

Alteration of microbially precipitated iron oxides and hydroxides

D. ANN BROWN,¹ J.A. SAWICKI,² AND BARBARA L. SHERRIFF^{1,*}

¹Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada

²AECL, Chalk River Laboratories, Chalk River, Ontario K0J 1J0, Canada

ABSTRACT

Iron oxide and hydroxides can be precipitated from solution with both Fe²⁺ and Fe³⁺ states by a microbial consortium enriched from surface water draining a granitic batholith. The Fe²⁺/Fe³⁺ 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 Fe²⁺ or equally divided between Fe²⁺ and Fe³⁺ 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 Fe²⁺ to be more stable than that as Fe³⁺. 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 Fe³⁺ 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.