Oceanic δ13C, environmental changes and Carboniferous coral reef development: Records from Tianlin and Ziyun (southern China)

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Metazoan reef builders receded globally during the Carboniferous, after the Late Devonian extinction event, with only few exceptions of coral-bearing bioconstructions reported worldwide. Among the latter, two exceptional extended coral reefs, dated as Late Viséan–Serpukhovian and Kasimovian-Gzhelian in age, respectively, were recently reported from southern China. The scarcity of coral buildups worldwide suggests global unfavorable conditions, with specific settings considered to represent refugia. To constrain these environmental conditions, seawater composition is reconstructed using carbon and oxygen isotopes originating from five measured sections located in southern China.

The resulting δ13C data reveals several environmental changes throughout the Carboniferous attributed to climate changes, ocean current variations, and proliferation of terrestrial plants. During the Late Viséan-earliest Serpukhovian, the high δ13C values (~3‰) are interpreted as recording short-lived glacial events, with the expansion of ice-sheets in South America and eastern Australia. The scarcity of coral reef growth suggests that the cooling acted as an inhibiting factor during this period. Conversely, the development of the exceptional coral reefs in southern China could be explained by the persistence of warm oceanic currents in the epicontinental sea, located in equatorial position. During the Kasimovian-Gzhelian, the gradual δ13C positive shift from -0.7 to +4.7‰ coincides with a short-lived warming, which should be suitable for the recovery of coral communities. However, in spite of the mild climate, the scarcity of Pennsylvanian coral reef leads to consider other inhibiting factors (e.g. biological competition and aragonite seas). Interestingly, the disappearance of coral reefs in southern China correlates with negative δ13C shifts (e.g. Mid-Viséan, Late Gzhelian), interpreted as related to intensified upwellings.

The reconstitution of the Carboniferous environmental conditions documents several factors contributing to the metazoan reef demise and recovery subsequent to the Late Devonian extinction events, and adds to our current knowledge of the longest reef recovery in the Phanerozoic.