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SLAB BREAK-OFF IN THE MICROSTRUCTURE? HINTS FROM MICROSTRUCTURES OF ECLOGITE FROM THE TAUERN WINDOW

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High-pressure (HP) and ultrahigh-pressure (UHP) metamorphic rocks have an essential role in the construction of geodynamic models concerned with convergent plate margins. Many eclogites may occur within continental basement sheets and sequences from former rifts and rifted continental margins. Extrusion of a high-pressure sheet or wedge from a subduction channel has been suggested for exhumation of such units, either driven by buoyancy or externally applied stress. In these models the transition from subduction to exhumation is often explained by a singular event, e.g., the break-off of a subducted slab.

Herein the microstructural evolution of eclogites from the Eclogite Zone, situated within the Penninic unit of the Eastern Alps (Austria) will be discussed, providing insight into structural changes at peak pressure conditions, i.e. during the transition from burial to subsequent exhumation.

Coarse-grained massive eclogites with a grain-size of up to 1 cm show a weak foliation. Coarse omphacite1 grains show undulatory extinction and the formation of subgrains. The subgrain boundaries are usually oriented subparallel to the prism planes. With an incrasing degree of deformation, the long axes of the subgrains are preferentially oriented subparallel to the trace of the foliation. Fine grains of dynamically recrystallized omphacite2 are formed along the grain boundaries of omphacite1. Several stages from coarse-grained eclogites to fine-grained eclogite mylonites are observable. Within these mylonites, dynamically recrystallised omphacites2 show an elongated shape with a preferred orientation subparallel to the penetrative mylonitic foliation. Grain boundaries oriented subparallel to the foliation are straight; grain boundaries highly oblique or perpendicular to the foliation are highly irregular and show a serrate shape. In YZ-sections, the grain boundaries are generally straight or slightly curved and form triple junctions. The deformational fabrics document a section of the prograde evolution from 17-20 kbar at 550-580°C for omphacite1, to the peak of HP metamorphism (21-25 kbar, 600-620° C) during the formation of omphacite2.

In coarse-grained layered eclogites, the shape preferred orientation of omphacite1 is well developed in XZ and YZ sections of the finite strain ellipsoide. The aspect ratios (R_f) vary between 2.1 and 2.3 in XZ, 1.9 and 2.3 in YZ, and 1.00 and 1.15 in XY. This indicates a strain geometry within the flattening field. In fine-grained mylonites, the shape preferred orientation of dynamically recrystallized omphacite2 is less developed in YZ sections. In XZ, the aspect ratios (R_f) range from 2.5 to 3.00, in YZ from 1.2 to 1.5, and from 1.6 to 2.4 in XY. This indicates a strain geometry close to plane strain and constriction. From WKOA1-01 to WK526, continuous mylonitization can be observed. WK526 displays fabrics of complete dynamic recrystallization of omphacite.

The evolution of CPOs (textures) of omphacite is to a great extent related to the deformation geometry. The omphacite CPOs from the Eclogite Zone show a continuous transition from S- to L-type fabrics. This corresponds to the transition from coarse-grained eclogites with omphacite1 to fine-grained omphacite2-mylonites. The transition from S- to L- type fabrics is interpreted to be related to the shape fabric of the grains (either flattened or elongated) due to a change in deformation regimes from flattening (S-type) to constriction (L-type). Omphacite1 eclogites are characterized by a well developed girdle distribution of the {001} poles. The corresponding {010} poles form a cluster close to Z. Eclogites with plane-strain shape fabrics show L>S-type fabrics. The {001} poles show a girdle distribution within the foliation plane with the tendency to form a maximum centered in X. The corresponding {010} poles form a well developed cluster centered in Z. The omphacite2 CPOs are L-type fabrics. The {001} poles form well defined clusters centered close to the X- axis of the finite strain ellipsoide. The {010} poles are distributed along a girdle close to the YZ-plane.

This study provides additional supplements for the reconstruction of the tectonometamorphic evolution of the Eclogite Zone in completion to the regional structural and PT evolution. Special emphasis has to be given to the change in the strain geometry. Flattening fabrics (with S- type CPOs) are related to the prograde path, constrictional fabrics (with L>S- and L-type CPOs) to the pressure peak and subsequent decompression (*i.e.*, exhumation). Thus, the transition from flattening to constriction occurred immediately at the pressure peak. Inevitably, this peak marks the change from subduction-related burial to exhumation.

The deformation geometry is interpreted to be controlled by the force balance between slab pull (related to subducted oceanic lithosphere), and the buoyancy of adjacent subducted continental lithosphere incorporating the eclogites. The magnitude of negative buoyancy increases during subduction of oceanic lithosphere due to its increasing density. If continental material is going to be subducted, the downward buoyancy decreases by an amount proportional to the volume of the subducted continental crust. In most cases, subduction of continental material to 100-250 km depth is possible. The subduction of continental lithosphere is allowed to continue until the negative buoyancy is reduced to zero. Low density continental lithosphere and transitional lithosphere including the eclogite protoliths (e.g., gabbroic intrusions) will be subducted as long as the negative buoyancy of appended oceanic lithosphere prevails buoyant forces of the subducted continental lithosphere. However, the vertical part of the buoyancy vector within the the continental lithosphere may contribute to subvertical flattening.

When buoyant forces are going to exceed the slab pull forces, buoyancy-driven extrusion between two lithospheric plates will be initiated. Note that buoyancy may be active even if the part of the eclogite-bearing unit is surrounded by low-density crustal rocks. Deeper parts may be rooted in the mantle, leading to a net buoyancy force acting on this unit. At a certain array within the subducted plate slab pull forces and buoyancy forces cancel out each other. This separates a dense (predominantely oceanic) slab sinking into the mantle, and a slab of low-density continental material expelled between two lithospheric plates. Consequently, slab break off may be initiated in this zone of buoyancy equilibrium. Admittedly, the domain around is properly affected by intense constrictional strain and explains the change from flattening to constriction coinciding with the pressure peak. Moreover, the release of slab pull suppositionally results in a advanced extrusion of the continental units and may explain exhumation rates in the order of several centimeters per year, accompanied by axial elongation (constriction). However, at crustal levels where the net buoyancy of the extruded (U)HP sheets is reduced to zero, extrusion has to be replaced by other exhumation mechanisms, e.g., crustal extension.

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