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The Planform of Mantle Convection

The surface expression of the convective circulation in the mantle beneath plate interiors is strongly modified by the thermal time constant and rigidity of the overlying plates. However, a number of different types of observations can be used to constrain the geometry of the circulation. Some magmas, especially mafic alkali basalts, are generated by decompression melting where there is mantle upwelling unrelated to plate separation. The convective circulation also generates dynamic topography and associated gravity anomalies. The most important and recent constraint comes from surface wave tomography. Three dimensional models of Vs can be used to calculate the temperature distribution. All these methods are first used to map the convective circulation beneath the Middle East, and show that a hot upwelling sheet extends from the Afar to Eastern Turkey. A convective planform consisting of plumes joined by sheets is well known from laboratory experiments, and is called spoke pattern convection. Maps of a larger area, of northern Africa and the Middle East, show that there are several spokes radiating from both the Afar and Eastern Turkish hubs, one of which is the Cameroon Line. This study shows that spoke pattern convection is likely to be widespread in the upper mantle.