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Petrographical Characteristics of Mylonitic Pseudotachylyte in Peridotitic Fault Zones

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Major earthquakes nucleate approaching the brittle-ductile transition zone (BDT) of rocks. Geological study of natural seismogenic faults is important for understanding earthquake-related processes.

Pseudotachylyte(PsT) is a fault rock produced during earthquakes, formed via frictional melting of the fault. Presence of glasses or dendritic microlites is the microstructural evidence for PsT identification. However, under high ambient temperature conditions typical of BDT, such textures are susceptible to recrystallization. Hence, there can be a bias that much seismic record of BDT has been overlooked. Also, there are several reports of PsTs intimately associated with ultramylonites, which implies some ultramylonites may have formed via frictional melting. Using a working category "mylonitic pseudotachylyte (M-PsT)" for such ultramylonite-like fault rocks which imply a seismic melting origin, we are studying PsTs and mylonites cropping out in the Balmuccia peridotite body in northwestern Italy. In this presentation, "mylonite" means ordinary mylonite formed only by solid state deformation.

There are networks of PsT and M-PsT and cataclasite faults and shear zones of mylonite in the study area. Cataclasites associated with M-PsT usually show partial recrystallization. The observable displacement of single jerk PsT faults ranges through 10cm ~ several tens of centimeter. There is a tendency such that the more melt-origin texture is obliterated by recrystallization, the less the fault has injection veins. However, there are some faults that contain both PsT and M-PsT textures gradually changing from one to the other.

M-PsT consists of porphyroclasts and ultrafine matrix. M-PsT faults often sharply cut coarse crystals of the wall, or have gradual boundaries with wall mylonite. The grain size of the matrix is submicron ~ a few microns, and constituent minerals are olivine, spinel, orthopyroxene, clinopyroxene, hornblende, dolomite, small amount of sulfide, and/or plagioclase. The grain boundaries of matrix minerals often form triple junctions. The formation depth of M-PsT is estimated from the mineral paragenesis to be about 20-40km. Matrix olivines have lattice preferred orientation (LPO). The M-PsT matrix has a collective optical anisotropy observed under polarization microscope, whose optical axes are consistent with the olivine LPO. Some porphyroclasts show texture of recrystallized cataclasite. The mineral clasts are olivines and spinels, and relatively rare pyroxenes.

M-PsTs are distinguishable from cataclasite or mylonite. Compared to cataclasite matrix, M-PsT matrix looks uniform in the grain size and is high in modal per cent. Cataclasite is clast?rich and the grain size ranges widely. Mylonite matrix has typically larger grain size (~a few tens of microns) and is typically colorless, whereas M-PsT matrix is pale brownish under optical microscope (probably due to minute sulfide particles in the matrix.)

Mylonitic PsT sometimes contain characteristic "spinel coronas" where deformation and recrystallization is not intense. The texture is such that aluminous spinel clast is surrounded by a corona that consists of fine-grained chromian spinel and interstitial Al-, Ca-rich phases. This corona is thicker far from the wall of the vein. Similar texture occurs in natural glass-bearing PsT in the same massif and in PsT produced by high velocity rotational shear experiment of the Balmuccia peridotite.

Another textural feature is that crack-like orthopyroxene or olivine exists inside coarse olivine or clinopyroxene, respectively. This texture is found only inside or vicinity of the M-PsT vein. The crack-like morphology and the spatial intimacy of the texture to fault implies that the texture is characteristic of seismic deformation.

These observational features of ultramylonite-like fault rock will be interpreted in relation to seismic processes. These kinds of studies can contribute to our understanding of deep seismicity.

Keywords: pseudotachylyte, ultramylonite, brittle-ductile transition, peridotite, microtexture, mylonitic pseudotachylyte