[AMERICAN JOURNAL OF SCIENCE RADIOCARBON SUPPLEMENT, VOL. 1, 1959, P. 76-80]

TRONDHEIM NATURAL RADIOCARBON MEASUREMENTS I.

R. NYDAL

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

The C^{14}-dating Laboratory in Trondheim has now been working for one year and a half. The present dating list covers the period from July 1957 to September 1958. The rather small number of datings made during this period is due to a lot of background experiments which have been carried out in the last half-year.

With a few exceptions the datings done before the period mentioned have been previously published (Marstrander, 1956-1957; Nydal and Sigmond, 1957; Skjelsvik and others, 1957-1958).

INTRODUCTION

Apparatus.—The counting apparatus used in carrying out the datings is almost the same as that described by Nydal and Sigmond (1957). The counter characteristics can be summarized as follows: The proportional counter has an effective volume of about 45% of the total volume of 6.3 liters. Normally the counter is filled with pure CO_2, at either one or two atmospheres. At two atmospheres the background was 13.2 counts/min and the net count of recent carbon was 30.5 counts/min. The variation of the background with barometric pressure was about 0.2 counts/min per cm Hg.

The counter background has now been reduced to about one-half of what it was when the datings were done. Further, the variation of the background with barometric pressure is now about 0.05 counts/min per cm Hg. The improvements were obtained by making a closed shell of shielding tubes (Reath, Sevold and Pederson, 1951) in metal. It appeared that about one-half of the earlier background was due to mesons penetrating through gaps between the Geiger tubes. We had earlier expected that a great deal of the background was due to γ-radiation from the glass tubes, but by adding an extra layer of Geiger tubes we were surprised to find that radiation from the Cintel glass tubes increased the background negligibly.

Pretreatment of the samples.—Wood samples are all treated in the same way: treatment with 0.25 M HCl in order to remove carbonates and with 0.25 M NaOH in order to remove humic acid.

Samples of peat and gyttja are treated with HCl only, in order to remove carbonates. Some of the samples contained rootlets of possible younger age. These samples were mixed with water and filtered on a wire screen having a pore size of about 4 mm^2; large particles, including rootlets, were retained by the screen, and the filtrate was then dried and combusted for the C^{14} measurement.

The only shell sample (T-50) which appears in this list was washed and surface-treated for 2 min. with 0.5 M HCl.

Calculation.—The statistical error (σ) given for each dating is the standard deviation calculated from the counted particles. The calculated σ agrees

well with the σ measured from interval countings. Interval counting is possible by use of a camera, taking one exposure each hour during the entire counting period. The measured σ is also a check on the stability of the electronic apparatus, which has proved to be very good.

All datings are corrected for barometric pressure and radon content, but not for fractionation error. The C^{14} half-life which is used here is 5568 years. The standard deviation of this half-life, $\pm$ 30 years, is not included in the standard deviation of the dating results.

Our sample of recent carbon is a wood sample, 50 years old. This sample was chosen in order to avoid the error that arises from later disturbances of the C^{14} content of the atmosphere by industry and by the atomic bomb.

The date list is based on information furnished by those who submitted the samples.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Sweden

T-55. Angelsta, Småland **2560 ± 70**

Hewed stub of fir, found at a depth of 3.5 m in Rya Moor, Angelsta, Småland (59° 49′ N Lat, 13° 43′ E Long), Sweden. The dating result given here represents tree rings No. 101 to 150 from the core. Subm. 1955 by H. G. Östlund, Geological Survey of Sweden, Stockholm. *Comment*: the sample from Angelsta is used for cross-checking. Tree rings No. 1 to 50 have been dated by the C^{14} Laboratory of Stockholm (St-13, 2560 ± 190; Östlund, 1957) and by Lamont Geological Observatory (L-296, 2600 ± 80; Broecker and Kulp, 1957).

B. Norway

T-50. Bjorelv-terrace, Troms **10,500 ± 400**

Shells from the Bjorelv-terrace in Lenvik at Gisund, Troms (69° 20′ N Lat, 7° 20′ E Long), Norway. The shells were found in beds of fine sand in a gravel pit, about 10 m below the top of a marine terrace, alt. about 55 m. The Bjorelv-terrace is glaciomarine, deposited in front of the glacier that formed the Tromsö-Lyngen moraines. Coll. 1957 and subm. by B. G. Andersen, Department of Geology, University of Oslo; the C^{14} dating was done by R. S. Sigmond. *Comment*: suggested age by the submitter: between 10,900 and 10,300 yr.

T-53. Blinnfinnvan, Troms **10,720 ± 240**

Lacustrine dy and gyttja from the base of a peat bog, 4 m deep, at Blinnfinnvan near Bröstad, Troms (69° 5′ N Lat, 7° 0′ E Long), Norway. The peat bog lies between two end moraines of the Tromsö-Lyngen glacial substage, and the older of the two end moraines therefore must be older than the peat bog. Coll. 1957 and subm. by B. G. Andersen, University of Oslo. *Comment*: suggested age by the submitter: between 10,900 and 10,300 yr. He gives the following comment on the dates T-50 and T-53: "The Tromsö-Lyngen moraines are the most prominent terminal moraines in northern Norway, and they are usually correlated with the Ra-moraines which are the most prominent terminal

moraines in southern Norway (Vogt, 1913). The Ra-moraines correspond to the central Swedish moraines in Sweden and the Salpausselkä moraines in Finland, and their age lies between 10,300 and 10,900 years (Fromm, 1953)."

Halse and Hartmark series, Vest-Agder

Peat from a bog lying about 2 m above sealevel in the inner part of the Hartmarksfjord in Halse and Hartmark district, Vest-Agder (58° 2′ N Lat, 7° 38′ E Long), Norway. The peat was collected from the upper and lower layers of the 1.5-m-deep bog, which lay between layers of marine clay. Coll. 1957 and subm. by Gunnar Gabrielsen, Department of Geography, University of Oslo. *Comment*: the growth of the bog lasted for 640 ± 240 yr. The submitter suggests that a marine transgression has taken place, and is still working with this problem.

T-80. Peat from upper layer **8770 ± 100**

T-81. Peat from lower layer **9410 ± 220**

T-87. Maleröd-tjern, Vestfold **9090 ± 230**

Gyttja from the lake Maleröd-tjern, Brunlanes, Vestfold (59° 5′ N Lat, 10° 0′ E Long), Norway. The lake is situated about 124 m above sealevel; the sample was collected from a depth of 7.69 to 7.80 m, just above the contact between underlying and overlying lacustrine sediments. Coll. 1957 and subm. by Kari Egede Larssen, Geological Survey of Norway, Oslo. *Comment*: Pollen-analytic dating (done by the submitter) : Early Boreal time.

T-88. "Tjönna", Solum, Vestfold **8710 ± 280**

Gyttja from the lake "Tjönna", Solum, Brunlanes, Vestfold (59° 5′ N Lat, 9° 50′ E Long), Norway. The lake is situated 62 m above sealevel; the sample was collected from a depth of 7.05 to 7.20 m, just above the contact between underlying marine and overlying lacustrine sediments. Coll. 1957 and subm. by Kari Egede Larssen, Geological Survey of Norway, Oslo. *Comment*: pollen-analytic dating (done by the submitter) : Late Boreal time.

T-90. Napperöd-tjern, Vestfold **4980 ± 160**

Clay-gyttja from the lake Napperöd-tjern, Sandar, Vestfold (59° 10′ N Lat, 10° 10′ E Long), Norway. The lake is situated 32 m above sealevel; the sample was collected from a depth of 3.35 to 5.55 m, just above the contact between underlying marine and overlying lacustrine sediments. Coll. 1957 and subm. by Kari Egede Larssen, Geological Survey of Norway, Oslo. *Comment*: pollen-analytic dating (done by the submitter) : Near the transition between Atlantic and Sub-boreal times. The submitter gives the following comment on samples T-87, T-88, and T-90: "The pollen-stratigraphic results are part of a pollen-analytic investigation from Vestfold, southwestern part of the Oslofjord region, and they have not yet been published. Until now there have been no other C^{14} dates of pollen-analytic material from Norway, but the results correspond very well with Swedish ones (Lundqvist, 1957). With the work of Hafsten (1957) from the inner Oslofjord region, there is full pollen-analytic correspondence. His absolute chronology is based on that of Fries (1951), which is again based on G. de Geer's method. The age determinations of the

material from Vestfold by the C^{14} method are in good correspondence with the chronological system built up by the said authors."

T-92. Limestone, near Larvik **>31,000**

Stromatolitic limestone from the small island Malmö, in Tjölling near Larvik (59° 1′ N Lat, 10° 6′ E Long), Norway. The limestone forms plates 1 in. to a few in. thick, on vertical rocks. It is found just above sealevel, rarely as much as 12 m above sealevel. It is dark gray, hard, and concentrically layered. Chemical composition: 90% $CaCO_3$, 1 to 2% $MgCO_3$, 0.5% organic; remainder, Fe, Al, Si. It is supposed to have been precipitated by microorganisms in the sea. It resembles the stromatolites (Höeg, 1929, 1934) which have been found in all geologic periods back to the Precambrian. Plates of this type from the Quaternary have been found only in Scandinavia, however, and there only in a few places. Coll. 1957 and subm. by Ove Arbo Höeg, Department of Geology, University of Oslo. *Comment*: the lower limit for the age of the limestone, 31,000 yr, is here given with a probability of 66%. There is a 95% probability of a greater age than 27,000 yr.

T-98. Smestad by Oslo **7200 ± 270**

Wood from the bottom of a sandpit about 57 m above sealevel in Smestad, Baerum, N of Oslo (59° 55′ N Lat, 10° 28′ E Long), Norway. The sample, consisting of small pieces of wood, was compressed and lying in a humus-rich layer, limited by sand above and by clay below. Coll. 1957 and subm. by Jul Låg and Tollef Ruden, The Norwegian Forest Research Institute, Vollebekk. *Comment*: sample was mixed with rootlets of possible younger age, and these were carefully picked away during the pretreatment of the sample. Comment from the submitters: "Possibilities for a Tapes transgression are under investigation."

II. ARCHAEOLOGIC SAMPLES

A. Norway

T-37. Oseberg Viking Ship, Vestfold **1190 ± 60**

Oak from the burial chamber in the Viking ship of Oseberg, Slagen, Vestfold (59° 20′ N Lat, 10° 26′ E Long), Norway. The ship was found in a tumulus 44 m in diameter and originally 6 m high. Subm. 1956 by A. M. Rosenqvist, The University Museum of National Antiquities, Oslo. *Comment*: the historical age of the ship and the earliest of the other wooden objects is about 1160 yr (about A.D. 800). The most recent objects, and thus the burial and the chamber, are younger by about 50 yr (A.D. 850), or possibly a little more.

Raknehaugen series, Akershus

Pine and birch wood from Raknehaugen, Ullensaker, Akershus (60° 9′ N Lat, 11° 11′ E Long), Norway. Raknehaugen is a tumulus 95 m in diameter and 15 m high. The mound was partially excavated in 1869-1870; excavation was completed in 1939-1940. It contained about 10,000 logs, three samples of which are dated here. All of them are from different timbers. Coll. 1939-1940 by Sigurd Grieg, De Sandvigske Samlinger, Lillehammer. Samples T-82 and

T-83 subm. 1957 by Björn Hougen, The University Museum of National Antiquities, Oslo; T-86 subm. 1957 by Kristofer E. Ganer. *Comment*: a lot of work has been done by archaeologists (Lorange, 1870; Grieg, 1941; de Geer, 1937; Ording, 1941) in order to determine the age of Raknehaugen, but the question of the historical age has until now remained unsolved. Grieg (1941), who excavated the mound in 1939-1940, said, however: "Everything suggests that the mound was built in 6th cent. A.D., but I am willing to admit that it cannot be proved."

T-82.	**Pine**	**1430 ± 80**
T-83.	**Pine**	**1410 ± 75**
T-86.	**Birch**	**1430 ± 80**

References

Broecker, W. S., and Kulp, J. L., 1957, Lamont natural radiocarbon measurements IV: Science, v. 126, p. 1324-1334.

Fries, Magnus, 1951, Pollenanalytiska vittnesbörd om senkvartär vegetationsutveksling, särskilt skoghistoria i Nordvästra Götaland: Acta Phytogeographica Suecica, no. 29, 220 p.

Fromm, Erik, 1953, Nya C^{14}-dateringar av Allerödtiden: Geol. fören. Stockholm förh., v. 75, p. 403.

de Geer, E. Hult, 1937, Raknehaugen: Univ. Oldsakssamling Årb. 1937 [Oslo], p. 27-54.

Grieg, Sigurd, 1941, Raknehaugen: Viking, v. 5, p. 1-28.

Höeg, Ove Arbo, 1929, Studies in stromatolites: Kgl. Norske Vidensk. Selsk. Skr. 1, 60 p.

———— 1934, Studies in stromatolites: Kgl. Norske Vidensk. Selsk. Skr. 3, p. 1-10.

Hafsten, Ulf, 1957, Pollen-analytic investigation on the late Quaternary development in the inner Oslofjord area: Univ. Bergen Årb. 1956, naturv. rekke no. 8, 163 p., 16 pls.

Lorange, A., 1870, Fra Raknehaugen: Forhandlinger i Videnskabs-Selskabet i Christiania 1870 [Oslo], p. 472-480.

Lundqvist, Gösta, 1957, C^{14} analyser i svensk kvartärgeologi 1955-57: Sveriges geol. undersökning, ser. C, no. 557; Årsb. 51, no. 8, 25 p. [English summary, p. 22-24].

Marstrander, Sverre, 1956-1957, Radiocarbon dating of archaeological material: Kgl. Norske Vidensk. Selsk. Årb. 1956/57, p. 113-125.

Nydal, Reidar, and Sigmond, R. S., 1957, Radiocarbon dating in Trondheim: Appl. Sci. Res., sec. B, v. 6, p. 393-400.

Ording, Asbjörn, 1941, Skoghistoriske analyser fra Raknehaugen: Norsk Skogforsöksvesen Medd., no. 27, p. 91-130.

Östlund, H. G., 1957, Stockholm natural radiocarbon measurements I: Science, v. 126, p. 493-497.

Reath, C. H., Sevold, B. J., and Pederson, C. N., 1951, A multiple-anode anticoincidence ring counter: Rev. Sci. Instruments, v. 22, p. 461-463.

Sjövold, Torleif, 1957, Osebergfunnet og de andre vikingskipsfunn: Oslo, printed by J. Pelitz (Rolf Rannem).

Skjelsvik, Elisabeth, Rosenqvist, I. Th., Larssen, Kari Egede, and Sigmond, R. S., 1957-1958, A wooden causeway in Båsmyr on Freberg in the county of Vestfold: Viking, v. 21-22, p. 103-140.

Vogt, J. H. L., 1913, Om to endemoraenetrinn i det nordlige Norge: Norsk geol. tidsskr., v. 2, no. 11, p. 1-46.