ultramafic pseudotachylyte - a transition from plastic flaw to seismogenic frictional melting in the mantle

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An occurrence of ultramafic pseudotachylyte from the Ivrea zone, northern Italy, is reviewed (Obata and Karato, 1995; Jin, Karato and Obata, 1998). Although ultramafic pseudotachylyte is rare, it is an important sample because it may provide with important constraints for understanding seismogenic processes in the upper mantle. The pseudotachylyte occurs in a mantle-derived spinel lherzolite mass(5km x 800 m) that occurs in high-grade metamorphic rocks. Both fault-vein type and injection-vein type of pseudotachylytes are observed. The fault-vein type occurs in a narrow shear zone (~10-20 cm wide), where dynamic recrystallization and mylonitization took place toward the pseudotachylyte layer, which indicate that plastic flow and shear localization had predated the frictional melting. The fault is strike-slip right lateral and the displacement has been measured ~3m, guided by a marker of a primary pyroxenite band. The pseudotachylye has been produced by frictional melting of the host spinel lherzolite followed by rapid cooling. The differential stress has been estimated to be ~300MPa by means of a dislocation density and grain-size piezometer of olivine. Total mechanical energy, that is estimated from the stress and the fault displacement, is compatible with the thermal energy needed to melt a cm thick layer of peridotite completely. From kinetic argument of chemical and thermal diffusion, time scale of the melting and cooling has been estimeted to be order of 100 second.