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Stable isotopes as a proxy for continental chemical weathering preceding the Neoproterozoic Sturtian glaciation

Age constraints suggest that the oldest Neoproterozoic “Snowball Earth” glaciation, known as the “Sturtian" glaciation, began at ~717 to 716 Ma and may have been triggered by enhanced continental silicate weathering coinciding with the breakup of the low-latitude supercontinent Rodinia. The Tambien Group, a carbonate and slate unit in northern Ethiopia, spans a total age range of 821.2 Ma to 716.4 Ma and should therefore record any major shift in terrestrial weathering preceding the Sturtian glaciation. Since Li isotopes are sensitive to continental chemical weathering processes, I obtained new Li isotope, major, and trace element data for carbonate samples from the pre-Sturtian Tambien Group. δ^7Li values for the Tambien Group range from 1.9‰ to 15.7‰, which is consistent with other Neoproterozoic sequences and suggests that seawater was characterized by low δ^7Li values around 13‰ (~18‰ lower than modern seawater) (Crockford et al., 2021). A positive correlation exists between Mg/Ca and δ^7Li in the Assem Limestone, which suggests that dolomitization has affected carbonate δ^7Li values. A negative correlation between Sr/Ca and δ^7Li and a positive correlation between δ^{18}O and δ^7Li in non-dolomitic limestones was also observed in the Mai Kenetal Limestone and Negash Syncline, which is consistent with the diagenetic recrystallization of aragonite to calcite under fluid-buffered conditions. However, despite spanning a large range of δ^7Li values, no temporal trend is observed in Li isotope data for the Tambien Group. Samples from the Mai Kenetal (ages ranging from 782.6 to 794.1 Ma) span a nearly identical range in δ^7Li as samples from the Negash limestone, which immediately precedes glaciation (age range from 731.5 to 716.5 Ma). These correlations suggest that a portion of the range observed in δ^7Li values for each

stratigraphic interval reflects viable diagenetic recrystallization rather than temporal evolution of seawater composition. The lack of a clear temporal trend in carbonate δ^7Li may indicate that there was no major shift in the pre-Sturtain terrestrial weathering regime. The lack of temporal trends in δ^7Li may also indicate that Li behaved differently in the Proterozoic and may not be as sensitive to climatic changes in the Proterozoic as Li appears to be in the Phanerozoic, possibly due to different terrestrial chemical weathering cycles in the absence of land plants (Kalderon-Asael et al., 2021).

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