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Tracking the Iceland plume across the Arctic Ocean

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It is widely assumed that Iceland sits above a mantle plume or hotspot. This plume has been tracked back to about 60 Ma, when it resided beneath Greenland (e.g., Lawver and Muller, 1994). The widespread magmatism of the North Atlantic Large Igneous Province has been attributed to the rapid decompression of a large body of hot mantle (Saunders et al., 1997), perhaps representing the arrival beneath the lithosphere of a 'start-up' plume head (Campbell and Griffiths, 1990) at about 60 Ma – the initiating Iceland plume. There is, however, considerable uncertainty about any earlier magmatic expressions of the plume, if indeed there were any. The start-up plume model predicts none; prior to about 60 Ma the plume would have been en route from the deep mantle, and decompression melting would not yet have begun.

In this contribution we explore the alternative possibility that the plume existed long before 60 Ma and was responsible for volcanic activity in northern Canada, beneath the Arctic Ocean, and across the Barents Shelf and in Siberia. Plate reconstructions place the plume beneath what is now northeastern Canada at about 80 Ma (Forsyth et al., 1986a; but see alternative view by Lawver and Muller, 1994). This correlates with an episode of basaltic volcanism in the Queen Elizabeth Islands (Ellesmere and Axel Heiberg Islands), dated at around 90 Ma (Trettin and Parrish, 1987; Tarduno et al., 1999; Villeneuve and Williamson, in press). The aseismic Alpha Ridge is bathymetrically linked to northern Ellesmere Island, and extends northwards beneath the Arctic Ocean. The Ridge is at least also partly Cretaceous in age; comprises, at least in part, basalt (van Wagoner et al., 1986; Jokat et al., 1999); and has a structure reminiscent of plume-related ridges found elsewhere (Forsyth et al., 1986b; Jackson et al., 1986). There are currently insufficient data to indicate whether the basement of the Ridge increases in age northwards from Ellesmere Island, although this would be an excellent

target for future deep-sea drilling.

Earlier (lower Cretaceous) basaltic volcanism occurred on parts of Svalbard, Kongs Karl Land, Franz Josef Land and the De Long Islands (e.g., Grachev, 2001). Widespread subcrops of basalt, detected by geophysical surveys, occur to the south and east of Svalbard (Grogan et al., 1998), and are also inferred to be part of this broad igneous province (the High Arctic LIP: Maher, 2002; Drachev and Saunders, in press). Preliminary age data indicate that these widely-distributed outcrops are part of the same event, but the data are not as yet sufficiently precise to determine whether the occurrences are truly contemporaneous, or whether there is any systematic age progression across the Arctic region.

Several authors have raised the intriguing idea that the earlier Siberian Traps (ca. 250 Ma) were the product of the same plume that later would produce the magmatism of the High Arctic Large Igneous Province, the Alpha Ridge, Ellesmere Island, the North Atlantic Igneous Province and Iceland (e.g, Bailey and Rasmussen, 1997; Lawver et al., 2002). Recent Ar-Ar data from the Taimyr Peninsula, to the north of the main Siberian Traps, reveal Triassic (ca 225-230 Ma) and Jurassic (190-200 Ma) igneous activity (E. Eide, pers comm.), indicating that the locus of activity was moving (in a relative sense), northwards from the Siberian Craton and West Siberian Basin and out towards what is now the Kara Sea. It is not a great leap to speculate that the activity continued in the Cretaceous across areas of the Barents Shelf, and the then contiguous Lomonosov Ridge.

If this interpretation is correct – and it important to stress at this point that it is highly speculative – then several implications spring to the fore. Firstly, that this would be the longest-lived plume system on record – some 250 Ma. Secondly, that the plume varies dramatically in its output, with pulses of magmatism at 250, 230, 200, 125, 90, and 60 Ma. Thirdly, there are periods when the plume is virtually inactive, for example between about 90 and 60 Ma. This may be an artefact of sampling, but to our knowledge no basaltic rocks from this time interval have been recovered from eastern Canada, western Greenland or the Davis Strait, where they may be expected to occur.

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