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Mid to Late Holocene East Antarctic ice-core tephrochronology: Implications for reconstructing volcanic eruptions and their impacts over the last 5,500 years

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Ice cores are powerful archives for reconstructing volcanism and developing tephrochronological frameworks, as they can preserve both the soluble, i.e. aerosols, and non-soluble, i.e. tephra, products of volcanic eruptions. In addition, and particularly over Holocene timescales, high-precision annually resolved chronologies have been developed for these records and permit ages to be assigned to eruptions. The identification of tephra in ice cores in direct association with chemical indicators of volcanism, such as sulphate, can significantly enhance volcanic reconstructions as tephra can be linked to an eruptive source. Such source attributions can provide information on the location of the eruptions, the magnitude of aerosol emissions at the source and help assess any climatic impact. In addition, they can aid the reconstruction of volcanic histories and the assessment of future hazard risk.

The tephra record for the interior of East Antarctica over the last 5,500 years is potentially underexploited, as prior research has focussed on visible horizons and deep ice cores that cover longer time spans. Thus, only one horizon, dated to ˜3.5 ka BP (the Vostok Tephra), has been identified in these records. Here we discuss ongoing tephrochronological investigations of two ice-cores, B53 and B54, retrieved from the interior of the East Antarctic Plateau. High-resolution, sub-annual chemical records have been measured from both cores using a continuous melter system. These data were used to identify and sample > 50 potential cryptotephra horizons from ice containing coeval peaks in fine insoluble particles and non-sea-salt sulphur. This approach recently has been used to identify cryptotephras in both Greenland and Antarctic ice cores. When glass tephra shards were identified thin sections were created and individual glass shards were geochemically analysed using electron-probe microanalysis to help identify their volcanic source and permit correlations between records.

Thus far, more than 15 cryptotephra horizons have been identified, geochemically characterised and linked to regional sources such as the South Sandwich and South Shetland Islands. One cryptotephra derives from North Victoria Land, Antarctica and can be linked to the Rittmann Tephra (1252 CE), significantly increasing the known distribution of this event. In addition, the ˜3.5 ka Vostok Tephra has been traced in both cores as a visible layer. More detailed investigations are being conducted on samples from specific volcanic signals of interest that may derive from eruptions of ultra-distal volcanic sources. Such eruptions could have deposited very small glass tephra shards over Antarctica, which poses significant analytical challenges and necessitates the use of innovative approaches for tephra identification and geochemical analysis.

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Track Classification: Time scales and methods for ice dating