Downward Migration, Theory and Application to Suez Rift Basin Petroleum System

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This work aims at explaining the combination of geological and physical processes that may induce downward migration in a basin, a phenomenon which is still debated among the community. Based on the example of the Pre-Miocene and Miocene sequence in Gulf of Suez, we propose 4 circumstances in which downward migration is possible: 1/ Juxtaposition of source rocks and older reservoirs along geological discontinuities such as faults; 2/ Juxtaposition of source rocks and older reservoirs along steep slopes (e.g. the flank of an anticline); 3/ “Fill and Spill” process (generated hydrocarbons saturating the source rock first, then reaching underlying formations if there is no other “escape way”); 4/ “Fill and Spill” process enhanced by the water flow and/or capillary process. Petroleum system modelling (using the Darcy’s Law) shows that in fact downward migration results in a combination of different processes. It proves that the Suez Rift Basin petroleum system is physically possible. This result is compatible with oil-source correlations (geochemistry). Complex downward migration paths are particularly sensitive to parameters which are not often properly constrained in sources rocks and in low porous carrier beds: petrophysical properties, fractures and faults distribution, facies distribution. Understanding downward migration requires cogent basin models fully integrating physics and geology.