How long has the HIP been cool? The misunderstood youth of the Hebridean Igneous Province

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Many Large Igneous Provinces (LIPs) are deeply eroded, and large volumes of the volcanic products have been partially or completely removed by denudation. Consequently, the former volume of volcanic provinces, and the timing and rates of cooling, exhumation, and landscape evolution are generally poorly constrained. We combine apatite fission track (AFT) and the apatite and zircon (U-Th)/He thermochronometers to unravel the cooling history of the Palaeogene Hebridean Igneous Province (HIP) that formed as part of the pre-rifting phase of magmatism in the North Atlantic LIP.

In the HIP denudation has removed much of the basaltic lava pile and has exposed the plutonic complexes emplaced at its base. The thermochronology suggests that the oldest of the complexes experienced rapid syn-magmatic unroofing, consitent with existing conceptual models and field evidence. However, more complex thermal histories are recorded elsewhere. On the island of Skye, shallow level granites were emplaced at 59-55 Ma yet record rapid cooling from >250 to <80ºC at ~47 Ma. A similar story is evident from a tuffaceous sandstone near the base of the Eigg lava field. Despite being covered by <500 m of basalt at ~59 Ma, zircon (U-Th)/He ages are ~47 Ma. This cooling event is significantly younger than the onset of Atlantic Ocean rifting (~55 Ma), which marks the end of known igneous activity in the HIP.

Elevated temperatures at depths of 500 m - 2 km cannot have been maintained from 55-47 Ma without continued intrusive activity and/or much thicker volcanic sequences. There is no significant evidence for either of these scenarios. We therefore propose that elevated temperatures were re-established prior to the 47 Ma cooling event, requiring a significant, but localised influx of heat ~7 Myr after rifting. This suggests that limited magmatism in the HIP continued much longer than previously thought.

We will present a model for the regional evolution of the HIP combining the timing and rate of cooling, denudation, and the localised re-heating and cooling event at ~47 Ma. We will discuss the consequences of prolonged magmatism in the HIP, and the implications for the evolution of the continental flanks of the North Atlantic rift.