Selective chemical degradation of microbial mat residues and implications for lipid biomarker preservation

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Insoluble macromolecular organic matter (IMOM) is a significant component of marine sediments and plays a large role in the preservation of organic matter in both modern and ancient environments. In modern marine unconsolidated sediments, IMOM—also known as proto-kerogen—is a complex matrix containing lipids, carbohydrates, and proteins biosynthesised by living organisms in the water column. It is often structurally complex and inaccessible by conventional lipid extraction techniques. IMOM is able to sequester a wealth of biogeochemical information that is often overlooked during routine analyses of extractable lipids. Understanding how lipids are bound into IMOM during diagenesis allow sources inputs of marine organic matter preserved in the geological record to be more confidently recognised.

The evaporative pond system located in Guerrero Negro, Baja California, Mexico, is an extensively well-characterised ecosystem that is ideal for investigating lipid biomarker incorporation and diagenesis. It contains thirteen ponds that range in salinity from seawater up to gypsum precipitation. Ponds of intermediate salinity harbour thick accumulations of microbial mats inhabitated by cyanobacteria and other halotolerant microorganisms. These marine subtidal microbial mats experience diel cycle fluctuations from highly oxidising during the day to anoxic and sulfidic at night.

We performed catalytic hydropyrolysis on pre-extracted IMOM residues treated under three different selective chemical degradations: trichloroacetic acid precipitation, acid methanolysis, and periodate oxidation. Additionally, an untreated control residue was processed concurrently to monitor the effects of the experiments on the lipid biomarker composition. IMOM residues were prepared from two mat-sediment cores of differing salinity. Two depths from each core were analysed in this study, with one representing organic matter derived from an active mat layer and the other a sedimentary layer.