TITLE: CHRONICLES OF ICE AND FIRE: ARCHAEAL COMMUNITIES FROM AN ACTIVE VOLCANO IN ANTARCTICA (DECEPTION ISLAND)

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ABSTRACT:
Active volcanoes in Antarctica contrast with the predominantly cold Antarctic ecosystems, and comprise unique conditions capable of selecting versatile and diverse microbial communities. Deception Island (DI) is located in the South Shetland Islands and differs from other Antarctic volcanoes specifically by its higher temperatures and marine influence. We collected sediment samples associated with active fumaroles and glaciers at two geothermal sites on DI, with remarkable differences in environmental conditions over a short distance (primarily temperature, from 0 to 98 °C). We used 16S rRNA sequencing and shotgun metagenomics to understand how volcanic activity drives archaeal communities in polar ecosystems. Taxonomic and functional profiles showed that samples were assembled according to temperature and geochemical variation. Glacier communities were dominated by methanogenic Archaea (*Methanomassiliicoccus*) and genes related to osmotic stress and DNA repair via the photolyase system. Fumaroles with temperatures up to 80 °C were dominated by ammonia-oxidizer Archaea (*Nitrosopumilus*) and genes related to the nitrogen cycle and sulfur oxidation. In contrast, fumaroles with highest temperatures (>90 °C) were composed primarily by hyperthermophiles normally found at deep-sea hydrothermal vents (e.g. *Hyperthermus*, *Geogemma* and *Pyrodictium*). To our knowledge, this is the first report of these hyperthermophilic genera in Antarctica. Furthermore, genes related to sulfate reduction, chemolithotrophy, oxidative stress, base excision repair and hyperthermophilic adaptation (e.g. reverse gyrase and thermosome) were only detected in fumaroles with temperatures >90 °C. This suggests a clear separation of ecological niches across our environmental gradient, indicating that archaeal community structure is strongly niche-driven. Multivariate analysis of physicochemical data revealed that temperature is the most significant parameter responsible for shaping archaeal diversity on DI. The co-occurrence of hyperthermophiles and their specific adaptations with metabolically diverse cold-adapted microorganisms represents a unique community structure for Antarctic microorganisms. The possible interactions among such differently adapted microorganisms makes DI an interesting environment in which to study the evolution of extremophilic adaptations. This work represents the first ecological study of archaeal communities in a polar marine volcano using NGS, as well as the first study to sample across such a broad range of temperatures in a geothermal system in Antarctica.

Keywords: Extremophiles, archaea, Antarctica, volcano, 16S rRNA sequencing, metagenome, taxonomic and functional diversity

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