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Low viscosity zone and mantle dynamics

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With a three-dimensional mantle convection model the self-consistent generation of a low viscosity zone (LVZ) has been explored. Based on the indication that a low viscosity zone has a stabilising effect on the plate motion, a rheological model resulting in plate-like motion has been employed in this study. Rather than prescribing a viscosity drop, the influence of rheological properties on viscosity variations was investigated. In particular the interaction of a temperature-, pressure- and stress-dependent viscosity was explored. It is to be seen that the LVZ needs not to be imposed, but forms along with plate motion. But the existence of both is limited to a small parameter range. Only for the balanced combination of the temperature and stress dependence of the viscosity the formation of the LVZ beneath the moving, highly viscous plate and a viscosity maximum at mid-depth (HVZ) is received. Additional pressure dependence of the viscosity leads to a stronger HVZ and due to the wavelength influence to a more global LVZ.