Migration Lag – What Is It & How It Affects Charge Risk & Fluid Properties

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ABSTRACT

Traditionally one of the main goals of petroleum system analysis is to determine timing of petroleum generation relative to timing of trap formation. The idea is that if the trap formed later than the oil generation phase, it may miss the oil charge, or capture the late gas phase rather than oil. In recent years, there have been many oil discoveries in reservoirs that are deposited after the main oil generation phase. It seems that there is a time lag between oil generation and charging of reservoirs. In many cases, such lag has been estimated to be between 5 and 20 million years. In this paper, we will examine the mechanisms for this apparent lag, and how we could account for it in assessing petroleum system risks. Once we understand how it works, we may see that the processes which cause the lag can significantly affect charge risk and fluid type prediction.

During hydrocarbon generation, the initial HC fluid generated is taken up by the source rock itself: by adsorption to the organic matter and partially filling the pore space in the source rock interval. Primary migration out of the source rock then happens. The lag time between the beginning of generation and primary migration (primary migration lag) depends on the rate of generation, and the volumes required to satisfy adsorption and saturation thresholds. Typically this may take about 10 to 20% of the entire duration of the hydrocarbon generation window, or more if the source rock has more reservoir like properties (inter-bedded silt stone, organic porosity, etc).

Once the oil enters the first carrier bed, some of the initial volume is used to establish the minimum saturation needed to continue migration, and some of it is used to fill the micro and macro traps before it reaches the potential trap we may drill. This time lag depends on the rate of generation (again), and the saturation and thickness of the "waste zone" formed by the micro traps, and the size and number of larger "traps" it has to fill before reaching our target trap. If the target trap is not at the first carrier level but shallower, then the oil has to vertically migrate some distance to reach our trap. In that process, it also has to fill the sand intervals between the first carrier bed and the trap to either spill point or seal capacity. Time will again be consumed as these intermediate traps are being filled. Observation and simple estimates will show this time can be very significant.

Globally, there is a distinct distribution of fluid types in many basins, that the deeper fields are more likely to be gas, and shallower fields are more likely oil. This is also true laterally that up dip traps are more likely oil and deeper traps in the basin enter are more likely gas condensates. I believe these are at least partially a result of the migration lag process.