[RADIOCARBON, VOL. 4, 1962, P. 160-181]

TRONDHEIM NATURAL RADIOCARBON MEASUREMENTS III

REIDAR NYDAL

The Norwegian Institute of Technology, Radiological Dating Laboratory, Trondheim, Norway

This date list covers most of the datings done during the period January 1960 to December 1961.

Counter design.—Some work has been done during the two years in order to improve the technique earlier described (Trondheim II). C^{14} dating of interstadial and some interglacial samples (Siberian mammoths, shell and limestone from Southern Norway) now seems practical, owing to recent advances in the counting technique.

Counter 1 up to now has had an effective volume of ca. 75% of a total volume of 6.3 L. It has been rebuilt (though it has not yet been tested) in order to increase the effective volume to ca. 95% of total. The improvement is made possible by a small field grid (ca. 12 mm diam and ca. 60 mm long) surrounding the center wire at each end of the counter. The grids will be given a negative voltage corresponding to the distribution of potential in the distorted field near the end of the center wire. Electrons from decaying C^{14} atoms will penetrate the grid and give normal discharges close to the end of the counter, regardless of field distortion outside the grid. It also seems possible to reduce the background (formerly 11.3 counts/min) by placing a shell of old lead (free from Ra D) between the proportional counter and its multiple-anode anticoincidence ring counter (Trondheim II). The final result is expected to be ca. 75 counts/min for the recent standard, above a background of 5-10 counts/min at a CO_2 pressure of 2 atm.

Counter 2 has been used for dating all samples (except T-23 and T-26) appearing in this list. This counter now has a standard net count of 16.0 counts/min above a background of 1.3 counts/min at a CO_2 pressure of 2 atm. The counter is shielded with 3.5 cm old lead (ca. 200 yr) inside a multiple-anode anticoincidence ring counter filled with C_3H_8 at a pressure of 1.3 atm. The iron chamber has a thickness of 22 cm. Up to the end of 1961, the anticoincidence shielding was provided by single G M tubes, and the barometric effect was found to be 0.05 to 0.10 counts/min per cm Hg. The effect now is zero or negligible, which probably may be due to the C_3H_8-filled ring counter. It is obvious to us that one of the weak points in the earlier counting system was the large number of single G M tubes around the proportional counter. Variations of lifetime and plateau length for individual G M tubes very often cause much trouble and loss of time. Anticoincidence shielding provided by a multiple-anode counter working in the proportional region is for us the only effective solution for routine dating.

Pretreatment.—Samples of wood and charcoal are treated as before (Trondheim II). Other materials, such as peat, gyttja, meat, blood, skin and

sinews, are largely treated with 1 M HCl only. Shells are normally treated with dilute H_3PO_4. Generally 10 to 20% of the carbonate weight is removed. Deviations in pretreatment are pointed out in the text.

Purification of CO_2.—We encountered difficulties in getting rid of the large amount of SO_2 in the CO_2 prepared from mammoth and human bones (T-195B). The only effective purification method found was to dissolve the CO_2 in ammonia and precipitate the $CaCO_3$ by $CaCI_2$. After washing with distilled water, drying, and treating the carbonate with H_3PO_4, we at last obtained a completely pure gas. The above purification procedure has also been introduced for peat and gyttja. CO_2 from wood and charcoal is generally pure enough when it has passed the ordinary purification system (silver wool, Cottrel apparatus, $KMnO_4$, dry ice, and copper furnace).

Calculation.—In accordance with the new standard practice in other laboratories, ages are all calculated with the year A.D. 1950 taken as "present" in dates B.P. The NBS standard (95% of the C^{14} activity of the oxalic acid) has been applied in our laboratory since January 1960. The standard CO_2, which was prepared from the oxalic acid by wet combustion, shows a δC^{13} value of –18.37‰ relative to the Chicago PDB standard (Craig, 1961). As the mean δC^{13} value for several laboratories is found to be ca. –19‰, any correction in the standard would be negligible (ca. 10 yr). Our own C^{13} standard of stromatolic limestone (T-146, Trondheim II) shows a deviation of + 6.5 ± 1.0‰ from the PDB standard. Correction for isotopic fractionation is generally applied to dates only when samples show a δC^{13} of more than 1‰ from the normal value. Related to the PDB scale, the normal values are taken to be –25‰ for wood and –4‰ for marine shells (Craig, 1954). δC^{13} values given in the text are related to the PDB standard.

The dates are corrected for barometric effect when necessary. The radon content is checked for each dating, and the measurements are carried out with such a low radon content that no correction has been necessary. The C^{14} half life used here is 5570 yr; its standard deviation ± 30 yr is not included in the standard deviation (1σ) of the dating results.

Recalculated dates.—By diluting the CO_2 prepared from some small shell samples with inactive CO_2, we introduced an error because of a nonlinearity in the mechanical manometer (now replaced by a Hg manometer). Some previously published dates (see references below) have now been recalculated with the following results:

T-105 bis.	Primstad, lower layer (Trondheim II)	12,000 ± 300
T-111 bis.	Renså, Tromsö (Trondheim II)	11,000 ± 300
T-118 bis.	Foss Teglverk, Oslo (Trondheim II)	10,050 ± 350
T-122 bis.	City of Oslo (Trondheim II; Holtedahl, 1960a, p. 385-386)	980 ± 100
T-178 bis.	Kjelleollen, Tönsberg (Holtedahl, 1960a, p. 375; this date list).	10,200 ± 220

T-180 bis. Lutvatn near Oslo 9200 ± 300
(Holtedahl, 1960a, p. 385; this date list).

T-181 bis. Bestumkilen, Oslo 2050 ± 150
(Holtedahl, 1960a, p. 385-386; this date list).

T-187 bis. Djupvik, Troms 10,350 ± 300
(Holtedahl, 1960b, p. 415; Marthinussen, 1960, p. 418; this date list).

Except for T-122 bis, the correction is about the same amount as the limit of error (1σ) and therefore makes no important difference in geologic evidence.

ACKNOWLEDGMENTS

Sample descriptions have been prepared in collaboration with collectors and submitters of the samples. C^{13}/C^{12} ratios are kindly measured by R. Ryhage, Karolinska Inst., Stockholm. Most of the samples were selected by a committee consisting of Olaf Holtedahl, Dept. of Geol., Univ. of Oslo, Knut Faegri, Botanic Mus., Univ. of Bergen, and Sverre Marstrander, Videnskapselskapets Oldsaksamling, Trondheim. The manuscript has been reviewed by the members. Particular acknowledgment is made to the laboratory staff, Marianne Holm, Roar Saetherhaug, and Knut Lövseth for treating and counting the samples. Special thanks are due to Professor Dr. S. Westin, the supervisor of this laboratory, and to Norges Almenvitenskapelige Forskningsråd for financial support.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES, NORWAY

A. Driftwood, Northern Norway

Introduction by M. M. Driftwood occurs at the base of numerous peat bogs in the coastal areas, especially in W Finnmark and in the Vesterålen-Lofoten Archipelago. In studies of a great many bogs at different levels above the present seashore, no finds of driftwood (or of pumice accumulations) were made above the Tapes limit in these areas (Marthinussen, 1945, p. 257; 1960, p. 426). The driftwood samples submitted for dating were collected mainly at alt closely corresponding to the Tapes I-IV lines (in the system of Marthinussen, 1945, pl. II; 1960, pl. 16) and to the younger N_4 and N_2 lines. The dates appear to be reliable indications of the ages of these shorelines, and of logs older than the Tapes IV line in the outer coastal region. *Comment* (R.N.): in this series only samples T-183, T-245, T-266, and T-267 were analyzed by mass spectrometer.

T-183. Börfjordbotn, Finnmark (G I) 5500 ± 150

T-184. Börfjordbotn, Finnmark (G II) 5700 ± 150

Samples of *Picea* wood (id. by O. A. Höeg) from Börfjordbotn, Söröy, Finnmark (70° 36′ N Lat, 24° 41′ E Long), Norway. Samples found at the base of peat bogs ca. 20 m apart at alt of 10.5 to 11.0 m above sealevel (Marthinussen, 1960, p. 424 (table), and p. 425). Peat layers overlying the

driftwood are 1.5 to 1.8 m thick. Coll. 1939 and subm. 1959 by Marius Marthinussen, Univ. of Oslo. *Comment* (M.M.): expected age: 4800 yr or older. In this locality the Tapes lines II, III and IV lie at about the same level (as at the locality Börstrand; Marthinussen, 1960, pl. 16). The dates evidently refer to the Tapes III line, as the Tapes IV line is ca. 4800 yr old according to earlier dating (T-126, Trondheim II; Marthinussen, 1960, p. 424) and the maximum age of Tapes II line seems to be ca. 6250 yr (T-267, this date list). As the logs possibly may have drifted ashore slightly before the sealevel reached the Tapes III line, the date 5500 yr probably indicates the maximum age of this line.

T-185. Djupdalen, Finnmark **6350 ± 150**

Driftwood of *Pinus* (id. by O. A. Höeg) from Djupdalen, Ingöy, Måsöy, Finnmark (71° 05′ N Lat, 24° 05′ E Long), Norway. Found at the base of a peat bog 8.9 m above sealevel. Thickness of overlying peat layer is 1.4 m. Coll. 1949 and subm. 1959 by Marius Marthinussen. *Comment* (M.M.): expected date: 4800 yr or older. An age of 4800 yr would correspond to the Tapes IV level (cf. T-126), at which the driftwood was found (as at Steinvika, Ingöy; Marthinussen, 1960, pl. 16). The dating was arranged in an attempt to identify rather old drifts from levels below the Tapes IV line in the outermost districts, where a transport upwards may have taken place because of positive shorelevel displacements. The result so far is satisfactory as it points to a sealevel between 2 and 6 m, i.e. between Tapes I and II (Marthinussen, 1960, p. 424 (table); loc. Steinvika, Ingöy, pl. 16).

T-186. Saraberget, Finnmark **4100 ± 100**

Driftwood of *Larix* (id. by E. Mork) from Saraberget, Ingöy, Måsöy, Finnmark (71° 05′ N Lat, 24° 06′ E Long), Norway. Found at the base of peat bog at alt 6.5 m. Overlying peat layer here is 1.5 m thick. Coll. 1939 and subm. 1959 by Marius Marthinussen. *Comment* (M.M.): alt of 6.5 m corresponds to the N_4 line (expected date ca. 3800 yr) and the date fits well with expectation (Marthinussen, 1960, p. 424 (table); loc. Steinvika, Ingöy, pl. 16).

T-243. Austbotn, Finnmark **2450 ± 100**

Driftwood of *Picea* (id. by O. A. Höeg) from Austbotn, Kobbefjord, Måsöy, Finnmark (70° 48′ N Lat, 25° 20′ E Long), Norway. Found at the base of a peat bog at alt max 6.0 m. Thickness of overlying peat layer is 1.2 m. Coll. and subm. 1959 by Marius Marthinussen. *Comment* (M.M.): expected age: 2500 to 3000 yr. Alt of 6.0 m for the driftwood log corresponds at this locality to the N_2 line (Marthinussen, 1945, pl. II; 1960, pl. 16), and result indicates age of the line.

T-244. Lyngpollen, Finnmark **4100 ± 150**

Driftwood of *Larix* (id. by E. Mork) from Lyngpollen, Mageröy, Måsöy, Finnmark (71° 05′ N Lat, 25° 21′ E Long), Norway. Found at the base of a peat bog at alt 7.8 m. Thickness of overlying peat layer is 1.2 to 1.4 m. Coll. 1939 and subm. 1959 by Marius Marthinussen. *Comment* (M.M.): expected age: 4000 to 4500 yr. The wood seems to have drifted ashore at a sealevel corresponding to N_4 line, and its date is in accordance with result of T-186

(Trondheim II). The shoreline diagram for this area, not yet published, is similar to that of Marthinussen, 1960, pl. 16.

T-245. Skallelv, Finnmar **850 ± 80**

Driftwood of *Larix* (id. by O. A. Höeg) from S of Skallelv, Nord-Varanger, Finnmark (70° 10′ N Lat, 30° 18′ E Long), Norway. The log was found at alt 3.5 m, partly covered with sand and overlain by a layer of peat 0.5 to 0.8 m thick. Coll. and subm. 1959 by Marius Marthinussen. *Comment* (M.M.): as the locality is strongly exposed to attack by the sea, the sealevel corresponding to the altitude of the driftwood log seems to have been no more than 2.0 to 2.5 m above the present one. The youngest shoreline recognized by the writer, the N_1 line, is nearly twice as high at this place as the dated level (unpub. diagram). Because of the small altitude, the log was assumed to be quite young.

T-266. Nöss, Nordland **4500 ± 150**

Driftwood of *Picea* (id. by O. A. Höeg) from Nöss, Andöy, Nordland (69° 4.5′ N Lat, 15° 35′ E Long), Norway. Found at alt 7.4 m on deposit of sand overlain by a peat layer 1.0 m thick. The sand is inferred to be part of a beach ridge of the Tapes Sea, and reaches ca. 9 m alt farther seaward. Coll. and subm. 1960 by Marius Marthinussen. *Comment* (M.M.): corresponding sealevel seems to have been 7.0 to 7.5 m above present sealevel and coincides with the Tapes IV line, the age of which has been fixed at 4820 ± 160 yr (T-126, Trondheim II). It was thought that the date would either correspond to the age of the said line or, possibly, might be older (cf. T-185, this date list). The C^{14} dating agrees within 2σ with the date of T-126, and points to the first alternative. The Tapes IV line may have been stable for a comparatively long time. A shoreline diagram similar to that of pl. 16 (1960) is in preparation.

T-267. Nord-Mjele, Nordland **6250 ± 200**

Driftwood of *Picea* (id. by O. A. Höeg) from Nord-Mjele, Andöy, Nordland (69° 08′ N Lat, 15° 43′ E Long), Norway. Found at the base of a peat bog at alt 5.0 to 5.3 m. Overlying peat layer is 1.7 to 2.0 m thick. Coll. and subm. 1960 by Marius Marthinussen. *Comment* (M.M.): altitude of the driftwood points to a sealevel coinciding equally well with the N_3 line and with the much older Tapes II line. The dating approximately corresponds to maximum age of the latter. In contrast to the Djupdalen case (T-185, this date list), the driftwood here for some reason has not followed the continued shoreline displacement up to its maximum position at the Tapes IV level. A shoreline diagram similar to that of pl. 16 (1960) is in preparation.

B. Marine Transgressions, Northern Norway

Introduction by M. M.: The driftwood series (sec. A, this date list) implies that positive shoreline displacements may have taken place in outer coastal districts during Tapes I to IV time (cf. Djupdalen, T-185, and Nord-Mjele, T-267). In this section we are dealing with evidences of transgression consisting of occurrences of peat overlain by marine beach gravel or sand.

T-182. Tomaselv, Finnmark **7750 ± 150**

Peat from Tomaselv, Vadsö, Finnmark (70° 05′ N Lat, 29° 44′ E Long), Norway. Taken from upper part of peat layer, 8 cm thick, at alt 24.5 m. The peat, which occurs just inside the crest of the Tapes shore bar, is overlain by a layer of shore gravel 1 m thick and rests on slightly sea-washed gravel, primarily of glacial origin. Coll. and subm. 1959 by Marius Marthinussen. *Comment* (M.M.): stratigraphy shows marine transgression. Corresponding maximum sealevel is represented by the shore bar, at alt 25.5 to 26.0 m, and coincides with the Tapes I line (Marthinussen, 1960, pl. 16), the age of which is supposed to be ca. 6500 yr old. As the transgression is undoubtedly younger than the age found for the peat, we must assume that a top layer of the peat has been removed by marine abrasion (Marthinussen, 1960, p. 424).

Ramsåprofile I series, Nordland

Peat samples from deposits of Ramsåprofile I, Ramså, Andöy, Nordland (69° 10′ N Lat, 16° 05′ E Long), Norway. Section overlies rock from alt 0.1 m to ca. 9.3 m, and shows the following stratigraphic sequence from below upward: 0.1 to 0.55 m, gravel, probably shore gravel; 0.55 to 0.80 m, coarse sand and fine gravel with a zone of remnants of vascular plants (straw) in the lower part and with two very thin layers of peat near the top (T-271); 0.80 to 1.00 m, zone of thin layers of alternating peat and sand; 1.00 to 1.20 m, zone similar to the foregoing, but with much more peat (T-294); 1.20 to 1.25 m, sand; 1.25 to 1.85 m, peat, in middle and lower part rich in wood (T-295 from base; T-270, from top); 1.85 to 2.10 m, shore gravel resting on peat; 2.10 to ca. 9.30 m, marine sand with peat at surface. The uppermost peaty layer, ca. 0.3 to 0.8 m thick, consists of alternating zones of peat and sand, the latter evidently redeposited from the underlying bed by wind action. Thin zones of fine gravel containing shells are imbedded in the sand at 3.2 to 3.6 m. Coll. 1960 and subm. by Marius Marthinussen.

T-270. Ramså, ca. 7.5 m below surface **7400 ± 150**

Peat, 1.8 to 1.85 m above sealevel. subm. 1960.

T-295. Ramså, ca. 8.0 m below surface **9450 ± 250**

Peat, 1.3 m above sealevel. Subm. 1961.

T-294. Ramså, ca. 8.25 m below surface **9900 ± 200**

Peat, 1.05 m above sealevel. Subm. 1961.

T-271. Ramså, ca. 8.55 m below surface **10,600 ± 250**

Peat, 0.75 m above sealevel. Subm. 1960.

Comment (M.M.): the shore gravel at 1.85 to 2.10 m, overlain by sand and resting on peat, is direct evidence of marine transgression. Maximum sealevel of this transgression (here ca. 4 m) seems to be represented by Tapes I line, assumed to be ca. 6500 yr old. Greater age of peat (T-270, 7400 yr), may be explained (as in T-182, this date list) as an unconformity. The above sand deposit culminates in an important shore bar at alt 9.0 to 9.5 m. The latter seems to correspond to the youngest Tapes transgression, the maximum sealevel of which is represented by the Tapes IV line, ca. 4500 to 4800 yr (cf. T-126,

Trondheim II; T-266, this date list; Marthinussen, 1960, p. 425). As to a more detailed discussion of this profile, more datings as well as pollen analysis of peat are needed.

T-296. Ramsåprofile II, Nordland **6100 ± 150**

Peat from the deposits of the Ramsåprofile II, Ramså, Andöy, Nordland (69° 10′ N Lat, 16° 05′ E Long), Norway. Found at alt 4.05 m in a thin peat layer at the top of a deposit, 1.5 m thick, of mainly coarse-grained sand with some thin peat layers, especially in the middle and lower part of it. The peat layer at 4.05 m is overlain by marine sand, 1.2 m thick. Coll. and subm. 1961 by Marius Marthinussen. *Comment* (M.M.): as the investigation of this profile is not yet brought to an end, only a particular part of it is here dealt with. The stratigraphy reveals a marine transgression. The date seems to be younger than that of the Ramsåprofile I series. The peat in question probably coincides with a regression phase which followed the Tapes II transgression maximum (Tapes II line). The marine sand above the peat seems to tell of a still younger transgression phase.

C. Main substage (= the Tromsö-Lyngen substage), Northern Norway

T-187. Djupvik, Troms **10,350 ± 300**

Shells of *Portlandia arctica* from Slottet, ca. 1 km N of Djupvik, Lyngen, Troms (69° 46′ N Lat, 20° 28′ E Long), Norway. Found at alt between 4.5 and 9.0 m in a clay deposit, the maximum thickness of which (exposed above present sealevel) is ca. 11 m. The clay is partly overlain by postglacial shell beds. Situated outside an important terminal moraine (at Spåkenes) belonging to the substage in question (Marthinussen, 1960, p. 418). Coll. and subm. 1959 by Marius Marthinussen. No C^{13} analysis. *Comment* (M.M.): expected date 10,000 to 10,500 yr. Although relations between the clay and the moraine are not clear, the date of the shells coincides with the end of Younger Dryas period, and may therefore indicate the minimum age of the moraine. The shoreline represented by the Main line is believed to be contemporaneous with the Main substage at 65 to 66 m alt in this locality (Holtedahl, 1960b; Marthinussen, 1960, p. 418, fig. 144; 1961, fig. 17; Trondheim I, p. 77; Trondheim II, p. 85-86).

T-246. Saltenfjorden, Nordland **10,550 ± 250**

Shells of *Portlandia arctica* from the brickyard of Rönvik, Bodö, Nordland (67° 17′ N Lat, 14° 25′ E Long), Norway. Found between ca. 7 and ca. 10 m alt in middle and upper part of a big deposit of blue clay at least 7 to 8 m thick. The clay, including its upper part, is rich in *P. arctica* and is overlain by a postglacial shell bed (Holtedahl, 1953, p. 714). Coll. and subm. 1959 by Marius Marthinussen. No C^{13} analysis. *Comment* (M.M.): expected date: 10,000 to 10,500 yr. The result shows that the shells are contemporaneous with the Younger Dryas period. End moraines of corresponding glacial substage in this district are not yet identified with certainty. They must be situated E of Bodö, presumably in the Skjerstadfjord area (Holtedahl, 1953, p. 710, fig. 317; Marthinussen, 1961, fig. 17).

The clay deposit and its fauna corresponds in a general way to the Yoldia Clay of Brögger's system in Southern Norway (Holtedahl, 1960a, p. 375), and was assumed to be of Younger Dryas age. The dates of the shells from widely separated areas of Northern Norway including T-124 (10,300 ± 250, Trondheim II), confirm this view in a striking way.

D. Sandstrand shells, Northern Norway

Introduction by M. M.: The locality is situated outside a well-developed terminal moraine at the mouth of Astafjord, SE of Harstad. This moraine, named (by M. M.) the Outer Astafjord Moraine, was supposed to be somewhat older than the Younger Dryas period, because of distinct traces of the sea (shore marks, shells and foraminifera) at altitudes above the maximum sea-level of the said period. C^{14} dating of the shells seems to confirm this view.

T-269. Sandvannet (I), Troms **12,300 ± 250**

Shells of *Macoma calcarea* near Sandvannet, Sandstrand, Evenskjaer, Troms (68° 40′ N Lat, 16° 45′ E Long), Norway. Found in sandy clay at alt 69.0 m. Coll. and subm. 1960 by Marius Marthinussen. No C^{13} analysis. *Comment* (M.M.): the shells probably date the Outer Astafjord Moraine as of Older Dryas age. At Renså, ca. 6 km E of (and inside) this moraine, is another moraine ridge that seems to be of Younger Dryas age (Trondheim II, p. 86). Maximum sealevel of Younger Dryas time is ca. 68 to 70 m at Sandstrand, and the Older Dryas shore probably lies between ca. 73.5 and ca. 81 m (Marthinussen, 1960, fig. 144, pl. 16; 1961, footnote 7a et passim). A shoreline diagram of this area is in preparation.

T-316. Sandvannet (II), Troms **11,700 ± 250**

Shell fragments of *Mya truncata* near Sandvannet, Sandstrand, Evenskjaer, Troms (68° 40′ N Lat, 16° 45′ E Long), Norway. Found imbedded in a layer of shore gravel 25 cm thick at alt 73.2 to 73.4 m. Coll. and subm. 1961 by Marius Marthinussen. *Comment* (M.M.): age is Alleröd, and altitude of the shells seems to point to a corresponding shore level at ca. 73.0 to 73.5 m (cf. T-269, this date list).

T-214. Sandstrand (III), Troms **11,400 ± 250**

Shells of *Mya truncata* from the brickyard of Sandstrand, Sandstrand, Evenskjaer, Troms (68° 40.5′ N Lat, 16° 45′ E Long), Norway. Found at alt 30.5 m at the very base of a deposit of blue clay 5 to 8 m thick, which rests on sand and is overlain by thick sand layers. The shells occur in transition layer between clay and underlying sand. No shells were seen in the clay itself except some extremely scarce and scattered *Portlandia arctica*; the skeleton of a whale. *Balaena mysticetus*, was recently found in the clay at alt 32 to 35 m. Coll. 1959 and subm. 1960 by Marius Marthinussen. *Comment* (M.M.): the clay was supposed to correspond to the Yoldia Clay of Brögger (Holtedahl, 1960a, p. 375), and to be of Younger Dryas age. Consequently the shells from the said transition layer were expected to be somewhat older. The correctness of this view seems to be proved by the dating in that the age of the shells co-

incides with the Alleröd period. A climatic oscillation, probably corresponding to the transition from Alleröd to Younger Dryas time, seems to be reflected in the fossil Foraminifera from the transition layer and the overlying clay (examined by R. W. Feyling-Hanssen), which reveal subarctic and arctic climatic conditions respectively. Foraminifera near the base of banded clay at Sandvann, alt ca. 74 m, shows arctic climatic conditions. According to the altitude (and with due regard to the stratigraphic circumstances) the clay is inferred to be of Older Dryas age.

E. Late- and postglacial marine deposits, Southern Norway

T-178 bis. Kjelleollen, Tönsberg **10,200 ± 220**

Shells of *Macoma calcarea* from Kjelleollen, Tönsberg (59° 17′ N Lat, 10° 24′ E Long), Norway. Found in *Yoldia* clay in front of the Ra moraine (Brögger, 1901, p. 29). Coll. 1900 by W. C. Brögger; subm. 1959 by Olaf Holtedahl. *Comment* (O.H.): result fits well with T-117, 9950 ± 300 (Trondheim II) for *Portlandia arctica* from *Yoldia* clay of the Fredrikstad-Sarpsborg district on the other side of the Oslofjord (Holtedahl, 1960a, p. 375).

T-179. Eidsberg SSE of Oslo **9750 ± 250**

Shells of *Pecten* (=*Chlamys*) *septemradiatus* from Söreng, E bank of Glomma, Eidsberg (59° 31′ N Lat, 11° 13′ E Long), Norway. Found in *Arca* clay outside the Ås-Ski moraine substage (Rekstad, 1921, p. 54 ff). Coll. 1898 by P. A. Öyen, Univ. of Oslo; subm. 1959 by Olaf Holtedahl. *Comment* (O.H.): seems to fit well in the chronology of deposits in the Oslo region (Holtedahl, 1960a, p. 376).

T-180 bis. Lutvatn near Oslo **9250 ± 300**

Shells of *Mytilus edulis* from near Lutvatn, Oslo (59° 54′ N Lat, 10° 53′ E Long), Norway. Found in shell bed at alt 200 to 201 m (Rekstad, 1916, p. 1). Coll., probably 1913, by P. A. Öyen; subm. 1959 by Olaf Holtedahl. *Comment* (O.H.): helps in establishing the chronology of the uplift of the land just after the disappearance of the ice in this district (cf. T-119, Trondheim II). See also Holtedahl, 1960a, p. 385; by mistake *Littorina littorea* was printed in that work instead of *Mytilus edulis*, and Rekstad, who first described the locality, was mentioned as the collector.

T-181 bis. Bestumkilen, Oslo **2050 ± 150**

Shells of *Scrobicularia piperata*, near Bestumkilen, Oslo (59° 55′ N Lat, 10° 40′ E Long), Norway. Found in Scrobicularia clay (just above a layer rich in *Ostrea edulis*) near sealevel, 4 to 5 m below surface. Coll. 1952 by H. Rosendahl, Univ. of Oslo; subm. 1959 by Olaf Holtedahl. *Comment* (O.H. and H.R.): we seem here to have sampled a relatively old part of the *Scrobicularia* clay, while a sample from the city of Oslo (T-122 bis, 980 ± 100, Trondheim II, p. 87, and this date list) represents a very young part (Holtedahl, 1960a, p. 385-386).

T-223. Tönsberg Teglverk, Nötteröy **11,200 ± 200**

Fossil shells of *Portlandia arctica*, Tönsberg Teglverk, Nötteröy (59° 16′

N Lat, 10° 24′ E Long), Norway. Found in *Yoldia* clay (Brögger, 1901, p. 29). Coll. 1905-1909 by W. C. Brögger and P. A. Öyen; subm. 1960 by Halvor Rosendahl. *Comment* (H.R.): the locality lies well outside the Ra moraine and the clay may have been deposited in the transition period from Alleröd to Younger Dryas. For other age determinations of shells from the *Yoldia* clay and the Ra moraine see T-117, Trondheim II, p. 87; T-178, T-261, and T-315, this date list.

T-231. Ringvoll Teglverk, Baerum **8700 ± 200**

Fossil shells of *Pecten septemradiatus*, Ringvoll Teglverk, Baerum (59° 55′ N Lat, 10° 28′ E Long), Norway. In marine clay together with *Arca glacialis*. Coll. 1922 by P. A. Öyen; subm. 1960 by Halvor Rosendahl. No C^{13} analysis. *Comment* (H.R.): the clay was supposed to represent the typical younger *Arca* clay (Brögger, 1901, p. 152) but the age seems too low for that assignment.

T-286. Strömmen Verksted, Akershus **9500 ± 200**

Fossil shells of *Mytilus edulis*, Strömmen Verksted, Skedsmo, Akershus (59° 57′ N Lat, 11° 01′ E Long), Norway. In clay, 4 m below surface, the surface being at alt 147.5 m. Coll. 1948 by B. S. Halvorsen, engineer at Strömmen Verksted; subm. 1961 by Halvor Rosendahl. The material belongs to the "Strömmen shell-bed" (Öyen, 1906, p. 81 ff.; Rosendahl, 1942). *Comment* H.R.): the locality is situated inside (NE of) the moraine of the Aker substage (Holtedahl, 1960a, p. 377), and helps in dating the latter.

T-287. Hovlandsmo, Sigdal **9050 ± 200**

Fossil shells of *Mya truncata*, Hovlandsmo, Sigdal (60° 02′ N Lat, 9° 42′ E Long), Norway. Found in shell bed in terrace at alt 100 m. (Reusch, 1904, p. 7). Coll. 1906 by P. A. Öyen; subm. 1961 by Halvor Rosendahl. *Comment* (H.R.): the only locality with marine shells as yet found so far inland in this part of Norway.

T-290. Kaholmen in Oslofjord near Dröbak **8200 ± 200**

Fossil coral reef of *Lophohelia prolifera*, Kaholmen in Oslofjord near Dröbak, Akershus (59° 41′ N Lat, 10° 36′ E Long), Norway. In marine clay near present sealevel (Brögger, 1901, p. 182). Coll. before 1894 by A. J. C. Collett; subm. 1961 by Halvor Rosendahl. *Comment* (H.R.): the age of the *Lophohelia* reefs in the Oslofjord has long been a problem. Dead corals are common below as well as above sealevel (to ca. 30 m). Brögger believed them to be contemporaneous with the highest shorelines of the fjord area, but this specimen is younger.

T-291. Borge, Skoger, Vestfold **7250 ± 200**

Fossil shells of *Ostrea edulis* from Borge, Skoger (59° 41′ N Lat, 10° 10′ E Long), Norway. In clayey material dug from a well, alt 148 m (Rosendahl, 1937, p. 293). Coll. 1927 by the farmer Andvik, and 1935 by Halvor Rosendahl; subm. 1961 by Halvor Rosendahl. *Comment* (H.R.): the high altitude of the locality in relation to the marine limit at 185 m indicates an early immigration of *Ostrea edulis*, as now confirmed by the dating.

T-261. Bökeskogen marine clay, Larvik **11,000 ± 250**

Shell fragments of *Portlandia arctica* and others from Bökeskogen, Larvik, Vestfold (59° 05′ N Lat, 10° 01′ E Long), Norway. From clay in the Ra moraine (of Younger Dryas age) at Larvik on W side of the outer Oslofjord. Coll. 1920 by P. A. Öyen; subm. 1960 by R. W. Feyling-Hanssen, Geol. Survey of Norway. No C^{13} analysis. *Comment* (R.W.F.-H.): the Foraminifera of the clay sample from which the mollusc shells were taken, place the sample in the microstratigraphic Sub-zone A_m (Feyling-Hanssen 1957), now dated by the shells. Expected age was 10,800 to 10,900 B.P.

T-315. Valle Teglverk marine clay, Fredrikstad **10,700 ± 300**

Shells of *Macoma calcarea* from Valle Teglverk, Fredrikstad (59° 15′ N Lat, 10° 58′ E Long), Norway. Found in *Yoldia* clay at alt 1 m between Sarpsborg and Fredrikstad on E side of the outer Oslofjord. Foraminifera date the deposit as of early Younger Dryas age. Coll. 1899 by W. C. Brögger; subm. 1961 by R. W. Feyling-Hanssen. No C^{13} analysis. *Comment* (R.W.F.-H.): the clay belongs to the foraminiferal Sub-zone A_m, expected age 10,600 to 10,900 B.P. The shells confirm the inferred age of Sub-zone A_m, the second oldest unit in the Late Quaternary microstratigraphic sequence of the Oslofjord area.

Fossantjern series, Vestfold

Gyttja from a bog close to the lake Fossantjern, Hedrum, Vestfold (59° 05′ N Lat, 10° 03′ E Long), Norway. Lake surface alt 50 m. Samples were collected from a depth of 10.5 m at the contact between marine clay and overlying gyttja. Sample 241A is from immediately (0-5 cm) above, and sample T-241B from immediately (0-10 cm) below the contact, which records the isolation of the lake from the sea. Coll. and subm. 1960 by K. E. Larssen, Geol. Survey of Norway, Oslo.

T-241 A. Fossantjern, gyttja **7900 ± 250**

No C^{13} analysis was made.

T-241 B. Fossantjern, clayey gyttja **8000 ± 300**

Comment (K.E.L.): ages of the two samples date the isolation of the basin to ca. 8000 B.P. Pollen diagram (unpub.) makes this reasonable, as isolation took place in early Atlantic time, after immigration of *Alnus* and before the expansion of *Tilia*.

T-209. Ravnemyr, Vest-Agder, 7.2 m **7400 ± 250**

Gyttja from the basin Ravnemyr at Saltaag, Sögne, Vest-Agder (58° 02′ N Lat, 7° 41′ E Long), Norway. The basin is situated ca. 4 m above present sealevel. The peat lies at a depth of 7.2 to ca. 8.1 m between layers of marine sediments. The sample was collected from the top of the peat, just at the contact with overlying marine sediments. Coll. and subm. 1960 by Gunnar Gabrielsen, Dept. of Geol., Univ. of Oslo. No C^{13} analysis. *Comment*: see T-292.

T-292. Launesmyra, Vest-Agder **6800 ± 170**

Shell fragments, mostly *Ostrea edulis* from the basin Launesmyra, Hart-

mark, Vest-Agder (58° 01′ N Lat, 7° 38′ E Long), Norway. The basin, now covered by a bog, is situated ca. 8 m above present sealevel. The sample was collected from a depth of 5.4 to 5.5 m below surface. Coll. 1960 and subm. 1961 by Gunnar Gabrielsen. *Comment* (G.G.): the postglacial transgression in this district started between 9410 ± 220 (T-81) and 8770 ± 100 (T-80) B.P. (Gabrielsen, 1959, p. 1616; Trondheim I, p. 78), when the sea transgressed the threshold (alt ca. 2 m) at Dostad. T-209 shows that the sea passed the 4 m level 7400 ± 250 yr ago, and T-292 (6800 ± 170) coincides with the age of maximum transgression, corresponding to a shore level at ca. 8 m.

T-281. Ravnemyr, Vest-Agder, 2.2 m **3050 ± 100**

Gyttja from the basin Ravnemyr at Saltaag, Sögne, Vest-Agder (58° 02′ N Lat, 7° 41′ E Long), Norway. The sample was collected from the contact zone between overlying peat and underlying marine sediments, at ca. 2.2 m below surface. Coll. and subm. 1960 by Gunnar Gabrielsen. *Comment* (G.G.): after the transgression dated in the same section at 7400 ± 250 (T-209, this date list), the Saltaag basin was isolated from the sea owing to a regression. The dating (T-281) indicates that during this regression the altitude of the shore line 3050 ± 100 yr ago was ca. 4 m.

T-208. Vaage, Vest-Agder **7950 ± 170**

Gyttja from the basin at Vaage, Spangereid, Vest-Agder (57° 59′ N Lat, 7° 04′ E Long), Norway. The basin is sheltered from the sea by a rock threshold, ca. 0.5 m above present sealevel. The peat, 0.7 to 1.0 m thick, lies ca. 3.5 m below surface, between layers of marine sediments. The sample was collected just at the contact between overlying marine sediments and underlying peat. Coll. 1959 and subm. 1960 by Gunnar Gabrielsen.

T-273. Oftenes, Vest-Agder **8300 ± 250**

Gyttja from a basin at the headland Oftenes, Sögne, Vest-Agder (58° 04′ N Lat, 7° 46′ E Long), Norway. The basin is sheltered from the sea by rock thresholds ca. 5 m above present sealevel. The peat lies 1.5 m below surface, between layers of marine sediments. The sample was collected from the top of the peat, just at the contact with overlying marine sediments. Coll. and subm. 1960 by Gunnar Gabrielsen. No C^{13} analysis.

F. Bergen district

T-229. Osöyri, Os near Bergen **10,150 ± 300**

Shells of *Mya truncata* from Osöyri, Os near Bergen (60° 11′ N Lat, 5° 29′ E Long), Norway. Fragments of marine shells in clayey till. Coll. and subm. 1960 by Hans Holtedahl, Univ. of Bergen. No C^{13} analysis. *Comment* (H.H.): the till was evidently deposited by an advancing glacier in the Os area in Younger Dryas time (Kolderup, 1908).

T-304. Lundetre, Os near Bergen **10,050 ± 250**

Marine shells (*Balanus porcatus* and *Saxicava arctica*) from Lundetre, Os near Bergen (60° 12′ N Lat, 5° 29′ E Long), Norway. Shell fragments

found in clay, overlain by till, at alt 20 to 30 m close to a vertical cliff. Coll. and subm. 1961 by Hans Holtedahl. *Comment* (H.H.): fauna is of Younger Dryas age (Kolderup, 1908) and was buried by meltwater sediments laid down in front of an advancing glacier. Owing to its protected position the overriding glacier did not disturb the deposit, except in the upper parts where clay and marine shells were incorporated in the moraine. *Comment*: see T-229.

T-305. Bryozoan limestone near Bergen **11,700 ± 230**

Bryozoan limestone from Lundetre, Os near Bergen (60° 12′ N Lat, 5° 29′ E Long), Norway. A vertical cliff, 16 m high, alt 20 to 36 m, and facing SW, is covered by a layer of lime, with well-preserved Bryozoa of arctic types, tests of serpulids and basal parts of barnacles (*Balanus porcatus*). Shells were found in cracks in rock. Face covered with clay containing Younger Dryas fauna (dated by T-304, this date list), later removed by excavation. Coll. and subm. by Hans Holtedahl. *Comment*: highly abnormal fractionation: $\delta C^{13} =$ 10‰ (230 yr age correction). *Comment* (H.H.): fauna attached to vertical cliff is of Alleröd age and lived prior to the deposition of the clay, whose marine shells are of Younger Dryas age. The area must have been open water during Alleröd time, with the ice sheet a considerable distance away (Kolderup, 1908).

G. Southern Norway

T-249B. Höylandsmyr, Vest-Agder **11,500 ± 300**

Clayey mud from the bog Höylandsmyr at Lista, Vest-Agder (6° 43′ N Lat, 58° 05′ E Long), Norway. Coll. by Hiller borer from 4.83 to 4.98 m below bog surface, which is at alt 10 to 12 m. Sampled layer overlies dark blue lacustrine clay and underlies grey lacustrine clayey gyttja which at 4.255 m depth is sharply separated from the overlying organic deposits. Coll. and subm. 1960 by Ulf Hafsten, Univ. of Bergen. No C^{13} analysis. *Comment* (U.H.): pollen analysis of the bog profile is part of a comprehensive pollen-analytic investigation of the southernmost part of Southern Norway. The principal objective is to trace the late Pleistocene shoreline displacement from Lista to Kristiansand, expressing it by isobases drawn from Jaeren to the Oslofjord area, where the shoreline displacement has already been investigated (Faegri, 1940; Hafsten, 1957; Danielsen and Egede Larssen, in preparation). The presence of an Alleröd layer, now confirmed by the date, was considered likely from the stratigraphic sequence seen in the field, and verified by pollen analysis, though the pollen diagram is still incomplete.

T-293. Borgund, Möre og Romsdal **8250 ± 250**

Slightly humified *Sphagnum* peat from Borgund, Möre and Romsdal (62° 28′ N Lat, 6° 15′ E Long), Norway. Collected from the upper 5 cm of a layer of peat and gyttja, 38 cm thick, situated slightly below sealevel. The peat layer, 15 cm thick, was limited below by lacustrine drift gyttja, 23 cm thick, and above by marine clay gyttja with some sand. The whole series (ca. 70 cm) rests on sterile clayey sand which seems to have been deposited in sea water. Coll. 1960 and subm. 1961 by Ulf Hafsten, on request of A. E. Herteig, leader

of the archaeologic excavations of the medieval village at Borgund. *Comment* (U.H.): occurrence of marine clay gyttja on top of *Sphagnum* peat and lacustrine drift gyttja demonstrates a transgression of the sea. The pollen diagram confirms in detail the sequence of lacustrine and marine layers demonstrated in the field. The lacustrine mud gave a typical Preboreal pollen diagram, with more than 85% *Betula* and very little *Corylus*. The overlying marine clay gave a genuine Boreal diagram, with high *Pinus* and *Corylus* and almost no *Alnus*. The pollen spectra from the intervening *Sphagnum* peat, the upper 5 cm of which has been dated, are not so distinct, but probably refer to the Boreal period. The Boreal age of the marine transgression is proved by the pollen and confirmed by the date. A transgression of the same age has been described from Dostad, E of Mandal (Gabrielsen, 1959). The threshold of the Dostad basin is situated 2 m above sealevel.

T-285. Gråsubreen, Jotunheimen **2600 ± 100**

Organic fragments from an ice core in the outermost end moraine ridge at Gråsubreen, Lom, Oppland (61° 40′ N Lat, 8° 37′ E Long), Norway. From seismic soundings, electric resistivity measurements, and air-photo interpretation, it is obvious that ice cores exist in several moraine ridges in the Jotunheimen area (Östrem, 1960; 1961a). Crystallographic analyses of buried ice proved that it originated directly from snow *in situ* not from frozen ground water (Östrem, 1961b). Organic fragments are therefore inferred to have blown onto snow fields before they were covered by morainic material from the glacier snout. Thus, dating can give the (maximum) age of moraine deposition. Coll. and subm. 1961 by Gunnar Östrem, Geog. Inst., Stockholm, Sweden. *Comment*: 100 kg ice contained 1.5 to 2.0 g pure carbon. The organic fragments were pretreated with 1 M HCl only. The age is surprisingly high, as the outermost moraines were expected to be ca. 200 yr old, but as a date for the formation of a snow field the age corresponds well with what is known of postglacial climates.

II. ARCHAEOLOGIC SAMPLES

A. Settlement Sites, Norway

T-196. Gropbakkeengen, Finnmark **4750 ± 150**

Charcoal from Gropbakkeengen, Nesseby, Finnmark (70° 07′ N Lat, 28° 36′ E Long), Norway. Two separate habitation layers were found in close superposition in House-Site –4. Sample collected from a firepit in the lowest layer that was archaeologically distinguishable. Some artifacts were found in the same layer, not exactly in the firepit, but the contemporaneity is sure (Simonsen, 1958, p. 134-136; 1961, p. 160-169). Coll. 1952 and subm. 1960 by Povl Simonsen, Tromsö Mus. *Comment* (P.S.): archaeological dating, Late Stone Age, Period II, ca. 2200 B.C., Comb-Ceramic Culture. The Gropbakkeengen dwelling-place consisted of 85 house-sites from Period III, without preserved organic material. Under Sites –3 and –4 were remains of older houses, belonging to the previous period. The charcoal is from this older culture.

Elenholmen, Finnmark **Av.: 4600 ± 110**

Charcoal from the isle Elenholmen in the Pasvik River, Sör-Varanger, Finnmark (69° 36′ N Lat, 30° 12′ E Long), Norway. Collected from hearths in a Stone Age field. All over the large area were many firepits and fireplaces, containing much charcoal, but very few artifacts (Simonsen, 1959a, p. 47). Coll. 1958 and subm. 1960 by Povl Simonsen. *Comment* (P.S.): the field may have been used for sacrifice in the Younger Stone Age. Archaeologic dating is very weak because few artifacts were found. The site should be of about the same age as the nearest elevated shoreline, alt 15.5 m, but a C^{14} date has not yet been obtained for this level.

T-235. Hearth d **4550 ± 150**

T-236. Hearth a **4650 ± 150**

T-237. Holmfoss, Finnmark **2600 ± 150**

Charcoal from Holmfoss, Sör-Varanger, Finnmark (69° 36′ N Lat, 30° 12′ E Long), Norway. Collected from floor in a house-site ca. 2 km N of Holmfoss on the shore of the Pasvik River, opposite Elenholmen. The house site stood alone, near the shore, and was covered by *Sphagnum* peat nearly 1 m thick; no artifacts were found (Simonsen, 1959a, p. 47). Coll. 1958 and subm. 1960 by Povl Simonsen. *Comment* (P.S.): geologic dating based on altitude of site, which is 11 m, corresponds in time to the end of the Stone Age, Period IV, ca. 500 B.C.; although no archaeologic dating was possible, the C^{14} date is entirely reasonable.

Gressbakken series, Finnmark

Charcoal from the Lower West settlement site on Gressbakken, Nesseby, Finnmark (70° 04′ N Lat, 28° 53′ E Long), Norway. Collected from middens containing artifacts, unstratified by type, plus animal bones and shells. Most of the houses in this site lay on a slope with large middens below the houses at both sides of their doorways. Middens were ca. 1.5 m high and covered an area 8 by 15 m near each house. Coll. 1957 and subm. 1960 by P. Simonsen. *Comment* (P.S.): the dwelling place contained 13 large house sites, eight of which were excavated. Archaeologic dating, Late Stone Age, Period IV, ca. 700 B.C., Asbestos-Ceramic Culture (Simonsen, 1959b, p. 10-13; 1958, p. 137-138; 1961, p. 316-346).

T-198. Gressbakken, House 3 **3650 ± 150**

Collected from a typologically pure layer.

T-234. Gressbakken, House 4 **3850 ± 100**

No C^{13} analysis; collected from various places in the midden.

Kaupang series, Vestfold

Charcoal from a settlement site, alt ca. 1.9 m Kaupang, Tjölling, Vestfold (59° 02′ N Lat, 10° 65′ E Long), Norway. Two exploratory trenches were cut across the site of a Viking-age market place, mentioned in King Alfred's *Orosius*. Trenches dug up to 1959 cover ca. 300 m^2. Abundant material found

included many fragments of imported glass and pottery of types belonging principally to the 9th Century A.D., a date corresponding very well with that of the graves at the same site (Blindheim, 1960, 1961; Skaare, 1960). Coll. and subm. 1960 by Charlotte Blindheim, Univ. Oldsaksamling, Oslo. *Comment* (C.B. and R.N.): a well-constructed jetty was found at the market place, and sample T-232 (Trondheim II) of some wooden poles outside gave an age A.D. 840 ± 90. It is not quite clear why the present series tend to be 250 to 500 yr older than the archaeologic age and the mentioned C^{14} age.

T-252. Trench I (A.M.O.) **1500 ± 100**

Charcoal from foundation of House I.

T-253. Trench I (B.M.O.) **1400 ± 100**

Charcoal from a burnt plank found on a floor of beaten clay, outside House I, probably belonging to another house, still unexcavated.

T-254. Trench I (C.M.O.) **1600 ± 100**

Charcoal, perhaps from a fireplace, found close to a wall in House I.

T-250. Trench II (A.B.O.) **1350 ± 80**

Charcoal from a fireplace in a house which had the character of a workshop.

T-255. Trench II (B.B.O.) **1350 ± 100**

Charcoal from the whole trench area at different depths.

T-258. Sporanes, Telemark **3550 ± 150**

Charcoal from Sporanes, Rauland, Telemark (59° 40′ N Lat, 08° 03′ E Long), Norway, collected at a depth of 75 cm in a charcoal layer imbedded in sand close to a Stone Age settlement near the rock carvings of Sporanes. Charcoal layer is suggested to belong to the settlement, archaeologically dated to 1500 B.C. Coll. 1959 and subm. 1960 by Irmelin Martens, Univ. Oldsaksamling, Oslo. *Comment* (I.M.): as the planned excavation of the Stone Age site was not effected, the dating cannot be fully confirmed.

T-259. Langsœhelleren, Telemark **980 ± 110**

Charcoal from rock-shelter in Langesae, Vinje, Telemark (59° 45′ N Lat, 07° 18′ E Long), Norway, collected 0.5 m below surface in a habitation layer 90 cm thick. Sampled section limited above and below by two iron arrowheads. Coll. 1959 and subm. 1960 by Irmelin Martens. *Comment* (I.M.): arrowhead in stratum over collected sample is nearer A.D. 700 than 1000. In a habitation like this, one cannot exclude the possibility of some mixture of layers.

B. Stone and Bronze Age Finds, Norway

T-227. Dönnes, Nordland **2400 ± 200**

Wood from the helve of a stone or bronze axe, found in a peat bog at Hov, Dönnes, Nordland (66° 11′ N Lat, 12° 42′ E Long), Norway. Found 1.5 m below the surface of the peat bog. Discovered 1957 by farmer Olav Hov, subm.

1960 by Sverre Marstrander, Videnskapsselskapets Oldsaksamling, Trondheim. No C^{13} analysis. *Comment* (S.M.): a helve of this type has not been found in Norway before. There are, however, distinct resemblances between this helve and Danish finds from later Stone Age (Bröndsted, 1957, p. 153-156, and p. 207-208).

Byneset, Sör-Tröndelag **Av.: 2440 ± 100**

Wood from a bowl found on the farm Högstad, Byneset, Sör-Tröndelag (63° 25′ N Lat, 10° 24′ E Long), Norway. Wooden artifacts found close together in a peat bog at a depth of 1.5 m below soil surface. Coll. 1899 by the owner of the farm; subm. 1955 (T-23) and 1956 (T-26) by Sverre Marstrander. C^{14} measured in 1957, but not reported in Trondheim I. *Comment* (S.M.): there was formerly some doubt as to the character and age of this exceptional find. The ornamentation of some of the objects, however, indicated the middle part of Late Bronze Age as the most probable date. The C^{14} dating supports the evidence of the decorative art.

T-23. **2510 ± 140**

T-26. **2370 ± 140**

T-192. Eggehvammen 25-2, Nord-Tröndelag **2100 ± 150**

Charcoal from a fireplace under a grave of the Roman period from Eggehvammen near Steinkjer, Nord-Tröndelag (64° 02′ N Lat, 11° 29′ E Long), Norway. The grave had form of a circular pavement of stones, ca. 20 m diam. A spearhead of slate was found in the firepit. Coll. 1959 by Fr. Gaustad; subm. 1960 by K. R. Möllenhus, Videnskapsselskapets Oldsaksamling, Trondheim. *Comment* (K.R.M.): archaeologic dating of the grave: A.D. 0 to 400. Fireplace and slate spearhead must be interpreted as evidences of a Stone Age settlement before the grave was built (Möllenhus, 1961; Gaustad, 1962).

T-276. Eggehvammen 26-2, Nord-Tröndelag **1550 ± 100**

Charcoal from a burial pit in the grave field on Eggehvammen near Steinkjer, Nord-Tröndelag (64° 02′ N Lat, 11° 29′ E Long), Norway. The pit was found in center of a wide circle of stones with 18 m diam. Apart from burnt bones, grave contained no artifacts. Coll. and subm. 1960 by K. R. Møllenhus. *Comment* (K.R.M.): archaeological dating, which is A.D. 0-400 according to the type of grave, corresponds fairly well with C^{14} dating (Möllenhus, 1960).

C. Other Archaeologic Samples

T-274. Eisli, wooden trackway, Sör-Tröndelag **900 ± 140**

Pine wood from a wooden trackway found in Eisli, Skaun, Sör-Tröndelag (63° 15′ N Lat, 10° 05′ E Long), Norway. Trackway consisted of longitudinal stringers. Fairly similar to trackways dated earlier as T-99, T-100 and T-101 (Trondheim II). Coll. and subm. by K. R. Möllenhus. *Comment* (K.R.M.): according to an old tradition, this trackway has been called "Einar's road." It is said to be the trackway used by Einar Tambarskjelve (ca. A.D. 1050, a well-

known Norwegian chieftain of the Viking period, on his rides between his different estates in this region.

T-275. Röd, wooden trackway, Sör-Tröndelag 920 ± 100

Pine wood from a wooden trackway in Röd, Börsa, Sör-Tröndelag (63° 15′ N Lat, 10° 00′ E Long), Norway. The trackway, found in a bog, consisted of longitudinal stringers resting on sleepers at the ends, and small supporting poles at the sides. Construction is fairly similar to trackways dated earlier as T-99, T-100 and T-101 (Trondheim II; Möllenhus, 1960). Coll. and subm. by K. R. Möllenhus. *Comment* (K.R.M.): the find proves the local tradition of an old thoroughfare near this place.

Erkebispegården series, Trondheim

Wood from the old part of Erkebispegården (Archbishop's Palace) at Trondheim Cathedral, Trondheim (66° 11′ N Lat, 12° 41′ E Long), Norway. The building is closely connected to the cathedral, which, according to historical account, was finished for the first time in A.D. 1050. Measurements were made to date the oldest buildings. Coll. and subm. 1959 by Gerhard Fischer, Univ. Oldsaksamling, Oslo. No C^{13} analysis. *Comment* (G.F.): both the relative and the absolute datings fit well with the historical evidence.

T-204. Archbishop's Palace 1050 ± 100

Collected from the E wall of a wooden house, found at the main gate.

T-205. Archbishop's Palace 800 ± 100

Collected from wooden floor; local coordinates in architect Fischer's plan for the building: 32x, 47 y.

T-206. Archbishops Palace 900 ± 100

Collected from wooden floor: 95x, 45y.

T-207. Archbishop's Palace 900 ± 100

Collected from a timber belonging to the old street pavement: 30-40x, 46y.

T-157. Shipwreck at Folderöyhamn, Hordaland 530 ± 100

Wood from a shipwreck found at Folderöyhamn, Bremnes, Hordaland (59° 48′ N Lat, 05° 28′ E Long), Norway. The wreck was found imbedded in sand at a depth of 5 to 6 m below sealevel, 3 m from the shore. The ship seems to have had a length of ca. 20 to 25 m. Coll. 1958 and subm. 1959 by L. R. Pettersen Jr., Bergens Sjøfartsmuseum, Bergen. No C^{13} analysis. *Comment* (L.P.): the C^{14} date, indicating a medieval ship, makes the find very interesting, and efforts will be made to preserve it.

T-240. Shipwreck at Skien, Oslofjord Av.: 1350 ± 80

Wood (oak) from a shipwreck at Skien, Böler, Oslofjord, Vestfold (59° 12′ N Lat, 09° 36′ E Long), Norway. The ship, which has a length of ca. 20 m, was found imbedded in sand at a depth of 20 m below sealevel. It was a clinker-built vessel, but was totally crushed by an excavating machine. Coll. and subm. 1959 by Svein Molaug, Norsk Sjøfartsmuseum, Oslo. *Comment*

(S.M.): we can see that the ship had crossbeams, and the ends of these crossbeams would have been visible at the outside of the ship. Such beams are only known from the medieval period, and this technique, together with other details, should indicate that the vessel was not older than ca. 550 yr. The result of the C^{14} dating is therefore surprising. *Comment* (R.N.): no C^{13} analysis made on the two (independent) samples, but the error from isotopic fractionation would hardly exceed 100 yr. On the other hand it is hard to believe that the material was ca. 1000 yr old when the ship was built. Other possible sources of error in the C^{14} measurement are considered negligible.

T-240A. **1400 ± 100**

T-240B. **1300 ± 100**

D. Canary Islands

T-195. Burial cave, Tenerife **Av.: 1330 ± 70**

Human bones from a burial cave at alt 2000 m in the mountain of Tenerife, Santa Cruz (28° 22′ N Lat, 16° 30′ W Long), Canary Islands. The dead bodies were placed upon stones and dark, carboniferous ground, sheltered against rain water. Well-preserved bones and parts of the mummies were found. Coll. 1955 and subm. 1959 by L. D. Cuscoy, Mus. Arqueologico de Tenerife.

T-195A. Human bones, carbonate fraction **1310 ± 80**

T-195B. Human bones, protein fraction **1380 ± 120**

Comment (L.D.C.): dating was undertaken in order to examine the first settlement of Tenerife, as no other reliable datings exist. It has been of special interest to get some knowledge of the burial rituals and social aspects of the "Guanches," the first citizens of Tenerife. *Comment* (R.N.): the two results are in statistical agreement, with a mean age of 1330 ± 70 yr. The age is probably correct, as it is very unlikely that the two fractions should have received the same degree of contamination. Pretreatment: washed only with distilled water; CO_2 released from carbonate with acid treatment (dilute HCl); protein fraction combusted afterwards in oxygen. δC^{13}: –18‰ and –23‰ for T-195A and B respectively.

III. SIBERIAN MAMMOTHS AND RHINOCEROS

Samples of six mammoths (*Mammonteus primigenius* (Blumb.)) and one rhinoceros (*Coelodonta antiquitatis* (Blumb.)), collected in frozen ground from different parts of North Siberia received from the Zoological Mus., Akad. Nauk, SSSR, Leningrad (mammoths) and from the Paleontological Mus., Akad. Nauk, SSSR, Moscow (Coelodonta), have been dated. The material consisted mostly of skin, partly of sinews, muscles, fat, and dry blood. The samples were sent to Norway for C^{14} dating by Dr. V. Garutt, Leningrad, and Prof. K. Flerow, Moscow and submitted to the laboratory 1959 and 1960 by Prof. A. Heintz, Paleontological Mus., Univ. of Oslo.

Results will be published by Garutt and Heintz in a joint paper in *Doklady Akademii Nauk SSSR*. In this publication all the more precise in-

formation about the discoveries, excavations, localities, imbedding, preservation, etc. will be given. Heintz (1958, p. 140) mentioned that various Russian scientists (Pitzenmayer, 1926; Vollosovich, 1915) have been of the opinion that the preservation of the mammoth carcasses up to the present day is due to the presence of fossil ground ice in Siberia. Probably the mammoths accidentally fell into cracks and thus rapidly became deep frozen. *Comment* (R.N.): some of the animals have been measured up to three times on different CO_2 gas prepared from the same species. Various pretreatments have been used, but some of the samples were mechanically purified and treated with 1 M HCl only. By remeasuring two samples (T-170 and T-299) which were more carefully pretreated, the ages turned out to be considerably higher than before. This could only be explained as a contamination effect of younger material (perhaps humic acid from the ground) in the samples. The official age of the animals is therefore in most cases given greater than a lower limit, which is determined with an accuracy of 2σ.

T-169. Mokovaja mammoth **>32,500**

Skin of mammoth found at river Mokovaja, Yenisei, Yakut ASSR. Skeleton and remains of skin and muscles were found. Coll. 1914 by Kotomov. *Comment*: two samples from separate combustion gave a mean age of 35,800 ± 2700 yr, perhaps due to contamination. Only HCl pretreatment was possible.

T-170. Sanga-Jurjak mammoth **>39,000**

Fat from mammoth found at the river Sanga-Jurjak, Yakut ASSR. Mammoth carcass and remains of skin and muscles were found. Coll. 1908 by K. A. Vollosovich. *Comment*: the original sample consisted of skin with fat and muscles, and the complex material gave a measurable age (31,500 ± 2000 yr) after treatment with 1 M HCl. The result above (>39,000) was obtained on the fat only, which was separated in a boiling process. There was, however, a lending of a small activity left in the fat (0.065 ± 0.030 counts/min), which corresponds to an age of 44,000 ± 3500 yr.

T-171. Lena mammoth **>33,000**

Skin of mammoth found on the Lena delta, Yakut ASSR (73° N Lat, 124° E Long). Skeleton and remains of skin, sinews, and muscles were found. Coll. 1799 by M. Adams. *Comment*: one of the first more or less complete specimens. A piece of the same specimen was dated by the Yale laboratory (Y-633, >30,000, Yale V). A measurable activity was found in the sample (Age: 35,800 ± 1200 yr), perhaps due to contamination. Only pretreatment with HCl.

T-172. Nochnoj rhinoceros **>38,000**

Skin of woolly rhinoceros found at the brook Nochnoj at river Elga in 1948. Only pretreatment with HCl.

T-297. Taimyr mammoth **11,450 ± 250**

Sinews of mammoth found on the Taimyr Peninsula at river Mamontova. Skeleton and remains of skin, sinews, hair, etc., were found in 1948 (Portenko

et al., 1954; Savich-Liubitskaja and Abramova, 1954). *Comment*: geologic conditions indicate that the mammoth lived in a warm postglacial time (Zaklinskaja, 1954).

T-298. Gyda mammoth **33,500 ± 1000**

Skin of mammoth found in river Gyda, Yakut ASSR (71° N Lat, 78° E Long). Skeleton with remaining skin and hair was found in frozen ground. Coll. 1864 by F. Schmidt. *Comment*: pretreatment with and without NaOH gave the same result, and the above age is probably correct.

T-299. Beresovka mammoth **>39,000**

Blood and fat from the stomach region of mammoth found at river Beresovka, Yakut ASSR (68° N Lat, 155° E Long). A complete carcass was found in frozen ground on a slope 35 m above water level of the river. Coll. 1901 by O. Hertz. *Comment*: (Heintz, 1958, p. 140) : during the excavation of the Beresovka mammoth (Pfitzenmayer, 1926) one could see that the animal had probably slipped into a crack and been badly injured, or perhaps killed instantaneously. Study of pollen and other plant fossils in the stomach contents (Kuprijanova, 1957; Salensky, 1904; Sukhachev, 1914; Heintz, 1958) suggested the animal had lived in a relatively warm period (6000 to 7000 B.P.) *Comment* (R.N.) : the dated sample was treated with both HCl and NaOH there was a tendency of a small activity left in the sample (0063 ± 0026 counts/min) which corresponds to an age of 44,000 ± 3500 yr.

References

Date lists:

Trondheim I Nydal, 1959
Trondheim II Nydal, 1960
Yale V Stuiver, Deevey, and Gralenski, 1960

Blindheim, Charlotte, 1960, Kaupangundersökelsen etter 10 år: Viking, v. 24, p. 43-68.

———— 1960, The marketplace in Skiringssal. Early opinions and recent studies: Acta Archaeologica, København, v. 31, p. 88-100.

———— 1960, New Light on Viking Trade in Norway: Archaeology, v. 13, no. 4, p. 275-278.

———— 1961, Handelsplasser: Kulturhistorisk Leksikon for nordisk middelalder [Oslo], v. 4, p. 133-138.

Blindheim, Charlotte, Hougen, Ellen-Karine, and Skaare, Kolbjörn, 1960, Fra Kaupanggravningen 1959: Univ. Oldsaksamling årb. 1958-1959 [Oslo], p. 78-119.

Brögger, W. C., 1901, Om de senglaciale og postglaciale nivåforandringer i Christianiafeltet: Norges geol. undersøkelse no. 31, 732 p.

Bröndsted, Johannes, 1957, Danmarks Oldtid, v. 1, 2. edit., 408 p. Printed by Gyldendal, København 1957.

Craig, Harmon, 1954, Carbon 13 in plants and the relationship between Carbon 13 and Carbon 14 variation in nature: Jour. Geology, v. 62, p. 115-149.

———— 1961, Mass-Spectrometer analyses of radiocarbon standards: Radiocarbon, v. 3, p. 1-3.

Faegri, Knut, 1940, Quartärgeologische Untersuchungen im westlichen Norwegen; II, Zur spätquartären Geschichte Jaerens: Bergens Mus. Åarb. 1939-1940, naturv. rekke, no. 2, no. 7, 202 p.

Feyling-Hanssen, R. W., 1957, Micropaleontology applied to soil mechanics in Norway: Norges geol. undersøkelse no. 197, p. 5-67, (or Norges Geotekn. Inst., Pub. no. 20, p. 5-70) [Oslo].

Gabrielsen, G., 1959, A marine transgression of Boreal Age in the southernmost part of Norway: Nature, v. 183, p. 1616.

Gaustad, Fr., 1962, Report in Vidensk. Selsk. Oldsaksamling: [Trondheim], in press.
Hagen, Anders, and Martens, Irmelin, 1961, Arkeologiske undersøkelser langs elver og vann: Norske Oldfunn, ser. 10, [Oslo], p. 79 [95 p.].
Hafsten, Ulf, 1957, Pollen-analytic investigation on the late Quaternary development in the inner Oslofjord area: Bergen Univ. Årb. 1956, naturv. rekke no. 8, 163 p., 16 pls.
Heintz, A., 1958, Om pollenanalyse av mageinnholdet fra Beresovkamammuten: Blyttia, v. 16, p. 122-142 [English summary].
Holtedahl, Olaf, 1953, Norges geologi, v. 2: Norges geol. undersøkelse no. 164, p. 587-1090.
———— 1960a, Marine deposits of the Oslofjord-Romerike district: Geology of Norway, Norges geol. undersøkelse, no. 208, p. 374-389.
———— 1960b, Remarks on some western and northern parts of Norway: Geology of Norway, Norges geol. undersøkelse no. 208, p. 409-416.
Kolderup, C. F., 1908, Bergensfeltet og tilstötende trakter i senglacial og postglacial tid: Bergens Mus. Aarb. 1907, no. 14, p. 1-268 [German summary, p. 240-256].
Kuprijanova, L. A., 1957, Pollen analysis of plant fragments found in the stomach of the Beresovka-mammoth. In Russian: Botan. Inst. Akad. Nauk SSSR [Moscow-Leningrad] 1957, 359 p.
Marstrander, Sverre, 1948, Innberetning om befaring i Skaun, Börsa i Sör-Tröndelag: Report in Vidensk. Selsk. Oldsaksamling [Trondheim], topog. arkiv, 2 p.
———— 1956-1957, Radiocarbon dating of archaeological material: Kgl. Norske Vidensk. Selsk. Årb. 1956-1957, p. 113-125.
Marthinussen, Marius, 1945, Yngre postglaciale nivåer på Varangerhalvøya: Norsk geol. tidsskr., v. 25, p. 230-265.
———— 1960, Coast- and fjord area of Finnmark etc.: Geology of Norway, Norges geol. undersøkelse no. 208, p. 416-429.
———— 1961, Brerandstadier og avsmeltningsforhold i Repparfjord-Stabbursdalområdet etc., Finnmark: Norges geol. undersøkelse Årb. 1960, no. 213, p. 118-169.
Möllenhus, K. R., 1960, Befaring av trebrolegning på Röd, Börsa, Sör-Tröndelag: Report in Vidensk. Selsk. Oldsaksamling [Trondheim], topog. arkiv, 2 p.
———— 1961, Oldsaksamlingens tilvekst 1959: Kgl. Norske Vidensk. Selsk. Årb., p. 119.
Nutt, D. C., 1959, Recent studies of gases in glacier ice: Polar Notes, no. 1, p. 57-66. [Dartmouth College, Hanover, New Hampshire].
Nydal, R., 1959, Trondheim natural radiocarbon measurements I: Am. Jour. Sci. Radioc. Supp., v. 1, p. 76-80.
———— 1960, Trondheim natural radiocarbon measurements II: Am. Jour. Sci. Radioc. Supp., v. 2, p. 82-96.
Östrem, G., 1960, Ice melting under a thin layer of moraine, and the existence of ice cores in moraine ridges: Geog. Annaler XLI [1959], p. 228-230.
———— 1961a, Breer og morener i Jotunheimen: Norsk geog. tiddskr., v. 17, p. 210-243 [English summary].
———— 1961b, Ice-cored moraines in the Kebnekajse area: Biuletyn Peryglacjalny, no. 11.
Öyen, P. A., 1906, Skjaelbanker i Kristianiatrakten: Nyt mag. for naturvidenskaberne, v. 44, p. 81-93.
Pfitzenmayer, E. W., 1926, Mammutleichen und Urwaldmenschen in Nordost Sibierien: Leipzig.
Portenko, L. A., Tikhomirov, B. A., and Popava, A. I., 1954, The first results from the excavation of the Taimyr-mammoth etc.: Zool. Shur. SSSR, v. 30, p. 3-16 [in Russian].
Rekstad, J., 1916, Skjaelforekomst ved Lutvatn i Östre Aker: Norsk geol. tidsskr., v. 3, no. 10, p. 1-5.
———— 1921, Eidsberg: Norges geol. undersøkelse no. 88, p. 5-76.
Reusch, Hans,1904, Nogle notiser fra Sigdal og Eggedal: Norges geol. undersøkelse no. 7, p. 37.
Rosendahl, H., 1937, Nogen nyere norske kvartaergeologiske funn: Norsk geol. tiddskr., v. 16, p. 293 [1 p.].
———— 1942, Glasialfossil og kvartaergeografi: Norsk geol. tidsskr., v. 22, p. 203-209.
Salensky, W. W., 1904, Über die Hauptresultate der Erforschung des im Jahre 1901 am Ufer Beresovka entdeckten männlichen Mammutcadavers: Internat. Zool. Cong., 6th, Bern 1904, Comptes rendus.
Savich-Liubitskaja, L. I., and Abramova, A. L., 1954, Fossil mosses in the region of the Taimyr mammoth excavation: Moskva, Bot. Zhur., v. 39, no. 4, p. 594-603 [in Russian].

Scholander, P. F., a.o., 1961, Radiocarbon age and oxygen[18] content of Greenland icebergs: Meddelelser om Grönland, v. 165, no. 1.

Skaare, Kolbjörn, 1960, Vikingtidsmynter fra Kaupang-en handelsplass ved Oslofjorden: Nordisk Numismatisk Unionsblad, December 1960, v. 10, p. 195-197.

Simonsen, Povl., 1958, Recent research in East-Finnmark Stone Age: Riv. Scienze Prehistoriche [Firenze], v. 13, no. 1-4, p. 134-138.

———— 1959a, Tromsö Mus. Ärsberetn., p. 45-48.

———— 1959b, Varanger-Funnene I, Tromsö Mus. Skr., v. 7, no. 1, p. 10-13.

———— 1961, Varanger-Funnene II: Tromsö Mus. Skr., v. 7, no. 2, p. 160-169.

Stuiver, Minze, Deevey, Edward S., and Gralenski, J. L., 1960, Yale natural radiocarbon measurements V: Am. Jour. Sci. Radioc. Supp., v. 2, p. 49-61.

Sukhachev, V. N., 1914, Examination of plant remains from the food of the mammoth, discovered on the Beresovka-river, Jakutsk District: Nauchnye result. eksped. snar. Akad. Nauk dlja raskopki mamonta najd. por. Beresovka, v. 1903, p. 3, [in Russian].

Vollosovich, K. A., 1915, Mammoth from the Bolshoy Ljakhovskij Island, New Siberian archipelago: Sap. Imp. Miner. Obsh., ser. 2, 50 [in Russian].

Zaklinskaja, E. D., 1954, The question of vegetation at the time the Taimyr-mammoth lived: Akad. Nauk SSSR Doklady, v. 98, no. 3, p. 741-774 [in Russian].