Evidence for highly oxidizing groundwaters at 2.06 Ga

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Our research investigates the origin of the anomalous oxidized, subaerially erupted, ca. 2.06 Ga Kuetsjärvi Volcanic Formation (KVF) of Fennoscandia, deposited during the progressive oxidation of the Earth's atmosphere. The KVF displays a very large range of ratios of oxidized to total iron ($Fe^{3+}/\Sigma Fe$) with a mode of ≈0.5, while earliest Paleoproterozoic and late Paleoproterozoic volcanic formations in Fennoscandia have $Fe^{3+}/\Sigma Fe$ around 0.2. This study utilizes rock samples collected from FAR-DEEP Cores 6A, 7A, and 8B to test the two main hypotheses put forth to explain the oxidized nature of KVF: 1) eruption from a highly oxidized mantle, or 2) oxidation during terrestrial exposure by oxygen-charged groundwaters during the putative atmospheric pO_2 "overshoot" of the Great Oxidation Event.

Our preliminary petrographic observations and geochemical data suggest that the elevated $Fe^{3+}/\Sigma Fe$ values of the KVF are from post-crystallization hematization of the rocks that initiated at the erosional contact marking the top of the KVF, and progressed downward exploiting the oldest fracture sets. One of the strongest pieces of evidence for syndepositional oxidation predating regional metamorphism is the observation of the oxidized KVF clasts within the overlying conglomerate units, which otherwise do not exhibit pervasive oxidation. These observations, together with geochemical evidence for only modest alteration by surficial weathering, support the hypothesis of interaction with highly oxidizing groundwaters pursuant to eruption of the KVF.