American Mineralogist, Volume 109, pages 339–358, 2024

Reconstructing diagenetic mineral reactions from silicified horizons of the Paleoproterozoic Biwabik Iron Formation, Minnesota

Samuel Duncanson[1,*], Latisha Brengman[1,†], Jena Johnson[2,‡], Athena Eyster[3,4], John Fournelle[3,§], and Aurélien Moy[3]

[1]Department of Earth and Environmental Sciences, University of Minnesota–Duluth, Duluth, Minnesota, 55812, U.S.A.
[2]Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan 48109, U.S.A.
[3]Department of Geoscience, University of Wisconsin Madison, Madison, Wisconsin 53706, U.S.A.
[4]Department of Earth and Ocean Sciences, Tufts University, Medford, Massachusetts 02155, U.S.A.

Abstract

Primary phases in iron-rich chemical sedimentary rocks are important archives of seawater geochemistry throughout the Precambrian. The record of seawater chemistry, however, is obscured by post-depositional changes that occur during diagenesis, metamorphism, and modern weathering. Recent studies have identified silica-cemented horizons in some Archean and Paleoproterozoic iron formation that may preserve reduced, texturally early mineral phases, which may inform interpretations of oxygen dynamics preceding atmospheric oxygen accumulation before the ~2.3 Ga Great Oxidation Event (GOE). However, fewer investigations focus on silica-cemented horizons in Paleoproterozoic iron formation deposited after the GOE, a period where oxygen levels are poorly constrained. Here, we present petrographic observations, scanning electron microscopy, electron microprobe analysis, and Raman spectroscopy of iron mineral phases preserved within silica-cemented horizons of the ~1.9 Ga Biwabik Iron Formation (Minnesota, U.S.A.) to constrain texturally early iron formation mineralogy from this crucial post-GOE interval. Based on textural relationships, the iron silicate greenalite is identified as the earliest-forming iron silicate mineral preserved within silica-cemented horizons. The magnesium- and aluminum-rich iron silicates chamosite and stilpnomelane are preserved proximal to fine-grained, non-silicified horizons, suggesting local geochemical exchange during early diagenesis. The presence of well preserved, early-forming silicates containing predominantly ferrous iron may indicate reducing conditions at the sediment-water interface during deposition of the Biwabik Iron Formation. More definitively, future studies using iron silicate mineralogy as seawater geochemistry proxies should consider preservation by silica cementation, in addition to the effects of local geochemical exchange during diagenesis.

Keywords: Silicification, silica cementation, diagenesis, chamosite, greenalite