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Tephrochronology of the astronomically-tuned KC01B deep-sea core, Ionian Sea: insights into the explosive activity of the Central Mediterranean area during the last 200 ka

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ABSTRACT

We present a major, trace and rare earth element characterization of single glass shards from fifteen tephra layers found in the astronomically-tuned KC01B deep-sea core (Ionian Sea, Central Mediterranean-36°15.25′N, 17°34.44′E, 3642 m water depth). KC01B is considered a reference core for the Mediterranean area since it provides a new reliable astronomical tuned timescale for the last 1.112 My (Lourens, 2004). The studied deposits punctuate the marine record in a time span ranging from ca 16 ka to ca 191 ka B.P. encompassing the climatic zones Y, X, W and V. They are related to volcanic activity of the Campania Plain, Aeolian Islands, Mt. Etna and Pantelleria Island. Along with major main markers of the Central Mediterranean area such as Y-1, Y-5, and X-6, astronomically dated at 16.7 ka, 39.1 ka, and 110.5 ka, respectively, the succession contains a number of well preserved deposits which can represent useful inter-archive instruments of correlation. The Campania Plain, in particular, sourced at least nine compositionally homogeneous tephra layers prior to the Campanian Ignimbrite event. The data obtained in this work provide a new detailed analytical reference database for Ionian Sea tephrochronology and for proximal-distal correlation studies. They may help to unravel from the marine record the history of poorly known or unknown explosive activity on land since the middle Pleistocene along with chemical composition, size and dispersal of the products.

1. Introduction

Tephrochronology (tephrostratigraphy + tephrochronometry; Sarna-Wojcicki, 2000) at medial-distal areas may provide a detailed record of the Quaternary explosive volcanism which can therefore be used to establish time–space relationships of volcanism and insight into petrogenesis (e.g. Paterne et al., 1990) with significant implications for volcanic hazard prediction and risk management (e.g. Sulpizio et al., 2008; Lowe, 2011).

Tephra studies applied to long and continuous sedimentary records available from deep-sea cores can be very helpful when there is a gap in volcano data at proximal areas. Detailed tephrochronological records represent, in fact, an excellent tool to deepen the understanding of the explosive volcanic history of a region. In this context, tephra layers contained in astronomically-tuned sedimentary archives are regarded as being of greater consequence because: 1) they represent a powerful tool to reliably date explosive activity down to at least the Quaternary (Gradstein et al., 2012), 2) they have proven to provide robust absolute tie points in several areas, particularly in the Mediterranean region (e.g. Kraml, 1997; Kraml and Keller, 1997; Ton-That et al., 2001; Ciaranfi et al., 2010), the North Atlantic region (e.g. Davies et al., 2010), the northeast Indian Ocean (e.g. Hall and Farrell, 1995) and the New Zealand margin (Pillans et al., 1996) and 3) when suitable for age dating, they offer the opportunity to calibrate the **A**stronomical **T**uned **N**eogene **T**ime **S**cale (ATNTS 2012; Hilgen et al., 2012) through two independent absolute dating techniques i.e. the $^{40}Ar/^{39}Ar$ method and the Astronomical Time Scale (ATS).

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The last ~1.1 My of the ATNTS is based on a detailed sapropel-tuned and high-resolution isotope stratigraphy of the KC01B-ODP Site 964 cores (Lourens, 2004). The piston core KC01B, in particular, was collected by the French R/V *Marion Dufresne* in 1991 (MD69 cruise) in the Ionian Sea at a small ridge (the Pisano Plateau-36°15.25′N, 17°34.44′E, 3643 m water depth) from the lower slope of the Calabrian Ridge (see Fig. 1 for location). The KC01B is considered a reference core for the Mediterranean area because the record was used to fill the gap between the oldest sapropel S12 in core RC9-181dated at 483 ka B.P. (Lourens et al., 1996a) and the youngest one, "*v*", exposed in the land-based marine succession of Vrica section and dated at 1.280 Ma (Lourens et al., 1996b) (Fig. 2).

Sixteen tephra layers were visually recognised for the last 200 ka by Lourens (2004) who proposed an attempt of tephrochronological framework on the basis of their astronomical ages tentatively identifying the most prominent markers reported by Keller et al. (1978) for the Ionian Sea.

The KC01B offers a great potential in terms of tephrochronology as given by 1) a long record with a high-resolution and refined dating framework, mostly yielded by the combination of astronomical tuning, environmental magnetism and stable isotope stratigraphy; 2) its downwind position with respect to the major volcanic sources of the area and 3) the occurrence of tephra layers suitable to chemical analyses and radiometric dating throughout the succession.

In line with the above, the authors present the major and trace element composition of the tephra layers contained in the KC01B record spanning the last 200 ka, which have been determined through EPMA (Electron Probe MicroAnalysis) and LA-ICP-MS (Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry) analytical techniques. The main scientific goal is to provide a new analytical reference database for the Ionian Sea tephrochronology and for proximal–distal correlation studies in general, shedding some light on poorly known or unknown explosive activity on land since the middle Pleistocene.

2. Volcanism and tephrochronology in the Central Mediterranean area

The Central Mediterranean area is an outstanding natural laboratory for tephra studies because of the occurrence of a number of highly explosive volcanoes which have been active since the Plio-Quaternary (Lustrino et al., 2011 and references therein). These vents have been mostly identified in central-southern Italy, the Hellenic arc (e.g. Santorini) and the Central Anatolia in Turkey. The tephra fallout of Hellenic and Anatolian volcanic eruptions is primarily dispersed in the very eastern part of the Mediterranean (Keller et al., 1978; Druitt et al., 1989, 1995; St. Seymour et al., 2004; Aksu et al., 2008) while the Italian volcanoes provide a more likely source for tephras in the Central

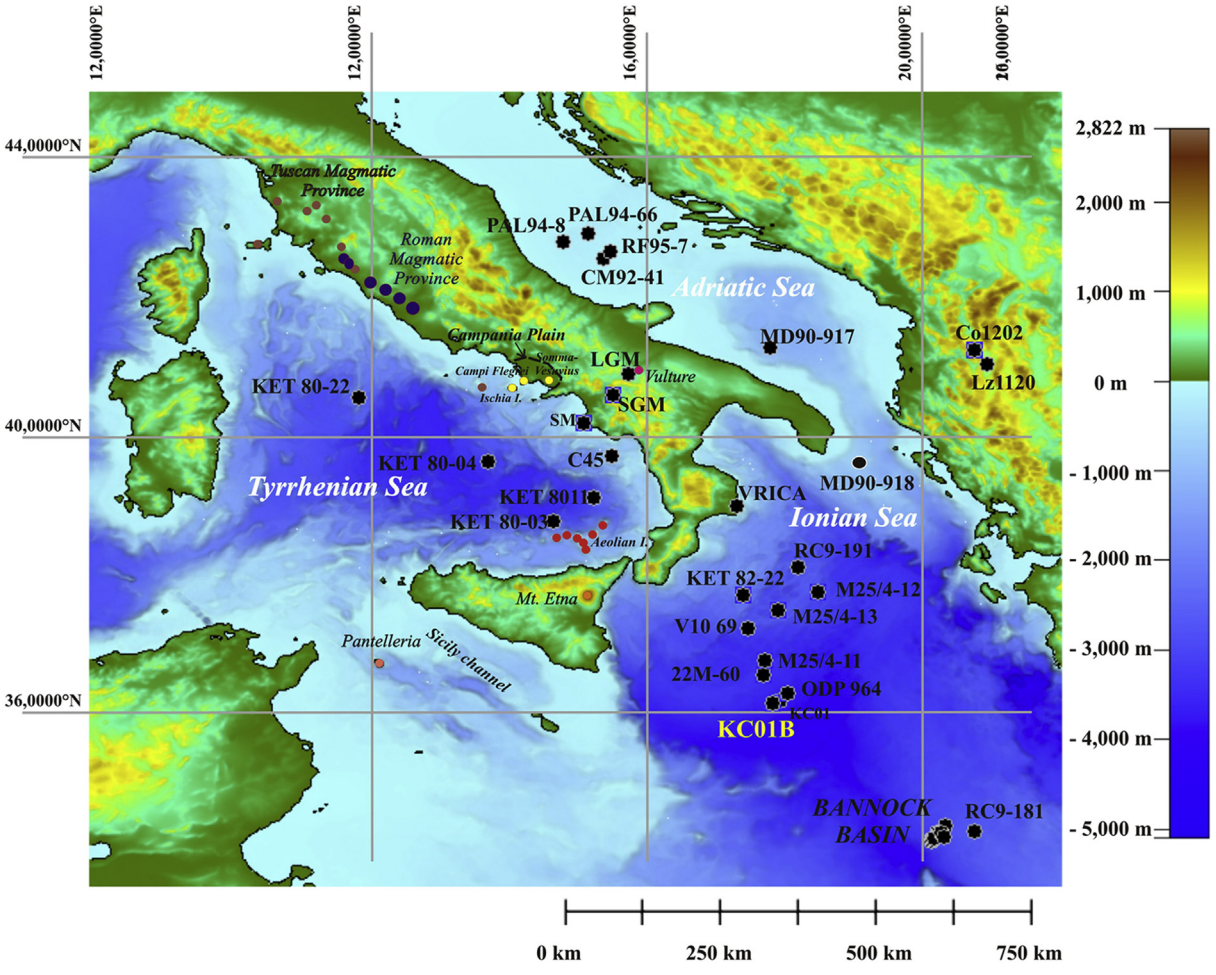

Fig. 1. Location of the KC01B site in the Ionian Sea. The main Italian volcanic centers and the marine and terrestrial sites cited in the text are also reported. LGM: Lago Grande di Monticchio; SGM: San Gregorio Magno.