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Hydrogen isotopes in pseudotachylyte-bearing faults of the Adamello batholith, Italy: the origin of fluids at seismogenic depth

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Occurrence of pore fluids within seismic fault zones is critical in controlling effective stresses and earthquake mechanics (e.g., Lachenbruch, 1980; Bizzarri and Cocco, 2006). Hydrogen isotopic compositions of pseudotachylytes (solidified frictional melts produced during seismic slip) and host rock from two seismogenic faults cutting the tonalitic Adamello batholith (Italian Southern Alps) have been used in evaluating weather seismic faulting occurred in presence of meteoric water, or in a closed system. Brittle faults were active during cooling of the Adamello, at 250-300˚C and 9-11 km depth. Host tonalite is composed by plagioclase, quartz, biotite, K-feldspar. Fault rocks are green cataclasites (a cohesive fault rock cemented by precipitation of epidote, chlorite and K-feldspar) and pseudotachylytes. From crosscutting relations, microstructural investigations and geochemical compositions (enrichment in Fe_2O_3, LOI, and LILE in both cataclasites and pseudotachylytes, Di Toro and Pennacchioni, 2005; Pennacchioni *et al.*, 2006), it has been assessed that frictional melting involved both intact host rock and cataclasites. Pseudotachylytes do not contain glass (Di Toro and Pennacchioni, 2004) and consist of plagioclase, biotite and minor K-feldspar. These minerals occur either as microlites or as cryptocrystalline aggregates. The hydrogen isotope composition of bulk pseudotachylytes is assumed to reflect that of the sub-micrometric biotite, the latter being the only hydrated phase in the rock. The δD values of bulk pseudotachylyte were compared with those of the biotite from unaltered tonalite in order to trace the origin of water involved into frictional melting. One bulk pseudotachylyte has δD essentially identical (lower by 3‰) to the biotite of the wall

rock, whereas the other 24 samples have δD lower by $\sim$10 - 30‰. These data suggest that there is no significant isotopic difference between pseudotachylytes cutting unaltered host rock and pseudotachylytes associated with cataclasites. The slight variation in isotopic composition between most pseudotachylyte and host tonalite suggests that no significant amount of meteoric water was present during seismic faulting and frictional melting in the Adamello faults. In fact, this difference in isotopic composition can be the result of hydrogen mobility, still significant in fine grained materials at 250-300˚C. We conclude that seismic faulting and production of pseudotachylytes occurred in a closed system where fluids were of late-magmatic origin.

References

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