

Developing a tephrochronological framework and assessing tephra delivery within the Atlantic sector of the Southern Ocean between 10-40 kyr BP

Peter Abbott (1,2), Samuel Jaccard (2), Steve Barker (1), Julia Gottschalk (3), Luke Skinner (4), and Claire Waelbroeck (5)

(1) School of Earth and Ocean Sciences, Cardiff University, Park Place, CF10 3AT, Cardiff, UK, (2) Institute of Geological Sciences and Oeschger Center for Climate Change Research, University of Bern, Baltzerstrasse 1-3, Bern 3012, Switzerland, (3) Lamont-Doherty Earth Observatory, Columbia University, PO Box 1000, Palisades, NY 10964, USA, (4) Godwin Laboratory for Palaeoclimate Research, Earth Sciences Department, University of Cambridge, Downing Street, Cambridge CB2 3EQ, UK, (5) Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, CNRS-CEA-UVSQ, Université de Paris-Saclay, Domaine du CNRS, bât. 12, Gif-sur-Yvette 91198, France

Tephrochronology is a powerful technique for the correlation of disparate palaeoclimatic sequences from a range of depositional environments and is underpinned by frameworks of isochronous ash deposits. A regional tephra framework for the Atlantic sector of the Southern Ocean and Antarctica, both downwind from several volcanic systems, could facilitate the correlation of important marine and ice-core palaeoclimatic archives. Such correlations could be used to explore the phasing of climatic changes between the ocean and atmosphere, improve existing chronological models and assess the magnitude of the marine reservoir effect. In addition, the Southern Ocean is thought to be a key area for the outgassing of CO₂ via deep-water ventilation during the last deglaciation. Establishing tighter constraints on the phasing between sedimentary evidence for deep-water ventilation, and ice-core evidence for past atmospheric CO₂ variations could help in testing models of past relationships between climate and CO₂. While there is an emerging tephra framework for the Antarctic ice-cores, limited investigations have been conducted on Southern Ocean marine records, particularly studies focused on the identification of cryptotephras, ash horizons not visible upon core inspection.

Here we report on high-resolution tephrochronological investigations of two marine cores from the Atlantic sector of the Southern Ocean (MD07-3076 and TN057-21). These cores have been investigated using recently developed methods for the identification of marine cryptotephras, which have focussed on finer grained material than prior investigations. Within the MD07-3076CQ record a peak in colourless glass shards only present in the 25-63 μ m grain-size fraction and with a profile indicative of isochronous deposition has been identified. This deposit has an age of \sim 25.3 ka BP and ongoing geochemical analysis will determine the source of the eruption and permit a comparison with tephra horizons in the Antarctic tephra framework. Within both records several zones of elevated green/brown (dacitic/basaltic) glass shard concentrations, most clearly resolved in the 25-63 μ m fraction, and with profiles indicative of non-isochronous or secondary deposition can be observed. The shard concentration, peak form and duration of these zones differs between the cores, however, there is a general similarity in their timing with events centred around \sim 17.5, \sim 24, \sim 31 and \sim 36 ka BP. These periods of tephra deposition are consistent with past studies of the coarse fraction of cores from the region, which attributed their occurrence to either Antarctic ice sheet instability or fluctuations in sea-ice transportation of ash. Ongoing geochemical work to identify the source of the deposits and comparisons to palaeoceanographic proxies will contribute to the debate regarding the mode of tephra delivery to these sites.