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Christoph Heubeck[1], C. Story[2], P. Peng[3], C. Sullivan[3], S. Duff[4] (1) Freie Universitaet Berlin, Berlin, Germany (2) DDD Energy, Houston, (3) BP, Houston, TX (4) Independent Contractor, Wellington, New Zealand

Integrated Reservoir Study of the Liuhua 11-1 Field, China, Using a High-Resolution 3-D Seismic Data Set

Liuhua 11-1 Field, located in the Pearl River Mouth basin offshore South China, consists of diagenetically altered Miocene limestone comprising a shallow-water carbonate bank. This bank forms the topmost and youngest interval of a larger, extensively karsted buried carbonate platform. A 3-D seismic survey of Liuhua field yielded a very high-resolution data set (>200 Hz), allowing a spatial resolution < 5m. This data set was subsequently used to produce a reservoir model that closely linked petrophysical, log, and seismic data.

The carbonate stratigraphy suggests several subaerial exposure events which significantly modify primary stratification of the carbonate bank through diagenesis. These include freshwater leaching, burial compaction, cementation, and late diagenetic flushing of the bank. The combined diagenetic changes had three principal effects: (1) They exacerbated primary facies-dependent differences in porosity through a series of dissolution-reprecipitation steps; (2) caused widespread incipient carbonate collapse at or below the scale of seismic resolution; and (3) are responsible for the formation of numerous regionally occurring karst sinkholes of up to 400 m diameter shortly before final drowning of the platform. Incipient collapse of the friable carbonate framework is expressed seismically by a reduction in amplitude. Carbonate dissolution appears to be ongoing because sagging continues to affect all strata overlying the reservoir to the seafloor. Subsurface dissolution may be a result of either flushing of the carbonate platform by cold, undersaturated marine waters or may be due to active biodegradation of the hydrocarbons along the oil-water contact and the concomitant release of acids.