

## A green rust precursor to Precambrian iron formations?

I. HALEVY\*, M. ALESKER, R. POPOVITZ, Y. FELDMAN  
AND E. SCHUSTER

Weizmann Institute of Science, Rehovot, Israel.

(\*correspondence: itay.halevy@weizmann.ac.il)

Iron formations (IF) provide strong evidence for the mobility of iron in Earth's oceans prior to ~2.3 billion years ago (Ga), which in turn implies that both dissolved oxygen and marine sulfide levels were low [1,2]. However, despite decades of IF research, driven by economic interest and the potential of IF to constrain marine paleoenvironments, several aspects of IF genesis remain incompletely understood. Notably, though recent hypotheses focus on amorphous ferric hydroxides [3,4], the precursor to the observed mineral assemblages in IF has not been conclusively identified [5]. One heretofore neglected precursor is the ferrous-ferric hydroxy-salt green rust. Combining thermodynamic calculations, laboratory experiments and dynamic models of the early iron cycle, we find that green rust likely had a quantitatively important role in IF genesis [6].

In laboratory experiments, we find that carbonate green rust: *i*) readily precipitates from Precambrian-analog seawater solutions of variable composition, *ii*) transforms upon aging into all of the mineral types observed in IF, *iii*) yields microtextures reminiscent of some IF. Importantly, a green rust precursor may explain how predominantly ferrous or mixed valence mineral assemblages formed diagenetically in organic-poor IF. Incorporating these results into a biogeochemical model of the early iron cycle, we find that for "typical" Archean and Paleoproterozoic conditions the precipitation and settling of green rust constitutes up to ~80% of the total seawater iron sink, with the remainder being removed from seawater by precipitation and settling of amorphous ferric hydroxides.

Our results carry implications for the availability of bioessential nutrients. Furthermore, they require a revision of the current understanding of the early iron cycle, of interpretations of the iron isotope and trace element records [7], and of the way in which these records are used to infer ancient paleoceanographic conditions.

[1] Holland (1973) *Econ. Geol.* **68**, 1169–1172. [2] Cloud (1973) *Econ. Geol.* **68**, 1135–1143. [3] Kappler *et al* (2005) *Geology* **33**, 865–868. [4] Fischer and Knoll (2008) *GSA Bull.* **121**, 222–235. [5] Bekker *et al.* (2010) *Econ. Geol.* **105**, 467–508. [6] Alesker *et al* (2014) *submitted*. [7] Schuster *et al* (2014) *Min. Mag.* this volume.