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Shear localisation at seismic slip rates: first results from high-velocity experiments on the gouge of the Usukidani fault, southwest Japan.

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Many exposures of or trenches across active faults show that the most recent co-seismic displacements took place in a narrow (1-10 cm thick) clayey gouge zone called central slip zone (CSZ), thought to exist down to depths of about 5 to 8 km. Hydratation of the CSZ varies with depth in relation with permeability properties, the geothermal gradient and the regional stress. The true frictional properties of the upper part of CSZ-bearing active faults will therefore depend on the clayey gouge moisture condition.

The properties of the clayey gouge were studied by the mean of high-velocity experiments carried out on the high-speed rotary-shear frictional testing apparatus of Kyoto University (Japan). The used gouges were prepared from a natural gouge exposed along the Usukidani fault, a potentially active fault of SW Japan, and are composed of a clay matrix (smectite and kaolinite) and of quartz and feldspar clasts (clast size ranging from 0.375 to 53 micrometers). The velocities were equal to 0.09 $m.s^{-1}$, 0.9 $m.s^{-1}$ and 1.3 $m.s^{-1}$. The applied normal stress was fixed at 0.6 MPa. Two types of gouges were used: dry gouges (room moisture conditions, 8 runs) or wet gouges (40 weight % water, 9 runs). Both types of gouges were precompacted for several hours before being sheared, in order to obtain the same homogeneous bulk gouge and to prevent a pore pressure build-up when testing for the wet gouges. A weight of 0.5 g of fault gouge was placed between two granite cores. The initial thickness of the reconstituted gouge ranged between 0.25 and 0.5 mm. In order to prevent gouge expulsion, the simulated fault was coated by a Teflon sleeve. Total achieved displacements are

comprised between 4 and 64 m (wet gouges) or between 4 and 43 m (dry gouges). The obtained results are as follows:

- Observation of thin sections shows that the deformation is localized along or near the gouge-granite interfaces and occurs in one or two discrete zones parallel to the interfaces. The deformed zones are characterized by a strong preferred orientation of the clay particles, which is also parallel to the interfaces. The total thickness of the deformed zones does not exceeds 50 % of the gouge final thickness, and is more important for wet gouges (25 to 50 %) than for dry gouges (10 %). The transition from undeformed zones to deformed zones is progressive for wet gouges but is sharp for dry gouges.
- For all runs except for the 0.09 m/s ones, the values of the coefficient of friction show an exponential decay (from peak values ranging from 0.55 to 1.08 down to steady-state values ranging from 0.14 to 0.38). The variations of the coefficient of friction are much more erratic for dry runs than for wet runs. For wet gouge runs, second-order variations of the coefficient of friction are tentatively explained by variations of water pore pressure.
- Preliminary XRD analyses do not show any significant mineralogical modifications at 1.3 $m.s^{-1}$ for wet conditions: the final gouges are still formed by smectites and no newly formed clay mineral could be detected.

SEM observations are underway in order to determine the nature of the strong preferred orientation of the clay and to better understand the mechanical differences between wet and dry gouges.