Melt water surge at end Marinoan glaciation: Os isotopic evidence

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The Neoproterozoic Cryogenian period records two global glaciation events [1], the long-lived Sturtian (717 to 659 Ma) and the much shorter Marinoan (ca. 645 to 635 Ma). Rapid, extreme climate change taxes the resolution of radiometric clocks. Melt-freeze periods oscillate on short time scales, causing fluctuations in continental detrital input, and rapid swings in the Os isotopic composition of seawater.

Here we report two stratigraphically-constrained end-Marinoan Re-Os ages from Nordauslandet (NE Svalbard, Wilsonbreen), derived from fresh outcrops of steeply dipping, thinly bedded slates with a clear Caledonian overprint. Remarkably, the slates preserve abundant primary framboidal pyrite (3-4μm), indicating an anoxic depositional setting and relatively low-temperature metamorphism. Two sample sites yield isochrons, both 635 Ma, within uncertainty – precisely the accepted age for the end of Marinoan glaciation. One isochron was acquired from a 10-cm stratigraphic interval of slate immediately overlying the Marinoan tillite (Os initial = 1.2). The second was acquired from a 10-cm interval of slate 106 m upsection (Os initial = 0.88). The data support rapid deposition of organic-rich shales and siltstones immediately following melting of Marinoan glacial ice. The high $^{187}Os/^{188}Os$ immediately above the tillite attests to release and deposition of radiogenic continental detritus held in the ice, whereas the lower $^{187}Os/^{188}Os$ upsection suggests rapidly declining continental input and return to more typical Os isotopic compositions for seawater.

This study shows that (1) indurated slates can provide primary depositional ages for shales [2], (2) highly deformed slates can preserve primary framboidal pyrite, (3) the end Marinoan is marked by rapid sedimentation with a high, and subsequently declining $^{187}Os/^{188}Os$, and (4) immediately post-Marinoan seawater may have a globally elevated Os isotopic composition of about 1.2 [3].

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References – [1] Hoffman et al (2017), *Science Advances*, **3**:e1600983; [2] Yang et al (2009) *Earth and Planetary Science Letters*, **280**, 83-92; [3] Rooney et al (2015), *Geology*, **43:5**, 459-462.