Soils as Documents of the Interaction Between Man and Environment

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Abstract

Soil is the reflection of all the influences which led to its formation. The major soil-forming factors are the following: climate, vegetation, parent rock, relief, hydrology, the time of soil formation and human activities.

Changes taking place in the soil can best be traced by morphological observations. Soil characterisation can be made more accurate by the analysis of chemical and physical traits. These include the determination of soil pH, lime content, plasticity, humus content and total phosphate content. Humus content is in very close relation to past and present soil-forming processes. The total phosphate content is an excellent indicator of human activity. It reflects the human habitation of a given area.

Human activities always modify the effect of the natural factors involved in soil formation, to an extent depending on the level of civilization. Human activity can stop, retard or alter the effects of existing natural soil-forming factors.

The most important human activities are the following: burning of forests, soil cultivation, digging pits, ditches and canals, constructing burial mounds, levelling the soil surface, filling ditches and pits, irrigation, manuring, drainage, etc.

1. Soil forming factors

Soil is formed as the result of interactions between various natural soil-forming factors, which participate to varying degrees in the development of different types of soils. Many different combinations of these factors are possible, leading to soil types with a wide range of characteristics. A soil profile is a reflection of all the influences which led to the formation of the soil and which continue to make their effect felt. The major soil-forming factors are the following: climate, vegetation, parent material, relief, hydrology, the time of soil formation, and human activities (Stefanovits et al. 1999).

1.1. Climate

It is a well-known fact that vegetation differs from one climatic zone to the other. Rocks also weather differently in the various climatic zones, and this naturally has an influence on soil formation. Of all the climatic factors, precipitation and temperature have the greatest effect on soil formation. Precipitation leaches a large proportion of the salts, nutrients and weather material from the upper soil into the lower layers, while temperature regulates the extent of evaporation, making it a decisive factor in the development of many soil types.

1.2. Vegetation

In a given area, vegetation suited to climatic and other environmental conditions develops and continues to grow until the conditions change to such an extent that this type of vegetation is no longer viable. At the same time, soil takes on characteristics peculiar to the specific type of vegetation. For instance, different types of soils are formed under pine, beech and oak forests, or under meadows and prairies.

The aboveground part of the vegetation serves primarily as a soil cover. This living soil cover protects the soil surface from drying out because of the cooling, heating and drying effects of the wind. It can thus be said to regulate the moisture and temperature conditions. Of course, not just bare soil, but soil with plant cover can also dry out to varying depths, depending on the type of vegetation. The deep roots of trees, for instance, dry the soil from below, while grasses affect the surface layers. The aboveground and belowground parts of decayed plants supply the vast majority of the soil organic matter.

1.3. Parent rock

In some cases, the soil-forming rock has the greatest effect on the type of soil to develop. The agrogeological classification of soils has been based on this effect, dividing soils into granite, basalt, sandstone, limestone, dolomite, clay slate and loess categories. The role of the soil-forming rock is much less important in the case of zonal soils, which cover huge areas in each climatic zone, and are much the same regardless of the basic rock type. In addition to the soil zonality observed parallel to the equator, vertical zonality can also be seen in hilly regions at various heights. This means that the soil zones corresponding to the major climatic zones are to be found within a few thousand metres in the mountains.

1.4. Relief

The soil-forming effect of the relief is also manifested in other ways. On the southern slopes of mountain ranges, the ground surface warms up intensely and dries out under the perpendicular rays of the sun, leading to the formation of soils similar to those found in warmer, drier zones to the south of the region, while on the northern slopes the soils resemble those of colder, moister zones. The relief also determines the areas most exposed to soil erosion and those where sediment is deposited.

1.5. Groundwater

In some cases, groundwater has a great impact on the type of soil to develop. This type of soil formation can be expected when the groundwater level is less than 4 m from the surface, since the moisture content in the capillary zone is greater in a 2 m layer above the groundwater level in looser soils and in a 3–4 m layer in heavier soils. Meadow soils tend to be formed if there is a rise in the groundwater level, while marsh or peat formation may take place if the groundwater level reaches the soil surface. The depth and salt content of the groundwater determine whether meadow or saline soils are formed. The groundwater level is usually at a depth of more than 4 m below chernozem soils, between 0.5 and 3.0 m for meadow soils and between 0.5–1.0 m in the case of marshy soils. Saline soils are formed if the groundwater contains salt and the groundwater level is close to the surface.

1.6. Time

Time is required for soil-forming factors to exert their effects. In the case of alluvial soils, formed on river sediment, there has not yet been time for any specific type of soil to develop on the eroded soil surface or on blownsand. In general, several hundred, or even several thousand years are required before the soils developing as the result of soil-forming factors reach an equilibrium with their environment. In the tropics, this equilibrium may in some cases be reached within a few decades. In general, it is difficult to predict the length of time required for a new soil type to develop in various parts of the world. We do know, however, that once a soil type has formed, it will continue to exist as long as the environmental soil-forming factors remain unchanged. If erosion destroys the humus layer of the soil, the results of previous soil formation processes cease to exist, and fresh processes are initiated on the new soil surface (Füleky 1988).

1.7. Human activities

Human activities always modify the effect of the natural factors involved in soil formation, depending on the level of civilisation. In the course of ploughing, for instance, the various levels become mixed, while liming reduces the acidity of the soil. By means of soil amelioration, soil can be transformed into an earlier or later stage of development, or the course of soil development can be radically changed. If the soil-forming forces remain unchanged, however, they will gradually cause the soil to revert to its original state. Sooner or later the effect of liming, for example, will disappear, since the calcium ions introduced into the soil in the course of amelioration will eventually be leached out of the soil.

2. Soil types

The best way to become acquainted with the major soil types found on the Earth is to consider the various climatic zones. As vegetation is closely linked with the climate, two can be discussed together from this point of view.

2.1. Zonal soils

In each climatic/vegetation zone the climate and the vegetation produce similar types of soil in places where there is nothing to prevent rainwater from draining away. These soil types occur over large areas where the factors producing them are available, so they are known as zonal soils. The effect of climatic factors on the course of soil formation is manifested chiefly through the extent to which the soil becomes moistened. Prairie soils are produced when soil moistening is moderate. A high degree of moistening leads to the formation of podzolic soils under forests in colder regions and red lateritic soils in the tropics.

2.2. WRB: the Word Reference Base

The latest FAO soil classification system concentrates not so much on the development of the soil, but on soil properties perceptible in the field. This classification is thus based on the description of diagnostic soil layers and diagnostic properties, so the soil type is not primarily a genetic category, though the soil properties give some indication of the history of soil development.

2.3. Genetic classification

The soils in Hungary are grouped according to scientifically based genetic principles and pedogeographical principles. The former is referred to as a genetic classification because it considers the processes by which the soils developed, while the latter classifies soil types in terms of geographical regions. Soils are grouped into the same type if they are formed under the effect of similar environmental factors and have reached a similar state of development. Some soils are influenced mainly by the effect of climate. Their development is not affected by groundwater or surface water, but only by rainfall. From an archaeological point of view, the genetic soil classification system currently used in Hungary is particularly useful, as it considers the soils historically, in the same way as the archaeologist regards his finds. The genetic soil classification also provides an indication of the natural environmental conditions under which the soil was formed. Naturally, modern classification systems also indicate the effect of human activities.

2.4. Skeletal Soils

The main characteristic of skeletal soils is that biological processes play little or no role in their development. These are young soils at the beginning of the formation process.

2.4.1. Stony, rocky soils

In the case of stony, rocky soils, the crumbling of the compact rock has not yet reached the stage where the soil is capable of providing sufficient water and nutrients to support a large mass of vegetation. Such soils occur on areas exposed to intense erosion, where water or wind transport crumbling products away soon as they are formed. The soil layer is generally less than 10 cm in depth and alternates with rocky patches.

2.4.2. Barren soils

On earthy, barren soils, the soil formation process is prevented not by the lack of weather rock, but by the rapid, constant erosion of the surface. The basic rock is unable to form a soil layer, as any material which is formed is immediately removed by erosive forces, so it is never exposed to the effect of soil-forming factors for any length of time.

2.4.3. Blownsand

Sand particles are constantly rolled along the surface of blownsand by the wind, or are caught up and carried away. Due to the constant movement of the surface, no permanent vegetation cover is able to develop or influence the soil-forming process.

2.4.4. Alluvial soils

The commencement of soil formation is hindered on alluvial soils by the fact that floodwaters regularly bring a new layer of sediment. If this process ceases and the surface is covered by vegetation for a longer period, humus is formed and the development of meadow or marsh soil begins. Alluvial soils are always found on river flats.

2.5. Brown forest soils

Forests are only able to develop on areas with a relatively high quantity of annual precipitation. Part of the rainfall evaporates from the foliage, but the majority seeps into the soil. The drying effect of the wind is reduced under the trees, so the air is always humid and the soil surface is covered by dead leaves. This all helps to reduce evaporation. The decomposition of pine leaves leads to the formation of extremely acidic humus compounds, so the pH of the topsoil under pine forests is always very low. The humus formed under beech or oak forests is far less acidic. The majority of forests in Hungary are composed of deciduous trees, so the humus compounds that are formed are less acidic. This, combined with the relatively sparse rainfall, leads to the formation of soils with less leaching than in podzolic soils. Due to the characteristic brown colour of many of these soils, this group is referred to as brown forest soils.

The characteristic soil formation process in brown forest soil with clay illuviations is the migration of clay, since the leaching caused by acidic humus compounds removes not just the bases, but also the clay particles from the leaching level. The migrating clay does not get beyond the accumulation level, where it creates a characteristic reddish brown clay level.

2.6. Chernozem soils

The most typical soil type of grasslands is chernozem soil. Grassland vegetation is formed on areas where the groundwater is at a depth of more than 4 m and the annual rainfall is less than 600 mm. As the groundwater level is low, drought-tolerant grasses are dominant on these areas. The sward dies off each year, and only the stems and roots overwinter. The soil has a high humus content and under well-aerated conditions calcium-rich humus compounds of high quality are formed. The topsoil becomes crumbly due to the large quantity of roots. Chernozem soils are characterised not only by the accumulation of humus compounds and the crumbly texture, but also by the two-directional movement of calcium-rich soil solution. Chernozem soils with lime accumulation get their name from the lime accumulation found at a depth of 30–70 cm, which coat the soil particles with a thin, microcrystalline membrane similar to mould. The pH of the topsoil is neutral or mildly alkaline. There is a gradual transition from the deep, humic A layer to the lime deposits of the B layer and the humus-free C layer.

2.7. Saline soils

Water-soluble sodium salts play a decisive role in the formation of saline soils and in determining their properties. Two basic types of saline soil can be distinguished. Solonchak soils are characterised by the accumulation (and sometimes precipitation) of water-soluble sodium salts in the topsoil or on the soil surface, while solonetz soils accumulate exchangeable sodium ions in the genetic layers below the surface. The soil profile of solonchak soils exhibits few distinct layers. The sodium salts result in unfavourable physical properties and a strongly alkaline pH. The topsoil is light grey when dry, being somewhat darker at lower levels, with rust-coloured veins. Salt accretions can be seen on the surface in dry periods. The A level of solonetz soils is generally less than 15 cm in depth and light grey in colour. It contains little or no water-soluble salt. Characteristically, more than 15% of the exchangeable cations are sodium ions. The B level, which typically has columnar structure, contains more clay than the A level, and is the site of salt and sodium ion accumulation.

2.8. Meadow soils

Flourishing meadow vegetation, consisting of hydrophilic grasses, is to be found in hillside valleys and on the deeper-lying parts of river flats. As these areas are lower-lying than the surrounding areas, the surface waters from the higher regions accumulate here and the groundwater is only 0.5–3.0 m below the surface. Damp, airless conditions are thus typical of meadow soils, as the result of which traces of the more mobile iron compounds can be seen, in the form of gley, iron particles and rust patches. Some of the humus is also bound to iron compounds, so the humus layer is black.

As the conditions are ideal for rock weather, meadow soils tend to become clayey, so they are often extremely heavy and difficult to cultivate. The proportion of magnesium among the exchangeable cations may be as high as 30%.

2.9. Marshy soils

Marshy soils are under water or saturated with water, either constantly or for a large part of the year. This means that the whole soil profile is airless. When the aquatic plants (reeds, rushes, sedges) die off, the remains decompose under anaerobic conditions. Marshy soils are formed by the accumulation of this organic matter.

3. Human activities

3.1. Characterisation – morphology

Changes taking place in the soil or the soil profile as the result of environmental factors or human activity can best be traced by morphological observations, for instance by determining differences in the structure, quality and size of the genetic levels in soil exposed to human activities and those without such exposure, which are thus often undisturbed. If no such undisturbed soil, produced purely by natural factors, can be found in the area, the soil under examination can be compared with the genetic structure assumed for the original, natural soil. If the genetic levels are not found in the correct order, it is clear that the soil is of anthropogenic origin, having been mixed up due to human activities. If genetic levels are found, but these do not resemble the natural soils in the area, the difference can be explained by local environmental factors or human activity.

3.2. Characterisation – measured properties

3.2.1. Chemical and physical properties

In addition to the description of morphological traits, soil characterisation can be made more accurate by the analysis of chemical and physical traits. Although numerous, extremely expensive soil analytical techniques are available, which are often indispensable (e.g. the mineralogical analysis of the soil or the C^{14} analysis of humus substances), a great deal of information on soil formation can be obtained even from simple, basic soil analyses. These include the determination of soil pH, which is indicative not only of the properties of the soil-forming material, but is also closely correlated with the natural, environmental factors that exerted an effect during soil formation. Tests on the lime content of the soil provide information not only on the initial soil-forming rock, but also on the environmental processes which have taken place during the "life" of the soil to date, on when and why the lime disappeared from the soil if the original rock contained lime, or on where lime excretions have come from if they are found in soil that originally contained no lime. In soils which originally contained lime, the appearance of various forms of lime accumulation is a good indicator of the formation of meadow soils under humid conditions. Interestingly enough, a mild form of lime accumulation is also observed in one of the subtypes of chernozem soils: chernozem soils with lime deposits. This can be probably attributed to a cycle of humid and dry seasons.

One of the physical properties of soils is the upper level of soil plasticity according to Arany (K_A), which is closely correlated with the particle composition or texture of the soil. This simple, rapid method indicates whether the soil is sand, loam or clay. This soil property is also a good indicator of the material from which the soil is formed (Füleky 1999).

3.2.2. Humus content

Humus content, which lends a dark colour to the topsoil, is in very close connection with past or present soil-forming processes and is an important indicator of the nature and extent of these processes. It also indicates how long the soil layer has been on the surface. This parameter may also change as the result of human activities. For instance, the humus content of soils formed under forests may decline exponentially after deforestation and use of the land for arable purposes. It is interesting to note that if ploughed land is later used as grassland, the humus content rises again to a certain extent.

3.2.3. Total phosphate content

The analysis of the total phosphorus content in the soils of archaeological digs provides an indication not only of the stage of soil development, but also of the intensity of human intervention. Under natural conditions, the total phosphorus content is characteristic of a given area and soil type. In Hungary, the total phosphorus content of the soil is generally less than 1000 mg/kg under natural conditions, but if humans have lived on the area for a shorter or longer period, there is a smaller or larger increase in the total phosphorus content. The extent of this increase depends on the intensity of the human presence, i.e. on whether a few people lived on the area for a long time or a large number of people for a short time, since the increase in total phosphorus content is proportional to the intensity of the human presence. One example of this is the increase in the phosphorus content from at most 1000 mg/kg P to 4–6000 mg/kg P in certain soil levels in the Neolithic tell at Polgár and the Bronze Age tell at Százhalombatta (Füleky 2003). So how do human activities affect the course or direction of soil formation processes?

	Depth, cm	Total-P mgkg^{-1}
Outside the tell	0–30	785
	30–60	412
	60–90	345
	100–140	748
Inside the tell	0–50	4552
	50–100	4120
	100–150	6368
	150–190	3990
	190–220	6264
	220–250	2484
	250–300	7560
	300–350	1256
	350–380	964
	380–400	772

Table 1. Total-P content at the Neolithic Polgár-Csőszhalom tell.

Depth, m	Total-P mgkg^{-1}
0.00–0.20	3699
0.20–0.65	2577
0.65–1.00	3457
1.00–1.05	3771
1.05–1.20	4614
1.20–1.30	4354
1.30–1.55	5709
1.55–3.00	6968
3.00–3.80	5760
3.80–4.05	1349
4.05–4.45	1337
4.45–	1130

Table 3. Total-P content inside the Százhalombatta Bronze Age tell.

Soil type	Horizon	Depth, cm	Total-P mgkg^{-1}
Brown mixed	A cult	0–140	2004
Brown	A	140–160	791
Reddish-brown	B	160–190	670
Grey sand	C	190–240	779
Iron crust	–	240–250	488
White limestone	–	250–	730

Table 2. Total-P content outside the Százhalombatta Bronze Age tell.

3.3. Burning of forests

The effects of human activities may be direct or indirect. Chronologically, the first indirect effect was the burning of forests to provide land suitable for agriculture. In addition to clearing the land of vegetation, thus exerting a substantial influence on the quality and quantity of humus formation, forest burning also influences the soil in other ways; for instance, the ash alters the soil pH, the fire destroys living organisms in the topsoil layer, and the exposed soil surface is more prone to damage by soil erosion.

3.4. Cultivation

Naturally, the next step in human activities after deforestation is agriculture, carried out at various levels of intensity. The use of a digging-stick made little impression on the genetic levels of the soil, but ploughing caused far greater alterations, principally due to its mixing effect. If ploughing is carried out in the same direction over a long period, agroterraces are formed, while if ploughing is carried out up and down the hill, erosive forces will begin to act. Areas which are cultivated and are only covered by vegetation during certain periods are perhaps the most susceptible to soil erosion. Erosion removes the soil from some areas and deposits it elsewhere. This way, previously well-developed soils may cease to exist, while land at the foot of the hill may become covered with erosion deposits, which mask the soils previously developed in these locations (FÜLEKY – MÁRITY 1997).

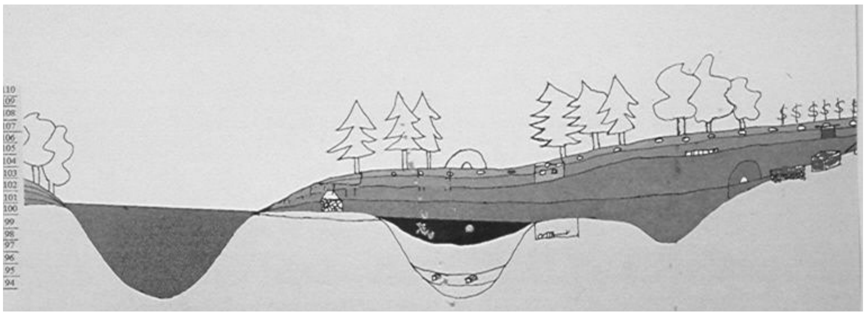

Fig. 1. Soil erosion covered the inhabited area at Budaújlak.

3.5. Digging pits

Pits dug as a source of various materials and later filled with rubbish or soil materials are of limited significance, as they only alter the original soil over a small area. If there is a dense network of pits, however, the soil of a larger area may in practice become anthropogenic.

Filling pits with rubbish and the soil from surrounding areas is a natural equilibration process, which again produces a new type of soil profile, though only on a restricted area. In many cases, conclusions can be drawn from the materials used to fill the pits on the material movements in the area and, with the help of archaeological finds, on the date of these processes.

3.6. Digging ditches

A further very frequent form of human activity is the digging of ditches. Human settlements have been surrounded by ditches from ancient times for defence purposes, to serve as boundaries and to drain off water. In many cases these ditches were formed by deepening natural erosion ditches (FÜLEKY – MÁRITY 1997; FÜLEKY ET AL. 2002). The earth removed from the ditches was generally used to form an embankment, thus altering the soil structure both in the ditch itself and on the site of the embankment.

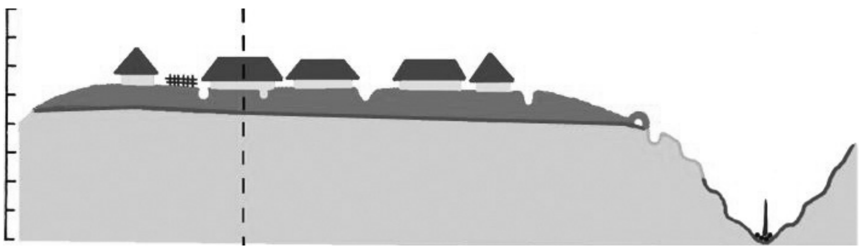

Fig. 2. The defence ditch at Százhalombatta was formed by deepening the natural erosion ditch.

3.7. Constructing canals

At a higher level of civilisation, these simple ditches were replaced by canals suitable for both drainage and water management. These canals were often based on earlier streams or riverbeds, which ensured the free movement of the water (TAKÁCS – FÜLEKY 2003; FÜLEKY – MÁRITY 1997). The soil removed from these riverbeds when they were broadened, deepened and developed into a network was placed on the banks, and this, together with the process of water management, caused widespread changes in the soil conditions of the whole area. A rise in the groundwater level may cause soils to become saline, while a drop in the groundwater level may lead to the formation of steppe-type soils. Irrigation with water having a high salt content may also result in saline soils, while marshy areas may develop if the canals are neglected.

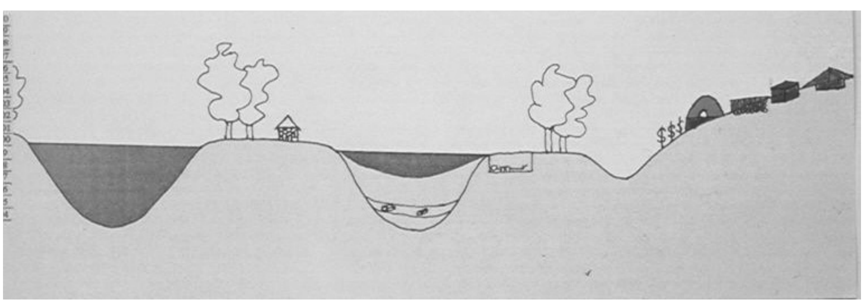

Fig. 3. The former riverbed (Danube) was replaced by a canal in Roman times.

3.8. Filling up of canals and ditches

The filling up of ditches or canals with rubbish or soil materials has a similar effect to that observed in the case of holes, but on a larger scale. Studies on the filling up of the ditches excavated near the Bronze Age tell settlement in Százhalombatta helped to reconstruct the history of the tell itself, since the material with which a ditch is filled presents quite a different picture if it found its way into the ditch naturally, as the result of erosion, or if it was placed there manually, either all at once, or over a long period of time.

Human activities not only exert an effect downwards, but also cause upward soil movements. There is a gradual accumulation of soil-forming materials from the remains of old dwellings during the formation of a tell, though the holes, ditches and erosion effects mentioned above may also be observed within the tell. Below the tell, the original soil profile can be found unchanged, or with minor modifications (Füleky et al. 2002).

3.9. Burial mounds

The builders of burial mounds marked the site of the grave by forming a mound of earth over the dead body. From the scientific point of view, this involved the removal of the topsoil from the surrounding area and its accumulation on the top of the grave, thus burying the original soil for thousands of years. A comparison of the soil under the mound with more or less undisturbed soils in the surrounding area may help to date soil-forming processes (Joó et al. 2003) and to reconstruct the environmental conditions during the interim period. Unusual soil formations, such as variously sized layers of calcium carbonate or iron oxide, often occur on the boundaries of disturbed and undisturbed soils in the transported soil or in the holes. This is an indication of whether, following human intervention, the soil-forming processes continued unchanged, slowed down, speeded up, or ceased altogether. Naturally, humus-forming processes were unable to continue on the original soil surface buried under the mound.

3.10. Manuring and irrigation

The role of waste materials in filling up ditches and holes has already been mentioned, but it must not be forgotten that these materials were also sources of the high phosphorus content found in human settlements. Long-term manuring may have a similar effect. Mention has also been made of the fact that, in addition to its favourable effects, irrigation may also cause the formation of saline soils unsuitable for agriculture if it is carried out with poor quality water with a high salt content. The role of water drainage in soil formation has also been touched on.

4. Case studies

A few examples will now be given of the joint soil-forming role of the environment and human activities.

4.1. Százhalombatta

Excavations and soil analysis in and around the Bronze Age tell settlement demonstrated that traces of the original soil profile could be found under the whole of the tell. In some cases the complete profile was found, while in other cases only the reddish-brown B level and the grey sandy C level were discovered. The properties of the buried soil suggest the formation of forest soil or, more precisely, that forest vegetation was found on the given area during the soil formation process.

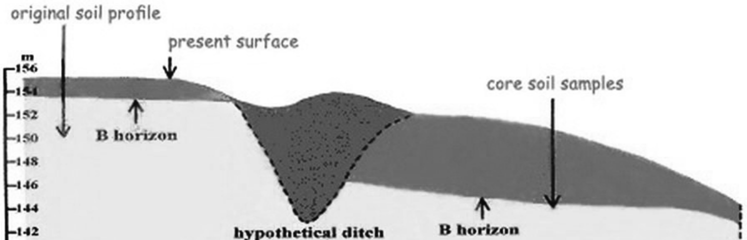

Fig. 4. The remains of the original soil profile could be found below the cultural layer of the Bronze Age tell.

The tell accumulated an average of 4 m of soil above the original level. The layers which could be distinguished in drillings from the centre of the tell had a phosphorus content of several thousand mg P/kg, which was many times higher than the total phosphorus content of less than 1000 mg P/kg in level A of the original soil. The fact that the mass of the tell gradually rose above the initial soil level means that the material used to build the houses must have been brought in from elsewhere. It is indicative of the effect of the contemporary natural environment, that the A and B levels of the buried soil had an acidic pH, despite the fact that the A level was formed on loess, while the B level was formed on the sandy material of the parent material. None of the soil layers involved in the construction of the tell had an acidic pH, due to the limey nature of the clay or clay loam and to the lack of both forest vegetation and of the higher rainfall quantities required for forests to develop (FÜLEKY 2003; VICZE 2001).

4.2. Polgár-Basatanya

An interesting phenomenon was observed in a Copper Age burial site in the neighbourhood of Polgár-Basatanya. Above the buried bones, and in some cases on the bones themselves, a lime layer could be seen, which had become cemented together. At the same time, an extraordinarily high total phosphorus content of around 10,000 mg P/kg was recorded throughout the burial site, and particularly in the vicinity of the human bones. Both phenomena are indicative of the climate experienced since the burials took place, or at least during certain periods. The lime accumulation must have occurred due to a rise in the groundwater level, accompanied by the formation of meadow soil. It is quite clear that this lime layer did not exist when the graves were dug, since it was found above or beside the bones. This means that there was a period after the Copper Age when rainfall was far more abundant than when the burials took place. The high phosphorus content is a natural phenomenon, since bones contain a large quantity of phosphorus. The more humid conditions will have promoted the dissolution of phosphate from the bones (FÜLEKY 1999).

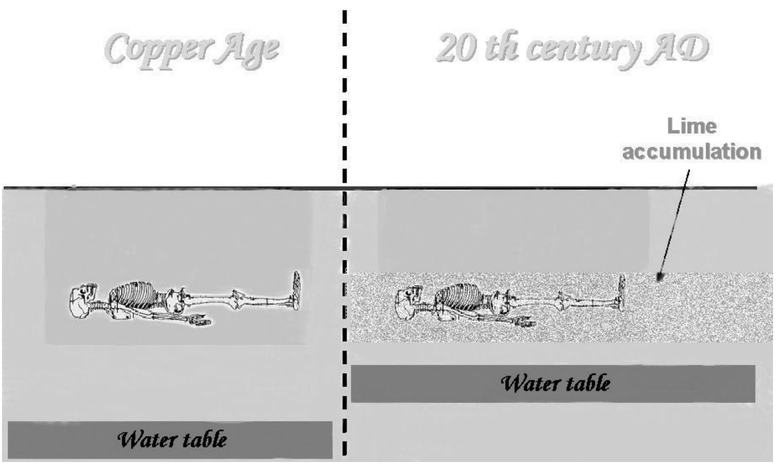

Fig. 5. Lime accumulation above the buried bones and on the bones themselves at Polgár-Basatanya.

4.3. Csípőhalom mound

The properties of the soil below and beside a mound at Csípőhalom, built on a low hill in Hortobágy have recently been analysed (JOÓ ET AL. 2003). Chernozem soil formation was discovered below the burial mound, indicating that the climate on this area favoured prairie vegetation 6000 years ago. Interestingly enough, at a small distance from the mound, on slightly lower-lying areas, solonetz soil was formed. The material of the mound also contained salt, indicating that it was transported from an area where the topsoil had a high salt content at the time the mound was built. Grassland soil formation was again observed on the top of the mound. This suggests that the climate at the time the mound was built was similar to that experienced today, leading to the formation of chernozem soils on higher areas and solonetz soils on lower-lying areas.

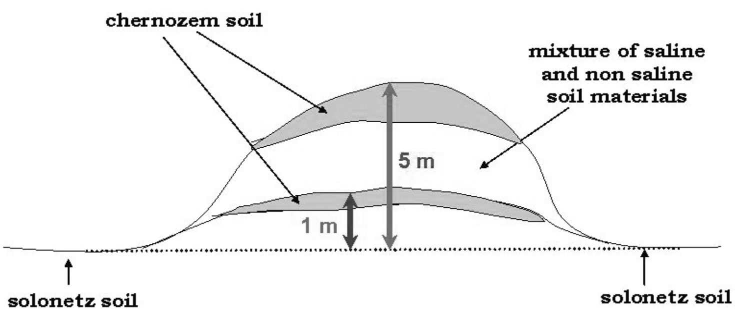

Fig. 6. Soil conditions below, beside and inside of a burial mound at Csípőhalom.

5. Human activity and soil formation

The role of environmental factors and human activities in soil formation can be summarised as follows: the soil formed under the influence of natural soil-forming factors (climate: rainfall and temperature, parent rock, relief, water conditions, plant cover) may be changed by human activities. These activities may *stop* existing soil-forming processes – for example, humus formation ceases under burial mounds when the ground is covered. In most cases, human activities *retard* the effect of soil-forming factors (e.g. when water erosion due to human activities washes away the uppermost soil layers). Human activities may also *alter* the natural pathway of soil formation under the given environmental conditions, for instance if salt water is used for irrigation under very dry conditions, leading to the formation of saline soils instead of the semi-desert soils which would otherwise arise.

A similar situation arises if large quantities of organic matter are regularly ploughed into the upper layers of the soil, leading to the formation of organic soils which would not have formed under the given natural conditions. In Western Europe, podzolic soils would probably have developed on these areas.

It is important to note that the total phosphorus content of the soil may increase substantially if intensive human activities continue for a long period. This means that a high total phosphorus content may be indicative of earlier human habitation on a given area.

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