THE ORIGIN OF ORGANIC RICH LAYERS IN THE MALDIVES

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PROJECT OBJECTIVES

- To understand the origin of organic-rich layers, some containing over 5 % organic material, alternating with organic poor layers within an 80 m thick interval in a shallow, open ocean setting.

PROJECT RATIONALE

During the drilling of International Ocean Discovery Program (IODP) Expedition 359 seven sites were drilled in the Maldives (Betzler et al., 2016). At Sites U1466 and U1468 approximately 80 m thick intervals were encountered, comprised of alternating black and white layers in upper Oligocene to lower Miocene strata above neritic carbonates with large benthic foraminifers. The black layers contained total organic carbon contents of between 1 to 5 wt %, while the white layers had less than 0.1% organic material and were rich in calcareous nanofossils. The black layers were also enriched in trace elements (such as Fe, V, U, Mo etc.), which are typically associated with organic-rich sapropelic-like sediments. The important question raised by this unusual occurrence of organic-rich sediments is whether they (i) represent a preservation signal resulting from anoxic bottom waters, or (ii) a production signal arising from high surface productivity.

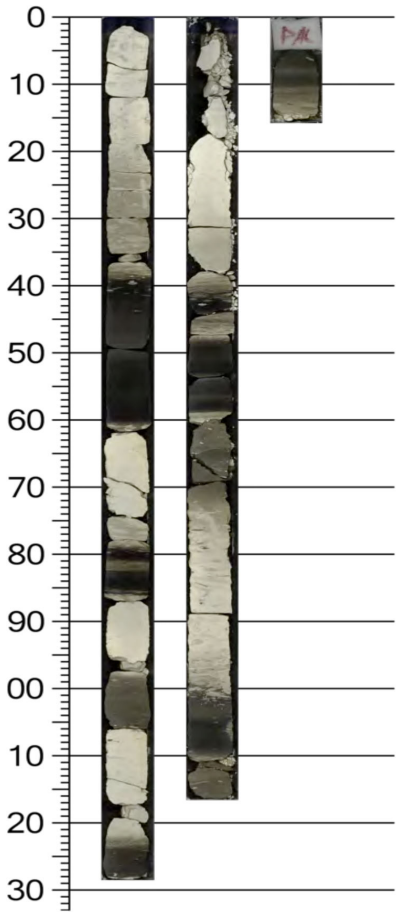

Figure 1: Sections from 359-U1466B-56R showing early Miocene intervals of organic-rich sediments interspersed with white coccolith-rich chalky oozes.

SCOPE OF WORK

In order to answer the above-mentioned question, we have been conducting a detailed study of the organic carbon content combined with analysis of the $\delta^{13}C$, $\delta^{15}N$ and C/N ratio and high resolution X-Ray fluorescence scans of the cores. Preliminary data indicate little change in the $\delta^{13}C$ value of the organic material, which could indicate variations in the source during this period. In addition, the $\delta^{15}N$ values are

close to 0‰, suggesting an absence of upwelling as a control on the supply of nutrients (an upwelling source would possess a high $\delta^{15}N$ value) and therefore productivity. Hence available data suggest a constant production of organic material in the surface water combined with periodic restriction of the bottom waters inducing anoxia.

Seismic data indicates that during the formation of these organic-rich layers the archipelago of the Maldives was not yet rimmed by large atolls but was a shallow basin. The Maldives archipelago was at the time still south of the equator in the middle of the Indian Ocean. It is possible that a shallow sill depth between the shallow basin and the open ocean periodically lead to stagnant anoxic bottom waters as sea-level oscillated.

SIGNIFICANCE

The significance of our findings is that source rocks can form in open oceanic atoll-like systems, given the appropriate oceanic conditions and restrictions of water input. Provided that an adequate seal is present, such systems may actually be important in forming hydrocarbons as there is a combination of a good source material underneath a porous reservoir.

REFERENCES

Betzler, C.G., Eberli, G.P., Alvarez Zarikian, C.A., and the Expedition 359 Scientists, 2016, *Expedition 359 Preliminary Report: Maldives Monsoon and Sea Level*. International Ocean Discovery Program. http://dx.doi.org/10.14379/iodp.pr.359.2016.