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Compositional variability of the oceanic crust as a function of spreading rate: insights from the ultra-slow spreading Gakkel Ridge (Arctic Ocean)

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Gakkel Ridge is the slowest spreading ridge on Earth (full rate:14.6-6 mm.yr^{-1}) in the Artic Basin. It extends over ~1,800 km, featuring a long ridge segment without transform faults. Bathymetric and gravity data show variations in crustal thickness and basalt chemistry, revealing three tectono-magmatic provinces: i) Western Volcanic Zone (WVZ), ii) Sparsely Magmatic Zone (SMZ), and iii) Eastern Volcanic Zone (EVZ).

The AMORE 2001 expedition (HLY0102 and PS59) recovered basalts, peridotites and gabbros from all provinces, allowing a detailed study of the mantle-crust chemical relationship at the Gakkel ridge. This contribution presents the petrography, chemical and isotope compositions of gabbros from the three sections. The SMZ gabbros range from troctolites to oxide gabbros and felsic veins, while the WVZ and EVZ gabbros are characterized by a lack of the most evolved and primitive lithologies, respectively. Magmatic amphibole is ubiquitous in the SMZ and EVZ gabbros.

In accordance with textural characteristics, mineral chemical differences between WVZ, SMZ, and EVZ show: i) SMZ and EVZ plagioclase having lower Anorthite (An) and FeO but higher K_2O than in WVZ, while clinopyroxene has higher Na_2O; ii) a covariation between Cpx Mg# and Plg An, with lower Plg An values in SMZ and EVZ compared to WVZ; iii) clinopyroxene in primitive gabbros from SMZ and EVZ has low TiO_2, suggesting early saturation of Ti-Fe oxides. Clinopyroxene from olivine gabbros and gabbros show primitive compositions, while those in oxide gabbros have higher REE and a deep Eu anomaly, consistent with fractional crystallization processes. However, SMZ clinopyroxene reveals enrichment in LREE (high La/Sm) relative to WVZ and EVZ. These data align with erupted MORB and suggest either lower mantle melting degrees or a more enriched mantle source. Comparison with other mid-ocean ridge gabbros indicates that Gakkel gabbroic crust is compositionally distinct and not strictly linked to spreading rates. The isotopic variability of the upper and lower oceanic crust suggests that not only the spreading rate, but also the mantle source composition plays a critical role in driving the lower oceanic crust chemistry.