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Age and Eruptive Style of Volcanic Rocks Dredged from the Alpha Ridge, Arctic Ocean

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The Alpha–Mendeleev ridge complex is a prominent physiographic and geological feature of the Arctic Amerasia Basin. The Alpha and Mendeleev ridges are, respectively, the eastern and western components of a continuous seafloor high that is approximately 2000 km long and 200–400 km wide. A surge of interest in the tectonic evolution of Arctic submarine features has led to a wealth of new geophysical data collected from the Alpha Ridge. Current interpretations of its origin vary but there is compelling evidence that the Alpha Ridge may have formed as an oceanic plateau during the Late Cretaceous. Geological samples are rare but most samples recovered indicate a genetic link with the High Arctic Large Igneous Province (HALIP).

In August 2016, Canada's Extended Continental Margin-United Nations Convention on the Law of the Sea Program dredged approximately 100 kg of volcanic rocks from the Alpha Ridge. The large size and pristine state of the samples enabled the first comprehensive study of a single eruptive event in the volcanic record of the Alpha Ridge. The dredge sample is a lapilli tuff containing vitric and basaltic clasts. Textural evidence and the coexistence of juvenile and cognate clasts suggest a phreatomagmatic eruption. The vitric fragments consist of sideromelane glass with abundant plagioclase microlites. Texturally, these basaltic glass lapilli display a fresh glassy core surrounded by Fe- and Ti-rich zones and a palagonite rim. Major and trace element analyses of glassy cores indicate remarkably uniform, mildly alkaline basaltic compositions. The plagioclase-bearing glass yielded a $^{40}Ar/^{39}Ar$ plateau age of 90.40 $\pm$ 0.26 Ma (2σ error) which included 89% of ^{39}Ar released. We interpret this result to represent the eruption age of the plagioclase microlites and consequently, of the host basaltic glass lapilli in the tuff. Volatile species analyses by infrared spectroscopy on the fresh basaltic glass suggests that the melt was effectively degassed to shallow level. Assuming equilibrium degassing, the homogeneous resulting values of H_2O_{total} in the range 0.1 to 0.19 wt.% (1σ error) indicate subaerial or shallow eruption (surface to 80 m).

The new $^{40}Ar/^{39}Ar$ age for the sample is consistent with a $^{40}Ar/^{39}Ar$ age of 89 $\pm$ 1 Ma obtained for a sample of tholeiitic basalt dredged from the central part of the Alpha Ridge, and with the range of ages reported for HALIP igneous rocks exposed onshore in the Canadian Arctic Archipelago (130-80 Ma). Our new data provide evidence for local emergence of the Alpha Ridge in the Late Cretaceous. A comparison of the Alpha Ridge and Kerguelen Plateau–Broken Ridge Large Igneous Province (LIP) provides new insights on the episodic nature of LIP magmatism and variations in eruptive style through time.