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Reservoir Compartmentalization in the San Andres Formation of Vacuum Field, Lea County, New Mexico—Peritidal Deposits and Karst Overprints Create Vertical and Lateral Barriers to Fluid Flow in Carbonate Platform Dolopackstones and Dolograinstones

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The San Andres Formation is a Leonardian/Guadalupian age (Middle Permian) dolomitized ramp carbonate unit that is one of the most prolific hydrocarbon reservoirs in the Permian Basin. At Vacuum Field, Lea County, New Mexico, the San Andres consists of approximately 1,500 feet of transgressive and high stand carbonate skeletal and oolitic/peloidal wackestones, packstones and grainstones. 95% of the interval is dolomitized. The upper 400-500 feet of the formation are hydrocarbon bearing and constitute the San Andres reservoir in Vacuum Field.

In ascending depth order, major depositional units in the reservoir interval include bryozoan/sponge/pelmatozoan wackestones and boundstones, fusulinid/peloid pack/grainstones, ooid/peloid pack/grainstones, and tidal flat capped cycles. The skeletal and peloidal grain-supported facies represent the reservoir units. They display porosities of 10-20% and permeabilities in the 5-100 md range. If these units were laterally and vertically continuous, they would represent a reservoir interval at least 400 feet thick that could be easily produced with widely spaced injector and producer wells, using either water flooding or CO_2 injection.

There are, however, two significant tight facies that compartmentalize the San Andres dolopackstones and dolograinstones. One is the overprinting of karst features associated with 3rd and 4th order sequence boundaries. These include dissolution, cave development, collapse structures, and sandstone infiltration. All karst porosity is plugged with sandstone, collapsed carbonate or evaporites. Thus, where karst overprints are present, they function as porosity and permeability barriers. Infiltrated sands are often mistaken for depositional sandstones on logs, resulting in erroneous lateral correlations.

The other tight facies consists of tidal flat capped (peritidal) carbonate cycles. These cycles can have terrigenous sandstone bases (but often do not) and they are always characterized by caps displaying fenestral textures, stromatolitic algal laminations, pisolites, teepees and other classic “intertidal/supratidal” sedimentary structures. Because the peritidal cycles display very low porosities and permeabilities they also function as vertical and lateral permeability barriers.

High total gamma ray responses in the peritidal intervals have traditionally been interpreted to reflect the presence of regionally deposited terrigenous sandstones; hence these units have been correlated across the entire Vacuum Field. In fact, the high total gamma ray counts usually reflect high uranium content in the tidal flat caps, due to the presence of thin organic units or dispersed organic material in the carbonates. The log signature of these peritidal units does not represent regional depositional events and is clearly not continuous across the entire Vacuum Field.

Analysis of at least 3,000 feet of core has resulted in the development of a sequence stratigraphic based correlation model for Vacuum Field. This model constrains the karst and tidal flat capped “tight zones” within several stratigraphic intervals, and clearly indicates that these units are not correlative across the field. Locally, however, they do constitute vertical or lateral flow barriers and serve to compartmentalize the reservoir. A better understanding of the distribution of flow barriers allows the planning of new vertical and horizontal wells that result in better drainage of this major reservoir.