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Influence of Large Igneous Provinces on Svalbard tectonics and sedimentation from the Late Mesozoic through Cenozoic: Insight from (U-Th)/He zircon and apatite thermochronology

Christopher Barnes (1), David Schneider (1), and Jaroslaw Majka (2)
(1) University of Ottawa, Ottawa, Canada, (2) Uppsala University, Uppsala, Sweden

Svalbard, the northwestern sub-aerial exposure of the Barents Shelf, offers significant insight into the geodynamics of the High Arctic. The tectonics and sedimentation on Svalbard from the Late Mesozoic through Cenozoic can be attributed to two Large Igneous Provinces: the High Arctic Large Igneous Province (HALIP; 130–90 Ma) and the North Atlantic Large Igneous Province (NAIP; 62–55 Ma). The relationship between the HALIP and the tectonics of the High Arctic remains somewhat unclear, whereas the NAIP is directly linked to opening of the North Atlantic Ocean. This study attempts to establish links between the HALIP and geodynamics of the High Arctic, and reveals the far-field tectonic consequences of the NAIP on Svalbard and the High Arctic. We focus on the Southwestern Caledonian Basement Terrane of Svalbard, characterized by the West Spitsbergen Fold and Thrust Belt, formed during the Eurekan Orogeny (c. 55–33 Ma). Crystalline basement was sampled from four regions (Prins Karls Forland, Oscar II Land, Wedel Jarlsberg Land, and Sørkapp Land) for the purpose of zircon and apatite (U-Th)/He thermochronometry which allows for resolution of thermal events below 200°C. We forward model our datasets using HeFTy software to produce temperature-time histories for each of these regions, and compare these thermal models with Svalbard stratigraphy to resolve the geodynamics of Svalbard from the Late Mesozoic through Cenozoic. The Cretaceous stratigraphy of Svalbard is characterized by a short-lived Mid-Cretaceous sub-aerial unconformity (c. 129 Ma) and a significant Late Cretaceous unconformity (c. 105–65 Ma). Our thermal models reveal a Mid-Cretaceous heating event, suggesting an increasing geothermal gradient coeval with development of the first unconformity. This may indicate that short-lived domal-uplift, related to the arrival of the HALIP plume, was a primary control on Svalbard tectonics and sedimentary deposition throughout the Mid-Cretaceous. Late Cretaceous cooling (85–65 Ma), coeval with development of the Late Cretaceous unconformity, is indicative of moderate uplift on Svalbard during this time. We interpret this as rift-flank uplift, related to opening in the Lincoln Sea north of Svalbard. Given the location of the HALIP plume on the southern Alpha Ridge, we suggest that HALIP emplacement contributed to a stress-field facilitating rifting in the Lincoln Sea (a precursor to rifting of the southern Eurasian Basin; c. 56 Ma). A change in paleoflow direction of Svalbard sediments from Paleogene NNE-sourced to Eocene W-sourced sediments denotes a change from HALIP-influenced to NAIP-influenced tectonics and sedimentation on Svalbard. An Eocene heating event (55–40 Ma) is the result of tectonic burial via overthrusting during the Eurekan Orogeny, providing the western sediment source. Eurekan tectonism on Svalbard is the result of the northward movement of the Greenland microplate, a consequence of spreading in the North Atlantic Ocean. The most recent cooling event (40–20 Ma) is primarily attributed to rift-flank uplift resulting from northward propagation of the North Atlantic Ocean and opening of the Fram Strait. Low-temperature (U-Th)/He low-temperature thermochronometry allow us to document shallow crustal processes that, which are linked to Large Igneous Provinces and other mantle dynamics.