Cover sand and cover sand stratigraphy in southern Denmark

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Younger and Older cover sands from southern Jutland are briefly described. The lithostratigraphical sequence in the cover sand areas is outlined, and tentative datings by means of pollen analysis are given for some of the deposits. It is concluded that the Danish sequence compares well with the Dutch. In the final chapter, variations in cover sand appearance are mentioned.

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During construction of a Danish gas pipe-line system in southern Jutland during the summers of 1981 and 1982, a continuous trench, approximately two meters deep, was dug (fig. 1). In this trench it was possible to study different types of sediments as well as the transitions between these, and the presence of Younger and Older cover sands which are thought to be of eolian origin was established (Kolstrup & Jørgensen, in press).

Deposits of cover sand have long been known in The Netherlands, Belgium, northern Germany, and Poland. They were first investigated in The Netherlands during the 1930's, and the name »dekzand« indicates that the deposits lie in sheets upon the underlying relief. In English they are called coversands, cover sands, or cover-sands (e.g., van der Hammen, 1951; Koster, 1982; West, 1977). In Danish literature, the word »dæksand« has been used by Sørensen (1972).

APPEARANCE

Both Younger and Older cover sands possess a characteristic horizontal to subhorizontal stratification, the individual layers of which range from a few millimeters to a few centimeters in thickness (figs. 2 and 3). By far the major amount of the particles are well-rounded, wind-polished quartz grains (fig. 4) and, generally speaking, the larger grains are the better rounded. The Younger cover sands are built up of layers of approximately equal grain size, usually with a maximum around 175 μ m, and in the Older cover sand two grain sizes are found, usually with maxima around 175 μ m and between 75 and 105 μ m, reflecting the alternation of fine sand and loamy fine sand layers within the unit.

The cover sands in southern Jutland make up the surface layers in flat and weakly undulating areas with a high ground water level.

LITHOSTRATIGRAPHY

West of the area glaciated during the Weichselian, it proved possible to establish a lithostratigraphical sequence in the cover sand areas along the pipe-line trench (table 1). The lower part of this sequence is made up of involuted (probably cryoturbated) loam, sand, and gravel. In places where cover sand deposits are thin or absent, it was observed that the involutions are up to approximately 1.5 meters deep. In two sites, frost fissure casts extended downwards from the lower part of the involuted layer. Yet this part of the sequence was rarely exposed.

Upon the involuted part of the sequence, a horizontal to weakly undulating horizon of wind-polished and faceted gravels and stones is found, suggesting a deflation surface. Upon the gravel bed is Older cover sand which may pass gradually upward into the Younger cover sand; otherwise, a layer of well-sorted, silty, fine sand without structures separates the Older and the Younger cover sand. The Younger cover sand makes up the top layer of the sequence, and the original layering is therefore often blurred or has disap-

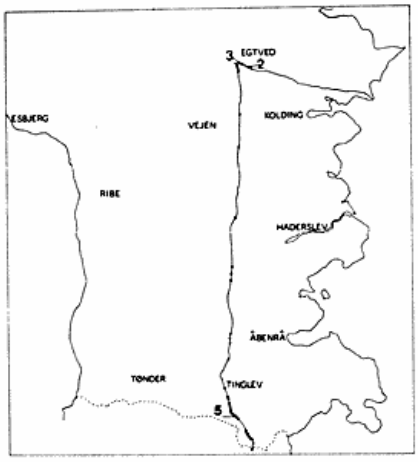

Fig. 1. Map of southern Jutland showing the location of the gas pipe-line trench (full line) with cover sand occurrences (fat line). Dotted lines indicate railways and the dashed line shows the Danish-German border. The location of figs. 2, 3, and 5 are indicated by the corresponding number.

Fig. 1. Kort over det sydlige Jylland. Placeringen af gasledningerne Frøslev-Egtved og Egtved-Lillebælt er angivet med en linie. De tykke dele af linien angiver dæksandsområder, de tynde, prikkede linier er jernbaner, og den stiplede linie er den dansk-tyske grænse. Tallene 2, 3 og 5 angiver lokaliteterne for de tilsvarende figurer.

Fig. 2. View along the gas pipe-line trench. Before trenching, the top soil has been removed and the lower part of a podzol is visible. The face in the trench shows a cover sand deposit. The visible part of the face is approximately 1.7 meters deep.
Fig. 2. Udsigt langs gasledningstraceet. For renden graves, fjernes overjorden fra arbejdsbæltet. I den ca. 1,7 m høje profilvæg ses den nedre del af en podzol underlejret af dæksand.

peared completely due to soil processes. In places where the thickness of the Younger cover sand amounts to approximately one meter or more, a bioturbated horizon and occasionally an organic layer may be found within this unit, suggesting a period of decreased deposition.

CHRONOSTRATIGRAPHY

A palynological investigation of the organic layer within the Younger cover sand reveals fairly high percentages of the pollen of birch, grasses, and sedges, and of spores of *Gymnocarpium*. Furthermore pollen of juniper, willow, and pine are present together with a number of herb types. A comparison to other Danish pollen diagrams makes it reasonable to assume that the organic layer represents the Allerød time.

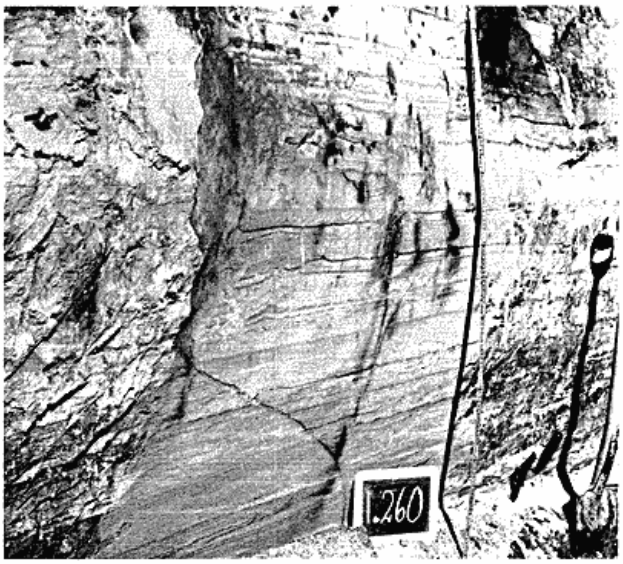

Fig. 3. Older cover sand (lower half of profile) with a gradual transition upwards to Younger cover sand. The ruler is 2 meters long.
Fig. 3. Ældre dæksand (nedre halvdel af profilet) med gradvis overgang opad til Yngre dæksand. Tommestokken er 2 m lang.

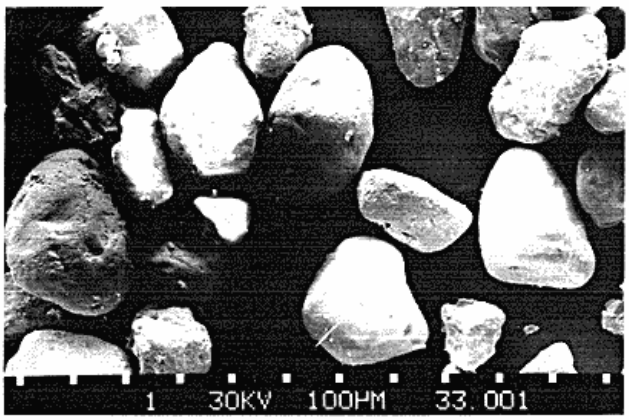

Fig. 4. SEM photograph of cover sand sample (Photo: J.B. Jørgensen).
Fig. 4. SEM foto af en dæksandsprøve (foto J.B. Jørgensen).

Organic material for pollen analysis has also been collected from layers within the Older cover sand. The composition of the pollen points to a pioneer vegetation with high percentages of grasses and sedges and, at one level, high percentages (48 %) of willow as well. The percentages of birch, juniper, and pine are on the other hand rather low. A fair number of herb pollen types were recognized, of which the most conspicuous are *Gentianella* and *Saxifraga* types. The composition of the pollen spectra deriving from Older cover sand is difficult to relate to results obtained elsewhere. It does not fit in well with Late-Glacial diagrams or parts hereof, and no indisputable records exist from The Nether-

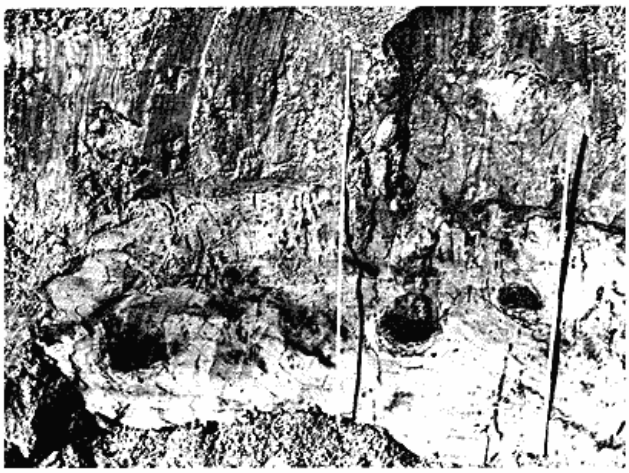

Fig. 5. Involuted cover sand with organic clods (black) presumably of Allerød age. The visible part of the ruler is 1.8 meters long.
Fig. 5. Involueret dæksand med organiske klumper (sorte), der sandsynligvis er af Allerød alder. Den synlige del af tommestokken er 1,8 meter lang.

The Netherlands		Southern Denmark	
Lithostratigraphy	Chronostratigraphy	Lithostratigraphy	Chronostratigraphy
Younger Coversand II	Late Dryas	Younger Coversand	Late Dryas
Loamy sand - organic mat.	Allerød	Loamy sand - organic mat.	Allerød
Younger Coversand I	Earlier Dryas	Younger Coversand	
Loamy sand - organic mat.	Bølling	Loamy sand	
Older Coversand II Pebble layer Involuted with frost wedge casts	Pleniglacial	Older Coversand Pebble layer Involuted with frost wedge casts	Pleniglacial ?

Table 1. (partly van der Hammen).
Tabel 1. Dæksandsområder.

lands concerning organic deposits from the Older Coversand II. On the other hand, a comparison to pollen records from the Dutch Older Coversand I (Kolstrup, 1980) shows fair agreement, and even though the two deposits (Dutch and Danish) do not overlap in terms of time of deposition, it may nevertheless be tentatively concluded that the pollen record from the Danish Older cover sand may represent a Pleniglacial vegetation from an environment similar to that of the Dutch Older Coversand I.

In table 1 the litho- and chronostratigraphy from The Netherlands (partly according to van der Hammen, 1971) and southern Jutland are outlined. It can be seen that the lithostratigraphic sequences are almost identical. The Danish chronostratigraphy is still incomplete, yet where information exists it seems to be in agreement with the Dutch record.

VARIATIONS IN COVER SAND

In the previous paragraphs an outline of the typical appearance of the cover sands is given, together with an outline of the complete stratigraphical sequence. However, apart from hiati, a number of deviations from the general pattern have been observed which may impede the possibility of interpretation in exposures of limited lateral and/or vertical extent (see also van der Hammen, 1951).

The layers within the Older cover sand may be relatively coarse with maxima of about 375 μ m and 175-250 μ m in extreme cases. Still, even in coarsely developed Older cover sands, an alternation between finer and coarser layers exists. Conversely, the Older cover sand may be very fine-grained. If this is the case, up to 15 cm thick layers dominated by particles with a grain-size maximum around 75 μ m may be found alternating with layers, a few centimeters thick, of slightly coarser material.

The lowermost part of Younger cover sand may possess alternating grain-size classes as does Older cover sand. Yet in such cases, the finer layers are usually few in number and relatively thin. Younger cover sand of this type may be impossible to distinguish from Older cover sand unless the loamy layer which sometimes separates the two is present or, alternatively, the layers can be followed laterally from a sequence with »normal« appearance.

Within the Younger cover sand, ½-1 cm thick layers of coarse sand and fine gravel, 1 to 4 mm in size, may occur. Likewise, single gravels up to 1.5 cm in size may be found.

Both Older and Younger cover sand may occasionally possess small-scale ripple lamination, usually only two or three ripples within a layer.

In areas with little gravel and stones in the lower, involuted sequence, the pebble layer at the deflation surface may be very poor in pebbles and it may be necessary to search for them.

Dislocations of the cover sands may occur occasionally. Small undulations of a few centimeters depth have been mentioned by Kolstrup & Jørgensen (1982) but strongly involuted sequences such as shown in fig. 6 are also present. In this figure the black clods contain organic material which has been investigated for its pollen content. Pine, birch, and sedges have percentages of 15-20, ca. 30, and 35-40 respectively. Besides these, 1-4 % pollen of juniper, various herb pollen types and spores of *Sphagnum* and *Gymnocarpium* are found. This pollen composition points to an Allerød age for the accumulation of the organic material. Later, probably during Late Dryas time, the organic layer became involuted together with the over- and underlying sediments, presumably due to the process of freezing and thawing.

Frost wedge casts have not yet been recorded in Younger cover sands in Denmark, but they are probably present since they are reported from the Younger Coversand II in The Netherlands (e.g. Maarleveld, 1964), and in deposits of Late-Glacial age in southern Sweden (Svensson, 1973).

SAMMENDRAG

Under udgravningerne i somrene 1981 og 1982 til det danske naturgasnet blev der i det sydlige Jylland fundet aflejringer af både yngre og ældre dæksandstype. Begge typer består af mm til cm tykke, parallelt, horisontalt lejrede, velsorterede lag. Forskellen mellem de to typer dæksand er, at de enkelte lag i de yngre dæksande er af stort set samme kornstørrelse, mens der i de ældre dæksande er en vekslen mellem meget finkornede og lidt grovere lag. De enkelte sandskorn i sedimenterne er velafrundede og polerede, og da dæksandsenhederne udgør toplaget i flade og svagt ondulerende områder, formodes det, at dæksandene er vindaflejrede.

Den lithostratigrafiske sekvens i dæksandsområderne uden for isens hovedopholdslinie er, hvor den er komplet, fra bund til top: 1)

en involueret (kryoturberet) sekvens af sand og grus, 2) et horisontalt-subhorisontalt lag af vindpolerede og -facetterede sten og grus, 3) ældre dæksand, 4) sandloess lokalt med bioturbation, 5) yngre dæksand, 6) bioturberet yngre dæksand eller evt. tørv, og 7) yngre dæksand.

Denne sekvens er identisk med de sekvenser, der er beskrevet fra dæksandsområderne i Holland, Vestbelgien og Nordtyskland. Pollenanalyser i tørven i enhed 6) giver en Allerød alder, hvilket er i overensstemmelse med de aldersbestemmelser, der er udført i vore sydlige nabolande.

Selv om dæksandenes udseende er ret konstant over store strækninger, kan der forekomme variationer i deres udseende. Både yngre og ældre dæksand kan være grovere eller finere end normalt, og der kan lokalt findes småskala strømribber. I enkelte tilfælde er det yngre dæksand blevet involueret, formodentlig i Yngre Dryas tid.

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Faststående og omlejrede saale-morænelersaflejringer. Et eksempel fra Sædding-området, Vestjylland

LEIF CHRISTENSEN

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Den større aktivitet indenfor bygge- og anlægssektoren i Danmark op gennem 1970'erne har øget kravene til særlige geomorfologiske og geologiske detailkort i stor målestok i områder med risiko for »slappe« jordarter eller blødbundsområder. Jordartsmaterialerne kan her have en lavere fasthed og styrkemæssigt være svage og sammentrykkelige. Ved projektering af bygge- og anlægsopgaverne er det en fordel på et tidligt tidspunkt at kende det berørte områdes geologi, således at områder med formodede »slappe« aflejringer kan afgrænses fra områder med formodede »faste« aflejringer.

Det antages almindeligvis, at periglaciale processer under Weichselnedisningen har omformet Saale-landskaberne i Vestjylland (fig. 1) Den måde disse landskaber i dag afspejler de tidligere periglaciale forhold afhænger af Saalelandskabernes materialesammensætning.

Kompakte morænelersaflejringer kan omlejres under periglaciale forhold ved solifluktion ned over en frossen jordoverflade – *gelifluktion* (Washburn, 1973) – og derved få ændret materialernes oprindelige fasthed og styrker. Saalelandskabernes morænelersaflejringer i Vestjylland har været isbelastet og er almindeligvis faste og mindre sammenpresselige. Dog er de sjældent så faste som Weichsel morænelersaflejringerne i Østdanmark. Solifluktionslag, skredjord og nedskylsjord har ikke været isbelastet, og er ofte meget »slappe«. Desuden kan de være underlejret af Interglaciale organiske aflejringer af begrænset mægtighed.

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