[RADIOCARBON, VOL. 17, NO. 3, 1975, P. 276-300]

UNIVERSITY OF KIEL RADIOCARBON MEASUREMENTS VIII*

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The measurements presented in this list are part of the joint research program "Sonderforschungsbereich 95" of Kiel University for interdisciplinary research on problems of "Interaction Sea-Sea Bottom", sponsored by the Deutsche Forschungsgemeinschaft. They are directed 1) to the study of the path of ^{14}C from the atmosphere into argillaceous sediments, and 2) to date stratigraphic records within sediment. Associated problems are to identify sources of different ^{14}C activity that contribute to recent deposits, and to learn about effects of morphologic and hydrographic factors, especially of bottom currents, on sedimentation sequence. Even short term processes can be successfully studied by analyses of bomb produced radiocarbon in the marine environment.

Results show that biogenic carbon, in the organic part as well as in the carbonate, is in isotopic equilibrium with water environment, which is valid even for benthic communities of muddy sediments in the deeper parts of Kiel Bight. Though most of the organic fraction in the sediments is of autochthonous origin a noticeable amount of carbon with different ^{14}C activity is supplied from other sources. Anthropogenic effects are particularly prevalent in the top layers of the sediment. Reduced sedimentation rates and erosional events are recognized in the sediments of the Kiel Bight channels.

According to the recommendations of the latest ^{14}C conference (Rafter & Grant-Taylor, 1972), ages are calculated with the Libby half-life, and refer to 95% of the NBS oxalic acid activity. ^{14}C activities figures listed for modern samples refer to that same standard activity. Data are not corrected for isotopic effects. Errors correspond to 1 standard deviation of the net counting rate including statistics of background and reference standard. δ^{13}C values with suffix S refer to an internal standard of Solnhofen limestone, which is not yet connected to the PDB scale. They may be converted approximately by adding a correction term of $-1‰$.

Pretreatment procedures and CO_2 purification techniques are the same as reported in Willkomm & Erlenkeuser (1970). However, wet oxidation by means of potassium bichromate and sulfuric acid according to

$$3\,C + 2\,K_2Cr_2O_7 + 8\,H_2SO_4 \rightarrow 3\,CO_2 + 2\,Cr_2(SO_4)_3 + 2\,K_2SO_4 + 8\,H_2O$$

resulted in markedly lower gas impurities, especially with sediment samples. The conversion yield was studied on different materials (coal, graphite, charcoal, wood, sediments), and quantitative conversion (better than 97%) was found in all cases. The programs for the evaluation of ^{14}C-count rates (Erlenkeuser & Willkomm, 1972, 1973a) were modified for

* Contribution No. 11 of the Sonderforschungsbereich 95 "Interaction Sea—Sea Bottom", University of Kiel.

a PDP 10 timesharing computer, for greater efficiency in processing the ^{14}C measurements.

ACKNOWLEDGMENTS

We are indebted to many colleagues of the Geologisch-Paläontologisches Inst, Universität Kiel and of the Inst f Meereskunde, Universität Kiel for helpful discussions and assistance in collecting samples, especially E Suess, Chr Samtleben, H J Black, and R R Dries. We particularly wish to thank F Werner for supplying sediment cores from Kiel Bight, G Unsöld for collecting mud samples from Nordstrand I., and W Richter for exposing floating plates. We thank V Lohr for processing the *Cyprina* series. Investigations were financially supported by the Deutsche Forschungsgemeinschaft within the Sonderforschungsbereich 95. The data processing in ^{14}C measurements was performed at the Computer Center of the University of Kiel.

A. Sea water samples

Kiel Bight series, 1972-1974

Water samples were coll, in monthly intervals, mainly from Vejsnäs channel, N Kiel Bight, and from Boknis channel, W Kiel Bight. 50L samples were taken from the water column at 5 to 7m intervals with a submergible pump and coll in 25L plastic bottles. Bacterial activity was ended by adding I_2–KI–solution (Mook, 1970). CO_2 was released at pH = 2 at room temperature, flushed by a stream of nitrogen bubbled through sample for ca 8 hr at 0.6L NTP/min, dried in concentric sulfuric acid and trapped at −194°C while carrier gas was fed back to sample. Results appear in Table 1.

General Comment: Kiel Bight is characterized by brackish water with strong variations of hydrographic parameters. High salinity water originating from the Kattegat Sea in the N enters Kiel Bight through Great Belt channel and is distributed at the base via Vejsnäs and Boknis channel into W and SW Kiel Bight (Wattenberg, 1949). The surface layer, however, is affected by outflow of low salinity water from the Central Baltic. Most of the year, Kiel Bight water shows pronounced saline stratification with salinity ca 22‰ (seasonal range: 14 to 30‰) in the basal layer below 20m water depth, and ca 15‰ (seasonal range: 9 to 20‰) in the surface layer above 10m (for details, see Wattenberg, 1949; Seibold *et al*, 1971). ^{14}C activity is high in the Baltic Sea (see Bornholm series) due to CO_2 exchange with the atmosphere, while it is kept low in the Kattegat Sea indicating combined influence of the Norwegian and North Seas (for ^{14}C level, see Gulliksen & Nydal, 1972). ^{14}C level in Kiel Bight water is intermediate and is correlated with salinity. With strong bottom water inflow, eg, July, 1972, however, ^{14}C activity is lower than calculated from a 2-box mixing model. This might indicate a stronger supply of low activity waters from the Norwegian Sea via the deep channels in the Kattegat area.

TABLE 1
Kiel Bight water 1972 to 1974

Location	Colln date (mo/day/yr) water depth	Lab no.	Sample depth	^{14}C activity % of modern activity $\pm 1\sigma$	$\delta^{13}C_S$ ‰
Stoller Grund flat	4/5/72	KI-585	6m	142.6 ± 0.9	+1.0
54° 31.4′ N, 10° 8.3′ E	15m				
Vejsnäs-Rinne (channel)	4/12/72	KI-588	4m	132.9 ± 0.7	+0.9
54° 51′ N, 10° 25′ E	30m				
Boknis-Rinne	4/25/72	KI-596.02	5m	139.3 ± 0.9	+1.6
54° 33′ N, 10° 6′ E	25m	KI-596.01	21m	130.5 ± 0.7	−0.2
Boknis-Rinne	5/18/72	KI-611	5m	140.9 ± 0.9	−0.6
54° 32′ N, 10° 2′ E	27m	KI-612	22m	131.6 ± 0.9	−0.7
Stoller Grund	6/23/72	KI-614	4m	143.7 ± 1.0	−0.3
54° 32′ N, 10° 10′ E	18m				
Vejsnäs-Rinne	7/19/72	KI-632	4m	144.7 ± 0.7	+2.4
54° 39′ N, 10° 39′ E	35m	KI-631	25m	131.4 ± 1.1	
Boknis-Rinne	8/21/72	KI-641	4m	143.9 ± 1.0	
54° 32′ N, 10° 2′ E	27m	KI-640	24m	127.7 ± 0.7	−1.3
Boknis-Rinne	9/18/72	KI-649	4m	143.0 ± 1.0	
54° 31 N, 10° 2′ E	27m	KI-650	24m	126.3 ± 0.7	−1.0
Boknis-Rinne	12/15/72	KI-668	4m	136.7 ± 0.8	−0.2
54° 32′ N, 10° 2′ E	30m	KI-669	24m	132.4 ± 0.7	−3.4

Boknis-Rinne	1/16/73	KI-673	1m	136.6 ± 1.1	−1.1
54° 32′ N, 10° 3′ E	26m	KI-674	5m	137.5 ± 1.1	−1.9
		KI-675	10m	135.5 ± 1.5	−1.6
		KI-676	15m	136.6 ± 1.1	−0.2
		KI-677	20m	134.6 ± 0.9	−1.8
		KI-678.01	26m	137.0 ± 1.2	−0.9
Boknis-Rinne	3/14/73	KI-692	5m	139.0 ± 1.2	−0.4
54° 32′ N, 10° 3′ E	27m	KI-690	15m	136.8 ± 1.2	−1.2
		KI-689	20m	137.2 ± 1.0	−1.1
Boknis-Rinne	4/10/73	KI-701	5m	141.9 ± 1.2	+0.8
54° 32′ N, 10° 3′ E	27m	KI-702	10m	136.6 ± 0.9	+0.9
		KI-703	15m	136.5 ± 1.2	+0.7
		KI-704	20m	134.9 ± 1.2	−0.6
Boknis-Rinne	6/19/73	KI-724	5m	141.3 ± 1.3	+2.5
54° 32′ N, 10° 2′ E	27m	KI-725	10m	137.9 ± 1.2	+1.1
		KI-726	15m	136.3 ± 1.2	+2.6
		KI-727	20m	136.9 ± 0.9	+2.1
		KI-728	25m	135.0 ± 1.2	+0.5
Boknis-Rinne	8/21/73	KI-739	5m	139.5 ± 0.9	+2.1
54° 31′ N, 10° 1′ E	27m	KI-740	10m	141.0 ± 0.9	+3.4
		KI-741	15m	137.9 ± 1.3	+0.5
		KI-742	20m	136.4 ± 1.3	+1.7
		KI-743	26m	137.9 ± 1.4	+0.3
Mittelgrund	8/21/73	KI-744	22m	135.2 ± 1.4	−0.8
54° 30′ N, 10° 4′ E	21m				

TABLE 1 (continued)

Location	Colln date (mo/day/yr) water depth	Lab no.	Sample depth	^{14}C activity % of modern activity $\pm 1\sigma$	$\delta^{13}C_S$ ‰
Boknis-Rinne	9/11/73	KI-752	5m	140.0 ± 1.1	+2.6
54° 31′ N, 10° 1′ E	27m	KI-753	10m	141.4 ± 1.0	+2.7
		KI-754	15m	137.7 ± 1.2	+2.5
		KI-755	20m	135.5 ± 0.9	−1.0
		KI-756	26m	132.5 ± 1.1	−1.5
Vejsnäs-Rinne	10/11/73	KI-760	7m	139.7 ± 1.3	+1.0
54° 39′ N, 10° 39′ E	31m	KI-761	14m	140.4 ± 1.1	+0.9
		KI-762	21m	136.5 ± 1.0	+1.7
		KI-763	28m	139.7 ± 0.9	+0.9
Boknis-Rinne	11/15/73	KI-783	5m	138.8 ± 1.1	−1.1
54° 32′ N, 10° 2′ E	27m	KI-784	10m	137.9 ± 1.2	+0.2
		KI-785	15m	136.5 ± 1.0	+0.5
		KI-786	20m	137.4 ± 1.0	−1.2
		KI-787	25m	137.0 ± 1.1	−2.2
	12/11/73	KI-788	5m	137.3 ± 1.1	−0.2
	27m	KI-789	10m	138.4 ± 1.1	−0.0
		KI-790	15m	137.7 ± 1.1	+1.4
		KI-791	20m	137.4 ± 0.9	−0.7
		KI-792	25m	140.6 ± 1.2	−0.3
Vejsnäs-Rinne	1/17/74	KI-815	5m	143.3 ± 1.1	+2.0
	30m	KI-816	10m	143.0 ± 1.3	+1.1
		KI-817	15m	143.5 ± 1.0	+1.4
		KI-818	20m	140.5 ± 1.2	+1.5
		KI-819	25m	137.5 ± 1.2	+1.8

Vejsnäs-Rinne	2/14/74	KI-828	5m	145.2 ± 1.2	+1.3
54° 42′ N, 10° 19′ E	30m	KI-829	10m	141.3 ± 1.1	+1.1
		KI-830	15m	138.5 ± 1.0	+1.4
		KI-831	20m	137.8 ± 0.8	+1.6
		KI-832	28m	133.3 ± 1.1	+2.8
Vejsnäs-Rinne	3/14/74	KI-835	5m	143.8 ± 1.2	+0.4
54° 42′ N, 10° 21′ E	27m	KI-836	5m	140.9 ± 1.1	+1.8
		KI-837	5m	138.5 ± 1.2	+0.9
		KI-838	10m	141.1 ± 1.1	+1.5
		KI-839	15m	141.2 ± 1.1	+0.4
		KI-840	20m	139.0 ± 1.1	−1.3
		KI-841	28m	139.9 ± 1.1	+1.9
Boknis-Rinne	4/17/74	KI-854	7m	139.9 ± 1.0	+2.3
54° 31′ N, 10° 2′ E	28m	KI-855	14m	141.4 ± 1.2	+3.2
		KI-856	21m	139.8 ± 1.2	+2.2
		KI-857	26m	138.6 ± 1.1	−2.1
Boknis-Rinne	5/13/74	KI-868	5m	140.9 ± 1.1	+0.9
	27m	KI-869	5m	140.2 ± 1.0	+1.3
		KI-870	10m	139.4 ± 0.9	+1.1
		KI-871	15m	140.9 ± 1.2	+3.4
		KI-872	20m	141.2 ± 1.2	+1.6
		KI-873	25m	139.1 ± 1.4	+1.5
Boknis-Rinne	6/18/74	KI-881	5m	140.0 ± 1.1	+1.5
	27m	KI-882	10m	136.6 ± 1.1	+1.6
		KI-883	15m	135.6 ± 1.0	+0.2
		KI-884	20m	135.2 ± 1.1	+0.8
		KI-885	26m	134.6 ± 1.1	+0.7

For comparison, some samples from terrestrial biosphere, Baltic Sea, and North Sea were measured.

143.1 ± 0.7%
KI-778. Modern leaves, Summer 1973 $\delta^{13}C_S = -26.6‰$

Leaves (*Malus domesticus*) coll Oct 1973 near Kiel (54° 18′ 27″ N, 10° 4′ 13″ E).

Baltic Sea series

Surface water coll in open sea.

148.0 ± 0.8%
KI-696.02. Bornholm 1 $\delta^{13}C_S = -4.0‰$

25km W of Bornholm I. (55° 11.5′ N, 14° 15.5′ E). Coll and subm March 1973 by H J Black, Inst Meereskunde, Kiel.

150.5 ± 0.9%
KI-862. Bornholm 2 $\delta^{13}C_S = +2.7‰$

20km NE of Bornholm I. (55° 19.0′ N, 15° 14.0′ E). KI-862-865 coll and subm April 1974 by Erwin Suess, Geol-Paläontol Inst, Univ Kiel.

146.9 ± 1.3%
KI-863. Bornholm 3 $\delta^{13}C_S = +0.2‰$

5km SE of Schonen, S Sweden (55° 24.5′ N, 14° 21.3′ E).

149.5 ± 1.1%
KI-864. Bornholm 4 $\delta^{13}C_S = +1.6‰$

100km NE of Bornholm I. (55° 43.1′ W, 16° 20.0′ E).

146.0 ± 1.5%
KI-865. Mecklenburg Bight 1 $\delta^{13}C_S = +1.4‰$

30km E of Fehmarn I. (54° 24.3′ N, 11° 50.0′ E).

General Comment: after isotopic correction KI-696.02, -862, and -864 show same activity as modern terrestrial biosphere. This high ^{14}C level probably results from CO_2 exchange with atmosphere. Response time of the Baltic as to atmospheric ^{14}C variations seems to be ca 10 yr, but too little is known for more comprehensive analysis. Activities are higher than in Kiel Bight. KI-865, Mecklenburg Bight, is clearly affected by Kattegat water, *cf* Kiel Bight series. KI-863 may represent water from Mecklenburg Bight drifting to the N or may reflect hard water effect of river discharge affecting coastal waters off Sweden.

Bornholm benthos series

Algae and mussels coll March 1973 by H J Black, 200m off shore of Bornholm I. (55° 16.3′ N, 14° 49.0′ E) at 2 to 4m water depth. *Comment*: correction for isotopic effects gives same activity as water sample, KI-696.02.

146.5 ± 0.7%
KI-697. Bornholm, *Fucus serratus* $\delta^{13}C_S = -16.6‰$

144.7 ± 0.6%

KI-698.01. Bornholm, *Furcellaria* $\delta^{13}C_S = -21.4‰$

Furcellaria fastigiata, plant.

143.3 ± 0.7%

KI-698.02. Bornholm, *Furcellaria* $\delta^{13}C_S = -23.7‰$

Furcellaria fastigiata, roots.

143.7 ± 0.8%

KI-699. Bornholm, *Ceramium* $\delta^{13}C_S = -21.7‰$

152.0 ± 0.7%

KI-700.001. Bornholm, *Mytilus* $\delta^{13}C_S = -1.6‰$

Shells (*Mytilus edulis*). Water depth 5m.

Kattegat benthos series

126.8 ± 0.7%

KI-733. Kattegat, Algae 1 $\delta^{13}C_S = -19.5‰$

Algae coll July 1973 by R R Dries, Inst Meereskunde, Univ Kiel, 18km SE of Skagen (57° 38.7′ N, 10° 51.5′ E). Water depth 19m, dredge sample.

126.9 ± 0.6%

KI-764. Kattegat, Algae 2 $\delta^{13}C_S = -16.2‰$

Algae coll Oct 1973 by R R Dries, 25km W of Tjörn (57° 59′ N, 11° 7.5′ E). Water depth 110m. Different kinds of algae, 2 or more yr old.

126.2 ± 0.7%

KI-765. Kattegat, Algae 3 $\delta^{13}C_S = -29.4‰$

Algae coll Oct 1973 by R R Dries in N entrance of Great Belt channel (55° 53.4′ N, 10° 54.5′ E). Water depth 14m. Annual algae, grown Spring 1973.

105.2 ± 0.5%

KI-734.001. Kattegat, *Modiolus* $\delta^{13}C_S = +1.8‰$

Shells (*Modiolus*), 65 to 90mm length; coll July 1973 by R R Dries in central Kattegat (56° 10.2′ N, 11° 46.0′ E). Water depth 40m. *Comment*: small atomic bomb effect is comparable to that of *Cyprina islandica* (see below).

B. Benthic samples from Kiel Bight

Algae, sponges, starfish

Organic part of specimens coll in SW part of Kiel Bight during 1972 (*cf* Table 2). *Comment*: after correction for isotopic effects, activity corresponds to ^{14}C content of water environment (see Table 1).

Kiel Bight mussels (except *Cyprina I.*)*

Flesh and shells of living specimens, coll by ^{14}C Lab, in SW and medium part of Kiel Bight, 1972 to 1974.

* In KI-nos, usually the 3rd decimal describes the kind of sample: 0 or no digit means organic component, 1 refers to carbonates. Exception: water samples have no subdivision though referring to inorganic CO_2.

TABLE 2
Organic fraction of benthic samples, Kiel Bight

Lab no.	Sample	Location	Colln date (mo/day/yr)	^{14}C activity in % of modern activity $\pm 1\sigma$	$\delta^{13}C_S$ ‰
KI-471	Starfish	Coastal area at Boknis Eck	6/1/71	136.3 ± 0.7	−17.1
KI-472	Sponges red algae	(54° 32.6′ N, 10° 2.5′ E)	6/1/71	134.7 ± 1.6	−23.7
KI-595	Brown algae	Stoller Grund flat	4/25/72	127.1 ± 0.7	−31.0
KI-598	Starfish	(54° 32′ N, 10° 11′ E)	4/25/72	139.1 ± 1.0	−17.1
KI-616	Starfish– small	Stoller Grund flat	6/23/72	133.5 ± 0.5	−18.4
KI-617	Starfish– large	(54° 31.5′ N, 10° 10.0′ E)	6/23/72	134.1 ± 0.8	−18.5
KI-652	Seaweed		9/18/72	137.7 ± 0.8	−12.3
KI-655	Grass weed		9/18/72	136.0 ± 0.8	−12.0
KI-657	Grass weed	Inner Eckernförde Bay	9/18/72	140.0 ± 0.7	−10.4
KI-658.01	Red algae	(54° 28.8′ N, 9° 54.0′ E)	9/18/72	133.9 ± 0.5	−20.8
KI-658.02	Grass weed		9/18/72	135.8 ± 0.5	−21.6

128.4 ± 1.1%

KI-474. Boknis Eck, 71 06 01 $\delta^{13}C_S = -21.1‰$

Living *Astarte borealis* from shoreline at Boknis Eck (54° 32.6 N, 10° 2.5′ E), SW Kiel Bight, 11m water depth. Samples were buried by 5cm coarse sand. Coll June 1971 by divers of Kiel Univ, subm by H Kudrass, Geol-Palaeontol Inst, Univ Kiel. Mussels were washed, killed in hot water, shells and flesh were separated and dried; only flesh was studied.

134.0 ± 0.7%

KI-597.001. Stoller Grund, 72 04 25-3 $\delta^{13}C_S = +0.6‰$

Mya arenaria, coll April 1972 on Stoller Grund flat (54° 32′ N, 10° 11′ E) at −6 to −8m on sand substrat; carbonate fraction. *Comment*: activity is lower than in present surface water. This may indicate shell age of ca 5 to 10 yr (see KI-833 f).

132.0 ± 0.7%

KI-599.001. Stoller Grund, 72 04 25-5 $\delta^{13}C_S = +0.3‰$

Shells (*Abra alba*), coll April 1972 W of Stoller Grund flat (54° 32.1′ N, 10° 10.3′ E) at − 18m with van Veen grab sampler. *Comment*: life span is known to be only 1 to 2 yr. Activity agrees well with that of water depth in Spring 1972.

KI-613. Boknis Eck, 72 05 18-3a

Astarte borealis from shoreline at Boknis Eck (54° 31.5′ N, 10° 5.0′ E) W Kiel Bight, coll May 1972, at − 18 to − 10m with van Veen grab. Silt and sand fraction of grab samples were flushed on a .5mm mesh, residue was washed and dried; intact specimens were picked out.

104.8 ± 0.6%

KI-613.011. $\delta^{13}C_S = -0.8‰$

Shells ca 20mm diam, carbonate fraction.

136.6 ± 0.5%

KI-613.021. $\delta^{13}C_S = +0.8‰$

Shells, 7 to 17mm diam (mean 11mm).

General Comment: low activity of KI-613.011 is probably due to high mussel life span; considerable part of shell carbonate was secreted before bomb produced ^{14}C entered the water environment since 1963. Activity figure points to mussel age of 10 to 15 yr, whereas group of small specimens (KI-613.021) is not older than 5 to 6 yr (*cf Cyprina* series, below).

KI-615. *Mytilus*, Stoller Grund, 72 06 23

Mytilus edulis, W of Stoller Grund flat (54° 31.5 N, 10° 10.0′ E), coll June 1972 at − 18m; dredge sample. Mussels washed, killed in hot water, flesh and shells separated and dried.

140.5 ± 0.8%

KI-615.011. $\delta^{13}C_S$ *ca* $-0‰$

Shells, 63 to 84mm (mean 71.7mm) length, carbonate fraction.

132.4 ± 0.6%
$\delta^{13}C_S$ *ca* −22‰

KI-615.010
Flesh from KI-615.011.

139.1 ± 0.8%
$\delta^{13}C_S$ *ca* 0‰

KI-615.021
Shells, 16 to 30mm (mean 22.2mm), carbonate fraction.

General Comment: carbonate activities agree well with present surface water activity. Mussels are probably shifted from Stoller Grund flat to greater depths by wave action (Samtleben, 1973). Age of larger specimens (KI-615.011) should be ca 5 yr, and water activity seems to have been essentially the same within that time.

Central Kiel Bight mussels

Benthic faunae and coarse grain fractions from surface layer of muddy sediments S of entrance of Great Belt channel into Kiel Bight (54° 36.6′ N, 10° 37.9′ E), − 18m. Coll July 1972 with van Veen grab sampler. Same treatment as KI-613.

111.1 ± 0.7%
$\delta^{13}C_S = -0.2‰$

KI-630.011.
Astarte borealis, 15 to 25mm diam, carbonate fraction. *Comment*: *cf* KI-613.

108.2 ± 0.5%
$\delta^{13}C_S = -0.5‰$

KI-633.021.
Undefined shells and shell fragments, 1.8 to 2.5mm linear dimension.

124.2 ± 1.1%
$\delta^{13}C_S = -1.3‰$

KI-633.031.
Undefined shells and shell fragments, smaller than 1.8mm.

General Comment: foraminifera studies yield evidence that carbonates are readily dissolved in muddy sediments of Kiel Bight (Seibold *et al,* 1971). KI-633 indicates that a major fraction of coarse shell fragments still present in sediment was formed in the pre-bomb era. Part of these carbonates will be probably supplied from the high biomass of long living *Cyprina islandica* and different *Astarte* species (Arntz, 1971).

111.5 ± 0.7%
$\delta^{13}C_S = -1.6‰$

KI-633.051.
Astarte montagui, 2 to 4mm diam.

113.0 ± 1.1%
$\delta^{13}C_S = +0.8‰$

KI-633.061.
Astarte elliptica, up to 25mm diam.

General Comment: as seen from *Cyprina islandica* series, low ^{14}C activity must be attributed to long life span of mussels that should markedly exceed 10 yr in this case.

KI-651.001. Benno 72 09 18-1 **140.6 ± 0.7%**

Shells (*Mytilus edulis*), coll Sept 1972 in interior Eckernförde Bay (54° 28.8′ N, 9° 54.0′ E), SW Kiel Bight.

KI-656.001. Benno 72 09 18-7 **140.0 ± 0.7%** $\delta^{13}C_S = +1.0‰$

Small fragments of mussel shells sieved from surface sediment, coll with KI-651.001.

KI-852.001. **140.7 ± 0.8%** $\delta^{13}C_S = -0.7‰$

Shells (*Mytilus edulis*) coll Feb 1971 by C Samtleben, Geol Inst Univ Kiel, in Gelting Bay (54° 47.0′ N, 9° 53.7′ E).

Floating substrata series

Semiramis experiment (Sarnthein & Richter, 1974). Different substrata (sand, gravel, clay) of ca $1m^2$ surface were exposed in definite heights above ground in the "Hausgarten" ("dooryard") of the SFB 95 near the shore of Boknis Eck (54° 33′ N, 10° 3′ E). The virginal substrata were populated by larvae and specimens that grew definitely during time of exposure. Activities (Table 3) compare well with average water activities at corresponding depth during that time.

Floating plates, Summer 1973

Plates of several dm^2 surface (KI-776 to 771, Table 3) were exposed from June to Oct 1973 by W Richter at same position as Semiramis experiment.

KI-853.001. **138.7 ± 0.7%** $\delta^{13}C_S = 0.0‰$

Shells (*Mytilus edulis*) coll alive March 1974 by C Samtleben, Geol Palaeontol Inst Univ Kiel on Stoller Grund flat (54° 31′ 53″ N, 10° 10′ 26″ E) SW Kiel Bight at 9m water depth.

KI-866.001. **900 ± 29** **AD 1050** $\delta^{13}C_S = +0.8‰$

Shells (*Cardium edule*), .8m below floor, from farm land at coast of Gelting Bay (54° 46′ N, 9° 53′ E), NW Kiel Bight. Coll and subm by C Samtleben. Shells were found *in situ* in medium-grained sand layer below clayey fine sand and recent top soil humus layers. *Comment*: area was diked at AD 1829. Sample indicates higher water level at AD 1000 (Voss, 1970).

***Cyprina islandica* series**

Shell carbonate and flesh of *Cyprina islandica* coll alive at different sites in Kiel Bight, W Baltic Sea. Adult specimens had far lower activities than present bottom water bicarbonate (Erlenkeuser & Willkomm, 1973b). This might be due to long life span of mussel or might indicate partial

uptake of pre-bomb carbon from sediment, either as carbonate or organic carbon.

KI-586. Gabelsflach 4/72

Samples, 40 to 60mm diam, from muddy sediment N of Gabelsflach flat (54° 37.0′ N, 10° 21.8′ E) medium Kiel Bight, 21m water depth. Coll April 1972 with van Veen grab.

KI-586.000. Flesh **127.4 ± 0.5%** $\delta^{13}C_S = -20.7‰$

KI-586.001. Shell carbonate **108.7 ± 0.7%** $\delta^{13}C_S = +0.9‰$

KI-618. Dorschgrund 6/72

Cyprinae, 40 to 60mm, from clayey mud in Dorschgrund basin (54° 37′ N, 10° 20′ E) medium Kiel Bight, 21m water depth. Coll June 1972 with van Veen grab. $\delta^{13}C$ not measured.

KI-618.000. Flesh **131.5 ± 0.8%**

KI-618.001. Shell carbonate **109.2 ± 0.6%**

TABLE 3
Floating substrata series

Lab no.	Sample	Depth of plate	^{14}C activity, % of modern activity $\pm 1\sigma$	$\delta^{13}C_S$(‰)
	Semiramis experiment			
KI-680.021	*Mytilus edulis*, 24-31mm long	10m	136.9 ± 0.9	−0.1
KI-680.031	*Balanus*	10m	140.1 ± 0.9	0.0
KI-680.051	*Mytilus* & *Balanus* small samples	10m	138.8 ± 0.6	+1.9
KI-679.021	*Mytilus edulis* larger samples 18-23mm long	15m	137.4 ± 0.6	+0.8
KI-679.031	*Balanus*	15m	137.3 ± 0.7	−0.5
	Floating plates, Summer 1973			
KI-766.001	*Mytilus edulis*	4m	139.4 ± 0.7	+0.8
KI-767.001	"	7m	139.7 ± 0.6	−0.1
KI-768.001	"	10m	138.6 ± 0.6	+1.6
KI-769.001	"	14m	139.1 ± 0.7	−0.1
KI-770.001	*Balanus*	16m	139.1 ± 0.7	−0.1
KI-771.001	"	18m	137.9 ± 0.6	+1.1

KI-629. Millionenviertel 7/72

Samples 50 to 70mm diam from muddy sand substrate of Millionenviertel (54° 36.6′ N, 10° 37.9′ E). Coll July 1972 with van Veen grab.

KI-629.011. Shell carbonate **110.4 ± 0.7%** $\delta^{13}C_S = +1.4‰$

KI-629.020. Flesh **120.5 ± 0.6%** $\delta^{13}C_S = -20.0‰$

KI-629.021. Shell carbonate **128.8 ± 0.7%** $\delta^{13}C_S = +0.5‰$

Outer rim, ca 10mm wide, of different shells. *Comment*: note higher ^{14}C activity in more recent parts of shells (*cf* KI-833, -843).

KI-633.081. Millionenviertel, 7/72 **133.1 ± 0.7%** $\delta^{13}C_S = +0.7‰$

Shell carbonate of smaller samples, 0.5 to 3.4mm from muddy sand of Millionenviertel area, S of Great Belt channel entrance into Kiel Bight (54° 36.6′ N, 10° 37.9′ E), 18m water depth. Coll July 1972 with van Veen grab. *Comment*: activity is markedly higher than for large *Cyprina* specimens (KI-586, -618, -629).

KI-833. Dorschgrund 2/74

Cyprinae dredged along transect in Dorschgrund area, a shallow basin with muddy sediments in medium Kiel Bight (54° 36.5′ N, 10° 19.3′ E to 54° 37.4′ N, 10° 19.6′ E), 21m water depth. Coll Feb 1974. Shells of 50 to 70mm diam were picked out and each cut into sector segments parallel to growth lines proceeding from outer rim towards hinge. Ring width is 5mm, measured on a sec at greatest distance between hinge and rim. Corresponding segments of the different shells were combined; carbonate fraction studied.

KI-833.011. 1st segment **133.8 ± 0.6%** $\delta^{13}C_S = -0.7‰$

0 to 5mm from rim.

KI-833.021. 2nd segment **111.9 ± 0.6%** $\delta^{13}C_S = -0.7‰$

6 to 10mm from rim.

KI-833.031. 3rd segment **102.6 ± 0.6%** $\delta^{13}C_S = -4.2‰$

11 to 15mm from rim.

KI-833.041. 4th segment $\delta^{13}C_S = +0.8‰$

16 to 20mm from rim.

KI-833.051. 5th segment **100.3 ± 0.8%** $\delta^{13}C_S = +1.1‰$

21 to 25mm from rim.

105.1 ± 0.8%
KI-833.061. 6th segment $\delta^{13}C_S = +0.7‰$
26 to 30mm from rim.

104.9 ± 0.7%
KI-833.071. Remnant hinge parts $\delta^{13}C_S = -0.1‰$
Smaller 25mm.

105.1 ± 0.6%
KI-833.081. Remnant hinge parts $\delta^{13}C_S = +0.7‰$
26 to 36mm.

KI-843.

Cyprina islandica, same position and treatment as KI-833. Coll March 1974. 82 shells, diam within 49 to 51mm, selected and cut as before.

137.2 ± 0.7%
KI-843.011. 1st segment $\delta^{13}C_S = +0.7‰$
0 to 5mm from rim.

116.6 ± 0.7%
KI-843.021. 2nd segment $\delta^{13}C_S = +1.1‰$
6 to 10mm from rim.

102.5 ± 0.6%
KI-843.031. 3rd segment $\delta^{13}C_S = +0.5‰$
11 to 15mm from rim.

103.0 ± 0.5%
KI-843.041. 4th segment $\delta^{13}C_S = +0.5‰$
16 to 20mm from rim.

102.9 ± 0.6%
KI-843.051. 5th segment $\delta^{13}C_S = +1.6‰$
21 to 25mm from rim.

104.9 ± 0.6%
KI-843.061. 6th segment $\delta^{13}C_S = +1.0‰$
26 to 30mm from rim.

106.7 ± 0.7%
KI-843.071. $\delta^{13}C_S = +1.5‰$
Hinge plates, without hinge bands, 30 to 45mm from rim.

108.8 ± 0.6%
KI-843.081. Hinge bands $\delta^{13}C_S = +0.5‰$

KI-843.09

Smaller samples of KI-843, 11 to 30mm diam (mean diam weighted by shell weight: 25.5mm).

133.5 ± 0.7%
KI-843.090. Flesh $\delta^{13}C_S = -20.6‰$

135.8 ± 0.7%
KI-843.091. Shell carbonate $\delta^{13}C_S = +0.3‰$

KI-851.001. Vejsnäs flat 12/71 **135.7 ± 0.7%**

Cyprina islandica from Vejsnäs flat (54° 47′ N, 10° 28′ E) N Kiel Bight. Coll Dec 1971 by C Samtleben and subm April 1974 by Samtleben and Lohr, ^{14}C Lab, Kiel. Mussels were coll alive with van Veen grab. Samples smaller than 31mm were selected for analysis of shell carbonate.

General Comment: ^{14}C variations of shell carbonate reflect increase of ^{14}C level in marine environment since ca 1960. Outer parts of ca 15mm width (KI-629, -833, -843) as well as small samples (KI-843.09, -851, -633.08) grew during last decade. Growth rate of samples up to 30 to 40mm diam is ca 3mm/yr (Kühlmorgen-Hille, 1962) so that total mussel age is ca 20 yr. Increasing ^{14}C activity towards hinge indicates gradual thickening during recent growth period. Medium parts of shells estimate pre-bomb ^{14}C level in Kiel Bight bottom water. A more detailed analysis is being conducted based on biometrical studies. High activity of KI-843.090 indicates most food originates from plankton from surface water. Older organic constituents with ^{14}C level lower than 100% found in uppermost layer of sediment (Erlenkeuser *et al*, 1974) do not seem nutritions. Flesh activity of adult samples (KI-586, -618, -629) is generally higher than carbonate activity, due to incorporation of high ^{14}C food by mussel.

C. Sediment pretreatment studies

Kiel Bight sediments contain organic constituents of different age (Erlenkeuser *et al*, 1974) at possibly different stage of diagenesis. Preliminary studies were performed to check effect of chemical pretreatment on ^{14}C age.

93.4 ± 0.5%

KI-600. Stoller Grund, 720425-6 $\delta^{13}C_S = -22.4‰$

Organic component of muddy surface sediment coll April 1972 at Stoller Grund (54° 32.0′ N, 10° 10.0′ E). Water depth 18m.

139.6 ± 1.0%

KI-604.001. Stoller Grund, 720425-7 $\delta^{13}C_S = -1.2‰$

Surface sediment like KI-600. Small-sized fraction was flushed and grain size class greater .1mm was coll; carbonate studied.

KI-610. Aeroe SW, GPI 11777-1

Muddy sediment from NW Kiel Bight (54° 46.2′ N, 10° 11.6′ E), W Baltic Sea. Coll and subm March 1971 by F Werner, Geol-Palaeontol Inst Univ Kiel, H Erlenkeuser, and H Willkomm. Box core from surface sediment, at −26m, from same location as KI-483 (Erlenkeuser & Willkomm, 1973). Upper half (ca 20cm) of core was thoroughly mixed to provide sufficient material for applying different pretreatment procedures and divided in several samples. Samples were prepared differently to study influence of HCl boiling on organic component. Results below account for water content of sample material. KI-483 (*cf* Erlenkeuser & Willkomm,

1973), a core coll .2km W, indicates that activity of organic component comprises range of 82 to 94% of standard activity.

87.5 ± 0.7%

KI-610.01. 1hr, 1% HCl $\delta^{13}C_S = -23.2‰$

1000g wet sediment (ca 300g by dry weight), boiled for 1hr in 1000ml 1% HCl (sample water included), centrifuged and decanted; stirred twice with 800ml water, centrifuged, decanted, stirred again with water and dialyzed for 6 hr until pH = 6. Afterwards, residual traces of Cl^- are negligible.

86.1 ± 0.8%

KI-610.02. 2hr, 1% HCl $\delta^{13}C_S = -21.4‰$

1000g wet sediment, boiled for 2hr in 1000ml 1% HCl, centrifuged, decanted, stirred up with 450ml water; no washing, dialysis for 6 days.

88.5 ± 0.9%

KI-610.03. 4.5hr, 1% HCl $\delta^{13}C_S = -22.9‰$

1000g wet sediment, boiled for 4.5hr in 1% HCl, centrifuged, decanted, washed by repeated centrifuging and decanting (5 times with a total of 1.6L water). Washing procedure did not remove Cl^- sufficiently; therefore, this time consuming procedure was replaced by dialysis; sample dialyzed for 6 days.

86.5 ± 0.6%

KI-610.08. 1hr, 0.9% HCl $\delta^{13}C_S = -21.3‰$

1000g wet sediment, boiled for 1hr in .9% HCl, not centrifuged but directly dialyzed for 6 days.

General Comment: CO_2 yield by oxidation seems to be correlated to intensity of washing: it was 2.5, 1.9, 1.1, and 1.0 (arbitrary units) for KI-610.08, -610.02, -610.01 and -610.3, respectively. However, no statistically significant trend is seen from the ^{14}C data, indicating that sample pretreatment does not affect ^{14}C dates appreciably for this type of sediment.

KI-620.472.

Sample of core, KI-620 (see Table 7), 96cm below sediment surface. Chemical treatment: initial wet weight 1000g; carbonates removed by hot 2% HCl; sample centrifuged and decanted; residue leached 3 times with 1n NaOH at 100°C for 5hr, centrifuged, and decanted. Eluate is acidified to precipitate humic acids, which are washed to neutrality on analytic filter and dried. Humic acid yield was 6.8g, 2.6g, 1.1g by dry weight for 1st, 2nd, and 3rd leaching procedures, respectively; fractions 1 and 2 were combined for dating. *Comment*: radiocarbon date fits well sedimentation line obtained from KI-620, indicating, that humic acid fraction is representative for ^{14}C activity of total organic fraction of sediment.

D. Sediment cores from Kiel Bight

Breitgrund channel series

KI-619. Sediment Core GPI 11881

Core, 58cm long, from bottom of Breitgrund channel, NW Kiel Bight (54° 47.4′ N, 10° 1.7′ E). Coll May 1972 in 32.5m water depth with box corer by Friedrich Werner, Geol Palaeontol Inst Univ Kiel. Upper layer, 22cm thick was of marine, lower part of limnic origin (with lake marl and plant residues). Core was cut into slices of 1 or 2cm (samples .02 to .08 with an inclination of 23° according to stratigraphic records within sediment), and both organic and carbonate fraction were dated (Table 4). *Comment*: an 8000-yr hiatus is found between marine and limnic sediments, which must be explained by lack of sedimentation or later erosion rather than by hard water effect of lake lime. Limnic sediment accumulates at a rate of ca .6mm/yr.

KI-621. Sediment Core GPI 11882

Core from SW slope of Breitgrund channel (54° 47.0′ N, 10° 0.9′ E) 1200m WSW of KI-619. Coll by F Werner May 1972 at 29m water depth with box corer; total length 2.90m. Below 145cm were limnic sediments

TABLE 4

Kiel Bight sediments, Breitgrund channel, GPI 11881 ≡ KI-619

Lab no.	Depth within sediment (mm)	Organic fraction Libby age BP ±1σ	$\delta^{13}C_S$(‰)	Carbonate fraction Libby age BP ±1σ	$\delta^{13}C_S$(‰)
619.01	0 to 40	750 ± 75	−19.9		
619.02	40 to 49	940 ± 70	—		
619.03	49 to 58	1000 ± 75	−22.1		
619.06	77 to 87	1360 ± 65	−21.6		
619.07	87 to 106	1990 ± 210	−22.6		
619.08	106 to 125	1120 ± 80	−18.4		
619.11	125 to 155	1370 ± 40	−21.7		
619.14	195 to 215	1330 ± 50	−22.2		
619.16	225 to 245	7060 ± 90	−25.9	10,420 ± 190	−3.9
619.18	255 to 270	10,120 ± 120	−31.1	10,060 ± 180	−2.5
619.22	330 to 350	10,220 ± 190	−27.6	10,520 ± 130	−4.0
619.26	410 to 430	10,000 ± 130	−27.8	10,330 ± 100	−4.7
619.28	450 to 470			10,430 ± 120	−1.7
619.29	470 to 490			9890 ± 130	−1.0
619.30	490 to 510	10,560 ± 210	−28.0	7930 ± 70	−4.5
619.31	510 to 530			10,560 ± 130	−1.4
619.32	530 to 550	10,740 ± 200	−28.7	10,280 ± 130	−0.8
619.34	570 to 586	10,920 ± 240	−30.6	10,810 ± 200	—

with clayey gyttja and peaty layers. Only these sediments were dated (Table 5). From organic component, a mean sedimentation rate of .3mm/yr is calculated.

KI-659. Sediment Core GPI 11888

Core from NE slope of Breitgrund channel (54° 47.4′ N, 10° 1.7′ E) 30m NE of KI-619. Coll by F Werner June 1972 at 30m water depth with short box corer. Organic fraction was measured (Table 6).

KI-660. Sediment Core GPI 11889

Core from bottom of Breitgrund channel (54° 47.4′ N, 10° 1.5′ E) 170m WSW of KI-619. Coll by F Werner June 1972 at 32.5m water depth with short box corer. Organic fraction of upper layers was dated (Table 6).

General Comment: recent studies on closely spaced samples from another core from bottom of Breitgrund channel indicate that ^{14}C variations in near surface sediments reflect anthropogenic affects as already recognized in Cores KI-620 and -483. Recent sediments then accumulate at only slightly reduced rate of ca 1mm/yr as compared to 2 to 3mm/yr in Kiel Bight basins, but total thickness of Holocene marine sequence is kept down by single erosional events.

KI-620. Sediment Core GPI 11883

Core from Boknis channel, outer Eckernförde Fjord, Kiel Bight SW (54° 31.5′ N, 10° 1.8′ E). Coll by F Werner, May 1972 at 29m water depth with box corer. Whole core (199cm) is of marine origin. Only organic fraction was dated (Table 7). *Comment*: ^{14}C dates of deeper layers give sedimentation rate of 1.4mm/yr and an (extrapolated) surface age of 850 ± 50 yr (90 ± .5% of standard activity). However, above 20cm depth (depth corresponds to AD 1830 if sedimentation rate is constant up to

TABLE 5
Kiel Bight sediments, Breitgrund channel, GPI 11882 ≡ KI-621

Lab no.	Depth within sediment (cm)	Organic fraction Libby age BP ±1σ	$\delta^{13}C_S$(‰)	Carbonate fraction Libby age BP ±1σ	$\delta^{13}C_S$(‰)
621.091	172 to 174			12,040 ± 400	+1.9
621.094	178 to 180	8110 ± 100	−29.6	10,570 ± 140	+0.1
621.099	188 to 190	8450 ± 110	−28.7	9530 ± 110	+2.2
621.104	198 to 200	8980 ± 110	−28.5	8620 ± 120	+2.0
621.109	208 to 210	8990 ± 75	−27.4	8370 ± 110	+0.4
621.114	218 to 220	9100 ± 120	−28.8	8490 ± 110	0.0
621.118	226 to 228			8760 ± 110	+1.2
621.121	232 to 234			9730 ± 100	+1.0
621.122	234 to 236	9985 ± 120	−28.0	9900 ± 120	−1.0

TABLE 6
Kiel Bight sediments, Breitgrund channel

Lab no.	Depth within sediment (cm)	Libby age BP $\pm 1\sigma$	$\delta^{13}C_S$ (‰)
KI-659.	Organic fraction. Core GPI 11888		
659.01	0 to 1	1100 ± 40	−23.6
659.02	1 to 2	710 ± 55	−23.5
659.03	12 to 13	1430 ± 75	−23.1
659.04	13 to 14	1390 ± 70	−22.9
659.08	21 to 22	2900 ± 110	−24.5
KI-660.	Organic fraction. Core GPI 11889		
660.01	0 to 1	780 ± 110	−23.9
660.02	1 to 2	810 ± 60	−23.3
660.04	3 to 4	1220 ± 55	−21.9
660.06	5 to 6	1210 ± 65	−22.7

TABLE 7
Kiel Bight sediments, Boknis channel, organic fraction,
Core GPI 11883 = KI-620

Lab no.	Depth within sediment (cm)	Libby age BP $\pm 1\sigma$	$\delta^{13}C_S$ (‰)
620.01	0 to 5	1930 ± 90	−22.6
620.02	5 to 7	2120 ± 70	−22.6
620.03	7 to 9	1450 ± 70	−21.5
620.04	9 to 11	1290 ± 55	−20.2
620.05	11 to 13	1400 ± 75	—
620.06	13 to 15	1080 ± 90	−22.5
620.07	15 to 17	1110 ± 40	−23.6
620.09	19 to 21	940 ± 55	−21.4
620.11	23 to 25	930 ± 40	−21.0
620.20	41 to 43	1160 ± 60	−22.7
620.24	49 to 51	1210 ± 50	−21.3
620.36	73 to 75	1490 ± 60	−21.5
620.37	75 to 77	1290 ± 40	−21.3
620.45	91 to 93	1500 ± 40	−20.8
620.47	95 to 97	1450 ± 55	−22.7
620.50	101 to 103	1560 ± 40	−22.3
620.61	123 to 125	1670 ± 70	−22.2
620.74	149 to 151	1860 ± 65	−22.0
620.86	173 to 175	2490 ± 60	−21.7
620.98	197 to 199	2820 ± 75	−22.3

surface), ^{14}C activity decreases to 77% approaching surface, reflecting increasing effect of industrialization (*cf* Erlenkeuser *et al*, 1974). Sediments SW Aeroe (*cf* KI-483 in Erlenkeuser & Willkomm, 1973) showed a similar stratification with respect to ^{14}C activity.

E. Marine sediment cores from different locations

Great Belt series

Sediment cores, coll by Friedrich Werner and Kyaw Winn, Nov 1972, both Geol Palaeontol Inst Univ Kiel, with box corer, from Great Belt channel, main inlet to Baltic Sea. Measurements are part of a study on sedimentology and morphology of Great Belt (*cf* Winn, 1974). ^{14}C dates of organic component of both cores are given in Table 8.

KI-736. Sediment Core GPI 12522-2

Core, 132cm long, coll in Great Belt (55° 22′ 35″ N, 10° 56′ 46″ E) in 27m water depth. 0 to 66cm marine sediments, 66 to 115cm limnic sediments, 115 to 132cm peaty gyttja.

KI-738. Sediment Core GPI 12519-2

Core 286.5cm long, coll in 25.5m depth 4km NNE of KI-736 (55° 24′ 40″ N, 10° 58′ 26″ E), marine sediments.

KI-847. Sediment Core GPI 12549-1 **1060 ± 75 AD 890**

$\delta^{13}C_S = -19.8‰$

Coll Jan 1973 by Heinz Lange and Kyaw Winn, both Geol Palaeont Inst Univ Kiel, in Great Belt channel 17km N of KI-736 (55° 32.5′ N, 10° 57.9′ E) in 27m water depth. Organic component between 25 and 35cm depth within sediment was dated (*cf* Winn, 1974).

KI-848. Sediment Core GPI 10511

Core, 236cm long, coll by Kyaw Winn at S exit of Great Belt channel, 8km S of Langeland I. (54° 39.7′ N, 10° 45.6′ E) in 26m depth with vibrocorer. Results are given in Table 8. 0 to 210cm sediment are sand, 210 to 236cm are gyttja. *Comment*: mean sedimentation rate is .30mm/yr.

KI-563. Landsort Basin Core GPI 10076-3

Sediments from Landsort Basin (58° 40.1′ N, 18° 19.2′ E), middle Baltic Sea. Coll Jan 1971 and subm by Erwin Suess, Geol Palaeont Inst Univ Kiel. Measurements of organic and carbonate component (Table 9) continue studies on same core publ under KI-405 (Erlenkeuser & Willkomm, 1973). *Comment*: KI-563.02 and -563.03 do not fit preceding results of KI-405. $\delta^{13}C$ values of carbonate are unusually low compared to carbon isotope ratios of recent Baltic surface water. Same ^{14}C activity of organic and carbonate indicates diagenetic effects to be important for carbonate formation.

TABLE 8
Great Belt channel sediments

Lab no.	Depth within sediment (cm)	Libby age BP $\pm 1\sigma$	$\delta^{13}C_S$ (‰)
KI-736.	Organic fraction. Sediment Core GPI 12522-2		
736.01	0 to 8	2280 ± 120	−22.4
736.02	8 to 15	7520 ± 170	−24.7
736.05	25 to 30	8490 ± 200	−25.6
736.08	40 to 45	8370 ± 220	−26.1
736.11	55 to 60	8650 ± 240	−25.6
736.14	70 to 75	8340 ± 200	−24.4
736.16	80 to 85	8350 ± 170	−22.7
736.18	90 to 95	8280 ± 220	−23.7
736.21	105 to 110	8460 ± 150	−25.0
736.24	118 to 120	8780 ± 170	−23.3
736.27	124 to 126	8840 ± 170	−22.2
KI-738.	Organic fraction. Sediment Core GPI 12519-2		
738.01	0 to 10	4390 ± 140	
738.02	10 to 20	7530 ± 240	−22.3
738.05	40 to 50	8320 ± 280	−23.0
738.10	90 to 100	8840 ± 220	−23.8
738.14	130 to 140	9050 ± 260	−22.3
738.18	170 to 180	8540 ± 230	−24.0
738.21	200 to 205	8180 ± 210	−24.3
738.22	210 to 215	8290 ± 280	−24.7
738.23	230 to 235	8130 ± 210	−23.9
738.27	250 to 255	8360 ± 240	−25.7
738.33	280 to 286.5	8340 ± 190	−26.4
KI-848.	Organic fraction. Sediment Core GPI 10511		
848.01	35 to 40	1860 ± 80	−24.1
848.02	130 to 135	4830 ± 100	—
848.03	230 to 234	8410 ± 110	−25.8

TABLE 9
Landsort Basin sediments

Lab no.	Depth within sediment (cm)	Organic fraction Libby age BP $\pm 1\sigma$	Organic fraction $\delta^{13}C_S$ (‰)	Carbonate fraction Libby age BP $\pm 1\sigma$	Carbonate fraction $\delta^{13}C_S$ (‰)
563.01	120 to 130	1680 ± 45	−26.9	—	−13.6
563.02	410 to 420	1640 ± 90	−25.5	1280 ± 90	−12.8
563.03	571 to 580	2280 ± 110	−26.7	2140 ± 140	−12.4

TABLE 10
Nordstrand sediment Core N III

Lab no.	Sedimentation date	Depth within sediment (cm)	Organic fraction Libby age BP ±1σ	Organic fraction $\delta^{13}C_S$ (‰)	Carbonate fraction Libby age BP ±1σ	Carbonate fraction $\delta^{13}C_S$ (‰)
695.01	1972	0 to 12	2260 ± 90	−20.8	14,940 ± 470	+1.8
695.02	Spring 1971	17 to 23	2290 ± 70	−22.1	17,320 ± 660	+2.2
695.03	1970	28 to 43	2490 ± 55	−21.8	13,750 ± 270	−0.3
695.04	Summer 1965	108 to 111	2290 ± 45	−21.0	16,030 ± 390	+1.6
695.05	Winter 1965	125 to 130	2460 ± 50	−22.4	12,350 ± 280	+0.4
695.06	Summer 1964	165 to 170	2650 ± 65	−21.1	16,950 ± 300	+0.5
695.07	Before 1964	213 to 218	3520 ± 120	−19.7	—	+0.8

Dredged pit Nordstrand, Suederhafen series

KI-695. Core N III

Sediment core, 240cm long, coll Nov 1972 by Gerhard Unsöld, Geol Palaeont Inst Univ Kiel at +70cm in foreland of SE Nordstrand (54° 28′ 10″ N, 8° 55′ 0″ E), island in shoals of SE North Sea. *Comment* (GU): core comes from deepening, ca 70,000m² dredged 1962/63, which now is silting up very quickly at several dm/yr. Winter deposits are laminated, while summer layers are completely disturbed by digging animals. This stratification pattern allows direct determination of sedimentation date (Unsöld, 1974). Organic and carbonate fractions were dated (*cf* Table 10).

KI-823.001. Nordstrand NF 9

3340 ± 50
1390 BC
$\delta^{13}C_S = -0.8‰$

Carbonate fraction of sediment deposited during June/July 1973 in a sediment trap near KI-695. Coll and subm by G Unsöld.

KI-824.001. Nordstrand NST 14

12,150 ± 110
10,190 BC
$\delta^{13}C_S = -1.7‰$

Carbonate fraction of uppermost sediment, 0 to 2.5cm depth, deposited during fall storms. Coll Dec 1973 by G Unsöld, near KI-823.

KI-825.001. Nordstrand NST 12

13,200 ± 450
10,250 BC
$\delta^{13}C_S = -0.4‰$

Material similar to KI-824. Sediment depth 0 to 3 cm.

General Comment: small activity of recent sediments (74.5% for organic fractions, 10 to 20% for carbonates compared to ca 120% recent water

TABLE 11
Gibraltar Street sediments

Lab no.	Depth within sediment (cm)	Factor of dilution	Libby age BP ±1σ	$\delta^{13}C_S$ (‰)
Core LY-II-13A coll in 1201m water depth (35° 58′ N, 7° 49′ W).				
KI-693	63 to 80	3.96	11,430 ± 680	−24.4
KI-793.02	193 to 210	6.14	14,230 $^{+1560}_{-1300}$	−24.9
KI-694	425 to 440	6.10	19,700 $^{+3700}_{-2500}$	−24.3
Core LY-II-13 coll in 1259m depth 22km E of 13A (35° 57′ N, 7° 34′ W).				
KI-794.01	120 to 145	3.59	12,710 ± 680	−23.0
KI-794.03	335 to 355	4.20	16,280 $^{+1190}_{-1040}$	−24.5

activity) indicates important admixture of inactive or at least late glacial material. Smaller activity (64.5%) of KI-695.07 might represent prebomb value.

Gibraltar Street sediment

Two cores coll April 1972 from USNS Lynch by Liselotte Hass, Geol Palaeont Inst Univ Kiel, and D J Stanley, 200km W of Gibraltar St to date variations in flow velocity (Diester-Haass, 1973). Samples contained 25 to 30% $CaCO_3$ which were removed. Only organic component was measured after dilution with inactive CO_2. *Comment*: mean sedimentation rate is .50mm/yr. Extrapolation to sediment surface gives age 10,000 yr BP.

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