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Phantom plumes in Europe and the circum-Mediterranean region

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Anorogenic magmatism of the circum-Mediterranean area (Tyrrhenian Sea, Sardinia, Sicily Channel and Middle East) and of continental Europe (French Massif Central, Eifel, Bohemian Massif and Pannonian Basin) has been proposed to be related to the presence of one or more mantle plumes. Such conclusions based on geochemical data and seismic tomography are not fully justified because: 1)a given chemical and isotopic composition of a magma can be explained by different petrogenetic models; 2)a given petrogenetic process can produce magmas with different chemical and isotopic composition; 3)tomographic studies do not furnish unique results (i.e., different models give different results); 4)the commonly adopted interpretation of seismic wave velocity anomalies exclusively in terms of temperature is not unique – velocities are dependent also on other parameters such as composition, melting, anisotropy and anelasticity. Tomography and geochemistry are powerful tools but must be used in an interdisciplinary way, in combination with geodynamics and structural geology. Alone they cannot provide conclusive evidence for or against the existence of mantle plumes.

The existence of large and/or extensive thermal anomalies under Europe is considered unnecessary, because other models, based on the existence of upper mantle heterogeneity, can explain the major, trace-element, and isotopic variability of the magmas. Volcanism in central Europe (the French Massif Central, Germany and the Bohemian Massif) is concentrated in Cenozoic rifted areas and is here interpreted as the result of passive asthenosphere upwelling driven by decompression. Similarly, anorogenic magmatism in Sardinia, the Tyrrhenian Sea and the Pannonian Basin is explained as the result lithospheric stretching in a back-arc geodynamic setting. The most important factors determining the locus and, in part, the geochemical characteristics of

magmatic activity are the Moho and the lithosphere/asthenosphere boundary depths. Where both are shallowed by tectonic processes (e.g., in rift zones or back-arc basins) passive upwelling of asthenospheric mantle can explain the magmatic activity.