

# Direct Hydrocarbon Indicators - a step forward in the largest discriminator of risk in petroleum exploration

Monigle, P.W.<sup>1</sup>, Hedayati, T.S.<sup>1</sup>, and Goulding, F.J.<sup>2</sup>

<sup>1</sup>ExxonMobil Upstream Company

<sup>2</sup>ExxonMobil Technology and Engineering Company

## Abstract

In petroleum exploration, predicting discrimination between success and failure is essential to constructing an economically successful exploration program. It is particularly true for frontier and emerging basins where chance of success is generally low. Where subsurface geophysical properties are amenable, incorporating Direct Hydrocarbon Indicator (DHI) observations have been shown to roughly double the success rate for DHI-prospects over non-DHI prospects. There is no other individual analysis that predicts discrimination as strongly (Rudolph and Goulding, 2017). In recent years, more challenging geological trapping configurations (i.e. low-dip stratigraphic traps) have required evolving characterization approaches, especially for more subtle geophysical responses. This paper describes an integrated step change for the DHI evaluation process through changes in DHI attributes, adaptation of machine learning, and integration with geologic risk linked to volume estimation.

In recent years, the ExxonMobil DHI evaluation process has evolved from an absolute measuring of attributes with final scoring directed by experts to an expectation-based system utilizing supervised machine learning (SML) system guided by experts. The evolved system is better optimized for fluid discrimination and calibrated to historic results. These adaptations have allowed the process to be more broadly applicable across a global portfolio of prospects and reduced bias in the risk evaluation process. DHI Discernibility, a new metric, describes the expectations and confidence in geophysical observations to inform the overall risking and resource estimation process. As DHIs impact most facets of assessed in-place hydrocarbons, Discernibility helps to ensure volumetric parameters are consistent with the geophysical expressions. DHIs directly influence a prospects container through area and column height definition as well as inform on applicable ranges for porosity and net-to-gross through the presence/absence of DHI attributes.

A significant challenge remains reconciling potentially contradictory information between geological and geophysical observations that propose different success estimates for the same prospect. Opposing views are not uncommon as the two independent risk processes, Geological Chance of Success (GCOS) and DHI scoring, focus on evaluating different aspects of the geologic container. Resolving discrepancies frequently requires geoscientists to choose which observations are the most critical in determining prospect risk, introducing bias and eroding predictability of each system. The updated workflow, Integrated Chance of Success (iCOS), combines GCOS and DHI through Bayesian logic using the GCOS as the starting (prior) value (Lowry et al., 2005; Nixon et al., 2018). DHI Discernibility influences the degree to which a DHI rating can modify the GCOS starting value in a positive or negative vector. This system additionally ensures that the absence of a DHI, when one is expected, is treated as a negative aspect, and handling it as such is unique in industry. Historically, DHIs are either not used for determining adequacy, just noted, or the DHI is tested against GCOS within some tolerance level (reconciliation).

Discernibility and iCOS presents an integration framework that ensures geological and geophysical descriptions are internally consistent, where appropriate. The updated framework allows for integration of all observations into a single Chance of Success value in a simple, repeatable process. Benchmarking studies indicate this new approach is 50-60% better at discrimination and has 30-40% improvement in accuracy over the individual systems, while also mitigating cognitive bias. This process results in an integrated description of the subsurface, with accurate descriptions of both risk and materiality to better inform economic evaluations and exploration decision making.

## References

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