Geographica Pannonica No. 1, 11-12 (1997)

SOIL-FORMING FACTORS AND THEIR IMPACT ON THE EVOLUTION OF SOILS IN THE UPPER SEMENIC MOUNTAINS

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Abstract

The Semenic Mountains are situated in the southwestern part of Romania (fig. 1). Their upper part comprises the area roughly defined by the peaks Semenic (1,446 m.), Piatra Nedeii (1,437 m.) and Piatra Goznei (1,447 m.). Here, the formation and evolution of the soils have been influenced by a strong interaction between internal and external factors throughout geological time. More recently, the presence of mankind as had a major impact on the region. The contemporary soil-structure therefore reflects a long period of evolution and the influence of human interaction with the environment.

Key words: Factors and processes of soil formation, mantle rock, soil cover, evolution.

In order to characterize the soil cover, it is crucial to take into account the factors which have had a bearing on the formation of the soils, and their spatial and temporal relationships. Such factors are: parent-rock, relief, climate, waters (stagnant and phreatic), vegetation, fauna, the passage of time and the impact of humankind.
In this paper, we will seek to analyse each of these factors separately - but in reality their action is synergistic.

Parent rock

In the upper area of the Semenic Mountains, this is represented mainly by metamorphic rock (crystalline schists). Here and there, however, erosion has brought to light plutonic rocks (granites and granodiorites). The constituent minerals of these rocks, stable during the period of their formation, began to suffer intense chemical weathering when thermodynamic conditions changed. This comprised a transformation into unstable forms, revealing a tendency to adapt to the new circumstances. The change in thermodynamic conditions resulted from successive tectonic movements since the Mesozoic, which elevated this area, and from climatic variations on the global level. The presence of some minerals prone to chemical weathering (e.g. feldspar), a tendency towards strong insolation followed by acute cooling of the rocks overnight, the freeze – thaw process and endo- and exokinetic chemical weathering led to the formation of mantle rocks up to 10 metres thick. Soils are consequently also deep, especially on the near-horizontal areas, which encourage a good percolation of meteoric waters. The existence of acidic rocks contributes to the formation of highly acid soils.

The relief

The surface relief has a relatively level aspect, dipping towards the south. lt belongs to the Semenic plateau, which has been described in detail by M. Grigore (1981). Its formation began in the Cretaceous – after the exundation of the Carpathian crystalline blocks following the Austrian orogenesis. The development of this surface was completed in a warm and dry climate that favoured an intensification of processes of pedimentation, the recession of steep slopes and the development of a pediplain. The old relief is now represented only by a few *inselberg*–type outliers, such as the *Semenic Piatra Nedeii* and *Piatra Goznei* peaks. Subsequent tectonic movements led to the raising of this surface to an altitude of 1250 to 1400 metres, but a gradual heeling-over has resulted in the northern part of the area today being at a higher elevation. The Semenic plateau declines towards the south at between three and eight degrees, but local declivities sometimes attain ten to fifteen degrees. These variances are reflected by the thickness of soil cover.

Climatic conditions

Climatic conditions have changed with the passage of time. From the Cretaceous to the present day, various types of climate have alternated. Each has either accelerated or decelerated the processes of soil formation. Although temperature and humidity have undergone significant variations, these processes have still continued without a break since the rock-surface attained its full development. During the Ice Ages, this area was not covered by ice, continuing its evolution under a periglacial climate. Climatic alterations have always impacted upon the vegetation, whose consequent variations have directly and indirectly influenced the development of soils. Despite the specific nature of the influences on soil-evolution in each climate period, the soil today reflects only the climatic conditions of the present day. The soil today may nevertheless be considered as a soil with a polyphasal evolution.

Figure 1. Geographical Situation of the Semenic Mountains

At present, the soils in the upper Semenic Mountains are developing in a climate of relatively low temperature and abundant precipitation. The mean annual temperature is 3.6 c and maximum daily temperatures do not exceed 17 c. The mean minimum temperature is positive between the months of May and November. Mean annual precipitation exceeds 1,100 mm, the highest values occurring in May – July.

Most of the water percolates through the mantle rock or comes to rest in peat bogs at the head of the valleys. The hydric regime of the soils is of a transpercolative type. On slopes exceeding 5 degrees from the horizontal, sheet erosion develops. Snow cover persists from November to May, soil forming processes thus being retarded during this period. The local De Martonne aridity index reveals a value of 88, indicating a surplus of humidity. Under these circumstances, soils show a high degree of acidity, and locally, peat forms. Physical and chemical weathering of parent rock is extremely active and leads to the formation of iron and magnesium oxides. As a result, the leaching of clay and organic substances down the profile is much reduced, and soils do not show Bt or Bhs horizons.

Surface and phreatic waters

Surface and phreatic waters influence the processes of soil formation only when they determine conditions for waterlogging. Phenomena of gleyza – or pseudo – gleyzation may appear. In the upper part of the Semenic Mountains, phreatic water is accumulated in the crystalline schist mantle rock, at a depth of 5 metres and more, where it has no influence on the soil profile. Waterlogging is frequent at the head of the valleys, where peat bog soils develop. Surface waters can also erode surface soil cover.

The vegetation

The upper Semenic Mountains has long been primarily a woodland area. Climatic changes have, however, had an impact on the composition of the forests. Pollen analyses show that pine, spruce, fir and beech forests have alternated. At present, climatic conditions are propitious for the development of mixed forests, comprising broadleaf (principally beech) and coniferous trees. Recently, as a result of anthropogenic intervention, the wooded slopes of the upper Semenic mountains have been supplanted by meadows, whose vegetation exert different influences on the processes of soil formation. The vegetation of the forest supplied the soil with a large quantity of organic matter and acted as a shield against direct solar radiation and precipitation. The growth of tree-roots also contributed to the weathering of parent rock, and channels resulting from roots decay brought an improvement in the circulation of air and water within the soil. Soil was better protected against erosion, but soil depletion of bases was increased. The secondary meadows that, at present, cover the area, impose a new trend on soil evolution.

The quantity of humus in the higher elevations is therefore dropping year by year, as **less** organic matter remains in the soil, while at lower elevations, the quantity is increasing, humus here being formed by the annual decay of plants roots. At the same time, evapotranspiration is intensifying and soil acidity is reducing slightly. The soil is retaining its moistness along its whole profile. The meadow vegetation offers a rather reduced protection to the soils, denudation and sheet erosion occurring where the declivity and length of slopes are favourable.

Time

Time has a directly influence on the processes of soil formation - the longer the time, the more developed the soil. In the upper area of the Semenic Mountains, parent rock weathering started immediately after the formation of the Semenic plateau, under variable climatic conditions. This weathering process developed over a long period, but soil formation began with the Quaternary. Due to a quasi-horizontal relief, soil formation was not hindered by erosion or soil fossilization and on large areas, deep profile soils could therefore develop.

Human society

This has affected the processes of soil formation both directly and indirectly. ln the area under investigation, man’s impact on the soils was initially a by-product of effecting a change in the structure of vegetal cover (clearing woodland in favour of meadows). Subsequently, man started to intervene directly on the soil cover. Forests were cleared to obtain wood for building or burning, but also aimed at extending the meadows for pasturage. Even today, the tree-line is being gradually lowered by local shepherds with flocks on the upper slopes. They either burn the trees or bark their trunks at the base. At the same time, overgrazing has led to the replacement of productive herbaceous species of greater importance for soil forming process by other, less valuable and less productive species, which offer the soil only diminished protection and small quantities of organic substance. Meadows with Festuca rubra, for example, have been gradually taken over by Nardus stricta.

In the vicinity of the Semenic tourist complex, building activities have led to the disturbance of the natural soil horizons. Man can, however, also influence the soil in a positive way. The land has, for instance, been subdivided into units and a rational grazing system developed. Efforts have also been made to improve the productivity of the land by the addition to the soil of substances to lower its acidity and enrich its fertility. At present, such activities are, unfortunately, seldom undertaken.

Each of these factors has a different weight in the processes of soil formation, and the soil cover is the product of their joint action. The soils developing under the meadows in the upper Semenic Mountains belong to the Cambisols level. On limited areas, intra-zonal (peat) soils are also present. Here and there, especially around the main peaks, parent rock has been brought to light and the soil-forming process retarded by high declivities which encourage triggers a high rate of denudation.

The Cambisols class is represented by brown acid soils, formed under the conditions of a hard lithological substrate, abundant precipitation, low temperatures and short vegetation interval. They extend over 87.7% of the area under investigation and are composed of two subtypes, namely: typical brown acid soils and brown acid soils with short profile. Each of them has formed a soil association with the bare rock.

Under the natural circumstances of the area analysed, an active process of clay formation and accumulation is not possible, because of intense destructive processes of silicates, developing mostly in situ. Therefore, soils with an Ao–Bv–Bv/C–C profile have developed, often containing rock fragments and showing an important accumulation of humus in the first 10 – 15 cm. They have a high acidity and a very low degree of base saturation, and usually develop on a quasi – horizontal relief.

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