The duration of Marinoan ^{17}O depletion episode

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At ~ 635 million years ago atmospheric O_2 had its most pronounced non-mass-dependent ^{17}O depletion over the last 1 billion years' history. This Marinoan ^{17}O depletion (MOSD) is best explained by an ultra-high pCO_2 and therefore confirmed one of the most important predictions of the Snowball Earth hypothesis. The duration of MOSD is closely linked to the post-meltdown Earth's surface dynamics and can provide critical information on the rates of change in biosphere and atmosphere. Current radiometric dates confidently confine the duration within 1 million yr. Global biogeochemical modelling also places the duration within 1 million yr with uncertainties. An effort to interpreting observed relative sea level changes in continental shelf in South China based on a glacial isostatic adjustment model places an independent constraint on the MOSD duration at ~ 1×10^5 yr, with uncertainties.

Here we propose another independent constraint based on the longevity of a freshwater surface ocean after the Marinoan meltdown and on the globally observed stratigraphic ranges of MOSD signatures. Global energetic constraints place a best estimate of ~5×10^4 yr for the post-deglaciation freshwater lid. If assuming that the sedimentary barite layers in the post-meltdown successions are the result of episodic disruption of the stratified ocean, as is consistent with the existing barite formation model, the disappearance of these barite layers should mark the complete overturn and the end of the freshwater surface ocean. It is then followed that data from the Wushanhu section in South China, where 4 additional ^{17}O-normal barite layers occur on top the many ^{17}O-depleted barite layers, should place the duration of MOSD in less than 5×10^4 yr. That is, the MOSD episode ended earlier than the freshwater lid or the stratified ocean, revealing an astonishing rate of biosphere-atmospheric transformation in the post-snowball world.