Tectonic controls on the timing and chemistry of Palaeogene flood basalt volcanism in NE Ireland

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A major part of the Palaeogene North Atlantic Igneous Province (NAIP), the Antrim Lava Group (ALG) consists of basaltic rocks that cover a large portion of NE Ireland. It is split into two main basaltic formations – the Lower Basalts and Upper Basalts – the eruption of which occurred in two cycles, separated by distinctive laterised red bole horizons and intermediate to felsic lavas of the Interbasaltic Formation. These cycles are believed to coincide with two province-wide pulses of magmatism at 60Ma and 56Ma respectively.

$^{4o}Ar/^{39}Ar$ ages for lava flows from the ALG give statisically meaningful age plateaus for each of the main formations. Stratigraphically constrained lava flows from one area in East Antrim indicate that, locally, Lower Basalt volcanism waned at 61.9 ± 0.4 Ma and, above a 10m succession of lateritised red bole, Upper Basalt volcanism began around 59.0 ± 0.4 Ma. A northward time progression is noted across the ALG, with some flows as young as 57.5 ± 0.7 Ma being found within the Interbasaltic formation in the North of Antrim.

Here we present new XRF and ICP-MS whole rock data, along with Sr, Nd and Pb isotopic data for lava flows across the province. This geochemical data also records geographic trends within the ALG. In particular, the Upper Basalts record the most variation, not only stratigraphically in individual localities, but also regionally at fixed stratigraphic levels. Variations in REE patterns, along with a $^{87}Sr/^{86}Sr$ range of 0.703-0.715, indicate that both the chemistry and the tectonic structure of the local crust play a major role in the emplacement and petrogenesis of the ALG. Understanding the magma pathways and residence times within the local crust is just as vital as the levels of contamination by that crust when explaining both geochemical and geochronological variation across NE Ireland.

The deep vadoze zone as a source of uranium to the near-shore aquifer at the Hanford Site, Washington

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The Columbia River exhibits large seasonal discharge/stage variations, particularly in the spring, which propagate directly into the near-river groundwater aquifer in the form of water table fluctuations. A persistent uranium (U) plume exists in the aquifer, hypothesized to originate from U capture by the rising water table, over the extent of its annual vertical excursion (the 'smear zone'). The uranium source was evaluated by bailing the uppermost 15 cm of the aquifer, daily, over the Integrated Field Research Center (IFRC) footprint. Conventional pumped samples were collected a the same time from the center of the fully screened wells. In some wells, the aquifer-top U concentration varied modestly above the pumped, low water, mid-winter values (e.g. ~50 ug/L). In others, dramatic concentration increases were observed (>300 ug/L), that were much higher (3x) than corresponding pumped-sample values. This behavior was observed during the multiple rise-and-fall cycles in river stage that occurred over the monitoring period. Although some vertical well flow was observed due to hydrologic head variations induced by river stage fluctuations, U solubilized from the smear zone did not mix with deeper groundwaters of the Hanford formation (there were three wells with short, deep completions), yielding a stratified system. The overall concentration of U, indicated by three evenly distributed shallow-completion wells, increased unevenly across the site during the experiment, indicating that the contribution from the vadose sediments was broad, but heterogeneous. Uranium isotopic measurements indicated that compositional variation was present in vadose U, and the results overall indicated that the deep vadose zone provided a seasonal, spatially heterogeneous source for seasonal recharge of U to the aquifer. This research is part of the ERSP Hanford IFRC at Pacific Northwest National Laboratory.