) and USGS Flagstaff personnel. The ability of NASA and USGS personnel to lead the astronaut training effort should be assessed. Personnel needs within NASA and the USGS should be identified and addressed through personnel hires and the inclusion of participants from academia to ensure a well rounded education and training team. Developing the training team at an early stage ensures a knowledgeable base of participants from which PI can form a science support room.

The development of the training curriculum and sites will be a critical factor in the success of future human science operations. However, neither will be effective if the personnel who lead the training do not themselves possess experience in field geology. Between May 1970 and November 1972 a total of 59 field experienced geologists trained the Apollo 15-17 crews. This is a ratio of nearly 10:1 field experienced geologists to astronauts who worked on the lunar surface. As such, it is critical that the NASA SMD continue to fund planetary analog field science. This is the only way to ensure a cadre of field experienced planetary scientists to maintain a 10:1 ratio of trainers to astronauts. Furthermore, such research will continue to drive the development of new science questions and hypotheses that are required to support human exploration of other planets