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Process Sedimentology of Deep-Water Petroleum Reservoirs: Offshore Krishna-Godavari Basin

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Summary

Process sedimentology (aptly "depositional process sedimentology"), a subdiscipline of physical sedimentology, is concerned with the detailed bed-by-bed description of siliciclastic sedimentary rocks for establishing the link between the deposit and the physics of the depositional process. It is the foundation for reconstructing ancient depositional environments and for understanding sandstone reservoir potential. Aspects of process sedimentology have been discussed in detail by Shanmugam (2006a).

The eastern continental margin of India, along the western region of the Bay of Bengal, is composed of four major sedimentary basins from north to south: (1) the Bengal, (2) the Mahanadi, (3) the Krishna-Godavari (KG), and (4) the Cauvery). Operator Reliance Industries Limited and Niko Resources discovered gas in Pliocene deep-water siliciclastic reservoirs of the Offshore Krishna-Godavari (KG) Basin in 2002. Gas production started in April 2009. These reservoir sands and the processes that deposited them are the focus of this paper, which was published in the Journal of Sedimentary Research by Dr. G. Shanmugam (UTA), Sanjay.K. Shrivastava (RIL), and Bhagaban Das (RIL) (2009).

A depositional model is proposed for deep-water petroleum reservoir sands (Pliocene) in the Krishna-Godavari Basin, Bay of Bengal (India). Based on examination of 313 m of conventional cores from three wells, five depositional facies have been interpreted: (1) sandy debrite, sandy slump, sandy slide, and sandy cascading flow, (2) muddy slump and debrite, (3) sandy tidalite, (4) muddy tidalite, and (5) hemipelagite. Debrites and slumps constitute up to 99% in one well. Sand injectites are common. Pliocene environments are interpreted to be comparable to the modern upper continental slope with widespread mass-transport deposits and submarine canyons in the Krishna-Godavari Basin. Frequent tropical cyclones, tsunamis, earthquakes, shelf-edge canyons with steep-gradient walls of more than 30°, and seafloor fault scarps are considered to be favorable factors for triggering mass movements. Pliocene canyons are sinuous, exhibit 90° deflections, at least 22 km long, relatively narrow (500-1000 m wide), deeply incised (250 m), and asymmetrically walled. Sandy debrites occur as sinuous canyon-fill massive sands, intercanyon sheet sands (1750 m long or wide and 32 m thick), and canyon-mouth slope-confined lobate sands (3 km long, 2.5 km wide, and up to 28 m thick). Canyon-fill facies are characterized by the close association of sandy debrites and tidalites. Reservoir sands, composed mostly of amalgamated units of sandy debrites, are thick (up to 32 m), low in mud matrix (less than 1% by volume), and high in measured porosity (35-40%) and permeability (850-18,700 mD). Because upper-slope sandy debrites mimic base-of-slope turbidite channels and lobes in planform geometries, use of conventional submarine fan model as a template to predict the distribution of deep-water sand is tenuous.

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