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Paleosoil records of the late Holocene climate swings in the steppe zone of the Russian Plain

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1 **Introduction. Paleosoils buried under archaeological monuments (such as funeral mounds) are a unique research material reflecting paleoenvironmental conditions for the period of the burial. The using of paleosoils as evidence of environmental changes is based on the relationship between soil properties, soil processes and soil forming factors. The soil is known to be a product of interection between the various factors (relief, parent material, climate, flora, time). In order to define the effect of any one of the factors, such as climate, therefore, it is important to select soils for the pedochronosequences. Soils representative of different chrono-cuts (time slices) should, at least, have been formed in the same lithologic-geomorphological conditions as minimizes the possible changes in soil properties attributable to other factors.**

2 **The objective of this study was to examine changes in climate-indicator soil properties over the last 40 centuries in the territory of the Russian Plain, and to estimate the intensity and scales of these changes as well as to reconstruct the past climatic conditions under-pinning them.**

Objects. Investigations were carried out in the Rostov region. This is an arid steppe zone with ordinary and southern chernozems. The study concentrated on the chronosequence, comprising paleosoils buried some 4000, 2400, 2000, 1900, and 1200 years ago under archaeological monuments and modern soils. All these soils were formed on clayey carbonate loessic loams on the plains. Dating of the monuments and, consequently, time of soil burial was established in accordance with the archaeological methods within 50-100 years for the Early Iron and the Middle Ages and 200-300 years for the Bronze Age.

Methods. Morphological properties, stratigraphy and the structure of soil profiles, content, compositions, stores, forms and level of accumulations of water soluble salts, gypsum, carbonate, exchangeable cations, humus content and composition (group and fraction), and particle size distribution were estimated using normal pedological methods.

Results and discussion. Changes of salt profile within 2m depth had a regular character during last 4000 years, periods of salinization (4000, 2000, 1200 years ago) alternating with periods of desalinization (2400, 1900). Similar regularities were also found for gypsum profile. Well-marked dynamics with repeated transition of solonetzicity from the active to the residual condition and vice versa were observed for the last 4000 years. A high content of exchangeable Na was recorded in soil-exchange complexes (9-13%) in soils buried 4000, 2000, 1200 years ago, while the amount of absorbed Na in other chronocuts (2400, 1900, modern) was small (1-2%).

For time intervals considered, some dynamics in the content and profile distribution of $CaCO_3$, the thickness of the accumulation horizon, and the quantity and size of carbonate neoformations was observed. The general tendency was as follows: decrease in the carbonate horizon thickness, raising of its upper boundary, increase in the quantity of soft, white sports with a decrease in size in the periods of climatic aridization (4000, 2000, 1200 years ago). All soils of the chronosequence were characterized by a low content of humus with a predominance of mainly humic acids. Some periods, however (2400, 1900 years ago) were more favorable for humification.

Conclusions. Considerable changes in soils at some Holocene chrono-cuts were observed. These changes were characterized by cyclicity with different temporal intensity and amplitude of soil parameter changes. Among all soil-forming processes that acted on the soils of this chronosequence, the leaching of salts (easily soluble, gypsum, carbonates) as well as the development of solonetzicity processes were the most dynamic effects and were closely connected with climatic conditions. It has been established that the Bronze Ages (4.0-3.7 ky) and the Middle Ages (VIII-XII) were characterized by climatic aridization, causing soil salinity. The Early Iron Age was a period of alternation of micro-arids and micro-pluvials episodes. About 2400 years ago the climate was cooler and marked by higher humidity, the evidence of which is absence of readily soluble salt and gypsum accumulations, lack of actual solonetzic features and lowered humus acid component. About 2000 years ago, however, this was interrupted by a shot micro-arid period.

Based on regressive dependency between a number of climatically-sensitive soil indices and the amount of atmospheric precipitation, the range of variation in climatic humidity in the territory under investigation over the last 4000 years may be estimated. These variations were within 380-500 mm.

Various temporal lengths in the soil-forming cyclicity were revealed. The 2000 years-rhythm is the best distinguished. The climate optimum of this rhythm was observed in the middle of the 3-rd millennium BC, in the middle of the 1-st millennium BC and in the middle of the 2-nd millennium AD.

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