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Lithospheric strength, thermal structure and potential mode of deformation at a magma-poor segment of the ultraslow opening Southwest Indian Ridge

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Lithospheric strength envelopes can be calculated on the basis of empirically gained constitutive equations and laboratory experiments. Strength envelopes are useful to analyse the mechanical behaviour of the lithosphere and are an essential ingredient for the modelling and understanding of tectonic processes. Under the assumption that the long-term mechanical behaviour of the lithosphere is reflected in its short-term seismogenic deformation, strength envelopes can also be constructed by forward modelling and fitting their shape to depth-histograms of background seismicity.
We present and discuss yield-strength envelopes that were established from depth-frequency distributions of microearthquakes recorded during a year-long experiment at the ultraslow spreading Southwest Indian Ridge. While forward modelling the strength envelopes we gained qualitative knowledge about along axis-changes in rheology, geothermal gradients and the depth of the transition zone from brittle to plastic (ductile) behaviour. Our results show a very weak upper lithosphere (down to 18 km depth at maximum) in which the weakening is best explained by serpentinization. The depth of the strength peak and its peak value vary considerable along axis, showing a deeper peak in a region where merely peridotite was sampled and a shallower, weaker peak in a region where basalts where sampled at the sea floor. While none of the current spreading models deduced from faster spreading ridges appears applicable, we speculate about the mode of tectonic deformation that is possibly associated with deep reaching, aseismic faults. However, with our contribution we intend to stimulate future studies that may include geophysics and tectonic modelling to test this hypothesis.