Fracture Analysis Of 3d Digital Outcrop Models From The Wadi Daqlah Analogue Section Of Arab D Reservoirs, Saudi Arabia

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Abstract

Objectives/Scope: Fracture networks may significantly influence permeability in the subsurface reservoir, affecting both well productivity and recovery factor. Despite the considerable advances in defining geological characteristics at reservoir conditions, methods to describe subsurface fracture networks are still poor at the mesoscale (cm - 10’s of m). This research aims to use digital photogrammetry to build high-resolution 3D Digital Outcrop Models (3D-DOM) that can be used to measure different fracture properties of the Arab-D Member outcrops located along Wadi Daqlah, approximately 100 km north of Riyadh (Kingdom of Saudi Arabia).

Methods, Procedures, Process: The methodology applied in this research follows a four-steps-based workflow, including data acquisition, 3D digital outcrop modeling (3D DOM), mapping of visible fractures, and fracture intensity (P21) computation. First, an extensive 3D digital photogrammetry data set was used to build Digital Outcrop Models (DOM) of the Arab-D Member along Wadi Daqlah, approximately 100 km north of Riyadh (Kingdom of Saudi Arabia). Then, the mapping of visible fractures along the outcrops was performed using the DOMs to define the main fracture sets and compute the fracture intensity (P21).

Results, Observations, Conclusions: 11950 fractures were traced in the DOMs, highlighting the presence of three fracture sets in the outcrops. The predominant sets have a general NE-SW, NW-SE, and N-S trend. Most of the fractures are sub-vertical and stratabound. The P21 analysis used the entire fractures dataset along the outcrop to describe lateral distribution and variability. The mean P21 value observed in the outcrops is 0.341 m-1. The fracture sets defined and measured in the Arab-D outcrop match those defined using the same methodology for the Hanifa and Jubaila formations outcrops in another study along Wadi Laban, Riyadh. Furthermore, previous studies characterizing subsurface fractures in Arab-D reservoirs to the east of the outcrops had reported fracture sets with a general trend of NE-SW, and NW-SE, matching with the general trends defined for the fracture sets in this study. In addition, P21 results show that the fracture intensity values increase near the long fracture corridors between 90 - 120% compared to areas with no visible fracture corridors (fracture length &gt 2m), meaning an increase of minor fractures (fracture length &lt 1m) in the vicinities of the long fracture corridors. However, fractures of more than two meters are scarce along the outcrops (less than 2%).

Novel/Additive Information: This research shows how digital photogrammetry can be used to reconstruct high-resolution 3D Digital Outcrop Models that are of primary importance in evaluating fracture patterns in outcrops where accessibility is
restricted. In addition, digital outcrop models allow an extensive and laterally continuous measurement of fracture properties on an interwell scale, which is impossible in reservoirs using subsurface data.