Trapped Sea-Lakes, the anomalous water bodies that herald the birth and demise of the oceans

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The tectonic opening and closure of oceans presents windows of opportunity for the formation of anomalous water bodies which we term “trapped-sea-lakes” (TSL); poorly connected or isolated water basins characterized by anomalohaline (brackish, hyperhaline, mixohaline or limnic according to the Venice system) conditions that change over time, reflecting the fluctuating connectivity with the global ocean and the climatic history of their watershed. TSLs contain elements typical for a sea (basin bathymetry, marine chemistry, faunistic elements), but also reflect lacustrine aspects like endemism and major environmental fluctuations over geological time. They are characterized by unusual large dimensions, long life-span (compared with classic lakes), anomalous environments with salinity and chemistry controlled by the limited connectivity with the global ocean and by climate forcing.

Here we present a classification of TSLs, supported by key studies, showing that Anoxic Giants, Salt Giants and brackish mega-basins are all related forms of TSLs and that transition between them is possible. We showcase several key TSLs that occurred over the last 100 Million years: the East African rift basins and the early South Atlantic basins providing a reference for the lacustrine-evaporitic transitions that characterize the opening of oceans and similarly the key moments in the closure of the Tethys ocean, presented to showcase the post-oceanic restriction episodes of the Paratethys waterworld in Central Eurasia, with its particular evaporite-brackish environment transitions.

The transition from marine basins to TSL is reversible and our model predicts that TSLs that lie in the proximity of the global ocean are likely to trigger cataclysmic floods during the partial or full reconnection with the global ocean if the reconnected water bodies have different water levels. These floods can be either in the form of marine flooding events, such as the Zanclean deluge of the Mediterranean, when TSL’s water level is below the global sea-level or in the form of “lake burst-floods”, if the isolated TSL evolves to a mega-lake with water levels above the global ocean. We present a first example of such lake burst-floods that scarred the Aegean Sea and likely turned the Mediterranean-Paratethys realm into a unique system of double-locked TSLs, in the eve of the Messinian Salinity Crisis.

How to cite: Palcu, D. V. and Krijgsman, W.: Trapped Sea-Lakes, the anomalous water bodies that