# Thermal decomposition in Carrara marble due to frictional heating: its implications on coseismic fault zone processes

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One of the 'hot'issues about coseismic fault zone processes is whether frictional melting is common in natural seismic fault zones. The question arises from the apparent scarcity of pseudotachlyte (PT) in natural fault zones and reflects our limited understanding of coseismic physico-chemical processes in fault zones. Here, we report results of high speed friction tests on Carrara marble, which clearly show that dramatic slip weakening is induced by thermal decomposition rather than frictional melting.

Our main results can be summarized as follows: (1) Slip weakening occurs in all experiments except for the runs at the lowest slip rate (V) of 0.09 m/s and the steady-state friction coefficient decreases systematically as V and normal load increase; (2) At the highest V (1.1-1.2 m/s) and normal stress of 7.3 MPa, the average steady-state friction coefficient is about 0.04; (3) Strength recovery occurs very rapidly and completely at the second sliding after the cessation of the first sliding; (4) XRD, EPMA and TEM observations confirm that thermal decomposition of calcite occurred for the runs with V over 0.09 m/s and that the decomposition products are nanoparticles of lime and/or hydrated lime; (5) CO2 gas measurements during the runs indicate the simultaneous onset of the CO2 emission (thus decomposition) and the weakening.

We suspect that the dramatic slip weakening is caused by lubrication by nanoparticles of the decomposition product together with the pressurization of CO2 gas released from the decomposition at high temperature and V, although the exact deformation mechanism of the nanoparticles is not clear at present. The decomposition weakening may be widespread in fault zones consisting of carbonate and hydrous silicate minerals since decarbonation and dehydration reactions are common at elevated temperature.