Panthalassa and Neotethys - two giant oceans facing the break-up of Pangea: Insights from the Mesozoic oceanic sediment record and LIP's

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The two largest Mesozoic oceans, Panthalassa and Neotethys, have almost totally disappeared from the Earth's surface, with the exception of the NW-Pacific and the Eastern Mediterranean Neotethys remnant. Relics of these giant oceans are preserved in accreted Circum-Pacific terranes and in suture zones of the Alpine-Himalayan mountain chains. These oceanic terranes contain ophiolites, i.e. remnants of oceanic basement, plateaus and ancient arcs, as well as radiolarites and other radiolarian-rich siliceous deposits, which are the dominant sediments produced in the world oceans over much of the Phanerozoic (Ordovician to Early Cretaceous,). Mesozoic radiolarian biochronology, developed over the last 30 years has largely contributed to the understanding of the relics of Panthalassa and Neotethys.

The break-up of the supercontinent Pangea began during the early Mesozoic with the opening of Neotethys within Gondwana, probably as a consequence of back-arc spreading related to the subduction of Paleotethys. Gondwanian terranes merged with Eurasia, leaving of Paleotethys nothing but a suture. During the Late Triassic and Jurassic, Gondwana separated from Laurasia by the progression of Neotethyan ocean basins from east to west. N-America and Eurasia separated from Africa and South America by the formation of the Central Atlantic and the Alpine Tethys since the Early Middle Jurassic, and the Proto-Caribbean since the Late Jurassic. While radiolarite sedimentation continued in Neotethyan and Panthalassan basins, this sediment never formed in the "Intra-Pangean" early Central Atlantic, nor in the Proto-Caribbean. Here, Middle Jurassic clay-rich sediments gave way to the first planktonic carbonates since the Late Jurassic. These nannofossil carbonates were dominated by *Nannoconus* during the latest Jurassic and Early Cretaceous. This nannofossil group was virtually absent from E-Tethys and Panthalassa. During the Late Cretaceous, planktonic carbonates became widespread and radiolarite deposition became episodic, mostly restricted to times of oceanic anoxic events.

The main paleo-oceanographic interpretation of this sedimentation pattern is the late onset of a circum-global equatorial current system. In our opinion, it was only effective during the middle-late Cretaceous, when high eustatic sea level and the emplacement of the Caribbean Large Igneous Province between the Americas created a large marine passage.

Mesozoic and, in particular, Jurassic radiolarites in Neotethys have often been interpreted as the result of equatorial upwelling, due to an equatorial current system flowing through the Tethys-Atlantic-Proto-Caribbean Seaway. We modelled Middle-Late Jurassic global current systems with a global coupled ocean - atmosphere model. We could not detect any major westward flow though the trans-Pangean seaway, both with open and closed variants of the Central American gateway. The young Central Atlantic had a lagoonal circulation with a stratified water column implying low surface fertility during the Jurassic and earliest Cretaceous.

Upwelling alone cannot explain Mesozoic radiolarite occurrences throughout circum-Pacific terranes now exposed in Japan, Western North and Central America and New Zealand. Si and O stable isotope data seem to indicate that the Mesozoic world oceans were less under-saturated in silicic acid than the modern oceans, resulting in better preservation of radiolarians and not necessarily in a higher productivity. This is especially true for the Jurassic and can be explained by more warm/humid continental climates brought about by the initial Pangea beak-up, resulting in increased continental weathering, and mega-monsoon conditions, producing a higher input of silicic acid to the ocean.

The Jurassic-Cretaceous transition is gradual without any distinct change in stable isotope values interpreted as a consequence of LIP’s, typical of other system boundaries. Accordingly, continuous radiolarite sections observed throughout Eastern Tethys and Panthalassa (>80% of the world ocean) do not show any marked change suggestive of a "natural" Jurassic/Cretaceous boundary. A major radiolarian turnover, and the appearance of caliponellids and nannoconids in Intra-Pangean Basins may all be related with the Tithoninan-Berriasian “Dry Event”, resulting in a global lowering of nutrient input to the ocean. The appearance of caliponellids and nannoconids in the Neuquén Basin is evidence for an Intra-Pangean latitudinal connection throughout S-America.

Weakening of mega-monsoon conditions and the beginning of a latitudinal ocean circulation through the Rocas Verdes Backarc Ocean connecting the Proto-Caribbean with Antarctica may have provoked global cooling near the end of the Jurassic.