Resolving potential sources of volcanism in Southern Victorialand, Antarctica using noble gases

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A relationship between lithospheric extension and mantle plumes is often assumed as the force driving rift evolution. Typically, only extension is supported by geological evidence, while the existence of a plume is commonly inferred from a combination of geochemical data and mantle tomography. The West Antarctic Rift System (WARS) is an active continental rift zone within the Antarctic Plate that is approximately 2000 km long. The WARS is associated with several long-lasting magmatic provinces, including the McMurdo Volcanic Group and Marie Byrd Land, that are highly alkaline and silica undersaturated with extreme enrichments in light rare earth elements. Most previous geochemical work in these provinces has focused on bulk classification, modal mineralogy, major element composition, trace element chemistry, and radiogenic isotopes (e.g., Sr, Nd, and Pb isotopes), but very few studies have evaluated volatile composition in this region. Previous explanations for WARS volcanism have included a plume beneath Marie Byrd Land, decompression melting of a fossilized plume head, decompression melting of a stratified mantle source, and mixing of recycled oceanic crust with one or more enriched mantle sources from the deep mantle. No explanation is universally accepted.

Unlike trace elements and radiogenic isotopes, which are highly affected by degrees of partial melting, prior melt differentiation, and mantle recycling, noble gases are chemically inert and present in low concentrations, making them reliable tracers of magmatic sources and subsurface processes. Here, we present preliminary noble gas isotope (e.g., $^{3}He/^{4}He$, $CO_2/^{3}He$, $^{40}Ar/^{36}Ar$, $^{40}Ar^{*}/^{4}He$) data for a suite of lava samples from the McMurdo Volcanic Group. By coupling noble gas geochemistry with more traditional geochemical techniques from the WARS, we can better constrain a magmatic source and provide geological evidence that could support or oppose the existence of a mantle plume, HIMU plume, or deconvolve mantle-lithosphere interactions.