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Interaction Between Mantle Plume Processes and Surface Topography in Incipient Rift Systems, EARS

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In an asymetric extensional setting such as the East African Rift System (EARS), the pronounced regional variations in topography are generally explained by two different models: a) a post-rift uplift resulting from mechanical relaxation that evokes an uplift of the rift shoulders, and b) a syn-rift uplift effected by mantle plume pushing during extension. However, an important pre-rift topographic feature can be documented in the Kenya rift. The pre-rift Yatta Plateau (13.5 Ma) is a phonolitic lava flow with a length of appr. 290 km that flowed eastward, away from the present-day eastern rift shoulder of the Kenya rift. Due to the combination of flow within a pre-existent river valley and later erosional processes the flow is now characterized by relief inversion. At present this river runs exactly parallel to its paleo-valley and erodes its western flank. We reconstruct the paleo-topography by estimating the pre-rift slope and assuming an active lava flow. Viscosities, derived from phonolitic and basaltic bulk rock compositions cooling down from their eruption temperature, permits the calculation of the lava flow velocity. The appliance of this method to unravel the history of this volcanic feature allows us to draw conclusions on the geometry of the central EARS and proves the existence of high topography and relief contrasts along its recent rift axis since appr. 14 Ma, prior to the extension. We propose that the topography is due to a pre-rift uplift caused by thermal expansion of the lithospheric rocks and effected by a heating mantle plume.