Problematic WRB classification of the so called “erubáz” soil, a volcanic soil type of Central Europe, Hungary

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Abstract

Today, the trend of re-evaluation of national and international soil classification systems carries new requirements on the recognition of soil genetic processes and their evaluation. The harmonization of the WRB and the national soil classification systems is frequently problematic, especially in the case of the small local soil groups of the national systems. The erubáz soil is a shallow soil influenced by the volcanic parent material in the Hungarian soil classification system. In the WRB the Andosols reference group assemblages the shallow volcanic soils with special physical, chemical and mineralogical properties. This study reveals the relationship between the erubáz soils and the Andosols, and makes an attempt on the WRB classification of the erubáz soils.

Key Words

Soil classification, WRB, Andosol, erubáz, Central Europe

Introduction

Development of the soil science in Hungary started in the end of the 18th century. In the 1950’s a new – and still used – genetic soil classification system was created by Pál Stefanovits (Stefanovits and Szűcs 1961). During the formation of this system he considered and evaluated the former soil classifications and included the novel results of soil science and information on the soils of the neighbouring countries. Biological, chemical and physical properties of the soils have been reviewed as these are the basis of the soil formation processes.

The so called “erubáz” soil is a shallow soil influenced by the parent material in the Hungarian soil classification system, developed on volcanic lithology. In spite of the detailed and thorough investigations of the former decade this soil is one of the less studied and most neglected soil types of the Hungarian soil science (Barczi 2000; Fehér *et al*. 2006; Fehér 2007; Madarász 2009), because it occurs in small patches dispersed in the hilly regions of Hungary, mostly on areas unsuitables for agriculture.

The denomination erubáz and the first description of the soil were created by von Hoyningen (1930), in connection with the soil classification of soils in North- and Middle-Germany. It is the amalgamation of the expressions “eruptive” and “basic”, which reflects well that this soil type occurs mainly on basic volcanic rocks, however it has been described on more acidic rocks as well. Later the name was adopted by Kubiëna (1953) in his work entitled “Guide and system of European soils”. This book was used by Stefanovits during the genetic soil classification in Hungary.

Volcanism had a special role in the Miocene-Pliocene evolution of the Carpathian basin. Volcanic rocks occur in a more or less continuous arch following the inner side of the Carpathian mountain chain, but they occur practically in the entire area of the basin system. Today, the formerly extensive volcanic fields are restricted to smaller areas (Karátson 1999). Accordingly, erubáz soils occur in small spots in a mosaic-like pattern on a large variety of volcanic rocks dispersed throughout the country. On the basis of the volcanic rock types 15 profiles were designated for a thorough study.

The World Reference Base for Soil Resources (WRB 2006) is a soil correlation system is a correlation-based soil classification system, where the volcanic soils form the so called Andosols reference group, with characteristic physical, chemical and mineralogical properties. The Andosols are intrazonal soils, which typically develop on pyroclastic parent materials rich in volcanic glass, mostly on tuff (Neall 1985).

Presently, the tendency of reconsideration of national and international soil classification systems brings about new requirements on the recognition of soil-genetic processes and their evaluation. The increasingly popular WRB provides a good basis for the scientists working in different parts of the World to find a common language.

This study aims at the WRB classification of the Hungarian erubáz soils and at finding out whether the erubáz soil type and the Andosols reference group corresponds to each other.

Methods

For the description of the studied soil profiles the FAO (1990) standard was used. Denomination of the genetic soil horizons occurred using the works of Szodfridt (1993) and Stefanovits *et al.* (1999). Laboratory analysis of the samples was carried out in the Geographical Research Institute of the Hungarian Academy of Sciences using the valid standards. Pedogenic Fe_d- and Al_d-components (Mehra and Jackson 1960) were extracted using natrium-dithionite solution. Components (Al_o, Fe_o, Si_o) of amorphous and weakly crystallized oxides (e.g. ferrihydrite) were dissolved using ammonium-oxalate (Schwertmann 1964). Al_p- and Fe_p-content attached to the organic phase of the soil was assessed by a solution created by pyrophosphate-selective extraction. The Fe-, Al- and Si-contents were determined using atom-adsorption spectrophotometer (AAS). Mineralogical and soil-mineralogical analysis of the samples occurred by a PHILIPS PW 1710 instrument with x-ray diffraction method in the Geochemical Research Institute of the Hungarian Academy of Sciences. WRB classification of the profiles was done using the WRB (2006) guidebook.

Results

According to my studies (Madarász 2009) general properties of the erubáz soils are as follows:
This soil develops normally on basic or neutral rocks, but it occurs on acidic lithology as well. Accordingly it was described on basalt, andesite and their tuffs and on rhiolite tuff as well, typically on the top surfaces and ridges, where extreme microclimatic conditions are controlling soil formation. Their average depth is 40 cm. Their structure is granular, crumby, rarely dusty, humus formation is strong and their pH is slightly acid. Texture of the erubáz soils is mostly loam, seldom sandy or clayey loam, their colour is dark, blackish and are rich in organic material (up to 8-10%). The high organic material content is due to the extreme microclimatic conditions, which leads to humus accumulation. The organic material and the clay minerals form a strongly bonded humic horizon. In accordance with the parent material and as a consequence of the sporadic but sometimes significant loess addition, the dominant clay mineral is the illite, but occasionally the presence of smectites is also considerable. The most important exchangeable cation is the calcium, the base saturation is low. Their flora has developed in accordance to the intensity and type of anthropogenic intervention. At deforested location closed meadows, while at other places, in function of the altitude, nicely developed oak and beech forests are found.

After a detailed analysis of the erubáz soils my second purpose was to find out whether this volcanic soil is corresponding to the Andosols group of the WRB. However the Andosols have developed on fresh volcanic ash, they were found on older volcanic material (Bäumler R 2004; Garcia-Rodeja *et. al.* 2004; Quantin 2004), and they were described at several locations in the Miocene volcanic rocks of the neighbouring countries, as well (Perepelita *et al.* 1986; Jurani 2002; Jakab *et al.* 2004, Füleky *et al.* 2006; Fehér 2007). However the erubáz soils and the Andosols have several similar features (structure, humus content, colour, mineral composition, etc.), their relationship could not be verified during the diagnostic classification.

Most important criteria of the Andosols is the presence of the andic or the vitric horizons. According to the laboratory analysis, the Hungarian erubáz soils do not fulfil the requirements of the andic horizon. Their Al_o+1/2Fe_o content remains well under 2%, which is one of the most important threshold values for an andic horizon. Values of phosphate-retention (max. 38%) remain also remain well under the needed percentage (70% <). The 0.9 g/cm^3 bulk density value is reached only by some samples. All these facts exclude the presence of the andic horizon in any of the profiles.

The vitric horizon can be regarded as a weakly developed andic horizon, which may grow into an andic horizon with time. Generally it forms as a consequence of weak weathering. Most of my samples correspond to the criteris of this diagnostic horizon (allophane content, bulk density, etc.), but they are unable to fulfil the most important feature, the 5% ≤ volcanic glass content. As there is no volcanic glass in the mineral assemblage of the Hungarian erubáz soils, no vitric horizon can be described in them. Consequently, it can be stated on the basis of my laboratory analysis, field observations and morphology that i*t is impossible to insert the Hungarian erubáz soils in the Andosol reference group of the WRB*. Nonetheless, their integration in any other WRB reference group is also problematic.

Following the criteria-system of the WRB diagnostic horizons (the first level of classification) only the mollic horizon could be determined for most of the erubáz profiles. For two profiles, where the parent material is more porous a relatively deeper soil has developed, therefore besides the mollic horizon, argic and cambic horizons were identified as well.

The second level of classification is the determination or the reference group on the basis of the diagnostic horizons. Some soils with a depth shallower than 25 cm and have no diagnostic horizon but the mollic, were classed as Leptosols. Where an argic or a cambic horizon was also present were included in the Luvisol and in the Cambisol groups. Most of the profiles, however, belong to the Phaeozem group because of their single mollic horizon and base saturation above 50%.

The above described features suggest that it is not possible to insert the erubáz soils into a single WRB soil group. Most of the typical erubáz soils belong to the Phaeozems, which comprise the mineral-soils of steppe areas. Formation of these soils is controlled by the climate and by the vegetation, therefore they do not reflect the effect of the volcanic parent material, in other words this group is not representative of the erubáz soils.

Formation of the Leptosols depends primarily on the morphology, as these are soils of high altitude areas with sloping surface. As a consequence of the slope, the soil particles are removed from their place of formation. Accordingly skeletal parts in these soils may exceed 80%. These characteristics are not suitable for the typical erubáz soil, they are suitable for only a few and special erubáz profiles where the depth is small and thus the soil almost falls into the skeletal soil (Lithosol) category.

At the other boundary of the erubáz soil group are situated the profiles where besides the mollic horizon another diagnostic horizon (argic, cambic) is also present. These soils, in accordance with their diagnostic properties developed due to local conditions, can be included in different reference groups, like the Luvisols and the Cambisols. However, neither of these can reflect the characteristic features of the erubáz soils. The Luvisols are mineral soils of wet, forested areas, and their formation is controlled mainly by the climate and the vegetation. Their most important feature is the texture-differentiation. Their equivalents in the Hungarian soil classification system are the brown forest soils with clay illuviation. The Cambisols are characterized primarily by their young age, they show the first signs of development of horizons. In the Hungarian system the brown earth soil group can be included in this cluster.

On the other hand, it is undoubted that some peculiar features of the erubáz soils point towards the chernozem soils: both have black colour, high humus content and deep humic horizon and frequently granular structure. Nevertheless there is no doubt, that erubáz soils do not belong to the chernozem group.

Conclusion

Criteria-system of the WRB emphasizes the steppe-like features of the erubáz soils, while the effect of the volcanic lithology is faded out. Consequently, WRB classification of individual erubáz profiles is possible, but the characteristic features of the erubáz soil group are not corresponding to any of the WRB reference groups. The erubáz soils, because of the diagnostic threshold values, could not be inserted in the Andosol groups, where shallow soils influenced by volcanic parent material are assembled. Majority of the profiles fulfilled the criteria of the Phaeozem group, however inclusion of the erubáz soils in this group of steppe-like mineral soils is not adequate.

Accordingly, complete substitution of the national, genetic soil classification systems by a modern, global soil classification system is not reasonable, as during categorization, important characteristics of special soils of local importance – like the erubáz soils of Hungary – may be ignored by the global sytem.

References

Barczi A (2000) Soils of the Tihany-peninsula (in Hungarian). 125 p (Bakonyi Természettudományi Múzeum, Zirc).

Bäumler R (2004) Soil development processess in non-volcainic Andosols. *Rala Report* **214.** 72–73.

Buzás I (1988) Soil- and agrochemistry analysis methodologies 2 (in Hungarian). pp. 37–41 (Budapest, Mezőgazdasági Kiadó).

Buzás I (1993) Soil- and agrochemistry analysis methodologies 1 (in Hungarian). pp. 37–41 (Budapest, INDA 4231 Kiadó).

FAO (1990) Guidelines for soil description. FAO–ISRIC 3rd (revised) edition. 70 p.

Fehér O, Füleky Gy, Madarász B, Kertész Á (2006) Morphologic and diagnostic features of seven soil profiles developed on volcanic rock according to the national soil classification and the WRB (World Reference Base for Soil Resources, 1998) (in Hungarian). *Agrokémia és Talajtan* **55**, 347–366.

Fehér O (2007). Examination of natural and human impacts on soil conditions in some typical regions of the Carpathian basin (in Hungarian). PhD thesis, 134 p (Szent István University, Gödöllő).

Füleky Gy, Jakab S, Fehér O, Madarász B, Kertész Á (2006) Soils of volcanic regions of Hungary and the Carpathian Basin. In ‘Soils of Volcanic Regions in Europe’ (Eds A Arnalds, F Bartoli, P Buurman, H Óskarsson, G Stoops, E Garcío-Rodeja). pp. 29-42 (Springer, Berlin).

García–Rodeja E, Taboada T, Martínez–Cortizas A, Silva B, García C (2004) Soils with andic properties developed from non-volcanic materials. Genesis and implications in soil classification. *Rala Report*

214. 74–75.
Hoyningen HPF (1931) Die Bodentypen Nord- und Mitteldeutschlands. *Jahrbuch der Preußischen Geologischen Landesaustalt* **51.** 524–564.

Jakab S, Füleky Gy, Fehér O (2004) Environmental conditions of Andosols formation in Transylvania (Romania). Soils of the Gurghiu volcanic chain. *Rala Report* **214**. 65–66.

Jurani B (2002) Volcanic soils of Slovakia. In 'COST 622 Meeting: Soil Resources of European Volcanic Systems in Manderscheid/Vulkaneifel 24.–28. April 2002'. pp. 21–22 (Mainz, Rheinische Naturforschende Gesellschaft).

Karátson D (1999) Erosion of primary volcanic depresions int he Inner Carpathian Volcanic Chain. *Zeitschrift für Geomorphologie* **144.** 49–62.

Kubiëna WL (1953) Bestimmungsbuch und Systematik der Böden Europas. 392 p (Madrid).

Madarász B (2009) Complex soil study of the Hungarian erubáz soils, with special emphasizs on their clay-mineralogical composition (in Hungarian with English summary). PhD thesis,. 134 p (Loránd Eötvös University).

Mehra OP, Jackson ML (1960) Iron oxide removal from soils and clays by dithionite-citrate systems buffered with sodium bicarbonate. *Clays and Clay Minerals* **7.** 317–327.

Neall VE (1985) Parent materials of Andisols. Proc. Sixth Int. Soil Classif. Workshop, Chile and Ecaudor. Part 1. 9–19.
Perepelita V, Florea N, Vlad L, Grigorescu A (1986). Asupracriteriilor de diagnostic ale andosolurilor si solurilor andice din Muntii Carpati. *Bucharest Anale I.C.P.A.*, **47.** 125–139.

Quantin P. (2004) Volcanic soils of France. *Catena* **56.** 95–109.
Schwertmann U (1964) Differenzierung der Eisenoxide des Bodens durch Extraktion mit saurer Ammoniumoxalat–Lösung. Zeitschrift für Pfalnzenernährung, *Düngung und Bodenkunde* **105**. 194–202.

Stefanovits P, Filep Gy, Füleky Gy (1999) Soil science (in Hungarian). 470 p (Mezőgazda Kiadó, Budapest).

Stefanovits P, Szücs L (1961) Genetic soil map of Hungary and its explanation (in Hungarian). pp. 34–35 (OMMI 1961).

Szodfridt I (1993) Forest Site Survey (in Hungarian). pp. 176–179 (Mezőgazda Kiadó, Budapest).

World Reference Base for Soil Resources (2006) World Soil Resources Reports 103. 132 p (FAO Rome).