

STRUCTURAL - FUNCTIONAL LEVELS OF SOIL SYSTEM INTEGRATION, PROCESSES AND EVALUATION INDICES

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Keywords: *system, soil, hierarchical subsystem, hierarchical levels, structural-functional organization*

Abstract

Pedogenesis process implies the formation of one complex system within which distinguish more several hierarchical subsystems. The last corresponds to certain structural – functional organizational levels: ionic-molecular level ↔ elementary particle ↔ aggregate ↔ horizon ↔ pedon. Due to this fact, both the soil constitution process as well its functioning implies hierarchical correlated processes, that ensure the self - regulation, self-managing and self - reproduction.

INTRODUCTION

According to I.P. Ghermanov, the pedogenesis process is the interaction of three elementary groups of processes: a) decomposition - transformation and synthesis of mineral compounds; b) decomposition - transformation and synthesis of organic substances; c) migration and accumulation of the mineral and organic substances (Gherasimov, 1973,1975). Later, this aspects were developed in the scientific works of [5, 6, 7, 3, 1]. Within specified research, the elementary pedogenetic processes were systematized depending by pedogenetic effects, mechanisms, interactions etc. (Figure 1). A simple analisys of pedogenetic elementary processes suggests that these are characteristic also for other physical bodies (sludges, river deposits, etc.), their role consists in involving inside the parental layer some new traits. In the same time, these don't show the formation mechanisms of soil system, wich differs from other biorutinar systems by the distinct structural - functional organization.

MATERIAL AND METHODS

Starting from this, Gh. Jigău proposed the grouping of the elementary pedogenetic processes depending on the implication in the structural-functional organization of the soil: **a)** structural-accumulative; **b)** structural-organizational and **c)** structural-morphogenetic (Gh. Jigău 2009). The time sequence and the group interaction of mentioned processes, lead to soil constitution in one organized form wich involve both the certain arrangement of primary and secondary particle, as

well as the space between these, and one certain differential vertical distribution in characteristic successive layers. Specially this arrangement of particle and sequence of layers defines or characterize the soil itself or the pedon as natural body with special organization and morphology, features and qualities determined by both the mentioned constituents which are in interaction and interconditioned as well their vertical distribution. All this ensemble integrates into the soil system which is one structural-functional unit [1].

RESULTS AND DISCUSSION

The structural/functional integration and organization implies hierarchization of entire process of soil formation in succession on subsystems with different levels of organization more complex. Each level of organization has its own relationships and specific rules (Table 1, Figure 2).

Because of the structural/functional organization, the soil systems has integral, historical, informational and antientropic character, as also capacity for self-conservation, self-regeneration, self-regulation and self-development from simple to complex forms of organization. The antientropic character give them stability in the relation with the other systems from the environment.

Hierarchy of the structural-functional integration processes of the soil system and their evaluation indices are presented in the table 2. In this context, we can consider that the pedogenesis, respectively, soil system formation and quality indices formation is the structural-functional integration of the pedogenetic effects achieved on various operating levels as follows: ionic-molecular level \rightarrow elementary particle \leftarrow aggregate \leftarrow horizon \leftarrow pedon.

CONCLUSIONS

1. Pedogenesis implies the formation of one complex system within which distinguish more several hierarchical subsystems. The last corresponds to certain structural-functional organizational levels: ionic-molecular level \leftrightarrow elementary particle \leftrightarrow aggregate \leftrightarrow horizon \leftrightarrow pedon.
2. Due to this fact, both the soil constitution process as well its functioning implies hierarchical correlated processes, that ensure the self-regulation, self-managing and self-reproduction.

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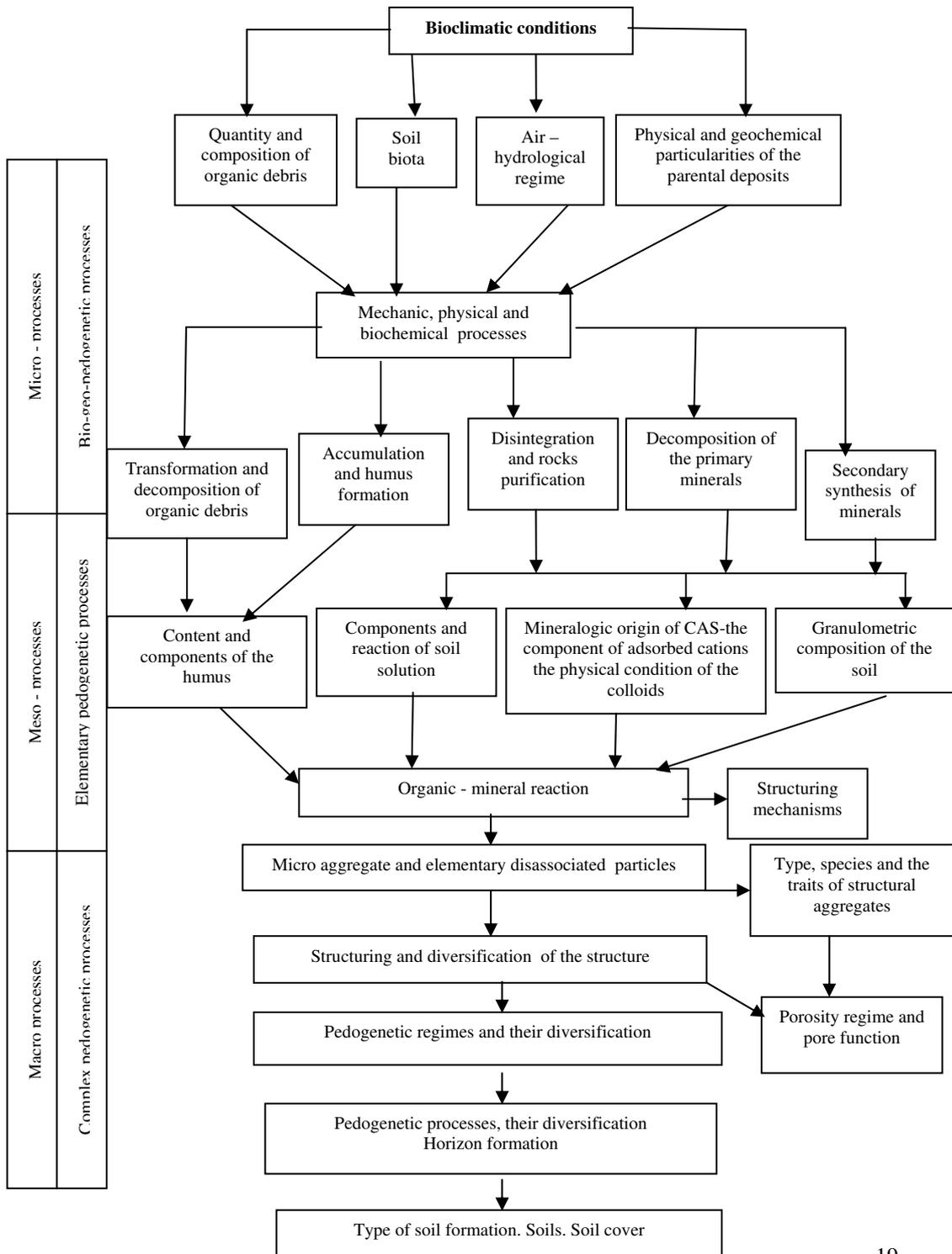


Fig. 1. Hierarchy and interaction of the elementary soil formation processes and pedogenetic elementary processes

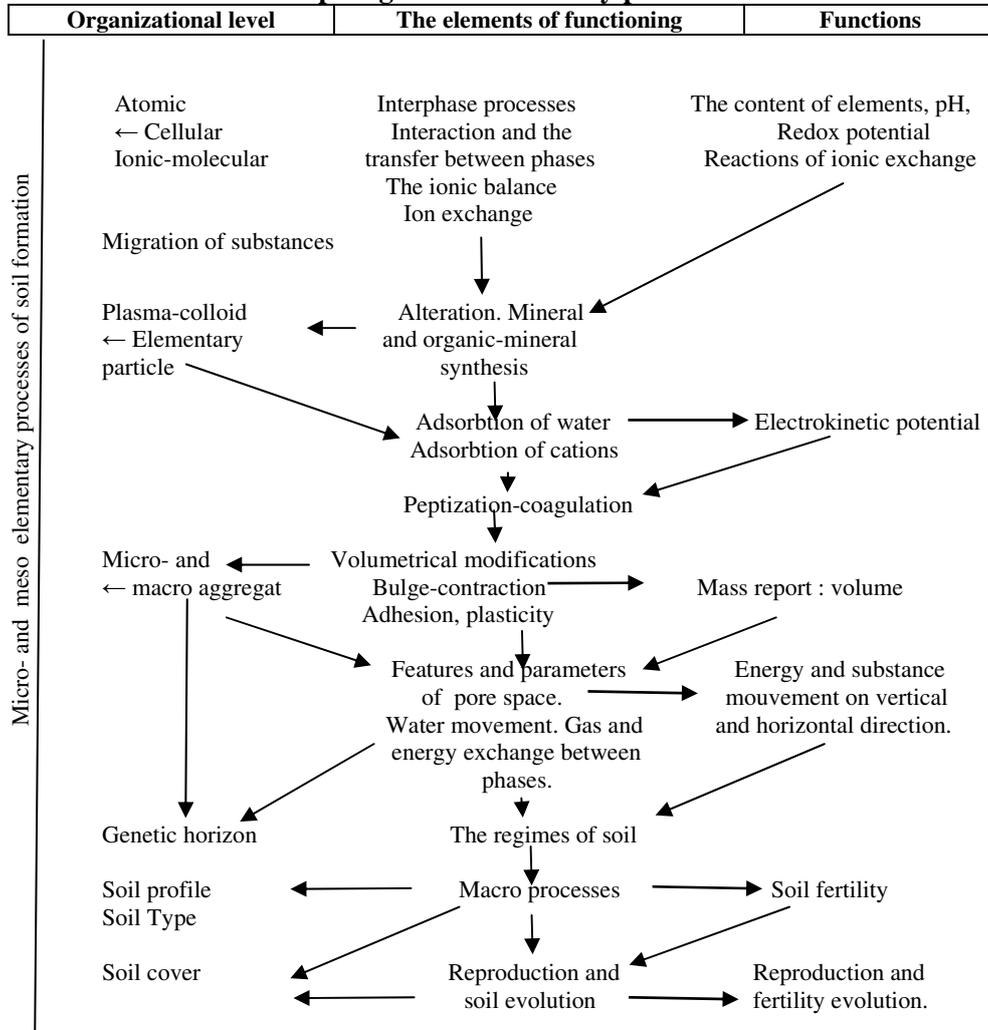


Fig. 2. Elements of functioning and pedon formation

Table 1

Structural - organizational levels of the soils and their main traits

Structural level	Structural elements	The particle size, mm	Specific processes	Specific changes and other features	Soil traits determined by the level
Atomic Ionic-molecular	Ions, stable radicals, mineral matrix (oxides, hydroxides, salts, carbonates, gypsum, aluminosilicates), organic matrix (protein, polysaccharides, nucleic acids, humic acids, fulvic acids)	$10^7 - 10^4$	Chemical reactions	Formation of new chemical and mineral compounds	Physical-chemical, physical, permeability, pH, filtration, cationic exchange capacity, degree of substance mobility, of water mobility, mechanic, rheologic
Plasmatic - colloidal Elementary particle	Mineral matrix, humic - mineral, ferment - mineral, micro organism - mineral matrix, ultra mineral aggregate matrix	$10^4 - 10^3$	Surface reactions (sorption and desorption) Participation to physical-chemical equilibrium establishment	The ion and molecules exchange between solid and fluid phase. Is influenced the ionic dynamic and its circuit between soil and plant	Hydro-physical, thermo-physical
Micro aggregate	The organic - mineral matrix	$10^3 - 0.5$	Water retention	Storage, water conservation and its circuit in the soil and between soil and plant	Thermo physical, the degree of water mobility and water accessibility
Aggregate	Micro aggregate, cutanes, manganese	0.5 - 2.0	Water retention inside aggregate, concomitant with air existence between aggregates Water and air permeability insurance. Activities combination of the aerobic and anaerobic micro-organisms (inside the aggregates)	Water and gas exchange between soil aggregates and gaps. Water adsorption (with nutrients) by the plants roots from aggregates. Capillary and gravity forces	Water and air permeability, hydraulic conductivity. Substances migration. Aeration porosity
Horizon	Morphon, neoformations, inclusions	-	Reversible and irreversible reaction, segregation processes. Humus, nutrients, water, air and salts accumulation, by additions, transformations, migrations. Diffusion processes and local transport	Exchange of different compounds between horizons Morphologic characteristics and specific properties formation, including the neoformations	Morphologic traits. Geochemical barriers
Profile	Horizons	-	Translocations and accumulations in the soil (predominantly on vertical direction) Humus, nutrients and water reserves formation etc. The dynamics of temperature (regimes), water, nutrients and salts content	Substance, energy and information exchange between soil and environment. Biogeochemical cycles of the chemical elements Hydrologic cycles (wetting -drying) Flows of solutions: washing, accumulation	Ecosystems stability. Agroecosystems stability

**For the table elaboration were used the scientific works of N. Florea (2005) and T. Zubcova, L. Carpavecchi (2001)*

Table 2

Structural - functional integration processes of the soil material (pedomaterial) and indices of evaluation

Level of integration	Integration processes	Indices of evaluation
Atomar Celular Ionic – molecular	Biochemical reactions (anabolism, catabolism) Pedogeochemical reactions (synthesis – decomposition, acidification – alkalization, oxidation – reduction, adsorption – desorption, solubilization – precipitation)	Reaction (pH) Adsorption capacity (cationic exchange capacity) Redox potential Transformation capacity Alkaliresistance
Plasmocolloidal Elementary particle	Processes and transformation reactions (alteration, mineral synthesis, decomposition, humification, clay formation, montmorillonitization, illization, salinization)	Garasovič indices $K_1 = \text{SiO}_2 : \text{Al}_2\text{O}_3$ $b_{a1} = \text{K}_2\text{O} + \text{Na}_2\text{O} + \text{CaO} + \text{MgO} : \text{Al}_2\text{O}_3$ $b_{a2} = \text{CaO} + \text{MgO} : \text{Al}_2\text{O}_3$ Deflocculant clay content in water Coagulated clay content Specific area Degree of dispersion The enriched index of organic matter The clay formation coefficient
Microaggregate Aggregate	Coagulation Association Agglutination Compression Compaction	Dispersion factor Structure factor Aggregation index Granulometric structuring index Aggregational density Aggregational porosity Hydrostability The specific aggregate area Average diameter weighted Structure crushing degree
Horizon	Spatial distribution	Total porosity Differential porosity Apparent density Density of solid phase Cohesion
Profile	Pedogenetical differentiation	Organic profile Profile of carbonates Profile of salts Hydrofizica profile Pedoaggregational profile