U-series based sediment fluxes and provenance south of Iceland since the last glacial maximum

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Sediment provenance in the Björn drift, south of Iceland, is thought to have alternated between European and Icelandic sources during glacial and interglacial periods, respectively. This alternation is consistent with the observed ($^{234}U/^{238}U$) cyclicity. ($^{234}U/^{238}U$) ratios in fine grained materials decrease with time because of alpha recoil processes. Therefore, locally derived Icelandic sediments have ratios close to secular equilibrium, whereas European sediments have lower ($^{234}U/^{238}U$) reflecting longer transport times.

To provide better constraints on sediment fluxes from European and Icelandic sources, and determine the influence of bottom currents on the ($^{234}U/^{238}U$) record, we present new high-resolution U-series results that span the last glacial maximum and deglacial at ODP site 984C, located on the Björn drift. We use ^{230}Th-normalisation to calculate vertical rain rates and compare these fluxes to mass accumualtion rates to determine the lateral advection of sediments.

The overall trend is that ($^{234}U/^{238}U$) ratios increase from the glacial to the Holocene, with distinctly lower ratios during Heinrich Event 1 and the Younger Dryas. Our detrital flux estimates coupled with ^{232}Th concentrations indicate that this long-term change is controlled by a decrease in the flux of European sediment whilst the vertical Icelandic flux remains approximately constant. However, the absolute ($^{234}U/^{238}U$) ratios predicted from vertical fluxes alone underestimate our observed values. Instead lateral advection of sediments transported by bottom-currents is required. These results show that the lateral focussing of Icelandic sediments occurs throughout the studied period, and increases during the Holocene. We interpret this higher Holocene focusing as the result of the intensification of the Iceland Scotland Overflow Water circulation. Prior to the Holocene, increased lateral transport of European sediments is required to match the observed and predicted values. This observation supports the hypothesis of a vigorous Glacial North Atlantic Intermediate Water (GNAIW), which would entrain European margin sediments and deposit them at the Björn Drift. Similarly the low ratios during cold events may be related to transient intensifications in GNAIW.

Petrogenetic inferences from zircon/ whole rock minor and trace element partitioning in ancient gneisses

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Element partitioning in mineral/melt (or /whole rock; /WR) can be modeled as the elastic energy required to force a sphere of radius r_0 (1+e) into a site of radius r_0 in a solid with a known Poisson ratio and compressibility. This behavior is predictable for the size and the elasticity of the crystal site in which substitution occurs [1, 2]. Igneous zircons have high HREE/LREE due to the lanthanide contraction and relative $HREE^{3+}$ compatibility in the Zr^{+4} site. In principle, REE concentrations in zircons should place constraints on growth conditions. Yet, experimental partition ($D^{zircon-melt}$) data show that REE values can range over several orders of magnitude [3] and because D-values are also controlled by P, T, fO_2, crystal and melt composition, inverse models used to reconstruct melt compositions based solely from zircon compositions are unsatisfactory. Studies of natural rock samples are warranted to further understand zircon D-values and their petrogenetic meaning. Minor- and trace element contents of metamorphic zircon vs. WR deviate strongly from predicted magmatic partitioning [4]; $D^{zircon-WR}$ for different zircon populations are useful to elucidate the petrogenetic history of ancient (and complex) poly-metamorphic terranes.

A suite of 4.02–3.75 Ga gneisses were chosen for *in situ* $D^{zircon-WR}$ measurements of trace elements (REEs, Ti, Th, U), minor elements (P, Fe, Y) and Hf in petrographic thin sections and mineral separates. These rocks experienced protracted deformational and P-T histories which ranged from 0.2-0.5 GPa at ~630°C, to 0.7-1.0 GPa at ~800°C [5-7]. Only for the igneous zircon populations do Onuma diagrams show systematic near-parabolic dependence on cation radius in $D^{zircon-WR}$: r_0 +3 curves peak near Lu (0.977Å), while r_0 +4 curves peak at 0.91Å (near Hf and Zr). Metamorphic zircons exhibit more horizontal $D^{zircon-WR}$ vs. ionic radius (↑La/Lu; variable Th/U). Integrated $D^{zircon-WR}$, $(Th/U)_{zircon}$, and U-Pb geochronology can effectively discriminate between igneous, inherited and metamorphic zircon populations in gneisses.

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