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Microstructures of fault-vein type pseudotachylyte of Balmuccia peridotite ; cyclic rupture, melting, and plastic deformation

Tadamasa Ueda[1]; Masaaki Obata[1]; Kyuichi Kanagawa[2]; Kazuhito Ozawa[3]; Takehiro Hirose[4]

[1] Earth and Planetary Sci., Kyoto Univ; [2] Dept. Earth Sci., Chiba Univ.; [3] Univ. Tokyo, EPS; [4] Dept. Geol. & Mineral., Kyoto Univ.

Fault-vein type ultramafic pseudotachylyte is a very important sample for exploring the seismo-mechanics in the lithosphere. Both fault-vein type and injection-vein type pseudotachylytes are reported from the Balmuccia peridotite massif in the Ivrea-Verbano zone, northern Italy (Obata and Karato, 1995; Jin et al., 1998). Obata and Karato(1995) assumed that the fault-vein type pseudotachylyte was formed by one shot of seismic rupture followed by a slip. More careful observations, however, revealed that there are several textural categories in these fault-vein type, suggesting that there were several stages and events of the formation of the pseudotachylyte. Some sample shows very complex microstructure that suggests multiple slip events in which semi-brittle deformation follows plastic deformation. Some veins have neither glass nor other textures suggestive of melt origin, in which case it may be difficult to distinguish them from subsolidus ultramylonites.

The fault-vein type pseudotachylyte dealt with in this study have ultramylonitic texture and does not contain glass and, therefore, it has been problematical whether this sample has been really formed through melting or only through solid-state deformation. Because of the extremely-fine grain size of the matrix, accurate petrography has been difficult. By applying FE-SEM and EBSD technique to these samples, we obtained the following observational results.

1)Constituent phases of the fine-grained matrix are olivine, clinopyroxene, orthopyroxene, spinel, dolomite, and locally, plagioclase; while glass is not present. The texture is nearly that of equilibrium. The matrix is homogeneous in small scale; and there is no compositional banding in which particular mineral dominates as typically observed in subsolidus mylonites.

2)There are cross cutting relationship of pseudotachylyte veins, suggesting multiple events of pseudotachylyte formation.

3)Fault veins typically show asymmetric structure in such a way that a younger vein tends to develop not in the center of a pre-existing old fault vein but at the edge of the former vein and that the wall rocks record, on both sides of the fault vein, contrasting degrees of grain-size reduction via dynamic recrystallization.

The physical condition of the recrystallization is inferred to be 400~600, ~3kbar, assuming the equilibrium of dolomite and plagioclase in the presence of olivine and orthopyroxene. Such P-T conditions, however, may not be compatible with the plastic deformation of peridotitic rocks.

References;

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