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Microstructural and metamorphic evolution of a high pressure granitic orthogneiss during continental subduction (Sudetes, European Variscan belt)

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A quantitative microstructural and metamorphic study of a naturally deformed medium- to high pressure granitic orthogneiss (Orlica−Śnieżnik dome, Bohemian Massif) provides evidence of behaviour of the felsic crust during progressive burial along a subduction-type apparent thermal gradient (∼10 °C/km). The granitic orthogneisses develops three distinct microstructural types, as follow: type I – augen orthogneiss, type II – banded orthogneiss and type III - mylonitic orthogneiss, each representing an evolutionary stage of a progressively deformed granite. Type I orthogneiss is composed of partially recrystallised K-feldspar porphyroclasts surrounded by wide fronts of myrmekite, fully recrystallised quartz aggregates and interconnected monomineralic layers of recrystallised plagioclase. Compositional layering in the type II orthogneiss is defined by plagioclase- and K-feldspar-rich layers, both of which show an increasing proportion of interstitial minerals, as well as deformation of recrystallised myrmekite fronts. Type III orthogneiss shows relics of quartz and K-feldspar ribbons preserved in a fine-grained polymineralic matrix. All three types have the same assemblage (quartz+plagioclase+K-feldspar+muscovite+biotite+garnet+sphene±ilmenite), but show systematic variations in the composition of muscovite and garnet from type I to type III. This is consistent with the equilibration of the three types at different positions along a prograde P−T path ranging from P<15 kbar and T<700 °C (type I orthogneiss) to P of 19−20 kbar and T>700 °C (types II and III orthogneisses). The deformation types thus do not represent evolutionary stages of a highly partitioned deformation at constant P−T conditions, but reflect progressive formation during the burial of the continental crust. The microstructures of the type I and type II orthogneisses result from the dislocation creep of quartz and K-feldspar whereas a grain boundary sliding-dominated diffusion creep regime is characteristic of the type III orthogneiss. Strain weakening related to the transition from type I to type II microstructure was enhanced by the recrystallisation of wide myrmekite fronts, and plagioclase and quartz, and further weakening and strain localization in type III orthogneiss occurred via grain boundary sliding enhanced diffusion creep. The potential role of incipient melting in strain localization is discussed.