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Different ways to portrait anisotropic mantle rheology.

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Anizotropic texture of the mantle rocks subjected to the high shear rates e.g. in subduction zones are unambiguously observed with seismic methods. Textured liquids have viscosity dependent on direction of flow that is described as a tensor parameter. Theory of viscosity tensor is used at the modeling of flow of liquid crystals and glaciers. In both cases the simplest transeversely –isotropic rheology (TIR) arises first. Moreover in 2D all variety of anisotropic rheologies is reduced to TIR characterized with two viscosity components normal (η_N) and parallel (η_S) to the shear direction. Texture can be specified by the single parameter – orientation of the vector (director) parallel to the layering. Director alignment evolves due to the effect of pure shear component and rotation. Subduction flow is similar to the simple shear. In a simple shear flow non-interacting director rotates to the position parallel to shear direction if parameter of the sensibility to extension λ=1. When $\lambda < 1$ (that is often a case) it oscillates with probability to find director orientation parallel to shear one increasing for λ approaching 1. We complete 2D FEM numerical code for liquid with TIR specified through the set of directors advected with markers. Expression for tensor of viscosity is taken from (Lev and Hager, 2008), while evolution of directors was calculated in accordance with (Pleiner and Brand, 2002). Poiseuille flow between parallel walls was considered as a simple test problem. Flow is specified by velocity boundary conditions applied at the outlet. To allow for the flow velocity field to adjust rheological transformations we put near the outlet portion of the low viscosity Newtonian liquid. With time flow rates in TIR part of liquid evolves from parabolic profile to plug-like one. Set of directors rapidly evolve parallel to flow near the no-slip walls. Near the inlet and outlet directors are guided by the boundary conditions. We use scalar variant of DPL rheology (Simakin and Ghassemi, 2005) to describe strain rate weakening in the same flow. DPL formalism yields uneven 2D distribution of structural component of viscosity. For the considered 2D flow we get pattern of scalar viscosity strikingly similar to TIR one at weak anisotropy (η_S/η_N =0.6-0.8). Arising DPL shear bands have orientation parallel to the flow direction in the central part while observed layering near outlet and inlet resembles director orientations in TIR runs. We find that high anozotropy (η_S/η_N =0.2) has qualitatively stronger effect on the flow implying potential importance of TIR induced at the upper mantle subduction on the flow at the larger depths. *RFBR is acknowledged for financial support with grant # 10-05-00697.*

Refences.

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