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Neogene transtensive faulting in the Rawil axial depression (SW Switzerland): preliminary results from field observations

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The Helvetic nappe stack in the Rawil depression between the Aar and Mont Blanc massifs is affected by dominantly dextral transtensional faults developed or reactivated during the Neogene. This area shows the evolution of a fault system from partially ductile to brittle conditions and is currently one of the most seimogenically active zones in Switzerland. This field study aims to establish which fault sets have been activated during the Neogene and possibly Quaternary to Recent, to better constrain their relative age and kinematics, and to study the transition from ductile to brittle behaviour.

The observed faults can be assigned to three general sets on the basis of their strike orientation. The first set (1) strikes NE-SW. Faults with distinctly different ages of initial activity are part of this set: Cretaceous normal faults with syn-sedimentary features; thrusts due to nappe-stacking; and later normal to oblique faults. All of these faults dip mainly to the SE. Paleo-tectonic features exposed in Plaine des Roses, les Audannes and Plaine Morte suggest that faults with this general orientation were already active during Cretaceous sedimentation. The post Aptian Cretaceous stratigraphic sequence is influenced by paleo-escarpments directly related to syn-sedimentary faults. These surfaces are marked in many places by karstification and silicification, sedimentary dykes and onlap of basinal younger formations. Some of these faults have been subsequently reactivated during Neogene syn- and post-collisional extension with normal to oblique kinematics. Transtensive reactivation of Cretaceous faults initially developed a ductile mylonitic fabric (expecially in limestones) that is overprinted by cataclasites and more discrete faults surfaces. Similarly oriented NE-striking veins were also developed under transitional brittle-ductile conditions in the limestones and, from relative age relationships, are the oldest veins developed in the area.

The transtensive fault sets striking (2) E-W and (3) NW-SE generally dip at a low to moderate angle to the S or SW. The two sets are broadly coeval, as indicated in the Rawil-Plaine Morte area by many examples of branching and bending of one set into the other and by similar displacement directions and deformation fabrics. Transtensional movements must largely post-date folding, because faults of sets (2) and (3) obliquely crosscut the fold system and the fold geometry can be matched to either side. Folding and the initial stage of normal to oblique faulting developed under very low grade metamorphic conditions, with exhumation during the Neogene related to extension that was parallel or slightly oblique to the main Alpine fold axis-trend. Also for these fault sets there is locally a transition from an initial more ductile mylonitic fabric to cataclasite. Calcite slickenlines and fibres on these Neogene fault planes indicate two main stretching directions. The older one is WSW-directed and generally plunges around 25°, whereas the younger one plunges S, with a steeper, mainly dip-slip movement. Crosscutting vein relationships and bending of vein tails planes indicate a counter-clockwise rotation of the stretching direction, from WSW toward S. The WSW–directed orogen-parallel stretching is similar in orientation to that associated with the Simplon-Rhône Fault and is probably coeval, implying possible activity throughout much of the Neogene. The orientation of the transtensive faults outcropping in the Rawil depression is consistent with fault plane solutions for earthquakes north of the Rhone Valley. Establishing the kinematics and mechanics of these faults developed at depth in this seismically active region can therefore help in understanding earthquake processes.