Chasing Large-scale Hypogenic Dissolution Features Using Seismic-assisted Machine Learning: A New Perspective For The Arab Formation In Saudi Arabia

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Abstract
Objectives/Scope: Large integrated studies have demonstrated that significant hypogenic modification of the Arab Formation in Saudi Arabia is quantifiable at well locations from abundant core and image log data. This has prompted efforts to characterize and model large-scale (foot to tens of feet) dissolution bodies using an array of technologies including machine learning (ML), as there are large implications on the distribution of dissolution-enhanced reservoir properties and their representation in 3D geological models.

Methods, Procedures, Process: This study utilizes an extensive dataset from the Upper Jurassic Arab Formation that includes cores, wireline logs, LWD and wireline image logs, production logs, and 3D seismic data. We present a seismically-based supervised ML approach to generate probabilistic 3D models of hypogenic non-matrix large-scale dissolution features which are then used in 3D modeling of reservoir properties. ML technology has allowed for greater 3D integration of seismic attributes and other spatial data types. Great success has been obtained once careful consideration is applied to what has been "processed out" of the seismic data.

Results, Observations, Conclusions: This paper outlines what has the most influence in the workflows setup to map these large-scale dissolution bodies, including investigating wells with total mud losses while drilling. A typical large-scale dissolution feature averages four feet in aperture and is easily identifiable using Focused Resistivity based image logs. Image analysis has shown that these dissolution features are intersected in over 14% of the well stock and are nearly always associated to total losses. The results of the ML classification and prediction exhibited a close resemblance to conceptual models of hypogenic non-matrix large-scale dissolution features and those outlined in the literature. The predicted regions in the model show the characteristic ramiform nature that is very diagnostic of this type of hypogenic modification. The predicted dissolution feature models were based on twenty equiprobable realizations, where each realization was benchmarked on a number of blind test wells. In addition, we discuss the significance of including dolomite replacement zones, and the right mix of extracted seismic attributes that have influenced the seismically-based ML predictions.

Novel/Additive Information: This paper demonstrates that supervised machine learning classification could offer a robust, rapid, and user-friendly alternative to conventional seismically-based geo-bodies modeling methods. An effort of this nature has not been previously undertaken for the Arab Formation in Saudi Arabia and its outcome may have significant and positive implications for hypogenic dissolution features characterization and 3D modeling.