The East Antarctic tephrostratotype of TALDICE ice core: implications for chronostratigraphic correlations

Biancamaria Narcisi[1], Jean Robert Petit[2], Antonio Langone[3]

[1]ENEA C.R. Casaccia, Rome, Italy biancamaria.narcisi@enea.it;
[2]Univ. Grenoble Alpes, CNRS, IRD, IGE, F-38000 Grenoble, France;
[3]IGG-CNR, UOS of Pavia, Italy.

Abstract

Non-reworked tephra deposits produced by powerful explosive eruptions form isochronous horizons on a geological timescale, which can be used to precisely connect different, widely separated depositional archives. Tephra-based correlations in polar areas provide independent age constraints for modelled timescales and help detect paleoclimatic differences. The TALDICE ice core (72°49′S, 159°11′E), retrieved from a coastal dome of the East Antarctic Plateau facing the South Pacific sector, represents a remarkable tephra repository due to its mid-distal location (~ 200 km) with respect to regional explosive volcanism, and to the relatively high accumulation rate at the site that enables a well-resolved record of tephra fallout with unmodified stratigraphic order to be preserved. Previous studies focused on the Holocene [1] and the Eemian interglacial ice portions [2] have already shown the value of this core as reference volcanic section for the Ross Sea sector of the Antarctic region. Here, we present the inventory of ice-core tephra layers deposited between 17 and 64 ka BP, a glacial period characterised by strong millennial-scale climate variability [3]. ~ 45 discrete tephra deposits precisely positioned stratigraphically relative to the temperature record for the core [4] and dated using the AICC2012 timescale, have been identified and examined through a multi-parameter approach. Quantitative grain size, glass-shard micromorphology, major and trace element glass geochemistry were studied to characterise each deposit. Particle characteristics and tephra fallout of the studied layers point to derivation from significant eruptions of the Victoria Land volcanoes capable of producing extensive tephra sheets. Despite the fact that the samples exhibit similar petrological signature typical of rifting Antarctic volcanism, they were reliably distinguished from one another using subtle but significant geochemical differences and/or their stratigraphic position relative to the rapid climate oscillations. Thus the main outcome of our work here is that we have identified several climate-independent markers (e.g. the tephra horizon settled at ca. 17.6 ka during deposition of the well-known ‘fluoride main event’) [5]. By integrating present results with previous work, the TALDICE inventory already consists of several tens of dated tephra deposits emplaced during the last glacial-interglacial cycle that could assist future stratigraphic correlations and dating once they will be detected in other ice and sediment Antarctic paleorecords. We also highlight that in addition to chronostratigraphic implications, the TALDICE tephra series represents a fundamental complement of the proximal record to enhance knowledge of the Victoria Land volcanic history.

Keywords: Tephra layers; Antarctic ice cores; Last Glacial period

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