Geophysical Research Abstracts
Vol. 20, EGU2018-19761, 2018
EGU General Assembly 2018

Reappraisal of the significance and origin of Cryogenian benthic macroscopic phototrophs in the Datangpo Formation, China

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The effects of snowball Earth events on provoking biological radiation in their aftermath are well established, but the biological record of the events themselves are poorly known. In China, reports of carbonaceous compressions of benthic macroalgae from shales between diamictites of Nantuo Formation in Shennongjia region of South China (Ye et al,2015) aroused great international interest. It was argued that the fossiliferous shales were subtidal, interglacial facies, with the macroalgae pointing to warm, shallow seas, in a refugia during the Marinoan glaciation. In this paper, we reappraise the context of these fossil-bearing rocks, and offer a different explanation. It is demonstrated that these fossils derive from a formation between the Gucheng (Sturtian) and Nahua (Marinoan) glaciations: the interglacial Datangpo Formation. At the macroalgae-bearing Mahuanggou section (in NE Shennongjia), the basal deposits comprise diamictites that are conformably overlain by the 13 m thick Datangpo Formation, which consists of interglacial dark gray, gray carbonaceous silty mudstones and shale. This is in turn overlain by the hundred metre thick Nantuo Formation diamictites, and is capped by 30-50 cm thick cap dolomite of the Doushantuo Formation of Ediacaran age. Carbon isotope values of the Gucheng Formation and Nantuo Formation tillites differ from those obtained from mudstones of the Datangpo Formation. The Gusheng (Sturtian) and Nantuo (Marinoan) display major negative excursions (-6 to -12‰), compared to low positive values (0-1‰) for the Datangpo. Furthermore, chemical index of alteration (CIA) values differ for the Gusheng and Nantuo (50-50%) and the Datangpo (60-70%). These changes chart the evolution from Sturtian to Marinoan glaciations with their associated interglacial. Reappraisal of the Datangpo Formation demonstrates that the macroalgae, together with abundant Churia-like fossils, are only present in lower carbonaceous, silty mudstones (0-6 m thick) and rare in the upper part of the formation. We propose that following the Marinoan glaciation, abundant influx of nutrients from rivers, in concert with an ameliorating climate, sufficient sunlight, and shallow marine environment produced the ideal conditions for a benthic algal community to flourish.