The Earth’s oxygen budget is important in understanding how our planet evolved and how it continues to evolve chemically over time. Scientists study the deep Earth to understand the oxygen cycle of the Earth’s interior, specifically the mantle, our planet’s largest oxygen reservoir. At the bottom of the sea, at mid-ocean ridges, the Earth is splitting apart and generating new ocean crust, bringing to the surface rocks from the upper mantle called abyssal peridotites (Fig. 1). As mantle rocks come to the surface, the lower pressure causes certain minerals in the rock to melt out preferentially to form magma; this is called partial melting. Geochemical differences among mantle rocks may be associated with varying degrees of partial melting and interaction with migrating melts as they travel to the surface. The Gakkel Ridge, located in the Arctic between Russia and Greenland (Fig. 2), is the slowest spreading mid-ocean ridge in the world (Hellbrand 2002), and the Earth is splitting apart and generating new ocean crust, bringing to the surface the slowest spreading mid-ocean ridge in the world (Hellebrand 2002), and samples were divided into categories based on both chrome number and light rare earth element (LREE) enrichment. Chrome number is directly related to melt extraction and interaction with migrating melts in the mantle. We used a thermodynamic property known as oxygen fugacity, which quantifies the ability for oxygen to react in a chemical system, in order to interpret how different types of melt processes affect the oxygen budget of the Earth’s interior.

**RESULTS**

“Normal” or fertile peridotites refer to mantle rocks that have experienced little melt-rock interaction while refractory peridotites exhibit a larger degree of melt-rock interaction and melt extraction. Normal harzburgites and lherzolites fall in the range of previous abyssal peridotite measurements of fO2, whereas refractory harzburgites show a trend of reduced fO2 with increasing chrome number (Cr# = Cr/(Cr+Al)), the normal hiezolites and normal harzburgites range from -0.1 to 0.6 log units relative to the QFM buffer (Fig. 5). Chrome number is relatively low for the normal peridotites (0.13-0.17), indicating low degrees of melt extraction from the rock, as chromium is compatible relative to aluminum during partial melting. Refractory harzburgites have low fO2 values, ranging from -0.7 to -2.7 log units relative to QFM. Chrome number in these samples is significantly higher (0.43-0.55), providing evidence of either large degrees of melt extraction or of melt-rock interaction.

**REFERENCES & ACKNOWLEDGEMENTS**

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**BACKGROUND**

The Earth’s oxygen budget is important in understanding how our planet evolved and how it continues to evolve chemically over time. Scientists study the deep Earth to understand the oxygen cycle of the Earth’s interior, specifically the mantle, our planet’s largest oxygen reservoir. At the bottom of the sea, at mid-ocean ridges, the Earth is splitting apart and generating new ocean crust, bringing to the surface rocks from the upper mantle called abyssal peridotites (Fig. 1). As mantle rocks come to the surface, the lower pressure causes certain minerals in the rock to melt out preferentially to form magma; this is called partial melting. Geochemical differences among mantle rocks may be associated with varying degrees of partial melting and interaction with migrating melts as they travel to the surface. The Gakkel Ridge, located in the Arctic between Russia and Greenland (Fig. 2), is the slowest spreading mid-ocean ridge in the world (Hellebrand 2002), and samples were divided into categories based on both chrome number and light rare earth element (LREE) enrichment. Chrome number is directly related to melt extraction and interaction with migrating melts in the mantle. We used a thermodynamic property known as oxygen fugacity, which quantifies the ability for oxygen to react in a chemical system, in order to interpret how different types of melt processes affect the oxygen budget of the Earth’s interior.

**METHODS**

Oxybarometry requires compositional data from the minerals, temperature, and pressure (Bryndzia and Wood 1990). We used electron microprobe analysis with Mossbauer-calibrated spinels to obtain the compositional data in each sample in order to calculate fO2 (Fig. 6).

6Fe3+Si2+O18 + 1/2.023 Fe2+SiO4 + 2Fe3+O4 + 3Fe2+O2 + O2

The above redox reaction shows how Fe2+ turns into Fe3+ as oxygen is added to the system (as fO2 increases), affecting the Fe3+/Fe2+ ratio in spinel, which we measure.

**DISCUSSION**

We observe that the most refractory samples in our suite record lower fO2s than any in the global peridotite array (Fig. 5). What is the timing and origin of such marked reducing conditions? D’Errico et al. (in prep) interprets the normal peridotites as recent melt extraction at the ridge, whereas the highly reduced refractory peridotites are believed to record a previous mantle melting event from the geologic past as well as recent melt interaction. Thus, the low fO2 recorded by these refractory samples either reflects a past melting event, or was overwritten by recent melt interaction beneath the ridge. These rocks record LREE enrichment (Fig. 8), which could arise from recent interaction with a mantle-derived melt; however, this hypothesis is not supported by the low Ti concentrations we measure in spinels (Fig. 8). Therefore, both the timing and mechanism that could account for our observations are poorly constrained. Further research on additional refractory harzburgites may provide insight of similarly reduced samples are discovered.

**SAMPLES**

Ten thin sections of abyssal peridotite were mapped using a petrographic microscope. These were variably altered by serpentinization processes which can make minerals a challenge to identify, sometimes even amnanalyzable (Fig. 4). Samples were divided into categories based on both Chrome number and light rare earth element (LREE) enrichment. Chrome number is directly related to melt extraction and LREE enrichment may indicate melt-rock interaction.

**REFERENCE**