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Influence of cratonic lithosphere on slab geometry and mantle flow: insights from 3D time-dependent modelling.

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Recent studies show a clear correlation between the occurrence of flat subduction and the proximity of areas of high elastic/thermal thickness in the overriding plate. A plausible explanation is that cold overriding plates lead to colder mantle wedge, increasing the hydrodynamic suction and decreasing the slab dip. In particular, recent numerical modeling has shown that the presence of cratonic lithosphere in the overriding plate has a significant effect on subducting slabs.
In this study we quantify the influence of cratonic areas in the overriding plate on subduction dynamics. We present 3D thermo-mechanical and time-dependent numerical models of buoyancy-driven subduction processes. A non-Newtonian pseudo-plastic rheology is assumed. Different simulations have been performed to quantify the effect of different factors, such as the craton width, thermal thickness and distante to the trench. Modelling results indicate that presence of cratonic lithosphere in the overriding plate produces strong along-trench variations of the slab geometry. These variations are maintained and propagated at great depths as the slab sinks deeper into the mantle. Significant trench-parallel flow in the mantle wedge is generated by time-dependent changes in slab dip. For cases of reduced slab pull, the slab and the base of the craton become coupled, which causes a dramatic reduction of subduction velocity and the formation of a slab gap.
The presence of cratons may have an important role on subduction episodicity and provide a new mechanism to explain slab gaps in areas where cratons have been located close to trenches, as is the case of South America and the Cenozoic subduction of North America. We further emphasize that the lithospheric structure of the overriding plate should be taken into account in analysis and modelling studies of subduction zones.