MECHANICAL ANISOTROPY OF THE LITHOSPHERIC MANTLE AND CONTINENTAL RIFTING: OBSERVATIONS AND MODELS

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The close temporal and spatial association between flood basalt extrusion and continental breakup suggests that mantle plumes play an important role on the rifting process. There is, however, a paradox between the pinpoint thermal and stress perturbation generated by an upwelling mantle plume and the linear geometry of rifts. Analysis of various plume-rift systems also highlights that rifts are offset relative to the plume head apex, where extensional stresses are maximum. Rift propagation is not random; it tends to follow the trend of the pre-existing orogenic fabric of the plates, systematically reactivating ancient lithospheric structures. Moreover, continental rifts often display a clear component of strike-slip deformation, in particular during the early rifting stage. The source of this structural inheritance lies in a mechanical anisotropy of the lithospheric mantle due to the preservation of a lattice preferred orientation (LPO) of olivine crystals formed during major orogenic episodes. We use a polycrystal plasticity model to calculate the viscoplastic deformation of a pre-structured lithospheric mantle in response to various tensional stress fields. Model results show that the interaction between the extensional stress field and the LPO-induced mechanical anisotropy of the lithospheric mantle may explain both the structural inheritance and the onset of transtension within continental rifts.