Migration Loss, Lag and Fractionation: Implications for Fluid Properties and Charge Risk

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Abstract

In the past 30 years, much effort has been put into the understanding of HC generation processes, such as kerogen kinetics and the composition of HC generated. There has been much less work on and progress in the understanding of what happens to fluids during primary and secondary migration, especially the significant changes in bulk properties. In recent years, the availability of large (big) datasets, both in conventional and unconventional settings, once put in the context of the of the petroleum system and reservoir engineering principles, have allowed us to see patterns of fluid type and properties along migration pathways that are caused by physical and PVT changes during migration. Globally, oil accumulations occur more frequently up-dip, or up-section of gas condensate accumulations. The GOR and API gravity of oil pools increase with depth. A fill-spill, or fill leak sequence fed by fluids with increasing maturity may only be part of the reason. In addition, charge disequilibrium and fluid grading (lighter fluids at the top) in reservoirs promote the spilling of undersaturated fluid (with lower API and GOR) and leaking of lighter fluids. The relationship between bubble point pressure and GOR in PVT correlations also partly limits the GOR of up-dip and younger accumulations.In gas condensate dominated systems, drier gas with lighter condensate is often found in shallow, up dip reservoirs, whereas liquid rich pools are found only at higher pressures. This is opposite to a maturity driven system. The most significant limiting factor seems to be the dew point pressure and CGR relationship. Phase fractionation processes also exert significant control on the composition and bulk properties of the condensate resulting in lower gravity oil rims and oil shows in areas with only gas condensate discoveries. The significant volumes retained within, and in the vicinity

of, the source rock, demonstrated by the unconventional plays, together with the fill-spill and fill-leak processes, also cause significant time delay in fluids reaching younger and up dip traps (which do not necessarily need to be formed before HCs are generated). As basins continue to subside, the increase in total HC volume due to successive cracking of the retained fluids, and the contemporaneous loss of storage (diagenesis, compaction, etc.) for the fluids, provide a significant driving force for secondary migration and charging of recently formed traps long after the source has passed the oil generation window. Greater amounts of secondary migration may indeed happen post oil generation. Overall, younger reservoirs are charged more recently, and with earlier generated, lower maturity fluid. Discoveries of unaltered oils in very shallow reservoirs in some basins also support this hypothesis.

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