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Stress history recorded by microstructures from an extensional shear zone in HP-LT metamorphic rocks in the Talea Ori, Crete

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In a major shear zone within high-pressure low-temperature metamorphic sediments in the Talea Ori, Central Crete, quartz veins occur at sites of dilation along extensional shear band boundaries, kink band boundaries and boudin necks. Bent elongate grains grown epitactically from the host rock and with abundant fluid inclusion trails parallel to the vein wall indicate vein formation by crack-seal increments during dissolution-precipitation creep of the host rock. The presence of sutured high-angle grain boundaries and subgrains shows that temperatures were sufficiently high for recovery and strain-induced grain boundary migration, i.e. 300-350°C, which is close to the peak metamorphic conditions for Central Crete. The time scale of stress-loading to cause cyclic cracking is on the order of hundred years, estimated from strain rates too high (on the order of 10-10 s^{-1} to $10{-}9$ s^{-1}) in relation to the Maxwell relaxation time of the metasediments undergoing dissolution-precipitation creep. The generally low amount of strain accumulated by dislocation creep in quartz of the host rock and most veins indicates low bulk stress conditions of a few tens of MPa. In contrast, some of these young veins discordant to the foliation, but also quartz veins concordant to the foliation and quartz-rich host rocks, can show locally heterogeneous quartz microstructures with micro-shear zones, sub-basal deformation lamellae and short-wavelength undulatory extinction. These microstructures indicate glide-controlled crystal-plastic deformation (low-temperature plasticity) and associated cracking at transient high stresses of a few hundred MPa. Subsequent recovery and strain-induced grain boundary migration at relaxing stresses indicate temperatures of 300-350°C. The transient, local high stresses are interpreted to be caused by high stress-loading rates controlled by seismic activity of the fault system in the overlying upper crust. The time scale for stress loading is controlled by the duration of the slip event along the fault, i.e. a few seconds to minutes. Both, the long-term and short-term deformation recorded by this ductile extensional shear zone are interpreted to represent an early stage during exhumation of the HP-LT metamorphic rocks in the Talea Ori.