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The role of rheology and of subducting sediments on the formation of back arc basins

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Both divergent and convergent plate boundaries have been studied extensively throughout the last five decades. Among a host of other aspects came the realization, that given the right circumstances, a broad extensional basin can form behind a convergent plate boundary. The exact mechanisms triggering backarc extension and why they appear to be episodic, lasting only for tens of millions of years is still debated. The absolute and relative velocities of the plates, the age of the subducting oceanic plate, the mantle flow pattern of the subduction zone, and the inherited rheological properties of the backarc lithosphere are all thought to be key players, controlling the dynamics of subduction zones and the back-arc systems.

Here, we use lithosphere scale plane-strain thermo-mechanical model experiments to investigate the factors controlling the formation of active back-arc extension and its interaction with subduction-rollback and slab breakoff during the closure of a small land locked oceanic basins, as for example in the Pannonian-Carpathian system and elsewhere in the Mediterranean. In settings as these there is only a small amount of oceanic lithosphere available for subduction limiting the slab-pull force.

Our results suggest that weakened back-arc continental mantle-lithosphere is required for significant thinning and rifting to occur. Slow convergence appears to be of paramount importance for the initiation of back-arc rifting as it allows for slab-pull to become a dominant force in the system causing subduction-rollback. The backarc region is less prone to thinning and extension when the weakened continental mantle-lithosphere is not directly adjacent to the subducting plate as corner-flow has a reduced impact on convective thinning of the weak back mantle lithosphere. Finally, the presence of a weak oceanic sedimentary layer helps reducing the frictional resistance along the subduction interface, resulting in a more efficient transfer of slab-pull into the backarc region. Models presented here compare favorably with observations from the Pannonian basin.