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KURGANS: MARKERS OF THE HOLOCENE CLIMATE CHANGE(S)

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ABSTRACT

The burial mounds, living mounds, guarding and border mounds (group name is "kurgan") have been under environmental protection in Hungary since 1996. Besides the fact that they are important elements from archeological point of view, in many cases they reserve valuable remaining parts of onetime steppes, and studying of their buried soils can provide new data to learn more about the ancient environment, flora and the soil-formation processes took place long ago. In this way it can be obtained information about the Holocene climate changes.
Our research team had seized the opportunity to examine several kurgans located in the Great Hungarian Plain. Two of them – the Csípő- and Lyukas-mound – has been examined in precise details through the involvement of experts of various disciplines. Due to this cooperation we could extend our researches and knowledge on the biogenic genesis of paleosoils and paleoecology concerning our kurgan studies. Therefore we utilized biomorphic analysis besides pedological investigations.
Though the differences in sampling methods were significant, but the existence of a buried, ancient, undisturbed soil profile can be stated. According to morphological description of soil that was done after the kurgan's excavation and drillings, we conclude that both the modern and paleosoils of the kurgans belong to Chernozem type soils, formed under predominantly arid steppe vegetation. Due to this fact we assume that the ancient environment of both kurgans was similar in many points with the modern landscape. Hence instead of closed forest vegetation rather loess-steppe or semi-shaded steppe can be reconstructed as the former environment of the mounds, which was mosaicly surrounded by water and salt affected areas. These results demonstrate that in the Carpathian Basin the Holocene climate changes are characterized by rather evenness, and but not the previously assumed character changes.

Keywords: mounds, markers, pedological, morphological examination

1. THE ROLE OF KURGANS IN PALEOECOLOGICAL RECONSTRUCTIONS

All anthropogenic formations that can be grouped under the the term 'kurgan', such as tells, border-, guard- and burial mounds, are under the protection of natural conservational law in Hungary since 1996. Besides their archaeological importance they preserve valuable remnant areas of steppe lands. The examination of the mound-body, the buried soil profile underneath and its surroundings can yield data on the reconstruction of ancient environments, the vegetation cover and the changes in paleo- and recent soil development [1] [2] [3].
However the analysis of the paleoenvironment through geomorphological, geological, paleontological investigations and archaeological excavations already began in the nineteenth century [4] [5], these methods have only been put into practise in Hungary recently. As a forerunner of these tendencies, Ref. [6] has undertaken the geoarchaeological research of a Bronze Age tell, the so called Test-mound located near Szakáld. Similar geomorphological and stratigraphical investigations of the Büte-mound and other kurgans situated on the southern plain territories of the Hortobágy National Park has been carried out by [7]. Ref. [8] has reconstructed the original soil profile buried under a Bronze Age tell near Százhalombatta by applying pedological examinations. Similarly, the paleoenvironmental conditions and site formation processes of Bronze Age settlements were carried out in numerous geographical area of the Carpathian Basin [9] [10].
The pedological survey of kurgans allows us to become acquainted with certain qualities of the recent and buried soil profile, to specify our knowledge on the trends and rate of soil development. The statement of Dokucsajev (1846-1903) that „*soil is the mirror of the landscape*" is still a sound observation nowadays. Through the examination of soils, changes in landscapes can be revealed, while the 'answers' of soils, there stability, can be measured through an environmental optimum [11]

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Presumably mounds were erected in one or more steps by heaping up the soil material in their closer environment [12] [13] [14]. Buried under the mound-body lies the isolated and conserved, several thousand-year-old soil profile, which preserves the attributes of ancient soil development.

2. SAMPLING SITES: THE CSÍPŐ-MOUND AND THE LYUKAS-MOUND

The Carpathian Basins alluvial plain is covered by loess and loess-silt. Small ridges of loess-sand and higher shifting-sand dunes emerge from the plain territory of the region that makes its relief conditions diverse. The annual mean temperature varies between 9.7-9.9 ˚C, while the climate is moderately warm and dry. The annual mean precipitation is around 550 mm-s. The usual wind direction is north-eastern, northern and south-western. The hydrology of the area is characterized by aridity, scanty runoff and water shortage. A small quantity of ground water is found in a depth of 2-4 meters beneath the ground level. Potential vegetation imply loess steppe lands, salt-affected areas and wet meadows. Huge territories of this region are home to agricultural production. Mosaics of Chernozem type soils with Solonetz soils and Vertisols are found in this landscape. All above mentioned factors, such as the geological, climatological and micro-geomorphological conditions determined the soil development of this microregion.

Getting to know the early environment of the sample area (Hortobágy and Hajdúhát) selected for the research was of key importance from the point of view of describing soil formation in Hortobágy: there are two different hypothesises drawn up regarding the formation of the Hortobágy steppe areas and the saline areas appearing amongst them. According to one scientific opinion in the Holocene, similarly to the other Great Plain areas, the Hortobágy was covered by forests, and the loess steppes appearing at the higher, island-like locations were surrounded by closed forests, while saline areas had not appeared yet [15] [16] [17] Under this interpretation the saline areas of the Hortobágy can be considered as secondary, their formation can be traced back for only a few centuries and their appearance is mainly due to the river regulations and forest clearance.

According to the other opinion, there could be no permanent, extensive coverage of the Hortobágy with forests. Salinization already appeared at the end of the Pleistocene, existed continuously throughout the Pleistocene, while large animal breeding cultures which settled in the barren areas, as well as river regulation in the 19th century only extended and stabilized the saline areas [18] [19] [20]. According to the latter hypothesis, salinization developed due to the connected parent material, climate and special geomorphologic conditions, and the saline soils have been the peculiarity of the Hortobágy and the Hungarian Great Plain for long millennia.

In order to get to know the previous environment of the Hortobágy, our target was the pedological study of the selected kurgans (Fig. 1., Fig 2.).

Figure 1. The Csípő-mound

Figure 2. The cross-section of the Lyukas-mound

The tasks were as follows:
The structure of the kurgan body was specified by pedological examinations, and the “conserved” characteristics of the buried soil.
The recent soil of the kurgan was compared to the buried soil formation, and to the soil formation of the wider surroundings.
We aimed to reconstruct the environment of the earlier soil formation of the several thousand years old kurgan, and to specify the changes in the soil formation.
To gain data on climate change trends of the Holocene based on the comparison of buried and recent soil profiles.

3. MATERIALS AND METHODS

The pedological survey of the area surrounding the kurgan was carried out using a Pürckhauer soil-sampler [21]. For the 1 m deep samples soil type, colour, physical type, carbonate-, pH and soil-moisture examinations were carried out; we determined the depth of the soil horizons and the soil types, as well as the soil spots were roughly separated.
The instrument for the pedological study and the sample taking of the Csípő-mound kurgan’s body was a Styl-spiral auger with two arms. The diameter of the boring head was 5 cm, the length of the auger was 100 cm and the lengths of the matching arms were 100 cm long. The principle of the sampling was the Birks-type paleoecological mapping boring taking into consideration the space-time dimension [22]. Five borings were started in the top third of the kurgan body, with the objective to study the material of the kurgan and the soil buried by the kurgan.
We examined the differences in colour, structure, moisture and compactness on the spot based on the morphological description of the samples recovered by the shallow geological drillings. Independently from the layers and/or horizons we examined the lime content in every 10 cm. We registered the location of the visible concretions, morphological signs (root-interweaving condition, animal tunnels, iron separations, calcium and silica separations, bones etc.). Based on the morphology we separated the material of the borings into layers/horizons, which we classified and prepared for later examinations.
In the case of the Lyukas-mound kurgan our research group had the possibility to examine its stratigraphy on a whole cross-section. Excavation permissions [23] [24] were obtained at the beginning of 2004. Soil sampling with Pürckhauer sampler was made in the surroundings of the kurgan. An excavator was used with the supervision of archaeologists and pedologists to excavate the site. After the machine work, human labour was used to clean and to precisely excavate the remaining smaller areas. The research trench was deepened till we reached the horizon of the former parent material. On the cross-section we examined the differences of the separate layers in colour, carbonate content, moisture and texture. We recorded the location of visible morphological keys (e.g. crotovinas, iron, lime and siliceous precipitations, bones, etc.). Description of soils was made according to the Hungarian soil classification system. From the view of pedological research, priority was given to assess soil development and process of soil genetic [25].

4. RESULTS

The soil conditions of the area surrounding the kurgans showed a mosaic pattern. Although the prevailing parent material is everywhere the loess type alluvial fundamental rock, according to the groundwater levels and micro-morphological conditions there are different types.
At the areas, where the loess remained in elevated heaps, there remained drier soil formations, and the prevailing soil was the Chernozem. Soil development shows humus materialisation, but due to unsuitable agro-techniques the structure of the upper horizon is degraded and occasionally leached. The heap-up area of the kurgan has been covered through the years due to human impact, so it can only be sighted near the north-western wall. Pseudomicelliar Chernozems are strongly degraded in their A-horizon, their structure is crumby and powdery with a squeezed, compact layer. In the B-horizon lime concretions can be found between 30-70 cm-s. This horizon is light, gray coloured and easily falls apart to its structural elements.

Traces of animals, such as crotovinas are visible. Parent material is loess type sediment with carbonate precipitations.

The soil conditions were also clearly indicated by the vegetation [26]. The locations and presence of the small loess heaps and the meadow soils are also shown by the loess vegetation (*Salvio nemorosae-Festucetum rupicolae* (Zólyomi 1957 ex Soó 1964) typical for the drier steppes.

The typical soil of the water flows, benches, and lower areas is the meadow Solonetz. Based on our on the spot examinations we could also register traces of a stronger water effect in the parent rock of the soil type (gleying), and the A-horizon was often destroyed due to benching, the typical erosion of salinity. These saline spots – located at the lower points of the kurgan foot and in the surrounding of the kurgan – are covered by the associations of alkaline meadow (*Artemisio santonici-Festucetum pseudovinae*, Soó in Máthé 1933 corr. Borhidi 1996).

From the five borings started on the Csípő-mound kurgan body the first three originated from the centre of the kurgan and reached the depth of 580 cm. The other four borings were located according to the corners. They were initiated from the top third of the kurgan. Their depths were: 480, 405, 405 and 405 cm-s, respectively.

In the recent, top soil formation of the kurgan body, invariably the 20-30 cm deep, dark coloured, crumbly structured A-horizon woven with roots was clearly identifiable. Below this a horizon with the depth of 50-70 cm was found, showing the carbonate dynamics typical for Chernozem B-horizon; lime incrustation was found only in three borings.

When boring deeper the usual fundamental rock was not encountered, since in case of the recent soil of the kurgans the “parent material” is the humus soil piled up as the material of the kurgan, with uniform dark brown colour. This cultural-anthropogenic layer, being sharply different from the recent soil in structure, being compact and shelly when dry, in downwards profile shows hydromorphic characteristics, stronger compaction and contains remnants of bones, as well. We could detect calcium carbonate in the culture layers only in traces.

Under the layers, which can be considered anthropogenic, there was a level with medium crumby structure, with higher lime content, 20 cm deep and dark brown. This horizon, which we determined as the paleo A-horizon, changed with a 30-50 cm paleo B-horizon into the appearing loess-type parent material.

The order was identical in the case of all core samples; the depths of the layers were different, mainly explained by the geomorphology of the kurgan.

Based on the lime, organic matter and salt dynamics, steppe (Chernozem) type, dry soil formation applied to the recent soil of the kurgan body. The cultural layer was piled up from the surrounding soil cover, which was characterised by high organic matter content. Many parameters of the buried soil were identical to the parameters of the cultural layer soil, indicating similar origins. The texture was uniform throughout the whole kurgan, no argillization and lessivage appeared, only slight traces of wash out could be found, therefore there were no signs of forest soil formation.

On the basis of the pedological, morphological examination of the different layers and horizons of the Lyukas-mound kurgan we conclude that the recent, modern soil covering the moundbody belongs to Chernozem type soils and attributes all relevant chemical and physical qualities of these soil types. In its loamy textured A-horizon, moderate carbonate content can be measured, which increases slightly in the B-horizon. The so-called Chernozem-dynamic can be identified, through the slow, moderate decline in organic matter content and increase of carbonate content in vertical depth of this layer. The pseudomicelliar horizon was encoded with a separate marking.

Underneath the modern soil, three cultural layers can be found. Amidst these layers horizons presumably showing soil development can be sighted. Their thickness depends on the hypothesized time-period between two separate heap-up processes. The material heaped up to form the mound derives from the soil horizons of the surrounding environment. This statement is supported by the dark colour, the significant organic matter content and the loamy texture.

Underneath the moundbody lies the ancient, original soil formation which can be separated into several horizons due to its morphology. The paleo A-horizon and the paleo B-horizon show resemblance with the recent, modern soil in terms of organic matter content, carbonate dynamics and texture. It is characterized by loamy texture besides other indicator identification keys which classifies it as a Chernozem type soil. This allows us to conclude that the buried paleosoil of the Lyukas-mound kurgan reflects soil conditions similar to recent development. The parent material is a pale yellow, highly carbonated, loamy-textured and structureless sediment.

5. CONCLUSIONS

Based on the pedological examination of the Csípő-mound kurgan and its surrounding, more than 6000 years ago we encountered flooded areas in the internal part of the Great Plain. In this waterlogged environment only the erratically stretching Pleistocene riverbacks covered by loess were dry areas. On the emerging ridges the Chernozem soil of the grasslands was formed. Human populations of the Copper and Bronze Age – accordingly to their cultural traditions – buried their dead on these drier, slightly elevated areas, and built a kurgan over the deceased person from the soil of the surrounding area.

The high salt content of the groundwater not only had an impact on the soil under the kurgan, but also on the characteristics of the soil formations in the lower areas between the loess ridges of the surroundings. Therefore in the surroundings of the kurgan, not only meadow soils, but in parts of the lower areas, saline soils could also be found, which alternated each other in mosaic arrangements, still visible today. So the saline areas in the examined area could be considered as early, and existed already at the beginning of the Holocene, while the river regulation did not create them, but only stabilized them.

The surrounding environment of the Lyukas-mound kurgan is dominated by a typical Cherozem type soil. After the cross section preparation we could identify 10 separate layers. Arid, Chernozem type soil development is typical for the uppermost layer of the kurgan and though its 'parent material', which is a result of human heap-up, is rich in organic matter and can already be considered as a developed soil formation, the recent, modern soil covering the kurgan's surface bears the identification keys of typical Chernozems, such as the crumby structure, carbonate dynamics and bioturbation.

All our pedological results support the idea that the buried soil is Chernozem, which formed under predominantly arid (in some places wetland patches were possible) steppe vegetation. Therefore the ancient, peleoenvironment showed similarities in a number of points with the recent, modern landscape and its development was determined by climatic and vegetation factors typical for steppe land environment.

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