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Frictional exsolution of CO_2 : a new slip-weakening mechanism

V. Famin(1), S. Nakashima(2), A.-M. Boullier(3), and K. Fujimoto(4)

(1) Institut de Physique du Globe, Université de la Réunion, France (vfamin@univ-reunion.fr), (2) Osaka University, Japan, (3) CNRS-Université Joseph Fourier, France (4) Geological Survey of Japan, AIST, Japan

An enigmatic feature is the carbon dioxide discharge monitored at the surface of major faults in periods of seismic activity. CO_2 has drawn a large attention because it may cause fluid overpressure in faults, reduce their resistance to slip and trigger or enhance earthquakes. Determining the magnitude of fault friction reduction is particularly important to estimate the tectonic stress released by seismic rupture or left for future damage. It is therefore essential to understand how, where and when the CO_2 is provided to fault zones, yet neither the origin of CO_2 emissions nor their link with earthquakes is well known to date. Here we show that pseudotachylytes (i.e. co-seismic friction-induced fusions of the fault walls) may be the missing link. Infrared mapping in pseudotachylytes from the Nojima fault (Japan) reveals that ancient earthquakes expelled 99 wt% of the fault rock CO_2 content, because of carbon supersaturation in the melts. This extraordinary exsolution implies that shakes such as the 1995 Kobe earthquake produce 1.8 to 3.4 10^3 tons CO_2 in a few seconds. Frictional exsolution is a new possible slip-weakening mechanism that also explains the surface emissions of CO_2. We anticipate CO_2 outflow in near-fault springs and soils to be proportional to the volume of rock molten by an earthquake, and hence to provide a new tool to constrain the magnitude of co-seismic fault friction.