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Revisiting Quanterness: new AMS dates and stable isotope data from an Orcadian chamber tomb

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ABSTRACT

A total of 20 new AMS radiocarbon determinations on human bone have been obtained for the Neolithic chamber tomb of Quanterness, Orkney. The results show poor agreement with the recorded stratigraphy, suggesting extensive mixing of the chamber deposits. A Bayesian model treating all of the determinations as deriving from a single phase of activity provides a start date in the range 3510–3220 cal BC *(most probably falling after* 3450 cal BC*), with the main phase of burial activity ending in the range* 2850–2790 cal BC *(95.4% probability). This presents a tighter range than previously available, but nevertheless appears to confirm the longevity of burial activity at the monument. Osteologically, there is no convincing evidence for excarnation, and the representation of the small bones of the hands and feet, together with the absence of sub-aerial weathering, make it unlikely that the bulk of the human bone assemblage was brought in from elsewhere, as had previously been suggested. Stable carbon and nitrogen isotope measurements average –20.5 ± 0.4‰ and 11.1 ± 0.6‰ respectively, indicating no appreciable consumption of marine protein despite the site's location less than 1km from the coast. There are tentative but intriguing diachronic trends in both isotopes, with* $\delta^{13}C$ *values decreasing, and* $\delta^{15}N$ *values increasing through time; this could suggest changing farming practices, though the details remain unclear. The dating and the palaeodietary findings are discussed within the context of Middle/Late Neolithic Orkney, emphasising the former's relevance to debates concerning the origin of Maes Howe-type passage tombs and the appearance of Grooved Ware. The radiocarbon dates support the view that Grooved Ware emerged as a novel pottery tradition in Orkney between* c *3300/3200 and* c *3100 BC.*[1]

INTRODUCTION

The Quanterness chamber tomb[2] is a key site for the Orcadian Neolithic. This stems from its excavation in 1972–4 to modern standards, its comparatively undisturbed state, and the sheer size of its human bone assemblage (Chesterman 1979; Renfrew 1979). Nevertheless, the importance of periodically re-visiting older excavations has been repeatedly demonstrated (eg Lawrence 2006). As part of a general re-analysis of the human bone assemblage from Quanterness that is being undertaken by one of the authors (RC),

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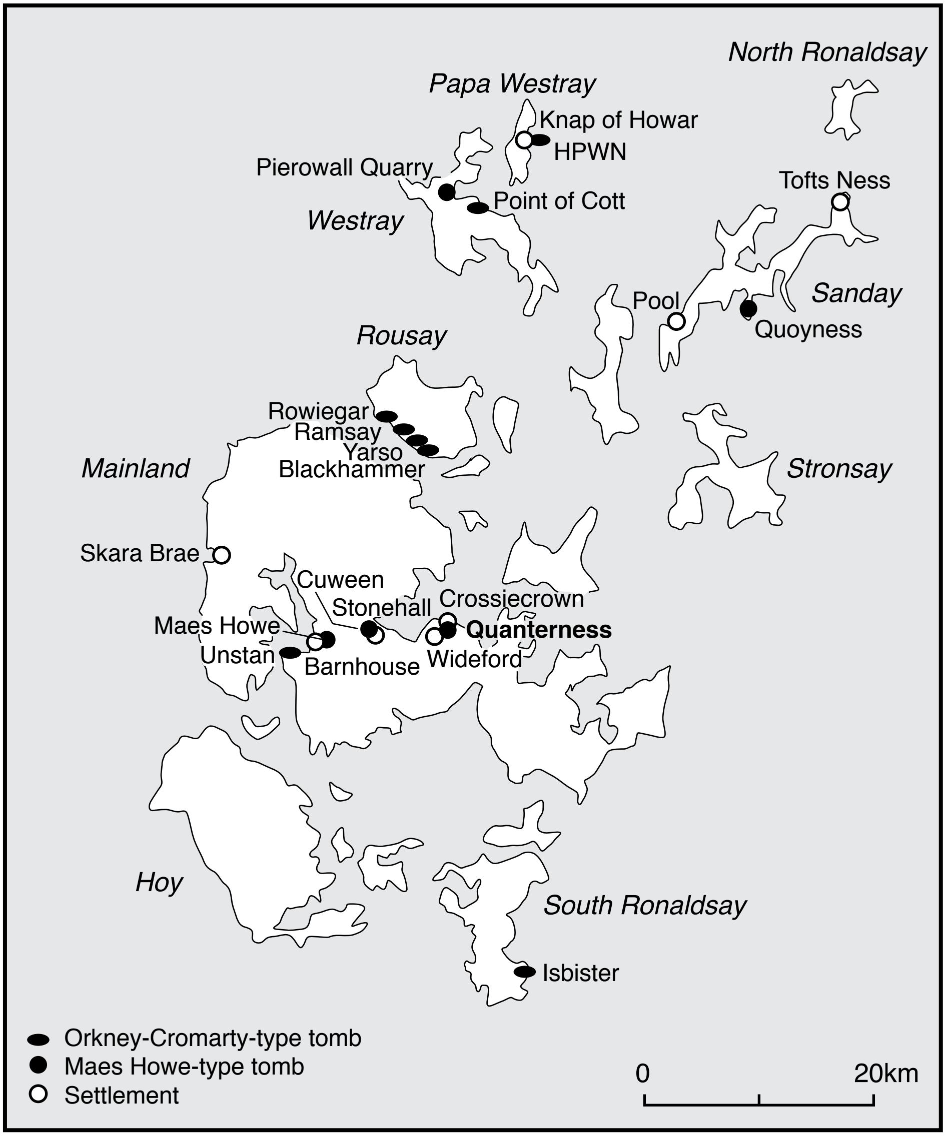
20 AMS radiocarbon dates were obtained on human bone to refine the chronology of the monument's funerary use. In conjunction with the dating programme, stable carbon and nitrogen isotope analyses were also undertaken. The results of this project are reported here, and placed within the wider context of Neolithic Orkney. Quanterness is important in this context, since it is the most informative example of a Maes Howe-type (or Quanterness–Quoyness type) passage tomb in Orkney (Renfrew 1979: 201–2; Davidson & Henshall 1989), with a large human skeletal assemblage as well as a sizeable amount of Grooved Ware pottery (Henshall 1979: 75–9). The chronological and cultural relationship between Maes Howe-type and Orkney–Cromarty (O–C)-type chamber tombs, and their associated pottery assemblages, has long been of interest and debate, with Renfrew having argued, for example, that the Maes Howe/Quanterness–Quoyness passage tombs started to be built several centuries after the O–C tombs (and their local variants, the Orcadian stalled cairns), with a 'transitional period' between 3300 and 3000 BC when both types of chamber tomb were in concurrent use (Renfrew et al 1976; Renfrew 1979: 208–12; see also Henshall 1985; Davidson & Henshall 1989: 85–94, who envisaged two separate cultural groups co-existing from the late 4th millennium and through the first half of the third). While few would challenge the idea that O–C tombs started to be built several centuries before the earliest Maes Howe-type passage tombs, the chronology of the funerary and ceramic traditions remains imprecisely known, as does the degree of overlap that might exist (Ashmore 1998; Cowie & MacSween 1999; Ashmore 2000). More widely, there are questions concerning the possible links between Orcadian and Irish passage tombs, particularly those of the Boyne Valley, that also depend on the availability of a good chronology (cf Eogan 1986; Sheridan 1986; 2004a; 2004b; Renfrew 2000; Bradley 2010).

A series of conventional radiocarbon determinations on human bone is, of course, already available for Quanterness (Table 2, illus 8; Renfrew et al 1976; Switsur & Harkness 1979). This dating programme was exemplary for its time, and innovative in its sampling strategy, including duplicate analyses of the same individuals by three different laboratories. But, while a total of nine determinations were made,[3] these derive from only four individuals, as well as a sample of 'organic soil' from the chamber. In addition, Ashmore et al (2000) suggest that the error terms for these dates, as well as those from Isbister and a number of other Orcadian chamber tombs, should be increased to a minimum of ±110 years to reflect a more realistic degree of uncertainty in the results from what were essentially still the early days of radiocarbon dating. Error terms for two determinations have been increased to *c* ±150 years, at which point they would simply be rejected by many archaeologists today. Even if retained, the calibrated age ranges they provide are so large as to cover a period of 700 to 800 years. Therefore, a new dating programme for Quanterness seemed warranted, particularly given advances in radiocarbon dating, comprising the advent of accelerator mass spectrometry (AMS), far greater precision (ie smaller error terms), and, most recently, the application of Bayesian modelling (Buck et al 1991; 1994; 1996; Bayliss et al 2007; Bayliss & Whittle 2007; Bronk Ramsey 2009a; b; Bayliss & O'Sullivan in press; Schulting et al forthcoming).

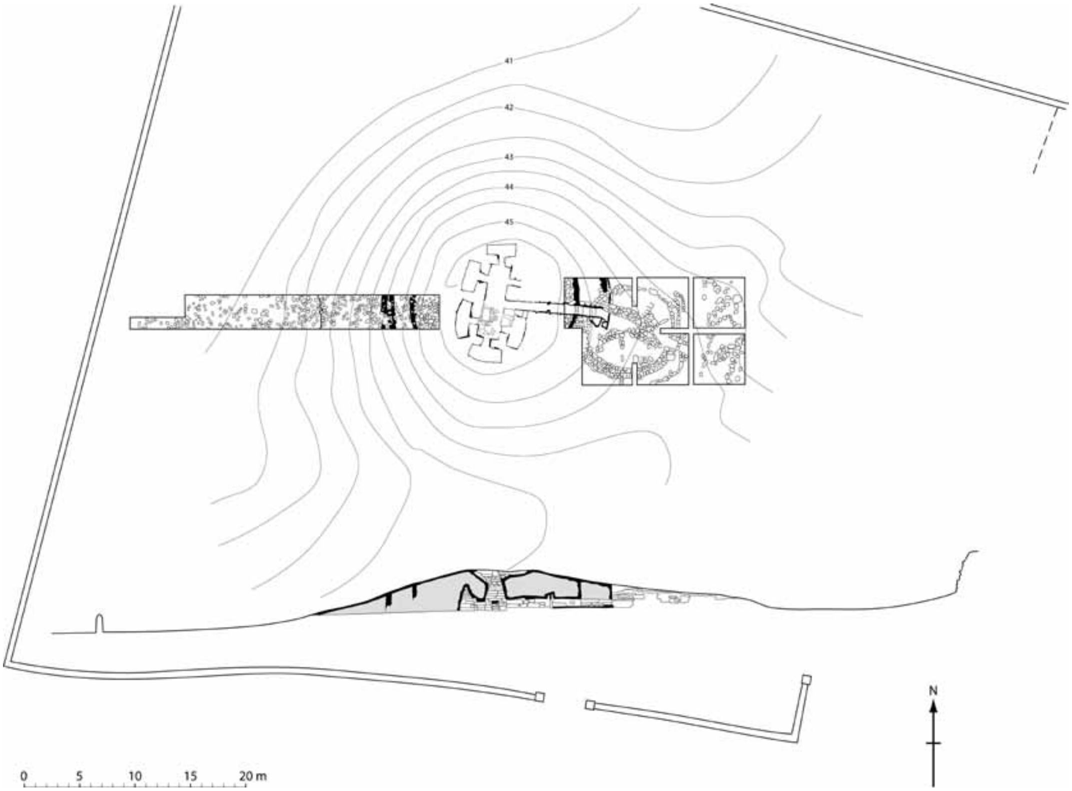
SITE SUMMARY

Quanterness is located on Mainland, Orkney, on the lower slopes of Wideford Hill some

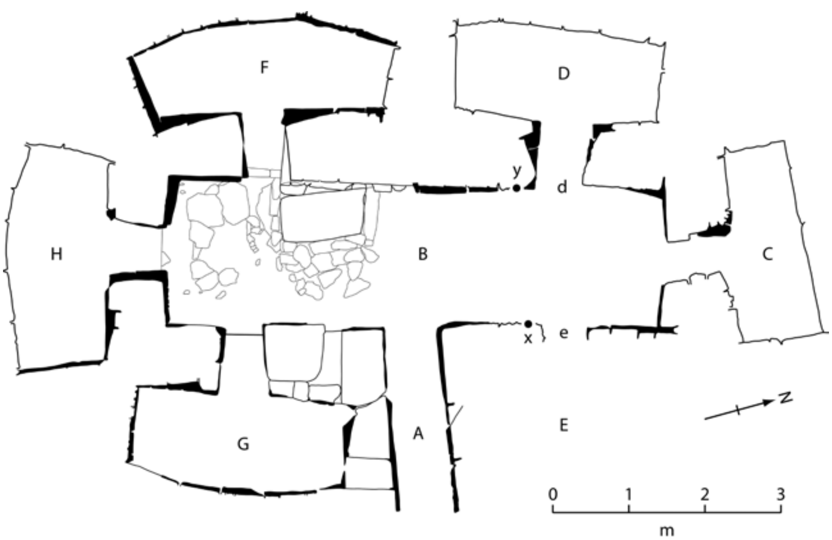


Illus 1 Map of Orkney showing locations of sites mentioned in the text

800m from the south shore of the Bay of Firth (NGR: HY 4177 1292) (illus 1). It is one of nine at least partially excavated examples in the Maes Howe group of passage tombs, designated Quanterness–Quoyness by Renfrew (1979: 201–2) to avoid using the exceptional Maes Howe as the type-site. A passage leads to a rectangular central chamber with six side cells opening off a corbelled central space (illus 2 and 3). The enclosing circular stone cairn measures some 30m in diameter, with a surviving height of 3.2m, though its placement on a natural eminence gives the impression of a



Illus 2 Plan of the Quanterness chamber tomb (after Renfrew 1979: fig 17)



Illus 3 Detail of the chamber (after Renfrew 1979: fig 28)

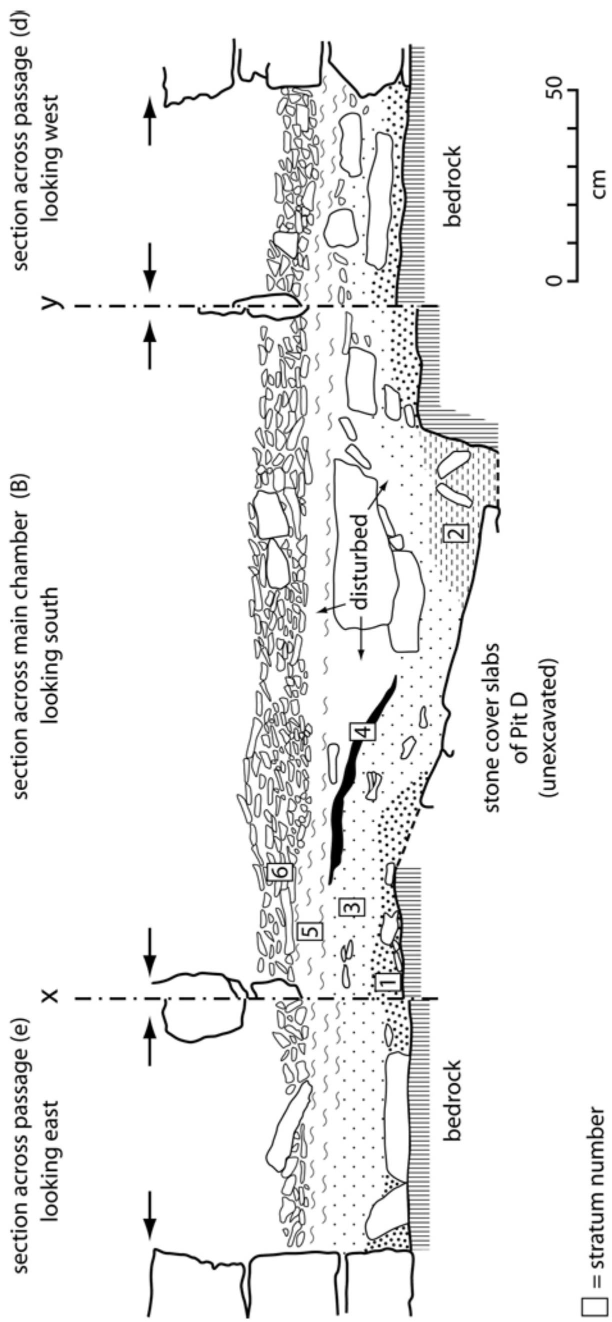
much larger and more imposing monument. Despite this, it is actually not the most prominent location locally, which is a rocky escarpment occupied by the current Quanterness farmhouse (Renfrew 1979: 45). This topographic position is echoed at the other Maes Howe-type passage tombs nearby at Cuween and Wideford Hill (albeit at a somewhat higher altitude).

An initial brief exploration by Barry (1805) is thought to have resulted in relatively minor disturbance of the burial deposits. Unlike many other prominent Neolithic monuments in Orkney and elsewhere, the site apparently then remained largely untouched until Renfrew's excavations in 1972–4, one of the main goals of which was to obtain samples for radiocarbon dating (Renfrew et al 1976; Renfrew 1979: 45). Excavation was to a high standard, with all finds larger than a few centimetres being point-plotted; all sediments from within the tomb were water-sieved through a 2mm mesh and the resulting finds recorded to a 50cm grid square (Renfrew 1979: 50). The stratigraphic sequence for the main chamber as recorded by Renfrew (1979: tab 4, fig 20) is provided in Table 1 and illus 4. A similar, though not identical, sequence was recorded for the single excavated south-west side-chamber.

A substantial quantity of disarticulated human remains was recovered during the excavations at Quanterness. Chesterman (1979) estimated that a minimum number of 157 individuals were represented in the main chamber (where the main bone layer was 0.3m thick), the single excavated side chamber and the passages, making the human bone assemblage one of the largest known from Neolithic Britain. Using Chesterman's figure, and extrapolating from the proportion of the tomb excavated (80% of the main chamber, and one of the six side chambers) it was suggested the tomb may have held as many as 400 individuals. However, the way in which Chesterman derived the figure of 157 is problematic. Rather than assess the minimum number of individuals (MNI) from the site as a whole, he totalled a series of MNI values derived from the excavated main chamber, the south-west side-chamber, the entrance passage and the forecourt. Given the degree of fragmentation and commingling throughout the tomb, this is an unreliable way of determining the true MNI. Furthermore, the MNI values for the individual areas are

Table 1
Stratigraphic sequence in main chamber of Quanterness (after Renfrew 1979: table 4)

Stratum 1	Deposits immediately on bedrock, cut in places by pits/cists
Stratum 2	3 pits/cists cut into bedrock (Pits A, B and cist D (not excavated)), pre-dating deposition of main bone spread
Stratum 3	Stony deposit, part of the main bone spread
Stratum 4	Main bone spread, usually above a recognisable stone surface
Stratum 5a	Collapse from chamber decay and latest burials; post-dates bone spread
Stratum 5b	Below 6, but localised post-Neolithic disturbance. Includes Pit C
Stratum 6	Rubble. 19th- and 20th-century artefacts and recent disturbance



Illus 4 Section through the deposits in the main chamber (after Renfrew 1979: fig 20)

in turn a total for Chesterman's 'Adult', 'Teenager', 'Child' and 'Infant' categories (all from different elements) (Chesterman 1979: 98). In addition, the current re-examination of the remains has raised queries concerning the accuracy of Chesterman's ageing techniques, casting further doubt on the accuracy of his MNI values even within each part of the monument. A similar issue with Chesterman's approach to the determination of MNI values has been highlighted recently by Lawrence (2006: 55) for the Neolithic chamber tomb at Isbister, where again calculations were based on the sum of the MNI values from each chamber (Chesterman 1983).

The human remains from Quanterness were highly fragmented and far from complete, leading Chesterman (1979) to suggest that the bodies had been excarnated elsewhere, with the bones then being gathered up and brought into the tomb. Colin Richards (1988) subsequently modified this interpretation to suggest that 'ancestral' remains from earlier monuments elsewhere on the island/s were being taken to Quanterness. However, as with Chesterman's MNI calculations, closer examination indicates that his interpretation of excarnation is also contentious (cf Barber 1988; Davidson & Henshall 1989: 58; Reilly 2003). Currently, the accepted archaeological signature for bodies which have been exposed includes the following features: bones that display signs of interference by animals (gnawing,

Illus 5 Human maxilla and tooth from Quanterness (small find no 2105) showing rodent gnawing (photo: Rebecca Crozier)

TABLE 2
Previously published radiocarbon results from Quanterness (recalibrated using IntCal 09: Reimer et al 2009, and including revised standard error estimates) (from Renfrew et al 1976)

Context	*Strat*	*Material*	*Lab. no*	*^{14}C yrs*	*±*	*Range cal BC (95%)*	*rev ±*	*Range cal BC (95%)*
III	1	'organic soil'	Q-1294	4590	75	3626–3031	110	3635–3013
Pit A	2	R & L tibia	SRR-754	4360	50	3308–2887	110	3363–2680
Pit A	2	humerus	Pta-1626	4300	60	3097–2698	110	3336–2620
Pit A	2	R & L femur	Q-1479	4170	75	2908–2502	110	3019–2471
Pit A comb	2	above 3 combined		4302	35	3000–2886		3090–2670
main chamber	3	L femur	Q-1363	4540	110	3620–2922	155	3635–2902
main chamber	3	L femur	Q-1451	4110	100	2912–2368	140	3079–2234
Pit C	5	L radius	Pta-1606	4130	60	2884–2500	110	3009–2350
Pit C	5	L tibia	Q-1480	3905	70	2574–2152	110	2849–2037
Pit C	5	R femur	SRR-755	3870	55	2476–2149	110	2832–1983
Pit C comb	5	above 3 combined		3970	36	2577–2348		2836–2235

splintering and scattering); weathering; and/or disarticulation and incompleteness in terms of skeletal representation, in particular the absence of smaller bones such as phalanges (Carr & Knüsel 1997: 170; Baxter 1999). Despite arguing for excarnation, Chesterman (1979: 102) originally noted that there were no signs of animal damage on the human remains. However, the current reanalysis has identified very occasional evidence of rodent gnawing (illus 5). While this is usually considered as evidence for exposure, such an interpretation applies more clearly to remains that are subsequently inhumed (and hence no longer accessible, at least to non-burrowing rodents). The architecture of chamber tombs provides continued access to bones by rodents, as is evident from the presence of numerous Orkney vole remains in the main chamber at Quanterness (Corbet 1979). Taking the second criterion, and contra Chesterman (1979: 102), there is little evidence of sub-aerial weathering on the human skeletal assemblage, which also argues against excarnation – unless this occurred within a covered space, for example another tomb. (There is, incidentally, also only limited evidence for burning on the human remains, contra Chesterman's findings; while a small number of elements do show clear charring, the more abundant small 'black spots' to which Chesterman refers (ibid) are geochemical in origin.) Finally, and most importantly, preliminary results of the ongoing re-examination of the assemblage indicate that every skeletal element from the human body is represented at Quanterness. This includes very small distal phalanges (finger/foot bones) and delicate hyoid bones, elements that are often difficult to recover during the excavation of complete skeletons, and would almost certainly be missing from remains representative of an excarnation process.

The impression of excarnation given by the scattered and incomplete nature of the assemblage could be the result of taphonomic processes occurring within the tomb itself, through repeated entry and associated trampling, particularly as this also seems to have involved the introduction of many large stones (cf Barber 1988; Reilly 2003; Beckett & Robb 2006). This is not to deny that some cultural selection and removal of specific elements, such as crania, may also have occurred (Richards 1988; Jones 1998), although this needs to be seen in the context of the incomplete excavation of the monument, particularly as only one of the six side chambers was fully excavated, and at Isbister it was here that many of the crania – an element underrepresented in the Quanterness assemblage – were found (Hedges 1983; Reilly 2003).

The artefactual finds, described by Audrey Henshall (1979; cf Davidson & Henshall 1989, 152–4), comprise a large amount of pottery (6.6kg) and a small assemblage of flint, stone, bone and antler artefacts. Almost all were found in the main chamber, most frequently in the area near the inner end of the passage; the exceptions are a flint scraper from the passage itself, two flint chips from the south-west cell, a rubber from a saddle quern plus a bone point made from a cormorant ulna, found in the north cell, and a bone tool from the north-west cell. The pottery all belongs to the Grooved Ware tradition, with at least 34 individual vessels represented, possibly many more. The sherds were found in all the strata but mainly in 3 and 4; joining sherds from the same pots were found in strata 2–5, 3–5 and 1/3/4/5 respectively, indicating post-depositional disturbance (and consistent with the impression given by the skeletal remains discussed below). Vessel forms appear to be flat-based and tub- and bucket-shaped, either with straight walls (as in Pots 1–3:

Henshall 1979: figs 33.1–3) or walls that curve in gently towards the rim (eg Pot 6a: ibid: fig 33.6a). The fabric varies, although most sherds contain abundant angular stone fragments, deliberately added as filler, with thick slip covering the exterior if not also the interior surface; a few pots had contained non-lithic inclusions which had burnt or dissolved out (see Henshall 1979: 75, 77 for details). Petrological analysis concluded that at least 12 of the vessels had been brought in from outside the Quanterness area, and showed that the non-lithic inclusion in two pots was shell (Williams 1979). Most of the sherds are undecorated but where decoration is present it includes not only incision and impression (as in Pot 2's horizontal and chevrony incised lines (ibid: fig 33.2); and Pot 8b's incised triangle filled with stabbed dots (ibid: fig 34.8b) but also applied cordons and pellets (as in Pot 1's chevrony slashed cordon above a horizontal grooved cordon (ibid: fig 33.1); Pot 3's plain sub-rim horizontal cordon (ibid: fig 33.3); and Pot 4's horizontal and sloping cordons interspersed with pellets (ibid: figs 33.1, 3, 4)). The Grooved Ware *comparanda* for the Quanterness vessels will be discussed below. Henshall noted that many sherds had been burnt and many of these had sooty accretions on the exterior, suggesting that they had been used for cooking prior to their deposition.

The lithic finds (ibid: fig 35, nos 26–50) included fragments of at least three ground flint knives (all scorched), three flint scrapers, several flakes, blades and chips of flint and chert, a 'pot lid' of thin bedded sandstone, at least one hammerstone and a saddle quern rubber fragment. A small bead made of lead ore is unique in the choice of material, although its form is paralleled at Skara Brae; as Henshall (1979: 81) pointed out, lead ore was available not far from Quanterness, so this seems to represent an adventitious use of local material, rather than any precocious knowledge of metal. The small bone and antler assemblage (ibid: fig 35, nos 52–8) comprises parts of two pins, one probably of dog bone; three bone points, including the aforementioned example made from a cormorant ulna; a fish vertebra bead; and a fragment of a red deer antler hammer or macehead.

THE ORIGINAL RADIOCARBON DATING PROGRAMME

Renfrew et al (1976; see also Switsur & Harkness 1979) reported conventional radiocarbon dates on human bone from three contexts: Pit A (cut into bedrock and covered with stone slabs) (illus 6), the overlying 'main bone spread' (illus 7), and Pit C, a shallow pit dug into the main burial layer and seen as referring to the final prehistoric deposits (Table 1). In addition, there is a

Illus 6 Crouched inhumation in Pit A (from Renfrew 1979: Plate XIb)

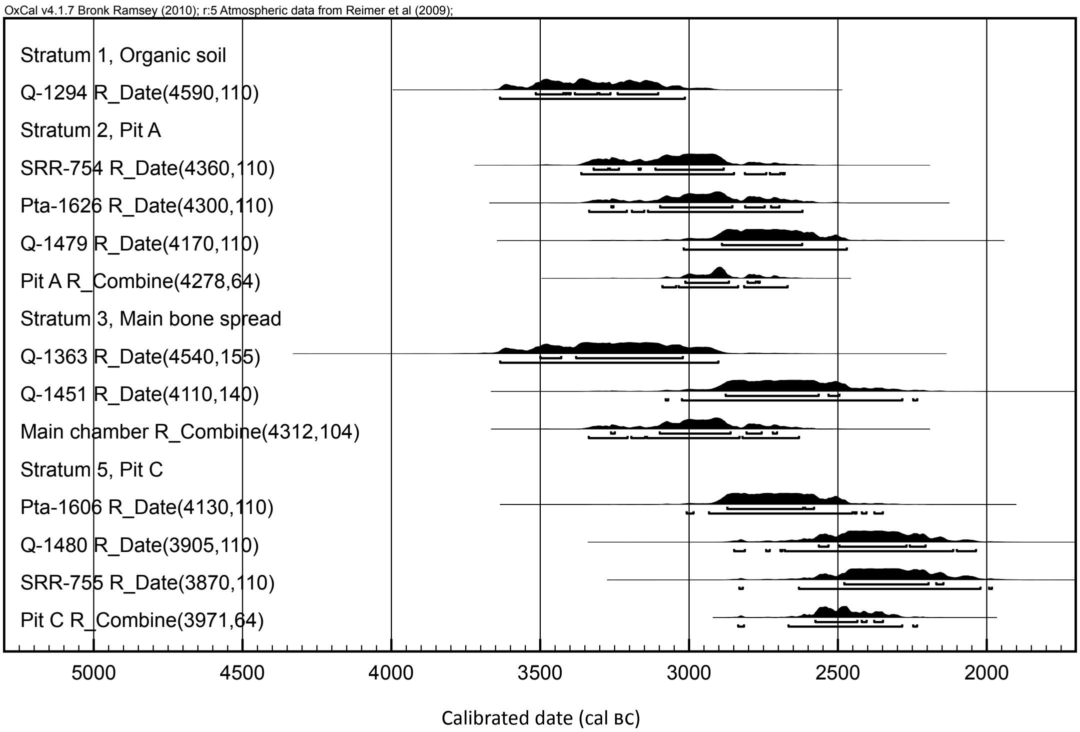
ILLUS 7 Stratum 4 of main burial layer in area III, the north end of the main chamber (from Renfrew 1979: Plate Xb)

determination on 'organic soil' from the chamber floor (Q-1294, 4590 ± 75/110 BP). The three determinations from both Pits A and C were run in triplicate at three different laboratories on what were identified as elements from the same individuals. Using the original error estimates, the results for Pit A can be combined to 3000–2886 cal BC at 95.4% probability, but those for Pit C cannot be combined satisfactorily ($\chi^2 = 11.4, 5\%, 6.0$; Ward & Wilson 1978). Given the quantity of bone required for conventional radiocarbon measurements, different elements were submitted to each laboratory; nevertheless, Pit C is described as containing an 'extended inhumation burial ... of which the lower part was well preserved' (Renfrew et al 1976: 197; Renfrew 1979: fig 21) and so the samples should refer to the same individual. Two of the determinations were made on the left tibia and the right femur, respectively, indicating a date within the second half of the 3rd millennium, while the third (Pta-1606, 4130 ± 60 BP) derived from a left radius attributed to the same individual. It is this last date that is out of line with the other two, and it seems conceivable that the radius may have belonged to a different individual, originally from the main burial layer. In any case, when using the revised error estimates (Ashmore et al 2000; Historic Scotland Radiocarbon Database, www.historic-scotland.gov.uk/radiocarbon-dating) they no longer fail the χ^2 test, at the expense of reduced precision. Dates for the intervening main bone spread suffer from especially large revised error terms of *c* ± 150 years, and so are of limited use, though it can be noted that the earlier of the two provides a calibrated range of 3635–2900 cal BC (Q-1363), theoretically allowing for earlier activity, while the other covers most of the 3rd millennium (Q-1451, 3080–2235 cal BC), overlapping with the ranges reported for Pits A and C. With the exceptions of Q-1294 and Q-1363, the overriding impression is of a monument that saw most of its use falling after 3000 BC (illus 8).

In addition, seven thermoluminesence (TL) dates were undertaken on pottery recovered from the main chamber and entrance passage at Quanterness, with results ranging from 3260 ± 410 BC to 1725 ± 440 BC, averaging to 2370 ± 250 BC (OxTL-189a) (Huxtable & Aitken 1979: tab 5). The large error term severely restricts the usefulness of this result; its midpoint is very late in the context of the radiocarbon determinations for the monument and, more importantly, for the Grooved Ware pottery assemblage. The estimate, from the early days of the technique, is therefore likely to be in error, and is not discussed further here.

THE NEW DATING PROGRAMME

A total of 20 human bone samples were selected for AMS radiocarbon dating and



Illus 8 Recalibrated original ^{14}C determinations (OxCal 4.1) from Quanterness employing the revised error estimates recommended in the Historic Scotland radiocarbon database. All dates, with the exception of Q-1294, were derived from human bone collagen

stable carbon and nitrogen isotope analysis. The criteria for selection were, firstly, to include a number of different contexts, ranging from those thought to be early on stratigraphic grounds, to those thought to be late in the use of the monument; and secondly, to ensure, as far as possible given the first criterion, that different individuals were sampled. (Thus, for example, both an adult and sub-adult element were selected from Stratum 1.) The high degree of fragmentation means that the second criterion cannot be guaranteed absolutely. However, the sample does include six right clavicles indicating that these are from different individuals. Fourteen of the 20 samples were of adult morphology, with the remainder comprising two adolescent elements aged 14–19 years, two older child elements aged 9–12, one younger child element aged 3–6 years, and one infant element, aged 0–6 months. The determination of sex for these elements was not possible. All samples were derived from the main chamber (ZB, see illus 3). One of the six right clavicles belonged to an adolescent, and at least three younger individuals are represented in other sub-adult remains, so that a total of at least nine individuals must be represented; given the large size of the assemblage, it is unlikely that there is much repetition. Unlike many older museum collections, the human bone assemblage from Quanterness has not been treated with any consolidants or preservatives.

As is common with chamber tombs, the nature of deposition and continued use – even in the absence of demonstrable post-Neolithic disturbance – is such that the integrity of the stratigraphy is subject to varying degrees of uncertainty (Renfrew 1979; Barber 1988; 1997). Thus one goal of the present project was an assessment of the recorded stratigraphy, and its interpretation. More widely, the main aim of the project was simply to provide a better understanding of the initial use, duration and final use of Quanterness for burial in the context of Neolithic Orkney. A secondary aim was to obtain dietary information on the dated individuals through stable carbon and nitrogen isotope analyses. The possible use of marine foods was of particular interest, given the site's proximity to the sea, and in the light of ongoing debates concerning the use of marine resources in the Neolithic (Milner et al 2004; Richards & Schulting 2006).

The samples were analysed for both AMS radiocarbon dating and stable carbon and nitrogen isotope analysis at the SUERC facility at East Kilbride. Standard sample pre-treatment at the laboratory involves weighing and crushing of *c* 1g of bone before demineralisation in 100ml of 1M HCL for 24 hours, or longer if required. Distilled water is added and the solution heated in a sand bath at 80ºC for three hours, cooled, and then filtered. Finally, the filtrate is freeze-dried to extract the collagen, which is then (for stable isotopes) combusted and measured on a Thermo Fisher Delta XP Plus mass spectrometer (Gordon Cook pers comm, 2011).

RESULTS

THE DATING PROGRAMME

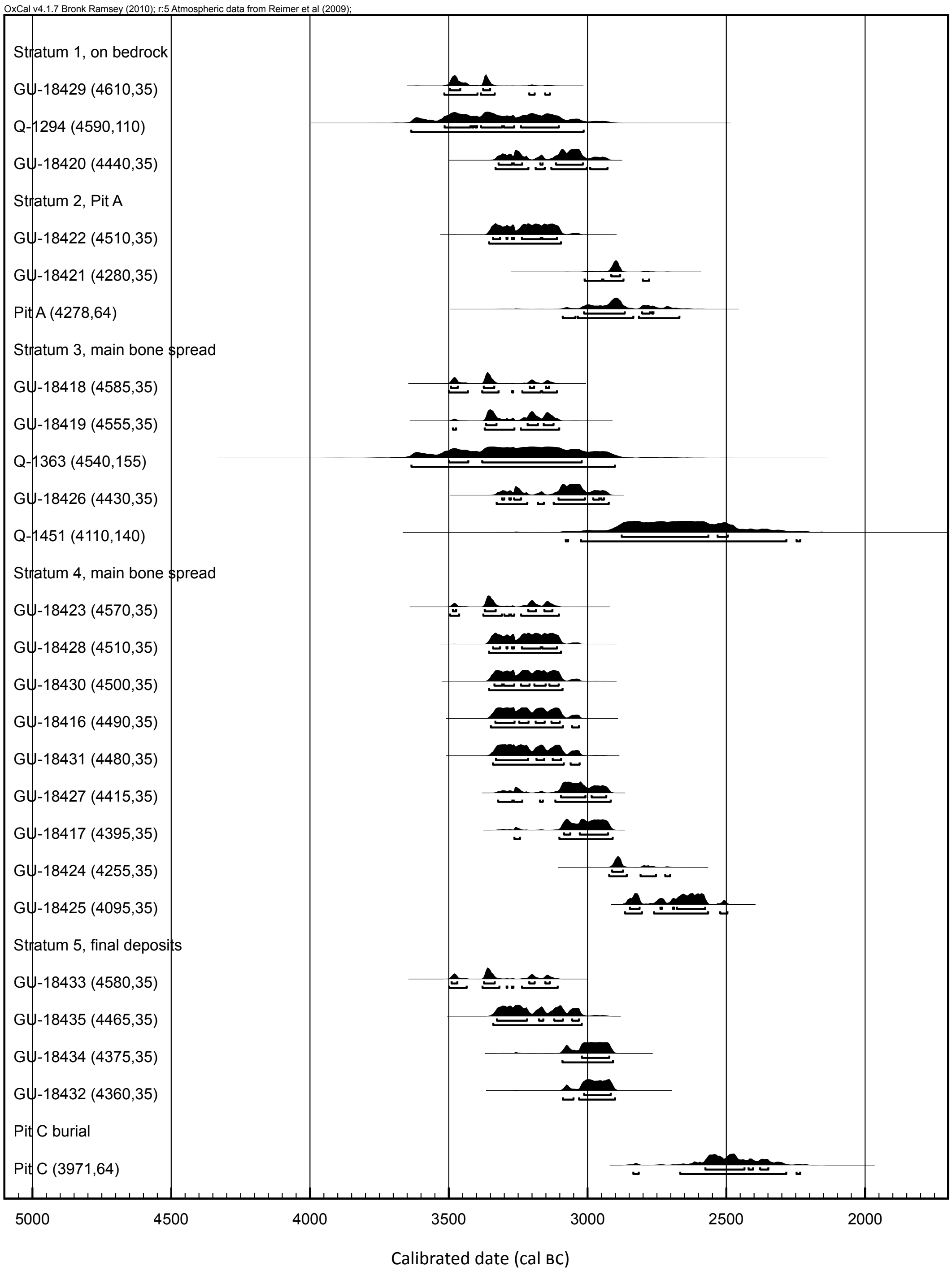
All 20 samples yielded well-preserved collagen with C:N ratios falling within the widely accepted *in vivo* range of 2.9 to 3.6 (DeNiro 1985). The AMS radiocarbon determinations and stable isotope measurements are therefore all seen as acceptable. Unless otherwise stated, all calibrated ranges (calibrated with OxCal v4.1, using IntCal09 and Marine09 where appropriate) are reported at 95.4% probability. Date ranges resulting from Bayesian modelling are presented in italics following recommendations by Bayliss et al (2007). It should be emphasised that the models presented here are not intended to be taken as the only ones possible; space prevents an exploration of all alternatives. Archaeological interpretation (eg of stratigraphic relationships, and of what events belong together as a phase) is required in all cases, and impacts strongly on the outcomes of the models.

The new results range from 3517–3137 cal BC (GU-18429, 4610 ± 35 BP) to 2866–2497 cal BC (GU-18425, 4095 ± 35 BP), although the latest date can be seen as something of an outlier (Table 3; illus 9). As discussed further below, the stable carbon isotope ($\delta^{13}C$) values do not indicate the need to take a marine reservoir correction into account.

One of the two new samples from Pit A in Stratum 2 (GU-18421, 4280 ± 35 BP) is comparable in date to the original three samples obtained from the crouched adult male individual in this context (combining to 4279 ± 31 BP, χ^2 test (1.6, 5%, 7.8)) and it is feasible that all the dated samples could belong to the same individual. The other sample recovered from the pit (GU-18422, 4510 ± 35 BP), however, is significantly earlier and is likely to be intrusive. Two samples were selected from Pit C in Stratum 5, in an attempt to resolve the discrepancy between the original three radiocarbon determinations. Unfortunately, within the timeframe of the project, no element could be assigned definitively to the same individual as originally sampled.[4] The two new samples

TABLE 3
Contexts and new ^{14}C AMS results. See Table 1 for descriptions of strata. Calibrated in OxCal 4.1.5 (Bronk Ramsey 2009a)

Cat. Id.	*Sample*	*Layer*	*Zone*	*Strat*	*Element*	*Lab no*	^{14}C *yrs*	±	*Range cal* BC *95%*	*C:N*	$\delta^{13}C$	$\delta^{15}N$
3023.04	252	23	II	1	phalanx, hand	SUERC-24000 (GU-18420)	4440	35	3332–2929	3.3	–20.4	11.4
1393.06	1167	71	III	1	cranium (0–6 mon)	SUERC-24012 (GU-18429)	4610	35	3517–3137	3.2	–21.5	10.5
327.01	21	26	Pit A	2	cranium	SUERC-24001 (GU-18421)	4280	35	3011–2779	3.6	–21.3	12.4
311.02	141	26	Pit A	2	femur	SUERC-24002 (GU-18422)	4510	35	3355–3096	3.4	–20.2	11.5
164.09	415	22	II	3	R clavicle (14–19)	SUERC-23998 (GU-18418)	4585	35	3500–3111	3.3	–20.3	9.7
221.04	420	22	II	3	R clavicle	SUERC-23999 (GU-18419)	4555	35	3486–3103	3.3	–20.5	10.6
1121.02	521	61	III	3	R clavicle	SUERC-24009 (GU-18426)	4430	35	3328–2924	3.4	–20.3	11.5
189.13	409	21	II	4	R clavicle	SUERC-23993 (GU-18416)	4490	35	3349–3031	3.4	–20.5	11.2
199.18	410	21	II	4	R clavicle	SUERC-23997 (GU-18417)	4395	35	3264–2910	3.4	–20.5	10.7
1084.02	877	57	III	4	L clavicle	SUERC-24003 (GU-18423)	4570	35	3496–3104	3.2	–20.6	10.3
1264	1456	60	III	4	R ulna	SUERC-24007 (GU-18424)	4255	35	2923–2703	3.2	–20.8	11.3
1263.03	1301	60A	III	4	sacrum (3–6)	SUERC-24008 (GU-18425)	4095	35	2866–2497	3.2	–21.0	11.4
1175.01	430	63	III	4	L ulna (9–12)	SUERC-24010 (GU-18427)	4415	35	3323–2917	3.3	–20.7	10.9
4009.19	424	64	III	4	R clavicle	SUERC-24011 (GU-18428)	4510	35	3355–3096	3.3	–20.6	10.2
1579.2	001	102	IV	4	metcarpal	SUERC-24013 (GU-18430)	4500	35	3355–3091	3.2	–20.2	12.1
1587.01	03	102	IV	4	calcaneous	SUERC-24017 (GU-18431)	4480	35	3342–3029	3.2	–20.2	10.9
4513.04	09	150	V	5a	R fibula	SUERC-24018 (GU-18432)	4360	35	3090–2901	3.3	–21.3	11.4
4542	35	151	V	5a	L tibia (9–12)	SUERC-24019 (GU-18433)	4580	35	3499–3108	3.2	–19.8	10.7
4574.04	3532	155	Pit C	5b	sacrum	SUERC-24020 (GU-18434)	4375	35	3091–2909	3.2	–20.1	11.0
4580.08	11	158	Pit C	5b	femur (14–19)	SUERC-24021 (GU-18435)	4465	35	3340–3022	3.3	–20.1	11.3

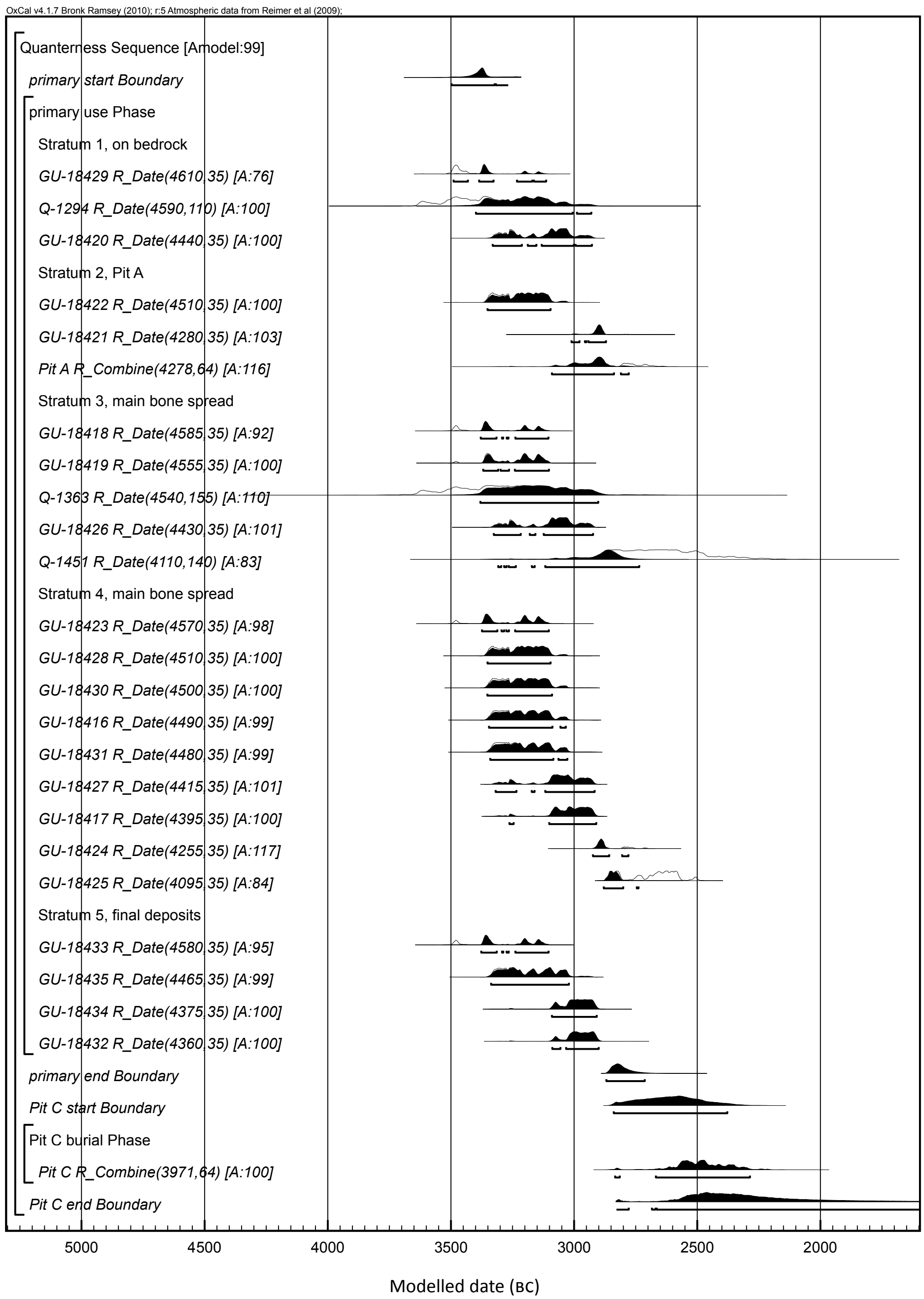


ILLUS 9 Plot of the calibrated new determinations compared with those previously available (Switsur & Harkness 1979, with increased error terms as recommended by Ashmore et al 2000). The lack of any relationship between the dates and the stratigraphy is clear, with the exception of the late placement of the original dates from Pit C

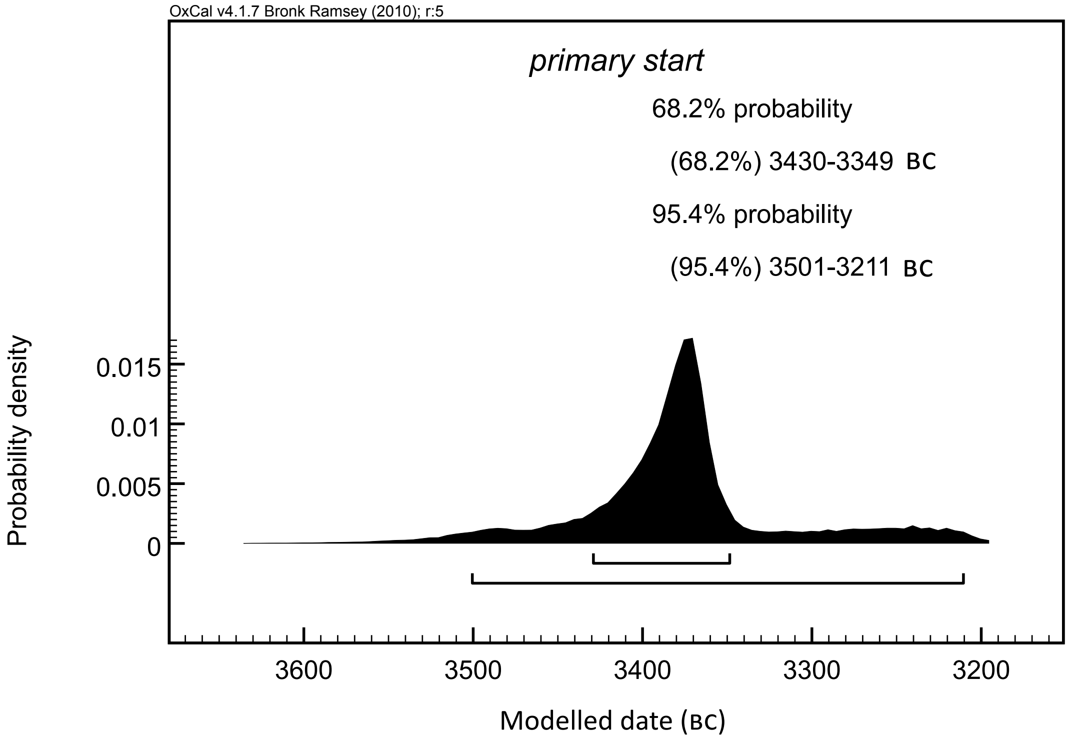
include a sacrum (GU-18434, 4375 ± 35 BP) that was thought to have a reasonable chance of belonging to the articulated burial, while the second was an unfused femur (GU-18435, 4465 ± 35 BP) that must belong to a different, immature individual. Neither determination matches well with the original series obtained for Pit C, but instead both clearly belong with the bulk of the dates from the main bone spread comprising Strata 3–4. However, the result of 4130 ± 60 BP (Pta-1606) for the articulated adult from Pit C is matched by a single determination in the present series (GU-18425, 4095 ± 35 BP), on an unfused child's sacrum from the main bone spread (Stratum 4). Since the latter bone cannot have been part of the adult individual buried in Pit C, this suggests that the early 3rd millennium use of the chamber involved more than one individual. This leaves open the question of the status of the two later dates (Q-1480, 3905 ± 70 BP and SRR-755, 3870 ± 55 BP) obtained by Renfrew from the Pit C individual. If the calibrated values falling in the period *c* 2500–2150 cal BC can be taken as referring to the actual date of this individual, it suggests that the other dated bones from Pit C were residual from the bone spread and did not belong to the same person. This question cannot be resolved without further dating.

The reported stratigraphy at Quanterness would seem to lend itself to a Bayesian model making use of the relationships between samples (Buck et al 1996; Bayliss et al 2007). However, it is readily apparent from illus 9 that there is no consistent relationship between the recorded stratigraphy and the AMS results. For example, the three earliest determinations, GU-18429 (4610 ± 35 BP: 3517–3137 cal BC), GU-18418 (4585 ± 35 BP: 3500–3111 cal BC) and GU-18433 (4580 ± 35: 3499–3108 cal BC) derive from samples lying on the bedrock, in the main bone spread, and in the final deposits, respectively. More formally, attempts to carry out a Bayesian analysis using the strata failed to meet acceptance criteria (index of agreement, $A_{model} = 0.1\%$, set against a minimal requirement of 60%) (for an explanation of this statistic, see Bayliss & Whittle 2007; Bronk Ramsey 2009a; b). While the removal of a small number of individual determinations can be justified when constructing a model, the present case would require the removal of at least eight results individually rejected for their poor agreement with the proposed stratigraphy.

The majority of the Quanterness determinations suffer from falling within the well-known radiocarbon calibration plateau in the second half of the 4th millennium cal BC (eg Ashmore 1998; 2005; Brindley 1999; Schulting et al forthcoming). Nevertheless, there is a sufficiently large number of dates – some of which do lie outside of the plateau – that the Bayesian model might be expected to provide some sense of any underlying sequence that did exist, especially given the additional leeway provided by the plateau. Its failure to do so strongly suggests either that little in the way of stratigraphic integrity ever existed in the bone deposits at Quanterness, or, more likely, that little remained at the time of excavation due to post-depositional disturbance. This finding is typical of deposits in chamber tombs, unless they are clearly separated by such features as stone paving, and even then, some post-depositional mixing can occur, as was noted at the simple passage tomb at Broadsands, Devon (Sheridan et al 2008). While numerous stones and stone slabs were encountered in the main bone spread at Quanterness, they were not sufficiently coherent to qualify as a pavement and thus no clear stratigraphy can be identified. As noted above, Henshall (1979: 77) came to the same conclusion from her study of the pottery:



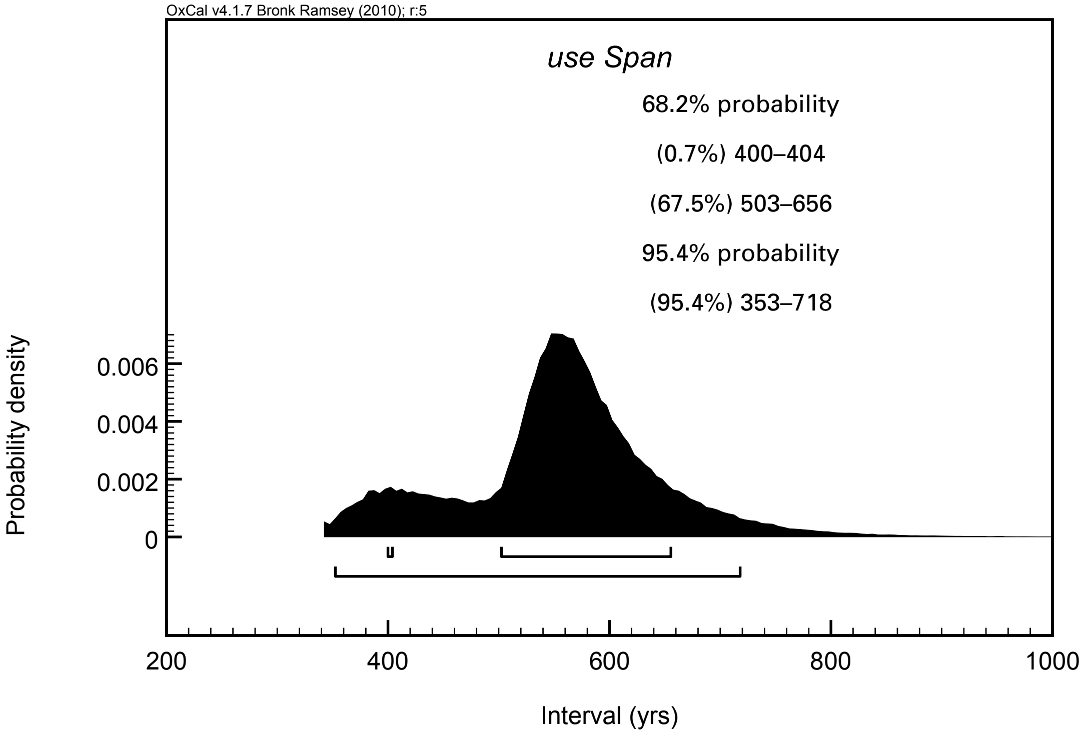
Illus 10 The results of a Bayesian model for Quanterness. The only stratgraphic relationship used in the model is the secondary position of Pit C, for reasons given in the text. The agreement indices for both individual determinations and for the overall model are high



ILLUS 11 The modelled start date for deposition of human bone at Quanterness, based on the model presented in illus 10

'Joining sherds from various areas and strata 2–5 within the chamber demonstrate that no significant stratigraphy existed as far as the finds are concerned …'. The exception to this is Pit C, the aforementioned shallow pit dug into the top of the bone spread with its skeleton that seems to post-date most or all of the dated individuals from other contexts. Renfrew (1979: 52–3, 150) is also clear that the skeletal material was very disordered, and that there were no clearly recognisable strata within the main deposits.

Having rejected the relevance of the recorded stratigraphy for present purposes, an alternative Bayesian model considers the dates from Pit A and the main burial layer as a single group, and simply assumes – and at the same time tests the likelihood of – a single phase of more or less continuous burial activity (Buck et al 1994). Pit C is treated as a later event. The resulting model has a good index of agreement (A_{model} = 99%), and no individual determinations fall below the recommended 60% agreement index (see Bayliss et al 2007). This indicates that the majority of the determinations can be reasonably interpreted as relating to a single 'continuous' phase of activity. The modelled start date for this phase is within the range *3510–3220 cal BC* (*3430–3350 cal BC* at 68.2%), with an end date in the range *2860–2780 cal BC* (*2900–2710 cal BC* at 68.2%) (rounded to the nearest decade) (illus 10 and 11). The main period of use of Quanterness for the deposition of human bone is modelled as lasting between *350 and 720 years* (95.4%) or between *400 and 660 years* (68.2%) (illus 12). Again, to some extent this range is likely to be extended artificially by

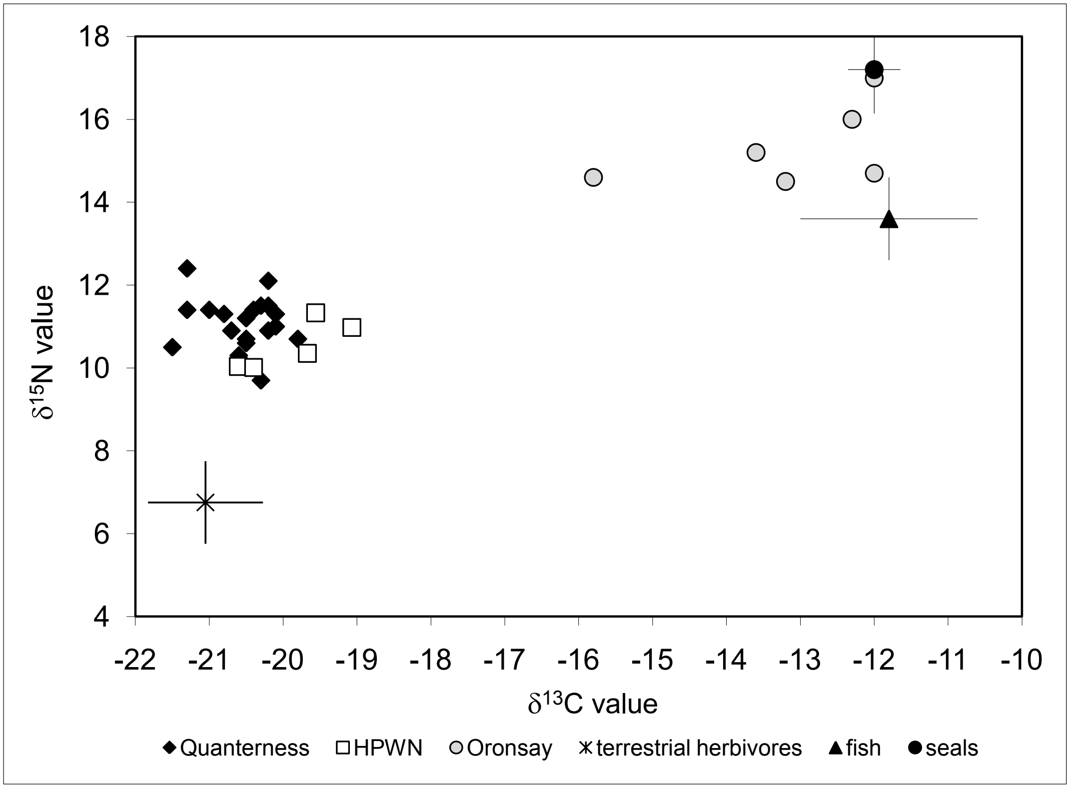


ILLUS 12 The modelled chronological span of human bone present at Quanterness, based on the model presented in illus 10

the calibration plateau; against this, however, is the fact that a number of determinations do fall after *c* 3100 BC, and so are not affected by the plateau; these contribute significantly to the monument's use-span. An alternative view, considered further below, is that older human remains from elsewhere could have been brought to Quanterness after its construction, so that this range does not necessarily refer to the monument's span of use as a place of interment.

STABLE CARBON AND NITROGEN ISOTOPE ANALYSIS

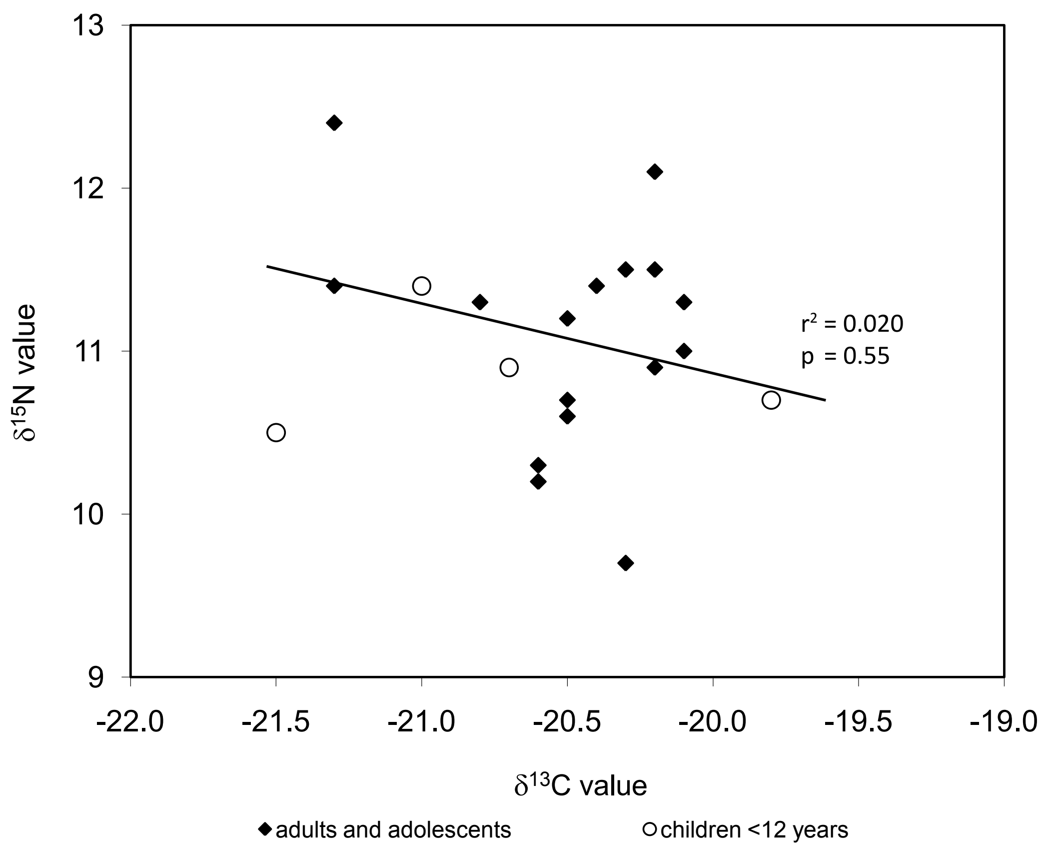
As noted above, all 20 human bone samples demonstrated acceptable collagen preservation and as such are suitable for palaeodietary analysis (Table 3). The $\delta^{13}C$ measurements show limited variability, ranging from –19.8 to –21.5‰, and averaging –20.5 ± 0.4‰ (Table 4). This is typical of prehistoric northern European diets with protein sources derived largely or entirely from C3 terrestrial sources, and can be contrasted with Mesolithic humans from Oronsay (Richards & Mellars 1998; Richards & Sheridan 2000) (illus 13). Nevertheless, assuming a marine endpoint of –12‰ and a terrestrial endpoint of –21‰ (cf Barrett et al 2001; Schulting & Richards 2002; Schulting & Richards 2009), the Quanterness average of –20.5‰ does allow the possibility of a very small contribution of marine protein, on the order of *c* 5%. This can be compared to the slightly higher $\delta^{13}C$ average of –19.9‰ at Holm of Papa Westray North (HPWN), for which the likelihood of a minor contribution of marine-derived



ILLUS 13 Bivariate plot of $\delta^{13}C$ and $\delta^{15}N$ values on human bone collagen from Quanterness, HPWN and Mesolithic Oronsay. Also plotted are terrestrial herbivores (n = 13) from Neolithic Knap of Howar and HPWN and fish (n = 4) and seals (n = 8) from Iron Age/medieval Newark Bay, Orkney (all fauna plotted as mean ± 2SE) (Sources: Richards & Mellars 1998; Richards et al 2006; Schulting & Richards 2009)

protein (less than *c* 15%) has been argued (Schulting & Richards 2009). However, the $\delta^{15}N$ measurements at Quanterness provide no corroborating support for any marine input. They are slightly more variable, ranging from 9.7 to 12.4%, although the lowest is something of an outlier, with the next value being 10.2‰. The average of all 20 measurements is 11.1 ± 0.6‰, which is rather high in comparison with Neolithic southern Britain, where most human values fall around 9–10‰ (Richards 2000; Schulting 2011). Stable nitrogen isotopes relate primarily to trophic level, and given the longer foodchains seen in marine ecosystems, most fish have comparatively high values that are then further enriched in human consumers, leading to a positive correlation between $\delta^{13}C$ and $\delta^{15}N$ values (Richards & Hedges 1999). Crucially, however, there is no such correlation between the $\delta^{13}C$ and $\delta^{15}N$ values in the present dataset (illus 14; $r^2 = 0.0203$, $p = 0.55$), which argues against any significant contribution of marine protein in the diets of the Quanterness population. An alternative interpretation of the high nitrogen values would be the consumption of freshwater fish, which can be elevated in $\delta^{15}N$, but show 'terrestrial' $\delta^{13}C$ values. This explanation seems improbable for Orkney. While trout and eel bones were found at Skara Brae (Andrew 'Bone' Jones cited in Nicholson 1997: 42), they are uncommon at other sites – they were not identified at Quanterness itself for example (Wheeler 1979) – nor is their freshwater status clear: the trout may have been sea trout, and eels are very adaptable in terms of their habitat, and may have had at least a partial marine $\delta^{13}C$ signal (Harrod et al 2005).

A more likely explanation for the high $\delta^{15}N$ values seen in humans at Quanterness is the manuring of small, intensively managed cereal plots, which would have the effect of greatly increasing the latter's $\delta^{15}N$ values (Bogaard et al 2007). Manuring would be both particularly effective and indeed probably necessary in Orkney, with the best agricultural land being relatively limited in extent, and seemingly high populations to be supported (to judge from the number of settlements and monuments) (Schulting & Richards 2009: 71). High stocking rates would have the same effect on pasture. Evidence for middening and manuring (with night soil, which would have elevated $\delta^{15}N$ values even more) has been forwarded for the multi-period prehistoric settlement at Tofts Ness, Sanday (Simpson 1998; Bull et al 1999; Simpson et al 1999), and manuring with both animal dung and seaweed are attested on Orkney historically



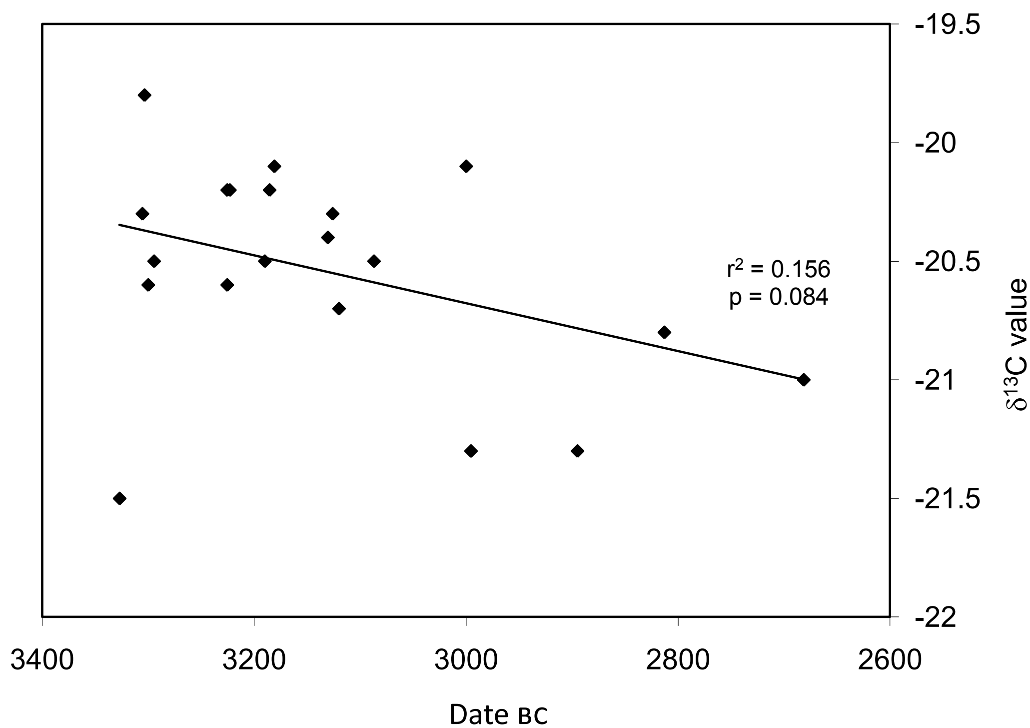
Illus 14 Bivariate plot of $\delta^{13}C$ and $\delta^{15}N$ values on human bone collagen from Quanterness. The lack of any correlation between the two isotopes, as would be expected if marine protein featured in the diet, is clear ($p = 0.55$)

Table 4
Summary of $\delta^{13}C$ and $\delta^{15}N$ isotope values in Table 3

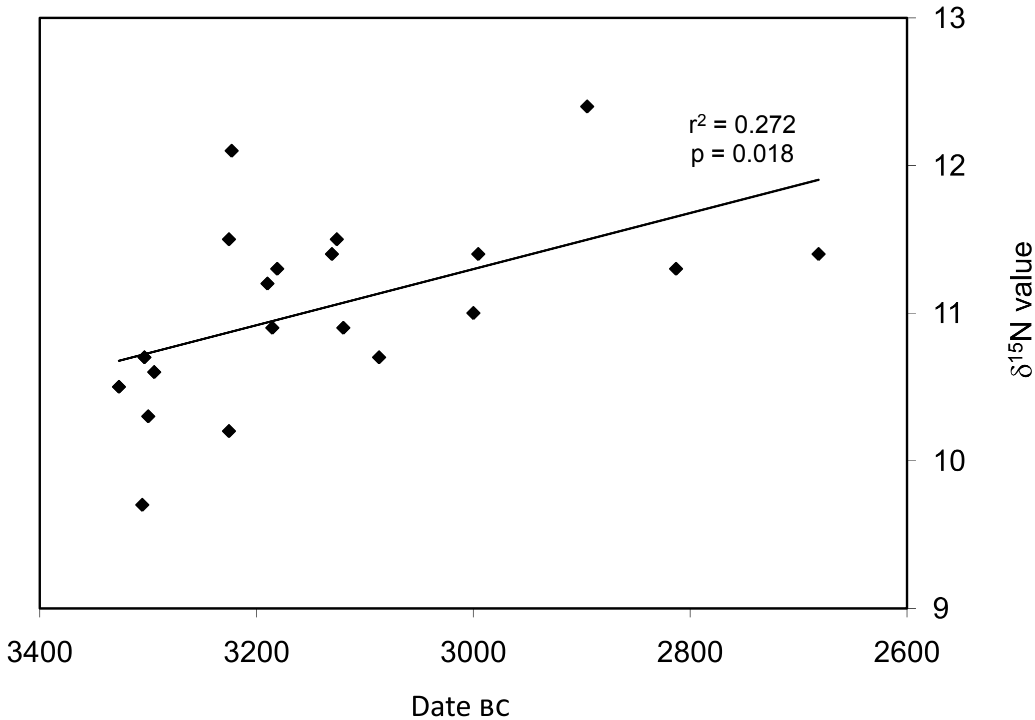
	$\delta^{13}C$ *X*	±	$\delta^{15}N$ *X*	±	*n*
all	–20.5	0.45	11.1	0.64	20
adults/adol.	–20.5	0.37	11.1	0.69	16
children < 12	–20.8	0.71	10.9	0.39	4

(Fenton 1978). It should be noted that the while seaweed would raise $\delta^{15}N$ levels in soils, and hence in the crops or grasses grown on them, it would not affect $\delta^{13}C$ values, since terrestrial plants obtain their carbon directly from the atmosphere via photosynthesis.

Six elements derive from sub-adults (with unfused epiphyses) of varying age. Only two individuals are sufficiently young (0–6 months, and 3–6 years) to have been potentially subject to raised $\delta^{15}N$ values relating to the nursing effect (Schurr 1998);



Illus 15 Plot of $\delta^{13}C$ values against midpoint of calibrated age. A slight trend to lower $\delta^{13}C$ values over time is indicated ($p = 0.08$)



ILLUS 16 Plot of δ15N values against midpoint of calibrated age. A moderate trend to higher δ15N values over time is indicated ($p=0.01$)

however, they differ in neither $\delta^{13}C$ nor $\delta^{15}N$ from the adults (Table 4; illus 14). The infant, if neonatal, would reflect its mother's isotopic values prior to breastfeeding and so would not be expected to be elevated in $\delta^{15}N$; the young child is likely to be of post-weaning age. Given the fragmentary and non-diagnostic nature of the elements selected for sampling, it is not possible to address sex-based variations in diet, although it is readily apparent, given the overall homogeneity of the results, that any differences that did exist along these lines would have to be very subtle.

There are slight indications of changes over time in the stable isotope values, but interpretation of this is made difficult by the fact that the trends run in opposite directions (and so are unlikely to relate to marine protein); that is, $\delta^{13}C$ values decrease slightly between *c* 3400 and 2600 cal BC, while $\delta^{15}N$ values increase over the same period (illus 15 and 16). Of the two, the latter is the stronger trend, and could suggest changes in farming practices (eg manuring), and/or in the balance of animal and plant protein over the period represented. Sample size is small, and the trend is not robust (eg removing one $\delta^{15}N$ value – the cranium from Pit A – reduces the significance of the correlation to $p=0.057$, though by the same token, removing one $\delta^{13}C$ value – the infant cranium – increases the significance of that correlation to $p=0.003$). Both AMS radiocarbon dating and stable isotope measurements would need to be carried out on faunal remains from Quanterness and on faunal and cereal remains from sites in the wider region to explore this issue further; this work is underway.

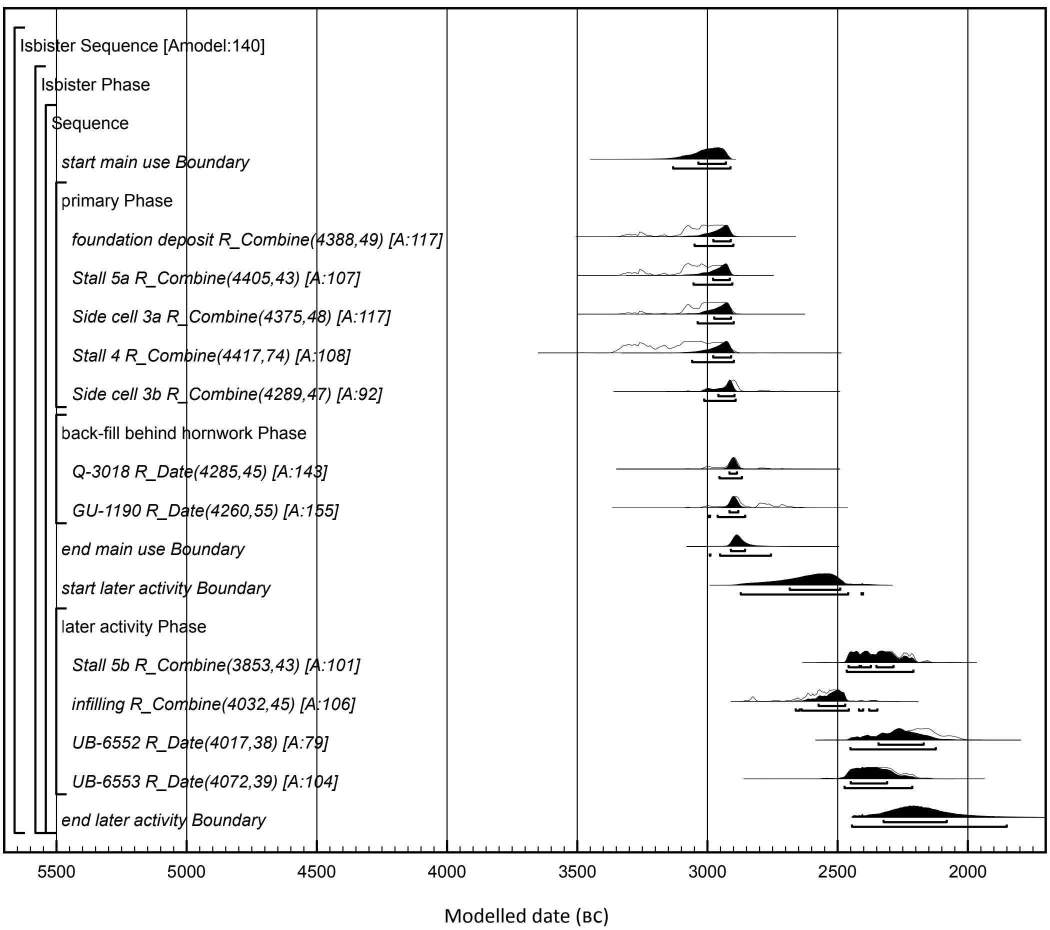
DISCUSSION

The new AMS determinations reported here modify and refine our understanding of the chronology of Quanterness. As noted above, the overriding impression from the original dating programme was of a monument that saw most of its use falling after 3000 BC. By contrast, the majority of the new radiocarbon AMS determinations fall prior to 3000 BC, with Bayesian modelling supporting a start date for deposition in the range *3510–3220 cal BC* (95.4% probability) or *3430–3350 cal BC* (68.2%); again, the range is affected to some extent by the calibration plateau. This is actually in good accord with the construction date of *c* 3400 BC tentatively proposed by Renfrew, although that was poorly supported by the then-available radiocarbon chronology, being based on one of the two determinations on human bone from the main spread (Q-1363, 4540 ± 110/155 BP) (Renfrew et al 1976: 197), and on a single date from the 'organic rich soil' of Stratum 1 (Q-1294, 4590 ± 75/110 BP) (Renfrew 1979, 69; or more cautiously, seeing Quanterness constructed before 3200 BC; ibid: 210). However, such an early initiation of activity at Quanterness raises issues in terms of the inter-linked question of the beginnings of Grooved Ware pottery and of Maes Howe-type passage tombs. As is typical of this type of chamber tomb (Davidson & Henshall 1989: 64), the pottery assemblage from Quanterness consists entirely of Grooved Ware (Henshall 1979: 74–9). The sherds were found distributed throughout the deposits; in other words, they cannot demonstrably be attributed to a late phase of activity on stratigraphic grounds although, as noted above, there is scarcely any stratigraphy and there seems to be a considerable degree of mixing of deposits. Yet this distinctive pottery has been thought to have appeared only from *c* 3100 cal BC (Ashmore 2005), being preceded by a ceramic tradition featuring Unstan Bowls and a variety of other decorated and plain round-bottomed vessel types, the whole subsumed within the unsatisfactory portmanteau term 'Unstan Ware' (Henshall 1983: 33–43; Davidson & Henshall 1989: 64–5, 77–8). The latter tradition is associated with the early settlement at Knap of Howar (Ritchie 1983), and, more importantly for present purposes, with Orkney–Cromarty-type chamber tombs (Davidson & Henshall 1989: 64–5, 77–8). The absence of Unstan Ware from Quanterness begs the question: if this passage tomb was indeed constructed before 3100 BC, then might Grooved Ware have started to be used before this date as well? We shall return to this issue below.

At the other end of the chronological range, the continued use of the monument after *c* 2500 BC, as indicated by the original dates obtained from Pit C, is not supported by the new series (nor indeed is its use after *c* 2700 BC) – although that is not to say that Renfrew's late dates for Pit C (*c* 2500–2150 cal BC) should be discounted. The four newly obtained dates for bones from Stratum 5, the uppermost (and supposedly final) layer in the main bone spread, are indistinguishable from those for Strata 1–4. If we exclude all the original determinations from Pit C – rejected from the primary use-phase by the Bayesian model – then the end date of the main use-phase is modelled as *2870–2720 cal BC* (95.4% probability). If the two latest dates (Q-1480 and SRR-755) are accepted, the articulated adult skeleton in Pit C in Stratum 5 would represent a significantly later re-use of the monument for burial, into the second half of the 3rd millennium BC (but see endnote 4).

QUANTERNESS IN ITS WIDER ORCADIAN CONTEXT

Understanding how Quanterness relates to the wider world of the Orcadian Neolithic is hampered by the fact that only a small number of chamber tombs have provided more than a few radiocarbon dates. The site most frequently compared with Quanterness is Isbister, South Ronaldsay (illus 1), primarily because both have produced very large human bone assemblages. While classed as an Orkney–Cromarty chamber tomb, Isbister can also be seen as something of a hybrid, possessing both a central chamber divided into stalls (a defining characteristic of Orkney–Cromarty tombs) and side cells (more typical of Maes Howe-type passage tombs), as Davidson and Henshall recognised (1989: 24–5, 125). Tipping the balance in favour of its identification as being an O–C type tomb with a Maes Howe-type feature, rather than *vice versa*, is the oval

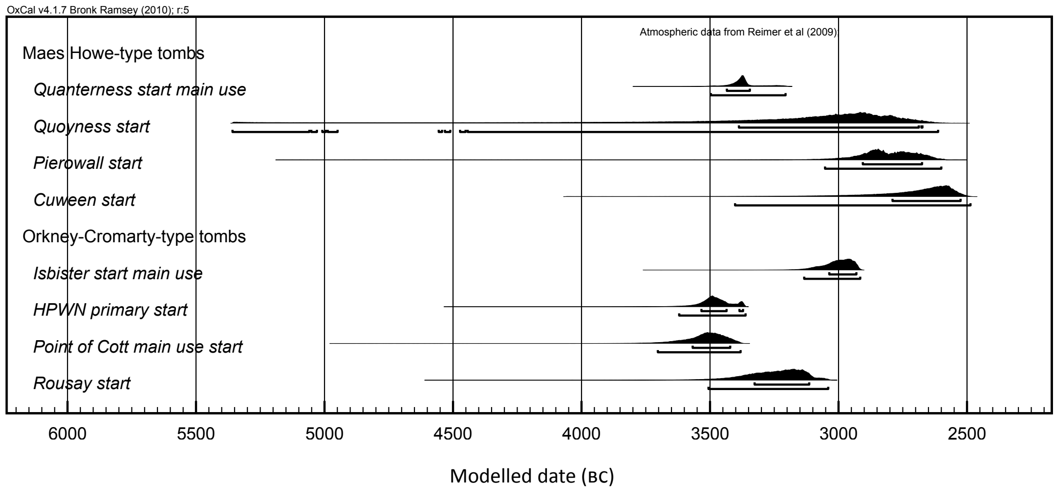


ILLUS 17 Bayesian model for Isbister, using original error terms (see text), and assuming three phases of activity. All determinations are on human bone, except Q-3018 and GU-1190 on terrestrial animal bone from the back-fill behind the hornwork, and UB-6552 and UB-6553 on sea eagle bone, with appropriate marine reservoir corrections applied (assuming 77% and 60% marine contribution, respectively)

shape of its cairn (rather than the round form associated with the Maes Howe group), and, most importantly, its Unstan Ware assemblage, this pottery type being strongly associated with stalled chamber tombs. The dating programme at Isbister, undertaken in the early 1980s, comprised 15 conventional radiocarbon determinations on human bone and two on animal bone, representing seven contexts (Renfrew et al 1983). Stratigraphic information is limited to the identification of foundation deposits, a main use-phase (represented by stalls 4 and 5, and by side cell 3), secondary infill and, finally, an intrusive burial (Hedges 1983). As with the original series from Quanterness, interlaboratory duplications were undertaken; again, because of the nature of the deposits, it is difficult to determine how many distinct individuals are represented in this series. The agreement between the duplicate determinations is very good (since all can be successfully combined; Ward & Wilson 1978), and arguably allows for the retention of the original error terms (ranging from ±50 to ±130 years, but generally less than 100 years), rather than those given in the Historic Scotland Radiocarbon Database, where they have been increased to between ±110 and ±180 years as a result of Ashmore et al's (2000) critical review of radiocarbon dates obtained before the mid-1990s. In the discussion that follows, the original standard deviations have been retained.

The Isbister results show no clear separation of the putative foundation deposits and main use-phase. Material from the infill is later by some centuries than the majority of the other determinations, with the exception of an individual from stall 5b, more or less contemporary with the infill dates. The main period of deposition has been interpreted as falling between *c* 3200 BC and *c* 3000 BC, with use continuing into the first half of the 3rd millennium BC, and with a later, intrusive Bronze Age interment in the fill behind the hornwork (GU-1187, 3250 ± 55/110 BP) (Hedges 1983; Renfrew et al 1983). Unexpected AMS radiocarbon results were obtained in 2005 from two sea eagle bones at Isbister, one from a 'foundation deposit' and the other from above the floor, both taken to represent deliberate deposition by humans. Despite the alleged stratigraphic separation between the samples the dates were indistinguishable at *c* 2450–2050 cal BC, including an adjustment for the marine reservoir effect (Sheridan 2005: 182; McCormick & Sheridan 2006). These results suggest that any 'totemic' use of sea eagles was not part of the initial use of the tomb. They also suggest that, not surprisingly, there may be problems with the reported stratigraphy (bearing in mind the informal manner of the monument's exploration by the farmer who owned it: pers comm the late Anne Brundle).

A Bayesian model for the Isbister dates, utilising the original error terms (see above) and assuming that there had been three phases of activity, places the start of human bone deposition in the chamber within the tightly constrained range of *3130–2920 cal BC* (95.4%), or *3030–2930 cal BC* (68.2%) (illus 17). The main phase of activity is modelled as ending in the range *2950–2760 cal BC* (95.4%). The results on two animal bones from backfill behind the hornwork are later than the main burial phase by about a century, although their inclusion or exclusion has only a modest effect on the model. (Excluding them gives a start date in the range *3180–2920 cal BC*, ending *3020–2780 cal BC* (both at 95.4%).) Deposition in Stall 5b, the infill phase and the locations where the dated sea eagle remains were found all relate to later activity, together spanning much of the 3rd millennium BC. As it stands, the dating evidence places the main phase of use at Isbister later than that at

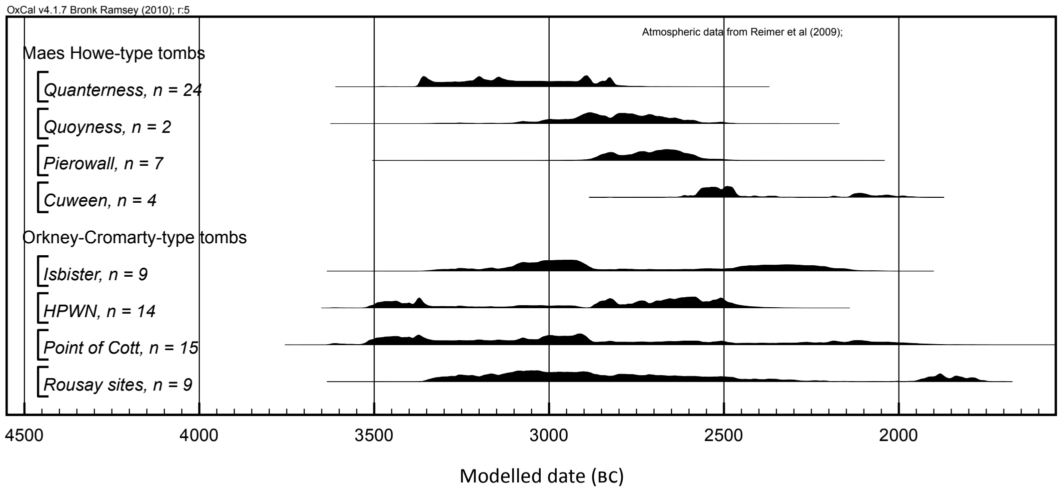


ILLUS 18 Modelled start dates for activity in Orcadian chamber tombs, including human and animal determinations. The range is exaggerated for sites with few determinations (eg Quoyness); one way of reducing this effect is to consider the 68.2% probability ranges (upper bars under each distribution)

Quanterness by at least one or two centuries. This could be regarded as surprising, given that Isbister's exclusively 'Unstan Ware' pottery assemblage would have been expected – according to the conventional reading of Orcadian pottery development – to pre-date the exclusively Grooved Ware assemblage at Quanterness (see below). Incidentally, the Bayesian models for the two monuments demonstrate that it is possible to distinguish their use-phases despite the added uncertainties caused by the later 4th millennium calibration plateau. That being said, a new programme of radiocarbon dating is clearly required in order to improve the chronology for Isbister, particularly given its Unstan Ware association.

The other two reasonably well-dated – and typologically less ambiguous – Orkney–Cromarty chamber tombs are Holm of Papa Westray North (HPWN) (Ritchie 2009) and Point of Cott, Westray (Barber 1997). Both have stalled chambers (plus a small and probably earlier terminal cell in the case of HPWN); Point of Cott has a horned cairn, while that surrounding the chamber at HPWN is rectangular. HPWN has six radiocarbon AMS determinations on human bone, and an additional eight on fauna; all but three of these dates were obtained through a recent radiocarbon dating programme. The three earliest results are all on human bone, and are interpreted as representing the primary burial deposits in the monument (Ashmore 2009; Schulting & Richards 2009). They form a consistent group centring on *c* 3500 BC and are therefore likely to precede the initial burial deposits at Quanterness by at least one to two centuries (illus 18). There is a clear second phase of burial activity nearer 3000 BC; this may be linked to the presence of small amounts of Grooved Ware pottery both within and outside the tomb (Henshall 2009: 36). Further activity, dating to the second quarter of the 3rd millennium, is attested by faunal remains (illus 19).

Point of Cott, Westray, has provided ten radiocarbon determinations on human bone,



Illus 19 Modelled summed probability distributions for Orcadian Neolithic chamber tombs. Multiple dates on the same individuals from Quanterness and Isbister have been combined. Revised error terms and marine reservoir corrections are used where appropriate (the latter applying to Isbister and HPWN). Note that while individual determinations are modelled in these distributions, they do not take into account additional error estimates for the start and end of activity derived from the Bayesian model (see illus 18). Additionally, the peaks and troughs in the distributions are partly an artefact of the calibration curve, and are not directly interpretable as changing intensity of deposition activity

and five on animal bone. The earliest results are all on human bone (the two earliest being Ut-1660, 4680 ± 50 BP and Ut-1658, 4680 ± 50 BP, both calibrating to 3632–3362 cal BC), and as with HPWN, precede the earliest dates from Quanterness (illus 18). Interestingly, and serving as a cautionary tale, most of the animal bone dates from both HPWN and Point of Cott are later than those on human bone, although this is not surprising as many of the former were selected specifically to date late contexts, such as upper fills and blocking deposits, and so post-date the use of the monuments for funerary activity. The same cannot be said concerning one of the Isbister sea eagles, which was thought to have been part of a foundation deposit but, as noted above, has been demonstrated to post-date the earliest dated deposits by several centuries.

Smaller numbers of radiocarbon determinations are available from seven other Orcadian chamber tombs. A total of nine determinations are available for four Orkney–Cromarty stalled cairns along the southern coast of Rousay: Blackhammer and the Knowes of Ramsay, Rowiegar and Yarso (illus 1) (Henshall 1972; Renfrew 1979; Davidson & Henshall 1989: 97; Sheridan 2005a). The context is unclear for many of these samples, but two from Rowiegar, including the only human bone in the group, are said to have derived from above the main burial layer, with results calibrating to *c* 3350–2900 cal BC (see Sheridan 2005: 182 for details). Dates previously obtained by Renfrew for cattle and deer bone from Rowiegar relate to secondary activity within the first half of the 3rd millennium, as do his results for animal bone from the Knowes of Ramsay and Yarso (Davidson & Henshall 1989: 97). As regards dates relating to Maes Howe-type passage tombs, two unstratified human bones from Quoyness, Sanday, produced results within the first four centuries of the 3rd millennium; their chronological relationship to the construction of the tomb cannot be determined. At Pierowall Quarry, Westray, the seven animal bones that were dated all clearly came from secondary contexts, so it is not surprising that they fall after the turn of the 3rd millennium (Sharples 1984). And at Cuween, bones from three of the 24 dogs found in the tomb produced dates that cluster around the middle of the 3rd millennium BC (Sheridan 2005b) and can be assumed to represent secondary use of the tomb, despite being attributed to the lower fills of the chamber. In this respect they are analogous to the dated eagle remains at Isbister. A human bone from Cuween proved to be of Early Bronze Age date (Sheridan 2005a: 182).

As at Quanterness, Isbister presents evidence for continued, if intermittent, funerary use after *c* 2700/2500 BC, albeit from only a single individual (aside from the intrusive Bronze Age burial). There are indications of use during the first half of the 3rd millennium BC at Holm of Papa Westray North, Quoyness, Pierowall, Cuween and the Rousay sites, but many radiocarbon dates from these sites are from uncertain or secondary contexts, and those obtained during the 1980s are again subject to revised error terms of ±110 years, severely reducing their chronological resolution. Thus, the conclusion that any of these monuments were actually built after *c* 3000 BC should be treated with caution; indeed, this would have been the impression given for Holm of Papa Westray North on the basis of the three previously available determinations on human bone, before the aforementioned recent dating programme demonstrated a much earlier phase that probably does relate to the monument's initial use.

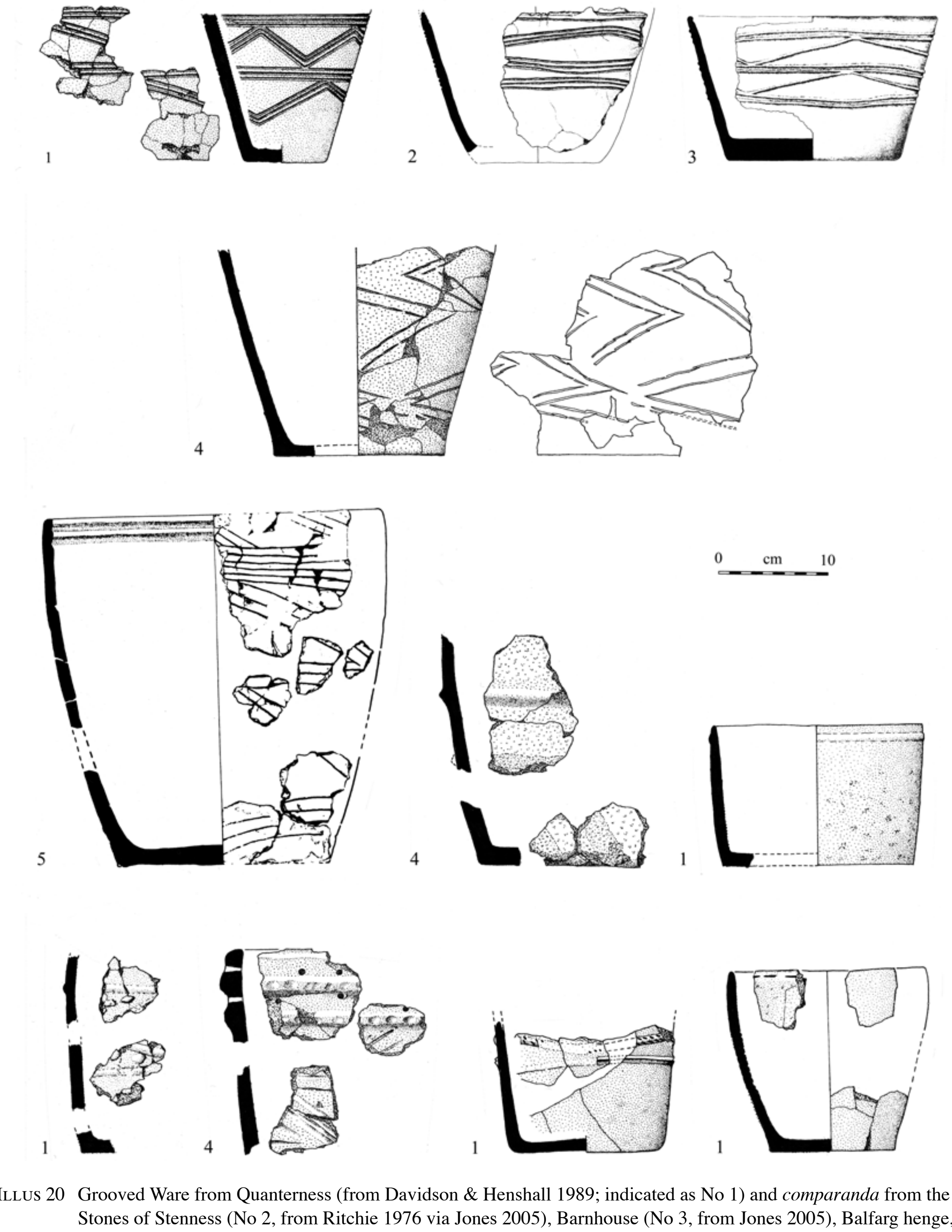
The modelled start and end dates for Quanterness provide for the possibility of a use-span of between *350 and 720 years* at 95.4% confidence. As discussed above, this may be affected by the calibration plateau of the second half of the 4th millennium BC. Nevertheless, the monument must have seen use over some centuries, given that a number of determinations extend to *c* 2700 BC, well past the calibration plateau. This is still a substantial period of time, and presents a very different picture from that derived from recent radiocarbon dating programmes in southern England, where the modelled use-spans of a number of long barrows and chamber tombs are far shorter than expected, with a number now placed at less than a century or two (Bayliss & Whittle 2007). This is not to say that this finding applies to all monuments in southern Britain, but it does support the notion that Quanterness is one of the longer-lived funerary monuments in Neolithic Britain (though see below). This might seem to imply a relatively stable sociopolitical situation. Indeed, Renfrew (1979: 162), on the basis of his dating programme and the demography of the burial population, has suggested that the monument may have been the burial place for most of the members of a single community over some centuries (although Andrew Jones (2000) has argued for more a complex relationship between the monument and Neolithic Orcadian communities). While deposition continued into the 3rd millennium at Isbister, its main period of use for burial, at least on present evidence, seems to have been much shorter than at Quanterness. Point of Cott and HPWN span some centuries although, again on present evidence, they do not appear to have been used for burial beyond *c* 2700 BC; the deposition of animal remains continues well past this, but it is not always clear to what extent this represents natural or anthropogenic accumulation.

The available radiocarbon dates for Blackhammer, the Knowes of Ramsay, Rowiegar and Yarso and for Pierowall are all derived from animal bone[5] (as are three of the Cuween dates) and thus, following the evidence from other monuments, their general lateness is not surprising as the animal remains probably did not enter the tombs as part of the monuments' initial funerary use (illus 19). While the two radiocarbon determinations from Quoyness (*c* 3000–2500 cal BC) are on human bone, these are also unlikely to represent the primary use-phase of the monument. Structurally, Quanterness has most affinity with Quoyness, and both contained Grooved Ware pottery assemblages (Childe 1952; Renfrew 1979: 202).

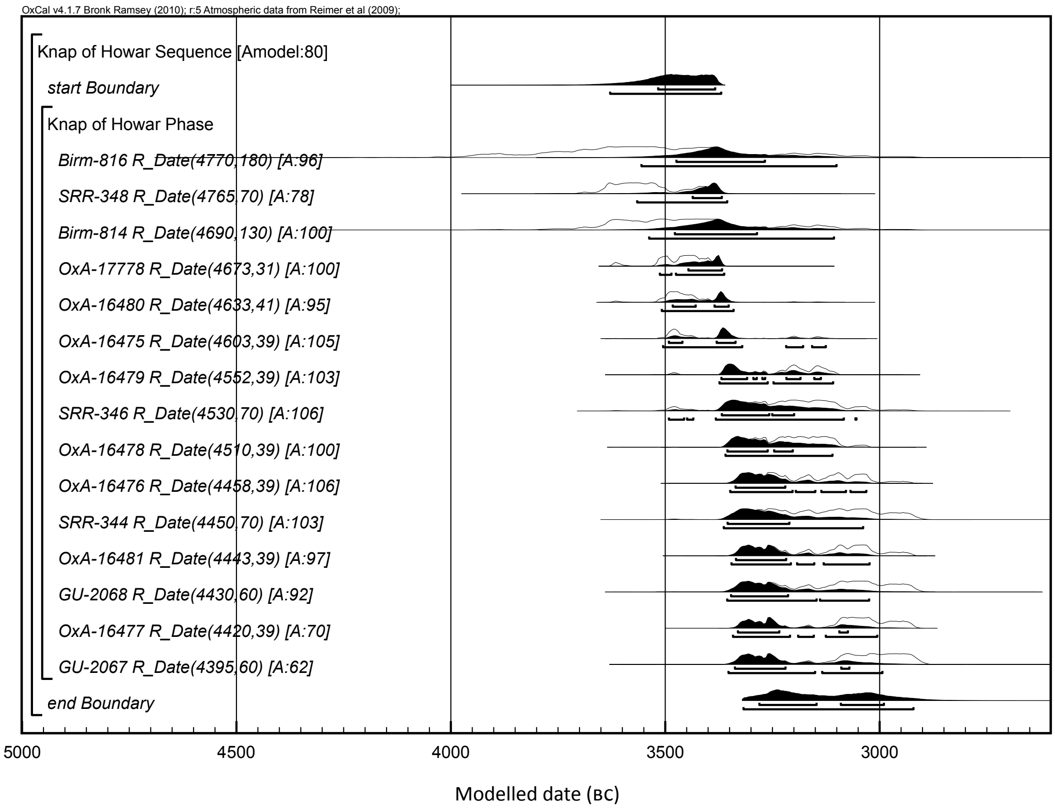
From the above discussion, it is clear that Quanterness was in contemporary use with a number of other chamber tombs in Orkney. While it may have been constructed from a few generations to a few centuries after some of the smaller stalled cairns, there is no evidence that these went out of use when Quanterness was built (illus 19). Indeed, the available results would seem strongly to support Renfrew's (1979: 208–12) suggestion of a period of overlap in the use of the two monument types, from *c* 3300 to 3000 BC. But this conclusion may not be quite so straightforward. Colin Richards (1988; 1998) has contended that the remains from earlier chamber tombs were intentionally removed and redeposited within and between sites during the Neolithic, as well as possibly during later periods, as may have been the case at Maes Howe. Against this, however, one could point out that the current reappraisal of the Quanterness human remains reinforces the view expressed by previous commentators (Barber 1988; Davidson & Henshall 1989: 58; Reilly 2003), calling into question Chesterman's claims for excarnation at this site. As noted above, the presence of the small bones of the hands and feet, together with other features of the assemblage, make it unlikely that the bulk of the human bone was brought in from elsewhere. Furthermore, the new dating programme for Quanterness provides no evidence for the redeposition of human remains from the earliest Orcadian chamber tombs, such as HPWN and Point of Cott. That said, one cannot altogether rule out the possibility that some skeletal material might indeed have been brought into Quanterness. The results do not contradict Reilly's (2003) suggestion that later monuments such as Quanterness saw the incorporation into a single monument of funerary rites that had previously been practised in different chamber tombs, in different locations across the landscape.

QUANTERNESS AND THE ORIGIN OF GROOVED WARE

As indicated above, the new dates for Quanterness potentially have a bearing on the issue of when Grooved Ware started to be used. The dating of this pottery tradition in Scotland remains imprecisely known, partly as a result of the additional uncertainties created by the plateau in the radiocarbon calibration curve in the second half of the 4th millennium BC. The argument that the tradition originated in Orkney (eg Ashmore 1998) is strongly supported by the sequence provided by the settlement at Pool on Sanday, where a round-bottomed 'Unstan Ware' assemblage from Phase 1 is overlain by a flat-bottomed Grooved Ware assemblage in Phases 2 and 3. The transition seems to have been rather marked, as no round-bottomed vessels are identified from Phase 2 onwards (MacSween 2007a: 325). Another clear change is evident with the onset of Phase 3, with primarily stone-tempered Grooved Ware pottery bearing applied decoration



Illus 20 Grooved Ware from Quanterness (from Davidson & Henshall 1989; indicated as No 1) and *comparanda* from the Stones of Stenness (No 2, from Ritchie 1976 via Jones 2005), Barnhouse (No 3, from Jones 2005), Balfarg henge, Fife (No 4, from Mercer 1981) and Knowth passage tomb 6, Co. Meath (No 5, from Eogan 1984). Reproduced by courtesy of the authors and publishers, including Edinburgh University Press and the Society of Antiquaries of Scotland



Illus 21 Bayesian model for Knap of Howar, based on 15 determinations on animal bone (Sheridan & Higham 2006; 2007). No stratigraphic relationships are taken into account here, since the dating results are difficult to reconcile with the stratigraphy. Further work on modelling the site is underway and will be reported elsewhere

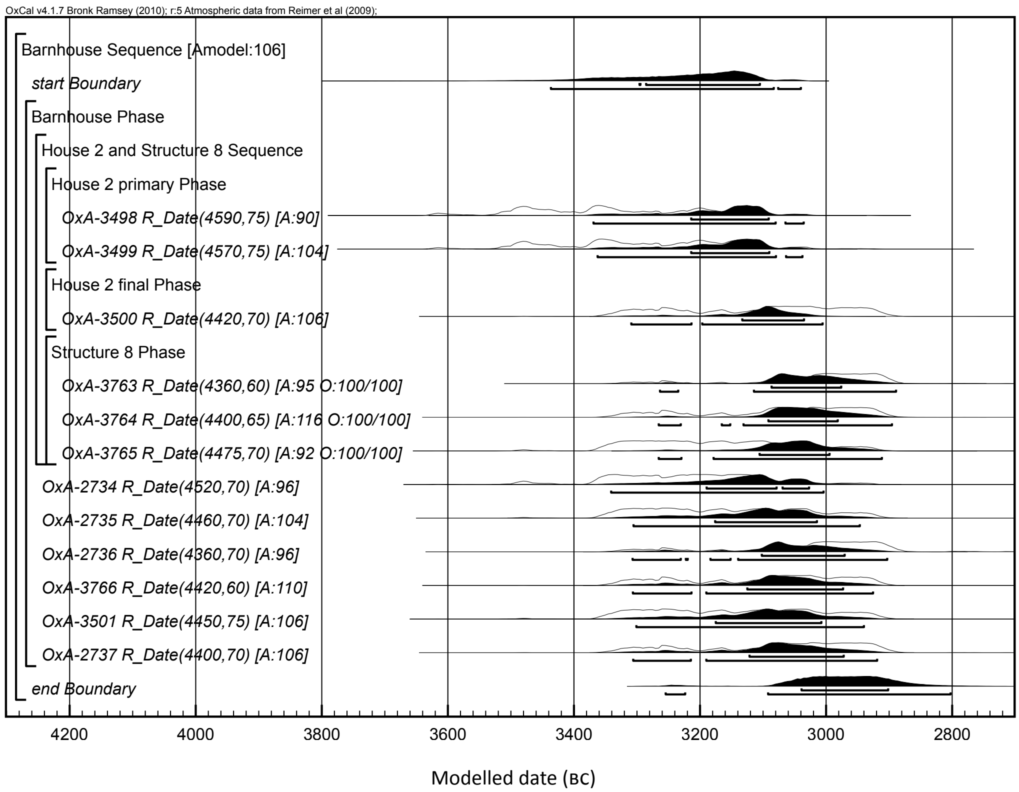
replacing the mainly shell-tempered pottery with incised decoration of Phase 2 (ibid). Radiocarbon dates (see discussion below) are only available for Phases 2.3 and 3.1, but the pottery from the earlier Phases 2.1 and 2.2 is similar to that of Phase 2.3 in vessel shape, size and fabric (with the incidence of decorated vessels increasing in Phase 2.3 (MacSween 2007a: 291–7)). It appears, then, that we are dealing with the conscious development of a new set of ideas in ceramic design, whose evolution served to differentiate Grooved Ware from the pre-existing 'Unstan Ware' tradition (cf MacSween 2007b). The degree of chronological overlap in the use of Grooved Ware and non-Grooved Ware pottery in Orkney is considered below.

Since Henshall reported on the Quanterness pottery in 1979, the number of Grooved Ware assemblages in Orkney (and indeed elsewhere in Britain and Ireland) has risen significantly, as has the number of associated radiocarbon dates, so that we are now closer to being able to construct an overall developmental sequence, at least as far as Orkney is concerned (Cowie & MacSween 1999; MacSween 1992; 1995; 2007a; 2007b and see various contributions in Cleal & MacSween 1999 for broader discussions of Grooved Ware typochronology). It seems that the southward spread of this ceramic tradition was comparatively rapid (MacSween 2007b), and likely that it was associated with the creation of timber and stone circles, along with a set of other practices and beliefs (Sheridan 2004a).

The Grooved Ware which, on stratigraphic (see above) and chronological grounds (see below), seems to be the very earliest comprises the narrow-based, mostly undecorated, tall coarseware vessels as seen in Phases 2.1 and 2.2 at Pool (MacSween 2007a: 291–4); where decoration exists, it is incised. Ann MacSween has pointed out (ibid: 322–3) that pottery similar to this – and to the Pool Phase 2.3 incised Grooved Ware – was found among the assemblage from the settlement at Knap of Howar on Papa Westray, to the north-west of Sanday; in particular, attention can be drawn to the shell-tempered, narrow-based pot 64 and the probably similarly shaped pot 67a (Ritchie 1983, figs 9 and 10). A Bayesian model treating the 15 available radiocarbon determinations on fauna from Knap of Howar as a single phase of activity – and note that inconsistencies between the stratigraphy and the dating results suggest mixing of the deposits – place the site's use between *3620–3370 cal BC* and *3320–2920 cal BC* (95.4%) (illus 21). However, the attribution of specific pots to specific points within this range is not straightforward, and there are hints (in the form of a few sherds of Grooved Ware with applied cordons, ie Pots 30, 32, 35 and 36) that there may be time depth in the use of Grooved Ware at this site. The site is better known, of course, for its 'Unstan Ware' assemblage (Ritchie 1983).

The next earliest, and more widespread variety of Grooved Ware is characterised by the more extensive use of incised (grooved) decoration. This has been found at a number of Orcadian sites, including Pool (Phase 2.3: MacSween 2007a and see above regarding Knap of Howar), Barnhouse (Jones 2005), the Stones of Stenness (Ritchie 1976), Crossiecrown (Jones et al 2010; Jones & Card pers comm), Stonehall (Jones pers comm) and the earliest levels at both Rinyo on Rousay (Childe & Grant 1939: plate XXII, 1–8) and Skara Brae (Childe 1931). Of these, the assemblages from the Stones of Stenness and Barnhouse provide the closest matches for the Quanterness pottery (illus 20). Interestingly, Andrew Jones (2000; 2005) has argued, on the basis of fabric analysis, that at least three Grooved Ware vessels from Quanterness had actually been made at Barnhouse, some 10km to the west. Inclusions in one of the vessels in question (Pot 2, no 1582) are of olivine-basalt (Williams 1979, 95), which is found as a filler in the early phase pottery assemblages from Houses 3 and 5 at Barnhouse. This material has been sourced to two outcrops, one near Unstan, Loch Harray and the other at Benziaroth near Finstown (ibid); while Jones (2000; 2005) emphasises the former connection, the latter is actually closer to Quanterness. In addition, Jones notes that Pot 2 is decorated with the same curvilinear scheme as seen at Barnhouse (illus 20, nos 1 and 2). A further two sherds from Quanterness were found to contain igneous dyke material that was also identified in the pottery from Houses 3 and 5. If Jones' reading of the evidence is correct, then this offers intriguing new detail expanding on Willliams' conclusion that some of the Quanterness pottery had been imported from outside the immediate vicinity.

Reliable AMS radiocarbon determinations on carefully selected, short-lived materials are now available for several Orcadian Grooved Ware assemblages (ie Pool, Barnhouse, the Stones of Stenness, Crossiecrown, Stonehall and – thanks to a recent radiocarbon programme on the Skara Brae material from David Clarke's excavations – Skara Brae (Clarke pers comm; see below for comments).

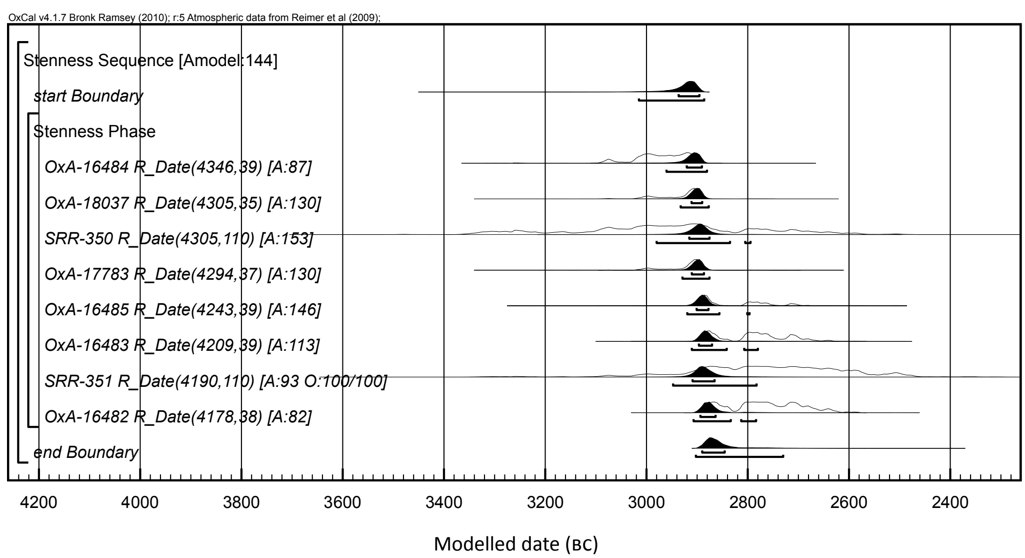


ILLUS 22 Bayesian model for Barnhouse, taking into account the stratigraphic relationships between House 2 and Structure 8 (see Ashmore 2005). The three determinations for Structure 8 are on birch charcoal, and use has been made of the 'charcoal outlier model' in OxCal 4.1.7 (Bronk Ramsey 2009b) to take their in-built age into account. All the remaining determinations are on charred grain

If we focus on the dates for Barnhouse and the Stones of Stenness – the sites with the most similar pottery to Quanterness – we find that at Barnhouse, the evidence is similarly affected by the plateau in the calibration curve while the later Stones of Stenness results are not. The following discussion will also include comments on some other dated Grooved Ware assemblages.

Based on a series of 12 radiocarbon dates derived from short-lived samples, of which nine are charred barley grains, Ashmore (2005: 386–7) places the most likely use of Barnhouse in the range *c* 3100–2900 BC. However, his analysis begins from the position that the site should not pre-date 3100 BC, so that he attributes the earlier part of the range, extending back to *c* 3400 BC, as an artefact of the calibration curve referred to above. The same argument has been applied to the initial appearance of Grooved Ware in Scotland more generally (Ashmore 1998), although in a later paper a date as early as *c* 3200 BC was acknowledged as being probable (Ashmore 2004: 130). While the earliest part of the Barnhouse range is indeed of low probability, this is not the case for the whole range. A Bayesian model using all 12 determinations from the site, and taking into account the stratigraphic relationships within House 2, and between House 2 and the overlying Structure 8, places the start of activity at *3440–3040 cal BC* (95.4%), or *3300–3110 cal BC* (68.2%) (illus 22). The model has good agreement, both for the individual determinations and as a whole (A_{model} = 106%). The three determinations on birch charcoal from the floor of Structure 8 will have an in-built age of unknown duration (Ashmore 2005: 386); this has been taken into account by the use of a 'charcoal outlier model' in OxCal 4.1.7, which treats all results so highlighted as being older than their contexts, in this case by up to 100 years (Bronk Ramsey 2009b). It can also be noted that an alternative Bayesian model treating all 12 determinations as a single phase of activity (ie ignoring the stratigraphic relationships (Buck et al 1994)) does not substantially alter this picture. Thus, a start date as late as *c* 3100 BC for the settlement at Barnhouse, and hence its Grooved Ware assemblage, is improbable.

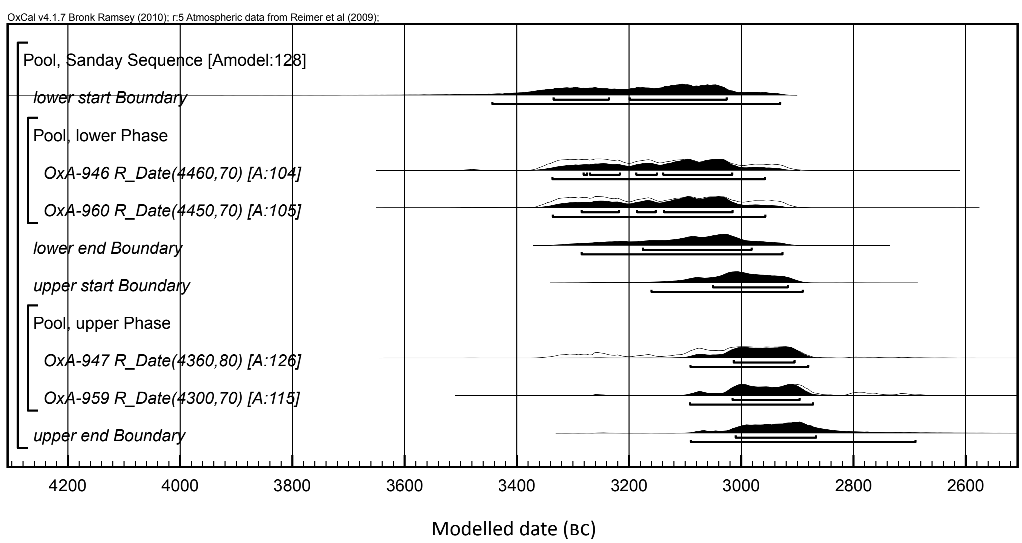
The henge at Stones of Stenness has provided six AMS determinations on animal bone, of which five are from the basal ditch fill and one (on calcined sheep bone) is from the central hearth-like feature (Sheridan & Higham 2006; 2007).[6] These join two conventional dates relating to initial activity at the monument that were obtained during the 1970s, one (SRR-350) on animal bone from the basal ditch fill and the other (SRR-351) on charcoal from the central feature; again, an increase in their standard deviations to ±110 in the Historic Scotland Radiocarbon Database renders them of limited utility. Given that the Grooved Ware was mostly found in the ditch terminals and the central feature, the dates from the basal ditch fill can be regarded as either pre-dating or being contemporary with the pottery in the terminals, while the date from the central feature is likely to be



ILLUS 23 Bayesian model for the Stones of Stenness, treating all the determinations as referring to a single phase of activity (Sheridan & Higham 2006; 2007). All are on animal bone with the exception of SRR-351 on unspecified charcoal, and treated as older than its context in a 'charcoal outlier model' in OxCal 4.1.7 (Bronk Ramsey 2009b)

contemporary with the pottery from that feature. A Bayesian model treating all of the determinations (including SRR-350 and 351) as belonging to a single phase places the onset of activity in the tightly constrained range *3020–2890 cal BC* at 95.4% or *2940–2900 cal BC* at 68.2%, suggesting that at this site, at least, incised Grooved Ware does not pre-date 3000 BC (illus 23).

Other early assemblages of Grooved Ware in Orkney, while still in the incised style, are arguably less similar to that from Quanterness. There are only four AMS determinations (on twigs, possibly of willow) that are relevant to the Grooved Ware component of the important site at Pool on Sanday (Gowlett et al 1987; Hunter 2000; 2007: 531; Ashmore 2005; MacSween 2007a. A series of TL dates is also available, but will not be considered here (see Hunter 2007)). Unfortunately, there is some uncertainty regarding the stratigraphic order of the radiocarbon-dated samples. The sample submission forms (on file at the Radiocarbon Laboratory for Archaeology and the History of Art, Oxford), along with the initial publication of the results (Gowlett et al 1987), present OxA-947 (4360 ± 80 BP) and OxA-949 (4300 ± 70 BP) as deriving from samples in the upper midden (ie Phase 3.1), *c*1m below the turf, and OxA-946 (4460 ± 70 BP) and OxA-960 (4450 ± 70 BP) deriving from samples originating from *c* 1m lower again, just above the second of two sterile sand horizons (ie Phase 2.3). Using this stratigraphic relationship produces a Bayesian model placing the start of activity for Phase 2.3 in the range *3450–2930 cal BC* (95.4%) or *3330–3030 cal BC* (68.2%) (A_{model} = 128%) (illus 24). However, in the final site report, this relationship has been reversed without any accompanying discussion, so that OxA-947 and OxA-949 refer to Phase 2.3, while OxA-946 and OxA-960 refer to Phase 3.1 (Hunter 2007: 62–3, table app 2.2). Using this stratigraphy, the start of activity for Phase 2.3 would be placed in the range *3350–2930 cal BC* (95.4%) or *3100–2790 cal BC* (68.2%) (A_{model} = 72.6%).



ILLUS 24 Bayesian model for Pool, taking into account the lower (2.3) and upper (3.1) phases of the site (Hunter 2000)

The difference between the two models is most evident in the 68.2% ranges, which comprise the bulk of the probability distribution. The former model – more or less identical with the proposed start date for the Barnhouse assemblage – provides greater consistency between the recorded stratigraphy and the radiocarbon dates, as is reflected in its higher index of agreement. However, the second model is not rejected, highlighting both the leeway allowed by this section of the calibration curve and the tight grouping of the radiocarbon determinations, which in fact can be combined to 4395 ± 37 BP (χ^2=3.5; 5%, 7.8). This model places the start of activity for Phase 2.3 at Pool as significantly later than that for Barnhouse. Regardless of which model is accepted (and it would appear that the aforementioned date switch was accidental, so that greater credence should be given to the first model) it should be emphasised that, as noted above, Phase 2.3 at Pool is stratigraphically preceded by Phases 2.1 and 2.2, both of which also contain incised Grooved Ware, though in the case of 2.1 this is limited to a single decorated sherd, the remainder of the small assemblage being undecorated (MacSween 2007a: 297). Phase 2.2 sees an increase in the number of decorated sherds, with motifs including chevrons, curved and straight lines (ibid).

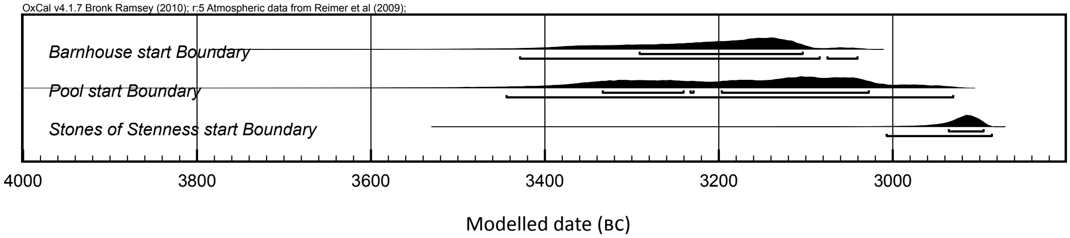
At Stonehall, the earliest date pertaining to Grooved Ware use is 4395 ± 40 BP (AA-51376: 3108–2906 cal BC (93.8% probability) (R Jones pers comm), suggesting possible contemporaneity with the Pool material. At Crossiecrown – spatially the closest Neolithic settlement to Quanterness yet discovered – there is currently some uncertainty as to identifying the earliest determinations likely to be associated with Grooved Ware, so the dating of the incised Grooved Ware there remains unclear (R Jones pers comm). The majority of the Grooved Ware assemblage at Skara Brae is in a later style, and neither the recently-obtained suite of 74 AMS dates on cattle bones (Clarke pers comm) nor the previously obtained dates, as discussed by Buck et al (1991) and subsequently by Ashmore (1998; 2005), pertain to the small amount of incised Grooved Ware from the earliest layers of Childe's excavations, and so this site will not be discussed further.

Incised Grooved Ware, some of it strikingly similar to the Quanterness vessels, has also been found beyond Orkney, for example at Balfarg henge, Fife (Mercer 1981: figs 43 and 44 and note especially figs 43.7 and 16 and fig 44.24) and at Knowth passage tomb 6 in the Boyne Valley, Ireland (Eogan 1984: fig 118).[7] This pottery appears to fall towards the late end of the ranges discussed above for Orkney. At Knowth passage tomb 6, for example, three AMS determinations from calcined human bone found in the immediate vicinity of the pot (illus 20, no 5) cluster tightly (when modelled) in the range *c 3000–2900 cal BC* (Schulting et al forthcoming), virtually identical to the dates for the Stones of Stenness. Note, however, that as with most material found in chamber tombs, the association between the dated bone and the pot cannot be guaranteed. At Balfarg henge the (admittedly lower quality) conventional dates obtained from bulk samples of alder charcoal in the main timber circle produced yet later dates (of 4180 ± 50/110 BP, GU-1160, and 4035 ± 50/110 BP, GU-1161 respectively: Mercer 1981: 145). However, both sites are outside of Orkney, and the chronology of the spread of Grooved Ware remains poorly known (cf Ashmore 2004). That the practice of using Grooved Ware may have spread to mainland Scotland before *c* 3100 BC is suggested by the dating evidence from Milton of Leys, near Inverness, where four samples of short-lived material (one of which is associated with Grooved Ware) attest to activities spanning from 4540 ± 65 BP (AA-

45644) to 4490 ± 50 BP (AA-45647) (Conolly & MacSween 2003). These are modelled here as providing a start date ranging from *3600–3040 cal BC* (95.4%) or *3380–3160 cal BC* (68.2%). (The Grooved Ware from this site does not have incised decoration, however, but includes one pot with applied vertical ribs and another with impressed cord decoration.)

Considering all the evidence presented above, it appears that the use of Grooved Ware probably preceded *c* 3100 BC, but how long before that is difficult to assess, owing both to the problems presented by the calibration curve of the late 4th millennium BC, and to the still limited numbers of high-quality radiocarbon determinations from stratified contexts bearing the early, incised style. The stylistic, stratigraphic and chronological evidence suggests that the incised Grooved Ware from Pool is among the earliest pottery of this tradition, with the Barnhouse, Quanterness and Stenness pottery probably post-dating it, but not necessarily by very long (cf Ashmore 2005: 387). While a pre-3100 BC use of this pottery is indicated at Barnhouse and Pool (see above for discussion of the latter), the Stenness assemblage (and similar Grooved Ware elsewhere) suggests that the particular kind of Grooved Ware seen at Quanterness might date no earlier than *c* 3000 BC (illus 23). Equally, of course, it must be recognised that even the earlier, incised form of Grooved Ware may have had a currency of perhaps a century or more, so that the later date of the assemblage from the Stones of Stenness need not contradict the earlier evidence from Barnhouse; both series consist of high-quality AMS determinations, primarily on short-lived materials, and there is clearly a real difference between their modelled start dates, despite the problem of the calibration plateau (illus 25). Moreoever, a close connection between the pottery from Barnhouse and Quanterness has been proposed, as discussed above, with some vessels possibly having been made at the settlement being deposited in the tomb (Jones 2000; 2005). At the same time, it must be acknowledged that the new Quanterness results, while providing good evidence for the deposition of human remains well before 3100 BC, unfortunately shed no particular light on the first deposition of pottery in the monument, since there is no means of determining – short of direct dating of charred residues on the vessels – the chronological relationship between the two (cf Barber 1988; 1997). Chamber tombs are not the ideal contexts from which to investigate this question. The question also remains as to why there is no 'Unstan Ware' or other vessels attributed to this earlier horizon at Quanterness: was it a question of cultural choice?

This uncertainty about the exact 'start date' for the use of Grooved Ware makes it hard



ILLUS 25 Modelled start dates for activity at the Grooved Ware sites of Barnhouse, Pool and the Stones of Stenness (Hunter 2000; Ashmore 2005; Sheridan & Higham 2006; 2007)

to resolve the question of the chronological overlap (if any) between the use of Grooved Ware and non-Grooved Ware (to use a less contentious term than 'Unstan Ware') (Renfrew et al 1976; Renfrew 1979; Clarke 1983; Henshall 1985; Davidson & Henshall 1989: 87, 90; Ashmore 2000). The evidence from Pool (and possibly also Knap of Howar), albeit inadequately dated, suggests a step-wise change from pre- and non-Grooved Ware to Grooved Ware, while the evidence from the recently excavated settlement at Wideford, not far from Quanterness – where the largest assemblage of non-Grooved Ware has been found – could be interpreted as either indicating no overlap, or a modest overlap (R Jones pers comm). The Isbister dating evidence, discussed above, could be taken to indicate up to two centuries of overlap (until *c* 3000 BC) – or perhaps longer, if the early 3rd millennium activities at the monument were associated with pottery. Here again, however, as with chamber tomb evidence in general, there is no guarantee that the non-Grooved Ware pottery there was contemporary with the dated bone. Thus, while it is now possible to state with confidence that non-Grooved Ware pottery was in use in Orkney from around the 36th century BC, thereby pre-dating the appearance of Grooved Ware by some centuries, it is still uncertain whether there was a significant period when both styles were in contemporary use. As far as the absence of non-Grooved Ware at Quanterness is concerned, we suspect that this was indeed a matter of deliberate cultural choice.

QUANTERNESS AND THE ORIGIN OF MAES HOWE-TYPE PASSAGE TOMBS: IRISH CONNECTIONS

The new dates for Quanterness are also pertinent to the question of whether Maes Howe-type passage tombs emerged as a result of the adoption of Irish monument building practices by people from Orkney, as had been suggested by several previous commentators (eg Henshall 1972: 268; Sheridan 1986; 2004a; cf Renfrew 1979: 210 for a critique, and Davidson & Henshall 1989: 90 for a retraction, of Henshall's original opinion). A detailed argument in favour of this view (Sheridan 1986; 2004a) has highlighted the many points of similarity linking the builders and users of Middle/Later Neolithic passage tombs in Orkney and Ireland (especially in the Boyne Valley), citing evidence such as the cruciform chamber shape, solstitial orientation (albeit in opposite directions, with the entrance at Newgrange facing the midwinter solstice sunrise, while that at Maes Howe faces the midwinter solstice sunset), the use of 'passage tomb art' (especially in spiral and other curvilinear designs) and the shared use of maceheads. The imposing yet unstable tower-like shape of the cairn – a feature noted by Childe in his excavation of Quoyness (Childe 1952: 134) and by Sharples in his discussion of the Pierowall passage tomb (Sharples 1984: 116) – can also be cited in support of this view, given the drum shape of the cairns covering the largest Irish passage tombs. This model, in which the construction of Maes Howe-type passage tombs is seen as a deliberate strategy by ambitious and widely travelled members of the Orcadian elite to enhance their power by appropriating an exotic tradition, is capable of accommodating the differences observed between Orcadian and Irish passage tombs (eg in the choice of grave goods, or details of the spiral design, or use of inhumation rather than cremation, or more angular shape of Orcadian chambers – the latter relating to the nature of the local building stone).

The Maes Howe-type passage tombs represented a step change in the tradition of passage tomb construction in Orkney, and were part of a strategy of conspicuous consumption of effort on monument building (cf Trigger 1990), which can also be seen in the building of increasingly large and elaborate stalled cairns, as for example at Midhowe (Davidson & Henshall 1989: 146–8). The long-distance external contacts of the Orcadian passage tomb builders are echoed in those of the builders of the largest Boyne Valley passage tombs, extending as far as Iberia (as most recently documented by Stout & Stout 2008), and the undertaking of such long journeys can be recognised as an example of what Mary Helms has called 'cosmological acquisition' (Helms 1993; cf Helms 1988, and see Needham (2000) for another example, linking Early Bronze Age elites in Wessex and Armorica).

So much for the theory: what about the chronological relationship between Quanterness and developed Irish passage tombs? In 1979, Renfrew stated: 'We should note here that the construction of Quanterness was approximately contemporary with that of such Boyne passage graves as New Grange. It preceded that of Tara, although probably later than the building of Knowth …' (Renfrew 1979: 210). Fortunately, in addition to the new dates for Quanterness, there are now significant numbers of reliable AMS dates for the Knowth cemetery and for Tara resulting from two recent dating programmes, providing a firmer basis on which to compare their chronologies.

A Bayesian model for the Mound of the Hostages, Tara, places the start of deposition of human bone there at *3345–3095 cal BC* (95.4%), with the main phase of activity in the range *3285–3075 cal BC* (O'Sullivan 2005; Bayliss & O'Sullivan in press). The preferred model for a total of 66 new determinations on human bone from nine passage tombs (of varying sizes and designs) at the Knowth cemetery places the start of deposition of human remains there in the range *3200–3050 cal BC* (95.4%); although there are hints of some earlier activity at Knowth, perhaps from *c 3400–3300 cal BC*, this cannot be associated with a specific tomb type (Schulting et al forthcoming). Of special relevance here is the small amount of Grooved Ware found at Knowth, including sherds from the aforementioned early style vessel found in a recess of the cruciform-chambered Tomb 6, which also produced three determinations on calcined human bone clustering tightly in the range *c 3000–2900 cal BC* when modelled (Schulting et al forthcoming). It has been argued elsewhere (Sheridan 2004a) that the appearance of Grooved Ware in Ireland at the beginning of the 3rd millennium is, like the appearance of pestle and ovoid maceheads, an example of the adoption of Orcadian material culture by Irish passage tomb users.

The dating evidence for Knowth and Tara therefore appears to pose a problem for the 'Orcadian adoption of Irish passage tombs' hypothesis if one accepts the Bayesian model's outcome that human remains were being interred in Quanterness from as early as *3510–3220 cal BC* (95.4%) or *3430–3350 cal BC* (68.2%). However, there are a number of complicating factors to consider. Firstly, the Bayesian models for both the Mound of the Hostages and the Knowth complex refer to the deposition of human bone, and not to the construction of those monuments: at Knowth in particular, the main period of bone deposition could have post-dated the construction of the passage tombs by some time, though of course it is difficult to argue from absence of evidence. Furthermore, these models still do permit the possibility of initial deposition in the 33rd century BC, which would not be incompatible with the estimated early activity at Quanterness, without the possibility of saying which came first. There is also the possibility that earlier remains were gathered up from other, earlier tombs and deposited at Quanterness, though this is here considered as unlikely, for the reasons discussed above.

While there are undoubtedly contacts between Ireland and Orkney during the Middle/Late Neolithic, their precise nature and timing remains unclear (Renfrew 1979: 201–2; Sharples 1984). The Maes Howe group of chamber tombs shares features with the passage tombs of the Boyne Valley, though, as one might expect, more local influences can also be traced from the Orkney–Cromarty tradition. In the other direction, Grooved Ware – an Orcadian innovation – appears in Ireland by (or around) the end of the 4th millennium BC (Sheridan 2004a). Thus, a period of mutual influences involving contacts between Ireland and Orkney might be envisaged over some centuries during the late 4th and early 3rd millennia BC.

PALAEODIET AT QUANTERNESS

Orkney is unique in Scotland for the quality and quantity of both its surviving Neolithic architecture and its bone preservation. It is thus possible to compare the stable carbon and nitrogen isotope data from Quanterness with zooarchaeological and, to a lesser extent, palaeobotantical data. The site is also of considerable interest in terms of its 'peripheral' position in Neolithic Britain (though the applicability of this concept is debatable given the richness of the Orcadian record for this period) and, more importantly, the presumed importance of marine resources. It is arguably the case that, given the shortened, if intense, growing season and the islands' exposed position both to Atlantic gales and to North Sea storms, farming in Orkney would have been a riskier enterprise than for many other locations in Britain. Countering this impression, however, is Orkney's abundance of fertile, low-lying soils and the warming influence of the North Atlantic Drift (the 'Gulf Stream') (Davidson 1979; Schulting et al 2004). From historic accounts, there is no doubt that farming has been a viable, if sometimes uncertain, way of life for Orcadians (Fenton 1978).

The mammalian faunal remains recovered from Quanterness are dominated by sheep, with very young animals particularly well represented (Clutton-Brock 1979). As with many other chamber tombs, however, the origins of the assemblage are likely to reflect a combination of intentionally introduced remains and natural accumulation (eg animals sheltering in the monument, or introduced by predators or scavengers: Barber 1988). The dominance of domestic fauna is also seen at other Orcadian Neolithic sites (Childe 1952; Barker 1983; Dockrill et al 1994; King 2005; Bond 2007; Dockrill et al 2007; Card 2010), including Knap of Howar, which has produced the earliest known Neolithic faunal assemblage (Noddle 1983; Ritchie 1983; Tresset 2003; Harman 2009). Cereals, most notably barley, have also been found at a number of sites, including the earlier Neolithic settlements at Knap of Howar, Pool and Tofts Ness, as well as the later Neolithic settlements at Barnhouse and Skara Brae (Dickson 1983; Dickson & Dickson 2000; Hinton 2005; Bond 2007; Dockrill et al 2007).

While no remains of marine mammals were found at Quanterness (Clutton-Brock 1979), excavations did yield a small but diverse assemblage of fish remains, with rockling, wrasses, flounder, ling, scad and red sea bream being noted among the 29 bones that were identifiable to species (Wheeler 1979). Otters and seabirds may be responsible for the introduction of some of the smaller fish, but Wheeler concluded that the majority of the assemblage was anthropogenic. He further suggested that the presence of a

Illus 26 View north from Quanterness towards the Bay of Firth, and the multi-phase Neolithic settlement at Crossiecrown (photo: Rick Schulting)

number of these species was indicative of offshore fishing, though this has been disputed by Colley (1983a; 1983b). Thus, there does seem to be something of a disjunction between the zooarchaeological and isotopic evidence reported here. Assuming that the fish remains are indeed the result of human consumption (and that they are contemporary with the human bones), to judge from the carbon and nitrogen isotope data they must have formed only a minor dietary component, of no more than *c* 5% protein intake on average. Alternatively, fish may have made a more substantial contribution to the diet at particular times, for example during years when crops and/or herds did poorly. Such periodic high consumption would not be readily apparent in isotopic measurements on adult human bone collagen, which reflects averaged protein intake over a period of approximately a decade (Stenhouse & Baxter 1979; Robins & New 1997; Hedges et al 2007).

Therefore, the stable isotope results from Quanterness provide additional confirmation of the absence of any significant contribution of marine protein in Neolithic diets across Britain (Richards et al 2003), making an important contribution to ongoing debates on this subject (Milner et al 2004; Richards & Schulting 2006). The lack of clear evidence for marine resource use is particularly interesting in the context of Orkney, given not only Quanterness' proximity to the sea (today some 800m, though somewhat more distant during the Neolithic given postulated relative sea level rise since that time, eg Smith et al 1996) (illus 26), but also the general position of the archipelago as a whole, surrounded by relatively productive waters. Many researchers previously have assumed a greater role for marine resources in the Orcadian Neolithic than is indicated by the stable isotope results (Renfrew 1979: 200; Clarke & Sharples 1985: 77). But Quanterness does not stand alone in this regard, with human bones from other Scottish Neolithic chamber tombs also showing strongly terrestrial signatures (Schulting & Sheridan in prep). The recent programme of AMS radiocarbon dating and stable isotope analysis on humans from the chamber tomb of Holm of Papa Westray North pushes evidence for predominantly terrestrial diets back to *c* 3600 cal BC, which is at or very near the onset of the Orcadian Neolithic as currently understood. The results here do suggest the possibility of a small contribution (less than *c* 15%) of marine protein, but this may have derived at least in part from the consumption of seaweed-eating sheep (Schulting et al 2004; Balasse et al 2006; Schulting & Richards 2009). Further isotopic analyses on human and faunal remains from Quanterness are currently underway.

Admittedly, more results from other sites would be useful in providing additional corroboration, and in investigating the possibility of minor contributions of marine resources between Orcadian sites and through time, as well as between Orkney and the Scottish mainland. Stable isotope analysis is currently being undertaken on human remains from Isbister, and this will provide a useful point of comparison with Quanterness (David Lawrence pers comm 2010). On present evidence, Neolithic populations in Orkney seem to have been fully committed to a farming way of life from their initial appearance, and to have remained so throughout the Neolithic period. But the patterning in the Quanterness stable isotope results suggests that other avenues of investigation may be more worthwhile, involving changing farming practices over time.

CONCLUSIONS

Phrased in the most cautious manner possible, the present dating project indicates that the earliest human remains deposited in the Quanterness passage tomb fall within the period *3510–3220 cal BC* (95.4% probability). The need for such caution is predicated on the idea that remains deposited in other locations, most probably other monuments, may have been removed to Quanterness as part of a re-alignment or re-organisation of the Orcadian mortuary space (Richards 1988; 1998). However, both the dating programme and the ongoing re-analysis of the human skeletal assemblage have thus far provided no firm support for this scenario, and it may be that we can speak instead of the actual construction and use of Quanterness for the interment of the newly deceased within this timeframe. This does not preclude the possibility of there having been some importation of human remains from elsewhere, since the presence of the small bones, arguing against excarnation, as discussed above, need not apply to the whole period of use of the monument. While the wider comparison with other Orkney chamber tombs has necessarily been preliminary (in the absence of new dating programmes and Bayesian analyses), the present impression is that the use of this large chamber tomb does indeed overlap with that of the stalled cairns of the Orkney-Cromarty tradition, with their 'Unstan Ware' associations.

The augmentation of the radiocarbon record with a series of high-quality determinations for Quanterness addresses one of the most pressing problems facing Orcadian Neolithic archaeology (as highlighted, for example, by Ashmore 2000; 2005 and Renfrew 2000). Yet, as will be clear from the foregoing discussion, the currently available dating evidence for Quanterness, for other Orcadian chamber tombs and for Orcadian Neolithic pottery traditions, despite considerable recent improvements in precision, still does not allow us to resolve some of the long-standing key questions surrounding this period of prehistory. While the late 4th millennium calibration plateau presents considerable challenges to this effort, there are indications that the problem is not insurmountable, given sufficient numbers of AMS radiocarbon determinations – ideally from good stratigraphic contexts – combined with Bayesian modelling. Yet many more high quality dates are needed before we can further refine our ideas and begin to choose more confidently between various alternative scenarios. Together with recent improvements in dating and statistical modelling, the recent explosion of new discoveries and new excavations, particularly of settlements and ceremonial structures (eg R Jones 2005a, b, c; R Jones et al 2010; Card 2010), presents an unprecedented opportunity in this respect, to improve our understanding of Orcadian Neolithic society, both in life and in death, and to impart a sense of history to prehistory.

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ENDNOTES

1 All dates mentioned in the text are calendar dates BC; the prefix 'cal' is used when referring to specific radiocarbon dates and to Bayesian-modelled dates.

2 The term 'chamber tomb' (rather than the commonly used 'chambered tomb') is used throughout to describe monuments containing a burial chamber (usually megalithic). The term 'chambered' is reserved for descriptions of the cairn, since it is the tomb's *cairn* that is chambered.

3 Excluding three much later determinations from an adjacent Iron Age roundhouse.

4 Co-ordinating the existing human bone archive with Chesterman's notes has not been straightforward, and identifying a particular fragment of bone (in a collection of 10,500 entries/fragments) was impossible at the time of sample submission because the laborious process of transferring the notes onto a database and cross-referencing these with the information on the specimen bags was not yet complete. Elements attributed to the skeleton in Pit C have since been identified and, as this paper went to press, a result of 4115 ± 29 BP (UBA-18424: *2865–2577 cal BC*) was obtained on a left ilium, SF 4596.01 (highlighted in Chesterman 1979, fig 36). This is indistinguishable from one of three previous results from Pit C, of 4139 ± 60 BP (Pta-1606; *2884–2500 cal BC*), supporting this date for the burial, over the two later results purportedly from the same individual (see Table 2).

5 New AMS determinations are being obtained for Knowe of Rowiegar by Meg Hutchison at the Marischal Museum, University of Aberdeen.

6 Four of the AMS dates discussed here replace previously obtained determinations on the same bones by the Oxford Radiocarbon Accelerator Unit, which had been affected by contamination during sample sample preparation: see Sheridan and Higham 2006 for details.

7 Note that the use of incision as a Grooved Ware decorative technique is not limited to its earliest versions, as demonstrated for example by the material from Durrington Walls, securely dated

to the 26th century BC (Mike Parker Pearson pers comm). However, the incised Grooved Ware discussed here does belong to the initial phases of Grooved Ware use.

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