An investigation of mineral formation during mixing of low temperature serpentinization-derived hyperalkaline waters, seawater and continental runoff waters

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Serpentinization of peridotites produces high pH waters that discharge at springs on the seafloor or on ophiolite surfaces where they can mix with waters of the local environment (seawater, formation waters or continental runoff). This creates very sharp composition, temperature, pH and redox gradients that produce conditions favorable to the development of a prebiotic chemistry, but also to the formation of secondary minerals (Ca-carbonates, brucite) that may build up large submarine hydrothermal chimneys (e.g. Lost City, Prony) or travertines (e.g. Oman). Fluid composition data reported for 11 different serpentinizing environments (Oman, Liguria, Lost City, Mariana forearc, Portugal, Cyprus, Turkey, New Caledonia, Newfoundland, California, Jordan) show that the highest pH value reported at each site varies from 10.7 (Cabeço de Vide, Portugal) to the all-site record value of 12.7 at Maqarin (Jordan). Hyperalkaline waters are Ca-enriched, and carbonate and Mg-deprived. Thermodynamic calculations show that brucite is stable at pH values above about 10.5, that delimitates the domain of hyperalkaline waters. Ca-Mg carbonate minerals (dolomite, huntite, etc.) are largely supersaturated at intermediate pH values (around 10). This is also the case for a variety of Mg-silicates that have never been found in hyperalkaline spring sediments although poorly cristallized talc-like minerals are commonly described in the low temperature alteration of peridotites. On another hand such serpentinizing environments are host of adapted microrganisms that may induce mineral formation through biomineralization or organomineralization processes. This raises the question of the energetics of mineral formation and the respective roles of inorganic and biogenic processes in the chemical element budget, especially carbon, in low temperature serpentinizing environments.