Modelling of early diagenesis of lacustrine carbonates associated with Mg-silicates

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Diagenetic processes occuring in time and space are critical in the evolution of sedimentary rocks. They need to be assessed to improve our abilities for palaeoenvironmental interpretations. A numerical model was developed with the reactive transport code CrunchFlow to assess the chemical and physical processes occurring during the early diagenesis of lacustrine carbonates formed in rift settings, using as a case study the carbonate sediments associated with Mg-silicates of the alkaline volcanic crater lake, Dziani Dzaha (Mayotte).

The model relies on the compositions of the solid phases in the first meter of sediments, the porosity, the pore water chemistry and an age model for the sediment based on radiocarbon measurements. Chemical and isotope analyses reveal the inflow of magmatic CO_2 and intense microbial methanogenesis activity in the lake.

The alkaline pH of the lake induces oversaturation of porewaters relative to aragonite, hydromagnesite and saponite. Carbonates form close to equilibrium and dominate the mineralogy of the shallow sediment while kinetic effects inhibit the formation of saponite that precipitates only at depth. Magmatic CO_2 inflow and microbial degradation of organic matter cause a decrease in pH with depth that leads to destabilization of hydromagnesite.

The model brings new insights on the palaeoenviroments and on the early diagenetic processes leading to the lacustrine carbonates formed in rift settings. It quantifies the mechanisms involved in the early diagenetic processes without which minerals reactivity, pH and porosity would not be described over the sediment depth. This study represents a first step towards the forward modeling of the evolution of the solid and fluid phases of carbonate sediments from their deposition to their current settings in the sedimentary column.