Plagioclase metastability during HP-metamorphism? Observations and models from the Adula Nappe

Kurzawski, R.M.[1] & Nagel, T.J.[2]

[1] GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, 24148-Kiel, Germany
(rkurzawski@geomar.de)
[2] Steinmann Institut für Geologie, Mineralogie und Paläontologie der Universität Bonn, 53115-Bonn, Germany
(tnagel@uni-bonn.de)

The Adula Nappe in the Central Alps consists of pre-Mesozoic basement with some Mesozoic cover rocks. Its rock assemblage is assumed to be derived from the distal Mesozoic European continental margin towards the North Penninic ocean. In Eocene times, at least parts of the Adula Nappe experienced extensive alpine metamorphic overprint at eclogite-facies conditions and subsequent rapid exhumation to mid-crustal depths. The Adula Nappe displays a stunning lithological heterogeneity and has been referred to as a lithospheric high-pressure/ultra-high-pressure (HP/UHP) mélange though it is not clear whether (1) the heterogeneity results from intense mixing in the alpine subduction channel or (2) is partly inherited from the pre-Mesozoic history while the Adula Nappe remained coherent during alpine history.

Here, we describe the metamorphic record in orthogneisses from the central portion of the nappe (Alp de Ganan). In the study area, thin layers of orthogneiss are intercalated with HP garnet-mica-schists, which enclose eclogite-cored metabasic boudins. In contrast, the orthogneisses display the commonplace assemblage Qtz + Kfs + Pl + Wm + Bt ± Grt ± Czo/Aln ± accessory minerals (Ap, Zrn, ore minerals). Equilibration under eclogite-facies conditions, however, is expected to produce plagioclase-free jadeite-gneisses. Several explanations exist for the absence of high-pressure relicts in the metagranitoids: (1) The orthogneisses never experienced HP conditions, (2) the orthogneisses did experience HP conditions, were transformed to jadeite-gneisses and completely re-equilibrated to plagioclase-gneisses during retrograde metamorphism, and (3) orthogneisses experienced HP conditions but plagioclase remained metastably through the metamorphic history.

We present petrographic descriptions, whole rock chemical data and extensive microprobe data including chemical maps from orthogneisses sampled at Alp de Ganan. The only clear hint to high-pressure conditions is phengitic white mica preserved in cores of matrix grains and as inclusions in K-feldspar porphyroclasts. In the foliated matrix, white mica coexists with biotite. These matrix grains show pronounced chemical zoning with high silica contents up to ca. 3.4 Si p.f.u. in cores. The increase of Al towards the rim is secondary and controlled by diffusion, probably during biotite growth or deformation. Biotite is only weakly zoned and displays phlogopite components between 50 and 54 %. K-feldspar porphyroclasts consistently contain high-Si phengite as inclusions. Equilibrium assemblage diagrams calculated for the bulk compositions of our samples predict the observed matrix evolution during nearly isothermal decompression from 16 kbar at 700 – 750 °C. This trajectory exactly matches the lower pressure part of published P-T data concerning the nearby-located Trescolmen eclogites. Si-contents as high as observed, however, are predicted only at considerably higher pressures in assemblages with clinopyroxen. The entire sequence of assemblages including observed high-Si contents in phengite can be reproduced in equilibrium phase diagrams if clinopyroxen is removed from the database and a PT-Path as recorded in the adjacent eclogites is assumed. We therefore favor a scenario in which plagioclase remained in the rock metastably through the P-T evolution of a coherent basement unit. Similar metastable survival of plagioclase is described from other HP/UHP terranes.