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From coronitic- to mylonitic-eclogite. A microstructural and petrological investigation of eclogites from the typelocality (Koralpe, Eastern Alps, Austria)

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In 1822 eclogites have been officially discovered, described and named by René-Just Haüy, at the eclogite type-locality in the Sau-Koralpe region (Easter Alps, Austria). Over decades eclogites have been extensively studied in terms of their mineralogy, their origin (magmatic vs. metamorphic) and their deformation behaviour. Nowadays, we know that eclogites form in subduction and collision zones during high- to ultrahigh-pressure metamorphism of mafic rocks like basalt and gabbro but their deformation behavior and the processes resulting in eclogite exhumation remain enigmatic.

For this contribution we investigated a series of eclogites from the eclogite body 'Hohl' in the type-locality region (Koralpe, Austria). Eclogites ranging from coronitic over protomylonitic to mylonitic eclogite have been investigated in terms of their mineralogy, structure and texture with optical and electronic microscopy, including electron backscatter diffraction as well as electron microprobe. All samples are composed of garnet (grt), clinopyroxene (cpx), quartz (qtz) and a fine grained mixture of plagioclase, kyanite and clinozoisite (pl+ky+czo). Secondary amphibole and ilmenite also occur. While the general mineral paragenesis is similar in all investigated samples, we do observe a variation in the volume fraction of each mineral with respect to the different eclogite types. The volume fraction of the fine grained pl+ky+czo mixture decreases in favour of grt and cpx during the evolution from coronitic to mylonitic eclogite.

Microstructurally coronitic eclogites are characterized by grt coronas surrounding cpx in a pl+ky+czo matrix with minor cpx crystals occurring in the matrix. Garnet crystals tend to be coarser grained and show crystal faces growing towards the matrix while rather fine grt grains and intergrowths with cpx develop towards the corona center. In protomylonitic eclogites grt occurs in clusters surrounded by cpx and pl+ky+czo matrix. Locally micro-shear zones nucleate in heterogeneous stress fields in the vicinity of grt cluster. Clinopyroxene grains start to develop a shape preferred orientation (SPO) together with a weak crystallographic preferred orientation (CPO). Mylonitic eclogites are characterized by a pronounced foliation defined by a SPO of cpx and elongated layers of pl+ky+czo. Garnet occurs in layers or dispersed in the matrix. Where grt cluster occur, we do observe precipitates of qtz or cpx between the different cluster fragments/grains. Clinopyroxene does show a CPO that can be classified as L- to LS-Type. The continuous development of a SPO together with a CPO of cpx indicates that deformation took place by dislocation creep. Even though we do observe crystal plastic behavior of grt in the form of misorientation and low-angle grain boundary development at high stress regions in clusters, we think that grt is mainly behaving as rigid objects starting to decouple from coronas and clasts in high strain regions. In all samples we observe symplectites composed of diopside and pl surrounding recrystallized cpx grains indicating that mylonitisation likely occurred at HP conditions. Additionally, we do observe the growth of secondary, probably retrograde plagioclase in fine grained layers, growing at the expense of quartz. Our microstructural and petrological observations might help us to constrain the deformation processes yielding to eclogite exhumation.