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Primary organic matter preserved in chert from the Pre-salt Barra Velha Formation

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Aptian Pre-Salt deposits off the coast of Brazil in the Santos Basin record the history of the rifting of Gondwana and formation of a vast lake that predated opening of the Atlantic Ocean. Sedimentary facies contain a mixture of carbonates and magnesium silicates facies thought to have been deposited in an alkaline lake. Carbonate facies contain extensive “shrub” and “spherulite” carbonate textures, but their origin is enigmatic, and constraints on water chemistry, microbial communities, mineral formation mechanisms, and any preservation of primary organic matter in the lake are limited. Chert in these deposits is especially under-studied and petrographic studies of drill-cores from the Barra Velha Formation suggest that silicification of these deposits likely involved multiple generations of silicification ranging from early to late, post-compaction diagenetic processes. Of these, potential early diagenetic chert in the Barra Velha Formation stands out as it may preserve a record of primary processes and lake water chemistry.

Here, we investigate potential early diagenetic chert from two samples of the Barra Velha Formation and find evidence of putative microfossils and primary organic matter that may record the microbial communities that thrived in this alkaline lake. Transmitted and reflected light microscopy reveal the presence of crypto- to microcrystalline chert between carbonate grains that is intimately associated with early Mg-silicate clays. This chert appears to pre-date compaction of the clays and is texturally distinct from the coarse-crystalline, void filling chert that likely represents a later stage of diagenetic chert. Within this potential early-diagenetic chert, we identified enigmatic circular structures, 20-30 µm in diameter, as well as wispy lamination. Scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS) and Raman spectroscopy reveal that the spherical structures and the laminae are composed of organic carbon. We suggest that these organic structures and laminae represent primary organic matter that was preserved in early diagenetic chert that formed before compaction near the sediment-water interface. These results provide a path toward understanding the lake water chemistry, mineral formation, organic preservation, and microbial communities that characterized the ancient lake.