# MODES OF SLAB BEHAVIOR: FROM THE TRANSITION ZONE TO THE MID-LOWER MANTLE

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Subducting slabs may exhibit buckling instabilities and consequent folding behavior in the mantle transition zone, accompanied by temporal variations in dip angle, plate velocity, and trench retreat. Governing parameters include both viscous (rheological) and buoyancy (thermo-petrological) forces. Numerical experiments suggest that many parameter sets lead to slab deflection at the base of the transition zone, typically accompanied by quasi-periodic oscillations in largely anticorrelated plate and rollback velocities, resulting in undulating stagnant slabs as buckle folds accumulate subhorizontally atop the lower mantle. Slab petrology – of mantle phase transitions and hydrated crust – is a dominant factor in this process [1]. For terrestrial model parameters, trench retreat is common and trench advance quite rare, due to rheological and ridge-push effects. Global plate-motion studies indicate that trench advance is rare on Earth, too, being largely restricted to the Marianas-Izu-Bonin arc. Dynamical models based on the unusual double-subduction geometry of the Philippine Sea region do yield persistent trench advance [2].

Imaging of buckled stagnant slabs is complicated by smoothing effects inherent in seismic tomography, but velocity structures for petrologically layered slabs, spatially low-pass filtered for comparison with tomography of corresponding resolution, yield a better fit to $V_P$ anomalies from stagnant slab material beneath northeast China for undulating (vs. flat-lying) slabs [3]. Earthquake hypocentral distributions and focal mechanisms (especially below 660 km) also provide insights into slab buckling in regions of slab stagnation [4], and these can be compared to stress fields computed from our dynamical models.

A combination of driving forces governs slab stagnation. Buoyancy arising from thermal perturbation of equilibrium phase transitions contributes to slab bending and may partly control depth of stagnation [5]. Additional buoyancy from possible metastable persistence of olivine or pyroxene phases may enhance slab stagnation, and temporal decay of such metastability by thermal equilibration may lead to slab foundering [5, 6, 7, 8, 9]. Complexities in mantle viscosity structure, associated with mineralogical transitions, may also contribute to slab stagnation [1, 10].

Subsequent descent of buckled slab material into the lower mantle may occur in a variety of ways: drawn downward from the distal (relative to the trench) edge, from the proximal edge, or from somewhere in between [11], or by bulk foundering of the entire megalith-like mass. Mode selection appears to be governed by factors such as rheological structure and trench motion.

Presence of foundered slab material is likely indicated by seismic scatterers observed in the mid-lower mantle [12]. Proposed origins of such scatterers include: structural transitions in relict silica phases [13], electronic spin transitions in hydrous ferromagnesian silicates [14], and electronic spin transitions in alkalic hexagonal aluminous phases [15], all occurring primarily within subducted crustal material.

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