Strong 13C enrichment in Dziani Dzaha Lake (Mayotte, France): Evidence for methanogenesis impact in a new modern analogue of Precambrian oceans

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Over geological time, carbon isotopic composition associated with carbonates in the sedimentary record ($\delta^{13}C_{carbonates}$) can be considered as stable at around 0‰, with two main time intervals presenting positive isotope excursions at 2.2-2.0 Ga and 710-600 Ma. These excursions are commonly explained as global perturbations of the carbon cycle due to increased organic matter burial. However, doubts remain and local perturbations of the carbon cycle have thus been proposed due to enhanced methanogenesis.

We report here the first results obtained on a possible new analogue of environments presenting anomalously high $\delta^{13}C$: the volcanic crater lake Dziani Dzaha located in Mayotte (France). It is a saline and alkaline lake, permanently anoxic below 1 m depth in spite of seasonal mixing, with a biomass overwhelmingly dominated by prokaryotes. CO_2 (42-220 mmol/m^2/day, stratified-non stratified water column resp.) and CH_4 (136-38 mmol/m^2/day, same) continuously degas into the atmosphere and H_2S (1 to 6 mmol/L) and CH_4 (up to *ca*. 2 mmol/L) accumulate below the halocline during the stratified season. $\delta^{13}C$ values of organic (-15±2‰) and inorganic carbon (+13±2‰) in the water column and surface sediments are very high compared to the ocean.

A box-model of the carbon cycle in the lake points to the methanogenesis coupled to methane degassing as the dominant processes accounting for these positive $\delta^{13}C$ values.

Overall, these results confirm that the lake Dziani Dzaha shares many similarities with Precambrian environments and support to the hypothesis that methanogenesis (when associated to methane degassing) may have been at least partly responsible for the positive $\delta^{13}C$ excursions in the Precambrian.