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Altai mountain soils of Mongol
(In case study of Harhiraa Turgen mountains)

O.Batkhishig

Institute of Geography, Mongolian Academy of Sciences
Ulaanbaatar 210620, Mongolia. *E-mail: batkhishig@gmail.com*

1. Introduction

Mountain area occupied big territory of Mongolia specially western and north-central part of country. This is main important pasture resourse of country, which on agroculture dominated nomadic husbundry. But, the mountain soils of Mongolia still not sufficient studied, especially high mountain areas. Only few materials published on the russian and mongolian languages [Bespalov 1952, Ogorodnicov1980, Maximovich Nogina1984, Batkhishig 2000, 2003, Dorjgotov 2003]. This is some characteristics of mountain soils mostly from Hangai and south-west part of Mongol Altai mountain regions. The classification of high mountain soils not complitely developed. About unsufficient study of high mountain soils noticed on the monography "The soils of Mongolia" [1984] and Mongolian National Atlas (text of chapter of "The soils").

On this paper presented result of mountain soil study, morphological, physical-chemical properties, specific of soil forming process in case of Harhiraa Turgen massif of Altai mountains of western Mongolia.

Mongolia is Central Asian country with extracontinental climate conditions. According to soil geographical regionality whole Mongolia including south side Russion East Sibyria dystuingished as „Central Asian soil bioclimatic phacia" [Nogina 1984]. The high elevation (average elevation Mongolia 1580m a.s.l) complicated relief feature other hand influence of extracontinental climate, long cold season, short vegetation period formed specific nature conditions, geography, soil and plant cover. Rapid changing nature geographic zones from desert to steppe,mountain forest and meadow. Many of scientists noticed about Mongolian soils cover as very complicated by the surface differences, soils characterized by short profiles with stony content, micelar form of carbonate and have influense of paleoprocess in soil features. Mountain soils have very clear exposition differences and horizontal zonality.

2. Study area and methods

The Harhiraa Turgen massifs belong to the Mongol Altai range mountain systems located in the northern part (fig.1). In the north-eastern side boundered by big depression-without outlet salted Uvs lake basine. Which surrounded by desert, desert- steppe and sand fields. Lowest point of western Mongolia is Uvs lake level with elevations 759 m a.s.l. From semidesert areas of depression up to mountains distributed mountain dry-steppe, meadow steppe, forest, high mountain meadow, and glacieted nival zone. The elevations of mountains up to 4000 m a.s.l (peak Turgen 3978m a.s.l) top with glaciers. High area of mountains with planation surfaces. One is biggest top plato is Olon Nuur situated in western side of Harhiraa Turgen massifs on the altitude about 2600m a.s.l. There is many small lakes and bog, meadows with permofrost. The slope exposition differences very clear, north slopes usually more steep some areas with forestry and south slope gentle without forest. This is evidence of more water erosion and solifluction activity of north slopes. Steep slopes usually with debris, and rocks.

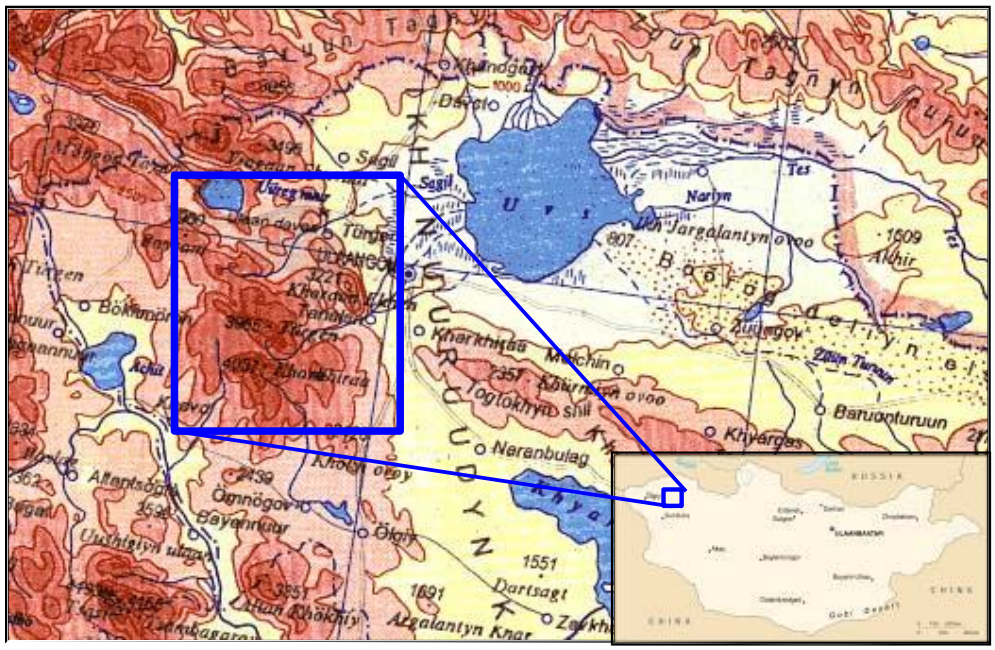


Figure 1. Study area

Base rock of mountain is mostly paleozoic granite, metamorphic schict and conglomerate paleozoic age. Parent soil sediment is gravil stony loam silt and loam, down slope and intermountain valleys more fine materials, silty. Some part of south slope of Harhiraa mountains from 2600m a.s.l and down occured morain gravil boulders filling by aeolian like fine sand, coarse silt sediments. This sediment usually without carbonate or deep leachad.

Climate of study area like as whole Mongolia characterized by extracontinentality, with long cold winter (January -20-30), short summer (July +20+25 ^{o} C T) and also days amplitude of air temperature big. Mean annual precipitation aruond 100-250mm, up to 70-80% of precipitations in the June-August moths. Soil developing period is short, most times in frozen conditions, very short (1-2 week) tranzit period between warm and cold season. In the mountain areas according to elevations increased precipitation (fig.2). The summer air temperature in high areas lower than down area, but in the winter marked climate inversion process up to 2000-2500 m a.s.l (increase air temperature). Comparing to central part of Mongol Altai mountain systems, the Harhiraa Turgen mountain area had more humid influnce by the high latitude position. Meadow and forestry north slopes is one is indicator of such humid influence.

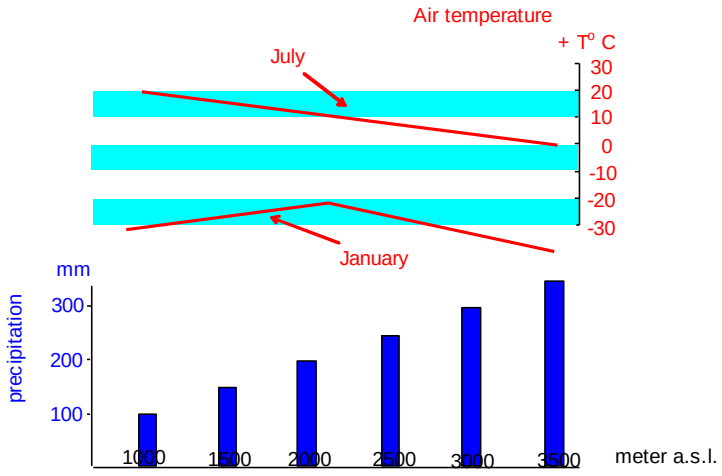


Figure 2. Mean annual precipitation and average air temperature of July, January months in different elevations of Uvs lake basine and Harhiraa Turgen mountain area.

The field investigations was conducted in 1995-1997. On this papers represented 14 most typical soil profiles in the (more than 2000 m a.s.l) Has and Hutul area of Harhiraa Turgen mountains. Compiled soil map of Harhiraa Turgen mountains in scale 1:500 000. Conducted main physical-chemical analyze of soils: organic carbon (humus)- by Turin method (oxidation by bichromat potashium-sulfur acid), $CaCO_3$- calcimetric, pH water (1:2.5)-pH potentiometric, texture-pippete method, exchageble cations - by Trilon B tetrimetric, F_2O_3 - Tamm extraction.

3.Mountain soils

The Harhiraa Turgen mountain regions situated just boundary positions between subarid and subhumid horizontal zonality of soils and plant cover. Morphological feature of mountain is like as Mongol Altai type with steep slopes high elevations but in climate of this area have more humid influense from north-west side. The Turgen mountain areas with forestry north slopes more subhumid than Harhiraa regions. But in the soil geographical regionality of Mongolia this area belong to the subarid zonality like whole Mongol Altai mountain systems. Subarid horizontal zonality is usually without forest.

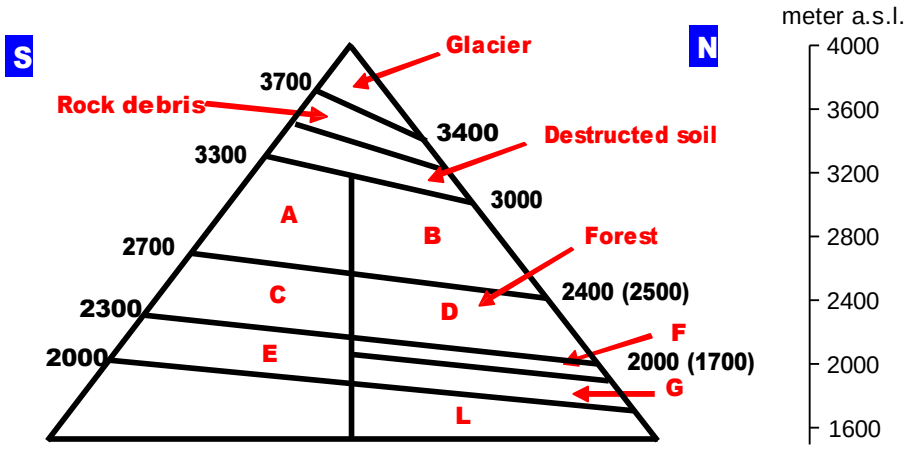


Figure 3. Schema of horizontal distribution of mountain soils in Harhiraa Turgen mountain area (Mongol Altai).

North slope soils: B-Mountain meadow, mountain boggy-meadow.
D-Mountain derno-taiga, mountain chernozem.
F-Mountain meadow chernozem,
G-Mountain dark kastanozem
L-Mountain kastanozem.

South slope soils: A-Mountain meadow, Mountain meadow steppe.
C-Mountain steppe, (raw humus)
E-Mountain dark kastanozem, mountain kastanozem.
H-Mountain kastanozem, Kastanozem.

In the Harhiraa Turgen regions we established horizontal distribution of soils north and south slopes according by elevations (fig.3). Slope exposition differences very clear. Boundary of soils not so sharp, defence of slope steepness.

General distribution of soils shown in fig.4. and soil map of Central part of Harhiraa Turgen mountain in scale 1:500 000 (fig.5).

The rock weathering, humus forming, soil erosion and accumulation is typical soil process in mountain areas. But, intensivity character pecularity of this process is cuased by microrelief and microclimate conditions of territory. Relief and climate is mian factor of soil forming process in mountain areas. Mongolia specially mountain areas have very short vegetation periods (90-70days in year). So, biological activity of decay and humus accumulation is weak. Permofrost and glasiers melting water is becoming one is additional source of moustere of gruond and soils specially north slopes. Slope steepness directly influensed soil erosion and accumulation activity and water regime. Also vegetaion cover, parent rock, permafrost and paleogeographical history have influence of soils features.

We defined 4 different areas of distribution of mountain soils in due of geomorphological positions.

1. Planation surface.
2. North slope.
3. South slope.
4. Valley bottom meadow.

Planation surface soils. High part of mountains begining around 2500-2700m a.s.l different level of planation surfaces. The planation surface area have more mousture conditions. Under mountain meadow grass vegetations formed mountain meadow-boggy, meadow and meadow steppe soils. With undreinad small depressions usually meadow-boggy soils on the permafrost.

High mountain meadow steppe soil. One is most typical soil of high mountain area. This soil tranzit positions between Mountain meadow and mountain steppe soils. Result of global warming and retreat of glaciers, occured steppization of meadow area.

Profile No.4. On the top of Has mountains. 2760m a.s.l. Even plato, with paleo poligonal frozen structures. Poligons diametr 1-1.5m, boundary fissures filled by stones, centre small depressions. High mountain meadow grass-forbs with lichen. (*Carex melanantha, C.macrogyna, Kobresia bellardii, Cetraria sp, Cladonia sp*).
Organic (O) accumulation horizon (0 - 6 sm), dark coloured, undecaeyd plant residues and roots, silty. Humus (A) horizon (6 -15sm), dark brown, grass roots, clay silty, stone (10-20%), boundary sharp by colour. Silt accumulation and parent rock stones (BC) tranzit horizons from 15sm to 30sm, yellowish dark brown coloured silt stony (40-50%) metamorphic schit.
Soil rich witn undecayed organic content, shallow humus layers, not clear mottly gleyzation and permfroyst, because polygon fessure is becaming good dreinage. In down of profiles very little carbonate content (tab.1). Exchangeble cations not so high 8-4 meq/100g of soil, because soil reaction is neitral. In high elevations more precipitation in summer season, so this time soil with active leaching rejimes marked movement of iron oxid Fe_2O_3 up to 2,5%.

Mountain meadow-boggy soil. On the planation surfaces of mountains distributed many areas with boggy soils which not indicated on the Soil maps of Mongolia (scale 1:1 000 000). Soil scientists which was invistigated mountain soils of Mongolia not characterized and mentioned about mountain boggy soils. But some parts of mountains big area occupied by boggy soils, for example: Olon nuur. The mountain boggy soil is not typical for subarid horizontal zonality. One is additional source of water is permofrost and glacier.

2800 m a.s.l . Mountain boggy on the permofrost , Carex (*C.macrogyna, C.orbicularis*) and moss, plant cover 90-100%,relief with small moundy.

Table1. Chemical properties and texture of mountain soils

Profile No. Soil horizons	Depth (cm)	pH (H2O)	$CaCO_3$ %	Humus %	Exchangable meq/100g. Ca^{+2}	Exchangable meq/100g. Mg^{+2}	Fe_2O_3 %	Physical clay < 0.01 mm	Clay < 0.001 mm
PLANATION SURFACE SOILS									
4. High mountain meadow steppe. 2760m a.s.l									
AO	0-6	6.8	-	11.3	8.0	5.0	2.2	30.1	11.0
A	6-15	7.0	-	7.7	8.0	4.0	2.5	28.0	17.5
AC	15-30	6.8	0.3	2.9	6.5	3.5	2.2	40.5	12.7
14. Mountain meadow-boggy. 2790m a.s.l									
O	0-10	6.5	-	23,4*	29.4	2.5	n.d.	41.4	20.6
ABg	10-17	6.5	-	5.5	21.0	3.2	n.d.	32.2	13.5
Ab	17-23	6.8	-	5.3	20.4	1.7	n.d.	39.2	15.8
BCg	40-50	7.3	0.4	0.5	14.7	2.4	n.d.	30.4	12.3
NORTH SLOPE SOILS									
12. Mountain meadow. 2850m a.s.l									
AO	0-7	7.3	-	12.9	22.4	5.6	n.d.	34.4	14.7
A	7-12	6.0	-	9.8	19.3	4.8	n.d.	35.8	12.0
AB	12-18	6.5	-	8.9	18.3	1.7	n.d.	33.7	15.3
BC	18-30	6.5	1.13	6.5	14.2	1.8	n.d.	37.8	17.3
3. Mountain boggy-meadow. 2450m a.s.l									
O	0-10	7.0	-	27,5*	13.0	6.7	1.2	41.6	17.2
ABg	10-20	7.5	-	10.9	11.3	5.0	1.3	33.9	12.2
5. Mountain meadowish-steppe. 2400m a.s.l									
AO	0-5	7.4	-	7.3	7.0	3.0	3.5	50.1	17.2
A	5-15	7.2	-	7.8	6.8	2.2	2.8	59.8	20.7
AB	15-31	7.0	-	3.6	6.5	2.0	2.5	68.6	25.5
BC	31-50	6.9	-	3.2	5.4	1.0	0.8	54.9	23.2
6. Mountain meadow-peat. 2390m a.s.l									
O	0-7	7.0	-	15.0	6.2	3.0	3.4	47.9	21.0
A	7-20	7.3	-	14.2	6.4	3.0	3.4	57.0	25.0
AC	20-30	7.0	-	12.5	6.4	3.2	2.8	42.5	26.4
2. Mountain derno-taiga. 2260m a.s.l									
O	0-4	7.0	-	11.3	14.7	10.0	0.7	27.7	11.6
AO	4-15	7.1	-	10.5	18.0	6.5	1.3	29.3	12.3
BC	15-30	8.0	-	4.4	16.0	4.0	2.4	44.1	15.6
7. Mountain meadow chernozem. 2170m a.s.l									
AO	0-8	6.6	-	17.6	5.5	3.3	2.8	40.9	21.3
A1	8-14	6.8	-	10.3	5.6	3.3	1.4	44.6	14.5
A	14-30	7.2	-	7.1	5.0	2.8	1.4	38.3	20.6
BC	30-50	7.2	-	0.9	5.6	2.0	1.0	38.0	18.0

* - loss of ignitation

Profile No.14. Harhiraa mountain, 4-5km east side from Harhiraa peak glaciers top plato depression with small lakes Hutuliin nuur surrounded by small hills with tuff basaltic rokcs.

Organic accumulation (O, 0-10 sm) horizon, dark greyish coloured, grass moss root mass, silty. Humus and tranzit horizon (ABg, 10-17sm) grey dark, with gleyd mottly stain, stone fine sand silty. From 17sm buried organic layer (Ab, 17-23) dark greyish, few stone silt,

boundary sharp by colour. Down greyish yellow, gravil sandy, tranzit horizon up to permafrost (60sm). Soils very wet up 20sm filled by water. The mountain boggy soils has accumulation of organic residues, peat. In reduction conditions very active gleyzation process. Soil reaction weak acid(tab.1). Exchangeble calcium reach 29.4-20,4 (meq/100g of soil) possible migration of Ca surrounding tuf basaltic rocks hills and accumulation in the depressions.

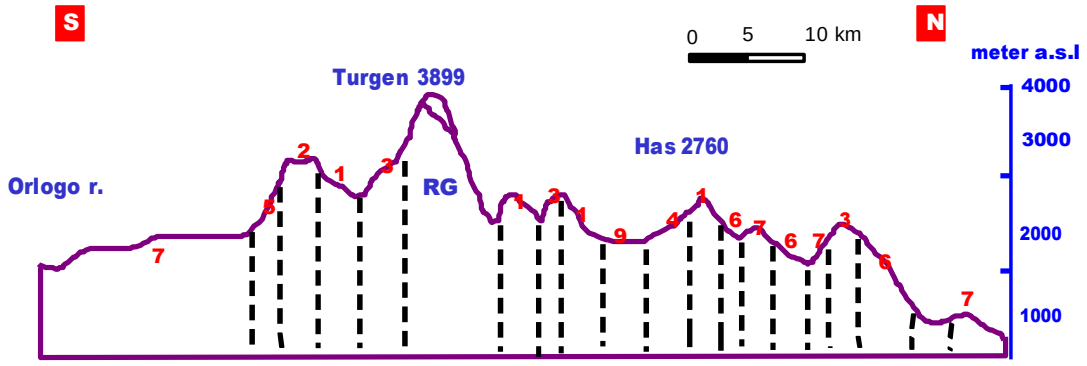


Figure 5. Soil-geomorphological transect of Harhiraa Turgen mountains.
Soils: 1-Mountain meadow, 2-Mountain meadow-boggy, 3-Mountain meadow-steppe, 4-High mountain steppe, 5-Mountain dry-steppe raw humus, 6-Mountain derno-taiga, 7-Mountain dark kastanozem, 8-Mountain meadow chernozem, 9-Meadow cryomorphic, RG-Rock debris and Glaciers.

4.North slope soils.

North slopes more moustere conditions than south slope, glacier, permofrost melting water becoming one is additional source of soils water. Soils cover very complicated defence of slope steepnes, micro-relief , plant cover and rock materials. In field investigations we are distinguished following area of distribution of soils cover (fig.3). Low boundary of glaciers 3400 m a.s.l , from glaciers down until 3000 m
rock debris, only low parts around 3000m a.s.l with small depressions with permafrost melted water areas covered by vegetations 20-40%. Mostly lichen. Very thin humus laeyr.

Area between 3000-2400m a.s.l developed mountain meadow and boggy-meadow soils. Some steep slopes with debris and rocks. On the slopes, steepe than 25-30^{o} very fragmentar destructed soil and plant cover.

Mountain meadow soil. One is main type of soils in high part of mountains. Basically developed north slopes, under mountain meadow vegetations.
*Profile No.12.*Up stream part of Harhiraa river valley. North slope 4-5°, 2850m a.s.l. Meadow with Kobresia-carex. (*Carex melanantha, C.orbicularis, Kobresia bellardii*). Plant cover 85-95%.
Organic humus horizon (AO 0-7sm) dark black coloured plant roots concentration, few gravils, silt. Humus (A 7-12sm) horizon black, plant roots less than up horizon, few gravil (5-10%) silty, subangular structure. AB (12-18sm) horizon black kastanozem coloured down becaming yellowish chesthut, stony(20-30%) silt. BC (18-30sm) brown kastanozem, stony(30-40%) silt. From 30 sm (C) parent rock, stones, basaltic tuf, metamorpic shcist, slatestone.
Mountain meadow soils with good developed humus horizons, upper parts concentration of roots. Specific of mountain meadow soil is not active gleyzation because stony parent material is good drainage. Leached by carbonates, soil reaction neitral down profile weak acid. In the upper organic humus laeyrs increased content of exchangable Ca and Mg, this is related to the amount of organic humus content.

Mountain boggy-meadow soil. On the north slopes very often small depressions solifluction permofrost originally. This depressions with stagnant of waters developed boggy-meodow soils. Mountain boggy-meadow soils on the slopes not occupied big area comparing to planation surface areas.

Profile No.3. East-north slope of Has mountains. 2450m a.s.l. Slope with rocks. Small boggy depressions 10m long and 7m wide. Forb-carex boggy meadow.

Carex melanantha, C.orbicularis, Peat accumulation (O, 0-10sm) laeyr with greyish dark colour,concentration of roots and peats. Humus gley horizon (Abg 10-20sm) black grey, red stainy, mottly, roots, silt. water (after 10 min). This soils have thin organic humic laeyr.

On the small depressions accumulated organic materials and peat. Clear soil gleyzation process. Soil reaction is neitral.

Mountain meadowish steppe soil. More drained, positive part of slopes developed soils with featuress steppe soils.

Profile No. 5. East-north slope (8-10°) of Has mountains. 2400m a.s.l Small mound with rocky. Forb-gras mountain meadow-steppe. Soil have good developed humus horizons (31sm) with content of humus 7.8-3.6% , upper ptofiles with concentration of roots, humus horizons black kastanozem coloured gravil stony silty, from 50sm-s begineng parent rock. Between parent materials and humus horizons have tranzit horizons (BC) accumulations of clay particles. Soils silty humus contents penetrated by stones. On the surface of the stones covered by very clear humic clay cutans, which indicated by horizontal movement.

Mountain meadow peat soil. From upper boundary of distribution of forests up to 30-50m continiud tranzit zone between forest and high mountain (alpine) meadow area. On this tranzit zones growing single trees and small bushes. Soils have features between mountain derno-taiga and mountain meadow soils. The relief surface is different rocky up area and depressions. Small depressions with bushes developed mountain meadow peat soil.

Profile No. 6. Mid part of north-east slope of Has mountains, hearby profile No.5. Elevetion 2390m a.s.l. steepness 8-10°. Smal depression with size 1.5 and 3.0m. Bush (*Dryas oxyodontha*), moss.

Soil have peat humus horizons with high content of humus 15-12%. Down profile humus content not so decreased. Soil reaction is neitral. Depression with bushes have more humid condition, so it is suitable for peat accumulation.

Mountain derno-taiga soil. North slopes mountain between 2400-2000 m a.s.l covered by forests(Larix Sibirica). Some area with steep slopes forest begining from 1700m a.s.l. On the forests developed derno-taiga and mountain forest dark coloured soils. In Mongolian forest regions not developed podzolic soil. Because, for the soil leaching process not enough presipitation, very short warm period, even in this time soil temperature very low by the permafrost impact.

Profile No.2. North-east slope of Has mountain. 2260 m a.s.l. steepness 5-7°. Forest (larix Sibirica). Forb and moss.

Soil covered by trees needles and organic materials. Short organic humus horizon content of soil organics very sharp decreased by depths. From 15 sm begining stone and gravils. On the surface of the stones clay movement. Soil reaction up part weak acid, down neitral. Not permafrost, profile was makinc late 24 August possible melteng other wise stone gravil texture not long frozen.

Mountain meadow chernozem. On the north slopes down to 50-100m from forests distributed mountain chernozem and meadow chernozem soils. This area moustered by ground and surface water from forest.

Table2. Chemical properties and texture of mountain soils

Soil horizons	Depth (cm)	pH (H_2O)	$CaCO_3$ %	Humus %	Exchangable meq/100g.		Fe_2O_3 %	Physical clay	Clay
					Ca^{+2}	Mg^{+2}		< 0.01 mm	< 0.001 mm
SOUTH SLOPE SOILS									
11. High mountain steppe.2910m a.s.l									
A	0-6	7.5	-	16.7	24.3	2.7	n.d.	36.3	17.6
AC	6-15	6.3	-	13.4	19.5	5.0	n.d.	45.2	22.8
13. Mountain meadow-steppe. 2850m a.s.l									
AO	0-4	6.3	-	16.0	17.4	2.6	n.d.	41.9	20.0
A	4-16	6.3	-	7.0	18.4	2.4	n.d.	27.9	10.2
BC	16-30	6.3	-	0.7	9.0	1.4	n.d.	26.4	12.7
15. Mountain dry-steppe raw humus. 2600m a.s.l									
AO	0-7	6.5	0.75	8.1	15.6	2.4	n.d.	36.1	20.5
A	7-20	6.5	0.75	4.1	13.0	2.0	n.d.	29.1	12.3
AB	20-32	7.0	1.13	3.4	14.0	1.8	n.d.	28.5	11.3
BC	40-50	7.3	1.50	0.5	17.6	1.0	n.d.	28.4	12.1
8. Mountain dark kastanozem. 2230m a.s.l									
A	0-8	7.0	0.14	12.7	8.2	2.0	0.7	31.0	15.1
AB	8-20	7.3	0.14	3.2	8.4	4.6	0.8	25.8	24.2
VALLEY BOTTOM SOILS									
9. Mountain meadow frozen. 2690m a.s.l									
O	0-6	7.1	-	7.19	8.2	2.8	1.4	35.3	15.4
Ag	6-20	7.0	-	6.26	8.4	5.6	1.8	42.3	15.4
BC	20-30	6.9	-	3.25	8.4	5.6	2.0	49.9	20.4
1. Typical meadow stepped. 2160m a.s.l									
AO	0-5	7.6	-	4.7	16.4	6.6	0.7	22.8	11.9
A	5-23	8.0	-	5.1	10.0	4.6	1.2	26.8	11.4
ABg	23-51	7.8	-	4.8	9.5	4.0	1.5	24.3	10.2
Ab	51-55	8.1	0.20	10.3	8.0	3.5	1.1	41.6	15.0
B	55-75	7.5	0.20	6.4	5.7	2.0	-	34.8	13.3
ABb	75-85	7.6	0.20	7.7	3.0	1.5	-	36.5	14.9
C	85-95	7.0	0.20	0.8	3.8	1.0	-	26.7	10.7

* - loss of ignitation

Profile N°. 7. Has river valley. Fan slope of Has mountains. 2170m a.s.l. East-north exposition 4-6°. Meadow. (*Leumus chinensis, Ranunculus sp, Potentillia sp).*
Soil have good developed humus horizon (30sm). Upper part of profiles with root concentrations. Black kastanozem colours no mottlys. Not stagnation of waters. Humus and organic content accumulated mostly from up sides by the surface water flows.

5.South slope soils

The south slope is more dry comparing to north slopes. Solar radiation caused more evaporation in the south slopes. In the south slopes formed mostly steppe featured soils. The

soils cover also complicated by relief character, slope steepness and vegetation, rock debrys e.t.c. But dystinguished by general distribution of soils by elevation differences. In the high elevations from 2700m a.s.l up to 3300 m a.s.l occured mountain meadow-steppe, meadow and steppe soils. Down to mountain slopes this soil changed to mountain dry steppe raw-humus, mountain dark kastanozem and kastanozem soils (fig.2).

High mountain steppe soil. This soils distributed in mountains in elevations between 3300-2700m a.s.l. Mostly on the south slopes, more drained part of reliefs.
Profile No. 11. In 5-6 km east from Harhiraa peak mountains. On the top of the mountains 2910m a.s.l. South exposition 2-3°. On the surface rock and stones, soils cover 40-50%. High mountain steppe. (*Cobresia sp, Carex sp, Potentillia sp,*) Lichen.
Shart soil horizon (A,AC), in the 15sm beginning rock gabbro-diorit. High content of humus and organic residues.

Mountain meadow steppe soil. On the small depression, plain gentle slopes formed this soil. *Profile No.13.* In 500 m south from profile No.11. South slope 3-4°. Mountain meadow steppe. Forb-Cobresia-Carex, plant cover 70-80%.
Upper 4sm of soil profiles is peaty, root plant concentration, down (4-16sm) humus horizon structured, stony, black coloured with greyish shine. BC horizon (16-35sm)-brown dark coloured fine snd silty, from 35sm rock stone. Soil not effervishing from 10% HCI. Comparing to mountain steppe soils, this soils have more thick horizon, distuingished tranzit (BC) horizon.

Mountain dry-steppe raw humus soil. In the central part of Mongol Altai regions described this soils N.A.Nogina and Maximovich (1984) and classified as mountain dry-steppe raw humus soil. Morfological feature of this soils very like to the dark kastanozem soils, but have more raw coarse humus content.
Profile No.15. Harhiraa mountains up stream of Orlogo river. South slope 4-6°, with moraine granite boulders. 2600m a.s.l. Mountain steppe. Forb-Cobresia-Festuca vegetation cover 60-70%. Cobresia and Festuca formed small pillow like mound with 4-7sm height and 10X20sm size. AO(0-7sm)-humus organic horizon with root organic accumulations, A(7-20sm)-dark kastanozem with brown reddish shine, structured, fine sand texture, AB(20-32sm)-structured, stony, fine sand texture, BC(32-50sm)-morain sand granit stone. Soil horizon boundary not so sharp, all profiles with reddish shined kastanozem colours. Not accumulation of carbonate only down part of profiles small content of carbonate. Texture of soils fine sand, aeolian like sediment with moraine granit boulders.

Mountain kastanozem soils. One is most distributed soils of mid elevations of mountains. This soils occur on the south slopes up to 2300m a.s.l, north slopes up to 2000m a.s.l. From up boundary to down distributed mountain dark kastanozem, m-kastanozem, m-light kastanozem soils. Lower boundary of this soils approximetily boundary between mountain and plains.
Profile No.8. East mountain from Has valley. Mid part of south-west slope 18-20°. Mountain steppe Artemisia-Festuca. Vegetation cover 60-70%. On the surface gravil stones. A(0-8sm)-dark kastanozem, rooty, stony(20-30%) silt. AB(8-20sm)-kastanozem, stony (50-60%) silt, rock stone from 20sm. Soil profile very shallow and stony.

6.Valley bottom soil.

Intermountain valley bottoms with meadow, bogs and steppes. Nearby river territory floodplains developed meadow and boggy frozen soils. Lower than 2000 m a.s.l part of

intermountain depressions distibuted dark kastanozem soils. Width of valleys different, high part of mountains becoming more wide some areas reach to 1-2km. Soils cover will vary from relief and mousture conditions.

Mountain meadow frozen soil. *Profile No.9*. Up stream of Turgen river U shaped valley, north side of Tsagaan Deglyi (peak Turgen). West slope 5-6°, 2690 m a.s.l Moraine boulder, rock and stones, boggy-meadow and meadow. Soil covered by moss raw humic layer(0-6sm), down (Ag 6-20sm) humus gleyer horizon with little grey shined and small rare red stains. Soil humus and fine materials penetrated by between stones from 20sm and down. Soil course silty down increased clay content (Tab.4). Mobil Iron oxid increased down.

Typical meadow stepped soil. *Profile No.1*. Has valley bottom 2160 m a.s.l. Meadow stepped, Forb-grass Leymus chinensis, Potentillia, Carex.
Soils formed on the laeyred silty and sandy sediments. 0-5sm rooty silt, 5-23sm humus horizon, black kastanozem, fine sand and silty, 23-51sm laeyred silt and fine sand with small rare reddish stains, 51-55sm fossil humus horizon with high content of humus (up to 10.3%) course silty, 55-75 sm laeyred silt gravil fine sandy, 75-85 sm next fossil humus silty, 85-95 sm gravil sandy sediment. This soil one is example for the steppezation soils of mountain areas. Upper part soil reactions becaming weak alkaline, down profiles marked little accumulation af carbonate.

Conclusion

1. In result of investigations was established and accuraced vertical and horizontal distribution (compiled soil map scale 1:500 000) of soils in Harhiraa Turgen mountain areas.
2. Characterized morphlogical and physical-chemical properties of most typical mountain soils specially high mountain areas.
3. In the high part of Harhiraa Turgen (in altitude 2600-2800m) mountains on the planation surfaces distributed mountain boggy and boggy-meadow soils, which was in Mongol Altai regions fisrt time characterized.
4. On the south slopes between 2500-2700m formed specific soils with raw humus. Soil morphological feature is like as kastanozem soils but humus organic content more raw with undecayed organic contents. This is influense of long cold condition not sufficient biological active time for decay organics.
5. High mountain soils leached by carbonate only mountain steppe soils (mountain kastanozem, mountain dry-steppe raw humus) have carbonate horizon.
6. Very short vegetation period so humus forming process is slowly. Mountain soils covered by thin laeyrs with undecayed organic resudies. Shallow humus horizon 15-20sm, between humus and parent rocks usually tranzit horizon.
6. In the high mountain soils and mountain derno-taiga soils marked iron oxid movement. Gleyzation process not active only indicated by weak greyish shine colours, undreinad area boggy soils more clear gley features.
7. In the mountain soils down to profiles occured not intensive but clear silt and clay movement, the surface of stones with clay cutans.
8. In the Harhiraa Turgen mountain areas in result of global warming, soils steppezation process activated, very often soils have stepped features.

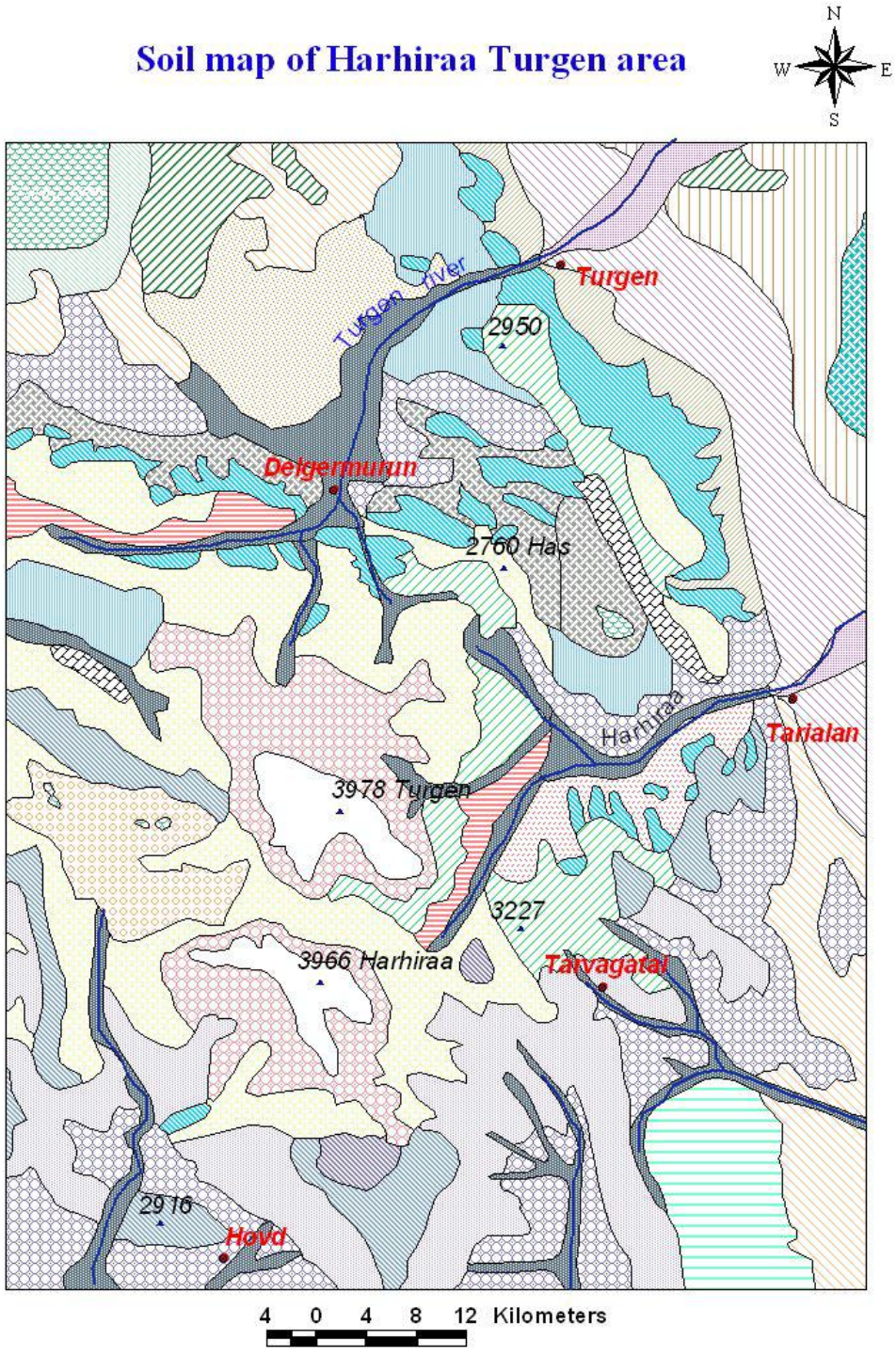
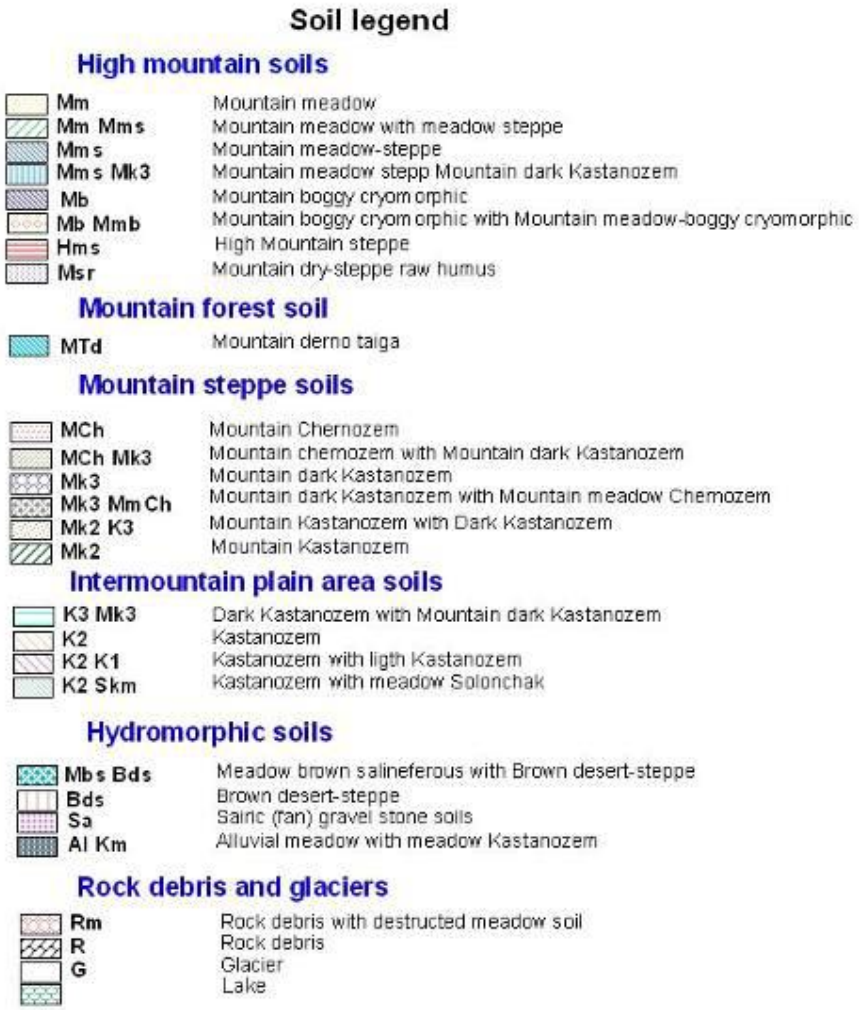


Figure 5. Soil map



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