Outwash of terrestric soils into Lake Saksunarvatn, Faroe Islands

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A number of radiocarbon datings from Saksunarvatn, Faroe Islands, (figs. 1, 2 & 3 and table I) has shown that in some cases older strata overlay younger layers. The explanation is that due to erosion of peat in the catchment area, older material has been transported out into the lake. This is shown by the content of fungal hyphae in the sediments (fig. 4). Sediments from lakes with river inflow can therefore not be used for palaeoecological studies unless close radiocarbon datings can make sure that this serious error does not occur. It is supposed that these processes of redeposition demonstrated for this Faroese lake occur in all mountain areas.

In 1972 the Geological Survey of Denmark made a coring in lake Saksunarvatn, Faroe Islands. A core of 36.75 m of sediments was obtained. Rather extensive work has since then been made on the material. These investigations (pollen analysis, chemical analysis, etc.) will soon be completed. This account appears now because the radiocarbon datings and measurements of the content of fungal hyphae in the sediments have given results which I believe will be of some importance when evaluating data from lake sediments in other areas.

The location of the lake is seen in fig. 1, the bottom relief in fig. 2, and fig. 3 represents a photo of the lake and its environment. A continuous series of sediments were sampled in mostly 1 m, in some cases 0.5 m, long tubes with a diameter of 7 cm. The uppermost 32 m of sediment consisted of lake mud and the lowermost 5 m was clay (fig. 4). Solid rock was not reached. The coring was made in two stages and overlapped for about 2 m. The connections in fig. 4 are made according to the depth of water as registered by the coring crews.

The radiocarbon datings

32 samples were radiocarbon dated and the results are listed in table 1. Ages are given both in conventional C-14 years and in calendar ages corrected according to Damon *et al.* (1972). The lowermost 5 m of clay could not be dated.

Table 1. A complete list of the radiocarbon datings.

	Sample K-No	Depth below bottom of lake m	Conventional C-14 age bp	Calibrated C-14 age
Coring I	2333	0.88 – 0.98	1890 ± 100	40 ± 105 AD.
(Depth of	2334	1.91 – 2.01	1840 ± 100	100 ± 105 –
water	2335	3.03 – 3.13	1730 ± 100	220 ± 105
15.20 m)	2336	3.77 – 3.86	1690 ± 100	270 ± 110
	2337	5.08 – 5.18	1570 ± 100	400 ± 110
	2338	6.03 – 6.11	1830 ± 100	110 ± 105
	2339	6.65 – 6.73	2250 ± 100	380 ± 110 BC.
	2340	7.90 – 8.00	2530 ± 100	720 ± 140 –
	2341	8.88 – 8.98	2470 ± 100	650 ± 140 –
	2342	9.78 – 9.88	2340 ± 100	490 ± 110 –
	2343	10.81 – 10.91	2240 ± 100	370 ± 110 –
	2344	11.70 – 11.78	2120 ± 100	220 ± 110 –
	2345	12.83 – 12.93	2190 ± 100	310 ± 110 –
	2346	14.33 – 14.43	2610 ± 100	820 ± 140 –
	2347	16.63 – 16.73	3120 ± 100	1470 ± 160 –
Coring II	2157	14.94 – 15.01	2890 ± 100	1180 ± 130 –
(Depth of	2321	16.99 – 17.07	3320 ± 100	1730 ± 140 –
water	2322	18.02 – 18.07	3680 ± 100	2190 ± 120 –
14.00 m)	2323	19.00 – 19.10	3780 ± 100	2320 ± 150 –
	2158	20.70 – 20.81	4140 ± 100	2780 ± 150 –
	2324	20.93 – 21.03	4310 ± 100	3000 ± 190 –
	2325	22.24 – 22.28	4520 ± 100	3260 ± 140 –
	2326	24.10 – 24.20	4930 ± 100	3750 ± 120 –
	2327	25.11 – 25.21	5330 ± 100	4190 ± 140 –
	2328	26.33 – 26.41	5790 ± 100	4670 ± 130 –
	2329	26.97 – 27.07	6190 ± 110	
	2330	28.04 – 28.12	7240 ± 100	
	2331	29.05 – 29.13	8230 ± 100	
	2159	30.75 – 30.83	9180 ± 140	
	2332	31.22 – 31.32	9380 ± 130	
	2160	31.99 – 32.10	9390 ± 150	

The depth-age relationship is shown graphically in fig. 4. From 32.10 m and up to about 12 m the curve appears to be quite normal with a slightly changing sedimentation rate. From a depth of 12 m the curve is inverted – the samples becoming older upwards. This trend continues up to the recent lake bottom except for a short stage between 8 and 5 m where the trend again is normal. The uppermost sample that has been dated was taken 1 m below lake bottom and has the calibrated age 40 AD. The youngest date in the whole profile is at a depth of 5 m and has the corrected age 400 AD. As can be seen, the two inverted parts of the curve are linear.

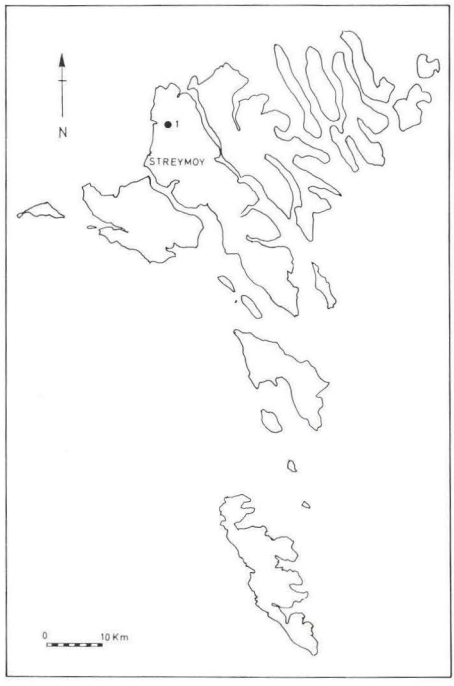

Fig. 1. Map of the Faroe Islands. Lake Saksunarvatn is indicated by the black dot no. 1.

Content of fungal hyphae in the sediments

In 31 samples the amount of fungal hyphae was measured. This was done because these hyphae are of strictly terrestric origin and can only enter the lake by erosion in terrestric soils. They therefore indicate the amount of terrestric material in the lake sediments.

Lycopodium spores in a known quantity (Stockmarr 1971) were added to 1 cm^3 of fresh sample. The lengths of all hyphae were measured and the result expressed as total length of hyphae per 25 Lycopodium spores pr. 0.002 cm^3. The result is shown in fig. 4, left side.

All the samples contain hyphae except the lowermost 5 m which consist of clay (see fig. 4). There is a high content between 32 and 26 m. From about 26 to about 9 m the content is minimum, except for a very pronounced peak at 16.5 m. The amount of hyphae decreases somewhat, but remains on a relatively high level until a depth of 9 m. From that level we see a decrease in amount of hyphae with a last increase from 1 to 0 m.

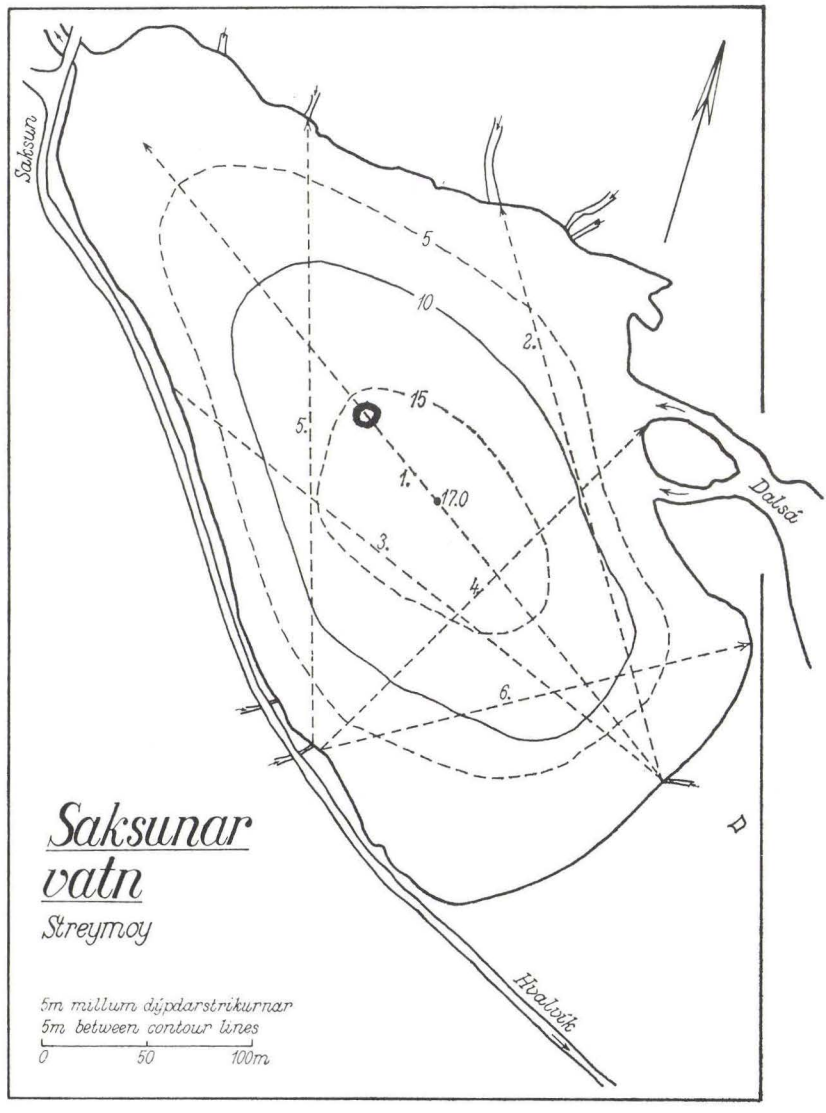

Fig. 2. The bottom relief of Lake Saksunarvatn with the sampling site indicated with a circle. Reproduced with the permission of Føroya Fróðskaparfelag.

The relationship between C-14 age and content of hyphae

As can be seen from fig. 4, there is some resemblance between the two curves, but it is not consistent. The hyphae only indicate the *amount* of terrestric material in the samples, but do not say anything about the *age* of

Fig. 3. Lake Saksunarvatn. Photo A. Villumsen.

this terrestric component. Between 32 and 27 m, the large amount of terrestric soil, as indicated by the hyphae, does not cause any inversions of the dates – presumably because the soil washed out is contemporary or almost so with the time of deposition. Between 12 and 8 m there is a large content of terrestric material which is older than the time of deposition, and therefore causes the inversion. Between 8 and 5 m we see a minimum of hyphae and the depth/age curve is normal. From 5 m up to the present day the terrestric component is low, but the washed out material is apparently very old, giving rise to the latest inversion.

Conclusion

The reason for the abnormal course of the C-14 curve in Lake Saksunarvatn seems to be clear: The inversions are due to outwash of older terrestric soils into the lake. The linear course of the C-14 curve in the reversed intervals in Saksunarvatn must be caused by steady erosion down through still older layers. We cannot know the age of the start of the inversions. The latest date that looks normal, i.e. is younger than the sample below, is 220 BC., but we can safely conclude that also that sample contains older material and there-

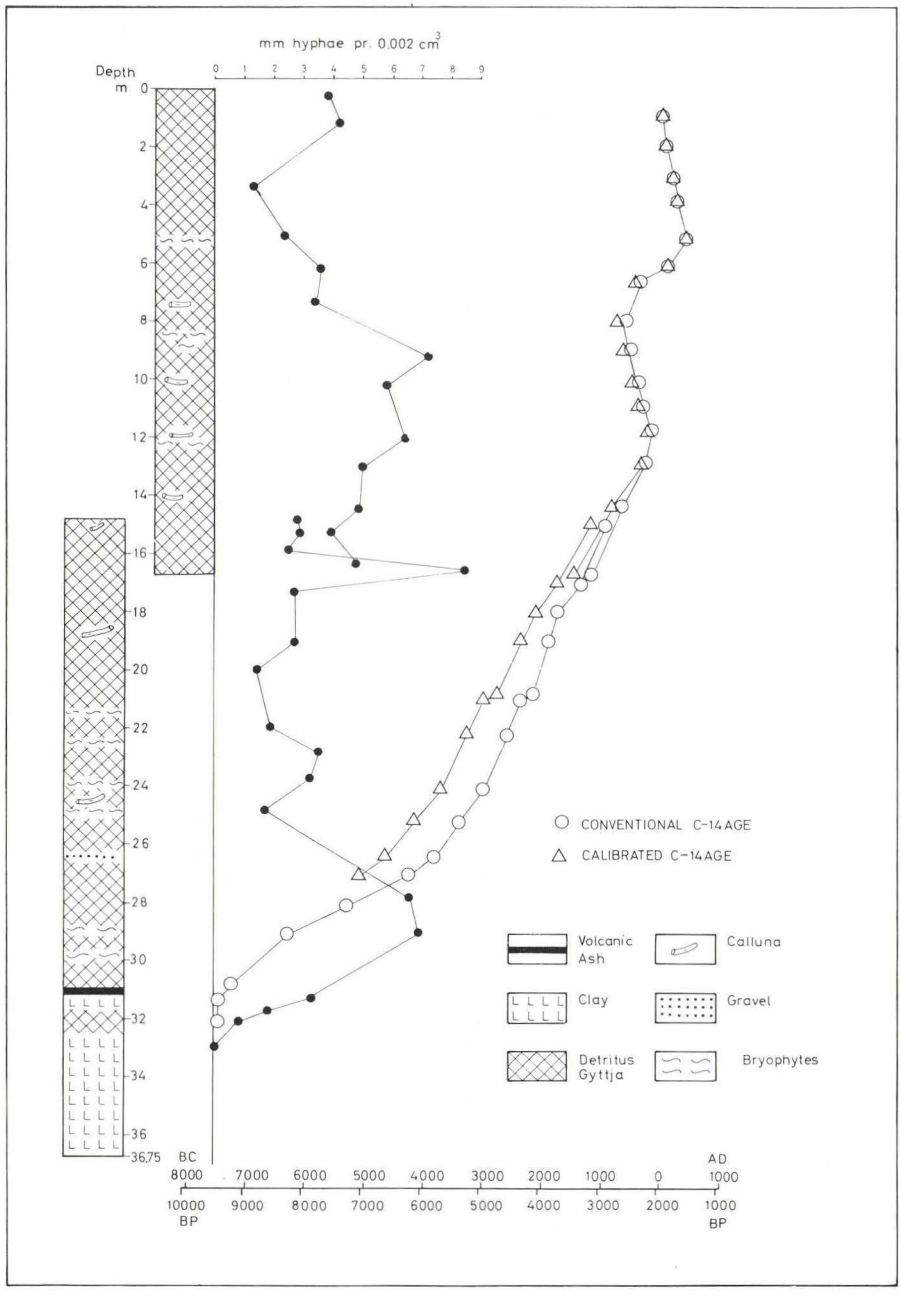

Fig. 4. The profile, content of fungal hyphae and the curve of the radiocarbon datings.

fore is deposited after 220 BC. The reason why the inversion starts at that point is not clear at the moment.

The present material demonstrates a potential grave source of error in palaeolimnological work. Tutin (Pennington) (1969, 1975) has also demonstrated inversions of C-14 dates in the Lake District. She ascribes the abnormalities there to forest clearances which then lead to increased erosion.

As far as I know, it has not earlier been demonstrated how invalidating this source of error can be. The error is likely to occur in all mountain areas. In such regions, therefore, it is not advisable to use sediments from lakes with river inflow unless close radiocarbon datings are used to make sure that there are no inversions on the time scale. The amount of fungal hyphae should also be measured or at any rate estimated in some way.

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Dansk sammendrag

En række C-14 dateringer fra Saksunarvatn, Færøerne (fig. 1, 2 og 3) viser to perioder hvor prøverne bliver ældre opefter (fig. 4, tabel I). Forklaringen er, at der på grund af erosion i området er transporteret ældre, terrestrisk materiale ud i søen. Sedimenterne indeholder svampehyfer, som viser den terrestriske oprindelse, idet hyferne stammer fra jordboende svampe og kun kan komme ud i søen ved erosion i terrestriske jordarter. Som det ses af fig. 4 svinger mængden af hyfer og der er ikke fuldstændig korrelation mellem C-14 dateringerne og hyfeindholdet. Det kan man heller ikke forvente, fordi hyferne viser mængden, men ikke alderen, af terrestrisk materiale pr. prøve.

Erosion med udskylning af terrestriske jordarter i søer må formodes at forekomme i alle bjergrige egne, men denne alvorlige fejlkilde ved palaeolimnologiske studier har været overset.

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