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High-amplitude sea-level fluctuations along the northern Gondwana margin suggest transient glaciations during the Visean

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Although it is well documented that the late Paleozoic experienced one of the most severe ice ages of Earth's history, the exact timing and frequency of glaciations is still debated. This is in part due to the difficulty of accurately dating glacial deposits that are often barren, with no faunal recovery, and riddled with stratigraphic hiatuses. In order to circumvent these limitations, one alternative way to reconstruct the evolution of grounded ice volume during the Early Carboniferous is to use far-field reconstruction of eustatic sea-level fluctuations.
In this study, we report on a detailed sedimentological investigation of Early Carboniferous strata from Western Libya. In the Late Paleozoic, this region was part of the Saharan platform, on the Northern margin of Gondwana, that formed a widespread, extremely low-angle, tectonically stable ramp. During the Early Carboniferous, extensive and thick exposures of siliciclastic-dominated sediments were deposited along a N-S orientated outcrop belt, parallel to depositional dip.
A total of 4800m of sedimentary section was logged over a ca. 400km-long transect. Fieldwork observations and integrated subsurface data allow establishment of a detailed sequence stratigraphic framework. During the Tournaisian, Visean and Early Serpukhovian, six lowstand system tracts are identified, composed of incised valleys filled with fully amalgamated fluvial sandstones, capped by open marine packages. These incised valleys can reach a thickness of 50m. Given that they are embedded within shoreface to offshore marine deposits, total sea-level fluctuations of at least 70-80m can be estimated from these deposits. Due to the stable tectonic nature of the Saharan Platform during the Early Carboniferous, glacio-eustasy is the most-likely explanation for the origin of the observed scale of sea-level fluctuations, pointing at the onset of incipient Late Paleozoic glaciation during the earliest Visean. This is compatible with published evidence of Visean glacial deposits in Southern Sahara and South America, further inland on the Gondwanan margins. Ice sheet retreat is probably the mechanism responsible for contribution of the large volume of coarse continental clastics that initially fill the valleys exclusively with fluvial facies, preserved by the followed rapid transgression associated with ice melt.
In line with paleotemperature reconstruction, our study indicate that the Late Paleozoic Ice Age has started prior to what is generally depicted in the literature. The location of the study area, on a stable passive margin, provides confidence in the mechanism controlling the incision, and the results provide improved resolution that offers an insight into the scale and frequency of glacial cycles in the Visean.