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Interrelationships Between Carbonate Diagenesis and Fracture Development: Example from Monterrey Salient, Mexico and Implications for Hydrocarbon Reservoir Characterization

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This study proposes a new protocol to predict fracture characteristics of subsurface carbonate rocks. The methodology is based on integrated analyses of diagenesis and fractures from outcrops. The study area is characterized by multiple fracture sets. Relationships between fractures and diagenesis suggest various times of fracture formation. Three main fracture events were identified. The first event is characterized by veins with synkinematic (precipitated during fracture opening) calcite cement and postkinematic (precipitated after fracture opening) dolomite cement. This event is related to near-surface processes, as demonstrated by clasts within evaporite solution collapse breccias and soft-sediment boudinage structures. A second poly-orientational fracture event, characterized by synkinematic dolomite and postkinematic calcite cementation, probably occurred during burial. The third major event includes faults, flexural slip planes and fibrous calcite-filled veins developed during Laramide-age orogeny. Forty carbon and oxygen isotopic analyses of dolomite and calcite cements from both veins and host rocks are consistent with precipitation under increasing temperatures during progressive burial. Three main groups of calcite cement can be differentiated isotopically and are consistent with the fracture chronology and diagenetic history. This knowledge provides a better understanding of the genesis and evolution of fractures and their relations with other diagenetic processes, and can be applied to predict fracture characteristics of related rocks in the subsurface for hydrocarbon reservoir characterization.