How volcanic heat affects biodiversity in Antarctica

Report on field trip to Deception Island, February 2016, supported by Antarctic Science

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Project background

Antarctica was heavily glaciated at the peak of the last Ice Age (~18,000 years ago), but we know from genetic research that many Antarctic terrestrial species have existed on the continent for millions of years. How did Antarctic species that require ice-free habitat, such as mites, springtails and mosses, survive ice ages on an ice-covered continent?

There are many volcanoes in Antarctica that are known to have been active since the last Ice Age (Fig. 1). Ice-free land close to volcano summits, and subglacial caves formed by volcanic steam, could have existed throughout Pleistocene ice ages, and might have provided habitable environments ('refugia') that allowed Antarctic plants and invertebrate animals to survive on the continent.

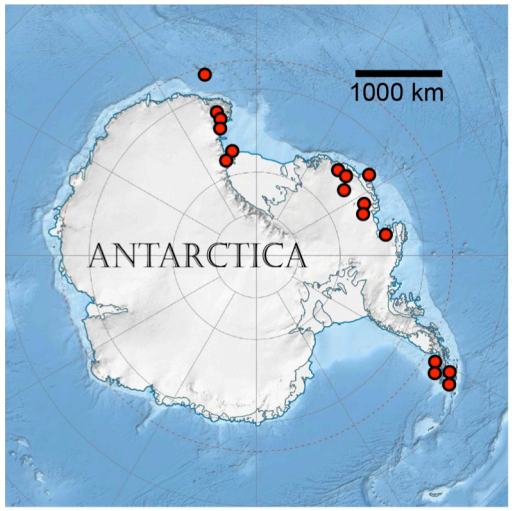

Fig. 1: Locations of Antarctic volcanoes known to have been active during the Holocene; these areas might have supported life during Pleistocene ice ages.

Postglacial colonisation away from ice age refugia is typically marked by drastically lower genetic diversity in recolonised versus refugial regions. Under a hypothesis that geothermal heat allowed localised persistence of Antarctic species throughout recent ice ages, **I predict that genetic diversity of a range of species will be highest close to volcanically-warmed areas, and lowest further away.**

We can test this hypothesis on a range of scales, from continental (thousands of kilometres) to local (metres to kilometres). This trip to volcanic Deception Island aimed primarily to test whether the diversity of life varies with the temperature of land over local scales.

Sampling

Samples were collected from nine areas on Deception Island, near the tip of the Antarctic Peninsula. These areas were: Sea Lion Beach, Crater Lake, Stonethrow (Downie Ridge), Fumarole Bay, Obsidian Cove, Telefon Bay, Pendulum Cove, Whalers Bay, and South East Point (Fig. 2). At each site, 30 samples of the moss *Bryum pseudotriquetrum* were collected, along with a small amount of vegetation for extracting ground-dwelling invertebrates. Soil samples were also taken (30 ml soil collected with sterile spatulas) for environmental DNA analysis. Where there was no local (within-site) thermal gradient in surface soils, only three soil samples were taken. Where there was a strong thermal gradient away from localised heated spots, soil samples were taken along a transect from hot (30-50°C) to cold (< 0°C).

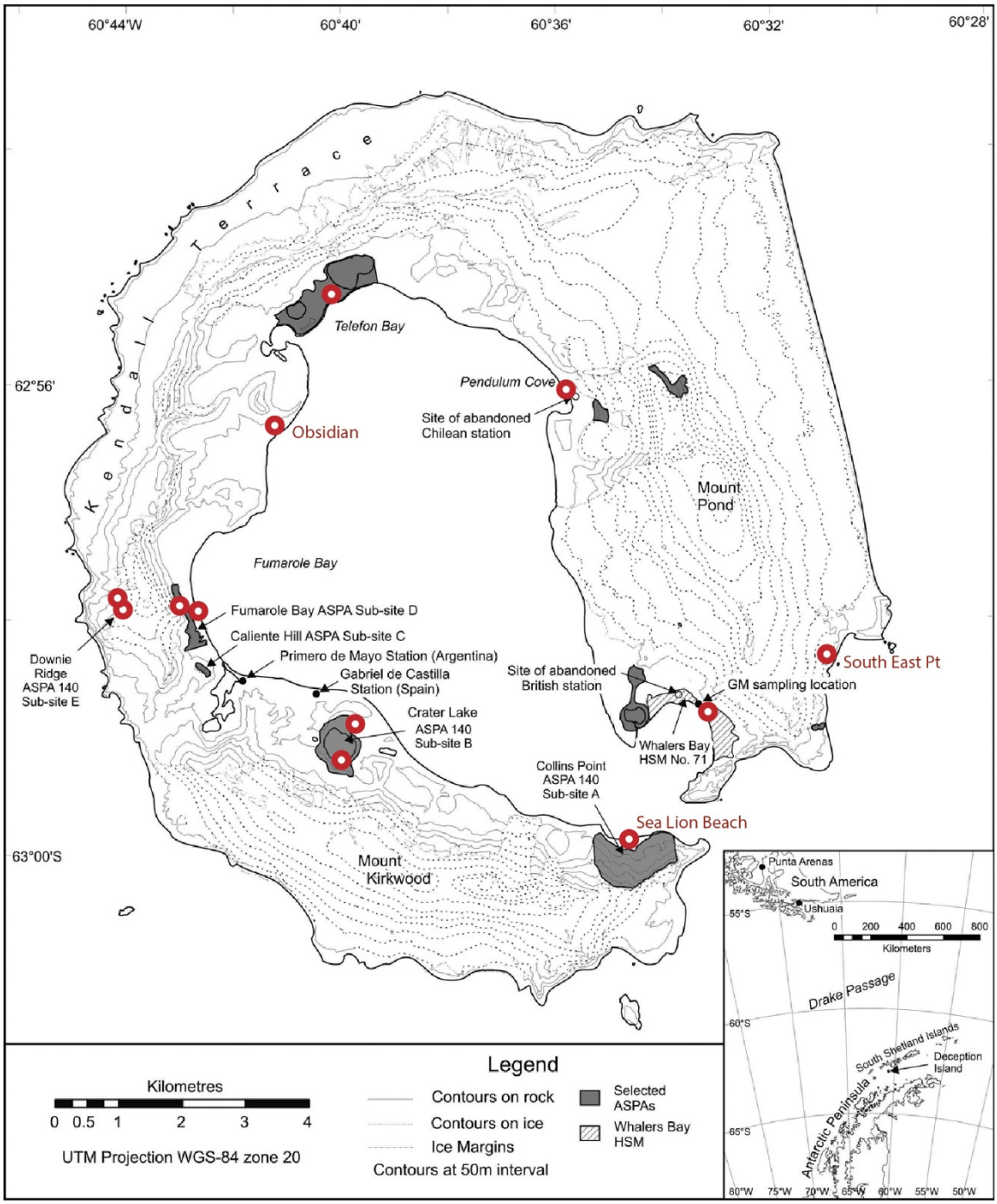

Fig. 2: areas sampled for moss, invertebrates and soil, February 2016.

Analyses

Analyses of samples are currently underway. Each set of samples is being analysed with a different method. The invertebrates (targeting primarily the springtail *Cryptopygus antarcticus antarcticus*) are being analysed using a 'Genotyping by Sequencing' (GBS) approach, which involves randomly breaking DNA into fragments using enzymes, and sequencing all DNA fragments of a given size range. The mosses, which can have a range of fungal and bacterial 'hitch-hikers' (making it difficult to be sure you are targeting moss DNA if using a random approach such as GBS), are being analysed using exon-capture techniques.

The soils are being analysed using ‘environmental DNA’ approaches, which use universal primers to amplify DNA from any organism in or on the soil, and which can provide an overview of community diversity. For all samples, the goal is to test whether diversity (intra- or inter-specific) is higher on warmer soils, and lower on colder soils; i.e. whether geothermal heat promotes diversity on local scales. I anticipate that the lab work for all of these samples will be complete by the end of 2016, and that paper/s from the work will be submitted in 2017.

Acknowledgements
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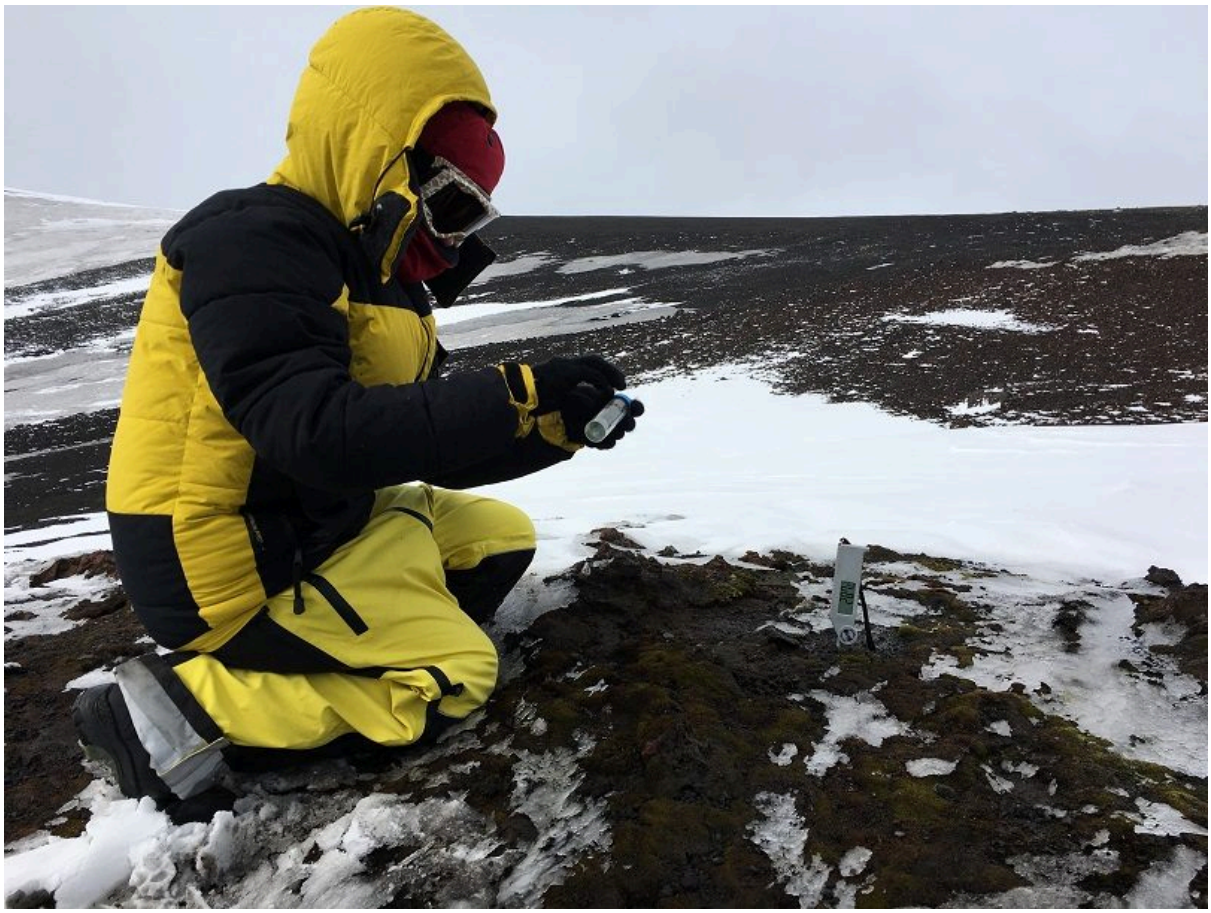
Image Gallery



Crid Fraser sampling on Stonethrow Ridge. Soil was >20°C at this site, despite sub-zero air temperatures.

Tullgren Funnel extractions of invertebrates from vegetation samples, on base, Deception Is

Crid Fraser and Geoff Kay, walking to a site on Deception Island.

Crid Fraser relaxing with penguins.