ANALYSIS OF ANTARCTIC LOGISTICS AND OPERATIONS DATA: RESULTS FROM THE ANTARCTIC SEARCH FOR METEORITES AUSTRAL SUMMER SEASON, 2002-2003. D. B. Eppler, Constellation Advanced Projects Office, Mail Code ZX, NASA-Johnson Space Center, 2101 NASA Parkway, Houston TX 77058

Introduction: The operational and logistical experience associated with putting a team of four scientists in a hostile environment was investigated as part of the Antarctic Search for Meteorites (ANSMET) project during the austral summer of 2002-2003. This study was initiated because operations in Antarctica are totally dependent on the logistical support that keeps the principal consumables, food and fuel, coming to the continent. Activities in Antarctica represent one of the few remaining operations on the planet where human beings are in constant peril from the environment and must be supplied with the necessary logistical support in order to survive and carry out useful work. Without that logistical support, operations on the continent would, of necessity, cease. Because of that fact, Antarctica resembles the kind of exploration program that NASA will implement on either the Moon or Mars. In order to understand how to initiate and support long-term, sustained activities on planetary bodies off the Earth, the experience gleaned by USAP since its inception in the 1950s will be critical for NASA to understand. The ANSMET reconnaissance team, consisting of four crewmembers, aligns particularly well with NASAs plans for lunar return missions.

Initial put-in for the Reconnaissance Team took place on 10 December 2002 with a flight to Amundsen-Scott South Pole Station (NPX), followed by a flight to the camp at the La Paz Ice field. Redeployment from the field took place on 15 January 2003 through NPX. The reconnaissance team consisted of four members, who were to conduct a wide area reconnaissance on five ice fields that had only minimal examination in the past. In addition to the activities associated with hunting for meteorites, the author kept track of 1) all aircraft manifests going into the field, including mass, volume and categories of cargo; 2) the time interval spent each day doing a variety of science and logistical support activities, including time spent preparing and recovering from each day's traverse, time spent doing the normal "housekeeping" functions associated with living in a remote camp with no support personnel, the time lost for traversing to bad weather; and, 3) the distance of travel during meteorite hunting traverses and the breakout of time during spent traveling versus the time spent curating and collecting meteorites. Once out of the field, the time duration data was categorized into four broad areas: traversing, logistics, weather down time, and sleep. A similar data set was developed for the Apollo J-missions, based on timelines published in the Apollo Lunar Surface Journal (Jones, 2002). In addition, the time/traverse distance data was compared to similar data from the Apollo J-missions.

Results: The 2002-2003 ANSMET Reconnaissance Team deployed into the field with 7514 kg of material that took up a volume of 85 cubic meters. Of this mass, 655 kg consisted of food, 4318 kg of various hydrocarbon fuel to run stoves and snowmobiles, and 2541 kg consisted of personal gear, team gear, and transportation assets. This material occupied most of the cargo bay of a C-130 during the team deployment to NPX.

While in the field, the reconnaissance team spent 13% of it's time in the field conducting science traverses, 40% of the time in normal sleep periods, 39% of it's time doing logistics, and 7% down time due to bad weather.. In comparison, the Apollo J-missions spent 21% of the time, on average, conducting science traverses, 43% doing logistics and 36% in normal sleep periods. If one assumes that the 7% of the time ANSMET lost to weather would otherwise have been spent traversing, the comparison of the two different mission sets is remarkably similar. This favorable comparison is surprising in that logistics activities carried out on the Apollo missions was completely different from the logistics activities carried out in Antarctica. From a logistical point of view, the only commonality shown between the two mission sets was the objective to carry out science and exploration activities in an extremely hostile environment. These data suggest that the Antarctic environment may allow detailed logistics and operational planning models for planetary exploration to be checked against real life situations in a terrestrial setting. These data further suggest that the business of staying alive in an environment intrinsically hostile to humans may dictate basic logistical and operational requirements that cannot be ignored, at least in early planetary surface exploration. In particular, the author believes the data suggest that planning for greater than 20% of the crew's on-surface time for science operations may be inappropriate, in light of the logistical requirements that staying alive on a hostile planetary body may impose on any surface exploration.

Comparison of the traverse data between ANSMET and Apollo is inconclusive. In general, average speeds on Apollo and ANSMET traverses are similar, but that may be more related to the basic similarity between the two types of traverses or the lack of prepared roads or pathways. J-mission traverses involved traveling to a series of pre-planned stops where the crew would sample and describe as much of the local geologic context as possible so the samples could later be tied to a larger picture of the geology of the Moon. ANSMET traverses, in contrast, were searches conducted along roughly circular traverse paths for the purpose of collecting samples whose lithology had nothing to do with the area in which they were found. The one piece of information that can probably be stated with some specificity is that both missions demonstrate the need for roving vehicles with significant range in order to conduct adequate science activities. As it is hard to imagine doing the ANSMET Project without snowmobiles, so it is clear that the Apollo Program came into its own as a mission to conduct serious, detailed, scientific investigation of the Moon only after longer stay times and mobility assets were provided that allowed the crew to see as much of the countryside as was possible within the stay times achieved.

The data collected from the ANSMET Reconnaissance Team 2002-2003 season suggests that Antarctica is valuable analog for collecting data on logistics and operations on remote planetary surfaces. Several future activities should be pursued, to include: 1) increase the statistical database on operations time over the limited data set collected this season; this could include looking at larger ANSMET parties, or additional field projects in the USAP Program that may be good analogs for future planetary activities, and may lend themselves to similar kinds of data collection; 2) conduct more complete studies on the logistics associated with deploying large parties to remote Antarctic field locations; 3) develop a more complete statistical database on rover traverses, using GPS data collected from ANSMET field parties (this data set may already be in place as part of the record of past ANSMET activity); 4) determine the completeness of the USAP logistic database as a model for long-term logistical planning for lunar and Mars exploration; and 5) compare the operational time data set developed from this study and compare it to as-flown times from Space Shuttle dedicated science missions, such as SpaceLab Life Sciences Mission, and the as-flown information from the International Space Station.

Conclusions: Operational time data collected during the 2002-2003 season, when compared with similar data from the Apollo J-series missions, suggests that crew time available to science on future exploration missions will be no more than 20% of the available surface time, due to the logistical requirements of staying alive in a hostile environment. Comparison of statistics derived from ANSMET meteorite search traverses to similar traverses from Apollo is inconclusive, other than reinforcing the requirement for robust rover capability in order to cover as much ground as necessary. Lastly, data associated with deploying equipment and supplies for the four person team to the field suggest that supplying a Mars or lunar mission with the necessary "beans and oil" would take up a significant amount of the up mass prior to initiating trans-Mars or lunar injection.

References:

[1] Jones, E.M., 2002, The Apollo Lunar Surface Journal (http://www.hq.nasa.gov/office/pao/History/alsj), NASA Headquarters History Office.