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The 100–133 ka record of Italian explosive volcanism and revised tephrochronology of Lago Grande di Monticchio

Sabine Wulf [a,*], Jörg Keller [b], Martine Paterne [c], Jens Mingram [a], Stefan Lauterbach [a], Stephan Opitz [d], Gianluca Sottili [e], Biagio Giaccio [e], Paul G. Albert [f], Chris Satow [g], Emma L. Tomlinson [f,h], Marco Viccaro [i], Achim Brauer [a]

[a] GFZ German Research Centre for Geosciences, Section 5.2 – Climate Dynamics and Landscape Evolution, Telegrafenberg, 14473 Potsdam, Germany
[b] Institute of Geosciences, Mineralogy – Geochemistry, Albert-Ludwigs-University Freiburg, Albertstrasse 23b, 79104 Freiburg, Germany
[c] Laboratoire des Sciences du Climat et de l'Environnement (IPSL-CEA-CNRS-UVSQ), Domaine du CNRS Bât. 12, Avenue de la Terrasse, 91198 Gif-sur-Yvette, France
[d] Alfred Wegener Institute, Telegrafenberg A43, 14473 Potsdam, Germany
[e] Istituto di Geologia Ambientale e Geoingegneria, CNR, Via Salaria km 29,300, 00015 Rome, Italy
[f] Department of Earth Sciences, Royal Holloway University of London, Egham TW20 0EX, United Kingdom
[g] Department of Geography, Royal Holloway University of London, Egham TW20 0EX, United Kingdom
[h] Department of Geology, Trinity College Dublin, College Green, Dublin 2, Ireland
[i] Dipartimento di Scienze Biologiche Geologiche e Ambientali, Università di Catania, Corso Italia 57, 95129 Catania, Italy

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ABSTRACT

Laminated sediments of the maar lake Lago Grande di Monticchio in southern Italy exhibit a unique sequence of numerous primary tephra events that provide both insights into the Late Quaternary eruptive history of Italian volcanoes and an archive of essential marker horizons for dating and linking palaeoclimate records throughout the Central and Eastern Mediterranean. The acquisition of new sediment cores from this lake now extends the existing 100 ka-tephra record back to 133 ka BP, the end of the penultimate Glacial. The additional ca 30 m of sediments host a total number of 52 single tephra layers forming 21 tephra clusters that have been characterised on the basis of detailed geochemical and petrographical examinations. Tephras can be assigned to hitherto poorly known Plinian to sub-Plinian eruptive events of the nearby Campanian (Ischia Island, Phlegrean Fields), Roman (Sabatini volcanic district) and Aeolian-Sicilian volcanoes (Etna, Stromboli, Salina) and are dated according to the varve and sedimentation rate chronology of Monticchio sediments. The most prominent tephra layers within the interval of investigation – TM-25 and TM-27 – can be firmly correlated with Ionian Sea tephras X-5 (ca 105 ka BP) and X-6 (ca 108–110 ka BP). In addition, a further 26 tephra layers are correlated with radiometrically and radioisotopically dated volcanic events providing the basis for a robust revised tephrochronology of the entire Monticchio sediment sequence for the last 133 ka.

1. Introduction

During the past decades, tephra studies in the Central Mediterranean facilitated the dating and linking of numerous distal terrestrial and marine palaeoenvironmental records leading to a continuous development of detailed tephrostratigraphies of Italian explosive volcanism for at least the last 100 ka BP (e.g., Keller et al., 1978; Paterne et al., 1986; Siani et al., 2004; Wulf et al., 2004, 2008; Lowe et al., 2007; Calanchi and Dinelli, 2008; Paterne et al., 2008; Sulpizio et al., 2010).

Tephrostratigraphies, in general, require a complete record of major eruptive events, reliable dating, a clear stratigraphic order and an unambiguous identification of tephras, which in combination are difficult to derive from a single archive. Proximal volcanic areas (up to 5–15 km from vent), for example, are ideal for dating tephra deposits, but may lack complete stratigraphies due to burial and erosional processes. Distal environments may record only large-magnitude eruptions and miss small-scale events, but have the potential to document the stratigraphic interfingering and super-positioning of tephras from multiple volcanic sources. However, the dating of tephras in distal sedimentary archives can be problematic due to the lack of datable material. In this respect, annually laminated crater lake sediments are exceptionally valuable archives since they provide both eruptive evidence from

* Corresponding author. Tel.: +49 (0) 331 2881381; fax: +49 (0) 331 2881302.
E-mail address: swulf@gfz-potsdam.de (S. Wulf).

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adjacent volcanic centres and robust chronologies (e.g., Brauer et al., 1999; Wulf et al., 2004). In the central Mediterranean, such an archive is provided by the maar lake Lago Grande di Monticchio in southern Italy. A total of 293 visible tephra fallout layers from volcanic sources in central and southern Italy, which are located between 100 and 540 km away, were previously identified in the Monticchio sediments providing a detailed tephrostratigraphy of the explosive volcanism in Italy for the last 100 ka BP (Newton and Dugmore, 1993; Narcisi, 1996; Wulf et al., 2004, 2006, 2008). Detailed studies created a large data set of chronostratigraphical and geochemical information of individual tephras that are widely used as references for the correlation and dating of other distal and proximal tephra deposits (e.g., Lowe et al., 2007; Bourne et al., 2010; Smith et al., 2011; Giaccio et al., 2012).

The extended sediment record from Lago Grande di Monticchio (Brauer et al., 2007) exhibits another 52 tephra layers providing a record of Italian volcanism for the period 100–133 ka BP. Petrography and geochemistry of the tephras are described and interpreted in this paper. The ages of tephra deposition are provided by a combination of new varve counting for the extended 30 m section and a partial revision of the varve and sedimentation chronology of the <100 ka profile (Brauer et al., 2007). These data contribute to the establishment of a reliable tephrostratigraphical record in the Central Mediterranean.

2. The study site

Lago Grande di Monticchio (40°56′N, 15°35′E, 656 m a.s.l.) is located about 120 km east of Naples in the Monte Vulture volcanic complex in the region of Basilicata, southern Italy (Fig. 1a). It is the larger of two adjacent maar lakes that were formed during the final phreatomagmatic eruptions of Monte Vulture at 132 ± 12 ka BP (Lago Grande di Monticchio; Brocchini et al., 1994; Stoppa and Principe, 1998) and 141 ± 11 ka BP (Lago Piccolo di Monticchio; Villa and Buettner, 2009), respectively. Lago Grande di Monticchio has a total surface area of 0.4 km^2, a maximum water depth of 36 m, and has no major in- or outflows (Fig. 1b).

Lying 100–350 km away, the site is in a favourable downwind position to the active volcanoes of the alkaline Roman Comagmatic Province (RCP). The RCP is subdivided into the Campanian and Roman volcanic area. The Campanian area includes the volcanic fields of Monte Vulture, Roccamonfina, Somma-Vesuvius, the Phlegrean Fields and the Islands of Ischia, Procida-Vivara and Ponza. Most of these centres are still active, while activities of Procida-Vivara and Roccamonfina ceased at ca 14 ka BP (Scandone et al., 1991) and 130 ka BP (Radicati di Brozolo et al., 1988), respectively. Volcanism in the Roman area is older than in the Campanian area. The youngest tephra producing eruptions are known from the Alban Hills (560–33 ka BP; Giaccio et al., 2009; Marra et al., 2011), the Sabatini Volcanic District (800–86 ka BP; Sottili et al., 2010) and the Vico volcanic centre (≥420 to 95 ka BP; Sollevanti, 1983; Laurenzi and Villa, 1987). Activities of both the Campanian and Roman volcanoes produced huge amounts of tephra fallout, mainly K-alkaline trachytic–phonolitic in composition. Lago Grande di Monticchio is furthermore located 280–540 km northeast of the active volcanic centres of the Aeolian Islands (280 km), Mount Etna (360 km) and the Island of Pantelleria in the Strait of Sicily (540 km). Erupted material of these volcanoes ranges in composition from calcalkaline (Aeolian Islands) to Na-alkaline and pantelleritic (Etna, Pantelleria). Some of these

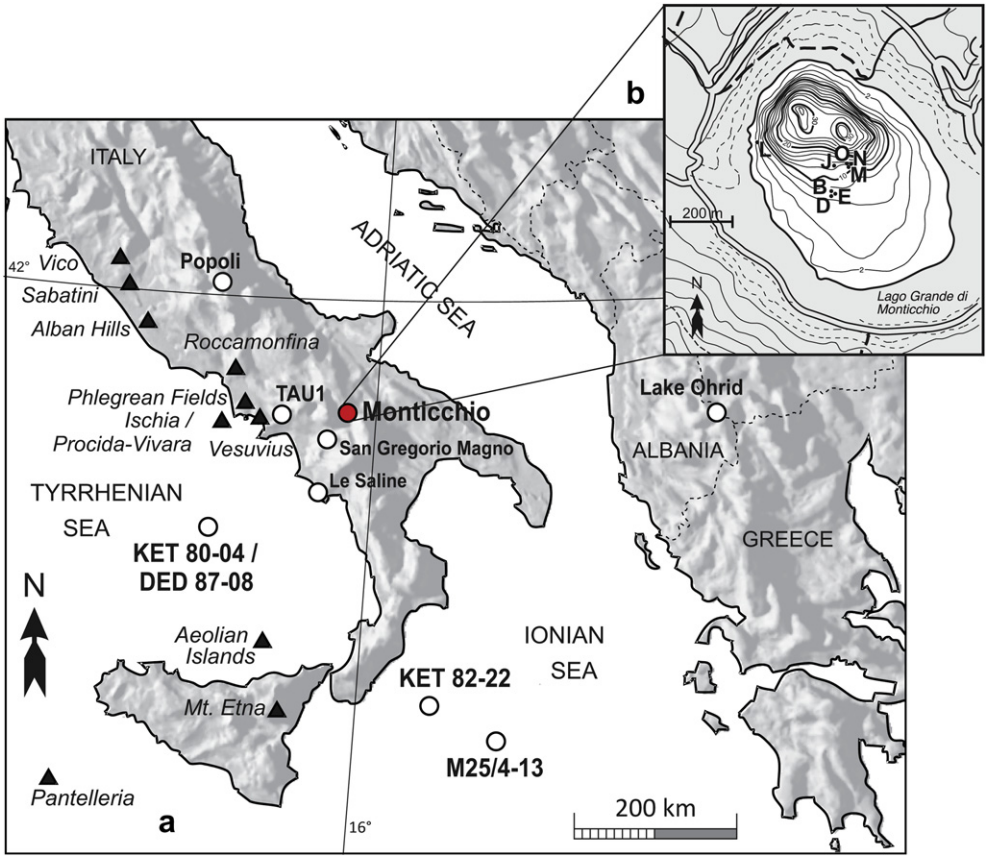

Fig. 1. a) Site map of Italy showing major volcanic centres, the location of Lago Grande di Monticchio and distal correlation sites mentioned in the text. b) Bathymetric map of Lago Grande di Monticchio with coring sites.