

REPORT

on the results of technical task implementation related to the additional research of Amulsar ESIA - Soil Survey

Amulsar is located at the northern part of Zangezur mountain ridge with its surrounding areas constituting a part of administrative areas of Vayots Dzor marz's Gndevaz and Saravan and Syunik marz's Gorayk communities.

The areas under survey are described with the following geomorphological terrain types. Starting from areas adjacent to Gndevaz community up to the right bank of Vorotan river the slopes are gently inclined (3-7°) with inclined (7-12°) shield-shaped masses divided with ravines of different depths and inclinations. A quite well-shaped valley is formed at Vorotan River's entrance to Syunik marz where at the right side Amulsar is seated with its peaks of different heights (2600-2990m).

This part forming the end of Zangezur mountain ridge is distinguished with its straight steep (>20°) slopes, corbelled out rising tops divided by deep V-shaped gorges and valleys with vivid bedrock exposures and accumulations of stone fields. The canyons and ravines of the area form the riverbed for snowmelt and rain events which feed Arpa and Vorotan rivers. Eluvial and diluvial silting deposits of volcanic andesite, andesite-dacite, trachyte, trachyandesite, breccia, tuff breccia conglomerates have served as bedrock for the formation of soils of the area, which very often occur mixed together.

The area is characterised with cold and humid (the upland and mid zones of Amulsar) or temperately cold and humid climatic conditions (starting from slightly inclined slopes of Gndevaz up to the valley of Vorotan river), whereas southern slopes (in the areas of Saravan and Gorayk communities) are characterised with dry and mild climatic conditions. In general the annual average temperature according to Celsius is from -3° to 3° and the average temperature in January descends up to -9° to -14°, in July ascends up to 9° to 13°. The maximum prevailing air temperature in July is 24°-30°, while the minimum prevailing temperature in January descends -37° to -46°. In this regard, the sum of air temperatures higher than 5° varies from 650-1800°, while the sum of temperatures higher than 10° varies from 500-1100° in average.

The quantity of total annual precipitation in cold and humid climatic conditions is approximately 1000mm, where 600mm falls in the warm period of the year and in the temperately cold areas precipitation is 500-800mm where 350-500mm falls in the warm period of the year.

The maximum thickness of the snow cover in the cold, humid, highland areas is 100-170, while in the lowlands it is 60-920 cm. During the studies in the period from May 20 to June 20 the thickness of the snow cover was > 2500 m reaching the tops of the mountains and in some parts islands of 0.5-0.7 m thick snow cover remained. The diversity of relief types and climatic conditions are conditioned by unequal distribution of vegetation-cover types.

The vegetation-cover in the sub-alpine zone is represented with cereals, graminaceous plants and variegated grasses, out of which

1. *Bromopsis verigata*
2. *Festuca varia*
3. *Koeleria alborib*
4. *Festuca*
5. *Poa*

6. *Horcum violareum*
7. *Campanula*
8. *Aster*
9. *Festuca*
10. *Salvia*
11. *Nepeta*
12. *Mentha*
13. *Agropyron trichophorum*
14. Փքլած աղվեսագին- *Alopecurus*
15. *Lotus caacasigus*
16. *Trifolium*
17. *anthyllis*
18. *Anemonasqrium fasciculatum*
19. *Betonika macranta*
20. *Alchimilla*
21. *Centaurea*
22. *Pimpinella*
23. *Carex humulis*
24. *Veronica*
25. *Herakleum*
26. *Centiana*
27. *Capalaria gigantos*

The grass-cover is used as a meadow and pasture.

The following plant species are common in the meadow steppe zone:

1. *Festuca velasiaca*, *F. ovina*
2. *Koeleria albobvil*, *K. cristata*
3. *Stipa Lessinglana*
4. *Stipa Tusra*
5. *Stipa capilata*
6. *Scabiosa*
7. *Elitrigia trichophora*
8. *Veronika*
9. *Astemisia*
10. *Achillea*
11. *Callum verum*
12. *Befriochloa ischacmum*
13. *Astragalus*
14. *Betonika grandiflora*
15. *Centaurea Ficheri*
16. *Bronopsis verigata*
17. *Trifolium ambbigium*
18. *Ricia ariabilia*
19. *Medigago*
20. *Lotus caucasicus*

The grass cover is used as a meadow and pasture.

The following mat-grass cereal-variegrassy, variegrassy, tragacanth plant species are common in the steppe zone:

a) In the northern, north-eastern humid and moderately humid areas:

1. *Aeropyron trichophorum*
2. *Achillea noliles*, *A. micranta*
3. *Stipa stenophylla*
4. *Phleum phleoides*
5. *Festuca sulcata*
6. *Koeleria gracilis*
7. *Galium verum*
8. *Plantago lanceolata*
9. *Thymus*
10. *Dianthus crinitus*
11. *Scutellaria*
12. *Medicago sativa*
13. *Lotus caucasicus*

The grass-cover is used as a pasture, meadow and arable land.

b) In comparatively arid slopes of southern and south-western exposition festucaceum and tragacanth plant species are dominating, but do not form a full vegetation cover. The following *Astragalus* and festucaceum plant species are common:

1. *Stipa capillata*
2. *Koeleria gracilis*
3. *Achillea nobilis*
4. *Zizifera*
5. *Teucrium polium* *Helichrysum*
6. *Helichrysum* *Thymus*
7. *Thymus*
8. *Lotus caucas*
9. *Medicago sativa*
10. *Onobrychis cornuta*
11. *Callium eruciata*
12. *Onobrychis transcaucasica*
13. *Agropyron trichophorum*
14. *A. repens*
15. *Rumex*
16. *Teucrium*

Low-growing trees and shrubs of *Malus*, *Pyrus* and *Rosa* occur in small islets and separately.

Grass-cover is used as a pasture, meadow and in some areas as arable land. Field survey was carried out for the purpose of soil characterisation and examination of soil characteristics. For this purpose 32 permanent and 105 half-dug soil pits were established. For the analysis the soil samples were taken only from permanent soil pits.

The gross chemical composition of soil types, the quantity of carbon in the humus, mechanical and structural composition, pH of soil solution and the volumetric masses of the soil were determined in the result of the chemical analysis.

Analysis of absorbed bases (Ca^{2+} , Mg^{2+} , H^+ , $\text{A}^{2+}\text{O}^{3-}$) and the content of available nutrients is underway and will be included in the report.

Soil map of the area under investigation was prepared according to soil types and with indication of the height of established soil pits (in Armenian).

Mountain meadow soils

These soils occupy 2600m and higher slopes and plain areas adjacent to Amulsar. Here can be found a variety of relief types. The northern part is characterized by relatively mild relief where slightly and moderately inclined slopes occupy a considerable area and the southern and south-western part is characterized by relatively complex ragged relief.

In the conditions of not very complex relief sod-soils of medium capacity have developed, while in moderately and strongly inclined slopes weak skeletal sod-soils are common. In the area under investigation mountain meadow dark coloured and mountain meadow sod-soils are developed.

Dark soils are characterised with a developed turf layer, weak differentiation of genetic horizons, dark brown colouring, not very deep humus horizons, high content of organic components and granular and slight to medium loamy mechanical structure (Table 2.). Loamy sod soils of medium capacity rich in organic components with granular structure have developed in plain and ragged areas of distribution areal of these soils, while in the inclined slopes weak skeletal degraded sod soils with weak mechanical structure are common.

As compared to sod soils dark mountain meadow soils are distinguished with a thick turf layer, high quantity of humus in the soil, fine structure, brown colouring, weak and medium capacity of humus horizons, slight to medium loamy mechanical structure with their granular structure parallel to the depth of soil profile gradually turns into an unstructured homogeneous yellow-brownish mass rich in rock chips. The differentiation of horizons is not well expressed. In the conditions of mild relief the turfiness occurs in deeper layers (>12cm) while in the inclined slopes it occurs in the surface layers (starting from <8-12 cm).

Since these soil subtypes were formed in individual islets one inside the other they do not form an individual zone.

The morphological description of the fraction of mountain meadow soils is given below.

Cut piece N 30 was taken from a slightly inclined slope of 2690m height of south-western exposure:

Horizon AD - 0-9cm in depth, with dark brown colouring, medium sand-loamy mechanical structure, weakly hardened, without stones or crushed stones, porous, well defined turf layer and gradual transition to the next horizon.

Horizon A1 - 9-20 cm in depth, with brown colouring, heavy sand-loamy structure, granular, weakly hardened, porous and visible transition to other horizons.

Horizon B1 - 20-30cm in depth, with brown colouring, heavy sand-loamy structure, granular, of medium hardness, weak skeletal and pebbly, gradually transiting.

Horizon B2 - 30-41 cm in depth, with brown colouring, medium sand loamy structure, slightly granular, weak skeletal and pebbly, of medium hardness, with vivid transition.

Horizon C1 - 41-56cm in depth, with light brown colouring, medium sand loamy, without structure, weakly hardened and skeletal, gradually transitioning.

Horizon C2 - 56-115cm in depth, with brown-ashy colouring, light sand-loamy, without defined structure, crumbling, weak skeletal and pebbly masses on andesite-basalt fractures.

The cut piece is devoid of lime layer, root system reaches 0-28cm, some reach up to 90cm in depth.

The cut piece N29 was taken from a slightly inclined slope of 2895m height of northern exposure:

Horizon AD - 0-12 cm in depth, with dark brown colouring, light sand-loamy, powder grained, crumbling, porous, without stones, visible transition.

Horizon B - 12-20cm in depth, with dark brown colouring, light sand-loamy, light pebbly and skeletal crumbling, porous, visible transition.

Horizon C - 20-74cm brown-yellowish, without a defined structure, medium sand-loamy, strongly pebbly and skeletal, crumbling, porous.

The entire profile is devoid of lime layer, the general depth of roots reaches up to 0-20cm in the layer, while some reach up to 54cm.

Laboratory studies (Table 2) showed that structure of mountain meadow soils is light and medium loamy; moreover, as compared to the slopes where the natural/mechanical composition is light in mild relief conditions the natural clay quantity is greater. This is due to the presence of silt fragments and clay accumulations in the upper layer of the slightly inclined relief, whereas due to wind erosion of rocks and slow clay formation in the lower layer their quantity is small.

Analytical data of gross chemical composition (table-1) shows that the chemical elements are almost equally distributed in the profile, since these soils were developed in humid climate conditions where biochemical processes contribute to intensive dilution of aluminosilicates of the whole soil profile.

The high content of organic substances is conditioned by humid and cold climate conditions, slow decomposition of well-developed root system and mineralization. The penetration of humus substances is visible in the lower layer of the soil profile. The reaction of the soil solution is mainly acidic.

The upper turf and humus rich horizons are characterised with high water resistance of aggregates while in the lower horizons water resisting capacity of structural aggregates decreases.

High content of organic substances have given these soils crumbling structure resulting in different ranges of consistence in the 40cm upper layer of fine-grained soils which in the sod-soils 0,6-0,92 g/cm³ while in the dark soils 0.81-0.98g/cm³.

Since these soils are pebbly and fractured after their extraction the fine-grained soil in the 0,40sm layer in sod soils remains 2481t/ha and in dark soils 2150t/ha, where humus reserves constituted consequently 166t/ha and 132t/ha. In this respect, the upper sod-soil layer can be used (10-12cm) and after removing stones fine-grained soil laying up to 40cm.

The gross chemical composition of mountain meadow soils

Table 1

Sample N	Genetic horizons, the depth of taken soil sample, cm	In percent												Molecular interaction/correlation		
		Heat loss	SiO ₂	R ₂ O ₃	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	MnO	K ₂ O	Na ₂ O	P ₂ O ₅	SO ₃	$\frac{\text{SiO}_2}{\text{R}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Al}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Fe}_2\text{O}_3}$
From the calculated absolute dry soil mass																
30	A ₁ 0-9	18.63	48.05	26.93	19.62	7.01	1.72	1.71	0.22	1.59	1.26	0.34	0.43	-	-	-
	A ₂ 9-20	14.11	49.99	27.74	20.35	7.03	1.82	2.04	0.22	1.72	1.25	0.37	0.42	-	-	-
	B 20-30	13.34	50.33	27.95	21.23	7.18	2.22	2.20	0.22	1.66	1.61	0.46	0.67			
	B ₂ 30-41	9.07	53.17	29.02	21.35	7.27	2.81	2.39	0.22	1.31	1.53	0.40	0.84	-	-	-
	C ₁ 41-56	8.02	53.64	29.49	21.70	7.30	3.79	2.47	0.22	1.18	1.53	0.49	0.45			
	C ₂ 56-71	6.32	52.63	29.62	21.34	7.76	3.75	2.87	0.20	1.42	1.77	0.51	0.49			
From the calculated incandescent mass																
30	A ₁ 0-9	-	59.10	33.12	24.13	8.62	2.12	2.10	0.27	1.95	1.54	0.42	0.53	3.40	4.17	18.22
	A ₂ 9-20	-	57.98	32.17	23.60	8.15	2.11	3.36	0.25	1.99	4.45	0.42	0.49	3.42	4.18	18.94
	B ₁ 20-30	-	57.93	32.14	24.41	8.26	2.55	2.53	0.25	1.91	1.85	0.53	0.77	3.31	4.04	18.56
	B _{BC} 30-41	-	58.46	31.92	23.48	7.99	3.09	2.61	0.24	1.44	1.68	0.44	0.92	3.40	4.12	19.36
	C ₁ 41-56	-	58.47	32.14	23.65	7.96	4.13	2.69	0.24	1.29	1.67	0.53	0.49	3.44	4.16	19.81
	C ₂ 56-71	-	56.31	31.71	22.83	8.03	4.01	3.07	0.21	1.52	1.89	0.54	0.52	3.42	4.19	18.76
18	A ₀ A ₁ 0-10	68.2	61.76	30.40	21.27	8.48	2.10	4.00	0.20	0.18	0.16	0.51	0.37	9.11	4.98	19.43
	B _c 6-20	35.5	61.80	30.30	20.70	8.80	2.40	3.00	0.23	0.70	0.42	0.63	0.76	9.20	5.07	18.73
	C ₁ 20-51	31.8	59.78	32.60	23.96	7.92	1.75	3.65	0.24	0.26	0.25	0.56	1.71	8.03	4.17	20.00
	C ₂ 51-82	30.8	57.68	33.41	22.55	8.69	1.71	3.88	0.25	0.24	0.28	0.54	1.82	7.50	4.00	17.69

Some chemical, physical and physicochemical properties of mountain meadow soils

Table 2

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	PH of water	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg –eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁺	Sum	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
18 2691	A ₀ A ₁ 0-6	21.7		6.2	5.4						6.7	17.9	25.5		
	BC 6-20	11.9		4.9	4.4						5.8	29.7	65.0		
	C ₁ 20-51	2.4		5.8	4.3						5.4	33.4	Not determined		
19 2703	A ₀ A ₁ 0-14	13.2		6.0	5.2						12.5	32.4	64.4		
	A ₁ 14-26	6.9		5.8	4.9						12.5	34.1	75.8		
	B 26-55	4.8		6.3	5.5						10.2	46.2	70.2		
	C 55-87	2.0		6.9	5.8						10.2	37.7	Not determined		
28 2727	A ₁ 0-9	16.2		6.1	Not determined						10.9	40.9	76.1		
	A ₂ 9-16	10.2		5.9	-						11.2	41.0	78.8		
	B ₁ 16-29	6.6		5.0	-						13.1	47.2	64.8		
	B ₂ 29-39	5.3		5.0	-						12.0	40.7	57.3		
	C 39-64	2.2		5.3	-						4.4	26.9	Not determined		
29 2895	A ₁ 0-12	12.9		6.0	-						8.7	23.7	54.9		
	B 12-20	6.4		5.5	-						4.7	27.8	23.9		
	C 20- 74	0.8		5.3	-						8.5	37.4	Not determined		
30 2690	A ₁ 0-9	13.7		6.6							6.3	31.5	88.7		
	A ₂ 9-20	6.1		6.4							8.9	43.9	73.7		
	B ₁ 20-30	3.4		6.1							10.5	46.9	71.9		
	B ₂ 30-41	2.6		6.2							9.1	36.9	50.6		
	C ₁ 41-56	0.9		6.2							8.7	38.8	Not determined		
	C ₂ 56-71	Not determine		6.3							7.7	37.9	-		

		d													
14 2840	A ₀ 0-9	14.0		4.7	3.8						45.8	65.2	64.6		
	A 9-23	8.4		4.6	3.8						41.4	67.8	57.1		
	B 23-39	4.1		4.7	3.8						36.0	58.3	27.3		
	C ₁ 39-69	0.9		5.1	3.9						32.6	53.0	Not determined		

Meadow steppe soils

These soils occupy an intermediate space between the black soils and mountain meadow soils extending on 2400 to 2600 m heights. Depending on the type, exposure, water-temperature conditions of the relief the cutoff of maintain meadow soils of the area are characterized with different morphological structures resulting in different capacities of humus horizons.

Generalized descriptions of indicators of genetic horizons of studied mountain meadow steppe soils are given below.

A_{Δf} horizon- with 8-10cm capacity, turfy, very crumbling and porous, dry with black-dark chestnut coloring and fine cloddy structure, light sand-loamy, stoneless, with dense disheveled coarse root network, which gradually passes to horizon A.

A - horizon- with 10-15 cm capacity, humid with black-dark chestnut or dark brown coloring, cloddy structure, root-rich, crumbling, with presence of skeletal structure, limeless and with vivid transition to Horizon B

B – transition horizon 10-20cm capacity, dark brown, cloddy, sand-loamy, weakly hardened and granulated, rubbly, humid, hardened, with vivid transition to the next horizon.

BC – 10-15cm capacity wet, brown, medium sand-loamy, rubbly, hard, porosity of fine-grained soils, reaction of soil solution is neutral, weak acid, the transition from C horizon vivid.

C horizon- on eluvial and diluvial silting deposits of bedrock, with yellowish-red shade without a defined structure, weak sand-loamy-sandy, rubblier than the previous horizon, wet.

Morphological descriptions of two separate pits of different capacity are given below.

Pit N20 was dug on a slope of north-eastern exposition of 2515m height.

A_Δ - 0-11cm in depth, with dark chestnut, light brown colouring, light loamy, cloddy, with fragile structure, limeless, stoneless, humid porous.

A - 11-26cm, black chestnut-brown, medium loamy, cloddy, fragile, weak skeletal, porous, humid limeless, with gradual transition.

B₁ – 26-42cm chestnut-brown, medium loamy, with granular structure, fragile, slightly pebbly, medium skeletal, limeless, humid with gradual transition.

B₂ – 42-54cm chestnut-brown, medium loamy, fine grained, fragile, slightly pebbly, medium skeletal, humid with gradual transition.

C₁ 54-68cm brown, lightly loamy, without structure, of medium hardness, strongly skeletal, wet, limeless.

The general depth of the 70% of roots is 0-26cm in the layer, whereas the other 30% reaches up to 68cm.

Pit N 26 is put on the height of 2493m on the slope south-western exposition (5').

A₁ horizon- 0-10cm, dark chestnut with black shading, slightly loamy, with fine-grained structure, weakly hardened, porous, weakly skeletal, limeless, with gradual transition.

A₂ horizon- 10-29cm, dark chestnut, slightly loamy, cloddy, weakly hardened, porous, limeless, with vivid transition.

B₁ horizon– 29-41cm, dark brown, slightly loamy, with granular structure, weakly hardened, porous, medium pebbly, strongly skeletal, humid, limeless, with vivid transition.

B₂ horizon– 41-62 m², light brown, slightly loamy, medium hardened, porous, with fine-grained structure, medium pebbly, skeletal, wet limeless, with vivid transition.

C horizon– 62-86 cm, brown with yellowish shading, slightly loamy, without structure, medium hardened, strongly pebbly and skeletal, wet, limeless.

The general depth of roots is 0-28cm in the layer, whereas some reach up to 75cm in depth.

The description of the two soil pits shows that the meadow steppe soils formed in the area of Amulsar have medium capacity (<60cm), slight subdivision of genetic horizons, slight mechanical structure, in some limited incised areas of the open relief the capacity reaches (<60cm) or is of higher capacity, heavy loamy, rich in humus and turf layer.

The mineral elements in gross chemical composition of the horizons of the cutoff are evenly distributed, except for Al_2O_3 and Fe_2O_3 , the quantity of which in the upper layer is sometimes higher than that of the lower layer, while the quantity of CaO in the lower horizon and rock is conditioned by the predominance of the Ca usage during the wind erosion and soil formation in contrary, in parallel to the depth of biological accumulation the quantities of K_2O and Na_2O increase as well (Table 3).

The quantity of organic elements in the meadow steppe soils ranges from 6,6 to 15,3 % and together with increasing depth it decreases.

Despite the light mechanical composition of these soils the content of water-resistant aggregates is high (Table 4), which is due to the humus and the Ca content. In horizon A water-resistant aggregates make 55-80, and in horizon B 33-67%, where 3 mm fractions are prevailing.

Above described characteristics have conditioned the crumbling structure of the upper horizon A of the meadow steppe soils due to which volumetric mass ranges from 0,94 to 1,21 g/cm^3 , below which it is becoming denser 1,43 g/cm^3 .

If we take into account that the soil capacity is about 50-60cm in the mountain slopes and 70-80cm in lowlands and that the pebbly mass in the lower layers constitutes 30-60%, it would be clear that in the 0-30cm layer 3200t/ha soil is available with 2200t/ha stones in the layer of 30-60cm (the quantity of extracted stones).

In other words, in the 0-60cm soil layer the quantity of soil is about 5400t/ha, which can be used after the mine closure for recultivation purposes. The abovementioned layer contains 307-310t/ha humus.

The gross chemical composition of meadow steppe soils

Table 3

Sample N	Genetic horizons, the depth of taken soil sample, cm	In percent												Molecular interaction/correlation		
		Heat loss	SiO2	R2O3	Al2O3	Fe2O3	CaO	MgO	MnO	K2O	Na2O	P2O5	SO3	SiO2 R2O3	SiO2 Al2O3	SiO2 Fe2O3
From the calculated absolute dry soil mass																
27	A1 0-11	12.48	53.07	25.41	18.85	6.35	3.45	2.0	0.22	1.61	1.65	0.21	0.65	-	-	-
	A2 11-26	9.62	54.83	26.78	20.08	6.53	3.28	1.93	0.22	1.73	1.82	0.15	0.56	-	-	-
	B1 26-42	7.36	56.93	27.30	20.80	6.61	3.86	1.74	0.22	1.65	1.87	0.20	0.68	-	-	-
	B2 42-54	6.58	56.28	27.61	21.02	6.53	3.78	2.05	0.14	1.85	1.87	0.05	0.43	-	-	-
	C1 54-68	4.97	57.93	26.68	20.28	6.29	4.29	2.78	0.14	1.85	2.27	0.10	0.21	-	-	-
26	A1 0-10	17.02	59.06	19.06	13.63	5.05	1.19	1.12	0.07	1.76	0.90	0.33	0.36	-	-	-
	A2 10-20	14.62	59.73	19.94	14.40	5.16	1.24	1.14	0.14	2.39	1.23	0.37	0.31	-	-	-
	B 29-41	10.31	61.80	20.81	15.45	5.03	1.66	1.06	0.14	2.53	1.39	0.33	0.38	-	-	-
	C1 41-62	5.23	64.61	23.92	19.32	4.34	1.05	0.20	0.04	3.0	1.69	0.24	0.45	-	-	-
	C2 73-122	5.07	64.19	24.33	19.46	4.66	1.05	0.40	0.04	3.32	1.54	0.20	0.49	-	-	-
From the calculated incandescent mass																
27	A1 0-11	-	59.96	28.97	21.48	7.24	3.93	2.28	0.25	1.83	1.88	0.25	0.74	4.46	3.70	22.20
	A2 11-26	-	60.86	29.72	22.28	7.25	3.64	2.14	0.24	1.92	2.05	0.18	0.62	4.83	3.92	21.57
	B1 26-42	-	60.91	29.48	22.46	7.14	4.17	1.88	0.24	1.78	2.02	0.21	0.73	4.61	3.84	23.07
	C1 42-54	-	60.22	29.54	22.49	6.99	4.04	2.19	0.15	1.98	2.0	0.06	0.46	4.54	3.81	23.63
	C3 54-68	-	60.83	28.01	21.30	6.60	4.50	2.92	0.15	1.94	2.38	0.10	0.22	4.78	4.01	24.73

	C4	97-140	-	60.59	25.41	19.51	5.68	4.75	2.32	0.14	2.37	2.31	0.20	0.79	5.28	4.45	28.06
26	A1	0-10	-	70.87	22.87	16.40	6.06	1.43	1.34	0.08	2.11	1.08	0.36	0.43	7.36	5.99	31.10
	A2	10-29	-	69.88	23.33	16.80	6.04	1.45	1.33	0.16	2.80	1.44	0.43	0.36	8.18	6.73	36.40
	B	29-42	-	68.60	23.10	17.14	5.58	1.85	1.20	0.15	2.81	1.54	0.36	0.42	6.80	5.67	33.52
	C1	42-54	-	68.49	25.35	20.47	4.60	1.11	0.21	0.06	3.18	1.79	0.25	0.48	5.70	5.0	40.75

Some (chemical, physicochemical and physical) properties of meadow steppe soils

Table 4

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	pH of water solution	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg –eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁺	Sum	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20 2515	A ₀ 0-11	8.9		6.3	6.1						5.6	32.6	67.2		
	A ₁ 11-26	6.0		6.2	5.8						8.2	46.1	85.0		
	B 26-54	4.3		6.4	6.1						12.5	28.3	77.7		
	C 54-89	1.9		7.0	6.3						5.7	25.4	–		
21 2481	A 0-10	15.7		6.6	5.9						2.7	21.8	59.6		
	B 10-24	11.5		6.3	6.1						5.9	24.5	62.5		
	C 24-43	2.2		7.7	6.2						7.2	23.6	–		
25 2604	A ₀ 0-8	14.1		5.7	4.9						46.3	71.4			
	A ₂ 8-19	8.7		5.4	4.5						48.4	72.4			
	B ₁ 19-32	5.5		5.4	4.4						45.5	69.6			
	B ₂ 32-48	3.1		5.6	4.4						42.5	67.0			
	B ₃ C ₁ 48-64	1.4		6.0	4.6						31.6	54.0			
	C ₂ 64-95	0.8		6.4	5.1						28.9	45.5			

13 2413	A ₁	0-16	7.0		6.7						4.9	31.5	80.2		
	A ₂	16-33	3.5		6.5						10.3	46.5	82.5		
	B ₁	33-44	2.1		6.5						6.7	39.8	Not determined		
	B ₂	44-66	2.4		6.5						9.2	49.9	-		
	C	66-82	1.7		-						10.4	48.0	-		
26 2493	A ₁	0-10	11.7		6.1						2.7	20.2	58.8		
	A ₂	10-29	8.1		6.2						4.4	23.6	26.9		
	B ₁	29-41	4.8		6.1						4.4	25.9	10.8		
	B ₂	41-62	3.9		6.3						4.6	30.1	Not determined		
	C	62-86									2.6	28.9	-		
27 2513	A ₁	0-11	7.1		6.5						4.0	29.8	61.9		
	A ₂	11-26	5.1		6.6						6.0	39.8	70.9		
	B ₁	26-42	3.2		6.6						7.3	39.7	33.1		
	B ₂	42-54	3.0		7.4						7.0	36.3	10.8		
	C ₁	54-68			7.4						5.8	28.8	-		

Mountain black soils

The analysis of the field research data of the region allows the black soils to be characterized by the following morphological indicators:

1. Broad variations in the capacity of humus horizons (37-106), the upper horizons of black or dark brown and lower horizons of light colouring, with vivid differentiation of genetic horizons, with turfiness of the A horizon.
2. With light (in the slightly and medium loamy soils of) and strong (heavy loamy and clay soils) hardness, with well expressed cloddy, granular structure, limeless, separate and small areals of soil distribution, with light and medium skeletal structure of the profile.

The description of the morphological structure of the limeless black soil profile on the example of soil pit N20 according to the genetic horizon is given below.

Soil pit is established on the 2275m height on the slopes of southern exposition.

A. (0-15cm) black with dark chestnut shading, slightly humified, slight loamy and hardened porous, stoneless, without boiling, with gradual transition to the next horizon.

B. (15-3cm) dark chestnut, humid, medium loamy, humid, slightly expressed cloddy-granular, hardened, slightly pebbled and skeletal, slightly boiling, with vivid transition to the next horizon.

C. (39-59cm) white, very humid, slightly loamy, powder-grained, strongly boiling, hardened, with a vivid transition to the andesite-basaltic horizon.

The depth of roots reaches 0-22cm, while some reach down to 51cm.

The description of the morphological structure of the limeless black soil profile on the example of soil pit N23 according to the genetic horizon is given below.

A₁ (0-19cm) dark chestnut with black shading, humified, medium loamy, cloddy-granular, slightly hardened, porous, stoneless, without boiling from hydrochloric acids, with gradual transition.

A₂ (19-36cm) dark chestnut, humid, heavy loamy, cloddy, hard, porous, slightly pebbly with noticeable transition.

B₁ (36-47cm) chestnut, humid, slightly loamy, cloddy, porous, stoneless, without boiling, with noticeable transition.

B₂ (47-62cm) chestnut, slightly loamy and cloddy, very hardened, without boiling.

B₃ (62-106cm) chestnut with brown shading, medium loamy, with coarse structure, hardened, porous, slightly pebbly, without boiling, with apparent transition.

C. (106-138cm) light chestnut, heavy loamy, without structure, pebbly crumbling, boiling from hydrochloric acids, fine-grained soil is weakly hardened and porous.

The roots reach 0-21cm in the layer, some reach down 96cm. Connected to the relief types and the nature of the bedrock the black soils are characterised with different chemical, physicochemical and physical features (Tables 5 and 6).

Analytical data of gross chemical composition (Table 5) shows that in the steppe conditions of soil formation the distribution of mineral elements in the profile is almost even and the content of silicate soils doesn't change very much with the exception of limeless subtype, where in the upper layer accumulation of SiO₂, while in the lower layer slight

increase of Al_2O_3 and Fe_2O_3 can be noticed. In the upper layers of the soil biological accumulation of P_2O_5 is present. The relationship between SiO_2 -and dioxides (especially Al_2O_3) shows a presence of significant mineral content of high absorption capacity.

In the horizon of humus accumulation the content of humus is 6.3-8.3 % and in parallel to the depth it gradually decreases, while relatively little quantities of humus are recorded in soils formed on the southern and south-western declivity.

The reaction of soil solutions from all soil pits (pH) is neutral on the surface, while in the lower layers it is of the basal nature (Table 6). In the limeless black soils silt fractions and clay accumulations can be found in the middle and lower horizons. Data on the content of water-resistant aggregates shows that it is very stabile (52.7-84.8%), which in weak limeless soils is conditioned by the presence of carbons, clay and humus content in the soils.

According to the volumetric mass studies of the black soils in the 0-50cm depth weak limeless soils the mass constitutes 1.20 g/cm^3 , while in the 0-50cm it is 1.25 g/cm^3 . Calculations show that in weak limeless soils of 0-50 depth the content of fine-grained soils constitutes 6000t/ha, where humus reserves are 300-350 t/ha and in 1m layer of 12800t fine-grained soils the humus is 450t/ha. In the limeless soils this indicators respectively constitute 5650t/ha fine-grained soils and 550ha humus in the 0-100cm layer.

The gross chemical composition of black soils

Table 5

Sample N	Genetic horizons, the depth of taken soil sample, cm	In percent												Molecular interaction/correlation		
		Heat loss	SiO ₂	R ₂ O ₃	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	MnO	K ₂ O	Na ₂ O	P ₂ O ₅	SO ₃	$\frac{\text{SiO}_2}{\text{R}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Al}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Fe}_2\text{O}_3}$
From the calculated absolute dry soil mass																
36	A ₁ 0-10	18.47	48.68	25.86	17.03	6.41	3.78	2.91	0.22	1.59	0.91	0.28	0.30	-	-	-
	A ₂ 10-20	19.43	44.42	22.42	15.96	6.24	8.68	2.79	0.22	1.61	1.03	0.21	0.29	-	-	-
	B 20-37	20.63	39.40	20.32	14.53	5.62	14.33	1.99	0.21	1.63	1.27	0.17	0.28	-	-	-
23	A ₁ 0-19	14.02	55.15	22.92	16.73	5.96	1.83	1.07	0.22	2.21	1.19	0.23	0.22	-	-	-
	A ₂ 1-36	9.04	57.94	25.36	18.63	6.64	1.74	1.27	0.22	2.09	1.47	0.10	0.22	-	-	-
	B ₁ 36-47	8.23	58.19	26.75	20.54	6.22	1.91	1.36	0.21	1.95	1.54	0.004	0.21	-	-	-
	B ₂ 47-62	8.12	57.63	26.84	20.18	6.68	1.83	1.68	0.21	2.01	1.19	traces	0.21	-	-	-
	B ₃ 62-83	8.03	55.83	28.71	22.02	6.84	1.57	1.95	0.19	1.84	1.08	traces	0.19	-	-	-
	B ₄ 83-106	7.76	55.52	28.65	21.85	6.80	1.66	2.03	0.19	1.85	1.23	traces	0.19	-	-	-
	C 106-138	7.99	55.40	28.33	21.55	6.84	2.79	2.15	0.19	1.67	1.48	traces	0.19	-	-	-
From the calculated incandescent mass																
36	A ₁ 0-10	-	60.11	30.40	21.11	7.94	3.11	3.60	0.27	1.97	1.12	0.35	0.37	4.09	5.09	20.77
	A ₂ 10-20	-	59.12	29.92	21.28	8.36	3.57	3.37	0.29	2.15	1.30	0.28	0.38	3.90	4.42	19.0
	B 20-37	-	59.10	30.37	21.79	8.43	3.97	2.88	0.31	2.44	1.90	0.25	0.42	3.90	4.62	18.60
23	A ₁ 0-19	-	63.98	26.66	19.45	6.91	2.13	1.24	0.25	2.57	1.40	0.27	0.32	4.76	5.60	24.74
	A ₂ 1-36	-	63.74	27.89	20.19	7.59	1.95	1.40	0.24	2.31	1.63	0.11	0.15	4.36	5.60	22.57
	B ₁ 36-47	-	63.43	29.16	21.99	7.12	2.08	1.50	0.23	2.12	1.68	0.04	0.27	4.08	4.91	23.75
	B ₂ 47-62	-	62.88	29.25	21.61	7.64	2.0	1.63	0.22	2.19	1.30	traces	0.38	4.04	4.93	22.27
	B ₃ 62-83	-	60.85	31.29	23.33	7.98	1.71	2.14	0.20	2.0	1.18	traces	0.58	3.66	4.51	20.69

	B ₄ C 83-106	-	60.51	31.22	23.32	7.97	1.81	2.21	0.20	2.01	1.35	traces	0.20	3.65	4.44	20.57
	C 106-138	-	60.38	30.88	22.91	7.98	2.96	2.36	0.20	1.80	1.61	traces	0.29	3.67	4.46	20.40

Some chemical, physical and physicochemical properties of the black soils

Table 6

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	PH of water	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg – eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁺	Sum	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
16 2025	A ₁ 0-20	6.58		6.8							10.0	36.7	56.7		
	B ₁ 20-34	4.81		6.9							6.3	42.1	78.4		
	B ₂ 34-48	3.16		7.3	1.95						4.8	38.7	80.7		
	C 48-72	0.74		7.5	4.06						4.8	35.3	-		
23 2275	A ₁ 0-19	8.1		6.9							4.4	40.4	58.3		
	A ₂ 19-36	6.1		6.7							9.7	56.6	64.2		
	B ₁ 36-47	3.7		6.8							14.7	67.2	53.3		
	B ₂ 47-62	2.7		6.9							12.5	64.6	52.7		
	B ₃ C 62-106	1.4		7.0							19.8	77.3	28.6		
	C 106-138	-		7.9							9.9	53.1	-		
24 2290	A ₁ 0-23	6.3		6.8							10.0	44.4	58.2		
	A 23-32	4.0		6.8							20.5	45.5	57.4		
	B 32-63	1.3		6.9							21.1	33.1	42.9		
	C 63-85	0.8		7.0							-	-	-		
31 2311	A ₀ 0-9	7.1		6.7							16.3	60.8	67.2		
	A ₁ 9-27	3.3		6.8							21.5	66.2	71.2		
	B ₁ 27-44	2.3		6.9	0.1						27.6	66.6	84.8		
	BC ₁ 44-101	1.3		7.2	2.3						30.2	70.0	73.3		

Brown soils

Brown soils of the middle current of the river Arpa in the area of Gndevaz are presented with dark chestnut subtype, which is characterised with stretched humus horizon and brown-chestnut colouring (in the upper part of the profile) which turns into dark chestnut in the lower part of the profile. Increases of carbonates in parallel to the depth and absence of cementation in the lower part is peculiar to these soils.

Analysed soils have a good profile with the following structure

$A_K - B_K - BC_K - S_K - C_{KK} D$,

where the S_K (cementation) horizon is absent. Profile description of soil pit N17 is represented below.

$A_{1(K)}$ (0-11cm) horizon of humus accumulation, with dark chestnut coloring, slightly hardened, porous, with unstable cloddy structure, slightly (<0.5%) pebbly, boiling in the presence of hydrochloric acid, with weak quite dense root network, transition to the next horizon vivid undulating.

A_2 (11-26cm) A_1 the continuation of horizon A, with dark chestnut-brown coloring, with small pores, quite firm, cloddy, slightly pebbly (5-10%), boiling stronger than the previous horizon, sparser root system, noticeable transition to the next horizon.

B_1 (26-41cm) this is the transition horizon and has a lighter color as compared to the previous horizons (B_K) firm, slightly porous, with unstable cloddy structure, medium pebbly (30 %), boiling in the presence of hydrochloric acid, transition to the next horizon vivid undulating.

B_2C_K (41-71cm) mineral horizon, with light field color, crumbling fine-grained soils, without structure, strongly pebbly 50 % and boiling, noticeable transition.

C_{2K} (71-96cm) chips of eroded bedrock, with light mechanical structure, carbonate (rapidly boiling in the presence of hydrochloric acid), firm, strongly pebbly (~80%), light-whitish, main root system reaches down 0-26cm in the layer, some reach down to 96cm.

Analytical data of gross chemical composition (Table 7) shows that the quantities of silicates SiO_2 , iron and aluminium dioxides Fe_2O_3 and Al_2O_3 in the profile decrease in parallel to the depth while the quantities of Ca, Mg and S oxides increase. K_2O is distributed evenly.

In the dark chestnut soils of the area the quantity of organic substances (humus) decreases from 5.75% in the horizon of humus accumulation in parallel to deepening up to 1.08 % in the mineral horizon (B_2C). The quantity of carbonates (CO_2) changes in the same way, reaching from 0.3% in A_1 horizon to 6.3% in B_2C horizon. In the result the reaction of the surrounding changes as well (in A_1 horizon 6.75 to 7.2 in B_2C horizon).

According to the mechanical structure of the dark chestnut soils are medium loamy, where in parallel to the depth the quantities of mechanical clay and sludge reduce. In opposite to this, quantities of water-resistant aggregates increase (64.4-77.6%) in the profile which is conditioned by carbon increase.

Due to the decrease of humus and clay, increase of carbonates and stones in parallel to the depth volumetric mass of the soil increases by horizons constituting 1.12 in A horizon, 1.21 in A_2 horizon, 1.26 in B_1 horizon and 1.41g/cm³ in B_2C horizon. On the bases of the studied volumetric mass of the profile the estimated clean soil layer and humus resources constitute 0-71cm with 3651t/ha clean fine-grained soil quantity and 179.3t/ha humus resources.

Gross chemical composition of dark chestnut soils

Table 7

Հողափնսի համարը, հարիզոնը և խորությունը սմ-ով	SiO ₂	Fe ₂ O ₃	Al ₂ O ₃	P ₂ O ₅	MnO	CaO	MgO	K ₂ O	Na ₂ O	SO ₃	Molecular interaction/correlation		
											<u>SiO₂</u> Al ₂ O ₃	<u>SiO₂</u> Fe ₂ O ₃	<u>Al₂O₃</u> Fe ₂ O ₃
17	61.56	7.62	20.14	0.17	traces	2.98	2.54	2.37	2.36	0.52	5.15	21.46	4.17
A ₁ 0-11	61.22	6.82	20.67	0.20	traces	3.19	3.02	2.06	2.82	0.45	5.05	23.90	4.70
A ₂ 11-26	61.28	6.27	20.52	0.16	traces	3.70	2.80	1.97	2.94	0.52	5.10	26.15	5.13
B ₁ 26-41	61.26	6.61	20.42	0.17	traces	3.12	3.58	1.54	2.37	0.88	5.10	24.88	4.86
B ₂ C ₁ 41-71	61.74	6.48	19.75	0.15	traces	3.56	2.64	2.18	2.49	0.69	5.42	25.75	4.75
C ₂ 71-96	63.47	5.82	18.40	0.16	traces	3.01	2.74	2.32	2.92	0.54	5.89	29.44	5.00

Some (chemical, physicochemical and physical) properties of dark chestnut soils

Table 8

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	pH of water solution	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg –eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁺	զումարը	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17 A slightly inclined surface of western exposure h=1821մ	A ₁ 0-11	5.75		6.75	0.3						29.2	42.2			
	A ₂ 11-26	5.60		6.85	1.1						25.3	42.1			
	B ₁ 26-41	3.52		6.95	4.2						21.5	35.4			
	B ₂ C ₁ 41-71	1.08		7.25	6.3						20.1	32.4			
	C ₂ 71-96	0.60		7.40	5.1						23.2	38.9			
	C ₃ 96-120	0.55		7.20	3.2						27.2	42.1			

Forest brown steppe soils

after-forest soils

The reaction of soil solutions from all soil pits (pH) is neutral on the surface, while in the lower layers it is of the basal nature (Table 6). In the limeless black soils silt fractions and clay accumulations can be found in the middle and lower horizons. Data on the content of water-resistant aggregates shows that it is very stabile (52.7-84.8%), which in weak limeless soils is conditioned by the presence of carbons, clay and humus in the soils.

According to the volumetric mass studies of the black soils in the 0-50cm depth weak limeless soils the mass constitutes 1.20 g/cm^3 , while in the 0-50cm it is 1.25 g/cm^3 . Calculations show that in weak limeless soils of 0-50 depth the content of fine-grained soils constitutes 6000t/ha, where humus reserves are 300-350 t/ha and in 1m layer of 12800t fine-grained soils the humus is 450t/ha. In the limeless soils this indicators respectively constitute 5650t/ha fine-grained soils and 550ha humus in the 0-100cm layer.

The gross chemical composition of black soils

Table 5

Sample N	Genetic horizons, the depth of taken soil sample, cm	In percent												Molecular interaction/correlation		
		Heat loss	SiO ₂	R ₂ O ₃	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	MnO	K ₂ O	Na ₂ O	P ₂ O ₅	SO ₃	$\frac{\text{SiO}_2}{\text{R}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Al}_2\text{O}_3}$	$\frac{\text{SiO}_2}{\text{Fe}_2\text{O}_3}$
From the calculated absolute dry soil mass																
36	A ₁ 0-10	18.47	48.68	25.86	17.03	6.41	3.78	2.91	0.22	1.59	0.91	0.28	0.30	-	-	-
	A ₂ 10-20	19.43	44.42	22.42	15.96	6.24	8.68	2.79	0.22	1.61	1.03	0.21	0.29	-	-	-
	B 20-37	20.63	39.40	20.32	14.53	5.62	14.33	1.99	0.21	1.63	1.27	0.17	0.28	-	-	-
23	A ₁ 0-19	14.02	55.15	22.92	16.73	5.96	1.83	1.07	0.22	2.21	1.19	0.23	0.22	-	-	-
	A ₂ 1-36	9.04	57.94	25.36	18.63	6.64	1.74	1.27	0.22	2.09	1.47	0.10	0.22	-	-	-
	B ₁ 36-47	8.23	58.19	26.75	20.54	6.22	1.91	1.36	0.21	1.95	1.54	0.004	0.21	-	-	-
	B ₂ 47-62	8.12	57.63	26.84	20.18	6.68	1.83	1.68	0.21	2.01	1.19	traces	0.21	-	-	-
	B ₃ 62-83	8.03	55.83	28.71	22.02	6.84	1.57	1.95	0.19	1.84	1.08	traces	0.19	-	-	-
	B ₄ 83-106	7.76	55.52	28.65	21.85	6.80	1.66	2.03	0.19	1.85	1.23	traces	0.19	-	-	-
	C 106-138	7.99	55.40	28.33	21.55	6.84	2.79	2.15	0.19	1.67	1.48	traces	0.19	-	-	-
From the calculated incandescent mass																
36	A ₁ 0-10	-	60.11	30.40	21.11	7.94	3.11	3.60	0.27	1.97	1.12	0.35	0.37	4.09	5.09	20.77
	A ₂ 10-20	-	59.12	29.92	21.28	8.36	3.57	3.37	0.29	2.15	1.30	0.28	0.38	3.90	4.42	19.0
	B 20-37	-	59.10	30.37	21.79	8.43	3.97	2.88	0.31	2.44	1.90	0.25	0.42	3.90	4.62	18.60
23	A ₁ 0-19	-	63.98	26.66	19.45	6.91	2.13	1.24	0.25	2.57	1.40	0.27	0.32	4.76	5.60	24.74
	A ₂ 1-36	-	63.74	27.89	20.19	7.59	1.95	1.40	0.24	2.31	1.63	0.11	0.15	4.36	5.60	22.57
	B ₁ 36-47	-	63.43	29.16	21.99	7.12	2.08	1.50	0.23	2.12	1.68	0.04	0.27	4.08	4.91	23.75
	B ₂ 47-62	-	62.88	29.25	21.61	7.64	2.0	1.63	0.22	2.19	1.30	traces	0.38	4.04	4.93	22.27
	B ₃ 62-83	-	60.85	31.29	23.33	7.98	1.71	2.14	0.20	2.0	1.18	traces	0.58	3.66	4.51	20.69

	B ₄ C 83-106	-	60.51	31.22	23.32	7.97	1.81	2.21	0.20	2.01	1.35	traces	0.20	3.65	4.44	20.57
	C 106-138	-	60.38	30.88	22.91	7.98	2.96	2.36	0.20	1.80	1.61	traces	0.29	3.67	4.46	20.40

Some chemical, physical and physicochemical properties of the black soils

Table 6

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	PH of water	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg – eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁺	Sum	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
16 2025	A ₁ 0-20	6.58		6.8							10.0	36.7	56.7		
	B ₁ 20-34	4.81		6.9							6.3	42.1	78.4		
	B ₂ 34-48	3.16		7.3	1.95						4.8	38.7	80.7		
	C 48-72	0.74		7.5	4.06						4.8	35.3	-		
23 2275	A ₁ 0-19	8.1		6.9							4.4	40.4	58.3		
	A ₂ 19-36	6.1		6.7							9.7	56.6	64.2		
	B ₁ 36-47	3.7		6.8							14.7	67.2	53.3		
	B ₂ 47-62	2.7		6.9							12.5	64.6	52.7		
	B ₃ C 62-106	1.4		7.0							19.8	77.3	28.6		
	C 106-138	-		7.9							9.9	53.1	-		
24 2290	A ₁ 0-23	6.3		6.8							10.0	44.4	58.2		
	A 23-32	4.0		6.8							20.5	45.5	57.4		
	B 32-63	1.3		6.9							21.1	33.1	42.9		
	C 63-85	0.8		7.0							-	-	-		
31 2311	A ₀ 0-9	7.1		6.7							16.3	60.8	67.2		
	A ₁ 9-27	3.3		6.8							21.5	66.2	71.2		
	B ₁ 27-44	2.3		6.9	0.1						27.6	66.6	84.8		
	BC ₁ 44-101	1.3		7.2	2.3						30.2	70.0	73.3		

Brown soils

Brown soils of the middle current of the river Arpa in the area of Gndevaz are presented with dark chestnut subtype, which is characterized with stretched humus horizon and brown-chestnut coloring (in the upper part of the profile) which turns into dark chestnut in the lower part of the profile. Increase of carbonates in parallel to the depth and absence of cementation in the lower part is peculiar to these soils.

Analyzed soils have a good profile with the following structure

$A_K - B_K - BC_K - S_K - C_{KK} D$,

where the S_K (cementation) horizon is absent. Profile description of soil pit N17 is represented below.

$A_{1(K)}$ (0-11cm) horizon of humus accumulation, with dark chestnut coloring, slightly hardened, porous, with unstable cloddy structure, slightly (<0.5%) pebbly, boiling in the presence of hydrochloric acid, with weak quite dense root network, transition to the next horizon vivid undulating.

A_2 (11-26cm) A_1 the continuation of horizon A, with dark chestnut-brown coloring, with small pores, quite firm, cloddy, slightly pebbly (5-10%), boiling stronger than the previous horizon, sparser root system, noticeable transition to the next horizon.

B_1 (26-41cm) this is the transition horizon and has a lighter color as compared to the previous horizons (B_K), firm, slightly porous, with unstable cloddy structure, medium pebbly (30 %), boiling in the presence of hydrochloric acid, transition to the next horizon vivid, undulating.

B_2C_K (41-71cm) mineral horizon, with light field color, crumbling fine-grained soils, without structure, strongly pebbly 50 % and boiling, noticeable transition.

C_{2K} (71-96cm) chips of eroded bedrock, with light mechanical structure, carbonate (rapidly boiling in the presence of hydrochloric acid), firm, strongly pebbly (~80%), light-whitish, main root system reaches down 0-26cm in the layer, some reach down to 96cm.

Analytical data of gross chemical composition (Table 7) shows that the quantities of silicates SiO_2 , iron and aluminum dioxides Fe_2O_3 and Al_2O_3 in the profile decrease in parallel to the depth while the quantities of Ca, Mg and S oxides increases. K_2O is distributed evenly.

In the dark chestnut soils of the area the quantity of organic substances (humus) decreases from 5.75% in the horizon of humus accumulation in parallel to deepening up to 1.08 % in the mineral horizon (B_2C). The quantity of carbonates (CO_2) changes in the same way, reaching from 0.3% in A_1 horizon to 6.3% in B_2C horizon. In the result, the reaction of the surrounding changes as well (in A_1 horizon 6.75 to 7.2 in B_2C horizon).

According to the mechanical structure dark chestnut soils are medium loamy, where in parallel to the depth the quantities of mechanical clay and sludge reduce. In opposite to this, quantities of water-resistant aggregates increase (64.4-77.6%) in the profile which is conditioned by carbon increase.

Due to the decrease of humus and clay, increase of carbonates and stones in parallel to the depth volumetric mass of the soil increases by horizons constituting 1.12 in A horizon, 1.21 in A_2 horizon, 1.26 in B_1 horizon and 1.41g/cm³ in B_2C horizon. On the bases of the studied volumetric mass of the profile the estimated clean soil layer and humus resources constitute 0-71cm with 3651t/ha clean fine-grained soil quantity and 179.3t/ha humus resources.

Gross chemical composition of dark chestnut soils

Table 7

The number of the pit, horizon and the depth, cm	SiO ₂	Fe ₂ O ₃	Al ₂ O ₃	P ₂ O ₅	MnO	CaO	MgO	K ₂ O	Na ₂ O	SO ₃	Molecular interaction/correlation		
											<u>SiO₂</u> Al ₂ O ₃	<u>SiO₂</u> Fe ₂ O ₃	<u>Al₂O₃</u> Fe ₂ O ₃
17	61.56	7.62	20.14	0.17	traces	2.98	2.54	2.37	2.36	0.52	5.15	21.46	4.17
A ₁ 0-11	61.22	6.82	20.67	0.20	traces	3.19	3.02	2.06	2.82	0.45	5.05	23.90	4.70
A ₂ 11-26	61.28	6.27	20.52	0.16	traces	3.70	2.80	1.97	2.94	0.52	5.10	26.15	5.13
B ₁ 26-41	61.26	6.61	20.42	0.17	traces	3.12	3.58	1.54	2.37	0.88	5.10	24.88	4.86
B ₂ C ₁ 41-71	61.74	6.48	19.75	0.15	traces	3.56	2.64	2.18	2.49	0.69	5.42	25.75	4.75
C ₂ 71-96	63.47	5.82	18.40	0.16	traces	3.01	2.74	2.32	2.92	0.54	5.89	29.44	5.00

Some (chemical, physicochemical and physical) properties of dark chestnut soils

Table 8

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	pH of water solution	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg –eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁺	sum	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17 A slightly inclined surface of western exposure h=1821u	A ₁ 0-11	5.75		6.75	0.3						29.2	42.2			
	A ₂ 11-26	5.60		6.85	1.1						25.3	42.1			
	B ₁ 26-41	3.52		6.95	4.2						21.5	35.4			
	B ₂ C ₁ 41-71	1.08		7.25	6.3						20.1	32.4			
	C ₂ 71-96	0.60		7.40	5.1						23.2	38.9			
	C ₃ 96-120	0.55		7.20	3.2						27.2	42.1			

The brown forest-steppe soils in the surrounding areas of Amulsar were formed in the area of Gndevaz in the right bank of Arpa River and are neighbored by chestnut and black soils.

These soils are characterised with high quantity of clay and silt in the mid-horizons as compared to the higher humus accumulation layer, high and medium capacity, with gradually decreasing humus quantity with the depth, brown colouring, which is replaced by chestnut in the lower horizons, especially in the middle zone which has a quite stable structure.

The morphological description of the pit under study is given below.

Soil pit N22 was established on the plain area of western exposition and mild inclination of <5° with the height above sea level of 1840m, approximately 3.5km from Gndevaz village.

Horizon A (0-14cm) – brown, with cloddy-granular structure, medium loamy mechanical structure, slightly firm, porous weak skeletal, without stones, limeless, slightly humid, with undulating transition.

B₁ (14-35cm) – dark chestnut, with cloddy-granular, medium loamy structures, slightly porous, firm, slightly skeletal, without stones, weakly carbonated, humid, with visible transition.

B₂ (35-50cm) – chestnut with light brown shading, cloddy with small nut-like granules, medium loamy, firm, porous, with stones and skeletal structure(<20%), carbonated (mildly), very humid, with vivid transition,

B₁C (50-94cm) – quite stretched, light chestnut, cloddy, medium loamy firm, porous, with stones and skeletal structures of 20-30%, strongly carbonated, abrupt transition to horizon C, seated on the carbonated chips.

C (94-115cm) capacity:

The main network of roots stretches down to 0-27cm, while others reach down to the horizon D.

The gross chemical composition (Table 9) of the soils is not homogenous. Aluminum silicate part in parallel to deepening becomes poorer in silicate soils and richer in dioxides, especially aluminum.

The decrease of Mg and Na is apparent in the soil profile. Other elements are distributed unevenly (TiO₂, P₂O₅, MnO, CaO, K₂O, SO₃).

The description of the profile structure of brown forest-steppe soils is conditioned by the formation of volumetric masses.

A	horizon	0-14 cm	capacity	1.15q/cm ³
B ₁	horizon	14-35 cm	capacity	1.18q/cm ³
B ₂	horizon	35-50 cm	capacity	1.20 q/cm ³
BC	horizon	50-94 cm	capacity	1.29 q/cm ³
C ₁	horizon	94-115cm	capacity	1.35 q/cm ³

According to the volumetric mss calculations it was determined, that in 1ha of these soils the total capacity of humus horizons (94cm) contains 8190t/ha fine-grained soil and 274t/ha humus.

Gross chemical composition of brown forest-steppe soils

Table 9

The depth of the horizon	SiO ₂	Fe ₂ O ₃	Al ₂ O ₃	TiO ₂	P ₂ O ₅	MnO	CaO	MgO	K ₂ O	Na ₂ O	SO ₃	Molecular interaction/correlation		
												<u>SiO₂</u> Al ₂ O ₃	<u>SiO₂</u> Fe ₂ O ₃	<u>Al₂O₃</u> Fe ₂ O ₃
A 0-14	63.5	9.3	16.15	0.78	0.22	0.08	2.68	3.47	2.06	2.0	0.80	6.62	18.27	2.76
B ₁ 14-35	64.0	9.9	15.95	0.87	0.19	0.15	2.25	3.61	1.76	2.0	1.24	6.69	17.26	2.58
B ₂ 35-50	62.6	8.8	17.70	1.01	0.20	0.12	3.27	2.70	2.22	1.84	0.91	6.12	18.91	3.09
BC 50-94	62.0	9.8	21.0	0.78	0.20	0.05	2.30	1.40	1.80	0.90	0.88	5.15	16.88	3.28
C ₁ 94-115	63.0	9.0	22.0	0.60	0.22	0.07	1.65	1.90	1.60	1.15	0.77	5.0	18.75	3.75

Some chemical, physic-chemical and physical features of brown forest-steppe soils

Table 10

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	PH of water	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg –eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁻	sum	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
22 Western exposition, slightly inclined h==1840m	A 0-14	5.2	6.9		NA						7.8	35.7	50.0		
	B ₁ 14-35	4.5	7.2		1.3						10.9	43.9	60.0		
	B ₂ 35-50	2.6	7.4		2.8						10.0	42.3	60.0		
	BC 50-94	1.7	7.5		4.3						13.0	38.7	Not determined		
	C 94-115	0.4	7.6		5.9						9.0	22.8	Not determined		

Valley meadow-steppe soils

These soils were formed in the middle current of Vorotan River, where the water flow slows down in the result of the reduction of inclination of the area and in the season of flooding the water of the river mixed with sludge and sand rinses the valley and sometime later, after the reduction of the water flow the abovementioned mass sediments in the valley. Here, during rains and snowmelt silt particles are brought to the valley from the surrounding slopes.

For this reason, the soil layer formed here in the course of time doesn't have classically formed genetic horizons, and were separated as formed in different periods during the studies.

It should be noted, that there is a quite well formed vegetative cover in surface layer which resembles steppe zone vegetation since being surrounded by black soils.

In different parts of the valley soils possess different capacities and not similar structural profiles, as well as different mechanical composition, layering and morphological features.

The morphological features of the established pit are given below.

Pit N 32, established in the Valley of Vorotan River on a plain area of 2188m in height.

I layer 0-27cm powder-granular, with cloddy, humid, heavy loamy mechanical structure, dark chestnut with black shading, not very firm, filled with porous roots, stoneless, boiling in the presence of hydrochloric acid, with a noticeable transition.

II layer 27 – 60cm, humid, chestnut, with medium double-sand mechanical structure, dust like, firm, porous, skeletal, boils, and vivid transition to next horizon.

III layer 60 – 80cm wet, chestnut, heavy loamy mechanical structure, dust like, without structure, firm, densely laid, addition of skeleton presence of stones of 5 – 10cm 10 - 15%, boils, transition to the lower layer (limestone, road-metal) with vivid transition.

In the result of laboratory studies it was found out (Table 11) that the entire profile as compared to the surrounding soil types is poorer in organic substances. In the first layer humus content is 3.23% which reduces by 60-80cm in the third layer reaching 7.9 – 8.7% which is brought by the surrounding inclined areas. For this reason strong basal reaction occurs. The silt quantity reduces from top to the bottom in the cutoff piece, but this hasn't affected the total silt quantity. The high content of silt and clay in the upper layer is conditioned by the accumulation of biological organic part. This is proved by the high quantity of water-resistant aggregates in the first horizon, while in the total profile the development of structures must be connected to carbonation.

Taking into consideration the fact that the medium capacity of the soils does not extend 60cm the soil mass and humus reserves were calculated by 60cm, the volumetric mass of which constitutes 1.20g/cm³.

Soil mass in one hectare constitutes 7200t, while that of the humus is 187t.

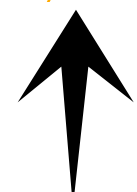
Some chemical, physic-chemical and physical features of valley meadow-steppe soils

Table 11

Pit N ^o	Horizon, Capacity cm	Humus %	The total N, %	PH of water	CO ₂	mg –eqv in 100g of soil					%			The degree of saturation	Absorbed Na ⁺ mg – eqv in 100g of soil
						Ca ²⁺	Mg ²⁺	H ⁺	Al ³⁺	sum	Fraction < 0.001 mm	Fraction < 0.001 mm	Water resistant aggregates		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
32 Vorotan River Valley 2188m height	0-27	3.23		8.3	8.7						30.1	56.5	41.7		
	27-60	2.05		8.3	8.7						25.5	44.0	34.3		
	60-80	0.65		8.1	7.9						16.7	47.1	29.2		

Քարտեզ-սխեմա
Անուլսար հանքավայրի լեռնահատկացման և հետախուզական
լիցենզիաների տարածքների հողային տիպերի

Մասշտաբ 1:20000



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- բնակավայրեր

Ավտոճանապարհներ

 - հանրապետական նշանակության
 - միջհամայնքային և այլ նշանակության
 - գրունտային

գետեր

վտակներ

բարձրության հորիզոնականներ

Սարավանի հետախուզական լիցենզիա

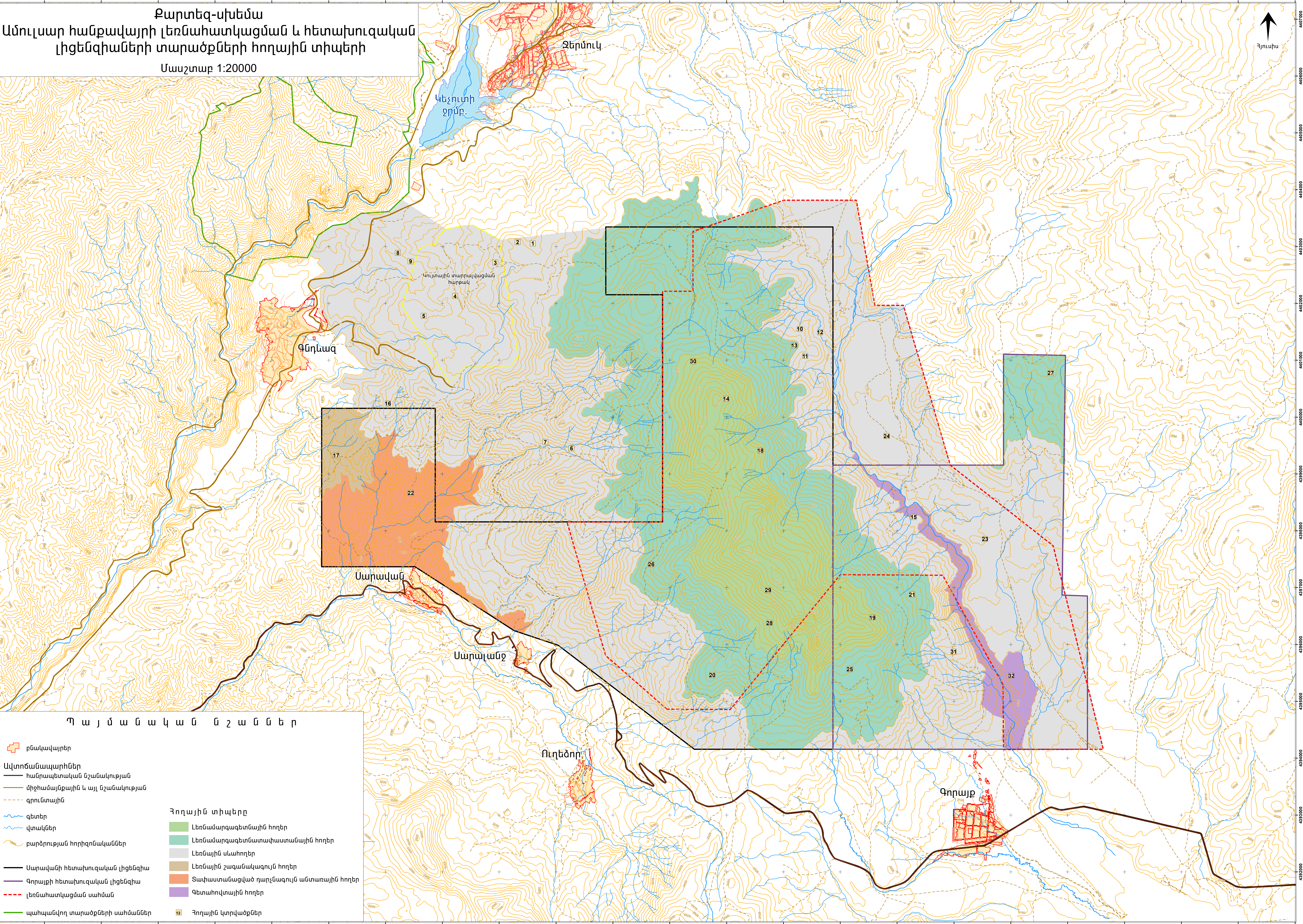
Գորայքի հետախուզական լիցենզիա

լեռնահատկացման սահման

պահպանվող տարածքների սահմաններ
- Հողային տիպերը

 - Լեռնամարգագետնային հողեր
 - Լեռնամարգագետնատափաստանային հողեր
 - Լեռնային սևահողեր
 - Լեռնային շագանակագույն հողեր
 - Տափաստանացված դարչնագույն անտառային հողեր
 - Գետահովտային հողեր

Հողային կտրվածքներ



"Scientific Center of Soil Science, Agrochemistry and Melioration after H.
Petrosyan" Branch of National Agrarian University of Armenia

RESEARCH REPORT

(Final)

on the main types, structure and physicochemical composition of
the soils in the heap leach pad location of
Amulsar Gold Mine Project

Project Manager: Dr.sc.agr. H. Ghazaryan

Performers: Head of the melioration department Dr.sc.agr. -V. Papinyan

Researcher: R. Grigoryan

YEREVAN 2013

Amulsar is located at the northern portion of Zangezur ridge with surrounding terrain forming the administrative areas of Vayots Dzor marz's Gndevaz and Saravan and Syunik marz's Gorayk communities.

The survey area occupies some 575 hectares and is hosted within the administrative area of Gndevaz community, at the foot of Amulsar. The aforementioned area is described with south westerly aspect, extending on different slope degrees and in conditions of gently sloping plains of 2-3 degrees.

Parent materials serving for soil formation include eluvial sedimentary and deluvial silt deposits of volcanic andesites, andesite-dacites, trachytes, trachyandesites, breccia and tuff breccia conglomerates, which very often occur intermixed.

The study area is located on the right side of Vayk-Gndevaz highway, some 2.5-3km away from Gndevaz community. The topography is rugged with an average depth ravine dividing the terrain into two halves. The highway is neighbored by a plain area used under cereal crops, mainly wheat, while the other part is occupied by fruit gardens of apricot, walnut and other fruit-tree species.

Field studies revealed that mainly two soil types are common in the area, namely, mountain chestnut and cinnamon forest soils with typical and carbonate-rich dark chestnut, chestnut and cinnamon forest subtypes.

Chestnut soils

Chestnut soils are disseminating across the right side of Vayk-Gndevaz highway, mainly on plain areas with one part used under cereal crops and the other under perennial crops.

4 test pits (1; 2; 7; 17) and many profile cuts were prepared in the area.

According to the study, the first three test pits (1; 2; 7) represent chestnut soils, while test pit N17-dark chestnut soils being distinguished by humus-rich horizon and dark colouring of the upper layer changing to grey chestnut colouring at deeper layers. The characteristics of the test pits are given below.

Test pit log N1 - is placed about 200m away from Vayk-Gndevaz highway and represents chestnut soils used under wheat fields with gentle slopping /2-3 degrees/ and southern exposition.

Horizon A - 0-22cm- chestnut colouring/with dense root remains/; flimsy; weakly expressed cloddy-granular structure; heavy clay-sandy texture; poorly humid; gradual succession of genetic horizons,

Horizon AB - 22-46cm - light chestnut colouring; humid; weakly-hardened; coarse-structured; heavy clay-sandy texture; calcareous; unnoticeable succession of genetic horizons,

Horizon BC- 46-80 cm- light chestnut colouring /straw color/; humid; well-hardened; heavy clay-sandy texture; distinguished by no structuring; calcareous; stony; absence of cemented layers.

Test pit log N2 - is placed some 800m to the south-west of the test pit N1. A portion of the land is used for tillage, while the other- under perennial crops.

Horizon A-0-25cm- chestnut colouring; flimsy; presence of granular root remnants and plant root refuse; poorly humid /fresh/; heavy clay-sandy texture; weakly calcareous; gradual succession of genetic horizons,

Horizon B 25-48 cm- light chestnut colouring; poorly humid; small-walnut-granular structure; heavy clay-sandy texture; slightly stony with fine stone fragments; calcareous; apparent succession of generic horizons,

Horizon BC- 48-77cm- light chestnut colouring; distinguished by no structuring; humid; well-hardened; calcareous; medium clay-sandy texture of the horizon.

Test pit log N7 - is placed 500m away from the test pit N2, on a slope of 5-7 degree of north westerly exposition.

Horizon A - 0-23cm- chestnut colouring; turf; poorly humid (fresh); heavy clay-sandy texture; granular structure; shallow stoniness; unnoticeable succession of genetic horizons,

Horizon B- 23-48cm- light chestnut colouring; poorly humid; walnut-granular structure; calcareous; of medium clay-sandy texture; apparent succession of genetic horizons.

Test pit log N17 - Dark chestnut soils are disseminating on slopes of 7-10 degrees of south westerly exposition.

Horizon A_{1k} 0-11cm- humic-accumulative horizon of dark chestnut colouring; weakly hardened, pour-rich; with unstable cloddy structure and shallow stoniness; weakly calcareous; apparent succession of genetic horizons,

Horizon A₂ 11-26cm- dark chestnut colouring with cinnamon tinting; porous; weakly hardened; powdered - cloddy structure; slightly stony; weakly calcareous; apparent succession of genetic horizons,

Horizon B₁ 26-41cm - chestnut colouring; weakly hardened; rich in fine porous; unstable large-cloddy structure; medium stony; boiling under the influence of hydrochloric acid; apparent succession of genetic horizons,

Horizon B_{2k} 41-7cm- light strew colouring; flimsy fine soils; porous; distinguished with no structuring; very stony; high-boiling; apparent succession of genetic horizons,

Horizon C_{2k} 71-96 cm- light strew colouring; weathered parent materials; light clay-sandy texture; highly calcareous (high-boiling under the influence of hydrochloric acid); hard; very stony.

Physicochemical, chemical and physical characteristics of the test pit samples by genetic horizons are shown in the table below.

Table 1

Physicochemical, chemical and physical characteristics of chestnut soils

Test pit number N, exposition, inclination, elevation, m	Horizon Capacity cm	Humus content, %	Total N ^o , %	PH of water solution	CO ₂ %	Absorbed cations, mg-equiv/100g					Mechanical composition, Water resistant aggregates %			Nutrients, mg/100g		
						Ca ²⁺	Mg ²⁺	Na ⁺	K	Total	Fraction < 0.001 mm	Fraction < 0.01 mm	Water resistant aggregates	N	P ₂ O ₅	K ₂ O
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
N1- Southern exposition, inclination 2-3 degrees, 1690m	A 0-22	4.5	0.23	7.0	Not available 3.0 4.3	33.0	18.0	1.2	1.8	54.2	17.7	55.6	53.1	5.3	3.6	100
	A B 22-46	3.2	0.11	7.3		35.0	15.1	0.5	2.0	52.6	16.0	50.0	56.4	5.5	4.2	80
	BC 46-80	1.2	0.08	7.4		36.5	24.4	0.5	1.0	62.4	21.3	47.3	43.3	4.2	3.3	39
N2- Southern exposition, inclination 2- 3 degrees, 1680m	A 0-25	4.2	0.19	7.0	0.8	32.0	17.0	0.9	2.0	51.9	16.9	58.4	55.3	4.4	3.8	88
	B 25-48	2.7	0.122	7.3	4.4	38.5	14.1	0.5	1.8	54.9	17.8	51.0	54.1	4.0	3.2	73
	BC 48-77	1.0	0.1	7.4	3.9	36.0	20.2	0.4	2.0	58.6	19.3	44.0	47.7	3.8	3.0	40
N7- North-eastern exposition, inclination 5- 7 degrees, 1640m	A 0-23	4.2	0.198	6.9	0.4	38.8	13.4	0.9	2.1	55.2	16.4	48.8	55.0	5.5	3.4	42
	B 23-48	2.8	0.11	7.3	3.9	41.4	10.3	0.5	2.2	54.4	17.3	44.0	49.0	3.8	3.0	40
N17- South-western exposition, inclination 7- 10 degrees, 1821m	A ₁ 0-11	5.75	0.28	6.75	0.3	29.1	2.2	1.4	2.0	34.7	29.2	42.2	52.4	3.7	3.8	72
	A ₂ 11-26	5.60	0.23	6.85	1.1	28.8	3.0	0.7	1.9	34.4	25.3	42.1	50.8	3.0	4.0	60
	B ₁ 26-41	3.52	0.16	6.95	4.2	24.6	4.1	0.5	2.0	31.2	21.5	35.4	44.7	2.6	3.0	40
	B ₂ C ₁ 41-71	1.08	0.09	7.25	6.3	17.0	6.8	0.5	2.1	26.4	20.1	32.4	44.0	2.1	3.0	35
	C ₁ 71-96	0.55	0.04	7.40	5.1	12.5	11.0	0.4	2.0	25.9	23.2	38.9	40.2	14	2.5	40

Table above shows that cultivated chestnut soils (test pits N 1, 2, 7) have differentiated soil profile and comparatively low content of humus gradually decreasing with the depth.

The last pattern is observed during the distribution of the total quantity of Nitrogen. The upper soil horizon has neutral (PH-7, 0) reaction gradually changing to weak base reaction (PH-7, 3-7, 4) with the depth. The carbonation of the soil increases with the depth amounting to 4, 3-4, 4 /by CO₂.

Calcium content is dominating in the complex of exchangeable cations amounting to 38, 8-41, 4 mg-equiv/100g, while Magnesium ranges between 10, 3-24, 4 mg-equiv/100g which is quite high in cultivable soils. The content of both absorbed sodium and potassium is not high.

Absorbed sodium content is under the permissible limit. Soils of the cultivable areas are characterized by heavy clay-sandy texture transiting to medium-to-light texture with depth. The content of silt fractions in cultivable areas is increasing with depth constituting 21.3% (test pit N1), whereas the content of water-resistant aggregates decreases.

Studied chestnut soils are characterized by low content of nitrogen, low-to-medium content of phosphor and high content of potassium.

The picture of humus content is as follows: humus content in 0-46cm layer of the test pit N1 amounts to 212.5t/ha, while in the 48-80cm layer it amounts to 49.0t/ha. The total quantity in 0-80cm layer amounts to 261.5t/ha.

The content of humus in 0-48cm soil layer of the test pit N2 amounts to 198.7t/ha, while in 48-77cm layer it is 33.6t/ha. The total content of humus amounts to 232.3t/ha.

The total humus content in the soil layers of the test pit N7 is 226.8t/ha, while it amounts to 306.8t/ha in the test pit N17.

In summary, humus content in the humic horizons of the chestnut soils amounts to 218.4-306.8t/ha, thus, in accordance with test pits, 0-50cm and 0-80cm soil layers need to be stored prior to mining operations for the implementation of rehabilitation in the future.

Cinnamon forest soils

(After-forest soils)

Cinnamon forest soils surrounding Amulsar were developed on the left bank of the river Arpa and are common on the territory of Gndevaz community bordering with black-soils and chestnut soils. These soils were developed on weathered products of different parent rocks and eluvial-diluvial-talus (rocks are represented by metal conglomerates, porphyrites, limestones, andesites, andesite-dacites and tuff breccia).

The soils of the study area are developing under conditions of complex rugged relief with separate areas of outcrops of severely eroded and washed parent rocks.

Cinnamon forest soils are distinguished by strong-to-medium capacity humic horizon with gradually decreasing humus content with depth, clay-sandy texture, cinnamon colouring, well expressed cloddy-granular (walnut) structure of the upper horizons and neutral-to-weak base reaction.

5 test pits and many profile cuts were performed in the study area. The description of the study area test pits is given below.

Test pit log N3 - placed on the left side of the ravine, 1300m away from the test pit N1, on a slope of 7-10 degrees of western exposition. The lands are steppified and used under pasturelands.

Horizon A-0-20cm – dark cinnamon colouring; flimsy; granular structure; plant root remains; heavy clay-sandy texture; porous; limeless; poorly humid, unnoticeable succession of genetic horizons,

Horizon B-20-72cm – cinnamon colouring, humid, hardened, medium clay-sandy texture; walnut-granular-coarse structure; stony; apparent succession of genetic horizons.

Test pit log N4 - placed 300m away from the soil pit N3, on the weakly eroded gently inclined (5-7°) slope of western exposition.

Horizon AB-0-32cm - light cinnamon colouring; stony; poorly humid; heavy clay-sandy texture; apparent succession of genetic horizons,

Horizon BC-32-42cm - light cinnamon colouring; pebbly layer; medium clay-sandy texture, apparent succession of genetic horizons.

Test pit log N5 - placed some 900m below the test pit N3, on a field with slope of 3-5 degrees of western exposition used for cultivation of Lucerne crop. The area is irrigated.

Horizon A-0-32cm - dark cinnamon colouring; turfy horizon; poorly humid; heavy clay-sandy texture; unnoticeable succession of horizon with cloddy-granular structure,

Horizon AB-32-56cm - cinnamon colouring; humid; heavy clay-sandy texture; small-walnut-granular structure; slightly carbonated; unnoticeable succession of horizons,

Horizon BC-56-90cm - light cinnamon; with fine stone fragments; humid; clayey texture; coarse structure.

Test pit log N6 - placed some 700m away from the test pit N5, on the wheat field of south-western exposition, sloping 5-7 degrees.

Horizon A-0-22cm - light cinnamon colouring on the surface; small-granular structure; weakly eroded; poorly humid; heavy clay-sandy texture; unnoticeable succession of horizons,

Horizon B-22-48cm -light cinnamon colouring with grayish tint; hard; stony; with poorly expressed structure; heavy clay-sandy texture; unnoticeable succession of horizons,

Horizon BC-48-93cm -light grayish with strew colouring; hard; stony; poorly humid; coarsely-structured; heavy clay-sandy texture.

Test pit log N8 - placed some 600m to the west of the test pit N6, on a slope of western exposition and 7-9 degree inclination.

Horizon A-0-26cm - cinnamon colouring; turfy; slightly stony; heavy clay-sandy texture; cloddy-granular structure; poorly carbonated; gradual succession of horizons,

Horizon B-26-45cm- light cinnamon colouring; walnut-granular-structured; medium clay-sandy texture; slightly stony; poorly humid; apparent succession of horizons.

In summary, studied cinnamon soils are distinguished by darker colouring and heavy clay-sandy texture on the surface and medium clay-sandy texture in the deeper layers, poor carbonation, humic horizons of strong-to-medium capacity, steppe lands which are used both under cereal crops and fruit gardens, as well as, for tillage and under pastureland.

Some physicochemical and chemical characteristics of the area's soils can be found in the table below.

Table 2

Physicochemical and chemical characteristics of cinnamon forest steppe soils

Test pit number N, exposition, inclination, elevation, m	Horizon Capacity cm	Humus content, %	Total N ^o , %	PH of water solution	CO ₂ %	Absorbed cations, mg-eqv/100g					Mechanical composition, Water resistant aggregates %			Nutrients, mg/100g		
						Ca ²⁺	Mg ²⁺	Na ⁺	K	Total	Fraction < 0.001 mm	Fraction < 0.01 mm	resistant aggregates	N	P ₂ O ₅	K ₂ O
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
N3- North-western exposition, inclination 7-10 degrees, 1780m	A 0-20	4.2	0.24	7.4	3.6 5.2	29.7	10.8	1.2	2.0	43.7 49.0	6.5	48.8	55.6	3.7	2.4	42
	B 20-72	2.40	0.11	7.3		33.2	13.9	0.5	1.4		6.2	44.0	50.0	3.5	1.2	40
N4- Western exposition, inclination 5-7 degrees, 1770m	AB 0-32	4.2	0.195	7.3	4.0 5.5	28.0	13.0	0.9	1.6	43.5 38.4	7.5	53.6	54.4	4.1	2.7	44
	BC 32-42	2.0	0.115	7.4		25.5	10.4	0.5	2.0		7.0	42.0	47.8	3.8	1.6	40
N5- Western exposition, inclination 3-5 degrees , 1640 m	A 0-32	4.53	0.296	7.5	1.8 2.3	47.2	11.9	1.1	2.3	62.5 60.1	8.1	60.6	48.9	5.1	4.5	83
	AB 32-56	2.20	0.124	7.4	4.7	50.1	7.3	0.7	2.0	54.5	7.3	55.0	58.0	4.0	0.9	63
	BC 56-90	0.85	0.09	7.4		31.1	20.8	0.5	2.1		10.6	48.8	50.4	4.0	0.9	44
N6- Western exposition, inclination 5-7 degrees, 1660 m	A 0-22	4.70	0.24	7.3	2.2 4.8	40.1	20.8	0.5	1.1	62.5 49.9	8.0	62.2	51.0	4.9	2.6	71
	B 22-48	2.30	0.136	7.2	5.2	39.9	8.8	1.2	2.2	51.1	8.8	56.8	53.8	3.8	2.7	48
	BC 48-93	0.8	0.11	7.3		42.4	7.2	0.5	1.0		12.4	50.0	47.3	3.0	0.3	41
N8- Western exposition, inclination, 7- 9degrees, 1825m	A 0-26	3.5	0.215	7.1	1.7 4.2	40.5	11.6	0.7	2.2	55.0 55.9	7.1	52.4	57.8	5.0	4.1	39
	26-45	2.8	0.140	7.3		39.6	13.8	0.5	2.0		7.8	43.0	50.1	4.3	3.6	40

The data shown in the table (table N2) reveals that the soils of the studied area are characterized from neutral-to-weak base reaction (PH-7-7.4) and low content of carbonates on the surface. Soil moisture content ranges from 38-62.5 mg-eqv/100g depending on the soil texture.

In the cultivated soils 55-60 and even higher mg-eqv/100g content of water can be found which decreases with depth to 40-42 mg-eqv/100g.

Exchangeable calcium is predominating over magnesium in the available water content amounting to 60-65% and in some test pits (N5) up to 75,5% with low content of exchangeable sodium and potassium.

The content of humus in the upper A horizon of the soil ranges between 4.0-4.7%. Depending on the humus content, the content of nitrogen is low and counts to 0.2-0.1%.

Physical clays in the upper horizons amount to 55-60% decreasing with depth. The content of silt fractions (<0,001mm) is ranging between 6-12%.

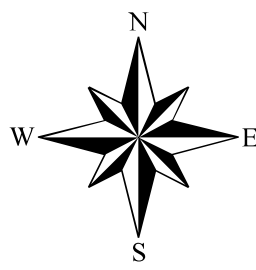
The content of nutrients in the cinnamon forest soils and chestnut soils shows the following tendency: low content of nitrogen, low-to-medium content of phosphor and low content of potassium.

The calculations indicate that the content of the humus in 0-72cm soil layer of the test pit N3 amounts to 265.2t/ha, in test pit N4 it amounts to 312.8t/ha, in test pit N5 it amounts to 246.4t/ha, in test pit N6 it amounts to 226.8t/ha and in test pit N8 it amounts to 184.3t/ha.

Summarizing, it can be concluded, that the soil layers of the upper horizons of the mentioned areas need to be collected and stored before mining operations to be used for rehabilitation in the future.

Քարտեզ-սխեմա
28-րդ տեղամասի սահմաններում
իրականացված հողերի տիպերի
ուսումնասիրության

Մասշտաբ 1:10 000



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բնակավայրեր

Ավտոճանապարհներ

- հանրապետական նշանակության
- միջհամայնքային նշանակության
- գրունտային

- գետեր
- վտակներ
- ջրանցքներ
- ջրամբարներ

բարձրության հորիզոնականներ

28-րդ տեղամասի արտաքին սահման

2 հողային կտրվածքներ

$\frac{1}{74.3}$ - $\frac{\text{հողատիպը}}{\text{զբաղեցրած տարածքը} \cdot \text{հա}}$

Հողերի տիպերը

- 1 լեռնային շագանակագույն հողեր
- 2 անտառային դարչնագույն տափաստանացված հողեր
- 3 ուժեղ թեք, խիստ հողատարված, մայր ապարի համատարած ելքերով տարածք

05.12.2013

ՀԱԱՀ «Հրամտ Պետրոսյանի անվ. Հողագիտության, ագրոքիմիայի և մելիորացիայի գիտական կենտրոն» մասնաճյուղ				
	Անուն, ազգանուն	Ստորագրություն	Մասշտաբ	Թերթերի քանակը
Կազմեցին	Վ. Պապինյան Ռ. Գրիգորյան		1:10 000	1
Ստուգեց	Ս. Կրոյան			
Տնօրեն	Հ. Ղազարյան			

