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# Biostratigraphy of the Upper Pleistocene (Upper Neopleistocene) of the Southern Urals

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ABSTRACT

This paper is a synthesis of the previously published and unpublished materials dealing with the stratigraphy of the Upper Pleistocene (Upper Neopleistocene according to the Russian stratigraphic scheme) of the Southern Urals. It is the second review about the characteristics of the Pleistocene deposits of the easternmost part of Europe. It follows a previous paper concerning the biostratigraphy of the Late Middle Pleistocene of this region. The deposits which constitue the regional stratigraphic units are characterized. The results of the mammalian, malacological and palynological investigations as well as the radiocarbon data provide the basis for the stratigraphical subdivision and the reconstruction of the palaeoenvironments. The main geological and biotical events of the Southern Urals region which took place during Late Pleistocene are characterized in the paper. Erosional processes became active at the beginning of Kushnarenkovo time when uplift took place in the Urals and when the Late Chosarian regression began on the Caspian Sea basin territory. Fluvial deposits can be observed at the base of the second terrace which developed above the floodplain. A soil was formed on the subhorizontal surfaces. Forest-steppe and steppe landscapes characterized this interval. The climate was warm and humid. The Saigatka horizon formed under cold conditions. Slope processes and solifluction were the main relief-forming processes and fluvial erosion processes became weaker. Floodplain sediments accumulated in the river valleys and formed the upper parts of the second terraces above the floodpain which were intensively eroded. The plains were covered by steppe and the mountainous areas were occupied by tundra and forest–tundra landscapes. The next erosional cycle began during the following Tabulda period, because of the lowering of base level of the erosion and increased uplift of the territory. The fluvial sediments now form the lower parts of the first terraces above the floodplain. A soil was formed on the watersheds. Sites contain Late Palaeolithic artifacts. The floral association was close to Southern Uralian flora of the present-day. The climate was moderately warm in the plains and drier and cooler in the mountains. The subsequent Kudashevo event can be correlated with the Late Glacial when the climate became colder. Loess-like sediments and floodplain deposits form the upper parts of the first terrace above the floodplain and cover the watersheds, where they contain cryogenic structures. The climate was moderately cold. Late Palaeolithic sites attributed to the Kudashevo time are known in the Southern Urals region. The stratigraphical positions of the main Upper Neopleistocene localities of the Southern Urals are discussed. The Southern Urals subdivisions are correlated with the Western European stratigraphical scheme (Eemian–Weichselian interval).



## 1. Introduction

During the Late Quaternary, as well as during all the Quaternary, the Southern Urals was characterized by continental climatic conditions and by tectonic activity. The region was a non-glacial area during the cold climate periods. Fluvial deposits containing organic remains represent the main elements in the palaeogeographical reconstructions and for correlation between the various sediment units. Deposits dating from the Upper Neopleistocene (a unit of the Russian stratigraphic scheme, equivalent to the Upper Pleistocene subseries; time interval 0.27–0.01 Ma) are locally preserved. The systematic study of the Neopleistocene deposits of the Southern Urals region has been carried out for more than 50 years. Over 50 key localities, expose the Upper Neopleistocene deposits. All these

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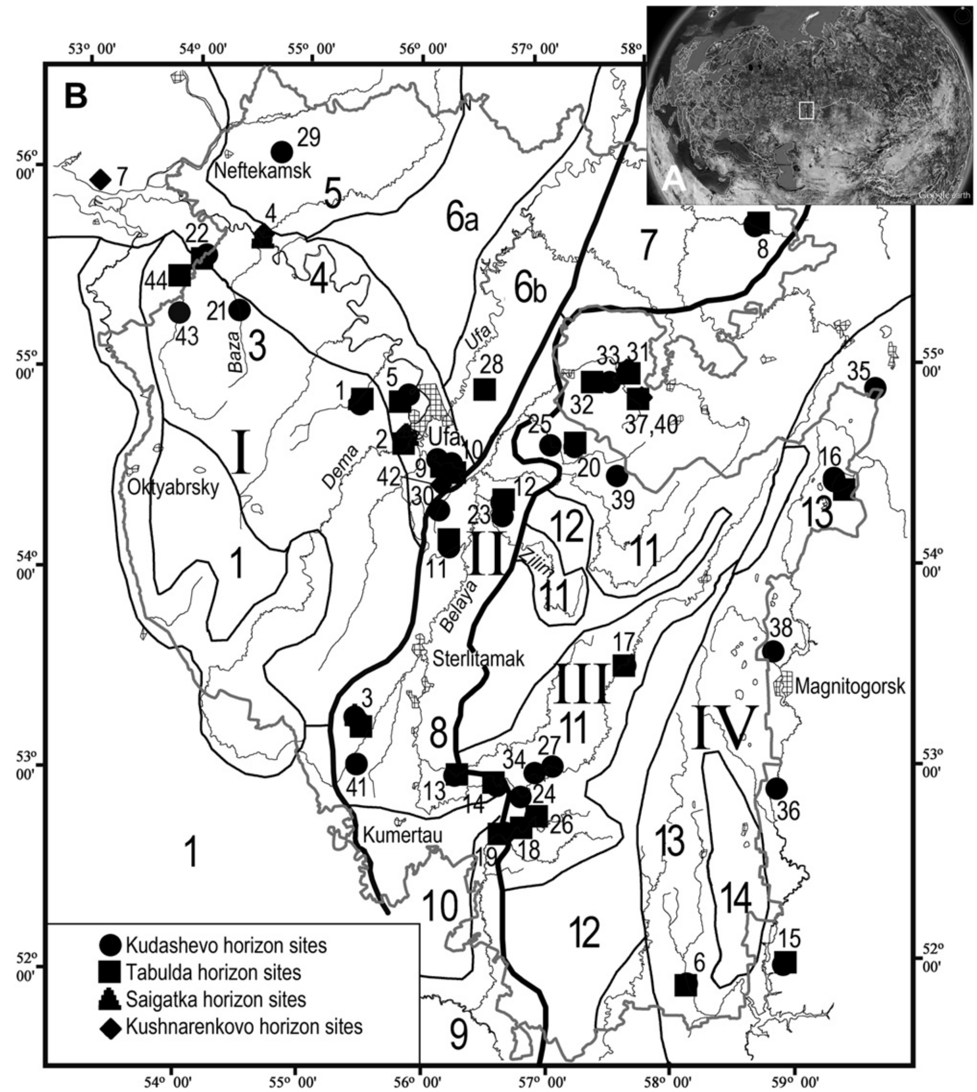



**Fig. 1.** General map (A) and location of the studied area showing the key Upper Neopleistocene sites (B). A – a general map followed the Google-earth. Legend: I–IV-s: I – Southeast of the Russian platform; II – Fore-Uralian; III – Uralian; IV – Trans-Uraltau; 1–14 – regions: 1 – Bugulma–Belebei Highland, Obshyi Syrt Highland (eastern part); 2 – Ik and Dema (upstreams) Rivers Basin; 3 – high left bank of the Belaya River (Syun' and Baza Rivers); 4 – Belaya River Basin from Ufa town to the river mouth; 5 – high right bank of the Belaya River (Bui and Bystryi Tanyp Rivers); 6a – Ufa River Basin (between the Krasnoufimsk city and the river mouth); 6b – western slope of the Ufimian Plateau; 7 – Yuryuzan and Ai Rivers Basin (56°–55° N); 8 – Belaya River Basin (including high right and left banks of the river) (55°–53° N); 9 – Sakmara and Ural Rivers Bassin (53°–52° 30′ N); 10 – Interfluves; 11 – Belaya River Basin with tributaries (between the upstream of the Belaya River and the Nizhnebikkuzino village); 12 – Interfluves; 13 – Ui, Sakmara, Ural Rivers Basin (from the upstream of these rivers to Kuvandyk town); 14 – Interfluves. Key Upper Pleistocene sites (small Arabic numbers): 1 – Sultanaevo; 2 – Voevodskoye; 3 – Tabulda; 4 – Chui–Atasevo III; 5 – Gornovo I, II; 6 – Burybai; 7 – Krasnyi Bor; 8 – Novobelokatai; 9 – Starye Kiishki; 10 – Kabakovo; 11 – Uteimullino II; 12 – Kuznetsovka; 13 – Basurmanovka; 14 – Nizhnebikkuzino; 15 – Tanalyk I, II; 16 – Ilchino I, II; 17 – Kaga; 18 – Syuren'; 19 – Mrakovo; 20 – Zapovednaya cave; 21 – Sultino and Yantuganovo (Baza River); 22 – Kipchakovo (Syun' River); 23 – Magash; 24 – Akbuta; 25 – Kalinovka II; 26 – Bajslan-Tash cave; 27 – Shulgan-Tash (Kapova) cave; 28 – Minzitarovo; 29 – Novokudashevo; 30 – Karlaman; 31 – Ignatievskaya cave; 32 – Asha I cave; 33 – Prizhim 2 cave; 34 – Maksyutovo Grotto; 35 – Ustinovo Grotto; 36 – Syrtinskaya cave; 37 – Serpievskaya 2 cave; 38 – Smelovskaya 2 cave; 39 – Verkhnaya cave; 40 – Serpievskaya 1 cave; 41 – Zlatoustovka; 42 – Chatra; 43 – Yabalakovo; 44 – Aktanyshbash.

sites are located in the Belaya River Basin and particularly in the terraces resting above the modern floodplain and in the caves of the mountainous part of the Southern Urals (Fig. 1).

## 2. Materials

Forty Upper Neopleistocene deposit localities amongst the 50 sites have been biostratigraphically investigated and described (Fig. 1). Sixteen and eighteen of these localities have yielded small (around 29,000 determinable bones) and large mammalian (more than 31,000 determinabled bones) fossils. A total of 22 localities contain mollusc shells (nearly 8000 mollusc shells or their identifiable fragments have been studied). Twenty-five localities display clear palynological characteristics.

## 3. Methods

The traditional methods of dispersal of sediments in water, using sieves with a mesh size of 0.8–1.0 mm), were used to recover the small-mammal, molluscan and plant remains (Zhadyn, 1952; Guslitcer, 1979; Sinitskikh, 1982; Agadjanian, 1987). Processing of the samples for the palynological analyses has been done using the standard methods described by Grichuk and Zaklinskaya (1948) and Pokrovskaya (1950). Species determination was done following Likharev and Rammelmeier (1952), Zhadyn (1952), Shileyko (1978, 1984), Gromov and Baranova (1981), Shileyko and Likharev (1986), Gromov and Erbaeva (1995), Nederlandse Fauna 2 (1998) and Kerney and Cameron (1999). The palaeontological collections are kept at the Institute of Geology of the Ufimian Scientific Centre RAS (Ufa) and at the Institute of Ecology of Plants and Animals of the Uralian branch of the RAS (Ekaterinburg). Radiocarbon dates were performed by geochronological laboratories of the Geological institute (GIN) of the RAS (Moscow), the Institute of Geography of the Saint-Petersburg university (LU) and the Institute of Geology of the Siberian branch (SOAN) of the RAS (Novosibirsk).

## 4. Stratigraphical subdivision of the Upper Neopleistocene

Upper Neopleistocene deposits are known in alluvial and subaerial (eluvial, colluvial and deluvial) facies in various places of the Southern Fore-Urals region. Local names have been used for the stratigraphical subdivisions. They incorporate the upper part of the regional stratigraphic scheme, in which Kushnarenkovo, Saigatka, Tabulda and Kudashevo horizons have been recognized. The correlation of the Southern Urals and Eastern European stratigraphical units is shown in Table 1.

### 4.1. *Kushnarenkovo Horizon*

This horizon (Danukalova, 2010) is named after Kushnarenkovo village (Bashkortostan Republic, Russia). The horizon is characterized by lacustrine-subaerial loam, fluvial gravel and sand, including 1) the second Voevodskoye hydromorphic soil (Voevodskoye, 0.6 m thick); 2) the third Sultanaevo soil (Sultanaevo, outcrop 107, 0.2 m thick) and 3) the third Chui–Atasevo soil (Chui–Atasevo III, 1.2 m thick) formed at the interfluves. The total thickness of the deposits is 0.2–0.85 m. The deposits rest on the lacustrine loam of the Elovka Horizon (Late Middle Pleistocene) and are overlain by lacustrine and diluvial silty loess-like loam and fluvial sand of the Saigatka Horison (Karmasan Suite) or by soil of the Tabulda Horison. Erosional intervals exist between them.

**Table 1**
Stratigraphic scheme of the Upper Neopleistocene of the Southern Urals region and correlation with schemes of other regions.

| Global Quaternary scheme (Gibbard and Cohen, 2008) | | | Marine isotope stages | Stratigraphic scheme of Russia (Zhamoida et al., 2006) | | | Southern Urals region (Yakhemovich et al., 1987, 1988; Danukalova, 2007, 2010) | | Eastern European platform (Shick et al., 2004) | | Urals (Stefanovsky, 1997) | | Lower Volga region (Shick et al., 2004) | | West European stratigraphic divisions (The Netherlands) (Zagwijn, 1996) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| System | Series | Subseries, stages | | Division | Subdivision | Link | Superhorizon | Horizon | Superhorizon | Horizon | Superhorizon | Horizon | Horizon | | Horizon | |
| Quaternary | Pleistocene | Upper | 2 | Pleistocene | Neopleistocene | Upper | Valdai | Kudashevo | Valdai | Ostashkovo | Northern Uralian | Polar Uralian | Khvalyn | Sarpino | Weichselian | Upper |
| | | | 3 | | | | | Tabulda | | Leningrad | | Nevjansky | | Enotaevka | | Middle |
| | | | 4 | | | | | Saigatka (Nurlino Suite) | | Kalinin | | Khanmeisky | | Tereshkino | | Lower |
| | | | 5a–d | | | | | Kushnarenkovo | | Chermenino | | Streletsky | Khazar | Upper | | |
| | | | 5e | | | | | | | Mikulino | | | | | Eemian | |

**Table 2**
Upper Neopleistocene molluscs of the Southern Urals region.

| Species | Horizons | | | |
|---|---|---|---|---|
| | Kushnarenkovo | Saigatka | Tabulda | Kudashevo |
| *Succinea putris* (Linnaeus, 1758) | | | U2 UB2 K1 | U1, I |
| *Succinella oblonga* (Draparnaud, 1801) | | S1 | U2 G5 G3 UB2 K1 | U1 G2 G4 Tn R I K2 Ak |
| *Oxyloma elegans* (Risso, 1826) | | S1 | G5 G3 | Tn R Ak |
| *Succinea* sp. | | | U2 K1 | U1 |
| *Cochlicopa lubrica* (Müller, 1774) | | S1 | Z | R Ak |
| *Vallonia costata* (Müller, 1774) | S2 | S1 | U2 G5 UB2 Z K1 | U1 G2 B2 R I K2 Ak |
| *V. tenuilabris* (Al. Braun, 1843) | | | U2 G3 K1 | U1 I K2 |
| *V. pulchella* (Müller, 1774) | | | U2 | U1 Tn I |
| *Vallonia* sp. | | | U2 K1 | U1 B2 |
| *Vertigo antivertigo* (Draparnaud, 1801) | | | | I |
| *V. pygmaea* (Draparnaud, 1801) | | | | Tn R Ak |
| *Vertigo* sp. | | | | Tn |
| *Columella* sp. | | | K1 | |
| *Pupilla muscorum* (Linnaeus, 1758) | | | U2 G3 K1 | U1 G2 B2 Tn I K2 |
| *Vitrea contracta* (Westerlund, 1871) | | S1 | | |
| *Ena* sp. | | | | |
| *Discus ruderatus* (Hartmann, 1821) | | | G3 UB2 Z | R Ak |
| *Chondrula tridens* (Müller, 1774) | | | Z | K2 |
| *Perpolita hammonis* (Strom, 1765) | | | UB2 Z | |
| *P. petronella* (L. Pfeiffer, 1853) | | | | Tn |
| *Pseudotrichia rubiginosa* (Rossmässler, 1838) | S2 | | G3 | G4, G2 I |
| *Fruticicola fruticum* (Müller, 1774) | | | | B2 |
| *Lymnaea stagnalis* (Linnaeus, 1758) | | | | Il |
| *Lymnaea* (*Peregriana*) *peregra* (Müller, 1774) | | | N | U1 B2 R |
| *Lymnaea* sp. | | | K1 | U1 |
| *Stagnicola palustris* (Müller, 1774) | | | G5 G3 UB2 N | U1 B2 Tn R Ak |
| *Stagnicola* sp. | | | | I |
| *Planorbis planorbis* (Linnaeus, 1758) | C | | U2 G5 G3 N | U1 B2 Tn I |
| *Anisus spirorbis* (Linnaeus, 1758) | | | U2 G5 G3 UB3 N K1 | U1 G2 UB2 B2 Tn I |
| *A. vorticulus* (Troschel, 1834) | | | B1 | |
| *A. vortex* (Linnaeus, 1758) | | | | B2 Tn |
| *Bathyomphalus contortus* (Linnaeus, 1758) | | | U2 G5 | Tn |
| *Gyraulus albus* (Müller, 1774) | | S1 | | B2 I |
| *G. laevis* (Alder, 1838) | | | U2 G5 | U1 B2 I |
| *G. rossmaessleri* (Auerswald, 1852) | | | UB2 | R Ak |
| *G.* (*Armiger*) *crista* (Linnaeus, 1758) | | | U2 UB2 K1 | U1 B2 R Ak |
| *G.* cf. *gredleri* (Gredler, 1853) | | | K1 | U1 Tn |
| *Gyraulus* sp. | | | K1 | Tn I |
| *Aplexa hypnorum* (Linnaeus, 1758) | | | | Tn I |
| *Segmentina nitida* (Müller, 1774) | | | UB2 | Tn R Ak |
| *Acroloxus lacustris* (Linnaeus, 1758) | | | | Tn |
| *Ancylus fluviatilis* (Müller, 1774) | | | UB2 | |
| *Borysthenia naticina* (Menke, 1845) | | | | I |
| *Valvata piscinalis antiqua* (Morris, 1820) | | | G5 | Tn |
| *V. piscinalis* (Müller, 1774) | C | | U2 UB2 | U1 B2 Tn R I Ak |
| *V. pulchella* (Müller, 1774) | | S1 | U2 K1 | U1 Tn R I K2 Ak |
| *Bithynia troscheli* (Paasch, 1842) | | | U2 UB2 | U1 B2 |
| *Bithynia tentaculata* (Linnaeus, 1758) | | | | I |
| *Bithynia* sp. (*operculum*) | | | G3 | |
| *Pisidium amnicum* (Müller, 1774) | C | | U2 G5 G3 | U1 B2 Tn R I Ak |
| *P. nitidum* (Jenyns, 1832) | | | U2 | U1 R Ak |
| *Pisidium* sp. | | | K1 | |
| *Sphaerium rivicola* (Lamarck, 1818) | C | | U2 G3 K1 | U1 Tn I |
| *Unio* sp. | C | | Gr | B2 R Ak |
| *Anodonta* sp. | | | Gr | |

Ak, Akbuta, bed 6; B1, Basurmanovka, bed 10; B2, Basurmanovka, beds 6–7; C, Chatra, bed 10; G2, Gornovo I, beds 2–6; G3, Gornovo I, bed 7; G4, Gornovo II, bed 1; G5, Gornovo II, beds 2–3; Gr, Gruzdevka, beds 6–11; I, Yabalakovo, beds 2–6; Il, Ilchino II, bed 2; K1, Karlaman, bed 10; K2, Karlaman, section II, beds 2–7; N, Novobelokatai, beds 3–5; R, Krasnyi Yar, section 1, bed 4; S1, Sultanaevo, excavation 2, bed 5; S2, Sultanaevo, excavation 2, bed 7; Tn, Tanalyk, section I, bed 2; U1, Uteimullino II, beds 2–9; U2, Uteimullino II, beds 6–10; UB2, Nizhnebikkuzino, excavation 1, beds 2–5; UB3, Nizhnebikkuzino, excavation 2, beds 1–15; Z, Zapovednaya cave, excavation 1, bed 3.

Deposits form the lower part of the erosional second above the floodplain river terrace (8.35 m high). Due to erosion, those deposits are rarely found in the region.

The Sultanaevo stratotype site is located at 110 m above sea level (outcrop 107, beds 4–6) (Yakhemovich et al., 1983; pp. 4–36) (Fig. 2). The key sites for the Kushnarenkovo Horison include the second Voevodskoye hydromorphic soil located in the Voevodskoye (excavation 1, bed 5, 0.6 m in thickness) (Yakhemovich et al., 1980; pp. 4–29); fluvial gravel in grey sand cement found at the Tabulda site (excavation 2, bed 7, 0.4 m in thickness) (Yakhemovich et al., 1985; pp. 39–44); the third Sultanaevo soil (excavation 2, bed 7, 0.2 m thick and excavation 3, bed 8, 0.2 m thick) and lacustrine-subaerial loam (outcrop 107, beds 4–6, 0.85 m thick) sampled in the Sultanaevo site (Yakhemovich et al., 1983; pp. 4–36); and the third Chui–Atasevo soil observed in the Chui–Atasevo III site (bed 4, 1.2 m thick) (Yakhemovich et al., 1987; pp. 6–21).

The vegetation during the deposition of this unit was characterized by *Pinus-Picea* and *Betula* forests with *Tilia*, *Alnus*, *Quercus* and *Fraxinus* admixture. Various types of herbs covered some open areas. Forest-steppe and steppe became widespread at the end of this time. The palynological data probably do not reflect the climatic optimum. The climate was warm and humid (Yakhemovich et al., 1983, 1987). The molluscan assemblage investigated at the Sultanaevo (excavation 2, bed 7) and Chatra (bed 10) localities (Fig. 1) consist of 2 terrestrial (*Vallonia costata* (Müller.), *Pseudotrichia rubiginosa* (Rossmässler)) and 5 freshwater species (*Planorbis planorbis* (Linnaeus), *Valvata piscinalis* (Müller), *Pisidium amnicum* (Müller), *Sphaerium rivicola* (Lamarck), *Unio* sp.) (Sidnev and Chepalyga, 1983; Osipova, 2009a, 2009b; Osipova and Danukalova, 2011) (Table 2).

**Table 3**
Upper Neopleistocene small mammals of the Southern Urals region.

| Species | Horizons | | | |
|---|---|---|---|---|
| | Kushnarenkovo | Saigatka | Tabulda | Kudashevo |
| Insectivora | Ig3 FS2 | | Ig2 | Ig1 P |
| *Talpa* sp. | Rb | | | |
| *Sorex* sp. | Rb | | | M, Us |
| *Ochotona pusilla* Pallas, 1773 | | | | S |
| *Ochotona* sp. | Ig3 FS2 | | G1 U1 Ig2 A | Ig1 P M Kp FS1 SS Us Sr Us Sr S |
| *Spermophilus major* Pallas, 1779 | | | | |
| *Sp. pygmaeus* Pallas, 1778 | | | | Sr S |
| *Sp. superciliosus* Kaup, 1839 | Ig3 FS2 | | Ig2 | Ig1 P FS1 SS |
| *Spermophilus* sp. | | | G1 | M |
| Mioxidae | Rb | | | |
| *Sicista* sp. | Ig3 FS2 | | | P Sr S |
| *Allactaga major* Kerr, 1792 | | | | Ig1 M Sr S |
| *Alactagulus pumilio* Kerr, 1792 | | | | Ig1 Sr |
| *Alactagulus* sp. | | | U1 | |
| *Cricetulus migratorius* Pallas, 1773 | Ig3 FS2 | | U1 Ig2 | Ig1 P M Kp FS1 SS Us Sr S |
| *Allocricetulus eversmanni* Brandt, 1859 | Ig3 FS2 | | G1 | Ig1 P M SS Sr S |
| *Cricetus cricetus* Linnaeus, 1958 | Ig3 FS2 Rb | | Ig2, A | SS Sr S |
| *Apodemus uralensis* Pallas, 1781 | Ig3 | | | |
| *A.* ex gr. *uralensis-agrarius* | Ig3 | | Ig2 | |
| *A. flavicollis* Melchior, 1839 | Ig3 FS2 Rb | | | |
| *Ellobius talpinus* Pallas, 1770 | | | | Us Sr S |
| *Ellobius* sp. | | | G1 | |
| *Lemmini* gen. | Ig3 FS2 | | Ig2 | |
| *Myopus schisticolor* Lilljeborg, 1844 | Ig3 FS2 | | | |
| *Lemmus sibiricus* Kerr, 1792 | Ig3 FS2 | | Ig2 | Ig1 FS1 SS |
| *Lemmus* sp. | | | | Us |
| *Dicrostonyx torquatus* Pallas, 1778 | | | | Kp |
| *D. simplicior* Fejfar, 1966 | Ig3 | | | |
| *D. guilielmi* Sanford, 1869 | | | Ig2 | Ig1 P FS1 SS Us |
| *Dicrostonyx* sp. | | | | Sr |
| *Eolagurus luteus* Eversmann, 1840 | FS2 | | G1 U1 Ig2 | Ig1 P M SS Us Sr S |
| *Lagurus lagurus* Pallas, 1773 | Ig3 FS2 | | G1 U1 Ig2 | Ig1 P M Kp FS1 SS Us Sr S |
| *Clethrionomys rufocanus* Sundevall, 1846 | Ig3, Rb | | G1 Ig2 | Ig1 P FS1 SS |
| *Cl. glareolus* Schreber, 1780 | FS2, Rb | | Ig2 | |
| *Cl. ex gr. glareolus-rutilus* | Ig3 FS2 | | U1 Ig2 | Ig1 P M FS1 SS Us Sr S |
| *Cl. rutilus* Pallas, 1779 | FS2 | | Ig2 | Ig1 P SS |
| *Cl. ex gr. rutilus* Pallas, 1779 | | | G1 | |
| *Arvicola terrestris* Linnaeus, 1758 | Ig3 FS2 Rb | | G1 U1 Ig2 | Ig1 P FS1 SS Us Sr S |
| *Microtus oeconomus* Pallas, 1776 | Ig3 FS2 | | G1 U1 Ig2 | Ig1 P M FS1 SS Us Sr S |
| *M. gregalis* Pallas, 1779 | Ig3 FS2 | | G1 U1 Ig2 | Ig1 P M Kp FS1 SS Us Sr S |
| *M. agrestis* Linnaeus, 1761 | Ig3 FS2 Rb | | Ig2 | Ig1 P SS S |
| *M. arvalis-agrestis* | Ig3 FS2 | | Ig2 | Ig1 P SS Us |
| *M. arvalis* Pallas, 1778 | FS2 Rb | | | M Sr S |
| *Mustela nivalis* Linnaeus, 1766 | Ig3 | | | M Ig1 P SS |

A, Asha I cave, beds 1–4; FS1, Serpievskaya 1 cave, bed 2; FS2, Serpievskaya 1 cave, bed 3; G1, Gornovo I И II, excavation 2, beds 11–12; Ig1, Ignatievskaya cave, excavation II, bed 2a; Ig2, Ignatievskaya cave, excavation V, bed 8; Ig3, Ignatievskaya cave, excavation V, bed 9; Kp, Shulgan-Tash (Kapova) cave, cultural layer; M, Maksyutovo Grotto, beds 2–3; P, Prizhim 2 cave, beds 1–8; Rb, Krasnyi Bor, bed 5; S, Smelovskaya 2 cave, horizons 19, 7, 9; Sr, Syrtinskaya cave, horizons 32, 28, 24, 18, 15, 13, 11; SS, Serpievskaya 2 cave, beds 2, 3; U1, Uteimullino II, beds 2–9; Us, Ustinovo Grotto, beds 2, 3.

The small mammal assemblage from the Kushnarenkovo Horison is known in the Fore-Urals and in the Urals. They were found at the Krasnyi Bor locality and are characterized by the dominance of waterside and forest biotope species such as *Sorex* sp., *Talpa* sp., *Lepus* sp., *Apodemus flavicollis* Melchior, *Clethrionomys rufocanus* Sunderval, *Clethrionomys glareolus* Schreber, *Arvicola terrestris* Linnaeus and *Microtus agrestis* Linnaeus. (Sukhov, 1972; Yakovlev, 2003, 2009) (Table 3). At the end of this interglacial, small mammals (Ignatievskaya cave, excavation 5, bed 9; Serpievskaya 1 cave, bed 3) were represented by steppe, waterside, forest and tundra biotope species such as *Talpa* sp., *Sorex* sp., *Ochotona* sp., *Spermophilus superciliosus* Kaup, *Sicista* sp., *Cricetulus migratorius* Pallas, *Allocricetulus eversmanni* Brandt, *Cricetus cricetus* Linnaeus, *Apodemus uralensis* Pallas, *A. flavicollis* Melchior, *Myopus schisticolor* Lilljeborg, *Lemmus sibiricus* Kerr, *Dicrostonyx simplicior* Fejfar, *Lagurus lagurus* Pallas, *C. rufocanus*, *Cl. glareolus*, *Cl. rutilus* Pallas, *A. terrestris*, *Microtus oeconomus* Pallas, *Microtus gregalis* Pallas and *M. agrestis*. This fauna was living in moderate climatic conditions and belongs to the southern variant of the periglacial Late Pleistocene faunas. Lemmings were represented by *D. simplicior*, which is characteristic of this fauna (Smirnov et al., 1990).

The large mammal assemblage identified in the caves (Ignatievskaya cave, excavation 5, bed 9) belongs to the Late Palaeolithic complex and includes *Ursus* cf. *savini rossicus* Borissiak (Smirnov et al., 1990).

### 4.2. Saigatka Horizon

This horizon was first defined and described by Yakhemovich in 1983. The deposits which were described were taken from the drilled stratotype sections during the Hydroproject survey (200, 203, 205, 411–413 and 1104) (Gromov, 1948; p. 281; Goretsky, 1964; fig. 48). This horizon was named after the Saigatka River on the left side at the left bank of the Kama River in the surroundings of Chaikovsky city (Northern Fore-Urals, Perm district). The Nurlino Suite represents the analog of the Saigatka Horizon in the periglacial area. This suite was named after Nurlino village (Bashkortostan Republic) by Danukalova (2010).

This suite is represented by lacustrine and diluvial loesslike loam. The total thickness of this unit is 1.2 m. The deposits overlie the lacustrine loam and the gravel of the Kushnarenkovo Horizon or the diluvial loam of the Elovka Horizon (Shemyak Suite, Middle Neopleistocene) showing erosional intervals. These deposits are, in turn, overlain by subaerial sediment or fluvial gravel of the Upper Neopleistocene (Tabulda and Kudashevo Horizons), with erosional gaps.

The deposits of the Nurlino Suite form the upper part of the erosional second above the floodplain river terrace, reaching 8.35 m

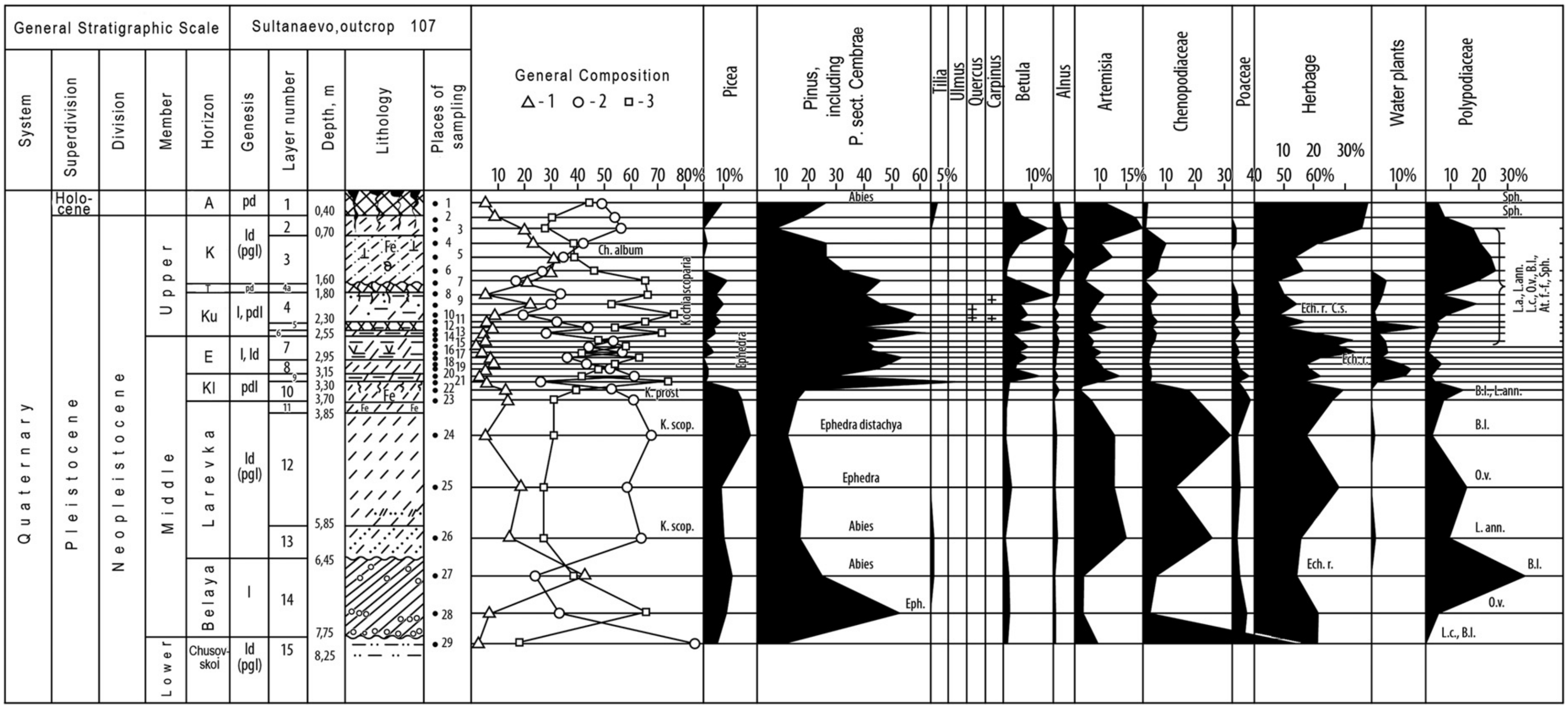



**Fig. 2.** Stratotype site of the Kushnarenkovo Horizon. The Sultanaevo locality (outcrop 107, beds 4–6) and the percentage diagrams for the main taxa (by Yakhemovich et al. (1983); fig. 2 with authors corrections). Legend: Horizons: A – Agidel; K – Kudashevo; T – Tabulda; Ku – Kushnarenkovo; E – Elovka; Kl – Klimovka. Deposit genesis indexes: *d* – diluvial slope deposits (loam); *l* – lacustrine deposits (clay); *ld* – lacustrine–deluvium deposits; *a* – alluvium; *a(rf)*, *a(pt)* – alluvium (coarse grain stream deposits); *a(pr)* – alluvium (fine grain floodplain deposits); *pgl* – periglacial deposits; *pd* – soil (loam); *pdl* – hydromorphic soil (?). General composition: 1 – trees and bushes, 2 – grass, 3 – sporophytes. +, places of single spore and pollen finds. Botanical data: Abies – *Abies* sp.; Acer – *Acer* sp.; Al. – *Alisma* sp.; At.f.-f., A.f.-f. – *Athyrium filix-femina* (Linnaeus) Roth; Atriplex hastata – *Atriplex hastate* Linnaeus; B.l. – *Botrychium lunaria* (Linnaeus) Swartz; C.s., Cal.s., C. sepium – *Calystegia sepium*; Carp. – *Carpinus* sp.; Ch. album – *Chenopodium album* Linnaeus; Cor. – *Corylus* sp.; Dipsac. – Dipsacaceae; Ech. r., Ech. ritro, Echinops ritro – *Echinops ritro* Linnaeus; Eph., Ephedra – *Ephedra* sp.; Ephedra distachya – *Ephedra distahya* Linnaeus; Eurotia cerat., Eurotia ceratoides – *Eurotia ceratoides* (Linnaeus) C.A. Mey; Frax. – *Fraxinus* sp. K. prost. – *Kochia prostrata* (Linnaeus) Schrader; K. scoparia, Kochia scoparia – *Kochia scoparia* (Linnaeus) Schrader; Kochia laniflora – *Kochia laniflora* (S.G. Gmelin) Borbas; Knautia – *Knautia* sp.; L.a. – *Lycopodium alpinum* Linnaeus, L.ann. – *Lycopodium annotinum* Linnaeus; L.app. – *Lycopodium appressum* (Chapman) F.E. Lloyd & Underwood; L.c. – *Lycopodium clavatum*; L.s. – *Lycopodium selado* Linnaeus; Larix – *Larix* sp.; Lin. – *Linum* sp.; M. – *Myriophyllum* sp.; N.l. – *Nuphar lutea* (Linnaeus) Smith; O.v. – *Ophioglossum vulgatum* Linnaeus; Onagr. – Onagraceae; Os. – *Osmunda* sp.; Os.c. – *Osmunda cinnamomea* Linnaeus; Plumb., Plumbag. – Plumbaginaceae; Salicornia herbacea – *Salicornia herbacea* Linnaeus; Salsola foliosa – *Salsola foliosa*; Salsola ruthenica – *Salsola ruthenica* Iljin; Scabiosa – *Scabiosa* sp.; Sph. – *Sphagnum* sp.; T. – *Typha* sp.; Tilia – *Tilia* sp.; Tsuga – *Tsuga* sp.; Ulmus – *Ulmus* sp.; Valeriana – *Valeriana* sp.

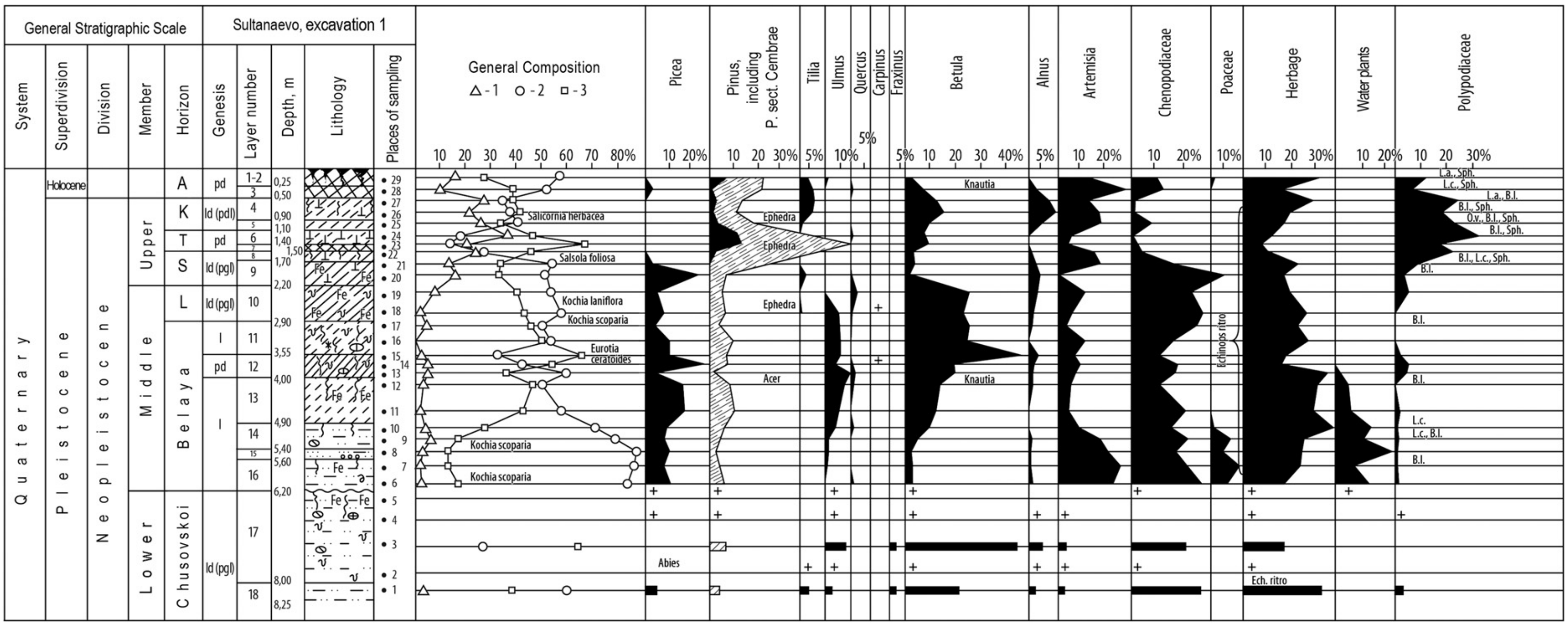



**Fig. 3.** The stratotype site of the Nurlino Suite. The Sultanaevo locality (excavation 1, beds 8–9) and the percentage diagrams for the main taxa (Yakhemovich et al., 1983; fig. 12 with authors' corrections). Horizons: A – Agidel; K – Kudashevo; T – Tabulda; S – Saigatka; L – Larevka. See Fig. 2 for the legend.

in thickness. They have been intensively eroded and are known only within the Belaya river valley.

The stratotype site is located in Sultanaevo (excavation 1, beds 8–9 and borehole 1, beds 4–5) (Yakhemovich et al., 1983; pp. 4–36) (Fig. 3). The parastratotype site is in Tabulda village (excavation 2, beds 4–6 and excavation 1, bed 13) located at 205 m above sea level (Yakhemovich et al., 1985; pp. 39–44). The key sites for this unit are situated in the Southern Fore-Urals where they show loesslike loam at Voevodskoye (excavation 1, bed 4, 1.0 m thick) (Yakhemovich et al., 1980; pp.4–29); lacustrine and diluvial loam at the site of Sultanaevo (excavation 1, beds 8–9, 0.8 m thick; borehole 1, beds 4–5, 0.9 m thick; excavation 2, beds 5–6, 0.35 m thick; excavation 3, bed 7, 0.3 m thick) (Yakhemovich et al., 1983; pp. 4–36); loam at the Tabulda site (excavation 2, beds 4–6, 0.95 m thick; excavation 1, bed 13, 0.66 m thick) (Yakhemovich et al., 1985; pp. 39–44); and the loam at the Chui–Atasevo III site (bed 3, 1.2 m thick) (Yakhemovich et al., 1987; pp. 6–21).

Spore and pollen remnants are not numerous and are represented by *Pinus*, *Picea*, *Betula*, *Tilia*, Chenopodiaceae, *Artemisia*, herbage, *Ephedra* sp. and *Salsola foliosa* (Linnaeus) Schrader. *S. foliosa* is characteristic of salty steppe biotopes. Steppe vegetation covered the plains. Tundra and forest-tundra landscapes dominated in mountains (Yakhemovich et al., 1970). Trees existed on the mountain valley slopes. The climate was cool.

The molluscan assemblage from the Nurlino Suite is known from the Sultanaevo site (excavation 2, bed 5) (Fig. 1) and consist of 5 terrestrial (*Succinella oblonga* (Draparnaud), *Oxyloma elegans* (Risso), *Cochlicopa lubrica* (Müller), *V. costata*, *Vitrea contracta* (Westerlund)) and 2 freshwater taxa (*Gyraulus albus* (Müller), *Valvata pulchella* Studer (Sidnev and Chepalyga, 1983; Osipova, 2009b; Osipova and Danukalova, 2011) (Table 2).

### 4.3. Tabulda Horison

This horizon was first distinguished and described by Yakhemovich in 1983. It is named after Tabulda village (Bashkortostan Republic, Russia).

Here, the deposits form the lower part of the first river terrace (up to 15.4 m high), above the floodplain, and are consist in lacustrine subaerial loam, fluvial gravels and sand. The palaeosols from that time are the third Voevodskoye soil (Voevodskoye, 0.4 m thick), the forth Sultanaevo soil (Sultanaevo, excavation 1, 0.4 m thick) and the second Minzitarovo soil (Minzitarovo, 0.7 m thick). The total thickness is up to 0.1–3.5 m. The deposits rest on the eroded surfaces of the underlying lacustrine and diluvial loam of the Saigatka Horizon of the Upper Neopleistocene or Elovka, Klimovka or Belaya Horizons (Middle Neopleistocene) (Danukalova et al., 2007a) and are overlain by loam of the Kudashevo Horizon. The stratotype site is the Tabulda locality (excavation 2, bed 3 and excavation 1, bed 12) (Yakhemovich et al., 1985; pp. 39–44) (Fig. 4) and the parastratotype site is Gornovo II, beds 2 and 3, with a better exposure of the deposits than in the stratotype site (Yakhemovich et al., 1981, 1987; pp. 25–27; Danukalova et al., 2002a) (Fig. 5).

The key sites for the Tabulda Horizon are fluvial pebble gravel, located in the Tabulda site (excavation 1, bed 12, 0.1 m thick, excavation 2, bed 3, 0.15 m thick) (Yakhemovich et al., 1985; pp. 39–44); clayish silt in the erosional pockets at the Gornovo IIa site and the Gornovo II (beds 2, 3) (Yakhemovich et al., 1987; pp. 22–50; Danukalova et al., 2002a, pp. 27–48; Danukalova and Yakovlev, 2006; pp. 37–43); the third Voevodskoye soil of the Voevodskoye site (excavation 1, bed 3, 0.4 m thick) (Yakhemovich et al., 1980; pp. 4–29); the second Minzitarovo soil of the Minzitarovo site (bed 2, 0.7 m thick) (Yakhemovich et al., 1985; pp. 5–9); lacustrine loam and fluvial pebble at the Burybai site (beds 5–7, 3.5 m thick) (Yakhemovich et al., 1985; pp. 65–66); the fourth Sultanaevo soil of the Sultanaevo site (excavation 1, beds 6–7, 0.4 m thick) (Yakhemovich et al., 1983; pp. 4–36); diluvial loam at the Kipchakovo site (beds 5–6, 1.32 m thick) and also observed in the Novobelokatai site (Danukalova and Yakovlev, 2006; pp. 37–43); in the Uteimullino II site (Danukalova et al., 2007b; pp. 40–54); in the Kuznetsovka site and Zapovednaya cave (Danukalova et al., 2008; pp. 38–57); in the Nizhnebikkuzino site (Danukalova et al., 2011; pp. 23–43); in the Tanalyk I and II sites (Kosintsev et al., in press); and in new sites for the Tabulda Horizon which include Starye Kiishki, Kabakovo, Basurmanovka, Ilchino I and II, Kaga, Syuren' and Mrakovo. $^{14}$C dates were obtained (Table 5).

Spore and pollen remains are common in these deposits. They include *Pinus* sect. *Cembrae*, *Pinus* sp., *Picea exelsa* Link., *Betula* sp., *Ephedra* sp., *Ulmus* sp., Asteraceae (Crepis and Aster), *Artemisia* sp., Chenopodiaceae, Caryophyllaceae, Brassicaceae, *Calystegia sepium* (Linnaeus) R. Brown, Polygonaceae, Poaceae and *Lycopodium clavatum* Linnaeus. Fragments of *Picea* stumps and trunks were found in the Gornovo site. Fir grew along the banks of the rivers and lakes. The climate was moderately warm during this period (Yakhemovich et al., 1987; Danukalova et al., 2002b).

Molluscs were found in the Gornovo I (bed 7), Gornovo II (beds 2–3), Novobelokatai (beds 3–5), Uteimullino II (beds 6–10), Basurmanovka (bed 10), Nizhnebikkuzino II (bed 3), Karlaman (bed 10), Kabakovo (bed 4) and Zapovednaya cave (excavation 1, bed 3) sites (Fig. 1). The molluscan assemblage (3081 determined specimens) consists of 13 species and 11 genera of terrestrial molluscs (*Succinea*, *Succinella*, *Oxyloma*, *Cochlicopa*, *Pupilla*, *Columella*, *Vallonia*, *Discus*, *Perpolita*, *Chondrula and Pseudotrichia*) preferred wet habitats and 21 species and 13 genera of freshwater molluscs such as *Lymnaea*, *Anisus*, *Planorbis*, *Gyraulus*, *Segmentina*, *Bathyomphalus*, *Ancylus*, *Valvata*, *Bithynia*, *Sphaerium*, *Pisidium*, *Unio* and *Anodonta* were also found, they inhabited lakes and rivers characterized by slow streams (Osipova, 2009a, 2009b; Danukalova et al., 2002a, 2011; Osipova and Danukalova, 2011) (Table 2).

Small mammals were investigated in several sites: Gornovo I and II; Uteimullino II and Ignatievskaya cave. In the Southern Fore-Urals the steppe species dominated in the small mammal fauna during the Tabulda phase (Gornovo I and II). In this formation, *M. gregalis*, *Lagurus lagurus*, *Ochotona* sp., *A. eversmanni*, *Eolagurus luteus* Eversmann and *Ellobius* sp. were found. The nearwater and forest biotope species such as *A. terrestris*, *M. oeconomus* and *Clethrionomys* sp. were less numerous (Yakhemovich et al., 1987; Danukalova et al., 2007b; Yakovlev, 2009) (Table 3). The steppe small mammal species (*C. migratorius*, *Lagurus lagurus* and *M. gregalis*) are also dominated during this phase in the mountains of the Southern Urals (Ignatievskaya cave). The forest species (*A. flavicollis*, *A. uralensis*, *C. rufocanus*, *Cl. rutilus* and *M. agrestis*) the same as nearwater (*A. terrestris* and *M. oeconomus*) and tundra species (*Dicrostonyx guilielmi* Sanford and *L. sibiricus*) occur associated with the small mammal assemblage of the Tabulda Horizon. This small mammal fauna belongs to the Late Pleistocene periglacial fauna with steppe and forest species dominance and rare tundra taxa. Lemmings were represented by *D. guilielmi* (Smirnov et al., 1990).

Large mammals were also investigated in the archaeological sites and caves (Gornovo I and II; Tabulda; Zapovednaya cave; Ignatievskaya cave; Asha I cave). They belong to the Late Palaeolithic complex. *Mammuthus primigenius* Blumenbach, *Megaloceros giganteus* Blumenbach, *Bison priscus* Bojanus, *Bos primigenius* Bojanus, *Coelodonta antiquitatis* Blumenbach, *Lepus tanaiticus* Gureev, *Ursus spelaeus* Rosenmüller et Heinroth, *Crocuta spelaea* Goldfuss and *Pantera spelaea* Goldfuss were found (Yakhemovich et al., 1985, 1987; Smirnov et al., 1990) (Table 4).

**Table 4**
Upper Neopleistocene large mammals of the Southern Urals region.

| Species | Horizons | | | |
|---|---|---|---|---|
| | Kushnarenkovo | Saigatka | Tabulda | Kudashevo |
| *Lepus tanaiticus* Gureev, 1964 | | | Z Ig2 | CU B M Ig1 P FS1 SS Us |
| *Lepus* sp. | Ig3 Rb | | Ig2 A | Ig1 P FS1 SS Kp Us |
| *Marmota bobak* Muller, 1776 | Ig3 | | Z Ig2 A | Kp CU M B Ig1 P FS1 SS Us |
| *Castor fiber* Linnaeus, 1758 | | | | |
| *Canis lupus* Linnaeus, 1758 | Ig3 | | Z Ig2 A | M B Ig1 P FS1 SS Us |
| *Canis* sp. | Ig3 | | | |
| *Alopex lagopus* Linnaeus, 1758 | Ig3 | | Ig2 | M Ig1 P FS1 SS Kp Us |
| *Vulpes vulpes* Linnaeus, 1758 | Ig3 | | Z Ig2 A | M B Ig1 P FS1 SS Kp Us |
| *Ursus* cf. *rossicus* Borissiak, 1930 | Ig3 | | | |
| *Ursus spelaeus* Rosenmüller et Heinroth, 1794 | | | Z Ig2 A | CU Ig1 SS Kp |
| *Ursus arctos* Linnaeus, 1758 | | | | M P |
| *Martes martes* Linnaeus, 1758 | | | | M B |
| *Martes* sp. | Ig3 | | Ig2 | FS1 SS |
| *Gulo gulo* Linnaeus, 1758 | Ig3 | | Ig2 | |
| *Mustela erminea* Linnaeus, 1758 | Ig3 | | Ig2 A | M B Ig1 P SS |
| *Mustela eversmanni* Lesson, 1827 | | | Z | M |
| *Mustela* sp. | Ig3 | | | |
| *Putorius* sp. | Ig3 | | Ig2 | Ig1 SS |
| *Crocuta spelaea* Goldfuss, 1823 | | | Ig2 A | Ig1 |
| *Lynx lynx* Linnaeus, 1758 | | | Ig2 | |
| *Pantera spelaea* Goldfuss, 1810 | | | Z A | M SS |
| *Mammuthus primigenius* Blumenbach, 1799 | | | Ig2 T | FS1 |
| *Cervus elaphus* Linnaeus, 1758 | Ig3 | | Ig2 A | M SS |
| *Megaloceros giganteus* Blumenbach, 1803 | | | A G1 | |
| *Alces alces* Linnaeus, 1758 | | | G1 | |
| *Rangifer tarandus* Linnaeus, 1758 | Ig3 | | Ig2 | CU M B Ig1 P FS1 Us |
| *Bison priscus* Bojanus, 1827 | Ig3 | | Z Ig2 A G1 | CU FS1 Us |
| *Bos primigenius* Bojanus, 1827 | | | G1 | |
| *Bison priscus gigas* Flerov, 1969 | | | G1 | |
| *Bison priscus mediator* Hilzheimer, 1918 | | | G1 | |
| *Bison* sp. | | | T | |
| *Bos* et *Bison* | | | Ig2 | Ig1 |
| *Ovis* cf. *ammon* | | | G1 | |
| *Saiga tatarica* Linnaeus, 1758 | | | Ig2 | M Ig1 P Us |
| *Equus caballus fossilis* | | | G1 | |
| *Equus* cf. *hemionus* Pallas, 1775 | | | G1 | |
| *Equus uralensis* Kuzmina, 1975 | | | | FS1 |
| *Equus latipes* V. Gromova, 1949 | | | | UB1 |
| *Equus* sp. | | | Z Ig2 T | M B Ig1 P SS |
| *Coelodonta antiquitatis* Blumenbach, 1799 | Ig3 | | Ig2 A T | M FS1 SS Zl |

A, Asha I cave, beds 1–4; B, Bajslan-Tash cave, lower part of the layer 4; CU, Verkhnaya cave, bed 1; FS1, Serpievskaya 1 cave, bed 2; G1, Gornovo I И II, excavation 2, beds 11–12; Ig1, Ignatievskaya cave, excavation II, bed 2a; Ig2, Ignatievskaya cave, excavation V, bed 8; Ig3, Ignatievskaya cave, excavation V, bed 9; Kp, Shulgan-Tash (Kapova) cave, cultural layer; M, Maksyutovo Grotto, beds 2–3; P, Prizhim 2 cave, beds 1–8; Rb, Krasnyi Bor, bed 5; SS, Serpievskaya 2 cave, beds 2, 3; T, Tabulda, excavation 2, bed 3; UB1, Nizhnebikkuzino, excavation 1, bed 6; Us, Ustinovo Grotto, beds 2, 3; Z, Zapovednaya cave, excavation 1, bed 3; Zl, Zlatoustovka.

**Table 5**
Radiocarbon dating results from the Tabulda horizon deposits.

| Radiocarbon dating results | Age in yr BP | Reference of specimen | Material |
|---|---|---|---|
| Aktanyshbash | 27,570 ± 480 | BashGI-33 | Wood |
| Gornovo II | 26,950 ± 560 | LU-3711 | Wood |
| | 28,800 ± 124 | BashGI-36 | |
| | 29,700 ± 1250 | H 1856/1287 | |
| | 26,990 ± 150 | LU-3712 | |
| | 33,670 | LU-4153 | |
| Novobelokatai | >50,000 | BashGI-60 | Wood coal |
| | 41,070 ± 1570 | LU-4149 | |
| Tabulda | 34,900 | LU-1377A | Bones of *Mammuthus primigenius* |
| | 31,360 ± 250 | LE-2153 | |
| | 34,910 ± 300 | LE-2154 | |
| Nizhnebikkuzino | 30,700 ± 800 | GIN-10856 | Bone of *Equus latipes* |
| Zapovednaya cave | 28,700 ± 1050 | LU-3715 | Bones of *Ursus spelaeus* |
| | 37,250 | LU-3876 | |
| Bajslan-Tash cave | >38,100 | GIN-10855 | Bone of *Equus* sp. |
| Burybai | 36,000 | LU-1380A | Tusk of *Mammuthus primigenius* |

### 4.4. Kudashevo Horizon

This horizon was distinguished and described for the first time by Yakhemovich in 1983. It is named after Novokudashevo village (Bashkortostan Republic, Russia).

The deposits of this horizon form the upper part of the first terrace above the floodplain (15.4 m high) and incorporate lacustrine and diluvial loam and fluvial sand and pebble. They are 14.4 m thick. The deposits lie on the eroded surfaces of the alluvium (floodplain facies) and lacustrine loam of the Tabulda Horizon or on the eroded surfaces of the loam of the Klimovka Horizon (Middle Neopleistocene). The Kudashevo Horizon is overlain by Holocene floodplain clay or soil.

The stratotype site is located in Novokudashevo, outcrop 89, beds 3–11 (110 m above sea level) (Yakhemovich et al., 1988; pp. 23–24) (Fig. 6). The parastratotype site is known in the Gornovo I locality, beds 2–6 (Yakhemovich et al., 1987; pp. 22–50;

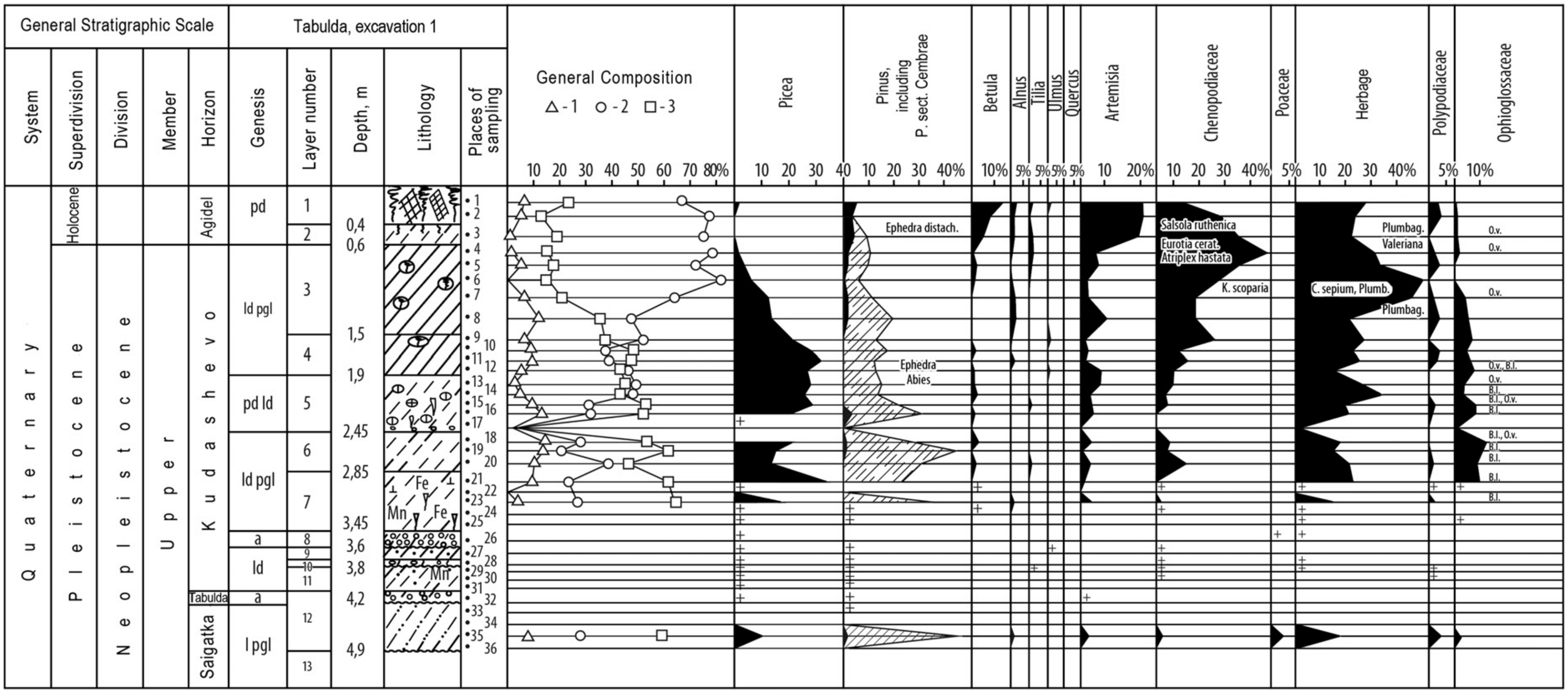



**Fig. 4.** The parastratotype site of the Tabulda Horizon. The Tabulda locality (excavation 1, bed 12) and the percentage diagrams for the main taxa (Yakhemovich et al., 1985, fig. 28 with authors' corrections). See Fig. 2 for the legend.

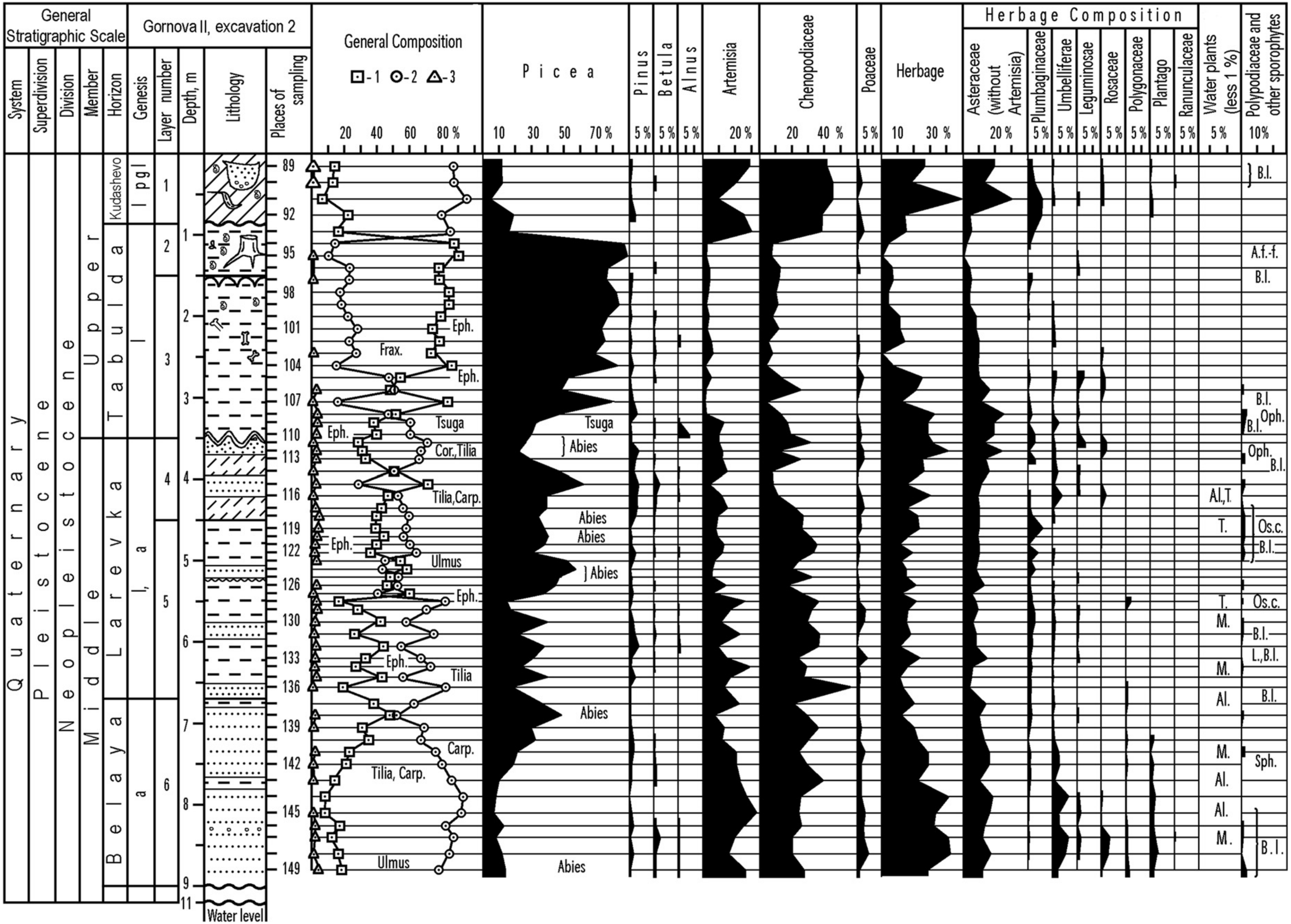



**Fig. 5.** The parastratotype site of the Tabulda Horizon. The Gornovo locality (excavation 2, beds 2 and 3) and the percentage diagrams for the main taxa (by Yakhemovich et al. (1987) with authors' corrections). See Fig. 2 for the legend.

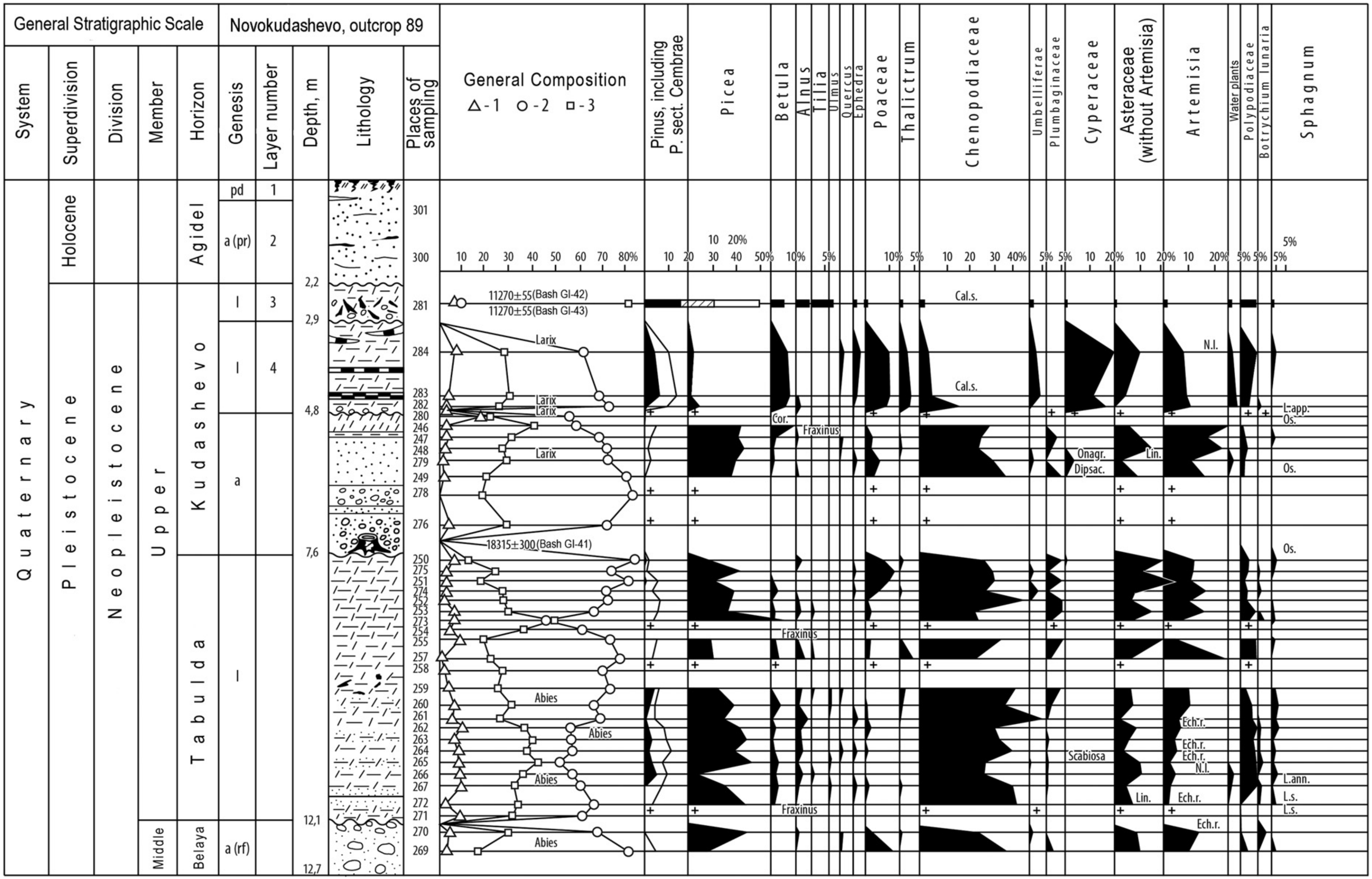



**Fig. 6.** Stratotype site of the Kudashevo Horizon. The Novokudashevo locality (outcrop 89, beds 3–11) and the percentage diagrams for the main taxa (by Nemkova (1976); fig. 6 with authors' corrections). See Fig. 2 for the legend.

Danukalova et al., 2002a, pp. 27–48). The key sites in which the unit is found include lacustrine and diluvial loam of the Gornovo I site (beds 2–6, 14.4 m thick) (Yakhemovich et al., 1987; pp. 22–50; Danukalova et al., 2002a, pp. 27–48; Danukalova and Yakovlev, 2006; pp. 37–43; Yakovlev et al., 2006; pp. 115–121); loam at the Voevodskoye site (excavation 1, bed 2, 0.15 m thick) (Yakhemovich et al., 1980; pp. 4–29); lacustrine and diluvial loam in the Tabulda site (excavation 1, beds 3–11, 3.4 m thick; excavation 2, beds 1–2, 1.2 m thick) (Yakhemovich et al., 1985; pp. 39–44); lacustrine and diluvial loam in the Burybai site (beds 3–4, 2.6 m thick) (Yakhemovich et al., 1985; pp. 65–66); lacustrine and diluvial loam in the Sultanaevo site (excavation 1, beds 4–5, 1.1 m thick) (Yakhemovich et al., 1983; pp. 4–36); lacustrine loam and fluvial sand and pebble gravel at the Novokudashevo site (beds 3–11, 5.8 m thick) (Yakhemovich et al., 1988; pp. 23–24); diluvial and fluvial sandy loam, loam and pebble gravel in the Sultino-Yantuganovo site at the Baza River (beds 3–7, 2.4 m thick, new data); diluvial loam at the Kipchakovo site close to the Syun' River (beds 3–4, 1.8 m thick, new data); diluvial loam was described in several additional sites such as Novobelokatai (Danukalova and Yakovlev, 2006; pp. 37–43); Uteimullino II (Danukalova et al., 2007b; pp. 40–54); Magash, Kuznetsovka, Kalinovka II and Zapovednaya cave (Danukalova et al., 2008; pp. 38–57); Nizhnebikkuzino and Akbuta (Danukalova et al., 2011); Tanalyk I and II (Kosintsev et al., in press); Bajslan-Tash cave (Yakovlev et al., 2006; pp. 115–121); Starye Kiishki; Kabakovo; Karlaman; Basurmanovka; Ilchino II and III; Kaga; Syuren'; Mrakovo and in the Shulgan-Tash (Kapova) cave. $^{14}$C dates were obtained (Table 6).

**Table 6**
Radiocarbon dating results from the Kudashevo horizon deposits.

| Radiocarbon dating results | Age in yr BP | Reference of specimen | Material |
|---|---|---|---|
| Novokudashevo | 11,270 ± 55 | BashGI-42 | Wood |
| | 11,680 ± 55 | BashGI-43 | |
| | 18,315 ± 300 | BashGI-41 | |
| Syun' I | 17,000 ± 100 | BashGI-78 | Wood |
| | 17,200 ± 170 | BashGI-79 | |
| Gornovo I | 21,280 ± 550 | LE-145 | Wood |
| | 22,660 ± 125 | BashGI-35 | |
| Zlatoustovka | 12,330 ± 120 | LU-1668 | Tooth of *Coelodonta antiquitatis* |
| Bajslan-Tash cave | 13,560 ± 250 | GIN-10853 | Bones of small mammal |
| Verkhnaya cave | 22,750 ± 1210 | LU-3714 | Bones of *Ursus spelaeus* |
| Shulgan-Tash (Kapova) cave | 14,680 ± 150 | LE-2443 | Wood coal |
| | 13,930 ± 300 | GIN-4853 | |

Palynological remains are not numerous. Pollens are dominated by herbs, Chenopodiaceae and *Artemisia*. Pollen of *Picea*, *Betula* and *Pinus* trees also occur but pollen of broadleaved taxa such as *Tilia cordata*, *Fraxinus*, and *Corylus* are rare. Herb – *Artemisia* – Chenopodiaceae meadow–steppe associations covered the main part of the investigated area during the Kudashevo phase. *Picea-Betula* forests grew in the river valleys and humid depressions. The climate was cool (Nemkova, 1976; Danukalova et al., 2002a; 2002b).

The mollusc assemblages were found in the Gornovo I site (beds 2–6); Gornovo II site (bed 1); Uteimullino II site (beds 2–4); Basurmanovka site (beds 6–7); Nizhnebikkuzino I site (bed 5); Tanalyk I site (bed 2); Akbuta site (bed 6); Yabalakovo site (beds 2–6) (Fig. 1). Mollusc associations (4870 determined shells) consist of 16 species and 12 genera of terrestrial species like *Succinea*, *Succinella*, *Oxyloma*, *Cochlicopa*, *Vertigo*, *Pupilla*, *Vallonia*, *Chondrula*, *Discus*, *Perpolita*, *Pseudotrichia*, and *Bradybaena* and 25 species and 15 genera of freshwater (*Lymnaea*, *Stagnicola*, *Planorbis*, *Anisus*, *Gyraulus*, *Segmentina*, *Bathyomphalus*, *Acroloxus*, *Aplexa*, *Borystenia*, *Valvata*, *Bithynia*, *Pisidium*, *Sphaerium*, *Unio*) molluscs (Danukalova et al., 2002a, 2011; Osipova, 2009a, 2009b; Osipova and Danukalova, 2011) (Table 2).

Mixed small mammal assemblages were also found at the Southern Urals (Ignatievskaya cave, excavation II, bed 2a; Serpievskaya 1 cave, bed 2; Prizhim 2 cave; Maksyutovo Grotto, beds 2–3; Shulgan-Tash (Kapova) cave, cultural bed; Serpievskaya 2 cave, beds 2 and 3; Ustinovo Grotto, beds 2 and 3; Bajslan-Tash cave, lower part of the bed 4) (Table 3) and are characterized by steppe biotope species including *M. gregalis*, *Lagurus lagurus*, *C. migratorius*, *Ochotona pusilla* and *Allactaga major* Kerr. In these assemblages the tundra taxa were presented by *D. guilielmi*, *Dicrostonyx torquatus* and *L. sibiricus*; forest species were represented by *C. rufocanus*, *Cl.* ex gr. *glareolus-rutilus*, *Cl. rutilus* and *M. agrestis*. The climate indicated by these taxa was cold (Smirnov et al., 1990; Kuzmina and Abramson, 1997; Danukalova et al., 2011). The composition of the small mammal species of the Southern Trans-Urals (Syrtinskaya cave, horizons 32, 28, 24, 18, 15 and 11; Smelovskaya 2 cave, horizons 19, 9 and 7) was similar to the faunas of the mountainous part of the Urals but with a steppe and semi-desert species dominance (Kuzmina, 2009).

Large mammal assemblages of the Kudashevo Horizon were found in the deposits of the river terraces (Zlatoustovka) and cave sites of the Southern Urals (Ignatievskaya cave, excavation II, bed 2a; Serpievskaya 1 cave, bed 2; Prizhim 2 cave; Maksyutovo Grotto, beds 2–3; Shulgan-Tash (Kapova) cave, cultural bed; Serpievskaya 2 cave, beds 2, 3; Ustinovo Grotto, beds 2 and 3; Verkhnaya cave; Bajslan-Tash cave, lower part of the bed 4). The large mammal fauna belongs to the Late Palaeolithic mammal complex (Smirnov et al., 1990; Danukalova et al., 2008, 2011) (Table 4) and had some features such as *C. spelaea* that disappeared from this association at the beginning of the Kudashevo phase. *U. spelaeus* disappeared in the middle of this period (Kosintsev, 2003).

## 5. Discussion

The malacofauna of the Late Neopleistocene of the Southern Urals region is represented by freshwater and terrestrial Holarctic and widespread molluscs. Terrestrial molluscs (*Succinella*, *Succinea*, *Oxyloma*, *Cochlicopa*, *Pupilla*, *Vertigo*, *Columella*, *Vallonia*, *Vitrea*, *Discus*, *Perpolita*, *Chondrula*, *Pseudotrichia*, *Bradybaena*) inhabitated forest biotopes in plains and mountains and lived under fallen leaves, in bushes, grass or under old tree bark. Freshwater molluscs (*Lymnaea*, *Stagnicola*, *Anisus*, *Planorbis*, *Gyraulus*, *Segmentina*, *Bathyomphalus*, *Ancylus*, *Acroloxus*, *Aplexa*, *Borysthenia*, *Valvata*, *Bithynia*, *Sphaerium*, *Pisidium*, *Anodonta*, and *Unio*) inhabited mainly water reservoirs without current with growing water plants and muddy bottoms, or rivers with slow currents.

In the Russian Plain the Late Neopleistocene deposits containing mollusc shells were described by Danilovskyi (1955), Shevyrev and Alexeeva (1979) and Moskvitin (1976). The composition of the species of these faunas is similar to the Uralian faunas except for *Iphigena*, *Melanopsis*, *Lithoglyphus* and *Theodoxus* which were probably redeposited from the underlying deposits. Stefanovsky (2006) gave a list of the mollusc species for the Urals and Trans-Urals, with similar assemblages to the investigated faunas.

In the Ukraine region, Gozhik (1965), Veklich and Sirenko (1972), Kunitsa (1974), show that during the Late Pleistocene, terrestrial molluscs were numerous. Among them, different Helicoidea species and *Arianta* existed. The list of water molluscs contains mainly freshwater but also brackish water species (Hydrobiidae and Cardiidae). A rich variety of molluscs was described by Alexandrowicz and Alexandrowicz (2010) from the Lower Weichselian of Poland, where Alp-Carpatian species (*Acicula*, *Aegopis*, *Aegopinella*, *Ruthenica*, *Macrogastra*, *Clausilia*, *Bulgarica*, *Orcula*, *Perforatella*, *Pagodulina*, *Tricha*, *Helicodonta*, *Arianta*, *Chilostoma*, *Cepaea*, and *Helix)* existed together with more widespread molluscs.

Malacalogical data from the Irig and Batajnica sites (Serbia) show the existence of malacological assemblages with European and Alp–Carpatian similarities (*Helicopsis*, *Aegopinella*, *Oxychilus*, *Cepaea*, *Arianta*, *Clausilia*, *Granaria*, *Orcula*, *Vestia*, *Semilimax*, *Ceciloides*, *Trichia*, and *Cochlodina*) (Ložek, 2000; Sümegi and Krolopp, 2002; Marković et al., 2004, 2008, 2007).

In the Weichselian deposits of Germany (Nussloch site, Rhine valley) (Moine et al., 2005), France and England (Martin et al., 2005; Moine, 2008) molluscs associations are of Holarctic origin but also include the species identical to the Uralian faunas with admixture or sometimes with dominance of European and Alpian species such as *Helicopsis*, *Trichia*, *Arianta*, *Trochoidea*, *Clausilia*, *Candidula*, *Neostyriaca*, *Orcula*, *Abida*, *Jaminia*, *Arianta*, *Pomatis*, *Cepaea*, *Testacella*, *Aegopinella*, *Eucobresa*, *Monacha*, *Cochlicella*, *Oxychilus*, *Ferussacia*, *Cernuella*, *Theba*, *Deroceras*, and *Helicodiscus*. In summary, comparison with the European malacofaunas shows that European and Alp–Carpatian species did not exist in the Uralian area, mainly because it was more continental.

The variety of the small mammals of the Kushnarenkovsky Horizon sampled in the Southern Uralian area is almost the same as that of the Central Europe (Eemian), England (Ipswichian), Russian Plain (Mikulino) and Siberia (Kazancevsky) and consist of *A. terrestris*, *Cl. glareolus*, *M. agrestis*, *M. arvalis*, *M. oeconomus*, Soricidae and *Desmana* sp. In the southern parts of the Russian Plain steppe (*Lagurus lagurus* and *M. gregalis*) and semi-desertic (*E. luteus*) species represent a significant part of these faunas (Markova, 1982, 1985; Agadjanian, 2009).

Small mammal faunas of the Last Glacial of the Norhtern Eurasia are common and well studied. The Western, Central and Eastern Europe, Russian Plain and Western Siberia (Chaline, 1972; Sutcliffe and Kowalski, 1976; Zazhigin, 1980; Maleeva, 1982; Markova, 1982; Smirnov et al., 1986; Rekovets, 1994; Agadjanian, 2009) show the dominant presence of *D. guilielm*; *L. sibiricus*, *M. gregalis* and *Lagurus lagurus* are less abundant. Late Glacial faunas are only different in their species composition.

Late Neopleistocene large mammal faunas have been well investigated in the Uralian region. *Hystrix vinogradovi* Argyropulo and *Ursus thibetanus* G. Cuvier are known inside the Kushnarenkovo deposits of the Machnevskaya cave (Middle Urals). These species did not exist in the latest large mammal assemblages. Large mammals of the Tabulda period from the Middle and Northern Urals are typical for the Late Palaeolithic Mammal Complex.

In the Northern Urals at the beginning of the Late Glacial, *E.* cf. *latipes* V. Gromova and small cave bear disappeared. *U. spelaeus* also disappeared in different parts of the Urals in the middle of the Late Glacial epoch (Kosintsev, 2003).

## 6. Conclusions

Erosional processes started to become active at the beginning of Kushnarenkovo time when uplift took place in the Urals and when the Late Chosarian regression began in the Caspian Sea basin (Yakhemovich et al., 1981; Yanina, 2009, Tables 1 and 7).

Fluvial deposits can be observed at the base of the second terrace which developed above the floodplain. They were almost completely eroded during the variations of the water level of the Caspian basin (base of the erosion) and under the influence of the tectonic uplift of the Urals (Yakhemovich et al., 1985). A soil was formed on the subhorizontal surfaces (e.g. the third Sultanaevo soil, the second Voevodskoe soil, and the third Chui–Atasevo soil) (Yakhemovich et al., 1981, 1983; Danukalova et al., 2002b). Meadows covered the open areas; forest–steppe and steppe landscapes became widespread at the end of the Kushnarenkovo phase (which can be probably correlated with the beginning of the Weichselian, MIS 5a–d).

The subsequent Saigatka cold period is correlated with the beginning of Valdai period known in the Russian Plain (it can be correlated with MIS 4). The Early Valdai ice sheet occupied Fennoscandia but its eastern boundary was located close to the modern Volga and Kama river valleys (Velichko, 1982). The region was unglaciated during Valdai time (Saigatka and Kudashevo phases) although small cirque glaciers formed in mountains. Mountains altitudes were close to the present day values. Slope processes and solifluction were the main relief-forming processes (Rozhdestvensky, 1971) and fluvial erosion processes became weaker. Floodplain sediments accumulated in the river valleys and formed the upper parts of the second terraces above the floodpain which were intensively eroded (Yakhemovich et al., 1981, 1983, 1985). The plains were covered by steppe and the mountainous areas were occupied by tundra and forest–tundra landscapes (Yakhemovich et al., 1970). Trees grew on the slopes of the interfluves.

The next erosional cycle began during the following Tabulda period because of the lowering of base level of the erosion and increased uplift of the territory. The incision of the valleys with time was replaced by lateral erosion when the second river terrace was destroyed. The fluvial sediments now form the lower parts of the first terraces above the floodplain. Lacustrine deposits accumulated in the small freshwater basins which contain organic material (wood and algie, bones) (Yakhemovich et al., 1985; Danukalova et al., 2002a; Danukalova and Yakovlev, 2006). A soil was formed on the watersheds (fourth Sultanaevo soil, the third Voevodskoe soil, and the second Minzitarovo soil) (Yakhemovich et al., 1981, 1983, 1985). The Gornova and Tabulda sites contain artifacts (Yakhemovich et al., 1985, 1987) from the Late Palaeolithic, which is correlated with the last middle Valdai optimum (Velichko and Ivanova, 1969; Rogachev and Anikovich, 1984). The Tabulda Horizon is correlated with the middle part of Valdai mega-interstadial. In some areas, including the South Urals, the Tabulda period corresponds with the phase of warming (short interval of interglacial, MIS 3): the floral association was close to that of the present-day. The climate was moderately warm in the plains and drier and cooler in the mountains where vertical climatic zoning formed.

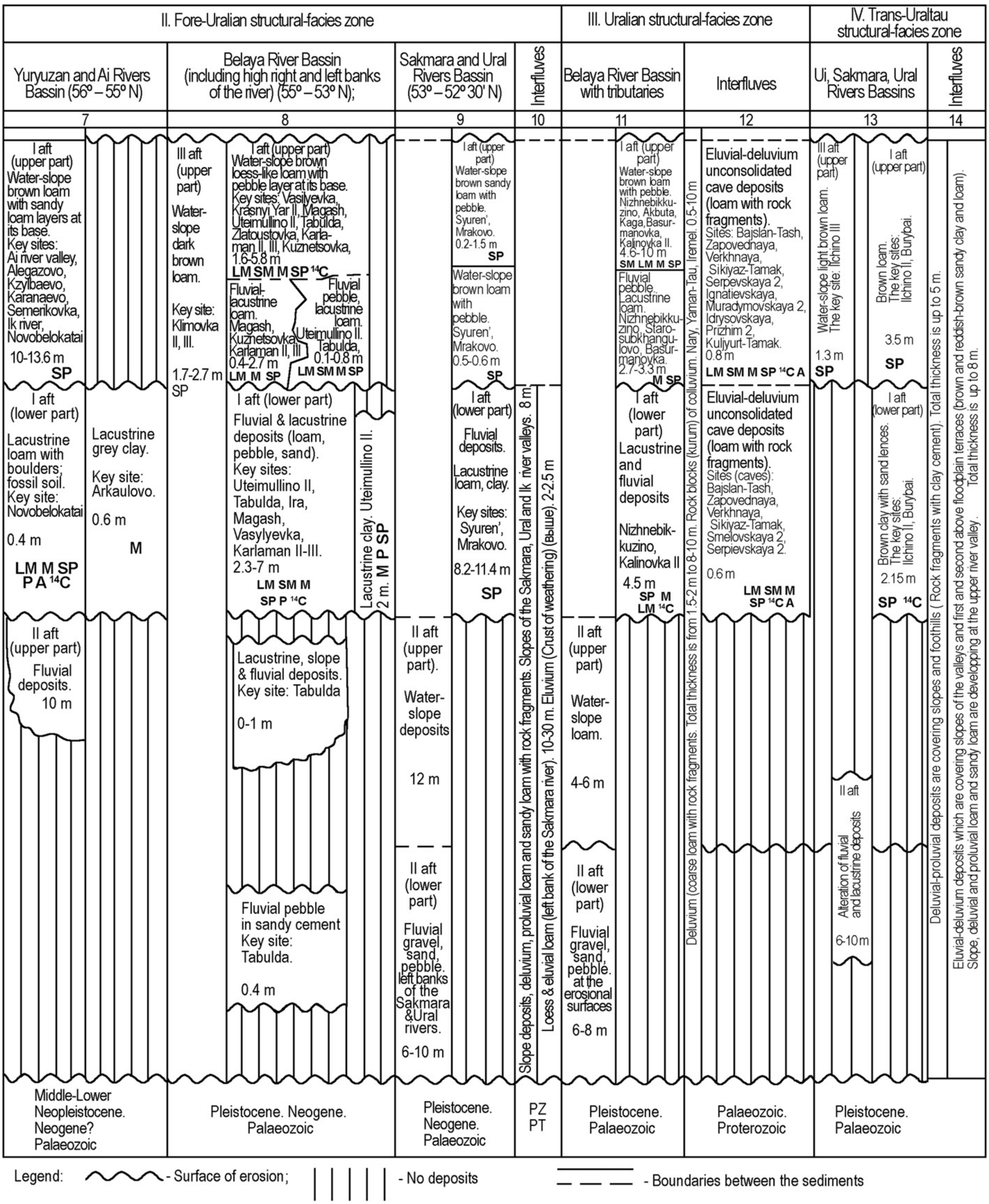
The subsequent Kudashevo event can be correlated with the late Valdai period (Ostashkovo glaciation) and the Late Glacial when the climate became colder. The Valdai ice of the maximal stage covered areas which existed to the northwest of the present-day Volga, Vyatka, and Kama river valleys (Velichko, 1982). Seasonal frost penetration was widespread in the Southern Fore-Urals region (Velichko, 2002). Loess-like sediments and floodplain deposits form the upper parts of the first terrace above the floodplain and cover the watersheds, where they contain cryogenic structures (Yakhemovich et al., 1981, 1983, 1985, 1988; Danukalova et al., 2000; Danukalova and Yakovlev, 2004, 2006; Danukalova and Eremeev, 2006). The climate was moderately cold. Late Palaeolithic sites attributed to the Kudashevo time are known in the Southern Urals region. They are located in Shulgan-Tash (Kapova), Zapovednaya and Bajslan-Tash caves, Syun' I site, and others (Danukalova and Yakovlev, 2006).

Taken as a whole, the studied palaeontological materials allowed the reconstruction of the main environmental characteristics of the area and differentiation of the Late Pleistocene Horizons of the South Urals. Future studies will solve some questions concerning the precise age of the horizons in the easternmost part of Europe.

**Table 7**
Correlation of the Upper Neopleistocene deposits from the different regions of the Southern Urals (G.Danukalova)

<table>
<tr><th rowspan="3">Horizons</th><th colspan="10">I. South-East of the Russian platform structural-facies zone</th></tr>
<tr><th colspan="3" rowspan="2">Bugulma-Belebei Highland, Obshyi Syrt Highland (eastern part)</th><th colspan="5">Belaya River Bassin</th><th colspan="2">Ufimian Plateau</th></tr>
<tr><th>Ik, Dema Rivers (upstreams)</th><th>High left bank of the Belaya River</th><th colspan="2">Belaya River valley from Ufa town to the river mouth</th><th>High right bank of the Belaya River</th><th>Ufa River Bassin</th><th>Western slope</th></tr>
<tr><td>Holocene</td><td colspan="3">1</td><td>2</td><td>3</td><td colspan="2">4</td><td>5</td><td>6a</td><td>6b</td></tr>
<tr><td>Kudashevo</td><td rowspan="4">Eluvial-deluvial products of weathering on the subhorizontal surfaces. The composition depends of the underlying deposits: 1. Reddish brown sandy clay, loam with rock debris on the base of Ufimian red-colored deposits. 2. Grey sand and sandy loam or clay on the base of Lower Kazan deposits. 3. Limestone fragments in the sandy clay cement, reddish brown loam with rock debris on the base of Upper Permian deposits. 4. Reddish brown sand and sandy loam with rock fragments on the base of Tatarian deposits. 5. Grey and yellow sand and pebble on the base of Neogene deposits. 6. Loam, sandy loam and clay on the base of Eopleistocene and Lower Neopleistocene deposits. Total thickness: 0-10 m.</td><td rowspan="4">Deluvium (Solifluction) brown loam and sandy clay with rock fragments on steep river valley and ravine slopes. Total thickness is.5-10 m.</td><td></td><td>I aft<br>(upper part)<br>Water-slope light-brown loam, gray fine-grained sand.<br>Key sites and boreholes: Absalyamovo, Kyzyl-Yarovo, New Bavly, Nikitinka, Urussy, Tuimazy Nikifarovo, Aitovo, Chekan, Novotroitskoye, Russky Shugan.<br>1.1-14.5 m</td><td>Loam (Syun I)<br>3 m SP A<br><br>I aft<br>(upper part)<br>Water-slope loam with sand and pebble layers.<br>Key sites: Syun I, Berdasla, Old Tukmakly, Chermasan, Upper Saitovo, Tyurkeevo, Tyuryushtamak, Sultanaevo, Kalmashka.<br>3-5 m SP</td><td>Water-slope brown loam.<br>Key sites: Gruzdevka, Ilenka III-IV, Biktimirovo, Voevodskoye<br>0.55-2.6 m<br>SP</td><td>Water-slope brown loess-like loam with dense clay. in the lower part.<br>Key-sites: Gornovo I-II, Starye Kiishki II, Kabakovo.<br>8.2 m<br>SP P M $^{14}C$</td><td>Lacustrine loam with peat. 2.6 m<br>Key site: Novokudashevo<br>M SP P $^{14}C$<br><br>Lacustrine light brown loam with fluvial sand and pebble layers.<br>Key site: Novokudashevo.<br>2.8 m<br>SP P $^{14}C$</td><td>I aft<br>(upper part)<br>Fluvial clayish sand, pebble, gravel.<br>Water-slope sandy loam, brown clay with gravel, pebble & rock fragments.<br>Key sites: Karaidel, upper stream of the Bir', Baiki rivers; Ar, Deush-Buz, Mryasim-Eche</td><td rowspan="4">Eluvial (1-1.5, up to 5 m), eluvial-deluvium (0.1- 5-7 m) deposits occur at the interfluve surfaces, valley slopes and talus at the foot of the slopes. Loam, sandy loam with rock fragments.<br><br>Deluvial (Solifluction) brown loam and sandy clay with debris of Upper Permian rocks</td></tr>
<tr><td>Tabulda</td><td>Soils:<br>IV Sultanaevo soil 0.4 m<br>II Minzitarovo soil 0.7 m<br>III Voevodskoye soil 0.2-0.6 m</td><td>I aft<br>(lower part)<br>Lacustrine loam and clay.<br>Fluvial pebble and sand.<br>Key sites and boreholes: Absalyamovo, Tuimazy, Kysyl-Yarovo etc.<br>1-9 m</td><td>Lacustrine dark grey loam<br>Key sites: Syun' I, Nur, Aktanyshbash.<br>2-3 m<br>SP $^{14}C$</td><td></td><td>I aft<br>(lower part)<br>Lacustrine loam, fluvial deposits<br>Key sites: Gornovo II, Starye Kiishki II, Kabakovo, Vaityakovo, Karatamak<br>8.3-12m<br>LM SM M O In SP P $^{14}C$</td><td>Lacustrine loam with sand at it's base.<br>Key sites and boreholes: Novokudashevo, Vanysh, Vaityakovo, Karatamak.<br>4.8 m<br>LM SP P</td><td>I aft<br>(lower part)<br>Fluvial pebble and gravel, sand.<br>Key sites: Upstreams of the Ufa, Bir', Baiki Rivers, Deush-Buz, Mryasim-Eche<br>10 m</td></tr>
<tr><td>Saigatka</td><td></td><td></td><td>II aft<br>(upper part)<br>Nurlino Suite. Lacustrine-deluvial loess-like loam<br>Key sites: Chui-Atasevo III, Sultanaevo.<br>0-1.2 m<br>SM O SP</td><td></td><td>II aft<br>(upper part)<br>Nurlino Suite. lacustrine deluvium loess-like loam<br>Key sites: Gornovo II, Voevodskoye<br>0-1.2 m<br>M O SP</td><td></td><td></td></tr>
<tr><td>Kushnarenkovo</td><td>Soils:<br>III Sultanaevo soil 0.2 m<br>III Chui-Atasevo soil 1.2 m<br>II Voevodskoye soil 0.6 m</td><td></td><td>II aft<br>(lower part)<br>Lacustrine loam.<br>Key site: Sultanaevo.<br>0.65 m<br>M</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Underlying deposits:</td><td>Middle Neopleistocene. Upper Permian</td><td>Middle-Lower Neopleistocene. Eopleistocene. Upper Permian</td><td colspan="2">Middle-Lower Neopleistocene. Eopleistocene. Neogene Upper Permian</td><td>Middle Neopleistocene. Neogene. Upper Permian</td><td colspan="2">Pliocene? Upper Permian</td></tr>
</table>

Legend: SP - spore and pollen; A - archaeological artefacts; $^{14}C$ - radiocarbon data; P - palaeocarpological remains; O - Ostracoda finds; M - mollusc shells; SM - small mammal data; LM - large mammal finds; In - finds of insects. I aft - first above floodplain river terrace, II aft - second above floodplain river terrace, III aft - third above floodplain river terrace. PZ - Palaeozoic; PT - Proterozoic.


II. Fore-Uralian structural-facies zone
III. Uralian structural-facies zone
IV. Trans-Uraltau structural-facies zone
Yuryuzan and Ai Rivers Bassin (56° – 55° N)
Belaya River Bassin (including high right and left banks of the river) (55° – 53° N);
Sakmara and Ural Rivers Bassin (53° – 52° 30' N)
Interfluves
Belaya River Bassin with tributaries
Interfluves
Ui, Sakmara, Ural Rivers Bassins
Interfluves
7
8
9
10
11
12
13
14
I aft (upper part) Water-slope brown loam with sandy loam layers at its base. Key sites: Ai river valley, Alegazovo, Kzylbaevo, Karanaevo, Semerikovka, Ik river, Novobelokatai 10-13.6 m SP
III aft (upper part) Water-slope dark brown loam. Key site: Klimovka II, III. 1.7-2.7 m SP
I aft (upper part) Water-slope brown loess-like loam with pebble layer at its base. Key sites: Vasilyevka, Krasnyi Yar II, Magash, Uteimullino II, Tabulda, Zlatoustovka, Karlaman II, III, Kuznetsovka, 1.6-5.8 m
LM SM M SP 14C
Fluvial-lacustrine loam. Magash, Kuznetsovka Karlaman II, III 0.4-2.7 m LM M SP
Fluvial pebble, lacustrine loam. Uteimullino II. Tabulda, 0.1-0.8 m LM SM M SP
I aft (upper part) Water-slope brown sandy loam with pebble. Syuren', Mrakovo. 0.2-1.5 m SP
Water-slope brown loam with pebble. Syuren', Mrakovo. 0.5-0.6 m SP
I aft (upper part) Water-slope brown loam with pebble. Nizhnebikkuzino, Akbuta, Kaga, Basurmanovka, Kalinovka II. 4.6-10 m SM LM M SP
Fluvial pebble. Lacustrine loam. Nizhnebikkuzino, Starosubkhangulovo, Basurmanovka. 2.7-3.3 m M SP
Eluvial-deluvium unconsolidated cave deposits (loam with rock fragments). Sites: Bajslan-Tash, Zapovednaya, Verkhnaya, Sikiyaz-Tamak, Serpevskaya 2, Ignatievskaya, Muradymovskaya 2, Idrysovskaya, Prizhim 2, Kuljyurt-Tamak. 0.8 m LM SM M SP 14C A
III aft (upper part)
Water-slope light brown loam. The key site: Ilchino III 1.3 m SP
I aft (upper part) Brown loam. The key sites: Ilchino II, Burybai. 3.5 m SP
I aft (lower part) Lacustrine loam with boulders; fossil soil. Key site: Novobelokatai 0.4 m LM M SP P A 14C
Lacustrine grey clay. Key site: Arkaulovo. 0.6 m M
I aft (lower part) Fluvial & lacustrine deposits (loam, pebble, sand). Key sites: Uteimullino II, Tabulda, Ira, Magash, Vasylyevka, Karlaman II-III. 2.3-7 m LM SM M SP P 14C
Lacustrine clay. Uteimullino II. 2 m. M P SP
I aft (lower part) Fluvial deposits. Lacustrine loam, clay. Key sites: Syuren', Mrakovo. 8.2-11.4 m SP
I aft (lower part) Lacustrine and fluvial deposits Nizhnebikkuzino, Kalinovka II 4.5 m SP M LM 14C
Eluvial-deluvium unconsolidated cave deposits (loam with rock fragments). Sites (caves): Bajslan-Tash, Zapovednaya, Verkhnaya, Sikiyaz-Tamak, Smelovskaya 2, Serpievskaya 2. 0.6 m LM SM M SP 14C A
I aft (lower part) Brown clay with sand lences. The key sites: Ilchino II, Burybai. 2.15 m SP 14C
II aft (upper part) Fluvial deposits. 10 m
Lacustrine, slope & fluvial deposits. Key site: Tabulda 0-1 m
II aft (upper part). Water-slope deposits 12 m
II aft (upper part) Water-slope loam. 4-6 m
II aft Alteration of fluvial and lacustrine deposits 6-10 m
Fluvial pebble in sandy cement Key site: Tabulda. 0.4 m
II aft (lower part) Fluvial gravel, sand, pebble. left banks of the Sakmara &Ural rivers. 6-10 m
II aft (lower part) Fluvial gravel, sand, pebble. at the erosional surfaces 6-8 m
Slope deposits, deluvium, proluvial loam and sandy loam with rock fragments. Slopes of the Sakmara, Ural and Ik river valleys. 8 m
Loess & eluvial loam (left bank of the Sakmara river). 10-30 m. Eluvium (Crust of weathering) (выше). 2-2.5 m
Deluvium (coarse loam with rock fragments. Total thickness is from 1.5-2 m to 8-10 m. Rock blocks (kurum) of colluvium. Nary, Yaman-Tau, Iremel. 0.5-10 m
Deluvial-proluvial deposits are covering slopes and foothills ( Rock fragments with clay cement). Total thickness is up to 5 m.
Eluvial-deluvium deposits which are covering slopes of the valleys and first and second above floodplain terraces (brown and reddish-brown sandy clay and loam). Total thickness is up to 8 m.
Slope, deluvial and proluvial loam and sandy loam are developping at the upper river valley.
Middle-Lower Neopleistocene. Neogene? Palaeozoic
Pleistocene. Neogene. Palaeozoic
Pleistocene. Neogene. Palaeozoic
PZ PT
Pleistocene. Palaeozoic
Palaeozoic. Proterozoic
Pleistocene. Palaeozoic
Legend: - Surface of erosion; - No deposits - Boundaries between the sediments

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