Arctic Mars Analogue Svalbard Expedition (AMASE) 2007. A. Steele[1], H.E.F. Amundsen[2], P.G. Conrad[3], L. Benning[4] and M. Fogel[1], on Behalf of the AMASE 07 team. [1]Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Road, Washington DC., [2]Earth and Planetary Exploration, Oslo Norway., [3]Jet Propulsion Laboratory, Pasadena, California, [4]University of Leeds, Department of Earth Science, Leeds UK.

Introduction: The Arctic Mars Analogue Svalbard Expedition (AMASE) in 2007 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 four 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 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.

AMASE 07 took place between 12th – 26th August. Twenty five scientists and engineers involved in Mars exploration including the MER, MSL and ExoMars robotic missions as well as human space flight planning conducted instrument testing and simulate Mars training exercises. In all 12 instruments were deployed into the field testing their individual capabilities, utility within an instrument suite and the performance as part of a remote instrument suite during simulated Mars mission conditions. The instruments included, biotechnology instruments (LAL, ATP, PCR, protein Arrays (ExoMars Life Marker Chip), GCMS (SAM), XRD/XRF (CheMin), portable GC, portable Raman, remote Raman, deep UV spectrometer (hand held and rover arm mounted), digital and rover mounted mounted microscopy imaging and mimicked PanCam, Hazcam and NavCam imagery. Furthermore wearable computing technology for sample acquisition by an astronaut on the moon or Mars was also developed and tested.

Highlights of AMASE 07: The Team undertook 4 Rover deployments, 3 of which were successful. We added and tested Mars sample return sample-caching capability to the cliffbot this was successfully tested in the field using rigorous cleaning and sample contamination control criteria. We also deployed spectroscopy instrumentation alongside microscopic imaging on the Rover arm to test sample collection criteria for Mars sample return. Deployed ship to shore communications allowing remote field teams to send data to the research vessel. Used the above capability to undertake 3 remote science operation working group activities (SOWG) using the current MER working ethos as a template. This enabled the crew to perform remote science in a simulated Mars mission environment. In all, 15 sols of activities were completed in 3, 1 day exercises. Trained scientists from both MSL and Exomars in science operations working group (SOWG) working environment. Deployed 12 instruments into the field both testing their capabilities and using them as part of the remote field testing equipment during SOWG activities. These included, biotechnology instruments (LAL, ATP, PCR, protein Arrays (ExoMars Life Marker Chip), GCMS (SAM), XRD/XRF (CheMin), portable GC, portable Raman, remote Raman, deep UV spectrometer (hand held and rover arm mounted), digital and rover mounted microscopy imaging and mimicked PanCam, Hazcam and NavCam imagery for SOWG like activities. Collected and curated 52 common samples from the field in a custom designed web based database. This database is currently being used to curate analysis on-line. Tested wearable computing technology for sample acquisition and logging with human space flight activities in mind. This was conducted with Dean Eppler from Constellation at JSC. Laboratory based studies of year 1 samples have proceeded and 20 of these samples are in the process of being sequenced for microbial characterization.

Simulated Mars Operations. Three simulated Mars mission training exercises were conducted using a template derived by Steve Squyres to mimic within the conditions of the expedition a science operations working group format similar to that currently used on the MER missions and that employed by the MSL slow motion field test. These were labelled Sol 100, 200 and 300 activities. The template used for these activities was as follows; The crew were divided into three teams; *Instrument teams* – Either on ship or at the field site. Primary responsibility was to generate data for the science team based on science team operating plan and samples collected by the Rover. Instruments deployed include, Chemin, Raman, deep UV fluorescence, Microscopic imager, PanCam, HazCam and NavCam imagery and a life marker chip suite consisting of ATP, LAL and later laboratory based PCR analysis. Samples were communicated to a single member of SAM team for analysis with the instrument on board ship.

Rover team – in the field during deployments and was responsible for rover operations, rover safety and ensuring implementation of the science plan. One rover team member was available on ship for the for the SOWG activity at all times. *Safety team* –ensured the personnel safety of the field team. *Science team* (Science Working Group) – Consisted of representatives of the instrument teams, management team and rover team. This team stayed on the ship and received only remote communications and data from the instrument and Rover teams. This team was led by a SOWG chair who communicated with a Mission Manager, who was the only member of the team in communication with the field teams and helped mitigate unexpected circumstances in the retrieval and transmission of science output and field data. with the field scientists. The SOWG chair led the science working group efforts and communicated to the instrument and Rover team representatives. Instead of dividing up the tasks of the science team based on which instruments the scientists were involved in, there were 3 sub groups based on science capabilities. These were geology, geochemistry and mineralogy and biology / organic chemistry.

The SOWG activities were planned using a token system to limit the activities it was possible to perform in a single sol. The SOWG could utilize up to 200 tokens per sol with the costs of activities metered out as follows;

• Traverse: 10 tokens every 10 meters, plus mobility penalty tokens for particularly difficult terrain
• Stereo Hazcam pair: 4 tokens
• Stereo Navcam pair: 4 tokens
• Single Pancam image: 6 tokens
• Remote Raman spot: 10 tokens
• MI image: 10 tokens
• LINF measurement: 10 tokens
• Drill/sieve/portion/deliver: 50 tokens
• Life marker chip measurement: 50 tokens
• SAM measurement: 150 tokens
• CheMin measurement: 150 tokens

Three SOWG activities took place;

Sol 100 took place on Sverrefjell at a small outcrop site containing basalt, exposed xenoliths, carbonate and basement rocks.

Sol 200 took place on the Devonian red bed site were the science team were deployed in the field at a site slightly removed from the Rover team. This activity took place using the cliffbot rover and imagery and analysis from the actual rover were fed to the science team directly.

Sol 300 took place at a cretaceous bioherm outcrop site.

Wearable Computing technology Wearable computer technology was deployed by Dean Eppler and Garrett Huntress and consisted of a Quantum 3D computer, wrist wearable keyboard, voice activated programming, monocle for screen visualization, throat microphone and ear buds for voice feedback with the system, and a remote toughbook touch screen to emulate touchpad control. The utility of this system for collecting and cataloguing samples was tested. Such systems will be essential for human exploration of the moon and Mars.

Future goals. AMASE 08 will build on the field experiences of the last 5 years.

• Complete any outstanding aspects of year 2 goals.
• Continue investigation and experiments into the nature of macromolecular carbon in Martian meteorites and xenoliths from Svalbard.
• Complete the microbial sequencing of samples collected on AMASE including: cryptoendoliths, "ice cave "ice, hot springs, weathered xenoliths and snow algae.
• Define the habitability of concretion sites on Svalbard.
• Complete survey and studies into cryoprecipitation of carbonates.
• Tie up field observations and laboratory studies to produce a database of samples investigated during AMASE. Feed that database to MSL and exomars based \instrument teams for use during instrument calibration and operation on Mars.
• Survey several new sites during AMASE 08 including known microfossil locations, bioherm deposits, concretion sites.
• Continue the SOWG activities and undertake 3 SOWG training activities.
• Expand software utility of wearable computer to enable full sample characterization by human operator.
• Finish testing of life marker chip technology.
• Integrate 4 instrument teams from ExoMars into AMASE 08.

The AMASE 07 team was as follows; Hans Amundsen – Expedition Leader, A Steele – Expedition science leader, Ivar Mitkandal – Safety leader, Kjell Storvik, Gry Karstad, Cecilie Rego, Dave Potts, Tor Amundsen, Gareth Huntress, Marilyn Fogel, Liane Benning, Pan Conrad, Maia Schweizer, Verena Starke, Jen Eigenbrode, Steve Squyres, Kirsten Fristad, Dave Blake, Philippe Sarrazin, Will Brinner, Rohit Bhartia, Claus Morgensen, Terry HUntsberger, Ashley Stroupe, Michael Garrett, Paulo Yonse, Dean Eppler, Oliver Bhotta, Fernando Rull, Pablo Sobron, Gerhard Kminek, Jorge Vago.

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