Volume: 2 Issue: 1 Year: 2024
ISSN: 2992-894X | http://journals.proindex.uz

On the Oil and Gas Potential of the Assakeaudan Trough of the Ustyurt Region

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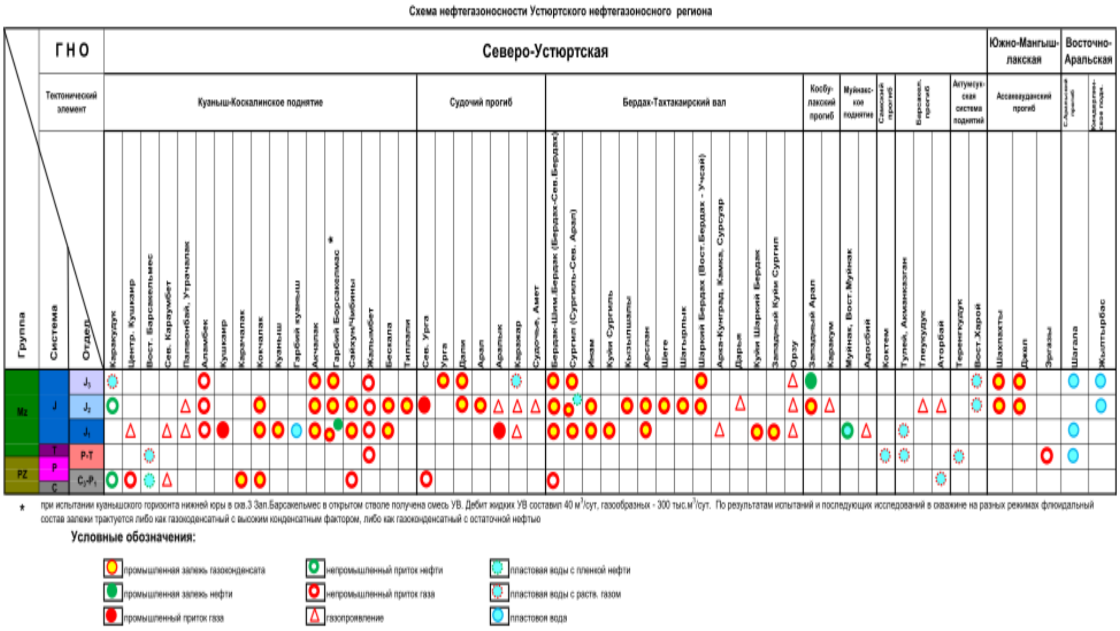
Abstarct: This article discusses the features of the formation of hydrocarbon deposits and the stratigraphic features of the oil and gas potential of the Assakeaudian trough.

Based on the drilling data, a structural map and a thickness map were compiled, and correlation schemes were analyzed to clarify the structure of the studied territory. Discovering productive horizons based on research results presents the greatest difficulties. In almost all fields of the Assakeaudian trough, opening and drilling in productive formations were carried out with a significant excess of bottomhole pressure over reservoir pressure. The possibility of absorption occurring and its intensity depend not only on the excess of the bottomhole pressure over the formation pressure, but also on the reservoir properties of the rocks, on what the reservoir is filled with.

Key points: deposits, hydrocarbon, geological structure, Jurassic deposits, oil and gas potential, deposits, trap, structural type, trough, fold, lithological wedges, stratigraphic unconformity.

As of 01/01/2023 In the Ustyurt region, 27 gas condensate and gas fields have been discovered, 14 of them are located in the North Ustyurt syneclise, two in Southern Ustyurt. Hydrocarbon deposits have been identified in a wide stratigraphic range – from the Lower Carboniferous to the Upper Jurassic inclusive [Picture.1].



Picture.1. Scheme of oil and gas potential of the Ustyurt region (according to M.G. Yuldashev)

The proven regional industrial productivity of Jurassic and Upper Paleozoic formations of the Ustyurt region indicates the possibility of discovering deposits within the Assakeaudan trough.

The total area of the Ustyurt oil and gas region is 113 thousand km2, in general, the estimated total reserves of hydrocarbons D1+D2 for Jurassic and Paleozoic fields amount to 2220.5 million tons of standard fuel, estimated natural gas resources. 1.94 trillion cubic meters m, condensate – 179.6 million tons, oil – 101.2 million tons.

The territory of the Ustyurt region borders on three oil and gas regions: North Ustyurt, South Mangyshlak and East Aral, which have the peculiarities of geological structure: the vertical section consists of a Precambrian crystalline basement, an intermediate Paleozoic stage and a sedimentary cover.

The study area with an area of 2972.0 km2 includes the lands of the Assakeaudan trough and the Batpak swell [Fig. 2].

According to oil and gas geological zoning, the study area is divided into Assakeaudan, Batpak and North Assakeaudan gas and oil regions (GNR).

The Batpak GNR is elevated relative to the Assakeaudan and North Assakeaudan and is characterized by a reduced thickness of Jurassic deposits. The Jurassic is represented by all departments, but the thickness of the Lower Jurassic is small - 70–157 m (Kossor, East Assakeaudan), while in the Assakeaudan GNR in the Kindyksay area the thickness of the Lower Jurassic is 237 m.

The estimated hydrocarbon resources were assessed for all sections of the Jurassic and pre-Jurassic rock complex, and the calculations were made using the recommendations of the “Methodological Guide for the Quantitative Assessment of Oil, Gas and Condensate Resources.” To assess the predicted hydrocarbon resources in pre-Jurassic deposits, a volumetric-statistical method was used; for Jurassic deposits, methods of averaged structure and geological analogy (specific densities) were used.

Since there are no identified deposits in the study area, data from the Shakhpakhty GNR with the Shakhpakhty deposit served as a standard for Middle and Upper Jurassic deposits. To calculate oil and gas resources for the Lower Jurassic in the southern part of the Assakeaudian trough, reserve densities were used in the reference area of the Kuanysh-Koskalinsky GPR of Northern Ustyurt.

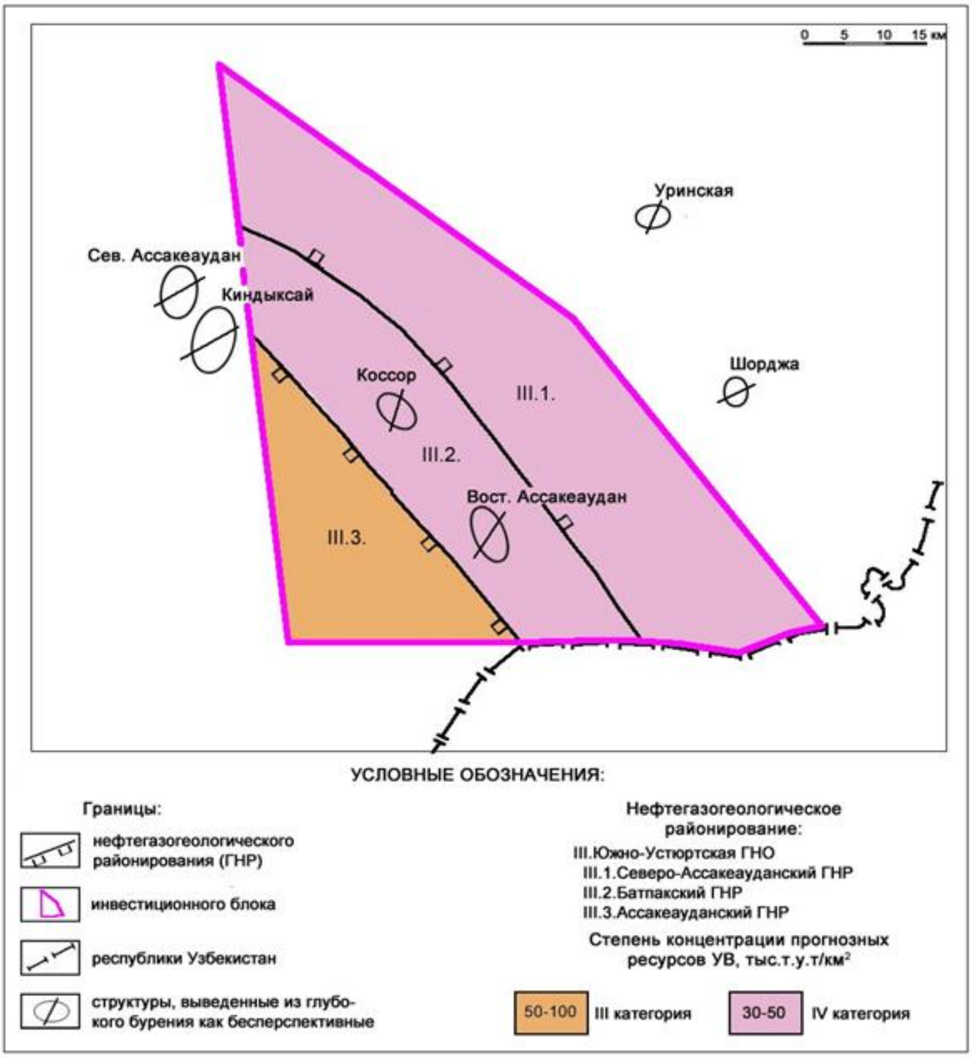
The predicted hydrocarbon resources for the pre-Jurassic complex, calculated using the volumetric statistical method, are shown in Table 1 and are: free gas - 36.3/30.8 billion m3, oil - 9.0/2.3 million tons and condensate - 7.3/ 4.7 million tons. The calculation of predicted hydrocarbon resources in Jurassic deposits was carried out using two methods.

The first is the specific density method [3; p.168], with the use of which the forecast hydrocarbon resources amount to 105.9/89.7 million tons of fuel equivalent, including for the Lower Jurassic - 4.5/3.4 million tons of fuel equivalent, Middle Jurassic - 18, 7/15.7 million tce and Upper Jurassic - 82.7/70.6 million tce. The second method based on the averaged structure, using which the predicted hydrocarbon resources are calculated in the amount of 99.4/83.8 million tce, for the Lower Jurassic complex - 3.0 /2.2 million tce, Middle Jurassic - 16.3/13.7 million tce and Upper Jurassic 80.1/67.9 million tce.

Predicted gas resources have been calculated for all sections of the Jurassic, oil – for the Lower Jurassic and pre-Jurassic complexes.

The density of distribution of forecast hydrocarbon resources in the study area as a whole is characterized by a value of 54.2 thousand t.t./km2, including in the following regions: North Assakeaudansky - 46.3 thousand t.t./km2, Batpaksky - 47, 3 thousand tu.t./km2 and Assakeaudansky – 88.6 thousand tu.t./km2.

The distribution of predicted hydrocarbon resources by density in the block territory is shown on the map of oil and gas potential prospects.



Picture.2. Map of the prospects of the Assakeaudan trough (according to A.Kh. Nugmanov, 2009).

Characteristics of oil and gas deposits.

Shakhpakhty gas field. Administratively, the Shakhpakhty field is located on the territory of the Kungrad district of the Republic of Karakalpakstan, 220 km southwest of the city of Kungrad. The nearest main dirt road runs 150 km north of the deposit.

Tectonically, the Shakhpakhty structure is located in the central part of the tectonic step of the same name, complicating the northern side of the Assakeaudan trough.

The structure was identified in 1958 by a geological survey [scale 1:200000], and prepared in 1963 by structural drilling in Paleogene and Cretaceous deposits.

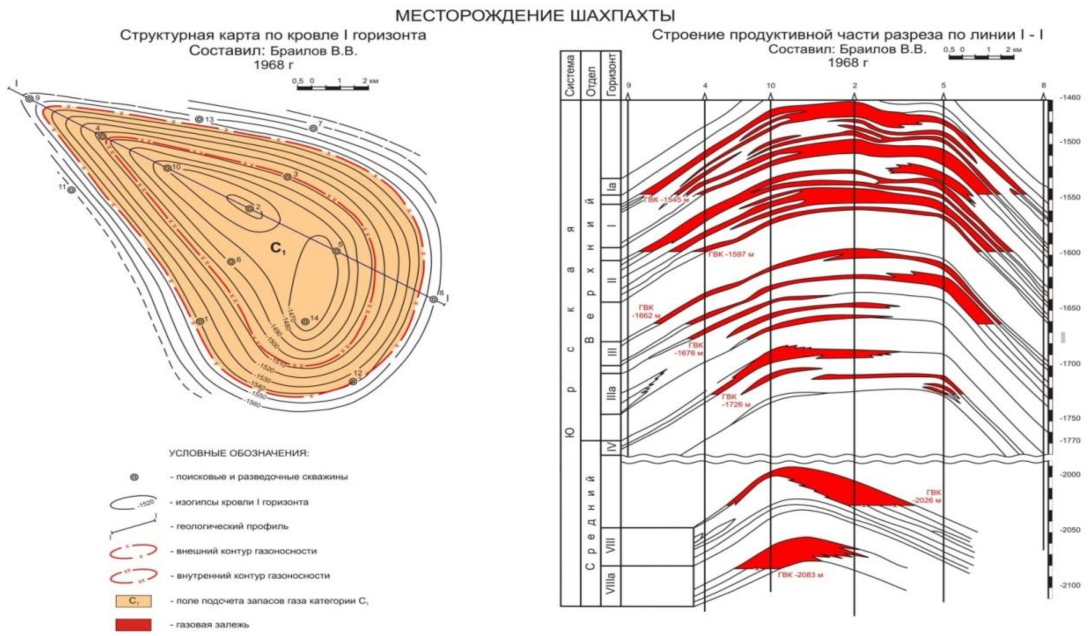
In 1963, drilling of parametric well No. 1 began. In 1965, when testing exploratory well No. 2, commercial gas inflows were obtained from Upper Jurassic deposits. Exploration well No. 2 was the pioneer of the Shakhpakhty field.

A total of 15 deep wells were drilled at the field, including 2 parametric, 3 prospecting and 10 exploratory wells; the volume of deep drilling amounted to 36,366 m. 1,084.0 linear meters were covered by core drilling along productive horizons. m, while 494.0 linear meters were selected. m of core. Of the 346 selected samples, 174 characterize the reservoir rock. The exposed section at the Shakhpakhty field is represented by rocks of Permo-Triassic, Jurassic, Cretaceous, Paleogene, Neogene and Quaternary ages.

In 1968, gas reserves were calculated for the Shakhpakhty field (Brailov V.V., Shulzhenko L.A., Safonov S.I., etc.) with their approval in geocosmic sounding of the earth (GKZ).

The model of the Shakhpakhty field on the top of the first horizon of Upper Jurassic deposits (isohypsum -1550 m) is a brachyanticlinal fold with a narrow and elongated northwestern pericline and a wide southeastern one. The vault of the structure is complicated by two domes. The first is located in the area of the well. No. 2, and the second - in the area of well. Nos. 5 and 14. With depth, the second dome is localized in the area of the well. No. 14, and well. No. 5 gravitates towards the first dome. The dimensions of the structure are 16.5 x 10.0 km, height – 88 m (Fig. 3).

Gas flow rates range from 74.48 thousand m3/day through a 12.7 mm fitting (well No. 5) to 478.87 thousand m3/day through a 19.05 mm fitting (well No. 2). Types of deposits – strata dome. Deposit sizes range from – 7 x 4 km to 15.5 x 8 km; gas-bearing levels - from 21 to 88 m. Average gas-saturated thicknesses vary from 2 to 9.4 m. In terms of reserves, the deposit is classified as large, with a complex structure.



Picture.3. Structural map and geological profile of the Shakhpakhty deposit.

Gas condensate field Dzhel.

Administratively, the Jel field is located within the Republic of Karakalpakstan. The nearest populated area is the Kyrgyz railway station, located 165 km northeast of it. Orographically, the work area is a typically desert area. Absolute elevations of the area range from 110 to 190 m above sea level.

The Dzhel structure was identified based on the results of CDP 2D seismic exploration in 2007–2008. It partially coincides with the previously (1965–1980) studied Western Shakhpakhty object, and in 2008 it was prepared and transferred for deep exploratory drilling. In 2008, drilling of exploratory well No. 1 began, during testing of which in 2009 commercial gas inflows were obtained from Jurassic deposits. The structure was included in the category of fields in 2009. In total, 10 wells were drilled at the Dzhel field (taking into account the area of Western Shakhpakhty), of which 4 (No. 1, 2 Dzhel and No. 1, 6 Western Shakhpakhty) are exploration wells, with a total footage of 1,1352 m , and 6 wells (No. 3, 4 Dzhel and No. 2, 3, 4, 5 Western Shakhpakhty) - exploration, with a total footage of 15194 m. Of the 10 drilled wells, 5 (No. 1, 2, 3, 4 Dzhel and No. 2 Western Shakhpakhty) – found themselves in the gas-bearing contour. Of the ten wells, 6 (No. 1, 2, 3,4, 5, 6 Western Shakhpakhty) were abandoned, 4 (No. 1, 2, 3, 4 Dzhel) were mothballed.

The exposed section at the Dzhel field is represented by rocks of Permo-Triassic, Jurassic, Cretaceous, Paleogene, Neogene and Quaternary ages.

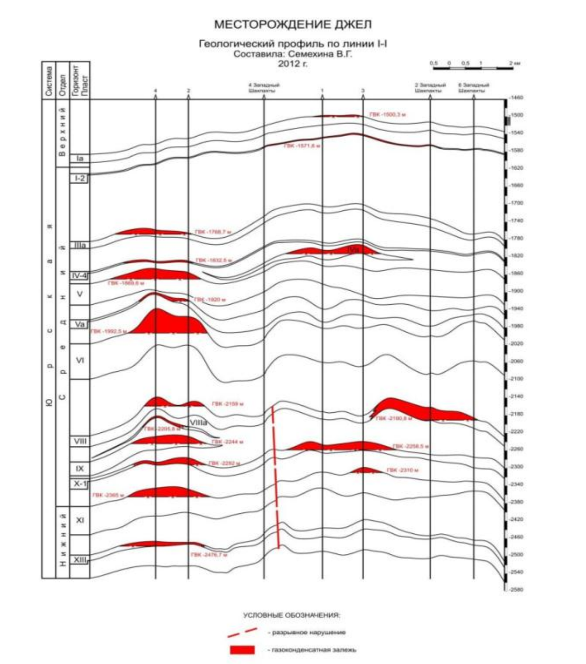
Tectonically, the Dzhel field is located within the western part of the Shakhpakhty stage of Southern Ustyurt.

At the top of the reservoir of the productive X-1 horizon, the Dzhel structure is a brachyanticlinal fold of northwestern strike, complicated by two (northern and central) domes. The dimensions of the structure along the isohypsum - 2300 m are: length -12.1 km, width -3.6, height - more than 70 m (Fig. 4). The southwestern wing of the structure is steeper than the northeastern one. The central dome is complicated by a series of faults. On the roof of the VIII horizon there are 3 domes - northern, central, and southeastern.

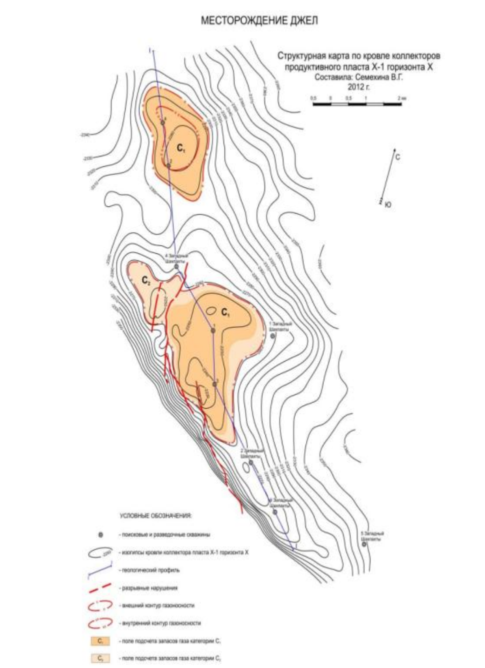
At the Dzhel field, industrial gas content was established in sediments: Lower Jurassic age - XIII-1 and XI horizons; Middle Jurassic – X-1, IX, VIIIa, VIII, VI, Va, V, IVa, IV-4, IIIa, I-2 horizons; Upper Jurassic – Ia horizon.

Gas flow rates ranged from 5.75 thousand m3/day at a 2 mm choke (well No. 3, XIII horizon) to 417.2 thousand m3/day at a 16.3 mm choke (well No. 1, X horizon). The gas-water contact varies from -1500.3 m (Ia horizon, central dome) to -2476.7 m (XIII-1 horizon). The dimensions of gas deposits vary within the range: from length 1.9 km, width 1.0 km, height 2 m (1a horizon, central dome) to length 4.1 km, width 2.4 km, height 30.5 m (1 -2 horizon, central dome).

Types of deposits: strata-massive - within the northern dome - XI, X, IX, VIII, V horizons, within the central dome - XI, X horizons; layered - within the northern dome - XIII-1, VIIIa, VI, Va, IV-4 horizons, within the central dome - Ia, I-2 horizons; layered, lithologically screened - within the southeastern dome of the VIII horizon; strata, tectonically limited - within the central dome of the IVa horizon; strata-water – within the northern dome of the IIIa horizon. Reservoir pressure varies from 154.7 atm (Ia horizon, central dome) to 245.5 atm (XIII-1 horizon, northern dome).



Picture.4. Geological profile along line 1-1 of the Dzhel deposit (Compiled by V.G. Semenova 2012)



Picture.5. Structural map of the Dzhel field

Effective gas-saturated thicknesses vary from 0.9 m (Ia horizon, central dome) to 11.7 m (XI horizon, northern dome). Open porosity coefficients range from 0.12 (Ia horizon, central dome) to 0.20 (V horizon, northern dome), gas saturation coefficients range from 0.48 (IIIa horizon, northern dome) to 0.69 (VIII horizon, northern and southeastern dome).

The gases of the Upper Jurassic deposits (Ia horizon) are dry, low carbon dioxide, low sulfur, low nitrogen. The molar fraction of components in the gas is (%): methane – 90.29; ethane – 2.45; propane – 0.69; butane – 0.56; pentane and higher – 0.17; carbon dioxide – 1.21; nitrogen + rare – 4.63. The gas density (in air) is 0.741 g/cm3.

The gases of the Middle Jurassic deposits (I-2, IIIa, IV-4, V, Va, VI, VIII, VIIIa, IX, X-1 horizons) are dry, low-carbon dioxide, low-sulfur, low-nitrogen. The molar fraction of components in the gas is (%): methane – 90.69–92.84; ethane – 1.94–3.06; propane – 0.39–1.45; butane – 0.07–1.59; pentane and higher – 0.06–0.37; carbon dioxide – 0.34–2.21; nitrogen + rare – 2.34-4.78. The gas density (in air) is 0.723–0.744 g/cm3.

The gases of the Lower Jurassic deposits (XI, XIII-1 horizons) are dry, low carbon dioxide, low sulfur, low nitrogen. The molar fraction of components in the gas is (%): methane – 91.59–92.43; ethane – 2.08–2.30; propane – 0.45–0.54; butane – 0.18–1.26; pentane and higher – 0.11–0.215; carbon dioxide – 0.52-1.61; nitrogen + rare – 2.75–3.98. The gas density (in air) is 0.729–0.737 g/cm3.

Condensates of Middle Jurassic deposits (1-2, IIIa, IV-4, V, Va, VI, VIII, VIIIa, IX, X-1 horizons) are medium-heavy, sulfurous. The potential content of condensates in the reservoir gas is 3.51–28.07 g/m3, and its recovery factor is 0.9. The molar fraction of components in the condensate is (%): sulfur 0.035–0.22; paraffin – 0.19–4.98; silica gel resins – 0.04–3.38. The density of the condensate is 0.734–0.790 g/cm3.

The condensates of Lower Jurassic deposits (XI, XIII-1 horizons) are medium-heavy, sulfurous. The molar fraction of components in the condensate is (%): sulfur – 0.15–0.42; paraffin – 1.14–2.94; silica gel resins – 0.09–1.42. The density is 0.770–0.786 g/cm3.

As of January 1, 2018, the Dzhel field is in the exploration category.

Conclusion.

In terms of the degree of established oil and gas content of the Lower Jurassic deposits, the leaders are Shakhpakhty and Dzhel, shafts with open fields, then the territories of Ergazy and Eastern Assakeaudan, where direct and indirect signs of gas content and the need for further exploration are noted.

The industrial productivity of Lower Jurassic deposits has been proven in the central part of the Assakeaudan trough (on Shakhpakhty and Dzhel), the maximum gas flow rates were obtained from depth intervals of -1500.3–2476.7 m.

The oil and gas potential of the studied area was analyzed, and it was found that basically all hydrocarbon deposits were identified in the upper and middle Jurassic sediments. Deposits that are in the process of development and structures at the stage of deep drilling have been clarified. Objects were identified and recommendations were proposed for further geological exploration activities.

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