The Most Important Factors in Charge Risking & Best Practices

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ABSTRACT

The typical basin modeling evaluation in the industry is to construct burial and heat flow history (1, 2 or 3D) models of the basin, and in turn maturation of the source rock(s) based on detailed kinetic models. A choice migration algorithm along with assumption of migration along faults and other discontinuities are used to make sure oil (or gas) enters our trap. Finally the volumes and type of fluids available for the proposed prospect are "predicted". Although arguments are usually around the sophistication of the methods, sensitivity and uncertainties of such a model, the prospect invariably looks good on the final presentation. The model matches maturity data from wells very well, and even the location of existing fields, so confidence is high. However, with all that effort, if we look back at the outcome of drilling these prospects in the last 20 of years, the vast majority of them (~70%) failed to find commercial hydrocarbons. For those that failed due to charge, there are simply three mechanisms, all related to migration: 1) Structure focusing, 2) Seal capacity and structure relief, and 3) Ultimate Expellable Potential (UEP) and migration loss.

Recognizing that these are the three main factors that control the possibility of a prospect receiving charge, our work would be more impactful if we could focus on evaluation of the factors, especially the ones with most uncertainty. Amongst the factors, the structure geometry and relief is usually better known and can be mapped, while seal capacity and migration losses are much less examined in the literature, when compared to such topics as kinetics and heat flow, which only partially address the volume expelled part of the second issue.

In recent years, we have developed a systematic approach to rank a prospect based on the probability of charge, by scenario testing of the key parameters within the likely range. These key parameters are rarely measured, but often can be calibrated indirectly with related observation in the basin we are working, and or geological analogs. When we deal with uncertainties in structure focusing, the role of faults can be unknown. By scenario testing whether faults can be lateral seals, and scoring the prospects based on how many scenarios they do or do not receive charge, we may arrive at the likelihood of the charge probability.

When looking at the seal vs structure closure mechanism, the geological model is first setup with the most likely seal capacity at each possible carrier level, and the migration model will either miss or charge our prospect. Then a number of scenarios of higher and lower cases of seal capacities are tested and in each scenario the different prospects are marked either as charged or not charged. This would lead to a probabilistic view of the prospects, and the prospects that receive charge in most of the scenarios will be ranked higher. If a prospect cannot get charged with reasonable range of seal capacity assumptions, it is deemed very high risk. Similarly, scenarios of migration losses can be used to assign charge probabilities to prospects. The source rock input, kinetics and thermal history also play a part in this exercise, but in most cases the overbearing control is migration loss. It is especially so when the source rock has a lower UEP, or less mature. The scenarios can also be constrained with the spatial distribution of known accumulations and their fluid types, as well as dry holes that may confirm charge failure.