ALOCAÇÃO DE COMPLEXOS PALEOFACIAIS ALUVIAIS NOS DEPÓSITOS DO JURÁSSICO SUPERIOR DO SUDESTE DA BACIA DE PETRÓLEO E GÁS NATURAL DA SIBÉRIA OCIDENTAL

DETACHMENT OF ALLUVIAL PALEOFACIAL COMPLEXES IN THE UPPER JURASSIC DEPOSITS OF THE SOUTH-WEST OF THE WEST SIBERIAN OIL AND GAS BASIN

ВЫДЕЛЕНИЕ АЛЛЮВИАЛЬНЫХ ПАЛЕОФАЦИАЛЬНЫХ КОМПЛЕКСОВ В ВЕРХНЕЮРСКИХ ОТЛОЖЕНИЯХ ЮГО-ВОСТОКА ЗАПАДНО-СИБИРСКОГО НЕФТЕГАЗОНОСНОГО БАССЕЙНА

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RESUMO

O artigo trata do problema de identificação do grupo continental de fácies nos DEPÓSITOS do Jurássico Superior da PARTE sudeste da bacia sedimentar da Sibéria Ocidental usando o exemplo de complexo aluvial de rios do tipo meandrante. As fácies aluviais estudadas incluem: um complexo acrecionário de leitos e barras, canais antigos, área aluvias, lagos, pântanos, bancos de canais e cones de ruptura. O autor descreve as características da sedimentação. Com base em estudos teóricos e padrões de formação de fácies do complexo aluvial de rios do tipo meandrante, o autor determinou e executou o diagnóstico da localização e fácies, e analisou a estrutura geológica dos depósitos aluviais no sudeste da bacia de petróleo e gás natural da Sibéria Ocidental.

Palavras-chave: *bacia sedimentar da Sibéria Ocidental, depósitos aluviais, fácies, sedimentação, arenito.*

ABSTRACT

The problem of identification of the continental group of facies in the Upper Jurassic sediments of the southeastern part of the West Siberian sedimentary-rock basin is examined in the article on the example of facies of the alluvial complex of rivers of meandering type. The investigated alluvial facies include the accretion complex of streams and bogs, oxbows, floodplains, lakes, marshes, riparian ramparts, and breakthrough cones. The author cites the characteristics of sedimentation environments. Based on theoretical studies and regularities in the formation of facies of the alluvial complex of meandering-type rivers, the author established the location and diagnostics of facies, and analyzed the geological structure of alluvial deposits in the southeast of the West Siberian oil and gas basin.

Keywords: *West-Siberian sedimentary-rocky basin, alluvial deposits, facies, sedimentation, sandstone.*

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АННОТАЦИЯ

В статье рассматривается проблема идентификации континентальной группы фаций в верхнеюрских отложениях юго-восточной части Западно-Сибирского осадочно-породного бассейна на примере фаций аллювиального комплекса рек меандрирующего типа. Исследуемые аллювиальные фации включают в себя: аккреционный комплекс русел и кос, старицы, пойму, озера, болота, прирусловые валы и конуса прорыва. Автор приводит характеристику обстановок осадконакопления. На основе теоретических исследований и закономерности формирования фаций аллювиального комплекса рек меандрирующего типа автором было определено местоположение и проведена диагностика фаций, осуществлен анализ геологического строения аллювиальных отложений юго-востока Западно-Сибирского нефтегазоносного бассейна.

Ключевые слова: *Западно-Сибирский осадочно-породный бассейн, аллювиальные отложения, фации, осадконакопление, песчаник.*

INTRODUCTION

The West Siberian oil and gas basin are one of the main, operating and potential sources of hydrocarbon raw materials in the Russian Federation. Recently, there has been a significant adjustment of the methodology for constructing conceptual models of hydrocarbon deposits (Panero *et al*., 2018). This is due to the growing inconsistency of the features of the geological structure of the real geological objects being developed and the established traditional views on the structure of natural reservoirs, the spatial change in the filtration-capacitive characteristics, and the saturation of productive deposits. The construction of qualitative conceptual models of hydrocarbon deposits makes it possible to effectively solve many practical problems: to identify different types of reservoir rocks, to predict the spread of their improved differences, to increase the efficiency of prospecting, to improve the accuracy of calculating the initial geological reserves of hydrocarbons, to justify the most optimal development systems, and etc.

This article deals with the problem of identification of the continental group of facies in the Upper Jurassic deposits of the southeastern part of the West Siberian sedimentary-rock basin. It is considered on the example of facies of the alluvial complex of rivers of meandering type, the conceptual scheme of which is presented in Figure 1.Alluvial facies include an accretionary complex of streams and bogs, oxbows, floodplains, lakes, marshes, riparian ramparts, and breakthrough cones.

The study and classification of alluvial deposits involved such well-known researchers of Quaternary geology, as V. T. Frolov (Frolov, 1992), Yu. P. Kazansky (Kazansky, 1976), N. I. Makkaveev (Makkaveev and Chalov, 1986), and others. At the present time among the experts-sedimentologists are spread the results of the research of E. Yu. Baraboshkina (Barrabshin, 2005; Barabashkin, 2007; Barrabshin, 2007).The characteristic of sedimentation accumulations described below is given by the classification of E. Yu. Baraboshkina (Barabashkin, 2011; Barrabshin, 2007), where they are subdivided into three large groups: continental, transitional, marine.

MATERIALS AND METHODS

Layers of facies of meandering rivers contain deposits of minerals. To study the sedimentation of meandering rivers, based on theoretical studies (Alekseev, 2007; Yezhov, 2005, Reading, 1990; Berner, 1981; Nenadić *et al*., 2016; Argyroudis and Pitilakis, 2012; Leader, 1986; Sellie, 1989; Belozerov *et al*., 2006; Sultanova, 2015; Einsele, 2000) on the structure and facial features of meandering rivers, the author determined the location and carried out the diagnosis of alluvial facies. For this purpose, the facies group of the Upper Jurassic sediments of the southeastern part of the West Siberian sedimentary-rock basin was diagnosed. Representative samples of the core, materials of special studies were studied, features of the geological structure of the studied sediments (material composition, structure, texture, the degree of sorting, granularity, roundness, inclusions, traces of bioturbation and fragments of flora) were characterized.

The solution of the set tasks was provided by a combination of petrographic, diffraction, spectroscopic and geochemical methods. Petrographic methods combine the macroscopic study of rock samples, optical and electronic microscopy of raster and translucent types, as well as genetic granulometry. Determination of the phase composition of sediments, the proportion of the clay component in them was carried out by X-ray analysis and IR spectroscopy. For the correct identification of clay minerals, determination of their quantitative relationships and structural characteristics, a new modern method of mathematical modeling of complex x-ray diffraction profiles were used. Thus, as a methodological approach to the study of the Lower Jurassic terrigenous rocks of the southeast of Western Siberia, the author proposed a sequential transition from a macroscopic study to a microscopic one, then to an analysis of the fine mineralogical features of the deposits, and finally to the study of the behavior of individual chemical elements and their compounds. At the last stage of the work, all the results obtained were generalized for the purpose of carrying out paleogeographic and facial reconstructions.

RESULTS AND DISCUSSION:

2.1. The accretionary complex of river beds and forelands

The deposits of the complex are usually represented by small- and medium-grained sandstones, often with coarse and coarse-grained psammitic admixture, with sustained medium and shallow plane parallel oblique flow (Figure 2). Sorting sandstone varies from medium to good. For sediments of the channel, section are characterized either by a gradual decrease in graininess from base to the roofing layer or grain is more or less constant in the lower and middle part of the complex and in the upper portion thereof is reduced. Within the sand bodies, there may be more coarse interlayers, including gravel-pebble, accumulations of carbonized wood residues and various-sized clay intraclasts (Figure 3), fixing the plantar parts of the channel incisions that occur during lateral migration of the beds. The thickness of sediments of river beds and forelands is usually several meters (up to 10-15 m). Channel sediments are in association with facies sediments of the floodplain, riverbed, breakthrough cone. In the case of interception of the riverbed or it's dying off, the channel sands are gradually overlapped by oxbow sediments (Hallam, 1983).

2.2. Oxbow Alluvium

The deposits of the oxbow in the lower part of the section are composed of fine-grained oblique sandstone, which gradually turns into siltstones and mudstones of the overgrown floodplain. The roof of the section of oxbow deposits is characterized by the presence of numerous carbonated roots. Sediments are usually non-textural due to mixing with plant roots (Figure 4). Oxbow deposits always lie on channel sandstones, and they overlap either with clayey deposits of the floodplain when the oxbow is filling or with coals at its gradual bogging.

2.3. Floodplain alluvium

Floodplain deposits are mainly siltstones with thin interlayers and lenses of fine-grained sandstones falling out of the suspension during the flood period (Figure 5). Slight deposits of argillites and thin interlayers of coal are found less frequently. In the deposits of the floodplain, there are often observed prints of the flora and the remnants of the roots of plants, horizons paleosoils. In the section, floodplain sediments usually regularly replace channel facies during their lateral migration. The association with the facies of the breakout cone and the peripheral shaft is typical.

2.4. Lacustrine (lemnic) sediments

The deposits of the drainless or weakly flowing lakes of the alluvial plain are represented by a very thin material, mainly clayey and silty. A characteristic feature of lake sediments is the rhythmic, very sustained horizontal (band) layering, which occurs when sedimentation is calm in an isolated reservoir (Figure 6). Sometimes there are textures of landslides, incl. Convolutional stratification (Botvinkina, 1965) and cracks of sediment consolidation. The presence of traces of bioturbation and Flora fragments is not typical for lake deposits. Quite often thin interlayers and lenses of coarser (usually sandy) material indicate the occurrence of short-term currents or a splash of waves. Lake, deposits can occur with cryptocrystalline siderite concretions. Upward along the section, an increase in the clay component and carbonaceous inserts is usually observed, which is due to the overgrowth of the reservoir. Lake sediments are in association with marsh and flood plain facies.

2.5. Marsh sediments

The deposits of bogs are usually represented by homogeneous or layered coals, somewhat less often by carbonaceous argillites (Figure 7). Often there are siderites and carbonaceous-argillaceous siltstones. In coals of continental origin, in contrast to the coals of coastal marshes, the presence of pyrite is not typical. The thickness of the interlayers of coal is from tens of centimeters to the meters. Marsh sediments are associated with sediments of the floodplain, lake, and oxbow.

2.6. Deposits of breakthrough cones

Subfacies of breakout cones are formed during floods as a result of flooding of vast interspaces with river water. They are represented by fine- and fine-fine-grained, medium-sized sandstones with sustained unidirectional oblique layering, not infrequently rising ripples (Figure 8), which is the result of a very rapid, "avalanche" sedimentation of grains. Upward along the cut, a decrease in the size of the grains is usually observed, reflecting the gradual decrease in the strength of the flow. Layeredness is underlined by the addition of siderite or MSA. Sandstones can contain impurities of small clay intraclasts and coal in the form of thin interlayers, lenses and formless inclusions. The thickness of the sandstones of the subfacies of the breakout cones decreases from the first meters near the mouth of the breakthrough to their complete wedging to the inner parts of the floodplain. The lower boundaries of the interlayers, as a rule, are erosive. The sandstone layers of the subfacies of the breakout cones are usually found among the deposits of the floodplain.

2.7. Subfacial sedimentation at riverbeds

Sedimentation of the subfacies of the riverine valleys is formed during flood periods, when river waters carry a large amount of terrigenous material, leaving the channel to cover the floodplain, lose their speed and deposit the aleuritic-sandy material they attract on a narrow strip, forming a longshore bank (Reinek and Singh, 1981). Riverbed shafts are composed of fine- and fine-grained, poorly sorted oblique sandstones, often with a considerable amount of aleurite-clay material in the form of thin layers. The riverine valleys rise to 0, 5-1,0 m above the floodplain, in this connection, they bear the signs of drainage – frequent carbonized roots and traces of their presence, which break the primary textures. Often there are traces of landslides (Figure 9). The sediments of the riverine valleys are associated with the subfacies of the channel, floodplain, and near marshes.

CONCLUSIONS:

In the article considers the problem of identification of the continental group of facies in the Upper Jurassic deposits of the southeastern part of the West Siberian sedimentary-rock basin. When investigating this issue, was description of sedimentation environments. Determined that alluvial facies include an accretionary complex of streams and forelands, oxbows, floodplains, lakes, marshes, riparian ramparts, and breakthrough cones. On the basis of theoretical studies and regularities in the formation of facies of the alluvial complex of meandering-type rivers, the location, and diagnostics of facies were determined, and the geological structure of alluvial deposits in the southeast of the West Siberian oil and gas basin was analyzed. Determined that the most preferable for exploratory drilling are the deposits of essentially sandy subfacies – the accretion complex of river beds and braids, oxbow alluvium, deposits of breakthrough cones, sediments of the subfacies of the river valleys. They have improved filtration-capacitive properties, high saturation with hydrocarbons. They should be linked with the main prospects for discovering hydrocarbon deposits. These deposits are the main objects of setting up prospecting for oil and gas.

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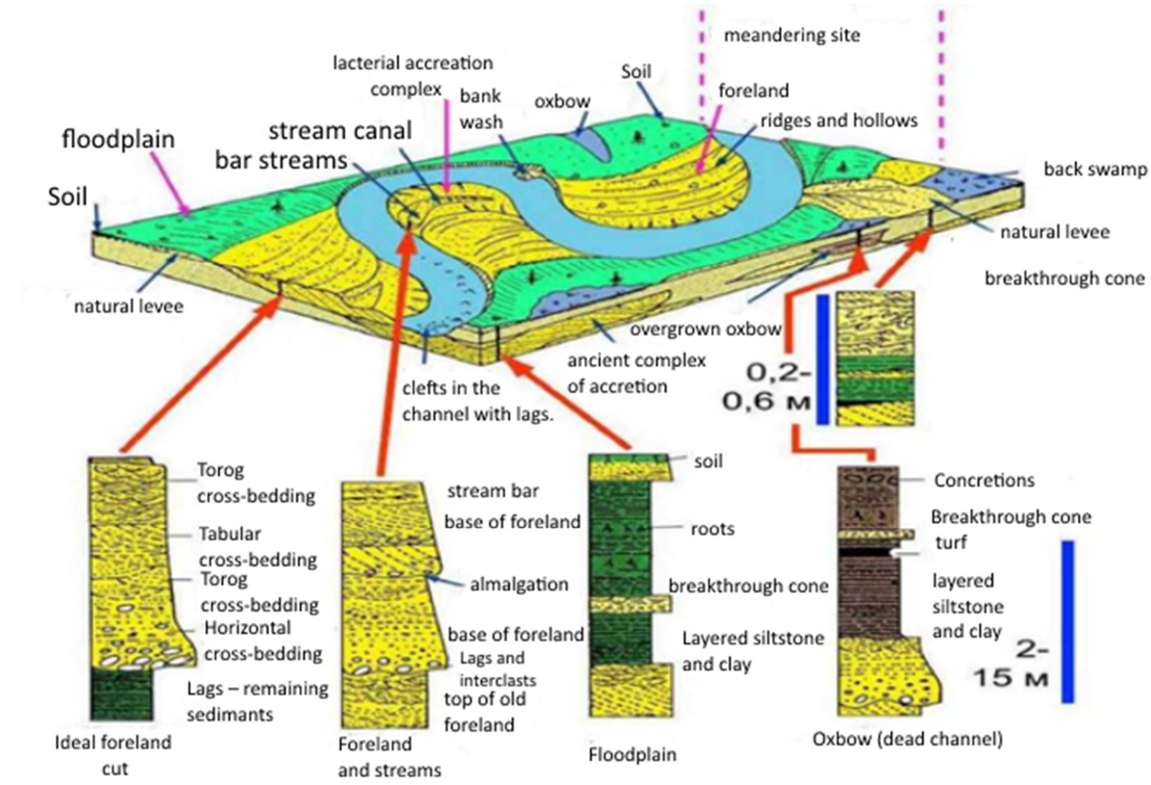

Figure 1.*The conceptual scheme of river structures with a meandering channel [5, 7]*

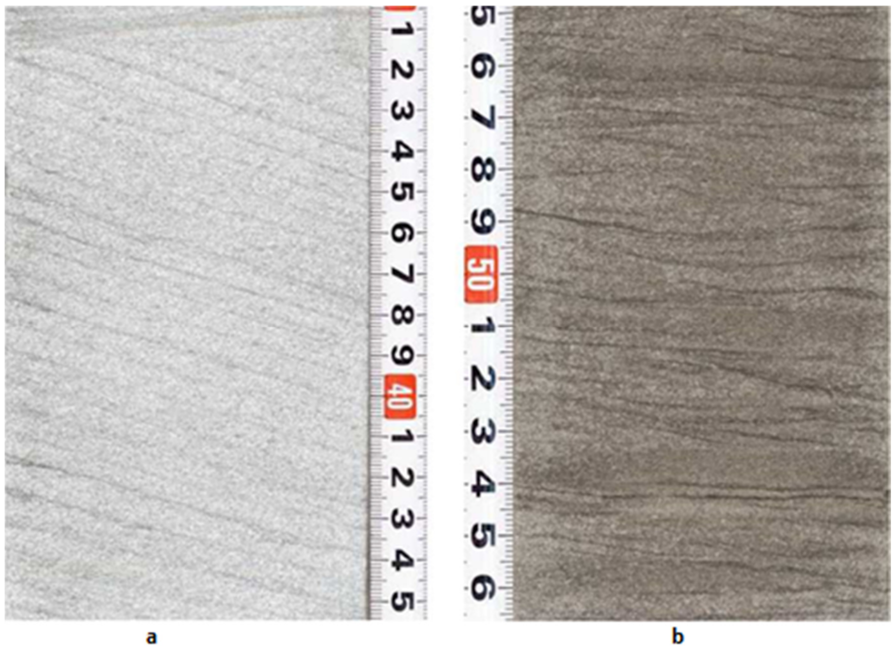

Figure 2*. The typical model of subfacies deposits of the accretion complex of channels and accretion complex of channels and forelands: a – medium-fine sandstone with sustained planar-parallel oblique lamination; b – sandstone with a thin unidirectional oblique layering of ripples*

a b

Figure 3.*Plantar parts of channel incisions: a – sandstone with inclusions of gravel, coalified wood residues, clay intraclasts; b – medium-coarse-grained coarse-grained sandstone with gravel-pebble fragments*

a b

Figure 4. *Typical model of deposits of the subfacies of the Oxbow: a – siltstone with numerous carbonified roots (primary textures are not preserved); b – siltstone with numerous carbonated roots (primary textures are not preserved)*

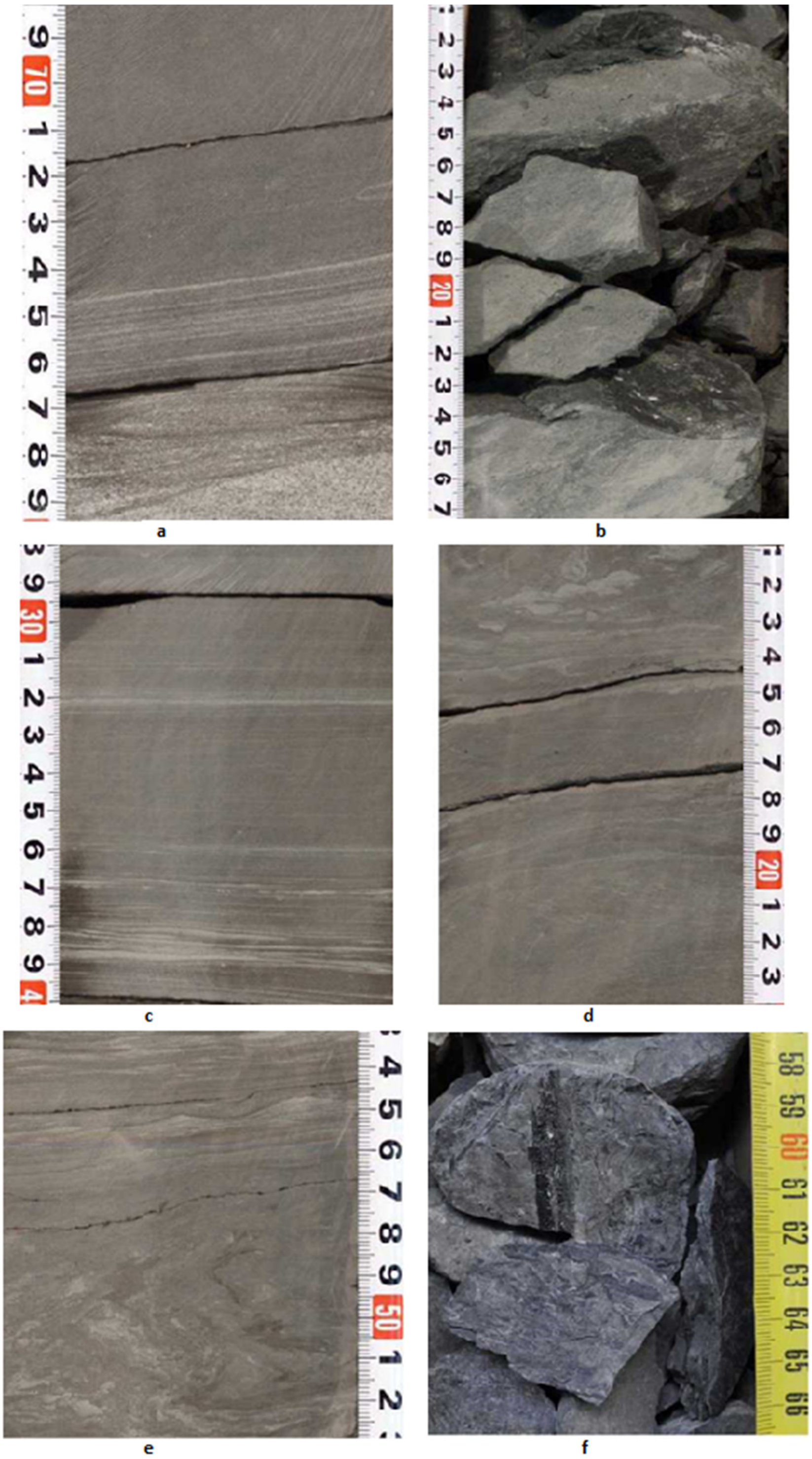

***Figure 5**. Typical model of depositions of the subfacies of the floodplain: a – clayey siltstone with seasoned thin horizontal stratification, overlapping oblique sandstone bed (bottom); b – argillite is not clearly laminated with weak traces of landslides, on the planes of cleavage – prints of flora and URD; c – aleurolite clayey horizontally layered with sparse, very thin interlayers and sandstone lenses; d – argillite clayey not clear with traces of landslides; e – argillite aleuritic horizontally layered with thin interlayers and sandstone lenses, in the lower and sole parts – traces of intensive landslides, possibly "rolls"; f – mudstone with numerous flora prints*

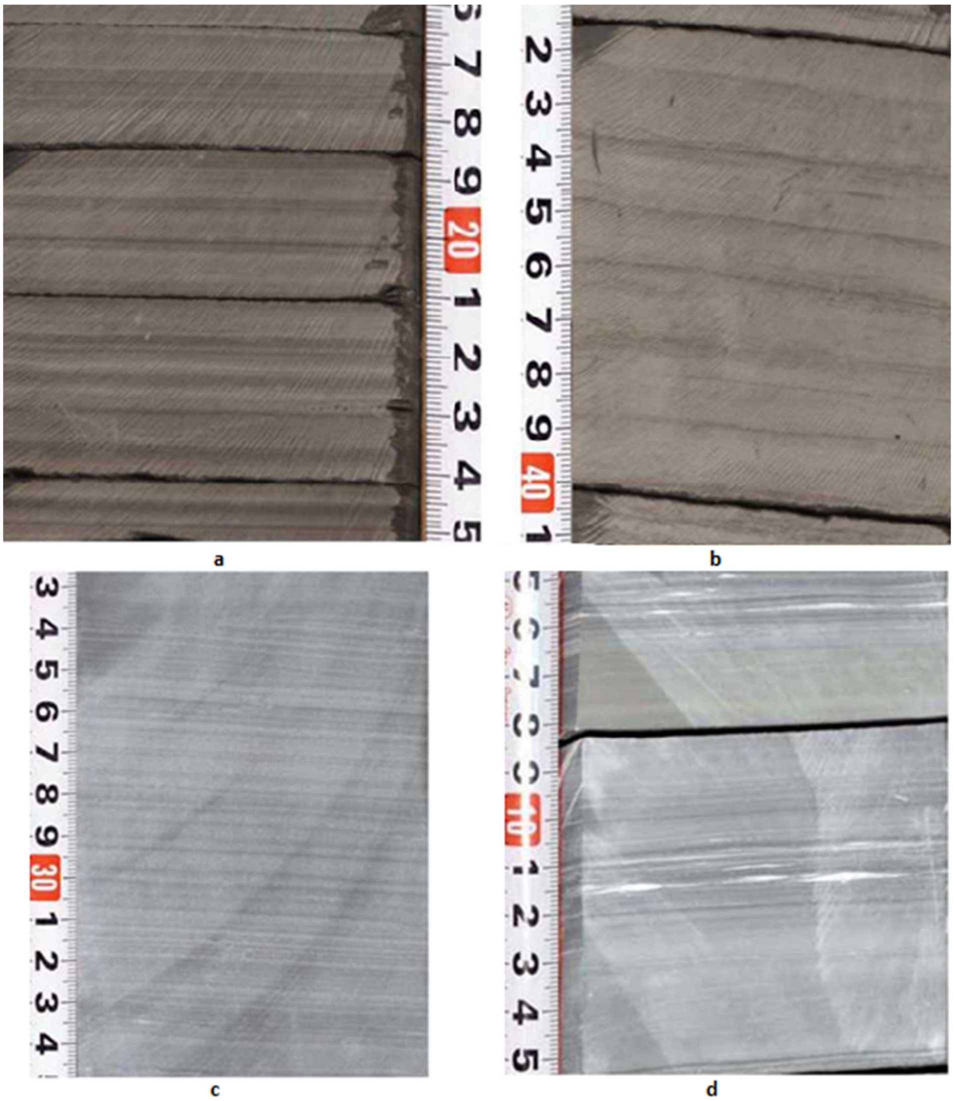

Figure 6. *Typical model of lacustrine deposits: a – argillite is carbonaceous with fine well-maintained horizontal (ribbon) layering; b – clay-argillaceous argillite horizontally layered, traces of frequent overgrowing of the lake in the form of carbonaceous puffs and traces of the presence of plant roots; c – clayey siltstone with fine well-maintained horizontal (ribbon) ply; d – silty mudstone with thin horizontal layering, individual sandstone lenses were formed as a result of short-time currents or splash of waves*

***Figure 7**.Typical model of marsh sediments*

***Figure 8**.Typical model of sediments of the breakthrough of the breakout cone: a – fine-grained sandstone with well-defined unidirectional oblique lamination, areas of ascending ripple; b – fine-grained sandstone with the unidirectional oblique layering of ascending ripples*

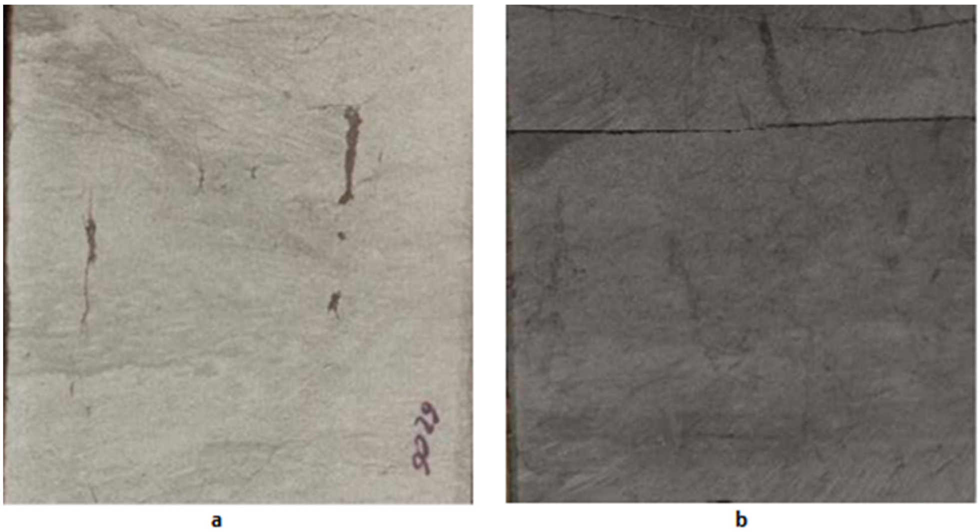

Figure 9*.Typical model of sediments of subfacies of riverbeds: a – fine-grained sandstone with traces of plant bioturbation; b – fine-grained sandstone with traces of plant bioturbation*