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Trace element systematics of high-pressure metamorphic rocks from Syros (Greece)

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Exhumed HP metamorphic rocks in fossil subduction zones comprise important information on trace element storage in different lithologies and element transport during de-volatilisation of subducting slabs. However, it is difficult to decipher the relative roles of various processes that may have modified the budgets of major and trace elements of HP rocks. This dilemma can be (partly) solved by comparing signatures of elements of different behavior.

In this study, we analysed HP rocks from the island of Syros (Greece) that are interpreted as parts of subducted oceanic crust (basalt, gabbro, plagiogranite, serpentinite, sediment), equilibrated at about 1.5 to 2.0 GPa and 500 °C. Major and trace elements were analysed using a variety of analytical methods for ~ 50 elements including XRF for major elements and LILE, solution-ICP-MS for HFSE, REE, U, Th, Pb, solution-ICP-AES for Li and Be and prompt gamma neutron activation analysis (PGNAA) for B, Cl and H and major components. PGNAA was performed using the cold neutron beam at the Budapest Neutron Centre.

Along with petrographic observations, the analytical results enable us to distinguish two major groups of HP rocks. Group I includes samples that preserved their peak-pressure mineral assemblages without indications of retrograde fluid influx. Group II are rocks that were over-printed by hydrous fluids during exhumation. Chemical compositions of the latter are strongly in-fluenced by retrograde processes, whereas group I rocks, representing peak metamorphic compositions, can be used to monitor the behavior of different trace elements during prograde HP metamorphism and dehydration. Major element compositions and REE patterns were used to distinguish between former gabbros, plagiogranites, basalts, rodingites and fresh and strongly altered basalts. Taking all group I rocks together, strong positive correlations between H₂O content and B/Be and B/Nb ratios show loss of B from the rocks during progressive dehydration. Ba, Rb and Cl also show very low concentrations in the dehydrated rocks. In contrast, Li, Pb and Sr contents are above MORB values in some eclogites, suggesting a more conservative behavior of these elements during dehydration.

The investigated HP rocks from Syros comprise information on the mobilisation of various trace elements in different lithologies down to the blueschist-eclogite transition at a depth of subduction of 50 to 70 km.

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Nitrogen isotope compositions of the Cooma metamorphic complex, Australia: Implications for ¹⁵N-enriched reservoirs

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The well-studied Paleozoic (435 Ma) Cooma metamorphic complex is centered on the township of Cooma 110 km south of Canberra, Australia. It is characterized by a uniform siliciclastic protolith, with a range of metamorphic grade from lowest greenschist to highest granulite facies; the metamorphic index minerals are chlorite, biotite, andalusite, and sillimanite, and migmatite [1]. Accordingly, it provides a natural window to investigate N concentration variation and $\delta^{15}\text{N}$ values during prograde metamorphism. Nitrogen decreases as $\delta^{15}\text{N}$ increases through progressive metamorphic zones from slates containing 250 ppm N, $\delta^{15}\text{N} = 2.4\text{‰}$; through chlorite zone (greenschist facies) with 210 ppm N, $\delta^{15}\text{N} = 3.2\text{‰}$; and the biotite and andalusite zones (amphibolite facies) having 130 ppm N, $\delta^{15}\text{N} = 3.8\text{‰}$, and 125 ppm N, $\delta^{15}\text{N} = 4.3\text{‰}$ $\delta^{15}\text{N}$, respectively; to the sillimanite and migmatite zones (granulite facies) with 71 ppm N, $\delta^{15}\text{N} = 12.3\text{‰}$, and 77 ppm N, $\delta^{15}\text{N} = 12.9\text{‰}$ $\delta^{15}\text{N}$, respectively. These results show: (1) small $\delta^{15}\text{N}$ shifts of 1 to 2‰ from lower greenschist to amphibolite facies, consistent with previous empirical studies of the Catalina Schist Complex [2] and the Erzgebirge terrane [3], and experimental studies on the fractionation of nitrogen isotopes [4]; and (2) large fractionations of 8 to 10‰ at granulite facies. Low-grade N systematics can be explained by N₂-NH₄⁺ exchange at T of 300 to 600°C for Rayleigh distillation or Batch devolatilization, whereas high-grade shifts can be interpreted as NH₃-NH₄⁺ exchanges at T of 600-730°C using equilibrium models. Archean cherts at greenschist facies, show a range of $\delta^{15}\text{N}$ from -6 to +30‰, where depleted values have been interpreted as primary, indicative of reducing conditions and enriched values as metamorphic shifts [5,6]. The results rule out those interpretations of metamorphic shifts, but rather a $\delta^{15}\text{N}$ -enriched reservoir exists [7], as well as locally oxic conditions from low Th/U ratios in 2.7 Ga shales [8].

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