



HAL
open science

Nitrates Production by Volcanic lightning during Explosive Eruptions

Delphine Contamine, Erwan Martin, Adeline Aroskay, Slimane Bekki, Sophie Szopa, Joël Savarino

► **To cite this version:**

Delphine Contamine, Erwan Martin, Adeline Aroskay, Slimane Bekki, Sophie Szopa, et al.. Nitrates Production by Volcanic lightning during Explosive Eruptions. EGU General Assembly 2024, Apr 2024, Vienna, Austria. pp. EGU24-13523,, 10.5194/egusphere-egu24-13523 . insu-04507919

HAL Id: insu-04507919

<https://insu.hal.science/insu-04507919>

Submitted on 4 Jun 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

EGU24-13523, updated on 04 Jun 2024

<https://doi.org/10.5194/egusphere-egu24-13523>

EGU General Assembly 2024

© Author(s) 2024. This work is distributed under the Creative Commons Attribution 4.0 License.



Nitrates Production by Volcanic lightning during Explosive Eruptions

Delphine Contamine¹, Erwan Martin¹, Adeline Aroskay¹, Slimane Bekki², Sophie Szopa³, and Joël Savarino⁴

¹Institut des Sciences de la Terre de Paris, Sorbonne Université, 75, Paris

²Laboratoire Atmosphères, Observations Spatiales, 75, Paris

³Laboratoire des Sciences du Climat et de l'Environnement, 91, Gif sur Yvette

⁴Institut des Géosciences de l'Environnement, 38, Grenoble

Volcanic lightning during explosive eruptions has been suggested has a key process in the abiotic nitrogen fixation in the early Earth. Although laboratory experiences and thermodynamic models convincingly suggest that volcanic lightning can fix atmospheric nitrogen (e.g. Navarro-Gonzalez et al., 1998, Martin et al., 2007). No geological archives of N-fixed by volcanic lightning have been found yet. Recently, high nitrate concentrations in volcanic deposits from large Neogene explosive eruptions (VEI>7; Aroskay et al. 2023) have been discovered. It is tempting to infer that these nitrates correspond to the end-product of N-fixation by volcanic lightning. However long-term atmospheric deposition of nitrate is suggested to be responsible of nitrate deposits in arid environment (e.g. Atacama Desert and Mojave Desert – Michalski et al. 2004, Lybrand et al. 2013). Therefore, the long-term atmospheric deposition could contribute to nitrates preserved in volcanic deposits.

Our study aims to distinguish the origin of nitrates in volcanic deposits: end-product of volcanic lightning or long term atmospheric deposition? To answer this question, volcanic samples from super-eruptions as well as sediments have been collected in the Tecopa Basin – California, USA. The whole sedimentary column (sediments interspersed with volcanic deposits) has been preserved in the same arid conditions for the last 2Ma. The multi-isotopic composition of nitrate has been measured ($\delta^{18}\text{O}$, $\delta^{15}\text{N}$ and $\Delta^{17}\text{O}$) and shows clear distinction between nitrate from volcanic deposits and those from sediments. It appears that while nitrate from sediments result from a mix between atmospheric nitrate and biogenic nitrate, in volcanic deposit the nitrate are most likely the end product of volcanic lightning.

As a conclusion, we demonstrate that volcanic deposits can be an archive of N-fixation by volcanic lightning. This is an open window on the direct quantification of N-fixation by large explosive volcanic eruptions and their role on the development of life on the early Earth.