Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19690

Opaline silica synthesis under geologically-relevant conditions with applications to Earth and Mars

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Opal (Amorphous hydrated silica or even opaline silica, $SiO_2 . nH_2O$), is a mineral formed by the aqueous alteration of silicate rocks, through both weathering and hydrothermal alteration. Terrestrial and Martian observations, coupled with fluid-rock alteration experiments, show that opal forms at various scales (up to several km large outcrops), at the expense of various minerals (e.g. feldspars, volcanic glass and even clays and olivine) and in several geological contexts (e.g. acidic volcanic traps, alluvial fans and deltas, hydrothermal hot springs...) [1][2][3]. This makes opal a widespread witness and signature of fluid alteration. However, the conditions of its natural formation are not fully understood as it has not been synthetized under geologically relevant condition, applicable for Earth and Mars surfaces.

We developed a method of opal synthesis under conditions as close as possible to the geological ones in weathering context (< 50°C and atmospheric pressure). Considering that alteration in nature releases silica in solution, we prepared silica monomers solution (H_4SiO_4) by filtrating sodium metasilicate (Na_2SiO_3) in a cation exchange resin. We then induced silica polymerization (without crystallization) by controlled incorporation of silica monomers into an alkaline solution. The progressive growth of silica nuclei forms a colloidal suspension of silica nanograins (25 to 40 nm in diameter) that are then cemented and agglomerated by adding silica hydrogel solution. After drying, the obtained synthetic opal shows microstructures and Raman properties close to the natural ones. In addition, it features realistic water content and contains only geologically-relevant chemicals, by contrast to other synthetic opals [4]. Our method paves the way to study the influences of various chemicals on opal properties.

By tuning our versatile protocol and studying the analogues so-produced could allow the scientific community to identify more discrete and specific signatures present in natural opals, belonging for example to: particular physico-chemical conditions (e.g. temperature); particular fluid chemistries (e.g. pH); co-occurrence/co-precipitation with complex molecules (e.g. organics).

[1] Chauviré, B et al., (2017). *The Canadian Mineralogist*, *55*(4), 701-723.

[2] Jones, B. (2021). *Sedimentary Geology*, *413*, 105820.

[3] Pan, L et al., (2021). *The Planetary Science Journal*, *2*(2), 65.

[4] Gouzy et al. In preparation