

# Paleogeographic and litho-facies formation conditions of Mid-Upper Jurassic sediments in S-E Western Siberia (Tomsk Oblast)

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**Abstract** This paper describes the criteria to identify Tumen (lower Bathonian) and Naunak (upper Bathonian-Callovian- Oxfordian) suites within S-E Western Siberia (Tomsk Oblast). The specific paleogeographic and litho-facies formation conditions of sediments and numerous vegetable remains and ichnofossils indicated the fact that this territory was the location of sedimentogenesis transition during Tumen and Naunak suite formation. Based on integrated survey oil-gas potential litho-facies groups were defined in Mid-Upper Jurassic sediments within S-E Western Siberia.

## 1. Introduction

Mid-Upper Jurassic sediments in S-E Western Siberia are the most potential oil-gas deposits. However, it should be noted that due to existing polyfacies cross-sections it is rather difficult to identify complex-structured reservoirs [7]. Mid-Upper Jurassic sediments in S-E Western Siberia include Vasugan horizon embracing marine Vasugan suite and coastal-marine Naunak suite [4] being underlain by Tumen suite. Today, there are two controversial questions which are under discussion: what are the distinct and visible division between these suites and how to trace the reservoirs within these suites. Hard-to-identify stratigraphic units are conditioned by the lenticular lithological bodies and insignificant suite rock component contrast intensity.

Traditionally, production logging data is applied in sectional layering. However, log data interpretation of geological bodies with different facies features scarcely ever seems to be distinct. In this case, direct methods are more significant in the biostratigraphic control [3].

Backstripping and effective forecasting of natural petroleum and gas reservoirs were based on core sampling involving paleobotanic (macro-plant remains), lithological-petrographic, geochemical, fluorescence microscopy and X-ray diffraction methods, as well as logging interpretation.

## 2. Data and methods

Investigation target is Mid-Upper Jurassic sediments in S-E Western Siberia (Tomsk Oblast)-Sneznyaya field (wells 135, 170, 301, 430, 446) and Mayskaya (wells 228, 309, 393, 400, 698).

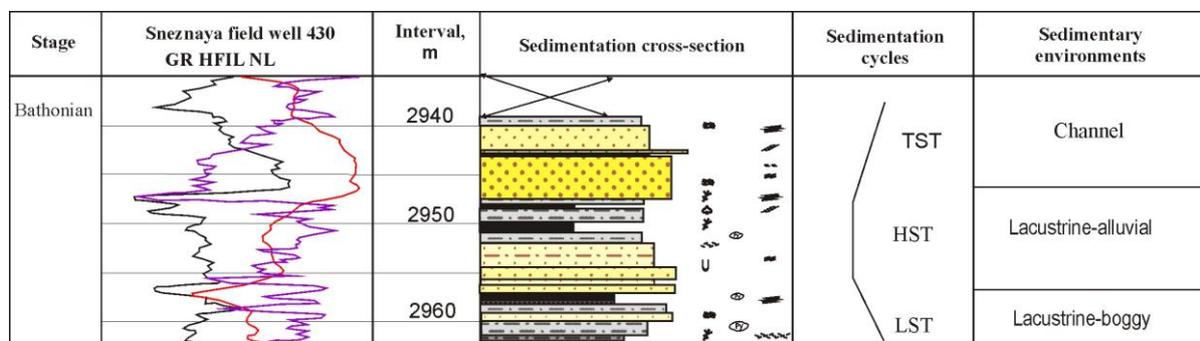
The investigated fields embraced rocks of different facies genesis: coastal-marine (aleurolites, silt-sandstones), lacustrine-boggy (silt-claystones, argillites), lacustrine-alluvial (silt-sandstones, sandstones) and channel facies (sandstones) [2]. Obtained results are based on calculated geochemical models of Yudovich and Ketris [8] and plotted asymmetry-excess diagrams (according to grain size measurement data).

## 3. Results and discussion

Based on the integrated analysis the lithological-petrographic and palaeontological criteria were established for the diagnosis of Tumen and Naunak suites.



Tumen suite is mainly composed of argillites and silt-argillites, including thin layers of sandstones and silt-sandstones (fig. 1).



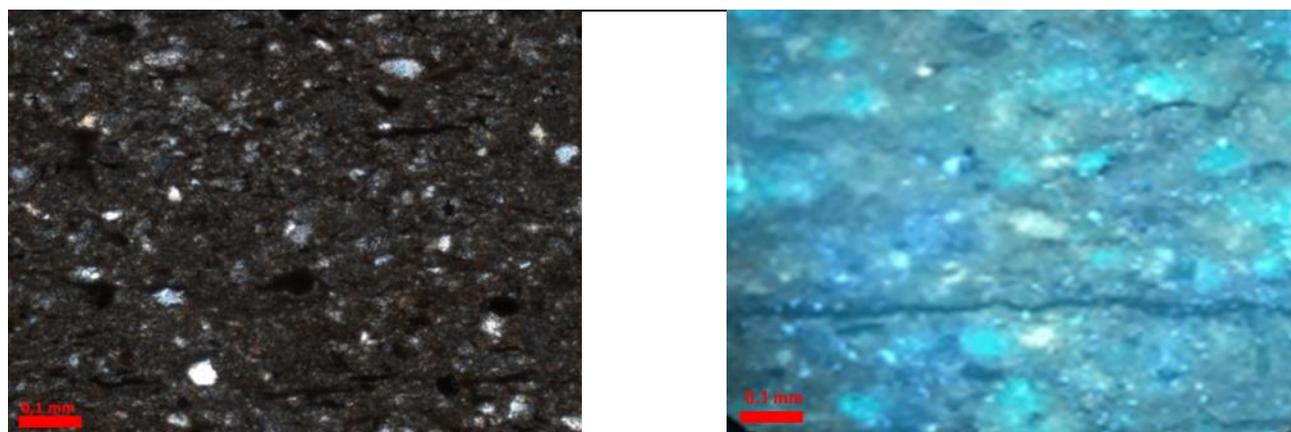
**Figure 1.** Vertical sedimentation model of Tumen suite

\*HFIL- High Frequency Induction Logging      GR- gamma ray      NL- neutron logging

#### Characteristic features of Tumen suite

Argillites and silt-argillites are of silicious hydromica and insignificant amount of fossilized vegetable remains. The rocks are oriented- structured governed by flattened silt-to-quartz sized fragments alongwise the bedding plane. One can also observe interrupted bituminous-filled cracks in this bedding direction.

Studied polished thin sections under fluorescent microscope MIKMED II reflected numerous bitumen migration traces. Bitumen composition varied from greasy-resinous (yellow-brownish luminescence) to resinous- asphaltene (dark-brownish luminescence) and predominately resinous bitumen (dark yellow-brownish luminescence). Bitumen content was 0.02-0.04% (fig. 2).



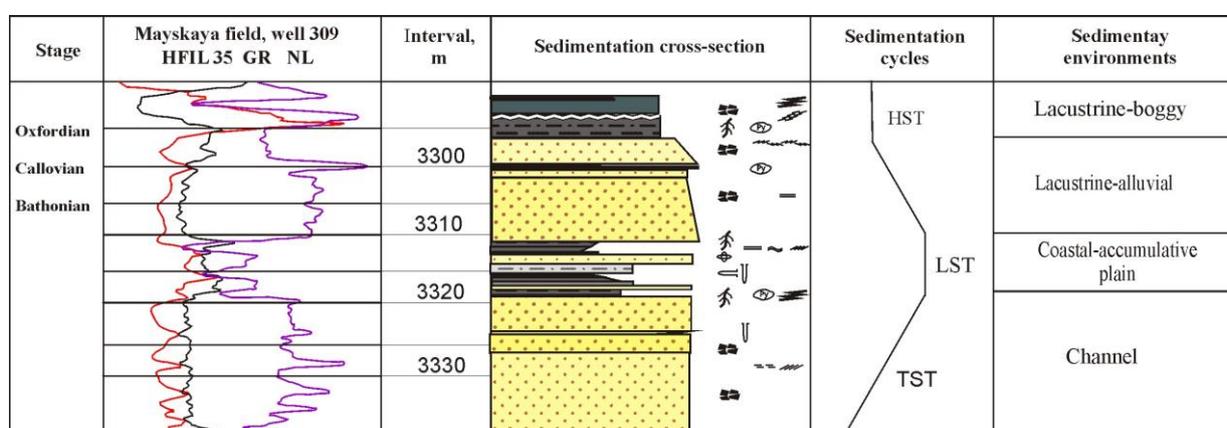
**Figure 2.** Silt-, bitumen argillite  
(left: nicol prism; right: under fluorescent microscope MIKMED II)

The fragment material composition in sandstones and silt-sandstones was predominately quartz and feldspar of average roundness and sorting. The cementing matter included mainly hydromica, chlorite, muscovite (more often plastically deformed), which, in its turn, indicates the fact of intensive catagenesis. The postdiagenesis alteration in Tumen suite was more intensive than in Naunak suite (intensive cataclasis, fracturing, flatness of fragments alongwise the bedding plane).

Numerous and various plant traces pertaining to upper Tomsk phytohorizon (Lower Bathonian) could be observed on the bedding surface [5]. This flora included equisetum (horsetail), fern and ginkgophyta, of which the predominate type was *Coniopteris* (fern). The following could also be found throughout Tumen suite profile: *Equisetites sp.*, *Coniopteris vialovae*, *C. simplex*, *Raphaelia diamensis* and *Nilssonina urmanica*. Based on detailed studies of the taxons several ferns such as *Coniopteris vialovae* and *Raphaelia diamensis* were revealed as limited stratigraphic bands. This, in its turn, could be applied in stratigraphic breakdown and correlation of the continental sediments in S-E Western Siberia.

#### Characteristic features of Naunak suite

Naunak suite is mainly composed of thick medium-coarse grained sandstone and silt-sandstone interbeds (fig.3).



**Figure 3.** Vertical sedimentation model of Naunak suite

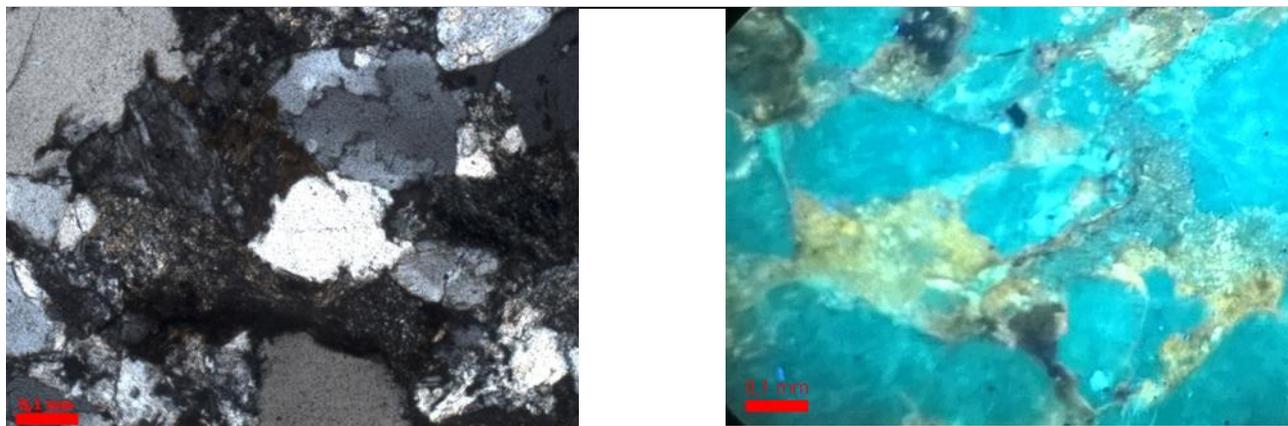
\*HFIL- High Frequency Induction Logging      GR- gamma ray      NL- neutron logging

The terrigenous varieties in Naunak suite comparable to those in Tumen suite involve weakly sorted and less rounded fragment material. The cementing matter includes not only micaceous minerals but also carbonates (siderite, calcite) and authigenous glauconite. Post-diagenesis alteration predominately embraces the corrosion and regeneration of the quartz fragments and feldspar kaolinization; however, to a lesser extent, it also involves cataclasis and fracturing.

Studied polished thin sections under fluorescent microscope MIKMED II reflected numerous bitumen migration traces. Bitumen composition varied from greasy (light yellow luminescence) to resinous- asphaltene (dark-brownish luminescence) and predominately greasy-resinous bitumen (light yellow-brownish luminescence). Bitumen content was 0.04-0.06% (fig. 4) [9].

A few horizon cross-sections revealed a high bitumen content being confined to the pores and cementing matter. Naunak phytohorizon plant traces (upper Bathonian-Callovian-Oxfordian) could be observed on the bedding surface involving an insignificant paleoflora composition comparable to underlying Tomsk phytohorizon. This composition predominately includes gymnosperms (naked-seeded): *Czekanowskiales*, *cycadales*, *ginkgoales* and *coniferales*. Lower ranking sequence involves ferns. Sporadically equisetum types can be found. *Czekanowskia* types are few in number-only 3-4. However, they form monodominant accumulations composing interbeds within terrigenous sediments. The following plants have been identified: equisetopsida *Equisetostachus sibiricus*, ferns *Coniopteris hymenophylloides*, *C. burejensis*, *C. latilobus*, *C. simplex*, *C. burejensis*, *Czekanowskiales* *Czekanowskia tomskiensis*, *ginkgoales* *Sphenobaiera sp.*, *cycadales* *Nilssonina urmanica*, *N. maiskaja* and *coniferales* *Podozamites lanceolatus*, *Podozamites sp.* [6]. Fine-pinnulate *Coniopteris* is the major

fern type, i.e. *Coniopteris latilobus*, *Nilssonina maiskaja* and *Podozamites eichwaldii* are predominate in Naunak suite.



**Figure 4.** Feldspar-quartz graywacke with hydromica cement indicating decomposition of feldspar grains and quartz and bituminous grain co-ordination

(left: nicol "++"; right: under fluorescent microscope MIKMED II)

#### 4. Conclusion

Chemical-petrographic study of coals from Tumen and Naunak suites via Rock-EVAL method did not only indicate different biochemical coal formation environment conditions but could also be applied in identifying the stratigraphic units.

The analysis of geophysical data based on gamma ray, high-frequency induction logging 35, neutron logging and induction electrical logging in correlation with complex lithological and biofacies studies made it possible to isolate the sedimentation cycles in Tumen and Naunak suites. The most potential petroleum-gas reservoirs (irrespective of age) are sandstone sediments of channel facies formed during TST [1]. Horizons enriched by migrated bitumen of greasy-resinous (light yellow-brownish luminescence) and greasy (light yellow luminescence) composition were identified under the fluorescent microscope. Such horizons having porous and cemented bituminous structure could be potential hydrocarbon reservoirs.

Therefore, detailed integrated study of hard-to-identify Mid-Upper Jurassic sediments in S-E Western Siberia furthered possible stratigraphic breakdown and intraregional correlation, as well as the prediction of potential reservoirs [10].

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