Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.15398

Novel biomarker-based insights into the operation of the terrestrial methane cycle across the Cenozoic (and beyond).

DAVID NAAFS

University of Bristol

Presenting Author: david.naafs@bristol.ac.uk

Wetlands and lakes represent the largest natural source of methane to Earth's atmosphere, where this powerful greenhouse gas influences Earth's radiative budget. The flux of methane from wetlands and lakes to the atmosphere ultimately depends on the relative contribution of methanogens that produce methane and methanotrophs that consume methane. However, the relative balance between these two biological processes and hence the operation of the terrestrial methane cycle beyond the reach of the Antarctic ice core data (currently 0.8 Myr ago) are poorly constrained.

To address this problem, I will present a high amount of novel biomarker data (specifically, $\delta^{13}C$ of various bacterial lipids and plant waxes) that record the relative contribution of methanotrophs to the bacterial pool in ancient wetlands (and some lakes). I will use a unique dataset that consist of >400 lignite samples from across the world and which span most of the Cenozoic, including key hyperthermals like the PETM and ETMs (as well as a lake record from the Toarcian OAE hyperthermal). The aim is to explore the operation of the terrestrial methane cycle during different climate states, including hyperthermals that are characterized by rapid environmental change.

The data show that the contribution of methanotrophs (based on $\delta^{13}C$ of bacterial hopanoids) to the wetland bacterial pool has been remarkably stable through time, including across major climatic events like the K/Pg boundary, the Eocene – Oligocene transition, and the mid-Miocene climatic optimum. These results indicate that the terrestrial methane cycle is robust to long-term climatic perturbations and does not operate fundamentally different during greenhouse periods. However, during hyperthermals such as the PETM and the T-OAE, etc, the data indicate a significant perturbation of the terrestrial methane cycle. This means that transient warming events have the potential to destabilize this key biogeochemical cycle, which suggests that the terrestrial methane cycle will be impacted by anthropogenic climate change in the future.