Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30958

Linking Lipids in Organic Matter from Deep Hot Sediments in the Guaymas Basin to Environmental Conditions

YANNICK ZANDER[1], VERENA HEUER[1], WEIMIN LIU[1], LEONIE WITTIG[1] AND KAI-UWE HINRICHS[2]

[1]MARUM - Center for Marine Environmental Sciences of the University of Bremen
[2]MARUM - Center for Marine Environmental Sciences, University of Bremen

The deep marine biosphere is an important microbial habitat on Earth but remains poorly understood. Microbes employ various strategies to adapt to harsh environments, for example, through the regulation of their membrane lipids. However, this lipid pool remains largely unexplored. Investigating it could provide valuable insights into deep biosphere microbial communities and their environmental interactions. Conventional targeted analyses usually focus on only a small fraction of the total lipid pool found in sediments. This limitation is particularly relevant in the deep biosphere, where microbes may produce novel lipids essential for survival and adaptation.

Here we present data from two locations from the Guaymas Basin (Expedition 385, sites U1545 and U1549) with the objective of identifying molecular fingerprints that are imprinted by various environmental processes. The Guaymas Basin is rich in organic compounds that, through hydrothermally accelerated maturation of hydrocarbons, provide an ideal breeding ground for a variety of microbial communities.

Unsupervised learning was used to first group the 8500 detected compounds into clusters based on their co-occurrences within and across sites. By comparing these clusters with contextual biogeochemical data, we found that some clusters are closely linked to well-known processes: the gradual degradation of organic matter from the water column, high microbial activity around the sulfate-methane transition zone, and alteration of molecules at high temperatures.

ClassyFire was utilized to annotate compounds based on their fractionation and isotope patterns, thereby obtaining compound class assignments for almost half of the compounds. Significant enrichment of certain compound classes are found for each cluster, indicating the link between molecular structures and environmental conditions.

Future efforts will focus on the unification of the untargeted and targeted approach. Revealing new compound groups related to environmental conditions through untargeted lipidomics is an important step towards understanding geochemical processes and the life of microbial communities in deep, hot sediments. Additionally, extending our knowledge of diagnostic lipids to larger compound groups may help in other studies to make results less dependent on specific compounds and therefore, by including more information into the analysis, lead to a more complete understanding of processes at play.