Geophysical Research Abstracts
Vol. 21, EGU2019-12883, 2019
EGU General Assembly 2019

Mesozoic-Cenozoic uplift and exhumation in Central Europe – data and concepts

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The Mesozoic-Cenozoic intracontinental Central European basin system comprises many areas where subsidence was punctuated by uplift during some period of the basin history. Uplift events are documented by incomplete sedimentary successions, unconformities, present-day elevation of marine strata, recent erosion, and topography. Long-standing, several hundred Myr-scale highs such as the Bohemian Massif, the London-Brabant Massif and Ringkøbing-Fyn High have slightly thickened crust that probably represents remains of Paleozoic orogenic roots. Thermochronological ages from the Rhenish and Bohemian Massifs indicate slow uplift over extended periods of time. The most substantial exhumation event occurred in Late Cretaceous time from about 100-60 Ma. Thermochronologic data from the German uplands (Mittelgebirge) demonstrate that erosion was centered on blocks and subbasins raised by folding and thrusting in a widespread "Subhercynian" phase of tectonic inversion. However, exhumation of smaller magnitude also affected intervening synclinal areas, suggesting that a mechanism other than thrusting contributed to the Late Cretaceous uplift. Basinal areas to the north, from the southern North Sea to Poland, also show inversion structures but no generalized regression. By contrast, the following Paleocene ca. 60 Ma "Laramide" uplift event is marked by regional regression and a reorganization of the sedimentary system with chalk being replaced by shale deposition. Different from the Late Cretaceous uplift, no localized folds or thrusts formed, indicating that crustal shortening was not involved in the Paleocene event. Together, the Cretaceous and Paleocene uplift phases resulted in a crescent-shaped elevated area surrounding the North Sea Basin in the west and south and including Great Britain and the German uplands. An emergent area of similar shape and extent is already visible on paleogeographic maps during a period of low sea-level in Early Cretaceous time, and a comparable pattern of uplift around the North Sea basin was interpreted for Neogene time. A Cenozoic phase of contraction affected the Channel area, southern England (e.g., the Weald Basin) and the southern North Sea in Eocene to Early Miocene time, but unlike the Cretaceous inversion event was not associated with regional uplift.

Differences in wavelength, amplitude and persistence over time of uplifting regions probably offer the best diagnostic criteria for identifying the processes creating them. Crustal shortening is expected to produce rapid, short-wavelength, high-amplitude, long-lasting uplift. Thinning of the mantle lithosphere should induce slower and potentially long-lasting uplift of smaller magnitude over larger areas, whereas mantle upwelling should lead to rapid and transient uplift (dynamic topography) of limited magnitude in subcircular regions more than ca. 1000 km across. The Late Cretaceous uplift of the German uplands was fast, of high amplitude, of regional extent and persistent. Only a combination of different processes seems capable of achieving this. Crustal shortening is documented in many localized structures. Incipient thinning of the mantle lithosphere is consistent with sparse occurrences of latest Cretaceous to early Tertiary alkaline volcanics and probably continued to culminate in more widespread Cenozoic mafic volcanism. The rapidity of the initial regional uplift may indicate a component of dynamic topography. Extricating the individual contributions remains an observational and conceptual challenge.