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Dissolved silica driven dolomite precipitation in the Great Salt Lake, Utah

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Since discovering dolomite, numerous attempts have been made to understand its sedimentation and precipitation mechanism. It has been recognized that the dehydration energy barrier for surface Mg^{2+}-water complex impedes dolomite nucleation and growth. The relationship between microbial life and dolomite has been validated with laboratory synthesis that specific organic molecules, such as polysaccharides, exopolymeric substances, and hydrogen sulfide, could promote dolomite precipitation. However, some dolomite appears to have an abiotic origin, and previous laboratory work shows that dissolved silica promotes disordered dolomite precipitation at room temperature. Modern occurrences of dolomite in the Great Salt Lake (GSL) have been studied since the early last century. Dolomite dominates the sediments in the South Arm while the North Arm sediments contain mostly aragonite. This heterogeneous distribution of sediments in GSL provides a perfect case study to understand abiotic dissolved silica-driven dolomite formation. Earlier studies proposed that dolomite precipitation in the GSL was possibly induced by microbial activity. However, the microbial mats of the North Arm contain only aragonite with no dolomite. Instead, this work demonstrates that dolomite abundance is positively correlated with dissolved silica concentration and suggests that dissolved silica likely controls dolomite formation in the GSL. Even though the North Arm has a much more concentrated Mg and Ca water from lack of freshwater input, dissolved silica levels in the South Arm (> 0.5 mM) are much higher than in the North Arm (< 0.2 mM). Dissolved silica is input from streams feeding into the South Arm that carry at ~0.2 mM and is concentrated through evaporation. A high concentration of dissolved silica catalyzed the nucleation and growth of dolomite in the South Arm. However, a significant amount of silica was removed from the solution through adsorption on carbonate and authigenic clay mineral precipitation, resulting in silica-depleted lake water in the North. This dissolved silica catalyzed model explains many sedimentary Phanerozoic dolomite associated with limestone. This new finding could also provide a new proxy for constructing climate changes in the GSL area based on dolomite controlled by the abiotic process.