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# Partial pressure of atmospheric CO2 during the Paleoproterozoic global glaciation

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The Paleoproterozoic Makganyene Glaciation is a particular enigmatic geologic event in that ice covered the oceans even at low latitude (Snowball Earth). This event might have drastically curtailed biological productivity but melting of the oceanic ice presumably induced a cyanobacterial bloom, leading to an acceleration of global oxygenation. It has been predicted that this event occurred as a result of the drawdown of greenhouse gases in the atmosphere. However, atmospheric CO2 levels at that time are still under debate. Here, we constrained the CO2 concentration in seawater based on fluid inclusions in subseafloor hydrothermal quartz deposits from the 2.2 billion years (Gyr) old Ongeluk volcanics, South Africa, in which the ancient water and carbon dioxide are preserved. The quantitative analysis of the concentration and stable carbon isotopes of CO2 in the fluid inclusions revealed that the CO2 concentration in the seawater was limited to be less than 7 mmol/kg. Because the Ongeluk seawater was locally open to the atmosphere, atmospheric CO2 level was also estimated to be lower than 33 times the present atmospheric level (PAL) ($<1.3\times10$?2 bar) assuming equilibrium between the Ongeluk seawater and atmosphere. This CO2 level was not enough to compensate the faint young sun and keep the ocean temperature sufficiently above freezing point by itself. Although the behavior of other greenhouse gases is still unknown, our results demonstrate that the deficient atmospheric CO2 level was a significant contributing factor to the 2.2 Gyr global glaciation.