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Recent development of high-velocity gouge experiments and a renewed view on geological evidences of seismic fault motion

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High-velocity shearing experiments on fault gouge (started by Mizoguchi) simulating seismic fault motion in the last several years has been providing a new ways of searching for geological evidences of seismic fault motion in natural fault zones, by comparing textural and material changes between experimental shear zones and natural fault zones. This presentation will visually review the development and proposes the significance of reproducing fault-zone structures using the fault zone materials for each individual case in finding new geological evidences, other than pseudotachylite. References are many and will be given during the presentation. Finding geological evidences is not easy because fault motion over a wide range of slip rate produces similar sheared structures. D. S. Cowan (1999) concluded that seismic fault motion is of such a short duration that it can not leave clear geological record other than pseudotachylite.

Melting fault gouge is not easy in high-velocity gouge experiments, but measured and calculated temperature indicates that the temperature rise in gouge can be as high as several hundred degrees Celsius and can cause changes in gouge some of which can be left as geological records. During the Nojima fault-zone probe project after the 1995 Kobe earthquake, ESR signal was reduced substantially, but not down to zero, in a narrow slipping zone of about 5 mm in width along a margin of fault gouge of about 100 mm in total width (work by Fukuchi and others). The core was recovered from about 400 m in depth. This change in ESR signal reproduced by high-velocity experiments and heating experiments, indicating temperature rise of about 300 to 400 degrees Celsius. Inferred shear stress from this temperature rise agrees with measured gouge friction in high-velocity experiments. Likewise fission track changes in and close to fault zones have been known for a long time and substantial changes has been recognized in Nojima fault too (work by Tagami et al.). Another big advancement is the finding that thermal decomposition can occur during short seismic slip (carbonate decomposition found by Han and others, 2007). Siderite decomposition form magnetite and changes gouge color to very black and the black gouge in cores of Chelungpu fault zone that caused the 1999 Taiwan Chi-Chi earthquakes can be a natural example of this. Brantut, Hirose and others showed that kaolinite and serpentine gouges undergo similar decomposition. Decomposition of those minerals may not leave long-term geological records, but one might get new insight from natural fault zones by reproducing changes in fault zones during seismic fault motion and inter-seismic period.