Compound Specific Isotope Analysis of Hydrocarbons Derived from Marine and Terrstrial Phototrophs; A Case Study of an Early Eocene Hyperthermal Event

R. H. Williams[1], S. Dutta[2], A. Nandi[2], R. E. Summons[1]
[1]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, USA; rosshw@mit.edu [2]Department of Earth Sciences, Indian Institute of Technology Bombay, Mumbai-400076, India

During the early Cenozoic, Earth experienced several instances of dramatic, rapid climate warmings termed 'hyperthermals' [1-3]. While the causal mechanisms remain debated, they are marked by large inputs of isotopically light carbon into the ocean-atmosphere system, which can be investigated through compound specific isotope analysis. While extensive work has been done in studying these events at high and mid- latitudes, only a handful of studies have examined sedimentary records from near to the paleo-equator. Such studies report that for tropical regions a up to a 3-5°C warming in tens of thousands of years occured. It is important to elucidate the impact of such drastic climate change on vegetation already living in the warmest climes. Here we present a stable isotope and biomarker study of one such site from northwestern India.

A core was drilled from Valia near the Vastan Lignite Mine in the province of Gujarat, India for biomarker study and complimentary biostratigraphy. This formation contains multiple and discontinuous seams of lignite deposited within the larger Cambay Shale and is underlain by the Deccan Trap basement. The accepted depositional environment is lagoonal with coastal wetlands forming the lignite deposits in a marsh-bay complex. This provides a record that is able to furnish biomarkers from both the terrestrial and marginal marine settings as shown by the presence of compounds characteristic of marine algae and assemblages of triterpenoids characteristic of an angiosperm-dominated flora.

We have established a biostratigraphic framework based upon the shallow benthic zone foraminifera that place the unit through the Early-Middle Eocene [4]. This is a notable time for the region with the development and spread of tropical dipterocarp rainforests [5]. We further developed a bulk organic $\delta^{13}C$ profile and complementary C-isotopic records for individual compounds derived from marine and terrestrial phototrophs across realms. We observed concurrent C-isotopic anomalies for bulk organic carbon and the hydrocarbon cadalene that is likely derived from dipterocarp resin. These data are complemented by conventional sterane and triterpane biomarker parameters characterized by unsaturated and saturated triterpenoids as well as angiosperm markers.

This dataset reveals additional aspects of the nature of this equatorial ecosystem and how higher plants may have responded to periods of transient yet intense warming.

[1] DeConto, Robert M., et al. Nature 484.7392 (2012): 87-91.
[2] Nicolo, Micah J., et al. Geology 35.8 (2007): 699-702.
[3] Zachos, James C., et al. Earth and Planetary Science Letters 299.1 (2010): 242-249.
[4] Nandi, Anindya. "Biostratigraphy and Organic Geochemical Characterization of the Eocene Section from Valia, near Ankleshwar, Cambay Basin, Western India." Thesis. Indian Institute of Technology, Bombay, 2014
[5] Dutta, Suryendu, et al. Review of Palaeobotany and Palynology 166.1 (2011): 63-68.