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Carbon emissions from Skaergaard Intrusion and Plateau Basalt: What do melt and fluid inclusions tell us?

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The current climate crisis is gathering the interest of scientific community towards the study of Large Igneous Provinces and their greenhouse gas emissions, considered as the closest natural analogue for ongoing anthropogenic gas emissions [1]. Extending from Greenland to the Scandinavian Peninsula and the British Isles, the North Atlantic Igneous Province (NAIP) represents the most recent example since its peak activity coincided in time with the Paleocene–Eocene Thermal Maximum (PETM) [2]. Past greenhouse gas emissions may be reconstructed via the investigation of volatile species preserved by melt and fluid inclusions within magmatic minerals [3]. Here, we study melt and fluid inclusions within intrusive and effusive rock samples from the (300 km^3 sized) Skaergaard Intrusion and its overlying (6-8 km thick) Plateau Basalt lava pile to constrain greenhouse gas emissions across the PETM. At the time of their emplacement, Skaergaard Intrusion and Plateau Basalt were the closest location to the centre of NAIP mantle plume [4]. Our Raman microspectroscopy data on fluid phases within melt and fluid inclusions in different magmatic mineral phases from Skaergaard Intrusion and Plateau Basalt indicate an evolution of carbon speciation across their emplacement. In the effusive rock samples from Plateau Basalt, olivine and clinopyroxene phenocrysts host primary melt inclusions containing CO_2 or elemental C within gas bubbles. In the intrusive rock samples from Skaergaard Intrusion, primary melt inclusions within olivine and clinopyroxene crystals do not contain any gas bubble. However, in the same rock samples, olivine crystals sometimes host CH_4-bearing fluid inclusions, and quartz crystals usually host abundant multiphase (i.e., gaseous ± liquid ± solid phases) fluid inclusions, containing CH_4 and sometimes CO_2 along with liquid H_2O in different proportions [5]. Relying on volume ratios reconstructed via optical observations and (Synchrotron) X-ray microtomography, we attempt to quantify the different carbon species degassed throughout NAIP emplacement across the PETM.

[1] Grasby & Bond (2023), *Elements* **19**, 276–281. [2] Jones *et al.* (2019), *Nat. Commun.* **10**, 5547. [3] Capriolo *et al.* (2024), *J. Petrol.* **65**, egae103. [4] Larsen & Tegner (2006), *Lithos* **92**, 181–197. [5] Larsen *et al.* (1992), *Contrib. Mineral. Petrol.* **112**, 428–437.