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Eccentricity Scale Conodont O and Sr isotopic Trends During Carboniferous Climate Transitions

Osleger, D.J.[1], Chen, J. [1,2], Griffin, J.A.[1], and Montañez, I.P.[1]

[1]Dept. of Earth and Planetary Sciences, Univ. of California, Davis, CA 95616, USA; ipmontanez@ucdavis.edu
[2]Nanjing Institute of Geology and Paleontology, Nanjing, China

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Icehouses have been relatively rare in Earth History, with only two major periods of continental glaciation since the evolution of multicellular life and vascular plants. The late Paleozoic Ice Age (LPIA), which occurred between 325 to 260 Ma shared many similarities with the current icehouse (widespread continental ice sheets, orbitally forced climate cycles, and very low atmospheric CO_2), but may have been more dynamic, at times possibly involving tropical low-elevation glaciation, whereas at other times, experiencing extensive retraction of ice sheets and global warming. One aspect of the LPIA that remains poorly constrained is the timing and extent of continental glaciers in southern Gondwana. There is increasing evidence that Southern Hemisphere glaciation was characterized by numerous ice sheets emanating from multiple ice centers rather than a single massive ice sheet and that glacial events may have progressed diachronously across southern Gondwana during the Pennsylvanian and early Permian. The extent of continental ice and its volume in turn would have strongly impacted ocean circulation and glacioeustasy, climate, terrestrial biomes, continental weathering and likely atmospheric pCO_2.

It has been argued that low-latitude stratigraphic archives of glacioeustasy are perhaps the most robust record of ice volume changes during the LPIA as these records capture the global sum of changes in ice volume, whereas glaciated sedimentary successions may be plagued by erosion and reworking of past glacial deposits. Here we present a U-Pb calibrated conodont-based oxygen isotopic ($\delta^{18}O$) record from the Donets Basin that is resolved at the eccentricity time-scale and argued to record changes in seawater $\delta^{18}O$ during several glacial-interglacial transitions of the LPIA. The influence of seawater temperature of measured conodont $\delta^{18}O$ is evaluated using published and new clumped isotope (D_{47}) temperatures from paleotropical precipitates. We further couple the conodont $\delta^{18}O$ and Sr isotopic compositions from two intervals of hypothesized rapid climate and biotic change (the late Serpukhovian through early Bashkirian and Middle to Late Pennsylvanian boundary interval) in order to evaluate potential climate-weathering linkages. Comparison of the conodont isotopic records to recently published, contemporaneous sea-level, tropical climate, and paleo-atmospheric CO_2 records reveals coincident changes that indicate repeated perturbation to the climate system during our penultimate icehouse.