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ПОЙМЕННЫЙ АЛЛЮВИЙ БАССЕЙНА р. СЕЛЕНГИ: СТРОЕНИЕ, ВОЗРАСТ, ЭТАПЫ ФОРМИРОВАНИЯ

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Представлены новые данные о строении и возрасте аллювия пойм рек в бассейне р. Селенги. Выполнены описания разрезов, получена информация о составе речных осадков, радиоуглеродном возрасте. В бассейне р. Селенги выделяются два уровня пойм: низкие высотой до 2 м и высокие высотой 2–4 (5) м. Выявляются большие различия в строении и составе аллювия поймы в зависимости от морфологии долин рек, расходов воды, структурно-тектонических условий бассейнов. Установлено, что формирование отложений низких пойм в бассейне р. Селенги началось в позднем голоцене. Возраст отложений высокой поймы рек в бассейне р. Селенги – ранний-поздний голоцен. Выделены хронологические этапы осадконакопления и почвообразования. Установлено событие резкой смены литологического состава отложений, высоких паводков (3.8–3.4 тыс. кал. л. н.), выявлены криогенные деформации в верхнеголоценовом аллювии.

Ключевые слова: низкая пойма, высокая пойма, аллювий, осадконакопление, почвообразование, голоцен, бассейн р. Селенги

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1. INTRODUCTION

Rivers are a dominant feature of most landscapes; therefore fluvial sediments are widespread. Fluvial deposits are represented by a continuum of sediment types (Shantser, 1951; Lazarenko, 1964) that range from clay– to gravel–size particles, and include both mineragenic and organic deposits. Distinctive features of river sediments are good sorting, roundness, horizontal and oblique bedding depending on sedimentary environments. Fluvial sediments provide an important link between weathering and slope processes in source areas as well as sedimentation processes within depositional basins (Allen, 1965). In this regard, much attention is paid to the study of alluvium (Nikolaev, 1947; Lamakin, 1948; Lavrushin, 1966). There are numerous studies of forming conditions, structure and age of alluvium on the territory of Baikal region and Mongolia (Ravskii, 1972; Logachev et al., 1964; Bazarov, 1968; 1986; Tseitlin, 1979; Devyatkin, 1981; Endrikhinskii, 1982; Konstantinov, 1994; Mats et al., 2001; Karasev, 2002; Lehmkuhl et al., 2011). At the same time, much less investigations is devoted to the study of floodplain deposits and the timing of their accumulation in the Selenga river basin (Ravskii, 1972; Bazarov, 1968; 1986; Lehmkuhl et al., 2011). Given that floodplains are among the most dynamic landforms, this information may shed light on the response of river systems on the impacts of climate changes (Törnqvist et al., 2015; Malsy et al., 2017) and permafrost dynamics (Moore et al., 2009; Törnqvist et al., 2015) during the Holocene.

The aim of this study is to assess of the chronological framework of floodplain deposits accumulation in the Selenga river basin as a reflection of the dynamics of hydrological conditions during the Holocene.

2. OBJECTS AND METHODS

Selenga River is most important tributary of Lake Baikal, which contributes about 50 to 60% of its surface water influx. Moreover, the Selenga's 447 060 km^2 watershed covers 82% of the Lake Baikal basin (Nadmitov et al., 2014), which means that any environmental changes along the Selenga and its tributaries may ultimately impact Lake Baikal.

Floodplains are one of the most common landforms of river valleys in the Selenga basin. They have different height (0.5–5 m), structure and age of deposits. On small rivers, floodplain heights do not exceed 1–3 m, on large rivers they reach 4–5 m. There is

Fig. 1. Location of the study territory and investigated floodplain sections.
Рис. 1. Местоположение исследуемой территории и изученных разрезов пойм.

a low (rarely low—medium) floodplain up to 2 m high and a high 2—4(5) m floodplain (fig. 1). Both the consistency of the height marks of the floodplain along the river valleys and significant differences in different parts of the valley are noted. The width of floodplains varies from 1—10 m in mountainous areas on small rivers to several km in large river valleys and basins. The floodplains are often leaning against the first river terraces (5—7 m high).

The study territory is located in Selenga middle mountains and Mongolia (fig. 1).

A detailed morphogenetic and stratigraphic description of floodplain deposits as well as sampling for further laboratory studies were carried out during the fieldworks. The sections are located within the floodplains of different heights. To identify the chronology of the formation of deposits of low floodplains, the structure of the floodplain (1—2 m high) on the right bank of the Tarbagatayka River was studied near the village Burnashevo (fig. 1, tabl. 1). The Tarbagatayka River flows in the Kuitun intermountain depression. The landscape and climatic conditions of this territory are described in detail earlier (Ryzhov, Golubtsov, 2017; Ryzhov et al., 2021). In addition, sections of low floodplains up to 1.5 m high were studied in the foothills of the Khangai ridge (Mongolia) in the upper reaches of the Orkhon River (fig. 2, tabl. 1).

To reveal the structure and chronology of the formation of high floodplains, the floodplain deposits of the Itantsa and Il'ka rivers (Selenga middle mountains) were studied. In addition, a high floodplain was studied on the right bank of the Boroo-Gol River (left tributary of the Kharaa-Gol River, Mongolia). The rivers are characterized by different hydrological regimes and structural-tectonic conditions. The Itantsa and Il'ka rivers flow, respectively, in the Itantsa and Il'ka basins. Section of the high floodplain of the Boroo-Gol River (Shivert-Gol) is located in an intermountain depression.

Under laboratory conditions, soil and sediment samples were air-dried, crushed, and sieved through a 1 mm sieve. The total organic carbon content was determined by the method of wet combustion according to Tyurin. The determination of particle size distribution was carried out on the basis of an average sample in stagnant water using the pipette method. The age of soils and sediments was determined by the radiocarbon method with scintillation measurement of ^{14}C activity at St. Petersburg State University and at the Institute of Geology and Mineralogy of the Siberian Branch of the Russian Academy of Sciences by the carbon of humic acids. Radiocarbon dates were calibrated using the IntCal20 scale (Reimer et al., 2020).

3. RESULTS

3.1. Structure of sediments and chronology of sedimentation on low floodplains

3.1.1. Tarbagatayka floodplain. Following horizons are distinguished (from top to bottom) in the section of the low floodplain (1—1.5 m) of the Tarbagatayka river (fig. 2):

— brown sandy loam silty enriched in organic matter with coals (0—16 cm);

— brown sandy loam and fine-grained sands with the inclusion of medium-coarse-grained sands (16—26 cm);

— alternation of dark brown sandy loam, fine-grained light brown sands with the inclusion of medi-

Table 1. Radiocarbon and calibrated age of floodplain sediments in the Selenga river basin
Таблица 1. Радиоуглеродный и календарный возраст пойменных отложений в бассейне р. Селенги

Dated material	Depth, sm	Lab. number	^{14}C Age, years BP	Cal. years BP (±1σ)
Low floodplain (1–1.5 m) Tarbagatayka River, 51°27′11.5″ N, 107°22′07.3″ E, 582 m				
Humic sandy loam, charcoal	43–46	LU-9339	2580 ± 230	2616 ± 267
Humic sandy loam, charcoal	54–56	LU-9340	1890 ± 70	1798 ± 81
Humic sandy loam	60–63	LU-9387	860 ± 130	757 ± 78
Low floodplain (1.5 m) Orkhon River (Mongolia), 47°24′06.8″ N, 102°51′51.0″ E, 1468 m				
Humic sandy loam	13–17	LU-9820	1380 ± 120	1288 ± 112
Humic sandy loam	59–63	LU-9821	2030 ± 140	1985 ± 164
Humic sandy loam	88–94	LU-9822	2130 ± 110	2085 ± 96
High floodplain (1.5–2 m) Itantsa River, 52°10′30.1″ N, 107°31′49.8″ E, 500 m				
Humic peaty loam	115–120	SOAN-9761	3120 ± 65	3319 ± 79
High floodplain (2.5–3 m) Boroo-Gol River, 48°25′26.2″ N, 106°11′42.7″ E, 1050 m				
Humic loam	3–7	LU-9814	δ^{14}C=1.57 ± 0.83%	1954–1958 гг.
Humic loam	14–17	LU-9815	1640 ± 100	1507 ± 101
Humic loam	26–31	LU-9816	1940 ± 120	1856 ± 143
Humic loam	114–120	LU-9342	3340 ± 220	3615 ± 270
Humic loam	196–204	LU-9817	4050 ± 110	4533 ± 118
High floodplain (2.5–3 m) Il'ka River, 51°41′43.9″ N, 108°37′20.3″ E, 629 m				
Humic sandy loam	10–15	SOAN-9855	1930 ± 120	1857 ± 145
Humic sandy loam	27–32	SOAN-9856	2535 ± 105	2618 ± 133
Humic sandy loam	40–45	SOAN-9857	3200 ± 150	3410 ± 182
Humic sandy loam	45–50	SOAN-9858	3400 ± 300	3709 ± 375
High floodplain (2.5–3 m) Il'ka River, 51°41′58.2″ N, 108°37′26.5″ E, 625 m				
Humic sandy loam	59–67	SOAN-9859	275 ± 40	357 ± 71
Humic sandy loam	87–96	SOAN-9860	800 ± 180	783 ± 138

um-grained sands and thin (1–3 cm) interlayers of humus dark brown to black sandy loam with coals (26–63 cm);

– fine-grained light brown sands with the inclusion of medium and coarse-grained sands and coals (63–93 cm);

– grayish-brown fine–grained sands with coal inclusions (93–103 cm).

Three radiocarbon ages were obtained from the 26–63 cm layer (tabl. 1). The youngest one refers to the lower Ah layer. An inversion of radiocarbon ages occurs up the section. We consider this layer of sediments to be the result of the accumulation of products of runoff and erosion of soils from the watershed. The Ah layer at depths of 60–63 cm is located on sandy alluvium and reflects, in our opinion, the real time of its formation. In accordance with the structure and the obtained radiocarbon age the following stages of the formation of the studied deposits are assumed:

– accumulation of gray and light brown sands with the inclusion of coals (63–103 cm) > 0.84 kyr BP;

– accumulation of fine and medium-grained alluvial sands and thin layers of sandy loam enriched in organic matter (26–63 cm) 0.84–0.34 kyr BP;

– accumulation of fine-grained sands and sandy loams with the inclusion of medium-grained sands (16–26 cm) 0.34–0.21 kyr BP;

– accumulation of sandy loams enriched in organic matter with coal inclusions (0–16 cm) <0.21 kyr BP. This stage of sedimentation is associated with modern soil formation and sediment inflow from slopes as a result of soil erosion during agricultural land use in the last 250 years.

3.1.2. Orkhon floodplain. In the structure of the low floodplain of the Orkhon river the following horizons are distinguished (fig. 2) (from top to bottom):

– brown humic sandy loam with small pebbles (0–12 cm);

– grayish-brown sandy loam with Fe redox features (12–33 cm);

– grayish light brown sands with inclusions of clastic inclusions (gruss) and gravel (33–39 cm);

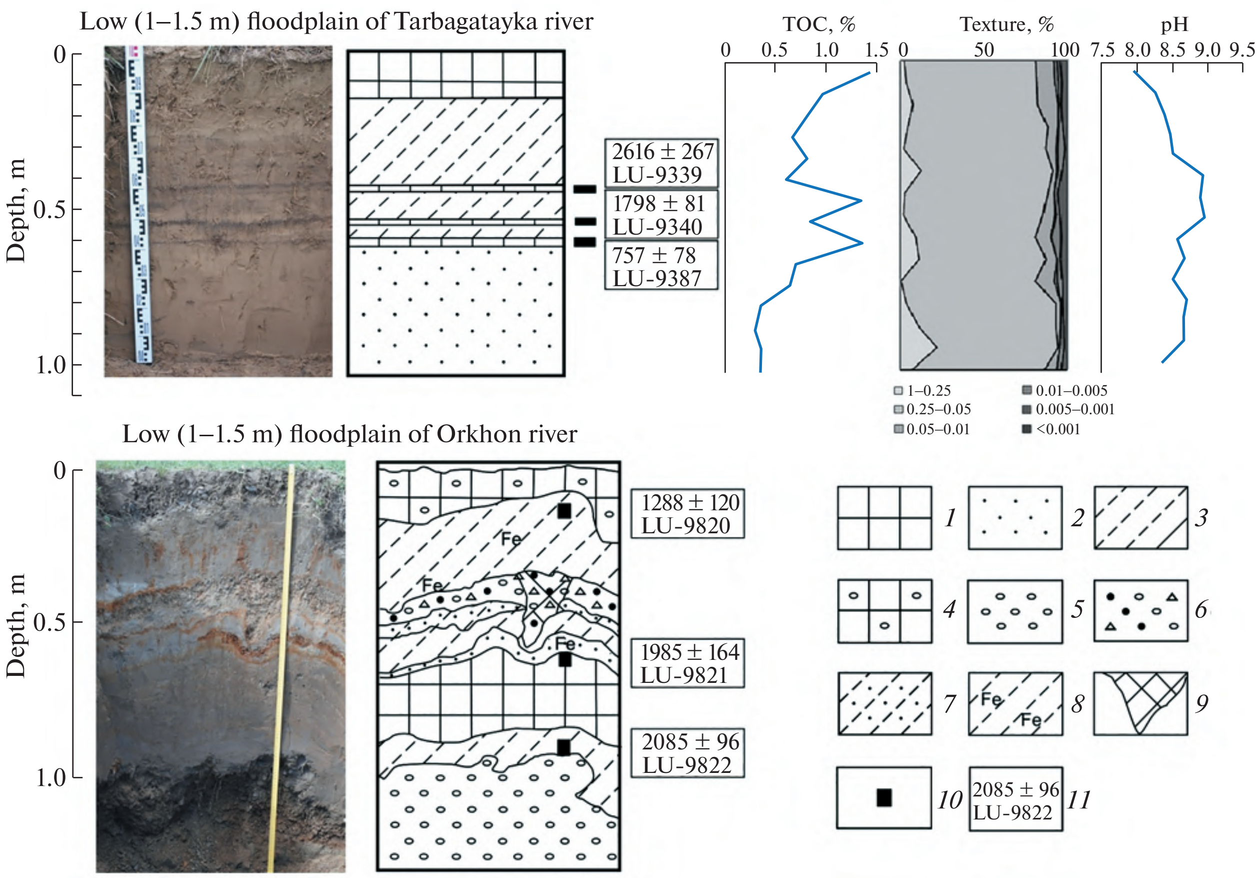

Fig. 2. Structure and calibrated age of studied low floodplains.

1 – modern and buried soils; *2* – fine sands; *3* – sandy loams; *4* – soils with pebble inclusions; *5* – gravels and pebbles; *6* – sands with dress and gravels; *7* – sandy loam with sand; *8* – sandy loam with iron redox features; *9* – sands with pebbles and gravels; *10* – ground wedges; *11* – places for radiocarbon sampling; *12* – calibrated age and sample lab number.

Рис. 2. Строение и календарный возраст отложений низкой поймы (1–2 м) рек в бассейне р. Селенги.

1 – современные и погребенные почвы; *2* – пески мелкозернистые; *3* – супеси; *4* – почвы с включением гальки; *5* – гравий с галькой; *6* – песок разнозернистый с включением дресвы и гравия; *7* – супеси с включением песка; *8* – супеси с пятнами, линзами и прослоями ожелезнения; *9* – пески разнозернистые с гравием и галькой; *10* – грунтовая жила; *11* – интервал отбора проб на ^{14}C; *12* – календарный возраст и лабораторный номер образца.

– sandy loam gray whitish with sand inclusions (39–44 cm);

– whitish sandy loam with Fe redox features in the top of the layer (44–51 cm);

– fine-grained yellowish–brown sands with Fe redox features (51–58 cm);

– dark brown sandy loam enriched in organic matter and Fe redox features (58–81 cm);

– gray sandy loamy gleyed with Fe redox spots (81–94 cm);

– gravels and pebbles (94–130 cm).

The horizontal bedding of the layers is disturbed by cryogenic deformations. At 39–60 cm depths a ground wedge (tessellon) up to 14 cm wide on top is distinguished. It is composed mainly of sands with the small clastic inclusion (gruss) and gravel. The time of formation and filling of the wedge-shaped cryogenic structure is about 1.7–1.6 kyr BP. Layers at depths of 39–60 cm have a wavy bedding, indicating deformations during seasonal freezing and thawing of wet sandy loams and fine-grained sands, underlain by humic sandy loams.

The following stages of accumulation of deposits are distinguished:

– accumulation of channel alluvium (94–130 cm) >2.1 kyr BP;

– pedogenesis (58–81 cm) 2.1–1.95 kyr BP;

– accumulation of fine–grained sands (51–58 cm) 1.95–1.84 kyr BP;

– accumulation of gray whitish sandy loam (44–51 cm) 1.84–1.73 kyr BP;

– accumulation of gray whitish sandy loams with the inclusion of inequigranular sand (39–44 cm) 1.73–1.65 kyr BP;

– accumulation of sands with the small clastic inclusion (gruss) and gravel (33–39 cm) 1.65–1.55 kyr BP, indicating an increase in the water level of the river and high floods;

– accumulation of gray sandy loam with Fe redox features and enriched in organic matter (12–33 cm) 1.55–1.0 kyr BP;

– accumulation of humic sandy loam with pebble inclusions (0–12 cm) during the last 1 thousand years.

3.2. Structure of sediments and chronology of sedimentation on high floodplains

3.2.1. Itantsa floodplain. In the section of a high floodplain (1.5–2 m) on the right bank of the Itantsa river floodplain (0–120 cm) and channel alluvium (120–150 cm) are distinguished (fig. 3).

Floodplain sediments are represented by the following horizons:

– dark brown sandy loam enriched in organic matter with small pebbles (0–10 cm);

– sandy loams with iron redox features (10–33 cm);

– fine and medium-grained sand with the gravel inclusions (33–46 cm);

– light peaty loams dark brown (46–75 cm);

– medium peaty loams with lenses of medium to fine-grained sands and iron redox features (75–120 cm);

– inequigranular sands with gravel and pebble inclusions (120–170 cm).

Radiocarbon dating 3120±65 (SOAN–9761) was obtained from the bottom of loams from a depth of 115–120 cm (tabl. 1). A cryogenic wedge up to 25 cm vide is located at 36–65 cm depths. The time of its formation and filling is about 0.8–0.5 kyr BP. The following stages of formation of floodplain deposits are distinguished:

– accumulation of channel alluvium (120–170 cm) >3.4 kyr BP;

– accumulation of peaty loams (46–120 cm) 3.4–1.3 kyr BP;

– accumulation of inequigranular sands with gravel inclusions (34–46 cm) 1.3–0.9 kyr BP;

– accumulation of brownish sandy loams (10–33 cm) 0.9–0.3 kyr BP;

– modern pedogenesis (<0.3 kyr BP).

3.2.2. Boroo-Gol floodplain. The following deposits and stages of their accumulation are distinguished from top to bottom (fig. 3):

– the upper part (0–31 cm) represented by the modern soil profile is composed of light brown sandy loam (1–3 cm), dark brown to black loams (3–7 cm), light silty brown loam (7–14 cm), light dark brown loam (14–31 cm). The formation of this part is divided into four stages: accumulation of humus light loams (14–31 cm) 1.9–1.3 kyr BP; accumulation of aeolian light brown silty loams (7–14 cm) 1.3–0.3 kyr BP; soil formation stage (3–7 cm) 300–40 yr BP; accumulation of silty aeolian sandy loam (1–3 cm) during the last 40 years.

– the second unit (31–74 cm) is represented by light loams and sandy loams of gray and dark gray color, uneven occurrence of layers of different lithological composition. The accumulation of deposits is confined to the time interval of 2.8–1.9 kyr BP;

– the third sediment unit (74–130 cm) is represented by dark gray humus loams that accumulated 3.8–2.8 kyr BP;

– below (130–175 cm) lie obliquely layered light loams with interlayers and lenses of brown sandy loam with sand inclusions. The color of deposits varies from brown, gray to dark gray. The thickness of the layer is not constant and varies from 30 to 45 cm with a slope downstream of the river. The accumulation of sediments based on the obtained radiocarbon dates took place 4.3–3.8 kyr BP;

– at depths of 175–204 cm (the fifth sediment member), light gray and dark gray loams occur with interlayers and lenses of gray and brown clayey and inequigranular sand, which accumulated 4.6–4.3 kyr BP;

– below (204–224 cm) there is an alternation of interlayers of gray and dark gray light loam and interlayers of grayish–brown sand with weathered clastic inclusions and a rare pebble inclusions. The accumulation of these deposits is confined to the interval of 4.8–4.6 kyr BP.

3.2.3. Il'ka floodplain (Il'ka 1). The sediment thickness of the Il'ka-1 section is about 1.5 m. The stages of sediment formation and pedogenesis have been identified. For section four radiocarbon dates were obtained at 10–50 cm depths in the range of 1.8–3.7 kyr BP (fig. 3, tabl. 1). Following horizons are distinguished in the section from top to bottom:

– dark brown to black humus peaty sandy loam (0–48 cm), accumulated during the last 3.4 kyr BP;

– alternation of fine to medium grained sands (48–80 cm), formed 3.4–4.2 kyr BP;

– coarse sands with small clastic inclusions (gruss), gravel and small pebbles (80–150 cm), representing the channel facies of alluvium and formed in the first half of the Holocene.

A ground wedge (tessellon) up to 40 cm wide with inclined and vertical occurrence of layers is located at 45–140 cm depths. The width of the wedge is 20–40 cm at 40–70 cm depths. It becomes thinner to 1–10 cm below. The wedge is covered with humus sandy loams younger than 3.4 kyr BP. At the same time, the wedge is filled by fine sands underlying the humus sandy loam the formation time of which is estimated at 3.8–3.4 kyr BP. The time of formation and filling of a ground wedge is about 3.8–3.6 kyr BP. Sands with small clastic inclusions and gravel occurred below in-

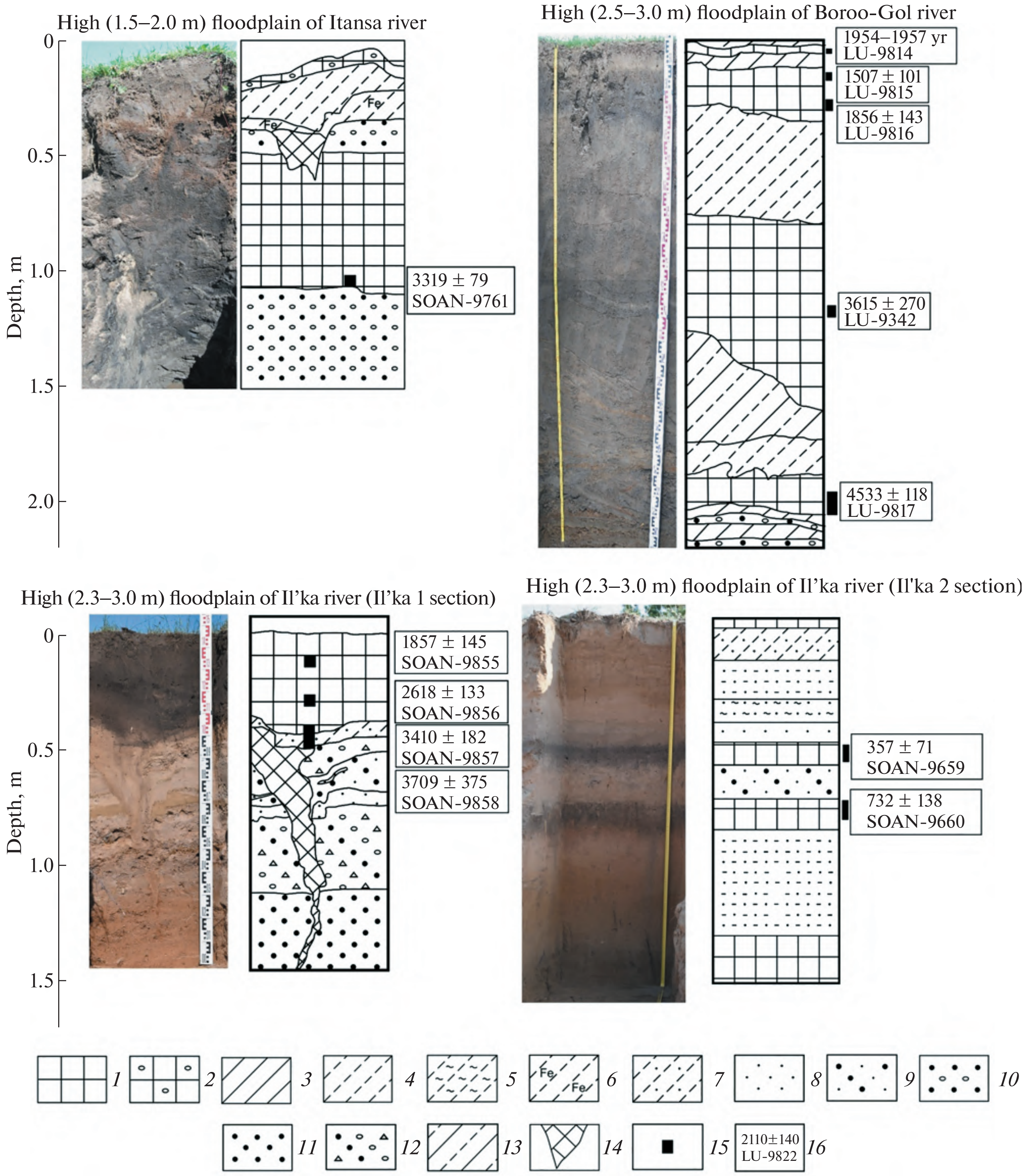

Fig. 3. Structure and calibrated age of high floodplain deposits of Selenga river basin.

1 – modern and buried soils; *2* – soils with pebble inclusions; *3* – loam; *4* – sandy loam; *5* – loess-like sandy loam; *6* – sandy loam with iron redox features; *7* – sandy loam with sand inclusions; *8* – fine sand; *9* – coarse to medium sand; *10* – sand with gravel and pebbles; *11* – coarse sands with gravels and pebbles; *12* – coarse sand with small clastic inclusions, gravels and pebbles; *13* – loams with interlayers of sandy loams and sands; *14* – cryogenic wedges; *15* – sampling places for radiocarbon dating; *16* – age and sample lab number.

Рис. 3. Строение и календарный возраст отложений высокой поймы (2–3 м) рек в бассейне р. Селенги.

1 – современные и погребенные почвы; *2* – почва с включением гальки; *3* – суглинок; *4* – супесь; *5* – супесь пылеватая карбонатная; *6* – супесь ожелезненная; *7* – супесь с мелкозернистым и тонкозернистым песком; *8* – песок мелкозернистый; *9* – песок разнозернистый; *10* – песок крупнозернистый; *11* – песок разнозернистый с включением гравия; *12* – песок разнозернистый с дресвой и гравием; *13* – гравий с галькой; *14* – грунтовая жила; *15* – интервал отбора проб на ^{14}C; *16* – календарный возраст (кал. л. н.) и лабораторный номер образца.

dicates powerful floods. The time of their manifestation is about 4.2–3.8 kyr BP.

3.2.4. Il'ka floodplain (Il'ka 2). The second section (Il'ka 2) with a thickness of 1.72 m was located 460 m north of the Il'ka 1 section on a high floodplain 2.5–3 m high with aeolian blowing sands (fig. 3, tabl. 1). Two radiocarbon dates were obtained for described section at depths of 59–67 and 87–96 cm in the time frames of 357–782 yr BP.

The following horizons are identified in the section:

– partially deflated Ah horizon of modern soil (0–4 cm), represented by dark brown sandy loam and formed over the past 70 years;

– gray-brown sandy loam (4–20 cm), formed as a result of aeolian activity 110–70 yr BP;

– fine-grained clayey, dark gray-brown, layered, alluvial sand (20–38 cm), formed 220–110 yr BP;

– fine-grained silty, dark brown sand with coal inclusions up to 3 mm, layered (38–49 cm), formed as result of aeolian activity 280–220 yr BP;

– fine-grained grayish-brown sand (49–58 cm), formed 330–280 yr BP;

– dark gray sandy loams enriched in organic matter with coal inclusions (58–69 cm), accumulated 450–330 yr BP;

– fine- and medium-grained yellowish-brown sand (69–86 cm), accumulated 700–450 yr BP;

– grayish-brown sandy loam with coal inclusions (86–100 cm), formed under conditions of lower flood heights and a stable subaerial surface 900–700 yr BP;

– fine-grained clayey, yellowish-light brown sands with humus streaks and coal along plant roots (100–156 cm), formed 1.7–0.9 kyr BP;

– fine-grained clayey sand gray to dark gray enriched in organic matter with coal inclusions along the plant roots (156–172 cm), accumulated 2.0–1.7 kyr BP.

4. DISCUSSION

On the one hand, the obtained data on the age and stages of accumulation of the floodplain deposits, generally confirm the previously obtained data on the time of formation of alluvium of the low (low and middle) and high floodplains (Ravskii; 1972; Bazarov, 1968; 1986). On the other hand, they specify the age and chronology of the stages of alluvium accumulation during the time of floods and soil formation when they decrease. The floodplains of large rivers are characterized by Holocene age (Endrikhinskii, 1982). Floodplain deposits of rivers of smaller orders accumulated mainly during the second half of the Holocene (Endrikhinskii, 1982). The alluvium of the high floodplain accumulated in the first half – the middle of the Holocene, while the low floodplain accumulated in the second half of the Holocene according to (Bazarov, 1986).

The stage of a sharp change in the lithological composition, high floods on rivers aged 3.8–3.4 have been identified in the floodplain deposits in Selenga river basin. For example, the bottom of the floodplain alluvium represented by peat has an age of 3.4 kyr BP on the Itantsa floodplain. There is unconformity boundary below determined by stage of erosion with interbedded sands and gravels, indicating strong floods and incision of the river. In the section of the high floodplain of the Boroo-Gol River oblique and wavy layered light loams with interlayers and lenses of sandy loam and sands aged 4.3–3.8 kyr BP occurs under humus light loams aged 3.8–2.8 kyr BP with sharp erosional boundary. Consequently, high floods and erosion were observed about 3.9–3.7 kyr BP. Gravel layers in the bottom sediments of Mongolian lakes with an age of about 3.6 kyr BP were revealed by V.P. Vipper et al. (Vipper et al., 1989). The authors attribute these deposits to the stage of heavy rains and the washing of gravel into lakes. Wet period 4.4–3.4 kyr BP identified according to the palynological and diatom analysis of peatlands in Northern Mongolia (Fukumoto et al., 2014). High Baikal stand was 3.7–3.6 kyr BP according to geoarchaeological data (Vorobieva, Goryunova, 2013). An anomalously high runoff into the Baikal lake (more than 250 km^3/year compared to average present-day values of 57 km^3/year) has been reconstructed 4.0–3.9(3.8) kyr BP (Goldberg et al., 2005).

Traces of high floods 3.8–3.4 kyr BP found in many river basins of Eastern Siberia. On the floodplain (6–8 m) of Muya river (near Ust'-Muya settlement) the floodplain facies of alluvium has a thickness of 1 m (layers 1–2). The exposed unit of the channel alluvium (layers 3–4) is 4.8 m (Kulchitskii et al., 1982). Layer 2, represented by siltstones with fine–grained sand lenses and inclusions of charcoal 0.75 m thick, is associated with large floods (Kulchitskii et al., 1982). A radiocarbon date of 3280 ± 35 years BP (SOAN–1599) was obtained from the top of layer 3 based on wood remains, which corresponds to 3514 ± 42 cal. years BP.

Traces of high floods in the interval of 4.4–3.4 kyr BP were found on the Ilya and Aga rivers in Transbaikalia (Bazarova et al., 2014). Phases of abnormally high river levels in the upper and middle reaches of the Yenisei river were identified (Yamskikh, 1993) about 4.0–3.5 and 3.3–2.7 thousand years ago (4.5–3.8 and 3.5–2.8 kyr BP). On the East European Plain palaeofluvial episodes of low (4.6–3.5 kyr BP) and high (3.5–1.9 kyr BP) fluvial activity were revealed (Panin, Matlakhova, 2015). Approximately ~3.9–3.8 kyr BP began increase in the frequency of high palaeofluvial activity events and decrease palaeofluvial events of low fluvial activity (Panin, Matlakhova, 2015).

5. CONCLUSIONS

1. Low and middle floodplains up to 2 m high and high floodplains (2–4(5) m high) are distinguished in the Selenga river basin. Floodplain deposits were formed in various dynamic conditions, have a horizontal, wavy, inclined bedding and are represented by sediments of channel, floodplain and oxbow facies of different thickness and grain size composition. Organogenic deposits (sandy loam and loam enriched in organic matter, peat bogs) accumulated on the floodplain with a decrease in river flood intensity.

2. The research results indicate that the low floodplain began to form in the Late Holocene. The channel alluvium of the low floodplains is older than 2.1 kyr, floodplain alluvium younger than this age. The soils are dated to less than 2.1 kyr BP.

3. A high floodplain is composed of Middle–Late Holocene alluvium and leans against the first river terrace. It is separated from the low floodplain by a ledge 0.5–2 m high. The formation time of the ledge is 3.8–3.5 kyr BP. The channel alluvium of the high floodplains is of Early Holocene age. The soils of the high floodplain began to form from the second half of the Holocene based on the radiocarbon dating.

4. A stage of a sharp change in the lithological composition of deposits, high floods (3.8–3.4 kyr BP) was established.

5. Cryogenic deformations in the floodplain deposits of Selenga river basin associated with climate cooling and local environmental conditions during Late Holocene.

FLOODPLAIN ALLUVIUM IN THE SELENGA RIVER BASIN: STRUCTURE, AGE, FORMATION STAGES

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New data on the structure and age of alluvium of river floodplains in the Selenga river basin are presented. Based on the data of field and laboratory studies of floodplain sedimentary sections, data on the morphology, composition and radiocarbon age of river sediments were obtained. There are two main levels of floodplain in Selenga river basin: low (up to 2 m), high (2–4(5) m). The main differences in the structure and composition of floodplain alluvium are associated with the morphology of river valleys, differences in the dynamics of water discharge, structural and tectonic conditions of individual river basins. It was revealed that the formation of deposits of low floodplains in the Selenga river basin began in the late Holocene. The high floodplain sediments in the Selenga river basin are characterized by Early – Late Holocene age. The chronology of sedimentation stages and soil formation have been identified. The event of a sharp change in the lithological composition of deposits, high floods (3.8–3.4 kyr BP) was established, Cryogenic deformations in the Late Holocene alluvium have been revealed.

Keyworlds: low floodplain, high floodplain, alluvium, sedimentation, soil formation, Holocene, Selenga river basin

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