# WHAT BRAKES FOR PLATE TECTONICS?

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What is the relative importance of interplate friction, of dissipation in the bending zone, of deeper viscous resistive stresses and of processes linked to phase transitions for supporting the subducting slabs? Short- and intermediate-wavelengths gravity and geoid anomalies are used to provide constraints on the mechanical structure of subduction zones and on the forces involved.

This study is based on 2D cartesian dynamically self-consistent models with Newtonian and power-law rheologies. For Newtonian models, we show that both strong decoupling (t ~ $10^7$Pa) of the two convergent plates and weakened bending lithosphere are necessary to reproduce the observed geoid and gravity data. The former impedes stress transmission from the slab upward to the upper plate, preventing the development of a large gravity down-warping over the arc. The latter is required to avoid unreasonably large trenches and forebulges. For high values of the stress exponent, models with a power-law rheology display a relatively thin "fault-like" weak zone, which naturally emerges without the need for any predefined faulting region. Good fit to gravity data is found for a relatively low failure stress (~ 3-5.$10^7$Pa). The models which do not fit the gravity data because of a too stiff rheology in the decoupling or bending region are also characterized by plates which tend to fall vertically. For all models providing a reasonable fit to the gravity data, only a small fraction of the weight of the down-going slab (~ 3- 6.$10^{12}$N/m, less than the equivalent of a slab section 100km long) is transmitted to the surface plates. About 10% of the energy is dissipated in the contact zone between the two plates, 10% to 20% in the bending region, and more than 70% in the sublithospheric mantle. The shear stress on a plane at 80km depth (bottom of the lithosphere) has a large amplitude both in the plate-slab contact zone and below the arc, with a sign reversal between these two regions. These basal tractions tend to pull the two plates towards each other (forces of the order of ~1-4.$10^{12}$N/m). However, the net shear-stress may be non-zero. This results in a net motion of the plates with the subducting plate moving faster than predicted by the no-net motion principle. As the models which fit the short-wavelength gravity anomalies are characterized by a slab mainly supported from below, in the case of pure whole mantle convection, a marked positive geoid anomaly is predicted above subduction zones at medium wavelengths(l=2000-4000km). Such large geoid highs are not observed. Introducing 'partial layering' linked to the phase transformations is necessary to reconcile model predictions and observations for these medium wavelengths.

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