ISSN 2229-5518

Some Peculiarities of Soil Geography and Genesis of Mountain-Forest Zone (on the example of Ajara Region, Georgia)

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Abstract— Soil formation factors of interior mountainous Ajara has been studied in the field research. It has been established that there are some cases when the law of vertical zone of soil geographical distribution is completely violated and soils form series according to the type of distribution. Deep chemical transformation processes (in the fields of alite-sahlite and feralitization-rubification) are locally visible on the south and south-east part of interior Ajara in Shavsheti-Arsiani and Ajara-Guria mountains and through the influence of intrazonal distribution red color soil is formed where Cambisols Chromic soil formation takes place in case of genesis.

Index Terms— Ajara, Alite exhaustion, Feralitization, Geography, Red color soil, soil genesis, zonality.

1 Introduction

The natural-historical body – soil represents one of the important subsystems of Biosphere. Soil formation is extremely difficult process. Vasily Dokuchaev who is the founder of soil science proved that as a result of combining soil forming factors with each other in time and space taxon soils are formed. Accordingly, certain characteristics of geographical distribution are peculiar to them [1], [2], [3], [4], [5], [6].

In our modern world relationship between humans and nature has been strengthened. Therefore, rational use of soil resources has become an extremely acute issue throughout the world. The same problem exists in mountainous countries including Georgia [7], [8], [9], [10], [11], [12], [13].

2 Procedure for Paper Submission

The aim of our research is to investigate different characteristics of genesis and geographical distribution of soil in the interior mountainous Ajara, we opted to use field research method which is scientifically approved method and studied soil profile in order to evaluate the characteristics of soil morphology and genesis [7], [14], [15], [16].

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Despite its small territory (2900 km^2), Ajara is well-known for its diversity of nature [17], [18] neighborhood with the Back Sea, alteration of lowlands, valleys and mountains, all this factors condition the diversity of nature. In Ajara, soil forming rocks are andesite or basaltic andesite alluviums with strong magmatic intrusive cracks and mostly the combination of exhaustion mechanisms is characteristic to their transformation and translocation which takes place in different directions and determines soil taxon formation [19].

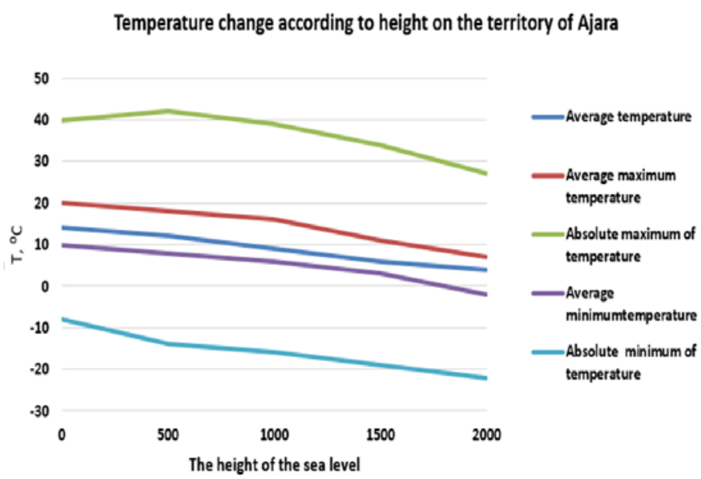
On the east, Ajara is surrounded by Arsiani Mountains, on the north by Ajara-Guria Mountains and on the south by Shavsheti Mountains which are of medium and low height, extremely featured because of wrinkling processes, mostly having more than 150 inclinations with the slope of different exposition [18], [20].

Climate is subtropical and extrahumid in the lowland of Ajara (table №1), the average annual rainfall is 2200-2500 mm, maximum rainfall is in spring and autumn, the average temperature in summer and autumn is +21+22^{0}C.

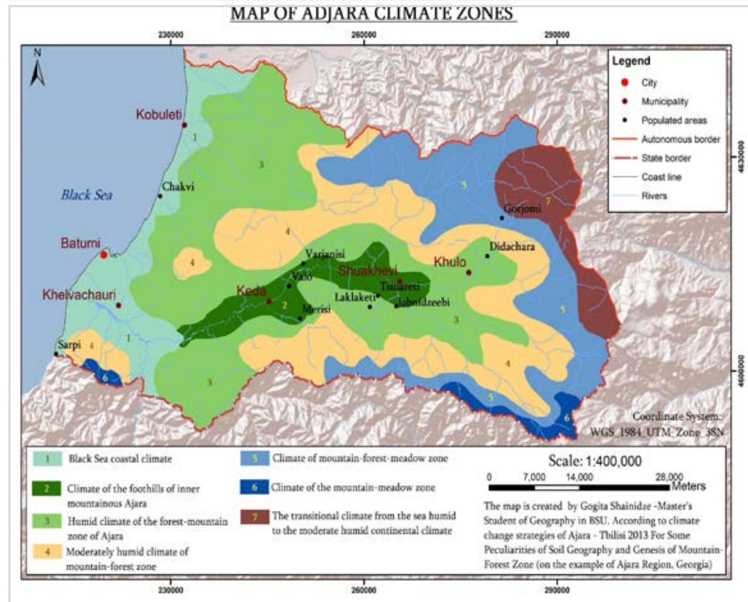
Average annual temperature is +14^{0}C, in winter +3+5^{0}C. Negative temperature (-0,5^0-2^{0}C) only in certain years and for not a long time, that's why soils do not freeze. As for interior mountainous Ajara, climate is more strict, snow cover remains during 4-5 months, the minimum temperature drop of air is -2-7^{0}C and the average annual amount of sediments decreases as well (1200-1400 mm).

According to drawing №1, average, average maximum and minimum temperature as well as an absolute maximum and minimum temperature decreases along with increasing the height of the area.

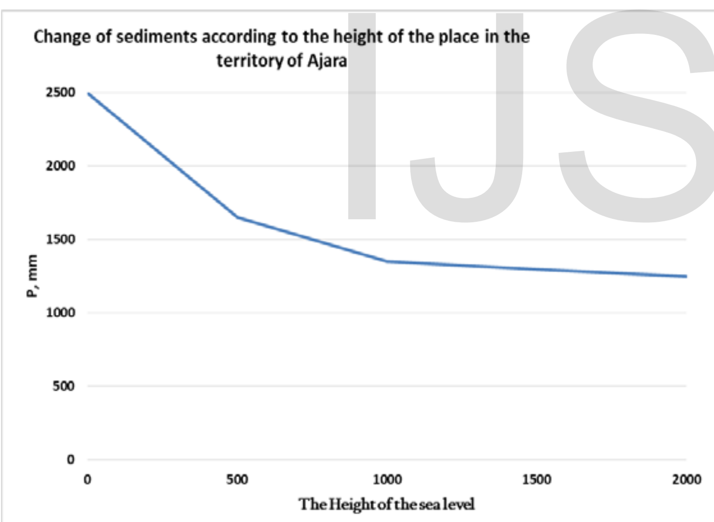
It is worth noting that with the change of temperature apart from height growth the amount of rainfall decreases as well (drawing №2).



drawing. №1 Temperature change according to height on the territory of Ajara



Map №1 – Map of Ajara Climate Zones



drawing. №2 Change of sediments according to the height of the place in the territory of Ajara

Distinctive type distribution of climate elements forms the climate diversity on the whole territory of Ajara and correspondingly, we get the following (Map №1):

So, in compliance with the overall results, Interior Mountainous Ajara changes from extrahumid subtropical into humid subtropical and forest-mountain temperate climate conditions.

The climate of interior mountainous Ajara forms the plant cover which is represented by Colchic type polydominant forests and evergreen sub-forest. This special feature is very visible from the Black Sea zone to the village Dandalo (Keda Municipality), at 720 meters above the sea, especially on the north slopes but coniferous forest prevails in Chvana valley.

According to the results gained from the fundamental researches conducted on geographical distribution and genesis peculiarities of soil cover of forest mountain zone in different countries including Georgia [3], [5], [6], [21], [22], [23], [24], [25], [26] it has been proved that in these zones we come across Leptosols Rendzic, "TERRA ROSSA", brown soils related, Cambisols Chromic soil types with different subtypes and regularities. However, information about Ajara regions is very scarce.

From the researches carried out on forest mountain soil (Leptosols Umbric) forming factors and after comparing regularities of geographical distribution and genesis peculiarities with each other, it is clear that (Table №1) these soils are similar and at the same time different by chemical content and transformation of their parent rock.

TABLE №1
Basic morphological characteristics of red soils of extrahumid zone in the valley and basic soil taxons of Georgia forest-mountain

№	Characteristics	Soil taxons				
		Cambisols Chromic	Brown soil related	Leptosols Rendzic	"TERRA ROSSA"	Nitisols Ferralic
1	Profile building	A_0 - A - B_m- C	A_0-A-B-Cg, or A_0-A/Cg	A_0-A-AB-BBC, or A+B	A_0-A-AB-BC, or A+B	A-AB-B-BC-C, or A_0-A-AB-B-BC-C
2	Basic diagnostic sign	existence of clay Bm horizon	Superficial and contact gleying	Well expressed horizon A-, Mummified in depth	Well expressed horizon A-, Mummified in depth	Lithomarge forming, primary minerals are not found or are little in number ,SiO_2 is washed
3	Differentiation and color of genesis horizon	Weak; more or less monotonic of brown color	Well expressed, brown color	Weak ; Grey-brown color	Weak; upper layers brown-crimson, lower layer of red color	Well-expressed, brown-red
4	Dead cover	Well-expressed	expressed	Expressed at the average or weak level	Expressed at the average or weak level	Expressed at the average or weak level
5	Structure	Nutty-crumbling	Nutty-cloggy	Grained- and coarse crumbling	Grained-crumbling	Cloggy-grained
6	Mechanical composition	heavy- clay loam , skeletal (stony)	heavy- clay loamy , skeletal (stony)	Lightweight or average clay, strongly skeletal (stony)	Average or heavy clay strongly skeletal (stony)	heavy clay loam heavy clay
7	Physical-mechanical characteristics	Small volumetric density and high non-capillary porosity	In the aggregated layer low but in the gley layer high volumetric density high non-capillary porosity	Small volumetric density and high non-capillary porosity	Small volumetric density and high non-capillary porosity	Small volumetric density and high non-capillary porosity
8	Profile distribution of R_2O_3	Accumulates in middle and lower parts	Accumulates in middle and lower parts	Accumulates in middle and lower parts	Accumulates in middle and lower parts	Accumulates in middle and lower parts

Also, vertical distribution is characterized to Cambisols Chromic and brown soils related, Leptosols Rendzic, "TERRA ROSSA" soils are intrazonal.

Pursuant to the research, damp subtropical climate of the Black Sea and the relief (forms, exposition, angle of inclination and the degree of fragmentation) indicates on correlational link between climate peculiarities of interior mountainous Ajara, exhaustion process mechanisms on plant covers and soil formation. Therefore, (in villages: Gegelidzeebi, Tsoniarisi, Dandalo, Furtio, Tsinareti, Fushrukauli, Khikhadziri, Tkhilvana, Mtisubani, Kalota, Tago, Gurta etc.) the law of vertical zonality of soil geographical distribution is completely violated and Cambisols Chromic, Acrisols Halpic soils existing on this area form series according to the type of distribution. According to the researches carried out in the fieldwork on Shavsheti, Arsiani and Ajara-Guria mountains on the part of south and south-east slopes of interior mountainous Ajara, at different heights from the sea level, in particular, at 360-1200 m (Villages: Gundauri, Inasharidzeebi, Kvashta-Vaio, Uchamba-Jabnidzeebi, Laklaketi, TsinaretiDidajara, Iremadzeebi, Gorgadzeebi, Tunadzeebi), rocks are characterized by deep chemical, particularly, by transformation processes in the fields of alite-sahlite and feralitization-rubification. In fact, silicon crystalline lattice in these areas is decomposed and is frush having friable layered structure.

Moreover, this type of exhaustion is localized on the catchment areas, which in combination with heavy cavity of magma intrusive layers make it possible to leak rainfalls and water surface streams into the depth of 10-15 and more meters causing the chemical exhaustion of layers. At the same time it appeared that because of rocks transformation red color soils have been formed on these areas. Pursuant to scientific literary sources [11], [27], [28], [29], [30], [31], [32], [33] Nitisols Ferralic is widespread under subtropical, tropical and equatorial humid evergreen forests (in the south-east China, Japan, North America-Florida, Australia, South America etc.) and are included in Pulvoferalite soil family.

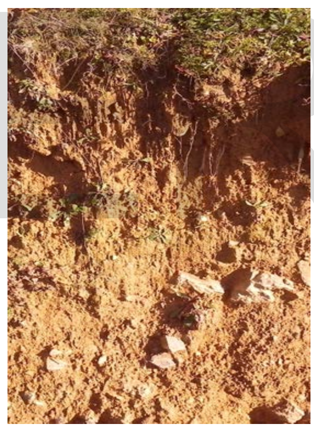
In western part of Georgia Nitisols Ferralic are only in those orographic conditions where climate is equally extra humid. Exactly these types of conditions are on the mountainous and hilly areas of Ajara black sea coastline which is Georgia's extrahumid subzone of subtropical valley zone including on the mountainous and hilly areas of the plane zone of Ajara Black Sea coastline [2], [7], [28], [29].

The Nitisols Ferralic of Georgia differs from mountain soil (Leptosols Umbric) by its geographical distribution regularities and morphogenesis characteristics (Table №1), in particular, red Nitisols Ferralic genesis takes place on hilly areas in subtropical extra humid conditions, its main diagnostic sign is litomarge formation, skeletal absence or its insignificant content, etc.

3 Results and analysis

The field research carried out with standard method [7], [14], [15], [34] proved that there is the red color soil in interior Ajara (Pic.№1,2,3)

Red color soils in Mountations Adjara



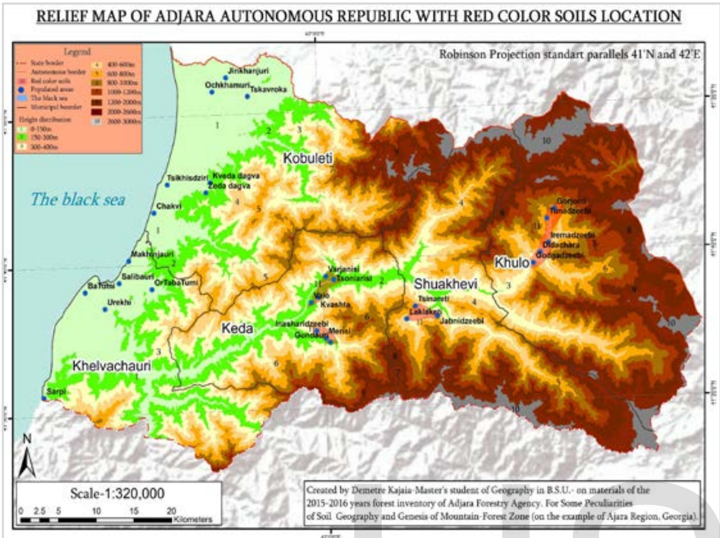
Pic. №1 Keda, Merisi valley

Pic. №2 Shuakhevi, Uchamba valle

Pic. №3 Khulo, village Tunadzeebi

- It is spread on the areas (map. №2) of Keda, Shuakhevi and Khulo Municipality, on the south of Shavsheti Mountain and on the south-east expositions of Arsiani Mountain, it is intrazonal, at the height of 360-1200m above the sea;

- On the area of this soil formation, the relief is on average SM and TM inclined mountain, according to the location middle and lower part of the slope (MS;LS), shape of which is really difficult-X (uneven, complex), average-07 and strongly-08 inclined [15];



Map №2 Relief Map of Adjara Autonomous Republic with Red Color Soils locations

- There are aquatic (flat-WS and ruffle-W) erosive processes, areas with erosion are of class 4, 25-50 % of the area is covered with erosion average- M quality;

- According to human economic influence we can observe on average VM violation of the natural vegetation cover, workers plough lands-PL, through melioration they carry out sprinkler-IS or listering-IF irrigation, bring fertilizers-(FE), there are maize fields, vegetables and orchards [15];

- Description of profile (table №2) building revealed that profile building is A-AB-B_m-BC-C or A_0-A-AB-B-BC-C; peculiarities of genesis horizontal margins and topography is gradual-G 5-15cm, even (approximately even - S);

- Genesis horizons are differentiated weakly. Dead cover is expressed weakly or on average (amount of roots is small on average (F;C));

- Having nutty-crumbling-cloggy-grained structure (SN+GR);

- Parent rock former does not include any carbons or is little carbonated (SL), andesite-basalt (magmatic acid-A) exhaustion products are alluviums (represented by clastic rainfalls-SC1 conglomerates and breccias, sandstone-SC2, claystone -SC3 and ironstone -SC5);

- Natural vegetation consists of Coniferous and deciduous forests with evergreen subforest and grassland (WS+ SD+ HF) [15];

TABLE №2
Genesis conditions, geography and morphological signs of red color soil of interior Mountainous Ajara

№	Characteristics	Red color soil of interior mountainous Ajara		
1	Geography	Exposition of mountain and its ridge	Municipality	Villages where those soils are common, location above the sea
		Shavsheti, South	Keda	Merisi-Inasharidzeebi, Gundauri 430-560 m; Kvashta-Vaio, 360-380 m; Tsoniarisi-Varjanisi, 380 m;
		Shavsheti, South	Shuakhevi	Uchamba-Jabnidzeebi, 950 m; Laklaketi and Tsinareti, 1200 m;
		Arsiani, south-east; Ajara-Guria, south-east	Khulo	Didajara-Iremadzeebi, 1020 m; Gorjomi-Gorgadzeebi, 1000 m; Tunadzeebi, 1200 m;
2	Soil-forming factors	Distribution regularities		Intrazonal
		Rocks		Not carbonate or little carbonate, andesite-basal exhaustion products, alluviums
		Natural vegetation		Coniferous and deciduous forests with evergreen subforest and grass-vegetation
		Climate conditions (perennial average)	Rainfalls	1200-1400 mm
			Soil moisture regime	Permacidic
			Temperature	+4+10^{0}C
3	Morphological signs	Profile building		A-AB-B_m-BC-C or A_0-A-AB-B-BC-C
		Basic diagnostic signs		Clayed B_m horizon existence, skeletal; Brick-brown-red color
		Differentiation of genesis horizons		weak
		Dead cover		Expressed weakly or on average level
		Structure		nutty-crumbling-cloggy-grained
		Mechanical composition		Average or heavy loamy
		Physical-mechanical characteristics		Small volumetric weight and high capillary porosity
		Profile distribution of R_2O_3		Is noticed on the surface, accumulates in middle and lower parts

- Climate (perennial average) indices: rainfalls-1200-1400 mm, regime of moisture is humid, permacidic. Temperature +4+10^{0}C;

- From cutans iron marks and metal skins are notable (M-in number, many 15-40 %), which is natural clay and contains one the half oxides (CS);

- Mechanical composition of this soil is average or heavy loamy (D;E) or heavy loamy-stony (SCL), rock fragments are average (C), they are stones and boulders by their size (SB);

- Humus is of dark-grey color [15];

- It is characterized by small volumetric weight and high capillary porosity;

- Profile distribution of R_2O_3 is noticed on the surface, accumulates in middle and lower parts;

- Basic diagnostic sign of this soil is: clayed Bm horizon existence, brick-brown-red color, accumulation of one and the half oxides, in particular of Fe_2O_3, skeletal (stony) and nutty-crumbling-cloggy-grained (SN+GR) structure.

When we compared genesis (morphological)-geographicalfeatures of red color soil with forest –mountain (Leptosols Umbric) and Nitisols Ferralic of Georgia, it appeared that this soil (table №3):

TABLE №3

Comparison of Georgia's forest-mountain basic soil taxons and lowland exrahumid zone red soil and red color soils of interior mountainous Ajara

№		Characteristics		Soils: Cambi sols Chromic)	Brown soil related	Leptosols Rendzic	„TERRA ROSSA“	Nitisols Ferralic	Red color soil of interior mountainous Ajara
1	Geography-height above the sea (m)			- +	-	- +	- +	-	360-1200 m
2	Distribution regularity			-	+	+	+	-	Intrazonal
3	Soil-forming factors	rocks		- +	- +	-	-	- +	SL
		relief		+	- +	- +	- +	-	SM and TM
		Natural vegetation		+	- +	- +	- +	- +	WS+ SD+ HF;
		Climate conditions Perennial average	rainfalls (mm)	+	- +	- +	- +	-	1200-1400 mm
			Moisture regime	+	+	+	+	- +	Humid Permacidic
			Tempe-rature	+	- +	+	+	-	+4+10^0 C
4	Morphological signs	Profile building		- +	-	-	-	- +	AB-B_m-BC-CorA_0-A-ABB-BC-C
		Basic diagnostic signs		- +	-	-	-	- +	Clayed B_m horizon existence, brick-brownred color, nuttycrumbling-cloggy-grained structure
		Differentiation of genesis horizons		+	-	- +	- +	- +	G
		Dead cover		-	- +	+	+	+	Average or weak
		Structure		- +	- +	- +	- +	- +	SN+GR
		Mechanical composition		- +	- +	- +	- +	- +	D;E
		Physical-mechanical characteristics		- +	- +	- +	+	+	Small volumetric weight and high capillary porosity
		Profile distribution of R_2O_3		- +	- +	- +	- +	- +	Noticed on the surface, accumulates in middle and lower parts.

Footnote: - significantly different, + - partially similar; + significantly similar.

- is very similar to Ajara forest-mountain Cambisols Chromic because of following soil-forming factors: relief, natural cover and climate, it is also skeletal (stony) and owns genesis horizon differentiation. At the same time, is significantly different by geographical distribution regularities, dead cover, profile color, rock transformation and Fe_2O_3 accumulation;

- Is very similar to the Nitisols Ferralic of Ajara subtropical lowland extrahumid subzone by the dead cover, profile color, rock transformation Fe_2O_3 accumulation, physical-mechanical features; It is also very different by geographical distribution regularities, soil-forming factors (relief, natural cover and climate) is of same skeletal (stony) type and owns genesis horizon differentiation;

- Main reason of causing the genesis of red color soil in Ajara forest-mountain is gapping and decomposition of parent rock and catchment area. Therefore, simultaneously Cambisols Chromic formation and Nitisols Ferralic formation takes place in the soil.

We can assume that in case of thorough research this soil can be separated as independent soil taxon by the name of Nitisols Ferralic-Cambisols Chromic soil.

4 Conclusions:

1. In interior mountainous Ajara due to peculiarities of soil-forming factors the law of vertical zone of soil geographical distribution is completely violated and Cambisols Chromic and Acrisols Haplic soils form series according to the type of distribution;

2. On the slopes of Shavsheti Arsiani and Ajara-Guria Mountains on the south and south-east parts of interior mountainous Ajara deep chemical (in the fields of alite-sahlite and feralitization-rubification) and transformation processes of rocks are recognized. In fact silicon crystalline stockade in these areas is decomposed and is frush having friable layered structure;

3. This type of exhaustion is localized in the territories where the area is catchment along with the heavy cavity of magma intrusive layers;

4. Apart from rocks deep transformation in interior mountainous Ajara red color soils are formed and they are characterized by the following diagnostic sign: clayed Bm horizon existence, brick-brown-red color, accumulation of one and the half oxides in particular of Fe_2O_3, skeletal (stony) and nutty-crumbling-cloggy-grained structure;

5. In the process of red color soil genesis in Ajara forest-mountain zone brown and red soil formation takes place at the same time, which prompts us to assume that is case of complete research this soil can be separated as independent soil taxon by the name of Nitisols Ferralic -Cambisols Chromic soil.

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