Numerical simulation of the plate motions: Effects of rheologies of the lithosphere

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A numerical simulation of mantle convection in a 3-D spherical shell model has been conducted to understand the effects of rheological models of the lithosphere on the Earth's surface tectonics, mainly plate motions. Three rheological models are considered: a model of weak plate boundaries and stiff plate interiors, yielding, and strain-rate-weakening(SRW). Yield and SRW rheologies have been applied to only the high viscosity lithosphere. Density anomalies are inferred from the seismicity and the history of the subduction. We consider two cases for yielding; yield occurs in all parts of the lithosphere and only near the plate boundaries . When yield occurs in all parts of the lithosphere, plate motions are far from the observed plate motions. When yield occurs only near the plate boundaries, overall pattern of plate motions is improved. The results show the similar to those of the weak plate boundaries. With SRW rheology and the density anomalies distributed in the whole mantle, very narrow weak zones are formed in the high viscosity lithosphere and they divide the lithosphere into plate-like high viscosity regions. However, weak zones do not correspond to real plate boundaries. For a density anomalies confined in the upper mantle, only some part of plate boundaries become weak. Thus, SRW rheology do not improve the models.