

### 3.9 Marie-Claude Williamson



Dr. Marie-Claude Williamson is a research scientist at the Geological Survey of Canada (GSC), and adjunct research professor at Carleton University, Ottawa.

Dr. Williamson completed her undergraduate studies at l'Université de Montréal, acquiring field mapping experience while working during the summer months for the Québec Department of Natural Resources. A growing interest in volcanic rocks and love of the sea brought her to Nova Scotia in 1979 to pursue graduate studies. In 1982, she received an M.S. for completing a project on ancient volcanic rocks located along the western shore of Cape Breton Island. Following a year of technical work in marine geology, and in search of a Ph.D. project, she was offered an opportunity by a pioneer of the GSC's Operation Franklin, Dr. Neil McMillan, to map and study large tracts of igneous rocks exposed along spectacular ridges and cliffs in the Canadian High

Arctic. The field work for this project was carried out on Axel Heiberg Island and northern Ellesmere Island from 1983 to 1985, in collaboration with staff at GSC Calgary who were experts on the thick succession of sedimentary rocks known as the Sverdrup Basin. Expeditions were typically compact in nature, involving herself and an assistant supported by the Polar Continental Shelf Project (PCSP). Fly camps were established in remote areas of the two islands by Twin Otter and helicopter flights originating out of Resolute or Eureka.

Dr. Williamson was invited to join the Division of Planetary Exploration at the Canadian Space Agency in July 2005. The newly formed division required geoscience expertise to respond to interest worldwide in robotic and manned exploration missions to the Moon, Mars, and beyond. She became the first geologist on staff in August 2007 with specific mandates to promote geology and geophysics both in programs and research, particularly at analogue sites in the Arctic Islands; give a voice to the Planetary Sciences community in Canada; and work with engineers on the selection of scientific instruments targeted for lunar surface investigations by Canadian-built robotic rovers.

In 2003 and 2004, Dr. Williamson carried out geological mapping and sampling from PCSP-supported fly camps on Axel Heiberg Island. In 2007-2008, in collaboration with the PCSP, Mars Institute, and McGill University, Dr. Williamson coordinated the logistics requirements for 17 planetary analogue research projects deployed out of the Haughton Mars Project Research Station on Devon Island or the McGill Arctic Research Station on Axel Heiberg Island. In 2008-2009, she co-chaired the first Canadian Planetary Geology and Geophysics (CPGG) Working Group to define, for the planetary geology and geophysics community, a set of Scientific Priorities for the Global Exploration Strategy.

Dr. Williamson completed her 2-year secondment at the Canadian Space Agency (CSA) in August 2009. She has since joined the Central Canada Division of the GSC located in Ottawa. In her capacity as field geologist, Dr. Williamson contributes to a 5-year project initiated in 2008 to update geological maps of the Canadian Arctic landmass. Her current assignment is the Minto Inlier, located on Victoria Island, Northwest Territories.

## A7 – Presentation of Marie-Claude Williamson

### *Science Traverses in the Canadian High Arctic*

[Slide 1] Science Traverses in the Canadian High Arctic, Marie-Claude Williamson (Canadian Space Agency); Current address: Central Canada Division, Geological Survey of Canada.

[Slide 2] The presentation is divided into three parts.

Part I is an overview of early expeditions to the High Arctic, and their political consequences at the time. The focus then shifts to the Geological Survey of Canada's mapping program in the North (Operation Franklin), and to the Polar Continental Shelf Project (PCSP), a unique organization that resides within the Government of Canada's Department of Natural Resources, and supports mapping projects and science investigations. PCSP is highlighted throughout the presentation so a description of mandate, budgets, and support infrastructure is warranted.

In Part II, the presenter describes the planning required in advance of scientific deployments carried out in the Canadian High Arctic from the perspective of government and university investigators. Field operations and challenges encountered while leading arctic field teams in fly camps are also described in this part of the presentation, with particular emphasis on the 2008 field season.

Part III is a summary of preliminary results obtained from a Polar Survey questionnaire sent out to members of the Arctic research community in anticipation of the workshop. The last part of the talk is an update on the analog program at the Canadian Space Agency, specifically, the Canadian Analog Research Network (CARN) and current activities related to Analog missions, 2009-2010.

[Slide 3] This slide shows the position of Axel Heiberg Island, in the Canadian Arctic Archipelago, on the General Bathymetric Chart of the Oceans (GEBCO) bathymetric map of the Arctic Ocean (Jakobsson et al. 2000). The island is separated from Ellesmere Island by the Nansen Sound. Most of the field work illustrated in the presentation was carried out in western and central parts of the island. Axel Heiberg Island and Devon Island are both uninhabited islands of similar areal extent:

Axel Heiberg Island:	43,178 km <sup>2</sup>
Devon Island:	55,247 km <sup>2</sup>
Ellesmere Island:	196,235 km <sup>2</sup>

GEBCO website: <http://www.ngdc.noaa.gov/mgg/bathymetry/arctic>

This is my favorite map simply because I lived in an oceanographic institute and it includes the study area for my doctoral degree. On this polar projection, some important physiographic features of the Canadian Arctic Islands are worth noting:

1. The narrow polar continental shelf, adjacent to a large sedimentary basin that underlies most of the Arctic archipelago, the Sverdrup Basin –
2. the proximity to Greenland, across the Nares Strait,

3. The Canada and Eurasia Basins. The Lomonosov Ridge, Alpha Ridge, just north of Ellesmere Island, and Chukchi Plateau. The red dot indicates the locations of Axel Heiberg Island, topic of most of this presentation.

[Slide 4] This slide shows the chronology of events leading to Norway's claim of the Sverdrup Islands under international law in 1928. Captain Sverdrup and his predecessor, Fridtjof Nansen, were the first to explore the islands located west of the Nansen Sound (Kenney, 2005).

The *Fram* Expeditions (under Nansen and Sverdrup) were sponsored by the Norwegian Consul, Axel Heiberg, and the Ringnes brothers (Ellef and Amund) of brewing fame. The *Fram*'s Second Arctic Expedition, under the command of Otto Sverdrup started on June 24, 1898, and lasted four winters. The expeditions formed the basis for a Norwegian claim to the area.

[Slide 5] Although Otto Sverdrup and the *Fram* crew explored a much wider area, the Sverdrup Islands (Axel Heiberg Island, Ellef Ringnes Island, and Amund Ringnes Island) were undiscovered. This slide shows the location of Axel Heiberg Island, Ellef Ringnes Island, and Amund Ringnes Island in the archipelago.

[Slide 6] This slide shows an ASTER image of Axel Heiberg Island and Ellesmere Island. Folded rocks are visible beneath the light snow cover that is typical of this polar desert environment. The red square delimits the area explored by Otto Sverdrup and his crew during the second *Fram* expedition, 1898-1902 (Kenney, 2005). The short book by Gerard Kenney on the Norwegian-Canadian Expeditions of the early 20th century is a compelling account of the hardships endured by Otto Sverdrup and his men during the course of the expedition. The names of the crew are listed in the top right-hand corner of the slide. These names are familiar to Arctic explorers but also to scientists engaged in geological work on these islands: Sverdrup Basin, Stolz Peninsula, Schei Point, Fosheim Peninsula, Isachsen Formation, Baumann Fiord, Bay Fiord, and Hassel Formation.

[Slide 7] In response to the Norwegian Expeditions, the Canadian government sponsored a number of Canadian patrols in the Eastern and Central Arctic, some of which I have listed here. As a result of increased activity in the North, the Norwegian government withdrew its claim to sovereignty over the Sverdrup Islands in 1930. However, the exploits of the Norwegian men who ventured in this hostile environment on the *Fram* are forever recorded in Canadian geographic annals and geological history.

[Slide 8] This slide illustrates important milestones in the exploration of the Canadian Arctic Islands and adjacent ocean.

- Operation Franklin: Fifty years ago, in the summer of 1955, the Geological Survey of Canada conducted Operation Franklin, the first helicopter supported exploration program in the Canadian Arctic Islands. It was a reconnaissance program, covering approximately 200,000 square miles, about the same area as France. The project used a DC-3 aircraft, two Sikorsky S55 helicopters, and three dog teams. The geologists did a lot of walking from their fly camps, but the study areas still look small and scattered when they are plotted on a map of the Arctic. We jokingly referred to this phase of exploration as "postage stamp geology." For those of us who were on Operation Franklin, it was an unforgettable adventure. It also was a scientific milestone that set the stage for government and industry to further explore and understand our high Arctic. (Extract from a talk by J.W. Kerr.) <http://www.cspg.org/events/luncheons/2005/20050922-kerr.pdf>

- Exploration Drilling in the Sverdrup Basin: Data from Operation Franklin surveys revealed a thick layer of sedimentary rocks and structures in the Arctic Islands, similar to those found in oil fields. The petroleum industry was quick to carry out investigations for oil and natural gas.
- Arctic Oceanographic Experiments – Ice Islands: See a description of the Canadian Experiment to Study the Alpha Ridge as an example of operations on the Arctic sea ice: <http://www.thecanadianencyclopedia.com/index.cfm?PgNm=TCE&Params=A1ARTA0001490>
- United Nations Convention on the Law of the Sea (UNCLOS): The Director of UNCLOS Canada is Dr. Jacob Verhoef, Earth Sciences Sector: NRCan. [http://ess.nrcan.gc.ca/scient\\_e.php](http://ess.nrcan.gc.ca/scient_e.php)

[Slide 9] The Polar Continental Shelf Program (PCSP). The value of support in 2007 tripled in 3 years over its previous base partially due to climate change studies and International Polar Year (IPY) support. The 2007 report has just been completed and can be downloaded from their website (<http://polar.nrcan.gc.ca>). A history of the PCSP can also be found on the website History of PCSP at [http://polar.nrcan.gc.ca/about/history\\_e.php](http://polar.nrcan.gc.ca/about/history_e.php)

One reason the PCSP works well is that it is run military style; the base camp manager is the ultimate authority when it comes to field operations. You make your twice-a-day radio calls and follow protocols or you do not get your resources the following year.

[Slide 10] This slide shows a schematic map of Axel Heiberg Island, northern Ellesmere Island, and northwestern Greenland. The red oval and square illustrate the extent of my Ph.D. study area, and the location of base camps. Field operations were based on the system pioneered during Operation Franklin. Fly camps were established with support from PCSP fixed- and rotary-wing aircraft. Mapping and sample collection were planned according to a set of 10-15 km foot traverses radiating out from base camp. This part of the Arctic Archipelago is characterized by volcanic and intrusive rocks of Cretaceous age emplaced in a large continental rift basin reactivated during the opening of the adjacent Arctic Ocean.

[Slide 11 – skipped in presentation] Looking back at some of the events that were impressed upon me during field work on Axel Heiberg Island brings me to a helicopter flight from our base camp at Bunde Fiord, on the northwestern part of the island, to a site revisited by a Survey geologist based out of Ottawa during Operation Franklin, Jack McMillan.

[Slide 12] For the Geological Survey of Canada, Operation Franklin was the first large-scale effort to carry out geological mapping with helicopter support – flying a path, setting up a fly camp, and then moving on as long as the weather didn't close in. I was looking for a Ph.D. thesis and Jack knew what needed to be completed, what gaps remained at the end of Operation Franklin.

There had not previously been any females at the base camp and at first my participation was declined by the base camp manager. Fortunately, Jack McMillan kept working to get me a spot and that changed. A very wise decision by the GSC camp manager that year was to include two other women in the field party of about 25.

[Slide 13] This slide show Bunde Fiord glacier in July 1983.

[Slide 14] These are pictures from the 1983 field season. Taking a look at the photo of the helicopter at the top left would alert any geologist working these camps in the 1980s that this was an emergency

landing. Small tents such as this one were restricted to the pilots; everyone else used Logan tents (bottom left). So ice fog, tent's up, the pilot is stranded: Resolute, we have a problem.

[Slide 15] If you were going to the arctic next year, then planning for the expedition would have to start early this year, e.g. September 2009. These are the planning steps you would need to outline with your CoI. The government and some universities now also require a risk analysis.

[Slide 16] These are the next planning steps that are required, and timelines.

Once you get your letter from the PCSP offering aircraft and logistics support, things start to move faster. One note, you cannot negotiate with PSCP; for example, if they decide they are decreasing your requested flight hours by one half, you have to live with it and adjust the field season as a consequence.

[Slide 17] Operations – The first challenge is site selection. You will use all the information you have to plan your sites. But, unless this is a return trip to a previously studied area, once on the helicopter, the geologist is the navigator and must choose the right location for a base camp; taking into account not only the science, but logistics, such as access to drinking water.

[Slide 18] These are photographs from some of the previous sites I have visited. Some of them are problematic, some of them are not. Site selection is entirely driven by science goals but the availability of drinking water remains a critical issue during field work in proximity to salt domes.

[Slide 19] Everyone always asks about the weather. The truth is, it is changing. There never used to be much rain in the polar desert now you can get weeks of wet weather. You have to be prepared for everything ([http://polar.nrcan.gc.ca/about/manual/pdf/operations\\_manual\\_e.pdf](http://polar.nrcan.gc.ca/about/manual/pdf/operations_manual_e.pdf), Advice to the Arctic Researcher). The greatest threat during foot traverses is hypothermia, not necessarily from falling in glacial streams but from the gradual effects of a cold wind over time.

[Slide 20] The next two slides are about aircraft support. Twin Otter support is very different from helicopter support. Basically the extent of your relationship with the Twin Otter pilot is take-off to landing. Rarely does the PI have any power of negotiation regarding the landing site, particularly if there are no landing strips and we need to land directly on the tundra. This slide shows the Twin taking off after dumping our gear at Strand Fiord. It took our party of four about six hours to move the gear to a better location, and set up camp.

[Slide 21] This slide shows the difference between fixed-wing and rotary-wing aircraft support. In the aftermath of a snowstorm at a site near Lightfoot River, on northern Axel Heiberg Island (August 2008), the helicopter pilot worked very hard to get our team of three geologists back to the Eureka weather station in close to white-out conditions.

[Slide 22] This slide illustrates a basic concept for any type of polar work, in the Arctic or Antarctic: Once you get past aircraft support and the weather, these some of the other challenges you will need to face. Depending on the profile of your field crew members, some or all of these may start failing at some point (team work, navigation, achieving science goals), and be compounded by equipment failure and isolation. Sometimes this implies that as the leader you have to make unfortunate decisions.

[Slide 23] These are the sort of things you need to take into account: terrain, logistics (moving camp), equipment breakdown, wildlife (there are only 17 species in the arctic, but you have to deal with all of them), etc... Again, be prepared.

[Slide 24] As beautiful as it is, at some point you are far away from home, cold, wet and bored. You need to prepare your team ahead of time and manage any crises with confidence to avoid disaster.

[Slide 25] This slide of the tundra at Lightfoot River on Axel Heiberg Island illustrates how difficult it is to navigate with very few landmarks for mapping. If the weather closes in, the situation becomes dangerous even with a GPS.

[Slide 26] And of course there is the problem of isolation.

[Slide 27] As a team leader, I have had my experiences with bizarre behavior by my team members. This is a list of the factors that I found impact their behavior. Fatigue is probably the biggest factor for a geologist as you are performing physical labor 10 to 12 hours a day. Waning interest can be a problem with young investigators that have always wanted to go to the field in the Arctic but now that they have been there for awhile (3-4 weeks), it is no longer as exciting – field assistants need to be strongly motivated to keep going.

[Slide 28] In my own experience, I have found that effective people leadership starts with prioritization. It all ends up on that radar screen in your mind – the question is ‘how close are we to a crisis’ – what can be done to resolve the issue now or at least keep it under control until more information is available or I can get advice from Base Resolute.

Of course, that doesn't always work.

In my experience, the most difficult decision when a problem arises with a team member is to make the conscious decision, as the leader, to slow down the intense pace of foot traversing and science activities to allow some time to deal with the issue. This requires a personal decision to shift focus, observe, consult if necessary, and decide – one that has the immediate and beneficial effect of capturing the team's attention. If/when that happens, I found that the approach is effective. Now with the full (surprised, concerned) attention of the field team, dialogue can be initiated, the problem can be addressed, and a solution can be found. It takes time, attention, and effort but the process usually pays off in the end, and gets us back on track, albeit with revised objectives, hopefully with the field party intact and ready to move on.

[Slide 29] In the next five slides, I illustrate some aspects of team selection. Remember, I am a public servant, so when I talk about different cultures, I am usually referring to the cultural differences between government and academia – two different types of accountability, reporting structures and deliverables. I like this slide, because if I had to pick the perfect person, it would be someone like this gentlemen who realizes and understands the risks, yet remains calm.

[Slide 30] This ideal is rarely achieved. In reality, you are looking for someone who is motivated, enthusiastic, curious, and resourceful.

[Slide 31] You also want someone who is capable of some degree of autonomy, and of relaxing in any environment, such as this field geologist waiting for the helicopter to show up for a camp move.

[Slide 32] At the same time, we always had meals together, and we shared the work at base camp. The professor here on the right did not really want to cook, but we eventually convinced him to try it.

[Slide 33] As illustrated on this slide, participants also need to be sociable and get along in a larger group – have barbecues, for example, when other researchers in the area come by for a visit.

[Slide 34] This slide illustrates some statistics concerning the polar survey that I mentioned earlier. The data show some interesting trends, but I am still evaluating the results. This is a breakdown of the survey participants, in terms of numbers, expertise, gender, and experience.

[Slide 35] This slide illustrates some of the results to the questions of “Most Important Quality of the Field Team” and “Valuable Qualities of Individuals”.

[Slide 36] This slide shows a graph of the relative importance of various factors on mission success. If CSA is going to fund universities to perform planetary analog work, we need to look at the results of surveys such as this one to realize what is important to the arctic science community, and how can we best work with these preferences as a funding agency.

[Slide 37] These are the CSA analog sites in the arctic. Key to colored dots: Green, Resolute; Red, Haughton Mars Project on Devon Island, and McGill Arctic Research Station on Axel Heiberg Island; yellow: Eureka Weather Station.

Through the Canadian Analogue Research Network (CARN), CSA has invested infrastructure and research projects at two sites in the Canadian High Arctic: the Haughton-Mars Project on Devon Island in collaboration with the Mars Institute and McGill Arctic Research Station on Axel Heiberg Island in collaboration with McGill University. This summer, a reconnaissance team led by CSA in collaboration with Environment Canada travelled to the Fosheim Peninsula on Ellesmere Island to investigate the potential for the development of a third site to support field teams based out of the Eureka Weather Station.

All three sites are very different, but a common denominator is their potential for Mars analog research. In Canada, lunar analog sites consist of impact craters in anorthositic rocks (Manicouagan, Mistastin), and there are no sites yet identified for studies of lunar regolith (unconsolidated materials) – we will probably need to go to Iceland.

[Slide 38] In the Recommendations proposed by the CLEAR-1 mission SDT (June 2009), geological and geophysical investigations of the lunar regolith are given priority re: lunar science objectives related to In Situ Resource Utilization and Astronaut Activities with rovers.

The Arctic polar desert does not provide a suitable (high-fidelity) analog. The Lunar Analogue Site Analysis Team (LASAT) Iceland report (Potential for Lunar Analogue Research at Askja and Hekla Volcanoes, Iceland) contains a detailed description of the Askja caldera as a potential analog where such studies can be carried out.

[Slide 39] The next two slides show a definition of analog missions, and some of the operational requirements.

[Slide 40] This slide illustrates a list of tests and measurements acquired during analog missions that provide Lessons Learned. Logistics are not explicitly included but are implied through Infrastructure. The list is biased towards instrument-based scientific investigations.

[Slide 41] From my experience trying to gather metrics, by for example timing how long it took to describe geology at outcrops, I have concluded that some technologies could facilitate the process. We need technology that records the metrics without interfering with the work being done.

[Slide 42] These are iPaq's loaded with a basic set of data before going to the field

- 1) Vector (points, lines and polygons)
  - a) streams, lakes, roads, etc ...
  - b) National Topographic Database (NTDB) - 1 : 50,000 and 1 : 250,000 scale
  - c) Terrain Resource Inventory Mapping (TRIM) – 1 : 20,000 and 1 : 250,000 scale
  - d) National Atlas Information Services (NAIS) – 1 : 2 M, 1 : 7.5 M, 1 : 30 M scale
- 2) Raster (images)
  - a) Geological map, geophysical data, Earth observation data, station locations, etc ...

These have a built in GPS and chronometer to automatically measure when and where work is being done and recorded.

Meetings between the Geomatics team at CSA Planetary Exploration and GSC (Québec and Ottawa offices) have centered on adapting the GANFELD software package to a broader set of field entries. GANFELD is intended for the capture of geospatial data and geological information during field traverses.

[Slide 43] And here are my conclusions. In my view, the most important factor to consider if Arctic field work is considered for training is the duration of the mission. By analogy, if a team sets out to participate in an Ironman competition with no previous experience, the coach might wish to start training the team for a "Sprint Triathlon"; the individual segments are shorter, but the athletes will have to deal with all the critical transitions: swim to bike, bike to run. Once they have trained for, and experienced these transitions, they can shift their focus on the endurance factor of their "mission", and eventually attempt an Ironman Triathlon.

[Slide 44] Acknowledgments

[Slide 45-47] Backup slides with charts on the Polar Survey.



Marie-Claude Williamson  
Canadian Space Agency  
[Marie-Claude.Williamson@csa.gc.ca](mailto:Marie-Claude.Williamson@csa.gc.ca)

## Science Traverses in the Canadian High Arctic

*Polar Traverse Workshop  
August 2009*

1

 Canadian Space Agency / Agence spatiale canadienne



### Outline

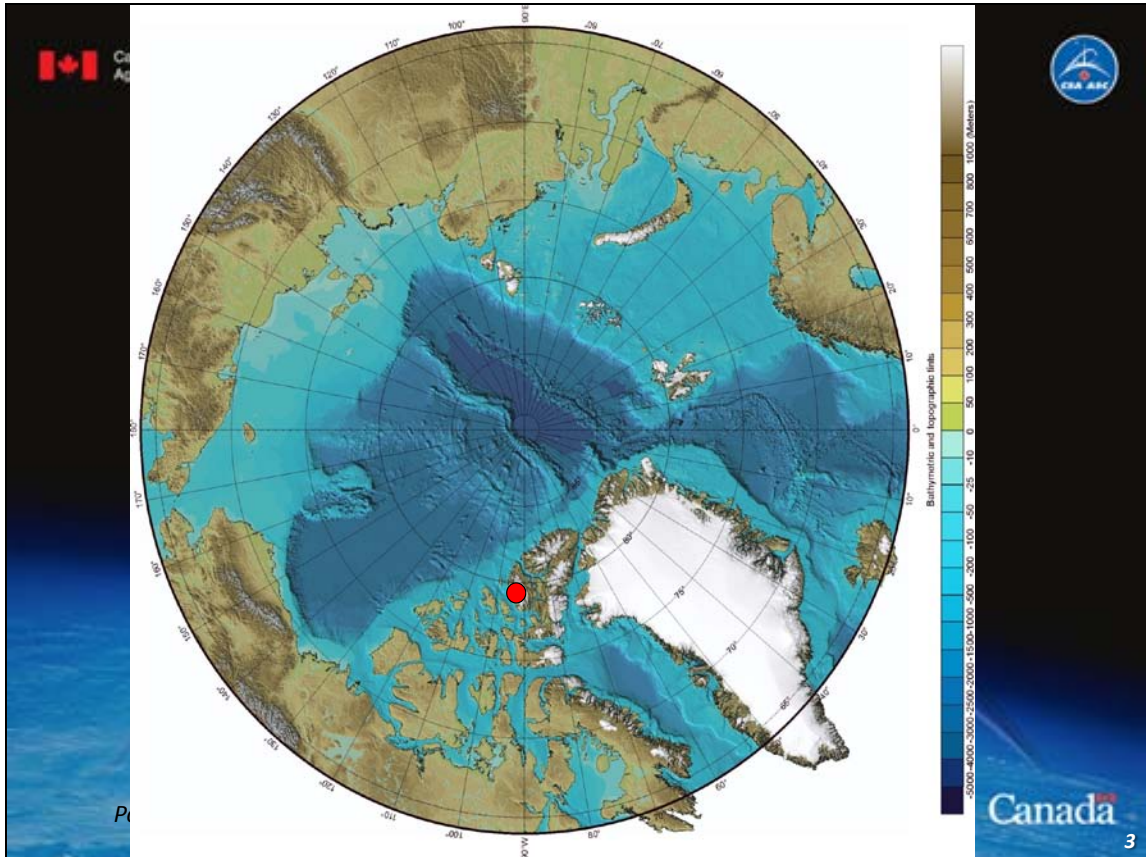
- Exploration Highlights, Arctic Archipelago
- The Polar Continental Shelf Project (PCSP)
- Planning Arctic Field Deployments in 2009
- Operations
- Challenges
- Lessons *\*We Have Already\** Learned :  
*A Polar Science Survey*
- Analog Sites in the Canadian Arctic :  
*Managing Expectations*
- Planetary Analog Missions : CSA update

*Polar Traverse Workshop*

*4 August, 2009*

Canada

2

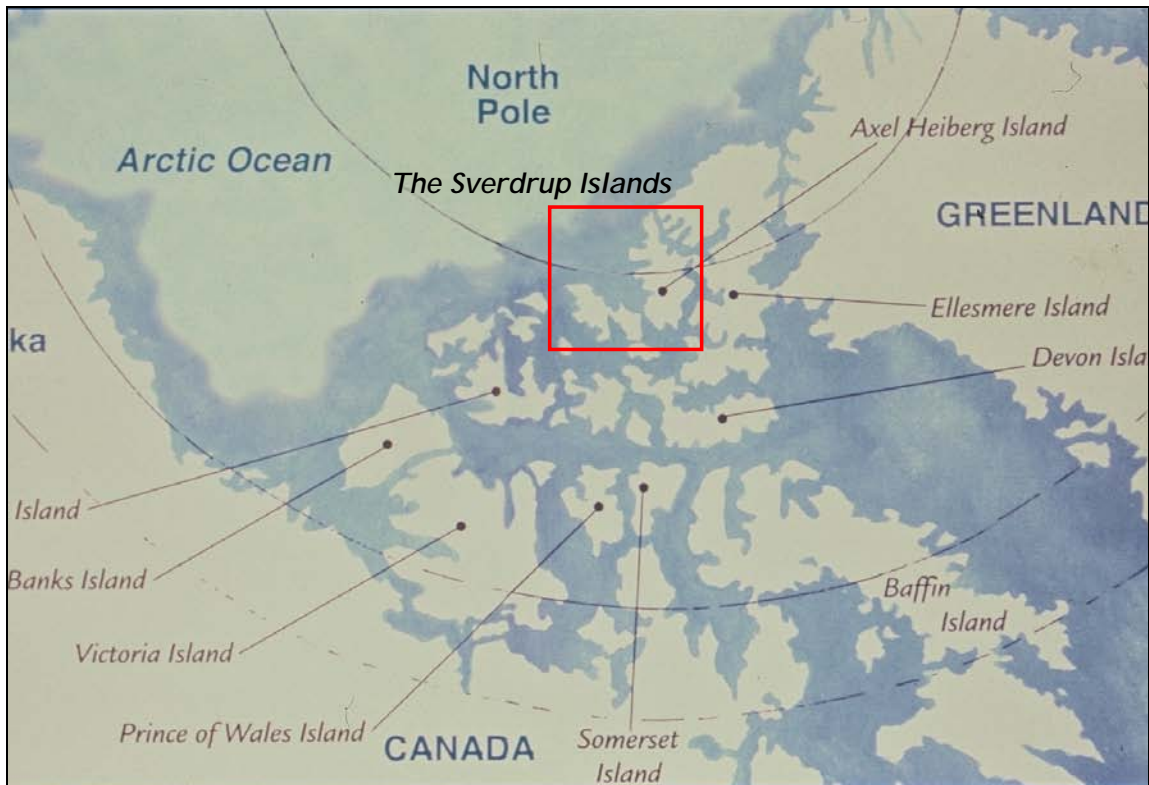


## The Norwegian Expeditions 1893-1902

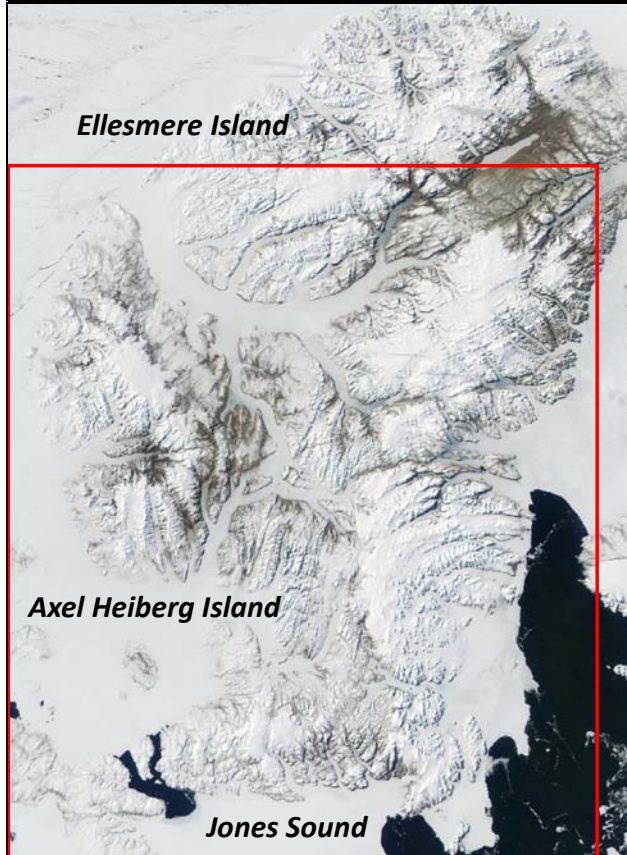
- Exploration
- PCSP
- Planning
- Operations
- Challenges
- Lessons Learned
- Polar Science
- Survey
- Analog Sites
- Analog Missions

- 1880 Canada inherits all remaining northern tracts of land from the British Crown
- Captain Otto Sverdrup leads a crew of 15 men on the *Fram* for an Expedition to the High Arctic Islands, 1898-1902
- 1928 Norway reserves all rights under international law over the Sverdrup Islands

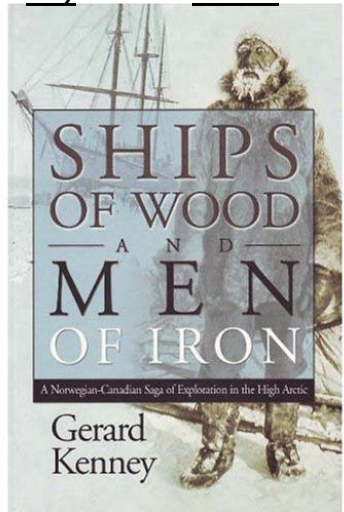




**THE HIGH ARCTIC**



- Otto Sverdrup Jacob Nodtvedt
- Peder Leonard Hendriksen
- Karl Olsen Rudolph Stolz Per Schei
- Ivar Fosheim Herman Simmons
- Ove Braskerud Johan Svendsen
- Gunerius Ingvald Isachsen
- Victor Baumann Olaf Raanes
- Edvard Bay Sverre Hassel





## The Canadian Expeditions 1903-1948

- Albert P. Low (geologist) and the *Neptune*, 1903-1904: the first Eastern Arctic Patrol
- Joseph E. Bernier and the *Arctic*, 1904-1925
- V. Stefansson and the *Karluk*: The Canadian Arctic Expedition, 1913-1918
- Henry A. Larsen and the *St. Roch*, 1928-1948
- 1930 The Norwegian government formally recognizes Canada's sovereignty over the Sverdrup Islands

Polar Traverse Workshop

4 August, 2009

Canada

7



## The Geological Survey of Canada

- **Operation Franklin, 1955, 200,000 sq. miles**
- Exploration drilling in the Sverdrup Basin, 1960-1980
- Geophysical Experiments, Arctic Ocean
  - LOREX, 1979
  - CESAR, 1983
- *Ice Island*, N Ellesmere Island 1984-1993
- UNCLOS program for Canada

<http://www.international.gc.ca/continental/limits-continental-limités.aspx?lang=eng>

Polar Traverse Workshop

4 August, 2009

Canada

8



# The Polar Continental Shelf Program

## PCSP Base Resolute Camp Managers

Barry Hough Dave Maloley

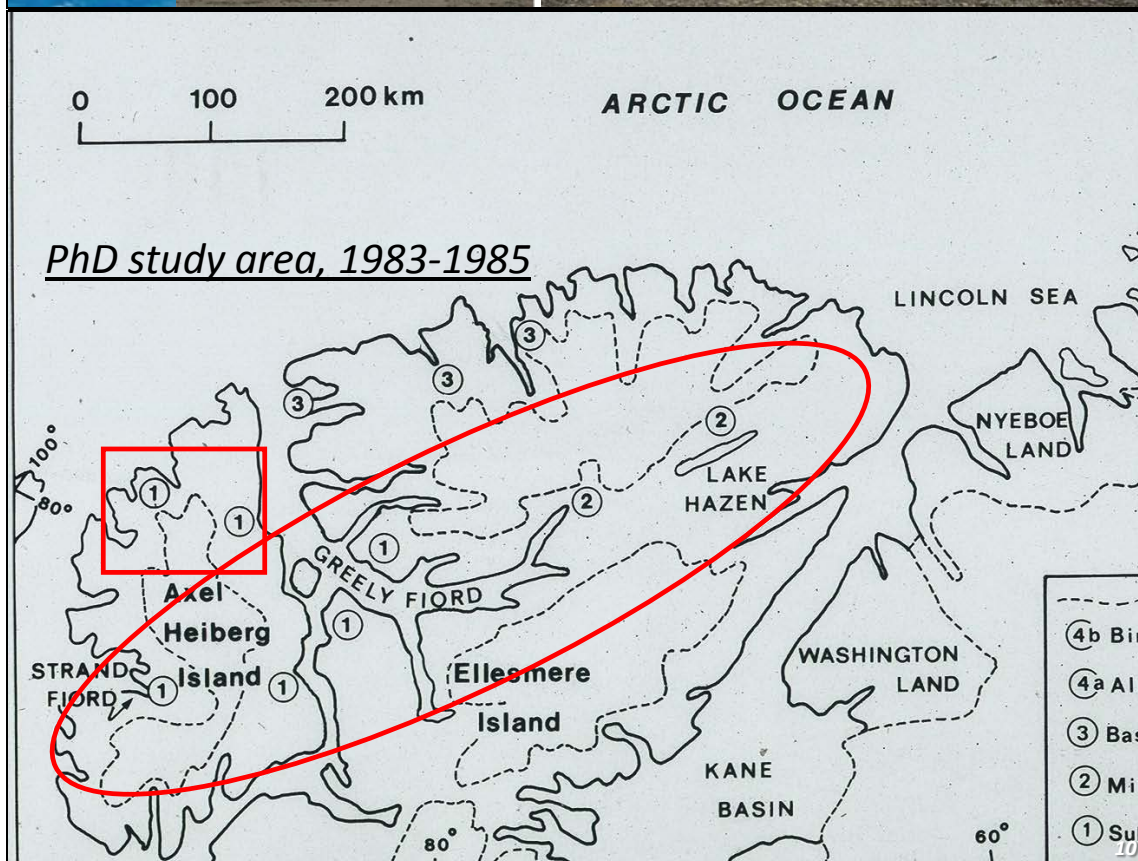
Mike Kristjanson Tim McCagherty

<http://polar.nrcan.gc.ca>

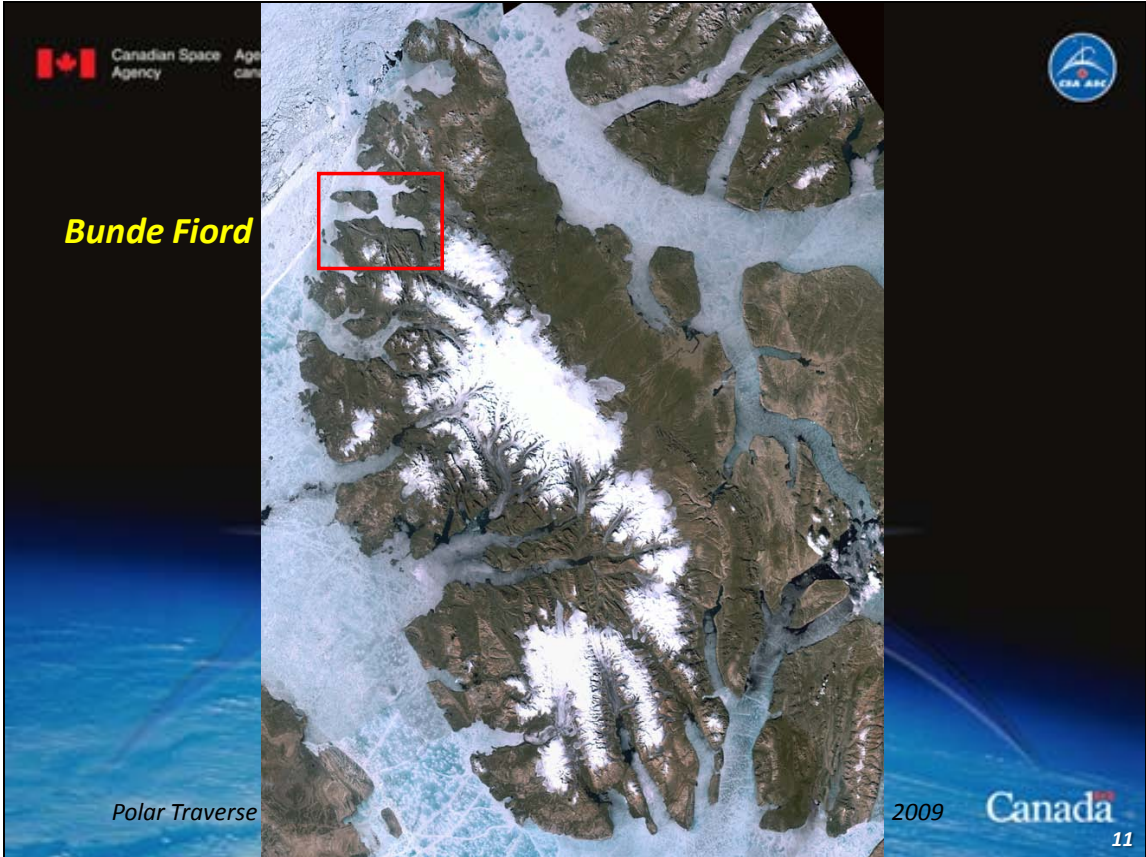
- Exploration
- PCSP
- Planning
- Operations
- Challenges
- Lessons Learned
- Polar Science
- Survey
- Analog Sites
- Analog Missions



PCSP field season 2007  
 Value of support \$7,971,500  
 Projects supported 123  
 Field personnel 1135  
 Twin Otter flight hours 1726  
 Helicopter flight hours 3783









*Glacier Observation Monuments, Bunde Fiord, July 17, 1983*



13



14



# Planning Fly Camps

- Exploration
- PCSP
- Planning**
- Operations
- Challenges
- Lessons Learned
- Polar Science
- Survey
- Analog Sites
- Analog Missions

- Science Objectives
- Geographic area and Timelines
- Operational Planning : access, infrastructure, science instruments, supporting technologies
- Risk analysis
- Field party
- Logistics**

2009  
SEPT  
OCT  
NOV



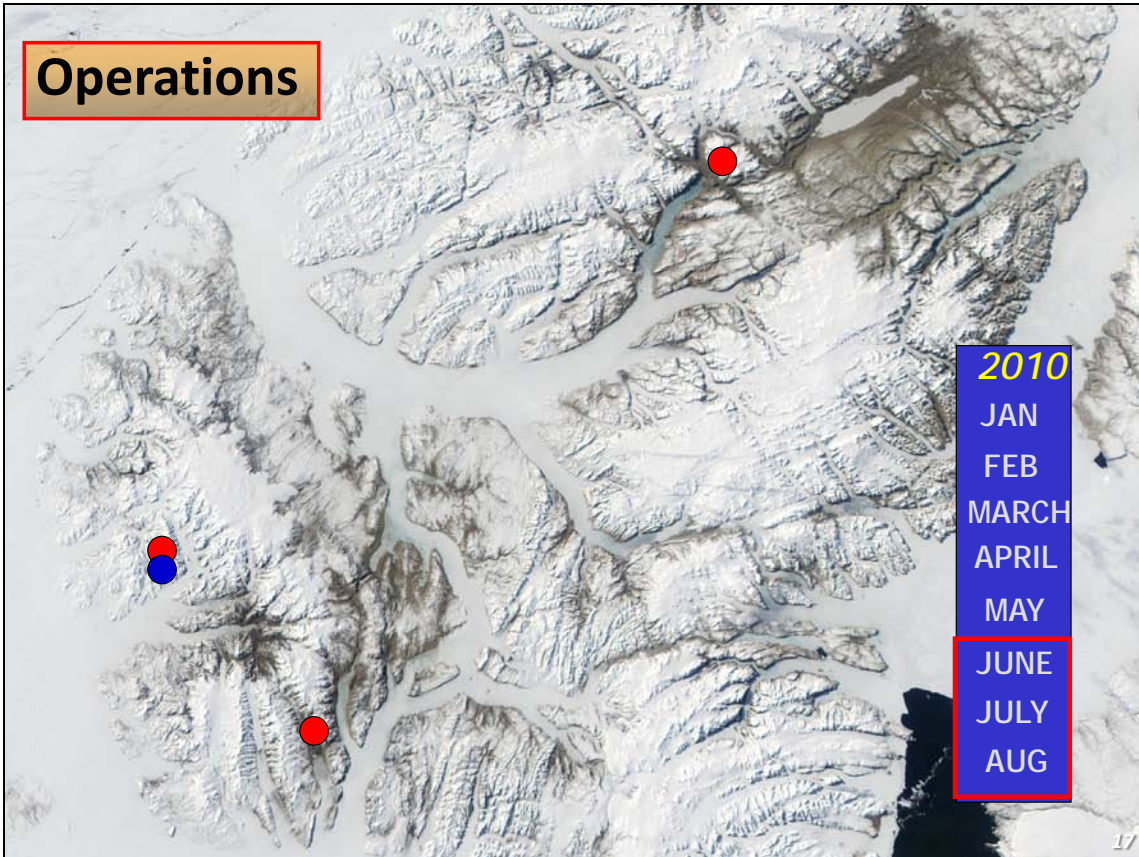
# Planning Fly Camps

- Application for PCSP Aircraft & Logistics
  - Application for Research License NRI
    - Nunavut Environmental Impact Review Board
  - Application for Nunavut Water License
  - **PCSP Letter of Support**
  - **NRI License and Water License**
  - **PCSP request for final IN-OUT flights, fixed-wing and rotary-wing aircraft**
  - **OPERATIONAL READINESS REVIEW**
- Team, food, equipment, instruments, logistics

2009  
OCT  
NOV  
2010  
JAN  
FEB  
MARCH  
APRIL  
MAY  
JUNE



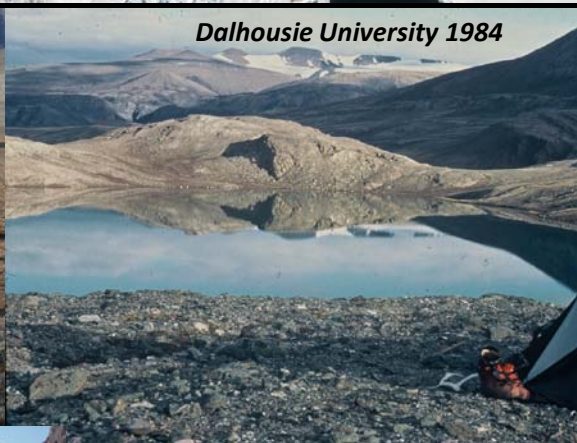
# Operations



CSA 2008



Dalhousie University 1984



GSC 2004



GSC 2004







# The Weather. Well?

- Exploration
- PCSP
- Planning
- Operations
- Challenges
- Lessons Learned
- A Polar Science Survey
- Analogue Sites
- Analogue Missions

**PCSP Operations Manual**  
**2. Advice to the Arctic Researcher**

- [2.18. Hypothermia](#)
- [2.19. Frostbite](#)
- [2.20. Dehydration](#)



4 August, 2009

Canada

19

## Aircraft Support:

*Strand Fiord airstrip, July 2003*



20

*Lightfoot River, August 2008*



21

## **(Other) CHALLENGES**

- **Team work**
- **Navigation**
- **Achieving science goals**
- **Equipment breakdown**
- **Isolation**



22





23



24



*Lightfoot River, August 2008*  
*N80°45' W92°25'*



25



26

# Human Factors

*Isolation*

*Fatigue*

*Waning interest*

*Anxiety*

Leadership

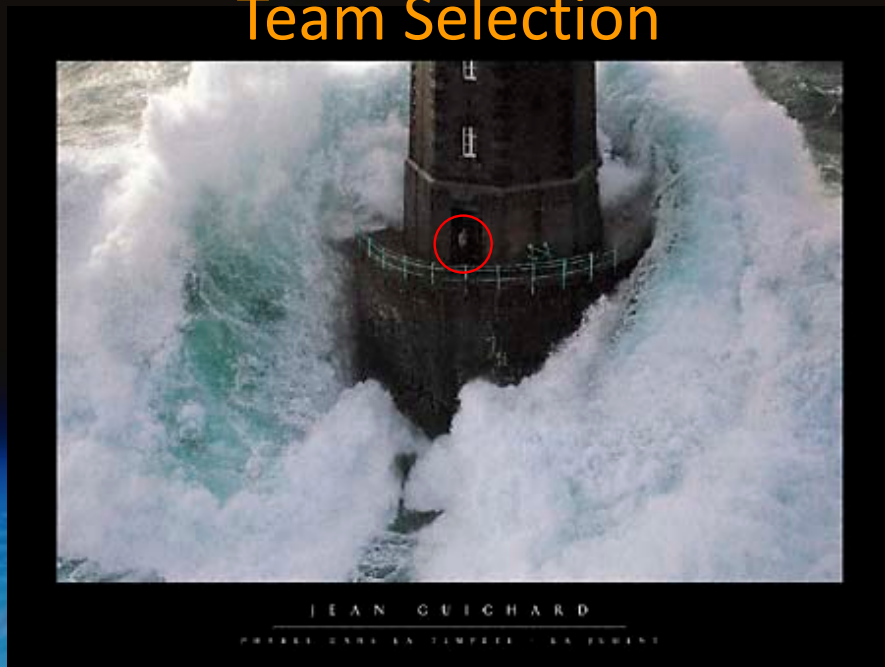


*What's on the Radar Screen?*





# Team Selection



Polar Traverse Workshop

4 August, 2009

Canada

29

Expedition Fiord, July 2008



30



*Whitsunday Bay, July 2004*



31

*Eureka Pass, July 2003*



32



*Expedition Fiord, July 2008*



33

 Canadian Space Agency / Agence spatiale canadienne



## Participants

### *Polar Survey 2009*

Exploration  
PCSP  
Planning  
Operations  
Challenges  
Lessons Learned  
*A Polar Science Survey*  
Analog Sites  
Analog Missions

- Questionnaire sent out mid-June
- 13 participants
- 12 Principal Investigators, Canada, U.S.A., U.K.
- CMN [1], CSA [2], GSC [2], Universities [7], HS [1]
- PhD, Postdoctoral 3
- Women 5, Men 8
- # of field seasons in the Arctic 2 - 25
- Study areas: Arctic Archipelago, Baffin Island - Nunavut; , Mackenzie Valley - NWT, Central and northern Yukon, Iceland, Antarctica

*Polar Traverse Workshop*

*4 August, 2009*



34



# Results, Team Selection

## Most Important Quality of the Field Team

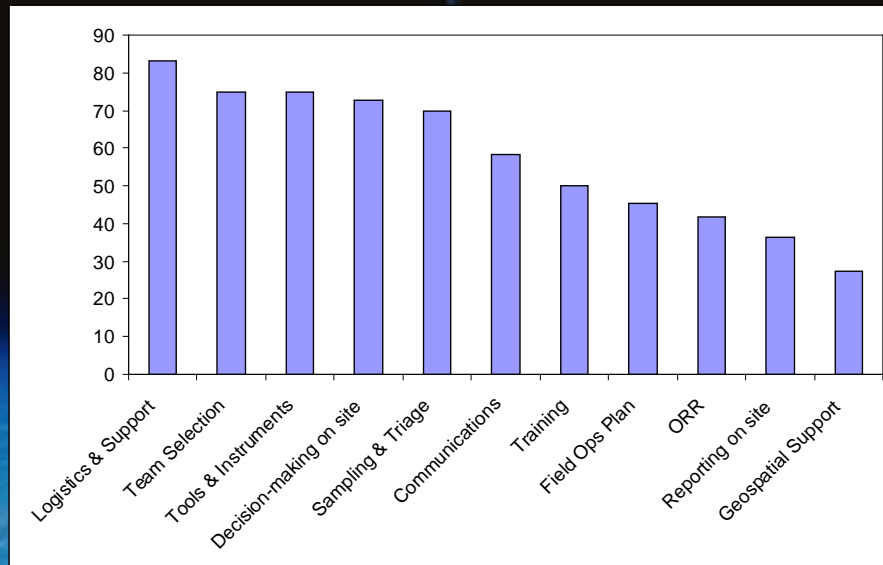
- Congeniality
- It's quality
- Dedication
- Planning
- Skills to meet research objectives
- Common sense
- Compatibility
- Complementary expertise
- A good sense of humour
- Getting along while still competent
- Camaraderie
- Highly-motivated

## Valuable qualities of individuals

- Physically fit
- Endurance (stamina)
- Mentally sound (emotionally stable)
- Academically qualified
- Good sense of humour
- Reliable
- Team player (cooperative)
- Willingness to contribute
- Adaptable (flexible)
- Enthusiastic
- Ingenious
- Curious (adventuresome)
- Common sense (not reckless)
- Leader

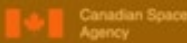


# Results, Impact on Mission Success

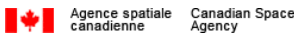





37



Canadian Space Agency



Agence spatiale canadienne Canadian Space Agency




## Potential for Lunar Analogue Research at Askja and Hekla Volcanoes, Iceland

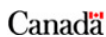
### Report & Recommendations

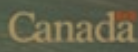
Lunar Analogue Site Analysis Team (LASAT)

Meeting at the Canadian Space Agency  
July 6-8, 2009



*Polar Traver*





38





# CSA Analog Missions update

## ANALOG MISSION

- Exploration
- PCSP
- Planning
- Operations
- Challenges
- Lessons Learned
- A Polar Science Survey
- Analog Sites
- Analog Missions**

An integrated set of activities that will encompass multiple features of the target mission (including human factors) and result in system-level interactions



## Operational Requirements

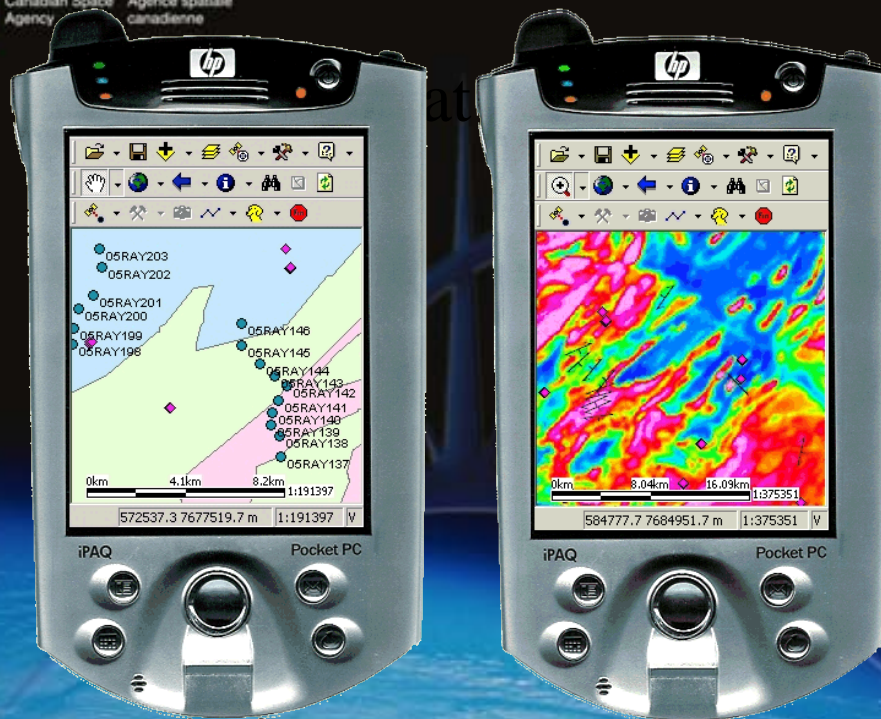
- Team selection
- Operational plan & readiness reviews
- Test of infrastructure support
- Test of communications
- Instrument performance and versatility
- Data quality
- Sample identification, and triage
- Database management
- Metrics**
- Test of geospatial support
- Reporting & decision-making on site

# Metrics



To compile the measurements that will lead to a better understanding of work efficiency during field traverses, we need instruments that will:

- (1) allow the rapid storage of these data on site;
- (2) support - not interfere with - the normal business of conducting science experiments and technological field tests.





## Lessons Learned

- From past expeditions to the High Arctic,
- contemporary traverses by Arctic scientists
- fly camp planning and operations enabled by PCSP aircraft and logistics support

*can be applied to long-duration space missions but close attention must be given to the transition in physical and mental endurance levels expected from the crew; the ability to achieve science goals while adapting to new challenges; and the greater (continued) demand on the supporting infrastructure*



## Acknowledgments

**PCSP Project 507-08:** Wayne Pollard, Chris McKay, Marianne Mader, Krystal Aubry, Joey Sliwinski, Ron Peterson, the Spaceward Bound team 2008, and the UH pilots

**CSA:** Alain Berinstain, Martin Lebeuf, Vicky Hipkin, Richard Léveillé, James Doherty, Martin Tétreault, Bernard Marsan

**GSC, PCSP:** Marc d'Iorio, Martin Bergmann, Mike Kristjanson, Pierre Brouillette

**Polar Science Survey:** Jim Basinger, Jean Bédard, Rebecca Carey, Sean Clark, Steve Grasby, Timothy Haltigin, Denis Lacelle, Jay Nadeau, Steve Rippington, Natalia Rybczynski, John Smol, Helen Smyth, Caroline-Emmanuelle Morisset

**LASAT-Iceland:** Denis Lacelle, Mickael Germain, Maxime Phaneuf, Kim Binsted, Rebecca Carey, Eric Negulic, Brian Cousens



# BACKUP SLIDES

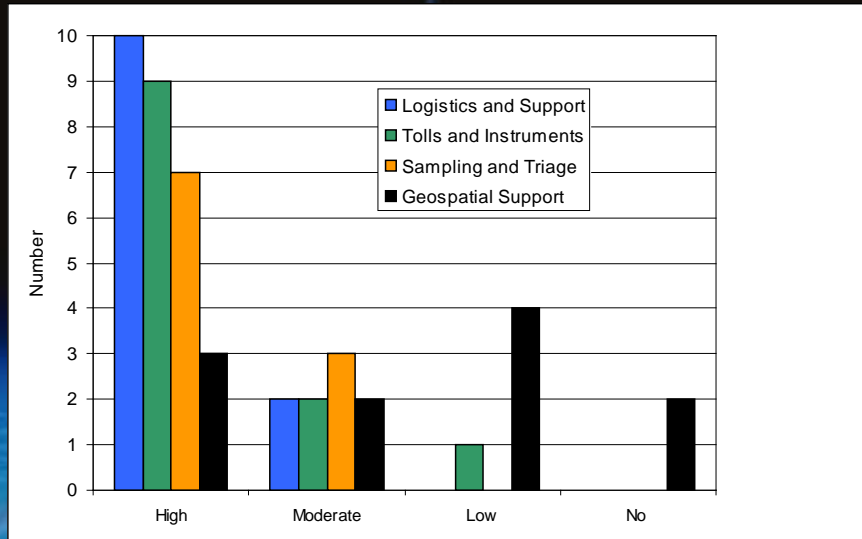
Polar Traverse Workshop

4 August, 2009

Canada

45

## Polar Science Survey Q. 11



Polar Traverse Workshop

4 August, 2009

Canada

46

# Polar Science Survey Q. 11

