S142-020 **Room: IC** **Time: May 30 15:45-16:00**

Evolution of asperity contacts during flash melting and velocity weakening law

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Friction mechanism changes from non-thermal mechanical friction, through flash melting to partial and full melting during seismic slips. Friction increases temporarily at the partial melting stage, but others are slip-weakening and/or velocity weakening processes. Here I focus on flash melting during stick-slip experiments.

If we understand the points of flash melting theory by Ettles (1986), friction coefficient y at the distance X from the tip of an asperity is written as

$y=(T/2P)(3.14*KRC/VX)^{1/2}$ ——(1),

where T: the difference between meting and ambient temperatures, P: indentation hardness, K: thermal conductivity, R: specific density, C: specific heat, and V: slip velocity. Since almost of frictional heat flows away to an infinite half body, and the melted materials are removed promptly away from true contacts, then non-contact areas are kept cool.

Equation (1) represents y at X on one asperity. Therefore, macroscopic friction coefficient is not known until the number density and shape of asperities are known. Especially, the rolls of the grains of fault gouge are very important.

Now I conducted stick-slip experiments at Pc of 150-180 MPa for granite and gabbro samples with the mirror-finished precut surfaces. Observing the parts of the slip surfaces which are free from overwriting by successive slips, the evolution of surface structures were analyzed. The characteristics are as follows.

1) Wavy ductile structures just like Schallamach wave (Schallamach, 1971) were formed sometimes around the tip of carrot-shaped scratch grooves.

2) The materials (gouge) scratched from grooves are of ductile paper-like feature, and they are arranged with equi-distances. These materials adhere on the grooves, and could not be removed by water washing.

3) The grooves were developed well especially in the interval of several micron meters from the tip, and the microfractures at a right angle to the grooves were formed inside.

4) When slips reached to about 0.1 mm, flash melting started. One or both sides of gouge layers were melted forming very thin melt layers. The grains of gouge are of ca. 500 nm diameter with rounded shapes, and adhere each other.

5) Melting degree increases as slips, associated with grooving as before, suggesting gouge grains acted as asperities.

6) The SEM observations indicate that the scratched grooves on one slip surface are in mirror relations with those on the opposite surface, suggesting that gouge grains act as asperities to scratch both surfaces. The length of grooves is nearly equal to the slip distance, and the width of grooves increases proportionally to the slip distance.

Based on the observation and modifying eq.(1), a macroscopic friction law can be formulated. Since the width of a groove is bilaterally-symmetric at the point of the half of slip distance U/2, the mean friction coefficient y' averaged over the groove is represented as

$y'=2^{1/2}T/P*(3.14KRC/VU)^{1/2}$. ——(2)

Since the width W of asperities is proportional to U, the area A of an asperity is $A=(Cw/4)U^2$. Since the number density N of asperities is kept constant during slips, the area density S is

$S=SN=CwNU^2/4$ ——(3).

Since normal stress F is supported by the contact stress (=P) acting on S, then eq.(3) is rewritten as

$U=2(F/CwNP)^{1/2}$. ——(4)

Substituting this into eq.(2), the macroscopic friction coefficient Y is written as

$Y=(T/P^{3/4})*(3.14KRC/V)^{1/2}*(CwN/F)^{1/4}$. ——(5)

This equation depicts strong velocity weakening and weak normal stress weakening. As ambient temperature increases, T decreases, but Y becomes large dramatically, because P decreases abruptly when the ambient temperature increases beyond the critical temperature. This is the reason why Y increases dramatically at the stage of partial melting.