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Geochemical characterization of migmatized orthogneiss from Porto Ottiolu (NE Sardinia, Italy) and its inferences on partial melting process

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Migmatites are very common in the northern part of the axial zone of the Sardinia Variscan chain. At Porto Ottiolu, about 30 km south of Olbia, a wide sequence of igneous- and sedimentary-derived migmatites crops out. Migmatized orthogneiss have a complex structural evolution characterized by three folding phases (D1, D2, D3) followed by a shear deformation. The oldest structure observed in the migmatites is a gneissose layering (D1). The second deformation (D2) is the most pervasive in the field and produces tight folds. D3 deformation caused symmetric folds with sub-horizontal axes. The leucosomes are coarse-grained, centimetre-thick, deformed leucocratic layers and/or patches following or cutting the D2 foliation. Other leucosomes are emplaced along shear zones (S4). The mesosomes are medium-grained foliated rocks in which the foliation is identified by biotite oriented along the S2 schistosity. The contact between mesosome and leucosome is frequently marked by thin biotite-rich selvedge. Leucosomes mainly consist of quartz, plagioclase, K-feldspar, minor biotite, muscovite and rare garnet. Mesosomes consist of the same mineral assemblage but they are rich in biotite and muscovite. Muscovite is found as submillimetre-sized crystals with variable phengitic component (Si: 6.1, Fe: 0.14, Mg: 0.13 a.p.f.u., XMg: 0.48 in less phengitic crystals, Si: 6.2, Fe: 0.18, Mg: 0.20 a.p.f.u., XMg: 0.53 in more phengitic ones). Biotite is titanium rich (Ti 0.3 a.p.f.u.) and has XMg 0.4. Very rare garnet occurs as submillimetric unzoned almandine with high manganese and low calcium content (Alm: 79mol.%; Prp: 5; Sps: 11-13; Grs: 3). Plagioclase is an unzoned oligoclase (XAb: 0.7), sometimes surrounded by a thin rim of pure albite. K-feldspar often shows perthitic exsolutions. The modal amount of feldspars varies significantly within the same leucosome and between different leucosomes. In particular, leucosomes along shear zones are feldspar rich. Evidences of melting are given by the occurrence of myrmekitic miscrostructures between quartz and feldspar, quartz films at the feldspar interface and by albite rims around plagioclase.
Some selected samples were analysed for major, minor and trace element content. The leucosomes are characterized by the following major elements content: SiO_2: 72.9-76.2; $Al2O_3$: 14.7-15.4; $Fe2O_3$tot: 0.1-0.7; MgO: 0.1-0.3; CaO: 0.5-3.2; Na2O: 2.4-3.5; K2O: 4.0-8.6 wt%. The noticeable wide range in CaO and K2O is related to the high variability of the plagioclase/K-feldspar ratio. Most leucosomes have granitic composition, except for those occurring along shear zones that have tonalitic composition. Mesosomes major elements contents are SiO_2 ca. 70; $Al2O_3$: 14.4-15.1; $Fe2O_3$tot: 2.1-3.4; MgO ca. 1.0; CaO ca. 3.0; Na2O ca. 3.5; K2O ca. 2.6 wt.%. They have granodioritic compositions. All leucosome and mesosome samples are corundum normative. Chondrite-normalized REE patterns of leucosomes are characterized by a marked positive Eu anomaly and by LREE enrichment. Mesosomes are characterized by marked negative Eu anomalies, as well as by LREE and HREE enrichment. $\sum$REE is higher in mesosomes (153 ppm) than in leucosomes (20-63 ppm). Field relationships, microstructural and geochemical data support the hypothesis that migmatization was generated by partial melting of a probaby Ordovician granitoid. The origin of the various types of leucosome has been discussed.