**AAPG HEDBERG CONFERENCE**
"***Microbial Carbonate Reservoir Characterization"***
**June 4-8, 2012 – Houston, Texas**

# Characteristics, distribution and morphogenesis of microbial carbonate systems in Shark Bay, Australia

Ricardo J. Jahnert [a], Lindsay B. Collins [b]

[a] Petrobras Company, Avenida Chile 300, Rio de Janeiro, 20031912, Brazil
[b] Department of Applied Geology, Curtin University, GPO Box U1987, Perth, WA 6845, Australia.

(E-mail: jahnert@petrobras.com.br - phone 55 21 21442697)

## Abstract

Shark Bay World Heritage area is located 800 kilometers north of Perth on Australia's westernmost coast. The region is recognized for its natural beauty and scientific significance, particularly the conspicuous stromatolites and thrombolitic structures, produced by microbial communities.
The morphological features of these modern microbialites resemble those of fossilized assemblages thereby providing extensive material for analogy with the ancient systems, some of the earliest life on Earth. The microbial carbonate system in Hamelin Pool has developed in response to a slow progressive change in environmental conditions transforming a near open marine system into a restricted embayment landlocked to the east, south and west and semi-closed to the north by a barrier bank, characterized by abnormal salinity, high alkalinity and high evaporation. Microbial sediment started depositing at about 2000 years ago long after the Holocene maximum flooding of the sea level in response to sea level fall of about 2.5 meters, as a minor variation within the Holocene stratigraphic highstand system tract.
The distribution, nature and extent of microbial deposits in Hamelin Pool, Shark Bay has been investigated and mapped with emphasis on the occurrence, external morphologies, internal fabrics, constructional mechanisms, microbial communities, growth rates and sediment associations in the intertidal and previously little researched subtidal zone.
Microbial carbonate is composed of aragonite (80-98%) that reveals high positive values of $\delta^{13}C$ and $\delta^{18}O$ as a characteristic of the highly evaporative environment with extensive microbial activity. Oldest dated heads are near 2000 years and the overall system was deposited in two stages; the first between 2000-1200 and the last from 900 years BP to the present. The microbial carbonate system is characterized by slow growth rates that vary from less than 0.1 mm/year to 0.5 mm/year.
Despite the very gentle morphologic gradient, the bacterial communities live in very specific positions showing definite zonation related to different water depth conditions in the tidal environment. Parameters like salinity, water depth, turbulence, luminosity and accommodation space, associated with shore morphology, waves, wind direction and sediment influx are responsible for the occurrence and distribution of the microbial communities and their resultant organo-sedimentary deposits. Substrate morphology in Hamelin Pool displays an important role in controlling the presence of microbial sediments growing as mats or build-up structures with conical, domical, elongate/ellipsoidal or club shaped morphologies dominant in places with steep gradient contrasting with mats that cover extensive areas with gentle substrate gradient. Different internal fabrics were constructed according to their position in relation to the littoral zone by distinct microbial communities, and known fabric relations have been expanded into the subtidal zone. Evidence of shallowing-upward fabric sequences of microbial origin reflects falling sea levels during the late Holocene and is likely useful in ancient environmental interpretation. A sequence of events

and constructional mechanisms are described emphasizing differences between the stromatolitic, thrombolitic and cryptomicrobial deposits in Shark Bay.

Subtidal structures contain consistently different internal fabrics with carbonate grains and fragments interbedded with aragonitic micrite arranged in millimetric laminae or sub-spherical patches, which display fabrics such as well laminated (Smooth), coarse laminated globular (Colloform), sub-laminar to irregular with voids and biofragments of bivalves (Microbial Pavement), irregular clotted (Pustular) and non-laminated (Cerebroid), constituting carbonate sediment with stromatolitic facies (Smooth and Colloform), thrombolitic facies (Pustular) and cryptomicrobial non-laminated (Cerebroid and Microbial Pavement).

The new substrate map and depositional history for this distinctive and peculiar microbial habitat establishes the significance of subtidal structures and emphasises the geoscientific importance of Hamelin Pool, especially with respect to early life studies and ancient analogues for understanding microbial activity, deposit characteristics, fenestral fabrics and distribution.

Based on the improved knowledge of the nature and distribution of Shark Bay microbial deposits a revised facies model has been constructed and is characterized by a relatively extensive and prolific activity of bacteria producing microbialites that are exposed in the supratidal zone and are progressively colonizing the subtidal zone as a consequence of sea level fall, although evidence of recolonization observed on the intertidal zone points to a recent short marine transgression.