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Support for a revised interpretation of the Lomagundi-Jatuli Event and oxygenation after the GOE

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The high carbon isotope ratios in carbonate rocks of the Lomagundi-Jatuli Event (LJE, approximately 2.3–2.1 Ga) have had a strong influence on interpretations of Earth's oxygenation following the Great Oxidation Event (GOE). Traditionally, the high carbon isotope ratios have been used to argue for elevated organic carbon burial that would have released large amounts of oxygen to the surface environment. This interpretation relies on carbonate rocks from this era faithfully preserving representative carbon isotope ratios with respect to the global ocean-atmosphere reservoir of carbon. However, challenges to this interpretation have also been proposed based on recognition of the complex local environments associated with some LJE rocks (e.g. [1]), as well as the facies dependence of carbonate carbon isotope ratios during this period [2]. We present new observations supporting a revised interpretation of the LJE, rooted in a general appreciation of the importance of diagenesis, dolomitization, and local environmental variability in shaping carbonate geochemistry.

We applied a multi-proxy isotopic approach to investigate the nature of the LJE in Fennoscandia. In the Umba and Kuetsjärvi Formations (FAR-DEEP cores 4A and 5A, respectively), calcium and magnesium isotope ratios suggest that dolomitization was a key influence on setting the major element composition of carbonates, including the high carbon isotope ratios characteristic of the LJE. The isotopic consequences of additional post-depositional events such as volcanic intrusions can also be recognized with this multi-proxy approach. In the Tulomozero Formation (FAR-DEEP cores 10B and 11A), isotopic fingerprints associated with evaporitic mineralization and brine evolution show that evaporitic processes were instead most important for controlling carbonate geochemistry at this location. These results support a different interpretation of the global carbon cycle during the LJE and therefore a different target for biogeochemical modeling of this dynamic interval of time. This revision resolves some of the outstanding difficulties with the original LJE interpretation, but also presents several new ones that remain areas for further research.

[1] Melezhik, Fallick, Medvedev & Makarikhin (1999), *Earth-Science Reviews* 48, 71–120.

[2] Prave, Kirsimäe, Lepland, Fallick, Kreitsmann, Deines, Romashkin, Rychanchik, Medvedev, Moussavou, Bakakas & Hodgskiss (2021), *Journal of the Geological Society* 179, jgs2021-036.