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Could environmental conditions play important role in carbonate facies formation? A reappraisal based on new bio-geochemical approach in modern microbialites from Japan

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Microbialites are organosedimentary structures formed by the direct and/or indirect activity of associated microorganisms. The term "microbialite" is used to describe authigenic accumulations such as stromatolites, some tufa and also travertine. Despite the identical chemical and mineralogical composition, tufa and stromatolites differ in some features like depositional environments and isotopic signals. These specific carbonate rocks have recently become subject of studies, because the recent oil field discovered in microbialites. The aim of this work is a detailed sedimentological and geochemical investigation in modern carbonate rocks from 10 hot springs in Japan. The island of Japan is one of the few modern environments where microbialites, tufa and travertine like precipitate. The study area is located in Kyushu, Honshu and Hokkaido islands. The three different islands were sampled in order to compare different geological background and environmental conditions, based on water chemistry, physical-chemical and geochemical parameters. Based on macro and microscopic data, six facies have been described: Stromatolite, Pool, Cascate, Shrubs, Bubble and Root. The data shows that water chemistry (temperature, pH, D.O.) directly interfere in precipitation and consequently in facies types. Furthermore, the morphology of the substrate these carbonates grow, likewise distance away from the vent, also contributes to different facies formation. Mineralogical results show that the Kyushu (NAG, SHIO and MYO) hot springs are mainly composed of aragonite and the Honshu (YAMA, NIIMI and KIBE) and Hokkaido (FURU, OKU, OHF and OKU) hot springs are mostly composed of calcite. Chemical results show high contents of CaO and subordinated contents of Fe2O3 and SiO2 in all samples. Subordinated, Arsenic contents were also observed and its origin is stills in debate. Biogenic precipitation would control the biomineral formation and the mineralogy would change accordingly to the phylogenetic lineage involved. The isotopic signals show depleted values of $\delta^{18}O$ in all sites and light enriched values of $\delta^{13}C$. Therefore, herein these microbialites have been interpreted as precipitated from meteoric water on surface due the degassing of CO2, with few or absent biological precipitation. The SEM images allowed nano scale observations and showed fossils related to EPS that characterizing biological influence during precipitation in the stromatolite facies. Micro-CT observations allowed a detailed examination of pores from all facies, showing that the bubble facies is the most porous one, followed by shrub, root, stromatolite, pool and cascate. This unique microbialite sequence found in Japan alowed the possibility to infer a precise understanding of microbialite geochemical signals associated with environmental conditions. These carbonate might potentially be an analogue for carbonate reservoirs, like the Pre-Salt in Brazil.