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Anatomy of lithosphere necking during orthogonal rifting

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The evolution of lithosphere necking is a fundamental parameter controlling the structural architecture and thermal-state of rifted margin. The necking shape depends on several parameters, including the extensional strain-rate and thermal layering of the lithosphere. Despite a large number of analogue and numerical modelling studies on lithosphere extension, a quantitative description of the evolution of necking through time is still lacking. We used analogue modelling to simulate in three-dimension the progression of lithosphere thinning and necking during orthogonal rifting. In our models we simulated a typical “cold and young” 4-layer lithosphere stratigraphy: brittle upper crust (loose quartz sand), ductile lower crust (silicon-barite mixture), brittle upper mantle (loose quartz sand), and ductile lower mantle (silicon-barite mixture). The experimental lithosphere rested on a glucose syrup asthenosphere. We monitored model evolution by periodic and coeval laser scanning of both the surface topography and the lithosphere base. After model completion, each of the four layers was removed and the top of the underlying layer was scanned. This technical approach allowed us to quantify the evolution in space and time of the thinning factors for both the whole lithosphere (βz) and the crust (γ). The area of incremental effective stretching (βy) parallel to the extensional direction was obtained from the βz maps.