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# The Value of Data Derived from Wellsite Gas Analysis in Petroleum Systems

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Traditional evaluation of fluids from wells has relied on analysis of samples from wireline or drillstem testing of wells. In the last few years this has been supplemented by sampling of wellsite gases using a mixture of more detailed compositional and isotope analysis.

Detailed compositional and isotope analysis of wellsite gases using closely spaced "isotube" samples has been used at a variety of scales to help solve issues from basin scale migration to definition of reservoir compartments. The examples reported here are from an offshore oil province, the Gulf of Suez, and an offshore gas basin, the deepwater Nile Delta in Egypt.

In the southern Gulf of Suez, the two primary source intervals are the Campanian "Brown Limestone" and Miocene "Lower Rudeis" formations. Downward migration of oil sourced from Brown Limestone, driven by higher overpressures in Lower Miocene section, is the main charge route for the large accumulations in older "Nubia" reservoirs. Where this pressure drive is absent, downward migration is not effective, leading to failure of underlying Nubia sandstone reservoirs. Understanding the pressure regime is essential to exploration successes and failures, but pressures are not always measured due to cost or time constraints.

Mudgas evaluations at the wellsite or via isotubes in the laboratory are sometimes the only method available for petroleum systems failure analysis. Fluids from the marine Class A (Type IIS) Brown Limestone are geochemically distinct from the Class B/DE (Type II/III) Lower Rudeis both in terms of gases and liquids. Gas compositions and isotopes can be used to define the upward or downward migration of Brown Limestone-sourced fluids as a consequence of the large isotopic shift between gases generated from the Brown Limestone and those generated from the Rudeis (up to 6 parts per thousand). Furthermore, the difference in maturity of reservoired Brown Limestone fluids and "in situ" generated Brown Limestone fluids drilled on the crest of structures is usually significant. The lack of downward migration is indicated by the presence of mature Brown Limestone-sourced fluids (reflected by gas compositions and isotopes) in the Lower Miocene section and/or the absence of mature Brown Limestone fluids in Nubia reservoirs and the intervening Nezzazat formation.

Raven field in the Nile Delta comprises gas condensate trapped in complex structural and stratigraphic traps. The reservoir section consists of a series of Langhian (Early Miocene) channelized turbidites which progressively infill an older erosional channel. A series of sands interpreted as individual channel complexes make up the overall reservoir system. The top seal to the reservoir is a composite surface comprising the abandonment facies of turbidite infill to the main erosional channel. A detailed program of analysis of isotube samples (every 3m through reservoir section, every 10m through pre-Messinian section and every 20m through Plio-Pleistocene section) was used in conjunction with wireline and drillstem test samples to define fluid variations. The high resolution of the sampling allows a clear interpretation of the positions of leakage from the two main Langhian reservoirs (penetrated in crestal positions by the Raven 1 and Raven 3 wells) and the continuation of that leakage vertically into Plio-Pleistocene section. The data also clearly show this leakage is the source of fluids in overlying Serravallian and Tortonian reservoir section and helps identify the position of the sealing section in the overburden.

Wellsite gas data define a fluid fill model for the Langhian via vertical leakage from the pre-Langhian section at the crest of the field followed by downbuilding of the gas column into the flanks of the field. Compositional and isotube data suggest a series of compartments in the Langhian section roughly equivalent to each of the main channelized turbidite infills even though initial pressure data shows one gas gradient across all the reservoir section in the gas leg. An extended DST confirmed the compartments described by the variations in wellsite gas data.

The keys to success in using of wellsite gas data are;- high sampling density; analysis of isotopes from C1 through C4; and confirmation via comparison to wireline sampling that the wellsite data is a good representation of reservoired fluids. The high sampling density allows some redundancy in the data and at reservoir scale allows enough data in any one reservoir compartment to allow for robust interpretations. Collection of both Carbon and Deuterium isotope data for C1-C4 fractions allows a robust interpretation of the sources of gases and unmixing of various end member sources.