Petrophysical Properties and Pore Structures of Stromatolites and Travertine

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Project Objectives

- Provide a petrophysical characterization of travertine and stromatolites from both marine and lacustrine environments.
- Describe the pore structures of both stromatolites and travertine.
- Compare the petrophysical properties and pore structures of stromatolites to travertine.

Project Rationale

The pre-salt reservoir facies located offshore Brazil is reported to consist predominantly of microbialites reminiscent of either stromatolites precipitating in a lacustrine setting or travertine. There is a general consensus that no modern environment can serve as an exact analog for these Cretaceous deposits. Furthermore, the pre-salt rocks are not uniform across the entire basin and thus, depending on the location the reservoir facies, might resemble stromatolites or travertine. Both deposits have recently received attention but mostly in regards to the biological interaction involved in their genesis (Figure 1). What is lacking is petrophysical characterization of these deposits and comparisons between them that can serve as a guide for the petro-seismic distinction of similar pre-salt rocks.

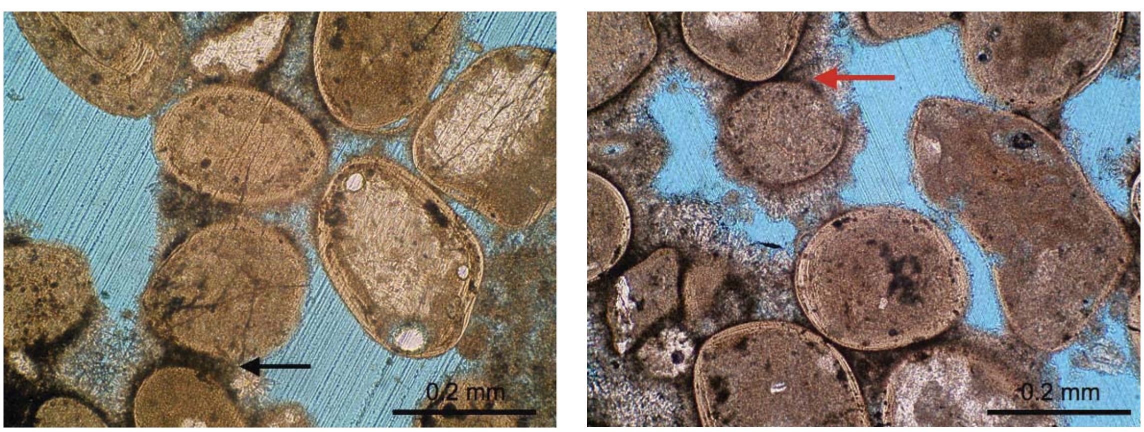

Figure 1: Photomicrographs of modern stromatolites from the Bahamas. Grains are cemented by dark, micritic, contact cements (arrows). Fine aragonite needles overgrow these micritic contact cements. In addition, micritic material is filling part of the pore space. The precipitation of micrite is related to photosynthesis, combined with sulfate reduction and sulfide oxidation, of the microbial community within the stromatolite (Visscher et al., 1998).

Project Description

We plan to collect samples from modern and ancient stromatolites from both marine and lacustrine environments and subject them to suite of petrophysical measurements. Similarly, travertine from various places will be measured. In both data sets, the petrophysical measurements of one-inch plugs will include porosity, permeability, acoustic velocity, and resistivity. In addition, the pore structure will be captured using the quantitative parameters from digital image analysis of thin sections taken from the end pieces of the sample plugs.

Initial results of eight samples from modern stromatolites show porosities between 12 -25%, permeability ranges between 70- 4600 mD (all but one sample have more than 350 mD), and velocities between 4480 – 5420 m/s. These velocities are faster than most limestone samples with similar porosity (Figure 2). These stromatolites are good reservoir rocks with both high permeability and high velocity.

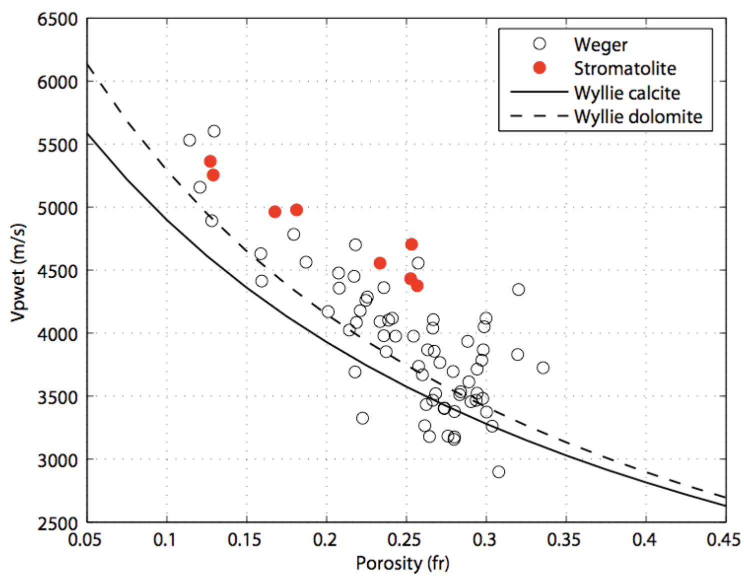

Figure 2: Velocity-porosity cross plot of limestone samples from Weger et al. (2009)(circles) and modern stromatolites (red dots). The stromatolites have mostly interparticle porosity but their acoustic velocity is approximately 1 km/s faster than what Wyllie's time-average equation predicts at a given porosity.

Deliverables

A data set will be generated that provides pore structures and petrophysical properties of rocks that are reminiscent of the pre-salt reservoir facies. This data set can be used for comparison with various facies in the pre-salt strata.

References

Visscher, P.T., Reid, R.P., Bebout, B.M., Hoeft, S.E., Macintyre, I.G., and Thompson, J. Jr., 1998, Formation of lithified micritic laminae in modern marine stromatolites (Bahamas): the role of sulfur cycling. American Mineralogist, v. 83, p. 1482-1491.

Weger R. J. Weger, Eberli, G. P., Baechle, G. T., Massaferro, J. L., and Sun, Y.F., 2009, Quantification of pore structure and its effect on sonic velocity and permeability in carbonates. AAPG Bulletin, v. 93/10, p. 1-21.