Ultra depleted mantle at the Gakkel Ridge

VINCENT SALTERS[1*], AFI SACHI KOCHER1, HENRY J.B.DICK[2]

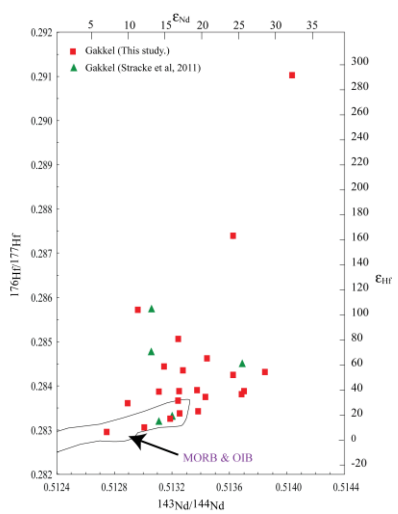
[1]NHMFL and EOAS, Florida State University, Tallahassee, Florida, USA, salters@magnet.fsu.edu (* presenting author) [8pt font size]

[2]MG&G, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA, hdick@whoi.edu

The Gakkel Ridge is one of the slowest spreading ridge segments in the global ridge system and with some of the thinnest oceanic crust. In some locations there is little or no evidence for volcanic activity and oceanic mantle is directly exposed on the ocean floor. This provides an excellent opportunity to investigate the heterogeneity of the oceanic mantle in situ.

We have analyzed a number of peridotites from the western end of the Sparsely Magmatic Zone (3^o to 28^{o}E as well as samples further west up to 65^{o}E) and found highly radiogenic Hf and Nd isotopic composition. All but five samples are more radiogenic in either Nd or Hf than MORB. Six samples lie in the extension of the OIB MORB array with ε_{Nd} up to 23.7 and ε_{Hf} up to 54.6. The remainder of the data (14 samples) lie above the OIB-MORB array and its extension with ε_{Nd} values up to 27.4 and ε_{Hf} values up to 291! These values are the most extreme values measured for oceanic mantle. This data confirms the ultra depleted nature of the Gakkel Ridge mantle [1] and its highly heterogeneous nature [2].

Since the Hf and Nd system is expected to behave similar during melting, melt can be added back in the peridotite until the Hf and Nd model age coincide. These calculations show that depleted Gakkel Ridge peridotites have very little melt extracted from them (<1%) and have model ages that ranges from 2.4Ga to future ages with most between 600Ma and 1.2 Ga. The MORB Hf-Nd isotope systematics indicate this depleted component (ReLish) is ubiquitous [3] but under-sampled in basalts due to its depleted character. The presence of ReLish decrease the amount of melt a heterogeneous parcel of mantle can yield during ascent and average melt rate can be much lower requiring depth of melting to start deeper.



[1] Stracke, A, *et al.*, *Earth Plan. Sci. Lett*, **308**, 359-368 (2011).

[2] Liu, C.Z., *et al.*, *Nature*, 452, 311-315 (2008).

[3] Salters, V.J.M., et al., *Geochem. Geophys. Geosys*. 12, Q08001.

Integrated TIMS-TEA/LA-ICPMS constraints on pluton emplacement

K. SAMPERTON[1*], B. SCHOENE[1], J. COTTLE[2] AND J. CROWLEY[3]

[1]Princeton University, Department of Geosciences, Princeton NJ, USA, ksampert@princeton.edu (*presenting author)

[2]University of California–Santa Barbara, Department of Earth Science, Santa Barbara CA, USA, cottle@geol.ucsb.edu

[3]Boise State University, Department of Geosciences, Boise ID, USA, jimcrowley@boisestate.edu

Major conceptual and technical breakthroughs over the past decade have increased temporal and spatial resolutions for both ID-TIMS and LA-ICPMS. An outgrowth of this development is the ability to address whether zircon U-Pb ages can be assumed *a priori* to equate to the timing of pluton emplacement. We employ an integrated analytical regime coupling U-Pb TIMS-TEA with *in situ* LA-ICPMS trace element characterization in order to 1) assess intra-grain trace element zoning at the five micron scale and couple this with “bulk” geochemical and geochronological data, 2) fingerprint crystal populations within a single sample and better interpret age spread in high-precision datasets, and 3) characterize the temporal and geochemical evolution of magmas during ascent, mixing, and pluton assembly.

We apply this methodology to the 32-30 Ma Bergell Intrusion (N Italy), which preserves a spectacular 12-15 km crustal section through a single, continuous magmatic system, in addition to distinct process zones (pluton roof, floor, and feeder zone/tail). Preliminary U-Pb ID-TIMS zircon geochronology of CL-imaged grain fragments documents 400-500 kyr of zircon growth within individual hand samples ranging in composition from megacrystic granodiorite to tonalite. Precision on individual analyses of 10-20 ka (~0.05%) makes this duration easily resolveable. *In situ* trace element transects performed on the exact same minerals prior to ID-TIMS dating exhibit evolving core-to-rim REE and Hf abundances, which are interpreted to represent evolving magma composition and/or temperature. Variability in trace elements across single grains is often small compared to variation across many grains, necessitating high-precision ID-TIMS U-Pb geochronology in conjunction with the trace element data in order to evaluate long term (> tens of ka) trends in magma evolution, even in apparently autocrystic zircon populations. Geochemical transects were used to generate numerically modeled bulk trace element signatures and compared to TIMS-TEA data. The combination of these approaches produces trends strongly suggestive of closed system evolution of zircon chemistry through time for samples from ~15-20 km paleodepth.

While our data support TIMS-TEA as a viable analytical protocol, further work is required to understand the emplacement history of the Bergell. Expansion of our existing geochronologic/trace element dataset to include other dateable accessory phases indentified in Bergell samples, including monazite, allanite, and sphene, will be integrated with field observations and structural data in order to place robust constraints on such geochemical information. Our geochronological approach in the context of detailed geologic mapping will allow us to directly test competing models of Bergell emplacement (e.g., diapiric uprise vs. incremental assembly) by comparing the chronologies of different process zones (e.g., synmagmatically-deformed pluton floor vs. ballooning roof).