Geophysical Research Abstracts
Vol. 20, EGU2018-9227, 2018
EGU General Assembly 2018

Crystal plastic deformation in carbonate fault rocks from a shallow crustal strike-slip fault, Northern Calcareous Alps (Austria)

Helene Bauer, Anna Rogowitz, Bernhard Grasemann, and Kurt Decker

University of Vienna, Center of Earth Sciences, Department of Geodynamics and Sedimentology, Vienna, Austria (helene.bauer@univie.ac.at)

Our study presents microstructural investigations including EBSD data of natural carbonate fault rocks that show clear indications of crystal plastic deformation, which is quite unexpected, as the fault rocks were formed in an upper crustal, low-temperature (<150°C) setting. Our data contribute to a suite of studies that proved the possibility of strongly localised, low temperature ductile deformation in carbonate rocks during the last years.

The investigated carbonate fault rocks are from an exhumed, sinistral strike-slip fault at the eastern segment of the Salzachtal-Ennstal-Mariazell-Puchberg (SEMP) fault system in the Northern Calcareous Alps (Austria). The SEMP fault system formed during eastward lateral extrusion of the Eastern Alps in the Oligocene to Miocene. Based on vitrinite reflectance data from fault related Teritary basins and geological models on lateral extrusion within the Northern Calcareous Alps, a maximum burial depth of 4 km for the investigated fault segment can be constrained, giving a burial temperature of less than 150°C. The investigated fault accommodated sinistral slip of several hundreds of meters and contains beside cataclastic also ductile deformed fault rocks.

Microstructural analysis of fault rocks includes scanning electron microscopy, optical microscopy and electron backscattered diffraction mapping. The data show that fault rocks underwent various stages of evolution including early intense veining (brittle fracturing), pressure solution assisted formation of stylolites and cleavage domains and the formation of localised ductile micro-shear zones. Cross cutting relationships reveal that veins never cross cut pressure solution microstructures such as clayey cleavage domains and stylolites. We conclude that pressure solution processes occurred after fracturing but before crystal plastic deformation, as micro-shear zones rework stylolites and cleavage domains. Clay enriched zones helped localizing further deformation, producing a network of small-scale clay-rich shear zones of up to 1 mm thickness anastomosing around carbonate microlithons, varying from several mm down to some μm in size. Clays decorating cleavage domains consist of chlorite and illite assemblages. Illite and chlorite crystallinity account for a diagenetic, zeolite facies temperature regime for the fault rock formation, which is in good accordance with the other data constraining the fault burial temperature clearly below 150°C. Crystal plastic deformation is proven by intense deformation twinning and undulose extinction patterns in coarse veins. In mirco-shear zones, we observe dislocation glide producing a strong CPO and creep dominated zones resulting in the formation of low-angle boundaries and recrystallization of small grains.

The investigated fault rocks give excellent examples of frictional, pressure solution and crystal plastic deformation processes operating in a shallow crustal carbonate fault in a low temperature regime (<150°C). We speculate that crystal plastic deformation typical for higher metamorphic shear zones in marbles, can be produced under much lower temperature conditions.