Microfabrics of Buried Soils in Loess Sediments of the Lower Volga Basin

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Introduction

Soils develop under the direct influence of climatic parameters, and they retain environmental information in their features (soil memory). Targulian and Goryatkin, (2008). Micromorphological features have their own soil memory, which makes it possible to distinguish between the results of pedogenetic processes under different environmental conditions and to specify the genesis of sedimentation processes. Buried soils provide an excellent opportunity to reconstruct paleoenvironments preceding their burying. The Lower Volga basin experienced considerable changes due to fluctuations in the Caspian Sea level together with other responses to glacial-interglacial cycles in the Quaternary. Numerous horizons of buried soils have been recorded in sedimentary sequences, and they have been used for stratigraphic correlations and paleogeomorphic reconstructions in the area (Konstantinov et al., 2016). However, the study of paleosols as a paleoenvironmental proxy has not been performed until now.

Method and Object

Micromorphological studies of a section of soil-sedimentary sequence were performed for the natural escarpment 1 km from Volopogor - Lower Achtuba paleosol-sedimentary sequence (48.705277 N, 44.89330709 E, 16 m asl).

The height of the section is 20 m. 7 levels of paleosols (MIS 1 to MIS 5) were identified.

Modern surface soil Kastanozem are underlined by marine clay clays

MIS1 (720÷70) Kastanozem typical for dry steppe areas.

MIS2 15.02±1.02 marine clays

Pedogenic features - gypsum accumulations, gleic (Fe-Mn) cutans

Pedogenesis processes:
- cryogenesis
- angular crystals of clays
- clay coatings, circular striped b-fabric

MIS3 Pedogenic level 3 35.58±2.80

MIS4 Pedogenic level 4 36.78±2.80

MIS5 Pedogenic level 5 68.28±1.17

Pedogenesis processes:
- Intermixture of fluvial and aeolian accumulation.
- Weak pedogenesis disturbed by alluvial sedimentation and cryogenises.

Pedogenic level 6 87.62±1.10 – 102.51±16

Pedogenic level 7 112.61±40

Bed 1 (3 cm) – pale and overcrossed peds, circular sand orientation

Bed 2 (13 cm) – gypsum infilling, parallel striped b-fabric

Bed 3 (13 cm) – decoration of clays, typic Calcic horizons

Bed 4 (15 cm) – gypsum infilling, parallel striped b-fabric

Bed 5 (5 cm) – thin clay coatings

Bed 6 (35 cm) – lithic clay coatings

Bed 7 (107 cm) – fragments of clay, typic Calcic horizons

Interstadial paleosols (MIS3 – polygenetic).

Sedimentary environment: Intermixture of fluvial and aeolian sedimentation, soils have been formed during short periods of mesomorphic pedogenesis coinciding with loess sedimentation, interrupted by increase of heavy rainfall activity. Pedofeatures: cold arid environment, frost wedges and inclusions, carbonate and even gypsum neoformations.

It was found that the buried soil had been formed under subaerial conditions with fluctuations of the periglacial and marine environment. The soil-losso sequence (MIS1–MIS5) includes seven paleosol layers separated by sediments of different compositions and genesis. Longer periods of interruption of sedimentation processes predetermined the formation of better developed soils. All the soils are polygenetic and contain contrasting sets of macro- and microfeatures reflecting different stages of pedogenesis: (1) steppe pedogenesis marked by well-shaped humus horizons with biogenic aggregation, diverse carbonate pedofeatures, and mole tunnels; (2) hydromorphic pedogenesis marked by gleyed mottles and Fe-Mn nodules that could be formed under conditions of long floods; (3) cryogenic pedogenesis under the influence of syngenetic (MIS3) and epigenetic (MIS5) cryogenises marked by frost cracks, ring-shaped arrangement of coarse fractions, fissuring of quartz grains, and specific aggregation.

The whole MIS5e - Late Khazarian transgression and includes three distinct soils formed in loess. The presence of pedogenetic levels indicate that the area was beyond Late Khazarian transgression of Caspian Sea. Formed paleosols are separated by loess layers.