

Canada and Analogue Sites for Mars Exploration

Stephen Braham and Peter Anderson^{*}
Simon Fraser University
Pascal Lee, Richard Alena, and Brian Glass[†]
NASA Ames Research Center

Abstract

Canada contains a unique site for possible analogue studies of Mars, from Mars-related science to studies of technologies that may be used for robotic and human exploration of other planets. This is the Haughton Crater, on Devon Island, Nunavut, in the Canadian High Arctic. This location is presently the site of an exciting NASA-led field research program, the Haughton-Mars Project.

The Authors describe the collaboration between SFU and NASA during the 1999 season of the Haughton-Mars project, in the area of space-based and medium-range packet radio communications. The work demonstrates the ample opportunities for use of Canadian communications expertise and technology in space exploration, as well as having an immediate impact on areas important to Canadians, such as TeleLearning, TeleMedicine, and disaster response.

Finally, the Authors describes the relevance of the Haughton-Mars project to the Canadian space program, and also indicate other potential locations of Canada where Mars and Moon analogue exploration research might take place.

Introduction

We have entered an exciting age, in which we are witnessing the detailed exploration of our solar system. We are reaching out to touch Mars with our robotic technology, and we are approaching the start of the century in which we will surely touch it with our own hands. There is a wide range of expertise and technology in Canada that may be applied in this new age of exploration, from communication systems and telematics through to microgravity science and operational space medicine. The PolyLAB and Telematics Research Laboratory, both located at Simon Fraser University, have recently demonstrated the possibilities via an exciting collaboration with NASA Ames Research Center, and many Canadian research partners, in the Canadian High Arctic.

With our present robotic surface and orbital probes of Mars, especially the NASA Mars Surveyor Program, and future human expeditionary missions, it is crucial to locate places on Earth in which analogue environments to those on the Red Planet exist. Needs range from the geological and biological, to allow us to understand processes that are taking

^{*} E-mail: {sbraham, anderson}@sfu.ca

[†] E-mail: {pcee, ralena, bglass}@mail.arc.nasa.gov

place on Mars, to the rugged locations needed to verify exploration technology such as communications, teleoperation, and mobility. Facilities are also needed for the reproduction of the physical environmental conditions on Mars, for all the reasons previously mentioned.

The Haughton-Mars Project

The Haughton-Mars project (HMP, cf. Ref. 1) is a NASA-led field research program (Principal Investigator Pascal Lee), dedicated to the study of the Haughton Crater and surroundings, on Devon Island, Nunavut. The twenty-kilometer diameter crater was formed in an impact approximately twenty-three million years ago. Today, the region is a cold, polar desert, and thus presents a wide variety of geological features and biological attributes that may shed new insights into the nature and evolution of Mars. The scientific study of the Haughton site provides a unique opportunity to also study the strategy, technologies, and human factors relevant to planning the future exploration of Mars by robots and humans.

PolyLAB and the Telematics Research Laboratory

The PolyLAB, headed by S. Braham, is a Sun Microsystems Technology Research Excellence Centre specializing in advanced applications of network computing (cf. Ref 2). The focus of the laboratory is particularly on the building of scientific collaboration systems for applications ranging from TeleLearning and TeleMedicine through to support of large-scale scientific research and other forms of technical telecollaboration. There is an increasing focus on the system needs for delivery over radio and space-based networking systems. The lab has high-power network computing facilities and has developed many advanced products and applications, especially in Java, through a wide range of funding sources. The PolyLAB is presently co-operated by the Centre for Experimental and Constructive Mathematics, at SFU, and the Telematics Research Laboratory. PolyLAB is a research laboratory for the North American OpenMath Initiative (NAOMI), an organization working on the implementation of standards for scientific and technical communication.

The Telematics Research Laboratory (TRL, cf. Ref. 3), headed by P. Anderson, has been established to perform research into all aspects of Telematics, ranging from networking infrastructure for TeleLearning through to TeleMedicine, but with a crucial focus on the needs of disaster communication and emergency preparedness. The TRL has close working relationships with Industry Canada and the Communications Research Centre (CRC). TRL facilities include a range of regional and local radio networking solutions, as well as Ku-band access to the Anik E1 spacecraft. The laboratory provides information services for a wide range of disaster and emergency preparedness agencies, ranging from local groups through to the United Nations and NATO.

The 1999 NASA HMP Expedition

HMP Expeditions have generally been comprised of several distinct phases of scientific and technical investigations, lasting approximately ten days. The 1999 Expedition was made up of four such phases, with logistical support in the field from the Polar Continental Shelf Project (cf. Ref. 4). A Base Camp was established in the crater, in the

Haughton River valley. S. Braham was present for all four phases, spending thirty-four days in the crater. Four space-based communication systems were deployed by the NASA-SFU team, including R. Alena and B. Glass, of NASA Ames Research Center, who were responsible for Communications and Computing for the 1999 field season. Two of the systems were satellite telephones supplied by Canadian companies; two MSAT units provided by TMI Ltd, and an Iridium unit provided by InfoSat Ltd., both donating time and equipment. Twenty-four hour network communications was provided by a C-band terminal linking to the Canadian Anik E1 spacecraft, terminating in a terminal located in Ottawa, both provided by the CRC. A second very high-speed link was used to the NASA Advanced Communication Test Satellite (ACTS) under the command and control of the NASA Glenn Research Center, terminating at a dish located at the United States Air Force Research Laboratory, located in Rome, New York. Ground station hardware and extensive technical support was provided by CRC, including a state-of-the-art ultra-small aperture terminal (USAT) unit. This was integrated to a range of radio networking solutions, including an SFU-provided medium-range packet networking system, using hardware provided by WiLan Ltd. of Calgary. All of the systems mentioned above have been explored by TRL for disaster communications, and by the PolyLAB for TeleLearning applications.



Figure 1: C-band Terminal and Base Camp

On HMP, NASA Ames is conducting experiments demonstrating communication and collaboration techniques applicable to remote field science activities, including the use of mobile vehicles. The communications infrastructure described above was used to provide network connectivity both in Base Camp, and on all-terrain vehicles (ATV) that could move throughout the area, and connect back to the Internet via the radio and satellite systems. The ATVs provided for long-range exploration of the crater, and provide a model for rover exploration of Mars. The communications infrastructure was used in a range of experiments. These included links with Mission Control Center at NASA Johnson Space Center and TeleMedicine work with both the NASA teams and Dr. Gary Gray, M.D., Flight Surgeon at the Canadian Space Agency. S. Braham also established links with Canadian Space Agency/Team Canada booth located at the UNISPACE III conference in Vienna, including a videoconference exchange with Canadian astronaut Chris Hadfield. Communication issues for the Mars Arctic Research Station (MARS), a long-term research facility planned by the Mars Society as a contribution to NASA HMP, were also explored.

The 1999 field season of HMP returned a wealth of geological and biological information, and the mobile and base communication experiments allowed the investigation of a wide range of issues involved in field exploration on the Earth, Mars, and elsewhere.

Impact and Possibilities

Canadian technology was able to provide significant capabilities for the 1999 field season of the HMP, and the collaboration between US and Canadian team members was extremely beneficial and exciting for all. Furthermore, the possibilities for the future are even more exciting for Canadian involvement in the exploration of Space; Canada possesses a site of extreme importance for analogue studies of Mars, a site that has the potential to be important in future human missions to the Red Planet. More importantly, Canada has the facilities to support the development and testing of technologies that could be deployed during future expeditions. For instance, environmental chambers that can simulate the Mars environment are available at the SFU Aerospace Physiology Laboratory (cf. Ref. 5) and at the Defense and Civil Institute for Environmental Medicine (DCIEM). There are also locations within southern Canada, such as the Pocket Desert in British Columbia, that provide terrain relevant for some equipment tests. Canadian scientists have also made a significant geological or biological contribution to the Haughton-Mars Project (cf. J. G. Spray, in these Proceedings). Benefits for Canadian space exploration are obvious, but there are also significant benefits for other important areas of Canadian life. The Canadian Arctic, especially Nunavut, represents an area where TeleMedicine and TeleLearning research and deployment are essential to enhancing the quality of life. Extensive scientific research taking place in the rich heritage that is present in the Canadian North benefits all Canadians. The technologies that can be developed and tested also provide for the essential needs of disaster communications and emergency preparedness, as well as providing a boost for Canadian communications research and industry. Interestingly, Devon Island, on the shores of the Northwest Passage, might find its true value as a Passage to Mars.

Acknowledgements

The Authors would like to thank all members of the Haughton-Mars Project, NASA, the US National Research Council, the Polar Continental Shelf Project, the Geological Survey of Canada, the Nunavut Research Institute, Communications Research Centre, the Canadian Space Agency, NASA Glenn Research Center, United States Air Force Research Labs, the United States Marine Corps, Carnegie-Melon University, the National Geographic Society, the Mars Society, WiLan Ltd, TMI Ltd, InfoSat Ltd, Salisbury and Associates Inc, and the members of PolyLAB and TRL at SFU. SFU's contribution was funded in part by the High-Performance Computing Network.

References

- 1) Haughton-Mars Project, <http://www.arctic-mars.org>
- 2) PolyLAB Sun Technology Research Excellence Centre, <http://polylab.cecm.sfu.ca>
- 3) Telematics Research Laboratory, <http://www.cprost.sfu.ca/telematics.html>
- 4) Polar Continental Shelf Project, <http://polar.nrcan.gc.ca>
- 5) Altitude and Aerospace Physiology, <http://www.sfu.ca/~ablaber>