Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35184

Extensive marine manganese oxidation during the Lomagundi-Jatuli Event

ANDREW A. SICILIANO[1], PETER CROCKFORD[2] AND CHADLIN M. OSTRANDER[1]

[1]University of Utah
[2]Carleton University

The ~2.3-2.05 Ga Lomagundi-Jatuli Event (LJE) constitutes the largest and longest-lived positive inorganic carbon isotope excursion in Earth's history. It is traditionally interpreted to signify exceptional worldwide organic carbon burial, a phenomenon that should have released a large amount of molecular oxygen (O_2) to the atmosphere on the heels of the Great Oxidation Event. However, a growing number of alternative hypotheses attribute the LJE to processes that do not *a priori* require any substantial O_2 release. Distinguishing between these hypotheses is critical to understanding Earth's redox evolution and its role in the emergence of complex eukaryotic life.

To address this gap, we present trace-metal and rare-earth element plus yttrium (REY) data from ~1,200 m of drill core spanning the carbonate-rich 2.1–2.0 Ga Tulomozero and Zaonega formations from northwest Russia. The syn-LJE Tulomozero Formation preserves a shallow-water dolomitic carbonate platform characterized by stable, elevated $\delta^{13}C_{carb}$ values, muted Fe and Mn contents, and exceptionally low Ce anomalies (Ce/Ce*) averaging 0.39 (n = 103) with a minimum down to 0.03—among the lowest values ever recorded in marine carbonates. These signatures indicate highly efficient marine Mn oxidation and concomitant Ce scavenging, consistent with O_2-rich surface waters during the LJE. In contrast, the overlying Zaonega Formation, deposited after the LJE, records a deeper-water, organic-rich setting with highly depleted $\delta^{13}C_{carb}$ values, elevated Fe and Mn contents, and variable Ce/Ce* that are commonly > 1 (maximum Ce/Ce* = 1.90), suggesting Mn oxide dissolution and release of sorbed Ce under anoxic conditions. A positive correlation between Ce/Ce* and Mn contents supports a primary Mn oxide-mediated driver of the marine Ce cycle under redox-stratified conditions.

Together, these data indicate the presence of highly oxygenated shallow waters during the LJE, transitioning to anoxic deeper environments in its aftermath. Because Ce anomalies reflect local conditions, these data cannot uniquely distinguish between basin-wide deoxygenation across the Tulomozero–Zaonega transition versus persistent vertical redox gradients. Nevertheless, the extreme magnitude of Ce depletion observed in shallow-water carbonates provides support for inflated surface-ocean O_2 levels during the LJE, perhaps consistent with aspects of the "oxygen overshoot" hypothesis.