

The Effect of Diagenetic and Depositional Heterogeneities with High Lateral Continuity in Natural Fractures Segmentation: Implication for DFN Parametrization

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Abstract

We studied the influence of heterogeneities with high lateral continuity in development of natural hydraulic fractures in a laminated micrite-limestone, a tight-class reservoir analogue, which present very low permeability - Crato Formation, Araripe Basin, NE Brazil. The heterogeneities found were classified as: 1) Depositional - loop bedding layers, convolute laminations layers, fluid escape structures, micro faults and centimetric to metric shear fractures; 2) Diagenetic - eo-diagenetic features correspond to calcareous concretions with chert, and pyrite formation. Meso-diagenetic features represent small vertical stylolites, centimetric to metric vertical and horizontal veins, filled with calcite and gypsum. Eo-diagenetic features included formation of joints, which remains open or partially sealed by calcite and gypsum, oxidation, local dissolution of layers and karst formation. The study was based on the complete description of structures in outcrops surfaces (integral discretization), the description of petrofacies and sample collection in vertical sections/strips (15 - 20 cm wide), for creation of pseudo-wells. In situ data acquisition consisted of rock uncompressed compressive strength measurements with esclerometer (Schmidt hammer), and gamma ray logs. Additional laboratory tests consisted of uniaxial strength tests performed in samples collected along the pseudo-wells, petrographic analysis and microtomography analysis. The results

showed the strong control of specific layers in which early cementation took place - layers with convoluted laminations and calcareous concretions. The early cementation possibly was influenced by sedimentation rates which created different pore water content in some lamination sets, which resulted in the formation of layers with higher early diagenetic silica content. Results showed two main controls in the occurrence of fractures: 1 - occurrence of vertical veins (density) was controlled by stratigraphic intervals, with up to 1.5 meter thick, with different mechanical properties. Intervals with higher early depositional porosity shows a higher content of chert and calcareous concretions. Intervals which possibly presented early lower porosity show less chert content and higher occurrence of veins; 2 - the heterogeneities formed by centimeter thick layers, with high continuity, locally controlled the propagation of vertical veins. These layers present a strong effect in the segmentation of the vertical veins planes. Thus, we propose that the creation of DFNs for laminated rocks, based on the estimation of fracture planes length related to the aperture values, should consider a vertical segmentation factor.

Keywords: mechanical stratigraphy, discreet fractures network, Schmidt hammer, laminate rocks