THE EXPLORATION OF MARAMBIO ANTARCTICA AS A MARS ANALOG. J. C. Rask[1], P. De León[2], M. M. Marinova[3], C. P. McKay[4], [1]Dynamac Corporation, Space Biosciences Division, NASA Ames Research Center, Moffett Field, CA 94035, jon.c.rask@nasa.gov, [2]Department of Space Studies, University of North Dakota, Grand Forks, ND 58202, [3]BAER Institute, Sonoma, CA 95476, [4]Space Sciences Division, NASA Ames Research Center, Moffett Field, CA 94035.

Introduction: Future human explorers on Mars will likely perform field operations that focus on the construction of field stations, the characterization of the local environment, and the search for life in permafrost. These efforts will require a durable, and flexible planetary spacesuit that can accommodate a wide range of activities while ensuring optimal human health and performance. To learn how a space suit limits these activities and to inform us of what modifications or tools may be needed, we performed field exploration, sample collection, and instrument deployment, utilizing a pressurizable prototype spacesuit in a rocky, permafrost-rich Mars-like location.

In March of 2011, a team of scientists and engineers traveled to Marambio Antarctica, an island along the Western Antarctic peninsula (Figure 1), to explore the region as a Mars analog field site using the pressurizable North Dakota eXperimental-1 (NDX-1) space suit [1]. Marambio Island (also known as Seymour Island) was chosen because of its rocky, exposed surface [2], permafrost [3][4], and operational accessibility.

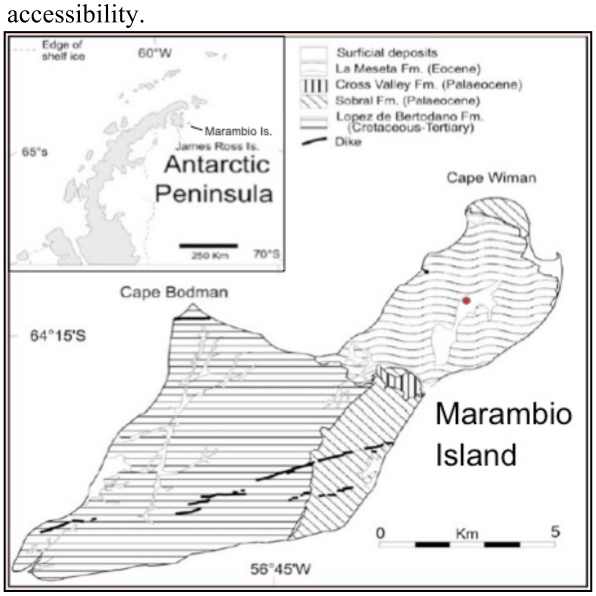

Figure 1: The red dot approximates the location of Marambio Base and expedition field activities (image adapted from [5]).

Field Activities: Three main field activities were designed and carried out on Marambio. They included (1) field testing of the NDX-1 pressurizable prototype space suit with an operator using subsurface drilling technologies and radiation detection technologies, (2) acquisition of subsurface permafrost samples for biological, chemical, and physical analysis, and (3) deployment of surface and subsurface climate and radiation monitoring instrument packages. This work builds upon previous analog field testing of the NDX-1 [6], and incorporates field activities that gather on-site data and samples by a suited operator that can be further analyzed in laboratories.

Figure 2: The NDX-1 was used to gather subsurface samples and radiation data on Marambio Island.

Results: We demonstrated for the first time the use of a pressurized prototype spacesuit in Antarctica. More importantly, we were able to use a hand-held electric drill to bore into permafrost, gather subsurface samples and place them into sterile containers, characterize the surface radiation environment, and perform simple construction operations–all by an operator inside the pressurized NDX-1 space suit (Figure 2). Preliminary biological analysis (post expedition) of a profile of samples revealed a cell population of ~40000 cells/g of soil at the surface that dropped to ~10000 cells/g of soil in the permafrost layer. Radiation measurements at the surface were observed to be 8 to 10 μrem per hour. While we recognize the data from Marambio are different than what would be observed on Mars, it is important to note we were able demonstrate a proof of concept: the gathering of scientifically useful data and samples from an unexplored astrobiologically interesting polar field site by an operator in a pressurized spacesuit (Figures 2). The data from this expedition complements similar data and samples collected in other Arctic and Antarctic locations.

Future Work: In addition to testing of the NDX-1, the team also successfully deployed sensors to gather a profile of surface and subsurface temperature and humidity data. We will retrieve data from this climate monitoring station (Figure 3) at least one year after the deployment date to characterize the local environmental conditions. This data will be compared with data from similar climate monitoring stations in the Antarctic Dry Valleys. The climate data from Marambio will also supplement long-term climate monitoring efforts as well. A profile of radiation sensors were deployed, and will be retrieved and analyzed with optical stimulated luminescence techniques to characterize the subsurface radiation environment. Radiation profile data will be compared to the biological profile data.

We also observed that much of the surface of the island around Marambio Base is nearly flat with a lag surface of pebbles and small rocks. This offers a very safe setting for future field activities with multiple operators in suits working together, possibly with rovers and other more complex technologies. The subsurface is made up of fine grained and water-rich frozen sediments, which may be useful for testing coring drills.

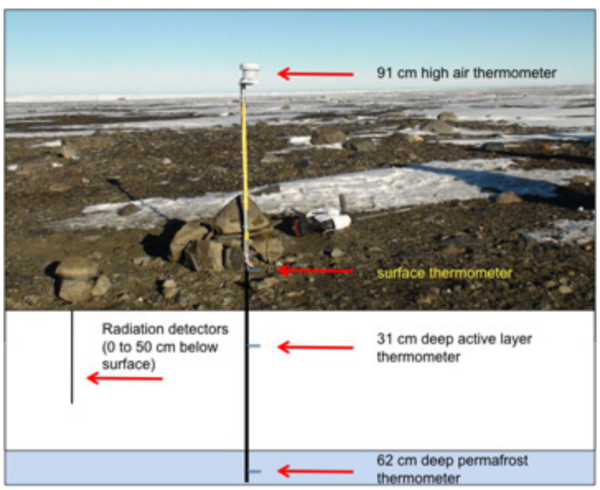

Figure 3: The Marambio surface and subsurface climate monitoring station is located on a rocky surface at 64°S 14.783', 56°W 39.131.

Relevance to the NASA Human Research Program (HRP): Improperly designed extravehicular activity (EVA) suit systems can result in the inability of the crew to accomplish planned mission objectives and can cause acute and long-term adverse impacts to crew health [7]. Thus, "compromised EVA performance and crew health due to inadequate EVA suit systems" has been identified as risk 2.3.1.4 in the HPR integrated research plan [7]. The NDX-1, when utilized in analog environments, can help scientists and engineers to understand the relationships among suit parameters, subject characteristics, and health and performance. Our work in Marambio, and future work, supports the mitigation of this HPR risk, and will help NASA make informed design decisions, which will lead to the creation of EVA systems that optimize human health and performance across the spectrum of anticipated exploration operational concepts [7].

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