

# **Walk-around VSP Anisotropic Analysis and Azimuthal Inversion for Fracture Characterization Magwa Marrat Carbonate Reservoir-Kuwait**

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## **Abstract**

The Marrat reservoir in the Magwa Field, part of the Greater Burgan field in Kuwait, was discovered in the mid 1980's. To date it has been produced by primary depletion with limited aquifer support. (KOC) is considering water-flooding the reservoir to increase recovery. As Magwa Marrat gears for water injection, the role of fractures, faults and variability of facies need to be assessed in detail for which the initiative is already underway. A Walk-around VSP survey was acquired in the Marrat carbonate reservoir in Magwa field to analyze shear wave splitting, and P wave attributes (interval time & amplitude ratios) to estimate azimuthal anisotropy for the Middle Marrat carbonate reservoir. Main objectives of the survey were to determine the directions of the fast and slow shear, and calculate the percentage of anisotropy (gamma parameter), P wave data was used to confirm the results of the shear wave analysis and give more confidence in analysis. Data was affected by variations in the near surface especially in the Sabhka regions. This caused quite a bit of variability in the waveform from shot to shot. This can be seen in the hodograms around the SE region. Shear wave fast and slow directions were calculated from the HR/HT ratio plots. Shear wave anisotropy was derived from the interval times of the fast and slow directions for two receivers over a specific zone. Analysis of the Marrat formation showed values of anisotropy at 5%. This was calculated using the PS converted wave at the top of the Middle Marrat reservoir & PS upgoing wave at the Lower Marrat. Shear wave analysis calculated a fast direction at 55 & 235 degrees (NE direction) and a slow direction of 135 & 320 degrees (SW direction). P wave amplitude ratio analysis agreed with these trends. Additional analysis using the PP reflection and downgoing arrival to calculate an estimate of the reflection co-efficient also match with the result from the shear wave analysis. Feasibility pre stack azimuthal inversion analysis for new HD PSDM 2020 in Magwa area showing one dominant open fractures with orientation NE-SW with good match with image data, so walk-around VSP & Magwa feasibility pre-stack azimuthal inversion results can be used to reduce risk related to both injectivity and reservoir heterogeneity in the secondary development of a major reservoir.