AAPG HEDBERG CONFERENCE
"Hydrocarbon Habitat of Volcanic Rifted Passive Margins"
September 8-11, 2002, Stavanger, Norway

The Hydrocarbon Potential of the Southern Atlantic Conjugate Continental Margins of Argentina and Namibia/South Africa

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A considerable oil and gas potential is presumed for the conjugate continental margins of Africa and South America. The origin and habitat of these petroleum systems is linked to the history of the opening of the Atlantic which was accompanied by heavy volcanism. This volcanism lead to the formation of widespread continental flood basalts -for example the Etendeka and Paraná flood basalt provinces in Africa and South America, respectively- and of 60 - 100 km wide seaward dipping seismic reflection patterns, commonly known as ‘seaward dipping reflector sequences’ (SDRS). Today these SDRS are found in water depths of 200 - 4500 m at about 70 % of the continental margins of the Atlantic (PLANKE et al. 1999). It was the discovery of the Kudu gas field with at least 3 TCF gas trapped in the feather edge of a SDR sequence (BRAY et al. 1998), that finally put the passive volcanic margins on the petroleum industry’s agenda. Known source rocks that occur in this setting are of lacustrine character from the Permian pre-rift and the Hauterivian syn-rift phase as well as of marine or terrestrial character from the Barremian/Aptian and the Cenomanian/Turonian sections of the drift phase.

Geochemical investigations on near-surface sediments, source rocks, natural gases, condensates, as well as numerical modelling of the hydrocarbon generation, migration and accumulation based on selected seismic sections and well data from offshore south-western Africa, are the components of an integrated approach to evaluate the hydrocarbon potential of the southern Atlantic.

Gas quantities, molecular compositions and isotopic signatures of light hydrocarbons desorbed from near-surface sediments (FABER & STAHL 1983) from offshore Argentina, Namibia and South Africa were measured to find surface expressions of the deep petroleum system and to decipher the type and maturity of source rocks (STAHL & CAREY 1975). The $\delta^{13}C_1$ and $\delta^{13}C_2$ values indicate an active marine source rock at both sides of the South Atlantic with a maturity between 0.8 and 1.4 % Rr offshore Argentina and between 1.3 and 2.0 % Rr offshore south-western Africa, respectively. Because of corresponding geological structures and a similar thickness of the sedimentary coverage at both continental margins different heatflow and sedimentation histories are assumed for the African and South American conjugate margin.

Numerical modelling of the well Kudu 9A-2 offshore Namibia indicates that the maturation of the sedimentary organic matter and therefore the generation of hydrocarbons stopped in the Latest Cretaceous due to uplift of the continental margin and erosion of about 400 m of sediments (MCMILLAN 1990). This implies that the hydrocarbons in the Kudu gas field are at least 65 Ma old. So the occurrence of oil to gas cracking during the Early Tertiary could be a reasonable assumption because, according to the model, reservoir temperatures exceeded 160 °C during this time interval. Numerical 1D modelling of the well Cruz del Sur offshore Argentina reveal a different sedimentation history without major uplift periods and distinctly lower heatflow values which corresponds to the findings of the surface geochemical investigations.

The geochemical results of investigations on source rocks, natural gas samples and condensates from the Kudu gas field challenge the opinion often held in literature that Aptian and Barremian rocks are the source for the Kudu gas (e.g. JUNGSLAGER 1999). Neither kerogen types nor maturities of the Aptian and Barremian source rock samples of the wells Kudu 9A-2 and Kudu 9A-3 fit the features of the natural gas and condensate samples. So lateral migration of hydrocarbons from less mature kitchens which lie more basinward in areas with a thinner sedimentary cover and maybe different depositional environments (higher proportion of marine sedimentary organic matter) is inferred.

References

BRAY, R., R. SWART and S. LAWRENCE (1998): Source rock, maturity data indicate potential off Namibia. Oil & Gas Journal Aug. 10, 84-89.

FABER, E. and W. STAHL (1983): Analytical procedure and results of an isotope geochemical surface survey in an area of the British North Sea. - Petroleum Geochemics and Exploration of Europe.- Spec. Publ. Geol. Soc. London, 12: 51-63.

JUNGSLAGER, E. H. A. (1999): Petroleum habitats of the Atlantic margin of South Africa. In: The oil and gas habitats of the South Atlantic (ed. N. R. Cameron, R. H. Bate, and V. S. Clure), Spec. Publ. Geol. Soc. London, 153: 153-168.

MCMILLAN, I. K. (1990): Foraminiferal biostratigraphy of the Barremian to Miocene rocks of the Kudu 9A-1, 9A-2 and 9A-3 boreholes. Communications of the Geological Survey of Namibia 6, 23-29.

PLANKE, S., E. ALVESTAD, E. and O. ELDHOLM (1999): Seismic characteristics of basaltic extrusive and intrusive rocks. The Leading Edge 18(3), 342-348.

STAHL, W. and B.D. CAREY (1975): Source-rock identification by isotope analyses of natural gases from fields in the Val Verde and Delaware basins, West Texas - Chem. Geol. 16, 4: 257-267.