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Historical synopses of desert RATS 1997–2010 and a preview of desert RATS 2011

Amy Ross *, Joseph Kosmo, Barbara Janoiko

NASA Johnson Space Center, Mail Code EC5, 2101 NASA Parkway, Houston TX 77058, USA

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ABSTRACT

Desert RATS objectives, hardware, locations, and participants have changed over time. This paper provides historical perspective on the original motivations for the Desert RATS analog, and an overview of the changes in RATS over time. The lessons learned from each year are synopsized. Finally, a preview of Desert RATS 2011 tests is included.

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1. Background

The scope and purpose of the Desert Research and Technology Studies (RATS) field analog has changed significantly over time, but its value to the engineers and researchers that continue to participate has remained constant. Whether studying a single space suit configuration or a complex multi-day integrated mission scenario analog test to drive out EVA exploration system requirements, the field analog test activities enable the integrated team of engineers and scientists to systematically generate, develop, and evolve realistic engineering requirements, scientific sampling, and collection techniques, hardware/software and operations development, in a relevant testing environment. Analog testing provides an invaluable tool for validation of emerging future mission concepts in concert with technology maturation, as well as, training an emerging generation of engineers and researchers who have not had previous experience in developing space flight hardware or defining appropriate mission operational scenarios for future space and planetary exploration. This article reviews the history and background of the various aspects of remote field test activities leading to the basis of the analog that is now called Desert RATS.

Initially, these field tests were focused on advanced space suit and EVA systems evaluation. Space suit configurations, mobility aids, robotic assistant interaction, field test support equipment, and EVA science were the primary objectives for evaluation. The test grew from one pressurized suit in a basic configuration, to the use of this suit in two different suit configurations, to simultaneous operation of two pressurized suits. Objectives shifted from mobility performance characterization to evaluation of EVA exploration components and gradually, the focus shifted toward performance of integrated mission scenarios. Rovers, roving habitats, habitats, robotic assistant elements, and exploration operations control centers have formed the central aspects of recent field test objectives. In addition, EVA information systems,

* Corresponding author. Tel.: +1 281 483 8235; fax: +281 244 6724.
E-mail address: Amy.j.ross@nasa.gov (A. Ross).

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communications infrastructure, and EVA procedures have continued to be matured and assessed. From four people at its inception to over two hundred participants, the Desert RATS tests have adapted to support mission program goals and emerging related technology needs.

The value of Desert RATS has intrinsically valuable aspects. First, field test objectives and goals help provide the incentive and momentum to establish concrete deadlines for technology development: the simple driver of a field test date facilitates technology development. Teams garner field experience, enable the establishment and implementation of technical requirements and operational performance needs, and the ability to operate and conduct integrated test activities in a challenging operational environment. Additionally, field test activities facilitate space system interface development because these systems have numerous and complicated interface relationships. The field test activity introduces teams with interfacing hardware to these challenges and encourages them to create a functional operational system to test. Cooperation, collaboration, and camaraderie among teams, subsequently generated during these field tests, directly contribute to the success of future flight systems.

Additionally, an important and consistent component of RATS has been public and education outreach. Starting with the 1998 field test, the last day of each test period was designated for team to present to public gathering that year's test hardware. As Desert RATS grew, the public outreach expanded, as well. Media days, Distance Learning Network (DLN) events (see Paul et al., 2012, this volume) and NASA public affairs broadcasts extended the reach of the science, technology, engineering, and mathematics education message through NASA engineers and scientists talking about their hardware lives from Desert RATS.

Finally, Desert RATS participants have learned lessons in how to organize, prepare for, and run a field test. Starting with an underpowered pick-up truck and temperamental communications systems, the Desert RATS leadership has learned, documented, and implemented the philosophy and steps for planning and performance of successful integrated field tests. Many of these lessons transcend field test to space flight mission performance as engineers apply logistics and systems lessons learned in Desert RATS to trades and planning for exploration missions.

This historical synopsis captures a small fraction of the knowledge and data garnered from Desert RATS. The authors strongly encourage those interested in greater detail to make use of the papers and reports referenced. Additional information is available from individual team reports and conference papers and subject reports produced by field test subjects (see, e.g., [1,2]), and hardware teams.

1.1. Desert RATS test sites

Desert RATS were carried out in geomorphically relevant terrestrial environments. The majority of RATS test sites are near Flagstaff, Arizona, and were identified by the USGS Astrogeology Research Program and selected by the advanced EVA team for their similarity to anticipated planetary exploration site terrain and features. A brief description of test sites is provided in Table 1 [7].

2. Synopses and preview

Each field test was shaped by the participants and their hardware and objectives. Test sites were selected to best accomplish the test objectives. Table 2 synopsizes the details for each field test. Additionally, specific accomplishments and 'firsts' are noted in the table. The discussion regarding lessons learned refers to the objectives in Table 2.

2.1. 1997

A series of laboratory-based suit mobility test activities initiated the desire to better understand the fundamental mobility-related tasks performed by a geologist on a representative planetary surface environment. A team of four, shown in Fig. 1, was assembled and traveled to

Table 1
Test site descriptions.

Test site	Description
Mars Hill Death Valley National Park, CA	Identified during the Space Exploration Initiative as representative of Martian strewn rock field as seen from Viking views, this location was not used in subsequent field tests because it is located in Death Valley national monument and is a designated wilderness area, in which no vehicle traffic is permitted. However, the initial field deployment used walking tests to collect ergonomic data on shirt-sleeve activities.
Silver Lake Flagstaff, AZ	A dry lake bed in the Mojave Desert, California, the site was selected by Ames Research Center for its relevance to the collection of astrobiology samples.
Cinder Lake Flagstaff, AZ	A volcanic area that was an Apollo-era training site with simulated crater developed by the United States Geologic Survey (USGS), the area is representative of lunar maria.
SP Mountain Flagstaff, AZ	A large volcanic cinder cone with extruded young lava flows and extensive rock rubble, the area is representative of a young Martian volcanic feature.
Grand Falls Flagstaff, AZ	A large, water-worn canyon area that contained a pyroclast volcanic ash bed layers with variety of rock outcroppings, volcanic ash, and rock rubble, the area is representative of a Martian canyon area.
Meteor Crater Flagstaff, AZ	A young impact crater area with ejecta boulder field that contained various slopes with loose rock rubble, the area is representative of young lunar and Martian impact craters.
Joseph City East of Flagstaff, AZ	A hilly, sandy terrain, the site is representative of Martian dunes or Loose lunar regolith.
Bar-T-Bar Ranch Flagstaff, AZ	An alluvial, plateau chinle formation, the site is representative of Martian terrain.
Black Point Lava Flow North of Flagstaff, AZ	A candidate lunar analog site identified during the Apollo-era. represented by the basaltic lava flow emanating from the San Francisco Volcanic Field.