

TRACE ELEMENTS IN DANISH TILLS

Knud Binzer

Geological Survey of Denmark

Abstract. Samples of unweathered till from the last glaciation, taken from localities presumed to represent different ice movements (Norwegian ice, Baltic ice) has been analysed for traces of the following elements: Li, Cr, Mn, Co, Cu, Zn, Ni and Sr.

As a preliminary result the investigation shows that the contents of trace elements in Danish tills are very similar. In some localities with more than one till, a certain variation can be demonstrated. The question whether the trace-element content derives from the local pre-Quaternary deposits is mentioned.

The following are the preliminary results of an investigation of the contents of trace elements in Danish tills. The investigation was carried out as a collaboration between the Mineralogical Institute, the Technical University of Denmark and the Geological Survey of Denmark and was supported by a grant from the National Technical Sciences Fund (Statens teknisk-videnskabelige Fond).

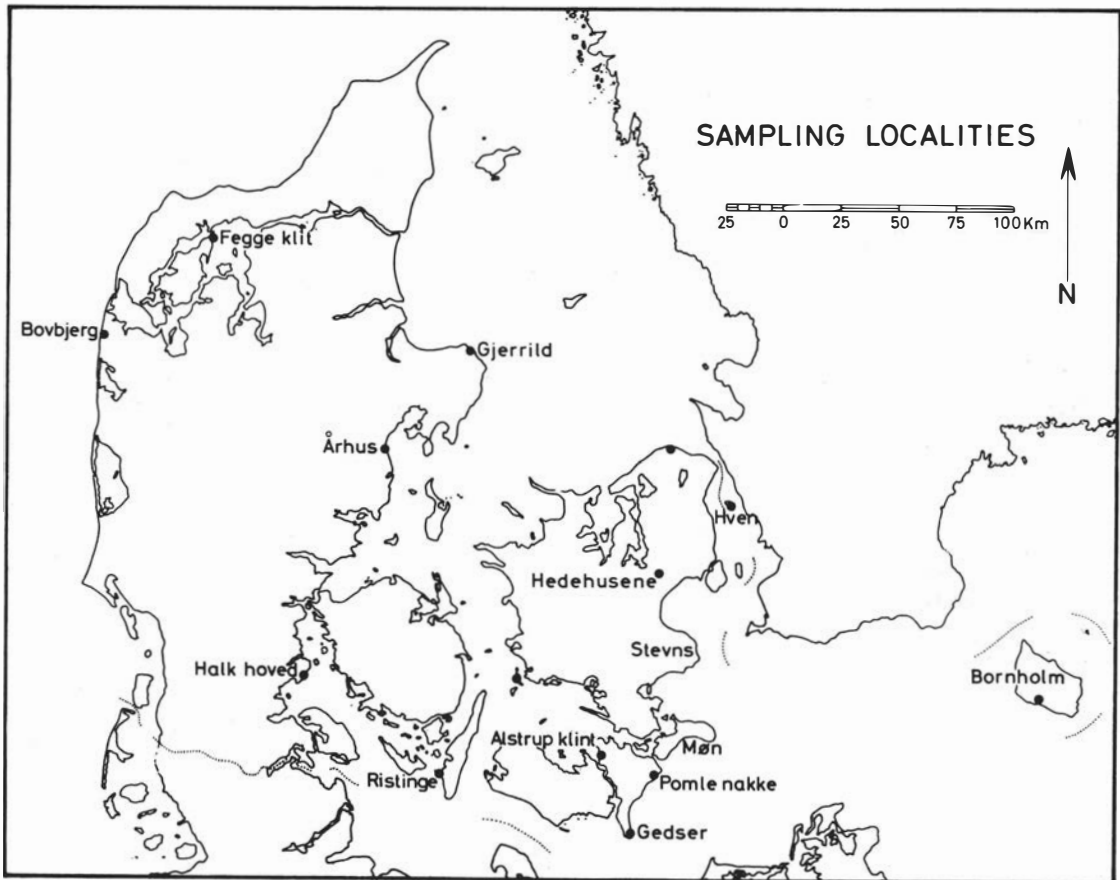


Fig. 1

Knud Binzer 1972

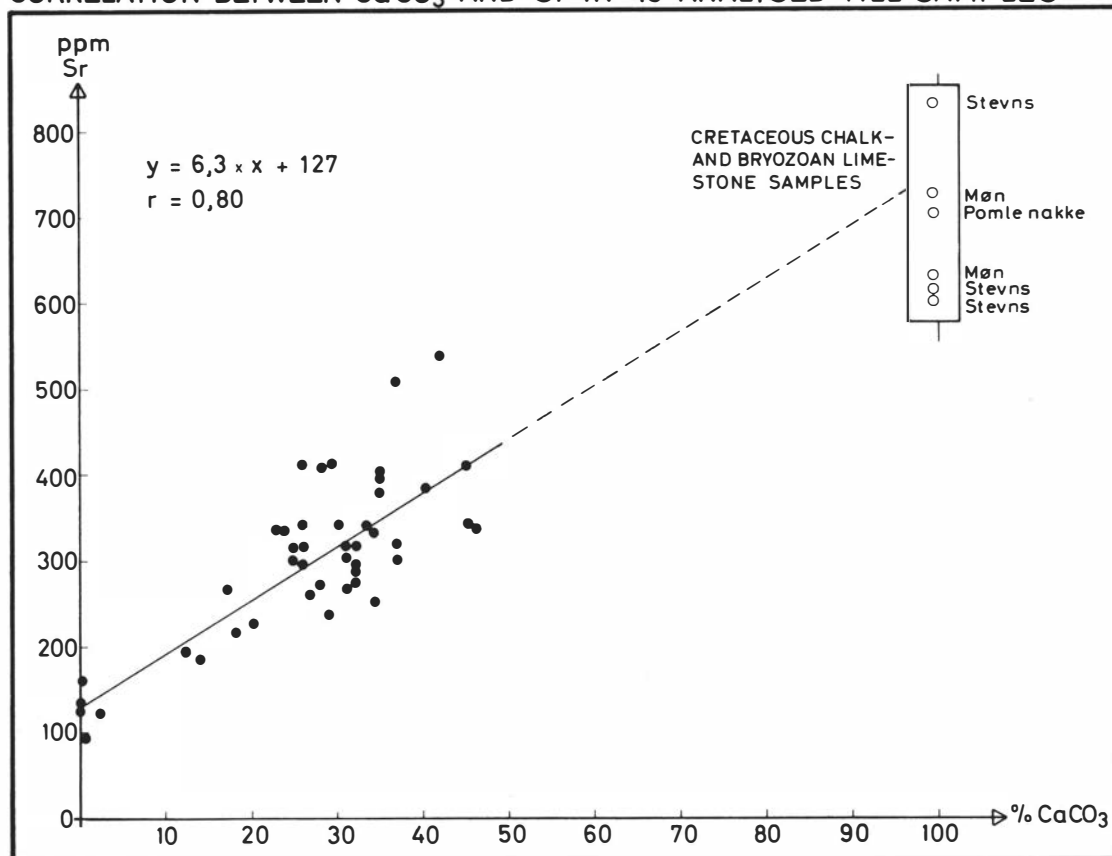
CORRELATION BETWEEN CaCO_3 AND Sr IN 45 ANALYSED TILL SAMPLES

Fig. 2

Knud Binzer 1972

The investigation included the measurement of the contents of heavy metals in tills which have not been affected by pedological processes. Apart from the geological aspect, the aim was to provide values for the trace-element contents, from which the heavy-metal contamination of soils could be evaluated.

The geological aspect of the investigation is whether there is a difference in trace-element content in tills which have been transported from different directions. If it is possible to demonstrate such a difference, this may contribute to the discussion about the ice movements in the Danish Quaternary sedimentary area.

The till material for the investigation consists predominantly of unaltered till from the Weichselian. The material represents what is generally believed to have been transported from the north (Norwegian ice) or from the southeast (Baltic ice). Most of the sampling localities (see map, Fig. 1) are situated on the coast,

where the tills are exposed in cliffs (one locality on the Swedish island of Hven). One locality (Hedehusene) is situated in a gravel-pit, where a till more than 5 m thick covers the exploited meltwater deposits.

At each locality up to five samples, each of 5 kg, were taken. Each sample was divided into parts, and from a 1-kg subsample of the material the -32-micron fraction was separated. This fraction was chemically analysed. In this fraction a higher content of trace elements can be expected, and there is a possibility of securing a more representative sample of the till. A similar investigation of tills has been successfully carried out in Canada (R.W. May, 1970).

The analyses were performed at the Mineralogical Institute of the Technical University of Denmark with a Perkin-Elmer atomic-absorption spectrophotometer. The trace elements analysed for were Cr, Mn, Co, Ni, Cu, Zn, Sr and Li. Li was analysed to get a reference

Table 1. Average (\bar{X}) and standard deviation (s) of till analyses. The values are in p.p.m. of the $\div 32$ -micron fraction, calculated on a CaCO_3 -free basis (except Sr).

Locality	No.	Li	Cr	Mn	Co	Ni	Cu	Zn	Sr	% CaCO_3	% $\div 32 \mu$	
Hedehusene	1	27	72	564	<5	48	29	51	505	37	50	
Alstrup	1	36	100	580	<5	36	43	133	299	37	50	
Gedser	5	\bar{X} s	37 2	85 19	541 50	6 3	35 5	36 4	100 14	263 16	30 2	65 10
Pomlenakke I	5	\bar{X} s	41 4	87 8	632 48	9 4	30 6	36 5	94 16	260 35	31 2	60 8
Pomlenakke II	1		41	99	743	6	50	35	88	314	32	55
Hven I	3	\bar{X} s	31 4	106 12	494 41	9 5	35 3	28 4	114 8	408 2	28 1	44 1
Hven II	1		41	104	750	24	45	30	102	194	12	65
Gjerrild	3	\bar{X} s	40 5	110 4	743 13	<5	40 13	48 11	88 15	358 41	42 4	38 13
Feggeklit I	2	\bar{X} s	37 2	77 2	491 41	22 1	42 5	59 2	132 29	133 3	0 0	33 3
Feggeklit II	1		44	84	572	<5	37	51	109	300	25	45
Feggeklit III	1		58	101	789	13	39	46	113	342	30	60
Bovbjerg	5	\bar{X} s	52 7	97 7	689 54	7 4	50 6	39 4	98 14	320 16	26 1	75 0
Århus I	2	\bar{X} s	37 2	93 12	661 173	9 5	60 1	40 10	141 45	107 11	2 1	35 5
Århus II	1		48	106	1093	17	42	110	169	225	20	45
Ristinge	3	\bar{X} s	30 9	127 13	713 101	10 5	39 11	32 9	151 36	402 93	40 6	52 2
Halk Hoved I	3	\bar{X} s	33 5	104 7	1826 75	20 1	61 9	38 3	134 15	370 29	35 1	70 0
Halk Hoved II	3	\bar{X} s	36 5	104 4	622 75	22 4	45 4	22 1	102 7	358 32	35 4	54 4
Bornholm	3	\bar{X} s	29 2	101 4	526 37	18 1	45 4	30 4	115 7	223 34	16 2	45 0
Total	44	\bar{X} s	38 10	98 15	716 325	10 7	43 11	36 9	108 27	301 92	27 11	54 13
Earth crust after Krauskopf (1967)			20	100	950	25	75	55	70	375		
Analytical precision			2	10	64	4	16	4	44	80		

value for the analyses of forest soils being carried out by the botanists at the Institute of Ecological Botany, University of Copenhagen.

The values for the trace elements chosen are calculated on a CaCO_3 -free basis, except for the Sr. This is done because the CaCO_3 -content in the samples is very high and very variable. Furthermore, analyses of calcareous sediments in the Danish pre-Quaternary deposits, from which the CaCO_3 content in Danish tills is predominantly derived, shows that the calcareous sediments do not significantly contribute to any of the trace elements analysed for, except Sr. The variation of the Sr contents in the tills can be shown to be correlated with the CaCO_3 (see Fig. 2). The analyses of six

Cretaceous calcareous sediment samples are shown as a control.

Table 1 shows that the trace-element distribution does not differ significantly in different parts of the country. However, there is a tendency to higher values for some of the elements (Li, Cr and Ni) in the northern part (Bovbjerg), compared with the southeastern part of the country (Pomlenakke).

Table 2 shows the values from two localities (Feggeklit and Halk Hoved) with more than one till. In Feggeklit there is a difference in the contents between the uppermost till (I) and the lowermost till (III). Li, Cr and Sr are higher in the lowermost till and Co, Ni, Cu and Zn are higher in the uppermost till. The till (II) in

Table 2 The values in ppm

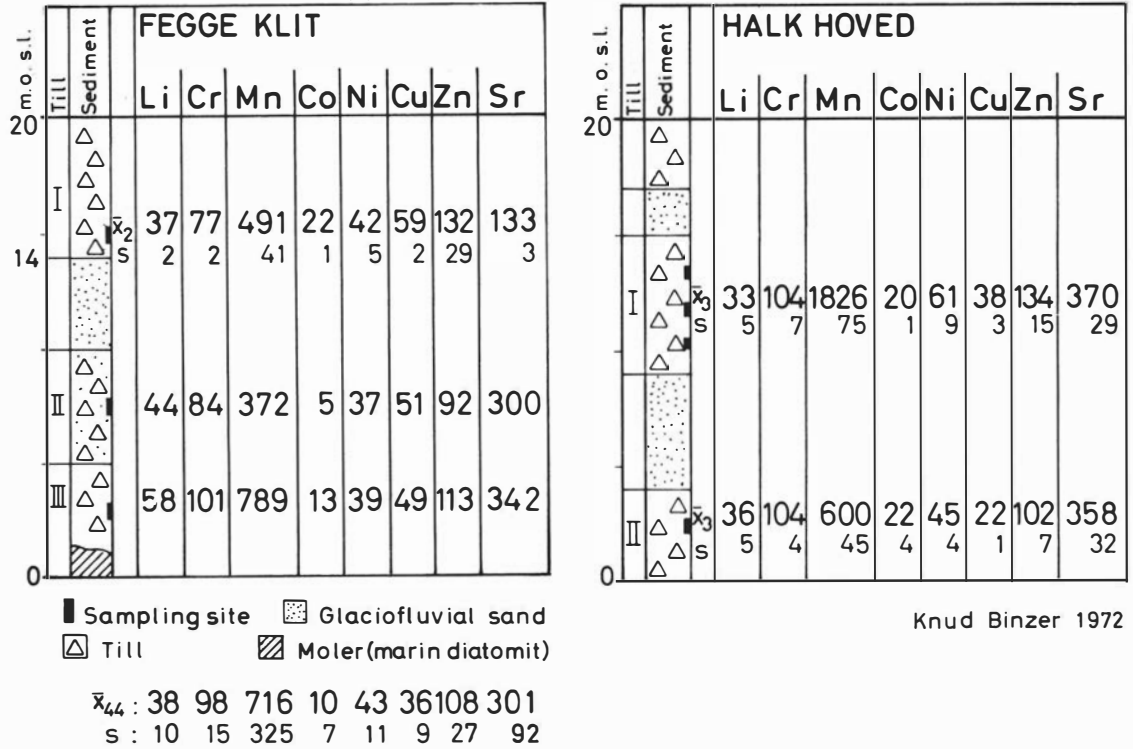


Table 3. Analyses of Quaternary clays and Danish pre-Quaternary sediments (values in p.p.m.).

Sediment	Li	Cr	Mn	Co	Ni	Cu	Zn	Sr	
"Stoneless clay" Møn	28	53	458	10	29	20	157	128	
Cyprina clay Ristinge	33	90	548	12	34	23	61	109	
Stoneless clay Ristinge	35	114	447	18	48	26	94	147	
Søvind marl Eocene, Århus	64	93	377	39	116	50	198	756	
Bryozoan limestone Danian, Stevns	2	<5	215	<5	8	7	88	599	
Fish clay Danian, Stevns	609	310	40	100	1200	117	910	1682	
Chalk Senonian, Stevns	2	<5	95	<5	<5	7	26	615	
Chalk Senonian, Møn	1	<5	261	<5	<5	6	16	628	
Jurassic clay Bornholm	77	114	98	20	37	15	69	97	
Jurassic sand Bornholm	4	41	41	5	10	<5	26	37	
Average of 44 till samples	\bar{X} s	38 10	98 15	716 325	10 7	43 11	36 9	108 27	301 92

between seems to occupy an intermediate position. In Halk Hoved the contents of Mn and Ni in the upper till (I) are significantly higher than in lower till (II) and also higher than the total average of the samples analysed, and the content of Cu is also higher. Here, consequently, is a till which it is possible to recognise and distinguish from other tills.

To elucidate the question about the sources of the trace elements in the tills, Table 3 shows analyses of some Quaternary clays and some Danish pre-Quaternary sediments. The table shows that the Quaternary clays generally have lower contents of the trace elements than the total average of the till material. The Tertiary "Søvind marl" shows higher values, except for Cr. The Cretaceous calcareous sediments have very low heavy-metal contents, and only the Sr content is high. The Cretaceous clay "Fish clay", on the contrary, shows remarkably high values of the trace elements, but this clay outcrops with such a small thickness and with so small a regional distribution that it is question-

able whether it has contributed to the trace-element content in the tills. The Jurassic clays have higher contents of Li, Cr and Co compared with the till average, and the Jurassic sand shows lower values, as expected. The table shows that the Danish pre-Quaternary deposits include sediments with high trace-element contents, from which the contents in the Danish till may have been derived.

REFERENCES

- Hansen, S. 1965. The Quaternary of Denmark. In Rankama, K. (editor), *The Geological Systems: The Quaternary*, 1. New York: Interscience Publishers.
- Krauskopf, K.B. 1967. *Introduction to Geochemistry*. New York: McGraw-Hill.
- May, R.W. 1970. Cu, Zn, Cr, Ni geochemistry of glacial tills in southern Ontario, Canada. *Geol. Soc. Am. Abstracts with Programs for 1970*, part 7, p. 618.