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History of the incipient Icelandic plume: Observations from ancient buried landscapes

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Ancient buried terrestrial landscapes contain records of vertical motions which can be used to probe histories of geodynamical processes. In the North Atlantic Ocean, sedimentary basins contain excellent evidence that the continental shelf experienced staged subaerial exposure. For example, now buried landscapes were uplifted, rapidly eroded, and drowned close to the Paleocene-Eocene boundary. We use commercial wells and three-dimensional seismic data to reconstruct a 57–55 Ma landscape now buried ∼1.5 km beneath the seabed in the Bressay area of the northern North Sea. Geochemical analyses of organic matter from core samples intersecting the erosional landscape indicate the presence of angiosperm (flowering plant) debris. Combined with the presence of coarse clastic material, mapped beach ridges, and dendritic drainage patterns, these observations indicate that this landscape was of terrestrial origin. Longitudinal profiles of ancient rivers were extracted and inverted for an uplift rate history. The best-fitting uplift rate history has three phases and total cumulative uplift of ∼350 m. Biostratigraphic data from surrounding marine stratigraphy indicate that this landscape formed within 1–1.5 Ma. This uplift history is similar to that of a slightly older buried landscape in the Faeroe-Shetland basin 400 km to the west. These records of vertical motion can explained by pulses of anomalously hot asthenosphere spreading out from the incipient Icelandic plume. Using simple isostatic calculations we estimate that the maximum thermal anomaly beneath Bressay was ∼50˚. Our observations suggest that a thermal anomaly departed the Icelandic plume as early as 58.5 Ma and had highest average temperatures at ∼55.6 Ma.