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Late opening of the Amerasia ocean basin following arrival of HALIP plume?

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The opening history of the Arctic Ocean remains poorly understood, particularly that of the Amerasia Basin and surrounding margins [1]. Key questions are: What is the extent of ocean floor versus extended continental margin? When did ocean floor spreading initiate in the Amerasia Basin? What is the age, spatial distribution, and role of mafic magmatism on the continental margins surrounding the Arctic Ocean? And what is the nature of the Alpha Ridge? Is it best understood as an oceanic hotspot trail or plateau and, if so, what is its age? Mafic volcanic rocks (tholeiitic flows) and intrusive dykes and sills are minor but widespread components of the continental margins facing the Arctic Ocean, and all are Cretaceous in age [e.g., 2,3]. This has led to the concept of a High Arctic large igneous province or "HALIP" [4] and a debate on its role in Arctic Ocean opening and in the formation of the Alpha Ridge. Results to date have shown that HALIP magmatic activity was prolonged and pulsed, with ages spreading out between ca. 130 Ma and 70 Ma. Variably disturbed K-Ar and Ar-Ar dates increase the overall dispersion of ages and have hindered a clear age picture. However, new U-Pb ages on zircon and baddeleyite [3,5], together with stratigraphic ages on volcanic units [6], are starting to bring the overall age distribution into focus. Here we present two precise U-Pb baddeleyite ages on large diabase sills in the Sverdrup Basin of Arctic Canada that are ca. 121 Ma, on northern Axel Heiberg and western Ellesmere Island. As small platy baddeleyite grains are commonly 0.5-1.5% discordant due to surface-related Pb loss, it is possible the age of these sills is ~1% older at 121-123 Ma. These new ages match the ages of sills and volcanic rocks around the Arctic Basin, from across the Sverdrup Basin, to Svalbard and Franz Josef Land on the Barents Sea margin, and to islands on the Siberian margin [e.g., 3]. We conclude that this 121-125 Ma tholeiitic magmatism represents the first major, and most voluminous, magmatic pulse of the HALIP, being present on all margins. Lower volume precursor magmatism may be as old as 126-128 Ma [5], but there are no robust magmatic ages prior to 128-130 Ma. The Canadian and Barents Sea margins both saw marine conditions during the late Jurassic and earliest Cretaceous, followed by pronounced shoaling and a transition, at ca. 135-130 Ma, to widespread terrestrial conditions (Isachsen Fm.) immediately prior to the onset of widespread tholeiitic magmatism. Another key observation is that major diabase dyke swarms associated with the early tholeiitic pulse of the HALIP tend to focus towards the Arctic continental margins [e.g., 7]. In particular, the radiating Lightfoot River swarm of ~N-S trending dykes, some as wide as 50-60 m, is oriented almost at right angles to Canada's Arctic margin, converging to an apparent magmatic centre where the Alpha Ridge meets this margin. These observations are easiest and most parsimoniously explained by the early, most widespread, and highest volume tholeiitic pulse of HALIP representing the arrival of a starting plume underneath an already extended Arctic Basin, initiating continental breakup and ocean opening shortly after 125-121 Ma, with the Alpha Ridge representing a broad oceanic hotspot trail and younger oceanic plateau. Shoaling and uplift at ca. 135-130 Ma represents the pre-magmatic uplift phase above the impinging starting plume. Ocean floor spreading in the Amerasia Basin started with the onset of the Cretaceous superchron, explaining the absence of magnetic striping. Younger HALIP pulses represent interaction of the waning

stages of the plume and plume tail with the margins, additional rift phases, and the delayed melting of onshore continental lower crust due to magmatic underplating.

References:

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