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Estimating Heatflow in Frontier Basins Using Bottom Simulating Reflectors (BSRs): Implications for Deepwater Hydrocarbon Prospectivity Offshore MSGBC Basin, The Gambia

Olawumi Owolabi[1], Mads Huuse[1], Jonathan Redfern[1], and Ben Sayers[2]

[1]University of Manchester, Manchester, United Kingdom.
[2]TGS, London, United Kingdom.

ABSTRACT

This study of frontier deepwater blocks offshore The Gambia models subsurface thermal conditions using stability parameter data from Bottom Simulating Reflectors (BSRs) and seismic velocity data to estimate depth and conductivity. Heatflow within the basin is assessed using shallow geothermal gradients calculated from temperature and pressure estimates from the seafloor to interpreted BSRs. The phase boundary between the gas hydrate stability zone (GHSZ) and the free gas zone beneath gives rise to the BSR due to the drop in velocity and density in the free gas zone. Knowing the BSR depth under hydrostatic pressure conditions allows its temperature to be estimated. Conventional 3D seismic mapping techniques and attribute analyses are employed to enhance the identification and interpretation of BSRs and focused fluid flow features. BSRs are observed to occur in the shallow subsurface – not deeper than 400ms below the seafloor. Emphasis is placed on seismic expressions of BSRs and their relationship to underlying stratigraphy to recognize any influence on facies changes, structures and/or traps to give a preliminary insight into possible fluid plumbing routes and links with petroleum system. Temperature at the BSR depth is estimated using published empirical relationships for methane and seawater phase boundary. Conversion of seismic velocities to thermal conductivity is based on an empirical dataset that permits a lateral and downward extrapolation of derived geothermal gradients to deeper stratigraphic levels, permitting an assessment of the overall present day temperature, heatflow and hydrocarbon maturity offshore The Gambia. A shallow geothermal gradient range of 55-65°C/km across the GHSZ was estimated from BSR and seabed depths, corresponding to heatflow values between 56 mW/m2 and 62 mW/m2. Using the velocity-conductivity transform for the overburden and a representative heatflow of 60 mW/m2 the bulk geothermal gradients were calculated across the study area resulting in geotherms between 33-40°C/km, increasing seaward due to the low thermal conductivity of the thick Cenozoic and upper Cretaceous mudstones in the ultra-deep water. The bulk geotherms were applied to assess the present-day thermal maturity of lower Neocomian source rocks. Results from this study indicate a mature source interval both basinward and landward of the Jurassic shelf margin, which is consistent with recent oil discoveries in Senegal immediately to the north of this study area.