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Volcanic stratigraphy and radiometric age constraints at the northern margin of a mega-caldera system: Athesian Volcanic Group (Southern Alps, Italy)

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Abstract

The Athesian Volcanic Group (AG) constitutes a major part of the Permian magmatism in the central-eastern Southern Alps. We applied a volcanic stratigraphy model in order to constrain the volcano-tectonic evolution of the investigated area, which represents the northern sector of a caldera margin. In-situ zircon geochronology was also obtained by combined methods (i.e. LA ICP-MS and SHRIMP U/Pb dating) on volcanic, plutonic and metamorphic rocks. The volcano-tectonic collapse involved the rising of a huge dome, which uplifted the central portion of the just-filled caldera with simultaneous collapse of some sectors. The condensed volcanic succession of the north-western margin of the AG is comprised between 279-274 Ma, which is about half the time interval (about 10 Ma) determined for the area immediately to the south. The Ivigna pluton (293.3 ± 1.5 Ma) is slightly older than the Monte Croce pluton (285.4 ± 1.6 Ma and 284.3 ± 0.7 Ma). The age of the protolith of the acid meta-volcanites from the South-Alpine metamorphic basement is constrained by SHRIMP U/Pb geochronology as Ordovician (472 ± 4 Ma), with possibly even older (Proterozoic) sedimentary protoliths. Finally, the radiometric ages confirm an Alpine age (34.1 ± 0.5) for the tonalitic lamellae intruded along the Periadriatic Line.

Keywords: Stratigraphy, Zircon, LA ICP-MS geochronology, SHRIMP geochronology, Permian volcanics, Caldera, Ordovician volcanics, Periadriatic intrusions

Introduction

The stratigraphy of the huge Permian volcanic succession cropping out in the north-western part of the Athesian Volcanic Group (AG) has been recently redefined (Avanzini et al., 2007) and constrained by zircon radiometric ages (Marocchi et al., 2008).

Geological mapping allowed a detailed reconstruction of the volcanic activity during the Lower Permian. Pyroclastic and lava products emplacement is strictly linked to the evolution of a large-scale caldera system extending over more than 50 km (Marocchi et al., 2008; Morelli et al., 2010). It is therefore crucial to understand the way this caldera system has conditioned the emplacement and geometry of the volcanic products, through thinning and/or lacking of volcanic formations outwards the caldera margins. The combination of volcanic stratigraphy and in-situ zircon U/Pb dating has proved to be a powerful tool in reconstructing the volcano-tectonic evolution of large igneous provinces (Marocchi et al., 2008) and of composite intrusive (Schaltegger et al., 2009).

Within this framework, the aims of this work are: a) provide a detailed reconstruction of the stratigraphy of the north-western margin of the caldera system between the Adige and Sarentino valleys; b) test and extend to this area the AG volcanic stratigraphy model applied to the volcanic succession cropping out immediately to the south (Marocchi et al., 2008) and c) complete age attributions through new in-situ high-precision zircon radiometric determinations.

Further radiometric age determinations obtained by combined methods (LA ICP-MS and SHRIMP U/Pb dating) have also been necessary to confirm that: a) the acid meta-volcanites intercalations inside the phyllites of the South-Alpine metamorphic basement belong to the Ordovician magmatism (Meli 1995, 1998; Meli and Klötzli 2001); b) the Ivigna and Monte Croce granodiorite and related rhyodacitic dykes belong to the Permian magmatism (Borsi et al., 1972; Bargossi et al., 1981; Rottura et al., 1997; Acquafredda et al., 1997; Rottura et al., 1998) and c) the tonalitic lenses intruded along the Insubric Line belong to the late-Alpine magmatism (Exner 1976; Bargossi et al., 1978; Martin et al., 1993, 1996; Pomella et al., 2010).