LATE PLEISTOCENE TERRACES IN RIVER VALLEYS OF THE CENTRAL RUSSIAN PLAIN: MORPHOLOGY, STRUCTURE AND HISTORY OF DEVELOPMENT

This poster participates in OSP

Outstanding Student Poster Contest

Matlakhova E. Yu.[1], Panin A.V.[1]

[1] Faculty of Geography, Lomonosov Moscow State University, Moscow, Russia

E-mail: matlakhova_k@mail.ru, a.v.panin@yandex.ru

INTRODUCTION

Morphology and sedimentary composition of low terraces of Seim and Khoper Rivers (Central Russian Plain) were studied by complex of field and laboratory methods. The results were used to establish chronology, mechanisms and conditions of formation of river valleys in Valdai (Weichselian) cold epoch (MIS 5d – MIS 2).

Traditionally the reconstructions of river valleys development were based on climatostratigraphical principles. And there are still exist many points of view about the rivers reaction to the climate changes. In our research we tried to elaborate the chronology of river valleys development in Late Pleistocene and to correct some regularities of this processes for the rivers of the central part of Russian Plain.

For this purpose we used complex data about morphology and structure of terraces, genesis and age of terrace deposits.

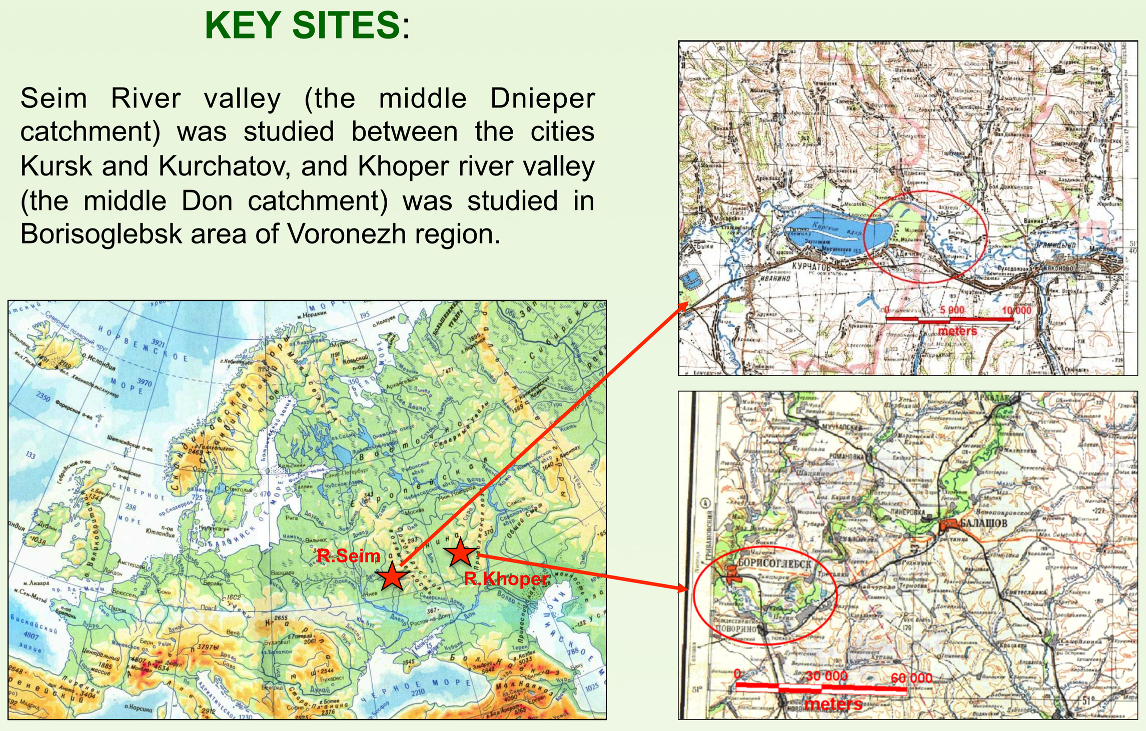
The results of absolute dating (OSL, C14) made it possible to correct existing concepts of river valleys development on Central Russian Plain.

The study of morphology of river valleys indicated contrasting runoff variations being the characteristic feature of the Valdai (Weichselian) cold stage.

To establish terrace sedimentation mechanisms we supplemented lithological data collected in the field with quartz grains morphoscopy technique (microscopic study of quartz grains surfaces). The results exhibit wide participation of aeolian and slope wash sediments in terrace deposits. So this fact made us to conclude that river terraces were subject to complex reworking by different processes after the alluvial sedimentation had finished.

KEY SITES:

Seim River valley (the middle Dnieper catchment) was studied between the cities Kursk and Kurchatov, and Khoper river valley (the middle Don catchment) was studied in Borisoglebsk area of Voronezh region.

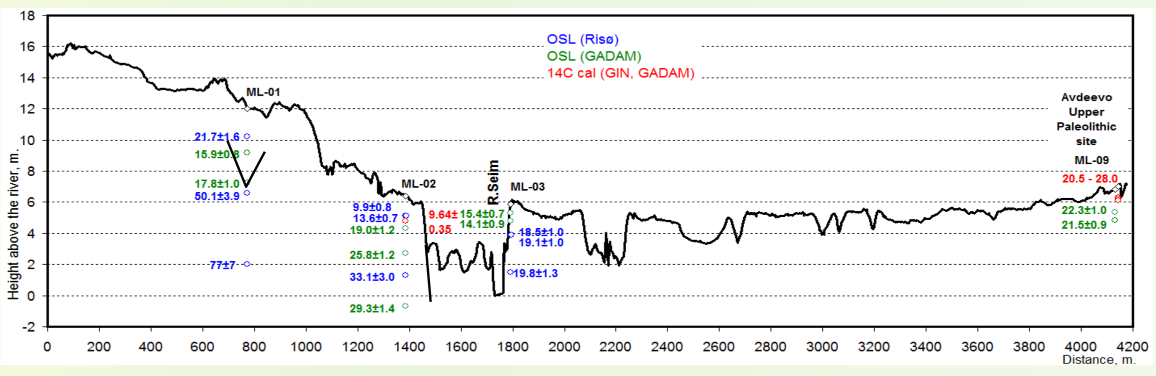


METHODS

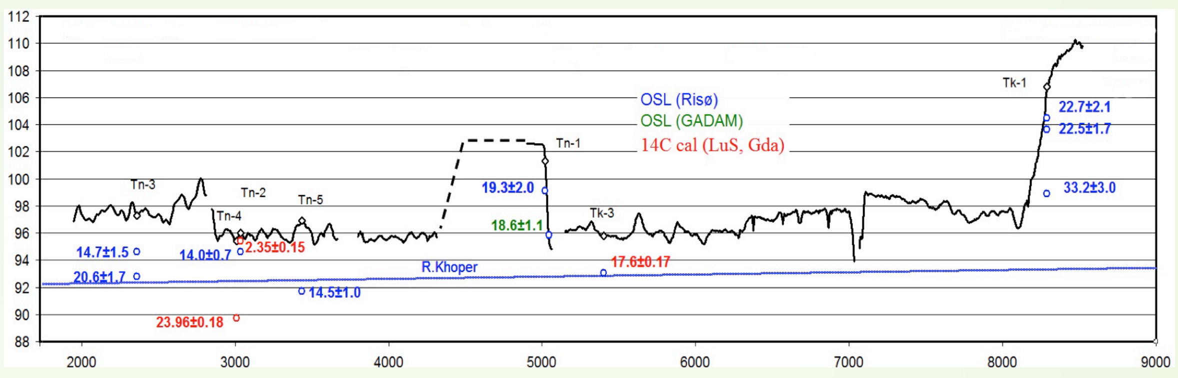
- Examination of natural exposures;
- Hand and mechanical coring;
- DGPS topographic profiling (Leica Smart Station);
- Subsurface exploration (ground penetration radar (GPR) Zond 12e).
- Grain size analysis;
- Spore-pollen analysis;
- 14C dating (Laboratories: Gliwice Absolute Dating Methods Centre, Poland (AMS); Institute of Geography, Russian Academy of Sciences, Russia);
- OSL dating (Laboratories: The Nordic Laboratory for Luminescence Dating, Aarhus University, Denmark; Gliwice Absolute Dating Methods Centre, Poland);
- Microscopic study of quartz grains;
- Archaeological data.

MORPHOLOGY AND STRUCTURE OF SEIM AND KHOPER LATE PLEISTOCENE RIVER TERRACES

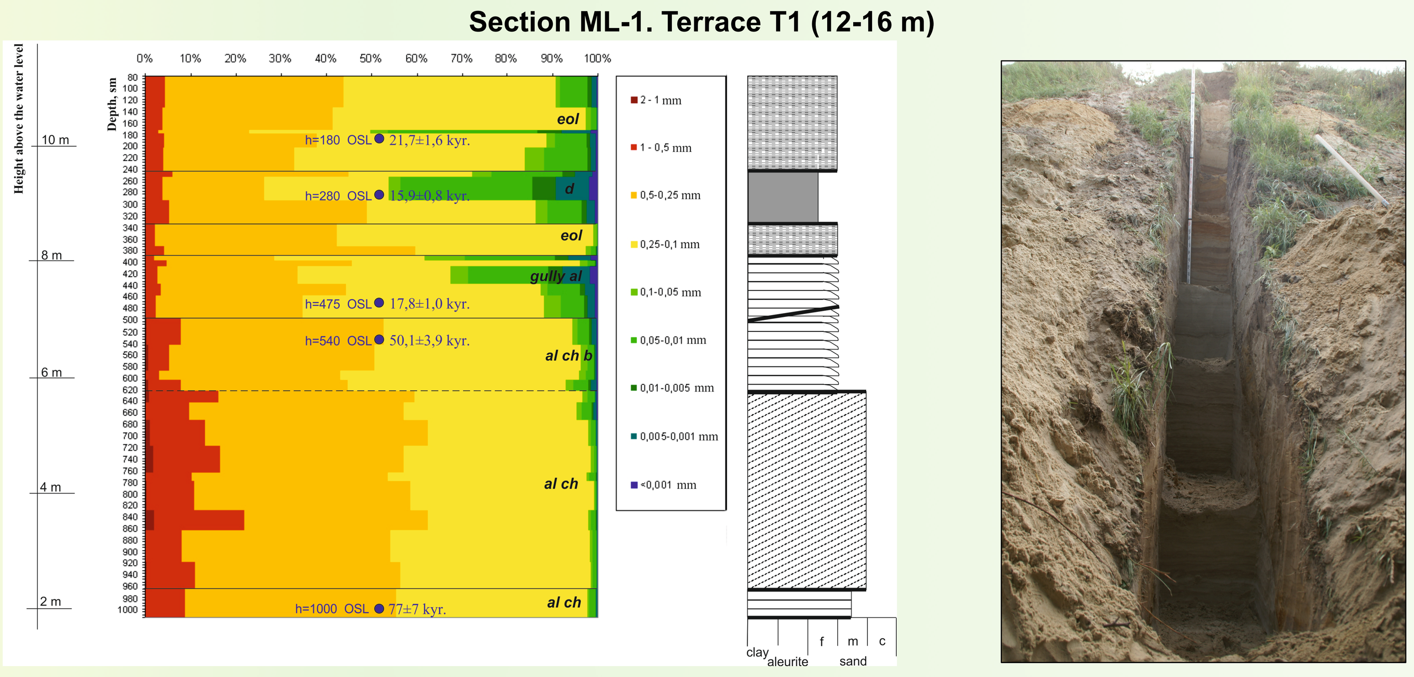
SEIM



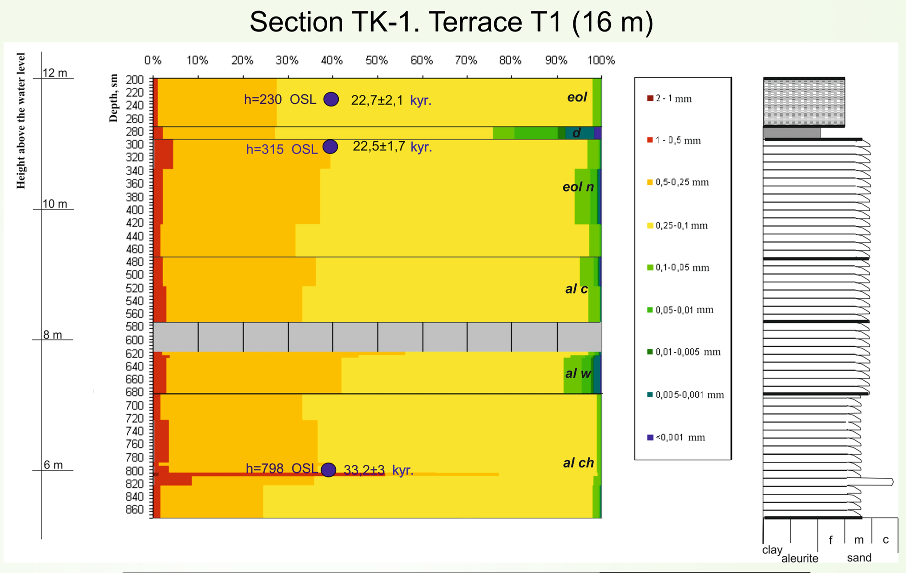
KHOPER

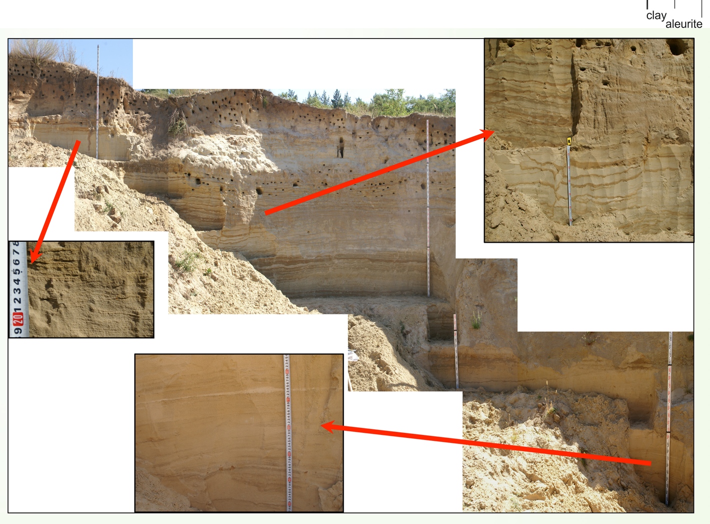


Section ML-1. Terrace T1 (12-16 m)

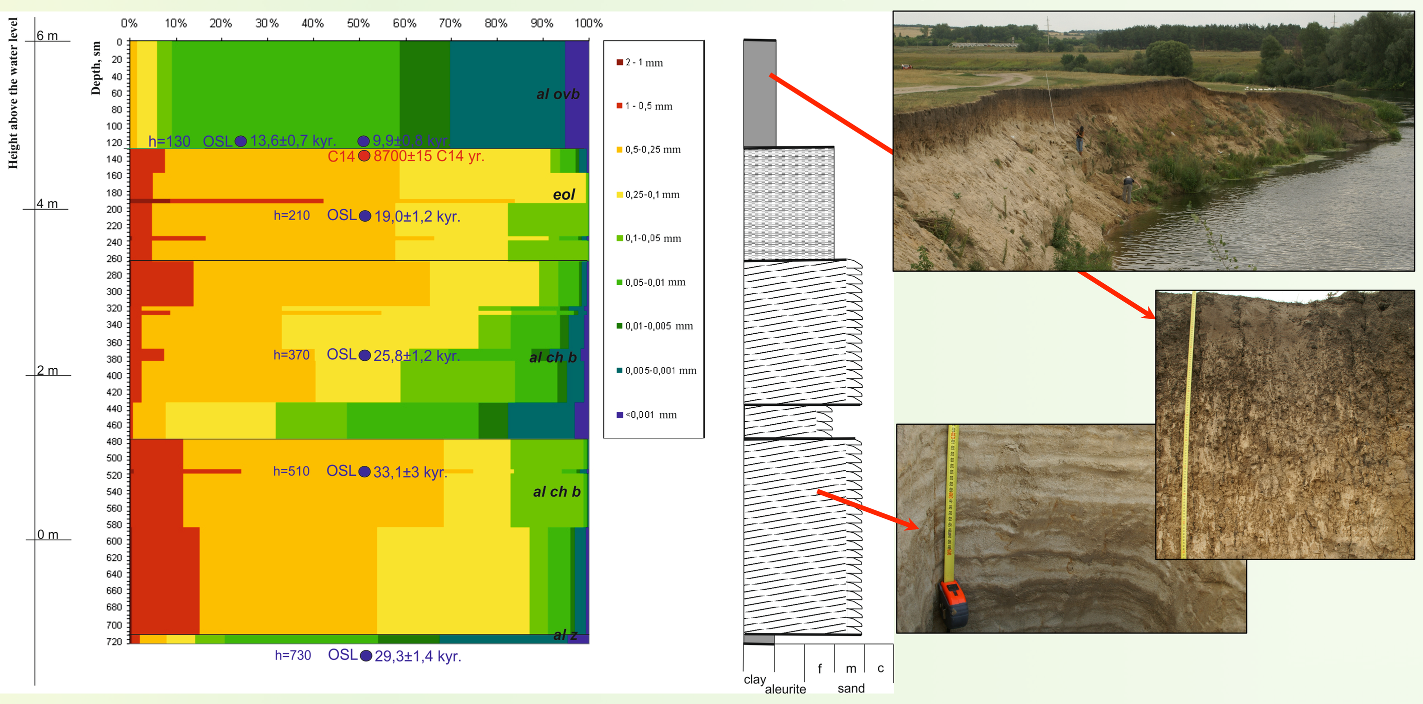


Section TK-1. Terrace T1 (16 m)

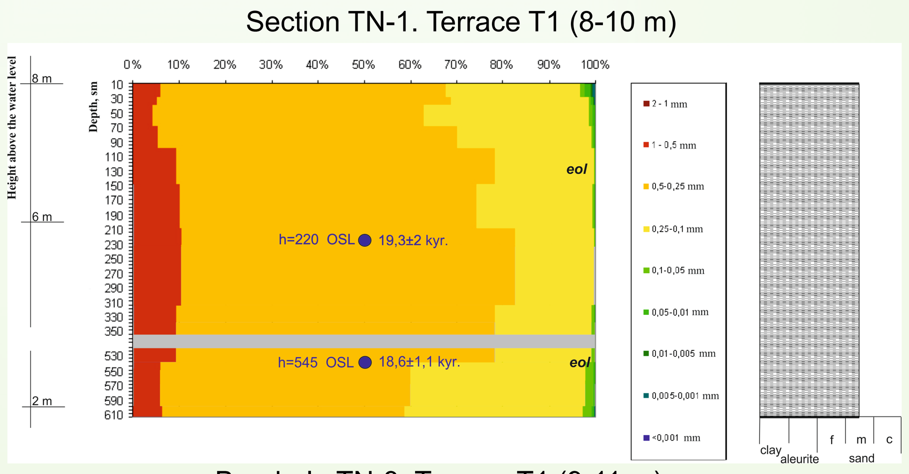




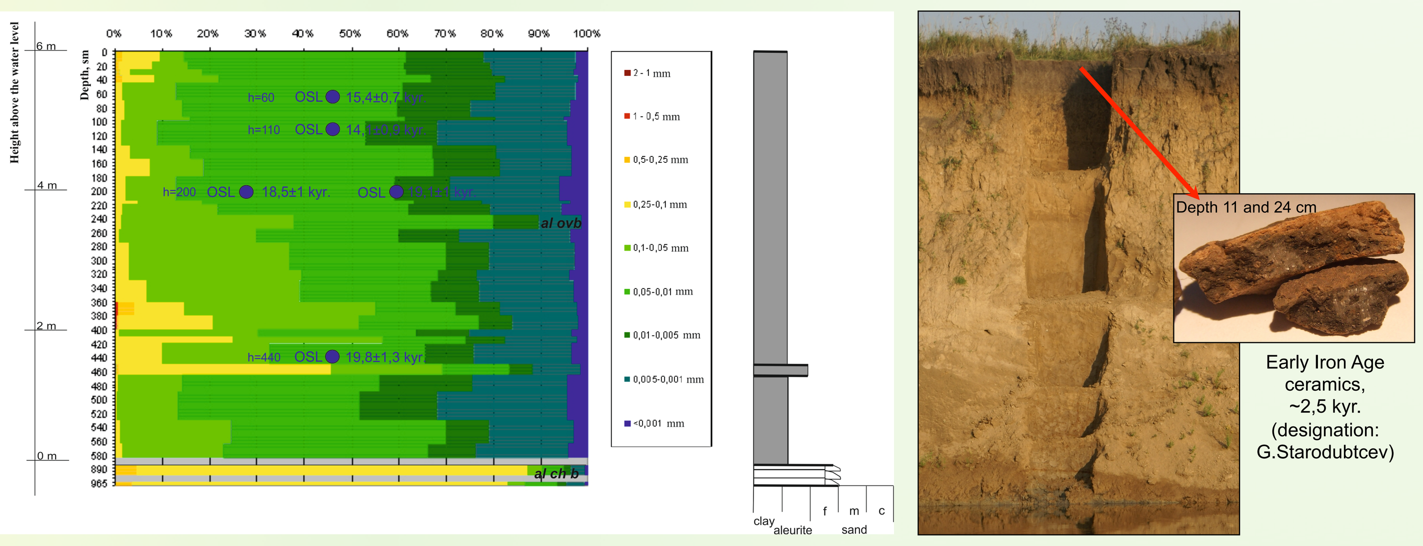
Section ML-2. Terrace T0b (6-7 m)



Section TN-1. Terrace T1 (8-10 m)

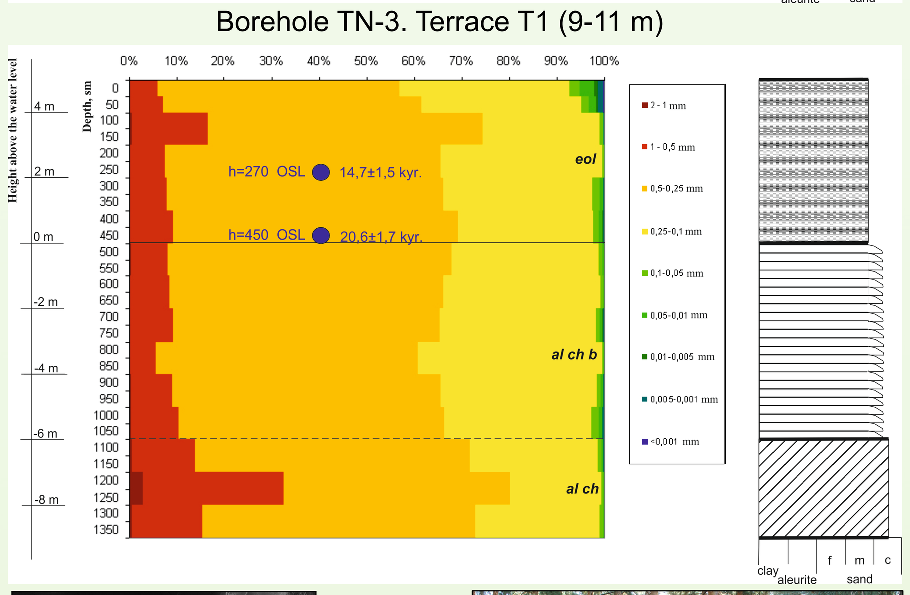


Section ML-3. Terrace T0a (5-6 m)

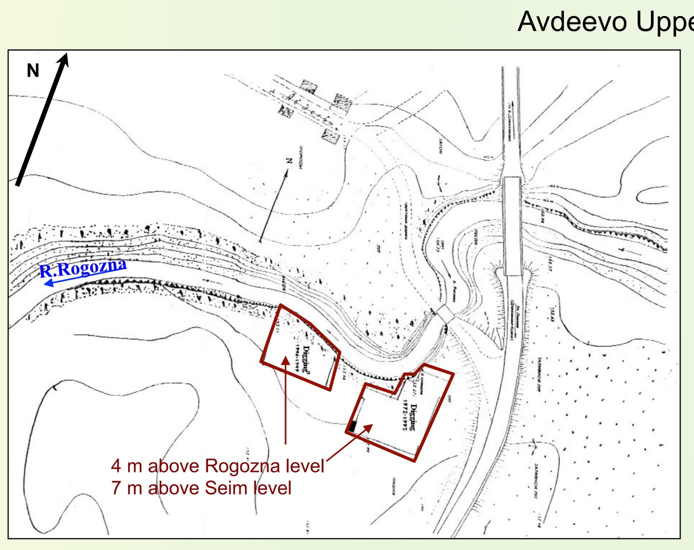


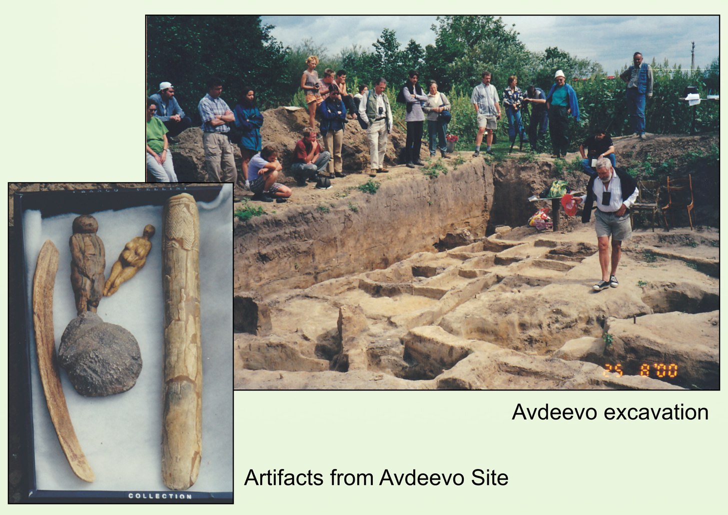
Early Iron Age ceramics, ~2,5 kyr. (designation: G.Starodubtcev)

Borehole TN-3. Terrace T1 (9-11 m)



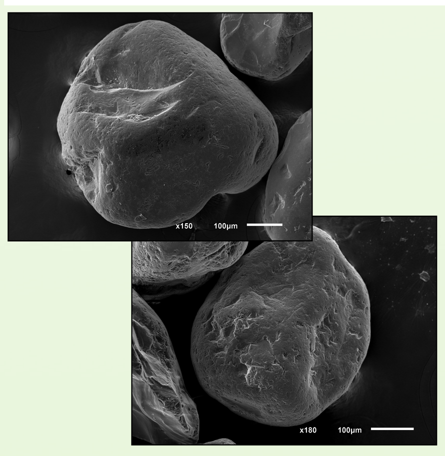
Avdeevo Upper Paleolithic Site





Avdeevo excavation

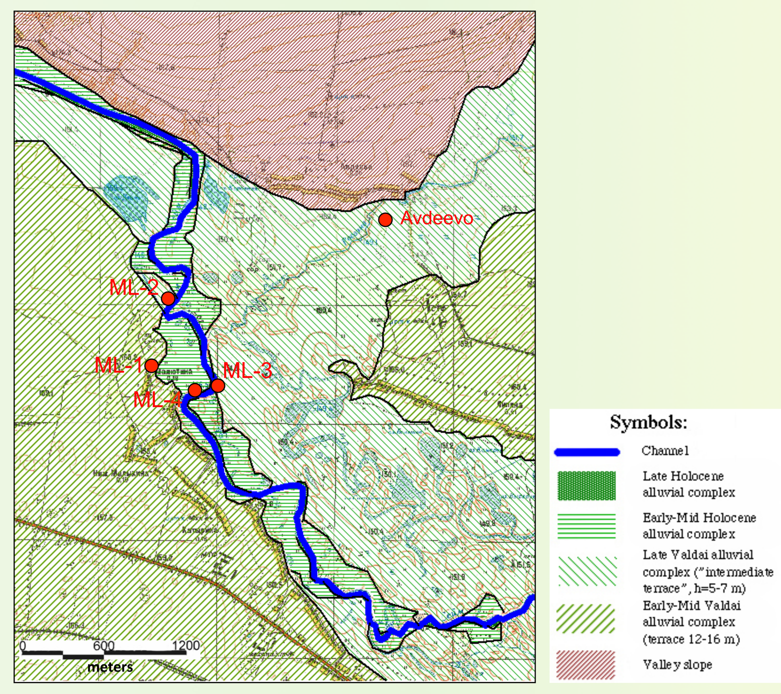
Artifacts from Avdeevo Site

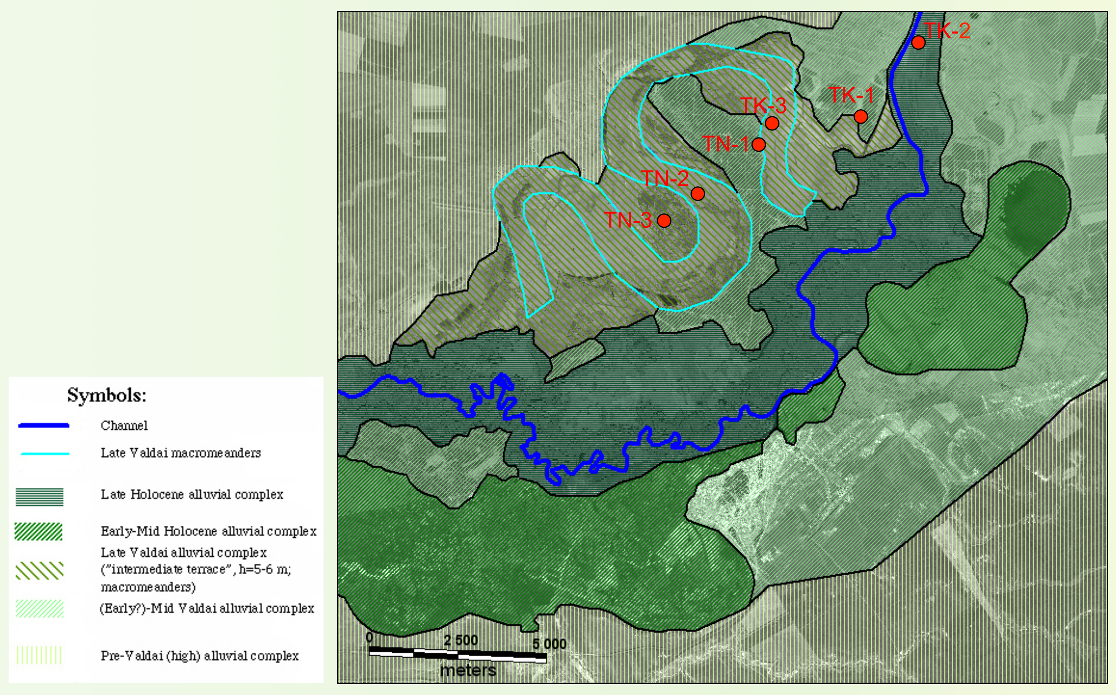


Quartz grains with aeolian reworking from borehole Tn-3.

Dune on the 8-10 m terrace surface near section Tn-1.

GEOMORPHOLOGICAL MAPS OF THE KEY SITES OF SEIM AND KHOPER RIVER VALLEYS





THE DEVELOPMENT OF RIVER VALLEYS OF THE CENTRAL RUSSIAN PLAIN IN THE LATE PLEISTOCENE

1) >77 – <50 kyr. BP: river aggradation, accumulation of 12-16-m Terrace 1 (T1) alluvium.
2) <50 – >25 kyr. BP: river incision by >10 m, formation of alluvial basement of so called intermediate, or “zero” 5-7-m terrace (T0). Incision was most probably caused by considerable increase of water discharges, which is evident from widening of valley floor due to active channel migrations.
3) >25 – ~18 kyr. BP: low runoff, river stability/aggradation, wide occurrence of aeolian sands interplaying with deluvial loams (climate aridity, scarce vegetation). Stationary human settlements existed on the T0 terrace, i.e. at low topographic positions which are subject to seasonal flooding now.
4) ~18 – ~ 12-13 kyr. BP: river incision 5-7 m below the present-day channel, formation of large meanders (macromeanders) with high wavelength. Seasonal inundation of the T0 terrace in Seim River valley resumed, which broke terrace occupation by humans and provided overlaying of cultural layers by overbank alluvium. About 14 kyr. this stage of high discharges and large meanders in Khoper River valley was interrupted by short epoch of aridization (activation of aeolian processes on the low levels of the valley bottom), in Seim River valley the signs of this aridization have not been found yet.
5) ~12-13 – ~10 kyr. BP: river aggradation to the preset-day levels as response to runoff decrease.
6) >10 kyr. BP – present: relative stability (no incision, no aggradation).

RESULTS

- Complex geomorphological study of the Late Pleistocene river terraces of the Central Russian Plain has been done.
- The history of Central Russian Plain river valleys development in Late Pleistocene based on complex data (including absolute dating) was reconstructed (see below).
- It was found that low river terraces were subject to complex reworking by aeolian, erosional and slope processes during Late Valdai. Terraces may contain sediments of different origin: aeolian, deluvial, gully alluvium. This reworking led to significant deformations in terrace morphology and topography.
- It was found that some sand surfaces believed river (alluvial) terraces are aeolian massifs accumulated during LGM and after LGM they were isolated by floodplain flows (macromeanders) (such situation was estaplished in Khoper River valley).

Symbols to granulometric diagrams and lithological columns:

Particle size: - 1; - 2; - 3; - 4; - 5; - 6; - 7; - 8; - 9.

Stratification: - a; - b; - c; - d.

Other symbols: - A; - B.

Facies: **eol** – eolian; **d** – deluvial; facies of alluvium: **al$_{ch}$** – channel; **al$_{ovb}$** – overbank.
Particle size: **1** – 2-1 mm; **2** – 1-0,5 mm; **3** – 0,5-0,25 mm; **4** – 0,25-0,1 mm; **5** – 0,1-0,05 mm;
6 – 0,05-0,01 mm; **7** – 0,01-0,005 mm; **8** – 0,005-0,001 mm; **9** – <0,001 mm.
Stratification: **a** – thin horizontal; b – horizontal; **c** – slanted; **d** – nonlamellated (massive structure).
Other symbols: **A** – erosional contacts; **B** – sampling sites on the absolute dating.
Abbreviations: f - fine sand, m - medium sand, c - coarse sand.

CONCLUSIONS

1) Valdai terrace complex consists of the following elements:
   - Terrace complex T1 (5-10 m above the level of floodplain):
     a) Accumulative Early-Mid Valdai terrace (>40-50 kyr.) [ML-1];
     b) Two-part Mid Valdai – LGM terrace (alluvial basement with the age 30-35 kyr. and covering aeolian sands of LGM time (age 20-24 kyr., thickness >4-5 m)) [TN-1];
   - Terrace complex T0 (“intermediate terrace”, 1-2 m above the level of floodplain):
     a) Two-part Mid – Late Valdai terrace (alluvial basement with the age 30-35 kyr. and covering overbank alluvium of the end of Late Valdai – Holocene age) [ML-2];
     b) Late Valdai accumulative terrace (LGM – the end of Late Valdai)[ML-3];
   - Late Valdai parts of floodplain (after LGM – 12-18 kyr.) [macromeanders].
2) Late Pleistocene river terraces were subject to complex reworking by aeolian, erosional and slope processes after the alluvial sedimentation had finished. Terraces may therefore contain sediments of different origin (aeolian, deluvial, gully alluvium) and terrace levels may vary according to the post-alluvial reworking. Valdai terrace complex includes accumulative massifs consisting of only aeolian sediments [TN-1] – aeolian layers isolated by floodplain flows. Deep aeolian reworking of terrace alluvium during LGM could be possible due to ground water lowering because of deep pre-LGM incision of rivers.
3) Terrace levels of the same height may have a different age. We need to analyze many different geomorphological and geological features to establish the age of the terrace. Genesis and detailed morphology of terrace levels are among these features.
4) The Valdai stage of river valleys development at the Central Russian (East-European) Plain is characterized by great amplitudes of water discharges (much more then in Holocene). Early Valdai was the time of low discharges and accumulation of sediments dominated in river valleys. Some epochs of Mid and Late Valdai were characterized by multiple growth of discharges. This led to isolation of Valdai terrace complexes (T1 “first” terrace complex 12-16 m, T0 “intermediate” terrace complex 5-7 m, high floodplain 2-5 m). We determined two main epochs of river incision in Mid and Late Valdai: 25-50 kyr. and 13-18 kyr. BP. These two epochs were divided by the epoch of low discharges and river stability/aggradation in LGM (20-23 kyr. BP).

Financial support for this study was received from the Russian Foundation for Basic Research (RFBR), Projects no. 09-05-00340-a, 12-05-01148-a.