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The augen gneisses of the Peloritani Mountains (NE Sicily): Granitoid magma production during rapid evolution of the northern Gondwana margin at the end of the Precambrian

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ABSTRACT

The medium- to high-grade polymetamorphic basement rocks of the Peloritani Mountains, northern Sicily, include large volumes of augen gneiss of controversial age and origin. By means of a geochemical and SHRIMP zircon study of representative samples, the emplacement age of the original granitoid protoliths of the augen gneisses and the most likely processes and sources involved in that granitoid magmatism have been determined. U–Pb dating of three samples from widely spaced localities in the Peloritani Mountains yielded igneous protolith ages of 565±5, 545±4 and 545±4 Ma, respectively. These late Ediacaran/early Cambrian ages are much older than was previously assumed on geological grounds, and are typical of the peri-Gondwanan terranes involved in the geodynamic evolution of the northern Gondwana margin at the end of the Avalonian–Cadomian orogeny. Major and trace element compositions and Sr–Nd isotopic data, in combination with zircon inheritance age patterns, suggest that the granitoid protoliths of the Sicilian and coeval Calabrian augen gneisses were generated by different degrees of mixing between sediment- and mantle-derived magmas. The magmas forming the ca. 545 Ma inheritance-rich granitoids appear to have had a significant contribution from partial melting of paragneiss that is the dominant rock type in the medium- to high-grade Peloritanian basement. The closeness of the inferred deposition age of the greywacke protoliths of the paragneisses with the intrusion age of the granitoids indicates rapid latest Precambrian crustal recycling involving erosion, burial, metamorphism to partial melting conditions, and extensive granitoid magmatism in less than ca. 10 Ma.

1. Introduction

The Calabria–Peloritani orogen (CPO), presently located in the central Mediterranean area at the boundary between the European and African plates, is an outstanding example of complex polymetamorphic basement. Resolution of the tectono-metamorphic history and geodynamic role of metamorphic terranes, particularly when polymetamorphism is involved or suspected, requires reliable petrogenetic and geochronological information on the basement-forming rock types. Indeed, although the metamorphism most widely documented in the southern CPO is Variscan (~300 Ma; e.g. Atzori et al., 1990; Graessner et al., 2000; Appel et al., 2011 and references therein), only a few authors favour an entirely Variscan polyphase metamorphic history (Atzori et al., 1984; Ioppolo and Puglisi, 1989). Others have suggested that the northern Peloritani Mountains are either part of a pre-Variscan polymetamorphic basement (Ferla, 2000; Ferla and Meli, 2007), or the result of the amalgamation of different pre-Variscan and Variscan terranes during the last stages of the Variscan orogeny (De Gregorio et al., 2003).

Augen gneisses of debated age and origin are exposed in the Peloritani Mountains of the southern CPO. Some relatively recent studies, based on field, petrographic and geochemical features, interpret these rocks to be the products of Variscan metamorphism of either rhyolitic to rhyodacitic ignimbrites (Atzori and Lo Giudice, 1982), Cambro–Ordovician granitoids (Rotolo, 1993; Ferla, 1994), or mixed sedimentary and felsic volcaniclastic protoliths (Lo Giudice et al., 1995). Similar augen gneisses exposed in southern Calabria, dated by SIMS zircon U–Pb, are metamorphosed Ediacaran/Cambrian granites (Micheletti et al., 2007), but very low grade porphyroids exposed in the southern Peloritani Mountains, dated by TIMS zircon, are mid-Ordovician rhyolites (Trombetta et al., 2004). As a consequence, the age and origin of the augen gneiss protoliths is a basic question in the larger scale debate focused on the history of the medium- to high-grade basement of the northern Peloritani Mountains.

By integrating existing and new field, petrographic and geochemical data with a sensitive high resolution ion microprobe (SHRIMP) zircon U–Pb study, we have defined the nature and age of the protoliths of the augen gneisses from the Peloritani Mountains, as well as the possible

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petrogenetic processes by which they originated, placing new constraints on the type, spatial distribution and geodynamic significance of the late Proterozoic to Ordovician magmatic activity in the southern European realm.

2. Geological background

The Peloritani Mountains (NE Sicily) are the southern termination of the Calabria–Peloritani orogen (CPO), a remnant of the Variscan Belt reworked during the Alpine orogeny (Fig. 1). The Peloritani Belt consists of a set of south-verging basement nappes with metamorphic grade increasing upwards, and remnants of a Mesozoic–Cenozoic cover sequence (Atzori and Vezzani, 1974; Lentini and Vezzani, 1975). The belt has been subdivided into two complexes with different tectono-metamorphic histories (Atzori et al., 1994; Cirrincione et al., 1999). The Lower Domain, in the southern part of the belt, consists of Cambrian to Carboniferous volcano-sedimentary sequences (Acquafredda et al., 1994 and references therein) affected by Variscan sub-greenschist to greenschist facies metamorphism and covered by Mesozoic–Cenozoic sediments (Cirrincione et al., 1999). The Upper Domain, in the northeastern part, consists of two tectonic units (Mandanici and Aspromonte–Peloritani Units) comprising Variscan greenschist to upper amphibolite facies metamorphic rocks with a local Alpine greenschist facies metamorphic overprint (Cirrincione and Pezzino, 1991; Atzori et al., 1994). Fragments of a weakly metamorphosed Mesozoic–Cenozoic cover sequence are locally interposed between these two units (Cirrincione and Pezzino, 1991, 1994).

The medium- to high-grade Aspromonte–Peloritani Unit (Pezzino et al., 1990, 2008) is the highest tectonic unit of the nappe pile. The most prominent rock types in the unit are amphibolite facies biotite paragneiss and augen gneiss, with minor amphibolite, granitoid gneiss, mica schist and marble. Estimates of the metamorphic P–T conditions are in the range 680–550 °C at 0.5–0.3 GPa (Ioppolo and Puglisi, 1989; Rotolo, 1993). The metamorphic basement is extensively intruded by small, late Variscan granitoid plutons of weakly to strongly peraluminous composition (Fiannacca et al., 2008 and references therein).

Atzori et al. (1984) and Ioppolo and Puglisi (1989) proposed an entirely Variscan origin for the medium- to high-grade basement of the Peloritani Mountains, whereas other authors (e.g. Ferla, 1978, 2000; Bouillin et al., 1987; Acquafredda et al., 1994) have suggested that most of the rocks of the northern Peloritani Mountains were part of a pre-Variscan basement. Most recently, De Gregorio et al. (2003) proposed that the Aspromonte–Peloritani Unit resulted from the amalgamation of various pre-Variscan and Variscan terranes during the last stages of the Variscan orogeny. Evidence for a pre-Variscan origin and a Northeast-African peri-Gondwanan affinity of widely separated portions of the basement of the northeastern Peloritani

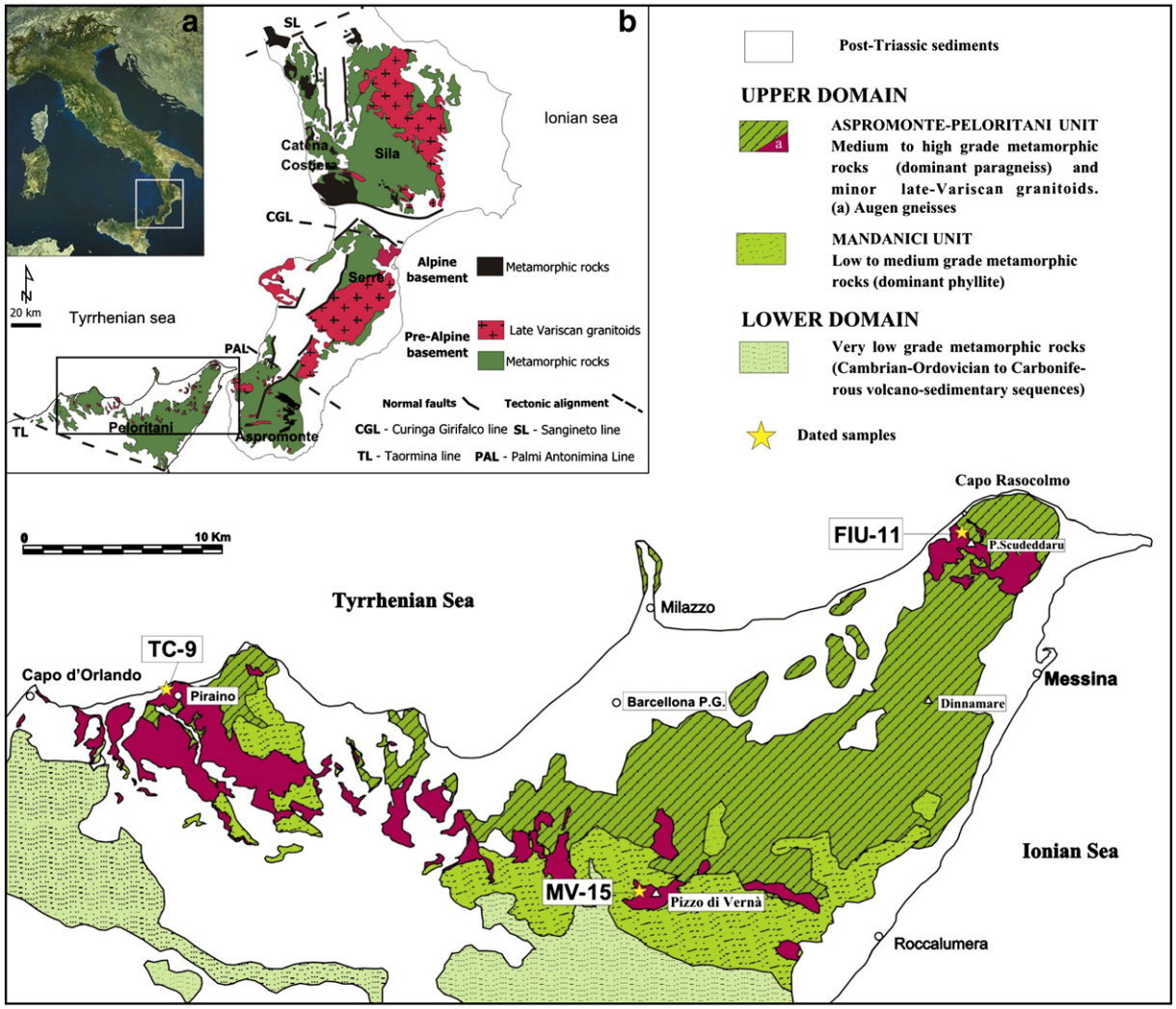

Fig. 1. Geological sketch map of the northeastern Peloritani Mountains with locations of dated samples (stars). The insets show: (a) location of the Calabria–Peloritani orogen in Italy; (b) a geological–structural sketch map of the Calabria–Peloritani orogen.
Modified after Angì et al., 2010.