# The marine carbon isotope curve around the Induan-Olenekian Boundary (IOB): Potential and problems

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The Early Triassic is a very peculiar period in Earth history, as it represents the time after the worst mass extinction event and shows a delayed biotic recovery after the extinction event. Therefore it is of great interest and importance to correlate in time slices findings in various Early Triassic sections to combine the archived evidence of processes and evolutions in different geographical regions,facies, etc.. However, correlation often is hampered by absence or scarcity of time-diagnostic (macro-) fossils. The Early Triassic carbon isotope curve is a very valuable tool for stratigraphic correlation, but there are existing several problems/facts that need to be taken into account, as they result in variations of the curve. These problems/facts are:

**A** Regional variations
**B** Diagenesis
**C** (Mixing of) different sources of carbon with significantly different isotope values

There potentially exist two carbon isotope curves for marine sections, the I) carbonate carbon isotope and the II) organic carbon isotope curves.
I) Usually the carbonate carbon isotope curve is investigated in sedimentary sections, if sedimentary carbonate is available. For sections consisting of dominantly pure carbonates very detailed isotope profiles can be produced and often the influence of diagenesis is not very significant. Carbonate carbon isotope curves can (and do) vary with respect to the geographic region of the section location. This can be utilized to investigate regional influences on the carbonate carbon isotope evolution and thus the regional influences on the marine carbon cycle, but this also might be problematic with respect to chemostratigraphy. Even more problematic is the existence of different sources of carbonate and the mixing of these sources When excluding diagenetic carbonate, there still might exist two different carbonate sources in deeper water sections: 1) authigenic carbonate formed close to the water-sediment interface with lower carbon isotope values and 2) shallow water carbonate formed either in the uppermost water column directly above (and thus sedimented by sinking to the seafloor), or in the uppermost water column in a shallow water environment and transported down the slope by currents and gravity flow, both having high carbon isotope values.
II) The bulk organic carbon isotope curve is usually investigated for sections lacking carbonates. As both carbon pools utilize the dissolved C in the water, also the organic carbon values vary regionally equivalent to the carbonate carbon values, but not identically, as different factors influence both commodities (which sometimes makes it interesting to compare both curves). Unless a significant thermal overprint or massive bacterial oxidation of organic matter, usually diagenesis is not a relevant issue with respect to the isotope curve. However, also for organic carbon two main reservoirs can exist: 1) marine organic matter having lower carbon isotope values (at pre-Cretaceous times) and 2) terrigenous organic matter having higher carbon isotope values (pre-Cretaceous times). With respect to the marine organic carbon pool, also deeper water and shallow water organic matter exists, however, usually less pronounced differences than between the two carbonate reservoirs. Compound-specific carbon isotope curves can circumvent this problem, but are more difficult to obtain.

## LOWER TRIASSIC:

Ad I) Carbonate carbon isotope curve regional variations have been documented, some of them most probably related to regional variations in the marine carbon cycle, mainly variations in shallow water sections (e.g. Uomo/Italy, Zal/Iran, Guandao/China). Additionally, also profound variations have been identified that should be related to different carbonate sources (e.g. differences between shallow water and some deeper water sections (e.g. shallow water sections mentioned before and Mud/India, Chaohu/China). In both of te latter two sections (Mud, Chaohu) the influence of carbonate sources is documented as shallow water sediment rocks (from turbiditic flows) show higher carbon isotope values than the authigenic carbonate.
Ad II) Organic carbon isotope curve variations have been documented regionally as well (though there generally do exist less data on organic carbon up to now). Furthermore, also variations that most likely are related to different sources of the organic matter have been shown. These variations are found within individual sections whenever the influence of main organic pool changes (marine versus terrigenous, e.g. Suol, Pautovaya) sections) and between sections depending on the dominant organic matter pool (marine or terrigenous, e.g. Pakistan section (terrigenous dominated) versus Siberian sections (dominantly marine)).

## CONCLUSIONS

Shallow water carbonate carbon isotope curves from well preserved rock samples most likely are the best commodity to study the (shallow water) marine carbon cycle and its variations, as carbonate only from one reservoir (shallow water) is present (when avoiding diagenetic carbonate). For deeper water sections there has to be taken into account the presence of carbonate from two different reservoirs (shallow water and deeper water) and the mixing of carbonate from these reservoirs. When interpreting bulk organic carbon isotope curves the presence of organic matter from two different sources (organic and terrigenous) has to be taken into account, and the mixing of organic matter from both sources. Sedimentation of organic matter of different origin might produce a carbon isotope curve which shows a different pattern masking the primary marine carbon isotope variations.