18th August 2010

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Antarctic Science Bursary 2008

Dr Joanne S Johnson

Unravelling the deglacial history of NW Alexander Island, Antarctic Peninsula

Introduction

The overall aim of the Palaeo-Ice Sheets project at British Antarctic Survey is to provide constraints for ice sheet models which will improve predictions of future sea level change. The terrestrial record of deglaciation of West Antarctica since the Last Glacial Maximum (LGM) is not yet well-known, and little is known about the onshore deglacial history of the western part of the Antarctic Peninsula Ice Sheet between Adelaide Island and Pine Island Bay. I applied for an Antarctic Science Bursary to fund surface exposure dating on rock samples from NW Alexander Island, with the aim of providing more data for testing and refining ice sheet models. This is the first time exposure dating has been undertaken in this area.

Methods

Early in 2008, an opportunity arose to collect samples for surface exposure dating from NW Alexander Island and Rothschild Island (Fig. 1). Unfortunately I was unable to undertake the fieldwork due to maternity leave, but colleagues from BAS (Dr Phil Leat) and British Geological Survey (Dr Jez Everest and Dr Nick Golledge) collected samples on my behalf. The samples consist of nine granite erratic cobbles from Mount Holt (Alexander Island) and Overton Peak (Rothschild Island), all deposited by retreating glaciers, and 4 olivine-bearing mantle xenoliths from a single site on Overton Peak. I undertook surface exposure dating in order to determine when each site became ice-free, and whether or not the summit of Mt Holt was ice-free at the LGM (suggesting its potential as a refuge for biological organisms during the last glacial period). The granite erratics were analysed for cosmogenic ^{10}Be by Dr Dylan Rood at Lawrence Livermore National Laboratory, USA and cosmogenic ^{3}He in the mantle xenoliths was analysed by Dr Finlay Stuart at the Scottish Universities Environmental Research Centre, UK.

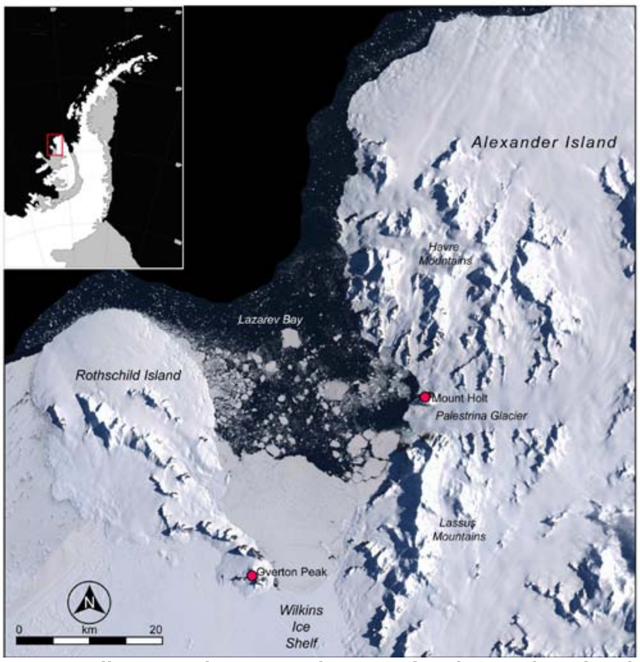

Figure 1. Satellite image showing sample sites (red circles) on Alexander Island and Rothschild Island. Inset: Alexander Island in relation to the Antarctic Peninsula.

Preliminary Results

The results of this work will form the subject of a paper to be submitted to Antarctic Science later this year. A summary of the main findings is given below:

- 3 x ^{10}Be exposure ages were obtained from Mt Holt, NW Alexander Island
- 6 x ^{10}Be exposure ages were obtained from Overton Peak, Rothschild Island
- 4 x ^{3}He exposure ages were obtained from xenoliths at 405 m a.s.l. on Overton Peak

Excluding one significantly older age (which probably reflects ^{10}Be inheritance from a previous period of exposure), the ^{10}Be ages are all in the range 10-22 ka. They imply that the summit of Mt Holt (729 m a.s.l.) was ice-covered at the LGM, and that Overton Peak was ice-free by 10 ka. This is consistent with findings from another project I have been working on, which indicates that the Marguerite Bay ice stream (north of Alexander Island) retreated rapidly from the inner shelf around 10 ka (Bentley et al., submitted). Since Mt Holt was covered by ice at the LGM, I was unfortunately not able to obtain the maximum thickness of ice at that time. The ^{3}He exposure ages from the mantle xenoliths are mixed, but are all younger than 40 ka. The range of ages is surprising, considering that they are all from the same locality. Preliminary interpretations suggest that they are the result of periglacial processes, which caused exhumation (and therefore exposure on the surface) of some xenoliths later than others. We have obtained recent aerial photographs of Overton Peak, in which patterned ground is visible close to our sample sites, supporting this interpretation. I envisage that these periglacial processes occurred without interfering with the larger granite erratic cobbles found at the same site, which gave a ^{10}Be exposure age (representing deglaciation) of 14 ka. However, none of my colleagues from BGS or BAS have experience of periglacial processes, so I intend to seek advice from others on this.

Final words

I am very grateful for financial support from the Antarctic Science Bursary, which has enabled me to obtain these first surface exposure ages from western Alexander Island. The bursary is also designed as a career development bursary, and I feel I have particularly benefited from it in this way. This project has given me my first experience of coordinating a large number of collaborators, delegating tasks and jointly writing a manuscript, as well as managing my own budget. I have also been able to test the use of ^{3}He exposure dating on mantle xenoliths, and combine this data with ^{10}Be dating, something that has (to my knowledge) not been done before. The interpretation of those data may involve invoking periglacial processes, a subject which will lead me to make new scientific contacts, and will broaden my understanding of the Antarctic environment and the processes occurring there.

Acknowledgements

Numerous people have been involved with this project. I would like to thank the Captain and Crew of HMS Endurance, without whose logistical support none these samples would have been collected. I am indebted to Jez Everest (BGS), Nick Golledge (BGS), Phil Leat (BAS) and BAS field assistant Mark Gorin, for collecting the samples and for their contributions to the upcoming manuscript. Dylan Rood (Lawrence Livermore National Laboratory) and Fin Stuart (SUERC) analysed the samples. Lydia Gibson (University of Cambridge) was kind enough to donate the xenoliths from her PhD project, and Adrian Fox (BAS) provided aerial photographs.

Mount Holt (summit 729 m), NW Alexander Island
[Photo courtesy of Jez Everest]

Mantle xenoliths (greenish rocks in foreground) at Overton Peak, Rothschild Island
[Photo courtesy of Phil Leat]