Exploring for Deepwater Petroleum Systems with Satellite SAR (Synthetic Aperture RADAR). Fact or Fiction? Comparing Results from Two of Today's Hotspots (Congo and Santos) with Two of Tomorrow's (Campeche and Cariaco)

Return to HTML

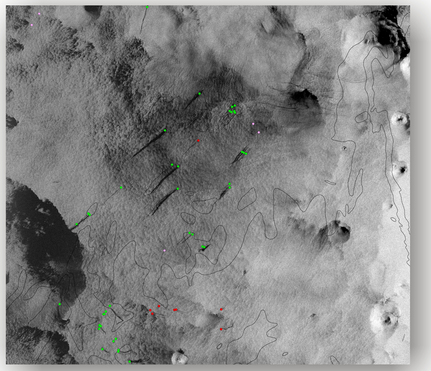
Alan Williams (NPA Group), Michael King (NPA Group), Geoff Lawrence (TREICoL) and Jan Roelofsen (IHS Energy)

Introduction

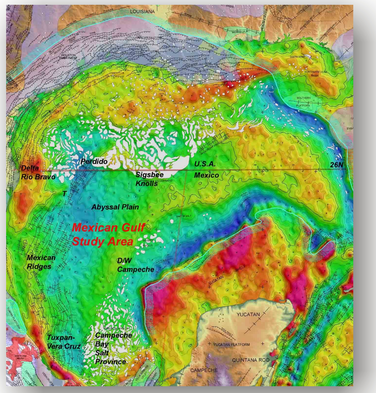
Both the Cariaco in Venezuela and the deep water Campeche Basin are under explored, particularly the Campeche where no wells have been drilled in excess of 300m.

In the Cariaco, Maraven drilled c.10 wells between 1979 and 1982 with only shows recorded. In the Campeche the giant Cantarel field has dominated exploration efforts in the shallow water.

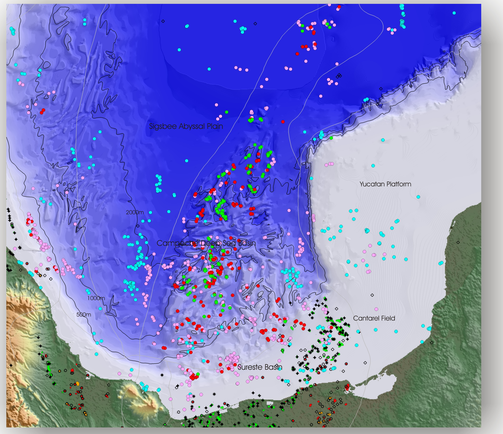
In both basins SAR seep screening studies have detected large numbers of multiple repeating high rank seeps in deep water.



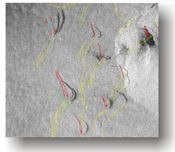
Interpreted Radarsat scene from deep water Campeche showing many large (15km+) high ranking seeps



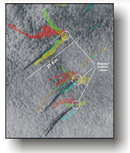
Free air gravity map of the entire gulf of Mexico showing the extensive (Salt-Cored) Campeche knolls.



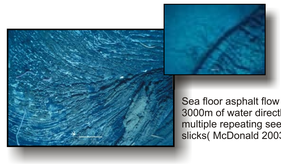
Deep water Campeche Basin showing seep results against bathymetry



Multiple repeating deep water seeps, deep water Campeche



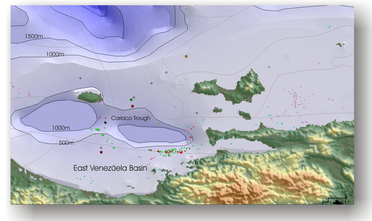
Same emission point shown on 5 separate days



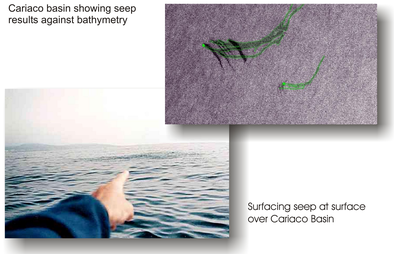
Sea floor asphalt flow in 3000m of water directly below multiple repeating seepage slicks(McDonald 2003).

Campeche Results Summary

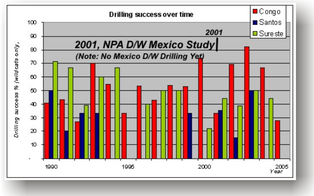
This remarkable survey maps seepage over a huge region of the Mexican Gulf of Mexico. There are ten groups of substantial seepage, varying in frequency, rate and marked by slicks of varying size, shape and density. In addition the persistent pollution around the mature Cantarell complex of heavy oil accumulations is mapped.
The main region of seepage characterises the Campeche Salt Province. A combination of thick sediments, overpressure and salt diapirs results in intense repeating seepage. The large seepage-slicks are vertically below gas mounds and vents, as was proven at Chapopote in the Campeche Knolls, where large repeating seepage-slicks occur vertically above vents on the seafloor over 3000m below. In contrast, the seepage-slicks along the Tuxpan-Mexican Ridges Fold Belt are smaller and follow a long linear pattern, probably fault controlled.
The diversity of slicks reflects different oils, in particular the API. Heavier oil in the vicinity of Cantarell and on the Campeche Platform results in irregular slicking that repeats less often.



Cariaco basin showing seep results against bathymetry



Surfacing seep at surface over Cariaco Basin



Cariaco Result Summary

Active seepage, plus the indications of gas-condensate in two wells, confirms an active working petroleum system in the Cariaco Basin. Long well-defined seepage-slicks identify a 150+ km long zone of prolific active oil seepage along the southern faulted margin of the Basin. The extent and repeatability of the seepage of the Cariaco is not dissimilar to other major seeping oil provinces such as the Gulf of Mexico and the Congo Fan off Angola. If the other elements for prospectivity are present (e.g. Reservoir-seal couplets in valid traps), the Cariaco Basin should host significant oil accumulations. Clusters of lower-confidence smaller seepage-slicks characterise the Margarita Basin to the east (the thinner sediment load might account for the less prolific seepage).

The Cariaco Basin is a large and deep (to 1500m) fault-bounded, late Neogene basin interrupting the broad shelf off central Venezuela. It developed by displacement partitioning along the Antilles Arc by en-echelon east-west strike slip faults ("pull-aparts"), or by transpression, in the late Miocene. The main subsidence was Pliocene-Pleistocene. The most pronounced structures are the thrusts along the transpressional plate boundary in the east, defining the southern boundary of the Cariaco Basin and north edge of the Paria Peninsula.

There are several geological controls enhancing seepage in the Cariaco. The most significant is probably the overpressure created by recent rapid subsidence and high sedimentation rates. Active faulting provides vertical migration pathways and transpression drives fluids upward in the Basin. Other non-geological controls have played a part in the observed seep distribution, such as the effect of seasonal regional upwelling on the near vertical transport of seeped oil and gas to the sea surface and the rich organic productivity of the basin which has enhanced the surface extent of the seepage-slicks.

A combination of restricted water exchange with the open Caribbean Sea, a marked seasonal upwelling (which assists the rise of seep plumes) results in vigorous phytoplankton growth and permanent anoxia below ~300m. A lack of bioturbation and high sedimentation rate determines that the Holocene-Recent sediments are an excellent record of climate variation in the Atlantic. For this reason, the Cariaco is the target of several major research programmes.

Conclusions

These four studies have shown that satellite SAR seep screening in undrilled frontier basins can be a very effective tool for source risk reduction. We have shown in deep water Congo that an early seep screening program can delineate the area of maximum seepage in which subsequent discoveries will be made.

In both deep water Campeche, Mexico and the Cariaco basin we have identified significant areas of deepwater oil seepage are presently undrilled. We predict that if the required source-reservoir cuplets are in place major oil and gas discoveries will be made in the future.

www.npagroup.com

Alan@npagroup.com, michael.king@npagroup.com, geoff.lawrence@npagroup.com, jan.roelofsen@ihsenergy.com