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Computer simulation of carbonate reservoir model by Facies-3D

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Facies-3D is a computer simulator for carbonate and siliciclastic sediments, which has been developed by the Technology Research Center of Japan National Oil Corporation. The Facies-3D carbonate model describes three-dimensional carbonate facies distribution based on water depth and current velocity in conjunction with basement (paleo-topography), over a simulation period. The output data at each step include facies and their thicknesses, and porosities, which are modified in meteoric diagenetic environments, for each grid. The Facies-3D carbonate model can be applied as a stratigraphic simulator on a basin scale and as a tool for reservoir characterization on a field scale.

Facies-3D has been applied to (1) Recent and Pleistocene carbonates in the Ryukyus, southwest Japan (Matsuda *et al.*, 1997), (2) Recent carbonates in the offshore Fraser Island, eastern Australia, (3) Miocene reefal carbonate reservoirs in the Southeast Asia including the Walio (Irian Jaya) and the Arun (North Sumatra), and (4) Cretaceous shallow water carbonate reservoirs in the Middle East. The results of the simulation in the Walio field show that the Facies-3D approximated to a high degree, the distribution of facies and the occurrence of porous intervals (Matsuda *et al.*, 2000).

A simulation case study was conducted using the depositional model of the F6 field located in Central Luconia, offshore Sarawak, Malaysia, including the whole F6 buildup and the reservoir section in the upper part of the buildup. Development of the F6 buildup in the Middle to Late Miocene was subdivided into build-out, build-up and build-in phases (Eping, 1989; Wee and Liew, 1988). The reservoir section in the uppermost part of the build-up phase and the build-in phase was subdivided into the lower, middle and upper units (Matsuda *et al.*, this volume). The lower unit mainly consists of a restricted back reef facies. The middle unit comprises an alternation of a shallow fore reef and deep fore reef facies. Backstepping of the reef occurred in association with siliciclastic inputs. The upper unit is mainly composed of a relatively open marine reef facies. The reef was drowned during a major subsequent transgression.

The F6 reef development and facies distribution in the reservoir section were simulated using Facies-3D. The simulation area size of the whole buildup is 30 km x 17 km with grid size of 500 m x 500 m. The simulation period is 15.2 Ma to 4.6 Ma at every 50,000 years with a total of 212 steps. The simulation area size of the reservoir section is 26.4 km x 14.4 km with grid size of 400 m x 400 m. The simulation period is 6.546 Ma to 5.336 Ma at every 10,000 years with a total of 121 steps. Input parameters for these two simulations were extracted from interpretative geological and geophysical data in the field.

The results of the simulations show that the Facies-3D carbonate model describes the above-mentioned depositional model including (i) the build-out and build-in phases of the F6 reef, and drowning of the reef, and (ii) the distribution of facies in the reservoir section.

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