The Radiocarbon Dating of String from Gr11Q9/1 and 2

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Chapter Five B

Appendix

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In July 2015 two small pieces of linen string were taken from items Gr11Q9/1 and 2 respectively and were sent to the Centre for Isotope Research, Groningen University, for radiocarbon dating. A second test was completed in 2016 on string from Gr11Q9/1 in order to verify the results, as part of the run of tests done on the textiles from the cave (see Van der Plicht *et al.* in this volume).

1. Radiocarbon methodology

Before the actual ^{14}C measurement, the sample materials have to be chemically pretreated in order to isolate the datable fraction, and to remove contaminants. The routine treatment of samples consists the so-called "AAA" treatment: Acid-Alkali-Acid.[1]

Both linen samples Gr11Q9 however were too delicate to undergo this full treatment; this would dissolve all material. In such cases the cleaning is limited to "A", only one gentle acid bath (4% HCl at room temperature).

After the chemical pretreatment, the samples are combusted into CO_2 by an Elemental Analyzer (EA), coupled on-line with a stable isotope Mass Spectrometer (MS). The EA is also used for purifying the CO_2; the MS provides precise measurements of the $\delta^{13}C$-values.

Subsequently, the CO_2 is reduced to graphite by reacting under excess H_2 gas.[2] This graphite is then pressed into target holders which are placed in the ion source of the AMS (Accelerator Mass Spectrometer). The Groningen AMS facility is based on a 2.5 MV accelerator, and measures the ^{14}C concentration in the graphite.[3]

The results are reported in conventional Radiocarbon years (BP), which includes correction for isotopic fractionation and usage of the conventional half-life[4].

1. M.G. Mook and H.J. Streurmann, "Physical and Chemical Aspects of Radiocarbon Dating," in W.G. Mook and H.T. Waterbolk (ed.), *Proceedings of the First International Symposium ^{14}C and Archaeology, Groningen 1981* (PACT 8; Strasbourg: Council of Europe, 1983) 31-55.

2. A.T. Aerts-Bijma, J. van der Plicht, and H.A.J. Meijer, "Automatic AMS Sample Combustion and CO_2 Collection," *Radiocarbon* 43/2A (2001) 293-8.

3. J. van der Plicht et al., "Status Report: The Groningen AMS Facility," *NIM B* 172 (2000) 58-65.

4. W.G. Mook and J. van der Plicht, "Reporting ^{14}C Activities and Concentrations," *Radiocarbon* 41/3 (1999) 227-39.

The ^{14}C dates (reported in BP) are calibrated into calendar ages using the presently recommended calibration curve IntCal13. [5] Both results (Gr11Q9/1 and Gr11Q9/2) are practically the same. Assuming they represent the same event, they can be averaged with result 200 ± 40 BP.

The calibration yields many possibilities between 1650 AD and modern times, because the natural ^{14}C content is strongly varying for this timeframe. Formally, the result is 1655-1680, 1740-1805, and 1935-1955. All numbers quoted here are rounded to the nearest 5, at 1-sigma (68.2%) confidence.

5. P.J. Reimer et al., "IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years cal BP," *Radiocarbon* 55/4 (2013) 1869-87.

The calibration is shown in the Figure. The ^{14}C timescale is plotted vertically, the calendar timescale horizontally. The (averaged) ^{14}C date is plotted in red; the calibration curve is the blue line. In grey is the probability distribution of the calibrated ^{14}C dates.

Given the surprising results for the researchers, it was decided to run a second radiocarbon test on string from Gr11Q9/1 in 2016. The same process was followed in regard to this test, and the results were very similar (see Figure 2). All three dates (Gr11Q9/1, 9/2 and again 9/1) yield the same date within error. The averaged result for the three is 220 BP with a measurement error of 30 (number rounded to 5). This means that the 14C measurement must be correct, there are no mistakes (like mixing up samples, wrong chemistry, wrong normalisation, etc). The linen string is sub-recent.

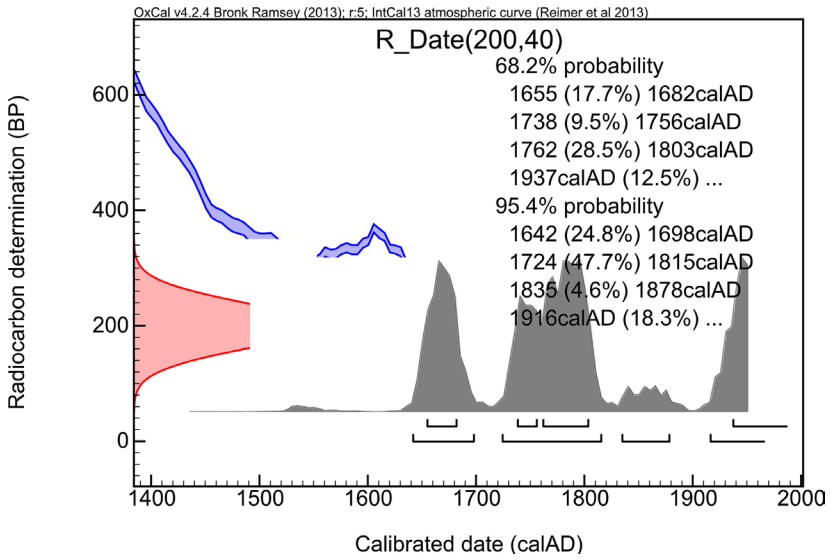

Fig. 1

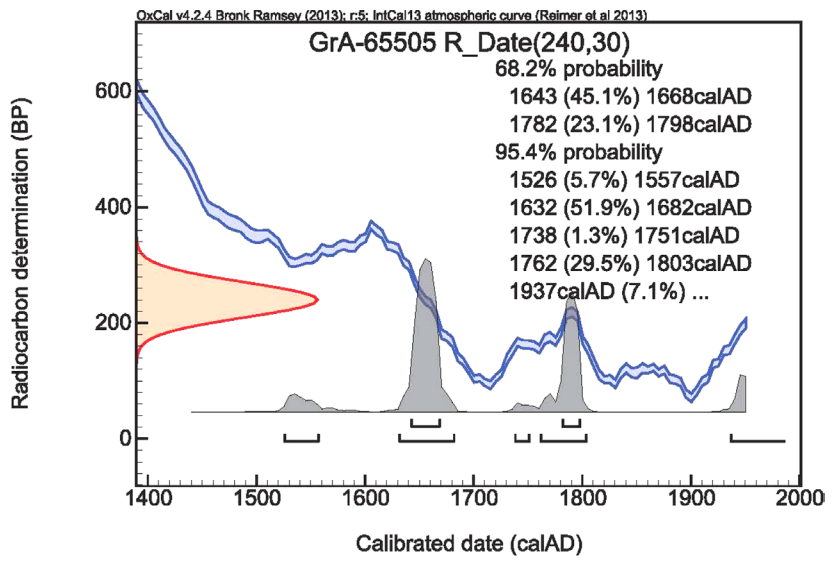

Fig. 2