High-Frequency Sequence Stratigraphic Controls on Reservoir Development in the Lower Leonardian (Permian) Abo and Drinkard Shallow-Water Carbonates on the Central Basin Platform, New Mexico

JOHNSON, IMELDA GORMAN, Badley Ashton & Assoc. Ltd.; G. B. ASQUITH, Texas Tech University; and R. WINN, Texas Tech University

The Abo and Drinkard units in the West Dollarhide Field, Lea County, New Mexico, were deposited on a shallow-water carbonate platform along the western flank of the Central Basin Platform during the lower Leonardian. The depositional facies indicate an environmental fluctuation between marginal to highly restricted marine conditions and have been grouped into three lithofacies associations. Diagenetic processes have resulted in partial to complete dolomitization of some, but not all of the subtidal and intertidal facies. The best reservoir quality zones are depicted by the shallow subtidal facies, which display well-connected intercrystalline pore systems.

The lower Leonardian Abo high-frequency sequence (HFS) in the West Dollarhide Field comprises subtidal bioturbated muddy wackestones to packstones, and silty intertidal laminated mudstones that form stacked m-scale, weakly upward-shoaling cycles. These facies were deposited in a low-energy inner ramp setting in a moderately to highly-restricted platform top environment. The Abo early highstand systems tract (HST) is dominated by stacked subtidal facies, within which three dolomitised reservoir zones are recognised. However, the late HST consists of a tidal flat complex in which pore systems are totally occluded by aphano to finely crystalline dolomite. Consequently, the only porosity within the late HST is associated with karst features (mosaic and chaotic breccias), which developed during a fall in relative sea level at the top of the Abo sequence.

The overlying Drinkard HFS was deposited during a longer-term relative sea level rise in a less restricted inner-ramp depositional setting. The basal Drinkard transgressive systems tract (TST) is characterised by silty tidal flat capped subtidal facies, whereas the early HST consists of stacked subtidal cycles and the late-HST is dominated cryptmicrobial-laminated intertidal caps overlying shallow subtidal facies. The lack of dolomitisation means that the TST comprises non-reservoir facies, whilst the only laterally continuous reservoir interval developed in the early HST consists of an ooid grainstone shoal, which is located towards the base of this systems tract (Figure 1). The best reservoir facies (medium to coarsely cystalline dolomitised shallow subtidal facies) are developed within the late HST (depositional cycles, CT9-18; Figure 1), in which the change from aggradational to a more progradational style of deposition produced broader facies belts. These facies are capped by peritidal cryptmicrobial laminate intertidal and supratidal facies. It is this close association with an evaporitic peritidal environment that is proposed as the source of dolomitising fluids in the late HST, and which led to the development of thin (5 to 15 feet), but laterally continuous, reservoir intervals.

Petrographic and isotope data support a syn- to early post-depositional evaporitic regime for dolomitization. The majority of Abo facies comprise aphano to finely-crystalline dolomite, whilst in the Drinkard, the nature of dolomitization is facies specific and the mud-rich subtidal facies have not been, or are only partially dolomitized. Drinkard intertidal facies have been replaced by aphanocrystalline dolomite, whereas the grain-rich subtidal facies have been replaced by a medium to coarse-grained dolomite. Two important factors may explain this difference: (1) the contrast in depositional settings between the Abo and Drinkard sequences, and (2), the nature of high-frequency relative sea level fluctuations, which are better represented in the Drinkard.

The modelling of depositional, diagenetic and petrophysical characteristics of the Abo and Drinkard has provided a better understanding of the stratigraphic framework on this part of the Central Basin Platform during lower Leonardian. In addition, the degree of connectivity, or compartmentalisation, of potential reservoir intervals can be shown.

ACKNOWLEDGEMENTS

Texaco Exploration and Production, Inc., Midland, Texas, provided support for this project. Access to four cores from the West Dollarhide Field and geophysical logs from ~60 additional wells made up the bulk of the database. Additional funding for IGJ was provided by the Department of Geosciences at Texas Tech University, the Society for Professional Well Log Analysts, AAPG, the Mary Lillyerstrom Foundation and the British Fulbright Commission.

Note: Depth measured in feet from the top of the Drinkard unit datum (0.0 ft ld)

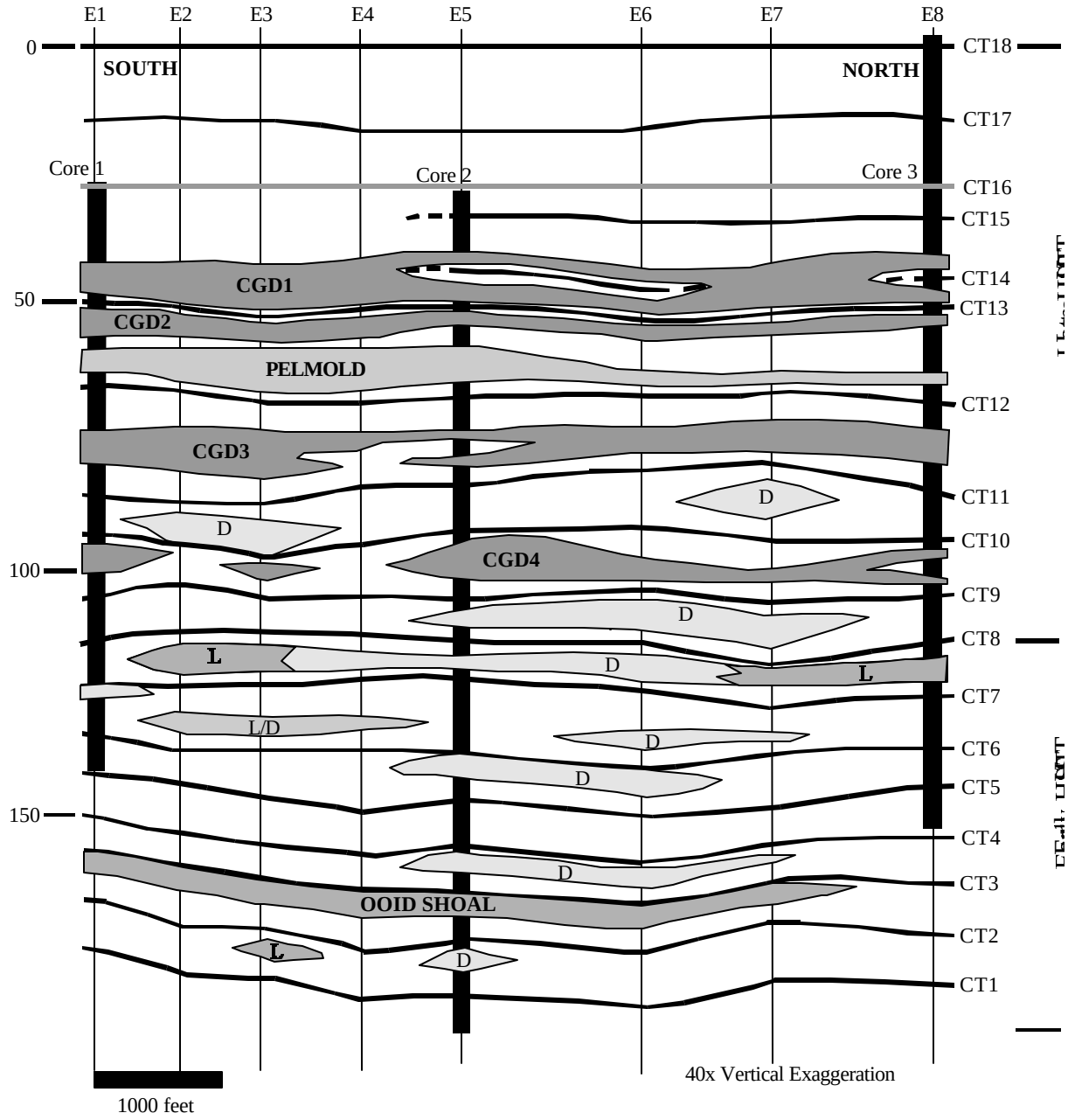

Figure 1: Cross-section of wells E1 to E8, incorporating three of the four available cored wells showing the distribution of all potential reservoir zones in the Drinkard unit of the West Dollarhide Field. The eighteen m-scale depositional cycles are shown (using the core identified cycle tops – CT), as is their position within a high-frequency (early and late) highstand systems tract (HST). CGD1-4 = coarser-grained dolomite reservoir zones one through four, Pelmold = peloidal/skeletal moldic reservoir zone, Ooid shoal = grainstone interval with open intergranular porosity, D = additional finer crystalline dolomitised reservoir zones, L = undolomitised packstone reservoir zones.