Chocolate Earthquake =The physics of friction law=

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Earthquakes have long been recognized as resulting from a stick-slip frictional instability (e.g., Scholz, 1998, Nature). Although phenomenological constitutive friction law such as rate- and state- dependent friction law have been used in numerical simulation, the physical meaning is unclear. As a result, many people, not only common men but also seismologists hardly answer the question what kind of materials is in the seismogenic zone. We propose a simple experiment to answer it.

A simple spring-slider model experiments have demonstrated with chocolate chips on the aluminum foil. Chocolate chips are once melted by hot plate and cooled off to weld with the foil. The acrylic rectangular slider (10cm x 10cm x 1cm height) on the chocolate chips is connected a spring and the free end of the spring is moving with the constant velocity (about 1.6cm/s). We change the surface temperature of chocolate chips with hair dryer.

In the experiments, stick-slip occurs at two cases. The first case is interlocking between edge of the acrylic slider and chocolate chips at low temperature (room temperature, 15C). We repeat the same experiments with the same chocolate specimen and find that frictional behavior changes from stick-slip to episodic stable sliding because the edge of the block wears the tip of chocolate chips. The abrasive wear process can be described by slip dependent friction law proposed by Matsu'ura et al. (1992, Techtonophysics)

The second case is moderate temperature (about 26C). We use the same specimen used at low temperature. In this case, chocolate chips adhere to the bottom of the acrylic slider. However, chocolate chip flows and stable sliding is observed at high temperature (40-60C). According to adhesion theory (Bowden and Tabor, 1964), frictional force equals the real contact area times the shear strength per unit area. At low temperature, real contact area is too small and hardly increases during stick because chocolate is too hard. On the other hand, shear strength per unit area is too small at high temperature because chocolate is too soft. When stick slip occurs, frictional force must rapidly increase during sticking. Therefore, moderate temperature is necessary to stick-slip because materials are semisoft. The result suggests that transition between brittle (abrasive wear) region to ductile (plastic flow) region is important for coseismic slip because of semisoft of fault material.