

# Lacustrine Microbialite Analogs to the Pre-Salt of the South Atlantic

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## ABSTRACT

The discovery of significant hydrocarbon reserves in lacustrine microbial carbonates of the Cretaceous pre-salt off the coasts of Brazil and Angola has re-vitalized and redirected microbialite research. Prior to this, most research centered on marine microbialites, microbialites as representatives of the most ancient records of life on Earth, and Proterozoic microbialite biostratigraphy. Now, lakes are in!

Lacustrine microbialites are forming in many lakes today and their record extends back at least 2,720 Ma. The fossil record has almost 300 formations with lacustrine microbialites and there are over 200 lakes in which microbialites are forming. Stromatolites dominate the lacustrine microbialite record, with thrombolites constituting a minor component in the fossil record, but are relatively common in extant lakes. In any given lake, microbialites are more likely to develop when calcium input is high, lake water is saturated with respect to calcite, the lake is primarily balanced-filled to over-filled, clastic sediment supply is low or lacking, nutrient input is relatively low, turbidity is low, and shallow-water conditions are relatively stable.

Little has been published on the lakes and microbial carbonates of the pre-salt. Based on available information, the lakes were large, hundreds of km across. The microbialites include: microbial shrubs, microbial shrub biostromes (note: the microbial origin of shrubs is presently under debate), amalgamated reef complexes, stromatolites, thrombolites, and oncoids. Shrubs and shrub biostromes appear to dominate the pre-salt microbialites and are laterally extensive and thick. In addition to the microbialites, stevensite and spherulites also occur.

Today, shrubs and biostromes of shrubs are found in travertine spring deposits. They are not common in lacustrine environments. However, shrubs and shrub biostromes are known from ancient lake deposits other than the pre-salt (the best examples are from the Eocene Green River Formation). Most lacustrine microbialites are found as isolated bioherms, <1 m in size, or in biostromes, <1 m thick, but laterally very extensive (up to many kms). Large, multimeter-size microbialite reefs are rare and known primarily from the fossil record. However, stromatolites and oncoids are common in extant and ancient lake deposits.

Despite the hundreds of examples of extant and ancient lacustrine microbialites, no single lake, modern or ancient, contains the complete suite of microbialites and other features at the scale found in the pre-salt. The Eocene Green River Formation comes closest. It is dominated by stromatolites (including amalgamated reef complexes), but also has extensive shrubs. In order to understand the pre-salt microbialites, their depositional setting, and develop facies models, a comprehensive hybrid interpretive model based on a combination of several modern and ancient lake deposits will need to be developed. The Green River Formation microbial carbonates have sufficient similarities with the pre-salt to provide a basis for the development of important exploration models.