Geophysical Research Abstracts
Vol. 12, EGU2010-10691, 2010
EGU General Assembly 2010
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Microfabrics in peridotites from the Baldissero, Balmuccia and Finero complexes in the Western Alps: High stress deformation and subsequent recrystallization at decaying stress

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The microfabrics of deformed peridotites from the Baldissero, Balmuccia and Finero complexes in the Western European Alps are investigated by optical and electron microscopic techniques (SEM/EBSD, TEM). The peridotites are mostly lherzolitic with 65-98% olivine, 5-30% orthopyroxene, 1-15% clinopyroxene and 1-2% spinel. Some samples from Balmuccia consist of olivine-websterites with 10-35% olivine, 15-50% orthopyroxene, 35-75% clinopyroxene and 1-2% spinel. Finero peridotites can contain minor amounts of hornblende and phlogopite. Samples from the Baldissero peridotite reveal evidence of significant brittle deformation by the common occurrence of transgranular shear zones. On the grain scale, olivine and pyroxene contain many microcracks and micro-shear zones. Olivine porphyroclasts show an intense undulatory extinction. Fine-grained recrystallized grains with a diameter of 10 μm to 15 μm are arranged along microcracks and micro-shear zones. Pyroxene porphyroclasts are twinned. Localized shear zones are also common in peridotites from Balmuccia. However, olivine and pyroxene show less intense brittle deformation. Recrystallized olivine grains with a diameter in the range of 20 μm to 50 μm occur mainly along grain boundaries of porphyroclasts but also along intragranular micro-shear zones. Olivine porphyroclasts show pronounced deformation lamellae, deformation bands and kink bands. Deformation lamellae and bands often developed parallel to (100). Deformation and kink bands in pyroxene porphyroclasts are parallel to (001). Some pyroxenes are mechanically twinned. Pyroxene recrystallized aggregates have a very fine grain size with a diameter varying between 2 μm to 25 μm. Samples from Finero show large elongate porphyroclasts with a long axis of up to 6 mm. Recrystallized grains have a diameter of up to 250 μm. Porphyroclasts as well as some of the recrystallized olivine grains show deformation bands and kink bands. Brittle deformation is restricted to localized shear zones.

The investigated samples from the Baldissero, Balmuccia and Finero peridotite complexes show evidence of non-steady state deformation with initial semi-brittle deformation at high stress followed by crystal-plastic deformation and recrystallization. Such a stress history is characteristic of non-steady state deformation related to the seismic cycle and is consistent with the known occurrence of pseudotachylytes at Balmuccia. High stress deformation and annealing experiments, designed to simulate earthquake-driven deformation at the base of the seismogenic zone, yield very similar microfabrics. The more intense brittle deformation in peridotites from Baldissero and the least intense brittle deformation in peridotites from Finero may reflect deformation at decreasing temperatures from Baldissero, over Balmuccia to Finero peridotites.