Seismic structure in central Mexico: Possible fragmentation of the subducted South Cocos plate

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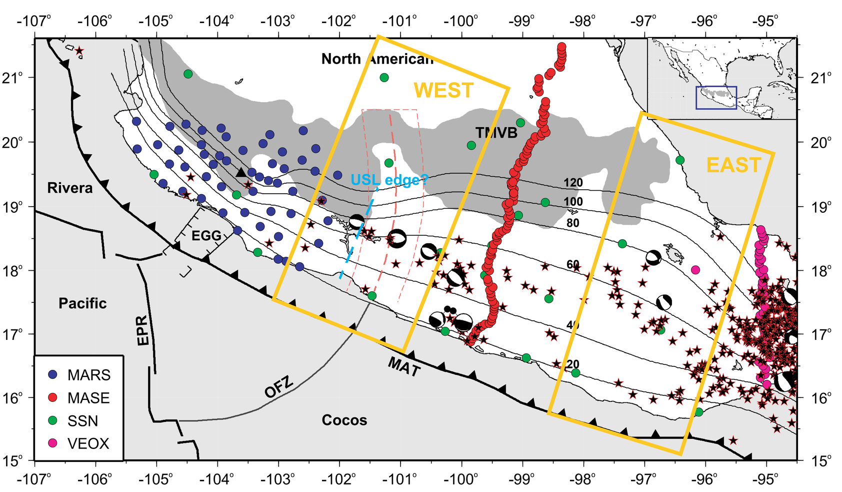
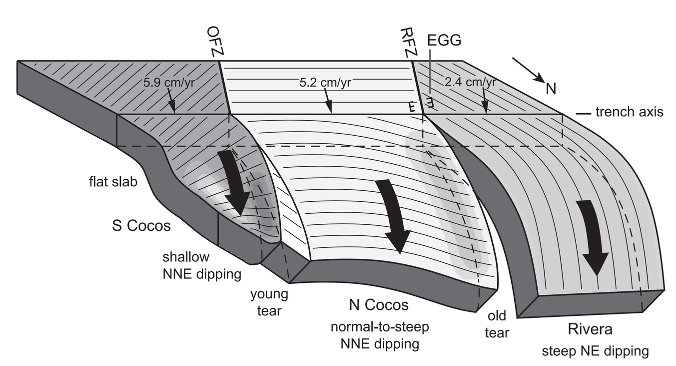
I. Background



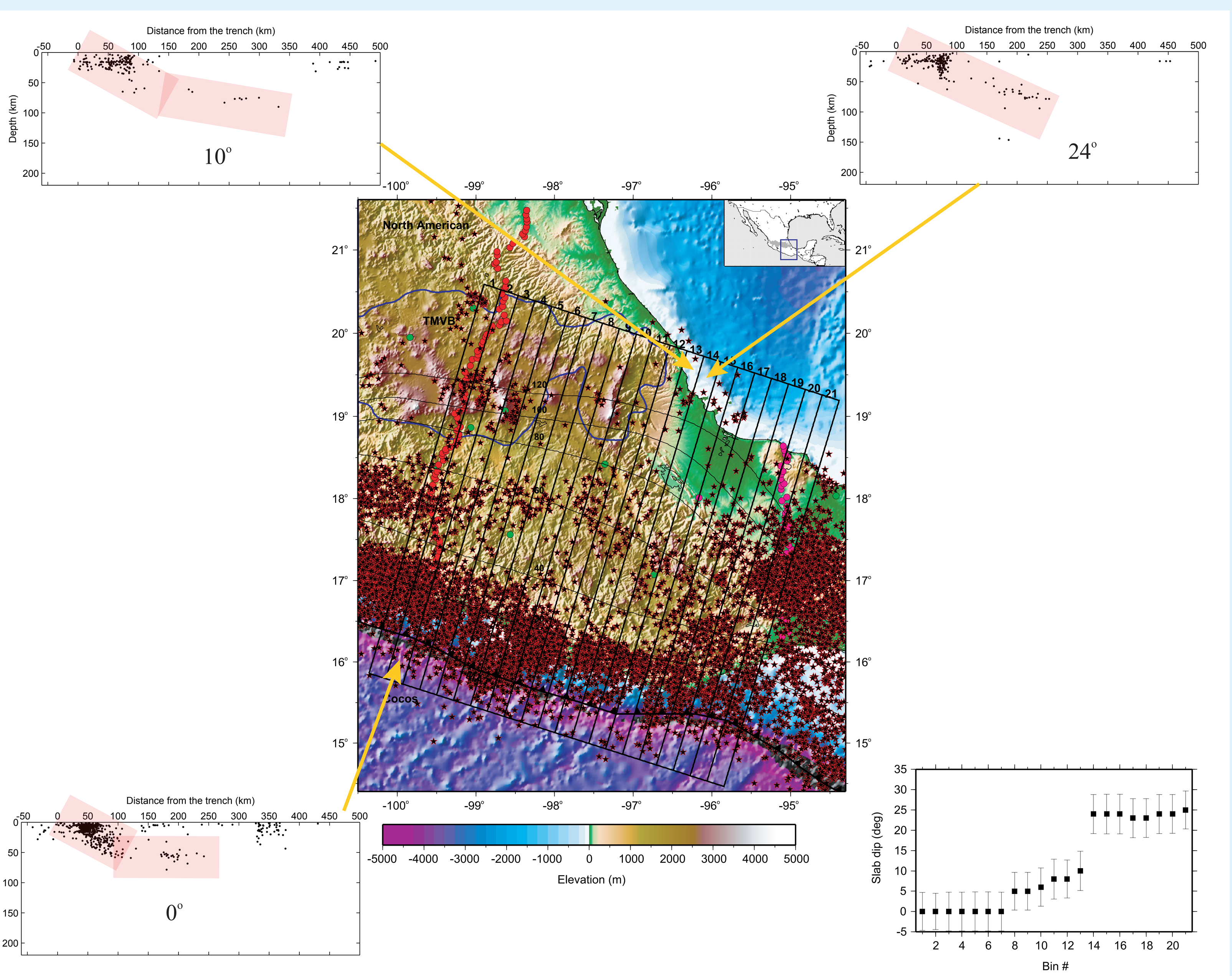
The fine-scale seismic structure of the subducted plate along the transitions from flat to normal subduction (orange boxes) is studied using moderate-sized (M4-6) intraslab earthquakes recorded by these arrays: MARS, MASE, VEOX, and Servicio Sismologico Nacional (SSN). Our previous structural modeling found an edge to the ultra-slow velocity layer (USL) that is approximately coincident with the western margin of the projected Orozco Fracture Zone (OFZ) region, indicating a structural boundary we interpret as a plate tear.



3D schematic of our two-tear model wherein the Cocos slab is currently fragmenting into a North Cocos plate and a South Cocos plate along the eastern projection of the OFZ.

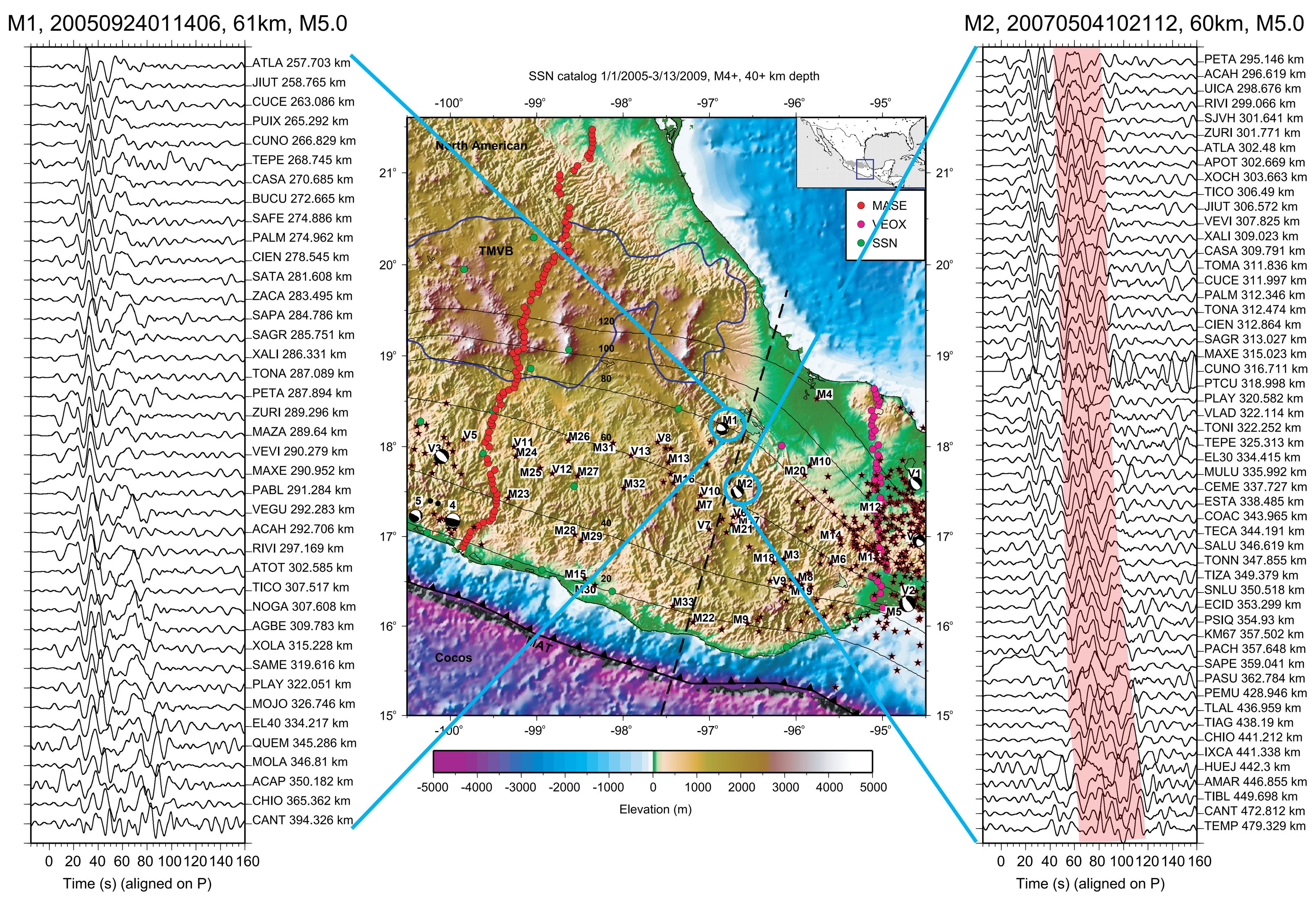
In the east, observations of a sudden change in slab dip combined with the abrupt end of the TMVB suggest a second possible slab tear located within the South Cocos plate

II. Slab Dip



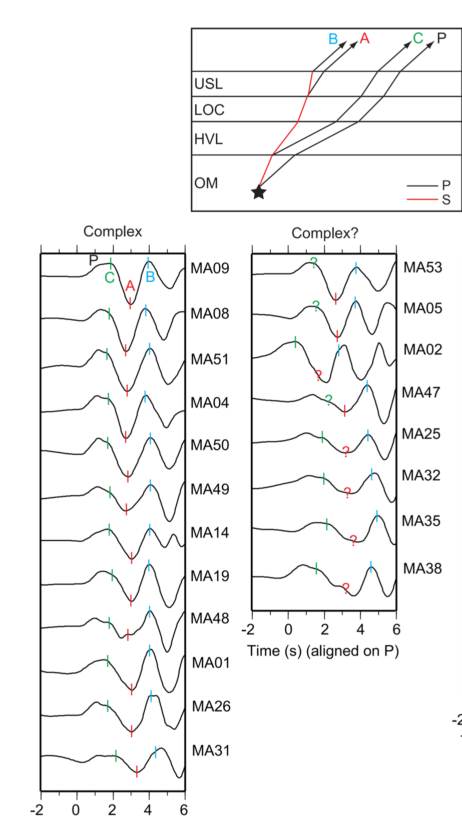
Examination of lateral variations in slab dip across the transition from flat to normal subduction located to the east of the MASE array. Seismicity from the 2001-2011 SSN event catalog is divided into twenty-one 25 km wide bins roughly perpendicular to the trench. Cross-sections of seismicity in bins 2, 13, and 14 are shown. The slab is flat beneath the MASE array, with it's dip gradually increasing to 10° by bin 13. Between bins 13 and 14 there is a sharp increase in slab dip of 14°, which may indicate a possible slab tear in the South Cocos plate.

III. Waveform Complexity

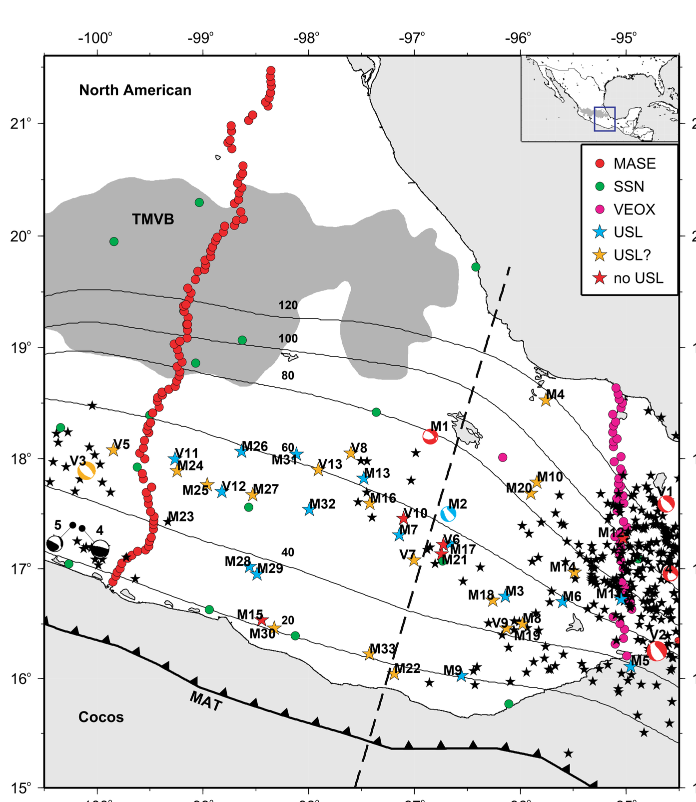


Observed changes in waveform complexity across the sharp transition in slab dip (black dashed line) for similar events recorded on the MASE array. Event M1, located west of the dip change, exhibits relatively simple waveforms compared to those for event M2, which is located east of the dip change. The increased complexity of M2 waveforms (pink shaded region) would be expected for waves which pass through a slab tear zone.

IV. Ultra-slow Velocity Layer

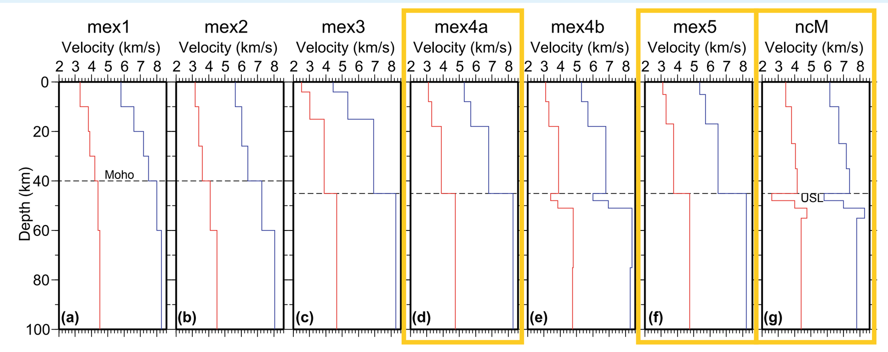


(Top) Schematic illustrating the ray paths of the P-wave and the three S-to-P phases (A, B, C) that comprise the complex P waveform, which is used to identify the presence of the USL. (Bottom) Examples of complex (left), possibly complex (middle), and simple (right) P waveforms from the MARS array. Questions marks on the possibly complex waveforms indicate a phase that is not easily identified. Simple waveforms lack the shoulder in the direct P pulse indicative of the C phase and also have uncharacteristic A and B phases, indicating there is no USL present.



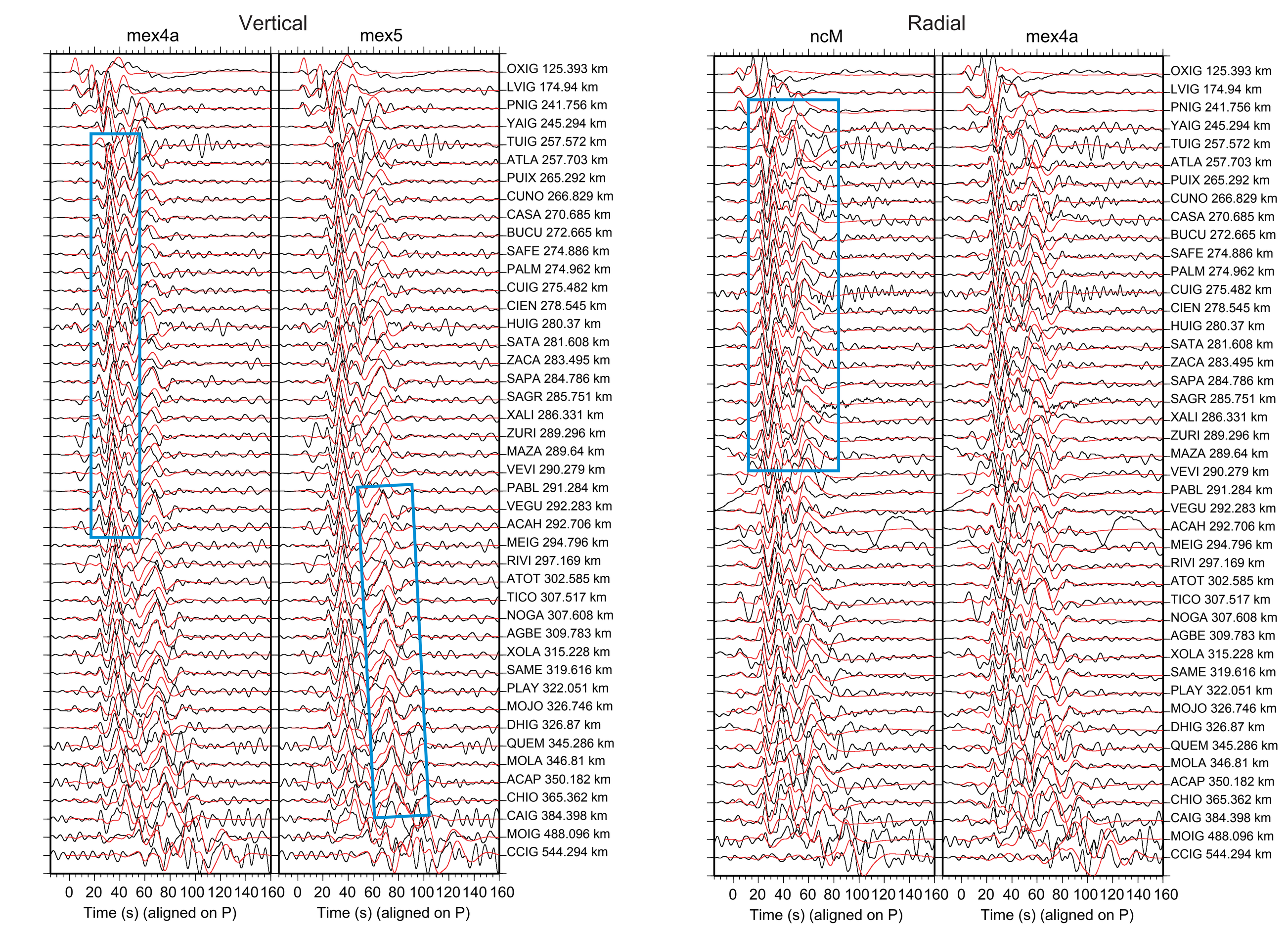
Mapping the eastern lateral extent of the USL using MASE, VEOX, and SSN waveforms to test if the USL ends along a lineament related to the potential slab tear. Preliminary results are shown. Events which indicate the presence of the USL are shown in cyan. Those which possibly indicate the USL is present are shown in orange. Red events indicate no USL is present.

V. 1D Velocity Modeling (Preliminary)



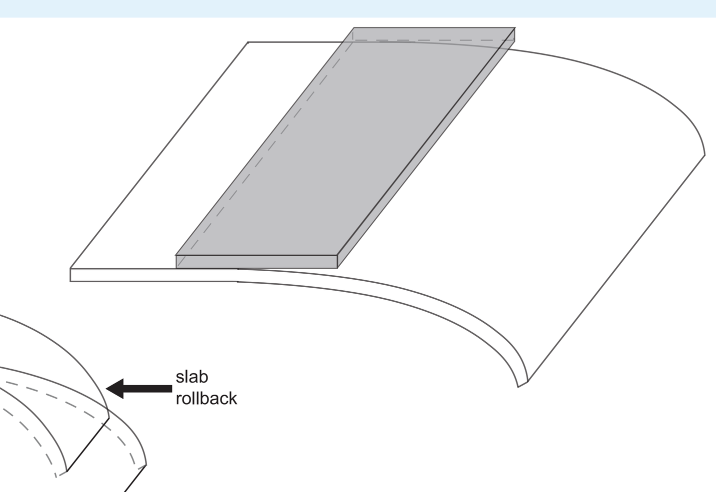
mex1: *Kim et al. (2012)*
mex2: *Iglesias et al. (2010)*
mex3: *Valdes et al. (1986)*
mex4a: *Furumura and Singh (2002)*
mex4b: *Furumura and Singh (2002)*
mex5: *Campillo et al. (1996)*
ncM: *Dougherty et al. (2012)*

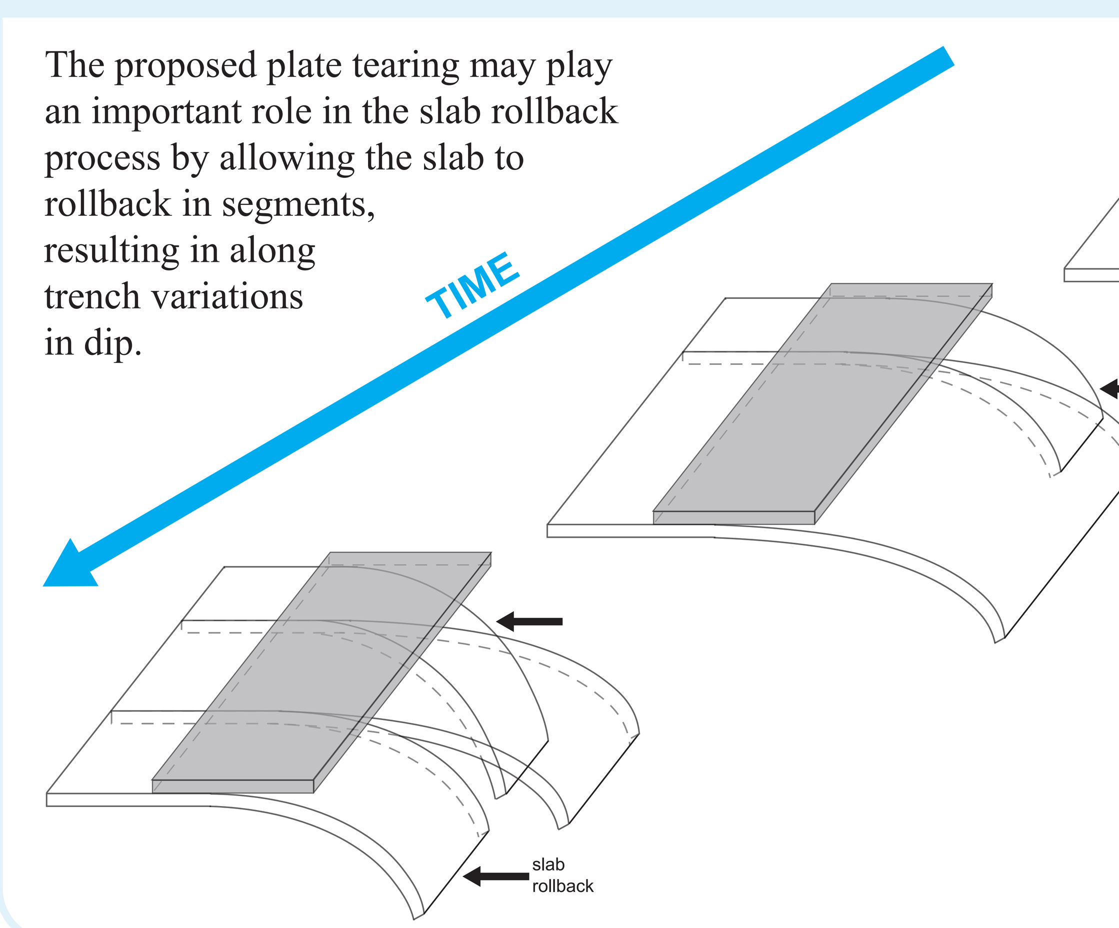
Examples of modeling results for the 3 best fitting models. While some phases at certain distances are predicted well by the models (blue boxes), the models are unable to predict the overall waveforms observed. Further modeling efforts are ongoing.



VI. Slab Rollback and Plate Tearing

The proposed plate tearing may play an important role in the slab rollback process by allowing the slab to rollback in segments, resulting in along trench variations in dip.





(Top) Start with a flat slab. (Middle) Slab rollback begins on only a segment of the plate; first plate tear develops. (Bottom) Slab rollback continues and a second segment of plate begins rolling back; second plate tear develops.

VII. Conclusions and Future Work

-Observations of a sharp transition in slab dip near the abrupt end of the TMVB coupled with a change in waveform complexity across this zone, suggest a second possible slab tear located within the South Cocos plate.

-Preliminary mapping of the eastern lateral extent of the USL does not indicate a linear USL edge which would be suggestive of a potential slab tear.

-Further 1D and 2D waveform modeling in order to image the structure of the slab and overriding plate in this region is ongoing.

Acknowledgements

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