American Mineralogist, Volume 83, pages 1419–1425, 1998

Alteration of microbially precipitated iron oxides and hydroxides

D. Ann Brown,[1] J.A. Sawicki,[2] and Barbara L. Sherriff[1,*]

[1]Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada
[2]AECL, Chalk River Laboratories, Chalk River, Ontario K0J 1J0, Canada

Abstract

Iron oxide and hydroxides can be precipitated from solution with both Fe^{2+} and Fe^{3+} states by a microbial consortium enriched from surface water draining a granitic batholith. The Fe^{2+}/Fe^{3+} ratio of the microbial precipitate is determined by both the initial environment and subsequent diagenesis. To evaluate the thermal aspects of diagenesis, biological precipitates, either largely Fe^{2+} or equally divided between Fe^{2+} and Fe^{3+} states, were heated at 80 °C for 12 weeks, under various redox conditions and compared to samples maintained under the same conditions at 4 °C. Mössbauer spectroscopy showed the iron oxide and hydroxides precipitated as Fe^{2+} to be more stable than that as Fe^{3+}. Only under air at 80 °C are the ferrous minerals altered to hematite, while the more labile ferric minerals are altered to $Fe(OH)_2$ at 4 °C and to hematite at 80 °C. In contrast, chemically precipitated Fe compounds, when incubated with the consortium, only form Fe^{3+} compounds, mainly fine-grained hematite. When no microbes are present, goethite is formed during diagenesis. Fe speciation in sediments may reflect a combination of microbial mediation that causes the initial precipitation of iron oxides and hydroxides and the subsequent conditions of the diagenetic processes characteristic of that particular depositional environment.