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Monitoring mineral precipitation sequence of Lake Magadi soda lake: A multi-technical approach

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Lake Magadi is a saline soda lake in East African Rift Valley, occupying the axial trough of Southern Kenyan Rift. Its fed by perennial saline hot/warm springs, which evolve into the soda and saline chemistry of the lake. The main processes thought to cause the enrichment of the lake in Na^+, CO_3^{2-}, Cl^-, HCO_3^- and SO_4^{2-} are evaporative concentration, mineral precipitation and fractional dissolution [1]. Lake Magadi is considered an analogous environment to the early Earth [2]. The high pH, silica and carbonate content of Lake Magadi allows the formation of silica and carbonate induced self-assembled mineral structures [3,4]. Revealing the mineral precipitation sequence of Lake Magadi have implications in understanding the geochemistry of evaporative rift settings and soda oceans. We have experimentally investigated the mineral precipitation sequence during evaporation at 25 °C. The sequence of mineral precipitation was recorded by using in-situ video microscopy. The mineral patterns observed in video microscopies were identified by spectroscopic, diffraction and electron microscopy techniques. The mineralogy and elemental composition of the precipitates were determined by using Raman spectroscopy, powder X-ray diffractions and scanning electron microscopy coupled with energy dispersive X-ray analyser. The results of the ex-situ analyses were compared with the in-situ X-ray diffraction. In-situ X-ray diffractions were performed on acoustically levitated droplets in the µSpot beamline at BESSY II synchrotron (Berlin, Germany). Finally, thermodynamic evaporation simulation was performed by using PHREEQC code with Pitzer database. Ex-situ and in-situ experiments revealed that mineral precipitation begins with trona, followed by halite and finally thermonatrite. In PHREEQC simulations, natron was observed instead of thermonatrite, suggesting the role of kinetics in the mineral assemblages. This multi-technical approach of in-situ monitoring and ex-situ characterization is a powerful approach to unveil mineral precipitation patterns and the resulting geochemical evolution in evaporative rift settings.

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