# The influence of climate on artefact form

## Neandertal adaptability visible in the archaeological record

M.H. Bezemer

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M.H. Bezemer
MA Thesis
0628107
Wil Roebroeks
Palaeolithic Archaeology
Leiden University
Faculty of Archaeology
Leiden, 12 June 2012

“make ye a mighty effort, and choose for yourselves a noble goal”

- 'Abdu'l-Bahá

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# Introduction

## 1.1 Introduction

In Palaeolithic archaeology there is an ongoing debate about the cognitive abilities of Neandertals (Beaman, 2007; Belfer-Cohen & Hovers, 2010; Coolidge & Wynn, 2007; d'Errico *et al.*, 1998; Henshilwood & Marean, 2003; Welshon, 2010). Subjects in this debate range from the first appearances of hominin behaviour (d'Errico *et al*., 1998; Henshilwood & Marean, 2003) to the absence or presence of a working memory in Neanderthals or other hominins and how these hominins had to deal with that (Beaman, 2007; Belfer-Cohen & Hovers, 2010; Coolidge & Wynn, 2007; Welshon, 2010). Cognitive studies are based on the study of the mental processes of humans and how those processes are used during thinking, feeling of emotion, and behaving (Kellogg, 2012). These studies cannot be applied to ancient hominins like Neandertals, but behavioural studies have been used to compare the behaviour of Neandertals to the behaviour of *Homo sapiens* based on the archaeological record (Wynn, 2002). The behaviour of *Homo sapiens* has been well established through listing possible markers for advanced behaviour (Klein, 1998; McBrearty & Brooks, 2000). Opinions are still divided on the key aspects of the cognitive abilities of *Homo sapiens* (Henshilwood & Marean, 2003). Perhaps one should say the opinions are divided on how well the archaeologists understand the cognitive abilities of *Homo sapiens* (Wynn & Coolidge, 2009). The cognitive abilities, or traits, researchers have looked at are, amongst others, the manufacture of certain tools, the use of ochre, planning capabilities, landscape use etc. A more widespread trait is adaptability. Adaptability is a trait that appears to encompass many other traits. By looking at adaptability, a whole spectrum of traits can become visible. From a behavioural perspective it is very interesting to study adaptability. It is interesting to see how Neandertals reacted to climate changes. *Homo sapiens* are famed for their adaptive powers (Andrews *et al*., 2002). They populated the entire planet by being able to adapt to the surroundings, or the environment, through their material culture. By looking at the adaptive powers of Neandertals and compare it to the adaptability of *Homo sapiens* it could bring archaeologists one step closer to understanding the cognitive capacities of Neandertals.

In 2009 a study has been done on the adaptability of Neandertals by looking at their artefacts (Bocquet-Appel & Tuffreau, 2009). The goal of the research was to understand more about the behaviour of Neandertals during climate change, since it seemed that only a continuity of lithic artefacts was present during climatic changes. Their hypothesis was that Neandertals increased the diversity of lithic artefacts during environmentally more favourable periods and decreased the lithic diversity during environmentally unfavourable periods to maintain carrying capacity. The carrying capacity is the minimum amount of food and other resources that are needed to sustain a minimum number of individuals of a species needed to survive and not die out (Dincauze, 2000: 561-462). The increase or decrease of lithic variability can be seen in the record when the lithic artefacts are analysed. The analysis was done by the researchers themselves and they used the bordian way to classify the material into assemblages. The researchers cross referenced the lithic material with benthic oxygen-18 information present in the site. The benthic oxygen-18 technique produces a global picture of climate change. This method uses the ratio of $^{16}O$ and $^{18}O$, present in the benthic organisms, to determine the global temperature (Aitken, 1997; Burroughs, 2005). During cold phases the $^{16}O$ isotopes were more present in the ice sheets than the $^{18}O$ isotopes. The ratio is reflected in the calcareous layers on the ocean floor. These layers are dead benthic foraminifera which lived during the moment the oxygen isotopes were trapped. This proxy is then used to create a curve which shows a climatic sequence for the entire world (i.e. Shackleton & Opdyke, 1973; and see illustration 1). The information is often transposed to continents by use of local climate information. This means that the proxy used for understanding climate change in the hypothesis of Bocquet-Appel & Tuffreau (2009) is not accurate enough. It shows a change in climate on a global scale and nothing more. For this hypothesis to be confirmed or disproved, more specific information on climate needs to be used. This can be achieved by using palynological information combined with zoological information.

The hypothesis that during less favourable climatic circumstances, the artefact diversity decreased, sounds logical. During less favourable climatic circumstances animal species will often also be less diverse. Less diverse species to hunt would imply

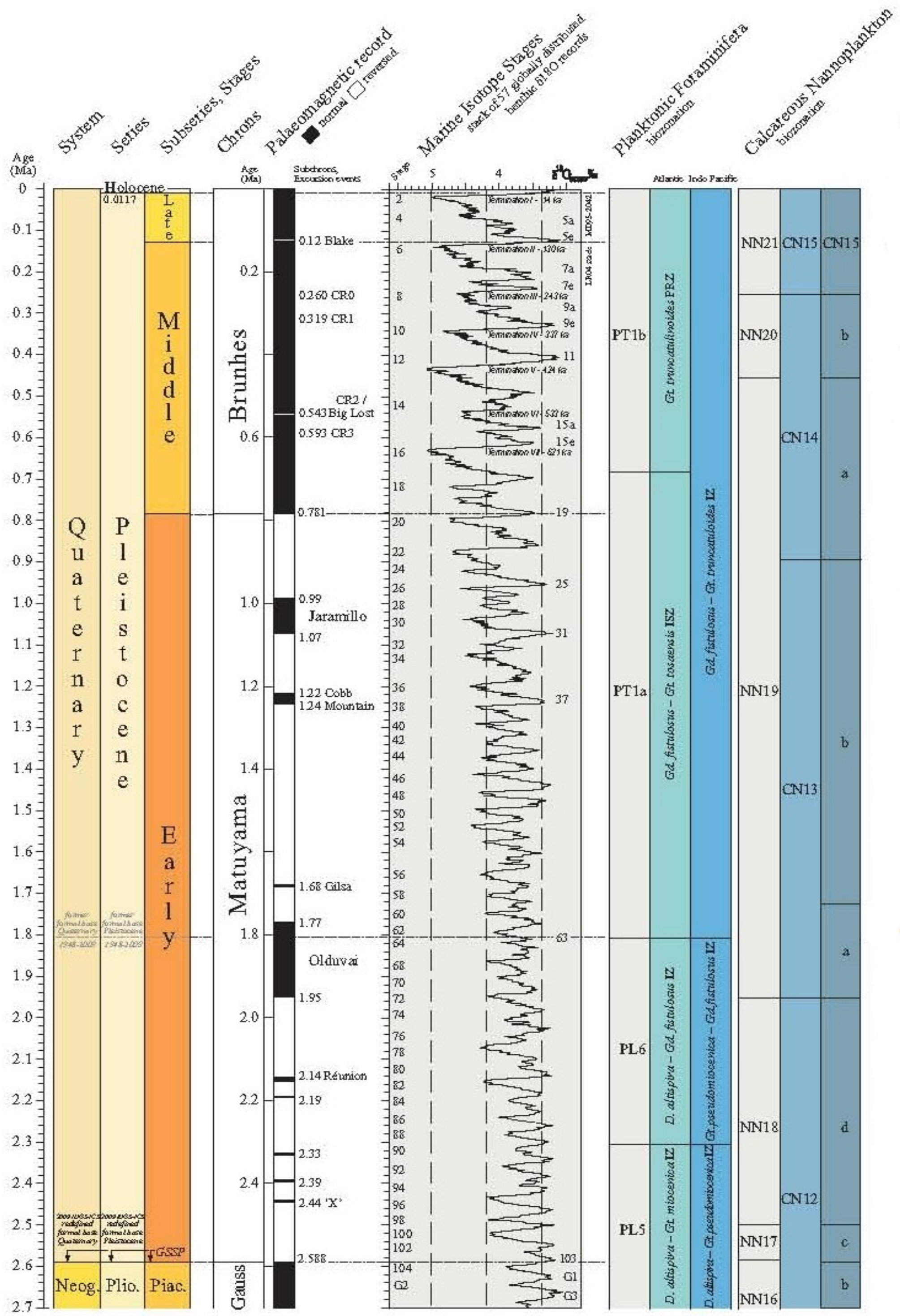


*Illustration 1: Excerpt from the global chronostratigraphical correlation table. (After: http://www.quaternary.stratigraphy.org.uk/correlation/POSTERSTRAT_v2011.jpg as seen on 19 March 2012).*

less specialised artefacts so the hominins could focus their tools on the remaining prey. The opposite can also be true. When less diverse food sources are available it would mean that a similar quantity of food needs to be extracted from a less diverse source. The conclusion is that more tools may be needed to extract similar protein rich resources from less animal species. Therefore the amount of artefact variability may not say much about climate, but a change in variability, either way, could. The approach chosen by Bocquet-Appel & Tuffreau (2009) was incomplete. The hypothesis was too specific and the method too simple. In this thesis a more appropriate hypothesis will be used, together with a more balanced method.

## 1.2 Hypothesis

To establish the hypothesis it is important to look at the possible variables that influence behaviour. This can be done by looking at how Neandertals might live. To state that climate influenced Neandertal artefact use, it is important to know how. Climate is seen as a generalisation of temperature and precipitation prevailing over a specified area and

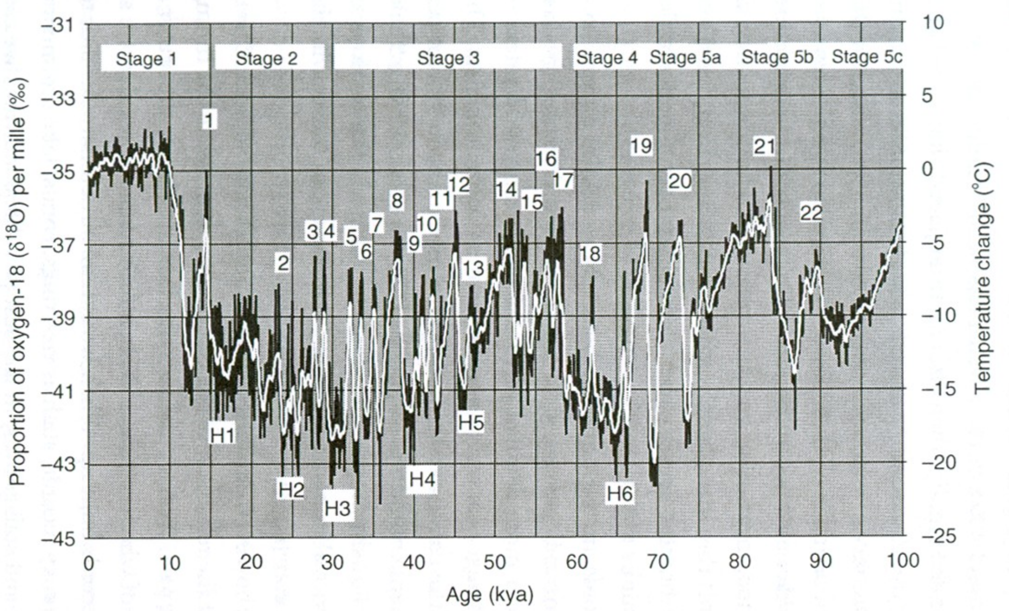


*Illustration 2: Temperature change through the measurement of oxygen-18. The stages are OIS stages. The numbers above the curve are Dansgaard/Oescher warming events. The numbers underneath the curve are Heinrich cooling events (Burroughs, 2005:30).*

time. Climates have changed throughout the Pleistocene form glacials to interglacials and back, see illustration 2. These changes have influenced all the organisms that lived in that specific area. This can be visible through a biological adaptation of the species such as a mutation within the group, the migration of a species from one area to another, or the extinction of a species. Neandertals were, like *Homo sapiens*, more cognitively advanced and they were therefore able to adapt their technology to new environments. Neandertals were capable to reassess the surroundings and create new solutions for new problems, just as *Homo sapiens* have always done (McBrearty & Brooks, 2000; Henshilwood &

Marean, 2003). When the temperature drops, the variability of species often also drops. This means a less varied diet. This implies that different artefacts, artefacts with a different shape, are needed than before to extract a similar quantity or quality of food. This is expressed in the archaeological record by a different composition of the assemblage.

It is important to understand that different climatic circumstances have different effects on plant and animal life. When plants can no longer sustain themselves, they die. The animals that eat these plants will have to change their subsistence strategy or migrate to a geographic area with a more similar plant life as before. Other species may enter this biome. A biome is a regional-scale unit of the biosphere and the biosphere is everything on the earth until the atmosphere ends. The other species that come into the biome are more accustomed to a colder climate. Different plants will emerge in the biome, now that seeds can enter the right climate for them to sprout. By a change of climate the whole biome changes. Hominins must be very adaptable to be able to cope with these new surroundings.

When climates turn colder the vegetation decreases and the variability of animals species is also less. When climates turn warmer, the vegetation becomes more dense and can make the visibility for resources poor. This encourages smaller animals, such as rodents and lagomorphs to migrate to the area. The biodiversity increases. There are other resources which can be taken away from the eye in a more densely forested area or an open plain with grass covered land. One of those resources is flint or other lithic resources. The scarcity of flint also influences the shape of the artefact.

Having taken all these climatic and ecological changes into account the hypothesis can be formed. Neandertals were influenced by climate as much as all other organisms and therefore their artefacts must have been influenced by it as well. Changes in Neandertal artefact shape or form occurred during climate changes in which the environment had to have changed as well. So, if the environment changes, the reaction of the Neandertals would be to adapt their artefacts, for they will have different functions in this new environment. This hypothesis uses the knowledge gained through the study of Boquet-Appel & Tuffreau (2009) and adds new ideas. Study has shown that *Homo sapiens* adapted their artefacts during climate changes (e.g. Blades, 2003). Here it will be argued that Neandertals acted in a similar way as *Homo sapiens* have. If this is visible one can argue that Neandertals had similar cognitive capacities as *Homo sapiens* regarding adaptability.

**1.3 Aim**

The aim of this research is to gain an insight into the adaptability of Neandertals. The results of this research could be useful in future research on the behaviour of Neandertals and possibly the implications of adaptability for the general view of their behaviour. This aspect is often referred to as “modernity”.

Modernity in archaeology is used as a synonym for a behaviour that is only associated with *Homo sapiens*. Yet, modernity can be explained in several ways and the most essential part of modernity is identity. Preferred here is the way Friedman (1994) explains it. He sees modernism as an identity which promotes to develop oneself and to be flexible. This flexibility can be seen as adaptability, since one cannot adapt to new situations without being flexible. Modernity is a term which implies identity and self awareness which only *Homo sapiens* are suggested to have. Therefore it is often used to explain the behavioural attributes of *Homo sapiens* and it is almost never used to explain the behavioural aspects of other hominins. Shea (2011) has proposed that the use of the term “modernity” applies on a qualitative study and that archaeological studies which involve quests for human origins should not be qualitative, but quantitative. Shea forgets that archaeological studies can only be qualitative since the selection on the sites which are excavated is so high that a random sample can never be measured (Dincauze, 2000:22). Here it is believed that modernity is not an objective word for it immediately excludes Neandertals. It is a term used to separate *Homo sapiens* from any other animal, such as the Neandertal. To avoid any confusion the term modernity will not be used further.

The research will consist of a literature study of the artefacts and type of assemblage used by the Neandertals followed by another literature study of the ecological surroundings in which the Neandertals lived. A time frame of 300ka (thousand years ago) to 40ka is set to narrow the research. In this specific time frame a clear knowledge of the climatic circumstances has been established and in this specific time frame many changes occurred in the artefact assemblages of the Neandertals. By adding a specific research area the research is facilitated. The focus will be on the geographic area of France, Germany and surrounding areas. The sites, which hold the necessary datasets, will be selected through qualitative sampling, instead of quantitative sampling. This is done because the archaeological record is not homogeneous (see above and Dincauze, 2000). Quantitative samples are taken in research which tries to prove universal hypotheses, while qualitative samples are used to preform a more focussed study on a specific area, or aspect. Quantitative samples are representative, which mean that they can be applied anywhere on anything. Archaeological samples are not random and they are not representative except for the site where they were taken from. By using specific criteria, which will be mentioned in the next section, the qualitative samples can be selected to be as representative as they can.

**1.4 Methods**

This section will portray the technical aspects of the methods used in this thesis. In the next chapter a more theoretical background will be given to the methods. It will also be explained why the methods are chosen for this research.

To research the adaptability of Neandertals, with the specific goal to discover whether the artefact assemblage variability and climate change are connected, it is important to have a good view of the archaeological record. Sites will need to be compared either to show a connection between artefact and climate or not. This will be done by looking at sites with multiple archaeological layers. The layers will need to have a different artefact assemblage. If the site consists of only two layers with a different artefact assemblage the site can be taken to the next selection process. In the next selection process the quality of the palynological and zoological assemblage is measured. If a clear assemblage is present it can be used to compare the information with the information of other sites. The criteria for a good site are the presence of two or more archaeological layers with different artefact assemblage types (or a transition, see chapter 2); an unambiguous palynological and zoological sample for the same layers; a date within the 300ka to 30ka boundary; and the site must be located within the geographic area of Northern Europe.

The lithic artefacts are very important for they are the only physical and archaeological evidence. For this research it is not necessary to analyse the artefacts. It is sufficient to use the analyses of other researchers. Using the analyses of other researchers brings a problem. Even though the same measuring techniques are used, there are still differences in the outcome of the measurements (Debénath & Dibble, 1994:17). Discrepancies are inevitable within this study and cannot be prevented. Therefore the choice has been made to accept the discrepancies, acknowledge them and account for them during the analysis of the results.

The lithic assemblage variability will be determined using the bordian method although other methods could also be used. The choice to use this method is rooted in the research history of Europe. In Europe it is the most widespread method used to describe artefacts for the past 50 years. This method and other methods will be analysed and compared in the next chapter. It is important to stress here that it is the shape of the artefact that is important in this research, not the technology used to make the artefact.

To represent the environment the information taken from palynological and zoological research will be used. This represents only a small part of the entire environmental spectrum, but is most widely available within archaeological research. The zoological information contains a relation between the diversity of species and the availability of the resources. This shows the influence of animal resources on the Neandertal subsistence strategy. The palynological record can be used to reconstruct the floral vegetation which influence the herbivores, the kind of animal most hunted by hominins.

Palynological data is used to study the species of plants and trees that were present at a certain moment in time. It is important to know how many pollen are dispersed per year and how many will end up in the ground. By catching the current pollen rains one can observe how many pollen per plant or tree are shed in a specific moment. When it is also measured how many pollen land on the site which is excavated, one can measure how many pollen represent the ecological situation as it is during the excavations. This information can be used during the pollen research. An estimation can be made how many pollen represent certain plants or trees. This kind of research may not be present in all the sites.

As a reference in this study it is possible to use Roebroeks *et al*. (1992) which describes in detail the expected climatic circumstances in Europe during several isotope stages. This cannot be used as a primary source but it can be used as a final reference to see if the results of this study fit into the results of Roebroeks *et al*. (1992). If it does not match the results of Roebroeks *et al*. (1992) it does not mean that the results of this study are wrong. Microclimates are present throughout Europe and can be identified during these kinds of research. Also, Roebroeks *et al*. (1992) may no longer be up to date.

Zoological data represents the animal bones from the excavation. The animal bones can be more biased, for it often represents a sample of hunted specimens. This means that before taphonomic processes turned the archaeological record in a selection, the hominins had already selected specific specimens (Lyman, 1994; Meadow, 1980; and see illustration 3).

By using palynology and zoology a few problems may arise. The researchers may exclude samples from their research for any reason. The fact that they are excluded is hardly ever mentioned. This makes it hard to see whether the sample is representative. Another difficulty may be that a different sample strategy may be chosen than is usual. For zoology this is not a problem. The animal bones are excavated using the methods of the specific excavation, usually mentioned explicitly in the excavation report. After the excavation the bones are analysed and examined. The tables created after this analysis hold both the identified as the unidentified bones. In palynology the samples are taken outside of the excavation methods, although they are often mentioned in the excavation report. A quantity is hardly ever mentioned and the success rate of the analysis is often not present. This makes it more difficult to make the samples representative for the whole excavation. Keeping this in mind the analysis in this study will still incorporate palynological studies of the environment.

The age of the site or the age of the layers can be of importance while creating an idea of the ecological surroundings. Age can be used to plot the layer of the site into the global stratigraphical correlation table (see, again, illustration 1). Therefore it will be used in this study. Palynological and zoological data are not always conclusive and can therefore be supplemented with MIS or OIS curves. As mentioned before the isotope methods portray a global climate curve, not a specific climate and are not used to substitute the data from the other proxies.

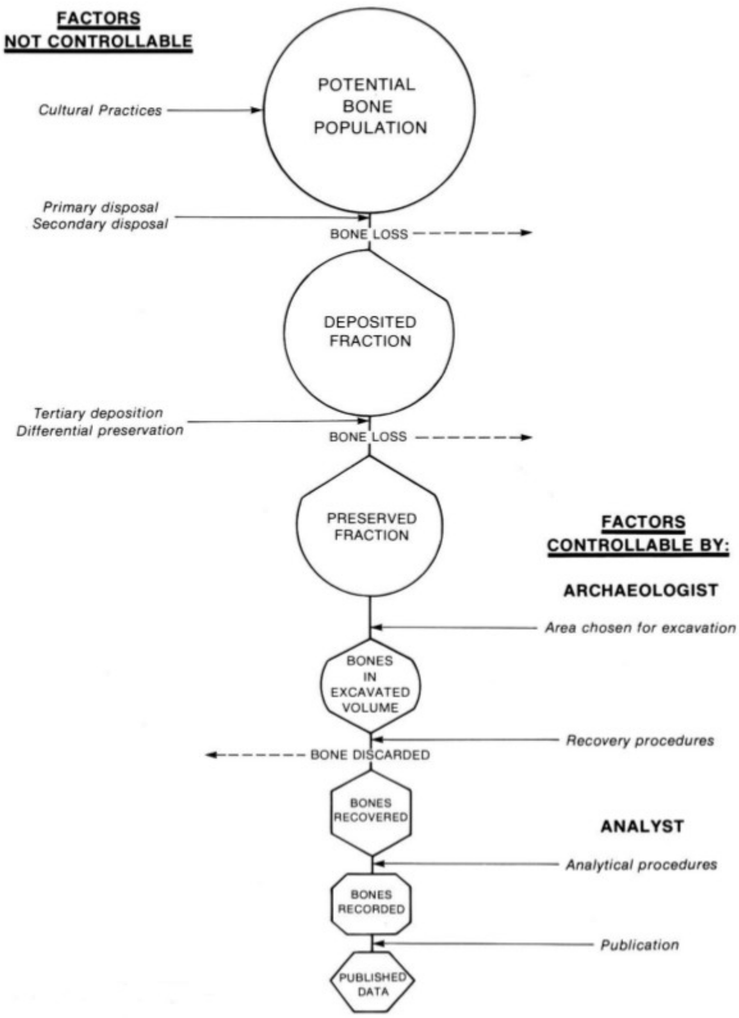


*Illustration 3: taphonomic processes for vertebrate species (Meadow, 1980:67).*

### 1.5 Outline

This thesis comprises of seven chapters. In the second chapter the theory behind the methods is explained. Also more in depth information is given on specific terminology to prevent confusion. These terms are lithic variability; transitions; environment; and adaptability. They will be explained using examples from the literature, or by explaining the theoretical background.

Although the first step in the method is the analysis of the literature on lithic artefacts, in chapter three, the palynological and zoological information will be shown first. This is done because the hypothesis states that climatic and environmental changes made Neandertals adapt their artefacts. The first part of the chapter will be an introduction to the different sites which will be examined. The second part of the chapter shows the palynological information per site. The third part is similar to the second part for it will show all the zoological information per site in a similar fashion. The fourth part shows the dating of the sites. This is added to put the sites into context and is one of the criteria of the method. The final part of this chapter combines the information of all the other parts, palynology, zoology and chronology. In this chapter a number of tables have been made to portray all the information. The tables can be found in the appendix.

In the fourth chapter the dataset of the artefacts will be established. The artefacts are the most important aspect of this research since they are true archaeological artefacts. A summary will be made of the artefact assemblages per layer per site. In this chapter, again, a number of tables are given to clarify the information. These can be found in the appendix.

In chapter five the climatic and environmental reconstruction will be combined with the information of the lithic artefact assemblages per layer per site. A result should become visible, if not the study could be adapted for future research. In this chapter tables have been used to show the information. The tables can be found in the appendix.

Chapter six is a discussion on the possible causes of lithic variability; the cause of some climatic variables visible in the archaeological record due to taphonomy or other processes; and the reason for inter-assemblage variability and how this is connected to this work. Also the aspect of cognition, briefly touched upon in the hypothesis, will be discussed here.

Chapter seven will hold the conclusion of this research with a critique on the methods used and sites chosen if necessary.

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# Theory

## 2.1 Introduction

In this chapter the theory behind the method is explained. In the last chapter the criteria for this research have already been addressed. In this chapter the background of the different criteria will be given. Also the choice for a specific method or theory in this research will be explained.

## 2.2 Lithic tool variability

In this research the artefacts are the most important aspect. The way they are researched is important for the validity of this research. To identify a change in artefact form which reflects a behavioural change due to climate change and change in environment, is very difficult. Therefore it is important to state which options are available and then show why the bordian method is chosen.

Many different ideas have arisen during the last decades concerning the meaning of an artefact assemblage. The main discussion was between Bordes, Binford and Dibble (Mellars, 1996). In the 1950s Bordes (1950; 1961; 1973; Bordes & de Sonneville-Bordes, 1970) created a quantitative way to describe artefacts. These descriptions are still used today. Bordes used this description as a way of categorising the different assemblages into taxonomic groups: Mousterian of Acheulean Tradition (MTA); Typical Mousterian; Denticulate Mousterian; Quina Mousterian; Ferrassie Mousterian; or a combination of the last two into Charentian Mousterian. Before the assemblages can be classified, the individual artefacts need to be analysed. Bordes has created a clear system with 63 different tool types (see Mellars, 1996:170). All the tool types have been given a clear description. The artefacts are described and categorised using this system. When this is completed statistics are used to determine the percentage of each tool type. Based on this percentage the whole assemblage can be classified. In this research the names of the taxonomic groups will be used. Bordes (1961) created three hypotheses which could explain the reason for the different assemblages.

1. The different assemblages represent a different season per year
2. Each assemblage shows an adaptation to different climatic circumstances
3. The different assemblages represent a way of expressing identity. Neandertals used the assemblages to differentiate themselves. They made cultural markers to express their identity.

Bordes could not find evidence for the first two so decided that the right hypothesis was the third. This hypothesis is no longer seen as accurate by most archaeologists including the author of this thesis. One of Binford's replies on the hypothesis of Middle Palaeolithic artefacts as cultural markers, is that the most distinctive marker is scattered over most of Europe in a similar shape, the biface. This makes the artefacts not useful as a cultural marker (Binford, 1973).

Binford (Binford, 1973; Binford & Binford, 1966; 1969) has a different view regarding the variability in artefact assemblage. The different assemblages are not part of a cultural marker, but have a more functional nature. Form and function are related and conclusions should be based on this. The different assemblages of artefacts represent a different use of the site in the landscape. For instance the artefacts needed to butcher animals at butchery sites will consist of different artefacts in a different quantity than at a gearing up site. This conclusion is based on artefact analysis and ethnographic studies (Binfrod, 1980). This is a very logical conclusion, since different activities lead to different artefact assemblages. There is a limit to this hypothesis. Some assemblages are not that much different. There is very little difference between the Quina and Ferrassie Mousterian, for their only real difference is the basic production technology. This implies that their function would be rather similar as well and if that is that case the hypothesis of Binford would not add new information (Mellars, 1996). Mellars clearly points out that the method of Binford is very well structured. However, it is still not clear what the functions of specific tool forms are, so a conclusion on the function of an assemblage seems far away (Mellars, 1996:319). Another point made is that the refuse left behind by hominins may not represent the activities they performed. Binford has done specific research on Nunamiut groups in Alaksa, which shows that the items which are discarded often were not used in the activities at that point (Binford, 1973; Mellars, 1996). Binford's conclusion is that there has been an organisational shift within the mind of *Homo sapiens* which would explain the Upper-Palaeolithic patterns and recent patterns in Nunamiut groups. Therefore, he maintains that Neandertals did leave everything behind, for they had an expedient life style, they immediately threw away the tools after using them (Mellars, 1996). The models of Binford leave something to desire for, therefore others have also attempted to explain the functional element of Middle Palaeolithic artefact assemblages.

Besides the functional analysis of Binford there is another functional analysis related to the amount of retouch on the artefact (Dibble, 1987; Dibble & Rolland, 1992; Rolland, 1981; Rolland & Dibble, 1990). This model does not look at the artefacts to find a deliberate end product, but realises that the artefacts may have had a long story to tell. Dibble states that the form of the tool is determined by the amount of retouch it has undergone. The reason that artefacts can be classified into a group, such as scrapers, implies that the variations on that group are the outcome of slight modifications. These modifications can be explained as an act of resharpening, an action performed, perhaps, many times, to maintain the use of the tool, see illustration 2. This would shape the artefacts into subgroups of Bordes classification method which comprise the composition of the assemblage. The presence or absence of these subgroups determine the name of the assemblage. With this model in mind the assemblages still keep their function for the archaeologist to see what tools are present. The whole assemblage may not give information on the function of the site or the culture of the maker of the artefacts, it does still show in a single glance what the assemblage is made of.

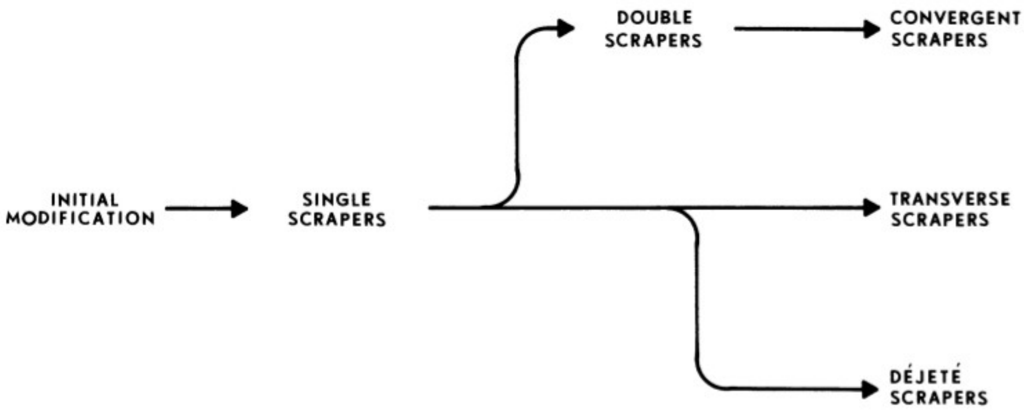


*Illustration 4: Scraper reduction flow chart which summarises the hypothesis of Dibble (Dibble, 1987).*

Mellars (1969, 1996) built on the idea of Bordes by looking at chronological and stratigraphical patterns in the occurrence of the different assemblages in south-western France. His conclusion was that there are patterns in the occurrence of assemblage type. This means that, generally speaking, MTA layers overlie Quina layers. He also came to the conclusion that these patterns can be linked to changes in climate during the last and the penultimate glaciation in Europe. Bocquet-Appel and Tuffreau (2009) tried to also make a link between the assemblage type and the climate. As mentioned before their hypothesis was too specific, their methods were incomplete and no real conclusions were reached. By restating the hypothesis to the one above, a new research can be carried out.

It has become clear that the initial function for classification is no longer used, but the method still helps archaeologists to analyse tools and to form hypotheses on artefact assemblages. In this research it is believed that form, function, culture and climate have all influenced the shape of Middle Palaeolithic artefacts. The possibility that debitage is more important than the retouched tools is becoming more and more plausible (Dibble & McPherron, 2006; Holdaway & Douglas, 2012). Therefore it is important not to get stuck in old ways. For this research the quantitative measurements of Bordes (1950; 1961; 1970; Bordes & de Sonneville-Bordes, 1970) will be used to give an accurate description of the assemblages. The names are not important. The most important aspect remains the difference there is between two archaeological layers.

### 2.3 Ecology and environment

One of the aspects of research is the environment in which the Neandertals lived. The environment is not the same as ecology. Ecology is the science which occupies itself with the relation between organisms and their environment (Hardesty, 1977:290). The environment includes all kinds of physical and biological aspects and relationships that influence an organism (Dincauze, 2000). For this research it is important to discover what a part of the environment looked like for Neandertals and how they interacted with it. This is called the niche of an organism, in this case the Neandertal. A niche is a specific place an organism has in the order of nature. This is influenced by what it eats and by what it is eaten. A niche is also influenced by a need for other natural objects the organism may need to survive. The climate in which the organism prefers to live is also needed to form a niche. In short a niche is determined by all the factors needed to survive. The niche of the Neandertal will be determined through the analysis of pollen and animal bones. The pollen will represent the vegetation at the site and the animal bones will represent the animal life in the area of the site. This will be used to create a climatic sequence, since a lot of vegetation and animals only live in specific climates. The information given by the pollen and the animal bones will determine what niche the Neandertals occupied.

Reconstructing the paleoenvironment is a interdisciplinary exercise and its goal is to get an insight in the “change in the physical and biological contexts of human existence” (Dincauze, 2000:23). The different disciplines that are touched upon are anthropology, biology, ecology, zoology, botany, geology, oceanography, climatology and pedology (Dincauze, 2000: 21). Borrowing concepts of different fields has a few connotations. It is impossible to be an expert in every field of these sciences. Also if concepts from a discipline are borrowed and added to the field of archaeology, the borrower may not fully comprehend the theoretical framework behind the concepts (Cremeens & Hart, 1995:16; Dincauze, 2000:20-22; Sahlins, 1972:51).

To set up hypotheses which investigate the paleoenvironment, it is important to realise what aspect of the environment influences the organism one wishes to research. The climate can change over a short period, within a life time, or over a long period, during several generations. It has been said that these kind of changes determine the flexibility or adaptability of a species more, than one major change from one type of landscape to another (Potts, 1998). This idea is good since it can also be tested today.

With all this in mind an approach has been chosen to encompass these aspects. To determine a reaction on either short term or long term climate change, the environment of the Neandertals will be examined. This will be done by looking at the pollen and animal bones. These specific studies are more incorporated into standard archaeological research. This means that the methods used are well considered, the theory behind the borrowed concepts are known and the two proxies can portray the differences in climate, when they occur.

### 2.4 Transitions

Archaeological research is usually about change or about the moments between the changes (Gamble, 1994). Changes can be designated by many words, one of which is transition. The essence of a transition is a change from one state or condition to the next. Since this research is about climate change, the change from one climatic situation to another could be seen as a transition. Climate changes occur more when the time frame gets larger. Therefore climate change is seen as variability: it changes more than it stays the same. Yet, in this research the climate changes are so important that they do resemble a transition. The hypothesis states that the influence of climate change is so big that the artefacts are used for different tasks. If the impact of climate change is this big, the change from one climate to another can be constituted as a transition.

To extract a proper approach, for this research, several transitional studies are analysed. The Levant has a long research history (Bordes, 1955; Garrod & Bate, 1937; Jelinek, 1981) and is still researched today, using the same information and new questions (Djindjian, 2012). In this area a time frame has been produced by looking at the changes and transitions over time from several behavioural differences (Bar-Yosef, 1998:45). A sequence has been made which goes from the Middle Middle Palaeolithic (MMP) to the

Late Middle Palaeolithic (LMP) to the Early Upper Palaeolithic (EUP). During the MMP the Levant was inhabited by *Homo sapiens*, the LMP by Neandertals and the EUP by *Homo sapiens* again. Every period had its own distinct features, therefore it is believed that the first wave of *Homo sapiens* became extinct in that area, called regional extinction, and reappeared from Africa later on (Shea, 2009). To come to this conclusion a list was made with the different types of behaviour seen in the record (Shea, 2009:79,

| Behavioral variable | MMP (130-75 ka) | LMP (75-45 ka) | EUP (45-25 ka) |
|---|---|---|---|
| Settlement in steppe-desert | No | Yes | Yes |
| Inferred residential mobility pattern | High | Low (coast) and high (interior) | High |
| Systematic hunting/ gathering of small mammals, birds, reptiles | No | No | Yes |
| Predominant core-reduction strategy | Radial-centripetal. core reduction | Unidirectional-convergent and radial-centripetal core reduction | Prismatic blade/bladelet core reduction |
| Characteristics of resulting debitage | Wide variation in flake shapes, but low returns on cutting edge per unit mass of stone | Morphologically consistent products (points and pseudo-Levallois points), but with low return of cutting edge per unit mass of stone | Morphologically consistent flakes and high return on cutting edge per unit mass of stone |
| Inferred strategic emphasis | Provisioning places | Provisioning places | Provisioning people |
| Microlithic technology | Cores-on-flake byproducts, largely unretouched | Cores-on-flake byproducts, largely unretouched | Retouched bladelets |
| Specialized stone and bone projectile armatures | No | No | Yes |
| Carved bone/ antler artifacts | No | No | Yes |
| Burials with mortuary furniture | Yes | Amud 7? | No |
| Mineral pigment production | Yes | No | Yes |
| Personal adornments | Shells, possibly modified | No | Shells and teeth, clearly modified |
| Lithic artifact style variation within Levant | No | No | Yes |
| Lithic artifact style variation between Levant and other regions | No | No | Yes |

*Illustration 5: Summary of MMP, LMP, and EUP behavioural differences (after Shea, 2009:79).*

see illustration 5). There are types of behaviour that occur in the MMP and in the EUP, but there are also types of behaviour that occur in the MMP and in the LMP or in the LMP and in the EUP. This shows that there are more factors in play than just the differences in species.

Another study on transition was made by Klein (1998). His hypothesis is that *Homo sapiens* was perhaps modern in an anatomical sense, but not in a behavioural sense until 40ka. He based this hypothesis by looking at the use of ornaments, the use of bone, ivory and shell implements, an increase in the variability of stone artefacts and advances in hunting and gathering techniques which could sustain larger populations. Klein looked at several sites in South-Africa and concludes a sharp line can be drawn between the Middle Stone Age (250-200ka to 50-40ka) and the Later Stone Age (after 50-40ka). Later research has invalidated this hypothesis by Klein (McBrearty & Brooks, 2000).

In Korea there have been several studies on the transition of the Marine Isotope Stage (MIS) 3-2 transition which spans from 40ka to 25ka (see Bae & Bae, 2011 for a synthesis of research on the MIS 2-3 transition). There are currently three models to explain the behavioural changes that took place during the transition. The first idea is that the indigenous inhabitants of the area developed a microblade artefact technology on their own. The second is that the groups which used microblade technology migrated from the north to the south. The third idea is that there was a migration/trade interaction. All three hypotheses can be used in studies. There is not enough information to select only one. The models were examined by looking at the presence of the different tool technologies around the transition (Bae & Bae, 2011) as done by Shea (2009) and Klein (1998).

In all the studies mentioned above, the transitions are examined by looking at the record before the transition and after the transition. These examples of transitional studies have helped establishing a research method regarding the transitional study of the different sites in Europe. For this research first a transition will be determined by looking at the different artefact assemblages, than the palynological and zoological assemblage from before the transition will be compared to the assemblage after the transition. For finding transitions it is easier to look at the stone tools first. However, in this thesis first the palynological and zoological information will be discussed since this is the crux of the research.

### 2.5 Adaptability

Adaptability is a trait which shows the amount of flexibility within the organism. This can be manifested through biological changes such as evolution, or through technological changes in a change of tool manufacture, which can be found within the archaeological record. There are more intangible manifestations of adaptability such as the mode of thought. These aspects are more interesting but cannot be directly researched. To achieve an approximation of such a research, lithic artefacts are analysed and through the technological changes and changes in the shape of the artefact which occur through time, a conclusion can be reached on the cognitive capacities of the knapper.

In this research biological changes due to adaptability are not important. Neandertals as a species have had a similar appearance since 300ka until their extinction around 30ka (Jurmain *et al*., 2009; Boyd & Silk, 2006 compare with Hublin, 2009). The important changes due to adaptability in this study are the technological changes or innovations. Examples of these are listed in McBrearty and Brooks (2000). Technological changes occurred in *Homo sapiens* society (Blades, 2003) and give a unique insight in the cognitive capacities of *Homo sapiens*. If Neandertals show a similar adaptability process by changing the technology, it might give new insights in their behaviour.

Adaptability is an important trait for the survival of all organisms. If an organism is rigid and is completely dependant of a specific climate, area and surrounding, the entire species will die out when the climate changes, the area turns into an ecologically different surrounding. An example of that can be found in the African record. The *Australopithecus robustus*, or the *Paranthropus robustus*, which lived around 2 to 1 million years ago, has a very pronounced rim on top of its skull. Also it appears to have enormous molars. The conclusion is that this species had specialised itself in eating hard nuts (massive chewing apparatus). It also died out relatively quickly compared to other hominins. It is believed that this species had specialised itself too much and had evolved itself into a corner. When the food the species was relying on vanished due to climatic changes or other influential occurrences, the species could not change its food habits and died out (Boyd & Silk, 2006). Therefore it is more useful to be highly adaptable to any change in the surroundings, climate or environment.

# -3-

# Palynology and zoology

## 3.1 Introduction

For this study fifteen sites have been analysed, only five sites possessed all the criteria of this research. These criteria are the presence of two or more archaeological layers with different artefact assemblage types; an unambiguous palynological and zoological sample for the same layers; a date within the 300ka to 30ka boundary; and the site must be located within the geographic area of Northern Europe. The five sites which came through the selection are Königsaue and Rheindahlen in Germany; Riencourt-lès-Bapaume and Grotte Vaufrey in France; and la-Cotte-de-St-Brelade on the Channel Island Jersey. Sites that were dismissed after analysis are Arcy-sur-Cure, Biache-Saint-Vaast, Combe-Capelle bas, Saint-Just-en-Chaussée, Seclin, in France, and Lehringen, Tönchesberg, Wallertheim, Wannen, Weimar-Ehringsdorf in Germany. One site would have been very interesting to research, Combe Grenal. However, it was impossible to obtain any literature on the excavation through the systems available.

In this chapter the palynological and zoological information will be addressed. Also the dates per layer per site will be mentioned and a conclusion will be made on the climatic circumstances at the site per layer using all the previous information from this chapter. First an introduction of the five sites will be given.

The information mentioned in this chapter are portrayed in tables. The tables can be found in the appendix.

### 3.1.1 Königsaue

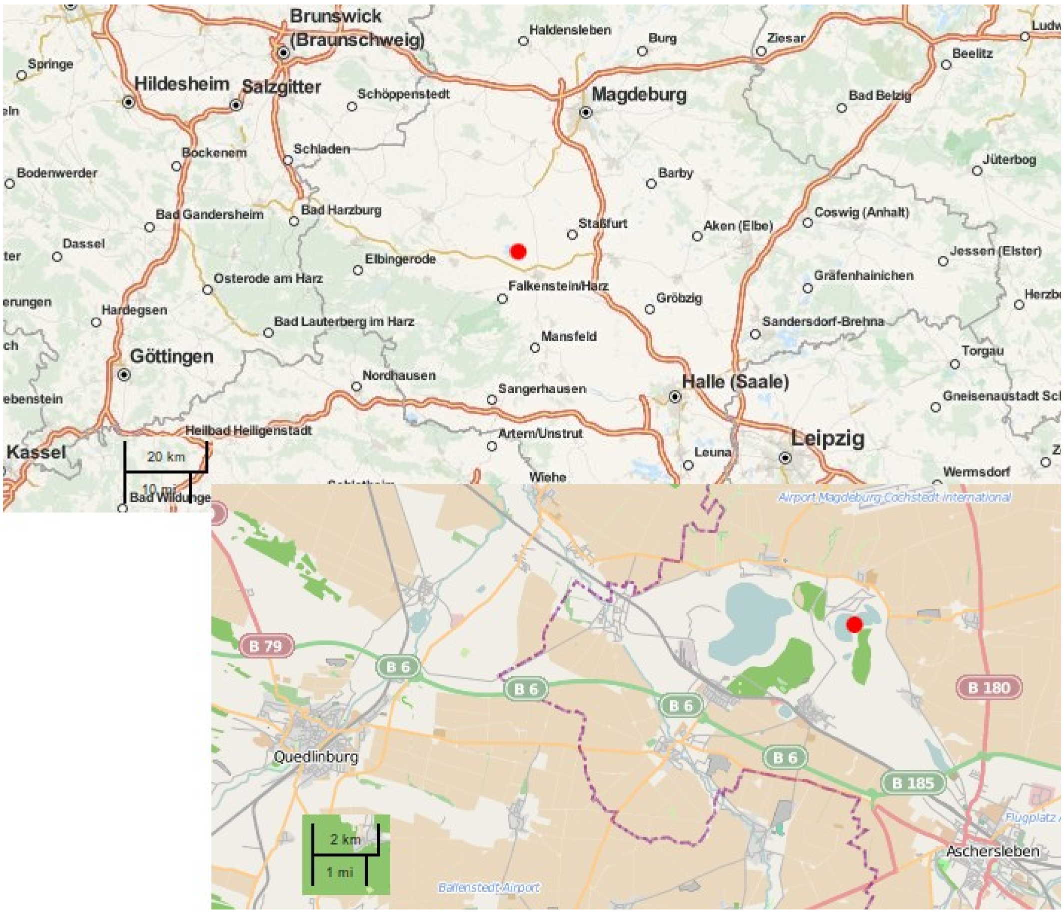


*Illustration 6: Königsaue, in Saxony-Anhalt, Germany (via openstreetmap.org). The red dot represents the location.*

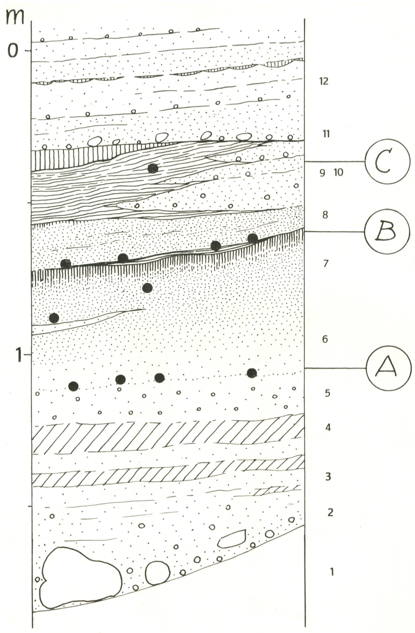


*Illustration 7: Schematic image of the stratigraphy at Königsaue (after Mania & Toepfer, 1973:66).*

Königsaue is a Palaeolithic site in Saxony-Anhalt in Germany, see illustration 6. The open-air site was located in an opencast lignite mine which was still in use during the excavations (Mania & Toepfer, 1973). The excavations were held in the years 1963 and 1964 by Mania and Toepfer (1973). The site consisted of three layers which were excavated quickly to stay ahead of the mining operation. The layers are Kö A; Kö B; and Kö C, see illustration 7. They are positioned in the geological layer of 1b which has been analysed during previous geological studies in the more general area of Aschersleben. This study showed that layer Ib is an interstadial. Using the geological characteristics of the specific glacial and interglacial complexes, through stratigraphic correlation (Nichols, 1999) layer 1b could be traced to an interstadial of the Weichselian glacial complex, see illustration 8. The opencast mine is now closed and has been turned into a lake called Königsauer See (Mania & Toepfer, 1973). An interesting type of artefact was found at the site of Königsaue (Grünberg *et al*.,1999). Two pieces of birch bark adhesives were found which were probably used to attach the lithic artefacts to another material to form a composite tool. The most common idea is that the lithic artefact was connected to a wooden artefact (d'Errico, 2003). For this research the adhesives are not important and will not be mentioned further.

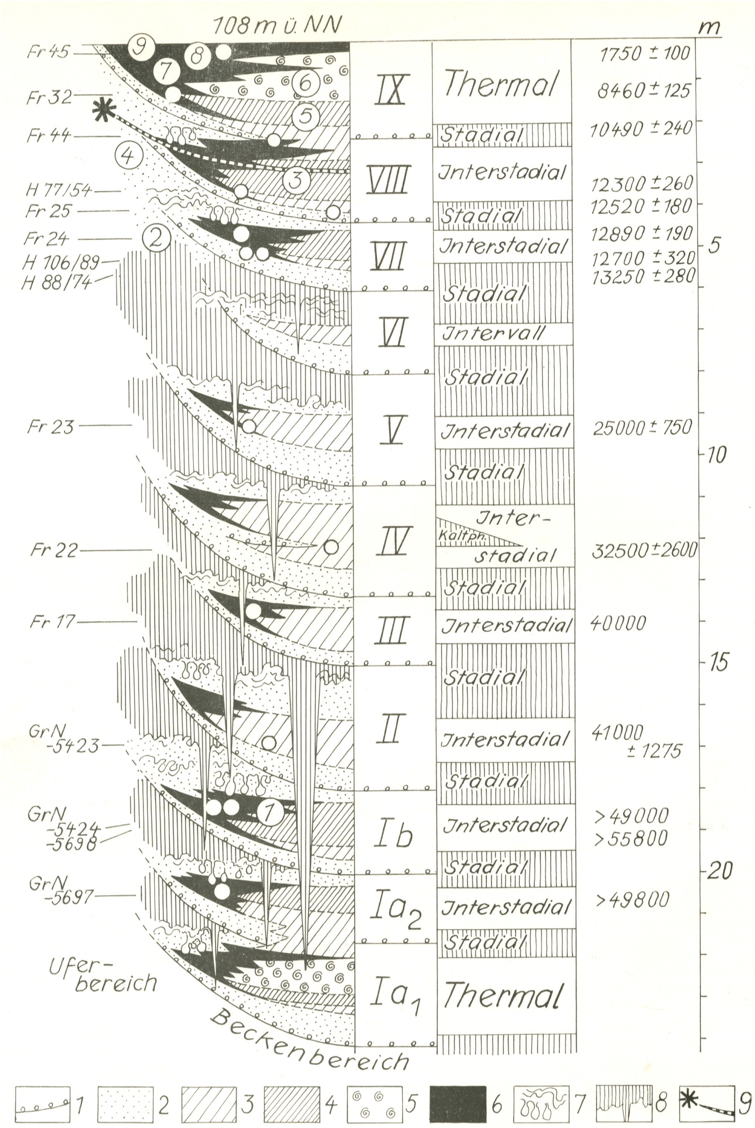


Illustration 8: Schematic image of the geological sequence of the general area of Aschersleben. 1. Denudation layer; 2. Sand and gravel like sand; 3. Sand and silt mud; 4. Clay mud; 5. Organic chalk muds; 6. Peat; 7.Percolated soil and cryoturbation; 8. Solifluction processes; 9. Volcanic ash from the Eifel area (Laacher See Tuff). The numbers in circles stand for specific finds from those periods. The dates were achieved through $^{14}C$ dating (in BP). Fr= Freiberg; H= Heidelberg; GrN= Groningen (after: Mania & Toepfer, 1973:24-25).

### 3.1.2 Rheindahlen

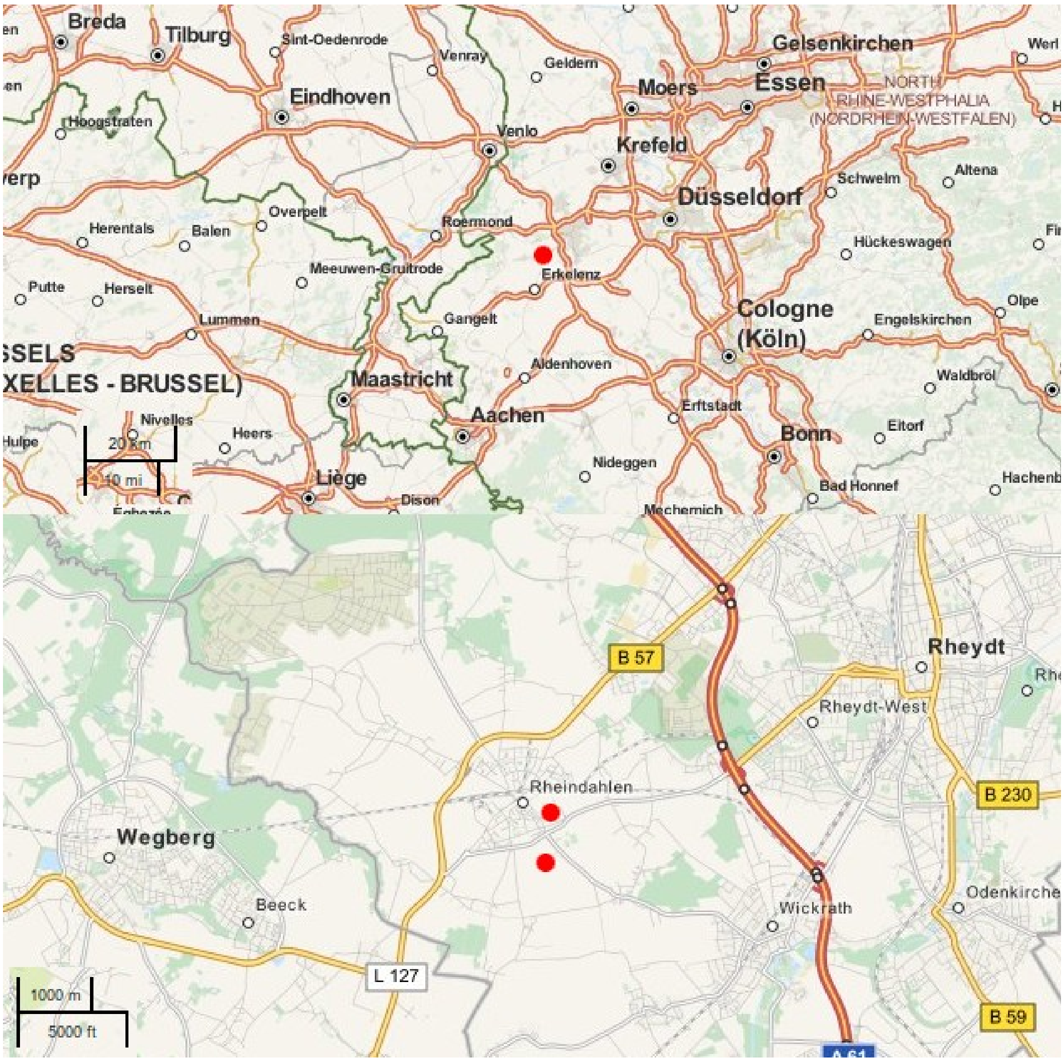


*Illustration 9: Rheindahlen, North Rhine-Westphalia, Germany. The red dots represents the location (via openstreetmap.org).*

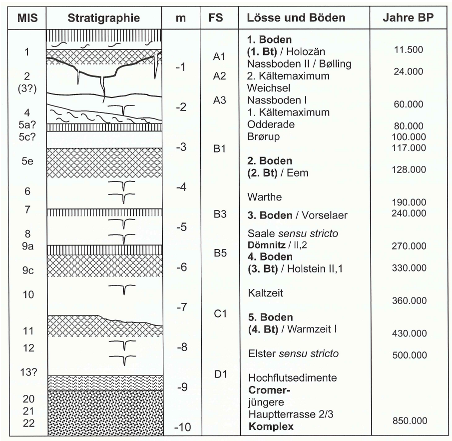


*Illustration 10: Schematic image of the stratigraphy of the site Rheindahlen. It shows the soils and the age per layer (Thissen, 2006:25).*

Rheindahlen is a site located in North Rhine-Westphalia. This is a site located in a brickyard pit called Dreesen, see illustration 9 (Thissen, 2006). The site has been revisited many times. In 1965 it has been excavated by Bosinski (1966) and from 1973 until 1975 and from 1979 to 1981 it has been excavated by Thieme (1977; 1983). The second to last visit was between 1984 and 1995 by Thissen. After 1995 research was continued from 1995 and 2001 (Thissen, 2006). During the last two excavations the research focussed on the archaeological remains, geochronology, $^{14}C$ and thermoluminescence dating (Thissen, 2006). The site consists of eight archaeological layers A1; A2; A3; B1; B3; B5; C1; D1. A1 is too young, 11.5ka, and C1 and D1 are too old, 430-850ka. Since the excavation took place in an opencast mine, a sequence has been made which ranges to the Oligocene. The stratigraphical information shows that there are five soils present of which four have a Bt horizon, see illustration 10. Since the soils showed specific characteristics of the periods in which they were formed, they were used to date the layers. The stratigraphy is clear and posed no questions for the position of the archaeology.

### 3.1.3 Riencourt-lès-Bapaume

Riencourt-lès-Bapaume is an open-air site situated next to a motorway between Bapaume and Bancourt in the area of Pas-de-Calais in Picardy, France, see illustration 12 (Tuffreau, 1993b). The terrain is now used for the high speed train infrastructure called TGV. 10.000 m² was excavated prior to the actual excavation as an exploratory study which lasted nine months from June 1989 until February 1990. The second project lasted from April 1990 until February 1991 (Tuffreau, 1993b). The excavations were directed by Tuffreau (1993a) and the focus of the study was on the lithic artefacts. A small palynological study has been done, but there hasn't been a zoological study done. The site consists of 5 archaeological layers. For the artefact research, the archaeological layers are used as designation, for the pollen study the stratigraphical designations have been used. There is no clear correlation between the two types of designation except for a couple of drawings in which circles indicate the archaeological layer, see illustration 11.

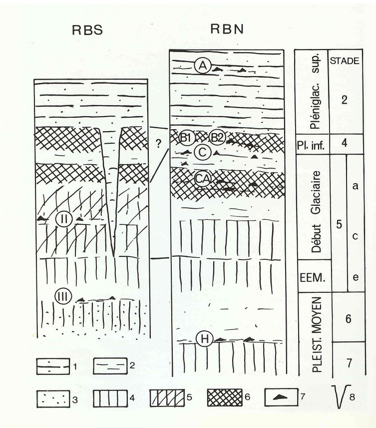


*Illustration 11: Schematic image of the stratigraphy at Riencourt-lès-Bapaume. RBS stands for Riencourt-lès-Bapaume Sud and RBN stands for Riencourt-lès-Bapaume Nord (Tuffreau & Van Vliet-Lanoë, 1993:20).*


*Illustration 12: Riencourt-lès-Bapaume, Pas-de-Calais, Picardy, France (via openstreetmap.org). The red dot represents the location.*

### 3.1.4 Grotte Vaufrey

The site of Grotte Vaufrey is located in the Dordogne, France, see illustration 13. It is located in a valley in which many more Palaeolithic caves are present and have had research done (Rigaud, 1989). Grotte Vaufrey has been excavated thoroughly by a large team of scientists from different fields. The focus of the research was as much on the tools as on the environment. The pollen samples were compared with the current pollen rains in that area (Bui-Thi-Mai, 1989). These kind of comparative studies are rare. There have been thermoluminescence dating studies (Huxtable & Aitken, 1989), uranium series dating studies (Blackwell & Schwarcz, 1989), animal remains studies (Caillat, 1989; Delpech, 1989; Marquet, 1989; Prat, 1989) and even a fish bone study done (le Gall, 1989).

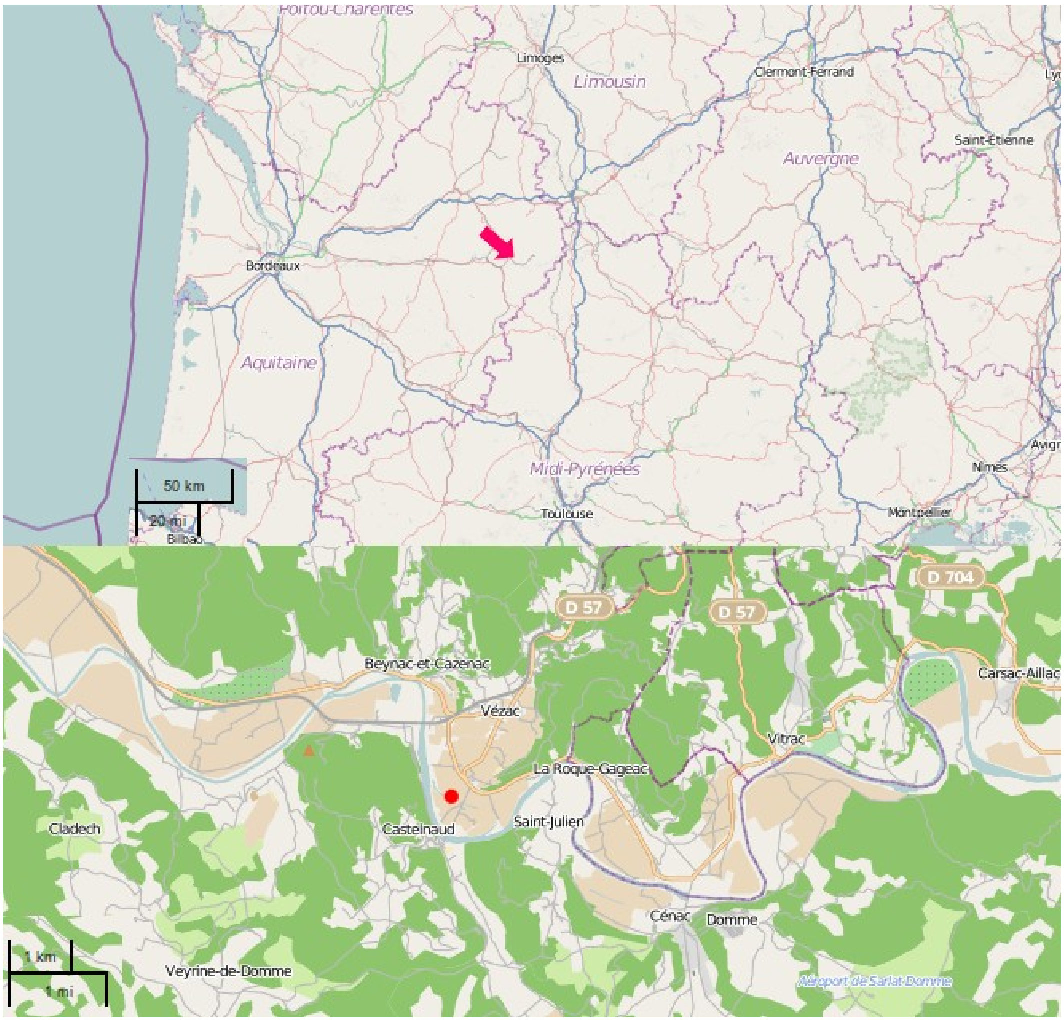


*Illustration 13: Grotte Vaufrey in the Dordogne, France. The red arrow and the red dot represents the location (via openstreetmap.org).*

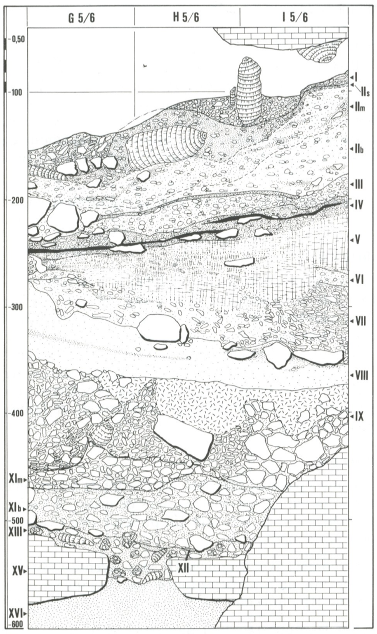


*Illustration 14: Schematic image of the stratigraphy at Grotte Vaufrey. The Roman numbers represent the layers (after: Kervazo & Laville, 1989: 94).*

The site consists of sixteen archaeological layers of which the oldest five are layers deposited before hominin occupation. On top of the first layer a thick layer of stalagmite material has been deposited. Between layers III and IV a similar layer has been deposited and layer XIII is also a stalagmite layer. Some layers possess characteristics of cave collapses throughout the occupation period and before. There collapses have improved the accurate division between layers, see illustration 14 (Kervazo & Laville, 1989).

### 3.1.5 La-Cotte-de-St-Brelade

La-Cotte-de-St-Brelade is located on the Island of Jersey, a Channel Island just on the shore of France, see illustration 15 (Callow, 1986a). This site has been included in this

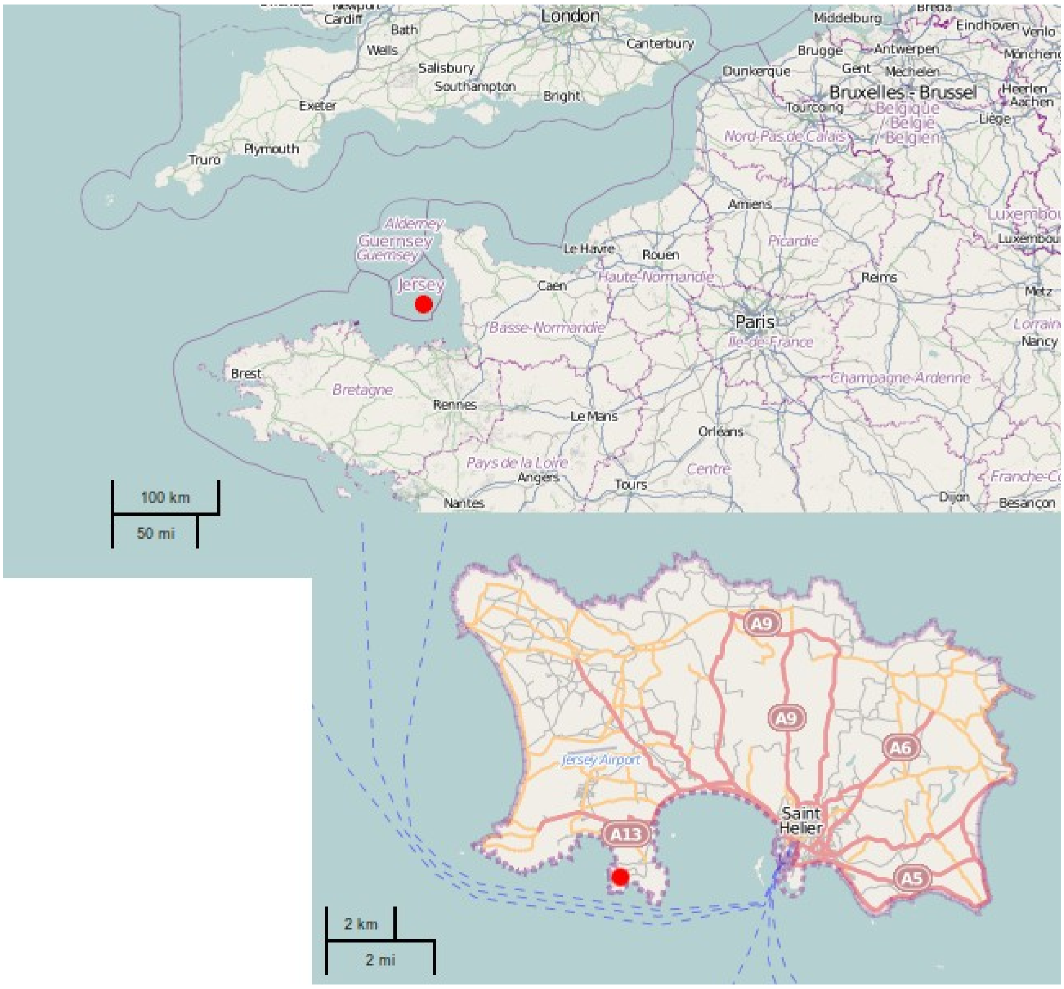


*Illustration 15: La-Cotte-de-St-Brelade, Jersey Channel Islands (via openstreetmap.org). The red dot represents the location.*

study since it was attached to the mainland of France for most of the time in the Pleistocene. This site has been excavated from 1961 until 1978 by McBurney (Callow & Cornford, 1986). In 1979 McBurney died and John Coles took over the responsibility for the project (Mourant & Callow, 1986). The project comprised of research on archaeological remains (Callow, 1986c; Callow, 1986d; Callow, 1986e; Callow, 1986f; Callow, 1986g; Callow *et al*., 1986; Cornford, 1986; Frame, 1986; Hivernel, 1986; Hutcheson & Callow, 1986; Jones & Vincent, 1986; Scott, 1986b; Stringer & Currant, 1986), sedimentology (Lautridou *et al*., 1986), botanic remains (Cartwright,1986; Jones, 1986), animal remains (Scott, 1986a; Chaline & Brochet, 1986) and thermoluminescence (Huxtable, 1986) and uranium series dating (Szabo, 1986).

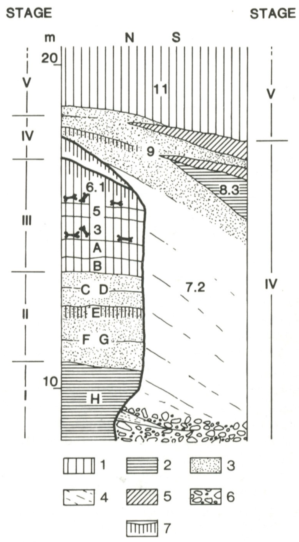


*Illustration 16: Schematic image of the stratigraphy at la-Cotte-de-St-Brelade. 1. Loess; 2. Water-laid silt; 3. Granitic sands; 4. Talus resulting from collapse of fossil cliff; 5. Humiferous deposits (ranker soils); 6 Marine gravel; 7. Truncated forest soil (after: Callow, 1986b:57)*

The site consists of twelve archaeological layers of which only four layers have been examined and published well enough for this research. These are layers H, E, C and A. These layers are deposited in three different stages. The first and the oldest stage is stage I (layer H) and is a loess deposition. Stage II (layers E and C) comprises of rock fall episodes. Stage III (layer A) holds granite blocks and a loessic matrix, see illustration 16. The preservation of the site is not very well. A lot of the bone material has been eroded (Callow, 1986b).

### 3.2 Palynology

In the first part of this chapter the pollen and other botanical remains will be addressed. The tables which are used in this section to clarify information, can be found in the appendix.

#### 3.2.1 Königsaue

During the excavations of Königsaue there were palynological studies performed. This consists of one study with two samples. One sample is taken from a mud level in sediment level Ib in which all three of the archaeological layer are. Another sample is taken just above archaeological layer B, see table 1.

In the general area of Aschersleben, the Aschersleben depression, where Königsaue is located, a pollen study has been done of the geological layer Ib, see table 2. This research has been used in the past to reconstruct the climate of the site and will be used in this thesis for the same reason (Mania & Toepfer, 1973). The total taxa at the site are *Potamogeton crispus* L.; *Potamogeton densus* L.; *Potamogeton filiformis* L.;

*Potamogeton obtusifolius* L.; *Potamogeton perfoliatus* L.; *Potamogeton pusillus* L.; *Potamogeton vaginatus* TURCZ.; *Potamogeton* sp.; *Ranunuculus aquatilis* L.; *Myriophyllum verticillatum* L.; *Hippuris vulgaris* L.; *Scirpus mucronatus* L.; *Typha* cf. *latifolia* L.; *Phragmites communis* TRIN.; *Carex* sp.; *Chara* sp.; *Pinus*; *Betula*; *Picea*; *Pinus silvestris*; *Picea omorika*; *Alnus*; *Populus*; *Ulmus*; *Tilia*; *Corylus*; *Artemisia*; Gramineae; Cyperaceae; Caryophyllaceae; *Sphagnum* (Mania & Toepfer, 1973). More specific information on the taxa can be found in table 1 and 2.

### 3.2.2 Rheindahlen

In Rheindahlen the research has been very extensive. Pollen research has been done on two layers B1 and B3. The research has been done in 1964 to 1965 by Bosinski. In the project of 1984-85 there have been a few charcoal finds. These have been implemented into table 3, but do not change the outcome of the palynological research (Thissen, 2006). The taxa found at the site are *Acer* sp.; *Betula* sp.; *Fraxinus* sp.; S*alix* sp.; *Carpinus betulus*; *Quercus* sp. cf.; *Corylus* sp.; *Pinus* sp.; *Picea* sp.; *Alnus* sp.; *Tilia* sp.; *Ulums* sp.; Gramineae; Cyperaceae; Ericaceae; Chenopodiaceae; *Artemesia* sp.; Umbelliferae (Thissen, 2006). See table 3 for more information.

### 3.2.3 Riencourt-lès-Bapaume

In Reincourt-lès-Bapaume the pollen research consists of 24 samples that were taken. The samples were taken from the sediment layers 4b; $4a^2$; $4a^1$; and 3. Many of the samples were sterile and only four made it to the final analysis. These samples came from $4a^2$; $4a^1$; and 3. In these layers the the artefact layers II ( $4a^1$ and $4a^2$); CA (3); C (3); B1 (3); and B2 (3) are present. However, there is no mention of the location within the layer from which these samples were taken except that they were 30 cm apart (Munaut, 1993). The taxa found at the site are *Alnus*; *Carpinus*; *Betula*; *Fagus*; *Corylus*; *Pinus*; *Quercus*; *Tilia*; *Ulmus*; Apiaceae; A*rtemesia*; Asteraceae *crepis* and c*irsium*; *Calluna*; Chenopodiaceae; Cyperaceae; Poaceae; *Dryopteris*; *Calluna*; *Plantago* (Munaut, 1993). See table 4 for more detailed information.

### 3.2.4 Grotte Vaufrey

In the research of Grotte Vaufrey pollen samples were taken. These samples have in turn been compared to recent pollen rains collected during the excavations (Bui-Thi-Mai, 1989). This is done to see how much of the pollen in the air set on the ground of the cave. The research is focussed on the first five layers. The layers older than V did not contain any palynological remains. Per layer an average of three samples has been taken.

Concretions between layers have had two to three samples as well (Diot, 1989). The taxa found at the site are *Pinus*; *Abies*; *Picea*; *Juniperus*; *Cupressus*; *Alnus*; *Corylus*; *Betula*; *Quercus ilex*; *Pistacia*; *Juglans*; *Tilia*; *Ulmus*; *Carpinus*; *Buxus*; *Fraximus*; *Quercus ped*.; Gramineae; Anthemideae; *Artemisia*; Carduaceae; Centaureae; Chicorieae; *Ephedra*; *Rubiaceae*; *Plantago*; *Rumex*; Dipsacaceae; Plumbaginaceae; Chenopodiaceae; Cruciferae; Urticaceae; Caryophyllaceae; Labiatae; Leguminosae; Scrophulariaceae; Campanulaceae; Umbellifereae; Malvaceae; Rosaceae; Valerianaceae; Cyperaceae; Ericacea; Typhaceae; *Potamogeton*; Liliaceae; Boraginaceae; Ranunculaceae (Diot, 1989). For more information, see table 5.

### 3.2.5 La-Cotte-de-St-Brelade

Since la-Cotte-de-St-Brelade has been excavated several times, there have been many pollen studies done. During the excavations of 1961-1978 a new insight to the stratigraphy was gained. Because of this the layers have been given a new name and the pollen research from older excavations are cross referenced with these new stratigraphical insights. The taxa found at the site are *Alnus*; *Betula*; *Quercus*; *Pinus*; *Ulmus*; *Tilia*; *Corylus*; *Hedera*; Ericaceae; Gramineae; Cyperaceae; Liguliflorae; Cirsium; Plantaginaceae (undiff.); *Armeria*; Rosaceae (undiff.); Umbelliferae; *Lotus*; *Rhinanthus*; *Vicia*; *Aconitum*; *Stratiotes*; *Filicales*; *Polypodium*; *Pteridium* (Jones, 1986). For more specific information on the taxa, see table 6.

## 3.3 Animal remains

In the next section the animal remains will be explored and summarised. In some research there has been a differentiation between large mammals, small mammals and other animals. It will be noted per site whether this is the case. The tables with the specific information on the zoological data per site can be found in the appendix.

### 3.3.1 Königsaue

At Königsaue a zoological study has been performed, see table 7. This study was performed during the excavations, not during the geological survey in the general area of Aschersleben. The zoological information represents a part of the fauna which was present at the time when the site was formed. The animals present are *Microtus arvalis*; *Microtus gregalis*; *Canus lupus*; *Crocutta spelaea*; *Panthera (Leo) spelaea*; *Mammuthus primigenius*; *Equus* sp.; *Equus (Asinus) hydruntinus*; *Cervus elaphus*; *Rangifer tarandus*; *Crocuta spelaea*; *Coelodonta antiquitatis*; *Dicerorhinus hemitoeches*; *Bison priscus* (Mania & Toepfer, 1973).

**3.3.2 Rheindahlen**

During the excavation of Rheindahlen there was a focus on artefacts and palynology (Thissen, 2006). Animal remains have not been analysed and can therefore not be used. The data of the palynological studies will have to be enough.

**3.3.3 Riencourt-lès-Bapaume**

During the excavation of this site no zoological studies performed (Tuffreau, 1993a). It is hoped that the information from the pollen assemblage is enough to create an image of the surroundings at the different moments.

**3.3.4 Grotte Vaufrey**

The research of the animal remains at Grotte Vaufrey was split into four groups: the large mammal remains without the bears (Delpech, 1989), bear remains (Prat, 1989), rodent remains (Marquet, 1989) and fish remains (le Gall, 1989), see tables 8 and 9 for the large mammal remains without the bears and the rodent remains per layer. The bear remains are taken out of the large mammal remains because the remains were deposited before hominins lived in the caves. The bears most likely died of natural causes. The bear remains, therefore, are not interesting and are taken from the study. The fish remains can be of interesting value. Fish remains are rarely researched and no other site used in this study has researched fish remains. Therefore, they will also be left out of this study. The species found at this site are C*apra* sp.; *Saiga* sp.; *Bison* sp.; *Cuon* sp.; *Lynx* sp.; *Hermitagus* sp.; *Canis lupus*; *Vulpus vulpus*; *Cervus elaphus*; *Equus* sp.; *Oryctolagus* sp; *Lagarus lagarus*; *Lemmus lemmus*; C*astor* sp.; *Microtus nivalis*; *Marmota* sp.; *Citellus* sp.; *Sicista* sp.; *Microtus malei/Microtus oeconomus*; *Eliomys quercinus*; *Clethrionomys glareolus*; *Apodemus* sp.; *Pitymys* sp.; A*rvicola* sp.; *Microtus arvalis*; *Microtus brecciensis*; *Pliomys lenki*; *Ochotona pusilla*; *Sciurus* vulgaris; *Microtus gregalis*; *Allocricetus bursae* (Delpech, 1989; Marquet, 1989).

**3.3.5 La-Cotte-de-St-Brelade**

The preservation of the bones is in this site very poor. In layer E only one species was identified even though many bones were found in that layer. Also layer H has a problem: the bones from that layer are probably from the layer D until 6 which lay on top of layer H. The species found in this site are *Canis lupus*; *Ursus spelaeus*; *Mammuthus primigenius*; *Coelodonta antiquitatis*; *Equus caballus*; *Megaceros giganteus*; C*ervus elaphus*; *Rangifer tarandus*; *Bos* sp. or *Bison* sp.; *Rupicapra rupicapra; Sicista* sp.; *Dicrostonyx torquatus*; *Microtus gregalis* (Chaline & Brochet, 1986; Scott, 1986a;

1986b). See table 10 and 11 for the zoological representation at this site per layer.

### 3.4 Dating

To give an idea of the time-frame in which this research is placed a date will be matched to the layers of the sites. This is not an important aspect of the research but gives a more broad impression of the sites in time and space. It does not matter whether a date is available or not, it only provides a context and can be used to put a layer or site within a certain glacial or interglacial. The tables with the information on the dates can be found in the appendix.

### 3.4.1 Königsaue

Besides pollen there are other plant remains in the form of birch pitch (Grünberg, 1999). There was a find in layer A and in layer B, which have been dated using the $^{14}C$ method, see table 12 and illustration 17. The dates were not calibrated. The maximum range of the $^{14}C$ method is around 50ka, which means that the dates of the birch pitch are on the edge of the spectrum. This can create false readings and the dates may not be as accurate as portrayed in the literature (Renfrew & Bahn, 2004).

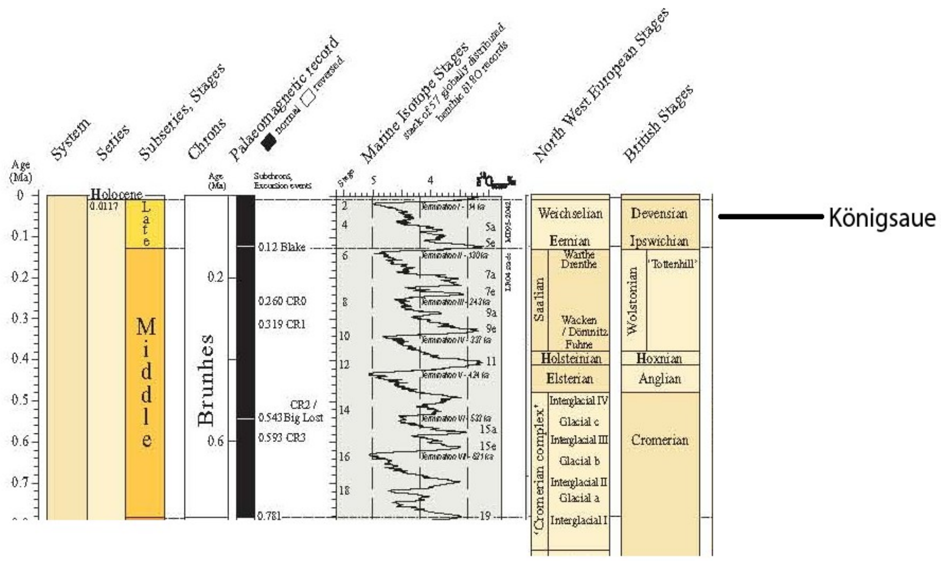


*Illustration 17: Date of the Königsaue site placed in the chronostratigraphical table. The layers are dated so close together that the whole site has been portrayed with one line. (Courtesy of Matthijs Hattinga Verschure).*

### 3.4.2 Rheindahlen

In Rheindahlen the dates were created by correlating the geographic layers with known information of other stratigraphical sequences as mentioned in section 3.1.2. The dates of this can be seen in table 13 and illustration 18 (Thissen, 2006).

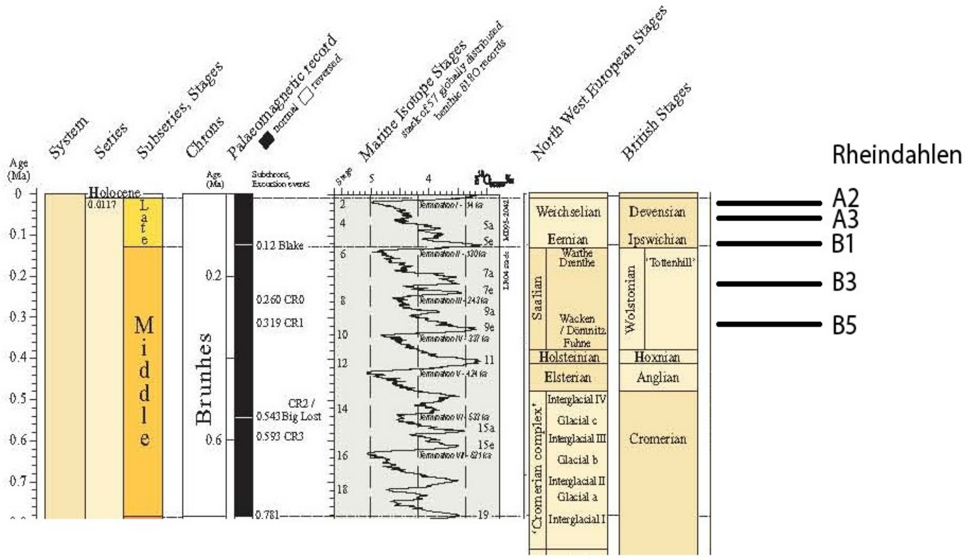


*Illustration 18: Dates of the archaeological layers of the Rheindahlen sites placed in the chronostratigraphical table. (Courtesy of Matthijs Hattinga Verschure).*

### 3.4.3 Riencourt-lès-Bapaume

During the excavations a sedimentological study was performed to estimate the age of the layers. The study was performed through the observation of the stratigraphical sequence at the site in a similar way as in Rheindahlen. The study used the geological designations to date the layers. No correlation to the archaeological layers has been done, see table 14 and illustration 19 (Tuffreau & van Vliet-Lanoë, 1993).

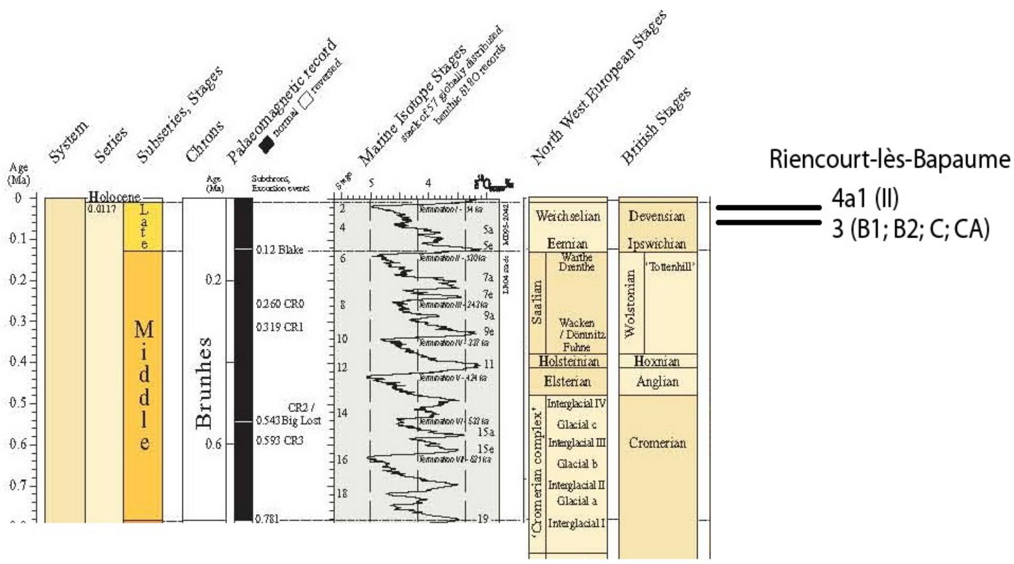


*Illustration 19: Dates of the geological layers of the site Riencourt-lès Bapaume placed in the chronostratigraphical table. Archaeological layers in brackets. (Courtesy of Matthijs Hattinga Verschure).*

### 3.4.4 Grotte Vaufrey

At Grotte Vaufrey there have been several studies done to date the layers. These used the methods of thermoluminescence dating and uranium series dating (Blackwell & Schwarcz, 1989; Huxtable & Aitken, 1989). For the thermoluminescence dating two samples from layer IV and two samples from layer VIII have been taken and analysed. The samples were taken from burnt flint. For the uranium series dating, about twelve samples have been taken throughout the site, mostly from speleothems between and in the layers. An average for the dates is presented in table 15 and illustration 20.

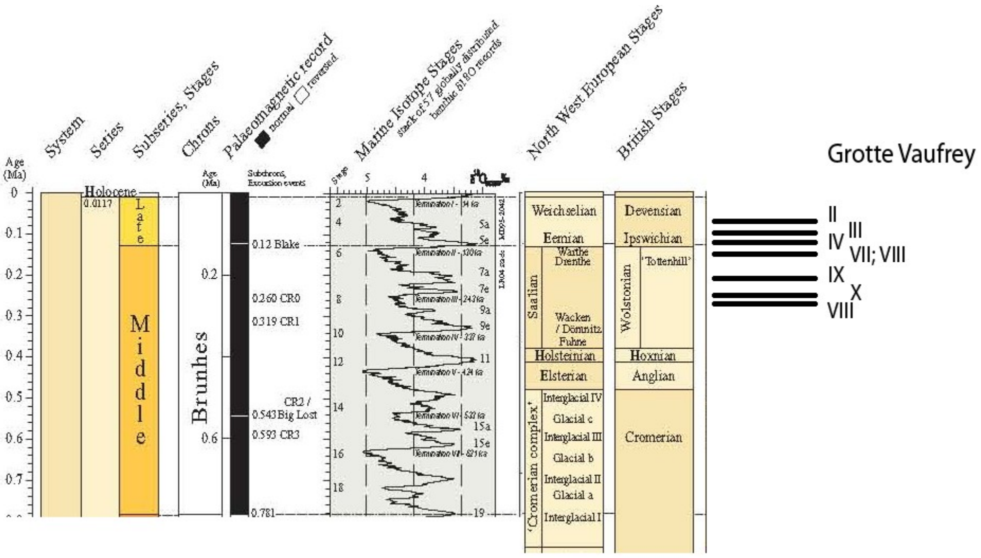


*Illustration 20: Dates of the archaeological layers of Grotte Vaufrey placed in the chronostratigraphical table. (Courtesy of Matthijs Hattinga Verschure).*

### 3.4.5 La-Cotte-de-St-Brelade

In la-Cotte-de-St-Brelade several burnt flint samples were dated using the thermoluminescence technique (Huxtable, 1986). The samples were taken from layer C, layer D (not included in this study) and layer E. The dates are represented in table 16 and illustration 21.

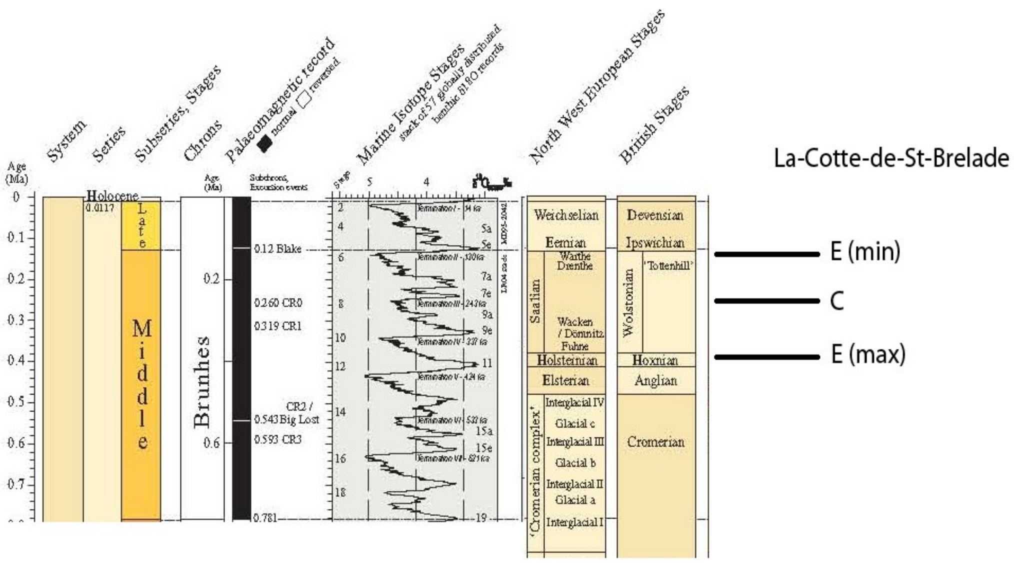


*Illustration 21: The archaeological layers of the site la-Cotte-de-St-Brelade placed in the chronostratigraphical table. Min stands for minimum age; Max stands for maximum age. (Courtesy of Matthijs Hattinga Verschure).*

### 3.5 Conclusions on the environment and climate

In this section conclusions will be drawn on the climate per layer, when possible. The tables used in this section, can be found in the appendix.

#### 3.5.1 Königsaue

The information on the mammal remains and the botanic remains is brought together and has produced a conclusion that layer Ib, in which the three layers of Königsaue are present, was an interstadial (Mania & Toepfer, 1973). The palynological report shows that birch and pine have a presence of 89%. The non-arboreal pollen are relatively abundant and compared with the presence of birch and pine it can be said that the layers of Königsaue are situated in a colder phase with warmer influences. One more conclusion has been made which is that the temperature increases from layer Kö A to Kö C. The conclusions of the researchers was that the site of Königsaue is situated in an interstadial. It is believed to be an interstadial in the glacial which is called the Weichselian in northern Europe and the Devensian in the United Kingdom, which can be seen in illustration 17. An interstadial is a slightly warmer phase in an overall cold complex. An interstadial is very similar to an interglacial only it is not as warm or as long as an interglacial. The dates of the site also back up that the site can be positioned in the Weichselian (Mania & Toepfer, 1973).

### 3.5.2 Rheindahlen

In Rheindahlen the palynological information is limited to two layers, B1 and B3, see the sections below.

#### 3.5.2.1 Layer B1

The palynological data of layer B1 shows an arboreal environment with only a few non-arboreal plants. Together with the date given to the layer, which is 117 ka to 128 ka, the environment can be placed in a specific glacial. This is the Saalian complex, for northern Europe, which is called the Wolstonian in the United Kingdom, which can be seen in illustration 18 (Thissen, 2006).

#### 3.5.2.2 Layer B3

In layer B3 the only palynological data comes from arboreal pollen. This implies a forested environment, especially due to the variation in tree types. The date of 220 ka places the layer in the Saalian complex, or the Wolstonian in the UK. The lack of non arboreal pollen suggests that this environment is colder than the environment in Layer B1 (Thissen, 2006).

### 3.5.3 Riencourt-lès-Bapaume

In layer $4a^{1}$ and 3 the pollen remains are not very conclusive. It is possible to make a few conclusions on the information per layer, which can be seen in the sections below.

#### 3.5.3.1 Layer $4a^{1}$ (II)

The pollen assemblage of the first sample, P1, in layer $4a^{1}$ indicates a similar amount of arboreal pollen as non arboreal pollen. In the second sample, P2, this is more differentiated. The arboreal pollen mostly come from *Betula* sp. and the non-arboreal pollen mostly come from the family *Asteraceae* taxa *crepis*. These are both the most common pollen and together with the sedimentologicial data therefore point to a climate which is getting colder. The most common flowers and trees still survive but the climate is changing from a warm to a colder environment (Munaut, 1993; Tuffreau & van Vliet-Lanoë, 1993).

#### 3.5.3.2 Layer 3 (B1; B2; C; CA)

The first sample, P3, of layer 3 shows more arboreal pollen than non-arboreal pollen. The second sample, P4, has an amount of pollen too little to make any conclusions. The open vegetation shows that the environment resembles that of a forest in a cold phase during a glacial.

### 3.5.4 Grotte Vaufrey

Delpech (1989) has made a clear diagram for the information the large mammals show on climate, see illustration 22. All the species of mammal were divided into several groups. Initially there are three groups. Group 1 is the group of mammals which prefer to live in an Arctic environment in which the temperature and the humidity is low. Examples of the species are: reindeer, ibex and chamois. In group 2 mammals are categorised which prefer a more temperate and a more humid climate. Examples of this group are the Saiga antelope, the horse and bovids. Group 3 are the mammals which prefer a very warm and humid climate. Examples of this group are deer, roe deer and boar. A fourth group was added (group 1') which consists of the tahr goats and is in between group 1 and 2, climate wise. A fourth and a fifth group is added for layers X and XI to have a more close up view of the boars and roe deer.

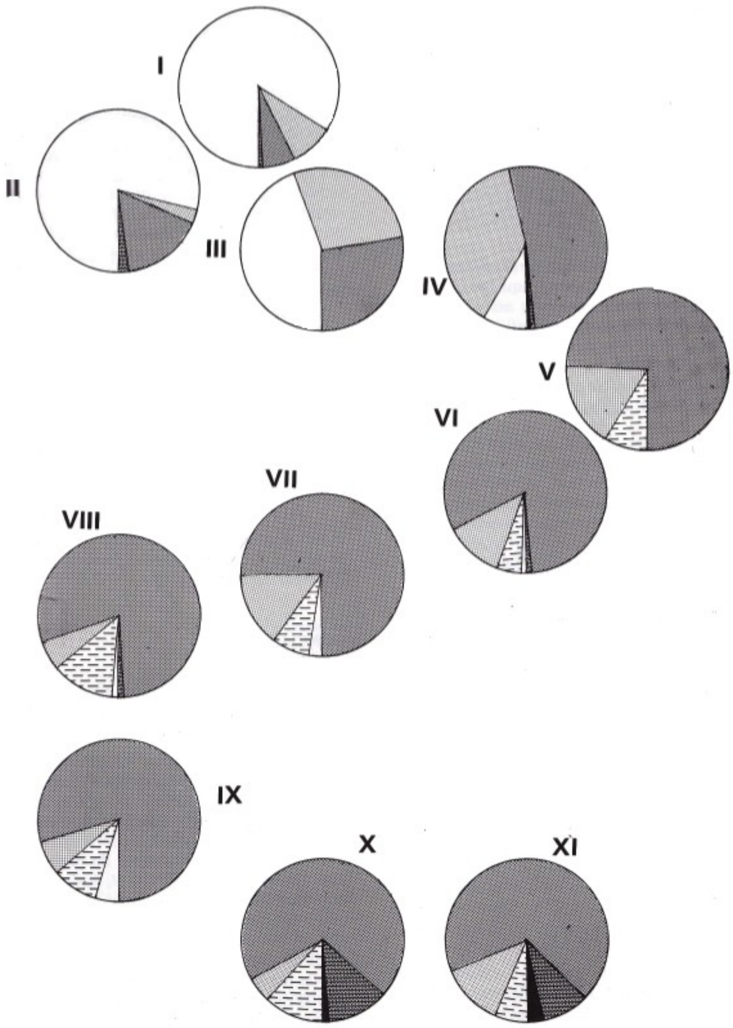


*Illustration 22: Diagram of the percentage of large mammal remains per layer, divided into the groups. White: group 1; Striped: group 1'; Light grey: 2; Darker grey: group 3; Black: boars; Darkest grey: roe deer (Delpech, 1989:257)*

### 3.5.4.1 Layer I

In layer I the scarcity of arboreal pollen and the abundance of Chicoreae shows cold temperatures with a low humidity.  The large mammal assemblage are mostly represented by species which prefer colder temperatures.  These species cover almost 70 percent of the assemblage.  The rodents represent a return of a humid and temperate climate.  The final conclusion of the climate of this layer is a cold and arid climate without big forests and clear plains with leafy plants and with reindeer and goats walking around.

**3.5.4.2.Layer II**

In layer II it is noticed in the pollen record that the climate is generally temperate and humid, which is interrupted by a short, intensive period of rigorous change. The large mammal remains give a picture of a cold, but humid environment. The rodents represent a dry and cold climate. The different proxies appear to contradict each other, although the pollen also mention relatively short periods of cold temperatures. Generally speaking it can be assumed that the climate was cold and the air was probably more humid than arid.

**3.5.4.3 Layer III**

In layer III arboreal pollen are mostly absent. The Gramineae and Chicoreae show a drop in humidity and the climate has a cold overall temperature. The large mammal remains in this layer consists of about 50 percent of species which prefer cold climates, 25 percent of species that prefer a more temperate climate and 25 percent that prefer a warm climate. The rodents represent a colder climate than in layer IV. The conclusion here is that the climate was more cold and the air more arid than in layer IV, but warmer than in layer II.

**3.5.4.4 Layer IV**

In layer IV the quantity of Centaureae and Carduaceae is high and the diversity of herbs is intensive. The temperature is not as cold as before and the air is more humid. The large mammal remains in this layer consists of 50 percent of species which prefer warm and humid environments (group 3), 40 percent of species which prefer temperate environments and the rest is a mix of group 1 and the group with the boars and the group with the roe deer. The rodents represent a humid and forested environment. The conclusion of these data is that the climate was most likely warm and humid. The conclusion of the researchers (Delpeche & Laville, 1989) is contradictory to this conclusion. However, no information by the researchers was suggested which implies another conclusion than the one made here. Therefore the conclusion of the researchers will be abandoned.

**3.5.4.5 Layer V**

In layer V, the last layer with pollen remains, the palynological data suggests a steppe like environment with a cold climate. In this layer the large mammal remains represent warm temperatures and a more humid air. The rodents represent a relative softening of the climate. The representation of species which prefer steppe like conditions has diminished. The final conclusion here is a warmer environment and a more humid air composition was present.

**3.5.4.6 Layer VI**

In layer VI the large mammal remains represent a warm environment and a humid air composition. The rodents represent still a more steppe like environment with only a few temperate forest dwellers. The information contradicts itself so the conclusion is that the environment was both warm and cold. Whether this occurred in short successions or in only one warm and one cold phase is unknown.

**3.5.4.7 Layer VII**

In layer VII the large mammal remains represent a warmer temperature and a more humid environment. The rodents represent a drop in forest dwellers and an increase in species that prefer steppe like environments. Again the information contradicts itself. The overall conclusion is that the climate was temperate and mildly humid.

**3.5.4.8 Layer VIII**

In layer VIII the large mammal remains show a temperate environment with 75 percent of the species which prefer a warmer environment. The rodents represent a cold period with tundra aspects. Again there is a contradiction which would imply a combination of both is the right environment.

**3.5.4.9 Layer IX**

In layer IX the large mammal remains are mostly represented by group 3 this implies a more temperate environment. The rodents represent a drop in temperate forestry. The conclusion is that the temperature was still low and the air was still arid as can be seen in the later layers.

**3.5.4.10 Layer X**

In layer X the large mammal remains represent a warm environment in which all species prefer a temperate or warm environment. Rodents represent a climate which is temperate to warm. This would imply that the environment had a temperate to warm climate and a humid air.

**3.5.4.11 Layer XI**

In layer XI the large mammals represent a warm environment with a humid air. Rodents represent a temperate climate and are mostly forest dwellers. In the top of the layer the the climate becomes less and less humid. The final conclusion is that the environment was warm and humid.

### 3.5.5 La-Cotte-de-St-Brelade

The information given by the palynological data, the large mammal remains and the rodent remains show a glacial environment. Specific changes between layers may be able to differentiate the diagnosis (Chaline & Brochet, 1986; Jones, 1986; Scott, 1986a; 1986b).

#### 3.5.5.1 Layer H

The large mammals that are present in layer H are the mammoth, the woolly rhinoceros, the wild horse and the red deer. These animals represent the animal composition of a glacial phase.

#### 3.5.5.2 Layer E

The large mammal remains of layer E consist of only the woolly rhinoceros. The bones in this layer were not very well preserved and numerous bone fragments were not identified. Therefore the woolly rhinoceros was probably not the only large mammal present in this layer. The presence of only the woolly rhinoceros in this layer does not necessarily mean that the environment was a very cold one. The woolly rhinoceros also lived in warmer climates than a glacial. The rest of the layers do indicate that this layer also belongs to a glacial phase.

#### 3.5.5.3 Layer C

The large mammals that are present in layer C are the wolf, the mammoth, the woolly rhinoceros, the wild horse, the red deer, the reindeer and the chamois. The presence of *Dicrostonyx torquatus* shows a Siberian environment which can be correlated to the pleniglacial in MIS 4. The date of the layer dictates it belongs to a cold period in the Saalian or Wolstonian Complex.

#### 3.5.5.4 Layer A

The large mammals present in layer A are the wolf, the cave bear, the mammoth, the woolly rhinoceros, wild horse, giant deer, red deer, reindeer, auroch or bison, and the chamois. In layer A *Dicrostonyx torquatus* is also present which gives the same conclusion for layer C based on the rodent information. Layer A is also a cold phase in the Saalian or Wolstonian Complex, which resembles the cold phase of the pleniglacial in MIS 4.

# -4-

# Lithic variability

## 4.1 Introduction

The stone artefacts are the most tangible aspect of this thesis. In this chapter the artefact assemblages of five sites will be scrutinised. As said before the only important aspect is the transition of one assemblage to another within a site or inter-assemblage variability. Sites were chosen by the presence of this transition. The transitions will be addressed per site.

Counting stones is important. It is often done to see what taphonomic processes took place (Hiscock, 2002). The influence of taphonomy on the artefact record is great. Several studies have been performed to see what glacials do to an assemblage (e.g. Dibble *et al*., 1997). By analysing stones the way animal bones are analysed the number of artefacts becomes more realistic. If all broken pieces are counted as an artefact, there will be more artefacts in the report than in the actual assemblage. By using similar, quantitative measures such as NAS (Number of Artefactual Specimens); NFS (Number of Flake Specimens); MNF (Minimum Number of Flakes); MNC (Minimum Number of Cores); and MNA (Minimum Number of Artefacts), a more accurate estimation of the content of the assemblage can be made (Hiscock, 2002). Of the researched sites, none used the methods described in Hiscock's paper (2002) which degrades the level of representation of the assemblage. To show that the assemblages are representative samples, the number of counted artefacts will be given. Not all sites published the amount of artefacts in the assemblages, so an accurate image of the assemblage cannot be given for all the sites.

In this chapter, again, tables are used to portray the information. The tables can be found in the appendix.

## 4.2 Königsaue

The artefacts from the three layers at Königsaue consists of flint artefacts and quartz artefacts. Both flint and quartz artefacts are in the total number of counted artefacts. The assemblages have been named according to the method of Bordes and they have been assigned to the Micoquian and the Mousterian (Mania & Toepfer, 1973). See table 17 for the typological names per layer and the number of counted artefacts.

## 4.3 Rheindahlen

The Rheindahlen site consists of eight layers of which only five will be used for the lithic information. The top layer is too young for this research and in the two oldest layers no archaeological remains were found. The artefacts at the site are well researched. The ratio of the different tool types has been carefully evaluated and is portrayed through many graphs. Because the site was examined several times from 1915 onwards, it is unclear how many artefacts were found per layer. B1 consists of 13 refitted cores which consists of several individual pieces. These pieces represent the number of counted artefacts. It is unclear whether more artefacts, besides the ones in the refitted cores, were found. The site consisted of the Laminar Mousterian, Micoqiuan, Ferrassie Mousterian and the Upper Acheulean assemblages (Thissen, 2006). See table 18 for the typological names per layer and the number of counted artefacts.

## 4.4 Riencourt-lès-Bapaume

The Riencourt-lès-Bapaume site consists of five layers of which all five will be used in this research. Not all the layers were researched thoroughly, which makes the results less representative. Layer CA, C and B1 have been well represented in the literature, II and B2 are not represented in the literature. The site consists of the Micoqiuan, the Mousterian, Ferrassie Mousterian and Ferrassie Laminar Mousterian (Ameloot-van der Heijden, 1993a; Ameloot-van der Heijden, 1993b; Ameloot-van der Heijden & Truffreau, 1993; Beyries, 1993; Lamotte, 1993; Marcy, 1993). In table 19 the typology per layer and the number of counted artefact, when present, can be seen.

**4.5 Grotte Vaufrey**

In the site of Grotte Vaufrey thirteen layers have been distinguished, eleven of which contained archaeological remains. The artefacts have been thoroughly described. The researchers have made tables and graphs to show the ratio between the artefacts. It is one of the most thorough and clear representations of artefact assemblages of the all the sites studied here. Not just for the lithic information, also the palynological and zoological information is very thorough. The assemblages in this site are Mousterian, Typical Mousterian and MTA (Rigaud, 1989). The information on assemblage type and the number of counted artefacts can be seen in table 20.

**4.6 La-Cotte-de-St-Brelade**

The site of la-Cotte-de-St-Brelade consists of 12 layers. Only four of those layers will be used in this analysis since the other layers do not fulfil all the criteria. The research on the artefacts was done extensively and can be used in a wide range of research. The four layers consist of the Denticulate Mousterian, Mousterian Racloir and the Upper Acheulean (Callow, 1986f). In table 21 the assemblages and the number of counted artefacts are visible.

# -5-

# Results

## 5.1 introduction

In this chapter the variability in lithic assemblage is compared to a change in the environmental circumstances. The environmental information can be found in the tables, which are placed in the appendix.

## 5.2 Königsaue

In table 22 the climate and the lithic variability from the site of Königsaue have been put next to each other. The change in climate described in chapter 4 is minimum. The only change visible is an increase in temperature. This increase is very relative, for it does not say with how many degrees it increased. The animal diversity appears to stay the same throughout layer Kö A and Kö B. The remains of layer Kö C were too few. It is unclear why this is so, but most likely this is due to the poor preservation of the layer. The wild horse, which was found in layer Kö C, lived in all sorts of climates and therefore does not specify a climate.

## 5.3 Rheindahlen

In the site Rheindahlen the comparison is limited to layer B1 and B3. There is a change in environment, be it a small one. The difference in date, 117-128ka for layer B1 and 220ka for layer B3, also suggest that the environment had the time to change, see table 23.

**5.4 Riencourt-lès-Bapaume**

In the site of Riencourt-lès-Bapaume the lithic artefacts often vary, although the last three layers are all Ferrassie based assemblages. The climate appears to be steady and constant, see table 24.

**5.5 Grotte Vaufrey**

Grotte Vaufrey is a well documented site which is of high value for this research. The variability of the lithic artefacts is not high. There are a few layers which can be compared: Layer III and IV, Layer VII and IX, and Layer X and XI, see table 25.

**5.6 La-Cotte-de-St-Brelade**

In all the layers of the site la-Cotte-de-St-Brelade the same large mammals occur with an introduction of the *Dicrostonyx torquatus* in layer C and A, see table 26. The absence in the later layers may indicate a warmer period in which the *Dicrostonyx torquatus* did not prefer to live. It can also represent a poor preservation of rodent remains for those layers or poor documentation during the excavation. An actual comparison is not possible here. The variability of the lithic artefacts in this site is high when the climate does not vary, see table 26. This is also very important to note.

# -6-

# Discussion

## 6.1 Introduction

In the past much research has been done tracing the reason why lithic variability occurs. As discussed before, Bordes (1950; 1955; 1961; 1973; Bordes & de Sonneville-Bordes, 1970) believes this was an intentional act by different ethnic groups of Neandertals. Binford (1973; 1980; Binford & Binford, 1966; 1969) believes that there are different types of sites where different activities take place and Dibble (1987; Dibble & Rolland, 1992) believes it has everything to do with the retouch and reduction of tools, before they are discarded. There are many different reasons why lithic variability might occur, here a few will be discussed, with the aim of assessing the implications for this research. The importance of palimpsests and research bias will also be addressed and the implications of these aspects for this research will be evaluated. First the issue of giving a lithic assemblage a designation needs to be addressed.

## 6.2 The lithic assemblage

As mentioned before the hypothesis behind the method of Bordes, (1950; 1955; 1961; 1973; Bordes & de Sonneville-Bordes, 1970) is no longer current in Palaeolithic research. The designations of the assemblages, e.g. Typical Mousterian or Micoquian, are still used. This is because the hypothesis behind the method is refuted, but the method is still very useful. The names of the lithic artefacts are from the hypothesis, are based on the idea that they were used for specific activities. The activities performed by the artefacts is still unclear, but the names given to the artefacts are very useful. If the names for the different tools (e.g. scraper, backed knife or biface) did not exist it would be impossible for archaeologists to have discussions (Debénath & Dibble, 1994). The same rule applies for the names of the whole artefact assemblage. Not all researchers use the names as a designation for a specific assemblage, but do show the percentages which are used to scale the assemblage into a specific category.

### 6.3 Lithic variability

Van Peer (1991) says very briefly that there are three factors in play for inter-assemblage variability in Africa during the Middle Stone Age, a period in Africa which can be compared to the Middle Palaeolithic in Europe. These factors are environment, time and style. Environment, as an aspect of the research by Van Peer (1991), has been mentioned as a factor for artefact shape several times, with some times a small investigation and is now the focus of this research (Mellars, 1969; Bocquet-Appel & Tuffreau, 2009). A large scale investigation is still missing for this line of research. The aspect of time which Van Peer (1991) mentions, means the changes which occurs in the shape of an artefact through the change of time. This happens over a time frame of thousands of years and can occur through copying errors. Style, the third aspect of Van Peer (1991), is a very difficult concept for it implies a cognitive and comprehensive action toward an object (Malafouris, 2004; Gowlett, 2009). Tool shape and reduction has been overestimated in research thus far (Bisson, 2001; Holdaway & Douglas, 2012). Research has shown that by following three simple rules in knapping flint, the result is always a Middle Palaeolithic like assemblage (Bisson, 2001). The goal of the three rules is to always produce a sharp cutting edge. This research implies that the *chaîne operatoire* has no meaning. The knapper has a final product in its head, but this has nothing to do with style, only function plays a role. If this is true, it would imply the method of only looking at the shape is preferred. When a new environment needs new tools for new functions, the tools would be different if all the knapper was interested in is a sharp edge, right for the job.

Holdaway and Douglas (2012) imply with their research that individuals prefer fresh, unretouched flint instead of retouching old pieces, which would refute Dibble and Rolland (1992; Dibble, 1987; Rolland & Dibble, 1990; Rolland 1981). The retouching of old pieces is only used when a new source of flint is far away. This is visible in the archaeological record from the debitage that has been left behind on places rich in flint. The best knapped pieces are taken and the rest is left behind. This would also imply that the *chaîne operatoire* has been limited to just knapping and selecting the right pieces. It is unclear in how far a parallel can be drawn with Europe in the Middle Palaeolithic. The record analysed by Holdaway and Douglas (2012) is located in New south Wales, Australia, and was made by *Homo sapiens*. In Australia the climate is one of extremes. It can be very dry, at those times the riverbeds are empty and contain many lithic nodules. At some moments the rain comes down in such quantities, the rivers overflow. This happens every year, but every year at another locale. Therefore one can never know where lithic sources are to be found. If similar activities took place in Europe new measures need to be taken. More emphasis needs to be on the non-retouched artefacts and the debitage. Similar studies to the Australian studies can be performed in Europe by looking at the debitage, refitting it and seeing how lithic sources are used.

Lithic variability is linked to lithic availability, which depends on several stages. In the first stage all the lithic raw material is present. In the second stage the lithic raw

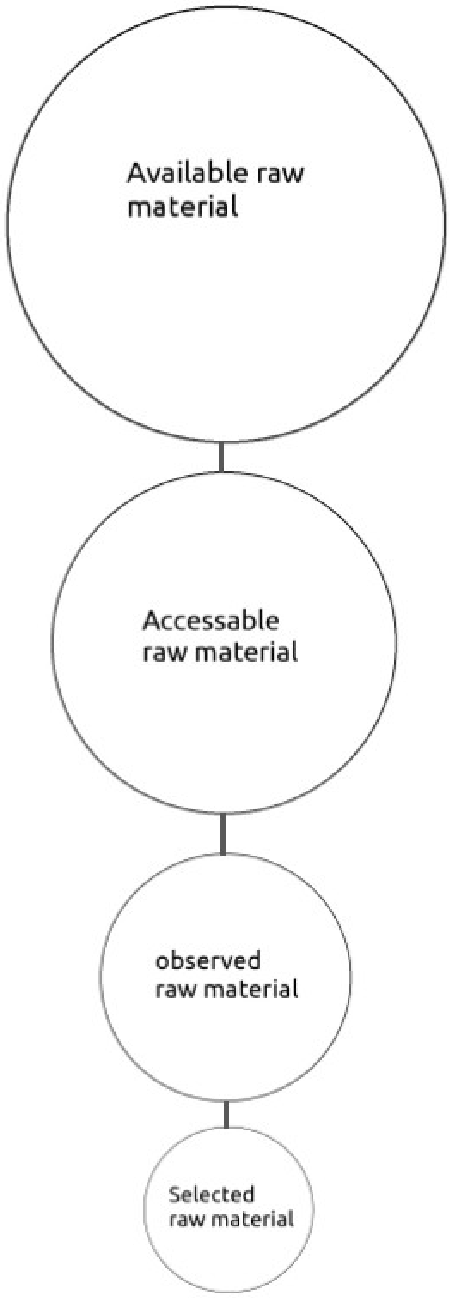


*Illustration 23: process of lithic raw material procurement (based on Wilson, 2007).*

material is narrowed down to the material which can be accessed by the hominins. In the third stage the lithic raw material is narrowed down to the material which is spotted by the hominins. The fourth stage is the final selection of the lithic raw material and consists of all the material actually used for knapping (see illustration 23). In the first two of these four stages geology or geography plays a role. This aspect can be calculated and determined for the landscape (Wilson, 2007). The third aspect is influenced by plant coverage. When the ground is covered with plants or fungi, the lithic raw material can be kept from sight. In cold phases of the climatic cycles the ground is often clear and flint nodules are more visible. The last aspect is a human factor and can be influenced from the selection on the quality of the flint to belief systems.

The procurement of lithic raw materials is often done along rivers which carry nodules of flint down from mountains. Although in some cases it has been said that mining occurred in the Middle Palaeolithic (Negrino *et al*., 2006), the evidence is very thin. Therefore it is assumed here that flint and other lithic raw materials were picked up from riverbeds and other easily accessible locations. This can be done in an acquisition round, where the hominins actively search for new lithic materials (Wilson, 2007), or it can be embedded in other activities, where the hominins pick up lithic raw material "along the way".

The lithic raw material availability influences the shape of artefacts and the composition of the lithic assemblage. This can be visible in artefacts made of a lesser quality of lithic raw material (Wilson, 2007) or by retouching the flint more and more to get the maximum use out of the artefact (Rolland & Dibble, 1990). The idea therefore is that lithic raw material availability influences the view of researchers on the artefact assemblages.

If the artefacts found in the archaeological record are not well thought out end products, but depend on the factors mentioned above, the question rises how much of the behaviour can still be seen in the artefact assemblages. All the different factors stand for one or more choices made during the knapping process, so the behaviour is still very visible. For this research it is important that adaptations are visible in the archaeological record through lithic artefacts and environment. The shape of an artefacts stands for all the choices made in reaction to one or more factors. These reactions show the flexibility and the adaptability of the individual or the whole group. All that needs to be done is see what the factors are that cause changes in the shapes of artefacts. The idea here is that the most influential factor is environmental change.

### 6.4 Palimpsest

The classification issue touches on the issue of palimpsest. Not all artefacts are discarded where they were used and not all discarded items remain in context. The last aspect can have many different reasons which are all grouped together under the term taphonomy and can be a real difficulty while excavating (Dibble *et al*., 1997). Also an assemblage is not just one discard moment, but many discard moments put together.

Palimpsests are not accounted for in the classification process. This has no influence on describing the artefacts, but has influence on the name given to the assemblage. If for some reason all the denticulate artefacts were removed from an originally denticulate rich assemblage the conclusion of the researcher will be different than if this did not happen. This means that the assemblage does not equal the tool kits used by the hominins (Odess & Rasic, 2007). For this reason naming the assemblages has been discontinued. Percentages are still given in research publications, but are no longer used to categorise the assemblage. As mentioned before, naming an assemblage or just portraying the percentages associated with a specific category holds a similar end result and therefore both can be used in a comparative study such as this one.

### 6.5 Research bias

The human factor plays a very big role in this line of research. This is visible in illustration 2, which has been created for bone material but can be applied to many other kinds of archaeologically deposited materials. The illustration shows how little of the entire deposited archaeological material will be recovered and that not only the archaeologists select the sample, but the hominins already made a selection while discarding the material. In this particular research it is important to realise that the information is taken from other researchers who had a different goal when they analysed the material. This does not only give a bias in their research, but also in this research since the results are taken from the initial, perhaps biased, research. Not all the literature showed the percentages of the lithic variability within an assemblage. In this research the information used was already interpreted and possibly biased by the desire to say more than is possible using the limited datasets.

A practical example of research bias is the fact that debitage has often been neglected at sites. Even though Dibble and McPherron (2006) have shown that debitage can tell a lot about the way artefacts were used, debitage is still not often researched. The fragments are small and can be sieved from the sand matrix, but this takes more time and has no research focus. Still a lot more can be said about behaviour if debitage was better and more thoroughly researched.

The human factor is also in play when the lithic tools are analysed. The classification process pulls the artefact out of the context it was originally placed in. The reasons why the artefacts are discarded is part of that context. The most logical reason for discarding a lithic artefact is that the artefact no longer suits the job it was made for. From Holdaway and Douglas' (2012) research it has become visible that artefacts are also discarded when a new lithic source has been found. Middle Palaeolithic artefacts can also be considered to be discarded when an artefact gets lost. It will accidentally enter the archaeological record. Even today, people lose all kinds of items, valuable or not. It can be estimated that the assemblage contains mostly intentional discarded artefacts and only a few artefacts which are lost. Discarded artefacts therefore have a low value for the producers of the artefacts. These artefacts are then classified into a system which does not account for the fact that these artefacts are no longer useful and therefore discarded. This classification is then used to say something about how hominins lived. The whole process leaves something to be desired for, but, granted, the knowledge of hominins and their artefact manufacture and use is very limited and all that can be analysed are the discarded lithic artefacts.

### 6.6 Cognition and lithic artefacts

For this research to have any ground, it is important to discuss how lithic artefacts can say anything about the individual who made it. There are many ideas on whether lithic artefacts can be linked to behaviour and, as mentioned before, lithic artefacts can say a lot about behaviour for the shape alone stands for all the choices made in the knapping process. Behaviour and cognition go hand in hand. The complexity of behaviour increases when the cognitive capacities become larger. In this research cognition is important for the final aspect of the hypothesis was that the cognition of Neandertals might be similar to that of *Homo sapiens*. Cognition is expressed in the archaeological record through many manifestations. Symbolism is seen as the most profound manifestation of high cognitive capabilities. The idea that symbolism says anything about cognition is therefore widely accepted (e.g. Klein, 1998; McBrearty & Brooks, 2000). Neandertals did not leave any symbolic objects behind although the Châtelperronian might be a moment in which Neandertals did (Higham *et al*., 2010 vs Mellars, 2010). However, symbolism can be seen as a way of storing information, such as memories (Wadley, 2001). This storage can take place in an *objet d'art* or in an abstract way i.e. through connections between individuals such as kinship. Connections through kinship cannot be excavated, but an *objet d'art* can, and they are. The lithic artefact is a manufactured item which may have contained a lot of meaning given by the knapper.

The diversity of lithic artefacts in an assemblage may therefore not just portray functional tools, but may also portray a complexity within the social structure in Neandertal society. This is a very far fetched hypothesis and cannot become more than an hypothesis. The storage of memories or information cannot be uncovered even though the object linked to those memories has been found. Even without the symbolism, lithic artefacts represent the inventiveness of a people. If lithic variability occurs as a reaction to an outside influence, in this case the environment, the cognitive capacities must be high enough to cope with the behavioural change. If this happens in Neandertals as well as *Homo sapiens* the same statement needs to be made for both hominins.

There are other hypotheses for a connection between cognition and lithic artefacts. One of such a hypothesis is the Tool-Cue Model (Byers, 1999). In this model the artefact is not only a functional piece, but also an iconic piece; it has been given a meaning as well as a function. This meaning has a pragmatic and semantic value. This would imply language, which cannot be stated Neandertals had, although the physical and genetic tools are present, such as the larynx, hyoid and the FOXP2 gene (Krause *et al*., 2007), it is not clear whether they had the cognitive capacity to speak (Lieberman, 1979; 1984; 2007; Boë *et al*., 2002; 2007). Therefore the discussion will not be focussed on the semantic value of artefacts, but on the pragmatic and functional meaning of an artefact. The hypothesis is very similar to the previously mentioned one. The artefact is seen as a method to transfer information, either on function or on efficiency.

Another hypothesis is that of the modularity of mind (Barrett *et al*., 2002; Mithen, 1996; Sarnecki & Sponheimer, 2002). This hypothesis is about the way the mind is shaped and how it works. The idea is that the mind of the modern *Homo sapiens* today consists of several modules of domain specific cognitive capacities, which interact with each other. These interactions make it possible for individuals to assess a situation without having to narrow down all the possible options (Sarnecki & Sponheimer, 2002:181). Mithen (1996) refers to these domains as intelligences. A specific domain stands for a specific intelligence (i.e. the intelligence of nature around you). This is a very complex idea, since it almost seems as if the intelligences are sources of innate knowledge. They are not, they are the use of common sense. They are also sometimes referred to as folk knowledge (e.g. folk physics). The common knowledge a community has of the daily activities (Barrett *et al*., 2002; Cosmides & Tooby, 1992; Fodor, 1983; 1992; Sperber, 1994; Tooby & Cosmides, 2000).

The idea of Mithen (1996), which is based on Fodor (1983), is that when these modules started to interact with each other, modern behaviour started to form. He places this event around 50ka using several behavioural markers (e.g the use of bone material for tools and artistic expression). Later it is realised that the behavioural markers used for this hypothesis manifested themselves much earlier than 50ka so that part of the hypothesis is not true (McBrearty & Brooks, 2000). Another part of the hypothesis of Mithen (1996) is that the modularity of mind is not present in any other animal besides humans. It is unclear whether this assumption can be made (Sarnecki & Sponheimer, 2002). Chimpanzees can connect information from different fields or domains to come up with a solution to a specific problem when encountered. The final conclusion of Sarnecki and Sponheimer's (2002) review of Mithen's (1996) work is, that the availability of a technology, by being cognitively able to form it, has nothing to do with actually making it and using it. Today there are many groups of people who live without certain technological innovations, who could make and use them to survive, but choose not to (Sarnecki & Sponheimer, 2002:184).

Robson Brown (1993) used the hypothesis of modularity of mind for a study on the mind set of the Zhoukoudian hominins. The conclusion of her analysis of a Zhoukoudian lithic collection was that the hominins who made the artefacts do not possess a human, or *Homo sapiens*, pattern of cognitive organisation, nor that of the great apes. This shows that the mental capabilities of the Zhoukoudian people were of their own calibre:

> "They fall neither within the human nor the great ape patterns of cognitive organization. This is not to say that the hominids could not have displayed a more human-like cognition in other facets of their behaviour; but on the basis of the archaeological evidence presented here, we should not make such an assumption".
>
> Robson Brown (1993: 243)

The conclusion made by Robson Brown (1993) is a sound one. Evolution of mind and cognition, could be very gradual, with certain punctuated events (Gould & Eldredge, 1977). The hypothesis that the mind of certain hominins, specifically that of the Zhoukoudian hominins, is neither that of a great ape nor that of a *Homo sapiens* makes perfect sense, for the hominins are neither a great ape or a *Homo sapiens*. The archaeological record does not often back up psychological studies, therefore rock hard facts cannot be presented.

The conclusions on the cognitive capacity of Neandertals contain little real proof. Maybe for research to make progress the hypotheses should be turned around. Assume that Neandertals were as cognitively advanced as *Homo sapiens* is today. Then find evidence that shows they were not as advanced. Information that is not conclusive enough should be removed from the study. Then see what the answer is.

### 6.7 Conclusion of the discussion

With all this in mind not any research will have true answers. There is no objective way of looking at the artefacts. The researchers are biased by their hypotheses and the artefacts themselves are biased through selection at many moments, either by hominins in the past or at present, or by natural phenomena. Researchers are trapped within their niche and every now and then look at theories of other disciplines when they need them. The only conclusion that can be reached here is that one will have to make do with whatever is present in the archaeological record and in the theoretical fields. Since the artefacts are a rock hard find category, of only few find categories, all that can be done is analyse them. Researchers are aware that the assemblage is only a small and limited view on life in the Middle Palaeolithic, but this does not mean that nothing can be said on the Middle Palaeolithic. Dincauze (2000) explains nicely what the differences between the physical and the social sciences are. The physical science uses quantitative data, which is a sample which is always representative for the whole. While social sciences need to use qualitative data. For archaeology this means that there are in total perhaps six sites, of a specific nature, excavated, while the total amount of present site of this nature may be six hundred. If they are not found, these six sites are the only representation of the 594 sites not discovered. This means that quantitative norms can only be applied in certain situations. One can quantify the amount of tools per site or per layer. Often in artefact research the most common tools are sampled to represent all the tools of the same category found in that site (Callow, 1986f). Artefacts of one site cannot be researched to represent another site, because no two sites are the same. This research is a combination of the two. It is a social research using qualitative samples (the sites) and examines those samples using quantitative methods (lithic analysis). Researchers can have true answers, if they abide by the laws of the science or by the theoretical concepts they are using to investigate.

# -7-

# Conclusion

**7.1 Introduction**

After all the results are analysed and are placed in a wider context in the discussion above, it is time to evaluate what the results mean for current and future research in similar fields. In this chapter the aim and hypothesis will be restated to show a connection with the results, which will be discussed further below. Before the results are discussed an evaluation of the research methods will be given. A critical view on the research methods will be helpful in the future. The chapter will finish with a proposal for future directions.

**7.2 Aims and hypothesis**

The aim of this research was to gain insight into the adaptability of the Neandertals during the climatic changes of the succeeding ice ages in the Late Pleistocene. This has been achieved through a study on the climatic changes through the appearance or disappearance of animals, plants and trees in the archaeological record and to link this information on lithic inter-assemblage variability. The hypothesis was formed based on this aim. If the environment changes, the reaction of the Neandertals would be to adapt their artefacts, for they will have different functions in this new environment.

**7.3 Methods**

The methods used in this study are not difficult. The main method was making a comparison of the lithic, palynological and zoological information. To be able to compare certain aspects, the aspects need to be analysed in a similar way. In this research the information came from the literature, which should make the analysis the same. However, the information in the literature was not collected and analysed in a similar way. The different researchers chose different ways to excavate the information, different ways of collecting pollen and sediment samples, different ways in analysing lithic and animal material. These discrepancies can be avoided if the different sites are excavated and the finds analysed in the same way.

The established knowledge of past climates and environments is limited. Processes that occur in ecosystems are well researched. This is not enough to understand all the processes that took place in the past. The way an ice age emerged is still a point of discussion (Berendsen, 2004). The limited knowledge on climatological events lead to an unclear description of the archaeological layers. The information on environmental proxies contradicted each other at times. This was present in, i.a. the site of Grotte Vaufrey in layer II and IV. In these cases there is not one proxy more important than another, so no conclusions can be made. Although, using common sense it is clear that the large mammal remains are collected through hunting and that the large mammals are always present, both in colder and warmer climates. It is also important to realise that the rodent information represents a microclimate, which can be more accurate for the region than the large mammal information. This influences the conclusion on environmental and climatic condition.

The lithic artefacts are not examined in a similar fashion. Some researchers only added the typology, because it is required, but did not give background information on how the conclusion was reached (e.g. Rheindahlen: Thissen, 2006). There are also researchers who would only describe the artefacts of some of the layers (Riencourt-lès-Bapaume: Ameloot-van der Heijden & Tuffreau, 1993; Marcy, 1993; Lamotte, 1993; Ameloot-van der Heijden, 1993a; Beyries, 1993; Ameloot-van der Heijden, 1993b; Rheindahlen: Thissen, 2006).

Another point to address about the methodology is the lack of access to literature. In the current library systems it is very hard to gain access to older materials. It is important to see the oldest reports on the sites. These are often published in old French journals which are not available for the years needed. It is also strange that a book on the excavations of Combe Grenal is not present in the library of Leiden University. It is a very important site and has had many different kinds of research done. There are only secondary texts available on this site.

If more time and money was available for this research, trips were taken to the depots were the lithic artefacts are stored to examine them in person. Also an interview with the excavators could have been held to understand how the sites were excavated and why certain choices were made. Questions could be asked regarding the palynological and zoological research, why was it absent or neglected? Why were the lithics examined the way they were? If these questions could be answered the research may weigh heavier.

**7.4 Conclusions**

The lack of clear and unambiguous information makes it impossible to make clear statements. The site of Königsaue has only one climatic aspect that changes, which is temperature. It increases slightly. The amount of change is too abstract to use. A clear measuring system should be used. This can be done if the study by Mania & Toepfer (1973) and this study had included the analysis of beetle remains, e.g. coleoptera (Lowe & Walker, 1997). The conclusion for the site of Königsaue therefore is that there is a slight change in temperature, which corresponds with a change in lithic assemblage composition, but the climate does not change that much to suggest a new flora and fauna in the environment, which needs to be approached with new tools. It is unlikely it had a major impact on the Neandertal population.

The site of Rheindahlen only has information on the climate in layers B1 and B3. In these layers there is a distinct difference in pollen composition. There is a shift between a system with arboreal flora only, to a system in which both arboreal and non arboreal flora exist. This shows evidence of a physical change in environment, which coincides with a change in lithic assemblage composition. The conclusion from this site therefore is that the two aspects, lithics and climate, may be linked.

The site of Riencourt-lès-Bapaume shows a similar climate throughout layers B1, B2, C and CA since the pollen samples were taken from the sedimentological layer system than the lithics. These layers were only used for the sedimentological and the palynological research. For the archaeological levels the layer system was only used for the lithics research. Therefore pollen samples were taken from points in the palynological system which cannot be correlated to the archaeological layers. The points from which the pollen samples were taken are not mentioned in the study and therefore it is unclear to which archaeological level they belong. Looking at the data which is available, a change in climate occurs between layers II and CA. The lithic assemblage composition does also change from a Ferrassie Mousterian to a Ferrassie Laminar Mousterian, which implies a change in the technology with which the lithic artefacts are made. Although the climate varies considerable from the beginning of the Weichselian (Devensian) to the middle of the Weichselian, or the pleniglacial, the change in lithic variability is minimal. The conclusion of this site therefore is that there is no clear connection between climate and lithic assemblage composition.

The site of Grotte Vaufrey has a long sequence and has thorough palynological and zoological studies performed as well as a clear lithic artefact study. The concepts chosen to represent the climate are very abstract and unclear, but do give a good indication of the climate and the gradual changes. There are three transitions in this site, the first one is between the layers XI and X. The MTA assemblage changes into a Mousterian assemblage while the climate changes from warm and humid to temperate to warm and humid. This is a very small change, for only the temperature changes. The second transition is between the layers IX and VIII. The lithic assemblage composition changes from Mousterian to Typical Mousterian while the climate changes from a cold and arid condition to a climate which gradually changes from a temperate to a cold and tundra like environment. The change between the lithic assemblage composition is minimal while the change in climate does show possibilities for a change in at least floral composition, since the fauna appears to remain the same throughout this site. The last transition within this site is between layers IV and III. The lithic assemblage composition changes from Typical Mousterian back to a Mousterian composition while the climate changes from cold and arid to temperate and more humid. This shows a change, however, in the whole sequence it appears that the general trend is that the climate is getting warmer throughout layers V, IV and III. This does not constitute as a clear change in climate and lithic variability and therefore this transition is also not representative for the hypothesis of this research.

The last site, la-Cotte-de-St-Brelade, has only one type of climate for the layers that could be researched with the literature available. Therefore no transitions in climate and environment took place.

It would appear that the site of Rheindahlen is the only one in which a clear connection between climate and lithic variability can be made. The other sites, except la-Cotte-de-St-Brelade, do have small variations in climate which coincide with lithic assemblage variability, but they are too small to be the cause of lithic variability. This would mean that the the hypothesis cannot be sustained at this moment with these samples. The information was inconclusive and more research needs to be done.

### 7.5 Future directions

The final conclusion is that this study should be performed by looking at the stone material itself and promote palynological and zoological research in excavations with only a focus on lithics, and vice versa. To sketch a detailed image of the environment, more proxies need to be introduced to the study. The importance of geomorphological studies has been underestimated in this research. Also the proxy of the beetles has been neglected. Therefore it is important to use this proxy along side the other proxies of palynology, zoology and lithic artefact studies. The advice is to look at sites which are currently under investigation or will be excavated in the near future. All the necessary steps and precautions can be made to ensure the right examination of the sites. Only then will this research give true results.

During the excavation of sites it is important to sample for pollen at regular intervals, by professionals, so contamination can be kept to a minimum. A clear report should be written in which all locations of the samples are mentioned so correlation during the analysis of the archaeological material can take place. During the excavation of the sites such a log should be present, but it is not published or widely made accessible and can therefore not be used in current research. When samples cannot be used, for whatever reason, this should be mentioned in the report, which it often is not. The palynological information should be approached from a similar perspective, this means that is should be done by the same researchers. For the zoological information it is important to always mention the preservation circumstances. This influences the result. Minimum number of individuals (MNI) should always be mentioned so an estimation of quantity can be made. During this study it was noted that the lithic information has been thorough. To improve the uniformity of the study it is important to examine the lithic artefacts, or to have them examined by one individual in a similar manner as the zoological information (Hiscock, 2002). If these steps are followed, a clear result should follow from the hypothesis used in this research.

It is also possible to choose one area of Europe and make a very thorough investigation of that area, so the results can be used for other areas as well. This method is not fool proof, for it is possible that there are areas in which life was easier than in others. This could lead to a wrong conclusion. An example of that can be found in the south west of France. In this area the caves of the Neandertals were located near a river for water supply and lithic raw material, easy access to animals for food and a warm sunny cave entrance looking out at the south (Mellars, 1996). Conditions in this area are so similar that a potential conclusion cannot be used for other areas.

# -Abstract-

This thesis addresses the issue of climatic and environmental change being the main cause of changes in tool shape or form in Neandertal society. This is approached through several literature studies of sites which have been excavated. These sites are Königsaue and Rheindahlen in Germany; Riencourt-lès-Bapaume and Grotte Vaufrey in France; and la-Cotte-de-St-Brelade on the Channel Island Jersey. Using the bordian typological sequence, transitions were determined within sites through changes in assemblage composition. The climatic changes were determined through the study of palynological and zoological material cross referenced to the MIS curve from the chronostratigraphical correlation table. After the analysis was complete the conclusion was that the quality of the information was insufficient to assess the validity of the hypothesis.

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# -Appendix-

## -List of tables-

# -Tables-

| Site name | Layer name | Botanical remains |
|---|---|---|
| Königsaue | Kö A | - |
| | Kö B | *Pinus*; *Picea*; *Betula*; *Alnus*; *Ulmus*; *Tilia*; *Corylus*; Gramineae; *Artemisia*; *Typha*; Caryophyllaceae; *Sphagnum*. |
| | Kö C | - |

*Table 1: Königsaue botanical remains layer B (Mania & Toepfer, 1973)*

| Site name | Botanical remains |
|---|---|
| Königsaue | *Potamogeton crispus* L.; *Potamogeton densus* L.; *Potamogeton filiformis* L.; *Potamogeton obtusifolius* L.; *Potamogeton perfoliatus* L.; *Potamogeton pusillus* L.; *Potamogeton vaginatus* TURCZ.; *Potamogeton* sp.; *Ranunuculus aquatilis* L.; *Myriophyllum verticillatum* L.; *Hippuris vulgaris* L.; *Scirpus mucronatus* L.; *Typha* cf. *latifolia* L.; *Phragmites communis* TRIN.; *Carex* sp.; *Chara* sp.; *Pinus*; *Betula*; *Picea*; *Pinus silvestris*; *Picea omorika*; *Alnus*; *Populus*; *Ulmus*; *Tilia*; *Corylus*; *Artemisia*; Gramineae; Cyperaceae |

*Table 2: Königsaue botanical remains from the general area of Aschersleben (Mania & Toepfer, 1973)*

| Site name | Layer name | Botanical and charcoal remains |
|---|---|---|
| Rheindahlen | A2 | - |
| | A3 | - |
| | B1 | *Acer* sp.; *Betula* sp.; *Carpinus betulus*; *Quercus* sp. cf.; *Corylus* sp.; *Pinus* sp.; *Picea* sp.; *Alnus* sp.; *Tilia* sp.; *Ulums* sp.; Gramineae; Cyperaceae; Ericaceae; Chenopodiaceae; *Artemesia* sp.; Umbelliferae |
| | B3 | *Fraxinus* sp.; S*alix* sp.; *Alnus* sp. or *Corylus*; *Quercus* cf.; *Betula* cf. |
| | B5 | - |

*Table 3: Rheindahlen botanical remains per layer (Thissen, 2006)*

| Site name | Layer name | Botanical remains |
|---|---|---|
| Riencourt-lès-Bapaume | 4a² (II) | *Betula*; *Carpinus*; *Corylus*; *Pinus*; *Artemisia*; Arteraceae *crepis* and c*irsium*; Chenopodiaceae; Poaceae. |
| | 4a¹ (II) | *Alnus*; *Betula*; *Carpinus*; *Corylus*; *Fagus*; *Pinus*; *Quercus*; *Artemisia*; Asteraceae *crepis* and c*irsium*; Chenopodiaceae; Cyperaceae; Poaceae. |
| | 3 (CA; C; B1; B2) | *Alnus*; *Betula*; *Corylus*; *Pinus*; *Quercus*; *Tilia*; *Ulmus*; Apiaceae; A*rtemesia*; Asteraceae *crepis*; *Calluna*; Chenopodiaceae; Cyperaceae; Poaceae; *Dryopteris*. |
| | 3 (CA; C; B1; B2) | *Alnus*; *Betula*; *Pinus*; Asteraceae *crepis*; *Calluna*; *Plantago*; Poaceae; *Dryopteris*. |

*Table 4: Riencourt-lès-Bapaume botanical remains per layer (Munaut, 1993)*

| Site name | Layer | Botanical remains |
|---|---|---|
| Grotte Vaufrey | I | *Pinus*; *Cupressus*; *Juniperus*; *Alnus*; *Corylus*; *Betula*; *Quercus ilex*; *Pistacia*; *Juglans*; *Quercus ped*.; *Tilia*; *Ulmus*; *Carpinus*; *Buxus*; Gramineae; Anthemideae; *Artemisia*; Carduaceae; *Centaureae*; Chicorieae; *Plantago*; Chenopodiaceae; Cruciferae; Urticaceae; Caryophyllaceae; Labiatae; Leguminosae; Scrophulariaceae; Campanulaceae; Umbellifereae; Rosaceae; Ericacea; Cyperaceae; Typhaceae. |
| | II | *Pinus*; *Abies*; *Picea*; *Juniperus*; *Alnus*; *Corylus*; *Betula*; *Quercus ped*.; Gramineae; Anthemideae; *Artemisia*; Carduaceae; Centaureae; Chicorieae; *Ephedra*; *Rubiaceae*; *Plantago*; *Rumex*; Dipsacaceae; Plumbaginaceae; Chenopodiaceae; Cruciferae; Urticaceae; Caryophyllaceae; Labiatae; Leguminosae; Scrophulariaceae; Campanulaceae; Umbellifereae; Malvaceae; Rosaceae; Valerianaceae; Cyperaceae; Typhaceae; *Potamogeton*; Liliaceae. |
| | III | *Pinus*; *Picea*; Gramineae; Anthemideae; Carduaceae; Centaureae; Chicorieae; *Ephedra*; Plumbaginaceae; Cruciferae; Caryophyllaceae; Labiatae; Cyperaceae; Typhaceae; Liliaceae. |
| | IV | *Pinus*; *Cupressus*; *Alnus*; *Corylus*; *Betula*; *Quercus ped*.; *Tilia*; *Ulmus*; *Fraximus*; Gramineae; Anthemideae; *Artemisia*; Carduaceae; Centaureae; Chicorieae; *Helianthenum*; *Plantago*; *Rumex*; Chenopodiaceae; Cruciferae; Urticaceae; Caryophyllaceae; Labiatae; Scrophulariaceae; Cyperaceae; Liliaceae; Ranunculaceae. |
| | V | *Pinus*; *Quercus ped*.; Gramineae; Anthemideae; *Artemisia*; Carduaceae; Centaureae; Chicorieae; *Plantago*; Urticaceae; Caryophyllaceae; Labiatae; Leguminosae; Boraginaceae; Ericaceae; Cyperaceae; |

*Table 5: Grotte Vaufrey botanical remains per layer (Diot, 1989)*

| Site name | Layer | Batanical remains |
|---|---|---|
| La-Cotte-de-St-Brelade | H | *Alnus*; *Betula*; *Quercus*; *Pinus*; *Ulmus*; *Tilia*; *Corylus*; *Hedera*; Ericaceae; Gramineae; Cyperaceae; Liguliflorae; Cirsium; Plantaginaceae (undiff.); *Armeria*; Rosaceae (undiff.); Umbelliferae; *Lotus*; *Rhinanthus*; *Vicia*; *Aconitum*; *Stratiotes*; *Filicales*; *Polypodium*; *Pteridium*. |
| | E | *Betula*; *Pinus*; *Ulmus*; *Corylus*; Grimaneae; *Cirsium.* |
| | C | *Corylus*. |
| | A | - |

*Table 6: La-Cotte-de-St-Brelade botanical remains per layer (Jones, 1986)*

| Site name | Layer | Mammal remains |
|---|---|---|
| Königsaue | Kö A | *Crocuta spelaea*; *Mammuthus primigenius*; *Equus* sp.; *Equus (Asinus) hydruntinus*; *Coelodonta antiquitatis*; *Dicerorhinus hemitoeches*; *Cervus elaphus*; *Rangifer tarandus*; *Bison priscus*. |
| | Kö B | *Microtus arvalis*; *Microtus gregalis*; *Canus lupus*; *Crocutta spelaea*; *Panthera (Leo) spelaea*; *Mammuthus primigenius*; *Equus* sp.; *Equus (Asinus) hydruntinus*; *Cervus elaphus*; *Rangifer tarandus*. |
| | Kö C | *Equus* sp. |

*Table 7: Königsaue mammal remains per layer (Mania & Toepfer, 1973)*

| Site name | Layer | Large mammal remains |
|---|---|---|
| Grotte Vaufrey | I | *Equus* sp. |
| | II | *Canis lupus*; *Vulpus vulpus*; *Capra* sp.; *Oryctolagus* sp. |
| | III | *Vulpus vulpus*; *Oryctolagus* sp. |
| | IV | *Lynx* sp.; *Canis lupus*; *Vulpus vulpus*; *Saiga* sp.; *Capra* sp.; *Equus* sp.; *Oryctolagus* sp. |
| | V | *Cuon* sp.; *Cervus elaphus*; *Equus* sp.; *Oryctolagus* sp. |
| | VI | *Cuon* sp.; *Cervus elaphus*; *Oryctolagus* sp. |
| | VII | *Vulpus vulpus*; *Cervus elaphus*; *Hermitagus* sp.; *Bison* sp.; *Equus* sp.; *Oryctolagus* sp. |
| | VIII | *Canis lupus*; *Vulpus / Alopex*; *Cuon* sp.; *Hermitagus* sp.; *Equus* sp.; *Oryctolagus* sp. |
| | IX | *Lynx* sp.: *Canis lupus*; *Cervus elaphus*; *Oryctolagus* sp. |
| | X | *Canis lupus*; *Vulpus vulpus*; *Cervus elaphus*; *Hermitagus* sp.; *Oryctolagus* sp. |
| | XI | *Canis lupus*; *Vulpus vulpus*; *Cervus elaphus*; *Equus* sp.; *Oryctolagus* sp. |

*Table 8: Grotte Vaufrey large mammals per layer (Delpech, 1989)*

| Site name | Layer | Rodent remains |
|---|---|---|
| Grotte Vaufrey | I | *Apodemus* sp.; *Microtus nivalis*; *Marmota marmota*; *Microtus arvalis*. |
| | II | *Microtus malei/Microtus oeconomus*; C*astor* sp.; *Apodemus* sp.; *Marmota marmota*; *Microtus arvalis*; *Lagarus lagarus*; *Allocricetus bursae*; *Pliomys lenki*; *Ochotona pusilla*. |
| | III | C*astor* sp.; *Apodemus* sp.; *Arvicola* sp.; *Marmota marmota*; *Microtus arvalis*; *Pliomys lenki*. |
| | IV | C*astor* sp.; *Apodemus* sp.; *Marmota* sp.; *Microtus arvalis*; *Citellus* sp.; *Lagarus lagarus*; *Allocricetus bursae*; *Pliomys lenki*; *Ochotona pusilla*. |
| | V | *Clethrionomys glareolus*; *Apodemus* sp.; *Marmota* sp.; *Microtus malei/Microtus oeconomus*; *Microtus arvalis*; *Pliomys lenki*; *Ochotona pusilla*. |
| | VI | *Dicrostonyx torquatus*; *Apodemus* sp.; *Marmota marmota*; *Microtus arvalis*; *microtus gregalis*; *Allocricetus bursae* . |
| | VII | *Sicista* sp.; *Apodemus* sp.; *Microtus nivalis*; *Marmota* sp.; *Microtus arvalis*; *Allocricetus bursae*; *Pliomys lenki*. |
| | VIII | *Sicista* sp.; *Lemmus lemmus*; *Apodemus* sp.; C*astor* sp.; *Microtus nivalis*; *Marmota* sp.; *Citellus* sp.; *Ochotona pusilla*. |
| | IX | *Sicista* sp.; *Microtus malei/Microtus oeconomus*; *Microtus arvalis*; *Microtus gregalis*; *Allocricetus bursae*; *Pliomys lenki*; *Ochotona pusilla*. |
| | X | *Apodemus* sp.; *Allocricetus bursae* . |
| | XI | *Eliomys quercinus*; *Clethrionomys glareolus*; *Apodemus* sp.; *Pitymys* sp.; A*rvicola* sp,; *Microtus arvalis*; *Microtus brecciensis*; *Pliomys lenki*; *Ochotona pusilla*; *Sciurus* vulgaris; *Microtus gregalis*; *Allocricetus bursae*. |

*Table 9: Grotte Vaufrey rodent remains per layer (Marquet, 1989)*

| Site name | Layer | Large mammal remains |
|---|---|---|
| La-Cotte-de-St-Brelade | H | *Mammuthus primigenius*; *Coelodonta antiquitatis*; *Equus caballus*; C*ervus elaphus*. |
| | E | *Coelodonta antiquitatis* |
| | C | *Canis lupus*; *Mammuthus primigenius*; *Coelodonta antiquitatis*; *Equus caballus*; C*ervus elaphus*; *Rangifer tarandus*; *Rupicapra rupicapra*. |
| | A | *Canis lupus*; *Ursus spelaeus*; *Mammuthus primigenius*; *Coelodonta antiquitatis*; *Equus caballus*; *Megaceros giganteus*; C*ervus elaphus*; *Rangifer tarandus*; *Bos* sp. or *Bison* sp.; *Rupicapra rupicapra*. |

*Table 10: La-Cotte-de-St-Brelade large mammal remains per layer (Scott, 1986a)*

| Site name | Layer | Rodent remains |
|---|---|---|
| La-Cotte-de-St-Brelade | H | No rodent remains |
| | E | No rodent remains |
| | C | *Dicrostonyx torquatus*; *Microtus gregalis*. |
| | A | *Sicista* sp.; *Dicrostonyx torquatus*; *Microtus gregalis*. |

*Table 11: La-Cotte-de-St-Brelade rodent remains per layer (Chaline & Brochet, 1986)*

| Site name | Layer | Date |
|---|---|---|
| Königsaue | Kö A | 43.8ka ± 2.1ka (uncalibrated) |
| | Kö B | 48.4ka ± 3.7ka (uncalibrated) |
| | Kö C | 55,8ka (maximum age) |

*Table 12: Königsaue dates per layer through* $^{14}C$ *dating of birch pitch (Grünberg* et al.*, 1999; Thissen, 2006)*

| Site name | Layer | Date |
|---|---|---|
| Rheindahlen | A2 | 20 ka – 60 ka |
| | A3 | 20 ka – 60 ka |
| | B1 | 117 ka – 128 ka |
| | B3 | 220 ka |
| | B5 | 320 ka |

*Table 13: Rheindahlen dates per layer through geological and stratigraphical information (Thissen, 2006)*

| Site name | Layer | Date |
|---|---|---|
| Riencourt-lès-Bapaume | 4a[1] (II) | Beginning of the Weichselian (Devensian) |
| | 3 (B1; B2; C;CA) | Pleniglacial of MIS 4 |

*Table 14: Riencourt-lès-Bapaume dates per geological layer through the observation of the deposition. Archaeological layers are in brackets (Tuffreau & van Vliet-Lanoë, 1993)*

| Site name | Layer | Date |
|---|---|---|
| Grotte Vaufrey | I | > 18 ± 4 ka (uranium) |
| | II | 74 ± 18 ka (uranium) |
| | III | 91 ± 51 ka (uranium) |
| | IV | 120 ± 10 ka (TL) |
| | V | No date |
| | VI | No date |
| | VII | 145 ± 40 (uranium) |
| | VIII | 270 ± 30 (TL) 142 ± 130/68 (uranium) |
| | IX | 209 ± 8 ka (uranium) |
| | X | 246 ± 00/70 (uranium) |
| | XI | No date |

*Table 15: Grotte Vaufrey dates per layer through both thermoluminescence and uranium series (Huxtable & Aitken, 1989; Blackwell & Schwarcz, 1989)*

| Site name | Layer | Date |
|---|---|---|
| La-Cotte-de-St-Brelade | E | 388 ± 35 ka (max average age) |
| | | 140 ± 35 ka (min average age) |
| | C | 250 ± 35 ka (average age) |

*Table 16: La-Cotte-de-St-Brelade thermoluminescence date per layer (Huxtable, 1989)*

| Site name | Layer | Lithic assemblage | NCA |
|---|---|---|---|
| Königsaue | Kö A | Micoquian | 1490 |
| | Kö B | Mousterian | 3991 |
| | Kö C | Micoquian | 297 |

*Table 17: Königsaue, NCA stands for number of counted artefacts (Mania & Toepfer, 1973)*

| Site name | Layer | Lithic assemblage | NCA |
|---|---|---|---|
| Rheindahlen | A2 | Laminar Mousterian | 432 |
| | A3 | Micoquian | 85 |
| | B1 | Micoquian | 1026 |
| | B3 | Ferrassie | 1742 |
| | B5 | Upper Acheulean | 19 |

*Table 18: Rheindahlen, NCA stands for number of counted artefacts (Thissen, 2006)*

| Site name | Layer | Lithic assemblage | NCA |
|---|---|---|---|
| Riencourt-lès-Bapaume | B1 | Micoqiuan | 361 |
| | B2 | Mousterian | - |
| | II | Ferrassie Mousterian | - |
| | C | Ferrassie Mousterian | 629 |
| | CA | Ferrassie Laminar Mousterian | 108 |

*Table 19: Riencourt-lès-Bapaume, NCA stands for number of counted artefacts (Ameloot-van der Heijden & Tuffreau, 1993; Marcy, 1993; Lamotte, 1993; Ameloot-van der Heijden, 1993a; Beyries, 1993; Ameloot-van der Heijden, 1993b)*

| Site name | Layer | Lithic assemblage | NCA |
|---|---|---|---|
| Grotte Vaufrey | I | Mousterian | 24 |
| | II | Mousterian | 58 |
| | III | Mousterian | 18 |
| | IV | Typical Mousterian | 85 |
| | V | Typical Mousterian | 38 |
| | VI | Typical Mousterian | 45 |
| | VII | Typical Mousterian | 229 |
| | VIII | Typical Mousterian | 181 |
| | IX | Mousterian | 36 |
| | X | Mousterian | 15 |
| | XI | MTA | 10 |

*Table 20: Grotte Vaufrey, NCA stands for number of counted artefacts (Rigaud, 1989)*

| Site name | Layer | Lithic assemblage | NCA |
|---|---|---|---|
| Cotte-de-la-St-Brelade | H | Denticulate Mousterian | 296 |
| | E | Mousterian Racloirs | 650 |
| | C | Upper Acheulean | 955 |
| | A | Upper Acheulean | 3631 |

*Table 21: Cotte-de-St-Brelade, NCA stands for number of counted artefacts (Callow, 1986e; Callow, 1986f)*

| Site name | Layer | Lithic assemblage | Climate |
|---|---|---|---|
| Königsaue | Kö A | Micoquian | Warm period in glacial complex |
| | Kö B | Mousterian | Warm period in glacial complex, warmer than layer A |
| | Kö C | Micoquian | Warm period in glacial complex, warmer than layer B |

*Table 22: Königsaue lithic variability and climate*

| Site name | Layer | Lithic assemblage | Climate |
|---|---|---|---|
| Rheindahlen | A2 | Laminar Mousterian | |
| | A3 | Micoquian | |
| | B1 | Micoquian | Glacial phase arboreal and non arboreal environment Saalian Complex/Wolstonian Complex) |
| | B3 | Ferrassie Mousterian | Glacial phase only arboreal pollen which suggests a colder environment than in B1 (Saalian Complex/ Wolstonian Complex) |
| | B5 | Upper Acheulean | |

*Table 23: Rheindahlen lithic variability and climate*

| Site name | Layer | Lithic assemblage | Climate |
|---|---|---|---|
| Riencourt-lès-Bapaume | B1 | Micoquian | Forest during cold phase of a glacial |
| | B2 | Mousterian | Forest during cold phase of a glacial |
| | C | Ferrassie Mousterian | Forest during cold phase of a glacial |
| | CA | Ferrassie Laminar Mousterian | Forest during cold phase of a glacial |
| | II | Ferrassie Mousterian | From a temperate climate to a cold climate |

*Table 24: Riencourt-lès-Bapaume lithic variability and climate*

| Site name | Layer | Lithic assemblage | Climate |
|---|---|---|---|
| Grotte Vaufrey | I | Mousterian | Open plains with herbs and grasses, arid and cold. |
| | II | Mousterian | Cold and a more humid than arid air. |
| | III | Mousterian | Warmer than in layer II, more cold and arid than in IV. |
| | IV | Typical Mousterian | Temperate, more humid and forested. |
| | V | Typical Mousterian | More temperate than cold and more humid than arid. |
| | VI | Typical Mousterian | Temperate forest. |
| | VII | Typical Mousterian | Temperate and mildly humid. |
| | VIII | Typical Mousterian | Change from temperate to cold, tundra like. |
| | IX | Mousterian | Cold and arid. |
| | X | Mousterian | Temperate to warm and humid. |
| | XI | MTA | Warm and humid forests |

*Table 25: Grotte Vaufrey lithic variability and climate*

| Site name | Layer | Lithic assemblage | Climate |
|---|---|---|---|
| La-Cotte-de-St-Brelade | H | Denticulate Mousterian | Cold |
| | E | Mousterian Racloirs | Cold |
| | C | Upper Acheulean | Cold |
| | A | Upper Acheulean | Cold |

*Table 26: La-Cotte-de-St-Brelade lithic variability and climate*