

HAUGHTON-MARS PROJECT RESEARCH STATION (HMPRS), DEVON ISLAND, HIGH ARCTIC: A PLANETARY SCIENCE AND EXPLORATION FIELD RESEARCH FACILITY. Pascal Lee^{1,2,3}, Stephen Braham⁴, Terry Fong³, Brian J. Glass³, Stephen J. Hoffman⁵, Christopher Hoftun¹, Brage Johansen¹, Kira Lorber¹, Christopher P. McKay³, Robert Mueller⁶, John W. Schutt¹, Michael Sims¹, Jesse T. Weaver¹, and Kris Zacny⁷. ¹Mars Institute, NASA Ames Research Park, Moffett Field, CA 94035, USA, pascal.lee@marsinstitute.net, ²SETI Institute ³NASA Ames Research Center, ⁴Simon Fraser University, ⁵NASA Johnson Space Center, ⁶NASA Kennedy Space Center, ⁷Honeybee Robotics.

Summary: The Haughton-Mars Project Research Station (HMPRS) on Devon Island, High Arctic, is a field research facility dedicated to supporting analog field research in planetary science and exploration. The upcoming HMP-2016 field campaign will be the HMP's 20th.

Introduction: The Haughton-Mars Project (HMP) is an international planetary analog field research project focused on planetary science and exploration studies at and around the Haughton impact structure on Devon Island, High Arctic (Fig. 1). The HMPRS is located at 75° 26 N, 89° 52 W. Devon Island is the largest uninhabited island on Earth. It is part of Nunavut, Canada. Haughton Crater (Diam ~ 20 km, Age: 21 MYa) is the only terrestrial impact structure set in a polar desert. The HMP has been in operation since 1997, with continuous support from NASA and additional support from the Canadian Space Agency (CSA). The project engages both professional researchers and students (grads and undergrads), and has contributed to many advances in planetary science and exploration. The HMP also supports education and public outreach. Research at HMP is divided into two areas: Science and Exploration.

Science. Science research opportunities at the site include the well-preserved medium-sized Haughton impact structure, and a wide range of candidate Mars analog geologic features including small valley networks (subglacial channel networks), canyons (glacial trough valleys), recurring slope lineae and gully systems, rock glaciers, sapping valleys, ground ice, patterned ground, impact-induced hydrothermal deposits, paleolacustrine deposits, polar microbial extremophile biology and ecology, polar desert micro-oases, planetary protection investigation opportunities, etc.

Exploration. Exploration research opportunities at the site include field studies and tests of robotic and human exploration systems, technologies, and strategies, including aircraft, drills, habitats, rovers, space-suits, mapping and navigation tools, etc. Investigations in human behavior and exploration practices in remote and isolated environments may also be conducted. Over the next several years, the HMP plans to conduct dual pressurized rover traverse simulations in support of NASA human planetary exploration planning.



Figure 1: Location map of Devon Island and Haughton Crater. (Adapted from National Geographic).

Facilities: The HMPRS is a permanent field research facility established in the northwestern rim area of Haughton Crater. The HMPRS is currently the largest privately-operated polar research station in the world. The station includes a Base Camp, a dirt Airstrip (200 m), a Helipad area, a Satcom area, and a network of connecting trails. Base Camp includes a Core hub, eight Weatherhaven™-style common tents, and the ACMG (Arthur Clarke Mars Greenhouse).

Structures. The Core is used as a multipurpose common kitchen, pantry, and mess facility. The eight tents serve the following specific functions: Office, Comms, Science, Lab, Medical, Garage/Workshop, Satcom, and Storage (Fig 2). HMP participants need to bring their own (4-season) sleeping tent to be pitched in a designated area ("Tent City", 100 m from Base).

Instruments and Tools. The Lab is equipped with an Olympus BX51 polarizing microscope. In addition, a wide range of shared field research gear is available on site, including rock hammers, hand lenses, shovels, mattucks, field markers, tarps, stakes (anchors), hand-operated augers and drills, and biological and geological sampling containers.

Assets & Resources: *Fuels.* Fuels available at HMPRS include mogas (91 octane gasoline), diesel, Jet-A, Jet-B, and propane.

Water. On-demand hot and cold water are available at Base Camp. Water is pumped from a nearby creek.

Power. Power is available at the HMPRS 24/7 during normal summer operations. Power sources at Base Camp include diesel generators (7 to 12 kW) with back-up, and several portable 1 to 3 kW gasoline generators. The gasoline generators may be transported for use deep in the field. The ACMG may be powered from Base Camp, and/or autonomously via dedicated solar panels and wind turbines. Plans are underway to augment solar and wind power generation capabilities at Base Camp.

Vehicles. The HMP operates a fleet of 10 all-terrain vehicles (ATVs) or quad bikes that may be used on a shared basis by visiting investigators upon completion of mandatory ATV training at the HMPRS. The HMP also operates one side-by-side (Kawasaki Mule) and two Humvees (AM General HMMWV or High-Mobility Multipurpose Wheeled Vehicle – modified military ambulance versions) designated *HMP Mars-1* (red) and *HMP Okarian* (yellow). The *HMP Okarian* was driven to Devon Island on sea-ice by way of the Northwest Passage, and is featured in the motion picture documentary film *Passage To Mars* (2016 release). In addition to being means of transport, all vehicles at HMP are considered to be field research tools, as they are critical in allowing access to geologic features, outcrops, and other data sources in the field.

Internet access. Wireless internet access is available at Base Camp via a K_a band satellite link. Remote internet access from deep field locations may be made available via deployable repeaters linking back to Base Camp. Data rates vary with location and the amount of sharing of the available bandwidth.

Access: Access to the HMPRS is controlled and restricted to MI-authorized persons only, including authorized external participants. Travel between a major US or Canadian city and HMPRS typically takes 2 to 3 days each way. Participants fly from Ottawa (YOW) to Resolute Bay (YRB) via Iqaluit (YFB) on a commercial air carrier (First Air) or on an HMP-chartered aircraft, then from YRB to HMPRS on an HMP-chartered Twin Otter turboprop aircraft equipped with tundra tires (operated by Kenn Borek). To return, this itinerary is reversed. All cargo bound for HMPRS must be sized to be loadable onto a Twin Otter with cargo doors, unless special arrangements are made with MI to use other means of airlift (helicopter sling for instance). During travel, one or more nights of lodging in YOW and YRB may be required, depending on weather and logistics.



Figure 2: The HMPRS with the grey impact breccias hills of Haughton Crater in the distance. (Photo HMP-2015/P.Lee).

Safety. Safety is paramount at HMP. HMP field deployments take place in an arctic expeditionary environment, with clear lines of authority, leadership, and reporting defined and agreed upon in advance. Effective safety measures and culture are also in place. After 19 summer and 5 winter field campaigns, totalling close to 10,000 person-days, no serious accident (with irreversible injury) has occurred at HMP. All personnel participating in HMP field campaigns receive mandatory and thorough field safety briefings and refresher training throughout each field campaign. Prior to deploying, participants receive safety documents and a personal equipment (packing) list to assist them in planning for a safe and productive field campaign. Wildlife encounters with polar bears have occurred over the years and are managed with effective deterrents, with no negative incident to date. HMP staff usually includes a Medical Officer trained in emergency field medicine, although medical facilities at Base Camp are very limited. If a serious medical issue arises, a medevac airlift would be called, weather permitting.

How To Participate. The HMP hosts and supports only research and outreach activities relating to planetary science and exploration. Individual researchers or teams interested in conducting research at the site should contact the HMP PI to discuss possibilities. The HMP Project Office (HMP PI & HMP Project & Logistics Mgr) will then assist the prospective participant in developing a field research plan, a logistics plan, and a budget. Adequate funding may then be sought from NASA and/or other funding agencies. Students (grads & undergrads) are encouraged to participate.

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