Vertical tectonics and stratigraphic evolution of rifted volcanic margins

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The relationship between mantle plumes and the development of rifted volcanic margins is arguably the most controversial aspect of our understanding of continental breakup. Recent ODP drilling in the Northeast Atlantic has done much to constrain the conditions of breakup and the influence of the Iceland Plume . In addition to the analysis of the volcanic dipping reflector sequences that characterize these areas the overlying sequences have been used to chart the subsidence of the margins since breakup. Comparison of these subsidence histories with models for the development of normal oceanic crust has permitted temperature anomalies in the underlying mantle to be identified and quantified. The 80-100°C anomaly implied at the time of breakup is significant as it is less than expected if the the 18-21 km of oceanic crust had been generated solely by passive upwelling and melting of the mantle. The result implies vigorous upwelling under the margin during breakup. Rapid subsidence of the margin, typically 5-7 m.y. following breakup, is interpreted as the dispersal of this anomaly. The figure shows the reconstructed history at ODP Site 918, where the depth/thermal anomaly (orange zone), lasts longer than those on the European margin and even increases after breakup. This surprising result is taken to reflect increasing influence of the Iceland Plume, which enters the basin after breakup, implying that the initial temperature anomaly may be more rift-related than plume-related. Collapse of the oceanic plate due to dispersal of the temperature anomaly contrasts with the more modest behavior of the continental shelf, where the thick lithosphere resulted in less “dynamic support.” The resultant steepening of the slope caused mass wasting and base-of-slope fan development in the Irminger Basin, an event normally related to falls in sea level.

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