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Identifying Heard Island volcanic signals in the Mount Brown South ice core

Content

The Kerguelen Plateau region is home to substantial annual phytoplankton blooms which contribute significantly to the biological productivity of the Southern Ocean. Here, we employ East Antarctic ice core archives in order to increase our understanding of the role of volcanism in the region's ecosystem. During bloom events, the waters surrounding the islands on the Plateau, including Heard and McDonald Islands (HIMI), can have more than double the background productivity of the iron-limited waters of the Southern Ocean. These annual blooms, however, can have high levels of both spatial and annual variability. This primary productivity acts as the base of the region's food web, in addition to playing a significant role in the biological carbon pump. It is therefore critical to understand the source of this variability, to assess both its role in the Southern Ocean ecosystem and the carbon sequestration potential of the area. The role of atmospheric fallout from regional volcanic eruptions, primarily from the Mawson Peak volcano on Big Ben, Heard Island (53.106°S, 73.513°E), is a poorly characterized but potentially significant source of iron across the Kerguelen Plateau, driving the primary productivity and accounting for the high inter-annual variability of blooms in the region. Assessing the impact of HIMI volcanism is complicated by the limited recorded eruption history, owing to the remoteness of the location and persistent cloud cover, which hinder observations of eruption events both in-situ and via satellite imagery.

We propose that due to its relative proximity to HIMI, the Mount Brown South ice core (MBS, 69.111°S, 86.312°E) has the potential to contain preserved volcanic signals, including (crypto)tephra, from HIMI eruption events. Preserved tephra in MBS would allow us to extend the HIMI volcanic record and investigate the iron fertilization potential of the volcanic fallout. In order for tephra to be present in MBS, atmospheric circulation conditions must be appropriate for transport from HIMI to MBS. Using the existing Heard Island volcanic record from Fox et al. (2021), together with HYSPLIT air parcel trajectories and atmospheric river data as a guide, we have performed extensive tephra sampling of the MBS core, with a primary focus on the satellite era. From these samples, we endeavor to find a "Goldilocks scenario" in which an eruption event was occurring at Mawson Peak, while conditions for transport to MBS were favorable, allowing for tephra to be transported to, and stored in the MBS core. Tephra shards have been identified in the MBS core based on this sampling strategy, and are analyzed for geochemical composition using electron probe microanalysis to determine the volcanic source. Tephra matching the unique geochemistry of Heard Island can be further analyzed for trace metals in order to assess the iron fertilization potential of HIMI volcanic aerosols in the Kerguelen Plateau region.

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