2D Dynamics of Slab Detachment Due to Ridge-Trench Collision

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Fully-dynamic 2D viscous models run using *CitcomCU* show that ridge-trench collision results in detachment of the subducted slab and abandonment of the spreading ridge for a case in which the ridge is oriented parallel to the trench. The initial thermal structure for our models defines a slab with a previous history of subduction and a spreading ridge positioned outboard of the trench. The model rheology is a composite dislocation-diffusion creep viscosity with a depth-dependent plastic yield stress. The plate boundary is modeled as a low viscosity shear zone.

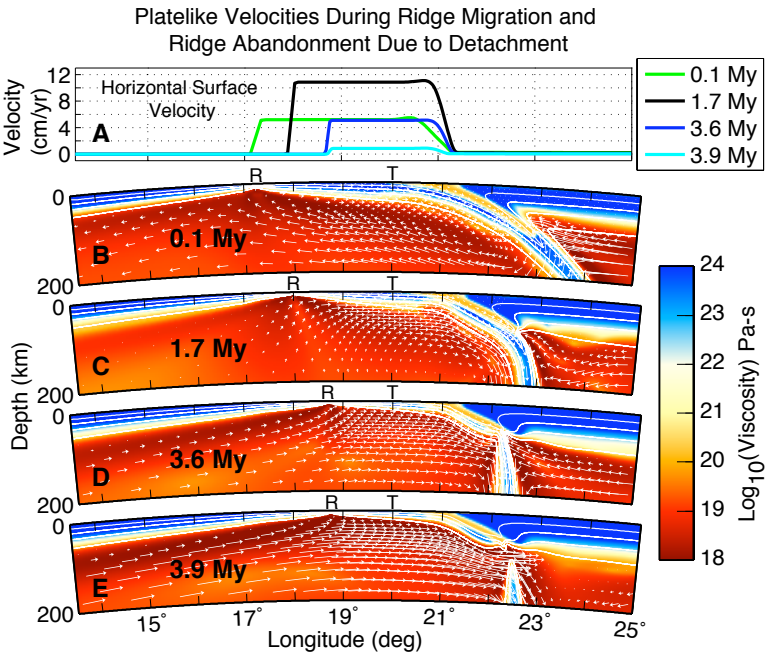

Figure 1. Plate Velocities and Viscous Flow Field. (A) Horizontal surface velocity profiles at four times before and during detachment for the same longitudinal extent as the plots below. (B)-(E) Viscosity plots for reference model. The changing ridge position is noted by an R and the fixed trench position by a T. White arrows indicate flow and white lines are temperature contours every 300°C.

We find that slab detachment, ridge abandonment, and opening of a shallow slab gap occur for a range of initial ridge positions (300-700 km outboard of trench), initial slab depths (200-1200 km), maximum yield strengths (300-1000 MPa), and shear zone viscosities (10^{21}-10^{23} Pa-s). In none of the cases tested does the ridge subduct, indicating that ridge subduction is not a prerequisite for slab detachment. Figure 1 summarizes the dynamics of ridge migration during subduction. First the subduction rate increases to a steady-state value (Fig. 1B-C). As necking of the slab begins, subduction rate rapidly decreases (Fig. 1D) before detachment of the slab and ridge abandonment occur (Fig. 1E). The uniform surface velocity from the ridge to the trench demonstrates rigid plate behavior during subduction, even as the plate velocity decreases because coupling of slab pull to the subducting plate drops as the slab detaches (Fig. 1A). The detachment occurs at a point along the slab where the age of the lithosphere is in the range of 7-12 My, indicating that increased weakening and positive buoyancy with proximity of the ridge to the trench lead to detachment of the older subducted slab from lithosphere younger than approximately 10 My. These results are consistent with observations of ridge abandonment offshore of Baja California together with anomalous volcanism along the peninsula suggesting the presence of a gap within the subducted slab.

References. Andrews (aka. Burkett), E. R., and M. I. Billen, *Competing Effects of Ridge Proximity and Slab Strength on Slab Detachment*, EOS Trans. AGU, 88(52), Fall Meet. Suppl., T11C-0729, 2007.