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Unraveling protolith ages of meta-gabbros from Samos and the Attic–Cycladic Crystalline Belt, Greece: Results of a U–Pb zircon and Sr–Nd whole rock study

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ABSTRACT

The focus of this study is on meta-ophiolitic rocks from Samos and the Attic–Cycladic Crystalline Belt, Greece. SHRIMP U–Pb zircon geochronology, Sr–Nd isotope and bulk-rock geochemistry have been applied to meta-gabbros that occur as blocks and lenses in blueschist-facies mélanges on Samos and Evia, and in the greenschist-facies Upper Unit on Tinos. The geodynamic significance of these meta-ophiolite fragments within the overall pattern of the Eastern Mediterranean region is unclear. Regional correlations within the Cyclades archipelago and with the Jurassic meta-ophiolites of the Balkan region or the Cretaceous occurrences in Turkey are uncertain. Although field, petrological and geochemical similarities among some mélange occurrences suggest a common genetic relationship, such interpretations remain speculative if not supported by robust geochronological data. SHRIMP U–Pb zircon dating of three meta-gabbro blocks from Samos yielded Cretaceous ages with weighted mean $^{206}Pb/^{238}U$ ages of 78.3 ± 1.3 Ma, 76.8 ± 1.4 Ma and 77.8 ± 1.4 Ma and almost identical intercept ages, interpreted to indicate the time of magmatic crystallization. These results further substantiate models suggesting a correlative relationship with mélanges on the islands of Syros and Tinos, central Aegean Sea, where similar rocks yielded almost identical U–Pb zircon ages.

Published and new Sr–Nd isotope data of meta-gabbros from Andros, Samos, Tinos (Lower Unit) and from mainland Greece (Pindos, Othris) reveal distinctive differences among ion probe-dated samples with Jurassic and Cretaceous protolith ages. Three groups can clearly be distinguished in a $^{87}Sr/^{86}Sr$ vs. $^{143}Nd/^{144}Nd$ diagram. However, these geochemical parameters do not allow assigning tentative age estimates for yet undated meta-gabbros from southern Evia and the Upper Unit of Tinos. The situation is further complicated by the observation that the Jurassic and Cretaceous meta-gabbros do not show other discriminating geochemical characteristics that could provide plausible arguments for an approximate age assignment to undated rocks.

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1. Introduction

Ophiolites are widespread in the Eastern Mediterranean region (Fig. 1) and can broadly be subdivided into two main groups based on their protolith ages. The first group comprises remnants of Jurassic oceanic lithosphere that are exposed in two subparallel, NNW–SSE trending belts stretching across mainland Greece, Albania, Croatia and Serbia (Hellenides and Dinarides) that document the former existence of one or two major oceanic basins (e.g. Robertson, 2002; Bortolotti et al., 2013, and references therein). The second group includes Cretaceous ophiolites that are widespread in Turkey (Taurides, Pontides, Anatolides), Cyprus and Syria (e.g. Parlak and Delaloye, 1999; Robertson, 2002). Ophiolites also occur on many islands of the Aegean Sea. The Aegean Islands are of special interest for in-depth understanding of the geodynamic history of the larger region because they represent the geographic link between the major ophiolite domains of the Eastern Mediterranean. For some of the Aegean occurrences either Jurassic (e.g. Crete, Andros) or Cretaceous (e.g. Syros, Tinos, Karpathos, Rhodos) protolith ages have been reported (Bröcker and Pidgeon, 2007; Koepke et al., 2002; Tomaschek et al., 2003), but the general picture remains fragmentary, due to the scarcity of isotopic age data for such rocks.

The focus of this study is on meta-ophiolites that occur as blocks and tectonic slabs (<1 m to several hundred meters in size) within mélanges of the lower and upper main units of the Attic–Cycladic Crystalline Belt (ACCB, Fig. 2a). Such block-in-matrix associations were described from various locations of the Cycladic Blueschist Unit (e.g. Syros, Tinos, Andros, Evia; e.g. Bröcker and Enders, 1999, 2001; Dixon and Ridley, 1987; Katzir et al., 2000; Mukhin, 1996) and from the structurally higher greenschist-facies Upper Unit (e.g. Tinos; Katzir et al., 1996; Zeffren et al., 2005). Geochemical characteristics of mafic mélange

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Fig. 1. Regional overview of the Balkan region and Turkey showing major ophiolite occurrences. (Modified after Koepke et al., 2002).

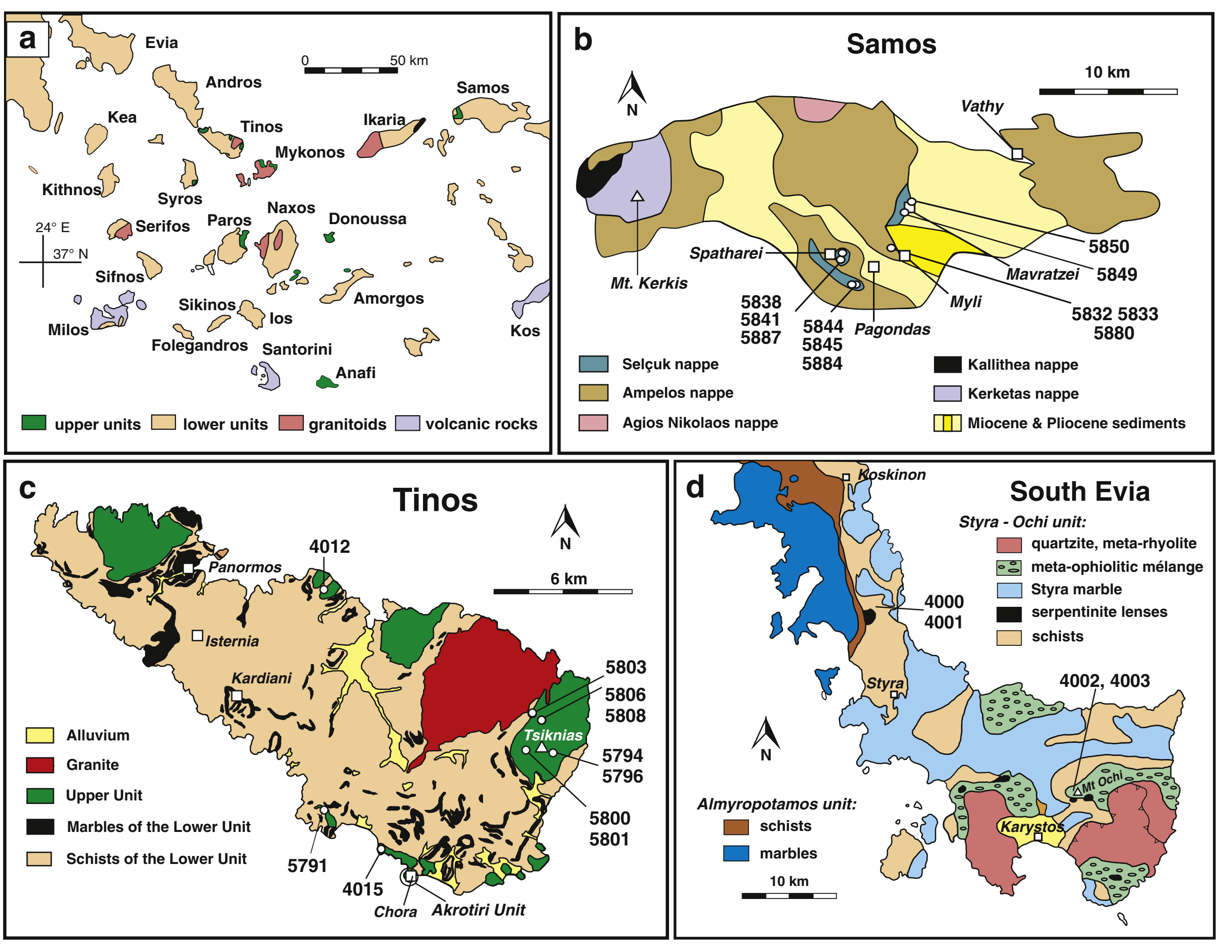

Fig. 2. Simplified geological maps showing the major rock units of (a) the Attic–Cycladic Crystalline Belt (modified after Matthews and Schliestedt, 1984), (b) Samos (modified after Ring et al., 2007b), (c) Tinos (modified after Melidonis, 1980) and (d) southern Evia (modified after Katzir et al., 2000). Numbers indicate sample locations. For details of the tectonic contact and fault pattern see the original papers.

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