The rise and fall of the giant stromatolites of the Lower Permian Irati Formation (Paraná Basin, Brazil)

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Giant stromatolites are meter-scale laminated carbonate biosedimentary deposits formed by the action of benthic microbiota under very specific conditions. Although occurrences of giant stromatolites are relatively common in Precambrian deposits, the Phanerozoic record is rare and sparse. During the Kungurian, the Paraná Basin was part of a very restricted epeiric sea with local development of confined low-gradient mixed carbonate platforms. In a small area along the northern paleomargin of this interior sea, conditions were optimal for the development of giant stromatolites. Here, we carried out an integrated analysis of the Lower Permian Santa Rosa de Viterbo giant stromatolite field (Irati Formation, Paraná Basin, Brazil). Using available and new descriptions of associated facies and stromatolite morphology, we applied a multi-proxy approach based upon sedimentological, paleontological and geochemical (C and O isotopes, XRF, XRD and ICP-MS) data to develop a detailed paleoenvironmental model for this particular occurrence. The NE-SW elongated giant stromatolites – of > 3 m in height, > 7 m in length, and > 1 m wide, forming a close-packed biostrome – have variable external shape and internal lamination, indicating continued changes in growth strategy due to changes in the hydraulic regime, bathymetry, and terrigenous input. The peloidal composition points to *in situ* microbially-influenced carbonate precipitation as the main accretion factor, besides suggesting an exclusively coccoidal microbial community. This last characteristic, $\delta^{18}O$ values, the smooth aspect of the lamination, the extremely low diversity and concentration of invertebrate fossils and the presence of vertebrate taxa resistant to high salinity (mesosaurids), point to deposition under high (possibly hyper) salinity, decreasing towards the upper part of the succession. High salinity, coupled with strong currents that shaped the elongated giant domes, were responsible for keeping away possible mat-grazers, protecting the living stromatolites from predation. Higher $\delta^{13}C$ values towards the top of the sampled succession are related to intense microbial activity, increased nutrient supply, and enhanced primary productivity, besides suggesting a gradual reduction in the restriction of the basin, as the highest $\delta^{13}C$ values at the top of the biostrome match the global Permian seawater signal. Y/Ho and $La/La^*_{(SN)}$ ratios also indicate a less restricted setting towards the top of the succession, which is consistent with the lower $\delta^{18}O$ values and increasing water depth, as recorded by the stromatolite morphology. After that, the smothering of most of the biostrome due to marl deposition, a drastic drop in $\delta^{13}C$ values and the transition to isolated, steep-sided domes, suggest the increase in terrigenous input as a result of a basin-scale transgression. Continued deepening of the basin and the great terrigenous entry finally brought on the demise of the microbial activity in the upper isolated domes, marking the downfall of the giant stromatolite saga that flourished and perished in the last epeiric sea of SW Gondwana.

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