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### ABSTRACT

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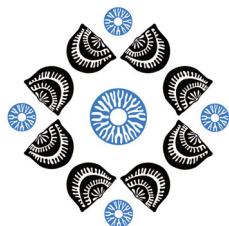
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# Drivers of the Late Ordovician Mass Extinction: redox, volcanism, atmospheric oxygen/carbon dioxide and/or glaciation

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The Late Ordovician marks an epoch of substantial change during Earth's geologic history. It documents the first mass extinction event of the Phanerozoic, which wiped out a plethora of marine genera. Though signatures of the extinction event are quite evident on the species level, there are many underlying uncertainties as to which factors drove the near destruction of Ordovician marine life. The exact causes and contributing factors of the Late Ordovician Mass Extinction (LOME) are highly debated. Previous studies propose processes such as redox shifts, volcanism, deep-water anoxia, low atmospheric oxygen, or excess CO<sub>2</sub> as significant influencers.

In this study, we utilized a multi-archive/proxy approach in reconstructing paleoenvironmental, stratigraphic, chronologic, and diagenetic signatures of halite and carbonate sequences from two localities containing the Ordovician–Silurian boundary. Our preliminary findings suggest that an abrupt, multi-pulsed glaciation was probably the main driver of the LOME. However, the exact duration, intensity, and number of cooling pulses are still up to interpretation and will require additional geochemical work to paint the entire picture.

Samples were obtained from two localities of similar low paleo-latitudes. Marine halite and carbonate were obtained from the upper Ordovician Red Head Rapids Formation, Hudson Bay Basin, Canada. Another suite of halite was collected from the Ordovician/Silurian Mallowa Salt Formation, Canning Basin, Western Australia.

The diagenetic integrity of Red Head Rapids halite and carbonate were assessed through strontium isotope analysis. Since the strontium isotope remains in equilibrium with seawater, we can cross-analyse the preservation potentials of both marine archives. All sample results lay within the  $\pm 0.00006$  ‰ natural variation of <sup>87</sup>Sr/<sup>86</sup>Sr measured in modern marine counterparts, providing evidence of primary material and accurate paleo-interpretations.

Trace element chemistry study was conducted on halite samples from both localities. Previous studies suggested that the spikes of Hg, Mo, and U concentrations signify the aftermath of a greenhouse event that triggered the expansion of deep-water anoxia. Furthermore, heightened volcanic activity led to significant greenhouse gas emissions and produced a period of warming. Instead, our halite Hg, Mo and U concentrations are extremely low, many below detection limits, which correspond to glacial signatures of an icehouse. Interpretation of the sedimentary cerium anomaly of the Red Head Rapids and Mallowa salts also revealed characteristics of an oxygenated marine environment, with all calculated values below the threshold, typical of anoxia.

Rigorous halite fluid inclusion analysis was conducted to qualitatively distinguish between primary and secondary material based on size, shape, orientation, and multiple growth patterns. Microthermometry homogenization temperatures derived quantitative distinctions between primary and secondary fluid inclusions of preserved and altered material, respectively. Paleotemperatures of primary fluid inclusions exhibited oscillations that were evident of daily/seasonal variation of inter- and/or glacial times, averaging approximately 24.2°C  $\pm$  0.5°C for the latest-Ordovician–earliest-Silurian. Apart from minor fluctuations, we noticed up to four major cooling pulses associated with the major glaciation characterizing the latest-Ordovician–earliest-Silurian time.