MICROBIALLY MEDIATED BLACK SLUDGE FOLLOWING A CYCLONIC EVENT IN SHARK BAY, WESTERN AUSTRALIA AND ITS LINK WITH COBBLE FORMATION

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On the 13th of March 2015 Shark Bay, Western Australia was hit by a category 3 cyclone, "cyclone Olywn", causing destructive wind gusts of up to 140 kilometers per hour and a record total of 122 mm of rain fell in 24 hours. This event caused significant structural changes to a microbial ecosystem found in Hamelin Pool. Immediately after the cyclone, the formation of a black sludge was observed in the impacted area, this black sludge is currently assumed to be a mixture of reconstituted extracellular polymeric substances (EPS) from impacted microbial mats, anoxic sediments containing iron sulfide minerals, marine debris and terrestrial matter (i.e. plant material). Upon returning to the site on the 7th of July 2016 it was found that the black sludge had turned into mud cobbles (Fig. 1).

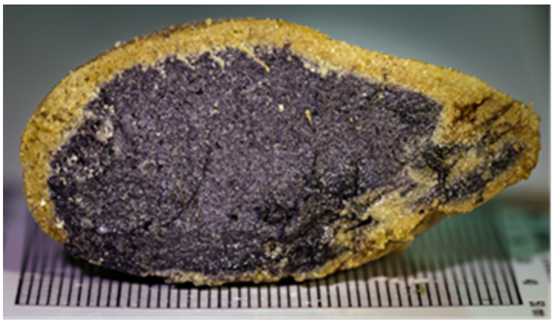

***Figure 1**. Cross-section of mud cobble (photographer: Aditya Chopra)*

These mud cobbles could represent modern analogues of carbonate concretions found throughout the geological record and provide insight into concretion formation. Organic and inorganic geochemical techniques along with genomics will be applied to the black sludge and mud cobbles in order to investigate biomarker and isotopic distributions, variations in sulfur speciation and microbial diversity. This multidisciplinary approach will allow for a greater understanding of how these mud cobbles developed and if they exhibit the necessary conditions and microbial communities such as sulfate-reducing bacteria, for calcium carbonate precipitation. Additionally, sulfurization is recognized as one of the most important diagenetic pathways; Raney nickel desulfurizations will be applied to the black sludge and mud cobbles to establish if biomolecular sulfurization is occurring (Köster et al., 1997).

Current findings indicate that the black sludge and cobbles are from a similar source. The overall molecular and isotopic profiles of the saturated hydrocarbon fractions are almost identical in regards to the distribution and abundance of higher plant, diatom and bacteria biomarkers. These markers and their prominence within the samples are highly common for areas such as Hamelin Pool (Allen et al., 2010). Hopanes, such as the $C_{31\alpha\beta}$ and $C_{31\beta\beta}$ hopanes were present in the free fractions of both samples, $C_{31\beta\beta}$ hopane can indicate the presence of sulfate-reducing bacteria (Pagès et al., 2015). Raney nickel desulfurization of the polar fractions released a series of sulfur bound steranes and hopanes. Two dimensional gas chromatography time of flight mass spectrometry (GCxGC-TOFMS) was used to gain a higher resolution of C_{27-29} sterane and C_{27-34} hopane distributions (Fig. 2).

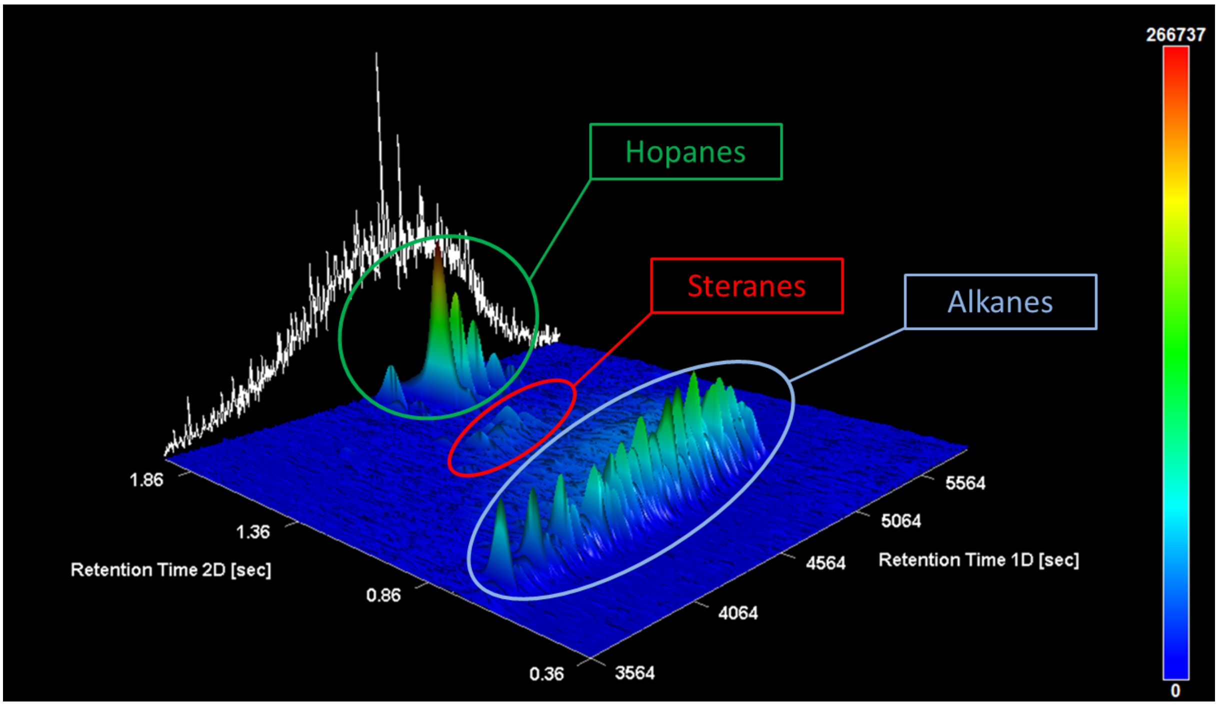

Figure 2. *GCxGC-TOFMS image of a saturate fraction gained from the Raney nickel desulfurization of the mud cobble's polar fraction exhibiting high resolution of steranes and hopanes.*

Sulfate-reducing bacteria are known to promote calcium carbonate precipitation within microbial systems and the early stages of biomolecular sulfurization indicates that the mud cobbles have the potential to form into carbonate concretion with the ability to preserve organic material. The further investigation into the microbial taxonomic and functional diversity as well as the inorganic properties of these samples will help to further gain an understanding of how these formations develop and potentially shed light into the major microbial species involved in concretion formation.

References

Allen, M.A., Neilan, B.A., Burns, B.P., Jahnke, L.L., Summons, R.E., 2010. Lipid biomarkers in Hamelin Pool microbial mats and stromatolites. Organic Geochemistry 41, 1207–1218. doi:10.1016/j.orggeochem.2010.07.007

Köster, J., Van Kaam-Peters, H.M.E., Koopmans, M.P., De Leeuw, J.W., Sinninghe Damsté, J.S., 1997. Sulphurisation of homohopanoids: Effects on carbon number distribution, speciation, and epimer ratios. Geochimica et Cosmochimica Acta 61, 2431–2452. doi:10.1016/S0016-7037(97)00110-5

Pagès, A., Grice, K., Welsh, D.T., Teasdale, P.T., Van Kranendonk, M.J., Greenwood, P., 2015. Lipid Biomarker and Isotopic Study of Community Distribution and Biomarker Preservation in a Laminated Microbial Mat from Shark Bay, Western Australia. Microbial ecology 70, 459–472.