Geophysical Research Abstracts
Vol. 20, EGU2018-1161, 2018
EGU General Assembly 2018

Investigating grain growth in mantle rocks within a full field model based on the level-set method in a finite element context

Jean Furstoss (1,2), Carole Petit (1), Clément Ganino (1), Marc Bernacki (2), and Daniel Pino-Munoz (2)

(1) Côte d'Azur, CNRS, OCA, IRD, Geoazur, France (jfurstoss@orange.fr), (2) MINES ParisTech, PSL Research University, CNRS, CEMEF, France(jean.furstoss@mines-paristech.fr)

Damage structures in the lithosphere have been linked to the origin of plate tectonics. In deformed mantle rocks, a switch from grain size insensitive to grain size sensitive creep by decreasing grain size can explain the strain localization at zones of low grain size.

The long-lived nature of these weak zones despite the relatively high lithospheric temperatures points out the need for a good knowledge of mantle healing kinetics due to peridotites grain growth.

Whereas experiments and mean-field models have already brought important constraints on this process, full-field approach (i.e. capturing the detailed topology of the system with a large number of grains) is still poorly investigated.

Here, we modelled the evolution of microstructures adapting a numerical simulation originally developed by CEMEF Mines ParisTech, in order to compute microstructural evolutions for metals during industrial processes. The full field modelling code uses an implicit description of the interfaces by level-set functions in a finite element framework. This approach has not been employed as far in geosciences and it is validated by years of industrial application for metals. This numerical context permits to model different mechanisms (e.g. grain boundary migration, Zener-pinning) within a unique formalism, making it a robust, adaptable and scalable code. Moreover, recent numerical developments had considerably increased the numerical efficiency of the code permitting 3D modelling for much lower computational costs.

Physical parameters needed to investigate grain growth as well as mobility and energy of a grain boundary have been extracted from multiple experimental data available on the microstructure evolution of peridotites. Once injected in the model, we produce numerical results in good agreement with those experiments which means that the code adaptation is correct.

Mean field models describing grain growth as well as the generalized Burke and Turnbull model for normal grain growth, or a modified version of the classical Zener equation in case of microstructure pinned by secondary phase particles can also be calibrated by our full field simulations.