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North Atlantic Igneous Province Formation: An interdisciplinary geophysical and geochemical review

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Continental break-up between Eurasia and Greenland at the Paleocene-Eocene transition marked the culmination of a ∼340 My period of predominating extensional deformation in the northern North Atlantic since the end of the Caledonian orogeny. This resulted in development of numerous sedimentary basins bordering the northern North Atlantic, accompanied by melt intrusions as well as by extrusive events. Earlier in the rift phase melt volumes were limited, but dramatically increased toward break-up. Following break-up, the Icelandic mantle anomaly has left its imprint on the oceanic lithosphere. These magmatic events prior to and during continental separation, and the continuous activity of the Icelandic mantle anomaly, formed one of the largest Large Igneous Provinces (LIP) in the world: the North Atlantic Igneous Province (NAIP). As several primary features of the NAIP region require adaptations of the classical plume hypothesis (cf. www.mantleplumes.org), a multidisciplinary re-evaluation of this LIP is crucial to really understand its formation.

A challenging question in the NAIP formation is the extent to which the Iceland mantle plume has been involved in the different stages of its evolution. Alternative scenarios have been proposed that require a less prominent role of the Iceland mantle plume or reject its influence altogether, such as (edge-driven) small-scale convection, impacts, and mantle heterogeneities. We have systematically combined and questioned all present data including: 1) the chemical content of igneous rocks in the NAIP, as well as age and distribution, 2) the seismic expression of the rifting and magmatism processes and their ambiguous interpretations, and 3) the vertical movements and tectonic evolution of the lithosphere during formation of the NAIP. This data set is com-

pared with numerical and analogue model predictions of mantle plume dynamics as well as the alternative hypotheses for NAIP formation.