Formation of Mg-aluminosilicates during early diagenesis of carbonate sediments in the volcanic crater lake of Dziani (Mayotte – Indian Ocean)

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Aluminosilicates are increasingly reported in ancient carbonate rocks, but their origin remains poorly understood, strongly limiting paleoenvironmental interpretations. The volcanic crater lake of Dziani in Mayotte is studied to assess the processes controlling the formation of silicates in carbonate sediments during early diagenesis.

The Dziani lake is characterized by CO_2-rich deep gases bubbling in three different locations, a seasonally CH_4-saturated water column due to archaeal methanogenesis and a high biologic productivity [1] leading to organic carbon contents of up to 25wt.% in the sediments. Alkalinity of ~0.26 molal and pH values of 9 to 9.5 in the water column [1] result in the precipitation of aragonite and hydromagnesite. Characterization of bulk samples (XRD, XRF) and clay fraction (<2µm) (XRD/EG solvation, EPMA, CEC) from the first meter of the sedimentary column indicates a decrease of the hydromagnesite content with depth and the concurrent accumulation of saponite, a Mg- and Al-rich smectite. Concurrently, analyses of pore waters show a decrease of pH values from 9 to 8.3.

We performed modeling with the reactive transport code Crunchflow, taking into account the sediment burial and the mineralization of organic matter. High pH values combined with the alteration of alkaline feldspars and clinopyroxenes from the volcanic catchment allow saponite to form and accumulate at depth. Production of CO_2 associated to methanogenesis is required to account for the observed pH decrease in the porewaters, which induces hydromagnesite destabilisation at depth leaving behind a saponite-aragonite mineral assemblage. Formation of Mg-phyllosilicates in the carbonate rocks of the Dziani lake is shown to be controlled by the alteration of the basic volcanic catchment and a singular carbon cycle controlling the pH values. The inputs of CO_2-rich deep fluids likely play a key role to initiate the observed carbon cycle.

[1] Leboulanger et *al.* (2017) *PLoS one*, **12**(1).