Microbialite formation in two hypersaline lakes (Bahamas): Insights into organomineralization

Christophe Dupraz[1*], Alexandre Fowler[1], Christina Glunk[2], Olivier Braissant[3], Kimberley L. Gallagher[1], Natalie J. Stork[1] and Pieter T. Visscher[1]

[1]University of Connecticut, Marine Sciences, Storrs, USA christophe.dupraz@uconn.edu (* presenting author)
[2]University of Lausanne, Geology and Paleontology, Switzerland
[3]University of Basel, Laboratory of Biomechanics, Switzerland

The precipitation of carbonate minerals within a microbial mat (microbialite) results from complex interactions between the microbial communities and the surrounding geochemical environment. This process is referred to as 'organomineralization', and differs from 'biomineralization' (*e.g.*, shells and bones) by lacking genetic control on the mineral product. Organomineralization can be '*active*', when microbial metabolic reactions are responsible for the precipitation through actively changing the saturation index (*"biologically-induced" mineralization*) or '*passive*', when mineralization takes place within a microbial organic matrix, but is induced by environmental reactions (*e.g.*, through degassing or evaporation; *"biologically-influenced" mineralization*). Microbial metabolism can changed the carbonate mineral saturation by acting as an 'alkalinity engine' (changing the total alkalinity and/or the distribution of carbonate species within the total alkalinity) as well as the calcium availability (through Ca-binding capacity of the organic matrix).

Here two cyanobacteria-dominated microbialites that develop in hypersaline environments (Eleuthera and San Salvador Bahamas) are compared with respect to precipitation mechanism. In both lakes, the microbial metabolic activity, the characteristics and turnover of the extracellular organic matter (EOM), and the physicochemical conditions in the water column and sediments were determined to identify the driving forces in microbialite formation. Geochemical modeling indicated an oversaturation with respect to carbonates (including calcite, aragonite and dolomite) in both systems, but these minerals were never found to precipitate at the mat-water interface. This is attributed to the capacity to bind calcium by the EOM in the water column and the upper layer of the microbial mat, inhibiting crystal formation. Therefore, organomineralization within the microbial mat is the consequence of local oversaturation of the EOM binding capacity and/or EOM degradation.

Both microbialites in this study exhibit tight coupling of element cycling and display a stromatolitic lamination, but differ in some mineral features. Notably, isotopic measurements (∂^{13}C and ∂^{18}O) performed on the top carbonate layer (the microbially most active zone) indicate that the precipitate, although resulting from a complex interaction of metabolisms, indicate two opposite isotopic signatures (autotrophic vs. heterotrophic). However, in both systems the early diagenesis of the mineral product (through burial) suggests an increasing influence of heterotophic processes in the mineral precipitation. In the both systems studied here, the organic matrix (EOM) plays a key role in the shaping of the mineral product.

Iron oxide compositional variations in tills along ice-flow paths: Case studies from Sue-Dianne IOCG, and Thompson Ni-Cu deposits, Canada

Céline Dupuis[1*], Anne-Aurélie Sappin[1], Margot Pozza[1], Georges Beaudoin[1], Isabelle McMartin[2], and M. Beth McClenaghan[2]

[1]Université Laval, Géologie et génie géologique, celine.dupuis.1@ulaval.ca
[2] Geological Survey of Canada, Isabelle.McMartin@NRCan-RNCan.gc.ca

Sue-Dianne IOCG deposit

The composition of iron oxides contained in 8 till samples, 0.25-1 mm in size, and five bedrock samples, were selected along a cross-section from up-ice, proximal to, and down-ice from the Cu-Ag-(Au) Sue-Dianne IOCG deposit, Great Bear Magmatic Zone, Northwest Territories, Canada. Iron oxides in tills show the same, but weaker, compositional variations related to the proximity of the deposit than bedrock samples. At and immediately down-ice of the deposit, hematite is the dominant oxide and shows dominant BIF and IOCG chemical signatures in the Ca+Al+Mn vs. Ti+V discriminant diagram. Up-ice and farther down-ice of the deposit, magnetite and titano-magnetite are the dominant oxides and show dominant Kiruna and IOCG signatures (Fig. 1).

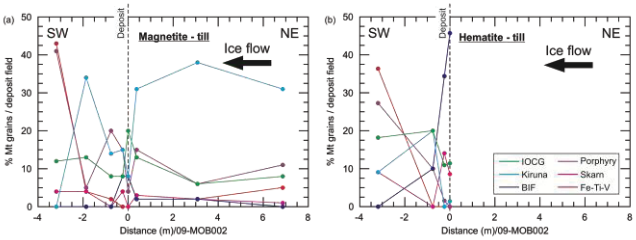

Figure 1: Magnetite and hematite proportion of grains falling in different deposit fields relative to the distance from the Sue-Dianne deposit.

Thompson Ni-Cu deposits

The 0.25-1 mm ferromagnetic fractions of 7 till samples are along a N-S profile along the first direction of ice-flow. In addition, 11 till samples were selected to document a 180 km-long cross-section from the Pikwitonei domain (East) across the Thompson Nickel Belt, Manitoba, Canada, and into the Kisseynew domain (West) along the direction of the last major ice flow movement. The proportions of magnetite having a Ni-Cu deposit signature in the Ni+Cr vs. Si+Mg discriminant diagram increase for at least 2 km to the south of the Pipe Mine along the direction of the first glacial movement, whereas the dispersion of the deposit-derived magnetite to the west is limited during the second glacial movement (Fig. 2)

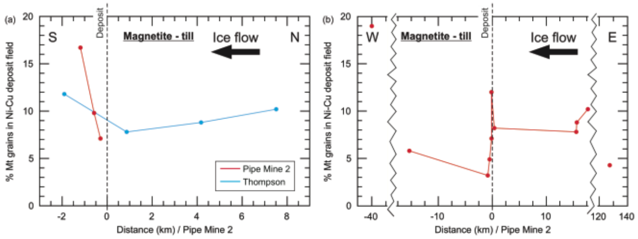

Figure 2: Magnetite proportion of grains falling in the Ni-Cu deposit field relative to the distance from Pipe Mine 2 deposit, Thompson Nickel Belt.