Episode of intense chemical weathering during the termination of the 635 Ma Marinoan glaciation

Subject Code: D02

With the support by the National Natural Science Foundation of China and the Thousand Talent Program for Young Outstanding Scientists, a research team led by Prof. Shen Bing (**沈冰**) at the School of Earth and Space Sciences of Peking University, uncovered chemical weathering during the termination of Marinoan Snowball Earth. This study was published in *PNAS* (2016, 113: 14904—14909).

The Cryogenian (~720—635 million years ago, Ma) global glaciations (the snowball Earth) represent the most extreme ice ages in Earth's history. At least two extreme glaciations (dubbed as snowball Earth events), each lasting millions of years and affected the entire globe, occurred during the Cryogenian Period. These glaciations are recorded by globally distributed glacial deposits overlain by cap carbonates. According to the snowball Earth hypothesis, cap carbonate deposition was driven by intense continental weathering during deglaciation, but there is not direct geological evidence to support this hypothesis.

Compared to traditional proxies (e. g., chemical index of alteration and strontium isotopes), Mg isotopes provide a more reliable tracer for chemical weathering. In this study, they report Mg isotope data from the terminal Cryogenian or Marinoan-age Nantuo Formation and the overlying cap carbonate of the basal Doushantuo Formation in South China. The results reveal a positive excursion with extremely high δ^{26} Mg values in the top of Nantuo Formation, indicating an episode of intense chemical weathering, whereas significantly lower δ^{26} Mg values occur in the siliciclastic component of the overlying Doushantuo cap carbonate, suggesting moderate to low intensity of chemical weathering during cap carbonate deposition. These observations suggest that cap carbonate deposition postdates the climax of chemical weathering, probably because of the suppression of carbonate precipitation in an acidified ocean when atmospheric CO_2 concentration was high. Our finding confirms intense chemical weathering at the onset of deglaciation, but indicates that the maximum weathering predated cap carbonate deposition. Cap carbonate deposition was a delayed response to the deglacial intense chemical weathering, which ultimately supplied Ca^{2+} and bicarbonate to support cap carbonate precipitation. This episode of intense chemical weathering may have also brought abundant nutrients to the ocean, which in turn might have triggered primary productivity, ocean oxygenation, and eventually the diversification of complex eukaryotes in the early Ediacaran Period.

The reviewers take the view of that "The idea of using Mg isotopes to track weathering intensity during and in the wake of Marinoan Glaciation is clever, as is the effort to relate those trends to pH in the ocean, pCO_2 of the atmosphere, and overall carbonate saturation state of the ocean. An important implication is an apparent lag between maximum weathering rates and cap carbonate precipitation."

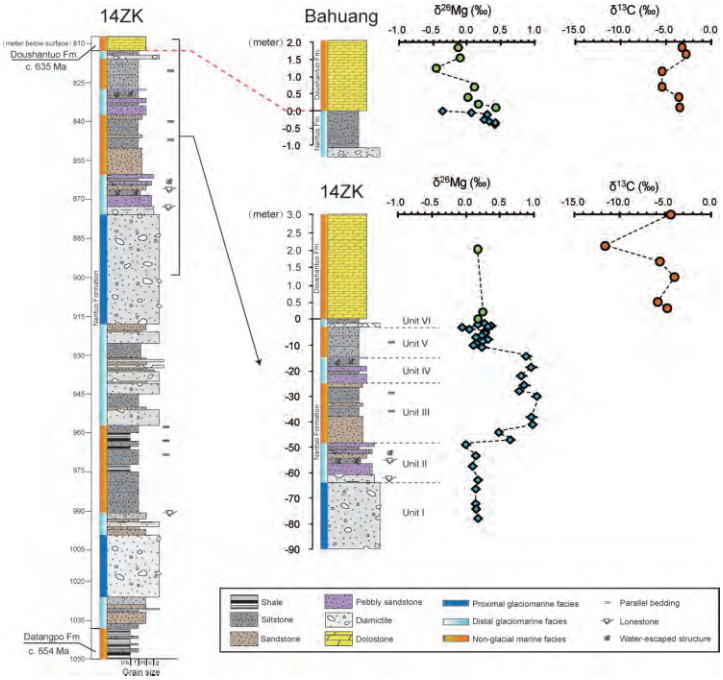

Figure Mg and C isotopic profiles of the Nantuo Formation and the Doushantuo cap carbonate, indicating a pulse of intense chemical weathering during deglaciation.

?1994-2018 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net