Asynchronous geological exploration operations at the HI-SEAS planetary surface analog mission simulation in Hawai‘i

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Abstract. The Hawai‘i Space Exploration Analog and Simulation (HI-SEAS.org) program studies team function and autonomy on long duration exploration missions conducted in a remote habitat located on Mauna Loa, Hawai‘i. The basaltic terrain and sparse vegetation of the site make it a good geologic analog to the Moon or Mars, and since the site is accessible year-round, it allows for longer-term isolation studies than other analog locations. NASA has funded HI-SEAS for four missions of increasing length starting with a 4-month mission in 2012 to a 12-month mission that will begin in fall 2015. Here we report on geology exploration operations carried out in the HI-SEAS program.

HI-SEAS missions are comprised of six crewmembers who live in the habitat and interact with a mission support team remotely via an imposed 20-minute communications delay to provide Mars-like operational latencies. Some of the crew's activities require them to leave the habitat and conduct extra-vehicular activities (EVAs) while wearing simulated space suits to approximate the encumbrances astronauts would face while conducting such excursions. We have designed a series of geology-related EVA tasks that we assign the crew on a bi-monthly basis. Each task serves as a mini research project for the crew, who must devise how to gather data and solve the given problem with minimal interaction or direction from mission support. The team-oriented tasks are designed to be gradable with quantifiable metrics so that meaningful conclusions about crew performance on missions of varying length can be drawn.

The geology tasks, which are given in the context of resource exploration and environment characterization, are presented in a progressive fashion so that each activity builds upon the previous one. First, features or areas of interest are identified in aerial imagery. The crew is then asked to scout these features on the ground and characterize their properties. This could take the form of measuring dimensions of a skylight, mapping flow units, collecting rock samples, or analyzing the samples using equipment in the habitat's laboratory. The HI-SEAS geology team evaluates how accurately the crew is able to accomplish these tasks compared with known values. The long duration of these tests enable an evaluation of how the crew is able to build an increasingly detailed understanding of the environment surrounding their habitat site in a manner similar to how future astronauts may explore another planetary body on a long surface stay mission. This unique science operations perspective is highly complementary to other analogs that focus on individual EVAs or shorter duration studies of science operations capabilities.