EVOLUTION OF CLAY MINERALOGY OF PALAEOSOLONETZS DURING LATE HOLOCENE

ALEKSEEVA, T. V., ALEKSEEV, A. O., DEMKIN, V.

Institute of Physicochemical and Biological Problems of Soil Science RAS [Институт физико-химических и биологических проблем почвоведения РАН], Pushchino, 142290, Russia
E-mail: alekseeva@issp.serpukhov.su

Burial mounds (earth or stone hills) which are known in the Russian literature as "khourgans" appeared across large areas of the Eurasian steppes about 5000 years ago. Usually the khourgans have been considered as objects of studies for archaeology, ethnography, or other humanities and contain information about the culture of steppe inhabitants during the Bronze (III–II millennia B.C.), Early Iron (beginning I millennium B.C. – 4th century A.D.), and Middle Ages (5th–16th centuries A.D.). However, they also contain buried soils, which developed in ancient times and have been conserved in different degree of effectiveness by burial up to the present time. These buried soils reflect the state and changes of various components of the environment, in particular, climate, vegetation, and relief, in their profiles and thus can be used for the reconstruction of palaeoenvironmental conditions.

Two series of soils buried under khourgans from the desert-steppe area of Lower Volga were studied. The modern soil cover is characterised by complexity which is determined by surface microtopography. Soil complexes include chestnut soils and solonetzs. Solonetzs which occupy about 40% of the territory are confined to flat micro elevations whereas light chestnut soils and meadow chestnut soils—to slopes and depressions respectively. Soil series consisted from modern and buried light chestnut soils with different degree of salinity and solonetzs of the following ages: IV–III millennia B.C. (5000 years ago), 19th–17th centuries B.C. (3800 ya), 4th century A.D. (1600 ya) and 13th–14th centuries A.D. (600 ya) ("Abganerovo" set) and III–II millennia B.C. (4000 years ago), 15th–14th centuries B.C. (3500 ya), 2nd–3rd centuries A.D. (1700 ya) and 13th–14th centuries A.D. (600 ya) ("Malyaevka" set). The series of soils were examined by: soil chemical properties, clay mineralogy (X-ray diffraction and Mössbauer spectroscopy) and a range of magnetic measurements.

Recently a strong statistical correlation between modern rainfall and the pedogenic magnetic susceptibility across the Russian steppe has been obtained (Alekseev et al., 2003; Maher et al., 2003) and a quantitative climofunction (of rainfall) has been established. This climofunction was applied to studied palaeosols for quantitative reconstructions of rainfall variations for Late Holocene. The obtained data allow to conclude that climate on the territory under investigation over last 5000 years had the cyclic character with the alternation of humid and arid epochs of different degree and duration. The annual precipitation changed within 330–440 mm with the most arid 2nd–3rd centuries A.D. and the most humid 13th–14th centuries A.D. Solonetzs appeared on the territory under study 4000–5000 years ago and since that time they underwent considerable changes. Obtained data show that diagenetic transformations which take place in the profile of buried soils don't allow to use the diagnostic properties of solonetzs such as profile distribution of pH, humic substances and exchangeable cations for the reconstructions of palaeoenvironment It was shown that the most sensible and reliable indicators of solonetz process are the morphology of B horizon, textural differentiation of the profile and its clay mineralogy. The evolution of solonetzs resulted in the increasing of coefficient of contrast from 2 to 5 (this is expressed as a ratio of clay content in B horizon against A horizon). Clay illuviation was accompanied by the decreasing of smectite content in A horizon from 50–60% till 10%. Clay fraction from a top horizon of modern and buried solonetzs contains visible quantity of fine dispersed quartz. The mineralogy of B horizon is close to that of parent material. The presence of chlorite in the 30 cm upper layer of solonetzs buried before 14th century A.D. testifies the existence of rather mild weathering conditions. The climatic optimum of the Middle Ages (the period from the 12th to the 14th century) lead to the remarkable changes of solonetz properties such as double increasing of clay content and specific surface area of A horizon, destruction of smectites in B horizon, and destruction of chlorites in both A- and B horizons. Additional to morphological characteristics on the base of which this soil profile was attributed to residual solonetz is the high content of fine dispersed quartz in the clay fraction of A horizon. The restoration of solonetz characteristics including the textural and mineralogical differentiation took less that 600 years. Modern solonetzs are characterised by the decreasing of exchangeable Na and they in a comparison with buried soils can be regarded as Mg-solonetzs.

References

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