

Interactive comment on “Constraints on the rheology of lower crust in a strike-slip plate boundary: Evidence from the San Quintin xenoliths, Baja California, Mexico” by Thomas van der Werf et al.

L. Menegon (Referee)

luca.menegon@plymouth.ac.uk

Received and published: 11 June 2017

Dear Authors, dear Editor, This manuscript presents a detailed study of granulite and lherzolite xenoliths from the San Quintin volcanic field, northern Baja California. The study combines microstructural observations, EBSD analysis, geothermometry and phase equilibria modelling to derive quantitative constraints on the rheology of a strike-slip plate boundary. Rheological parameters of the lower crust and upper mantle are derived from the extrapolations of experimental flow laws to the natural conditions of deformation. Discussion and conclusions are generally supported by the results. Over-

C1

all, this study is a very good piece of work that aims to use microstructural observations to constrain deformation at plate boundaries. The Authors made an excellent job in deriving deformation conditions and rheological parameters, and their effort to “upscale” microstructural observations on natural samples to the long- and short term rheological behaviour of a plate boundary must be applauded. Our limited understanding of the strength evolution of the lithosphere at plate boundaries and major faults clearly speaks to the need for more studies like this one, which aim to interpret the geological record in the light of recent geodetic and seismological estimates of the rheology of plate boundaries. The manuscript is generally well written and the figures are all informative and clear. I have left some specific comments and technical corrections in the attached annotated pdf. I have only two main comments on deformation mechanisms and microstructures, and in my view these can be addressed with minor revisions and clarifications. I am highly supportive of publication of a revised manuscript in Solid Earth.

1) The microstructure of granulites suggests that the recrystallized grain size (in particular of plagioclase) could have been modified by annealing and grain boundary area reduction. Triple junctions at 120 degrees are common, and the subgrains in plagioclase appear to be considerably smaller than the recrystallized grains (Fig. 3b). This can obviously have an influence on the palaeopiezometric estimate, and should be discussed in the paper. Also, the interpretation of the bimodal grain size distribution of plagioclase and cpx in xenolith SQ-16 is unclear. My understanding is that the Authors have used the smaller grain size for their piezometric estimate, but the small grains occur as clusters along grain boundaries. Is the smaller grain size indicative of a late, higher stress deformation at decreasing P, T conditions?

2) The microstructural evidence of grain boundary sliding is convincing (e.g. quadruple junctions, misorientation angle distributions), however the grain size is rather coarse for grain boundary sliding in crustal rocks. The Authors seem to rule out a possible effect of melt on deformation, because melt pockets are undeformed. But is it possible that

C2

an earlier generation of melt had assisted deformation and promoted melt-enhanced diffusion creep in the coarse-grained phases? See for example Rosenberg & Berger (Physics and Chemistry of the Earth (A), 2001).

Best wishes, Luca Menegon

Please also note the supplement to this comment:

<http://www.solid-earth-discuss.net/se-2017-45/se-2017-45-RC2-supplement.pdf>

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2017-45>, 2017.