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Neogene Uplift of the Anatolian Plateaux: Insights from Drainage Modelling and Basaltic Thermobarometry

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The origin of the high elevation and low relief Anatolian Plateaux remains enigmatic. Marine sedimentary rocks of Miocene age are scattered across Central and Eastern Anatolia, requiring 1–2 km of regional uplift over the last 10–20 myr. However, present-day patterns of crustal deformation, dominated by translation and extension, cannot explain this dramatic uplift. This observation, along with large positive free-air gravity, positive heat flux and slow upper mantle seismic wave speed anomalies, has led many authors to invoke processes ongoing in the sub-lithospheric mantle. Examples include fragmentation of subducting African lithosphere, delamination or dripping of the Anatolian lithosphere, and upwelling asthenospheric thermal anomalies. Alone, uplifted marine rocks provide a sparse record of regional uplift. More detailed information should be recorded by drainage networks. Indeed, major catchments contain prominent knickzones with heights of hundreds of meters and length scales of several hundred kilometers. The stream power formulation for fluvial erosion permits these knickzones to be interpreted in terms of uplift history along a river's length. Here, we jointly invert an inventory of 1,844 river profiles to determine a spatial and temporal uplift rate history. The inverse model is calibrated against independent observations of long term uplift and incision rate. When appropriate model parameters are used, an excellent fit to observed river profiles, uplift rates and incision rates can be achieved. Our results suggest that uplift initiated in Eastern Anatolia at around 20 Ma and propagated westward, with regional uplift rates of up to 0.5 mm yr^{-1}. Over the last 10 myr, abundant intraplate-style basaltic magmatism has also occurred throughout Anatolia. We use two independent techniques to estimate asthenospheric potential temperature from the compositions of high-Mg basaltic rocks. Both techniques reveal a gradient in asthenospheric potential temperature across Anatolia, decreasing from up to 1400°C in the east to approximately that of ambient mantle in the west. This gradient is consistent with an increase in seismic wave speeds from east to west that is present in a range of recent tomographic models. The apparent correlation between present-day elevations, the timing of uplift and magmatism, and asthenospheric mantle temperatures strongly implies that a principle control on the evolution of the Anatolian Plateaux has been the propagation of asthenospheric thermal anomalies.