Geochemistry of precious metals and metalloids in silica sinter deposits from Puchuldiza, northern Chile: Implications for metal transport and precipitation in high-altitude active geothermal environments.

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Silica sinter deposits are formed by precipitation from thermal fluids as they discharge and cool at the surface, and they are common surface expressions of underlying geothermal systems and low sulfidations epithermal gold deposits. Sinter deposits are texturally complex and are predominantly composed of non-crystalline opal-A, although can contain opal-CT and/or opal-C and microcrystalline quartz. Previous studies have documented unique geochemical and textural characteristics in sinters at the El Tatio (>4000 m a.s.l.) geothermal system in northern Chile. Mineralogical data suggest that environmental conditions play an important role in the silica precipitation rate. Furthermore, it has been suggested that dissolved species and metals may play an enhancing effect on silica precipitation rate. However, very little information exist on the potential effect of silica on metal precipitation in such systems.

In this study, we present new data from the Puchuldiza silica sinter and associated geothermal spring waters in the Altiplano of northern Chile. This system has been explored for both high-enthalpy geothermal resources and epithermal gold deposits. Here, we couple SEM observations of silica sinter samples with XRD and LA-ICP-MS data to assess their textural, structural and geochemical characteristics. SEM images showed different silica morphologies including micro-to-nano spheres with variable sizes, and quartz micro crystals. The XRD data identified the silica phases as opal A, opal CT, opal C, quartz, and accessory minerals such as cinnabar, oropimente and realgar. The opal A phases display similar high FWHM values than El Tatio's opal, confirming the effect of high-altitude on silica precipitation.

In contrast to the low metal contents of thermal spring water (Cu ~6.9–18.4 ppb, and Au ~0.4–1.8 ppt), the LA-ICP-MS data of siliceous phases in sinter show relatively high Cu (~0.7-3 ppm) and particularly Au (~1-5 ppm, up to 15 ppm), suggesting a key role for amorphous silica as an efficient adsorbant phase for metals in the active Puchuldiza field.