Did volcanoes sustain early life?

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Many biogeochemical cycles on the modern Earth are strongly driven by oxidative weathering of continental and oceanic crust. This process provides essential nutrients and metabolic energy sources. The near absence of oxidative weathering in the Archean, prior to the rise of atmospheric oxygen, may therefore have severely limited the early biosphere. However, emerging data and models suggest that hydrothermal vents and volcanisms may have been major sources of metabolic substrates. For example, volcanic outgassing, paired with photochemical reactions, were likely the primary source of sulphate in the Archean, which constituted the most abundant electron acceptor at that time [1]. In addition, hydrothermal fluids probably delivered more trace metals to the ocean than previously thought [2, 3]. New isotopic data from the Mesoarchean Sulphur Springs Group in Western Australia (~3.24 Ga) further suggest that hydrothermal circulation may also have played a significant role in recycling nitrogen in marine environments. Drill core samples through turbiditic sedimentary rocks overlying seafloor volcanics of the Kangaroo Caves Formation indicate transfer of ammonium from organic-rich sedimentary beds into hydrothermally altered igneous rocks, where it was trapped in phyllosilicate minerals. A similar ammonium transfer has been described from Phanerozoic settings and the modern ocean [4, 5], where it leads to a strong ammonium enrichment in hydrothermal fluids [6] and a thriving thermophilic biosphere proximal to the vent site [7]. If this process dates back to the Archean, it may have important implications for the habitability of the early Earth and possibly other volcanically active worlds.

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