The Establishment of Pedological Soil Data Bases in Denmark

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The construction of a main gas pipeline from the North Sea across Denmark offered a unique possibility of taking a subsequent number of soil profiles. Roughly 835 profiles have been described in detail according to a system very similar to FAO's Guidelines for Soil Profile Description, and samples from each horizon have been analysed in the laboratory. Based on easily detectable stable characteristics of the soil, about 8000 soil classifications were made down in the trench. The applied classification system, the analyses, the data storing system, and the principal soil conditions found along the pipelines are described in the paper.

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In 1975-80 a nationwide Danish soil classification of the farmland was carried out comprising soil sampling at about 35,000 sites. At every site a sample was taken from 0-20 cm depth, and at selected sites also from 35-55 cm depth. Texture, organic matter, and content of calcium carbonate were determined for all samples. On the basis of these analyses, soil maps in scale 1:50,000 were constructed, showing principally the texture at 0-20 cm depth (Mathiesen 1980). All soil maps and sampling sites have been digitized and hereafter stored in a computer system at the Ministry of Agriculture, Bureau of Land Data (ADK).

The computerized data have been widely used in agricultural planning. For this purpose transfer models have been elaborated to calculate e.g. the actual and potential drainage requirements within larger regions and the amount of nitrate leached from the farmland to the watercourses. To run these transfer models a need has arisen for more detailed information about the different soil types, especially with regard to drainage classes, soil water retention, root development, variation in texture and the pedological development within the uppermost 2 m of the profile.

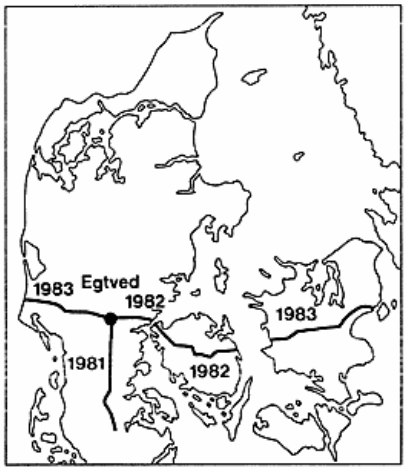

Fig. 1. Main gas pipeline system and the year of construction.
Fig. 1. Dansk Olie og Naturgas' hovedtransmissionsledninger gennem landet med angivelse af anlægsår.

The establishment of the main gas pipeline system from the North Sea gasfields across Denmark in 1981-83, fig. 1, represented a unique possibility of studying soil profiles and to build up computerized pedological soil data bases comprising systematical soil classifications, profile descriptions and analytical data.

This paper describes the pedological investigations carried out along the main gas pipeline system in 1981-83 and examples of combining the results with existing computerized soil- and landscape maps.

FIELD INVESTIGATIONS

The field investigations were carried out during the construction period of the main gas pipeline system, that

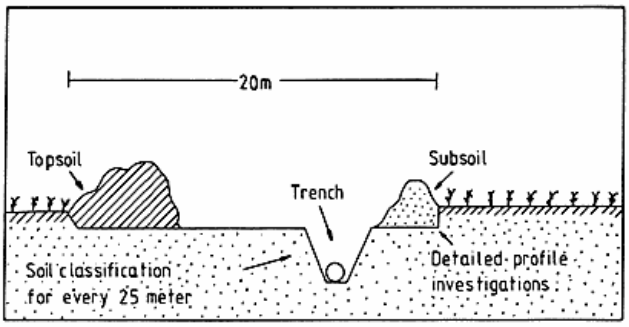

Fig. 2. A cross section of the working belt.
Fig. 2. Snit gennem arbejdsbæltet.

means May to November in 1981-83. Through the farmland a 20-m wide working belt was established. First the topsoil was romoved and placed along the one side of the working belt. The pipe sections were connected and an approximately 2-m deep narrow trench was dug, asymmetrically placed in the working belt, fig. 2. The subsoil was placed opposite to the topsoil. In forest areas the working belt was 12 meter wide and there was no separation between top- and subsoil.

The field investigations comprised pedological soil classifications for every 25 meter along the trench and detailed profile descriptions and soil sampling at the borderline between working belt and undisturbed agricultural land. Furthermore, some detailed profile investigations and soil samplings were carried out in nearby forests for comparing the pedological development in uncultivated soils with cultivated ones which are ploughed, limed, and manured.

In total, 835 detailed profile descriptions and 8440 pedological soil classifications were carried out.

Soil classifications in the trench

After the pipe had been installed in the trench bottom and before replacement of the subsoil to close the trench, soil classifications were carried out for every 25 meter over long distances in the roughly 2-m deep trench. Only where this followed highways, the soil profiles were frequently too much desturbed to be classified, and in a few places the trench was closed immediately after the pipe had been laid down so no time was left for soil classifications.

Because the topsoil was removed before the trench was dug, the soil classification was frequently based on only a thin A1 layer and on B and C horizons, and in some cases only on B and C horizons. A description of the A1 horizon can therefore not be complete, and problems of soil depth or depth to horizons with different soil characteristics arise. By the assessment of soil depth it was assumed that 30 cm of topsoil had been removed. If a soil layer e.g. began 40 cm below the surface of the trench, it was assumed to begin 70 cm below the surface of the undisturbed profile, and it was classified as beginning at 70 cm depth.

The field classifications must be based on parameters which are easily detectable on location, because no analytical data are or will be available for these classifications. Thus it has been necessary to build up a Danish pedological soil classification system based on soil characteristics which can be easily recognized and quantified in the field. These are

- The organic matter in the A1-horizon
- The genesis, thickness, and colour of the B and C horizons
- Soil depth to horizon with gley features
- Soil depth to horizon with different amounts of calcium carbonate
- Soil depth to bedrock
- The presence of fragipans or cemented soil layers within the uppermost 120 cm of the profile
- The presence of sodium-rich soil layer within the uppermost 120 cm of the profile
- The presence of degradated B horizons
- Texture

The system developed is an uncontrolled parametric system where no parameter excludes other parameters when present. In that way statistical treatment of the material will be favoured. The system is hierarchical with four levels: order, group, series, and phase. The soils are defined through the presence or absence of diagnostic horizons or characteristics. In table 1 the three highest levels are shown with a brief, but not complete definition. The system is discussed in detail in Madsen (1983).

The soil names are constructed according to the following principles:

- Only one name is given at order level, e.g. lessive.
- At group level up to three designations may be added to the order-name. The first group-name, e.g. typi, is always added, but the second and third group-name are only used if the defined paramenters are present.
- Order- and group-names are written as one word beginning with capital letter, e.g. Pseudogleytypilessive.
- The designation at series level is only used if the defined parameters are present. The series-names are written in front of the group-order-name as individuals beginning with non-capital letter e.g. gleyey entic Pseudogleytypilessive.

In the trench the soil classification was carried out to maximum series level but at least to group-level and the data were stored in the ADK computer system in numerical form. The figures are given in table 1, and in table 2 different soil names and their translation into numerical form are given.

The location of the field classifications was determined from distance-marks on the pipe and then plotted on aerial photographs in scale 1:4000 or on working plans in

SERIES	3 GROUP LEVEL	2 GROUP LEVEL	1 GROUP LEVEL	ORDER		
01 kolluvial A1: 40-80 cm thick 02 humusfattig A1 < 1 % organic matter 03 humøs A1: 7-20 % organic matter 04 histic peatlayer 10-40 cm thick 05 entic A1 < 10 cm thick 06 mor morlayer > 10 cm thick 07 gleyey 08 stagnogleyey 09 pseudogleyey 10 bleget pale subsoil 11 degraderet degradated Bt or Bs 12 fragi fragipan 13 placic placic horizon 14 hardnet cemented layer 15 natric high content of sodium 16 kalkholdig weakly calcareous layers 17 rendzin 18 ranker 31-39 name of order+like 41-52 top+name of order 61-72 sub+name of order		11 Gley 12 Stagnogley 13 Pseudogley	1 Typi 22 Bleg 6 Kalk 7 Rendzin 8 Ranker	01 rajord "Regosol"	A1 < 2 cm no diagnostic B horizon exc. Bj	DRY SOILS
		11 Gley 12 Stagnogley 13 Pseudogley	1 Typi 2 Blandings 6 Kalk 7 Rendzin 8 Ranker	02 blegsol "Arenosol"	2 cm < A1 < 80 cm below A1 pale colours	
		11 Gley 12 Stagnogley 13 Pseudogley	1 Typi 2 Struktur 3 Blandings 6 Kalk 7 Rendzin 8 Ranker	03 brunsol "Arenosol"	2 cm < A1 < 80 cm sandy brown soil without Bh or Bs horizon	
		11 Gley 12 Stagnogley 13 Pseudogley	1 Typi 2 Struktur 3 Blandings 6 Kalk 7 Rendzin 8 Ranker	04 brunjord "Cambisol"	2 cm < A1 < 80 cm clayey brown soil without Bt horizon	
	23 Brunsol 24 Brunjord 26 Podzol	11 Gley 12 Stagnogley 13 Pseudogley	1 Typi 2 Blandings 3 Band 4 Degra 6 Kalk 7 Rendzin 8 Ranker	05 Lessive "Luvisol" "Acrisol"	A1 < 80 cm soil having Bt horizon	
	25 Lessive	11 Gley 12 Stagnogley 13 Pseudogley	1 Typi 2 Humus 3 Sesqui 4 Brun 5 Initial 7 Rendzin 8 Ranker	06 podzol "Podzol"	A1 < 80 cm soil having Bs and or Bh horizon	
		11 Gley 12 Stagnogley 13 Pseudogley	1 Typi 26 Podzol 25 Lessive 6 Kalk 7 Rendzin 8 Ranker	07 kolluvial-jord	A1 > 80 cm	
	6 Kalk		1 Typi 26 Podzol 25 Lessive 7 Rendzin 8 Ranker	08 stagnogley "Gleysol"	stagnogley within the uppermost 40 cm	WET SOILS
	6 Kalk	22 Bleg 25 Lessive 26 Podzol	1 Typi 2 Vad 3 Brun 4 Kolluvial 7 Rendzin 8 Ranker	09 gley "Gleysol"	ground water gley within the uppermost 40 cm	
	6 Kalk	7 Rendzin 8 Ranker 25 Lessive 26 Podzol	1 Fibri 2 Hemi 3 Sapri 4 Kopro 5 Blandings	10 histosol "Histosol"	peatlayer (> 20 % organic matter) more than 40 cm thick	
	23 Brun 22 Bleg 25 Lessive 26 Podzol	11 Gley	1 Typi 2 Sedi 3 Blandings	11 rendzina "Rendzina"	> 30 % $CaCO_3$ normally within the uppermost 40 cm	SHALLOW SOILS
		11 Gley	1 Typi 2 Kolluvial 3 Litho 21 Rajords 22 Bleg 23 Brun 26 Podzol 25 Lessive	12 ranker "Lithosol" "Rankers"	lime free rock normally within the uppermost 40 cm	

Group level
1 - 5: special horizon sequences for the orders.
6 - 8: kalk = 5-30 % $CaCO_3$, rendzin = > 30 % $CaCO_3$, ranker = limefree rock. All three horizons begin within the uppermost 80 cm of the profile.
11 - 13: Groundwater gley or stagnogley beginning between 40-80 cm depth or pseudogley beginning between 0-80 cm depth.
21 - 26: Presence of other diagnostic horizons which might have qualified the soil at order level.

Series level
7 - 9: Groundwater gley, stagnogley and pseudogley beginning between 80-120 cm depth.
10 - 16: Horizon beginning within the uppermost 120 cm of the soil.
17 - 18: Rendzin = > 30 % $CaCO_3$, ranker = limefree rock. The two horizons begin between 80-120 cm depth.
31 - 39: Weakly expressed pedological developments without formation of diagnostic horizons.
41 - 72: Buried soils. The deepest soil profile beginning in the uppermost 60 cm qualifies the profile at order level. The other profile is described at series level with top or sub in front of the name of order.

Table 1. Schematic presentation of the Danish pedological soil classification system at order-, group- and series level.

Tabel 1. Skematisk gengivelse af det danske jordbundsklassifikationssystem på orden-, gruppe- og serieniveau med talangivelse til lagring af klassifikationerne i en database.

scale 1:1000. These plots were later readjused to »as built plans« showing the precise location of the pipeline, and they were digitized with reference to the UTM-coordinate system, so the soil classifications can be combined with already existing soil maps and other information available in the ADK-computer system (Mathiesen 1984, Madsen 1984).

	series	group	order
histisk Vådgley	4	0 0 2	9
fragi Pseudogleytypilessive	12	0 3 1	5
Lessivebrunpodzol	0	25 0 4	6
humøs Kalktypigley	3	6 0 1	9

Table 2. Soil types described in numerical form.
Tabel 2. Jordtyper beskrevet på numerisk form.

Soil profile investigations

Based on the soil classifications in the trench, sites were selected for detailed profile investigations and sampling for soil chemical and physical analyses. The selection of the profiles were based on differences in parent material, drainage class or on the presence of distinct pedological features such as placic horizon, fragipan or bog iron. The profiles were frequently situated as toposequences.

The pits were dug on the borderline between the working belt and the agricultural land, so the profile description was carried out on an undisturbed profile wall outside the working belt. The pits were 1.5 to 2.0 meter deep even in areas with permanent ground water near the surface. This was possible because the ground water was pumped down during the construction period.

The profiles were described according to a system similar to FAO »Guideline for Soil Profile Description«, but at some points readjusted to fit Danish conditions. The profile description comprises the following characteristics:

- Type and depth of horizons
- Soil colours (matrix and mottles)
- Borderlines between horizons (form and sharpness)
- The geology of the parent material
- Gley features
- Texture and organic matter
- Stoniness (shape, size, amount, sort, and state of weathering)
- Calcium carbonate (amount and sort e.g. nodules, powder or shells)
- Structure and consistency
- Soil pores (diameter above 1 mm)
- Roots (amount and thickness)
- Nodules and coatings
- Cementations and pans (type and continuity)

Furthermore general notations about date, name of surveyor, UTM-coordinates, slope, elevation, vegetation, and drainage class are made.

The profile descriptions were entered in standard schemes, and the quantification of the different parameters was given in numerical form to be stored in the ADK-computer system. It is thus easy to search on single features and combine different parameters in the profile description, e.g. finding soils having horizons with platy structure and gley features.

In order to make the profile descriptions easily available for different users, programs have been elaborated transforming the numerical soil profile descriptions into words (Munk 1984).

Soil samples have been taken from all major horizons. In average six samples have been taken from each profile. For chemical and textural analyses the samples were first air-dried and then sieved. Only the fraction finer than 2 mm was used for the chemical analyses. For determination of soil water retention and root densities undisturbed samples were used. These were collected in tubes of different size. For determination of soil water retention 3 samples were collected from each horizon in tubes of volume 100 cm^3. For determination of root densities one sample per 10-cm section was taken down through the profile using tubes 7 cm high and diameter 11 cm.

	1981	1982	1983
Texture, humus and pH	1400	1500	1700
CEC and exch. bases	245	245	450
Pyrophosphate sol. Fe and Al	700	130	280
Dith. citrate sol. Fe and Al	700	575	850
Total and organic P	100	700	150
Total N	800	700	500
KCl soluble Al	450	179	390
Citric acid soluble P	50	0	0
Mineralogical analyses	120	136	80
Soil water retention	970	800	700
Root density	0	408	342

Table 3. Number of different analyses carried out.
Tabel 3. Antal analyser udført ved jordprofilundersøgelsen.

ANALYSES

Table 3 shows the different analyses and the number carried out during the investigation period. Texture, organic matter, calcium carbonate, and pH($CaCl_2$) have been determined on nearly all samples, while the other analyses have only been caried out on a minor part of the samples. The CEC was mainly determined on samples from profiles situated in forest because of heavy liming of the farmland. Soil water retention and root determinations have been carried out solely on samples from profiles situated on farmland, because these parameters will be of great value especially in irrigation planning. Pyrophosphate-soluble iron and aluminium were mainly determined on sandy samples, while KCl-soluble aluminium only were determined on acid subsoils. KCl-soluble aluminium was determined for the evaluation of Al-toxidity in the root zone. The electric conductivity was only determined on

samples from marine deposits, because all other deposits are leached for easily soluble salt due to heavy surplus of rain during the wintertime. The total nitrogen and phosphorous contents were mainly determined on samples from or just below the topsoil, while citric-acid soluble phosphorous were determined exclusively on A1-material which fullfilled all other specifications to a mollic epipedon.

The analytical methods are described in detail in Madsen et al. (1985), but the following short comments should be made. Texture analyses were carried out by sieving of the sand fractions and the hydrometer method for determination of fine silt and clay. The following grain sizes were determined 2 μ, 20 μ, 63 μ, 125 μ, 200 μ, 500 μ, and 2000 μ. The content of organic matter was determined by an IR-Leco apparatus and the pH was determined potentiometrically in a suspension of soil and 0.01 M $CaCl_2$. Calcium carbonate content was determined by treating the sample with 4N HCl, catching the developed CO_2 in 0.1N $Ba(OH)_2$ followed by a titration with 0.1N HCl. The exchangeable bases were determined by AAS after treating the samples with 1N NH_4Ac, while the exchangeable acidity was determined by Pipers method. The CEC-value was determined as the sum of exchangeable bases and exchangeable acidity, except in lime-containing samples where the CEC-value was determined by treating the samples with 1N NaAc, thereafter washing the samples with alcohol and exchange the sodium with 1M NH_4Ac. Dithionite-citrate and pyrophosphate soluble iron and aluminium were determined by AAS after treating the samples over night with a dithionite- citrate solution or with a pyrophosphate solution (Soil Conservation Service 1972). The KCl-soluble aluminium was determined by mixing the soil samples with 1M KCl for one hour, filtration and titration with 0.02N NaOH. The total content of nitrogene was determined by the Kjeldahl method and the citric-acid soluble phosphorous content was determined spectrophotometrically after treating the samples for 18-20 hours with 1% citric-acid. The total phosphorous content was determined spetrophotometrically by ashing the samples and thereafter treat them with 12N H_2SO_4.

The soil conductivity was determined in the liquid phase after treating 25 g sample with 50 ml pure water for 16 hours.

The soil water characteristic curve was determined by the pressure plate apparatus method, and the water content was determined at: pF 1.0, pF 2.0, pF 3.0 and pF 4.2. The root densities were determined as cm root/ccm soil. The roots were separated from the soil by washing and their lengths measured on a grid with mesh-wide 1.27 cm.

After finishing the analyses the remaining part of the samples were stored in a soil sample library at ADK. This library contains today more than 40,000 soil samples.

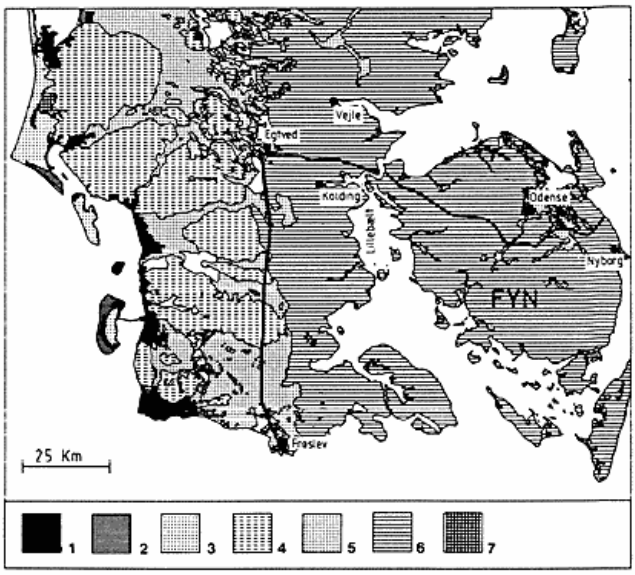

Fig. 3. The main gas pipeline system in southeastern Jutland and Funen in relation to landforms. 1: Marsh areas, 2: Marine forelands, 3: Dune landforms, 4: Saale glaciation landforms (= old moraine in table 4 and 5), 5: Outwash plains, 6: Weichsel moraine landforms (= young moraine in table 4 and 5), 7: Reclaimed areas.

Fig. 3. Hovedtransmissionsledningens forløb gennem forskellige landskabstyper i Sydøstjylland og på Fyn. 1: marsk, 2: marint forland, 3: klitlandskab, 4: bakkeø, 5: hedeslette 6: ungt moræne-landskab, 7: kunstigt tørlagt areal.

THE PRESENTATION AND USE OF DATA FROM THE PEDOLOGICAL INVESTIGATIONS

The database for soil profile descriptions is connected with the analytical databases, and programs have been developed to produce outputs giving the user a complete profile description in Danish and all corresponding analytical data. Fig. 4 shows an output for a single profile, a Pseudogleytypilessive developed in till.

In the profile description the exterior characteristics are mentioned first followed by a description of the interior characteristics for each horizon. In the first scheme a list of samples is given with sampling depth, sampling number, and ring numbers, the latter if samples for soil water retention have been collected. The second scheme shows the texture and the content of organic matter and calcium carbonate. The third scheme shows ppm dithionite-citrate and pyrophosphate soluble iron and aluminium. The fourth scheme shows the pH-values, exchangeable bases and acidity, CEC-values, base saturation, and electric conductivity, while the fifth scheme shows the nitrogene, phosphorous and carbon content. Root densities and soil water retention have not been determined.

The data from the profile investigations are today frequently used in combination with existing computerized

PROFILNR: 137

JORDBUNDSTYPE : JBnr 3

Pseudogleytypilessive
udviklet på moræneaflejringer

DATO : 11. 8.1981
UDTAGER : Lars Elkjær
FILM NR : 24 BILLED NR: 21 - 23
UTM KOORDINAT : 516141.71, 6136220.96
KORTBLAD :GI 1212 1V NV
TERRÆNKOTE : 58 m DNN
TERRÆNFORM : Kant af morænebakke
HÆLDNING : 0-2 grader
VEGETATION : Byg (vårbyg)
GRUNDVANDSDYB.: 150
PROFILDYBDE : 160
DRÆNINGSKLASSE: Moderat veldrænet jord

BEMÆRKNINGER :
Poreindholdet ikke beskrevet. Profilen er en
Gleyic Acrisol efter FAO's system.

HORISONTFØLGE:

Apg (0 - 22 cm):
meget mørk brun (10YR 2/2 f) lerholdigt siltet sand; få pletter af farven rød (2,5YR 4/8 f), pletterne er fine, afrundede med en klar grænse og tydelig kontrast; gleypletter på brunlig bund; humusholdig; svag subangulær struktur; meget sprød konsistens; meget få, små sten af alle former, der er uforvitrede og som lithologisk består af en blanding uden kalksten; nogle fine rødder; horisontgrænsen er klar og jævn.

A2g (22 - 55 cm):
lys olivengrå (5Y 6/2 f) leret siltet sand; en del pletter af farven kraftig brun (7,5YR 5/8 f), pletterne er store, brogede med en klar grænse og tydelig kontrast; gleypletter på grålig bund; humusfattig; moderat medium subangulær struktur; sprød konsistens; meget få, mellemstore sten af alle former, der er forvitrede i varierende grad og som lithologisk består af en blanding uden kalksten; meget få, små, hårde, afrundede noduler, der består af jernoxider og -hydroxider; få fine rødder; horisontgrænsen er abrupt og bølget.

B2tg (55 - 90 cm):
lys olivengrå (5Y 6/2 f) ler; en del pletter af farven gullig brun (10YR 5/8 f), pletterne er store, brogede med en klar grænse og tydelig kontrast; desuden findes pletter med farven sort (2,5Y 2/0 f); gleypletter på grålig bund; humusfattig; moderat medium subangulær struktur; meget sprød konsistens; meget lidt plettet af tynde coatings i rodgange og på aggregatoverflader, coatings består af lermineraler og sesquioxider; meget få, mellemstore sten af alle former, der er forvitrede i varierende grad og som lithologisk består af en blanding uden kalksten; horisontgrænsen er diffus og jævn.

B3tg (90 - 125 cm):
lys olivengrå (5Y 6/2 f) ler; en del pletter af farven gullig brun (10YR 5/8 f), pletterne er store, brogede med en klar grænse og tydelig kontrast; desuden findes pletter med farven sort (2,5Y 2/0 f); gleypletter på grålig bund; humusfattig; moderat medium subangulær struktur; meget sprød konsistens; meget lidt plettet af tynde coatings i rodgange og på aggregatoverflader, coatings består af lermineraler og sesquioxider; meget få, mellemstore sten af alle former, der er forvitrede i varierende grad og som lithologisk består af en blanding uden kalksten; horisontgrænsen er diffus og jævn.

Cg (125 - 160 cm):
lys olivengrå (5Y 6/2 f) ler; en del pletter af farven gullig brun (10YR 5/8 v), pletterne er store, brogede med en klar grænse og tydelig kontrast; desuden findes pletter med farven sort (2,5Y 2/0 f); gleypletter på grålig bund; humusfattig; svag subangulær struktur; meget sprød konsistens; meget lidt plettet af tynde coatings i rodgange og på aggregatoverflader, coatings består af lermineraler og sesquioxider; meget få, mellemstore sten af alle former, der er forvitrede i varierende grad og som lithologisk består af en blanding uden kalksten; horisontgrænsen ikke beskrevet.

PRØVER:

PROFILNR: 137

HORISONT	UDT.DYB	ÆSKENR	LAB.NR			
Apg	10- 15cm	87111	41218	454	381	449
A2g	27- 35cm	87115	41219	1104	1986	1825
B2tg	70- 75cm	87161	41220	1016	357	1835
B3tg	105-110cm	87194	41221	159	278	1269
Cg	140-145cm	87155	41222	0	0	0

HORISONT	DYBDE (cm)	ppm: Dith-citr.opløseligt JERN	Dith-citr.opløseligt ALUMINIUM	Pyrofosfatopløseligt JERN	Pyrofosfatopløseligt ALUMINIUM
Apg	10 - 15	2319	1020	1132	1020
A2g	27 - 35	6667	1060	1097	460
B2tg	70 - 75	6809	1160	800	2200
B3tg	105 - 110	6809	1020	800	1180
Cg	140 - 145	6809	820	911	360

HORISONT	DYBDE (cm)	%: LER	SILT	GROV- SILT	FIN- SAND	FINT- MELLEMSAND	GROFT- MELLEMSAND	GROV- SAND	GRUS	ORGAN. MAT.	CaCO3
STØRRELSE	(my)	2	2-20	20-63	63-125	125-200	200-500	500-2000	2-20 mm	-	-
Apg	10 - 15	8.0	13.6	12.1	14.6	11.2	28.9	6.6	+	5.04	0.0
A2g	27 - 35	11.2	7.5	6.8	11.6	16.6	34.6	11.1	+	0.58	0.0
B2tg	70 - 75	23.6	10.5	12.3	15.6	12.0	20.0	5.8	+	0.17	0.0
B3tg	105 - 110	22.4	8.7	14.7	14.6	13.4	20.0	6.0	+	0.17	0.0
Cg	140 - 145	24.3	9.8	11.9	15.8	11.6	20.8	5.6	+	0.17	0.0

HORISONT	DYBDE (cm)	pH (H2O)	pH (CaCl2)	mækv/100g jord: OMBYTTELIGE Ca-IONER	Mg-IONER	K-IONER	Na-IONER	BASER (I ALT)	SURE H-IONER	CEC	BASE-MÆTN. %	LEO-NINGS-EVNE mæko
Apg	10 - 15	6.00	5.60	11.13	0.32	0.14	0.07	11.66	6.97	18.64	62.55	*
A2g	27 - 35	5.60	5.10	5.46	0.38	0.20	0.05	6.09	3.44	9.53	63.90	*
B2tg	70 - 75	5.00	4.20	6.29	2.41	0.35	0.09	9.13	6.06	15.20	60.07	*
B3tg	105 - 110	5.10	4.20	6.31	2.57	0.37	0.09	9.34	5.63	14.98	62.35	*
Cg	140 - 145	5.40	4.60	7.63	2.41	0.35	0.10	10.50	4.12	14.61	71.87	*

HORISONT	DYBDE (cm)	%: C	N	C/N	ppm: P org.	P uorg.	P tot.	C/P	N/P
Apg	10 - 15	2.958	0.205	14.4	301	230	531	55.7	3.9
A2g	27 - 35	0.340	0.019	17.9	161	16	177	19.2	1.1
B2tg	70 - 75	0.100	0.013	7.7	171	18	189	5.3	0.7
B3tg	105 - 110	0.100	*	*	*	*	*	*	*
Cg	140 - 145	0.100	*	*	*	*	*	*	*

Fig. 4. An example of a profile description and analytical data.

Fig. 4. Eksempel på profilbeskrivelse med tilhørende analyseresultater.

	Num.of profi.	Podsol	Luvisol	Acrisol	Phaeozem	Cambisol	Arenosol	Rego. Rank.	Fluvisol	Gleysol	Histosol
Frøslev-Egtved											
Outwash plain	89	54%				9%	7%			18%	12%
Young moraine	119	13%	8%	29%	6%	18%	5%	3%		17%	1%
Old moraine	38	45%		26%	3%	13%	5%			5%	3%
Dunes	18	89%				11%					
Egtved-Lillebælt											
Young moraine	68	6%	13%	19%	18%	4%	9%		4%	25%	1%
Fyn											
Young moraine	158	4%	24%	14%	17%	11%	9%	1%	6%	9%	

Table 4. The percentage distribution of soil types along the main gas pipeline in relation to landforms. The soils are classified according to FAO-Unesco.

Tabel 4. Statistisk opgørelse af profiler langs traceen klassificeret efter FAO-Unesco.

	Num. of profiles	Spodosols	Alfisols	Ultisols	Mollisols	Inceptisols	Entisols	Histosols
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Outwash plain	89	54%			6%	11%	17%	12%
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Table 5. The percentage distribution of soil types along the main gas pipeline in relation to landforms. The soils are classified according to Soil Taxonomy.

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soil- and landscape maps. Through transfer models the profile data are used for irrigation planning (Madsen et al. 1983), drainage-class assessments (Holst 1985), and calculation of soil erodibility (Madsen et al 1985).

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The soil profile descriptions combined with the international laboratory methods make it possible to classify the profiles according to international systems like the FAO-Unesco system (FAO-Unesco 1974) and the American system »Soil Taxonomy« (Soil Survey Staff 1975). The classifications according to the FAO-Unesco system combined with existing soil maps give opportunities to readjust and progress existing soil maps covering Denmark, e.g. FAO soil map in scale 1:5000000 or EC-soil map in scale 1:1000000.

For classification according to FAO-Unesco and Soil Taxonomy the following assumptions were made

- Danish soils have a mesic soil temperature regime and a udic or aquic soil moisture regime
- The citric-acid soluble phosphorous content is less than 250 ppm. This excludes antropic epipedons
- If base saturation has not been determined, pH is used. If pH (H_2O) = 4,0 the base saturation is 0%, when pH (H_2O) = 8,3 the base saturation is 100%.

Fig. 3 shows the main gas pipeline system in relation to landforms in southern Jutland and Funen. The computerized landscape map (Holst 1985) divides Denmark into 9 different landforms of which six are present in fig. 3. In table 4 and 5 the number of investigated profiles within the different landforms are given and their classification according to FAO-Unesco and Soil Taxonomy.

On outwash plains and in dune sand areas, the parent material is exclusively sandy. The well drained soils are mainly podzolized, nearly 90% of the investigated profiles in the dune sand area and 80% of the well drained profiles on the outwash plains were podzols or spodosols.

In the Saale glaciation landscape approximately ⅔ of the well drained profiles have developed in sandy parent material. Podzols dominate just as found in the outwash plains. Among the relatively well drained soils developed in clayey parent material soils with clay illuviation dominate. These old soils are strongly leached and exclusively classified as acrisols, frequently gleyey because of pseudogley in the subsoil. According to Soil Taxonomy the major part are ultisols, but few alfisols are present.

In the Weichsel glaciation landscape soils developed in clayey parent material dominate. These soils are more or less leached and most of them have clay illuviation. In Jutland acrisols dominate, while on Funen luvisols are most pronounced. On Zealand acrisols are nearly not present on farmland. According to Soil Taxonomy alfisols dominate, but ultisols frequently occur in Jutland. In sandy parent material within the Weichsel glaciation landscape podzols dominate in Jutland and arenosols on Funen. This shows that the leaching of the profiles decreases towards the east and thereby the frequency of acrisols and podzols, while the frequency of luvisols and arenosols increases.

ACKNOWLEDGEMENTS

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Resumé

I perioden 1981-84 er der udført pedologiske undersøgelser langs den udgravning, der er foretaget af Dansk Olie og Naturgas A/S (DONG) til etablering af hovedtransmissionsledninger for naturgas. I det omhandlede tidsrum er gasledninger etableret og de pedologiske undersøgelser foretaget på strækningen Frøslev-Egtved, Egtved-Storebælt, på tværs af Sjælland og Egtved-Vesterhavet. Arbejdet har omfattet detaljerede profilbeskrivelser med ledsagende prøveudtagning til analyse fra 835 profiler gravet i kanten af arbejdsbæltet eller i nærliggende skove, samt registrering af profiludviklingen for hver 25 m i rørgraven over store strækninger. På næsten alle de udtagne prøver er der bestemt

textur, humus, pH og calciumcarbonat. På en del af prøverne er der tillige blevet bestemt total nitrogen, kationadsorptionskapacitet, indhold af ombyttelige kationer, pyrophosphat- og dithionitcitratopløseligt jern og aluminium, kaliumchloridekstraherbart aluminium, uorganisk og organisk bundet phosphor, citronsyreekstraherbart phosphor, vandretention samt rodintensiteter. Alle resultater findes på databaser ved Landbrugsministeriets Arealdatakontor, hvor de indgår i udbygningen af den danske jordklassificering.

Kortfattet kan man på baggrund af undersøgelsens resultater give følgende generelle beskrivelse af jordbundsforholdene langs traceen. De sandede jorde i Jylland er i overvejende grad podzolerede på nær tæt ved vestkysten, hvor helt unge jorde uden nævneværdig profiludvikling forekommer. En stor del af sandjordene på hedesletterne har gleypræg inden for de øverste 120 cm af profilen. På Fyn og Sjælland er sandjorde ikke så udbredte som i Jylland, og kun et fåtal af de fynske og sjællandske sandjorde er podzolerede. De lerede jorde er i overvejende grad præget af lernedslemning og pseudogleydannelse. De vestjyske lerjorde er foruden lernedslemning og pseudogleydannelse præget af periglaciale processer som jordflydning. Disse jorde vil ofte være stærkt udvaskede, og selvom de er blevet kalket, vil underjorden dog stadig ofte være stærkt sur. I Østjylland i det unge moræneområde er jordene almindeligvis stærkt udvaskede, og kalk findes kun yderst sjældent i de øverste 120 cm af profilen. Hyppigheden af stærkt udvaskede morænelerjorde falder kraftigt over Fyn, og frit kalk begynder at optræde i profilen. På Sjælland optræder frit kalk hyppigt i profilen.

I relation til internationale klassifikationssystemer vil dette sige, at podzols (spodosols) dominerer i de sandede vestjyske jorde. Acrisols (ultisols) dominerer på lerede aflejringer i Syd- og Vestjylland, mens luvisols (alfisols) dominerer på Fyn og Sjælland.

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