Old bones or early graves? Megalithic burial sequences in southern Sweden based on 14C datings

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Abstract

Megalithic tombs have since long been a focus of debate within the archaeological research field, not least regarding their emergence, use life and the various bursts of building activity in different regions and periods. The aim of this study is to investigate the temporal span of the main burial sequences in the conventional megalithic grave types of southern Sweden, with special focus on the less studied gallery graves. In Scandinavia, megalithic tombs are divided into three main types: dolmens, passage graves and gallery graves. Here, this prevailing typological seriation was tested. The study was based on 374 14C dates from unique individuals selected from 66 tombs. The form, layout and dating of the different types of tombs were studied in order to examine regional and chronological variation in the use of megaliths. By comparing sum plots, KDE models, individual 14C dates and typology of artefacts, the existing chronologies were evaluated. The 14C dates from dolmens and passage graves more or less agreed with the conventional chronology, while the presence of early skeletons in gallery graves was unexpected. The results indicate that megalithic graves appeared more or less simultaneously in southern Sweden and were first used around 3500–3300 cal BC. The dolmens and passage graves were used contemporaneously, although the proportion of early dates supports a slightly earlier start of the dolmens. Some of the gallery graves may also have been introduced at this time, although reburial of old bones cannot be ruled out.

Keywords Megalithic tombs · Radiocarbon dating · Burials · Neolithic and Early Bronze Age · Southern Sweden · Relics · Gallery graves

Introduction

The emergence and spread of megalithic graves in Europe has been in focus of a long lasting and still ongoing debate (e.g. Chapman 1981; Childe 1925, 1950; Joussaume 1985; Montelius 1905; Müller 1998; Renfrew 1973; Schulz Paulsson 2017; Sherratt 1990). In Scandinavia, megalithic graves are divided into three main types: dolmens, passage

graves and gallery graves. The conventional chronology of these megalithic graves is based on Montelius typological seriation from 1874 of chamber forms and axes. According to this chronology, the first megalithic graves were small closed dolmens which evolved to encompass bigger chambers and short passages, and developing into passage graves with longer passages and continued with large gallery graves in the final Neolithic period and then to small closed stone coffins in the Bronze Age (Montelius 1874, 1905). Since then, based on pottery typology and the implementation of radiocarbon dating, the understanding of the chronology of the Neolithic period has improved (see Ebbesen 2011; Sjögren 2003). Furthermore, the internal development of the various grave types has been refined and challenged (e.g. Anderbjörk 1932; Ebbesen 2011; Eriksen and Andersen 2014; Forssander 1936; Johansson 1961; Sjögren 2003). Nevertheless, the terminology of the grave types remains undisputed and the basis of Montelius typological seriation is still the prevailing model used by Swedish archaeologists. The aim of this article is to investigate the chronological span of the main burial sequences

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in the conventional megalithic grave types of southern Sweden, with special focus on the gallery graves.

It is commonly accepted that dolmens and passage graves in South Scandinavia were built at the transition between the early and the middle Neolithic periods (3500–3000 cal BC), in the cultural setting of the Funnelbeaker/Trichterbecher complex (TRB) (Mischka 2014; Persson and Sjögren 1995; Schulz Paulsson 2010, 2017; Sjögren 2003, 2011). Previous research indicates that dolmens emerged slightly earlier than the passage graves, but they were used for the most part contemporaneously (Persson and Sjögren 1995; Schulz Paulsson 2010). In Denmark and Sweden, a few dates as old as 3500–3350 cal BC occur in passage graves (Dehn and Illum Hansen 2006; Schulz Paulsson 2010; Sjögren 2011), while in northern Germany, they seem considerably younger than the dolmens (Furholt and Mischka 2018).

Based on the Danish Jutland graves, Forssander suggested that the oldest gallery graves were a continuation of the passage grave tradition and constructed by Single Grave Culture (SGC) people. Thus, the first gallery graves could be dated to the end of the passage grave period (Forssander 1936). As a result of the introduction of 14C dating, it was uncovered that the TRB was followed by a non-megalithic phase in the late Middle Neolithic (MNB, 2800–2200 cal BC), which complicated theories of a continuous development from passage graves to gallery graves. Gallery graves, which frequently have been ignored in megalithic research, are mainly assigned to the Late Neolithic (LN, 2200–1700 cal BC), even though a few MNB types are known from Danish contexts (Ebbesen 1985; Iversen 2015) and possible MN gallery graves in Sweden have been proposed (Algotsson 1996; Blank 2016).

At present, there is no consensus on the internal chronology of the graves defined as gallery graves or stone cists, although several attempts have been made to construct a chronology based on size and morphology (Anderbjörk 1932; Forssander 1936; Janson 1938; Johansson 1961; Montelius 1905; Nordman 1935). Furthermore, whether the gallery graves are a continuation of the first wave of megalithic tradition in Scandinavia, or a later independent phenomenon, and questions concerning their origin are still unresolved (Anderbjörk 1932; Ebbesen 1985; Forssander 1936; Iversen 2015; Janson 1938; Johansson 1961; Montelius 1905).

The introduction and primary use of megalithic graves is a complex issue due to the lack of preserved datable material related to the initial phase caused by poor preservation, repeated use and reuse of the graves and various prehistoric and modern disturbances. Previous 14C studies (Persson and Sjögren 1995; Schulz Paulsson 2010, 2017; Sjögren 2011) have included all types of available sources, such as bone and charcoal, and although the representativeness and reliability of the samples were scrutinized, samples of uncertain

origin, bones with unknown collagen quality and pre-AMS dates with large standard deviations occur. Preserved bark between slabs of dry walling found in Danish passage graves can be considered to reflect the construction phase (Dehn and Illum Hansen 2006). No similar finds of bark have yet been published from Swedish passage graves or found in dolmens and gallery graves. However, the number of available 14C datings on human remains have radically increased during the last decade (Bergerbrant et al. 2017; Blank 2017; Blank et al. 2018; Fornander 2011; Fraser 2018; Hollund et al. 2018; Sjögren 2011, 2015a; Tornberg 2018) enabling compilations of 14C dates of high quality. This study is based on 374 14C dates from unique individuals selected from a compilation of 499 14C dates on human remains and three dates on domestic animals, of which 158 were not previously published (Appendix 1).

The new dates derive from megalithic graves in Västergötland, southwestern Sweden, and mainly from the sedimentary area of Falbygden, where bone preservation is good. It is one of the few inland areas with dolmens and passage graves, which otherwise are concentrated to the coastlines. Falbygden is an important area for research on Neolithic megalithic graves as it has one of northern Europe's largest concentrations of passage graves, a large number of gallery graves and a few known dolmens. Furthermore, the gallery graves in Västergötland are relatively varied in shape and size compared with other regions and include relatively large graves with construction details such as port-holes, which do not occur in the more southern parts of the country or in Denmark. The many megalithic graves and exceptional preservation of skeletal material provide an ideal case for investigating aspects of the megalithic population and are suitable for detailed comparisons of burial sequences between different types and shapes of megalithic graves. However, as in most regions, old excavations and poor documentation are obstacles that cannot be avoided.

The form, layout and dating of the different types of structures are studied in order to examine regional and chronological variation in the use of the megalithic graves. By comparing 14C dates with geography and morphology of the graves, the existing chronologies of the megalithic graves can be evaluated and the emergence and connectedness of the graves can be addressed. This study is an attempt to estimate the time span in which humans were interred in the megalithic graves during the Neolithic and Early Bronze Age (EBA, 1700–1100 cal BC) and to compare these burial intervals between regions and grave types. Furthermore, the aim was to identify possible continuities or discontinuities in the use of the structures. The potential internal chronological patterns of the Västergötland gallery graves are also investigated and the validity of the conventional grave types is questioned.

Fig. 1 Revised chronology for Sweden

Background

Cultural settings

This article is set between Early Neolithic (EN) and EBA in South Scandinavian terms (Fig. 1). At the onset of the EN, ca 4000 cal BC, TRB rapidly spread in South Scandinavia. The TRB complex is associated with the introduction of agriculture, causewayed and palisade enclosures and ritual depositions in wetland. A new set of artefacts, such as TRB pottery and polished axes, appear as well as flat graves, non-megalithic long barrows and the first megalithic graves (Sjögren 2003). TRB remains have been found across all of southern Scandinavia up to middle central Sweden and southern Norway (e.g. Hallgren 2008; Malmer 2002). According to recent aDNA research, migration was an important factor for the spread of the TRB complex (e.g. Linderholm 2008; Malmström et al. 2015; Skoglund et al. 2012, 2014).

In the MNA, the Pitted Ware Complex (PWC) appeared mainly at Swedish coastal sites, Öland, Gotland, Bornholm, northern Denmark and Åland. Recent research suggests that the TRB and PWC were partly contemporaneous groups (Fig. 1) that coexisted with separate burial practices and subsistence strategies (Eriksson et al. 2008; Fraser et al. 2018). The TRB complex practiced farming and animal husbandry, while PWC groups were reliant on a marine economy, although agriculture was practiced to some extent (Eriksson et al. 2008; Fraser 2018; Sjögren 2017; Sjögren et al. 2019; Vanhanen et al. 2019). PWC burials usually contain single individuals buried in supine position sometimes in large grave cemeteries, and the majority of the graves have been found on the limestone rich islands of Gotland and Öland (Janzon 1974; Larsson 2009; Malmer 2002).

The Battle Axe Culture (BAC) or Boat Axe Culture appears in Sweden during the MNB (Fig. 1) and is, like the Danish SGC, considered a regional group of the European Corded Ware. It is characterized by flat grave burials of one or two individuals in flexed positions accompanied by battle axes and bowls (e.g. Edenmo 2008; Malmer 1962, 2002). The majority of the about 250 known BAC burials are found in

Scania (Malmer 1962, 1975). Limited BAC reuse of megalithic graves also occurs (Blank 2016; Sjögren 2003). In Sweden, BAC appears to chronologically follow TRB which has led to suggestions of internal developments and local transformation (Malmer 1962). However, recent aDNA studies have demonstrated a genetic influx from the Yamnaya on the western steppes, supporting migration of these groups into Europe and further into South Scandinavia (Allentoft et al. 2015; Haak et al. 2015; Malmström et al. 2019).

We use Vandkilde (1996) delimitation of LN (LNI 2350–1950 and LNII 1950–1700 cal BC). However, a later starting point of the LN (2200 cal BC) was chosen in the Swedish context, due to the dating of the previous BAC and PWC and the 14C dates of human remains in LN Swedish contexts (Bergerbrant et al. 2017; Tornberg 2018; this study). The South Scandinavian LN is often viewed as a time of increased social complexity, growing population density, cultural blending and stronger reliance on agriculture (Apel 2001; Artursson 2009; Iversen 2015; Kristiansen and Larsson 2005; Lekberg 2002; Prescott 2005; Vandkilde 1996). It is characterized by complex bifacial flint-working techniques, the continued development of long-house construction, an intensified import of gold and copper artefacts and increased long distance trading networks (Apel 2001; Artursson 2009; Kristiansen and Larsson 2005; Ling et al. 2014; Prescott 2005; Simonsen 2017; Vandkilde 1996;). The first part (2200–1950 BC) of the Scandinavian LN was influenced by Corded Ware and Bell Beaker traditions, and the second part (1950–1700 BC) largely by the Únétice culture of central Europe. LNII is characterized by an increased import of metal objects (Apel 2001; Iversen 2015; Prescott 2005; Vandkilde 1996). Furthermore, the LN is tightly associated with the emergence and use of gallery graves. However, gallery graves are not the only type of LN burials in southern Sweden. Besides collective burials in gallery graves, reuse of dolmens and passage graves, cremations and individual and collective inhumations in flat graves occur (Blank 2017; Forsman 2007; Pappmehl-Dufay 2010; Stensköld 2004; Weiler 1994). As noted in Appendix 1 and remarked in previous research (e.g. Blank

2016), LN reuse appears in all parts of the graves. LN flat graves are mainly found in Scania, and only one has been verified in Västergötland (Djurfeldt 1967).

Megalithic graves

Definitions

Megalithic graves are here defined as graves constructed by large stones. Megaliths in Scandinavia are constructed by stone blocks while chambers built of dry walling, as well as menhirs and cromlechs, are not known. In this study, the definition of dolmens, passage graves and gallery graves is primarily based on Sjögren (2003). According to Sjögren (2003, 80) dolmens are defined as polygonal or rectangular chambers at most 3 m long, without or with a passage less than 1.5 m and with only one roof slab (Fig. 2).

In a recent publication, Eriksen and Andersen (2014) divide the Danish dolmens into four subgroups. Type one has a small closed rectangular or trapezoid chamber up to 3 m long where the long sides mostly consist of one single slab. Type two is of a similar construction but is open and has a lower slab in the entrance gable. Type three is defined by an elongated chamber with an opening and sometimes with a short passage. Type four is characterized by a polygonal chamber with an opening and short passage. The size of the two last types is up to 3 m. Their classification is similar to that of Ebbesen (2011: 42), although they classify the “Stordysser”, with chambers measuring 3 m in diameter and more, as passage graves (Eriksen and Andersen 2014: 41–44). The described typology of Danish dolmens corresponds to Sjögrens definition, although more refined.

Fig. 2 Examples of dolmens. **a** Haga, Bohuslän. **b** Ansarve, Gotland. **c** Nedre Kapellsgården, Falbygden. **d** Slutarp, Falbygden

Passage graves are characterized by chambers with passages longer than 1.5 m perpendicular to the chamber, normally in an eastern or southeastern direction (Fig. 3). Both dolmens and passage graves are constructed above ground and surrounded or covered by mounds or cairns (Sjögren 2003: 80).

Gallery graves are common burial structures in the Scandinavian LN with a variety of designs and sizes. In this study, the term gallery grave encompasses the LN graves usually referred to as hällkistor (slab cists) and stenkistor (stone cists). The term stone cist is also used for graves from the Bronze and Iron Ages, whereas gallery grave denotes graves for successive burials (Ebbesen 2007: 9). In this study, we use Weilers (1994: 56) and Sjögrens (2003: 80) definition of gallery graves: four sided chambers of stone slabs, at least about 2 m long. They are recognized by construction details such as ante-chambers/passages in the gable ends, port-holes, trapezoid chambers, portal stones and multi-roomed chambers (Fig. 4). They were constructed above ground or dug under flat ground or in small natural elevations, and usually covered or surrounded by low mounds or low cairns (Sjögren 2003: 80 Weiler 1994: 56).

The classifications of dolmens and gallery graves overlap in the 2 to 3-m interval, which leads to difficulties to classify certain megalithic graves. Sjögren (2003: 80) defines a group of graves with overlapping characteristics (dolmens/gallery graves) which encompasses graves between 2 and 3 m. In this study, we only use the three main types (dolmen, passage grave and gallery grave) and the classifications are further motivated in Appendix 2.

There are also some construction details which occur in several of the main types, such as niches in chambers, dry walling, kerbstones in circles or squares around the graves/mounds, paved stone floors. Many passage grave chambers were divided into several niches by small slabs, while only single niche slabs appear in gallery graves.

Geographical distribution

In Scandinavia, most of the dolmens and passage graves occur in Denmark and northern Germany (Midgley 2008). In Norway, on the other hand, megalithic graves are scarce with only three to four dolmens located by the Oslo fjord (Østmo 2013: 303). In Sweden, dolmens and passage graves are mainly found in the coastal areas of Bohuslän, Halland and Scania and in Falbygden, in the inland of Västergötland (Fig. 5). Only a few graves are known from the eastern regions: one, possibly two, on Gotland, four in a restricted cluster on Öland, one in Östergötland and one in Västmanland (Hallgren 2008: 110; Sjögren 2003; Tilley 1999). Of the more than 525 known dolmens and passage graves in Sweden, 253 passage graves and four dolmens are found in the 40 × 30 km large area of Falbygden. Furthermore, about 80 megalithic graves of unknown type have been registered there (Persson and Sjögren 2001: 6). TRB occupation has been recognized by stray finds,

Fig. 3 Examples of passage graves. **a** Carlshögen, Scania. **b** Ingelstorp, Scania. **c** Mysinge, Öland. **d** Rössberga, Falbygden. **e** Kyrkerör, Falbygden. **f** Tossene, Bohuslän. **g** Firse sten, Falbygden. **h** Klövågården, Falbygden. **i** Landbogård, Falbygden

settlements and pollen studies between these regions, where no dolmens or passage graves are known.

The main part of the Scandinavian gallery graves, at least 2000, are located in Sweden while only about 120 are known from Denmark (Ebbesen 2007) and ca 20 from Norway (Østmo 2011). In Sweden, they are spread all over the southern regions, with a high density in parts of Småland and Västergötland (Fig. 5). Only a couple of graves have been identified in the more northern landscapes of Medelpad and Ångermanland. The rather modest number of gallery graves in

Scania might be explained by BA mounds covering some of the graves, although later grave constructions covering gallery graves are also suspected in other parts of the country. In Falbygden, about 125 gallery graves have been identified (Blank 2016: Table 1; Sjögren 2003: 81) and some of the unclassified megalithic graves are likely to be gallery graves.

A number of gallery graves, as well as other types of megalithic graves, in Falbygden as well as in other regions have been destroyed by, for example, agriculture (Andersson et al. 2016; Apel 2001; Sjögren 2008). In Falbygden, the

Fig. 4 Examples of gallery graves. **a** Skogsbo, Västergötland. **b** Ångamöllan, Scania. **c** Utbogård, Falbygden. **d** Helles, Kinnekulle. **e** Lilla Balltorp, Falbygden. **f** Fredriksberg, Falbygden. **g** Ranten, Falbygden. **h** Kapellgatan, Falbygden. **i** Backa, Falbygden. **j** Häffinds, Gotland. **k** Carlsgården, Kinnekulle. **l** Prästgården, Herrljunga

Fig. 5 Map of the regions and distribution of dolmens (green dots), passage graves (red dots) and gallery graves (orange dots) in Sweden. 1 lake Vänern, 2 lake Vättern

distribution of stray found flint daggers might indicate removed gallery graves, or destroyed LN flat graves, which however have not yet been verified in this area.

Regional traits

The megalithic graves are characterized by regional traits. The passage graves in Falbygden are rather homogenous with rectangular chambers and often symmetrically placed passages (Sjögren 2003: 18). They are more similar to megalithic graves in Halland and Scania than to the graves in Bohuslän and Jutland.

The Danish gallery graves, like the Scanian and eastern Swedish graves, are generally 2 to 3 m long while most of the graves in southwestern Sweden are between 5 and 7 m long (Ebbesen 2007; Weiler 1994: 56). Furthermore, large gallery graves measuring 8 to 14 m are restricted to southwestern Sweden with concentrations in central Västergötland. The large southwestern Swedish gallery graves have often been described as a local phenomenon, more similar to passage graves and dolmens than to the smaller single roomed gallery graves with fewer burials found in Scania and Denmark (Anderbjörk 1932; Ebbesen 2007; Weiler 1994). Resemblances between the southwestern gallery graves and the early Danish Bøstrup cists in northern Jutland and

Table 1 Number of included megalithic graves and radiocarbon dated samples in various geographical areas

Region	Dolmens		Passage graves		Gallery graves		Total	
	No of graves	No of samples	No of graves	No of samples	No of graves	No of samples	No of graves	No of samples
Gotland	1	18	—	—	3	18	4	36
Öland	—	—	1	29	6	20	7	49
Scania	—	—	6	22	5	25	11	47
Östergötland	1	12	—	—	1	2	2	14
Närke	—	—	—	—	1	5	1	5
Uppland	—	—	—	—	2	5	2	5
Bohuslän	—	—	1	2	1	1	2	3
Falbygden- Västergötland	4	12	11	78	19	104	34	194
Kinnekulle-Västergötland	—	—	—	—	3	18	3	18
Precambrian Västergötland	—	—	—	—	2	3	2	3
Total	6	42	19	131	41	201	66	374

similarities between the smaller gallery graves in Scania and eastern Denmark have been pointed out (Ebbesen 1985; Forssander 1936; Iversen 2015). The origin for Swedish gallery graves has been proposed to be the Danish gallery graves, which in turn have been interpreted as a continuation of the earlier individual SGC wooden coffins or as a new tradition influenced by Western Europe (Anderbjörk 1932:27; Forssander 1936:108,142,145; Iversen 2015: 124; Lomborg 1973:121).

In Scandinavia, port-hole gallery graves occur exclusively in a belt from northern Halland and Bohuslän on the west coast, across Dalsland and Västergötland into Östergötland and Närke. Only a few occur in Östergötland and Närke, while the majority occur in Västergötland. Most of the multi-roomed gallery grave as well as the gallery graves with portal stones are found in the same areas as the port-hole graves. Montelius (1905) argued that the idea of port-hole gallery graves was brought in from Britain to the Swedish west coast, and spread by the Göta river estuary and further into Västergötland by waterways. Other suggestions of the origin of the larger graves and the graves with port-holes have been northern France, Belgium and central Germany, considering the apparent resemblances to, for example, allées couvertes/sépulcrales of northwestern France and the Paris basin, Seine-Oise-Marne (SOM) culture and the galeriegräber in Westphalia and Hesse, Wartberg culture (WBK) (Janson 1938; Johansson 1961; Kaelas 1967).

Burials

In southwestern Sweden, inhumations of at least 130 individuals in passage graves (Ahlström 2009) and about 80 in gallery graves (Lennblad 2015; Retzius 1899) have been confirmed. Studies also show that a considerable number of the megalithic graves were reused for burials and submitted to

various activities during the LN and later periods (Blank 2016; Sjögren 2003). The inhumations in megalithic graves only represent a part of the expected population. Men and women of all ages have been buried in the megalithic graves, and the mix of ages and sex corresponds to a cross-section of a population. Nevertheless, it might be a segment of the population or a certain hierarchical level of the society and/or certain families or groups with common traditions, which were buried in the megalithic graves.

The burial practices in megalithic graves have been the subject of a long-lasting debate. In Scandinavia, the megalithic graves have been described as ossuaries where skeletonised remains were deposited and arrangement of bones was practiced (Hildebrand 1864; Midgley 2008; Shanks and Tilley 1982; Stensköld 2004), while other researchers have argued that they predominantly were used for primary burials (Ahlström 2009; Sjögren 2003; Strömberg 1971a; Weiler 1994). According to the most recent research, the megalithic graves in Sweden were predominantly used for successive inhumations of whole bodies, although cremations sometimes occurred and some variation of the treatment of buried individuals can be observed (Ahlström 2009; Hollund et al. 2018; Sjögren 2015a, b; Strömberg 1968; Weiler 1994). Temporal change (Hollund et al. 2018; Sjögren 2015a) as well as regional variation of burial practices must be considered.

Material

This study is based on 14C dates from unburnt human remains. In Appendix 1, 499 14C results from human remains and three dates from domestic animals, of which 158 have not previously been published, are listed. The appendix also contains C: N ratios when available, detailed information about

the samples and $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of the previous published samples.

We have not included all available ^{14}C dates in the analysis. Instead, our goal has been to select the most reliable dates from as many unique individuals as possible from each grave. A summary of the sample selection procedure is reported in the method section, and a more detailed description of the selection of samples from each grave is presented in Appendix 2. Furthermore, Appendix 2 contains a brief description of the graves and the related finds and criteria for the classification of the graves.

A total of 374 ^{14}C dates from 66 megalithic graves were included in the comparative analysis. The distribution of the

samples depends on the geographical spread of the different types of megalithic graves as well as the conditions for bone preservation. Most of the samples (358) derive from areas rich in limestone. ^{14}C results from dolmens are the least in number, deriving only from six sites. Most of the samples from passage graves originate from graves in Falbygden, but Scania, Bohuslän and Öland are also represented by a few graves. Samples from gallery graves have the widest geographical distribution but more than half of the samples derive from Falbygden (Table 1; Fig. 6).

The available human remains can only be considered to represent part of the original burials and thus the whole burial sequences might not be covered by the included radiocarbon

Fig. 6 Overview of included dolmens (blue squares), passage graves (green dots) and gallery graves (red triangles). The graves are further described in Appendix 2. In the above figure, sedimentary areas in Sweden are marked in light yellow. The term Falbygden is used in an expanded sense and encompasses the entire sedimentary zone including the areas surrounding the northern Billingen mountain. Numbers refer to site numbers in Appendix 1 and 2

Fig. 6 (continued)

dates. Most of the graves were partially excavated, robbed, disturbed and reused in later times, and bones were often disregarded due to bad preservation or lack of interest. Furthermore, only a small quantity of the originally described bones in most graves remain in the depository, generally well preserved skulls. The preservation of the oldest bones in megalithic graves with successive depositions was deteriorated by the high degree of fragmentation (Sjögren 2015a). Hence, the earliest dates could be expected from the less well preserved bones which often were left or discarded during older excavations.

Method

Sampling strategy and selection criteria

We choose only to include samples from unburnt human remains to minimize the sources of error. By doing so, the risk of dating remains from earlier settlement layers and later activities was reduced. Furthermore, the old wood effect, where dates are obtained on wood or charcoal from a long-lived tree sample, which can influence dates on cremated bones (Snoeck et al. 2014; Van Strydonck et al. 2010), was avoided.

For this study, 155 individuals buried in megalithic graves in southwestern Sweden, mainly from Falbygden, were sampled for ^{14}C analysis. The samples derive from bone material stored or exhibited for different lengths of time in various depositories (SHM, National historical museum; SM, Skara museum; FM, Falköpings museum; GU, University of Gothenburg). The skeletal remains originated from megalithic graves excavated between 1860 and 2014 (Appendix 2). The methods differ between the excavations as does the quality and quantity of the documentation. In earlier excavations, the bone material was often left, and if collected, the skulls were the focus (Retzius 1899). Hence, this has restrained the sampling strategy. To avoid sampling from mixed contexts and uncertain origins, the documentations were investigated and most of the sampled bones had already been marked up during excavation by experienced archaeologists.

In a first phase, skeletal remains, primarily teeth, from as many individuals as possible in a number of graves with well-preserved human bones were selected. Teeth were chosen to minimize the destructive intervention on the human remains as complementary analyses were conducted to investigate human mobility and diet (protein residues in dental calculus, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in collagen, $\delta^{13}\text{C}$, $\delta^{18}\text{O}$, $^{87}\text{Sr}/^{86}\text{Sr}$ analyses of the enamel as well as aDNA sampled on tooth roots). The results of these analyses are presented elsewhere.

Further samples of single or few individuals from graves within Falbygden, of various types, shapes, sizes and orientations were collected and analysed. Samples of small postcranial bones from gallery graves with unexpectedly early dates on cranial bones were also targeted, to resolve if the dates originated from primary burials or reburied relics.

Dating and analyses of stable carbon and nitrogen in collagen were, with a few exceptions, performed by the ^{14}C Chrono Centre, Queens University, Belfast. The Belfast laboratory employs methods with several cleaning steps including ultra-filtration and AMS measurement. The sample preparation and analysis is further described in Reimer et al. (2015).

The dates were complemented by previously published ^{14}C dates from megalithic graves in southern Sweden (Appendix 1). The ^{14}C dates were individually evaluated and the most reliable dates representing as many unique individuals as possible were included in the analysis. Conventional dates are avoided as much as possible, as these are considered less accurate. Dates with standard deviations exceeding ± 90 are not included in the analysis. Dates with known $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ values and C: N ratios were considered to be most reliable. However, in some occasions, the $\delta^{13}\text{C}$ values are measured from the AMS reported with the ^{14}C dates and are not as accurate as the values obtained by the separate isotopic analysis. These less reliable $\delta^{13}\text{C}$ values are marked in blue in Appendix 1. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of the samples analysed for this study were all obtained by separate isotopic analysis. The

recommended C: N values for well-preserved collagen are 2.9 to 3.5 (Bronk Ramsey et al. 2004; van Klinken 1999). None of the samples conducted for this study were outside this range, although some of the previous published samples were marked in red in Appendix 1.

A general problem is that the calibration curves have irregularities with plateaus, for example, at 3300 to 3000 and 2800 to 2600 BC that extend the calibrated probabilities in time. Another issue is the different quality of pre-treatment in various laboratories. In some cases, when the results were unexpected or deviating from the rest, the sample was re-dated at another laboratory, leading to a confirmation or rejection of the date. Uppsala dates, which have no reported C: N ratios, were treated with caution as problematic dates have previously been reported (Sjögren 2011). In the case of two equally reliable dates from the same individual, they were combined.

The artefacts collected from the graves were also taken into account. The information from the graves was assembled from publications and archives (mainly ATA, Stockholm), which in the case of Falbygden gallery graves was complemented by a reexamination of the finds stored at SHM, Stockholm, Falbygdens museum and Skara museum. In this study, the emphasis was to evaluate each sample according to its context.

The included dates are marked in green in Appendix 1, while the unreliable dates are marked in red. The remaining dates are considered reliable but were for different reasons not used (Appendix 2). In this study, we focus on the burials in the Neolithic and EBA, while later reuse is only touched upon in Appendix 2.

Reservoir and ground water effects

The consumption of marine foods can affect radiocarbon dating results. This is caused by the fact that carbon consumed by organisms in the ocean is older than that consumed by organisms on land. Thus, samples from marine life and from organisms that consumed a lot of sea-based foods may appear older than they are when analysed (Siegenthaler et al. 1980). Humans that consume large amounts freshwater fish from sources with hard water, rich in dissolved ancient calcium carbonates, have elevated levels of old and ^{14}C -depleted carbon in their systems (Philippsen 2013). Hard water reservoirs are common in limestone rich areas. Reservoir effects caused by carbon in old organic material are also present in soft water lakes (Björck and Wohlfarth 2001; Björck et al. 1998). The reservoir offset both concerning fresh water (FRE) and marine water (MRE) is complex and varies on a spatial and temporal scale. The global average of MRE in ocean surface water is about 400 years. Some factors affecting the reservoir effect in the Baltic sea is the topography of the sea floor, affecting the saline inflow, and freshwater runoff from river systems

(Lougheed et al. 2013). The freshwater reservoir effect in inland lakes and rivers fluctuates heavily, even within the same body of water (Philippsen 2013). In Germany, large and variable FREs of 400 years and more were measured in aquatic modern species (Fernandes et al. 2016). Temporal changes in catchment areas and in climate can influence the local FRE.

By measuring the carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotopes in bone collagen, information of the protein intake can be retrieved and possible reservoir effects can be estimated. Delta 13C can discern a diet based on marine from terrestrial sources, while $\delta^{15}\text{N}$ reflects the trophic level of a consumer with higher levels higher up in the food chain (Sealy 1986; Schoeninger et al. 1983). According to Schoeninger et al. (1983), a $\delta^{13}\text{C}$ value in human collagen significantly higher than -20‰ indicates an intake of marine foods. Consumption of fresh water protein can be uncovered by high levels of $\delta^{15}\text{N}$ in collagen.

There is no absolute $\delta^{13}\text{C}$ or $\delta^{15}\text{N}$ threshold determining when a sample might be biased by FRE or MRE, and recent studies have shown that the $\delta^{13}\text{C}$ values and $\delta^{15}\text{N}$ values of FRE biased samples are not as distinct as previously thought (Boethius et al. 2017). Fernandes et al. (2016: 291) emphasize the importance of considering that there are in fact multiple food groups and that the isotopic signals of the different groups may differ significantly when interpreting $\delta^{15}\text{N}$ collagen values. Nitrogen isotope fractionation is complex and not completely understood, and the enrichment seems to vary within and between species with a rather high variability of $\delta^{15}\text{N}$ values among individuals with a similar diet (DeNiro and Schoeninger 1983; Fernandes et al. 2012; O'Connell et al. 2012). Thus, the interpretation of the origin of the protein might differ depending on which fractionation level is assumed. Inter and inner bone variability of collagen $\delta^{15}\text{N}$ has also been noted (Balasse et al. 1999; DeNiro and Schoeninger 1983). Furthermore, $\delta^{15}\text{N}$ values can be affected by breastfeeding, the consumption of juvenile herbivores (as these are one trophic level above their mothers), physiological stress and the intake of manured crops (Bogaard et al. 2013; Fraser et al. 2011; Fuller et al. 2006; Hedges and van Klinken 2000; Schoeninger et al. 1983). Fernandes et al. (2016) recommend complementary reference chronologies independent from human material, based on, for example, 14C dates from samples of terrestrial plants and/or animals and typological datings of artefacts.

In European Neolithic populations, $\delta^{15}\text{N}$ values above 12‰ are often interpreted as biased by consumption of aquatic foods (Richards et al. 2003; Schoeninger et al. 1983). Eriksson et al. (2008) suggest that $\delta^{15}\text{N}$ of 13‰ or higher might be caused by the consumption of fresh water or marine fish/mammals, while samples with $\delta^{13}\text{C}$ values higher than -18‰ could be biased by a marine reservoir effect.

The samples from southwestern Sweden do not go above these values. As already mentioned, the megalithic graves in

inland as well as coastal areas were primarily used by agricultural populations with terrestrially based diets (Eriksson et al. 2008; Eriksson and Lidén 2013; Sjögren 2003). In Falbygden, the occurrence of fish bones at Neolithic sites is rare and the diets of the megalithic population both during the MN and LN were heavy reliant on plant foods (Blank 2019; Sjögren 2017). Hence, although a possible FRE effect (Sjögren 2003: 95) cannot be ruled out, in this case, it would have had a marginal impact (cf. Hornstrup et al. 2012; Sjögren and Price 2013).

A few samples from the Baltic Sea (Öland and Gotland) show possible signs of a reservoir effect with elevated $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values. A Marine reservoir offset of 70 ± 40 was used to correct for reservoir age on the PWC on Gotland (Eriksson 2004) and on some MN individuals in a study of megalithic graves on Gotland (Fraser 2018). Different offsets have been suggested for other time periods and for nearby areas in the Baltic region. For example, according to Lindqvist and Possnert (1999), the offset during the Mesolithic did not exceed 100 years. However, this is probably an underestimation as the difference may be as high as c. 300 years (Boethius et al. 2017). The MRE during the Neolithic period in the southeastern Baltic was estimated to 190 ± 43 and the FRE to 320–510 and above (Piličiauskas and Heron 2015). The MRE in modern time was estimated to 200 to 300 years in the surroundings of Gotland by Lougheed et al. (2013). Due to the current uncertainties surrounding the marine and fresh water reservoir effect, no corrections were used in this study. Instead, the results that might be affected by a reservoir effect which are marked in yellow in Appendix 1 and discussed in Appendix 2.

Sum calibrations, Bayesian modelling and kernel density estimation

The calibrations, plots and models were conducted by using the OxCal online software version 4.3.2 (Bronk Ramsey 2017) based on the IntCal13 atmospheric curve (Reimer et al. 2013). The two-sigma probability interval (95.4%), recommended by Millard (2014), was used when discussing the 14C results, and the one-sigma probability interval (68.2%) was added in the figures. All dates are presented as calibrated BC.

When dealing with a large amount of 14C dates, multiple plots are impractical for representing the general picture. As an alternative, the plots can be stacked into a summed distribution. The summed plots are a superposition of the individual calibrated distributions where the measurements are treated as independent events. Three main problems with sum distributions have been pointed out: noise as a result of a low number of samples, noise from the calibration process and spread of the dates due to measurement uncertainty (Bronk Ramsey 2017: 1811). The same issues are present in simple calibrated dates. According to Schulz Paulsson (2017: 17), summed probabilities do not inform us about the start, the end or the duration of a series of

events. On the other hand, they take the whole probability span into consideration, and unlike the Bayesian approach, they do not postulate any form of distribution pattern. In this study, sum calibration was used to produce maximum values of the burial spans within the defined categories.

Another approach is to plot the distribution of dates by using the non-parametric method of kernel density estimation (KDE; Parzen 1962; Rosenblatt 1956). This is a widely used frequentist method with no formal priors for the distribution. The advantage of this method compared with the sum function is that the noise from the calibration procedure is reduced (Bronk Ramsey 2017: 1817).

Bayesian statistical approaches for chronological modelling were developed in the late 1980s and early 1990s (e.g. Buck et al. 1991, 1992; Naylor and Smith 1988) and have since become common in archaeological research (e.g. Darvill et al. 2012; Müller 2009; Parker Pearson et al. 2016; Schulz Paulsson 2017; Whittle et al. 2011). For further technical details and thorough discussion of Bayesian methodology, see Bayliss and Bronk Ramsey (2004), Bayliss (2009), Bronk Ramsey (2009).

The concept of Bayesian modelling was summarized by Bayliss (2009: 127) as the following: Standardized likelihoods (“the dates”) $\times$ Prior beliefs (“the archaeology”) = Posterior beliefs (“the answer”). The Bayesian statistical approach unifies radiocarbon results, archaeological information and the high precision curve into one calibration process. To do so, you need stratigraphic or other relational information to be able to identify sequences of the events/burials. If this information is not available, the sequences must be postulated. It is essential that these assumptions are reasonable in order to get a trustworthy model. The fit of the model is indicated by the agreement indexes A_{model} and A_{overall} and should not fall below 60%. A_{model} provides a value for the agreement of the entire model, and A_{overall} is a function of agreement indices of the individual dates. However, the Bayesian method has been criticized for creating artefacts, when prior distributions are assumed. According to Steier and Rom (2000), assumptions about prior distributions implemented in the Bayesian modelling may create artefacts which can result in dates with higher precision but lower accuracy. In this study, a variety of models were tested in Oxcal based on possible interpretations of the 14C dates. Despite the different distributions and boundary functions used in the models, they all showed similarly high agreement indexes. Hence, a general problem with the Bayesian method is that there is no good tool for evaluating different models against each other.

In the case of megalithic graves, there is usually little reliable stratigraphic or spatial information related to events as the graves contain commingled and disarticulated skeletons from successive burials. There are a few cases where sequences of events can be identified, for example, by the separation of floors or superposition of articulated skeletons (Hommerberg 1944; Sjögren 2008; Strömberg 1971b).

In Oxcal, the dates can be grouped into different related, independent or overlapping phases. In addition to the uniform prior (Boundary), there are other options (Sigma_Boundary, Tau_Boundary and Zero_Boundary) which can be used. The pairing of specific boundary functions allow models with, for example, the maximum distribution in the middle, rising frequencies of events and decreasing frequencies of events. The Bayesian models all reduce the grouped dates towards a centre of gravity; the events are in one or another way compressed. This may be useful, when unreliable dates are included that otherwise can distort the results. However, in the present case, the dates have been selected with great consideration of various factors such as samples from earlier or later unrelated activities and errors associated to pretreatment and analysis in order to avoid any misrepresentation of the burial sequences (see above, Appendix 2).

On the other hand, the compilation of dates in this study represents a small part of the expected burials in megalithic graves. Due to preservation conditions and fragmentation of bones and possible clearing out of older burials, the use span of the graves can in several cases be expected to be longer than the dated samples suggest and the dates need to be treated equally and not necessarily be considered outliers. It is important to point out that the categories compared in this study sometimes include a single or few graves, and some of the graves are represented by a small proportion of the expected burials (Table 1, Appendix 2), which affects the result regardless of method used to plot or model the dates.

Bronk Ramsey (2017) recommends KDE modelling when dealing with data lacking reliable prior information. KDE modelling can be described as a mixture of the Bayesian and frequentist methods, where the KDE distribution is used as prior in the Bayesian model (Bronk Ramsey 2017: 1818). Hence, the events are in one or another way compressed and smoothed.

The main purpose of this study was to investigate the most likely use time of the various megalithic graves without intention to shorten the possible use time by conducting Bayesian modelling. Instead, we use sum probabilities complemented by KDE models (Appendix 3) in OxCal to compare the regions and grave types. Nevertheless, we also conducted various KDE plots and models and various Bayesian models in OxCal to compare with the sum plots. Both the KDE plots and KDE models have a tendency to smear out the dates so that gaps sometimes are masked and time intervals elongated.

Result

Use time of dolmens, passage and gallery graves

We started by comparing the 374 14C dates obtained from inhumation burials in the three main types of megalithic

Fig. 7 Sum plot (a), KDE plot (b) and KDE model (c) of 14C dates from megalithic graves (cal BC, 95.4%). Dolmens ($N=42$), passage graves ($N=131$) and gallery graves ($N=201$). KDE plot (b): dolmens $A_{\text{model}}=99.1$, $A_{\text{overall}}=97.6$, passage graves $A_{\text{model}}=90.3$, $A_{\text{overall}}=97$, gallery graves $A_{\text{model}}=74.9$, $A_{\text{overall}}=96.6$. KDE model (c): dolmens $A_{\text{model}}=91.3$, $A_{\text{overall}}=92.4$, passage graves $A_{\text{model}}=96.9$, $A_{\text{overall}}=94.3$, gallery graves $A_{\text{model}}=93.2$, $A_{\text{overall}}=98.9$

graves. The result is presented as a sum calibration, a KDE plot and a KDE model (Fig. 7).

As discussed in the method section, both the KDE plot and KDE model remove the spikes appearing in the sum calibration plot, but the smoothening effect, especially in the KDE plot, also conceals some of the gaps observed in the sum plot, which are actually there if the individual dates are considered (95.4% probability, Appendix 1), and elongates the use time (Fig. 7).

According to the sum plot, a first phase takes off around 3400 cal BC and drops sharply around 2800 cal BC. A second

phase starts shortly after 2200 cal BC and drops about 1650 cal BC. In the sum plot, a small peak, which might be an artefact created by the calibration program, occurs around 3500 cal BC. Furthermore, two smaller plateaus can be observed between 2800 and 2500 cal BC and between 1650 and 1250 cal BC, with some minor spikes continuing into 1100 cal BC.

The KDE model suggests a start already about 3450 cal BC and a first decline in the frequency of dates between 2800 and 2700 cal BC and falling to a low around 2400 to 2200 cal BC. The second phase is marked by an increase in frequency of dates after 2200 cal BC (most marked for gallery graves) which correlates with the sum plots. The second phase sees a decline after 1800 cal BC and ends around 1200 cal BC (Fig. 7). The LN peak for dolmens is weak, and both the passage and gallery graves appear to have been in use for longer times than the dolmens. This might, partly, be a result of the fewer dolmens sampled compared with the two other types.

Despite the variations between the plots (Fig. 7), they all clearly show that all three types of graves were in use simultaneously, with a first phase concentrated to the MNA, accentuated in the dolmens and passage graves, followed by a period with few or no dates, and then a second phase focused to the LNII and EBA, most prominent in the gallery graves.

The start of the burial sequences can also be investigated by comparing the earliest dates in each grave. The earliest dates in dolmens are presented in Fig. 8. At 95.4% probability, one dolmen contains human remains dated to 3500 to 3350 cal BC, four have bones dated to 3600/3500 to 3100/3000 and one dolmen to 3350 to 3000 cal BC (Fig. 8, Appendix 1). Hence, depositions of human remains dated to the ENII can be confirmed with 95.4% probability and is unlikely to be an artefact created by the calibration program. A second date from the same grave confirms this early date (Appendix 1). At 68.2% probability, two of the dolmens contain skeletal remains dated to 3500 to 3350 cal BC, two dated to 3500 to 3100 and two dated to 3350/3300 to 3100/3000 cal BC (only the second Ansarve date is considered, Fig. 8). Thus, in the latter case, a considerable part of the dolmens contain individuals dated to the ENII (33%) and to EN/MN (50%), which favours a burial sequence beginning already in the ENII (Table A1). However, the number of sampled dolmens is low, only six.

According to Fig. 9, a human bone dated as early as 3500 to 3350 cal BC (95.4% probability) occurs in one of the passage graves. Thus, the early start of the passage grave sum plot is due to this date. However, this is only one of 131 included samples from one of 19 passage graves (Fig. 8, Appendix 1). Whether this date is a statistical outlier, a reburied bone or a primary burial is difficult to assess. The oldest dates of most passage graves can be placed in the MNA (3300–3100/2900 cal BC), although earliest dates covering both EN and MNA (3500–3100/3000 cal BC) as well as the transition

Fig. 8 Earliest 14C dates in dolmens. F, Falbygden; ÖG, Östergötland; G, Gotland. The two first Ansarve dates were plotted, as the first one display a slightly elevated $\delta^{15}\text{N}$ value. OxCal v. 4.3.2. Bronk Ramsey (2017); r5 IntCal13 atmospheric curve (Reimer et al. 2013), 1 sigma (68.2%) and 2 sigma (95.4%). Backagården and Frälsegården are each represented by one single date in total

MNA/MNB (3000/2900–2700/2500 cal BC) are almost as common (Table A1; Fig. 9). Thus, there are some differences in the timing of the first use of the structures that probably are due to different building dates.

Considering that only one out of 131 14C dates can be assigned to the EN, it is quite possible that this date is a statistical outlier; nevertheless, many of the dates cover both EN and MNA. The proportion of passage graves with ENII

Fig. 9 Earliest 14C dates in passage graves. F, Falbygden; Ö, Öland; S, Scania; B, Bohuslän. OxCal v. 4.3.2. Bronk Ramsey (2017); r5 IntCal13 atmospheric curve (Reimer et al. 2013), 1 sigma (68.2%) and 2 sigma

(95.4%). Ingelstorp and Nästegården are each represented by one single date in total

burials is 5% and EN/MN burials 32% (95.4% probability) and accordingly lower than in the dolmens. However, the number of graves with confirmed EN dates are the same (one). Furthermore, the number of dates from the graves vary, and especially in graves with very few dates, these are probably not representative for the first burials in the graves.

The majority of the oldest dates in graves defined as gallery graves belong to the LNII (Appendix 1; Fig. 7). By comparing the first dates in these graves, most of them seem to have been constructed during the transition between the first and second part of the LN, although some of the graves contain inhumations dating as early as the first burials in dolmens and passage graves (Figs. 7 and 10). Six of the 41 gallery graves (15%) contain EN or MNA 14C dates, all from Västergötland (Table A2, Fig. 10). Two graves from Öland contain earliest dates from MNB (Fig. 10, Table A2). In six graves (15%), the

Fig. 10 Earliest 14C dates in the Gallery graves. VG, Västergötland; Ö, Öland; G, Gotland; U, Uppland; S, Scania; ÖG, Östergötland; N, Närke; B, Bohuslän. The two first dates from Torsborg 4 and 6 are included as the first ones show elevated $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values and might be biased by a reservoir effect. Rössberga, Rantens Torgplats, Mikaelsgården, Prästbolet, Skattegården, Kavlanda, Måns-Nilsgården, Carlsgården, Sanna, Håslöv and Annelund are each represented by one single date in total

earliest dates were EBA (Table A2, Fig. 10), which might indicate a continuation of gallery grave constructions into the EBA, although these dates do not necessarily represent the first use of the graves.

So far, the results indicate what appear to be a contemporaneous start of burials in the three types of graves at the EN/MN transition with a few ENII dates. Furthermore, synchronous use during two different phases concentrated to the MNA and LNII can be demonstrated, with most MN dates in the dolmens and passage graves and the majority of LN dates in the gallery graves.

The 14C dates from the dolmens and passage graves more or less agree with the conventional chronology of the megalithic graves, while the presence of early skeletons in gallery graves is unexpected and does not fit the prevailing view of these graves. Thus, the early dates in gallery graves require further discussion. Before that, regional chronological variation is examined with a closer study of the Västergötland megalithic graves.

Regional variation

According to the sum plot and the KDE model, the oldest dates from dolmens are contemporaneous in Östergötland, Gotland and Falbygden (Fig. 11, Fig. A1). However, as the comparison in Fig. 8 demonstrates the earliest dates derive from Falbygden and Östergötland, and ENII dates are only found in the Backagården dolmen, Falbygden (Fig. 8, Table A1). In Falbygden and in the Alvastra dolmen in Östergötland, very few dates span into the MNB, while the burials in the Ansarve dolmen on Gotland seem to continue into the MNB up to 2500 cal BC, with a reuse during the LN (Fig. 11).

Despite the uneven distribution of graves and samples, some chronological tendencies can be determined for passage graves (Fig. 12). Two main peaks of use can be determined to around 3000 cal BC and 1900 cal BC, although the second

Fig. 11 Sum plot of 14C dates from dolmens in different regions (cal BC, 95.4%). Gotland is represented by the Ansarve dolmen ($N=18$), Östergötland by the Alvastra dolmen ($N=12$) and Falbygden by four different dolmens ($N=12$)

Fig. 12 Sum plot of 14C dates from passage graves in different regions (cal BC, 95.4%). Falbygden ($N=78$), Öland ($N=29$), Scania ($N=22$) and Bohuslän ($N=2$)

peak in Scania and to some extent in Öland can be set in the EBA, about 1400 cal BC. In all regions but Öland, the burial frequency drops dramatically at the transition between MNA and MNB, with a break of a couple of hundred years in the late MNB and early LNI to reoccur in the LNI into BA period IV. The burials in the Mysinge passage grave on Öland seem to continue in the MNB and into the LNI and then drop at the end of LNI to increase in the end of LNII and continue into the BA period IV (Fig. 12).

Concerning the primary burial phase, the earliest dates do not appear to differ between the regions, although the only EN date from a passage grave derives from Rössberga, Falbygden (Figs. 9 and 12, Table 2).

The gallery graves appear in wider regions than the other two types of megalithic tombs. The earliest dates of gallery graves vary between regions. In the provinces represented by few dates, Bohuslän, Närke and Östergötland, the first inhumations can be dated to LNII, when the graves were used the most (Fig. 10, Table A2). In the provinces of Gotland, Uppland and Scania, the earliest dates appear in the transition between LNI and LNII (Fig. 10). In two of the Torsborg gallery graves on Öland, the earliest dates (without elevated $\delta^{15}\text{N}$ values) belong to the MNB phase. In Västergötland, from where most of the samples derive, the earliest dates fall in EN/MNA in two graves, in the MN in six graves and LN in 13 graves (Fig. 10; Table A2). Furthermore, Öland and Västergötland are the only regions with gallery graves containing LNI dates, although only few (Appendix 1).

In Fig. 13, all the 14C dates from gallery graves are plotted by region. In Västergötland, two separate phases can be observed with a gap of a couple of hundred years in the late MNB and beginning of LNI, while the Öland graves were used continuously from the early MNB into the LN and further into the BA (Fig. 13). The different patterns appearing in these two provinces is likewise distinguished in the passage graves (Fig. 12).

Some variation in the most intense use time can be discerned, with a LNII focus in Västergötland, Bohuslän, Uppland and Östergötland, while most of the burials in Scania and on Öland and Gotland are concentrated to the EBA (Fig. 13). Scanian gallery graves were used into the EBA period III, while inhumation burials in gallery graves in Västergötland, Uppland, Gotland and Öland continued into BA period IV. In regions where very few dates were available, the use time spans into the EBA period I and in Bohuslän only one date from the LNII was included (Fig. 13). This difference may reflect a sampling bias.

Burials in the megalithic graves of Västergötland

The numerous grave types and samples available from Falbygden and the surrounding areas of inland Västergötland allow more detailed comparisons, and in the two following sections, the 14C dates from Västergötland are further investigated.

Dolmens, passage graves and gallery graves

In Fig. 14, all 14C dates from the three main tomb types in Västergötland are plotted.

Figure 14 clearly illustrates two separate phases of contemporaneous use in the passage and gallery graves in Västergötland but with reversed proportions, while the dolmens only contain dates from the first phase. The result corresponds to the general picture of the megalithic graves in southern Sweden (Fig. 7), although no LN dates occur in the dolmens. Furthermore, the plateaus in MNB and EBA are less pronounced and the gap between the two phases is more distinct in Västergötland (Figs. 7 and 14). According to the plot, the beginning of the first phase observed in dolmens passage graves and gallery graves can be set to 3400 cal BC, or possibly 3500 cal BC, with intensive use in the MNA. After a gap from about 2600 to 2200 cal BC, a second phase concentrated to the LNII is visible in the passage and gallery graves, ending in BA period IV.

Gallery graves

In order to identify possible chronological patterns, the graves defined as gallery graves are presented with some details about the location, shape, construction, size etc. (Table 2).

Of the 23 sampled gallery graves in Västergötland, six contain human bone dated to the ENII, MNA and MNB (Table 2, Appendix 1). These early dates appear in the southcentral parts of Falbygden as well as at Kinnekulle (Table 2). Graves with more than one individual dated earlier than the LN only occur in the Falköping area, where the density of both passage and gallery graves is very high. It is also the only area in Västergötland, where LNI dates in gallery graves can be confirmed (Table 2).

Table 2 Gallery graves of Västergötland sorted by date

Site name (No)	Earliest date	Earliest finds	No. of chambers	Grave orientation	Grave placement	Chamber shape	Length (m)	No. of port-holes	No. of individuals	MNI	No. of 14C dates
Högebo (28)	EN/MN	MN	1 + AC	ENE-WSW	BG	R	4	1	50		3
Rösberga (39)	EN/MN	MN	IO	ENE-WSW	AG	R	3.5	N.D	N.D		1
Blinningsberg (56)	MNA	MN	IO?	NNE-SSW	AG	R?	5	N.D	>10		3
Järnvägens/Rantens (50)	MNA	MN	IO	NE-SW	BG?	R	2.6	0	7?		6
Rantens torgplats (51)	MNA	MN	1	NE-SW	AG	R	3	N.D	N.D		1
Måns-Nilsgården (32)	MNA*	MN?	1 + AC	NNE-SSW	AG	R	4.8	1	30?		1 + 1*
Utbogård (44)	MNA	LNII/LNII	2 + AC	N-S	BG	RI	7	2	60		10
Kapellgatan (53)	LNII	LNII/LNII	IC	NW-SE	BG	H	2.4	0	1		1
Fredriksberg (49)	LNII	LNII/LNII	1 + AC	NNE-SSW	BG	T	5.3	0	30		22
Mikaelsgården (47)	LNII/LNII	MN?	IO	NE-SW	N.D	R	4.5	N.D	N.D		1
Berga (42)	LNII/LNII	MNB	1 + AC	N-S	AG	R	2.9	0	30		16
Torsagården (64)	LNII/LNII	LNII	IC	N-S	BG	R	1.7	0	2		2
Brunnsgården (35)	LNII/LNII	LN	1 + AC	E-W	BG	T	5	1	N.D		3
Tomtens kalkbrott (40)	LNII/LNII	LN	1 + AC	NW-SE	BG	R	4.5	1	>15		5
Lilla Balltorp (41)	LNII/LNII	LNII/LNII	1 + AC	NNE-SSW	BG	RI	7.5	1	80		23
Helles (27)	LNII	MNB	1 + AC	NW-SE	BG	PS	7.3	1	20/60?		14
Skattegården (67)	LNII	–	1 + AC	NE-SW	BG	R	5.7	1	N.D		1
Prästbolet (37)	LNII	–	N.D	N-S	BG	R	2	N.D	N.D		1
Fastarp Mossgården (59)	LNII	LN	N.D	N.D	BG	R	N.D	N.D	3?		2
Munstorp (31)	LNII	LN	1?	NE-SW	BG	R	5	N.D	8–10?		2
Backa (33)	LNII	LN	1 + AC	N-S	BG	R	4	1	>9		3
Övre Sanna (30)	LNII/EBA	–	1 + AC	E-W	N.D	R	7	1	N.D		1
Carlsgården (29)	LNII/EBA	LNII	1 + P	N-S	BG	RNP	3.3	1	N.D		1

*bone from goat/sheep; AG, above ground; BG, below ground; AC, ante-chamber; P, passage; O, open; C, closed; R, rectangular; RI, rectangular-irregular; T, trapezoid; H, hexagonal; PS, pear-shaped; RNP, rectangular chamber with narrower passage

Fig. 13 Sum plots of 14C dates from gallery graves in different regions (cal BC, 95.4%). Västergötland is divided in three sub regions: Falbygden ($N=104$), Kinnekulle ($N=18$), Skara ($N=3$), Bohuslän ($N=1$), Öland ($N=20$), Scania ($N=25$), Gotland ($N=18$), Östergötland ($N=2$), Uppland ($N=5$), Närke ($N=5$)

Most of the graves with early dates were found below low cairns. However, it is problematic to determine if these disappeared over time or were constructed in a later phase; therefore, this aspect was not further investigated. The orientation of the graves seems to be independent of chronology, shape and location. However, none of the early gallery graves were oriented NW-SE (Table 2). Of the six graves containing EN/MN or MN dates, four were placed above and 2 below ground. In the gallery graves with exclusively LN and EBA dates, one was located above and twelve below ground. Thus, there is a tendency of constructions

Fig. 14 A sum plot of 14C dates from megalithic graves in Västergötland (cal BC, 95.4%). Passage graves ($N=78$), dolmens ($N=12$) and gallery graves ($N=125$)

above ground in the graves with early dates and below ground in the LN graves (Table 2).

Four of the graves with early dates are relatively small with single, and in three cases open chambers, while two are graves with a chamber and an ante-chamber. In the latter, only single early dates were confirmed. This result is illustrated in Fig. 15 where all the 14C dates from the gallery graves are plotted by the number of chambers.

It is evident in Table 2 that all of the confirmed open single roomed graves contain EN/MN artefacts and/or human remains, while closed single roomed graves are dated to the LN and placed below ground. The closed single roomed graves contain LN I human remains and/or LN I finds. Furthermore, two of the three graves indicating LN I use only contained one and two burials, compared with the rest of the graves which contain about 10 to 80 successive burials (Table 2).

The length of the graves, as mentioned above, also partly correlates with chronology, and although early dates can be observed in various size categories under 7 m, only the graves shorter than 3 m continue into MNB (Fig. 16). The largest graves here seem to be the latest, which contradicts most of the proposed internal chronologies of gallery graves (e.g.

Fig. 15 Sum plot of 14C dates by number of chambers (cal BC, 95.4%). AC, ante-chamber. 1 chamber ($N=15$), 1 chamber + AC ($N=94$) and 2 chamber + AC ($N=10$)

Fig. 16 Sum plot of 14C dates grouped by length (cal BC, 95.4%)

Anderbjörk 1932; Forssander 1936; Johansson 1961; Montelius 1905; Nordman 1935).

The width of the graves varies and seems to be independent of chronology and partially of length. Nevertheless, graves 7 m or longer are generally wider than the shorter ones. Furthermore, the two closed graves below ground are considerably narrower than the rest (Appendix 2).

EN/MN and MN dates only occur in rectangular graves (Fig. 17). A tendency of early LN dates in trapezoidal and hexagonal graves can be discerned (Fig. 17, Table 2). The pear shaped graves, sometimes compared with the Danish Bøstrup cists, date to the LNII and EBA and do not display any early dates (Fig. 17).

EN/MN and MN dates appear both in gallery graves with and without port-holes (Fig. 18, Table 2). Two of the gallery graves with port-holes contained single dates from the EN/MNA and several from the LN/BA, while in the other nine only LN and BA dates appeared. The graves without port-holes contained either exclusively EN/MN to MN or only LN to BA dates. Furthermore, the gallery graves without port-holes have a slightly earlier peak in the LN than the ones with port-holes (Fig. 18).

In all but one grave, Utbogården, the EN/MN dates can be supported by MN finds (Table 2). Nevertheless, the amber beads

Fig. 17 Sum plot of 14C dates grouped by chamber form (cal BC, 95.4%). Rectangular-narrow passage ($N=1$), hexagonal ($N=1$), rectangular ($N=49$), trapezoid ($N=25$), pear-shaped ($N=14$), rectangular-irregular (33)

Fig. 18 Sum plot of 14C dates grouped by graves with and without port-holes (cal BC, 95.4%)

in Utbogården gallery grave might be MN. There are four additional graves with MN finds but no dated bones: one single roomed open grave and three graves with a single chamber with an ante-chamber, of which two have port-holes (Table 2). If the MN finds in the graves are considered, EN/MN remains appear in ten out of 23 gallery graves (43%), which is a considerable portion.

Discussion

The introduction of megalithic grave types

The results confirm that the dolmens and passage graves were used at the same time and support the hypotheses of Persson and Sjögren about the construction time of these graves (Persson and Sjögren 1995; Sjögren 2003, 2011), although the introduction of both dolmens and passage graves can probably be pushed back to 3500 to 3400 cal BC, which agrees with the Bayesian models of megalithic graves (Figs. A5–7). The first burials of passage graves are also consistent with the dates of the bark samples from Danish passage graves (Dehn and Illum Hansen 2006). In eight passage graves, bark samples were dated to the transition between EN and MN with one single date placed in the ENII (Dehn and Illum Hansen 2006). However, considering the distribution and proportion of the early dates (Figs. 8 and 9; Table A1), a slightly earlier introduction of the dolmens is suggested (Figs. A5–7). Similar results, but with a later start of the passage graves, were presented in a study from the Flintbek cemetery in northern Germany, where the dolmens were dated to 3600 to 3350 cal BC and the passage graves to 3350 to 3100 cal BC (Furholt and Mischka 2018).

The unexpected EN/MN human remains recovered from some of the gallery graves have consequences for how we understand the succession and use of megalithic graves. Therefore, more thorough investigations are required. A few hypotheses are here suggested to explain the early dates:

- The early skeleton remains originate from reburial of relics (bones with special meanings, kept or circulated for specific purposes) or bones from earlier graves.
- These graves are misinterpreted dolmens.
- Some of the gallery graves are reconstructed graves of earlier types.
- Some of the gallery graves were actually constructed parallel to the dolmens and passage graves.
- The megalith types are not valid and shapes were more varied than previously thought.

The scenarios are tested by comparing the 14C dates with various characteristics of the gallery graves and by detailed discussions of the samples and grave constructions. Furthermore, the results are related to ethnographical examples and previous Neolithic and early Bronze Age research. Thereafter, the megalithic grave construction of Västergötland is discussed, and lastly, regional similarities and differences are addressed.

Old bones or early graves?

Ethnological examples have revealed that megalithic graves have been used in societies with different social organizations and ideological beliefs, sometimes involving complex burial practices in many steps extending over several years, including recovery of relics in and moving skeletal remains between graves (Bloch 1992, 1994; Hutton 1921; Jamir 2004; Jeunesse and Denaire 2018; Parker Pearson and Regnier 2018; Wunderlich 2019). Some observations are of particular interest concerning the handling of bones and the presence of older bones in the megalithic tombs. In Sumba, Indonesia, remains from individual graves can be moved to the collective clan dolmens 10 to 20 years after the primary burial (Jeunesse and Denaire 2018). Bloch (1988: 13) has described how the Merina on Madagascar exhume and rebury their deceased after some years in the megalithic graves. The intricate reasons for certain practices vary within and between different societies. Placing and moving of skeletons and bones can, for example, be determined by regulations concerning incest (Jeunesse and Denaire 2018). Among the Merina, the empty grave is considered dangerous and therefore bones from graves of former ancestors must be put in the grave before it can be used for new burials as one cannot be alone in the grave (Bloch 1982: 213).

Practices of recovering and moving of bones can thus be attested in ethnological examples and could have also been occurring in prehistory. However, these multifaceted burial traditions are often difficult to detect in the archaeological record. This means that burials that look very similar from an archaeological perspective can in fact be very different. The skeletal assemblages of often commingled bones in the megalithic graves are difficult to interpret. The manipulation

of human remains, such as relics and bones being moved and taken out of graves as well as the circulation of human remains, have been suggested during the European Neolithic and Bronze Age (Brozio 2016; Fowler 2010; Parker Pearson et al. 2005, 2007; Richards 1988; Thomas 1998). A missing femur of a woman buried in an EN flat grave at Oldenburg-Dannau, Germany, was interpreted as deliberately removed and placed in a nearby well (Brozio 2016).

The placement of remnants of ancestors might have been a practice when a new grave was constructed or when people first established themselves in a new area. Bones from older graves placed in new graves could have been a strategy of claiming a connection to former groups in a certain area. A similar interpretation of the extensive reuse of passage graves during the LN is possible. Some possible ways of identifying re-deposition are as follows: only crania or large bones have early dates, special placements of the early bones or a low number of early dates compared with the remaining burials. Furthermore, re-deposition of old human remains can most likely be excluded if accompanied by early artefacts and/or animal bones.

Considering the bone elements, small bones are in most cases absent as most of the graves were excavated at a time when the skeletal remains were neglected, with the exception of intact skulls. Of the EN/MN dates in gallery graves, nine samples derive from skulls (eight teeth and one cranium fragment) and five from arm bones (two radius and three humerus) (Appendix 1). The sampled individuals from single roomed graves derive from both cranial and postcranial elements. Both dates from multi roomed gallery graves derive from teeth. Hence, no conclusion can be drawn, as no small bones were available for dating.

In several cases, some kind of stratigraphy occurs in the megalithic graves with bones separated in different layers or horizontal division where older bones have been pushed aside. In the latter case, the oldest bones are expected to be found closer to the walls or in the back of the chamber. In several megalithic graves, the latest burial was found more or less intact compared with the older and more fragmented skeletons. Possible foundation depositions were observed in two passage graves (Ramshögen and Carlshögen) in Scania (Strömberg 1971a). However, these bones have not been dated. If an older bone was placed in the grave in an initial phase, then the location of the relic would not necessarily differ from the primary burials, if not a special/deviating location was chosen. However, if the older bone was placed in the grave at a later stage, then the bone would be found in a more unexpected stratigraphy.

In the single roomed graves, the bones were found in the chambers and in Utbogården gallery grave the MN bone derived from an adult individual found in the main chamber along with the majority of bones (Appendix 1, 2). The exact placement of the early bones are unknown. No special deposits in the studied graves could be observed, but due to the poor documentation of the bones, no conclusion can be drawn.

Considering the frequency of early dates in the multi-roomed gallery graves, the deliberate placement of old bones remains a possibility. Only one single individual was dated to the EN/MN or MN in each of the two multi roomed gallery graves with port-holes in Västergötland, while the rest were dated to LN and EBA (1/3 and 1/10). The single roomed graves with MN dates on the other hand do not contain any LN dates. Only single dates were achieved from two of them (Table 2; Appendix 2). The two remaining single roomed graves contained several individuals dated to the MN and the bones derived from individuals of different ages and of both sexes. It is thus likely that the open single roomed gallery graves with MN dates are indeed early graves, while the multi-roomed graves might contain relics.

If the low frequency of early dates in certain gallery graves is an argument for reburial of old bones, this can likewise be applied to passage graves and dolmens containing single EN dates. However, the older bones are expected to be more fragmented and less preserved in graves of successive burials and the possible practice of cleaning out earlier burials might also affect the low frequency of bones from the earliest burial phase. At Rössberga, two megalithic graves were placed only a few meters apart: a passage grave with a 9×2 m large chamber and an 8-meter-long passage surrounded by a cairn, and a 3.5×1 m large gallery grave covered by a low cairn (Appendix 2). In the passage grave, one of 24 sampled individuals showed an ENII date, while the rest of the burials were dated to the MN. The single tooth sampled from the nearby gallery grave displayed a date very similar to the earliest date in the passage grave (Appendix 1). The two graves might be contemporaneous and meant for two different categories of people/dead. A scenario when an older skeleton/skull was brought from the older gallery grave and deposited in the MN passage grave is also possible. Likewise, the nearby gallery grave might have served as a secondary grave where the remains of older burials from the passage grave were placed, which could explain the single ENII date.

Clearing out of megalithic graves has been discussed in several regions, both in passage and gallery graves (Blank 2016: 53; Chambon 2003; Hansen 1924; Persson and Sjögren 2001: 46; Strömberg 1971b). No examples of cleared out passage graves can be verified, but new floors were sometimes constructed to separate the new burials from the previous ones (Hommerberg 1944; Strömberg 1971b). A pit next to the gallery grave in Annelund with unburnt human bone and some artefacts have been interpreted as burials cleared out from the gallery grave (Andersson and Hjärthner-Holdar 1989: 211; Appendix 2). Cleared out gallery graves could explain the low number of MN dates recovered especially in multi-roomed gallery graves. However, the fact that the multi-roomed gallery graves with early dates show an extensive use in the LN and EBA compared with the dolmens and passage graves is more difficult to explain.

MN artefacts and animal bones are other arguments that support the assumption of early graves. As mentioned above, MN use of most of the gallery graves with MN 14C dates can be confirmed by MN artefacts, and two additional gallery graves with ante-chambers as well as an open single roomed gallery grave contained MN artefacts (Table 2). Furthermore, a multi-roomed gallery grave with a port-hole, Måns-Nilsgården gallery grave, contained a sheep/goat bone dated to the MNA and no traces of nearby settlements were observed (Table 2; Appendix 2).

The gallery graves outside of the sedimentary areas in western Sweden are difficult to date, due to the poor bone preservation. It is problematic to date megalithic graves in general as many of the graves have been exposed to later use and looting. However, there are several known MN finds from gallery graves in southwestern Sweden. In Table A3, a compilation of known MN finds from graves classified as gallery graves is presented. The finds might be depositions from earlier graves, although other explanations are also possible. Flakes or pieces of polished flint axes are rather common finds in gallery graves, especially in areas where raw flint is uncommon. The fragmented MN axes can therefore be explained by reuse of older artefacts. According to Apel (2001: 13), thick-butted flint axes were used into the LNI. The occurrence of MN artefacts such as tanged flint arrowheads and MN pottery could be a result of local continuation of certain craft traditions. The MN finds might also have been deposited in the graves during the LN and possessed a certain symbolic value. In some cases, the finds could originate from earlier settlements or graves, accidentally being part of the grave filling, although in the examples presented in Table A3 this is not likely.

In Table A3, twenty gallery graves of different size contained EN/MN finds. In the case of Björkö, numerous PWC pottery sherds and some flints were found in front of the entrance. This can be compared with the common practice of entrance deposition at passage graves. In addition to the finds in the table, polished thick-butted flint axes occur in other regions such as Halland (Hyltegården gallery grave, Förlanda parish and Hassungared gallery grave, Lindome parish) and a thick-butted stone axe is known from Källås gallery grave, Gillberga parish in Värmland. The early artefacts in these graves, at least in some of them, are likely to indicate when the graves were used.

Consequently, this opens up for a wider distribution of MN megalithic graves to areas between the coast and Falbygden and might also connect Falbygden with other known MN megalithic areas such as the west coast. Sjögren (2003: 81) has pointed out that some of the gallery graves in southwestern Sweden might be wrongly classified dolmens. Whether the early graves are dolmens and/or gallery grave is discussed below.

Another possibility which might explain older bones as well as older finds is that these gallery graves were rebuilt

dolmens or passage graves or that they were constructed on top of demolished early megalithic graves. This would leave traces of removed slabs and older burial layers or entrance deposits. There are no indications of this in the documentation of the concerned graves and this is therefore considered unlikely. However, there are several examples of passage graves which have been modified and rebuilt in various ways during the LN (Blank 2017; Hommerberg 1944; Sjögren 2003; Strömberg 1971b).

A similar possibility is that some of the dolmens or single roomed graves with early dates were extended and used in the LN, which then could explain the EN/MN dates from multi-roomed graves. All of the burials in the multi-roomed graves were deposited in the larger inner room. In one case (Utbogården), a few human bones were recovered in the smaller middle room, but these bones were dated to the same time span as the ones in the larger inner room where the youngest burials also were identified (Appendix 1). Furthermore, the shorter graves are generally narrower than the longer multi-roomed graves, which does not fit the extended grave hypothesis considering grave shape and location of the burial remains.

In the case of the single roomed gallery graves with EN/MN dates, the evidence unambiguously points to early graves. Much suggests that some of the multi-roomed graves with early dates too were constructed in the EN/MN, but re-depositions of old bones cannot be excluded.

Misinterpreted dolmens or early gallery graves?

As already mentioned, there is an overlap in form and size between dolmens and gallery graves, and in these cases, it is challenging to classify the graves. Several megalithic graves in Falbygden have been reclassified over the years. Nedre Kapellsgården was previously described as a gallery grave and as a damaged passage grave (Cullberg 1961; Appendix 2), before it was classified as a dolmen by Blomqvist (1989). Slutarp was classified as a dolmen by Lindqvist (1911) and a gallery grave by Riksantikvarie ämbetet but is now reclassified as a dolmen (Blomqvist 1989; Sjögren 2003).

In this study, two further dolmens in Falbygden are reclassified gallery graves. We chose to classify Frälsegården/Gökhem 164 as a dolmen based on the size and the position above ground in a cairn. Backagården measured about 3 m but was still classified as a dolmen due to similar characteristics as the Slutarp dolmen and as the type two dolmens defined by Eriksen and Andersen (2014).

The graves here classified as gallery graves containing MN 14C dates do not all meet the criteria for dolmens according to Sjögren (2003) and Eriksen and Andersen (2014). Although Sjögren's definitions tolerate some overlap between the gallery graves and dolmens, the graves are still more similar to the gallery graves based on the size, orientation, the constructions

below ground and the occurrence of ante-chambers (Appendix 2; Table 2). Of the 20 gallery graves containing MN finds, reported in Table A3, six had ante-chambers and eleven were longer than 3 m, while only six measured 3 m or less. Consequently, the early graves cannot solely be explained as misinterpreted dolmens.

In Västergötland, six of the seven gallery graves with MN 14C dates are between 3 and 7 m, and five are 3.5 m or longer. Even though graves of 3 m length or shorter could indicate a dolmen classification, 3 m is a common length of gallery graves, especially in southern Sweden. Three of the graves had ante-chambers and port-holes, construction details which are characteristic of gallery graves (Table 2).

The four single roomed graves are more difficult to fit in any of the conventional megalithic grave types. The 2.6 m long single roomed grave Rantens järnväg had a floor lower than the ground level supporting a classification as gallery graves, while the low number of slabs (three) is a common characteristic of dolmens. The nearby Rantens torgplats grave was described as similar to the former and contained the same type of amber bead (Appendix 1). However, the walls were constructed by two slabs each and it was probably constructed above ground (Appendix 2). Thus, it is possible that these two graves could be categorized as dolmens, although they are slightly wider than the dolmens (Appendix 2). The Blinningsberg grave was 5 m long and described as a single chamber open in the south containing two supposed niches (Appendix 2). The size is consistent with gallery graves and passage grave chambers, and niches are common in passage graves, although they also occur in dolmens and gallery graves. The opening in the narrower southern gable supports a classification as a gallery grave. However, it was only partially excavated and it is also possible that this is the remains of a passage grave chamber. The Rössberga gallery grave was constructed above ground but measured at least 3.5 m. Accordingly, it does not fit the classification of dolmens.

The two gallery graves with MNB dates found in Torsborg on Öland measured 3.5 m and consisted of a chamber and an ante-chamber. Parallels to the Danish Bøstrup graves, which were constructed in MNB, can be claimed. Two additional types of MNB gallery graves exist in Denmark: small closed stone cists without entrance and small trapezoidal Musse cists (Ebbesen 1985; Iversen 2015: 75). The small gallery graves in Falbygden with early dates were most likely all constructed with single open chambers and do not fit the Danish types. The only two small closed stone cist without an entrance, Torsagården and Kapellgatan, were constructed below ground and can by the earliest be dated to LNI. Thus, no similarities between the early Danish and Swedish graves can be observed.

The Backagården dolmen was oriented NE-SW, the most common orientation of the Västergötland passage and gallery graves included in this study, while the remaining three dolmens were roughly oriented E-W. The 3-m-long Ansarve dolmen on Gotland is also oriented E-W (Appendix 2). Maybe

the Backagården “dolmen”, like some of the single roomed “gallery graves”, are local/regional subtypes of dolmens. This might suggest that the definition of dolmens needs to be corrected to encompass a wider range of grave constructions.

If the early dates instead define dolmens, then some of the graves now classified as gallery graves would be categorized as dolmens and the term gallery grave would be of no use. If instead some of the gallery graves in Västergötland are considered to be constructed already in the EN/MN, then the parallels observed between gallery graves in northern France and Germany make more sense. The WBK and SOM graves are dated to 3400 to 2700 cal BC, although many of them were reused in later times, some of the SOM graves were used to about 2000 cal BC (Guilaine 2011: 85; Müller 1998; Salanova et al. 2011). Kaelas (1967) stressed the similarities of the Västergötland gallery graves to the gallery graves dug into the ground from the Paris Basin and to the graves above ground in Brittany. She suggested immigrations of small groups with different building traditions into Västergötland. The SOM graves were generally built on slopes and dug into the ground, sometimes with several chambers and an ante-chamber as wide as the chamber and measure between five and 10 m, while the graves in Brittany above ground were much larger (Guilaine 2011: 85f). There are also obvious similarities between some of the large Västergötland gallery graves and the allées de l’Aude from southern France. These graves are multi-chambered with port-holes and open ante-chambers and were dug into oval mounds. The graves are generally 5 to 10 m long and date to 3500 to 2500 cal BC (Guilaine 2011: 88f). Several of the large gallery graves in Västergötland also have openings in one of the long sides, a common characteristic for some of the WBK graves (Schierhold 2009; Weiler 1996).

Considering the dating of the German and French gallery graves, a similar dating of the Swedish port-hole graves would be expected. Thus, the parallels observed in the morphology and construction details of the building traditions in these two areas is another argument for an early construction of the western Swedish multi-roomed gallery graves. However, a living tradition of building similar graves is not necessary. Older grave traditions, local or from far away, could have been the inspiration for recreating similar graves in a much later stage with the purpose of relating to earlier traditions or groups.

To sum up, the graves classified as gallery graves in this study containing EN/MN dates do not entirely fit the conventional definition of dolmens, although three of the single roomed graves might be atypical dolmens and a fourth a destroyed passage graves. Others are typical western Swedish gallery graves with ante-chambers, some of them with port-holes displaying close similarities to German and French gallery graves dated to around 3000 cal BC. If the multi-roomed gallery graves were constructed as early as some of the burials, animal bones and artefacts suggest, is still

open for discussion. At this point, the material is still too small to draw any firm conclusions. Nevertheless, a new megalithic terminology might be needed to avoid preconceived notions of the conventional types and to emphasize the variation of shapes and appearance of contemporaneously constructed megalithic graves.

A reevaluation of grave type terminology

Are the conventional types of megalithic graves still valid or do we need new ways to think about the megalithic graves? Many of the morphological characterizations of megalithic graves, such as shape, form, orientation, the placement above or below ground, could partially be explained by the local environment and geology, the available building material and at what season the grave was constructed. Nevertheless, some deliberate choices are expected which might indicate variation or chronological trends. Figure 19 is an attempt to group the different graves in Västergötland, only considering the included graves. It is not meant as a typology of the megalithic graves, but a way to get a clearer view of the datings of the human remains and artefacts found in the sampled graves, with a special focus on gallery graves.

According to Table 2, many of the graves lack information about morphology and size due to several factors such as poor documentation, partial excavation or that the graves had been partly destroyed. The whole spectrum of various sizes and shapes has not been covered as many have not been excavated and some lack datable bone material. For example, there are few gallery graves above ground and no gallery graves larger than 8 m, as these are more common in the Precambrian areas of Västergötland where the preservation of bone material is poor.

The grave groups in this figure were mainly based on the 14C dates and finds as well as shape. In general, chronology seem to be independent of the size of the chambers, as already pointed out regarding the passage graves (Ahlström 2009; Sjögren 2003), although the size was also considered in some cases.

Group A includes all graves above ground consisting of chambers with a perpendicularly placed passage. In Falbygden, these graves are surrounded by mounds or cairns and the chambers measure between 2.7 and 17 m (Blomqvist 1989; Sjögren 2003). The 14C dates of the human remains recovered in the 19 included passage graves have previously been discussed in detail and are shown with the dating of the accompanied finds (Fig. 19).

Group B is rectangular chambers with a longitudinal passage constructed below ground and is represented by one single grave (Carlsgråden). The grave was covered by a low cairn and constructed by a 3-m-long chamber furnished with a half circular port-hole. Similar shapes are known, for example, Manered gallery grave, Lerum.

Group C includes rectangular single roomed chambers above ground constructed by four slabs with additional gable

Fig. 19 Datings of bone (black lines) and artefacts (grey lines) in various types of megalithic graves. Letters explained in text below

slabs. This group is represented by two graves (Slutarp and Backagården) 2.2 and 3 m long covered by mounds. In these cases, the human remains are dated to ENII and EN/MNA, with MNA artefacts in one of them (Fig. 19).

Group D consists of single roomed pentagonal graves with an opening above ground. Only one (Nedre Kapellsgården) grave is representing this group; however, this shape is known from other locations in southwestern Sweden, particularly at the coast.

Group E includes single roomed graves above or slightly below ground 3 m or shorter. Two graves located in Falköping stad (Ranten and Rantens torgplats), 2.6 and

3 m long, contained MNA finds and human remains, and in one of the graves, the 14C dates extended into MNB. This group also encompasses Frälsegården, a rectangular single roomed grave estimated to a size of 2×1 m, although the exact shape is unknown. This grave was covered by a low cairn and contained a skeleton dated to the MNA.

Group F consists of open single roomed rectangular graves above ground. Two graves (Blinningsberg and Rössberga), 3.5 and 5 m long, contained MNA artefacts and human bones from EN/MN and MNA. Both of these graves were originally covered by cairns. In a similar grave (Mikaelsgården)

measuring 4.5 m a MNA find was recovered, while a human bone was dated to the transition between LNI and II (Fig. 19).

Group G comprises single roomed closed graves below flat ground. Two small graves (Torsagården and Kapellgatan) belong to this category: a rectangular chamber with artefacts dated to the LNI and human bones dated to LNI/LNII and a hexagonal chamber with LN finds and a skeleton dated to LNI.

Group H is represented by one trapezoid shaped grave (Fredriksberg) below ground with an ante-chamber in the narrower gable. The grave measured 5.3 m. The chamber contained LNI finds and human remains dated to LNI/LNII and LNII. A second possible grave belonging to this category is Brunnsgården with a port-hole and with LNI and LN artefacts and human remains dated to LNI/LNII to LNII/EBA (Appendix 2, Fig. 19). Another example of this type of grave is Nedregården, Våmb in Västergötland.

Group I comprises pear-shaped graves with ante-chambers in the gable and is represented by the 7.3 m long Helles grave with a port-hole. The grave contained a tanged blade arrow-head dated to MNB and LNII to EBA burials, (Appendix 2, Fig. 19). Timmele Ek and Jällby Östergården are other examples of graves with similar shape and size in Västergötland. Both graves had an opening in the long side, a characteristic found in several of the large gallery graves in Västergötland.

Group J includes rectangular and slightly irregular graves below ground with ante-chambers in the gable and port-holes. Five graves (Backa, Högebo, Tomtens kalkbrott, Skattegården and Lilla Balltorp), 4, 4, 4.5, 5.7 and 7.5 m long, contained LN and LNII finds and human remains dated to the transition LNI to II and into EBA. Högebo also contained EN/MN human remains and MN artefacts (Table 2, Fig. 19).

Group K consists of rectangular graves above ground with ante-chambers in the gable and port-holes. In a grave (Måns Nilsgården) measuring 4.8 m, artefacts as well as animal bone could be dated to MNA while a human bone was dated to LNII. A second (Berga) measured 2.9 m and contained human remains dated to LNI/LNII and artefacts dated to MNB and LN (Appendix 2, Fig. 19).

Group L comprises graves constructed by two rooms and an ante-chamber in the gable with two port-holes. The grave (Utbogården) that represents this group measured 7 m and was placed below ground and covered by a low cairn (Appendix 2, Fig. 19). This type of grave appears both below and above ground in the central parts of Västergötland and often measures around 8 m. The artefacts found in some of these graves can mainly be dated to LNII and EBA, even though MN and LNI finds also occur (Table A3).

Figure 19 clarifies the results already discussed in the previous sections. Group A and most single roomed graves (C, D and E) can be assigned to the EN/MN, while the early dates in the multi-roomed graves either can be explained by a first burial phase or reburials of old bones. Rectangular and hexagonal single roomed graves with few burials

contain LNI burials, while in the other multi-roomed graves the LN burial sequence is later, at the transition between LNI and LNII (Fig. 19).

This section demonstrates that new ways of thinking about megalithic graves enable us to recognize new patterns. By applying the conventional typology, we risk to reproduce a simplified image of the megalithic varieties constructed during the different periods. This could also obstruct the possibility to identify and discuss local and regional variations. The tendency to classify graves which do not exactly fit the definition of dolmens and passage graves as gallery graves might also lead to a too great emphasis of homogeneity in the EN/MN megalithic phase and heterogeneity in the LN/EBA megalithic phase. Even though the variation of megalithic grave types is greatest in the LN/EBA, we have demonstrated that the variation was greater in the EN/MN than previously thought.

Contextualizing megalithic building in Västergötland

The results from the 14C dated human bones in Västergötland open up for several plausible scenarios. One possibility is that megalithic building consists of two separate traditions without any relation. Another scenario is that the megalithic tradition continued and transformed from the EN/MN into the LN and EBA. In both cases, the early dates in the gallery graves could be explained both by early construction of certain graves and the reburial of bones from older graves or relics. A third possibility, which does not exclude either of the two previous suggestions, is that the 14C dates in the megalithic graves reflect demographic fluctuations.

In Falbygden, the introduction of megalithic grave construction took place in the setting of the TRB complex at the end of the EN and intensified in the MNA. It is possible that various types of megalithic graves were built in several locations in Västergötland, some of which today are interpreted as LN gallery graves. It is also possible that the building traditions between different areas varied and that the large number of passage graves in Falbygden and few dolmens might reflect separate TRB groups of different origins or hierarchal levels of the society. It is probably more likely that the morphology of the passage graves and dolmens could be an expression of local developments. Some of the small dolmens and small single roomed gallery graves could be related to the passage graves and represent associated burial practices or burials of different categories of people within a society. Regarding the proportion of early dates in the dolmens and passage graves, it is probable that the dolmens were introduced slightly earlier than the passage graves but were also constructed and used simultaneously. Some of the multi-roomed gallery graves including the ones with port-holes were possibly built already in the EN/MNA and might have been

constructed by people of a different background than the groups constructing passage graves.

During the MNB and the first part of the LNI, the burials in megalithic graves decrease drastically and seem to disappear, and no megalithic constructions can be dated to this time interval. Here two interpretations may be considered: new burial practices were introduced and megalithic traditions were abandoned, or the megalithic tradition continued to some degree, as a subculture, with few/sporadic burials which are not visible in our archaeological record at this point. A third possibility, which is not contradicting the two previous proposals, is that the decreasing number of dates reflect the demographic development in the area.

Regarding the first scenario, the megalithic successive burial is abandoned and other burial practices were implemented by force or voluntarily possibly in connection with new ideologies brought by BAC groups. Stray finds in Falbygden of battle axes and BAC pottery are strong indicators of BAC graves (Sjögren 2003) and a few actual graves have been described in previous literature (e.g. Sahlström 1932: 32f). Some reuse of megalithic graves occurs during the MNB, although the BAC finds are generally found in the entrance area of the megalithic graves indicating a different kind of use more related to the closing than a continued use of successive burials (Blank 2016). Parker Pearson and Reigner (2018: 59) suggested in analogy with Madagascar populations that the megalithic tradition in the Neolithic ceased because of the change from cereal cultivation to economies more focused on pastoralism with a greater everyday mobility, when new groups were established in the north European region. Megalithic building could also be an expression of prestige competition between groups in societies based on a feasting/ritual economy with a possible surplus production (Jeunesse and Denaire 2017; Wunderlich 2017), thus be related to prevailing social organization and economic conditions.

The reappearance of megalithic building and use in the LN could be interpreted as an attempt to recreate older traditions and to relate to mythical ancestry. Thus, local groups and the increasing influx of people from outside the area during the LN (Blank and Knipper in press 2020) could claim the right to various locations but also reinforce group identity in times of change. This could explain the high degree of LN reuse of megalithic graves (Blank 2016; this study). In this scenario, the early dates in the multi-roomed gallery graves might be reburied bones from older graves, which could be a way of relating the reinvented megalithic tradition with the older one. According to Vandkilde et al. (2017), the LN practice of constructing gallery graves was a reinvention of the previous megalithic tradition. The 14C dates indicate that the tradition reappears slightly after 2200 cal BC, with a peak of successive burial rituals in megalithic graves around 2000 cal BC and continues throughout the EBA.

The second scenario suggests that the megalithic tradition in fact was adapted to new practices and continued and transformed from the EN/MN building and burial traditions to the LN ones. In eastern Denmark, Iversen (2015) suggests that TRB norms and social structures continued into MNB and blended with the new SGC influences. For example, the TRB traditions manifested in the continued use of megalithic graves (Iversen 2015: 173f). In Falbygden, only a few examples of reused megalithic graves in the MNB exist, if only skeletal material is considered. In one of the gallery graves, Rantens gallery grave, the grave seems to have been used continuously from MNA and well into MNB. Two of the MNB individuals buried in this grave measured low strontium isotope ratios, indicating a non-local origin and a possible origin from southern Scania, the west coast of Denmark (Blank and Knipper in press 2020). Thus, the use or reuse of this kind of graves could be a local expression of merging practices between local TRB and non-local BAC groups and could partly explain the relatively low number of typical BAC graves in Falbygden.

Even though no megalithic grave construction could be dated to the MNB in Västergötland, two multi-roomed MNB gallery graves from Öland can be confirmed by 14C dates of several humans and by numerous artefacts typologically dated to this period. Thus, the knowledge of building these kind of graves already in the MN in Västergötland is not unlikely, especially considering the early dates of human remains and the MN finds recovered in some of these graves. The early construction of some of the gallery graves with port-holes also seems logical considering the obvious influences from for instance France and/or Germany.

According to the third scenario, the intensive use of megalithic graves in MNA and LNII and the distinct decrease in MNB and LNI partly represents population density in the area. This interpretation assumes that most of the population was buried in megalithic graves or that the burials in megalithic graves were proportional to the total number of burials/depositions of dead. The decrease starting in the end of MNA could be an effect of the Yersinia pestis, at ca 3000 to 2900 cal BC, found in Frälsegården passage grave (Rascovan et al. 2019). However, the effects of this need more evaluation. The pattern found in the burial frequency of megalithic graves in Västergötland also correlates with the suggested population decline that occurred in Norway in the MNB followed by an increase in the LN (Nielsen et al. 2019). According to Nielsen et al. (2019: 88f), the population decrease can be related to an increase of interpersonal violence and the presence of Yersinia pestis in Europe (Nielsen et al. 2019: 88f). In addition, a population decline is supported by an abandonment of TRB settlements at the transition between MNA and MNB, which in Falbygden can be exemplified by the Karleby settlements (Sjögren et al. 2019). The pattern of burial distribution in the megalithic graves also more or less correlates to the

population dynamics suggested in Denmark and northern Germany (Feaser et al. 2019; Hinz et al. 2012).

Considering the 14C dates, there are two construction phases of megalithic graves, which are separated by about 300 years with no burials and by an even larger gap of about 500 years between the first burials (potential time of construction) in the graves. This corresponds to 10 to 17 generations and implies that the megalithic graves were built by people of different traditions. Although the variation of megalithic grave types in the TRB setting was larger than previously assumed, the burial practices seem more ritualized/standardized than in the LN/EBA period. Furthermore, the LN displays a higher degree of population dynamics with increased human mobility and variability in subsistence strategies than observed in MNA (Blank et al. 2018). Two separate phases consisting of rather homogenous TRB groups in the EN/MN and heterogeneous groups of people of different origins and traditions in the LN/EBA are here suggested, which could explain that the variety of megalithic grave types was larger during the LN.

Regional variation

The investigation of regional variation is limited by the uneven number of samples and graves (Table 1) and is therefore only intended to describe some tendencies. Nevertheless, in most regions represented by more than one megalithic grave, the 14C dates are separated in two phases with intensive use in MNA and LNII/EBA. On the Baltic island of Öland, the megalithic graves instead show continuous use into the MNB, LN and EBA.

According to the 14C results from human bones, the first burial phase appears contemporaneous, although a slightly earlier start can be suspected in Falbygden. ENII dates were only confirmed in dolmens, passage and gallery graves located in Falbygden and MN dates in gallery graves were only found in Västergötland and on Öland. In the case of early dates in Falbygden, this can be caused by the large amount of samples compared with the other regions but could also indicate a regional difference. Schulz Paulsson (2010) suggested an introduction of Scandinavian passage graves around 3500 BC, either developed in Västergötland and spread to Öland and Gotland or introduced somewhere from the south. The earliest individual (E from Landbogården passage grave, Falbygden) included in the above study (Schulz Paulsson 2010) was later re-dated to MNA (Sjögren 2011; Appendix 1). In a later publication, Schulz Paulsson (2017:307) instead suggests the megalithic graves from Gotland and Öland to be the first ones in Sweden. However, some of the earliest burials from the Ansarve dolmen turned out to be slightly younger when they were re-dated (Fraser et al. 2018; Appendix 1).

If only the inhumed skeletal remains are considered, there are no indications at this stage of earlier use of the megalithic graves from Gotland and Öland. With the new dates, the earliest dated individuals in passage graves as well as in dolmens

(ENII) are found in Falbygden: Backagården dolmen and Rössberga passage grave (Figs. 8 and 9; Appendix 1). Nevertheless, there is a sample from in Mysinge passage grave with unknown $\delta^{15}\text{N}$ and C:N values and a rather high $\delta^{13}\text{C}$, not included in this study, dated to the ENII (GrA-16,855, 4685 ± 40 BP, 3629–3367 cal BC, 95.4%). However, considering the dolmens and passage graves, the earliest 14C dates in Falbygden partly overlap the earliest dates in the other regions. The results do not support an internal chronological development from the rounded passage graves, common in Scania, to the T-shaped graves of Falbygden (Blomqvist 1989; Cullberg 1963; Tilley 1991). Instead our results favour the suggestion that the chamber forms of both dolmens and passage graves more likely are a result of regional differences (Persson and Sjögren 1995; Sjögren 2003).

Västergötland is the only region where EN/MN or MNA dates occur in gallery graves. Unlike in Denmark and on Öland, no constructions of megalithic graves are visible during the MNB in the available dates from Västergötland. In the case of early gallery graves, it is likely that this is a regional phenomenon. In general, the gallery graves in Västergötland deviate from the gallery graves found in the more southern regions with larger graves and more complex construction. No MN dates are known from the Scanian gallery graves, which generally are smaller and contain fewer burials. Based on dagger types, Ebbesen (2007: 23) claims that most of the Danish gallery graves were constructed in the transition between LNI and LNII. The Swedish smaller gallery graves might have been influenced by the Danish gallery graves, while the larger gallery graves were influenced by earlier European gallery graves (see below).

The second phase begins in the LNI, with only a few dates. The second peak occurs in the LNII in Västergötland and Uppland, while in the other regions, it is slightly later and concentrated to the EBA. In contrast to other regions, several Scanian gallery graves only contain EBA dates, indicating an EBA construction of gallery graves or a practice of clearing out older burials (Fig. 9). In the regions, where a considerable number of dates were included (Öland, Gotland, Västergötland, Uppland and Scania), the megalithic graves were used into BA period IV. The frequency of BA period IV dates is low, much lower than the dates from the previous period, which might indicate a continuous use of megalithic graves into period III, with sporadic reuse in period IV. Reuse of the megalithic graves also occurs during the LBA, IA and later periods (Appendix 1; Arne 1909; Blank 2016; Montelius 1873; Sjögren 2003; Strömberg 1971b; Weiler 1994).

Västergötland does seem to diverge from the more southerly regions, with burials from EN/MNA in all three types of megalithic graves and an intensive use in the LNII. This might reflect Falbygden as an important and densely populated region during the Neolithic, while the EBA peak in Scania and

on Öland and Gotland might be connected with an increased population in the EBA.

In Denmark, 14C dates from burials in gallery graves suggest a use time between 2200 and 1600 cal BC (Frei et al. 2019: Table 1; Fig. A8), and the few available 14C dates from Norwegian gallery graves indicate a similar burial sequence (Østmo 2011; Fig. A9). Furthermore, the x14C dates from Danish Bøstrup cists confirm a first burial phase in the MNB (Fig. A8). Unlike in Västergötland, no EN/MNA dates occur in the Danish and Norwegian gallery graves.

Conclusion

According to the 14C dates of human bones, the megalithic graves were first used in the last part of the EN around 3500 to 3300 cal BC. The initiation of the megalithic burial tradition seems to appear more or less simultaneously in southern Sweden, with some of the earliest dates recovered in Falbygden and Alvastra. The dolmens and passage graves were used contemporaneously, although the dolmens seem to have been introduced slightly earlier than the passage graves.

The conventional terminology should be used with caution. In Västergötland, four single roomed gallery graves of various sizes and two multi-roomed gallery graves with port-holes contained skeleton remains dated to the EN and MNA. The single roomed graves were most likely constructed and used simultaneously with the dolmens and passage graves and indicate that MN megalithic graves were more varied in size and appearance than the conventional typology of megalithic graves proposes. Consequently, this opens up a possibility for a wider geographical distribution of MN megalithic graves than what is currently known. MN artefacts and animal bones in Västergötland gallery graves, as well as graves with ante-chambers dated to MNB on Öland, support an early introduction of some of the multi-roomed gallery graves, although reburial of old bones cannot be ruled out.

In Västergötland, smaller single roomed graves with a limited number of inhumations were mainly dated to the early phase of the LN and long multi-roomed graves with a large number of successive burials to LNII and EBA.

In most regions with the exception of Öland, the megalithic graves were used in two separate phases with an intensive use in the MNA and in the LNII/EBA and continued to be used for successive burials throughout the EBA. In Falbygden, it is likely that the 14C dates of buried individuals partly reflects the demographical situation with a population decline in the MNB and the first part of LNI. However, other factors such as changed burial practices of course also affect this result. Investigations of pollen diagrams and artefact density over time could be a way of approaching this issue.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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