

Anatetic evolution of an amphibole-bearing migmatite from the Variscan basement of NE Sardinia - insights from modeling with PERPLE_X

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The Variscan basement in the coastal area of NE Sardinia consists of various types of granites and migmatites, in which rare lenses of retrogressed eclogite, granulite and calcsilicate rock occur. South of Punta Bados, northeast of the town of Olbia, a small area of unusual amphibole-bearing migmatites is exposed. The bulk-rock composition of these migmatites with tonalitic and granodioritic leucosomes, which amount to somewhat more than 10 vol% of the rock and are mainly oriented parallel to the foliation, points to an igneous rock (Cruciani et al., 2008). According to mineral assemblages of mesosome and leucosomes comprising quartz, plagioclase, biotite, amphibole, garnet and K-feldspar, P-T conditions of the anatexis were estimated to have been 10-12 kbar and 700-750°C (Cruciani et al., 2008).

In order to improve our knowledge on the anatetic evolution of the amphibole-bearing migmatites south of Punta Bados we have undertaken thermodynamic calculations with PERPLE_X (Connolly, 2005) using the data set of Holland & Powell (1998 and updates) and solid-solution models such as GTrTsPg for amphibole (see Connolly, 2005). In addition, the haplogranitic melt model by Holland & Powell (2001) was employed. The calculations in the system Na₂O-K₂O-CaO-FeO-MnO-MgO-Al₂O₃-TiO₂-SiO₂-H₂O were undertaken for average compositions of mesosome, tonalitic leucosome and granodioritic leucosome with different contents of water to construct pseudosections for the P-T range 2-20 kbar and 570-900 °C. These pseudosections were contoured by various parameters such as Na/K in melt, content of melt and Si in amphibole.

From the obtained calculation results we conclude that a clockwise P-T path, starting at about 12 kbar and 600°C, reaching peak-T conditions of 760°C at 8 kbar, and passing 730°C at 4 kbar during the initial cooling phase, is likely. This path is compatible with the previous P-T estimates (Cruciani et al., 2008). Along the deduced P-T path, melting started at 620°C from a rock that contained only 1.5 wt% water. Initial melts were tonalitic. Leucosomes with granodioritic compositions developed below 5 kbar along the initial cooling path without addition of water. Amphibole with low Si contents of about 6.15 per formula unit crystallized in the leucosomes at pressures around 7 kbar. The results imply that during the exhumation of the presently exposed orogenic crust, which was thickened by the Variscan collisional event, melt was permanently present at depths from about 40 to 15 km and did not escape from the system.

Connolly, 2005. Earth Planet. Sci. Lett. 236, 524-541.

Cruciani et al., 2008. Lithos 105, 208-224.

Holland & Powell, 1998. J. Metam. Geol. 16, 309-343.

Holland & Powell, 2001. J. Petrol. 42, 673-683.