SOIL FACIES – A GEOGRAPHIC LOCAL-REGIONAL COMPLETING OF SOIL TAXONOMIC UNITS

NICOLAE FLOREA[*]

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Soil facies – a geographic local-regional completing of soil taxonomic units. Because the soil units have a double nature, genetic and geographic ("double identity"), not completely reflected by the system of soil taxonomy, it was proposed to complete the name of the soil taxa by some additional aspects, named regional and local soil facies. These *soil facies* refer to the soil differentiating features of regional and respectively local significance. The soil name according to the soil taxonomy will be completed with the names of regional and local soil facies, generally geographic terms; for example Făgăraş skeletal loamy sand, Carpathian, Leptic-Entic Podzol. Of course, the system of soil facies entities, the criteria of differentiation and terminology of the delineated units needs to be discussed and to be agreed on. The European taxonomies could also be completed in this way with specific moisture and temperature regimes and other site characteristics. This particularization of the soil entities using soil facies can be carried on to the individualization of each soil area (delineation) in the framework of an information system and database correlated with the cadastral survey.

1. INTRODUCTION

In the nineteenth century, at the outset of soil science, the soil was considered as the weathering product of geological formations, defined especially by its lithological composition and origin, emphasizing especially the soil texture and its capacity to furnish plants with moisture and nutrients (*Soil Survey Manual*, 1993).

Based on this thought, the notion of *soil series* was developed in the United States of America as a detailed entity of soil on "ad-hoc" criteria. In the same time, in Europe, different soil kinds were defined in a more or less similar way based on the contents of soil in clay, sand, humus, lime and other salts, and iron oxides. In Romania as well, things developed in the same way (Gregorian 1896; Chiriţescu-Arva 1925; Florea 2008).

A soil genetic classification or taxonomy became possible only after a new concept of soils was introduced by V.V. Dokuchaev (1846–1903) in Russia, "as independent natural bodies, each with unique properties resulting from a unique combination of climate, living matter, parent material, relief and time" (*Soil Survey Manual*, 1999, p. 3).

The soil genesis is very important for soil classification and cartography because it produces the morphogenetic characteristics used as diagnostic criteria and because it helps to the understanding of the soil cover in landscape, contributing to a more efficient and of high quality soil survey. The diagnostic horizons, resulted from soil genesis, bring genesis indirectly into the definition of soil units (taxa) (Smith 1983).

This Russian School model of soil genesis, known as *factorial model* (Jenny 1941) has had a great influence in the studies and understanding of soil systems; it was followed by different other models. *The model of soil development in interaction with geological phenomena or geomorphic processes* (Erhart 1956; Butler 1959; Arnold 1965; Florea 1985; Buol *et al.* 1992) underlines the close connection between pedogenetic processes and geological and geomorphic processes. The *energy model* proposed by Runge (1973) insists on energy flux to the soil system, giving priority to some

[*] PhD., Academy of Agricultural and Forestry Sciences *Gheorghe Ionescu-Şişeşti*, Blvd. Mărăşti, no. 61, 011464, Bucharest, Romania.

factors of soil formation: water available for leaching, organic matter production and time; "this model places more emphasis on processes active in soil systems" (Smeck *et al.* 1983). The *residua and haplosoil model* proposed by Chesworth (1973, 1980, quoted by Smeck *et al.* 1983) "emphasizes changes in the chemical composition of soil system with time" and presents a "simplified view of soil genesis". The *model of the four basic processes* proposed by Simonson (1959) postulates that the ultimate nature of soil is determined by the balance among all the soil processes. The *soil-landscape model*, proposed by Hugget (1975), is an open system that is driven by a flux of material and energy between the soil system and its environment, in a three-dimensional territorial unit (valley basin, landscape system).

The models of soil genesis based on the general systems theory are the most comprehensive and realistic, but they are generally conceptual and cannot be rigorously tested, being very complex and lacking adequate quantitative data concerning the soil forming processes (Yaalon 1971; Huggett 1975; Smeck *et al.*, 1983; Hoosbeck 1994). Our recent model (Florea 2009) can be considered a complex and dynamic processual model of soil formation taking into account the general systems theory.

The soil concept as natural entity requires "all properties of soils to be considered collectively in terms of a completely integrated natural body" (*Soil Survey Division Staff*, 1993).

The soil classification evolved parallel with the soil concept evolution from a qualitative one, based especially on soil processes and factors, at least of high level of classification, towards a quantitative one, based on soil measurable morphological characteristics and properties (Guy Smith). Making use of the quantitatively defined classes of soils (taxa) also entails quantitatively defined mapping units, very important for soil survey and soil maps.

In the soil map of Europe (1:1,000,000) the different soil associations were presented in legend in a geographic differentiated way, grouped on great climatic regions; in such a way, the same soil or soil association can appear in various regions, having of course some different features depending on the climatic region conditions (that can be considered as provincial features).

Otherwise, the soil series themselves are defined in a restricted way, being always limited to a geological or physiographical province, such as Glacial or Loessial Province, for example (Smith 1983).

In Romania, Gh. Murgoci (1872–1925) introduced from the beginning of the soil science in this country the genetic concept of soil from the Russian School and on this basis he defined the soil (genetic) types; his followers developed the first investigations and defined and characterized the soil subtypes and soil varieties as well as the textural species, soil families (depending on rock) and soil variants (of anthropogenic nature) as it results from the *Romanian System of Soil Taxonomy* (2003).

However, there were sporadic attempts to define by local name – besides the taxon name – the soil particularities of a territory, as for example Northern Chernozem, Sourthern Chernozem (Ionescu Şişeşti 1947), Chernozem of Secaş (Cernescu *et al.* 1961), Piscupia soil complex (Popovăţ 1953a, b), Karasuluk (Florea *et al.* 1964), as well as the specifications of some soil characteristics determined by climatic conditions under the name of soil facies (Florea *et al*. 1968, *Soil map of Romania* at 1:500,000 scale, 1970–1971).

2. SOIL ENTITY HAS GENETIC AND GEOGRAPHIC FEATURES

The actual concept on soil is based on a model of soil formation ("pedological model" according to Arnold 1983), which emphasizes the interrelated influences of climatic and biologic factors on a parent material through time, which are modified by topography and landscape evolution. This model, enunciated for the first time by Dokuchaev (1883) has evolved very much from the first formalized factorial model and its "fundamental equation of soil formation factors" [(S = f (cl, b, p, r, t)] of Jenny (1941) to a dynamic processual model of soil formation and an equation of soil genesis

[S = $f_{t=0}^{t=\infty}(P,I,E,T,O)$] under influences of natural processes and environmental factors on soil system (P = parent material, I = input, E = output, T = transformations, translocations, etc., O = material organization, t = time) (Florea 2009).

In Figure 1, the relationships among factors and processes intervening in the soil formation are shown. This scheme presents generally known things and does not need additional explanations. However, the scheme brings forward in discussion, for the first time, the actions of two natural cycles very essential for the soil existence (dynamics), namely:

– recurrent soil moistening, circulation and loss of water from the soil (by evapotranspiration, seepage, surface running) in a yearly rhythm, correlated with the *hydrological cycle* from nature; this action of water is very important for all processes from the soil, translocations included, because without water nothing can happen;

– recurrent incorporation with a yearly rhythm of dead organic matter in the soil and its transformation, accompanied by the delivery of nutrients and energy in the soil and accumulation of organic matter (as humus), nutrients and chemical energy, in the framework of the general *bio-chemical cycle of nutrients*.

The connection of the soil with these two natural cycles not enough underlined until now – closely related with cyclic heating and cooling – assures rhythmically the water, nutrients and energy absolutely necessary for activity (life) in the soil and ecosystem. A soil, like a living organism, cannot function without recurrent moistening and recurrent feeding with organic matter, the complex pedogenetic processes from the soil being – from this point of view – equivalent with the metabolism specific to living organisms.

These two cycles bring in the soil system energy and assure the antientropic character of the soil by additions of substances with low entropy and expelling substances with high entropy.

These two connections and activities of the soil are fundamental processes for soil dynamics (with clearly annual cyclic evolution correlated with natural or geographic factor cyclicity), because they also determine (control) the development of the other soil processes and even the soil cover evolution.

Also, in Figure 2, different ways of pedosphere partitioning are mentioned, for each of them an adequate systematization being necessary. In this paper, only the first way – the elementary soil bodies classification – is taken into account (discussion).

From the basic pedological model of soil forming (Fig. 1), it results that any units of soil have two sides, naturalistico-genetic and geographic. The genetic side is marked by the soil physiognomy and its morphogenetic features and reflected by the system of the soil classification (taxonomy). The geographic side is not reflected in soil taxonomy, but only in territorial soil distribution. Philosophically speaking, the soil unit (entity) has a double identity, taxonomic and geographic (Munteanu and Coteț 2009). Arnold (1983, p. 11) considers that the soil forming factors "have geographic expression and that the degree and amount of overlap and interaction through time provide the fundamental concepts of soil as geographic body". Otherwise, Kellogg (1937) "states that mappable soil unit is a geographic body" (in *Soil Survey Manual* 1937, quoted by Arnold 1983, p. 10).

A taxonomic unit (taxon) is an abstract concept which has a correspondent in the cartographic unit from the soil map and in the concrete unit in the area from the territory; all these units are named according to the legend of soil map in which the used names are derived from the adopted system of soil taxonomy (the units of taxonomic system being generalized units). In this way, many particularities of the soil, especially connected with geographic features, are lost. Therefore, Arnold (1983, p. 17) considered that "the need for a bridge from the structured taxa of soil-classification schemes to the projected boundaries of natural occurring variability in landscapes has promoted the search for a basic soil geographic unit".

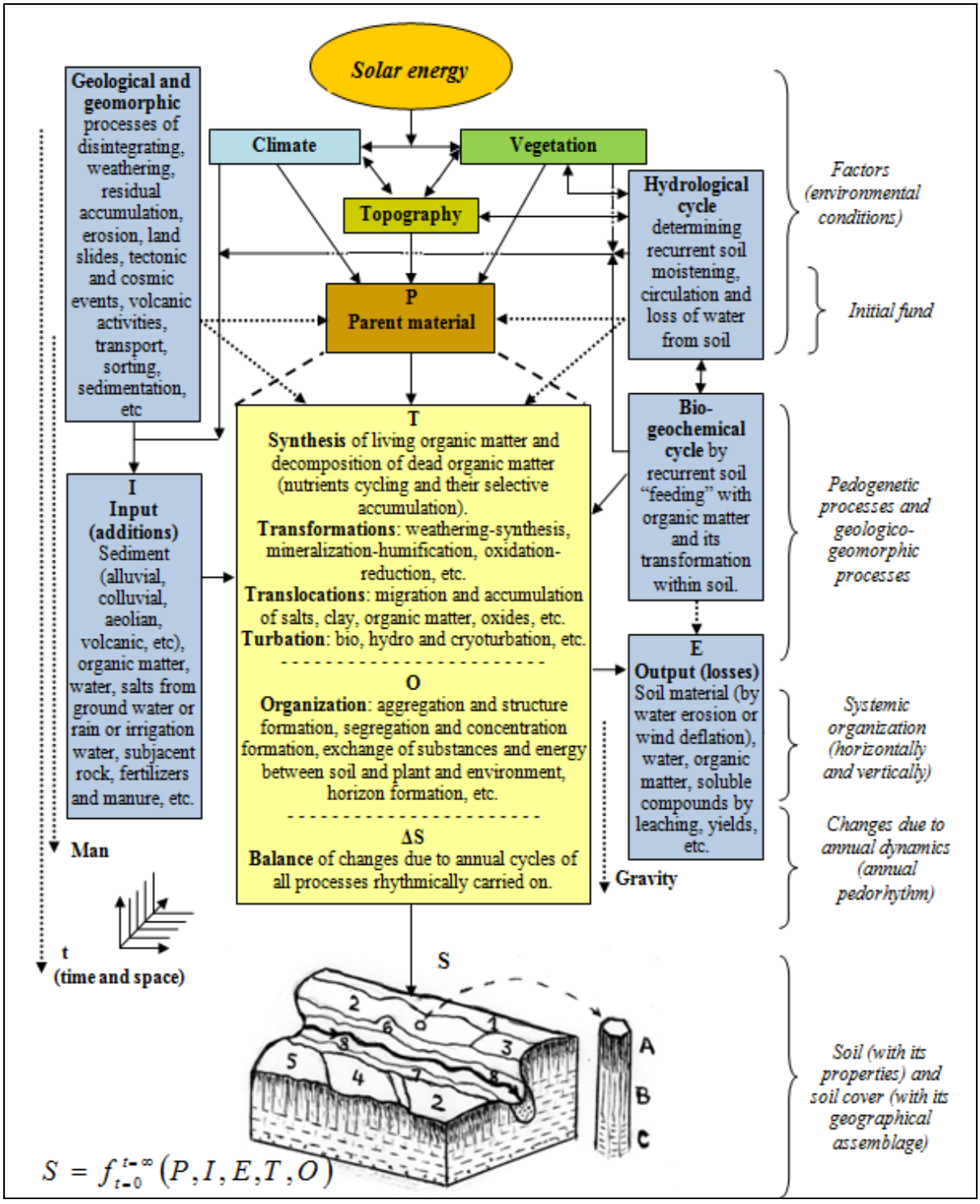

Fig. 1 – General scheme of soil (and soil cover) formation, as issue of the various balances of cyclic pedogenetic and geologico-geomorphic processes depending on different environmental conditions (soil cover formation needs a long time and evolves by the continuous minute changes of the parent material and then the soil (ΔS) as a consequence of the cyclic environment and soil dynamics, expressed in annual cycles of all processes rhythmically carried on). The recurrent soil moistening and heating and the recurrent soil feeding with organic matter in soil forming process is also underlined (Florea 2009, completed).

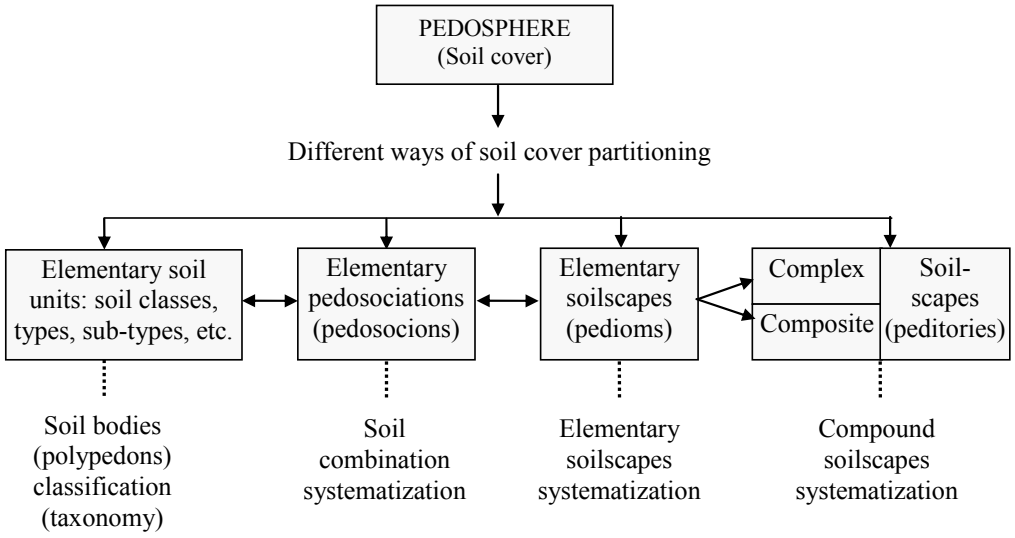

Fig. 2 – Different manners of consistent partition of the soil cover; the distinguished units of each manner of partition need adequate systematization.

Several elementary units, considered basic geographic units for soil by Arnold, were proposed and were also reviewed by Arnold (1983, p. 18); the concept of pedon and polypedon, out of these ones, came into general use. This elementary (basic) unit serves as reference entity (generalized) for the system of soil taxonomy on one hand, and on the other hand it is an elementary compound of different soil associations or soilscapes. Therefore, it has a double role, that of elementary reference entity in the soil classification as abstract notion and that of elementary component entity in different soilscapes as concrete body; however, its name is the same, according to the system of soil taxonomy.

3. THE NEED FOR PARTICULARIZING THE SOIL TAXONOMIC UNIT WITH PECULIAR FEATURES

The name for the soil entities (belonging to any taxonomic units irrespective of the adopted taxonomic system of soils) shows only the characteristics of the respective soil unit from a genetic point of view at a generalized level ("taxonomic identity"). But these soil entities, alongside their essential properties specific to each taxonomic unit, have also some features induced by some particularities of the environment conditions existing in the area occupied by the respective soils and by the specific historico-geographic evolution of the respective area ("geographic identity"). These features also influence the range of native of cultivated plants and therefore the land use, with consequence of practical avail. For this reason a soil systematization, denomination and characterization is necessary and useful, not only from genetico-taxonomic point of view, but also from a geographic features point o view at a regional and local level.

With the purpose of removing this drawback, Florea (2009a) proposed the completion of the soil taxonomic units by distinguishing some areas and features of regional and local significance, under the form of some entities of soil having characteristics determined by these regional or local conditions. This new proposed entity was named geographic soil facies or simply *soil facies*, denomination used in the past with a close meaning; the term is justified because it refers to an apart physiognomy of the respective soil due to some certain geographic and historico-evolutive conditions. This entity (soil facies) is added to the taxonomic entity, which thus become a peculiar taxonomic soil unit (Fig. 3) that is genetic and geographic, while the former unit is only general taxonomic soil unit (only genetic).

By this joining of soil taxonomic unit with geographic facies the question of the double nature of the soil unit (genetic and geographic) was solved in a way.

It must be mentioned that in the *Europe Soil Map* (1:1,000,000) the soil units were grouped on the map in great areas with specific climatic conditions considered soil regions (in total 176 regions resulting from the combination of 79 various soil associations and 14 types of parent materials); these areas are indeed climatic facies of soils, that represent a particularization of the soil entities.

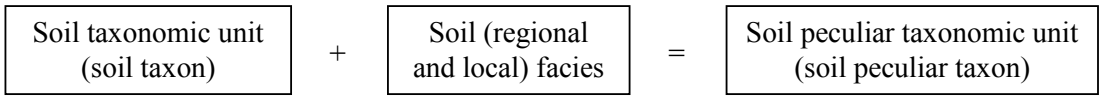

Fig. 3 – The scheme of the particularization of soil taxons by adding soil facies.

The name of genetico-taxonomic units or of soilscape units can be geographically specified by adding the name of the regional geographic facies applied to all soil taxons or landscape units of that region, and by adding the name of local facies applied to the peculiar characteristics mentioned.

Examples for the territory of Romania:

– Feteşti fine loam, Danubian, Calcaric-calcic Chernozem;
– Însurăţei sandy loam, Danubian, Haplic Chernozem;
– Şemlac fine loam; Pannonic, Calcaric-gleyic Chernozem;
– Făgăraş skeletal loamy sand; Carpathian, Leptic-entic Podzol;
– Sighişoara clay loam; Transylvanian, Albic-stagnic Luvisol.

4. SOIL FACIES

The soil facies – as soil "geographic identity" – represents a restricted collection of soils, very similar, characterized by some specific peculiarities linked both by regional bioclimatic conditions of actual soil dynamics and by apart properties of parent material or from soil evolution in the regional or local territorial circumstances. They are distinguished by narrow ranges of variation of the soil diagnostic characteristics specific to the taxon of which they belong to or/and by some proper features determined by the regional or local conditions. It presents, of course, a high homogeneity and a distinctive behaviour.

The concept of soil (geographic) facies embraces two aspects. One of them refers to the peculiarities and differentiating characteristics of the soil of general (spatial) order, named regional soil facies, and the other aspect refers to the discriminating characteristics of detail linked with some conditions for small areas, named local soil facies.

Therefore, the soil facies is a group of soil entities belonging to the same taxonomic unit having common characteristics which distinguish from other groups of the same taxonoimc unit through certain specific and distinctive features. In a way, the soil facies corresponds to the notion of race or breed from biology.

The *regional soil facies* represents the soil facies defined by characteristics determined or resulted under the influence of some specific environmental conditions that acted and act on large areas. The term is analogous with the term of bioclimatic facies, but the term of regional soil facies also takes into account features correlated with geological and lithological conditions, as well as the paleogeographic evolution of the territory.

The different units of regional soil facies and corresponding terms can be thought at three level of detail, at world and continental level, at great regions level and at province (county) level. The terminology at each level of different soil facies can be independent (not as subdivisions). At world level, for example, only the climatic regional differences can be used, like in the case of Europe Soil Map, 1:1,000,000.

The *local soil facies* represents the soil subdivision, defined in the framework of regional soil facies, being distinguished by peculiarities of detail marked by finesse differences concerning diagnostic characteristics used for the respective upper category delimitation or other soil properties unused for diagnosis. The most used criteria are: soil texture and its variation on profile, parent material origin, mineralogico-chemical characteristics, salt content and nature, organic matter content, soil reaction, ionic exchange capacity and others. The general class of soil texture is included, generally, in the name of the soil facies for more comprehensive information about the respective soil.

The name of the lowest soil unit – corresponding to the local soil facies – respectively of the lowest soil peculiar taxon is made of the name of the soil taxonomic unit to which the names of the regional and local facies are added (Fig. 3). Some examples are presented above. Generally, the name for the soil regional facies is a geographic term that suggests the specific characteristics of the respective large area, and the name of the local soil facies is also a geographic term for a point, forest, city, river, etc to which the textural class is added (as in the example: Făgăraş skeletal loamy sand, Carpathian, Leptic-Entic Podzol).

The soil taxonomic unit subdivided by adding soil facies is the most detailed entity, the nearest to the concrete soil body. A particularization of the soil entity is realized in such a way, emphasizing the regional and local imprint.

The introduction in use of the soil facies (geographic identity) completes the current soil taxa (genetico-taxonomic identity), approaching the soil entities from the real soil world and answering more adequately to the different problems of land use, agriculture, land improvement and environment protection, etc.

The system of the soil facies entities, the criteria of differentiation and the nomenclature of the delineated units could be discussed and agreed in the near future.

The soil series of the American Taxonomy seems to be equivalent in a way to the soil local facies. In this system of soil taxonomy one feels the lack of the regional soil facies that could do a good welding between the high level taxa and the soil series (in whose definition the regional differences are included).

5. THE INDIVIDUALIZATION OF EACH SOIL AREA

The richest information on soils can be obtained by a complete characterization of each soil area from the territory, represented on the soil map by a polygon (monotypic or polytypic). Each soil profile and soil unit, and each individual component of the unit of soil association represented on the map has to be described, characterized and evaluated from different points of view, with all their features (topographical, geographic, geometric, morphological, physical, chemical, quality, pretability for different uses, suitability for different plants, degradation risks, protection measures, etc.).

Each area (polygon) should receive a number and a code for identification and should be correlated with the system of the cadastral survey of the country. Of course, all information on soil units and soil profiles will be included in a database correlated with the Geographic Information System (GIS).

6. CONCLUSIONS

From soil definition and models of soil formation the double aspect of the soil entity (genetic and geographic) results. The soil taxonomy reflects only the genetic aspect, while the geographic aspect is reverberated by territorial soil distribution. The same soil corresponding to a certain category of the soil classification (taxon) can be distributed in different regions and can have in these regions

some special features connected with the particularities of the respective regions, features that are not marked by the taxonomic system.

In order to remove this drawback, the completion of the soil taxonomy was proposed, by adding special aspects, named *regional and local soil facies*, reflecting the soil features of geographic regional and respectively local significance. The moisture regime and the temperature regime of the soil can be included in such a way as a criteria of soil systematization (lacking in the European taxonomy).

By this joining of soil taxonomic unit (soil genetic identity) with the soil geographic facies (soil geographic identity), the question of the double (genetic and geographic) nature of the soil unit is solved in a way. The name of the soil would be completed in such a way: Făgăraş skeletal loamy sand, Carpathian, Leptic-Entic Podzol.

The American soil series seems to be – in a way – equivalent in soil local facies.

The system of the soil facies entities, the criteria of differentiation and the nomenclature of the delineated units could be discussed and agreed in the near future.

The particularization of soil entities by using soil facies can be carried on to the individualization and description of each soil area in the framework of an information system and database, correlated with the cadastral survey.

REFERENCES

Arnold, R.W. (1965), *Multiple working hypothesis in soil genesis*, Soil Sc. Soc. Am. Proc., **29**, pp. 717–724.

Arnold, R.W. (1983), *Concept of soil and pedology*, in: "Development in soil science", vol. **11 A**, Elsevier, Amsterdam, pp. 1–21.

Arnold, R.W., Szabolcz, I., Targulian, V.O. (1990), *Global soil change*, **II** ASA Laxenberg, Austria, 110 p.

Bunting, T. B. (1965), *The Geography of Soils*, London.

Buol, S.W. (1992), *Pedogenetic geomorphic concept for modelling*, in "Proc. First Soil Gen. Mod. Conf., USDA-SCS, Nat. Soil Survey Center, Lincoln, NE, 11–13.

Buol, S.W., Hole, F.D., McCraken, R.J. (1980), *Soil Genesis and Classification*, ed II, The Iowa State Univ. Press, Ames.

Butler, E.E. (1959), *Periodic phenomena in landscape as a basis for soil studies*, Austral. CSIRO Soil Publ., **14**, pp. 1–20.

Cârstea St. (2009), *Conceptul "seria de soluri", pivotul cheie în sistemul Taxonomia Solurilor în SUA*, Ştiinţa Solului, **XLIII**, *1*, pp. 116–133.

Cernescu, N.C. (1929), *Studiul analitic al podzolului de la Sighişoara*, XIVth Int. Congr. Agr., Bucharest.

Cernescu, N., Cârstea, D., Mavrocordat, Georgeta, Orleanu, C., Cucută, Al. (1961), *Condiţiile naturale şi solurile din ţinutul Secaşelor*, în vol. „Cercetări de pedologie".

Chiriţescu-Arva, M. (1925), *Morfologia şi tehnologia pământului*, Cluj, Inst. de Arte Grafice, Edit. „Cartea Românească".

Dijkerman, J.C. (1974), *Pedology as a science: the role of data, models and theories in the study of the natural soil systems*, Geoderma, **11**, Amsterdam.

Dokuchaev, V. V. (1883), *Russkii Chernozem*, (Russian Chernozems), Petersburg.

Erhart, E. (1956), *La genèse des sols en tant que phénomène géologique*, Masson, Paris.

Florea, N. (1983), *Unele consideraţii asupra conceptului de sol*, Ştiinţa Solului, nr. **4**, pp. 3–14.

Florea, N. (1985), *Conceptul de evoluţie a solului şi învelişului de sol*, Ştiinţa Solului, nr. **1**, pp. 10–31.

Florea, N. (1996), *The annual pedorhythms – The essential link in the process of soil formation and evolution*, R.R. Géogr., tome **40**, Edit. Acad. Rom., Bucureşti, pp. 103–111.

Florea, N., Munteanu I. (2003), *Sistemul Român de Taxonomie a Solurilor*, Edit. Estfalia, Bucureşti, 182 p.

Florea, N. (2008), *Scrierile lui Constantin Gregorian despre solurile agricole în România în perioada "agrogeologică" a ştiinţei solului*, Ştiinţa Solului, **XLII**, *2*, pp. 105–111.

Florea, N. (2009a), *Faciesul de sol, subdiviziune pedogeografică regională*, Ştiinţa Solului, **XLIII**, *1*, pp. 14–22.

Florea, N. (2009b), *Pedodiversitate şi pedociclicitate*, Bucureşti, 280 p.

Florea, N., Niţu, I., Bratosin, Niculina (1964), *Karasulucurile*, Com. Geol. Rom., St. tehn. econ., seria **C**, nr. *14*, Bucureşti, pp. 39–65.

Florea, N., Munteanu, I., Rapaport, Cornelia, Chiţu, C., Opriş, M. (1968), *Geografia solurilor României*, Edit. Ştiinţifică, Bucureşti.

Fridland, V.M. (1972), *Struktura pocivenovo pokrova*, Izd. "Mîsli", Moscova, 424 p.

Gregorian, C. (1896), *Clasificarea naturală a terenurilor agricole*, Jurn. Soc. Centr. Agr., Bucureşti.

Hoosbeck, M.R. (1994), *Pedodynamics: An approach to study and quantify soil forming processes*, Transactions, 15th World Congr. Soil Science, Acapulco, Mexico, vol. **6A**, pp. 164–178.

Huggett, R.J. (1975), *Soil landscape systems: a model of soil genesis*, Geoderma, **13**, pp. 1–22.
Ionescu-Şişeşti, Gh. (1947), *Agrotehnica*, Edit. Cartea Românească, ed. a II-a.
Ionescu-Şişeşti, Gh., Coculescu, Gr. (1939), *Principalele tipuri de sol din România*, Metode nr. **47**, Inst. Cerc. Agr. Rom., Edit. Imprim. Naţ., Bucureşti.
Jenny, H. (1941), *Factors of soil formation*, McGraw-Hill Book Company Inc., New York and London, 281 p.
Johnson, D.I., Watson-Stegner, D. (1987), *Evolutional model of pedogenesis*, Soil Science, **143**, *5*.
Kovda, V.A, Rozanov, B.G. (1988), *Pocivovedenie*, vol. **I** and **II**, Edit. Vâsşaia Şcola, Moskva, 368 pp, 400 p.
Monnier, G. (1966), *Le concept de sol et son evolution*, Science du sol **1**, Versailles.
Munteanu, I. (2002), *Geofluctuations and pedofluctuations*, in Proceedings Intern. Conf. "Soils Under Global Changes", Constanţa, România, 3–6 Sept. 2002, vol. **I**, pp. 233–240.
Munteanu, I. (2008), *Determinism and causality in soil genesis*, Ştiinţa Solului **XLII**, *1*, Bucureşti, pp. 94–107.
Munteanu, I., Coteţ, Valentin (2009), *Despre identitatea solului*, Lucr. XIX Conf. Naţ. de Ştiinţa Solului (Iaşi, 2009), Public. SNRSS.
Murgoci, G.M. (1911), *Zonele naturale de soluri din România*, An. Inst. Geol. Rom., **IV** (1910), pp. 1–21, Bucureşti.
Murgoci, G. (1924), *Considerations concerning the classification and nomenclature of soils*, Comité Intern. de Pédologie, IV-e Comm. Nr. **18**, Helsingfors.
Popovăţ, M. (1953a), *Cercetări pedologice în regiunea Cetatea-Bâcleş-Argetoaia-Terpeziţa (jud. Dolj-Mehedinţi)*, D.S. Com. Geol., vol. **XXXVII** (1949–1950).
Popovăţ, M. (1953b), *Sedimentele şi solurile din Oltenia Apuseană*, D.d.S. Inst. Geol., **XXXVII**, Bucureşti, pp. 169–174.
Rode, A.A. (1955), *Pochivovedenie*, Goslesbumizdat, Moskva – Leningrad.
Runge, E.C.A. (1973), *Soil development sequences and energy models*, Soil Sc., **115**, pp. 183–193.
Shelling, J. (1970), *Soil genesis, soil classification and soil survey,* Geoderma, Amsterdam, pp. 165–193.
Schlichting, E. (1986), *Diagnostic Properties, Horizons, Soils and Landscapes*, Zeitschrift für Pflanzenernährung und Bodenkunde, Band **149**, Heft *4*, pp. 412–499.
Simonson, R.W. (1959), *Outline of a generalized theory of Soil Genesis*, Soil Sc. Soc. Amer. Proc., **23**, pp. 152–156.
Simonson, R.W. (1978), *A multiple process model of soil genesis*, "Quaternary Soils", edited by W.C. Mahoney.
Simonson, R.W. (1997), *Evolution of soil series and type concept in the United States*, in vol. Advanced in Geoecology, **29**, pp. 79–108, Catena Verlag, Reiskirchen, Germany.
Smeck, E.N., Runge, E.C.A., Mackintosh, E.E. (1983), *Dynamics and Genetic Modelling of Soil Systems*, Pedogenesis and Taxonomy I, Development in Soil Science, vol. **11A**, Elsevier, Amsterdam, pp. 51–81.
Smith, G. (1983), *Historical development of Soil Taxonomy – Background*, in Development in Soil Science, vol. **11A**, Elsevier, Amsterdam, pp. 23–49.
Soil Survey Division Staff (1993), *Soil Survey Manual*, USDA, Washington DC, 437 p.
Soil Survey Staff (1975), *Soil Taxonomy*, USDA Dept. of Agric., Handbook **436**, Washington DC, 754 p.
Yaalon, D.H. (1971), *Soil forming processes in time and spaces*, Paleopedology (ed. Dan H. Yaalon), Israel University Press, Jerusalem, pp. 29–39.
Yaalon, D.H. (1983), *Climate, time and soil development*, Pedogenesis and Soil Taxonomy I, Developments in Soil Science, **11A**, Elsevier, Amsterdam.
*** (1970–1971), *Harta pedologică a României la scara 1:500,000, 1970–1971*, Inst. Geol., Bucureşti.

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