Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31111

Large-scale ammonium release from hydrothermal venting in the North Atlantic Igneous Province during the Paleocene-Eocene Thermal Maximum

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The Paleocene-Eocene Thermal Maximum (PETM) was a global warming event of around 5-6°C that occurred ca. 56 million years ago. It was caused by a rapid and massive input of carbon to the ocean-atmosphere system [1] and hydrothermal venting of greenhouse gases in the North Atlantic Igneous Province (NAIP) is thought to have played a key role. Much of the hydrothermal gas was derived from carbonaceous sedimentary rocks in contact aureoles around magmatic intrusions [2]. For this study, we analyzed several sediment core successions from a fossilized hydrothermal vent complex and a less-(hydro)thermally influenced site in the Vøring Basin, offshore Norway. We found that nitrogen, an essential and often limiting nutrient for life, is depleted in the underlying vent conduit relative to background values by ca. 70%. Upscaling these observations, we estimate 59 Pg of nitrogen was lost from conduit structures across the NAIP. In addition, we adapted a mechanistic model for thermogenic carbon release to investigate nitrogen loss from thermal aureoles [2]. The estimated mass of nitrogen released from thermal aureoles over the duration of the PETM (ca. 200kyr) is around 855 Pg, with a peak flux of ca. 18 Tg/yr. We speculate that the released nitrogen, likely dominated by ammonium, may have increased regional biological productivity, which has been proposed as a mechanism for re-sequestering elevated atmospheric carbon during the PETM [3]. In conclusion, the NAIP perturbed both carbon and regional nitrogen cycling, with possible implications for time periods with heightened magmatic activity in marine basins.

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