Snowball Earth hypothesis challenged

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Outcrop in the Terconi quarry, Mato Grosso, Brazil. The lower part shows a pink dolomite layer overlain by grey limestone, richer in organic matter. These carbonates lie directly above Marinoan glacial sediments. © Pierre Sans-Jofre

The hypothesis that the Earth was completely covered in ice 635 million years ago has received a serious blow. The atmospheric concentration of CO2 during that period was much lower than previously thought, according to a team of French researchers from the Institut de Physique du Globe de Paris (CNRS, France), working in collaboration with scientists from Brazil and the US. Their work, which is published in the journal *Nature* on October 6, challenges part of the so-called Snowball Earth hypothesis and rekindles the debate about the origins of the deglaciation mechanism.

The Earth has experienced several extreme glacial events, two of which took place during the aptly named Cryogenian period (710-630 million years ago). In 1992 and 1998 scientists hypothesized that around 635 million years ago our planet underwent a major glacial episode that left it entirely smothered in ice.

Today still, the question of how this episode came to an end remains unanswered, given that ice reflects more solar radiation back into space than rocks do. In the Snowball Earth hypothesis, it is assumed that enough CO2 of volcanic origin had built up in the atmosphere for this greenhouse gas to warm up the surface of the planet and cause the ice to melt. According to this scenario, CO2 concentrations must have fluctuated around 120 000 ppmv (parts per million by volume) (i.e.12%), which is 300 times greater than CO2 concentrations today.

In order to assess the atmospheric concentration of CO2 at that time, the French, Brazilian and US researchers studied carbonates deposited 635 million years ago (the Marinoan glaciation). These sediments cap the glacial deposits of that period, believed to have witnessed a global glaciation known as Snowball Earth. The study is based on the difference in carbon isotopic composition between carbonates and organic matter in fossilized organisms, which reflects atmospheric concentrations of CO2. The results show that CO2 concentrations were very close to what they are today (less than 3 200 ppmv), which is far from being sufficient to bring about the end of a glacial episode of this magnitude.

This work not only challenges part of the Snowball Earth hypothesis, but also implies that these glacial episodes were not as intense as previously suggested. Moreover, this data is consistent with the idea that the atmosphere at the same period was much more oxygen-poor, around 1%, as compared to today's levels of approximately 20%. Scientists will therefore need to examine alternative deglaciation mechanisms or gases other than CO2, such as methane, which has also been suggested as part

of this hypothesis.

More information: A carbon isotope challenge to the snowball Earth, P. Sansjofre, M. Ader, R. I. F. Trindade, M. Elie, J. Lyons, P. Cartigny and A. C. R. Nogueira – *Nature*, 6 October 2011

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