MANAGING SCIENCE OPERATIONS DURING PLANETARY SURFACE: THE 2010 DESERT
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Introduction: Desert Research and Technology Studies (Desert RATS) is a multi-year series of
hardware and operations tests carried out annually in the high desert of Arizona on the San Francisco
Volcanic Field. Conducted since 1997, these activities are designed to exercise planetary surface
hardware and operations in conditions where long-distance, multi-day roving is achievable. Such
activities not only test vehicle subsystems through extended rough-terrain driving, they also stress
communications and operations systems and allow testing of science operations approaches to advance
human and robotic surface capabilities. Desert RATS is a venue where new ideas can be tested, both
individually and as part of an operation with multiple elements. By conducting operations over multiple
yearly cycles, ideas that “make the cut” can be iterated and tested during follow-on years. This
ultimately gives both the hardware and the personnel experience in the kind of multi-element integrated
operations that will be necessary in future human planetary exploration.

Desert RATS 2010 tested two crewed rovers
designed as first generation prototypes of small
pressurized vehicles. Each rover provided the
internal volume necessary for crewmembers to live
and work for periods up to 14 days, as well as
allowing for extravehicular activities (EVAs) through
the use of rear-mounted suit ports. The 2010 test was
designed to simulate geologic science traverses over
a 14-day period through a terrain of cinder cones,
lava flows and underlying sedimentary units. Prior to
the test, a series of traverses were planned using
techniques that were first developed during Apollo
[1]. These traverses were based on a photogeologic
interpretation of air photo and satellite images
conducted by the USGS Branch of Astrogeology in
Flagstaff. They were designed to simulate a
reconnaissance investigation by 2 rover crews of a
planetary surface operating under a variety of
communications constraints. Predicted
communications coverage was overlaid on the
planned traverses [2] and geological stations were
adjusted to ensure communications supported the
planned test conditions (e.g., continuous
communications) during each day of the test. The
resulting set of traverses and stations were then field
checked by the test team leads to ensure compliance
with planned test conditions.

Conduct of the actual test took place between 31
August and 13 September 2010. Two crewmembers
lived in and drove each rover for a single week with a
“shift change” on day 7, resulting in a total of eight
test subjects for the two week period. Each crew
consisted of an engineer/commander and an
experienced field geologist. Three of the
engineer/commanders were experienced astronauts
with at least one Space Shuttle flight. The field
geologists were drawn from the academic
community. Three of the crews were male, with the
fourth crew being female.

Operations were tested with different
communication states and rover deployment
conditions. Three days of each week operated under
continuous communications with mission operations
team, and three days the rovers were operated with
communications only for ≈1 hour in the morning and
≈1 hour at the end of the traverse day. In addition,
portions of the traverses were conducted with the two
rovers in mutual support, largely operating as a single
entity, while during other periods, the rovers operated
out of line-of-site of each other, pursuing
independent science objectives.

Science Operations Management Approach:
In previous RATS operations, the science support
room has operated largely in an advisory role. This
approach was driven by the need to provide a loose
science mission framework that would underpin the
engineering tests, rather than be an element of the
operations that was conducting discipline specific test
operations. However, the extensive nature of the
traverse operations for 2010 drove the decision to
expand the role of the science operations and test
specific operations approaches as part of the science
support for the test. The success of the Apollo
mission science support team as well as the science
operations approach utilized by the MER missions
became the baseline for the science test [3].

Past experience has shown that overseeing
manned operations of multiple vehicles requires a
separate control room for each (e.g., Space Shuttle
and ISS operations prior to docking of the orbiter to
ISS or after undocking). Consequently, each rover
worked directly with a Tactical Science Operations
Team (TSOT) responsible for managing real-time
science operations while each crew was conducting
“boots on the ground” geologic field operations. The
crew members stepped off the rover.

stations, and the TSOT, which took over when the operations team, which controlled the rovers between managed the control handoff between mission operations team. In particular, OPSLINK liaison between each science team and the overall in the primary operations control trailer to act as the each TSOT maintained a team member (OPSLINK) advice to the TSOT Lead on operations. In addition, downlinking image data from backpack cameras, single crewmember. This activity included responsible for overseeing the science activities of a crew. A Documentarian assisted the TSOT Lead with a real-time, running “war diary” of field operations, describing the operations, identifying specific issues to be resolved downstream, and providing the overall daily reference document for science operations. Two of the remaining console positions were responsible for managing the operation of a variety of still, panoramic and video cameras and downlinking image products to be utilized in real-time for situational awareness and management of the science operations at a particular station. Lastly, two TSOT members were each responsible for overseeing the science activities of a single crewmember. This activity included downlinking image data from backpack cameras, listening to and conducting real-time science analysis of crewmembers’ verbal descriptions, and providing advice to the TSOT Lead on operations. In addition, each TSOT maintained a team member (OPSLINK) in the primary operations control trailer to act as the liaison between each science team and the overall mission operations team. In particular, OPSLINK managed the control handoff between mission operations team, which controlled the rovers between stations, and the TSOT, which took over when the crewmembers stepped off the rover.

The SSOT was conducted in a hotel conference room in Flagstaff, separate from the field operations site. Like the TSOT, there were a number of standing positions on the team held by a variety of scientists. The SSOT was managed by a team lead responsible for management and completion of all activities of the SSOT, including replanning of traverses for the following day’s science operations. In addition, the Team Lead was responsible for presenting any changes to the day’s plan to the Mission Management Team following the SSOT’s daily operations. The team also included a Documentarian whose role was similar to the counterpart on the TSOT. An SSOT Strategic Operations Lead was responsible for managing long-term constraints that affected the daily replanning process (e.g. communications constraints), and any items that may affect the mission in light of re-planned science operations. The Activity Planners were responsible for taking the recommendations of the SSOT Team Lead for changes to future tactical plans and preparing the revised daily plan for each rover crew. The Long-Term Planning Lead was responsible for coordinating the science teams that worked on datasets critical to planning the next day’s tactical activities, determining whether there were discoveries or issues that warranted traverse replanning, and revising traverse plans in accordance with new directions. Various geoscience teams were responsible for analyzing data sets produced by the crew Rover imaging and science teams (e.g., Crew Field Notes [4], panoramic or back pack imaging data), making specific recommendations to the Strategic Operations Lead on revising the following day’s geologic traverses, and identifying key samples collected that were candidates for further study.

The 2010 RATS Science Operations Test was extremely successful, testing a variety of old and new operations approaches to managing science data and crew operations on planetary surfaces. In addition to substantive lessons learned that will be discussed other abstracts (e.g., [5]), the test served to begin training a new generation of scientists in the demands of planetary surface science operations.