

## GRONINGEN <sup>14</sup>C DATA BASE

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### INTRODUCTION

Since May 1952 the Isotope Physics Laboratory in Groningen has dated ca 13,000 <sup>14</sup>C samples. Due to lack of time the publication of date lists in *Radiocarbon* ceased in 1971 and probably will not be resumed in the standard way. Most dates have been published but they are scattered over a great variety of books and articles.

The administration of these dates has become voluminous to such an extent that specific requests about dates can only be answered with great difficulty or cannot be dealt with at all. It is because of these practical considerations, though stimulated by the reigning “Zeitgeist,” that our laboratory has recently set up a computerized data system. The computer programming has been carried out by the first author, and the second, an archaeologist, is translating data from the old forms to the present format and storing the dates.

The objective of this operation is to increase the accessibility of our archives, rather than to replace them. Crucial to the program is the search mode, which enables the researcher to retrieve, in a very short time, groups of dates on a certain subject (eg, period, country), or individual dates lacking exact information. The system has its limits, however. A record contains enough information to identify a certain date, but will, in many cases, be inadequate to reveal its significance.

Once the data have been retrieved from the database system, further details (eg, forms, correspondence, drawings, pollen diagrams) can be found in the conventional files. A search is only effective if the data are stored systematically, *ie*, in a limited number of categories. Since May 1985 we began using a new submission form (Fig 1) to meet the needs of the computer program. It forces the submitter, at least partly, to choose from printed alternatives, instead of giving extraneous and subjective descriptions. Our earlier forms had to be more or less interpreted.

In the future new submitters will get the results of their samples in a printed “date list” (Fig 2) with comments from the laboratory.

### HARDWARE

The system consists of an Apple IIe microcomputer equipped with an 80 Columns Text Card and 64 kBytes extra RAM (auxiliary) memory. The computer is connected to a 10 mByte hard disk manufactured by ICE (Independent Computer Engineering). A backup copy of the contents of the hard disk can be made on a tape streamer, also manufactured by ICE. We use the UCSD operating system, version II.1, and Apple Pascal, version I.1, and Assembler programming languages. The Pascal version is unable to address the 64 kByte auxiliary memory in our system, so this area is exclu-

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Sample nr

GrN-  
GrU-

DO NOT USE THIS SPACE

## RADIOCARBON SAMPLE INFORMATION

COPIES NOT ACCEPTED

SUBMITTER, NAME ..... CODE:  
INSTITUTE .....  
Address .....  
Telephone ..... Date of submission .....

SAMPLE NAME  
(geographical or site name + serial number) .....

SAMPLE LOCATION: country/sea ..... Date of collection

province/district ..... day month year

town/lake/mountain/region ..... Collector's name

Geographical coordinates vs. Greenwich ..... Lat. .... E/W Long

Local coordinates (for Netherlands only) .....

SAMPLE DESCRIPTION (to clarify next heading, if appropriate) ..... WEIGHT g/l

**MATERIAL TO BE DATED**

<input type="checkbox"/> wood	<input type="checkbox"/> peat	<input type="checkbox"/> bone	<input type="checkbox"/> carbonate
<input type="checkbox"/> charcoal	<input type="checkbox"/> organic deposit	<input type="checkbox"/> charred bone	<input type="checkbox"/> marine shells
<input type="checkbox"/> (charred) seeds	<input type="checkbox"/> lake sediment	<input type="checkbox"/> pottery	<input type="checkbox"/> mar. sediment
<input type="checkbox"/> POC	<input type="checkbox"/> gyttja	<input type="checkbox"/> mortar	<input type="checkbox"/> DIC
	<input type="checkbox"/> DOC	<input type="checkbox"/> fresh-w.shells	<input type="checkbox"/> other (see above)

**OTHER CONSTITUENTS**

<input type="checkbox"/> sand	<input type="checkbox"/> clay	<input type="checkbox"/> carbonate
<input type="checkbox"/> roots	<input type="checkbox"/> humics	<input type="checkbox"/> preservatives
<input type="checkbox"/> other: .....		

**CONTEXT OF SAMPLE** (provide sketch overleaf)

<input type="checkbox"/> sediment	<b>Layer</b> <input type="checkbox"/> upper
<input type="checkbox"/> burial	<input type="checkbox"/> middle
<input type="checkbox"/> settlement	<input type="checkbox"/> lower
<input type="checkbox"/> unknown	<input type="checkbox"/> other: .....
	<input type="checkbox"/> whole

**POSITION OF SAMPLE**

A. Depth below surface .....	m/below sea floor .....
B. above / below NAP .....	m/Local ordnance datum .....

**TYPE OF INVESTIGATION**

<input type="checkbox"/> exposure (natural/man-made)	<input type="checkbox"/> boring
<input type="checkbox"/> (archaeol.) excavation	<input type="checkbox"/> isolated sample
<input type="checkbox"/> other: .....	

**FIELD OF STUDY**

<input type="checkbox"/> Archaeology	<input type="checkbox"/> Geology	<input type="checkbox"/> Palaeobotany	<input type="checkbox"/> Pedology	<input type="checkbox"/> Food/drinks
<input type="checkbox"/> Hydrology	<input type="checkbox"/> Marine geology	<input type="checkbox"/> Pollution	<input type="checkbox"/> Calibration	<input type="checkbox"/> Atmosphere
<input type="checkbox"/> Oceanography	<input type="checkbox"/> Limnology	<input type="checkbox"/> Geochemistry	<input type="checkbox"/> other: .....	

**ASSOCIATION (Pre)historical**

<input type="checkbox"/> Palaeolithic	<input type="checkbox"/> Mesolithic	<input type="checkbox"/> Neolithic	<input type="checkbox"/> Bronze
<input type="checkbox"/> Iron	<input type="checkbox"/> Roman	<input type="checkbox"/> Medieval	<input type="checkbox"/> (Sub)recent

**Stratigraphical**

<input type="checkbox"/> Early glacial	<input type="checkbox"/> Pleniglacial	<input type="checkbox"/> Late Glacial	<input type="checkbox"/> Holocene
<input type="checkbox"/> Preboreal	<input type="checkbox"/> Boreal	<input type="checkbox"/> Atlantic	<input type="checkbox"/> Subboreal
<input type="checkbox"/> Subatlantic	<input type="checkbox"/> Subatlantic		
<input type="checkbox"/> Basis Peat	<input type="checkbox"/> Calais	<input type="checkbox"/> Holland Peat	<input type="checkbox"/> Dunkerque

Unknown

Other: ..... **EXPECTED AGE**

<sup>14</sup>C: ..... years BP/hist: ..... AD/BC

Fig 1A. Present submission form

**SIGNIFICANCE OF SAMPLE** (problem to the solving of which the date should contribute)

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**DETAILS ABOUT POSITION OF SAMPLE WITHIN SITE** (grid)

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**RELATED INFORMATION**

(GrN-numbers of dates on same site)

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**REFERENCES TO LITERATURE**

(please provide reprints)

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**SKETCH** with scale and position of sample (provide sketch or pollendiagram on separate sheet if necessary).

Fig 1B. Reverse side of form

sively handled by our Assembler routines. We use this memory area to store and run most of the Assembler routines and to store large sets of data.

#### DATABASE PROGRAM

One of the main tasks in designing a data base is to define the contents of the records to be stored. In our case this was based on the existing material in our "paper" files and in conformity with our present submission form. We asked the users of our laboratory for their advice on this which resulted in the standardized submission form (Fig 1), to be filled in by submitters of  $^{14}\text{C}$  samples. This form was used to define the contents of the records used by the Pascal program. By carefully inputting in Pascal, the size of a single "data" record can be reduced to 256 bytes, which corresponds to the size of half a block (in Pascal, data are written to a disk in blocks of 512 bytes). However, not all information is contained in such a record. Obviously most institutions will submit more than one sample at a time. Thus, information about institutions is stored in memory and with its location on the disk indicated on each record. The same is true for data on the sampling site. The size of the "institution" records is 256 bytes, and the size of the "location" records is 64 bytes. Since an integral number of records is stored in one disk block, the position of individual records on the hard disk is known and the records can be accessed very rapidly using the Pascal low order I/O routines UNITREAD and UNITWRITE. With this set-up the hard disk is able to store information on 20, 480 dates.

In the sample information form (Fig 1) there are various places where a keyword must be filled in. Although keywords are also standard for the

- 
- GrN-6126 Hijkerveld 1970, no. 94b** **3970 # 35 BP**  
(–26.36)  
Beilen/Drenthe/Netherlands  
Charcoal from excavation, dating Neolithic burial. Treatment: acid/alkali/acid. Dated fraction: organic residue.  
Submitted by A.E. Lanting & O.H. Harsema (BAI)
- GrN-6152 Buinerveld** **3945 # 35 BP**  
(–26.36)  
Borger/Drenthe/Netherlands  
Charcoal from excavation, dating Neolithic burial. Treatment: acid. Dated fraction: organic residue.  
Submitted by J.D.v.d. Waals & J.N. Lanting (BAI)
- GrN-10544 Usselerveen (extr.)** **11330 # 160 BP**  
(–27.01)  
Enschede/Overijssel/Netherlands  
Peat from exposure, dating Late Glacial sediment. Taken from lower section of layer. Treatment: acid/alkali/acid. Dated fraction: organic extract.  
Submitted by J.de Jong (RGD)  
Comment: Alkali extract of same sample as GrN-10246. Influence of younger infiltration seems to be small.
- GrN-10246 Usselerveen (res.)** **12170 # 60 BP**  
(–26.88)  
Enschede/Overijssel/Netherlands  
Peat from exposure, dating Late Glacial sediment. Taken from lower section of layer. Treatment: acid/alkali/acid. Dated fraction: organic residue.  
Submitted by J.de Jong (RGD)  
Comment: Supposed to date Denekamp interstadial, but sample appears to be of Late Glacial age (Bølling interstadial).
- 

Fig 2. A sample date list. The first two records are standard. Comments are added to the other two records.  $\delta^{13}\text{C}$  values are given in parentheses. Only the two comments are edited.

computer records, we leave space to fill in a new keyword if required. Storing the keywords within the records as free text consumes too much space on the hard disk. Therefore, eight lists of standard keywords are maintained by the program on the hard disk. Each of these lists can contain up to 256 keywords as well as abbreviations for each keyword (keycodes) of up to four characters. The keywords are stored in the records as indicators to the proper position in the appropriate list. Apart from efficiency in using disk

```

VIEW : screens:{0..5} Dial Next Previous Substract Hardcopy Return
-----
GrN      12266                Sample Nr      7728                Screen Nr 0
Submitter      J.N.Lanting                Inst. code  BAI
Sample name    Eext 1983:4
-----
Country        Netherlands
Material 1     charcoal
----- 2
Context of sample  burial
Position - depth      L0.5                -0.6
- altitude
Investigation    excavation
Pre association  Bronze Age
Post association
Chemical treatment acid/ alkali/ acid
Delta 13 C      -25.91
Final C14 activity 63.99                #0.24
Final age B.P.   3585                  #30
Communication date 30/05/84

```

```

VIEW : screens:{0..5} Dial Next Previous Substract Hardcopy Return
-----
GrN      12266                Sample Nr      7728                Screen Nr 1
Submitter      J.N.Lanting                Inst. code  BAI
Sample name    Eext 1983:4
-----
Submitter      J.N.Lanting
Collector      S.W.Jager
Institute code BAI
Institute      Biologisch-Archaeologisch Instituut
Street         Poststraat 6
City           9712 ER Groningen
Country        Nederland
Telephone      050-636712

```

```

VIEW : screens:{0..5} Dial Next Previous Substract Hardcopy Return
-----
GrN      12266                Sample Nr      7728                Screen Nr 2
Submitter      J.N.Lanting                Inst. code  BAI
Sample name    Eext 1983:4
-----
Sample name    Eext 1983:4
Date of collection 7/11/83
Country / Sea   Netherlands
Province / District Drenthe
Town / Region   Anlo
Geogr. coords  % ' "                % ' "
Local coords   X = +245.60 Y = +560.50
Material 1     charcoal
----- 2
Context of sample  burial
Layer
Position - depth      L0.5                -0.6
- altitude

```

Fig 3. Search procedure step by step. See text example.

```

VIEW : screens:(0..5) Dial Next Previous Substract Hardcopy Return
-----
GrN      12266                Sample Nr      7728                Screen Nr 3
Submitter      J.N.Lanting                Inst. code BAI
Sample name    Eext 1983:4
-----
Type of investig.  excavation
Field of study   archaeology
Pre association  Bronze Age
Post association
Remark          barrow w.ring-ditch
Expected age B.P.      3400
Final age B.P.        3585                #30
Final C14 activity   63.99                #0.24
Communication date   30/05/84
Comment          No

```

```

VIEW : screens:(0..5) Dial Next Previous Substract Hardcopy Return
-----
GrN      12266                Sample Nr      7728                Screen Nr 4
Submitter      J.N.Lanting                Inst. code BAI
Sample name    Eext 1983:4
-----
Dated material   organic residue
Chemical treatment acid/ alkali/ acid
% C / org.fraction  68.0
% C / sample     17.9
Measured C14 act.  63.87                #0.24
Enrichment
Delta C13        -25.91
C13 / O18
Model age B.P.
Final C14 activity  63.99                #0.24
Final age B.P.    3585                #30

```

```

VIEW : screens:(0..5) Dial Next Previous Substract Hardcopy Return
-----
GrN      12266                Sample Nr      7728                Screen Nr 5
Submitter      J.N.Lanting                Inst. code BAI
Sample name    Eext 1983:4
-----
counter        date
Measurement 1      6      15/02/84
Measurement 2      6      18/02/84
Measurement 3
Measurement 4
Measurement 5
Measurement 6
Measurement 7
Measurement 8

```

Fig 3. Cont'd

space, standard keywords can also be used to check for typing errors and to avoid problems during a search.

#### DATA RETRIEVAL

Retrieving records of particular interest to a user is one of the main tasks of the database program. Searching for a single item (eg, range of ages, particular keyword) in all 20,480 records of the database files, takes about four minutes. The time needed to search for an item within a record is considerably shorter than the time needed to load a record, which almost solely entails loading the records from the hard disk into the computer memory. By limiting the number of records that have to be loaded, the time needed for searching is proportionally reduced. In order to limit the searching time, we have used the concept of the Pascal set-type. Our set-type should consist of 20,480 members (all records on the completely filled hard disk), whereas in Apple Pascal, a set can only have a maximum of 512 members. Therefore, instead of a set a packed array of boolean is declared within the program, the size of which is equal to the above-mentioned number. Whenever an element of such an array has the value TRUE, the record with number equal to the index value of that element is present in the set, otherwise it is absent. Procedures simulating the set operations (union, intersection, and set difference) as defined in the Pascal language, are written in Assembler. Additional procedures and functions serve to perform other actions on these sets (eg, clearing, determining the number of records present in a set). The program user is provided with ten different "user sets" which can be named (for reference), used to store results from searches, and to combine different sets by applying the set operations. There are also 32 "standard sets" maintained by the program. These can be (re)defined by the operator with a special subroutine. Standard sets can be copied into the user sets, but no operations can be carried out with them in the area of the standard sets (except updating). Searching takes place within the members of a particular set to be chosen from one of the user sets. The result of the search is written into another set. By selecting suitable sets, the user can thus limit the number of records that have to be loaded from the hard disk in order to be able to determine whether or not records satisfy certain selection rules. The user sets as well as the standard sets are too large to be resident as variables within the program. Thus, they are stored on the hard disk and loaded into the program only when needed. However, throughout the program one particular set is always resident, the so-called "date-list set." This can be filled by the user who can then look at individual members of the set, remove members, and finally produce a date list from all members of this particular set. In a future expansion of the program, this set may be used to do statistical calculations with members of the date-list set, etc.

#### USE OF THE DATA-BASE PROGRAM

At the start of the program, the user provides his name and code. The code determines which parts of the program are accessible to the user, preventing outsiders from changing the files. However, users are allowed to

view, search for records, and choose from several options which are displayed in a “Prompt-line” on top of the screen. These options are:

**VIEW:** Displays records. The information in a record is too long to be shown on a single screen, so that the display is divided into several screens which the user can choose at any time. There are six similar screens as shown in Figure 3. The user can also choose a new record to be displayed, either the next or the previous record in the date-list set, or a particular GrN number. It takes ca 0.3 seconds to load a new record and to display screen 0. Displaying another screen from an already loaded record takes <0.1 second.

**CHANGE:** To enter new or to change existing records. The records are shown to the user in exactly the same way as in the *VIEW* option. The user can edit information on any screen, except screen 0, that is only provided as a quick reference. The format in which information must be supplied is indicated in the prompt-line.

**LISTKEYS:** Displays the existing keywords and keycodes on either the printer or the screen. Also a list of institutions can be made.

**KEYWORDS:** To enter or change keywords and keycodes.

**DATELIST:** Prints a date list of the records contained in the date-list set (Fig 2). The user can choose between a list, generated automatically by the computer, or a list that can be edited, record by record. With the latter comments may be added to the date list, as is usual in *Radiocarbon* date lists.

**SEARCH:** To search the data files for particular keywords, dates, ages, names, etc. Details of this option are described in the previous section.

**UPDATE:** To update the contents of the standard search sets after entering/changing new records.

#### EXAMPLES

A geologist may be interested in a survey of dates of the so-called Denekamp interstadial (ca 29,000 to 32,000 BP) in the Netherlands. There are several ways to retrieve the relevant records. It is possible, eg, to search all records with the designation, “Denekamp,” resulting in 17 records. Besides the fact that half of these records turn out to be of considerably younger or older age, it is evident that there must be several useful dates which were not “labeled” at all or which were supposed to date other

```
SEARCH:[Age,Key,Word,Date]  Clear Transfer Get Operations Standard-list  Return
0      KEY: burial                574
1      KEY: charcoal             1587
2      burial/charcoal           418
3      bur/charc/Drenthe         130
4      bur/charc/Drenthe/Neolithic  37
5      bur/charc/Dr/Neol/36-4400  26
6      bur/charc/Dr/36-4400      36
7      set 5 or 6                10
8      .....
9      complete database         5296
```

Fig 4. Displays showing information contained by one record. Screen 0 is an automatically produced summary.

events (eg, Alleröd or Hengelo interstadials). To be sure that no such record is neglected, the best approach is to search all records with Dutch dates within certain age limits, *ie*, 26,000 to 35,000 BP. The result of this procedure is 35 records, giving a more reliable picture of <sup>14</sup>C dates on this geologic period. The user set includes, eg, two archaeological samples—prehistoric human activity can also be indicative of climatic amelioration!

An archaeologist may take an interest in an account of Late Neolithic burials in the province of Drenthe (northern Netherlands), as recorded by dates of charcoal samples. In this case it is preferable to narrow the scope step-by-step (Fig 4), first by combining some standard sets (step 0 to 2), then by subsequently searching keywords and age limits. As in the previous example, it might be useful to create an “age limit” user set, to check the reliability of the pure “Neolithic” set (set 7 shows the non-common dates). The whole procedure takes less than five minutes, the actual computer time being only a fraction of that (<1 minute).

The last step is examining the records (view mode), to delete dates of minor interest and to print a list of the remaining records (Fig 2). This list is in the format of a standard date list for *Radiocarbon*.

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