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The Wilson cycle and effects of tectonic structural inheritance on rifted passive margin formation

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The parallelism between older collisional belts and younger rift systems is widely known and particularly well portrayed along the Atlantic Ocean. How tectonic inherited and new-formed shear zones control rift nucleation and the final architecture of rifted conjugate passive margins is still poorly understood. Here we present lithospheric scale thermo-mechanical numerical models that self-consistently create extensional and contractional tectonic inheritance, where prior extension and contraction is systematically varied. Our results show that: 1) initial reactivation occurs along the former lithospheric suture zones; 2) upper crustal thick-skinned basement thrusts are partially or fully reactivated depending on the amount of prior contraction and size of the orogen; 3) with a small amount of contraction, thick-skinned thrusts are efficiently reactivated in extension and provide the template for rifted margin formation; 4) with larger amounts of contraction, thick-skinned thrusts distal to the lithospheric suture zone do not reactivate in extension; 5) reactivation of prior contractional shear zones dominates during the early stages of rifting, while during the final stage of margin formation new-formed extensional shear zones dominate. Force balance analysis predicts an inverse relation between mid-crustal viscosity and the maximum offset for reactivation of weak upper crustal structures. Force balance also predicts that the degree of weakening or healing of the weak suture and the thermal thinning of the necking area control at which stage suture reactivation is deactivated and extension proceeds by mantle lithosphere thermal necking. Two rifted conjugate margins with orogenic inheritance in the North and South Atlantic are used for comparison.