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Searching for mineral self-organization in soda lakes

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Mineral self-organization is an important subject to understand pattern formation in geology [1]. Among mineral self-organized phenomena [2], silica-induced structures such as silica-carbonate biomorphs and silica gardens are thought to be relevant for the earliest stages of the planet. They were likely forming during the evolution of silica-rich Hadean alkaline oceans from methane-rich to CO and CO_2-rich atmosphere and hydrosphere [3]. The precipitation of silica gardens generates electrochemical potentials [4] and selectively catalyse the synthesis of prebiotically relevant compounds such as carboxylic acids, amino acids, and nucleobases by condensation of formamide [5]. So far, silica gardens have been synthesized using laboratory solutions except for two cases where silica gardens form upon the interaction of model alkaline fluids with granites [6] and the interaction of serpentinization-driven natural alkaline water with metal salt pellets [7]. Here, we demonstrated that self-assembled mineral membranes form from carbonate-rich soda lake water (Lake Magadi, Southern Kenyan). Mineral vesicles and tubular membranes are obtained respectively by adding drops of barium, calcium, cobalt, magnesium, manganese, and zinc solutions or by immersing pressed pellets of these metal salts into high pH and high silica brine of Lake Magadi. The structures were studied by SEM-EDX, Raman microscopy and X-ray diffraction. We found that mineral membranes synthesized from carbonate-rich brine lack phosphorous in its structure. This confirms the interesting observation made recently that the high phosphate level of carbonate-rich soda lakes is due to the sequestration of calcium into carbonate minerals preventing phosphate removal by apatite precipitation [8]. Our result suggests that mineral self-organization could have been a geochemically plausible phenomenon in carbonate-rich closed basin environments of the early Earth.

[1] García-Ruiz & Otálora (2015) *Handbook of Crystal Growth, Vol. II*. 1-43. Elsevier.

[2] Nakouzi & Steinbock (2016) *Sci. Adv*. 2, e1601144.

[3] García-Ruiz et al. (2020) *Phys Life Rev*. 34-35, 62

[4] Glaab et al. (2012) *Angew. Chem*. 124, 4393.

[5] Saladino et al. (2019) *Chem. Eur. J*. 25, 3181.

[6] Satoh et al., (2014) *Eur. J. Mineral.* 26, 415.

[7] García-Ruiz et al. (2017) *Sci. Adv.* 3, e1602285.

[8] Toner & Catling (2020) *Proc. Natl. Acad. Sci.* 117, 883.