AAPG Annual Meeting
March 10-13, 2002
Houston, Texas

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Geodynamic Modelling of the SW Pacific and Its Application to Petroleum Exploration

The sedimentary basins of the SW Pacific, particularly the Lord Howe Rise and Norfolk Basin, have recently become a prospective area for deep-water hydrocarbon exploration. We have created 3D time-dependent geodynamic models of the SW Pacific based upon: (1) Plate tectonic reconstructions to determine a regional kinematic framework. (2) Mantle tomography images (S20RTS model) to determine mantle heterogeneity. (3) Mantle convection models using known mantle properties and incorporating the observed plate kinematics for the region. Our results suggest that the SW Pacific has been shaped as a result of four generations of subduction zone activity from the Cretaceous to the present. Generation 1 (G1) subduction occurred from ~120-100 Ma along the Norfolk Ridge and was subsequently followed by extension between 100-90 Ma leading to the break up of East Gondwana. At ~90 Ma, generation 2 (G2) subduction was initiated along the Loyalty-Three Kings Ridge, trapping crust within the Norfolk Basin and South Loyalty Basin. Concurrently, opening of the Tasman Sea (separating the Lord Howe Rise from Australia) occurred. G2 subduction ceased at ~45 Ma and reinitiated as a westward dipping generation 3 (G3) subduction. Trench roll-back caused the opening of the North Loyalty Basin (between ~45-35 Ma), opening of the Norfolk Basin (~45-35 Ma) and the South Fiji Basin (between 35-25 Ma) and leading to lull in spreading after ~25 Ma. Back-arc spreading and generation 4 (G4) subduction resumed at ~6 Ma forming the Lau Basin and Havre Trough. Our geodynamic models suggest a strong component of dynamic topography has influenced the subsidence/uplift curves of the region (cool downwellings (G1-G4) result in increased subsidence, hot upwellings result in increased uplift). Well data analysis must include the effects of dynamic topography if accurate subsidence/uplift curves are to be constructed.