

DESERT RESEARCH AND TECHNOLOGY STUDIES (D-RATS). B.A. Janoiko¹, D.B. Eppler², M.L. Gernhardt¹, A.F.J. Abercromby¹, R.O. Ambrose¹, J.E. Bleacher³, T.G. Graff⁴, K.E. Young⁵, D.A. Kring⁶, C.A. Looper¹, Z.A. Ney⁷, R.L. Howard¹, J.A. Skinner Jr⁸, J.J. Kosmo⁹. ¹NASA Johnson Space Center, 2101 E NASA Pkwy, Houston, TX 77058, barbara.a.janoiko@nasa.gov, ²The Aerospace Corporation, 2525 Bay Area Boulevard, Houston, TX 77058, ³NASA Headquarters, 300 E Street SW, Washington, D.C. 20024, ⁴Jacobs Engineering, 2224 Bay Area Blvd, Houston, TX 77058, ⁵NASA Goddard Space Flight Center, 8800 Greenbelt Rd, Greenbelt, MD 20771, ⁶Lunar and Planetary Institute, Universities Space Research Association, 3600 Bay Area Blvd., Houston TX 77058, ⁷Kellogg Brown and Root (KBR), 2400 NASA Parkway, Houston, TX 77058, ⁸USGS Astrogeology Center, 2255 N Gemini Road, Flagstaff, AZ 86001, ⁹Retired NASA Johnson Space Center, 2101 E NASA Parkway, Houston, TX 77058.

Introduction: NASA is preparing to land the first woman and first person of color on the Moon within the next decade and establish a permanent sustainable human presence before sending humans onto Mars. To ensure the success of these missions, NASA has performed operational testing in terrestrial, aquatic, and laboratory analog environments that simulate Lunar and Martian environmental characteristics. Desert Research and Technology Studies (D-RATS) is an example of a long-standing, high-fidelity terrestrial mission class analog.

Discussion: D-RATS is a combined group of inter-NASA center engineers and scientists, collaborating with representatives from other government agencies, industry, academia, and international partners, for the purpose of conducting integrated remote field analog tests in relevant terrestrial environments. This testing enables the team to systematically generate, develop, and evolve realistic engineering requirements, scientific sampling and collection techniques, hardware/software, and mission operational techniques, as well as validate emerging future mission concepts in concert with technology maturation [1].

D-RATS field tests have been conducted in geomorphically relevant terrestrial environments in high desert areas, the majority of which are near Flagstaff, Arizona. The sites were identified by the United States Geological Survey (USGS) Astrogeology Science Center and selected for their similarity to anticipated planetary exploration terrain and features [1]. These areas historically supported Apollo astronaut geologic training and is being planned for Artemis crew training as well. They provide a large area with high-fidelity science content to evaluate macro-scale operations. “Dry run” tests were conducted at the NASA Johnson Space Center (JSC) Rock Yard, or Planetary Analog Test Site (PATs), and in the Building 220 high bay in preparation for each field deployment.

Fourteen D-RATS field tests were conducted from 1997 to 2011 and one test in 2012 at JSC. Initially, the field tests were focused on advanced space suit and extravehicular activity (EVA) systems evaluations. Space suit configurations, mobility aids, robotic assistant interaction, field test support equipment, and

EVA science were the primary foci for evaluation. Objectives shifted from suited mobility performance characterization to evaluation of EVA exploration components to performance of integrated mission scenarios. Rovers, roving habitats, habitats, robotic assistant elements, and exploration mission operations control centers formed the central aspects of later field test objectives. From four people at its inception to over two hundred participants, the D-RATS tests adapted to support mission program goals and emerging related technology needs [1]. Future testing is anticipated to address Artemis needs.

Conclusion: D-RATS is a high-fidelity mission analog conducted in a terrestrial environment. Testing transformed from simple, focused EVA-related task activities and emerging technology component and subsystem level hardware field test activities to large-scale, multi-team integrated operational mission scenario demonstrations.

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References: [1] Ross A.J., et al. (2013) *Acta Astronautica*, Volume 90, 182-202.



Figure 1. Test subjects performing simulated lunar surface EVA operations at D-RATS. (A) Unpressurized Rover; (B) Pressurized Rover; (C) Rovers, Roving Habitat, Habitat, and Robotic Assistant Element; (D) EVA geologic sample collection; (E) Suit Ports.