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Ultramafic pseudo-tachylites in the Moncuni peridotite (Lanzo Massif, Western Alps): records of earthquakes in the lithosphere of the Jurassic Ligurian Tethys.

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Ongoing field, petrographic and geochemical investigations on the small (a few km^2) peridotite mass at Mt. Moncuni, a satellite of the South Lanzo body in the southern side of the Susa Valley, evidence peculiar structural and magmatic features which allow to unravel some steps in the oceanic evolution of this sector of the Jurassic Ligurian Tethys.

The ultramafic body consists of plagioclase(plg) peridotites, metre-scale masses of spinel(sp) dunites and harzburgites, and widespread gabbroic dykes. Metre- to decametre-scale shear zones cut the plg peridotites and deform the pre-existing gabbroic dykes, whilst mafic-ultramafic, coarse-grained porphyritic dykes cut across both deformed plg peridotites and shear zones. Within the shear zones cm- to dm-wide, dm- to m-long, veins of extremely fine-grained pseudo-tachylites are present, both concordant and discordant to the tectonite-mylonite foliation of the shear zones.

Host plg peridotites show structural and compositional features closely similar to the impregnated plg peridotites of the South Lanzo massif (Piccardo et al., 2006): they have high plg contents (up to 12-15 mole %) and microstructural features suggesting melt percolation and melt impregnation. They are intruded by coarse-granular gabbroic dikes. Peridotites and dikes are strongly deformed in the shear zones; neoblastic mineral assemblage (i.e. ol+plg+px) in the very fine grained peridotite tectonite-mylonite bands of the shear zones indicates that they formed under plg-facies conditions. In places within the shear bands, new Mg-hornblende to tremolite amphibole developed, the former stable with plg and pyroxenes (i.e. amph-bearing plg-peridotite facies assemblage), the latter replacing pyroxenes and ol (i.e. amphibolite facies assemblage). Structural-petrographic data indicate that these shear zones constituted preferential ways for fluid migration during exhumation of the peridotite body to progressively more shallow and cold levels. The plg-peridotite facies of the host plg peridotites record T of about 1150˚C, most probably related to the melt impregnations event, similarly to South Lanzo plg peridotites (Piccardo et al., 2006). The amphibolite-facies assemblage of the hydrated shear zones, away from the contact with the pseudo-tachylite veins, record T of about 900˚C, suggesting that this mantle sectoin reached shallower and colder levels during extension-driven exhumation, prior to pseudo-tachylite formation.

The concordant (*fault-vein type*) and discordant (*injection-vein type*) pseudo-tachylite veins show sharp contacts with the host rock. They are composed of an ultra-fine grained to glassy matrix with minor amounts of clastic olivine grains or aggregates and lithic mylonitic clasts. The matrix of the larger veins is crystallized and show spinifex-like structures, composed by radial aggregates of opx elongated crystals, with cpx rims, surrounded by a microgranular aggregate of rounded ol crystals.

Pseudo-tachylite bulk rock composition is peridotitic: SiO_2 = 42.9-44.3 wt%, Al_2O_3= 2.4-3.8 wt%, CaO = 2.3-3.1 wt%) and MgO = 39.4-41.9 wt%. Bulk rock C1-normalized REE patterns are almost flat in the MREE-HREE region ($<$ 2xC1) and variably LREE-fractionated (Ce_N/Sm_N 0.22-0.50).

In places, the component minerals have peculiar major element compositions both in the pseudo-tachylite veins [i.e. ol (CaO up to 0.39 wt%, Cr_2O_3 up to 0.4 wt%), cpx (Al_2O_3 up to 14.5 wt%) and opx (CaO up to 2.03 wt%)] and in the host peridotite close to the contact with the vein [opx (CaO up to 3.3 wt%)]. These compositional features suggest very high temperature of formation. In fact, geothermometric estimates indicate that very high temperature conditions assisted pseudotachylite crystallization (T $>$ 1250˚C), and were reached in the host peridotite at the contact with the vein (T up to 1430˚C).

Structural and compositional features suggest that pseudo-tachylites originated by localized, nearly complete melting of the host peridotite. Formation of ultramafic pseudo-tachylites implies the presence of strongly localized, very high shear heating due presumably to very high shear stresses on the fault plane of the shear zones. The formation of spinifex textures indicates very rapid crystallization of the ultramafic melt. These conditions are fully consistent with an earthquake. Thus, faulting close to the brittle-ductile transition in the hydrous peridotite system provides a mechanism for relatively shallow earthquakes in the upper mantle.

Ultramafic-mafic porphyritic dykes cut shear zones and pseudo-tackilite veins and postdate their formation. They consist of abundant fenocrysts of cpx, and subordinated plg and ol, in a coarse granular matrix composed by cpx+plg. Preliminary major and trace element investigations indicate the MORB affinity of the parental melt. Oceanic serpentinization and chloritization clearly developed later than pseudo-tachylite formation and porphyritic MORB dike intrusion.

Field and petrographic-structural knowledge, and literature data, allow to localize in space and time this seismic event. Shear zones and related pseudo-tachylites are younger than gabbroic dike intrusion, that has been dated at 160 Ma in the Lanzo massif (Kaczmarek et al., 2005). Pseudo-tachylite formation is younger than deformation of gabbroic dikes and amphibolite facies recrystallization within the shear zones but older than intrusion of porphyritic MORB dykes and serpentinization of the host peridotite, which must have occurred prior to exposure of the Moncuni peridotite to the sea-floor of the Late Jurassic Ligurian Tethys.

Thus, pseudo-tachylites are the record of Jurassic earthquakes related to faulting in the shallow mantle, during its exhumation from sub-continental lithospheric levels to the sea-floor of the Late Jurassic Ligurian Tethys.

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