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Oxygen and carbon isotope records of brachiopod shells calcite (Late Visean, SW Spain): evidence of Carboniferous paleoclimatic change.

M. Armendáriz, I. Rosales and C. Quesada

Instituto Geológico y Minero de España (IGME), Madrid, Spain(m.armendariz@igme.es / Phone: +34-917287283)

The Gondwana geological record was affected during the Carboniferous by one of the longest and most severe glaciations in Earth history. This cooling is of particular interest because it was accompanied by withdrawal of atmospheric CO_2 from extensive coal deposition and by continental drifting that culminated in amalgamation of the Pangea supercontinent. These dramatic changes likely produced changes in the chemistry, circulation and temperature of the Carboniferous oceans, as well as glacier fluctuations that are registered in the isotopic compositions of marine carbonates. The timing of the onset of the Carboniferous glaciation is a matter of debate. Geological and geochemical evidence suggests that the climate shifting from greenhouse to ice-house conditions began shortly after the Visean–Serpukhovian transition ($\sim$ 326 Ma ago), although oxygen isotopic data from this and other recent studies suggest that it may have begun earlier.

In order to evaluate the impact and timing of the onset of the Carboniferous glaciation in northern Gondwana tropical regions, we present here new isotopic and elemental data on exceptionally well-preserved Late Brigantian (latest Visean, $\sim$328 Ma before present) brachiopod shells from a shallow-water carbonate platform in the Guadiato basin of southern Spain (SW Iberian Massif). This Carboniferous basin formed as a foreland basin during the Variscan collision between northern Gondwana and Laurussia. A total of 20 brachiopods (*Gigantoproductidae*) have been selected after a rigorous diagenetic screening of more than 35 collected samples. Samples were collected from 2 stratigraphic intervals throughout a $\sim$26 m thick succession of shelf carbonate deposits that constrain the time resolution to a short period ($<$ 1 Myr). Criteria to

evaluate the degree of textural and geochemical preservation of the shells include optical microscopy, cathodoluminescence (CL), scanning electron microscopy (SEM) and chemical analyses (major and trace elements). Only the best preserved samples with very minor or not cathodoluminescence have been utilized for the isotopic study. The δ^{13}C signal shows a wider range of inter-specimen variability for contemporaneous samples (up to $1.5‰$) than the isotopic offset observed throughout the succession. This suggests that a significant vital effect may have been involved in the δ^{13}C composition of the large Gigantoproductids, obscuring the δ^{13}C global signal at our timescale resolution. On the contrary, comparison of the mean δ^{18}O values clearly shows an overall increase of $\sim 1‰$ (relative to PDB) from oldest to youngest samples. This positive δ^{18}O excursion, if interpreted in terms of paleotemperature, implies an abrupt drop of mean tropical seawater temperatures of about 5ºC, or alternatively an increase in continental ice volume, for a very short time period on the scale of < 1 Myr. Comparison of the Carboniferous isotopic data from Spain with those reported from North America and Europe suggests that this positive event in δ^{18}O during the Late Brigantian could be correlated worldwide. This synchronous global shift provides strong evidence for the onset of the glaciation during the Late Brigantian.