A paleopiezometer for eclogites: the omphacite grain size

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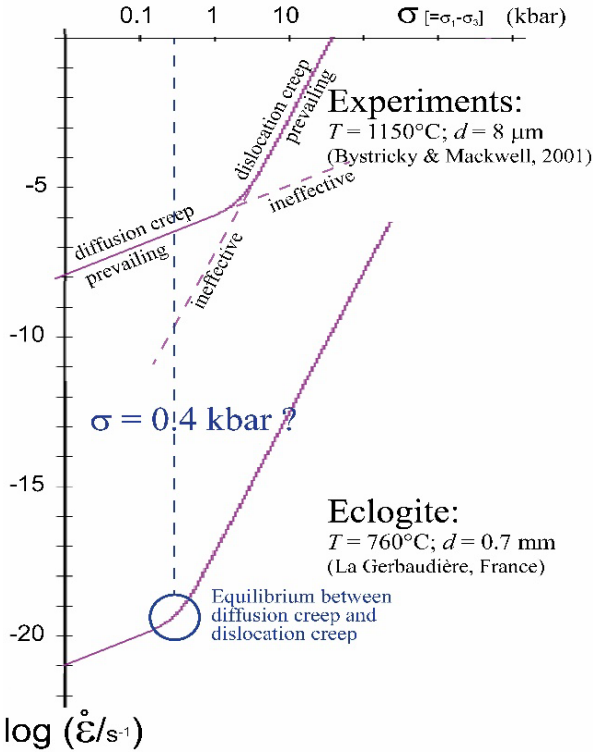
Paleopiezometry consists in determining the differential stress (σ) that has occurred during rock deformation, using a stress-sensitive microstructural criterion. Assessing paleo-stresses during deformation of HP rocks is of great importance, as it has been hypothesized that stress could combine with lithostatic pressure to allow the genesis of HP parageneses. Models have also suggested or assumed very inconsistent values of stress for HP rocks, ranging from a few bars to several kbars, making it all the more necessary to calibrate a paleopiezometer for these rocks.

A potential paleopiezometer would consist in using the size of dynamically recrystallized omphacite grains, like what is done for quartz. For 3 decades, an arduous discussion has persisted over the dominant mechanism prevailing during ductile deformation of omphacite, namely diffusion creep *vs.* dislocation creep. Dislocation creep involves the movement of dislocations through the crystal lattice, while diffusion of atoms, mainly at the grain boundaries, occurs during diffusion creep, which is highly favoured by small grain size. A most troubling fact of this debate is that microstructural evidence for each of these mechanisms can coexist in the same eclogites for the same deformation event (*e.g.*, Godard & van Roermund, 1995). We can explain this paradox by considering that an equilibrium can arise between both mechanisms: dislocation creep reduces the mean grain size by generating sub-grains and new grains, and thus promotes diffusion creep, while the latter increases grain size by eliminating grains, which in turn favours dislocation creep. The average grain size can then be potentially used as a piezometer.



We applied this approach to Armorican eclogites (Fig. 1), using the rheological law that Bystricky & Mackwell (2001) obtained by experimentally deforming diopside aggregates, whose grains were small enough to allow both diffusion and dislocation creeps under the experimental conditions. The results give moderate stress estimates (σ = 0.4 kbar: Fig. 1). It would be useful to improve this piezometer by using a rheological law, still combining both mechanisms, but obtained for omphacite under experimental conditions approaching as closely as possible the real conditions, in particular of pressure.

Fig. 1- The rheological law of Bystricky & Mackwell (2001) used as piezometer for eclogites. d: average grain size.

Godard, G., van Roermund, H.L.M.,1995. Deformation-induced clinopyroxene fabrics from eclogites. *Journal of Structural Geology* 17, 1425-1443.

Bystricky, M., Mackwell, S., 2001. Creep of dry clinopyroxene aggregates. *JGR* 106, 13443-13454.