Geophysical Research Abstracts, Vol. 8, 02801, 2006
SRef-ID:

Kinetic Scaling of Metastable Phase Transformations

M.R. Riedel

University Potsdam, Inst. Geosciences, Golm, Germany (miker@geo.uni-potsdam.de)

Rheological structure of subducting slabs at convergent plate boundaries is strongly influenced by changes in creep properties of slab materials due to high-pressure mineral transformations. Thermo-mechanical modelling of slab strength with inclusion of the olivine-spinel phase transformation in the mantle transition zone showed, for example, that subducting slabs have a complicated rheological structure, with strong variations both laterally and with depth, due to large variation in temperature, stress and grain-size.

One particular problem regards the influence of metastable phases. Sluggish kinetics due to metastable hindrance is likely to cause particular difficulties, because of possible strong non-linear feedback loops between strain-rate and change of creep properties during transformation.

In order to include detailed kinetics into thermo-mechanical modelling of convergent plate margins, reliable kinetic data of high-pressure mineral phase transformations is required. The derivation of mesoscopic transport coefficients like heat conductivity, shear or bulk viscosity, and other kinetic material parameter (including surface tension for solid-state nucleation) is, however, in general a time-scale dependent problem. The determined values of these coefficients are under laboratory conditions not necessarily in agreement with those valid for natural conditions at the geological time scale.

Here I will discuss a method how measured (in-situ) kinetic data at the laboratory time scale can be extraplolated to the geological time scale using a scaling law for the kinetic phase boundary of uni-variant phase transitions under natural conditions (Riedel and Karato, 1997).

According to this approach, any given kinetic phase boundary Δ p(T) (measured at the laboratory time scale) can be "scaled" to the corresponding critical isotherm at subduction zones, under experimentelly "forbidden" conditions (Liou et al., 2000).

References:

Riedel MR, Karato S (1997) Grain-Size Evolution in Subducted Oceanic Lithosphere Associated with the Olivine-Spinel Transformation and Its Effects on Rheology. Earth Planet. Science Lett. 148: 27-43.

Liou JG, Hacker BR, Zhang RY (2000) Into the forbidden zone. Science 287, 1215-1216.