

Stable carbon isotope composition of marine carbonates – fingerprint of carbon cycling through geological time and a powerful tool in stratigraphy

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Variations in global carbon cycling on geological time scales are best recorded in the stable carbon isotope composition of marine carbonate and to a certain degree of marine and terrestrial organic carbon. Calcium Carbonate precipitated from ocean water closely registers the carbon isotopic composition of the dissolved inorganic carbonate. Carbon isotope fractionation during precipitation of calcium carbonate is, in contrast to oxygen isotope fractionation, relatively insensitive to temperature and diagenetically precipitated calcite does not mask original marine carbon isotope signatures in pelagic limestones. Therefore, Mesozoic carbon isotope stratigraphies, which largely based on the analysis of bulk carbonate from pelagic limestones record global fluctuations in marine carbon reservoir.

Major fluctuations in stable carbon isotopic composition of carbonate through time are recognized as globally synchronous positive or negative „carbon isotope excursions“ which serve as powerful geochemical marker levels in stratigraphy. Positive carbon isotope anomalies are interpreted as indicators of increased export of C-12 by increased burial of organic matter depleted in the heavy C-13 isotope. Positive stable carbon isotope excursions in carbonates are sometimes punctuated by negative isotope anomalies of short duration of tens to hundred thousands of years. Originally these negative carbon isotope spikes were attributed to diagenesis and lithification. Today negative carbon isotope spikes of global extent are seen as the fingerprint of methane bursts triggered by sudden deep-water warming. These negative carbon isotope spikes are used as excellent stratigraphic marker horizons.

The Late Jurassic - Early Cretaceous carbon isotope stratigraphy (Fig. 1) was established over the last two decades in pelagic limestones from the southern Tethys. This carbon isotope stratigraphy serves as a correlation tool in paleoceanography, it provides the opportunity to correlate pelagic with hemipelagic and with shallow water sedimentary successions. Investigations in neritic limestones indicate that shallow water carbonate often preserves the original marine carbon isotope signature. However, diagenesis, fluctuating mineralogy and local water mass effects can significantly modify the bulk carbon isotope composition of these carbonates. A combination of biostratigraphy with chemostratigraphy provides opportunities to link the evolution of shallow water with open marine environments and to trace paleoceanographic change from deep-sea to coastal environments.

The Barremian-Aptian carbon isotope curve is marked by major positive carbon isotope excursions interrupted by an early Aptian negative C-isotope spike. This carbon isotope spike serves as a stratigraphic marker level that has been identified in marine and terrestrial carbon isotope records on a global scale. It is interpreted either as the result of a sudden release of isotopically light methane from clathrates or as the fingerprint of an episode of extreme volcanic activity. The negative carbon

isotope spike coincides with a widespread marine calcification crisis. We propose that sudden addition of volcanogenic or methane derived CO₂ caused an ocean acidification, which contributed to choking of biocalcification in shallow water and open marine environments.