Diamond Hill, Darwin Glacier. A proxy for the West Antarctic Ice Sheet

Kurt Joy[1], Bryan Storey[1], David Fink[2], Jamie Shulmeister[3]

1 Gateway Antarctica, University of Canterbury, Private Bag 4800, Christchurch, New Zealand.
2 Institute for Environmental Research, ANSTO, PMB1, Menai 2234, Australia.
3 Geography, Planning and Environmental Management, University of Queensland, St Lucia 4072, Australia.

KURT.JOY@PG.CANTERBURY.AC.NZ

1. Introduction:

A key to predicting the West and East Antarctic Ice Sheet (WAIS and EAIS) response to current and future climate change is to understand their behaviour in the past.

At the Last Glacial Maximum (LGM, 18-22ka) temperatures were depressed by 7 to 9°C and the thickened Ice Sheets had advanced well beyond their current positions. This research aims to provide new evidence on WAIS thickness by using insitu cosmogenic nuclide dating in ice free landscapes to reconstruct the response of the WAIS to the warming climate post LGM.

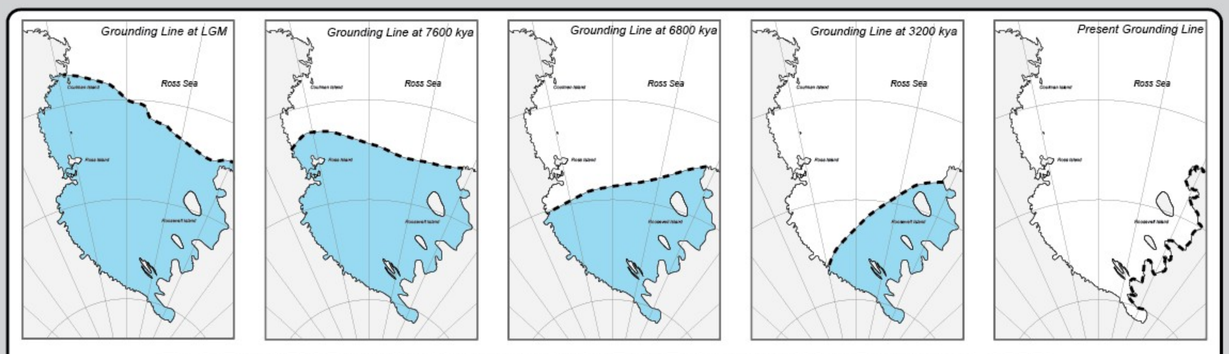

Fig 1: Post LGM Grounding Line retreat in the Ross Embayment. (After Conway et al. 1999)

2. The WAIS response since the LGM:

The current understanding of the WAIS behavior in the Ross Embayment is based on the work of Conway et al. 1999 and Denton and Hughes. 2000.

- Models suggest a "Swinging gate" retreat that was locked along the Northern Stiple Coast.
- The grounded ice of the WAIS in the Ross Sea extended beyond Coulman Island at the LGM.
- Outlet glaciers that drained through the Transantarctic Mountains were dammed by this grounded ice.
- This caused significant thickening in their downstream profile and retarded ice flow.

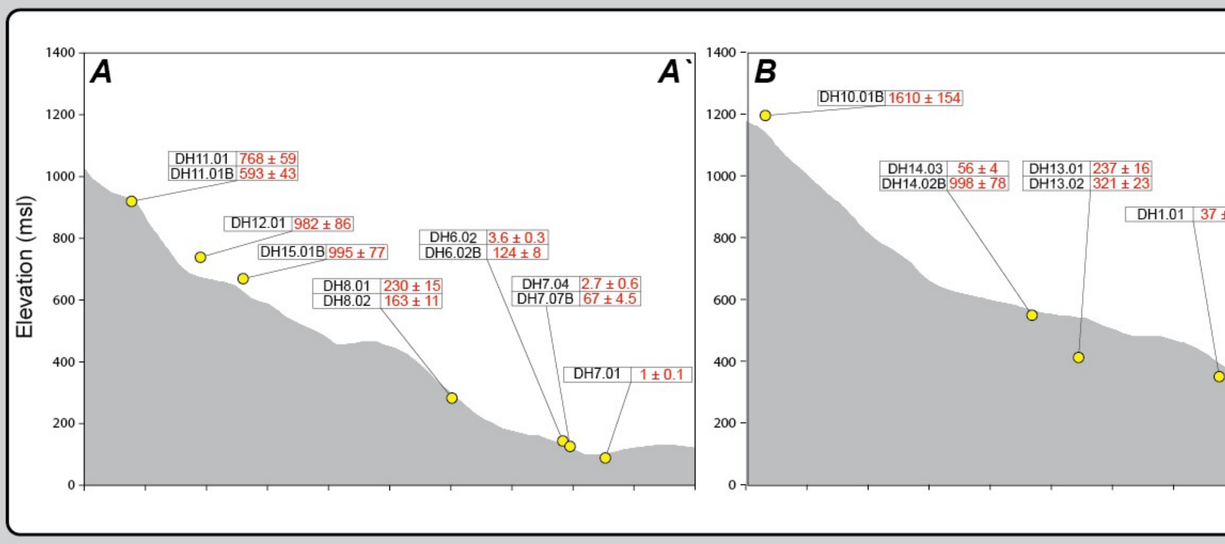

Fig 2:(Left)
^{10}Be ages for transects.
(All ages are in thousands of years)

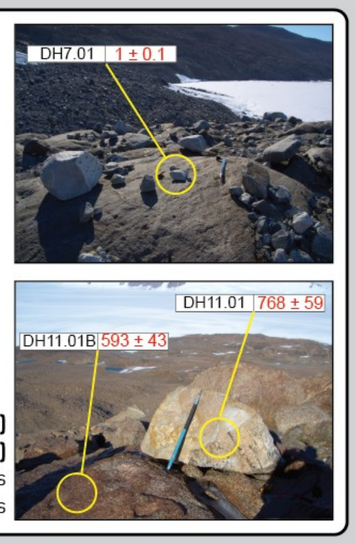

Fig 3:(Right Upper)
Fig 4:(Right Lower)
Examples of glacial erratics and bedrock samples

3. Cosmogenic dating at Diamond Hill:

Diamond Hill is located at the confluence of the Darwin Glacier and Ross Ice Sheet (Figure 5). Its position and geomorphology makes it an excellent archive of WAIS glacial history.

- Large areas of ice free landscape.
- Abundant evidence of glacial advances.
- Suitable Quartz rich lithologies for cosmogenic dating.
- 1200 meters of elevation above the current Ross Ice Shelf.
- Bockheim et al (1989) have suggested that at this site during the LGM, ice was 1000 meters thicker than present.

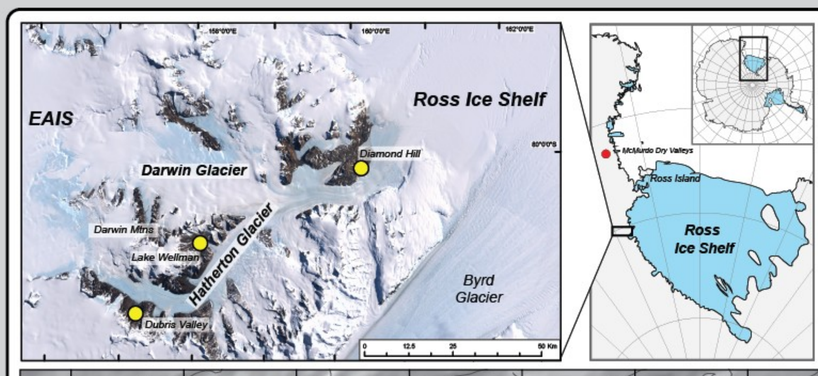

Fig 5:(Left)
Darwin Glacier regional map and study sites.

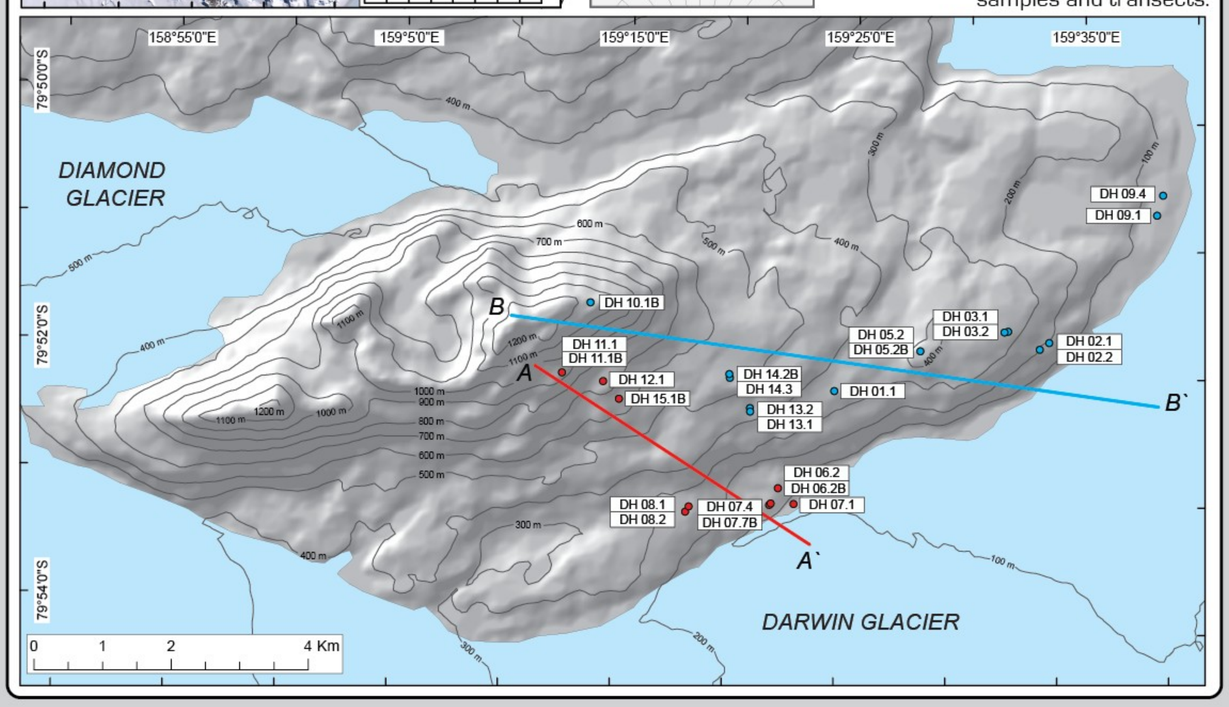

Fig 6:(Below)
Diamond Hill cosmogenic-samples and transects.

4. Preliminary results:

25 granite samples, (18 erratic and 7 bedrock) were collected in the 2008/2009 field season for dating via Beryllium-10 and Alumiunium-26 nuclides (Figure 2). An altitudinal range from the present ice surface to 1200 meters (Figure 6) was covered in two transects. By comparing exposure age with altitude, ice thickness at that time can be estimated and glacial histories constructed.

- Diamond Hill shares much of its glacial history with the Lake Wellman Site (Storey et al 2010).
- No cosmogenic evidence of large scale LGM advances was found.
- The largest ice advance was 1.5 million years ago, with ice thickened by approximately 1000 meters.
- While transect A shows a fairly simple exposure history, transect B is far more complex. Figure 4 shows an erratic with a ^{10}Be age 175ka older than the bedrock sitting below it.
- In transect A, the current ice margin shows little change in the last 10,000 years (Figure 3).
- Moraines at transect B show recycling of previously deposited material at Ross Ice Shelf margin.
- Once ^{26}Al analyses are complete, burial/exposure histories can be investigated, showing the role that cold based ice may play in the protection and modification of preexisting landscapes. (Atkins & Dickinson 2007, Bockheim 2010)

5. Further research:

Diamond Hill is only one of three sites in the Darwin / Hatherton Glacial System that has been visited for cosmogenic and geomorphological studies. By using this system as a proxy for changes in both EAIS and WAIS, we hope to understand the glacial history of Ice Sheet recession since the LGM.

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