Arctic Mars Analogue Svalbard Expedition 2007.

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Introduction: The Arctic Mars Analogue Svalbard Expedition (AMASE) in 2006 was the latest of a series of expeditions that have as primary goals to test portable instruments for their robustness as field instruments for life detection (for robotic and future human missions to Mars), to assess the Mars analogue environments for signs of life, to refine protocols for contamination reduction and to understand the effects of transport on sample integrity by assessing bioloads immediately in the field and then comparing these with laboratory measurements made after transportation. There have been three previous expeditions that were run in by the Department of Physics of Geological Processes at the University of Oslo in collaboration with the Carnegie Institution of Washington (CIW), NASA-JPL, NASA-Ames, the Lunar and Planetary Institute, University of Leeds, University of Burgos, Penn State University, MacQuarie University (GEMOC) and the Smithsonian Institution, and with invaluable help and support from the Norwegian Space Centre, the University Centre on Svalbard (UNIS) and the Norwegian Polar Institute.

A wide variety of science instruments and platforms was deployed on AMASE 06, including the two instrument prototypes for the Mars Science Laboratory (MSL) mission, namely the Sample Analysis at Mars (SAM) GCMS and the CheMin XRD/XRF instruments. Other instruments included a portable Raman spectrometer, a UV excitation spectrometer (laser induced native fluorescence), a digital color microscope, portable Lab-on-Chip test systems and a complete polymerization chain reaction (PCR) system. A rover carrying a camera and a microscopic imager and a non-pressurized MkIII prototype spacesuit with a portable computer system were the primary platforms.

R**over Activities:** The TRESSA system (Teamed Robots for Exploration and Science on Steep Areas), formerly cited in the literature as Cliff-bot is designed to allow access to steep slopes that are not feasible for traditional wheeled rovers. Such steep slopes and cliffs are of significant scientific and geological interest, as vertical faces provide a full range of geological history, rather than the single time-slice that is visible on a surface. An autonomous robotic ability to access these areas is critical for lunar and planetary surfaces, where human exploration may be decades away. Additionally, there may be planetary or terrestrial cliff sites of scientific interest that are too remote or dangerous for humans to safely explore. Traditional wheeled robotic vehicles are unable to traverse cliff faces; vehicles such as the Mars Exploration Rovers (MER) are realistically not statically stable beyond about 45 degrees and cannot climb slopes greater than about 30 degrees. The TRESSA system was successfully deployed on AMASE 06 on slopes up to 80 degrees.

Site Description: *Ebbadalen Formation*. The sediments at the Ebbadalen Formation in Billefjorden, central Spitsbergen, comprise Carboniferous (ca. 320 Ma) Ca-Sulphate bearing evaporates deposited in a shallow marine setting. Outcrops show mixed sulphate/clastic lithologies that might be analogous to evaporate sediments studied by the Mars Exploration Rover (MER) Opportunity at Meridiani Planum on Mars. Spheroidal concretions, morphologically similar to the "Blueberries" on Mars, are covered with lichens, and show a high level of biological activity. *Bockfjord Volcanic Complex (BVC)*. This region includes the Sverrefjellet and Sigurdfjellet eruptive centers, volcanic soils, and the erosional remnants of extensive flood basalt eruptions about 10 Ma ago that cap Devonian sediments to the east of the BVC. This site is interesting because of the presence of carbonate resottes similar to that found in ALH84001 as well as methanogenic cryptoendolithes in weathered olivine xenoliths and the presence of buried blue ice vents near the summit of the Sverrefjell volcano in which microbial activity has been detected. Other investigations in this area included sampling of gases at the Troll and Jotun hot springs, coring of glacial ice and sampling of snow algae at the adjacent glaciers and the deployment of the CliffBot and the space suit in the Devonian redbeds on the opposite site of Bockfjorden. *Murchison Fjord*. Murchison Fjord lies in the northwestern side of Nordauslandet. This site bears outcrops of ~800 Ma old stromatolites and lagoonal carbonates, which were collected for laboratory investigations to find biosignatures.

During this years expedition 12 common and 4 Rover colleted samples were taken. These samples were analyzed in the field by the full range of instrumentation on the expedition. Laboratory studies of these samples with comparable instrumentation are currently underway. When complete a comparison between lab and field studies will be made to understand the detection sensitivity and accuracy of field instruments compared to laboratory instrumentation. Furthermore, we will continue to assess changes in contamination of samples due to transport, in order to fully understand the changes to the integrity of samples during packaging and shipment.

Space Suit activities; The Planetary Society supported the deployment of a non-pressurized prototype of a Mark-III spacesuit for a project aimed at the understanding of forward-biocontamination during sample collection on a manned Mars mission. These efforts were combined with a computer-based collection and data-logging sequence that allows the astronaut to catalogue all information on a sample (physical description, images, spectroscopic and biological analyses) into on file during the Extravehicular Activity (EVA). The contamination studies were carried out using artificial sterilized samples, which were placed in the field by other team members. The astronaut walked up to them, opened them and analyzed the bioload using a Lab-on-Chip (LOCAD) Portable Test System (PTS). The samples were swabbed and introduced into the LOCAD-PTS, where they were analyzed with a Limulus amebocyte lysate (LAL) assay.

This years expedition exceeded expectations. Highlights of the achievements are as follows:

- Rover deployed at 4 sites, taking 4 samples that were analyzed by all instruments on board.
- Microscopic imaging was achieved on all deployments including variable focus and image montaging. Lichen species were positively identified by the color camera.
- Raman and LiNF instruments were integrated with the Rover sample arm and preliminary analysis of peridotite xenoliths was undertaken.
- Analysis was conducted on 16 common samples and 4 Rover collected samples.
- Chemin performed over 60 analyses and was deployed in the field for the first time.
- SAM performed ~60 analyses.
- Over 60 ATP, 50 LAL and 300 PCR reactions were conducted on the collected samples.
- A field cleaning protocol was successfully verified to ensure sample sterility during collection by both the Rover and during ice coring.
- The science teams began to integrate successfully with the Rover crew in making science decisions based on Rover imagery of suitable sites.
- Discovered samples containing ~300 million year old beach sand concretions within sandstones that were harboring a small modern microbial community. Successfully assessed mineralogy, organic and microbial inventory of these samples.
- Completed several “habitability transects” of BVC area constraining parameters to evaluate the chemical and environmental conditions for life to survive.
- Identified 2 new sites for exploration on AMASE 07.

Results of the analysis conducted on both the rover and human collected samples by all instrumentation will be presented as well as an assessment of the habitability parameters of each sample. Integration of science instruments with a rover crew for life detection purposes will also be evaluated.

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Figure 1. Field deployment of the JPL TRESSA system on Devonian Red Beds at the BVC site. A) shows the steepness of the slope on which the rover is operating. B) shows the rover taking a sample with its integrated scoop. C) shows the rover handing off the sample to the MarkIII space suit astronaut.

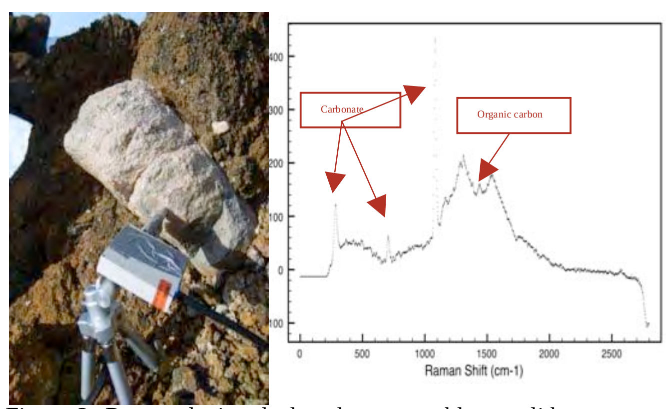

Figure 2. Raman device deployed on a marble xenolith on Sigurfjell, the resulting spectra (left) shows the presence of carbon and macromolecular and aromatic carbon indicative of a cryptoendolithic community.