Lithologic-facies and paleogeographic features of Mid-Upper Jurassic oil-gas bearing sediments in Nurolsk depression (Western Siberia)

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Abstract. Bathonian-Callovian-Oxfordian sedimentation environment reconstruction in SE Nurolsk depression, Western Siberia has been described. Paleogeographic and litho-geochemical features of sediments, numerous plant remains and ichnofossils indicated the fact that this territory during the Naunaksk suite formation was the transition in-situ sedimentogenesis. Based on the integrated research data, the potential litho-facies were identified in the Mid-Upper sediments within Nurolsk depression, Western Siberia.

1. Introduction

The relevant research target involves Bathonian-Callovian-Oxfordian sediments in the Naunaksk suite, comparable to other petroleum-bearing mid-Jurassic sediments in SE Nurolsk depression, West Siberia. The research area is very composite for areal layering and correlation due to the lenticular lithological bodies being governed by transition sedimentogenesis [5]. Although intensive referencing and publications have been conducted on the subject of the Naunaksk suite composition and structure, there still exists unresolved issues concerning the specific features of this suite, the influence of sedimentation and post-sedimentation factors on reservoir properties (porosity and permeability).So far, no consideration has been given to the geographical relation of the Naunaksk suite to the marine analogue-Vasugan suite [4]. There are disputable points in determining the formation conditions of above-mentioned suites.

According to the structural-facies zoning of West Siberian Callovian and Upper Jurassic, only the southernmost Nurolsk depression areas are within the transition sedimentogenesis zone: from Vasugan to Naunaksk suites. Based on the contemporary concepts of paleogeographic environment, Vasugan suite in SE Nurolsk depression was formed in Bathonian-Callovian-Oxfordian period, and this territory was the location of early marine sedimentogenesis. However, the lithological and paleontological features in the S-E Nurolsk depression reflect the transition sedimentogenesis conditions during the formation of the Naunaksk suite itself.

2. Research data

The basic research material was the deposits in the exposed wells: Maiskaya (№ 228, 379, 393, 568, 569, 572, 573, 698, 704), Western Maiskaya (№ 10), Central Maiskaya (№ 715), Eastern Maiskaya (№ 1) and Southern Maiskaya (№ 5, 309, 400, 410) areas in the S-E Nurolsk depression. All in all, 16 wells were investigated, six of which were located in Naunaksk suite. Besides, paleobotanic remains and ichnofossils were found in six wells (Maiskaya area- wells № 572, 573, 393; Southern – Maiskaya - wells № 309, 400, 410) (figure 1).

Biostratigraphic, litho-petrographic, geochemical, fluorescence microscopy, X-ray fluorescence methods were applied in the paleogeographic reconstruction and effective prediction of natural petroleum reservoirs via core analysis, and further geophysical logging interpretation.

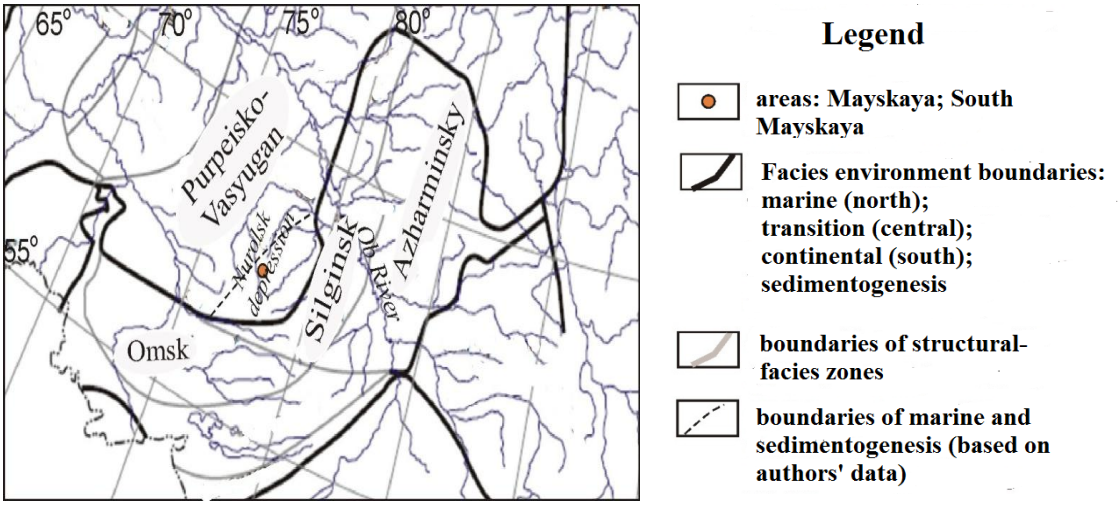

Figure 1. Structural-facies zoning of West Siberian Callovian and Upper Jurassic [3].

3. Research results

Based on the integrated investigation, the observed sediments were described and the following litho-facies groups were identified: silt-mudstones, aleurolites and sandstones. Bathonian-Callovian-Oxfordian rocks embrace the Naunaksk suite and are confined to the intervals with specific well logging-based characteristics, as well as are controlled by orthostratigraphic fauna.

Silt-mudstones are gray-black with laminated structure, distinct interrupted dark-gray aleurolite laminae. The rocks are enriched by carbonaceous wash-outs. There are fern imprints: *Coniopteris simplex, C. depensis, C. vialovae, C. latilobus, Raphaelia diamensis*; seed fern imprints: *Czekanowskia* sp., *Nilssonia urmanica;* pine imprints: *Podozamites eishwaldii*. Large-sized carbonized equisetaceous plant remains, the trunk width of which is more than the core diameter (95.0 mm), could be observed in the sediments.

The bulk mass of silt-mudstones is composed of hydromicas with impurities of fine-grained aleuritic fragments. Clastics include poorly-rounded quartz and feldspar grains. X-ray structure analysis results showed corroded quartz grains and feldspar partially substituted by quartz and kaolinite. These rocks embrace insignificant amount of bituminous matter including predominately resinous epibitumen (brownish luminescence), irregularly distributed throughout the rock mass. Resin-asphaltine bitumen (dark-brownish luminescence) is confined to micro-fractures, oriented by sublateral bedding (figure 2).

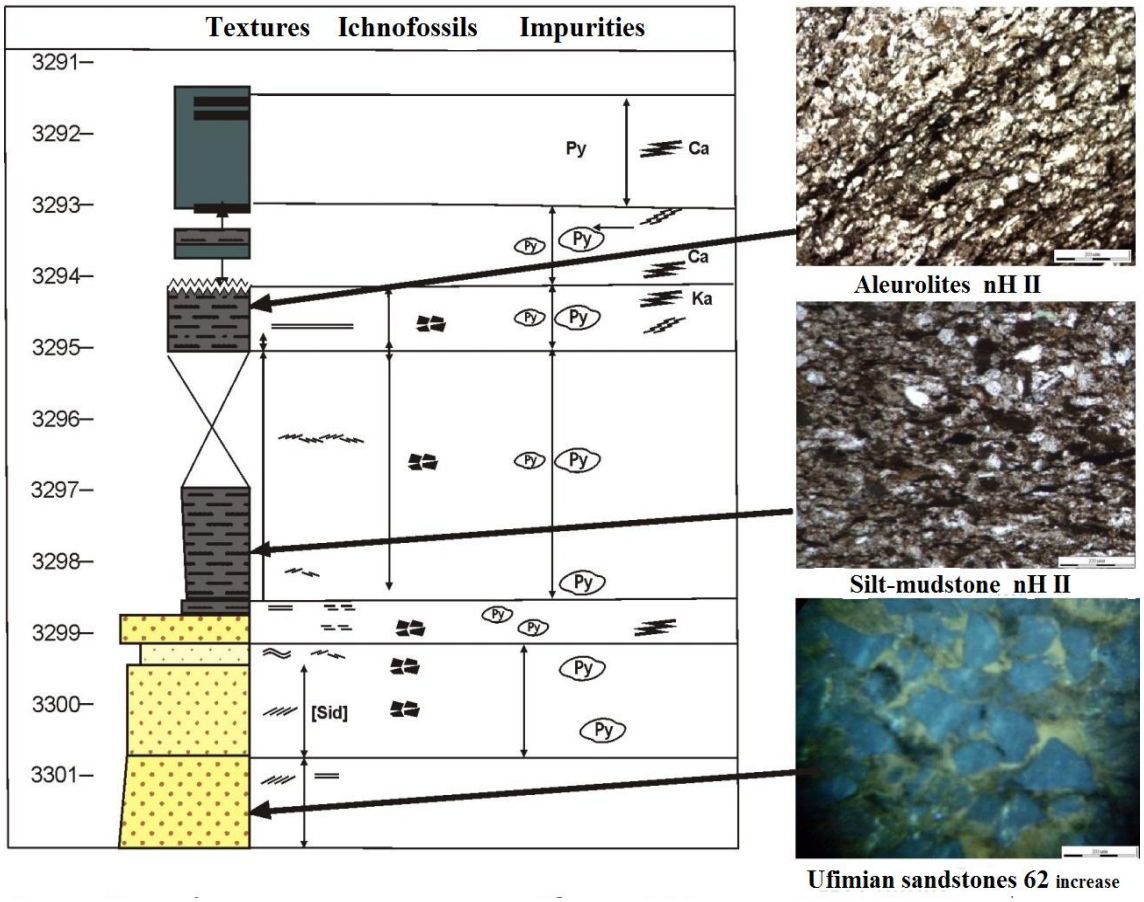

Figure 2. Litho-facies groups, well № 309 (Southern Maiskaya).

Gray aleurolites with rare carbonaceous-fauna debris. There are pyrite concretions of up to 1 cm. The rocks are coarse-grained aleurolite micro-structures. Clastics, predominately, quartz and feldspar, comprise of up to 90% of the thin section. There are single zircon grains. Quartz grains are corroded and often recomposed, K-feldspar is substituted by argillaceous and siliceous matter. Cementing matter- siliceous-hydromica; cement texture- contact-film. Bitumen of mixed genesis was revealed in ultraviolet fluorescent microscope. The bulk mass is impregnated by resinous bitumen (brownish luminescence), greasy resinous bitumen (yellowish luminescence) and resin- asphaltine (dark-brownish luminescence) which is confined to micro-fractures.

Light-gray sandstones, subhorizontal, wavy-cross bedding. Bedding reveals distinct siderite wash-outs and carbonaceous-plant detritus and coal seams (up to 10.0cm.).There are pyrite concretions.

The rocks are fine-medium grained, micro-structure, clastics is 75-90% of the thin section. Clastic composition- quartz (33%), feldspar (47%), rock clastics (20%), which according to Shavnov classification are feldspar greywacke. Post-diagenesis alteration shows corroded and weakly regenerated quartz clastics, most K-feldspar grains are substituted by quartz-kaolinite aggregates. Plagioclase is often substituted by albite (according to X-ray structure analysis results). Cement composition -siliceous-argillaceous; texture- contact-film, rarely, porous. Clay mineral composition includes hydromica and kaolinite, plastically deformed muscovite flakes. Ultraviolet fluorescent microscope revealed sandstone horizons enriched by migrated greasy resinous bitumen (light yellow brownish luminescence) and greasy bitumen (light yellowish luminescence) forming cement bitumen texture, which, in its turn, could be an indicator of hydrocarbon reservoirs.

Sandstone bedding is disrupted by vertical plant bioturbation (figure 3 – rb), horizontal and vertical ichnofossils (*Skolithos* (sk), *Palacophycus*, *Chondrites*). The animals that leave such traces are feebly moving eaters of suspended matter, which indicates a relatively high wave energy flow (coastal bars) [1]. These sandstones also include plant root system remains, oriented cross-bedding of pyritized branches. Leaves of Cherkanowsky sperms and pine Podozamites are located along major axis parallel to each other. This indicates the location of basin coastline with mangroves within shallow areas.

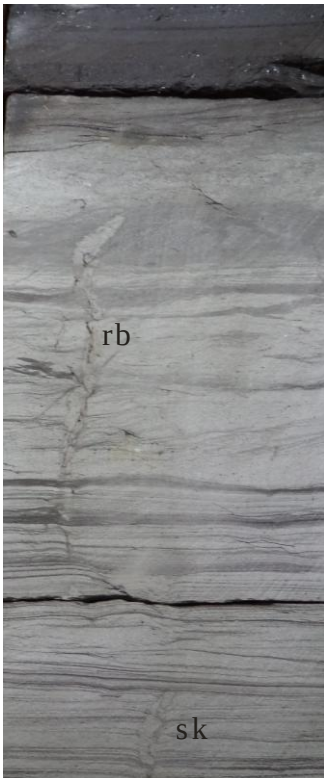

Figure 3. Southern Maiskaya area- well № 400.

Sometimes tubercular bedding, "ripple" type is found in these rocks, which, in its turn, is a non-unifrom combination of two or even three litho-types in Naunaksk suite sandstones.

Complex lithological rock composition in Naunaksk suite of Centeral Nurolsk depression is conditioned by alternating sedimentation environment facies within transition conditions.

Rozhkov genetic diagrams "asymmetry- excess" plotted to the granolmetric analysis results show that sedimentation of sandstones occurring in conditions of outgoing waves in shallow waters, intense littoral currents, oncoming sea (coastal-marine facies), continental beach microfacies of large lowland rivers (field V, figure 4).

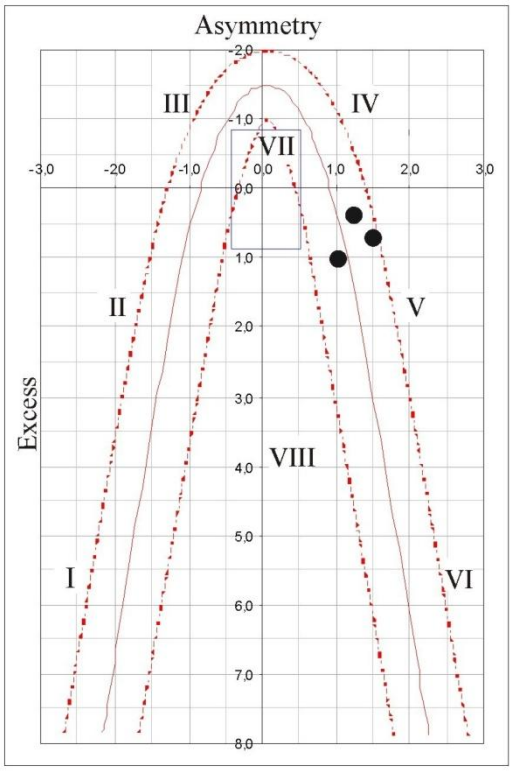

Figure 4. Rozhkov genetic diagram "asymmetry-excess".

Chemical analysis recalculation results and specification of lithochemical models [2] support the coastal-marine formation environment of Naunaksk suite and intensive post-diagenetic rock alteration (table 1).

Table 1. Calculation of lithochemical models.

Model	**Characteristic features**
TM=TiO_2/Al_2O_3=0,14	Humid climate
HM=Na/Al=0,02	Significant plagioclase alteration
FM=Fe_2O_3/SiO_2	No igneous rocks
B, Cl, Na, Rb, Ca, Al/Ti=3,8	Low paleosalinity of basin
KM=K_2O/Al_2O_3=0,11	Coast-marine sedimentation environment

4. Conclusion

Lithochemical and paleontological analysis data showed that Bathonian-Callovian-Oxfordian Bathonian-Callovian-Oxfordian Maiskaya and Southern Maiskaya areas involved sedimentogenesis transition with active ingression. The marine sedimentogenesis boundaries could have been shifted towards N-W comparable to the plotted map – Callovian and Upper Jurassic structural-facies zoning [3]. Litho-facies sediment alterations in the cross-section is governed by frequent changing sedimentation environment facies.

Litho-facies groups of Naunaksk suite sandstones enriched by greasy epibitumen were identified in the S-E Nurolsk depression, which, in its turn, could be potential indicators of hydrocarbon reservoirs.

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