Oxidation of iron formation in the Mesabi Iron Range, Minnesota, has negatively impacted recovery of the main ore mineral, magnetite, by two mechanisms. First, magnetite has been partially or completely oxidized to hematite (martite), which is not amenable to magnetic separation. Second, silica has been remobilized during the oxidation process, and comprises a higher percentage of the ore concentrate than is desirable due to its altered grain size, making it difficult to grind sufficiently. This study focuses on the cause and effect of silica remobilization with an eye to enabling prediction of the ore-waste cutoff in a mine from visual inspection of variably oxidized iron formation. Previous work (Losh and Rague, 2011 GSA Abstr. volume) shows that silica has not been remobilized on a mine scale by oxidation: geochemical indicators and petrographic observations showed no quartz ‘halo’ around oxidized zones. At the same time, fluid inclusion data showed that fault-channeled, diagenesis-stage fluids (mean T homog = 154° C; mean salinity = 9.5 wt% NaCl equivalent) were responsible for early oxidation of iron formation: this event is distinct from later, widespread, shallow-level supergene (lateritic) oxidation. Petrographic and SEM examination of rocks from early-oxidized zones show rims of recrystallized quartz around variably-oxidized magnetite in samples in which Fe-talc and/or minnesotaite have been oxidized to goethite, indicating silica redistribution during oxidation. No such rims have been noted in later (supergene)-oxidized iron formation, implying they may have formed only under diagenetic conditions. These recrystallized rims represent a textural change that can complicate grinding and processing of ore, even in samples in which magnetite is still relatively unoxidized. Silica rim abundance is determined not only by the extent of oxidation (that is, proximity to a fault conduit), but also by the abundance of goethite that formed by the oxidation and hydration of iron silicates, and is thus dependent on pre-oxidation mineralogy. Additionally, quartz micro veins have filled fractures formed in magnetite grains under the stress of faulting in the iron formation. Quartz micro veins in oxidized samples are smaller than grinding capabilities allow for magnetic separation, increasing silica content in the ore concentrate. A predictive field guide that can dictate grinding procedure and ore versus waste cutoff may rely on goethite abundance as well as magnetite oxidation and alteration.