

Acidification of some soiltypes in Bükk mountains

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INTRODUCTION

During the investigation of genetic soil-types in the area of Odorvár I recognized different processes connected with soil acidification. These natural and anthropogenic processes do not show to the naked eye, therefore we have to apply distinctive physical and chemical methods. The most important factors in the acidification are the following:

- pH of the precipitation
- buffer capacity of the soil
- chemical and physical properties of the base rock.

I took samples from 4 different soil-types in 1987 and in 1991 and I have investigated their physical and chemical properties in connection with changes in acid properties.

Acidification in acid, nonpodzolic brown forest soil

The acidification in brown forest soil is a natural, nonanthropogenic process. This soiltype is formed on shale, phyllite, porphyrite and hydroandesite. It contains clay minerals formed before the beginning of soil formation. These minerals significantly lose in their colloidal properties. The brownish-black illuvial layer is rich in humus, its structure is crumbled and grained. The pH value ranges from 3.5 to 4.5. We can always find aluminium and iron ions among the exchangeable cations. In the alluvial layer acidification is a significant process as well (Stefanovits P. 1981).

The acid property of brown forest soil is traceable to the quality of disintegrated remnants of dark grey shale, which is the base of the soil formation. The rock debris is poor in basic materials and therefore conditions are favourable for acidification (Máté F. 1987).

I examined the changes in pH values in 1987 and in 1991. The following figure (Fig. 1.) shows the pH values in three layers (5, 10 and 30 cm depths). The pH(H₂O) values were 6.2, 5.5 and 5.3, while the pH(KCl) values were 5.5, 4.4 and 4.0. If the difference

of distinctive pH values in a special layer (for example $\text{pH}(\text{H}_2\text{O}) - \text{pH}(\text{KCl}) = 1.3$ in 30 cm) is greater than 1, then it indicates intensive acidification.

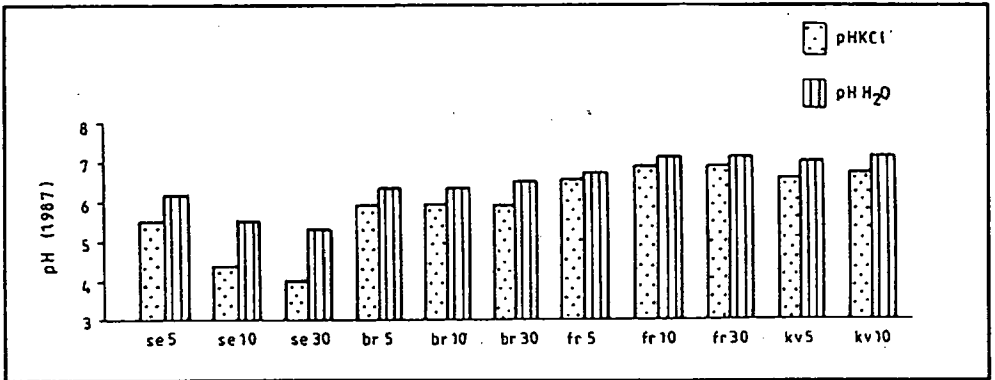


Figure 1 pH values (KCl and H₂O) in different soiltypes in 1987
 se=acid brown forest soil br=brown rendzina
 fr=black rendzina kv=skeletal, stony soil
 5, 10, 30 = depth of soil sample in cm

We can say that the acidification in brown forest soil is basically due to the chemical properties of dark grey shale, but this process may become harder due to the immission of acid materials of the atmosphere. Therefore I have investigated the sulphate and nitrate ion contents in soiltypes. These materials are immitted onto the Earth's surface by dry and wet immission and they are washed down into the lower soil layers by precipitation.

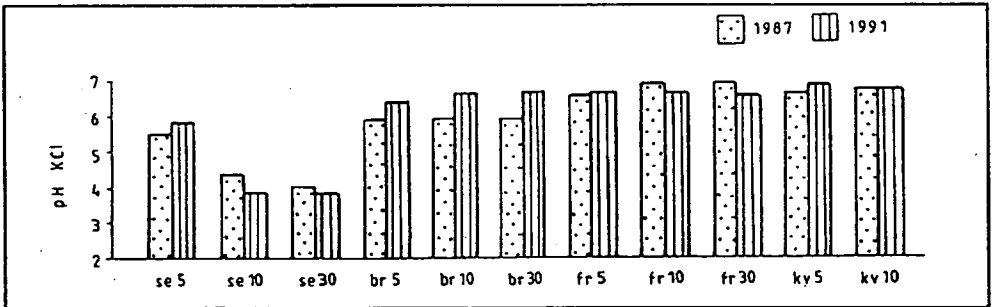


Figure 2 pH(KCl) values in different soiltypes in 1987 and 1991.
 se=acid brown forest soil br=brown rendzina
 fr=black rendzina kv=skeletal, stony soil
 5, 10, 30 = depth of soil sample in cm

In connection with the buffer capacity of the soil I have found lower nitrate content in the lower layers, while the distribution of sulphate ions was more uniform in the whole soil profile. In 1987 the nitrate contents in different soil layers were 8.3, 2.3 and 1.5 ppm, while in 1991 the ion contents were 8 times greater than four years before (64.7, 11.5 and 4.8 ppm). The sulphate content increased too but not so significantly. In 1987 the sulphate contents were 10.8, 11 and 25.4 ppm, while in 1991 they were 18.6, 16.6 and 22.1 ppm (Fig. 2-3.).

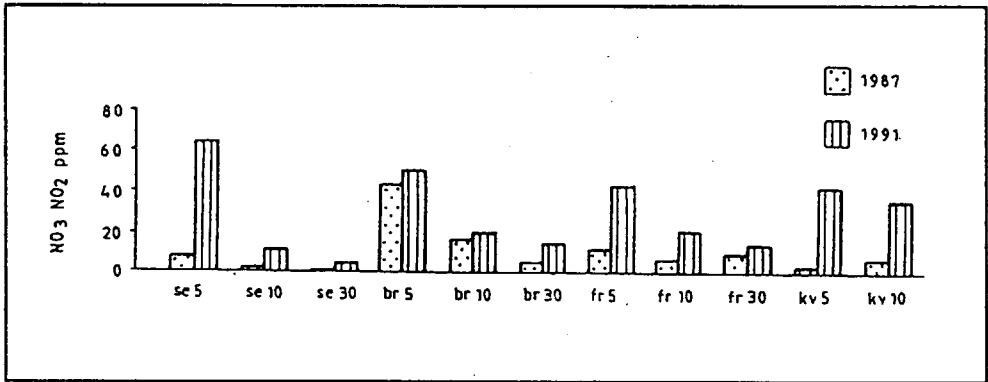


Figure 3 NO₃ and NO₂ contents in different soiltypes in 1987 and 1991 in ppm
 se=acid brown forest soil br=brown rendzina
 fr=black rendzina kv=skeletal, stony soil
 5, 10, 30 = depth of soil sample in cm

The development of acid brown forest soil shows that the acid rainfall strengthen the process of soil acidification. Due to the moderate buffering capacity this tendency will continue.

Process of acidification in soiltypes formed on limestone

By the side of geologic composition of the area of Odorvár the acidification is modified by climatic conditions. Basic materials are washed out from the upper soil layer by seeping precipitation. In the first stage the most soluble ions of alkaline metals and later their hydrocarbonates are carried away.

Minerals are dissolved in precipitation and in groundwater which contain carbon dioxide. Positive ions of metals are carried away together with anions and negative bicarbonate ions by seeping water down to the lower soil layers. If later the sulphuric acid gets into the soil then magnesium and calcium ions are carried away by sulphate ions.

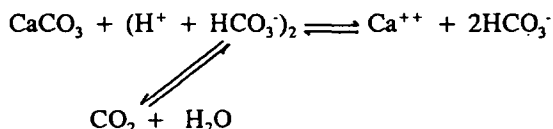
While the sulphate solution transport the cations, hydrogen ions remain in the soil and these are the cause of the acidity of the soil (Mohnen, V. 1988).

The seeping water contains organic acids formed during the microbiological decomposition of plant residues, which play a very important role in the acidification (biogenic factor). Acid organic materials arisen from the formation of humus combine with calcium ions into salt and calcium humate if there is sufficient calcium carbonate in the soil. The chemical reaction of the soil solution does not change by acid and basic influences as that of the distilled water, because of the buffer capacity of the soil.

Different soiltypes were formed in limestone on the area of Odorvár. The skeletal, stony soil is the erosional residue of black rendzina. The fragments of limestone and the calcium ion content of seeping water are the cause of the high buffer capacity of this soiltype. The surplus hydrogen ions are absorbed in the soil containing calcium and magnesium carbonates and chemical reaction of the soil layer is regulated by the



buffer system in accordance with the following



chemical reaction (Filep, GY. 1988.).

Therefore the pH value of the soil solution is not decreased while there are sufficient calcium and magnesium carbonate in the solid phase of the system. Calcium and magnesium ions can be washed out by seeping water if they are in solution.

Skeletal, stony soil does not cover the limestone surface continuously on the eastern, southeastern and southern slopes of Odorvár. The precipitation upon the covered and uncovered surfaces can be considerably acid.

The chemical reaction of the precipitation which absorbed free carbon dioxide content of the air is about 5.6, but the pH value can be 4.5 or lower if it dissolves air pollution emitted by industry (Mészáros E.-Horváth L. 1980). Dissolution of limestone by runoff starts in spite of rapid infiltration (rillen karren). If the seeping water is not saturated, it is able to absorb further calcium ions in the joints of the limestone or in the soil. The process is intensified by humic acids created by the decomposition of organic materials. The humus content of black rendzina ranges from 5.5% to 10% (Fig.4).

The most important factor in the soil acidification is the acid rain. I have found enormous differences between the sulphate and nitrate contents in soil samples gathered in 1987 and 1991. The sulphate contents in 1987 were 8.4 and 3.5 ppm. I had to sample from two layers because this soiltype is strongly eroded. The sum of the nitrate and nitrite contents was 2.9 and 6.6 ppm. In 1991 the sulphate contents were 20.4 and 19.2 ppm in the samples, while the sum of nitrate and nitrite ions was 42.5 and 5.5 ppm (Fig.5).

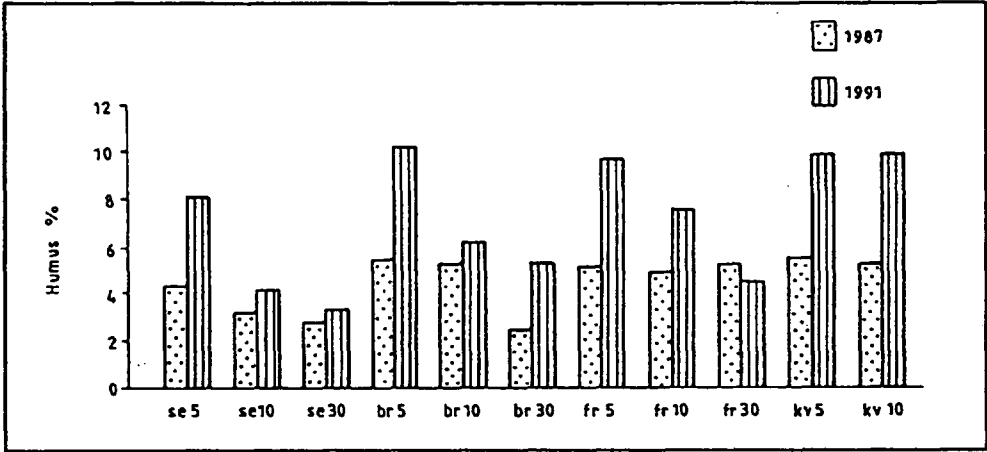


Figure 4 Humus contents in different soiltypes in 1987 and 1991
 se=acid brown forest soil br=brown rendzina
 fr=black rendzina kv=skeletal, stony soil
 5, 10, 30 = depth of soil sample in cm

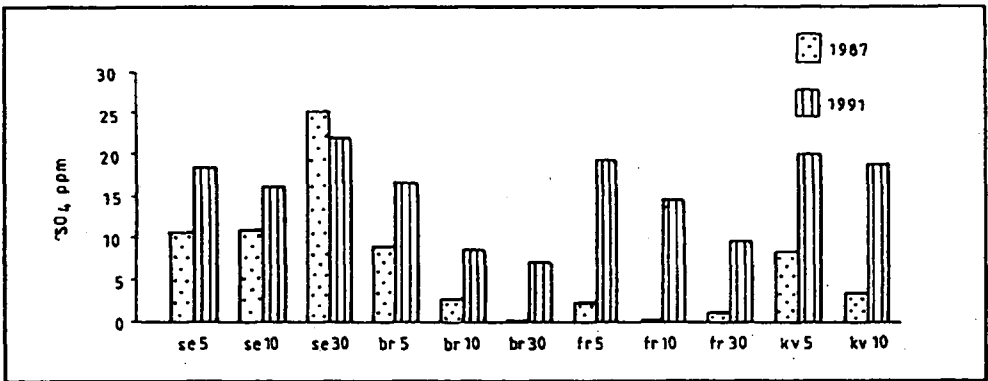


Figure 5 SO₄ contents in different soiltypes in 1987 and 1991 in ppm
 se=acid brown forest soil br=brown rendzina
 fr=black rendzina kv=skeletal, stony soil
 5, 10, 30 = depth of soil sample in cm

The distribution of these anions shows that this very thin soil layer can absorb the acid factors of precipitation by its high buffer capacity. The increasing sulphate and nitrate

contents prove that more and more anions are being absorbed on the colloid surfaces. If the sulphate and nitrate content of the precipitation will not decrease the buffer capacity of the soil will reduce. If it ensues, the seeping water will not be saturated and it can dissolve the dripstones formed in the caves. In the area of Odorvár we can find a very thin limestone layer over the Óriás Chamber of Hajnóczy Cave. The degradation of dripstone phenomena can be traced back to two reasons:

a, there is a lower relative humidity (80-85 % of other chambers, therefore the dripstone layers are broken off from the stalagmites,

b, the other reason for degradation is the guano of bats living in the cave. The dropping water is sinking through the guano, which can be 10 cm thick, and the seeping water becomes aggressive again.

CONCLUSIONS

1. The cause of the acidification in brown forest soil is the chemical property of dark grey shale, and this process is intensified by the acid rain.
2. The dark grey shale is eroded by external forces, its thickness is decreased and calcium content and the buffer capacity of the soil increase.
3. The buffer capacity of skeletal, stony soils and that of the black rendzina is good enough, but more and more anions are absorbed on the colloid surfaces.
4. Acidification in soiltypes formed on limestone is accelerated by acid rains.

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