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The lock-up angle for brittle activation of a phyllosilicate-rich mylonitic fabric (Grandes Rousses Massif, France): implications for friction coefficients

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One of the possible mechanisms explaining the nucleation and propagation of weak faults showing a non-Andersonian attitude is the mechanical anisotropy of phyllosilicate-rich mylonitic rocks. Here we analyze the mutual orientation of foliation and stress field axes in the specific case of the Grandes Rousse Massif (France) and discuss the implications in terms of mechanical anisotropy.

The Grandes Rousses Massif is one of the external crystalline massifs in the Helvetic/Dauphinois Domain of the French Alps. In the Lac Blanc and Lac Bramant area the chlorite- and mica-schists of the Grandes Rousses massif are characterized by an Alpine brittle deformation developing on an Hercynian mylonitic SCC' fabric. The brittle reactivation of the mylonitic fabric is limited to some areas, whilst in other areas we observe the development of Andersonian conjugate shear fractures. This different behavior is related to the attitude, and particularly to the dip angle, of the mylonitic fabric.

To better understand the relationships between reactivation and dip of the mylonitic fabric, we have reconstructed the paleostress field with Win Tensor. The analysis yields a wrench tectonics regime, with $\sigma 2$ almost vertical, $\sigma 1$ horizontal WNW-ESE, and $\sigma 3$ horizontal NNE-SSW. In the northern part of the study area, where the average mylonitic foliation attitude is dip/direction = 75/104, we observe the presence of cataclastic seams developed along S, C and C' surfaces. Moving to the south, where the average foliation is 82/100, cataclastic reactivation of the mylonitic foliation is very limited or not developed at all, and we observed the presence of Andersonian conjugate fractures (consistent with the mentioned stress field) cutting the foliation.

Assuming an homogeneous paleostress field, we believe that the different brittle deformation mechanisms can be related to the different dip angle, which implies a different angle between the mylonitic foliation and $\sigma 1$: ca. 70° in the northern area versus ca. 80° in the southern area. We propose that the lock-up angle for reactivation of the Grandes Rousses schists mylonitic foliation lies between these two values, at about 75°. This angle marks the boundary between a field where the reactivation of preexisting anisotropies is still possible and a field where reactivation is not possible and Andersonian fractures develop.

These field observations can be seen as a very large-scale triaxial experiment, which allows to define the ratio of the internal friction coefficient for reactivation of the mylonitic foliation to the isotropic friction coefficient , hence the degree of mechanical anisotropy.