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PALEOGRAPHIC FEATURES OF FORMATION OF PETROLIFEROUS LAYERS OF VASYUGAN SUITE OF WESTERN SIBERIA

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It has been shown that active tectonic nodes present within Western Siberian Plate and associated with re-formation of spatial wavefield with the periodicity of 18 million years, influences paleogeomorphological peculiarities of sedimentary basin and controls location of Upper Jurassic source area. Paleogeographic schemes of formation time of particular oil-and-gas bearing sand layers of horizon J1 of Vasyugan suite have been built for the first time.

Evaluation of the role of wave tectonic movements in formation of sedimentary cover of Western Siberian Plate (WSP) [1] opens new approaches in paleogeographic reconstruction of Middle Jurassic deposits. The allocated in their composition deposits of Abalak, Vasyugan, Georgiev and Bazhenov suites were formed as a result of consecutive display of Callovian Kimmeridgean-Volga transgressions. In western areas of the WSP these transgressions are a continuation of each other based on lithologic sequences, the argillaceous marine Abalan suite along the cut is replaced by relatively deep-water argillaceous and deep-water argillaceous-bituminous Georgiev and Bazhenov suites. In the east and southeast they are divided by regressive-transgressive sandy-argillaceous strata, attributed to the horizon J_1. Horizon J_1 is the main oil-nad-gas-bearing object of Vasyugan suite.

This horizon, considered earlier as a uniform hydrodynamic system, was further stratified in more details and divided into a number of hydrodynamic independent reservoirs which has allowed detailing paleography of Callovian-Oxonian. Performed researches have shown essential distinctions in formation of paleogeographic conditions of transgressive and regressive stages of development of Upper-Jurassic sedimentary basin. Considering connection of formation of Middle and Upper-Jurassic sedimentary section with display of wave oscillatory movements [1], the features of Vasyugan suite structure should be studied from the position of lithologic-facies complex allocation.

Based on the existing definition [2. P. 163–171], a lithologic-facies complex is understood to be a one-age, rhythmically constructed sedimentary strata represented by a natural combination of genetically connected types of rocks generated under the set of oscillatory movements. The analysis of the internal structure of the lithologic-facies complex can be carried out on the basis of systematization of the allocated section lithotype according to the constructed facies-dynamic model.

A lithotype, according to [3], is understood to be a rock species or «geological body with a certain complex of interconnected essential attributes constitutional: material composition, structure, etc., and additional, indicative: phytocenosis, concretions».

Facies-dynamic models, unlike traditional division into districts of the territory by section types, provide:

– revealing in the variety of available geological sections of the lithologic-facies complex of similarity features in separate lithologic packs, allowing to group them into section lithotypes;
– positioning of the allocated lithotypes into the genetic row reflecting transgressive or regressive stages of sedimentary basin development.

In Callovian and Upper-Jurassic three lithologic-facies complexes are allocated. *The first* is the regressive coastal-marine Callovian-Oxonian complex, which composes undercoal strata of Vasyugan suite. *The second* is regressive-transgressive (transitive) coastal-continental and continental Oxonian complex corresponding to the maximum of regress, allocated into intercoal strata of Vasyugan suite. *The third* complex is transgressive coastal-marine Oxonian-Cimmeridgean, which forms uppercoal strata of Vasyugan suite and ends by accumulation of abyssal-marine highly carbonaceous, carbonaceous-siliceous-argillaceous rocks of Bazhenov suite.

Facies-dynamic models of undercoal and uppercoal strata are represented by six lithotypes of regressive-transgressive row (Fig. 1).

Stratification of the allocated section lithotypes [4. P. 34–47] testifies to age sliding of borders of uppercoal and undercoal strata. The detailed correlation of sections of Vasyugan suite, according to the constructed facies-dynamic model, has allowed reconstructing lithologic-facies schemes and paleogeographic maps of formation time of separate sand layers. Researches have shown essential distinctions in paleogeographic conditions of deposit formation on transgressive and regressive stages of development of Upper-Jurassic sedimentary basin, which was connected to an orientation in change of phases of wave tectonic processes of periodicity 18±1,5 million years within the limits of the allocated active tectonic nodes (Fig. 2). Thus, at formation of undercoal strata (see Fig. 1), a faltering character of uplift of the sea-bottom of sedimentary basin in the southern tectonic cell of WSP has caused an echelon (clynomorphic) bedding in the section of layers J_1^3 (lithotype 5) and J_1^4 (lithotype 2). Formation of sand reservoirs has been connected to display of positive phases of periodicity 3 million years. In the zone of joint presence of layers J_1^3 and J_1^4 (lithotype 4) they often unite (lithotype 3). In the east tectonic cell, in the field of transition of marine clays of Vasyugan suite into con-

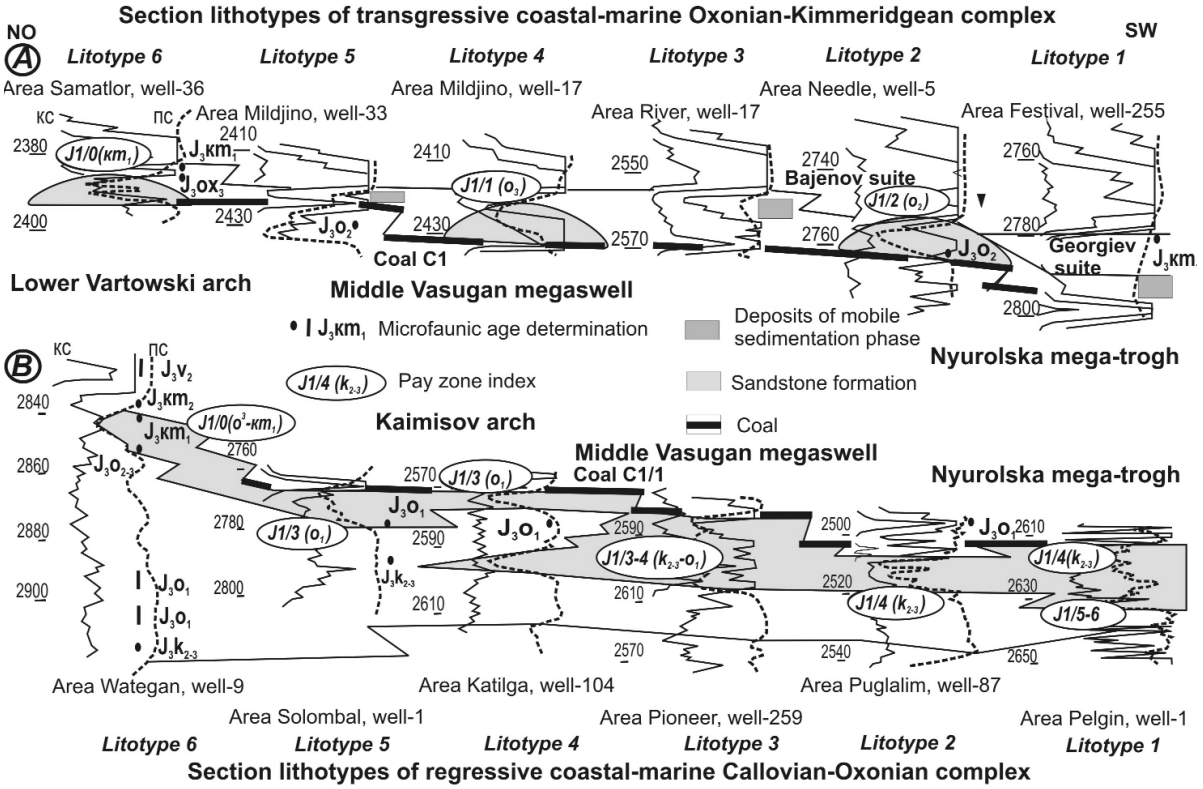

Fig. 1. *Facies-dynamic models of a) transgressive and b) regressive sedimentary complexes of Vasyugan suite*

tinental deposits of Naunak, more ancient coastal-marine sand layers J_1^5 and J_1^6 (lithotype 1) appear in the section. To the west (the territory of Surgut and the western part of Nizhnevartovsk arches), the regressive cycle of sedimentation appeared in the Upper Oxonian and Kimmeredgian (lithotype of the section 6), as based on the character of tectonic development this territory gravitates to the western tectonic cell of WSP where bowing processes had prevailed.

The culmination stage of Early- Middle-Callovian transgression was a significant expansion of sea basin, with mainly clay depositis of Lower-Vasyugan subsuite, Abalak and Tochinsk suites accumulated within its borders (Fig. 2). Development of the transgression has been caused by alignment of the territory and, probably, eustatic rise of the World Ocean level. On this background, the display of a negative tectonic phase of periodicity 3 million years in the allocated active tectonic nodes has promoted fast distribution of extensive by area shallow Epiplatform Sea on the most part of the West-Siberian Plate territory.

As a result of activization of positive tectonic processes in Late Callovian, which have slowed down the bowing speed of the sedimentary pool bottom within the limits of southeast and northern tectonic cells of WSP, Callovian Sea has shoaled. Its coastal line has gradually moved in the western direction (Fig. 2). It has caused accumulation of coarse-grained material of the layer J_1^4 in the coastal zone. As far as facies relation, the layer is represented by regressive overlapped sand complicated by accumulative constructions of deltoid complexes (Vakhsk, Luginetsk and other structures).

The lateral distribution of the layer J_1^4 is is limited by a strip of submeridianal prodeleting, covering central and east parts of Nyurolska mega-trogh, Middle-Vasyugan megaswell, western part of Pudinskiy mesouplift, Aleksandrovsk and northeast periclinal of Kaymysov arches, as well as Kolgotorsk mesodeflection and western board of Ust-Tym mega-trogh. To the West of this zone, on Nizhnevartovsk and Kaymysov arches in Yugansk mega-trogh and in Kolgotorsk mesodeflecton, the accumulation of marine aleuropilitic deposits of Lower-Vasyugan subsuite has proceeded. In the east, within the limits of Parabel megaswell, east part of Pudinskiy mesouplift, Aleksandrovsk arch and northern part of Ust-Tym mega-trogh, the conditions for deposition of alluvial-lake deposits of Naunak suite have preserved.

The subsequent impulse of ascending tectonic movements in Early Oxonian entailed further retreat of the sea and formation of the second step of overlapped coastal-marine sand (layer J_1^3), located to the west of the first. Two conditions of deposit accumulation are allocated for this period: continental and coastal-marine (Fig. 2). The border of their section within the limits of Nyurolsk mega-trogh coincides with the western border of the coastal-marine zone existed in the Middle-Late Callovian.

To the north, repeating contours of Middle Vasyugan megaswell, this border is traced further on Aleksandrovsk arch and dividing it, it leaves its central part in the field of continental sedimentation. Western and northwestern borders of development of the regressive sand cover are supervised by the board of Yugansk mega-trogh and a number of finer negative structures of the first order

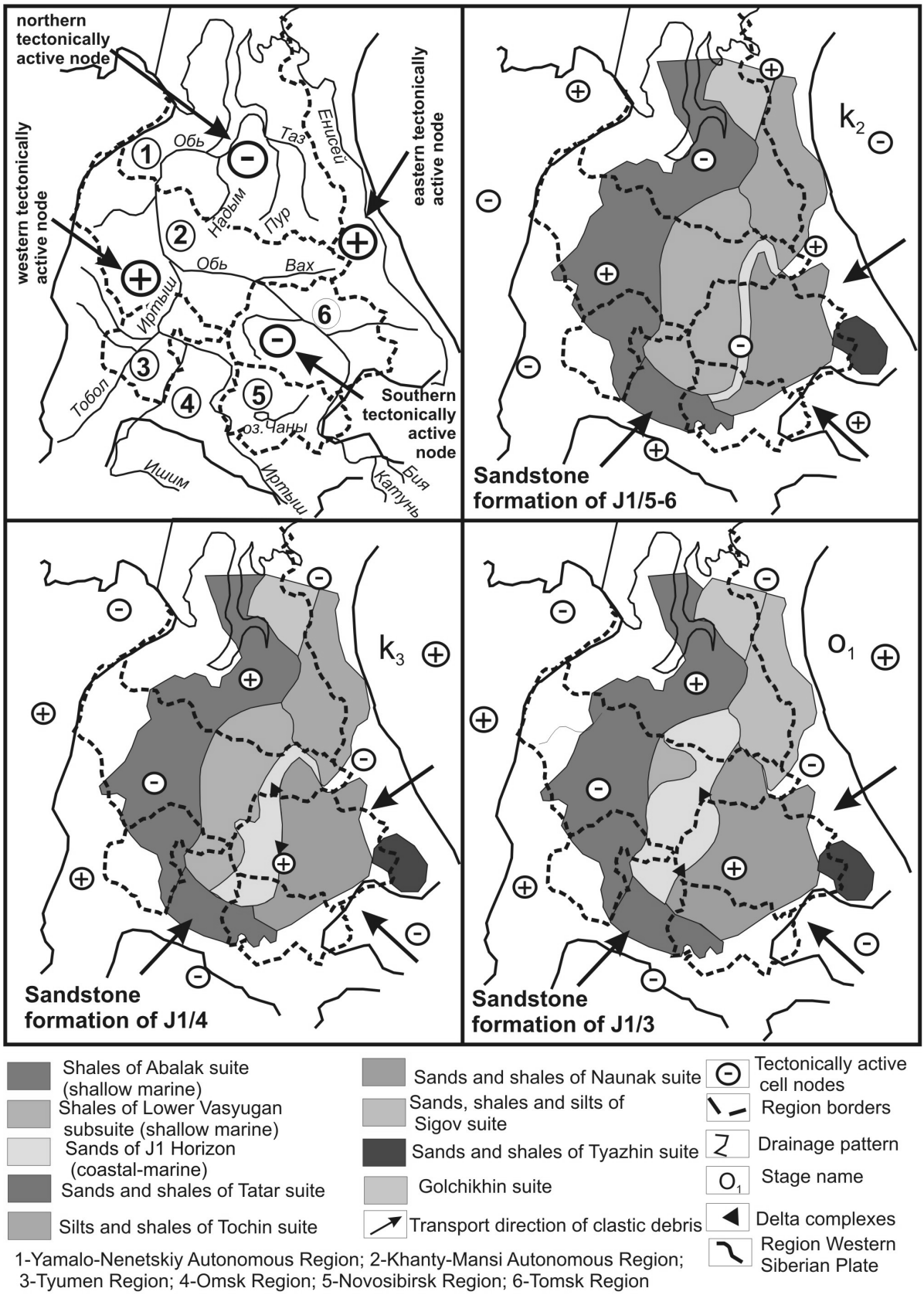

Fig. 2. *Paleogeographic schemes of Callovian and Early Oxonian of the West Siberian Plate*

(Verkhnetalov, Nergutinsk mega-troghs) which endured active deflection in connection with display of the negative phase of the wave tectonic process with the period of 18±1,5 million years in western cell of WSP.

In the southeast of the considered region, covering board parts of Nyurolsk and Ust-Tym mega-troghs, Middle Vasyugan megaswell, Pudinsk mesouplift and the east part of Aleksandrovskiy arch, the continental deposits of intercoal strata and Naunakskaya suite were formed. Just as for the layer J_1^4, coastal-marine deposits of the layer J_1^3 are represented by the overlapped sand complicated by bar constructions and deltoid complexes (Vakhsk, Krapivinsk areas). The total thickness of the regressive sand cover varies from 10 up to 20 m, increasing on the sites of association of layers up to 30 m and more.

In the finishing stage of regress on the border of Early and Middle Oxonian, within the limits of a greater part of the considered territory, the coastal-continental and continental modes of sedimentation were settled (Fig. 3). Coastal-marine conditions existed on the territory of Yugansk mega-trogh, western parts of Nizhnevartovsk arch and Verkhnedemyanovsk megaswell. The extensive zone of coastal marches was replaced to the east by the low alluvial-lake plain. According to paleoenvironments, deposits of continental intercoal strata were acuumulating here. These deposits wedgely increase its strata in the east direction and partially replace volumes of uppercoal and undercoal strata. At full replacement of Lower Vasyugan subsuite by continental deposits of intercoal strata, the Naunak suite is allocated.

The facies dynamic model of the coastal-marine complex of Oxonian and Kimmeridgean is represented by a set of sections of the transgressive row (see Fig. 1), where six lithotypes are allocated. The foot border for all lithotypes is a stratigraphically «sliding» coal layer $У_1$; the roof border is argillites of Georgiev and Bazhenov suites. A consedimentational growth of positive structures of the first and second order became more active in the transgressive stage, which has influenced the speed of transgression development. During the periods of fast moving of the coastal line (mobile phase of sedimentation), embedded an insignificant layer of sand-aleurite-clay deposits, and at stabilization of marine coast, an active accumulation of sand material was connected with specific facies conditions (bars, deltas, tidal swells, etc.). In the uppercoal strata of the *first lithotype,* a consecutive change upwards along the section of a low-power pack of aleuropelitic deposits of the mobile phase of sedimentation by clays of Georgievsk suite is marked. In *the second lithotype,* a Middle Oxonian sand layer J_1^2 is allocated. For *the third Lithotype,* an uppercoal strata is represented by consecutive change of clay deposits of the intertidal of aleuropelitic deposits of the mobile phase of sedimentation. Development of Late Oxonian sand layer J_1^1 is peculiar *to the fourth lithotype*. In *the fifth lithotype,* the analyzed interval of the section is represented by the reduced strata of aleuropilitic deposits of the mobile phase of sedimentation, and in *the sixth lithotype* the Oxonian-Kimmeridgean layer J_1^0 is allocated.

The analysis genetic row testifies to ocasionality of sand layer accumulation along the front of the transgression development, which is caused by the consecutive alternation of sediments generated during the periods stable (lithotypes 2, 4, 6) and mobile (lithotype 1, 3, 5) phases of sedimentation.

The initial phase of transgression most fully revealed itself in southeast and northern parts of WSP, as a result of change in the direction of active tectonic nodes of periodicity 18±1,5 million years. The transgression developed on the background of strengthening consedimentational growth of structures of the first and second order, at which negative tectonic elements (hollows, megadeflections) endured active deflection, and positive (arch, megaswell) endured raising. At the moment of slowing of deflection of sedimentation basin in the Middle Oxonian, which has been caused by the display of the positive phase of thewave of periodicity 3 million years, the continental condition continued to exist on Middle Vasyugan megaswell, greater part of Pudinsk mesouplift, Aleksandrovsk, central part of Kaymysov and northwest part of Nizhnevartovsk arches (Fig. 3).

Extensive zones of lagoons and intertidal plains are allocated within the limits of Kaymysov arch, southeast part of Nyurolsk mega-trogh. Rather deep-water zone was characteristic for central and southern parts of Nyuroslk, Yugansk mega-trogh, southern part of Koltogorsk mesodeflection. A sand layer J_1^2 was formed in the narrow zone of the coast sand strip bordering continental plain. In facies relation, the layer J_1^2 is represented by alongshore and barrier bar constructions, bars of the distant zone (Igolsk-Talovoe uplift), environments of deltoid sedimentation (Kalinov, Nizhnetabagan, Kinyaminsk, and other areas). The thickness of sandstones on average amounts to 2...6 m, increasing in deltoid complexes up to 10...5 m and more.

Development of intertidal channels and river systems, where thickness of sandstones changes from units up to the first tens (Karasyov, Vesennyaya, Strezhev, Malorechensk and other areas) meters, was characteristic for intertidal and continental plains of Kaymysov, Nizhnevartovsk, Aleksandrovsk arches, Pudinsk mesouplift, Verkhnedemyanov, Parabel and Middle Vasyugan megaswells.

The subsequent impulse of transgression on the boundary of Middle and Late Oxonian has changed the distribution of facies zones within the limits of the considered territory. Activization of immersing was showed the earliest in southern and northern, and uplifts in western and eastern tectonic cells (Fig. 3). It has essentially limited the intake of terrigenous material into the sedimentary basin from the main source area (Siberian platform, Kazakhstan).

In accordance with the carried correlation of radioactive packs of Bazhenov suite, based on the data of gamma-logging [5. P. 32–35], at the moment of the coastal line stabilization in Late Oxonian, in the most submerged sites of Nyurolsk and Ust-Tym mega-troghs (southern active tectonic unit), more ancient packs were formed. The coastal line, in general repeating a con-

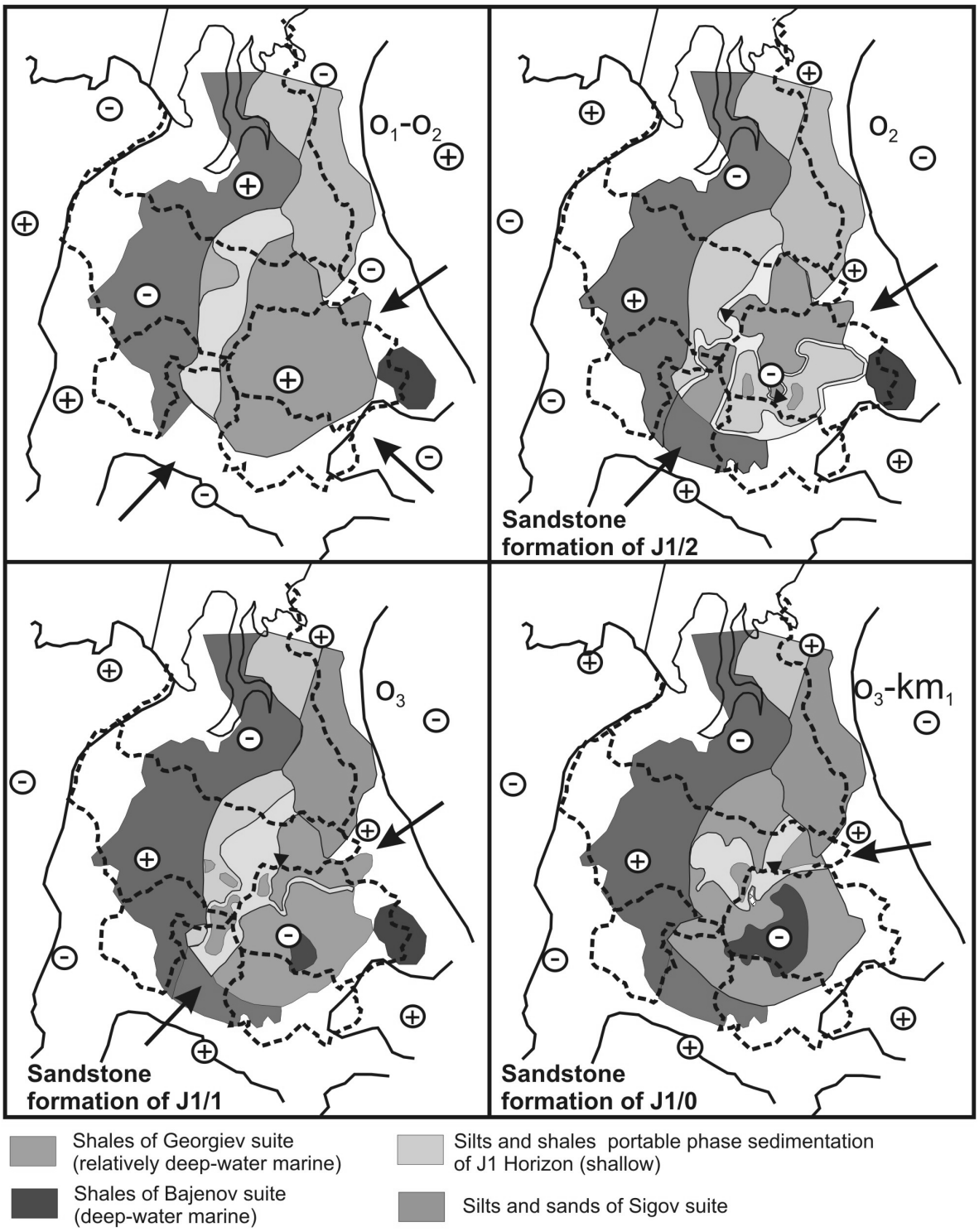

Fig. 3. *Paleogeographic schemes of Early Oxonian and Late Oxonian – Kimmeridgean of the West Siberian Plate*

figuration of coast of average Oxford, has moved in northern and northwest directions.

Overlapped character of development of the layer J_1^1 is marked within the limits of Nizhnevartovsk and northern periclinal of Kaymysov arches, northern part of Kolgotorsk mesodeflection. Deposits of coastal-continental and continental plains are revealed on Middle Vasyugan, Upper Demyanovsk megaswells where sandstones are dated to river channels and intertidal channels.

Outside the coastal-marine strip, aside the relative deep-water (Nyurolsk, Yugansk, Ust-Tym megaswells, Koltogorsk, Verkhneagansk mesodeflections, and adjoining them slope immersings of large platform uplifts), phosphorites, clay, and glauconite-containing deposits

of Georgiev suite were formed. In facies relation, the coastal-marine layer J_1^1 is composed oftransgressive coastal sand, alongshore barrier bars, and deltas. The thickness of Late Oxonian sand constructions for various facies zones are similar to Middle Oxonian.

The display of the positive phase of wave movements of periodicity 3 million years in early Kimmeridgean, after another impulse of transgression, again stabilized the position of the coastal line, having changed its configuration (Fig. 3). In comparison with Late Oxonian the area of coastal-marine sedimentation has reduced. Sand deposits are widespread only on the line connecting western and eastern active tectonic nods of the WSP, for which uplift processes were characteristic, which promoted formation of the sixth lithotype of the section of regressive row (see Fig. 1). Active immersing in Early Kimmeridgean of the territories located within the limits of northern and southern tectonic nods, was reflected in deflection strengthening of Yugansk, Nyurolsk mega-troghs, Yaraynersko-Etypurov, Verkhneagansk, Koltogorsk and adjoining slopes of positive structures of the first order. Mainly clay deposits of Georgiev suite deposited here. The sand material accumulated, basically, on slopes of Nizhnevartovsk and on northern periclinal of Aleksandrov arches. It is concentrated in bar constructions and deltas where thickness of the collector made 3 up to 10 m and more. In the central part of Nizhnevartovsk arch there was an extensive intertidal plain where coarse-grained deposits deposited in intertidal channels.

In Upper- Kimmerideian and Volga periods, deepwater conditions of sedimentation has extended on a greater part of sedimentary pool within the limits of northern and southern active tectonic nods where highly carbonaceous carbonate-argillaceous-siliceous deposits of Bazhenov suite were accumulating.

As follows from the above-stated, paleogeographic reconstructions of Callovian and Oxonian, carried out on the basis of the display of wave tectogenesis process, consider the accumulated actual material on stratigraphy and lithology of Vasyugan suite sediments.

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