New study sheds light on end of Snowball Earth period

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A composite image of the Western hemisphere of the Earth. Credit: NASA

The second ice age during the Cryogenian period was not followed by the sudden and chaotic melting-back of the ice as previously thought, but ended with regular advances and retreats of the ice, according to research published by scientists from the University of Birmingham in the journal *Nature Geoscience* today.

The researchers also found that the constant advance and retreat of ice during this period was caused by the Earth wobbling on its axis.

These ice ages are explained by a theory of Snowball Earth, which says that they represent the most extreme climatic conditions the world has ever known and yet they ended quite abruptly 635 million years ago. Little was known about how they ended - until now.

For the study, the scientists analysed sedimentary rocks from Svalbard, Norway that were laid down in that ice age. The deposits preserved a chemical record which showed high levels of CO2 were present in the atmosphere. Carbon dioxide was low when the ice age started, and built up slowly over millions of years when the whole Earth was very cold - this period is represented only by frost-shattered rubble under the sediments.

Eventually the greenhouse warmth in the atmosphere from carbon dioxide caused enough melting for glaciers to erode, transport and deposit sediment. The sedimentary layers showed ice retreat and advance as well as cold arid conditions. They reveal a time when glacial advances alternated with even more arid, chilly periods and when the glaciers retreated, rivers flowed, lakes formed, and yet simple life survived.

As theory predicts, this icy Earth with a hot atmosphere rich in carbon dioxide had reached a 'Goldilocks' zone - too warm to stay completely frozen, too cold to lose its ice, but just right to record more subtle underlying causes of ancient climate change.

The geological researchers invited a French group of physicists who produce sophisticated climate models to test their theory that the advances and retreats of ice during this period were caused by the Earth wobbling on its axis in 20,000 year periods. The rocks and the models agreed: slight wobbles of the Earth on its spin axis caused differences in the heat received at different places on the Earth's surface. These changes were small, but enough over thousands of years to cause a change in the places where snow accumulated or melted, leading the glaciers to advance and retreat. During this time the whole Earth would have looked like the Dry Valley regions of Antarctica - a very dry landscape, with lots of bare ground, but also containing glaciers up to 3 km thick.

Professor Ian Fairchild, lead investigator from the University of Birmingham's School of Geography, Earth and Environmental Sciences, said: 'We now have a much richer story about what happened at the end of the Snowball Earth period. The sediment analysis has given us a unique window on what happened so many millions of years ago. We know that the Earth's climate is controlled by its orbit, and we can now see the effect of that in this ancient ice age too.'

More information: Orbitally forced ice sheet fluctuations during the Marinoan Snowball Earth glaciation, *Nature Geoscience*, DOI: 10.1038/ngeo2502

Provided by University of Birmingham