Deformation during exhumation of Cretaceous high pressure units of the Eastern Alps

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The Saualpe-Koralpe high pressure (HP) complex as well as the UHP units of the Pohorje mountains are part of the Eoalpine HP belt which extends over about 350 km from west to east. It formed in conjunction with the Cretaceous orogenic cycle in the Eastern Alps and comprises eclogite lenses in a matrix of gneisses. The protoliths of the eclogites are gabbros and basalts which were probably emplaced along a continental rift zone. Most recent studies suggest that subduction took place within the Adriatic continent along an intra-continental subduction zone which formed along the pre-existing weakness caused by the Permian rift.

The Saualpe/Koralpe and Pohorje units reached peak pressure conditions of 2.2-2.4 GPa/630-690°C, 1.8-1.9 GPa/670°C and 3.0–3.7 GPa/710–940 °C, respectively at 100-90 Ma. PT-analyses, microstructural investigations and dating allow different mechanisms for the exhumation of these units.

In this study a set of samples containing pristine and retrogressed eclogite, as well as neighboring gneiss was collected in both the Koralpe and Pohorje HP units and analyzed using electron backscatter diffraction at the transmission electron microscope of the Institute of Geosciences at the University of Cologne.

Omphacite in both pristine and retrogressed eclogite forms a weak foliation and shows a moderate to pronounced crystallographic preferred orientation (CPO). The CPO indicates plane strain to slightly prolate strain. Omphacite in the samples displays a shape preferred orientation (SPO) with infrequent subgrain formation and recrystallization. Hornblende deformation is strongly localized. In most areas hornblende forms symplectites with feldspar, however there are frequent amphibolite facies shear zones cross cutting the omphacite foliation. The shear zones mainly contain small, recrystallized hornblende grains with a strong SPO and only few porphyroclasts. Hornblende shows a pronounced CPO in all samples. It is aligned within the omphacite foliation in the symplectitic areas likely mimicking omphacite CPO and aligned in the shear plane within the shear zones. Here, the CPO pattern is variable indicating various strain conditions from constriction over plain strain to flattening.

Where quartz is present in the samples it generally shows a weak but distinct, asymmetric CPO indicating simple shear. In the samples from the Pohorje area, quartz CPO in the eclogites differs from that in the surrounding gneiss pointing to a different sense of shear.

In summary, our study shows distributed deformation at eclogite facies conditions becoming more localized during exhumation to amphibolite facies conditions as indicated by the formation of anastomosing, hornblende-rich shear zones. Latest stages of exhumation are recorded by the quartz CPO of matrix gneisses. The comparison of quartz CPO in the eclogites with that in the gneiss samples in Pohorje indicates a change of shear sense from top- West under amphibolite-facies conditions to a top- East at later stages of exhumation.

The various types of strain, from constriction to flattening, may either be explained by local heterogeneities, e.g. boudins, or by heterogeneous overall flow during exhumation.