Abstract.

USGS Award No. 99 HQ-GR-0046
TITLE: COMPACTION, SHEAR AND SEALING OF FAULT GOUGE UNDER HYDROTHERMAL CONDITIONS

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TECHNICAL ABSTRACT

In the laboratory slide-hold-slide experiments using a simulated quartz gouge layer at hydrothermal conditions (200°C), we have identified a new mechanism for time-dependent healing of frictional strength. We infer that pressure solution creep is the underlying mechanism of this healing based on the following two reasons. First, this mechanism is turned on by the existence of hot pore water. Second, an experiment using an albite gouge, whose pressure solution under high pressure is known to be much weaker than quartz, has shown much smaller this type of healing. Third, healing was observed clearly with the fluid already satureted, denying the possibility that the healing is due to the non-stress aidied normal dissolution process.

The phenomenology of this healing differs clearly from the traditional room temperature healing mechanism in several important points. First, critical slip displacement associated with this healing is much longer than that associated with the traditional room temperature healing. Second, it has a logarithmic time dependence as the traditional healing, but has a much longer cutoff time.

From the analysis of temperature (100-200°C) and time (1-71 hrs) dependence of healing, we obtained the activation energy for this healing is 43-65 kJ/mol. But this value may be changed if we consider the potential effects of the applied shear stress on the healing rate.

At 100 and 150°C, the critical slip-displacement remains very long (600-1600 μm) over a wide range of conditions in terms of cumulative displacement and the time of sliding from the start of the experiement, but decreased with these factors at 200°C. But the strength revcovery was insensitive to these peripheral factors.

Creep mesurements during hold has shown that the creep velocity decreases as the interface strengthens with healing. This suggests that the general framework of rate- and state-friction law is applicable for the new mechanism of healing. Also exploratory velocity stepping tests has shown evolution effect as expected from the concept of effective contact time of slipping surfaces.

NON-TECHNICAL ABSTRACT

We have carried out friction experiments where earthquake cycles are simulated under hydrothermal conditions realistic to seismogenic faults. A new type of strength recovery has been found. This strength recovery mechanism works only with the existence of pore fluid and differs from the previously-known mechanism in many aspects, particularly in the time dependence and the way the recovered fault is broekn by fault slip (earthquake). The magnitude of the strengthening can exceed that of previously known strengthening mechanism. Also, energy necessary to break the faults healid with this mechanism is expected to be much larger than expected from the traditional room temperature healing mechanism, and hence the new healing mechanism can be more relevant to the overall behavior of larger earthquakes.