Origin of S-type granites coeval with I-type granites in the Hellenic subduction system, Miocene of Naxos, Greece

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Abstract: The island of Naxos in the Cyclades preserves a core complex developed by Miocene detachment faulting associated with extension of continental crust inboard of the Hellenic subduction zone. The extension has unroofed Miocene hornblende-biotite granite and leucogranite, previously defined as I-type and S-type granite respectively. Crystalline basement exposed by extension includes partially migmatised ortho- and paragneisses principally with Hercynian protolith ages and intercalated high-grade metasedimentary and metavolcanic rocks with Mesozoic protoliths. Most leucogranites, in addition to quartz, feldspar and biotite contain muscovite, tourmaline and garnet (almandine-spesartine). Mineral assemblages suggest crystallisation pressures $< 2.5$ kbar, with stability of muscovite and tourmaline resulting from high B, Mn and possibly F in the magma. Two types of leucogranite can be distinguished on the basis of rock chemistry, mineral chemistry and Nd isotopes. Earlier leucogranites (type II) have high LREE:HREE ratio, high LILE, low Y and Nb and $\varepsilon_{Nd} \sim -10$ and appear to be a partial melting product of Hercynian paragneiss. Leucogranite dykes within the I-type granite appear similar. Later leucogranites (types Ia, Ib) have low LREE:HREE ratio and $\varepsilon_{Nd} \sim -7$ and appear to be derived from melting of both Hercynian paragneisses and younger metasediments. The major element composition of rare leucogranite type Ic suggests derivation from partial melting of orthogneiss. These varied sources result in significant variation in mineral assemblages in the leucogranites.

Key-words: Greece, Cyclades, leucogranite, tourmaline, garnet, Nd isotopes, I-type granite, S-type granite.

Introduction

Geological setting

The Miocene granitoid plutons of the Cyclades (Fig. 1) appear genetically related to the Hellenic subduction zone, which has been active since at least the Oligocene (Meulenkamp et al., 1988). The Cyclades represent an early Tertiary collisional orogenic belt that has experienced Miocene to Quaternary extension, that resulted in unroofing of the plutons. Within the Cyclades, Altherr et al. (1982, 1988) distinguished I-type and lesser S-type granites on the basis of whole rock geochemistry, mineralogy and isotopic compositions. They showed that the I-type plutons varied geographically from granodiorite in the western, granite in the central and monzonite in the eastern Cyclades, with an eastward increase in K$_2$O at constant SiO$_2$. Detailed Sr and O isotopic studies of the I-type plutons (Altherr et al., 1988) showed that the magma batches resulted from mixing of a mantle-derived component with a recycled crustal component, with fractional crystallisation during crustal assimilation. S-type granites, found in Tinos, Paros, Naxos, and Ikaria, are peraluminous, biotite-muscovite granites, forming small bodies or dykes. Their origin and relationship to the I-type granites is not well understood. In Tinos and Naxos, I-type monzogranite is intruded by small S-type leucogranite bodies, whereas geochronology in Ikaria suggests that the S-type granite is older than the I-type granite (Altherr et al., 1982). Most of the island of Naxos consists of Permi - Mesozoic - Paleogene metasediments of the Basal Tectonic Unit of the Cyclades in contact with granitic gneiss (Fig. 2). Although some