

СЕКЦИЯ «ИННОВАЦИОННОЕ ПРИРОДОПОЛЬЗОВАНИЕ»

Reservoir characterization of the Aouinet Ouenine Reservoir In The Wafa Gas Field, Ghadames Basin, Libya

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The aim of my work is understanding the structural configuration and general stratigraphy of the Ghadames Basin, describing petroleum systems within the basin and investigating the petrophysical characteristics of the reservoir of the Wafa Gas Field. The studies include evaluation of reservoir characteristics (porosity, permeability, volume of shale), as well as estimation of reserves within the field.

The Ghadames Basin is a large intracratonic basin, covering portions of Algeria, Tunisia and Libya, and extending over 350000 km². The basin contains up to 6 000 m of Palaeozoic and Mesozoic sediments. Paleozoic-Mesozoic stratigraphic sequence of the Ghadames Basin is characterized by dominance of terrigenous successions.

Two sedimentary megacycles, respectively of Paleozoic and Mezo-Cenozoic age, are divided by a major angular unconformity of Hercynian age. In some cases, the Cenozoic sequence overlies a pre-Hercynian section of the Paleozoic sequence due to the Hercynian uplift that resulted in the Hercynian section being peneplained. The older megacycle (Paleozoic) is mainly terrigenous and contains the main hydrocarbon bearing targets of the basin: the Tahara, Aouinet Ouenine, Ouan Kasa, Tadrart Formations of Devonian age, the Akakus Formation of Silurian age and the Memouniat Formation of Ordovician age. The younger cycle (Mesozoic-Tertiary) mainly consists of siliciclastic and carbonate rocks, which, due to the absence of the cap rock and the lack of sufficient burial depth, are not prospective for hydrocarbon exploration in this region.

Two main potential source rocks are present in the Paleozoic sediments of the Ghadames Basin: the basal shaly member of the Tanezzuft Formation (Lower Silurian) and the Aouinet Ouenine formation (Late Devonian). Geochemical analysis suggests that the maturity conditions for hydrocarbon generation and expulsion were most likely reached in the Middle-Late Jurassic and, probably, lasted until the Late Cretaceous.

Main reservoir rocks within the basin are located within Silurian (Lower Akakus) that is representing the main producing unit in Libya. The Lower Akakus and equivalent reservoirs show maximum sand development on the southern flank, passing progressively into a more shaly facies in central and northwestern areas. Two reservoir units are present within the Lower Devonian, the Tadrart and Wan Kasa Formations. The Tadrart reservoir can be correlated throughout the basin, and consists in practically all areas of clean, medium- to coarse-grained sandstones deposited as widespread channeled sheets. The Ouan Kasa Formation is more difficult to correlate, because of facies changes and the erosional effects of a mid-Devonian (Frasnian) unconformity.

Top seal for the Lower Akakus sandstone reservoir is provided by shales within the Akakus which are persistent over a large area in the north-central part of the basin. Tadrart reservoir

is sealed by the shales of the Wan Kasa Formation and the overlying Emghayet Shale. The Hercynian unconformity locally forms a seal where overlain by Triassic.

The main trap type in the Ghadamis Basin is structural, although stratigraphic traps are also present, particularly beneath the Hercynian Unconformity traps formed by normal faults generated during the Hercynian orogeny and which may represent reactivated basement faults.

Wafa Gas Field is located along the Libyan-Algerian border in the south-western part of the Libyan side of the Ghadames basin, about 100 Km to the south of the city of Ghadames. Structurally, the field lies on the southern flank of the basin. Structurally the Wafa reservoir is formed by a stratigraphic pinch-out trap as part of a monocline dipping towards the northwest and covers the area of about 1000 km².

Although the first discovery well, D1-52, was drilled back in 1964, it is only in 1991 that the Wafa Field was discovered by well A1-NC169 that successfully tested hydrocarbons in the Middle Devonian sandstones (Aouinet Ouenine Fm). From that year until 1999, 11 more wells were drilled in the area as a part of an appraisal campaign.

The Wafa Gas Field has gas-oil contact at 6392-6396 sub sea ft and water-oil contact at 6454-6466 ft sub sea. The Net pay thickness of the reservoir is variable and ranged from 87ft to 166ft. In the studied wells, porosity of the reservoir is ranges from 11% to 13%. Water saturation ranges from 11 % to 20%.

In an attempt to meet the aim of this study all available data were used including the base map and wire line log data. The logs used include electrical resistivity, density log, gamma ray, sonic log and neutron log. These logs were used in correlation and construction of structural maps and stratigraphic cross-sections, net pay thickness and hydrocarbon per volume.

The reservoir rock in the Wafa field is the basal portion of the Aouinet-Ouenine formation (the F3 sandstone) of middle Devonian (Givetian) age deposited in a shallow marine offshore barrier bar environments and characterized by a typical coarsening upward sequence. The table below illustrates the results of the reservoir properties.

Литература

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Иллюстрации

No	Well No.	Top (ft)	Bottom (ft)	Thickness (ft)	porosity	Porosity %	Sw	Sw%	Net Pay(ft)	HPV	fluid type
		S.S	S.S								
1	A44	-6234	-6341	107	0.12	12	0.12	12	96	10.1376	gas
2	A37	-6268	-6378	110	0.13	13	0.11	11	123	14.2311	gas
3	A29	-6135	-6297	162	0.11	11	0.11	11	133	13.0207	gas
4	A25	-6144	-6278	134	0.12	12	0.13	13	110	11.484	gas
5	A33	-6241	-6374	133	0.12	12	0.16	16	102	10.2816	gas
6	A15	-6304	-6450	146	0.12	12	0.15	15	87	8.874	gas
7	A24	-6313	-6477	164	0.13	13	0.13	13	90	10.179	gas
8	A20	-6372	-6525	153	0.13	13	0.11	11	120	13.884	gas/oil
9	A1	-6349	-6492	143	0.13	13	0.14	14	142	15.8756	gas
10	A2	-6163	-6267	104	0.13	13	0.13	13	104	11.7624	gas
11	A3	-6342	-6484	142	0.13	13	0.12	12	142	16.2448	gas/oil
12	A4	-6407	-6555	148	0.09	9	0.2	20	148	10.656	oil
13	A6	-6394	-6525	131	0.09	9	0.25	25	131	8.8425	oil
14	A7	-6297	-6438	141	0.1	10	0.17	17	141	11.703	gas
15	A8	-6299	-6422	123	0.1	10	0.18	18	123	10.086	gas
16	A16	-6356.5	-6556.5	200	0.13	13	0.14	14	152	16.9936	gas/oil
17	A17	-6306	-6556	250	0.12	12	0.14	14	162	16.7184	gas/oil
18	A32	-6334	-6605	271	0.13	13	0.16	16	166	18.1272	oil

Рис. 1: The table illustrates the results of the reservoir properties.