Petrology and seismicity- partial melting during seismic events

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Petrology has access to paleo-fault systems, which allows reconstructing co-seismic processes during faulting. Faults may form under ductile or brittle regime depending on pressure, temperature and strain rate resulting in cataclastic, mylonitic or frictionally molten rocks. Typical rocks that formed by frictional melting during co-seismic faulting are called pseudotachylytes (Pst). They are formed at extreme shear velocities ($>$10cm/sec). Pseudotachylytes are most important evidences of paleo-seismicity in exhumed rocks. They consist mostly of fine-grained rocks formed by frictional melting.

The chemical composition of the melt differs in most cases significantly from the host rock. However, since melting is non-eutectic, the melt composition usually differs from the precursor in a way not expected by equilibrium thermodynamics. Still, temperature estimates can be well bracketed based on the composition of relict or newly formed minerals.

The prograde sequence of non-equilibrium frictional melting of rock-forming minerals leads to a melt continuously changing in composition and viscosity and volume. These parameters influence the fault zone behavior during the seismic event. Independent of preceding brittle or ductile deformation melting starts with brittle or ductile grain-size reduction enhancing melting processes. Frictional melting starts with the breakdown of (OH)-bearing minerals inducing continuous melting and therefore melt volume increase. Nearly independent of pressure, ongoing melting leads to an increase in H_2O (breakdown of micas) and alkalis (breakdown of alkali-feldspars), CaO, FeO, M_gO (breakdown of anorthite, garnet, pyroxene, garnet) and Al_2O_3 (alumo-silicates) and decreasing SiO_2. Most natural examples show fragments of quartz, without any evidence of melting, indicating a maximum temperature of the process zone lower than ca. 1770°, although higher temperatures at grain boundary (nano-) scale should occur.

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