Surface exposure dating using cosmogenic isotopes: a field campaign in Marie Byrd Land and the Hudson Mountains

Joanne S Johnson[1], Karsten Gohl[2], Terry L O'Donovan[1], Mike J Bentley[3,1]

[1]British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 OET, UK
[2]Alfred Wegener Institute, Postfach 120161, D-27515, Bremerhaven, Germany
[3]Durham University, South Road, Durham, DH1 3LE, UK

ANTARCTICA global science in the antarctic context

INTRODUCTION

Here we present preliminary findings from fieldwork undertaken in Marie Byrd Land and western Ellsworth Land (Fig.1) in March 2006, during which we obtained samples for surface exposure dating. This work was supported by helicopters from *RV Polarstern*, on an expedition to Pine Island Bay.

Surface exposure dating provides an estimate of the time when ice retreated from a rock surface, leaving it exposed. Nucleii in rocks are split apart by neutrons produced when secondary cosmic rays enter the atmosphere. The resulting cosmogenic isotopes (such as ^{10}Be and ^{26}Al) accumulate within the upper few cm of a rock surface over the duration of exposure, and can be measured to give an 'exposure age'.

Surface exposure dates from the samples we collected will provide a record of elevation change for the ice sheet surface in this region, and thus will help to constrain thinning of the ice sheet since the Last Glacial Maximum. A second field campaign is planned in this area for 2007/8.

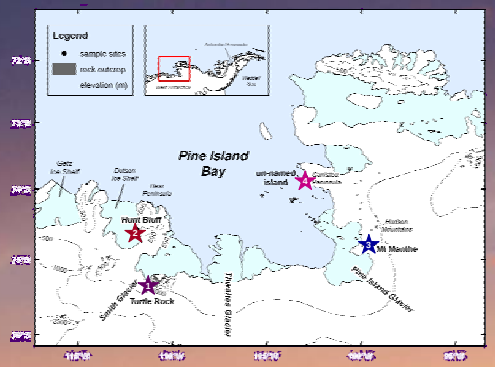

Fig. 1. Map of field area, showing sampling sites.

1. TURTLE ROCK

This site lies adjacent to the Pope Glacier and a few km west of Mt Murphy. Two superimposed hyaloclastite breccia sequences are overlain by vesicular capping lavas (Fig. 2). It was previously visited in 1990 and an eruption age for the lavas obtained (4.7±0.15 Ma, Smellie, pers. comm. 2006).

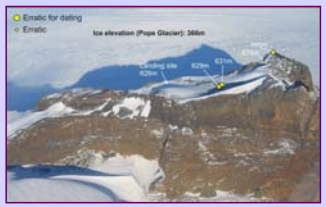

Fig. 2. Sample sites on Turtle Rock.

Fig. 3. Granitoid erratics amongst hyaloclastite

- Elevation of samples: 629-700m
- Several fairly small (less than 1m diameter) granite and granitoid erratics (Fig. 3)
- No striated surfaces found, but boulders are occasionally facetted

2. HUNT BLUFF

This site is a granite outcrop along the western side of Bear Peninsula, adjacent to the Dotson Ice Shelf. Lopatin *et al.* (1974) report an age of 301 Ma for the granite.

In half a day, we found only a few erratic samples (Fig. 4), and one example of a striated surface (Fig. 5). The striation direction of N-S gives an indication of ice flow direction over this site.

Fig. 4. Meta-sandstone boulder lying on granite bedrock.

Fig. 5. N-S trending striations

- Elevation of samples 470m
- Erratics are small (largest 30cm)
- Lithology of erratics: meta-sandstones and an alkali basalt
- Striations in bedrock granite

3. MOUNT MANTHE

The nunatak has one exposed hyaloclastite breccia/capping lava sequence on the northern side (Fig. 6). Le Masurier & Rex (1982) report a K-Ar date of 5.5±1.9 Ma for the capping lavas. Pine Island Glacier (PIG) lies immediately to the SW of the Hudson Mountains; dates from these samples will tell us when the surface of PIG receded below 500m.

Fig. 6. Hyaloclastite (hcb) overlain by lavas

Fig. 7. Granite boulder (inset) lying on basaltic capping lavas.

- Elevation of samples: 500m
- Erratic boulders are sparse: we found <5; all are sub-rounded granites (Fig. 7)
- The granite boulders have a similar lithology to some of those at Turtle Rock.

SUMMARY

- We collected 7 erratic and 2 bedrock surface samples, which are currently being processed for ^{10}Be, ^{26}Al and ^{3}He dating. We will visit the Hudson Mountains again in 2007/8 for further sampling and collection of geomorphological data.
- Samples from Turtle Rock, Mt Manthe and the un-named island are granite/granitoids; from Hunt Bluff we collected a meta-sandstone and basalt, in addition to granite bedrock.
- Erratic boulders at Mt Manthe and Hunt Bluff are scarce; at Turtle Rock and the un-named island, they are relatively common.
- Striated surfaces (N-S orientation) were found only at Hunt Bluff.
- Ages from Mt Manthe will tell us when the surface of Pine Island Glacier receded below 500m, and from Turtle Rock and Hunt Bluff about the thinning of ice to the west of Pine Island Bay, close to Smith Glacier.
- An age for the sample from the un-named island may represent the date that the island emerged above sea level during post-deglaciation isostatic rebound.
- Changes in the extent and thickness of the ice sheet in the Quaternary will be used to help constrain ice sheet models, thus aiding efforts to predict future behaviour of the West Antarctic Ice Sheet.

4. UN-NAMED ISLAND

This island, one of the Edwards Islands, lies west of Canisteo Peninsula (Fig. 1). It is low-lying but has no ice cover, unlike adjacent islands. It is home to seals and penguins, and is almost entirely covered by a brownish sediment-like material, presumably guano.

Fig. 9. Sampling an erratic boulder

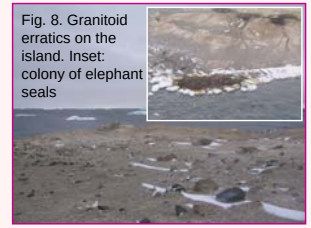

Fig. 8. Granitoid erratics on the island. Inset: colony of elephant seals

- Elevation of sample: 8m
- Elephant seal colony present (Fig. 8); evidence for penguin colony as well
- Thick deposit of ?guano
- Numerous granitoid erratic boulders (Fig. 9) are both embedded in, and lie on top of, guano (Fig. 8).

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL