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FACTORS CONTROLLING HYDROCARBONS HABITAT IN THE INTRACRATONIC PALAEOZOIC BASINS OF NORTH AFRICA (ALGERIA, TUNISIA, LIBYA)

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An exploration model, with main input parameters such as the preserved Palaeozoic type section, producing reservoirs, their optimal depths and factors controlling hydrocarbon distribution for each play, is presented. The proposed model is based on analysis of past exploration experience which can be used in early exploration phase, to evaluate new open acreages. It helps explain variations in reservoir quality and productivity across the area of study.

The Palaeozoic intracratonic basins (Murzuk, Ghadames, Mouydir-Oued Mya, Ahnet-Timimoun) have similar regional geology, but hydrocarbon richness varies widely across them, depending on the influence of factors such as the reservoir facies/diagenetic transformation, the tectonic erosional effect on the source rocks distribution and their communication with reservoirs, the thermal maturity evolution and timing of oil generation compared to Hercynian, Austrian and Pyrenean inversion.

The Ordovician reservoirs are very productive in the Murzuk, Illizi and Ahnet Basins, and are present as sandy glacial to periglacial sediments deposited in erosional palaeovalleys. Hydrocarbon charging occurs through cross-fault juxtaposition of the lower Silurian source rocks and the Ordovician reservoirs. Exploration success decreases rapidly northwards in deeper areas, where facies passes to more shaly marine deposits.

The Silurian fairways extend mainly along a SW-NE trend, coinciding with an intrabasinal Caledonian palaeohigh, extending from Illizi (Algeria) to the NW part of the Libya. Oil fields are located in areas not touched by the Caledonian erosional phase, with high sand content and effective intraformational seals. In the Southern flank of Ghadames Basins, the Silurian has been deeply eroded during the Caledonian phase, leading to direct communication between the Silurian lower Akakus reservoirs and the overlying lower Devonian Tadrart sands. As a result the Silurian reservoirs often lack a seal. In Illizi (Algeria), for the oil finds, the seal is provided here on unconformity by Upper Devonian seals, the lower Devonian having been removed by the Frasnian erosion. Over El Biod Arch, the Silurian and Triassic reservoirs have common oil-water contact (R. Nouss field).

The lower Devonian, principally the Tadrart reservoir, is very prolific over the southern flank of Ghadames-Illizi and the Ahnet basins, where they are constituted by a sandier facies and improved petrophysical properties. Reservoir quality deteriorates towards the northern deepest parts of these basins, where open marine shale prone and diagenetic transformation predominate. Additional factor for the local structures to be productive is the presence of significant faulting,

allowing the hydrocarbons charging from the deeper Silurian source. Lower Devonian reservoirs are unproductive when partially eroded and not sealed by the Upper Devonian-Carboniferous rocks.

The Middle-Upper Devonian reservoirs are more gas prone, productive essentially in the central part of the Ghadames-Illizi basin, areas not touched by the Hercynian erosional phase. Reservoir quality is considerably lower and more irregular than in the Lower Devonian.

For the Triassic play, hydrocarbon distribution is controlled by regional facies variations, the topography of the Hercynian Unconformity surface and the presence of the salt-anhydritic seal. Productivity is maximized in the areas where the sands were deposited as laterally continuous braided fluvial sand sheets, supplied from the Talemzane, and El Biod (for Oued Mya Basin), the El Biod, Dahar and Naffusah (for Ghadames basin) major Palaeohighs. Quality deteriorates rapidly towards the northeastern deepest part of Oued Mya and Ghadames basins, where conditions of deposition change to meandering fluvial system flowing SW to NE. The topography developed on the Hercynian Unconformity seems to form an important control on migration patterns. Most major Triassic oil/gas fields are located over palaeohighs on the unconformity surface. The largest number of fields occurs in areas where the Triassic reservoirs are in contact with, or in close stratigraphic proximity to, the Silurian source.

The distribution of oil volume across the Oued Mya and Ghadames basins vary according to various stratigraphic relationship resulting from the Hercynian erosion pattern. The number of discovered oil finds versus the degree of the Hercynian erosion has been statistically analyzed, indicating that the productivity of the Ordovician and Devonian reservoirs is maximal (84 and 95 % respectively, from total discovered fields) where the preserved Palaeozoic section is complete, up to the Carboniferous. The largest number of Silurian oil pools (70 %) is located in areas with Palaeozoic section, up to Devonian. For the Triassic reservoirs, the most productive areas (65 %) are where the Palaeozoic rocks have been eroded up to Silurian. So, in given area, there is a relationship between the producing reservoir and the Palaeozoic type section, present under the Hercynian unconformity. This relationship may be used as an exploration tool to predict the expected producing play, knowing the Palaeozoic type section, present in the evaluated area.