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Magmatic and thermogenic emissions reconstructed via melt and fluid inclusions in the North Atlantic Igneous Province

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Extending from Greenland to the Scandinavian Peninsula and the British Isles, the North Atlantic Igneous Province (NAIP) coincided in time with the Paleocene–Eocene Thermal Maximum (PETM), which is the most recent natural analogue for anthropogenic greenhouse gas emissions [1]. The temporal association between Large Igneous Provinces and climate perturbations throughout the Phanerozoic points to a potential causality via magmatic and thermogenic emissions, which may be reconstructed via the investigation of volatile species preserved by melt and fluid inclusions within magmatic minerals [2; 3]. In order to constrain greenhouse gas emissions from the NAIP, we studied melt and fluid inclusions within intrusive and effusive rock samples from East Greenland and Faroe Islands, which represent the locations closest to the original centre of the mantle plume on Western and Eastern margins, respectively [4; 5]. Our Raman microspectroscopy data on melt and fluid inclusions in rock samples from Skaergaard and its overlying Plateau Basalt (i.e., East Greenland) unveiled the occurrence of different carbon species. In the effusive rock samples, olivine and clinopyroxene phenocrysts host primary melt inclusions containing CO_2 or elemental C within gas bubbles. On the contrary, in the intrusive rock samples, most of primary melt inclusions within olivine crystals do not contain any gas bubble. However, in these rock samples, olivine crystals sometimes host CH_4-bearing fluid inclusions, and quartz crystals usually host abundant multiphase fluid inclusions, containing CH_4 and sometimes CO_2 along with H_2O in different proportions. These tiny amounts of carbon species preserved by melt and fluid inclusions represent the direct evidence of magmatic and thermogenic emissions from the NAIP. Their characterization and quantification are thus fundamental to reconstruct the Earth system response at the time of PETM.

[1] Jones *et al.* (2019), *Nat. Commun.* **10**, 5547. [2] Capriolo *et al.* (2020), *Nat. Commun.* **11**, 1670. [3] Capriolo *et al.* (2021), *Nat. Commun.* **12**, 5534. [4] Larsen & Tegner (2006), *Lithos* **92**, 181–197. [5] Jolley *et al.* (2022), *Earth Environ. Sci. Trans.* **113**, 75–98.