Structural Framework and Hydrocarbon Potential of the Inner Forearc Deformation Belt, Tobago Forearc Basin-Barbados Accretionary Prism Transition Zone

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Abstract

This study uses 10,000 km of modern, high-resolution, deep-penetration 2D seismic data provided by the oil industry to define the structural framework and hydrocarbon prospectivity of the Lesser Antilles subduction zone in the Barbados and Trinidad maritime zones. These data reveal new details on the following basins and tectonic features:1) the Palaeogene Tobago basin, formed as a forearc basin in front of the Lesser Antilles volcanic arc; 2) the Barbados submarine ridge and island of Barbados, which represents the Eocene Barbados prism accreted to the front of the Lesser Antilles volcanic arc; and 3) the Late Miocene inner forearc deformation belt (IFDB), a 50-70-km-wide zone of westward-verging folds and thrusts that formed as a result of ongoing convergence between the Tobago forearc basin (TFB) and Barbados tidge. Limited production of oil and gas on the island of Barbados confirms the presence of a working hydrocarbon system consisting of continentally-derived, quartz-rich turbiditic sandstone reservoir of the Eocene Scotland Formation; and the subsurface presence of both Tertiary terrigenous (Type III) and possibly Cretaceous marine (Type II) source rocks. The IFDB, which thrusts the Barbados ridge westward over the east-dipping basement of the Tobago basin, extends 400 km along strike from ~12°N to a northern limit near 15°N. The fold-thrust belt was erosionally truncated south of 12°N during the Miocene uplift of the Tobago platform as a result of the collision between the southern Lesser Antilles arc system and South America. Flower structures parallel to the Barbados ridge indicate that a component of strike-slip movement accompanied uplift and thrusting. Thick-skinned fold and thrust structures derived from mild inversion of normal faults and shale diapirs are observed in the western zone of the IFDB. Faults in the IFDB crosscut strata to provide conduits for fluid advection and fault-propagation type folding generate closures. The existence of a working petroleum system in the IFDB depends on both the existence of source rocks in the TFB and the extent of lateral migration of fluids from the Barbados accretionary prism to the east of my study area.