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High-Frequency Valley-Fill Sequences: Depositional Control on Giant Gas Fields of the Messinian Abu Madi Formation, Nile Delta, Egypt

A network of deeply incised valleys formed in northern Egypt during the late Miocene withdrawal of the Mediterranean Sea. Giant gas fields produce from the valley fills. One valley is over 300 m thick and 10 km wide, and extends through the central Nile Delta region. Sandstones of the Abu Madi Formation fill this valley and will yield several TCF of gas from the onshore El Qar'a and Abu Madi fields.

We integrated sedimentology, petrography, biostratigraphy, and geophysics to create a depositional and sequence-stratigraphic model for the Abu Madi Formation. It consists of stacked "levels" (I through IV) deposited in late Messinian through earliest Pliocene. The levels represent a series of fining-upward, high-frequency, retrogradational sequences that filled the valley during eustatic rise. The complete succession is a transgressive sequence set.

Each sequence (level) typically displays basal pebbly to coarse-grained, cross-bedded sandstones, denoting braided-stream deposition. This interval fines upward to cross-bedded sandstones with drapes of mud and carbonaceous debris. These beds likely formed in tidally influenced meandering rivers. Carbonaceous shales and paleosols also are present. Flaser-, lenticular-, and wavy-bedded sandstones and siltstones dominate the overlying section, suggesting intertidal to subtidal sedimentation, probably in an estuarine setting. Rhythmically interbedded mudstones and siltstones also occur, indicating central-basin deposition. Mudstones with wave ripples and small, low-diversity burrows cap each level and are incised by the ensuing sequence.

A simple model of transgressive fill does not apply here. Transgression punctuated by multiple stages of stillstand, erosion, and progradation explain the depositional complexity in this, and similar, valley fills.