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On the evolution of Subduction-Transform Edge Propagators (STEPs): application to the Pliny-Strabo 'trenches'

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At the eastern side of the Aegean slab, tomographic evidence shows that a slab edge is present. The subducting African plate needs to tear to permit continued subduction and rollback of the Hellenic trench. This vertical tear is named a Subduction-Transform Edge Propagator (STEP) and is defined as the region of active tearing. At the eastern side of the Hellenic trench, the active STEP is probably located along the Ptolemy 'trench'. The surface expression (deformation zone) of this propagating STEP is observed in bathymetry and seismology, where the Pliny-Strabo 'trenches' are referred to as the STEP fault zone, i.e. the deformation zone in the wake of the active STEP. Due to its immaturity, the plate boundary is a relatively wide zone as strain has not localized yet.

A key question is the propagation direction of an active STEP. It is suspected that passive margins may play a critical role in steering a STEP as they represents first order strength contrasts between oceanic and continental lithosphere. Here, we seek to identify the preferred propagation direction for a STEP and also investigate the effect of passive margins on STEP propagation (direction) through mechanical, finite element models. Our model results show that propagation of a STEP along a passive margin-ocean interface is likely for a range of models which show a passive margin-trench orientation within 15 degrees from a perpendicular setup. Passive margins are rarely straight features and with the inclusion of a change in strike of the passive margin ahead of the active STEP, model results show that propagation will occur along the passive margin-ocean interface if this change is less than 25 degrees from a perpendicular setup. Surprisingly, the subduction history and magnitude of the strength(/effective viscosity) contrast across the passive margin are less relevant. The STEP system seems relatively insensitive to small scale details, e.g. so that small, gradual changes in passive margin orientation do not affect STEP propagation.

For the eastern side of the Aegean slab, tectonic reconstructions suggest that the passive margin was oriented nearly perpendicular to the STEP fault in the Pliocene. Propagation of the STEP into the oceanic lithosphere of the Eastern Mediterranean basin along the Pliny-Strabo 'trenches' is therefore consistent with our model results, i.e. an expected consequence of the (past) tectonic setting.