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Ice volume and paleoclimate history of the Late Paleozoic Ice Age from conodont apatite oxygen isotopes from Naqing (Guizhou, China)

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A high-resolution and continuous conodont apatite oxygen isotope record spanning the late Viséan to Middle Permian is reported from South China, which is interpreted with respect to the ice volume and/or tropical seawater temperature history of the Late Paleozoic Ice Age (LPIA). The presented $\delta^{18}\text{O}$ record shows significant fluctuations in $\delta^{18}\text{O}$ from the late Viséan to Middle Permian with highest values observed in the Bashkirian (Early Pennsylvanian). The $\delta^{18}\text{O}$ maximum coincides with a major eustatic sea level fall recorded in low-latitude successions and postdates the significant increases in $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{13}\text{C}_{\text{carb}}$ measured on well-preserved brachiopod calcite, which can be interpreted as reflecting intensified weathering as consequence of the closure of Rheic Ocean as well as enhanced carbon burial. Both processes may have contributed to lower greenhouse gas levels and cooled down the Earth's surface, triggering the maximum glaciation. The high Bashkirian $\delta^{18}\text{O}$ values are interpreted to represent the glacial maximum of the LPIA. A coeval change in faunal composition and a decreasing diversity in climate-sensitive marine invertebrates can be ascribed to icehouse cooling and/or loss of habitat. Despite inconsistencies with earlier interpretations that the Early Permian represented the glacial maximum of the LPIA as inferred from Gondwanan glacial sediments records, the suggested Bashkirian glacial maximum agrees well with ice extent estimates based on the regional tectonic history in Gondwana, which suggests that the Bashkirian glaciation occurred during Gondwana interior uplift promoting maximum ice cover of the entire LPIA. However, maximum glaciation is only poorly represented in the depositional record because large parts of the glacial deposits were possibly removed by erosion as outlined by a major regional unconformity.

