SUBREGIONAL DEVELOPMENT OF RESERVOIR POROSITY AT A MAJOR PERMIAN UNCONFORMITY: SAN ANDRES FORMATION, WEST TEXAS

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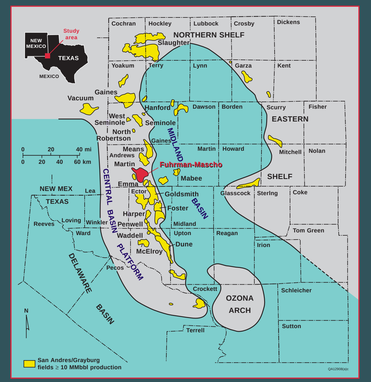
ABSTRACT

Most porosity development in carbonate reservoirs can be attributed in part or in total to diagenesis. This is especially true in Permian reservoirs of the Permian Basin, nearly all of which are dolomitized. Linking this diagenesis and associated porosity to unconformities representing major falls in sea level, however, is commonly problematic using typical reservoir data sets. New subsurface data from the San Andres Formation, a major oil-producing reservoir in Texas and New Mexico, coupled with relationships previously defined from equivalent outcrops, illustrate both the style and expression of such porosity development.

Although the San Andres is characterized by an upward-shallowing succession of outer- to inner-ramp carbonate lithofacies in most platform settings, pervious studies have demonstrated that the section is broken by a major unconformity that represents a sea-level fall of at least 100 m and a hiatus of 0.5 to 1 my.

Both the evidence and the result of this sea-level fall event are clearly expressed in the San Andres reservoir at Fuhrman-Mascho field. Although cryptic in some core sections, the hiatus is indicated by an abrupt shift from outer ramp deposits, composed of open marine fusulinid wackestones and packstones, to exposed tidal flat deposits. Porosity is developed in solution-enhanced vertical burrows below the unconformity. Although highly heterogeneous, the porosity in this burrowed zone reaches 15 m in thickness and extends for many kilometers. The widespread porosity development at this unconformity is a potential new target for both field exploitation and regional exploration operations.

INTRODUCTION

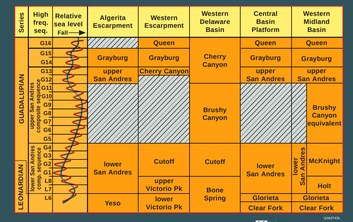


1. The Fuhrman-Mascho field is located on the Central Basin Platform, an early Permian constructional platform. During San Andres deposition, the field area lay on a generally eastward-dipping carbonate ramp.

SAN ANDRES STRUCTURE
FUHRMAN-MASCHO FIELD

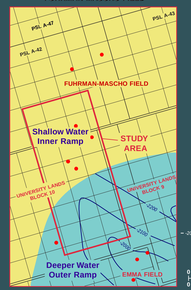
2. Structurally, the field exhibits a local relief of about 350 ft. Mapping of the McKnight shale, below, shows that the early San Andres paleotopography bears no relationship to current structure.

MIDDLE PERMIAN SEQUENCE STRATIGRAPHY
Permian Basin

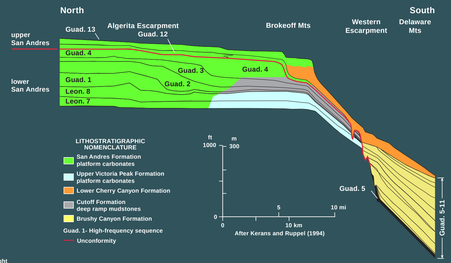


3. Comprehensive study of the San Andres and Grayburg Formations in outcrop in the Guadalupe Mountains by Kerans and co-workers shows that the San Andres platform carbonate succession is divided by a major uniformity representing at least 100 m of sea-level fall.

LOWER SAN ANDRES PALEOTOPOGRAPHY
FUHRMAN-MASCHO FIELD

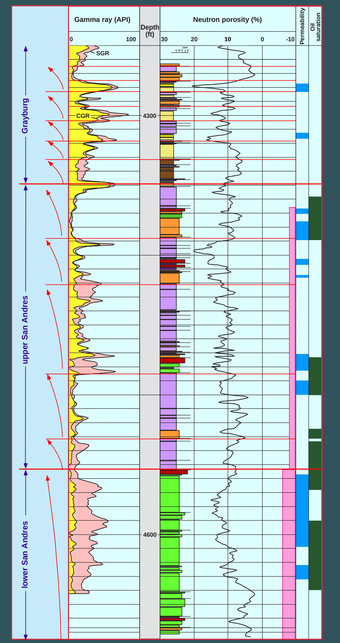


4. Lower San Andres carbonates comprise six Leonardian and Guadalupian high-frequency sequences (L7-L8, G1-G4), whereas the upper San Andres contains two high-frequency sequences (G12 and G13). During the long mid-San Andres lowstand platform hiatus, deposition was limited to lowstand sandstones of high-frequency sequences G5 - G11 (Brushy Canyon Formation).

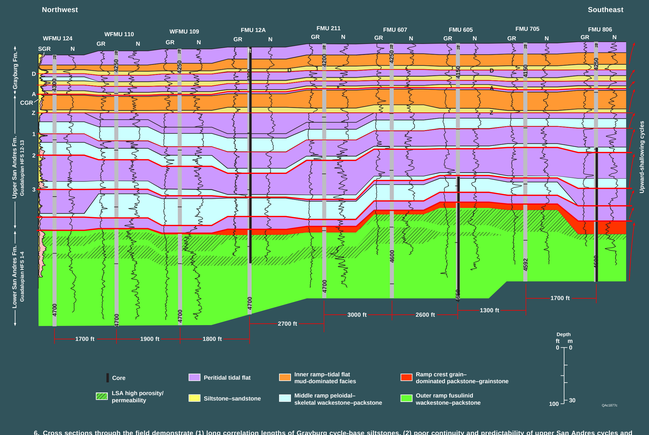


STRATIGRAPHY AND FACIES

SAN ANDRES-GRAYBURG STRATIGRAPHY AND FACIES
Fuhrman-Mascho Field



CYCLE STRATIGRAPHY AND FACIES ARCHITECTURE
Fuhrman-Mascho San Andres Field, Andrews County, Texas



6. Cross sections through the field demonstrate (1) long correlation lengths of Grayburg cycle-base siltstones, (2) poor continuity and predictability of upper San Andres cycles and component facies, and (3) major facies offset marking the unconformity at the upper San Andres–lower San Andres boundary. Outer ramp fusulinid wackestones at the top of the LSA are sharply overlain by pisolitic, tidal-flat facies of the USA suggesting partial erosional truncation of the LSA.

5. The reservoir section at Fuhrman-Mascho comprises an overall upward-shallowing succession of lower San Andres, upper San Andres, and Grayburg deposits.

Grayburg Formation deposits are composed of restricted inner platform cycles made up of siltstone-rich bases and tidal-flat caps.

Upper San Andres (USA) rocks comprise a complex cyclic succession of inner platform, shallow water subtidal carbonates (dominantly mud-dominated packstones), and cycle capping exposure tidal-flat facies.

Lower San Andres (LSA) rocks are dominantly outer ramp fusulinid wackestones with local capping peloidfood grain-dominated packstones and grainstones.