Temporal and Spatial Variability in the Fill and Diagenesis of Syndepositional Fault Zones, Permian Capitan Reef Platform, Slaughter Canyon, Guadalupe Mountains, New Mexico: Implications for Platform Development, Diagenesis and Connectivity of Yates Reservoirs

KOSA, EDUARD, and DAVE HUNT, University of Manchester, U.K.; GERALD ROBERTS, Birkbeck College, University of London, U.K.; WILLIAM FITCHEN, Exxon-Mobil Upstream Production Research Company, Houston, TX; MARIE-ODILE BOCKEL-REBELLE, Elf Exploration Production, Pau, France

The Permian Capitan Reef and equivalent platform strata are cut by at least nine major syndepositional faults with throws of up to 25 m in Slaughter Canyon, Guadalupe Mountains, New Mexico. These faults grew incrementally during deposition of the Seven Rivers, Yates and Tansill Formations. The fill, fabrics and diagenesis of four of these major faults, have been examined in two detailed outcrop windows, 200 m high, 500 m wide and positioned 0.7-1.2 km apart along depositional strike, 2.5-3 km shelfward (NW) of the canyon mouth. The fault zones localized the development of paleokarst and acted as conduits for dolomitizing fluids. The fill, diagenesis and tectonic fabrics of the fault zones provide evidence for incremental growth of the faults and for multiple phases of dissolution, deposition, collapse and dolomitization. Here, the temporal and spatial evolution of the fault zones are illustrated, and the implications for their structural, sedimentary and diagenetic evolution are discussed within the context of a well-constrained stratigraphic framework.

The average strike of the fault zones is 215°-35°, sub-parallel with that of bedding and dip both self- and basinward at angles of 79°-81°. The faults display both normal and reverse geometries and have high displacement gradients, as may be expected of syndepositional faults. The rare kinematic data indicate dip-slip-oriented faulting. Geopetal evidence indicates that the platform was subject to syndepositional tilting, as the faults developed.

The fault zones are themselves up to 25 m wide and contain a dominantly sedimentary fill. The most common vertical succession within the fault zones is: (1) limestone/dolomite breccia; (2) silty-sandy dolomite breccia; (3) beige- and brown-weathering sandstone and associated clast- and matrix-supported chaotic breccia ; and (4) laminated-massive pink silty dolomite to dolomitic siltstone. Spar-cemented crackle and mosaic breccias are developed locally, post-dating the carbonate (1) and silty-sandy dolomite (2) breccias. Internal offset of the sediment fills and the sealing of minor faults by later sediments provide evidence of episodic fault-reactivation. Significantly, the sedimentary fill inhibited subsequent deformation and mechanical collapse of cavern systems during burial, preserving the original morphology and relationships of the karst system. During early diagenesis, the faults acted as fluid flow conduits. Evidence of repeated dissolution and cementation related with brecciation and micritization is observed within and along the faults zones. Destruction of early marine cements, and solution-enlargement of cavity networks are commonplace in strata adjacent to the fault zones. Several distinct phases of dolomitization took place between and after these periods of dissolution. Thus, zones with distinct diagenetic evolution are developed within and along the fault zones. They provided vertical connection between strata-bounded aquifers and the top of platform where mixing of pore waters is likely, localizing dissolution and dolomitization. It is evident that the syndepositional fault zones exerted an important control on the development and diagenesis of the Capitan platform. If similar structures are also developed in the subsurface they would form important vertical connectivity between the compartmentalized sandstone reservoir horizons developed within the Yates Formation hydrocarbon reservoirs.