BACKGROUND AND PROJECT GOALS

It is known that during the last glacial period on Earth (which ended around 12,000 years ago), the global climate was unstable and turbulent, and that during this period, very rapid and very large temperature variations (in the order of 5–16 °C) occurred many times in the North Atlantic. Evidence for these large, rapid climate change events is recorded in Greenland ice, cave stalactites/stalagmites, and in deep-sea sediments, among others. The exact causes of the events are still debated, but they were likely connected to sudden changes in the water circulation of the North Atlantic Ocean (which has a very large influence on climate) that took place when large amounts of icy meltwater from the ice sheets entered it. This is concerning, because as the present climate warms up, and Arctic glaciers melt more and more, there is a risk that the extra meltwater entering the Atlantic Ocean could further destabilize the climate. It is therefore of great importance to better understand exactly how past rapid climate changes events occurred, so as to better predict (and thus be better prepared for) the future consequences of current global warming.

One way to answer questions about past climate changes during the last ice age is to look for "natural archives" that contain a record of these events. Barnes Ice Cap, which is located east of Kangiqtugaapik (Clyde River), is made in part of ancient ice that remained when the Laurentide Ice Sheet, which covered most of Canada, melted and shrank over 12,000 years ago. These ancient ice layers contain, trapped within the ice, soil dust particles that were transported by winds from distant regions during the ice age. What makes Barnes Ice Cap especially unique and valuable for climate research is that it is the only place we know of where it is possible to recover ancient, ice-age layers from the Laurentide Ice Sheet right at the surface, without having to drill through hundreds of meters of younger ice. By analyzing the dust particles trapped in ancient glacier ice, it is possible to identify where they came from, and therefore find out what were the main wind patterns in this period, and how dry were the regions from which soil dust was picked up. This, in turns, can provide us with very useful clues about how the global climate (especially in the North Hemisphere) adjusted during the rapid climate change events of the last ice age. Lessons from this turbulent period can teach us how our present-day environment might respond to future climate warming, and thus help us better prepare for such changes.

The goal of this project is therefore to recover ancient ice from Barnes Ice Cap, in order to reconstruct and interpret the history of past changes in global temperatures, wind patterns, and continental dryness, during the later parts of the last ice age. To accomplish this, we plan to collect ice samples from the ice cap surface across part of its northwest margin, where the oldest ice layers are known to be well-exposed and easy to access. This will be done by a 5-person team of scientists during a 14-day period in late August 2023. The project is an international collaboration between scientists in Canada, Hungary, Austria, Sweden and Switzerland. It will last several years, but only one field campaign (in August 2023) is planned, which is the one for which we are applying for permits.

DESCRIPTION OF ACTIVITIES

Because Barnes ice cap is very remote and far from most Baffin communities, it must be reached by air. We have therefore applied for aircraft support with the Polar Continental Shelf Project (PCSP), and anticipate a response in late March 2023. The target period for field work is between 17-31 August, 2023 (plus or minus 1-2 days). We plan to fly to the ice cap by Twin Otter from either Iqaluit or Resolute, and land at an existing gravel airstrip ("Lewis Camp") located at the northwest edge of the ice cap. From there, a helicopter (probably coming from Clyde River) will transport the field party to a site about 10 km away and closer to the ice edge (not accessible for a Twin Otter) where we will set up a small field camp. All field work will then be done on foot from this site (i.e., no other vehicles). Because of the remoteness of Barnes Ice Cap, the very high cost of aircraft support, and also to minimize our impact at the field site, our field party will have a maximum of 5 people, limited to those project members who are most needed (including 3 Canadian researchers experienced in Arctic field work). If possible, we might bring along an Inuit participant (e.g., wildlife monitor) but we can not be certain this will happen, as it will depend on how much aircraft support we get from PCSP.

Once on site, the actual field work does not require any heavy machinery. The only motorized equipment we will use is a small portable gasoline-powered electrical generator and a small, gasoline- or electrically-powered ice auger to collect ice samples from shallow holes directly on the ice cap surface. During sampling we may install metal poles in the ice as benchmarks, but these will be removed afterwards. There are no plans to install any long-term equipment of any sort at the study site. We might also bring a small battery-operated drone (quadcopter) to take images of our field work from the air. This will help us to properly locate our ice samples on a map of the ice cap, and will also be useful to make public outreach presentations describing our work to communities, later in the project. Other than this equipment, the rest of the field gear will consist in tents, a propane stove for cooking, portable field toilet with sanitary bags, insulated containers for food and ice samples, etc. At the end of the field work, the field party, all of their equipment, and all samples, will be evacuated in the reverse way as was done when staging, i.e., helicopter transport back to the airstrip, and Twin Otter flight back to Iqaluit, or to Resolute.

After the field work, the field samples will be sent to several laboratories in Canada (Universities of Ottawa and Alberta Edmonton) and in Europe for scientific analyses. The analytical work requires very specialized facilities that only exist in these laboratories. The various analyses will likely take 1-2 years to complete. In the meantime, and until the termination of the project, we intend to regularly communicate our progress and findings to Nunavut communities via the Nunavut Research Institute.

POTENTIAL IMPACT OF ON LAND/WATER/WILDLIFE

Our project requires some low-level aircraft flying (Twin Otter and helicopter). This should be limited to a few hours on two separate days, once when we move in to establish the field camp, the other when we evacuate. The landing site for the Twin Otter ("Lewis Camp") is a natural gravel flat on the bank of the Isortoq River (headwaters of the northern branch), so no artificial infrastructure is needed. The planned field camp site is about 10 km away, on tundra at the edge of Barnes Ice Cap. We are aware that animals (e.g., geese, caribou) may be present in this area, and therefore will pay close attention to avoid disturbing them when ferrying people and equipment between the landing strip and the field camp. The PCSP aircraft pilot may opt to cache a few drums of jet fuel at the landing strip during our stay, to allow on-site refueling during in/out flights. However these would be taken out at the end of the project, i.e., there are no plans to establish long-term fuel caches. We will inform the Land Division on CINARC of these plans. PCSP flight crews habitually carry spill kits in their aircrafts. Other than aircraft fuels, our own usage will be limited to ordinary gasoline (in jerry cans) for the portable generator, and propane cylinders for the cooking stove. We will take the usual precautions to avoid fuel spills whenever we handle it. The field camp will likely be set up on a gravel patch at the edge of a stream where there is little vegetation. We do not plan any trenching, excavation or any such disturbances at the camp site. Human waste will be collected in sterile bags for evacuation, and grey water (essentially dishwater) will be disposed of in a shallow hole away from any stream. Likewise, no garbage of any sort will be burned or buries on site: Everything will be taken out for safe disposal in Iqaluit or Resolute. Hence our field camp should have a very low impact, if any, on the local environment. On Barnes Ice Cap itself, the ice samples will be collected at regular intervals over a distance of a few hundred meters across the oldest ice layers. These samples will be taken at depths less than 1 m, which is much less than the actual thickness of ice that melts every summer at the edge of Barnes Ice Cap, so this will have a negligible impact on the ice cap. We will not be using any hazardous chemicals (e.g., acids, solvents) in our work. Neither do we have any plans to collect fauna, flora, or human artefacts.

SAFETY ASPECTS

The 3 Canadians in the project's field team have very extensive field experience in polar field work (all seasons), including on Baffin Island. All necessary safety measures will be specified in application for a scientific research license with the Nunavut Research Institute (pending).