Ambient Temperature of the Ductile-to-brittle Transition recorded in the Balmuccia Peridotite Body, Italy

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The condition of the brittle-ductile transition (BDT) of mantle rocks can be critical in geodynamic modelling. There is a little of difference in temperature estimates of the of BDT using geophysical disciplines (e.g., ~600 ˚C, McKenzie et al., 2005; 700-800 ˚C, Grose & Afonso, 2013), and there have been few good geological examples of the transition. Fault rocks in the Balmuccia peridotite body, Italy, can be classified into groups according to mineral assemblages, and these groups corresponds to generational stages during the exhumation of the peridotite body judging from crosscutting relationships (Ueda et al., 2020). In the highest-grade group, of the spinel-lherzolite facies, a transition from mylonitization to pseudotachylyte formation is recorded. The pseudotachylyte is associated with cataclasite. The cataclasite suffers a metamorphic reaction changing mineral compositions probably at the timing of its formation and usually shows textures not typical of cataclasite. However, thanks to their structural relationships to pseudotachylyte veins, the cataclasite was identified (c. f., BDT studies with abyssal peridotite like Jaroslow et al., 1996). The mylonitization is also associated with a metamorphic reaction. Then, the ambient temperatures of these deformed rocks could be estimated with geothermometers. Large grains in peridotite yielded, with a pyroxene geothermometer, initial equilibrium temperature of ~950 ˚C. An olivine-spinel Fe-Mg exchange geothermometer yielded a temperature condition clearly postdating the ductile-to-brittle transition, ~580 ˚C, judging from consistent temperature estimates among large grains and recrystallized/fine grains. Excluding this latter temperature, pyroxene geothermometers indicate ~720 ˚C both for recrystallized grains of the mylonite and fine grains of the cataclasite, which is likely the temperature of the transition. The pressure range of the transition is ~0.6-1.6 GPa according to the mineral assemblage, but its low-pressure side is more consistent with the regional geology. Then, the P-T condition for the ductile-to-brittle transition is roughly on the geotherm of a 10 Ma oceanic crust.

References

Grose, C. J. & Afonso, J. C. (2013). Geochemistry Geophysics Geosystems, 14(9), 3751–3778.
Jaroslow, G. E., Hirth, G., & Dick, H. J. B. (1996). Tectonophysics, 256, 17-37.
McKenzie, D., Jackson, J., & Priestley, K. (2005). Earth and Planetary Science Letters, 233, 337–349.
Ueda, T., Obata, M., Ozawa, K., & Shimizu, I. (2020). The Ductile-to-Brittle Transition Recorded in the Balmuccia Peridotite Body, Italy: Ambient Temperature for the Onset of Seismic Rupture in Mantle Rocks. Journal of Geophysical Research: Solid Earth, (in press).

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