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Siliceous Cements: Geochemical Constraints on the Precipitation Process

Siliceous hot springs (Cistern Spring, Norris Geyser Basin, and Deerbone Spring, Lower Geyser Basin, Yellowstone National Park, Wyoming) provide excellent natural laboratories for studying siliceous authigenic precipitates. Opal-A precipitation within these hot spring systems has been attributed to a variety of processes: evaporative concentration, cooling, changes in pH, and cation effects. In the past, little effort has been made to evaluate the relative importance of each of these factors in the precipitation process. Repetitive in situ (T, pH, alkalinity) and laboratory (major, minor, and trace elemental, stable isotopic) analyses of the waters, plus observations of silica precipitation on natural and artificial substrates (twigs, glass slides, copper plates) in the waters substantiate that subaqueous precipitation is occurring throughout the vent to distal end of flow in both siliceous hot springs. Thus, these measurements and observations facilitate geochemical evaluation of the precipitation models.

Based on a suite of measured and theoretical amorphous silica saturation indices, downflow changes in the system due to evaporative concentration (Cl, a conservative ion, increases 10%), pH (5.6 to 7.1), and cation effects (Al and Fe) have negligible effects on the saturation indices, and thus, on the subaqueous precipitation of hot spring opal-A. Although evaporative concentration is the most routinely invoked explanation of hot spring opal-A precipitation, the process can only be of minimal importance. Similarly, at the macroenvironmental scale, potential biotic effects on opal-A precipitation appear to be minimal. Modeling of the two active opal-A precipitating systems indicates that cooling (80 to 178C) is the predominant process governing subaqueous mineral precipitation.