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Working towards a universal formation model for spheroidal iron (oxyhydr)oxide concretions

Desiree Baker and Sally Potter-McIntyre
Southern Illinois University Carbondale, Carbondale, United States of America (desiree.baker@siu.edu)

Three principal models exist for iron (oxyhydr)oxide concretion formation in the Navajo Sandstone in southern Utah, USA and the most recent model by Yoshida et al. (2018) suggests that calcite concretions are precursors to iron (oxyhydr)oxide concretions. This model could account for the existence of a gradient of carbonate and iron concretions found in both red diagenetic facies (with primary hematite grains coatings retained) and white diagenetic facies (primary hematite grain coatings removed during diagenesis). However, evidence for calcite precursor minerals and an understanding of the fluid chemistries involved in these diagenetic reactions is lacking. This research focuses on spheroidal concretions in the Navajo Sandstone at Coyote Gulch—a site that is down gradient, but upsection from Spencer Flat (the focus of previous work) and tests the hypothesis that calcite concretions are precursors to iron (oxyhydr)oxide concretions. Bulk mineralogy, bulk geochemistry, and petrography provide elemental and mineralogical composition of the concretions and show that the concretions are calcite cemented (~40 wt.%) and the host rock is predominately iron (oxyhydr)oxide cemented (~3 wt.%). The host rock surrounding embedded concretions shows secondary iron (oxyhydr)oxide precipitation and decreases in calcite in transects away from the concretion. These relationships suggest that the calcite concretions formed prior to the precipitation of secondary iron (oxyhydr)oxides and may have provided a localized buffering environment for the precipitation of iron (oxyhydr)oxides. This study also represents an opportunity to determine a universal model for carbonate and iron (oxyhydr)oxide spheroidal concretion formation, and to understand the influence of fluid interactions in the search for subsurface redox reactions to power metabolisms on Earth and Mars.