

Svalbard Marinoan and Sturtian glacial suites marked by contrasting sulfate multi- isotope compositions

HUIMING BAO¹, IAN J. FAIRCHILD², PETER M.
WYNN³

¹ Department of Geology & Geophysics, Louisiana
State University, Baton Rouge, Louisiana, U.S.A.

² School of Geography, Earth and Environmental
Sciences, University of Birmingham,
Birmingham, UK

³ Lancaster Environment Centre, University of
Lancaster, Lancaster, UK

Two episodes of panglaciation, the Sturtian and Marinoan, are generally recognized in the Cryogenian Period (720 to 635 Ma) of the Neoproterozoic Era of the Earth history worldwide. One of the most pronounced features of the Marinoan glacial packages has been the occurrence of distinct non-mass-dependent ¹⁷O depletion in barite sulfate and/or carbonate-associated sulfate (CAS). Since the Marinoan ¹⁷O depletion (MOSD) has so far been identified in most Marinoan glacial deposits, MOSD has essentially become a marker for Marinoan glacial deposits. However, if the Sturtian glaciation behaved the same way as the Marinoan one in that the “Snowball Earth” was also melt back owing to an ultra-high pCO₂, we should expect to pick up a corresponding Sturtian ¹⁷O depletion or SOSD signature as well. Unfortunately, we currently do not have a reference section to test this hypothesis.

In the classic Neoproterozoic sections of NE Spitsbergen, Svalbard, occurrence of both the Sturtian and Marinoan glacial packages have been supported by an array of evidence. Importantly, due to its continental or close-to-continent deposition setting throughout the Cryogenian, Svalbard should be the most likely place to preserve SOSD if there was one. Here we present a set of $\delta^{34}\text{S}$ - $\delta^{18}\text{O}$ - $\Delta^{17}\text{O}$ data triplets for CAS traversing the entire Cryogenian sedimentary sequence, including the Elbobreen (E1, E2, E3, and E4), Wilsonbreen (W1, W2, and W3), and Dracoisen (D1, D2, and D3) formations. We found that while E1 and E4 have similar CAS multiple isotope compositions, the respective overlying Sturtian and Marinoan diamictite deposits (E2 and W) and their cap carbonate sequences (E3 and D) are distinctively different from each other. E2 has no ¹⁷O anomaly while W has the most negative $\Delta^{17}\text{O}$ values ever found. Furthermore, Cap E3 contains very low content of sulfate while Cap D is rich in sulfate with distinct ¹⁷O anomaly throughout the entire D1 and probably into D2. Our results argue for the likelihood of a qualitatively different panglacial event for the Sturtian than for the Marinoan. The Svalbard sulfate data provided justification for a new research perspective into Sturtian glacial sedimentary packages worldwide.