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PHYSICAL PARAMETERS AND MICROMORPHOLOGICAL DESCRIPTION OF SANDY SLOVAK SOIL

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A b s t r a c t. Physical characteristics of sandy soil of Slovakia treated with various substances with special attention to micromorphological description and crop yields are presented. A list of models suitable for crop prediction on such soil is proposed.

K e y w o r d s: sandy soil, physical characteristics, micromorphological description, crop models.

INTRODUCTION

The contribution of Slovak co-partners to the multilateral project 'Quantitative and qualitative assessment of soil structure functions for the sustainable agricultural plant production' is physical characteristics of sandy soil treated with various substances and the crop yield.

Additionally a micromorphological description of this soil and other soils of co-partners from Austria, Czech Republic, Hungary and Poland was done.

SOIL DESCRIPTION

Investigated soil profiles are located at Gbely within the Zahorska nizina lowland about 155 m a.s.l. This region is a part of the Vienna basin (SW Slovakia). It is built by Neogene and Quaternary sediments. The soil cover in this area is not uniform as the soils are derived from texturally different Quaternary sediments. All the soil profiles are located on Würm terrace which is covered by aeolian sands and are classified as light textured Phaeozem (local name: Ciernica typicka arenicka). Basic properties of these soils are described in other papers [3-5].

Soil profile description: Soil type: Arenic Hapli Gleyic Phaeozem (WRB 1994); Ap (0.0-0.3 m) dark, (2.5 Y 3/1 in wet conditions), crisp, structureless, sandy transition to A (0.3-1.0 m) dark, (2.5 Y 2/1 in wet conditions), rusty spots, more compacted, weakly crumb, sandy, gradual transition to A/Cg (1.0-1.2 m) brown, (2.5 Y 4/2 in wet conditions), rusty spots, compacted, weakly crumb, loamy sand, gradual transition to 2 Cg (> 1.2 m) light brown, (10 YR 6/7 in wet conditions), rusty spots, sandy loam.

Climatic data are shown in Table 1.

METHODOLOGY

Soil profile was digged in an experimental plot in which some experiments for the yield improvement are carried out. The pattern of this three year experiment is as follows:

1. Control, K or G-6, soil without fertilization.
2. Bentonitic clay application G-1.
3. Ekofert and bentonitic clay application G-2.
4. Ekofert, manure and bentonitic clay application G-3.
5. Manure and bentonitic clay application G-4.
6. Ekofert and manure application G-5.

Acreage : 0.5 h for each field
Crop rotation:
1) year - winter wheat,
2) year - ensilage maize,
3) year - sunflower.
Doses:
- bentonitic (marly) clay: 40 t ha^{-1} (particles < 0.001 mm = 46.2 %, carbonates content = 31.5 %,
- manure: 40 t ha^{-1},
- Ekofert: 5 t ha^{-1} (Market name for a lignitic coal specially treated).

The total content of some risky elements in Ekofert is given in following table:

Element	Limit of concentrations (ppm)	Actual conc. (ppm)
Cr	30	22-24
Pb	30	3
As	3	0-3
Cd	1	0.5-2
Hg	0.5	0.07

RESULTS AND DISCUSSION

The results of the experiments are presented in Tables 2-11. The soil fertility was changed very significantly. The crop yield on some treated fields has more than doubled as compare to the control.

But basic physical properties were not changed very significantly. Bulk density in the ploughed layer on untreated soil was 1650 kg m^{-3} but on treated soil ranged from 1550 to 1450 kg m^{-3}. The differences in the subsoil were much lower: from 1620 to 1550 kg m^{-3} for treated soil, and 1660 kg m^{-3} for untreated one.

Some more significant changes were observed in infiltration rate and hydraulic conductivity. The infiltration rate has lowered and ranges from 0.20 to 0.48 m day^{-1} on treated soil, which is two time lower as compare to 0.97 m day^{-1} for the ploughed layer in the control, except experimental field G-1 in which infiltration rate was 1.45 m day^{-1} in topsoil and 0.87 m day^{-1} in subsoil, respectively.

Table 1. Average air temperature (°C) for seasons: October 1992 - September 1993 and October 1993 - September 1994

Cool half-year							Warm half-year							Year
10	11	12	1	2	3	dev.	4	5	6	7	8	9	dev.	dev.*
October 1992 - September 1993														
8.1	3.9	-0.7	0.0	-2.0	2.7	-0.6	10.1	16.8	17.4	18.2	19.2	14.3	0.6	0.0
October 1993 - September 1994														
10.7	1.0	1.4	2.6	0.7	7.1	+1.3	9.8	14.3	18.0	22.4	20.7	16.6	+1.6	1.4

*dev. - deviation.

Table 2. Precipitation (mm) for seasons: October 1992 - September 1993 and October 1993 - September 1994

Cool half-year							Warm half-year							Year
10	11	12	1	2	3	N%	4	5	6	7	8	9	N%	N%*
October 1992 - September 1993														
41	33	62	21	33	34	96	18	41	78	81	75	23	90	92
October 1993 - September 1994														
53	27	79	53	14	34	111	67	116	41	22	49	33	101	105

* N% - percentage of normal.

Table 3. Soil texture of Arenic Hapli Gleyic Phaeozem (HGP)

Experimental field	Depth of soil sampling (m)	Percentage of fractions (mm)					
		>0.25	0.25-0.05	0.05-0.01	0.01-0.001	<0.001	<0.01
G-1	0.05-0.15	59.40	23.27	7.82	4.49	5.02	9.51
	0.25-0.35	53.78	28.93	7.42	4.27	5.60	9.87
G-2	0.05-0.15	54.07	29.15	7.15	4.31	5.32	9.63
	0.25-0.35	48.93	32.81	7.62	4.15	6.49	10.64
G-3	0.05-0.15	55.94	23.89	7.73	5.43	7.01	12.44
	0.25-0.35	53.24	26.11	8.40	5.59	6.66	12.25
G-4	0.05-0.15	51.07	26.34	8.72	6.40	7.47	13.87
	0.25-0.35	51-98	26.63	8.08	6.22	7.09	13.31
G-5	0.05-0.15	71.45	17.28	4.45	2.09	4.73	6.82
	0.25-0.35	69.98	19.39	3.92	2.64	4.08	6.72
G-6	0.05-0.15	65.76	19.98	5.30	3.66	5.30	8.96
	0.25-0.35	63.11	23.42	5.11	3.79	4.57	8.36

Table 4. Basic physical properties and hydraulic conductivity of HGP in GBELY (1992)

Experimental field	Depth of soil sampling (m)	Bulk density (kg m^{-3})	TP	NP	RWC	MCC	V_A	K_s (m d^{-1})
			(%, v/w)					
G-1	0.05-0.15	1550	39.2	7.1	25.4	28.1	11.1	0.92
	0.25-0.35	1600	39.5	4.8	26.7	32.5	7.0	0.50
G-2	0.05-0.15	1480	40.0	7.5	24.8	29.2	10.8	0.72
	0.25-0.35	1590	39.4	4.4	25.5	30.1	9.3	0.85
G-3	0.05-0.15	1490	41.0	7.7	27.4	29.5	11.5	0.58
	0.25-0.35	1570	38.5	4.5	29.0	32.1	6.4	0.43
G-4	0.05-0.15	1450	40.4	7.9	25.6	30.1	10.3	0.60
	0.25-0.35	1550	39.2	4.7	27.0	32.4	6.8	0.39
G-5	0.05-0.15	1470	40.8	7.6	25.8	29.4	11.4	0.62
	0.25-0.35	1620	39.5	4.9	26.8	33.0	6.5	0.41
G-6	0.05-0.15	1650	37.9	6.7	21.2	37.8	10.1	1.20
	0.25-0.35	1660	38.2	4.5	25.0	31.7	6.5	0.85

Explanations: TP - total porosity; NP - non-capillary porosity; RWC - retention water capacity; MCC - maximal capillary porosity; V_A - minimal air capacity; K_s - saturated hydraulic conductivity of water.

Table 5. Basic physical properties of HGP in GBELY (1993)

Experimental field	Depth of soil sampling (m)	Time of sampling	Bulk density (kg m^{-3})	TP	CP	NP	SP	MCC	RWC	WP	PDA
							(%, v/w)				
	0.05-0.15	IV	1520	42.0	22.5	10.2	9.3	27.4	22.5	6.9	15.3
G-1		IX	1680	36.2	18.9	9.9	7.4	22.9	18.9		
	0.25-0.35	IV	1760	33.3	21.7	7.7	3.9	24.4	21.7	7.0	15.2
		IX	1700	35.3	19.4	11.9	4.0	21.7	19.4		
	0.05-0.15	IV	1580	39.5	20.8	9.7	9.1	25.4	20.8	6.9	19.5
G-2		IX	1650	37.1	20.5	9.6	7.0	24.6	20.5		
	0.25-0.35	IV	1680	36.0	20.2	9.6	6.2	23.5	20.2	7.2	14.1
		IX	1670	36.4	21.1	11.1	4.2	23.2	21.1		
	0.05-0.15	IV	1570	40.4	24.2	8.5	7.7	28.2	24.2	7.7	16.6
G-3		IX	1600	39.0	22.3	8.8	7.9	26.7	22.3		
	0.25-0.35	IV	1690	35.9	21.8	9.3	4.8	24.0	21.8	7.7	15.4
		IX	1730	34.4	20.6	10.3	3.5	22.6	20.6		
	0.05-0.15	IV	1550	40.8	25.1	8.4	7.2	28.7	25.1	8.2	17.6
G-4		IX	1610	38.7	25.4	8.5	4.8	28.0	25.4		
	0.25-0.35	IV	1770	32.8	24.2	6.5	2.1	25.3	24.2	8.0	16.9
		IX	1680	36.2	22.4	10.8	3.0	24.0	22.4		
	0.05-0.15	IV	1580	39.9	21.8	9.2	8.9	26.4	21.8	6.1	16.3
G-5		IX	1580	39.8	20.1	9.2	10.5	26.4	20.1		
	0.25-0.35	IX	1720	4.5	21.5	7.7	5.3	24.8	21.5	6.0	16.4
			1670	36.4	20.7	10.6	5.2	23.7	20.7		
	0.05-0.15	IV	1600	39.4	23.6	8.7	7.1	27.9	23.6	6.7	16.6
G-6			1530	42.0	21.7	11.5	8.8	26.9	21.7		
	0.25-0.35	IX	1680	36.4	22.5	9.5	4.3	24.6	22.5	6.5	15.3
			1620	38.5	21.5	10.2	6.7	26.0	21.5		

Explanations: CP - capillary porosity, SP - semi-capillary porosity; WP - wilting point; PDA - point of decreased water availability; see also explanations in Table 4.

The infiltration rate for subsoil on treated fields ranged from 0.09 to 0.20 m day^{-1} and on control it is 0.47 day^{-1}. Similar trends are found for hydraulic conductivity in all experimental fields. From these findings it is obvious that after the different treatment of studied sandy soil the basic physical parameters were not changed significantly except those which reflect water regime changes in the soils.

Water regime of ploughed horizons

Soil moisture content was the lowest in August, especially in its first half part. In this month the soil water regime on fields G-1, G-2, G-4 and on the control field was in aridic interval (soil moisture content between hygroscopicity number and wilting point). This was valid for the years 1992 and 1993. In other remain fields the soil moisture content was higher

Table 6. Basic physical and some hydrophysical properties of HGP in GBELY (1994)

Experimental field	Depth of soil sampling (m)	Time of sampling	Bulk density (kg m^{-3})	TP	CP	NP	SP	MCC	RWC	V_A
							(%, v/w)			
G-1	0.05-0.15	IV	1482	43.6	17.3	15.9	10.4	22.3	17.3	21.3
		IX	1740	33.8	24.9	6.5	2.4	26.4	24.9	7.4
	0.25-0.35	IV	1765	33.0	21.7	8.6	2.7	23.7	21.7	9.3
		IX	1772	32.7	20.5	9.5	2.7	22.2	20.6	10.5
	0.40-0.50	IV	1764	33.6	23.4	7.5	2.7	25.1	23.4	8.5
		IX	1763	34.6	21.7	10.3	2.6	23.2	21.8	11.4
G-2	0.05-0.15	IV	1582	39.6	17.2	13.1	9.3	21.9	17.2	17.7
		IX	1792	33.3	23.4	6.5	3.4	24.1	21.7	9.2
	0.25-0.35	IV	1752	33.3	22.9	7.5	2.9	25.2	22.9	8.1
		IX	1752	33.3	17.2	10.1	6.0	20.7	17.2	12.6
	0.40-0.50	IV	1711	35.2	22.8	8.5	3.9	25.6	22.8	9.6
		IX	1823	31.0	18.0	7.7	5.3	20.7	18.0	10.3
G-3	0.05-0.15	IV	1563	40.5	21.1	11.3	8.1	25.3	21.0	15.2
		IX	1781	32.2	18.6	6.0	7.6	22.7	18.6	9.5
	0.25-0.35	IV	1762	33.0	21.7	7.7	3.6	24.1	21.7	8.9
		IX	1708	35.1	22.6	10.0	2.5	24.2	22.6	10.9
	0.40-0.50	IV	1699	35.9	18.3	9.5	8.1	23.6	18.3	12.3
		IX	1690	36.2	18.4	10.2	7.6	22.4	18.5	13.8
G-4	0.05-0.15	IV	1381	47.3	22.5	15.8	9.0	27.0	22.5	20.3
		IX	1818	30.6	21.0	6.7	2.9	22.9	21.1	7.7
	0.25-0.35	IV	1604	39.1	24.3	9.4	5.4	28.3	24.4	10.8
		IX	1689	35.9	18.4	10.2	7.3	21.9	18.4	14.0
	0.40-0.50	IV	1768	33.3	22.7	8.4	2.2	24.0	22.7	9.3
		IX	1681	36.6	24.3	8.7	3.6	26.9	24.3	9.7
G-5	0.05-0.15	IV	1628	38.0	24.2	9.2	4.6	26.6	24.3	11.4
		IX	1686	35.8	17.7	10.0	8.1	21.8	17.8	18.0
	0.25-0.35	IV	1752	33.5	22.3	6.4	4.8	25.2	22.3	8.3
		IX	1690	35.8	20.2	9.8	5.8	23.0	20.2	12.8
	0.40-0.50	IV	1746	33.9	23.8	8.0	2.1	25.3	23.8	8.6
		IX	1849	30.0	24.1	1.9	4.0	26.1	24.2	3.9
G-6	0.05-0.15	IV	1547	41.5	18.6	10.4	12.5	25.9	18.6	15.6
		IX	1840	30.4	18.5	4.8	7.1	23.4	18.5	7.0
	0.25-0.35	IV	1620	38.6	16.1	9.0	13.5	23.5	16.1	15.1
		IX	1742	34.0	19.0	6.2	8.8	23.7	19.0	10.3
	0.40-0.50	IV	1649	37.7	24.9	6.8	6.0	27.5	24.8	10.2
		IX	1696	35.9	22.7	10.5	2.7	24.5	22.8	11.4

Explanations as in Tables 4 and 5.

Table 7. Evaluation of soil structure on the experimental fields in GBELY

Experimental field	Percentage of agronomically important aggregates (1-5 mm)		Coefficients	
	dry state	wet state	Ks (%)	Kd (%)
G - 1				
I	8.82	5.14	59.15	6.37
II	8.70	3.62	51.34	2.50
G - 2				
I	4.45	1.33	46.42	3.38
II	9.61	3.94	55.14	12.48
G - 3				
I	20.44	5.48	53.27	9.84
II	15.83	3.75	47.61	13.66
G - 4				
I	21.34	4.90	49.40	4.55
II	19.67	4.38	49.58	7.48
G - 5				
I	19.34	5.55	72.32	9.30
II	11.99	4.17	62.20	14.46
G - 6				
I	3.81	1.40	40.78	6.41
II	4.34	3.58	47.90	8.32

Explanations: Ks - coefficient of stability; Kd - coefficient of dispersivity.

Table 8. Yield evaluation from the experimental fields in GBELY on the HGP for: winter wheat - grain yield, ensilage maize - yield of fresh green mass and sunflower - seeds yield

Experimental field	Winter wheat		Ensilage maize		Sunflower	
	$t\ ha^{-1}$	Index K = 100 %	$t\ ha^{-1}$	Index K = 100 %	$t\ ha^{-1}$	Index K = 100 %
G - 6	2.40	100.0	33.07	100.0	0.99	100.0
G - 1	2.98	+107.5	39.68	+19.9	1.33	+34.0
G - 2	4.92	+105.0	32.78	-0.6	1.31	+32.3
G - 3	4.46	+85.8	33.10	+0.1	1.53	+54.5
G - 4	2.78	+15.8	41.01	+24.0	1.80	+81.8
G - 5	1.88	-21.7	32.00	-3.2	1.13	+14.1

Explanation: K - control.

for the some period. The soil water regimes were in semiarid interval (moisture content between wilting point and point of decreased water availability).

For this site and soil conditions the most favourable moisture interval is semiuvidic (soil moisture content between point of decreased water availability and retention water capacity field capacity). It was found that untreated soil (control field) staied in such interval only once, in September 1993. This month was quite rainy. The treated soils on the experimental fields were in this interval during spring and also autumn period. The best results were obtained for the fields G-3, G-4 and G-5.

Water regime of subsoil

The soil on the control field was in unfavourable arid or semiarid interval during all investigated period (1992-1994). On the experimental fields was such unfavourable moisture content only in some period during the most dry month August in the most dry year 1992.

In the semiarid interval this treated soil was since half of June to the beginning of September. During spring and autumn period the

Table 9. Evaluation of soil infiltration and hydraulic conductivity of experimental fields in GBELY

Experimental field	Infiltration	K_S	Evaluation	
	(m day^{-1})		I	K_S
G - 1				
I.	1.45	0.92	medium high	medium
II.	0.87	0.50	medium	medium
G - 2				
I.	0.39	0.72	moderate	medium
II.	0.20	0.85	low	medium
G - 3				
I.	0.29	0.58	moderate	medium
II.	0.20	0.43	low	moderate
G - 4				
I.	0.20	0.60	low	medium
II.	0.09	0.39	very low	moderate
G - 5				
I.	0.48	0.62	medium	medium
II.	0.20	0.41	low	moderate
G - 6				
I.	0.97	1.40	medium	high
II.	0.47	3.58	medium	very high

Explanations: Ks - saturated hydraulic conductivity of water; I - infiltration rate. I. for K_s means the depth of measurement 0.05-0.15 m and for I means the beginning of the measurement. II. for K_s means the depth of measurement 0.25-0.35 m and for I means the end of the measurement.

Table 10. Organic matter content on the G-6 PLOT

Depth (m)	C_{ox}	Humus	HA	FA	HA/FA	$Q^{4/6}$
			(%)			
0.0 - 0.15	1.06	1.83	8.16	8.17	1.0	4.01
0.15-0.32	1.30	2.24	8.75	9.59	0.91	4.09
0.32-0.42	0.87	1.50	8.13	11.25	0.72	4.10
0.42-0.54	0.17	0.30	-	-	-	-
0.65 - 0.75	0.07	0.12	-	-	-	-

HA - humic acids, Fa - fulvic acids, $Q^{4/6}$ - $\frac{C_{ox}}{C_a}$ - carbon content.

Table 11. pF curve of G-6 plot

Depth (m)	pF 1.2	pF 2.2	pF 3.2	pF 4.2
	% of volume			
0.05 - 0.10	15.9	13.2	8.6	7.0
0.20 - 0.25	14.0	11.7	9.1	5.5

T a b l e 12. Structure forming factors (adopted from: Kooistra [6])

texture chemistry	organic matter clay-quantity and quality	activity of soil organism root action wind	groundwater drainage	weather precipitation temperature

↓

Natural structure forming processes

↓

Cementation, impregnation, shrinkage, swelling, hydratation, dehydratation, dispergation-coagulation

↓

Human influence

↓

tillage soil technology trafic	fertilizers pesticides application	manure crop residues

↓

Soil structure formation: type, sizes and shapes of aggregates, porosity, stability and dinamics

↓

Structure following factors and processes (structure functions)

↓

water, gas temperature management	transport of material	rooting	soil organisms

moisture content was in this soil in the most favourable semiuvidic interval.

Soil characteristics related to soil structure, relevant to crop yield prediction on sandy soil

It resulted from our research that for crop formation in sandy soil the limiting factor is soil water balance. In relation to the crop yield modeling of such soils the only such models are suitable which take real (measured) data characterising soil water regimes and hydraulic conductivity. It is not enough to have these parameters as constant agents included directly in model programme.

It also seems to be not enough for such soils to evaluate in the models changes among basic physical properties (for most models the physical properties are basic). From this point of wiew the following list of models more suitable for this soils is presented.

List of models suitable for crop prediction on sandy soil

- CERES models (maize, wheat, barley),
- Robinson J.M., Hubband K.G. (corn, wheat, sorghum, soyabean),
- SOYGRO, PNUTGRO, BEANGRO (soyabean, peanut, beans),
- SIMPOTATO (potatoes),
- SWACROP modification (oat),
- USDA ARS (winter wheat),
- Craft E.M., Cruse R.M., Miller G.A. (corn),
- Oropeza Mota J.L., Martinez E., Berbez J. (bean, corn),
- Swan J.B., Staricka J.A., Shaffer M.J. (corn),
- DANSTRESS (barley).

All these models mentioned above deal with water balance, saturated or unsatureted hydraulic conductivity.

Bulk density or total porosity values which are judged in other models are not significant for the treated sandy soils.

MICROMORPHOLOGICAL DESCRIPTION OF THE SOILS

A general remarks

Soil structure is understood as size, shape and arrangement of solid particles and associated voids. This is highly variable feature and is a result of complex set of interactions between mineralogical, chemical and biological factors.

It can not be quantified directly. That is also the reason why many soil scientists studying soil structure are not interested in soil structure per se, but rather in phenomena that reflects the funcionality of soil structure in the plant growth [7].

Soil micromorphology deals with the qualitative and quantitative analysis of soils, parent materials and sediments in thin sections using polarizing microscope and other microscope (submicroscope) techniques [1]. Entering the microworld of soils one can better get inside into the soil processes, characteristics and properties. By interpreting soil contituents, their organization and the phenomena which reflect the processes of soil development is also possible to understand soil structure forming processes and structure stability (sustainability).

The formation of carbonates, secondary Fe-, Mn-oxides and hydroxides, silica and alumina leads to stabilization of soil aggregates (soil structure). This process is known as *cementation.*

Humus particles which may bound with inorganic componets and may bridge between coarser inorganic-particles-clay-hydrous oxides together with specifically sorbed ions play an important role in soil *coagulation* (floculation).

Both processes *are structure - forming processes* and lead to structure stability. This stability depends on the resistance of the soil aggregates to the disintegrating influences of water and mechanical manipulation. By knowing the parameters of aggregation one can better understand soil structure functions.

Microscopic study can contribute to understand the organization of soil constituents, their distribution, forms and shapes in the matrix. Interpreting the phenomena which are the reflection of processes within the pedon and in the lanscape it is possible to understand the stability of soil structure [2].

According to the study of Kooistra [6] two main groups of factors and processes can be distinguished, namely *structure forming and structure following* processes and factors.

By using microscopic techniques most attention is paid to the structure - forming aspects. Both light and submicroscopy techniques may result in obtaining of datasets to interpret processes, their interrelations and actuality.

Usually obtained morphological information can help to decribe size, shape and degree of the developments of the peds and associated pores. But can also reveal composition, boundaries, location, orientation, distribution. The smallest fraction, individual mineral grains, with or without coating, groundmass, excrements, organo-mineral aggregates and organic fragments can give a better look inside of the origin and development of the soils and processes involved, including the factors and processes which may affect soil structure formation and stability.

In spite of the fact that water content is often a crucial factor of structural stability, some *coagulating* (humus, calcium, iron) and *cementing* agents (carbonates, iron-manganes oxides, silica) may hamper the disruption or may help the restoration of structure in some cases.

Micromorphology permits the analysis and quantification of structure - forming parametres and stabilizing factors and their vertical distribution in the profile.

By observing the phenomena and features in the soils, soil structure-determining processes could be explained and predicted. The factors an processes effecting soil structure formation are presenting in the Table 12.

Soil micromorphology can be useful in studying soil structure in several ways:

- in describing soil constituents and their organization within the pedon;
- in explainig the role of cementing or coagulation agents;
- in describing the pedality and the grades of pedality;
- by measuring global and site-specific areas (matrix, peds or voids volume fraction) size, size-class distribution (grain particles, pores).

In the project the main task of the micromorphological study is not devoted specificly structure formation and functions. Most study is devoted to desribe only the organization of soil constituens to form aggregates (peds) - microstructure, and to contribute in understanding the role of cementing (coagulating) agents and thus contribute in the context of other methods to soil structure functions.

From this is evident that main task of this study was to contribute to the knowing the soil characteristics which might be relevant to soil structure functionality and stability.

Thin sections description of the Gbely Arenic Haplic Gleyic Phaeozem

Horizon: Ap (0 - 20 cm)

Microstructure: Pellicular to intergrain microaggregate microstructure.

Mineral components:

Coarse: some rock fragments, quartz, single grains and polycrystalline, sand sized, feldspars, few pieces of silcretes (chalcedone), only admixture of mica (muscovite). All minerals have microcracks (see photos 1, 3, 4).

Fine: silty to clay humus mixture brown coloured in transmited light.

Organic components: Small microaggregates, organic pigment, few root sections.

Groundmass: Silty to clay and humus mixture. c/f limit at 10um: 85:15. Grano-striated b-fabric. Chitonic to porphyric related (c/f) distribution pattern.

Pedofeatures: Fecal pellets in the intergranular spaces, few iron mottles.Some coatings on the mineral grains.

Conclusions: A horizon of arenic soil on aeolians sands.

Horizon: Ah (30-40 cm)

Microstructure: Pellicular to intergrain microaggregate structure (see photos 3, 4) locally porphyric c/f related distribution pattern (see photo 7).

Mineral components:

Coarse: some rocks fragments, quartz, single grains and polycrystalline, feldspars, some micas.

Fine: humus clay complexes with silty mica and quartz (see photo 8).

Accessories: zircone, rutile, tourmaline, epidote, sillimanite.

Organic components: Some organic matter fragments, decomposed root fragments, pellets, and pigment.

Groundmass: Silty-clay mixture. Brown in transmited light. c/f limit at 10 m; 85:15 Chitonic to enaulic related (c/f) distribution pattern (see photo 2). Grano- and poro-striated b-fabric but not very typical development but open porphyric domains are also present (see photo 7).

Pedofeatures: Some excrements and pellets. Some humus clay coatings. Few ferruginous mottles and nodules.

Conclusions: A-horizon of Arenic Fluvi Gleyic Phaeozem on aeolian sands with some periglacial transformations. Felspars show the different stage of decomposition.

Horizon: A/Cg (60-70 cm)

Microstructure: Pellicular to grain structure (see photo 9). Some mineral grains are coated with thin film (see photo 5). Only some intergranular microaggregates are present (see photo 6).

Mineral components:

Coarse: rocks fragments, quartz single grains and polycrystalline, feldspars, some micas but only admixture. Minerals does not show microfissures like in topsoil.

Fine: humus clay mixture.

Organic components: No observable organic matter except few fragments.

Groundmass: Silty clay mixture with some ferruginous mottles (see photo 10). Chitonic related distribution pattern (c/f).

Pedofeatures: Fine coatings on sands.

Conclusions: Aeolian sand with some pellicular coatings on the surfaces. No iron coatings typical for this type of soil.

Horizon: C-aeolian sands (80-90 cm)

Microstructure: Single grain structure (see photos 11-14).

Mineral components: As above.

Organic components: No observable organic matter.

Groundmass: No groundmass except some thin film on the mineral grains (see photo 13).

Pedofeatures: Only few iron.

Conclusions: Aeolian sands.

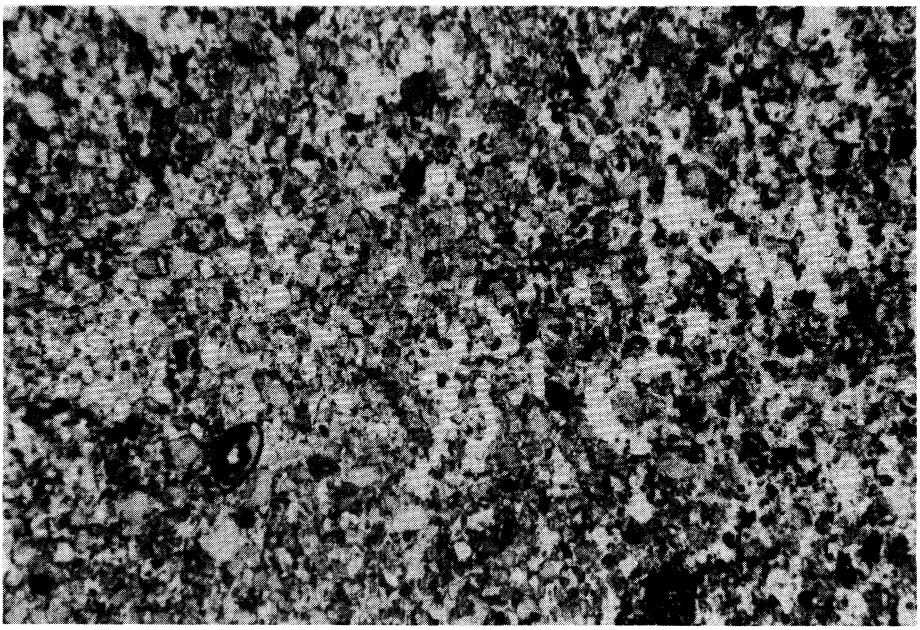

Photo 1. Intergrain microaggregate microstructure with enaulic to porphyric related distribution pattern (0-20 cm) Magn. 7x, //P (paralel polarizers).

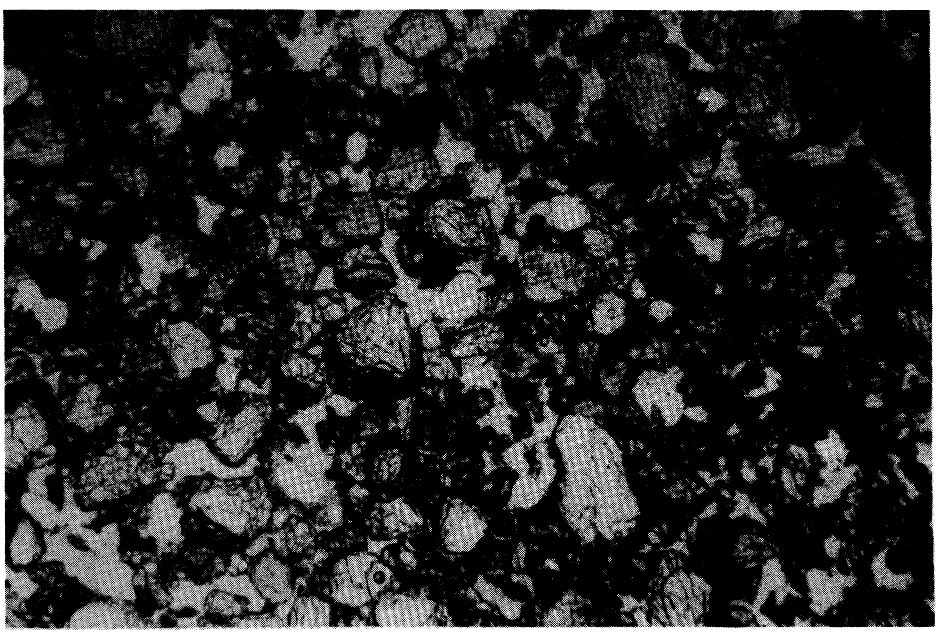

Photo 2. Enaulic appearance of related distribution pattern (c/f) is wisible under higher magnification (30-40 cm) Magn. 27x,// P.

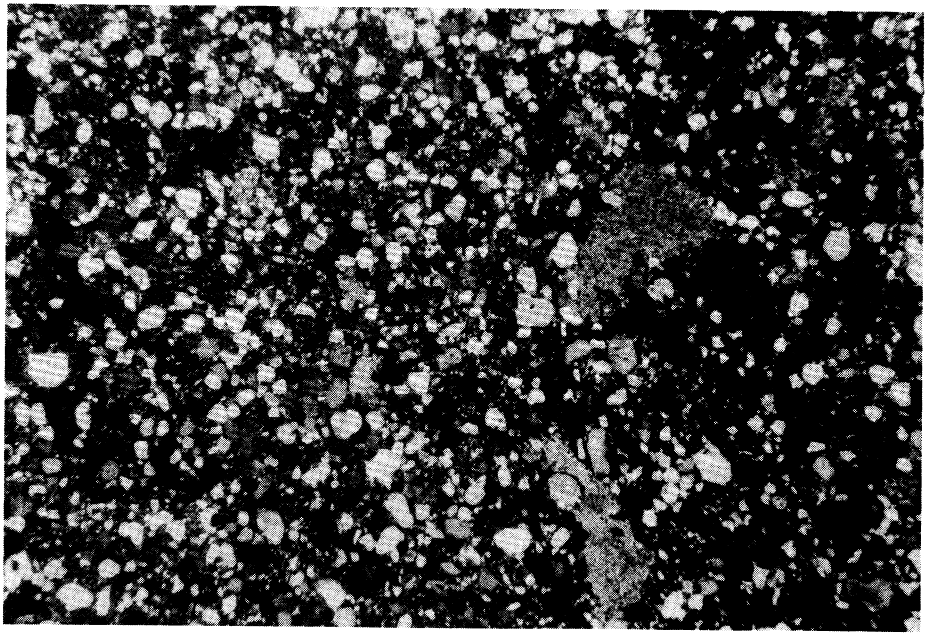

Photo 3. Similar type of the microstructure like in n.1 is also present in the field with the application of clay (small irregular pieces of grey colour) (0-10 cm) Magn. 7x, x P (crossed polarizers).

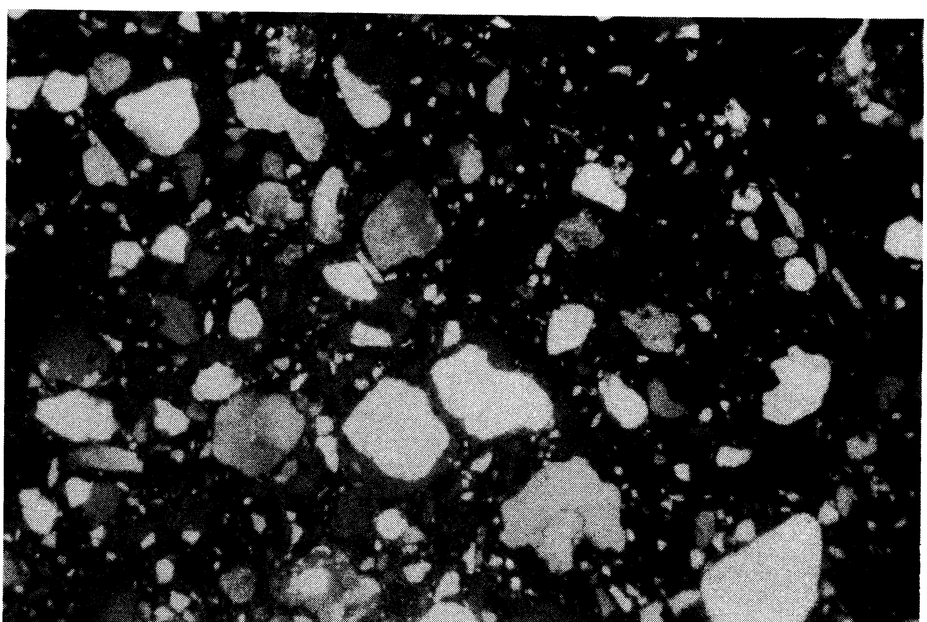

Photo 4. Intergrain microaggregate structure is recognizable by higher magnification and not fully crossed polarizers, (0-10 cm), Magn. 27 x, 1/2xP.

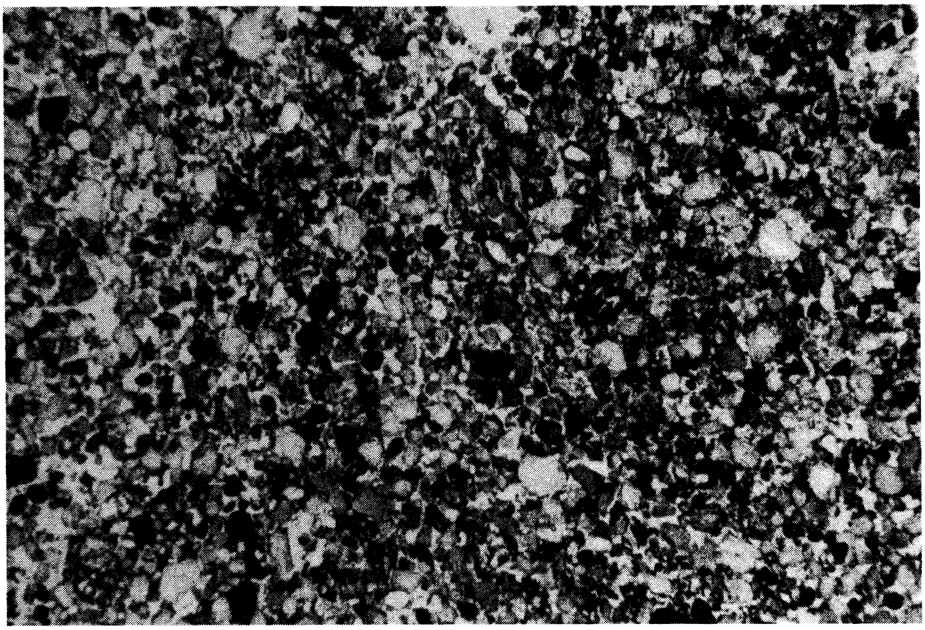

Photo 5. Single to compact grain structure is dominant over the intergrain microaggregate structure. 27x, // P.

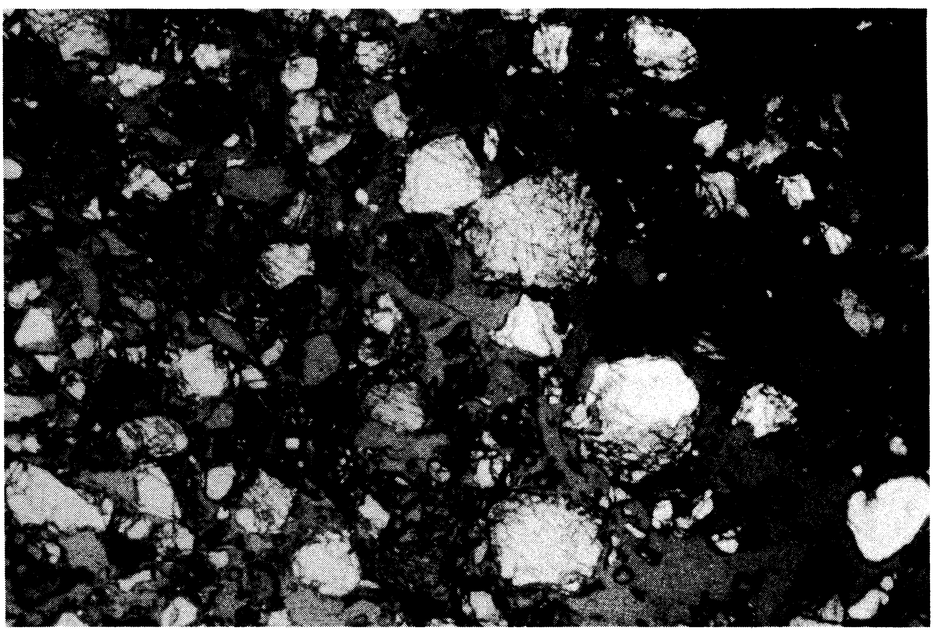

Photo 6. Generally uncoated quartz grains are filled by numerous organic (organic-silty inorganic) microaggregates in intergranular spaces (60-70 cm), Magn. 27x, 1/2x P.

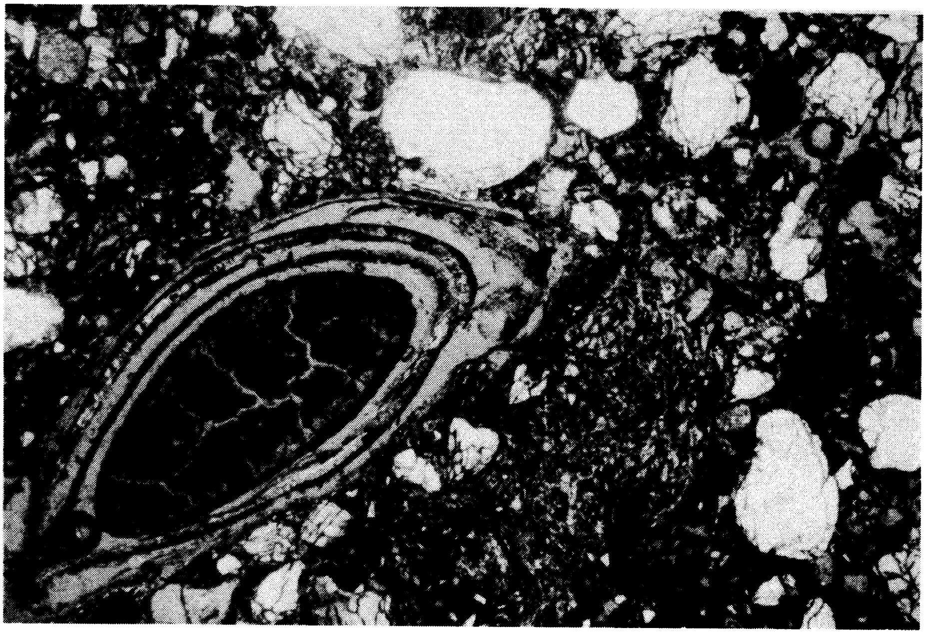

Photo 7. Locally also open-porphyric related distribution (c/f) pattern is present in places with higher content of organomineral groundmass. Note cross-section of plant root. (30-40 cm), Magn. 45x, 1/2x P.

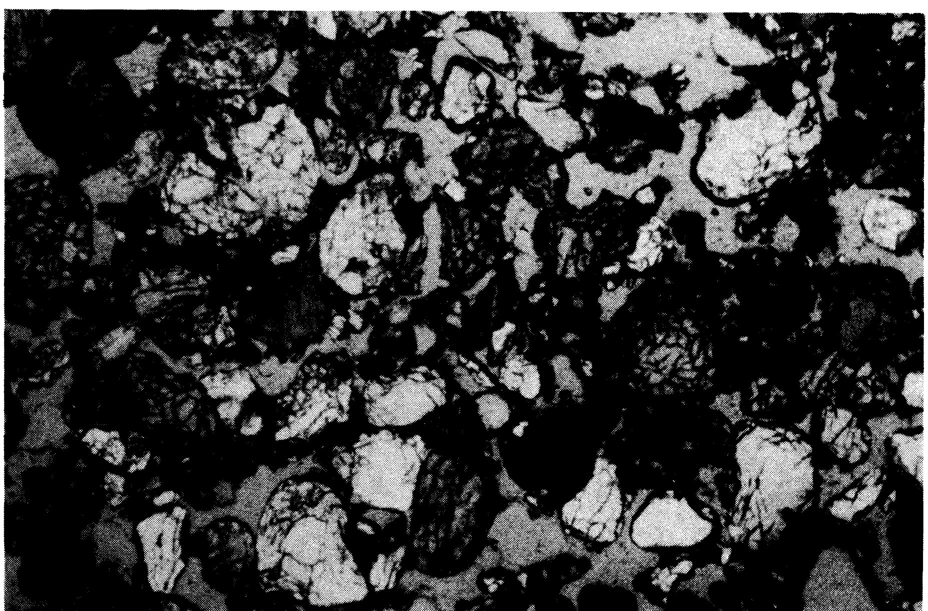

Photo 8. Individual grains of quartz and other minerals show a typical 'microfissures' which is explained as frost action, (30-40 cm), Magn. 45x, 1/2x P.

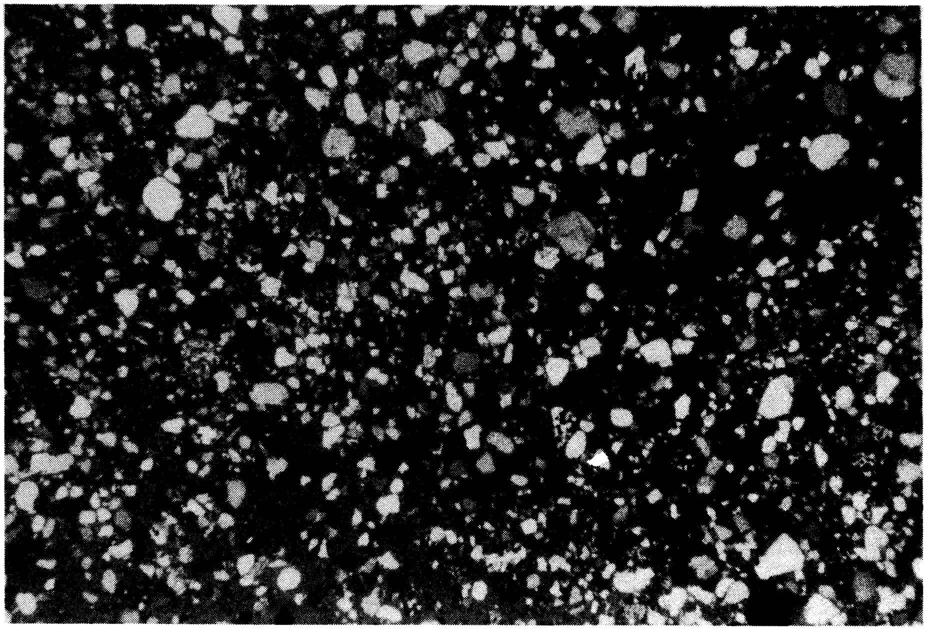

Photo 9. Single grain structure (60-70 cm). Single grain are loosely arranged with little or no fine groundmass. Almost monic related distribution pattern, Magn. 7x, 1/2x P.

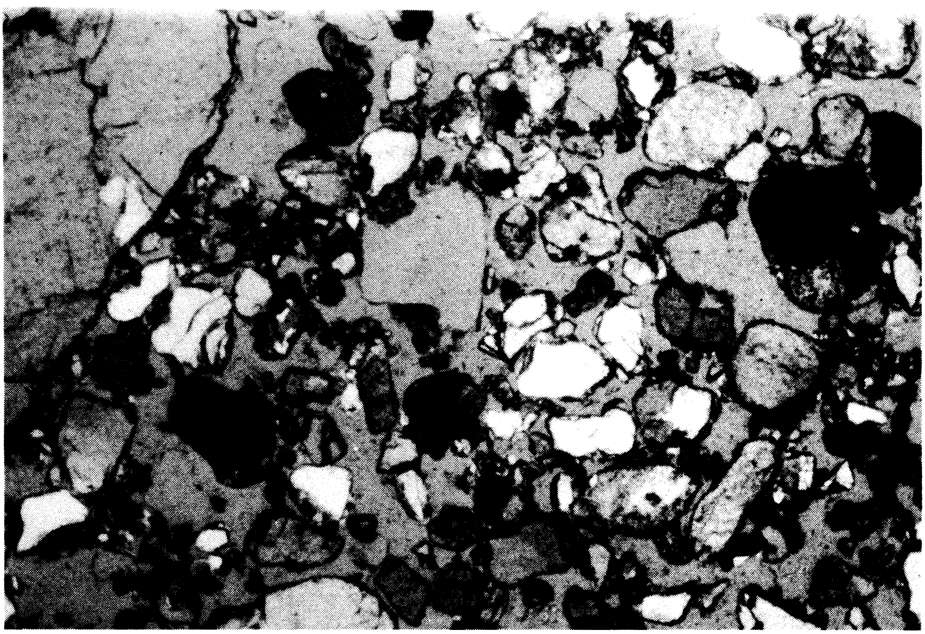

Photo 10. On places pellicular grain structure with brigged grains which welds them together.This is mostly iron coatings (humo-ferric). (60-70 cm), Magn. 45x, 1/3x P.

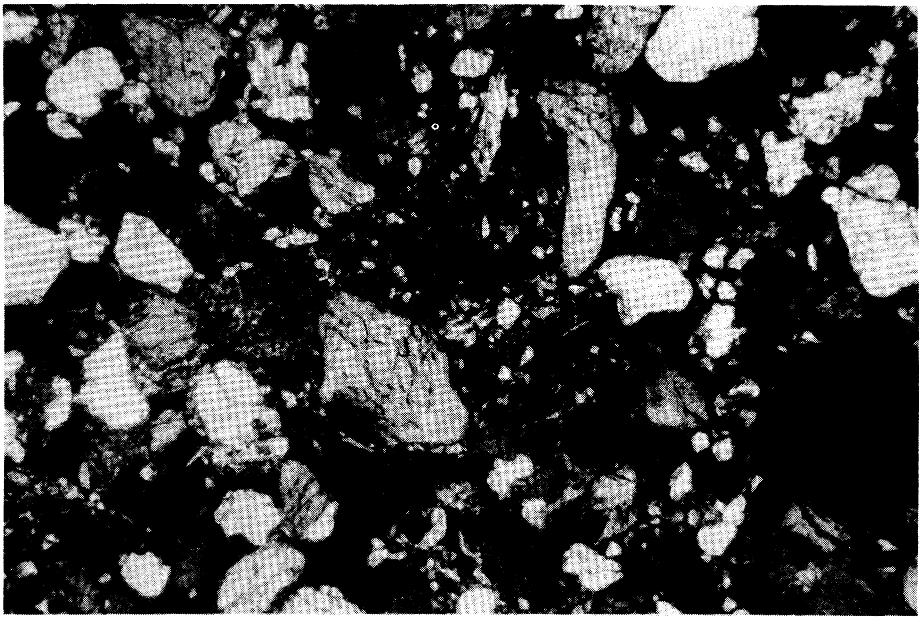

Photo 11. Single grain and pellicular grain structure can be observed also at the depth of (80-90 cm) under paralel polarizers. 11-45x; // P; 12-45x, x P.

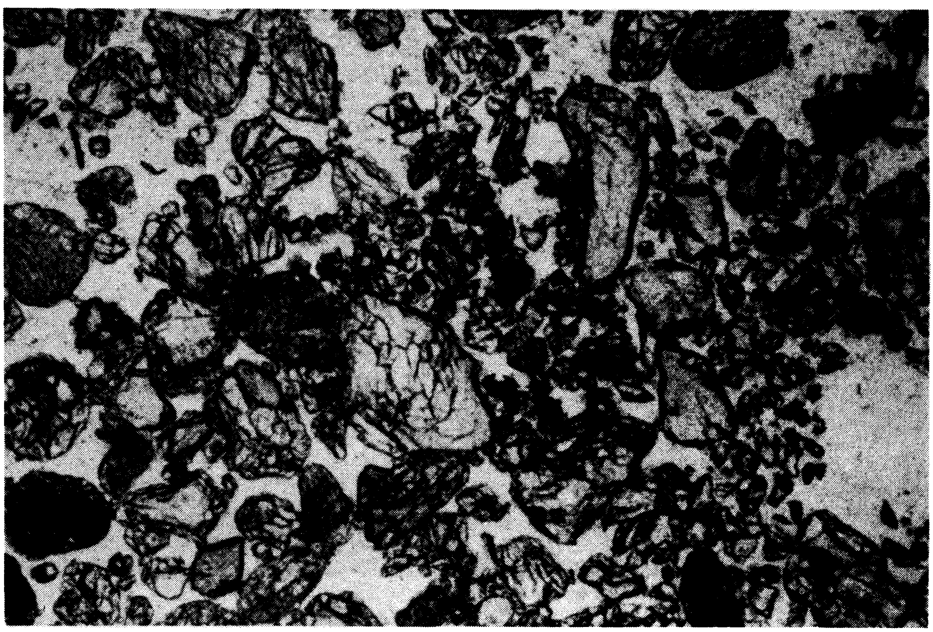

Photo 12. Dtto like 11 but under crossed polarizers.

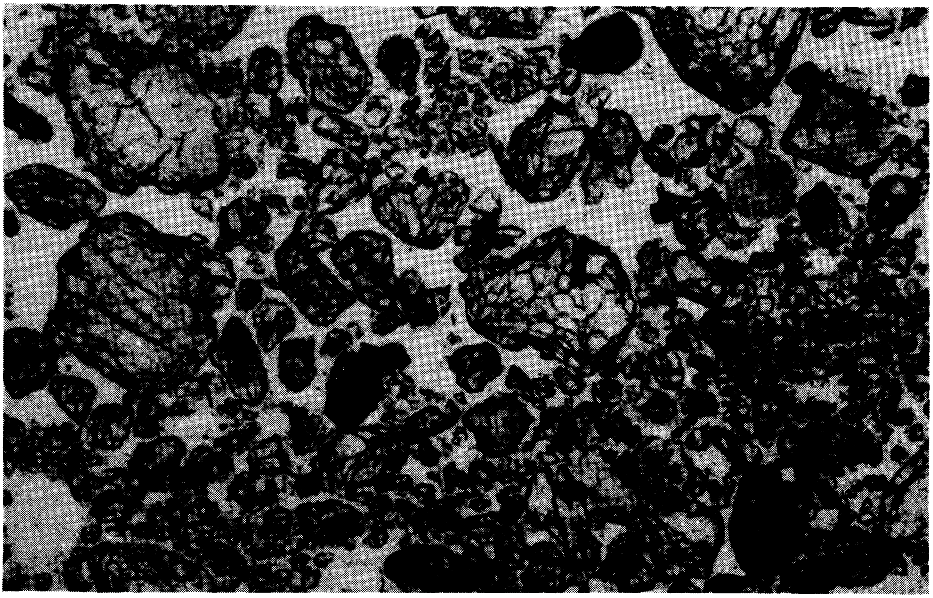

Photo 13. Single grain structure dominates below the 80 cm. Magn. 45x, // P.

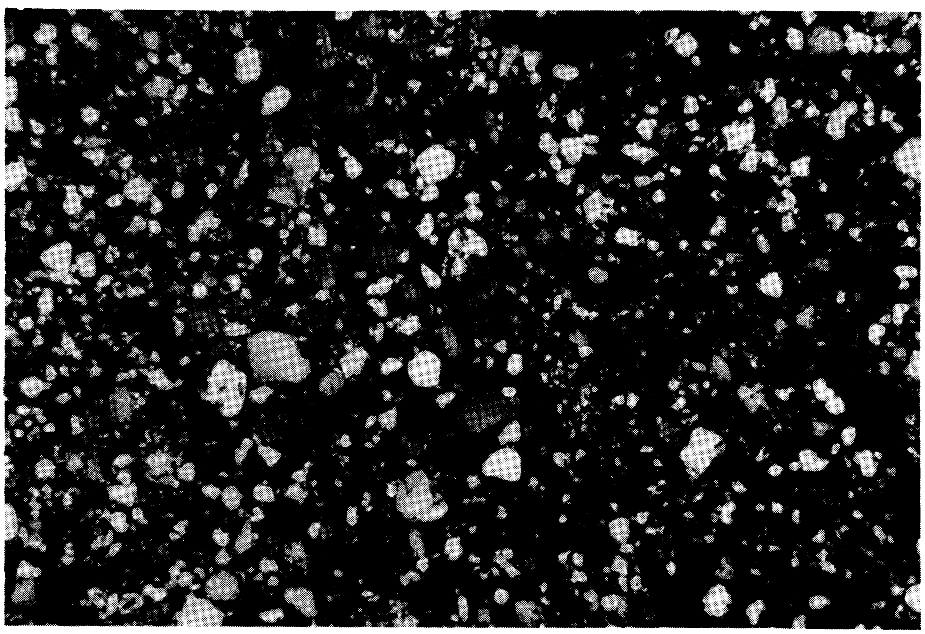

Photo. 14. Dtto like 13 but lower magnification and crossed polarizers. (<80 cm); Magn. 7x, x P.

CONCLUSIONS

Field experiments on sandy soil at Gbely (Arenic Hapli Gleyic Phaeozem) show that the differences in basic physical properties (bulk density, total porosity) in treated and untreated sandy soil are not significant.

On the other hand, changes in soil productivity were very significant. From this is obvious that these physical parameters do not reflect the crop formation processes.

Only soil water regime, or water balance (infiltration rate, hydraulic conductivity) values highly corelated with these changes. Therefore these data can serve as input parameters to model yield prediction in such soils.

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