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Geodynamic constraints on ophiolite emplacement

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Ophiolite complexes are commonly found outcropping along ancient suture zones in continental regions. Many geological studies suggest that, during subduction initiation, a small remnant of the oceanic crust can be thrusted upon continenal regions. This thrusting occurs during a process that is generally termed as “ophiolite obduction”. Despite the relatively small volume of the ophiolite rocks, their occurence provides important geologic/geodynamic constraints for the processes of subduction initiation.
Following the seminal work of Cloos (1993), oceanic lithosphere that is older than 10 Myrs is dense enough, and as a result, facilitates oceanic subduction in a spontaneous manner. This suggestion is based on the fact that buoyancy is one of the most important forces relevant to large-scale geodynamics. However, old oceanic lithosphere is also expected to be cold and, as a consequence, mechanically strong. The increased strength of the oceanic lithosphere hinders subduction initiation and makes ophiolite obduction difficult.
In this work we perform systematic numerical simulations to investigate the effects of initial geometry and convergence velocity on subduction initiation and ophiolite obduction. We use LaMEM to calculate 2D thermo-mechanical models that include the effects of visco-elasto-plastic rheology. In addition, we have incorporated a thermodynamically-consistent density structure for the crust and mantle. In this way, buoyancy forces are calculated in a consistent manner based on the pressure and temperature fields of the thermo-mechanical models. Our results show that when the oceanic lithosphere is older than 10Myr, subduction is very difficult and does not initiate in a spontaneous manner. Our systematic simulations provide insights for the range of conditions and parameters of oceanic subduction and ophiolite emplacement.

References
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