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Potassic and ultrapotassic magmatism in the circum-Tyrrhenian region: Significance of carbonated pelitic vs. pelitic sediment recycling at destructive plate margins

Riccardo Avanzinelli [a], Michele Lustrino [b,c], Massimo Mattei [d], Leone Melluso [e], Sandro Conticelli [f,g,*]

[a] Department of Earth Sciences, University of Bristol, Wills Memorial Building, Queens Road BS8 1RJ, Bristol UK
[b] Dipartimento di Scienze della Terra, Università degli Studi di Roma La Sapienza, Piazzale Aldo Moro, 5, I-00185, Roma, Italy
[c] Istituto di Geologia Ambientale e Geoingegneria (IGAG), CNR, Piazzale Aldo Moro, 5, I-00185, Roma, Italy
[d] Dipartimento di Scienze Geologiche, Università degli Studi di Roma III, Largo S. Leonardo Murialdo, 1, Roma, Italy
[e] Dipartimento di Scienze della Terra, Università degli Studi di Napoli Federico II, Via Mezzocannone, 8, Napoli, Italy
[f] Dipartimento di Scienze della Terra, Università degli Studi di Firenze, Via Giorgio La Pira, 4, I-50121, Firenze, Italy
[g] Istituto di Geoscienze e Georisorse, sezione di Firenze, CNR, Via Giorgio La Pira, 4, I-50121, Firenze, Italy

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ABSTRACT

The central-western Mediterranean is one of the most important areas on Earth for studying subduction-related potassic and ultrapotassic magmatism. In the circum-Tyrrhenian area leucite-free (i.e., lamproite) and leucite-bearing (i.e., kamafugite, leucitite, and plagioleucitite) ultrapotassic rocks have been emplaced and are associated with shoshonites and high-K calc-alkaline volcanic rocks. Four different magmatic provinces are recognised from this area. Eastward and then south-eastward migration of magmatism with time occurred following roll-back of the subducting plate. Leucite-free silica-rich lamproites are restricted to the early stages of magmatism, associated with shoshonites and high-K calc-alkaline volcanic rocks. Present day volcanic activity is restricted to the Neapolitan district where ultrapotassic rocks with variable geochemical and isotopic characteristics occur. Ultrapotassic rocks are strongly enriched in incompatible trace elements with variable fractionation of Ta, Nb, and Ti with respect to Th and large ion lithophile elements. Mafic ultrapotassic rocks are also variably enriched in radiogenic Sr and Pb and unradiogenic Nd. The main geochemical and isotopic signatures result from sediment recycling within the upper mantle via subduction. Selected trace element ratios suggest that high temperatures are required to generate sediment-derived melts. Recycling of carbonated pelites play an important role in the Roman province controlling the genesis of leucite-bearing magmas.

Large volumes of metasomatic components are predicted to be accommodated within a vein network in the sub-continental lithospheric mantle. Partial melting of the pure vein mineralogy is likely to generate ultrapotassic magmas of either lamproitic or kamafugitic nature. Over time, increased interaction between the metasomatic vein lithology and the surrounding mantle dilutes the alkaline component producing shoshonites and high-K calc–alkaline rocks. The addition of a further subduction-related component shortly before magma generation is required to explain the isotopic composition of rocks from the Neapolitan district. In the last phases of circum-Tyrrhenian evolution, a within-plate component appears within south-eastern Italy. This component is evident at Vulture volcano, in the Lucanian Magmatic province (SE Italy).

1. Introduction

The central-western Mediterranean is one of the most important regions of the world for studying the occurrence and genesis of ultrapotassic rocks and to investigate on the process of crust–mantle interaction during alkaline and ultra-alkaline magmatism at convergent plate margins.

Potassic and ultrapotassic rocks in the central Mediterranean (hereafter circum-Tyrrhenian) occur along the eastern margin of Corsica–Sardinia block (e.g., Velde, 1967; Wagner and Velde, 1986; Peccerillo et al., 1988; Mascle et al., 2001; Chelazzi et al., 2006), and along the Italian peninsula (Peccerillo, 2005, and references therein). In the Mediterranean region, potassic and ultrapotassic rocks have been also recorded from the western Alps (e.g., Venturelli et al., 1984a, Peccerillo and Martinotti, 2006; Owen, 2008; Prelević et al., 2008; Conticelli et al., 2009a), south-eastern Spain and north-western Africa (e.g., Nixon et al., 1984; Venturelli et al., 1984b; Beccaluva et al., 1994; Toscani et al., 1995; Turner et al., 1999; Duggen et al., 2004, 2005; Prelević et al., 2008; Conticelli et al., 2009a). In all central-western

* Corresponding author. Dipartimento di Scienze della Terra, Università degli Studi di Firenze, Via Giorgio La Pira, 4, I-50121, Firenze, Italy.
E-mail address: sandro.conticelli@unifi.it (S. Conticelli).

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Mediterranean occurrences, alkaline ultrapotassic rocks are associated spatially and temporally with shoshonitic, high-K calc-alkaline and calc-alkaline rocks (e.g., Conticelli et al., 2009a). However, differing from typical within-plate alkaline potassic and ultrapotassic rocks (e.g., Alto Paranaíba and Serra do Mar, Brazil; Toro-Ankole, Western African Rift; Eifel, Germany; Leucite Hills, Wyoming; etc.), Mediterranean ultrapotassic rocks are characterised by orogenic geochemical and isotopic signatures (Peccerillo, 2005; Peccerillo and Martinotti, 2006). Na-alkaline rocks possessing within-plate geochemical and isotopic signatures are observed in the western Mediterranean, (e.g., Tallante, and Calatrava, Spain; Lustrino and Wilson, 2007), but are erupted several million years after any corresponding orogenic event. In a few cases, within-plate geochemical and isotopic signatures also occur in the late products of the ultrapotassic orogenic suites (e.g., Corsica and Roman Magmatic Provinces; Peccerillo, 2005, and references therein; Conticelli et al., 2009b).

Despite their alkaline characteristics, the ultrapotassic rocks associated with destructive plate margins invariably show a strong depletion of Nb and Ta with respect to LILE, LREE and Th. These characteristics are thought to be derived through the recycling of sediments via subduction (e.g., Elliott et al., 1997; Elliott, 2003). In addition, high-MgO (mg-# = 65–78), Italian primitive ultrapotassic rocks show the highest levels of incompatible trace elements ever seen in any volcanic arc. These compositions make them useful for understanding the mechanisms of sediment recycling within the mantle wedge during subduction.

In this paper, we review the main geochemical and isotopic characteristics of the most primitive potassic and ultrapotassic rocks of the circum-Tyrrhenian magmatic associations (i.e., Corsica, Tuscan, Roman, and Lucanian Magmatic Provinces; Fig. 1). The origin of this potassic to ultrapotassic magmatism is discussed in the lights of the processes related to crustal recycling within the upper mantle and

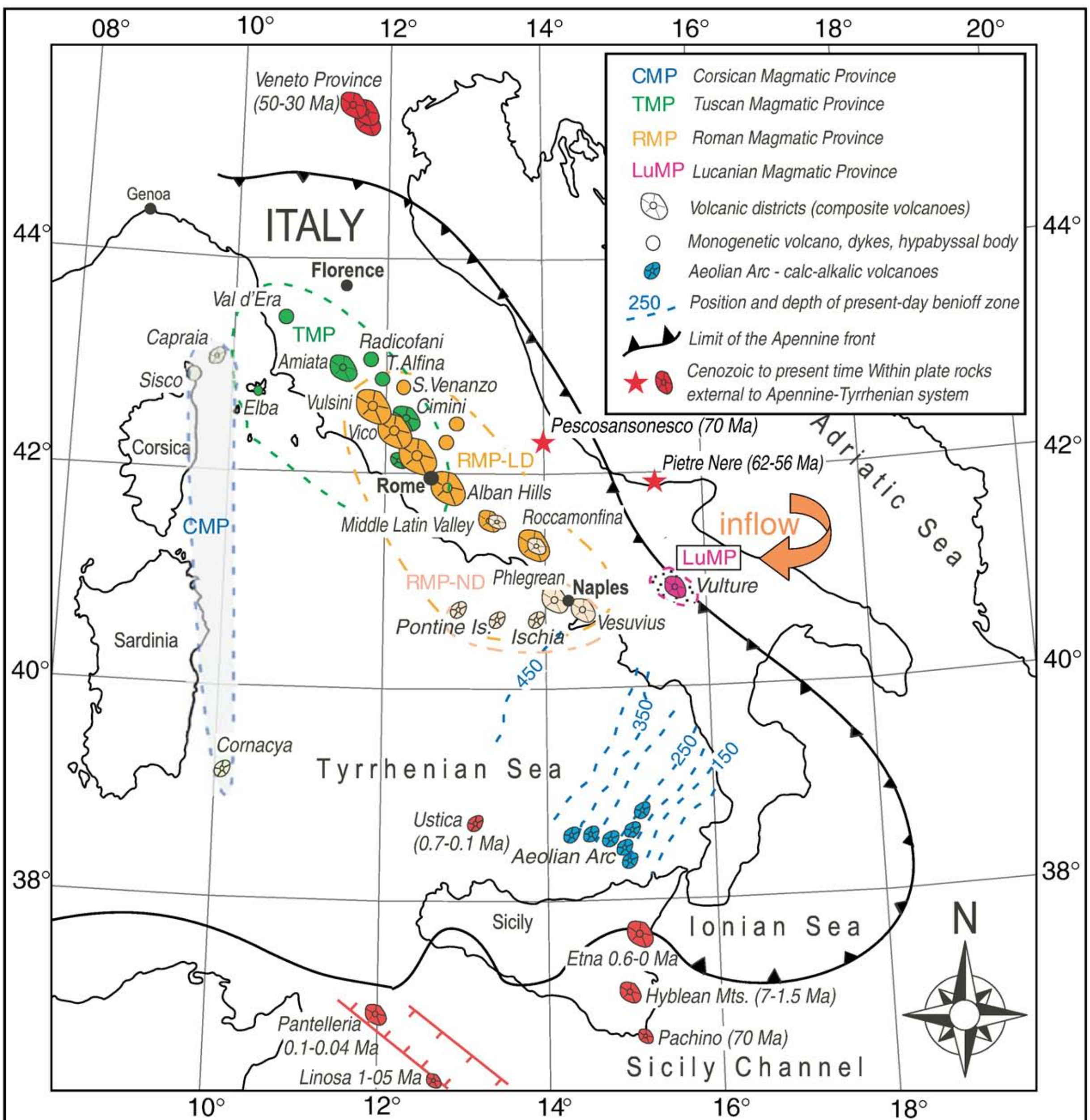

Fig. 1. Distribution of potassic and ultrapotassic volcanism associated with calc-alkaline rocks in Italy (redrawn after Conticelli et al., 2007; Avanzinelli et al., 2008). Also shown are Cenozoic igneous rocks from peninsular Italy and Sicily with within-plate geochemical characteristics. The large arrow represents the point for toroidal inflow within the mantle wedge through slab tears.