THE ARCTIC MARS ANALOGUE SVALBARD EXPEDITION (AMASE) 2010.

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Introduction:

The Arctic Mars Analogue Svalbard Expeditions (AMASE) 2010 was the latest of a series of expeditions that are NASA ASTEP and ESA PRODEX funded and have as their primary goals 1) testing portable instruments for their robustness as field instruments for life detection, 2) assessing Mars analogue environments for abiosignatures and biosignatures, 3) refining protocols for contamination reduction, 4) defining a minimal instrument suite for Astrobiology science on Mars and 5) sample acquisition, collection and caching of suitable samples by rover platforms containing sample acquisition hardware: first Cliffbot, then Athena. As well as testing ESA instrumentation for the ExoMars mission and NASA instruments for Mars Science Laboratory, the goals and technologies used during this 2010 campaign are very similar to that proposed by the current MEPAG MAX-C mission concept and therefore set the stage for future sample return missions. As such the field-tested technologies, procedures and protocols can be used to address specific science objectives proposed for the 2018 Mars mission opportunity. As NASA and ESA enter a new era of collaboration, AMASE has provided and will continue to provide, a test bed for both current insitu robotic missions and Mars Sample Return mission architectures. AMASE has proved to be a unique platform to build understanding and collaboration amongst scientists and engineers from Europe and the USA.

This years goals were split into two field sites. Science instrument deployment on Svalbard and Rover deployment at Mono lake with a prototype coring and caching system developed by P Backes at JPL.

Svalbard Expedition

AMASE 2010 explored 2 main sites (Sigurdfjell and Knorringfjell) using the following hypothesis;
Can we distinguish between abiotic verses biotic formation of carbon (S, N) compounds using a null hypothesis that there is no biological input to the formation of these compounds.
The consequence of this hypothesis is that an abiotic formation mechanism must be nullified to prove a biotic contribution and therefore is a much more scientifically robust methodology for life detection both on early Earth and Mars.

Field Sites

Test sites (Fig. 1) were selected based on scientific- and logistic criteria:

— ALH84001 type abiogenic carbonate deposits at the Sigurdfjell volcanic ridge in the Bockfjord Volcanic Complex
— Biogenic carbonate deposits represented by fossil Jurassic methane seeps at Knorringfjell
— Carbonate travertine terraces at Troll Springs in the Bockfjord Volcanic Complex

The highlights of this years activities are as follows;

- Deployment and testing of 7 Mars bound instruments in Svalbard including; SAM, CheMin, (from MSL) PanCam, MOMA, Raman/LIBS, SPDS Rock Crusher and CLUPI (from ExoMars).
- Compared and contrasted Sigurdfjell carbonates with those found at home plate (Comanche spur) on Mars (See Morris et al., 2011 and Amundsen et al., 2011 this meeting).
- In-field characterization of a series of samples (include, mineralogy, modern microbial load, organic geochemistry and isotope geochemistry), to enable the scientific distinction of abiotic verses biotic input to the formation of the samples studied (from Knorringfjell and Sigurdfjell).
- Development of successful curation and data management software building on year 1 experiences with commercial software.

Sigurdfjell volcanic ridge

Basaltic volcanic centers in BVC on NW Spitsbergen erupted through a thick icecap ca. 1 Ma ago and are associated with the worlds northernmost hot springs emanating through ca 400 m permafrost. BVC eruptive centers carry ubiquitous magnesian carbonate deposits including dolomite-magnesite globules similar to carbonates in the Martian meteorite ALH84001 (Treiman et al., 2002; Steele et al., 2007). Both ALH84001 and BVC carbonate deposits contain organic compounds formed by abiotic processes. The geology and geomorphology of BVC bears a close resemblance to volcano-permafrost-ice interactions on Mars. Massive ALH84001 type carbonate deposits associated with volcanic vents on Sigurdfjell volcanic ridge (Fig. 1) were discovered on AMASE 2009 and selected as a target for instrument testing on AMASE 2010.

Knorringfjell fossil methane seeps

The Knorringfjellet site is a ca 6 m diameter carbonate mound occurring within a sequence of late Jurassic deep marine shale. The carbonate mounds are interpreted to represent a fossil submarine methane seep associated with biogenic deposits of calcite and entrapment of hydrocarbons (Nakrem et al., 2010). The biogenic carbonates at Knorringfjellet were chosen as a target for comparison with the presumed abiogenic carbonate deposits at Sigurdfjell.

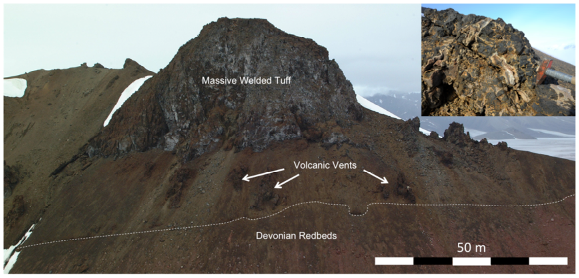

Figure 1: Eastern flank of Sigurdfjell volcanic ridge with volcanic vents associated with massive ALH84001 type carbonate deposits

Comparing analysis of a group of common samples from all techniques let to several interesting conclusions;

1. For bulk mineralogy the ExoMars PanCam with a range of filters for reflection spectroscopy, significantly narrows target space to lithologies of interest.
2. A combination of high resolution close up imaging, and contact spectroscopy techniques such as Raman, LIBS and FTIR can identify mineralogical diverse samples and aid in identification of trace mineralogies of interest that XRD (CheMin) may not detect. Although preliminary identification of interesting organic species is challenging, it is possible.
3. Microscopic imaging of intact samples for morphological characterization is highly desirable.
4. To completely falsify the null hypothesis, further characterization of the organic phases present by non spectroscopic means is essential. However, definition of interesting samples can occur with suitable spectroscopy instruments.
5. For MAX-C the development of arm deployable spectroscopic and non spectroscopic organic characterization will be essential.
6. SAM on MSL and MOMA on ExoMars will be critical instruments to define organic molecular species in interesting samples for the MAX-C mission.

Mono Lake Deployment

The goal of the 2010 AMASE domestic rover expedition was to determine how a particular coring and caching hardware approach performed on a variety of sample types analogous to what might be encountered on Mars in a Sample Return mission such as the proposed 2018 MAX-C mission. AMASE Sample Return requirements as proposed included a FIDO-class, mid-sized rover with mobility and capability similar to the MER rovers, which was to be used as a platform to integrate, operate, and field test science instruments and sample acquisition and caching systems in Mars analog environments. In AMASE 2009, a scooping system was tested was (Younse et al., 2010). For 2010, A JPL-developed sample acquisition and caching system called IMSAH was deployed on the Pluto MER-class rover (See Younse and Conrad abstracts from this meeting). This robotic acquisition, and caching system is a prototype for future potential Mars sample return missions (such as the proposed 2018 MAX-C). Specific goals for our investigation included:

- Determination of maximal rover operation parameters including terrain roughness, slope, communication, slip imaging and sample acquisition.
- Determination of the best sample handling and encapsulation protocols for use in field instruments, including an assessment of weathering effects on sample quality.
- Performance of integrated rover and instruments deployments to meet science objective and to develop protocols for sample targeting by a remote science team in the field.

In all 6 samples were cored and cached. Preliminary mineralogy and microbial load were performed in the field. Results are still being processed.

AMASE 2010 team (other than those already mentioned): Arnold Bauer, Dave Blake, Pan Conrad, Claire Cousins, Mihaela Glamoclija, Kyong Hou, Garret Huntress, Jean-Luc Josset, Laureline Josset, Inge Loes Ten Kate, Guillermo Lopez, Amy McAdam, Francis McCubbin, Ivar Midtkandal, Dick Morris, Carole Phillippon, Dave Potts, Antonio Sansano, Verena Starke, Eckhard Steinmetz, Jen Stern, Kjell Ove Storvik, Steve Squyres, Dominique Tobler, Tor Viscor.

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