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K. Joó (*), A. Barczi (*), P. Sümegi (**)

STUDY OF SOIL SCIENTIFIC, LAYER SCIENTIFIC AND PALAEOECOLOGICAL RELATIONS OF THE CSÍPŐ-MOUND KURGAN

Abstract - Kurgans are important cultural and historical sites of Hungary. Our research team made malacological and soil scientific observations of the kurgan called Csípő-halom situated in the Hortobágy steppe area of the Great Hungarian Plain. Our goals were to investigate the strata of the kurgan and gain data about the palaeoecology of its broader environment. Based on the data gained we can state that this kurgan was built in the Copper Age on an existing hill. Its surface is currently covered by Chernozem soil, and the buried soil feature below the kurgan preserved a soil with Chernozem features, too. Therefore, this kurgan was once surrounded not by closed forest vegetation (as former theories say), but by rather warm, dry steppe and half-shaded tall grass steppe environment, that surrounded mosaic wetlands and sodic areas. No factors referring to the formation of Luvisol were found.

Key words - Soils, malacology, palaeoecology, kurgan, Copper Age, Hungary.

Riassunto - *Studi pedologici e stratigrafici in relazione agli aspetti paleoecologici del* kurgan *di Csípő*. I kurgan sono importanti siti culturali e storici dell'Ungheria. Questo gruppo di ricerca ha effettuato osservazioni malacologiche e di scienza del suolo sul kurgan chiamato Csípő-halom, situato nell'area steppica di Hortobágy, nella Grande Pianura Ungherese. Il fine è stato investigare sugli strati del kurgan per raccogliere dati sulla paleoecologia dell'ambiente circostante. In base ai dati raccolti, è possibile stabilire che questo kurgan fu costruito durante l'Età del Rame su una collina preesistente. La sua superficie è oggi coperta da un Chernozem, e un suolo con caratteristiche di Chernozem è conservato anche al di sotto della struttura. Pertanto il kurgan non era circondato da foresta, come supposto secondo teorie precedenti, ma da un ambiente steppico piuttosto caldo, secco e con alte erbe che circondava un mosaico di aree umide e sodiche. Non sono stati individuati indizi riguardo alla formazione di Luvisols.

Parole chiave - Suoli, malacologia, paleoecologia, Kurgan, Età del Rame, Ungheria.

Introduction

Two different hypotheses exist about the steppe areas of the Hungarian Great Plain and about the generation of sodic soils occurring among these areas. According to the first scientific opinion, the plain territories – such as our sample area, Hortobágy – had become forested in the Holocene, and ancient loess steppe grassland patches occurring on the higher ridges were surrounded by closed forests, and sodic areas had not occurred yet.
The second hypothesis says that the Hortobágy could not have been covered by extended forests for longer times and salinisation processes have occurred since the late Pleistocene and were continuous during the Holocene. Hence pasturing cultures settled on the steppe, and river control works of the 19th century have extended and stabilised sodic areas. According to the second hypothesis, salinisation developed on the observed area as a consequence of the parent material, climatic and special geomorphological reasons.
As a representative of the first opinion, Székely (1984) reconstructed mild and wet climatic character in the Carpathian basin 7,000 years ago, as a consequence of which oak became dominant in the forests. This was followed by the florescence of the forests of the plain, with beech becoming dominant and the generation of oak, hornbeam-oak vegetation types. Soils transformed into Luvisol. Neolithic cultures first appeared in this period, bringing a sharp extension of anthropogenic effects that, together with decreasing forested areas, resulted in the development of former Luvisol towards Chernozem soils.
Surveys of Alexandrovskiy (2000) in a sample area of the North Caucasus also proved that, due to climatic changes during the Holocene, soil generation had changed. The sample area observed by him could had been a cold, dry steppe or forested steppe during the early Holocene. Due to climate change, forest has extended and Chernozem soil generated below the former steppe has changed into Luvisol. The some author says that a similar change characterised the Great Russian Plain and Central Europe. Based on paleobotanical data a steppe period held until the first half of the Holocene.
In connection with the question of treeless areas, Borhidi (1998) states that in the central parts of the Great Hungarian Plain climate influence alone was not enough to maintain forest vegetation, and considering also historical documents, forest cover in the 15th and 16th centuries could not have exceeded 30-40 percent. However, the author remarks that the Carpathian basin cannot be evaluated globally as one landscape unit. Its current mosaic type may be the product of its postglacial diversity.
Contrary to these opinions, Bodrogközy (1980) states that mainly Chernozem soil formation took place during the Holocene with the appearance of steppe vegetation on the Great Plain. He reconstructs sodic areas in the early Holocene, but explains their extension by river controls.

(*) Department of Landscape Ecology, Szent István University, Páter K. u. 1, Gödöllő, H-2100, Hungary.
(**) Department of Geology and Palaeontology, University of Szeged, Egyetem u. 2-6, Szeged, H-6722, Hungary.

Nyilas & Sümegi (1991) carried out sedimentological and malacological surveys on a sample area of the Hortobágy. The theory that the whole surface of the Great Plain – including Hortobágy – was covered by forests in the Preboreal (Soó, 1931) was not supported by malacological investigations (Nyilas & Sümegi, 1991).

Szöőr, Sümegi & Balázs (1991) took sedimentological and geochemical surveys on Upper Pleistocene palaeosol samples collected in the area of Hajdúság. Their results defined a kind of steppe characterised by sodic patches. They state that salinisation began not in the Holocene, but sodic soils could also have been generated during the warm and dry interglacial periods of the Pleistocene.

As we can see from the above, the soil generation processes of Chernozem and/or Luvisol in the Hortobágy during the Holocene and the causes for salinisation and development of the sodic steppe are still open questions.

Resolving these open questions is highly important for our understanding of the soil generation on the Hortobágy, since in the first case the generation of sodic soils can be followed back only for a few centuries, while according to the second opinion sodic soils have been characteristic of the Hortobágy and the Great Hungarian Plain for thousands of years. Evaluation of these different models and confirming the presence of sodic soils in the Holocene is an extraordinary scientific problem since the surface soil is changing. One cannot confirm the date of salinisation by observing current soils. Buried and intact Holocene soils are needed for deciding questions on soil history such that have not developed after their generation and changed postgenetically as little as possible. Such buried soil strata can be found on the Hortobágy in the kurgan burial sites of the Copper Age.

Kurgans are also called by Hungarian people «mounds of the Kun nation», «mounds of the Tartars» and «mounds of the Turkish». Kurgans are inestimable treasures of Hungary, as they are carriers of significant archeological, landscape, botanical and pedological values (Tóth, 1999; Csányi & Tárnoki, 1995; Papp, 1996). Their pedological value means that information can be gained from their observation about soil generation processes passed during the time since their creation, characteristics of buried soil strata, and environment of soil generation.

Since palaeosols are suitable also for the reconstruction of the ancient environment, an aim of our work was 1) to present the environment of the buried soil of the kurgan called Csípő mound on Hortobágy with the help of pedological investigations, 2) to state which soil generation processes took place since the building of the kurgan, and 3) to determine the soil type of the original soil stratum. Besides pedological researches, reconstruction of the ancient environment was completed by malacological investigations.

Methods, materials studied

Coenological investigations (Braun-Blanquet, 1951) and soil mapping with a Pürckhauer sampler (Finnern, 1994) were made on the selected kurgan called Csípő mound and its surroundings several times in 2000 and 2001. Due to the fact that kurgans are naturally protected areas in Hungary, to protect the kurgan and its valuable vegetation, samples were not collected by digging open profiles, but by systematically drilling the site (Birks & Birks, 1980). Cores were drilled to a depth of 5-6 meters on the body of the kurgan and to a depth of 2 meters in the surroundings. The aim of the cores was to observe the material of the kurgan and the underlying buried soil. The drilling started in the foothill area of the kurgan at the supposed accumulation zone, aimed at reconstructing the area that was destroyed during the building of the kurgan. The cores collected in the area surrounding the kurgan were supposed to sample areas that were not (or were slightly) disturbed during the building of the kurgan. Core samples were divided upon their morphology in accordance with soil strata; then malacological and soil investigations were carried out. Among soil examinations, $CaCO_3$, total organic carbon (pyrolisis), humus (Tyurin-method), pH (both H_2O and KCl), salt and mechanical analyses were carried out (Buzás, 1988).

Results and conclusions

Chernozem, Vertisol and Solonetz mosaics were found in the area surrounding the kurgan based upon soil observations. Mosaic shapes were determined by groundwater and micromorphology characteristics. Specific stratification could be seen on the kurgan (Fig. 1).

A Calcic Chernozem soil was identified on the top of the body of the mound. Below it, the thickness of the cultural stratum varied, but was homogeneous in colour. Beneath the cultural stratum, there were the buried soil and its parent material. Significant soil data from the cores from the centre of the kurgan are shown in Table 1.

The A and B horizons of the recent Chernozem correspond to dry habitats and can be characterised by humus and lime dynamics typical of Chernozem soils. Upon colour and humus content of the cultural stratum, it can be stated that the kurgan itself was built using material from its surroundings, which was rich in organic matter. High salt content in this spot may refer to sodic conditions contemporaneous to the building time of the kurgan. Based upon its colour, organic material and lime dynamics, the soil buried below the cultural stratum indicates a drier environment and the formation of a slightly sodic Chernozem type soil.

Snails were found in the top layer (Chernozem A horizon) of the body of the mound, in the buried soil and in its parent material, and in two spots of the surrounding area (C horizon of the ring surrounding the kurgan and A horizon of the surrounding soil). Dry steppe species (*Chondrula tridens*, *Cepaea vindobonensis*) were brought to surface from the buried soil by the drilling bored in the centre of the kurgan. Here, humus content (2.3%), slightly alkaline pH and $CaCO_3$ content (0.5%) of the soil indicate formation of a Chernozem. Species preferring slightly wet or alternating dry/wet environ-

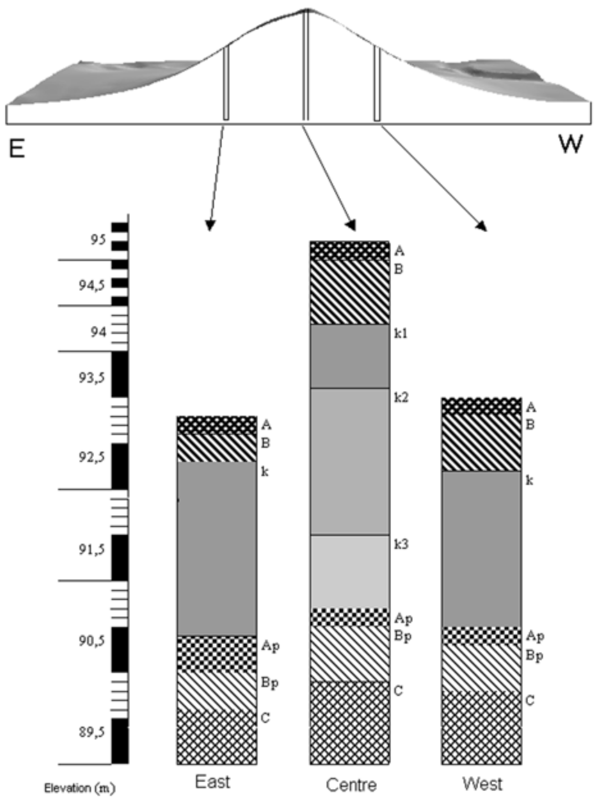

Fig. 1 - Stratification of the Csípő mound based on cores along E-W direction.

ments were found in the drillings bored at the edges of the kurgan (*Vertigo pygmaea*, *Helicopsis striata*, *Chondrula tridens*, *Vallonia pulchella*, *Cepaea vindobonensis*). According to their characteristics, buried soils found here are similar to the previously presented ones, although, their pH is slightly higher (pH H_2O 9.4; pH KCl 8.2). In the parent material, lime content increases (13%) and humus content decreases. In the soil covering the body of the kurgan, species indicating the driest environment were found (*Helicopsis striata*, *Chondrula tridens*, *Cepaea vindobonensis*). The examined soil horizon corresponds morphologically (animal burrows, lime dynamics etc.) to the B horizon of a Chernozem, and these observations are also confirmed by soil analysis.

The mechanical analysis of the material of the kurgan shows a loamy texture, which indicates clay formation, lessivage, strong leaching, and acidification. No evidence of forest soils (Luvisol) formation was found. On the contrary, we reconstructed a mosaic steppe environment that was frequently affected by water and salinisation processes.

By determining the altitude (above sea level) of the cores made on the body of the kurgan, the position of the loess sediments that are the parent material of the buried soils was also inferred (Fig. 2).

At the centre of the kurgan, the parent material lies about 30-50 cm higher than in the cores bored at the edges. This supports the pedological and malacological results, according to which the buried soil at the centre of the kurgan was formed under drier conditions, while the lower edges of the «hump» of the parent material were periodically covered by water or wet habitats. Therefore, the kurgan was originally built on a natural mound; this is not surprising, since it was a drier spot that served as proper burial site in an environment often covered by water.

Species found far from the kurgan can be attributed to a mosaic environment of wetland, sodic and steppe areas (*Planorbis planorbis*, *Anisus spirorbis*, *Oxyloma elegans*, *Chondrula tridens*, *Cepaea vindobonensis*). Some of the samples taken from this area are Chernozem soils covering a slightly higher ridge that emerges like an island from the mosaic of wet and sodic areas.

Pedological and malacological studies can be well compared with botanical results (Penksza & Joó, 2002). The dry loess grasslands harmonise well with the Chernozem soils developed on the top of the kurgan, and with

Tab. 1 - Results of soil analyses from the core of the centre of Csípő mound. A: recent soil A horizon; B: recent soil B horizon; k1, k2, k3: cultural layers of anthropogenic origin; Ap: buried (paleo) soil A horizon; Bp: buried (paleo) soil B horizon; C: parent material of buried soil.

Horizon (cm)		**pH (H_2O)**	**pH (KCl)**	**Salt %**	**$CaCO_3$ %**	**TOC %**	**humus %**	**Mechanical analyses**		
								clay %	**silt %**	**sand %**
A	0-20	7.72	7.06	0.07	2.29	7.19	3.43	38	39	23
B	20-110	7.80	7.40	0.20	2.31	6.33	2.63	39	35	26
k1	110-160	7.50	7.21	1.53	0.06	6.36	2.46	39	32	29
k2	160-320	7.25	6.81	1.35	0.07	6.18	2.82	38	40	22
k3	320-400	8.47	7.31	0.76	0.15	5.34	2.37	38	35	27
Ap	400-420	8.96	7.60	0.68	0.52	5.53	2.35	39	36	25
Bp	420-480	9.49	8.03	0.41	10.14	4.59	1.50	38	37	25
C	480-580	9.66	8.08	0.16	14.76	3.79	0.60	41	34	25

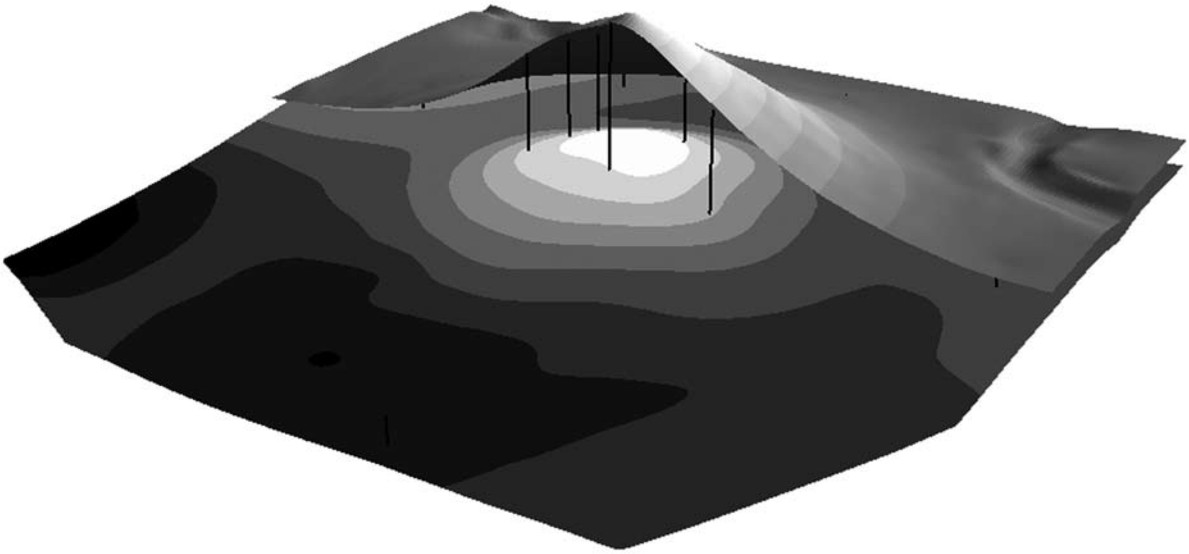

Fig. 2 - 3-d model of the cores and depth of the parent material under the Csípő mound.

the dry steppe snail species. However, loess vegetation is mixing with species of sodic pastures towards the foothill area of the kurgan. The ridges around the kurgan which contain snail species preferring both steppe and wet environment are well indicated by the patches of *Salvio nemorosae-Festucetum rupicolae* association (Zólyomi ex Soó, 1964) and by the protected *Phlomis tuberosa*. These ridges emerge only of 10-30 cm above the salt-affected environment. The typical association of the lower areas is the *Artemisio santonici-Festucetum pseudovinae* sodic pasture association (Soó in Máthé, 1933; corr. Borhidi, 1996).

Based on the pedological, malacological and botanical data collected from the Csípő mound and its surroundings we can state that the kurgan was built in the Copper Age onto an existing loess ridge that emerged from a wet area affected by salinisation processes. There is no evidence of forest vegetation and forest-type soil formation processes in the area. Conversely, Chernozem-type soil formation processes were most important over the past thousands of years. Current vegetation of the kurgan and its surroundings shows similarities with the vegetation of the building time of the kurgan.

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