AGROECOLOGY

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RELIEF AND DENSE ROCK IN THE PROCESS OF WEATHERING AND SOIL FORMATION OF SKELETAL SOILS

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Summarized monographic works on skeletal soils and soil-forming rocks are not presented in scientific studies within CIS, though diverse, partly fragmentary information about it, permitted to collect key investigations on genesis, weathering and redeposition of soil-forming rocks depending on geological materials and relief as it is.

Concerning factors of soil formation, geological materials and relief, denudation processes are of great importance for weathering and soil formation, earth moving and mixing, formation of skeletal soil composition, properties and fertility. The following authors researched this topic at different times: V.V. Dokuchayev [14], K.D. Glynka [12], S.S. Neustruyev [24], I.N. Antipov-Karatayev, L.I. Prasolov [1], S.A. Zakharov [16], V.R. Viljams [8], N.M. Sibirtsev [31], V.M. Fridland [36, 37], B.B. Polynov [28], M.A. Kochkin [22], N.N. Dzens-Litovskaya [13], E.M. Samoilova [30], A.I. Romashkevich [29]. They noticed processes of residual soils formation (fragmental, calcareous, sialite), which depend upon zonal and phased regularities, are not only a unit of geological cycle of matter, but they play a considerable role in soil formation, as well as rock transformation isn`t cyclic, but directed. Just this transformation of mineral compounds is basical in develppment of skeletal soils (stony, rubbly, pebble).

While researching primary soils on rocks of the Crimea, Caucasus, Tien Shan and Urals a huge geological, geochemical and soil forming role of microorganisms and lithophilous vegetation was emphasized; processes of mechanical disintegration and biochemical transformation of primary minerals and synthesis of secondary ones, including clay minerals and biolith were revealed as well; a special attention was paid to the level of mineral-resistance, their composition and proportion in fine earth of primary soils. Quite important achievement was determination of biological uptake lines and a leaching degree of ash constituents. Special enriching of colloidal and precolloidal soil layers by vadose minerals, organic and mineral compounds and products of humification and mineralization of lithophilous vegetation was also noted. Microorganisms and lithophilous vegetation were proved to be direct denudation agents, they process huge mass of rocks into a fertile fine earth and create favorable conditions for more highly-developed vegetative formations [2, 11, 17, 22, 26, 35].

In low-efficient residual and transit weathering crusts on surfaces which are in constant renewal process, soil profile of skeletal soils occupies horizons of unstable weathering crust completely or to a large degree. That`s why soil formation is closely connected with weathering in space and time. Thereupon it`s necessary to emphasize methodological works of S.A. Zakharov [16, 17], K.P. Bogatiryov [3], B.B. Polynov [28], V.O. Targuljan [35], M.A. Kochkin [22], V.M. Fridland [37], I.A. Sokolov, B.P. Gradusov [34], A.I. Romashkevich [29]. Weathering is scientifically considered as a process of parent rocks emergence (ortho- and paraeluvium), favoring soil formation and as a process of soil

profile formation. In the course of investigation the following points were noted: soil formation is an integral part of eluvium and non-eluvial weathering crust in its secondary occurrence as a result of alluvial, dealluvial, proluvial drift of eluvial rock strata, soil formation and exogenesis of former times prepared material for soils we have at present.

Soil scientists [9, 12, 14, 16, 22, 24, 28, 31, 36, 37] enunciated key points on the following items: leading role of dense rock chemical composition (its direction and rate of weathering and soil formation); connection of dense rocks and soils: substance composition and properties of dense rocks have the full activity on the initial stages of skeletal soil development, then as far as chemical composition of parent rocks changes, dense rock effect decreases, soils become zonal; at the same time rocks mainly containing calcium carbonate or silicic acid influence on generated soils as well, causing disorder of soil zoning; free carbonates, sulphates, chlorides slow down weathering of primary minerals according to the law of mass action; acid environment stimulates process of weathering, but neutral and alkaline conditions slow down it; the main processes of chemical weathering of carbonate soils are dissolution and carry-over of carbonates out of rocks and deposition of insoluble residue (SiO_2, R_2O_3); products of weathering of various rocks, which runs under the same conditions are much more resembling than initial rocks (the convergence rule as a result of zonal weathering peculiarity); having equal soil formers different rocks can create soils of the same type; different soil formers on the same rocks contributes to formation of various soils.

During rock weathering carry-over and activization of bases and sesquioxides slow down process of podzolization and regulate humid acids content, create infiltration geochemical barriers in the form of coherent layers or crusts under subvertical motion of carbonate and magnesium solutions, reduces to occurrence of magnesium malts, carbonate or solonetzic soils [3, 9, 19, 20, 25, 27, 34].

A certain effect of the dense rocks on weathering and soil formation depends upon climatic conditions. In humid zones weathering rate and as a result occurrence in the soil solution of R_2O и R_2O_3 is much higher, what grounds soil formation with undifferentiated profile on either calcareous or basic rocks. On acid rocks podzolic process is much more clearly marked. Concerning arid zones, where aridity slows down weathering, rock effect on soil formation is feebly marked therefore it`s not determinant. For instance, chernozem on carbonate skeletal sialite rocks is close to chernozem on carbonate loess-like loamy soils. In the former case mountain soil forming rocks are characterized by a high taxonomic value (type, subtype), as in geochemical terms processes of subsurface weathering conflict with processes in flushing soils. In the second case, on non-flushing soils where that conflict is not so substantial, dense soil forming rocks are considered as genus, type, variety or lithologic series [4, 9, 12, 16, 19, 33, 36].

Argillization is particularly important in subsurface weathering in skeletal soils which contain a great deal of primary minerals. It`s one of the key processes in formation of textural horizons of brown forest soils, chernozems, brown and other soils [3-5, 10, 13, 17, 19, 22, 23, 36, 37].

Weathering rate of rocks also depends upon proportion in rocks of different by weathering-resistance level principal soil forming minerals. Predominance of quite resistant minerals (quartz, rutile, tourmaline) favor accumulation of inert soil layer, which doesn`t take part in biological cycle of matters, moves without marked chemical changes in geological cycle as well. Therefore inert soil layer influences only on potential fertility of skeletal soils causing their hydro-physical properties. Predominance in rocks of unresistant to weathering olivine, augite, carbonate and alkaline plagioclases, hornblende plays much more considerable role in soil formation than predominance of more resistant biotites, potash feldspars. But in both cases components of active (soil solutions, absorbed cations) and surface-active part of soil (clay minerals, hydrogen oxides) occurred due to weathering,

participate in chemical, physicochemical and biochemical processes, conditioning efficient and potential fertility of skeletal soils.

Among geomorphological processes, which considerably effect on soil formation, scientists [7, 15, 16, 22, 29] emphasize denudation of watersheds, that leads to constant descending "rejuvenation" of skeletal soils having simultaneous soil formation processes in the weathering crust. Resultant of such syndenudation soil formation is determined by rate of weathering and soil formation processes and strength of denudation phenomena. If the latter factor intensifies, effect of debris on soil formation processes increases on eluvial depositions downward, but on dealluvial – from the surface, as in this case mainly fine earth moves, skeletal fractions gradually come to the surface and form rubbly armor which is capable to resist to weathering for a long time due to aridity and lack of plant roots.

To realize polygenetic holocene and pleistocene-pliocene skeletal soils and paleosoils on alluvial and alluvial-proluvium depositions of river valleys, synclines, on piedmont cones it`s necessary to registrate simultaneous processes of sedimentogenesis (subaqueous and subaerial), diagenesis and soil formation [6, 18, 32, 33]. Hydrogenetic (fluvial) and eolian accumulation of fine earth, skeletal fractions, true and colloidal solutions in river valleys, on piedmont plains, depressions causes ascending "rejuvenation" of ground profile; at the same time transit motions of moisture and metabolic by-product using side interflow are able not only to activate soil formation processes, but result overwetting and soil gleization, alkalinization and salinization in case of poor drainage [3, 16, 20, 22, 28].

Objective factors of chemical weathering of rocks are availability or lack of calcium carbonate, calcium sulfate, easily soluble soils, secondary minerals, degree of desilication or resilication (SiO_2/Al_2O_3), allitic (SiO_2/R_2O_3) in fine earth; factors of physical weathering are content of fine earth and skeletal fractions, physical clay and silt in fine earth [21, 28].

In conclusion it`s necessary to note, that leading factors of investigation might be the followings: history of area soil cover is a history of rock transformation into soils, that`s why total genetic characteristic of skeletal soil is impossible without its origin, parent rock properties and composition fine earth and skeletal layers of which tag rate and direction of soil formation process, morphological appearance, hydro-physical properties, granulometric and chemical mineralogical composition and fertility of skeletal soils in general, besides determine their systematic division on various taxonomical levels.

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The article presents summarized fundamental investigations of scientists in the field of genesis, weathering and redeposition of soil-forming rocks depending on rocks, relief, denudation phenomena. The work demonstrates that process of residual soils formation, depending on zonal and phased regularities, is not only a unit of geological cycle of matters, but it plays a considerable role in soil formation and development of skeletal soils.

Key words: s*keletal soils, geological materials and soil-forming rocks, relief, soil formation.*