Mikkel Sørensen

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A Dynamic Technological Investigation of Lithic Assemblages from the Palaeo-Eskimo Traditions of Greenland

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Technology and Tradition in the Eastern Arctic, 2500 BC–AD 1200: A Dynamic Technological Investigation of Lithic Assemblages from the Palaeo-Eskimo Traditions of Greenland

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Front cover image: Prehistorically knapped flakes made from killiaq located at the river bank of the Aarrusap Kussinersua river, near Qaarsut, North Greenland (Photo by the author).

Back cover image: A reconstructed arrowhead with detached flakes typical to the Saqqaq tradition technology. The raw material is basalt from Basalt Ø, Northeast Greenland (Reconstruction by the author, photo by J. Sørensen).

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Contents

Abstract

The main objective in this study is to bring the acts and thoughts of prehistoric people into focus. This is attempted by introducing the dynamic technological methodology, in a case study, to Arctic archaeology. The case study consists of an investigation of the lithic *chaînes opératoires* and lithic concepts of production for the five accepted Palaeo-Eskimo cultures in the easternmost Arctic (primarily Greenland).

As a precondition for the lithic *chaînes opératoires* analyses, a study of outcrops of lithic materials suited for knapping (microcrystalline quartzes (mcq), metamorphosed slates (killiaq), fine-grained basalts, quartz and quartzite, etc.), that are found in Greenland, was conducted. The study was primarily completed on the basis of information from earlier surveys by geologists and archaeologists, but was complemented by a survey of northern Nuussuaq in 2004.

The lithic *chaînes opératoires* studied is documented and explained by a comprehensive number of drawings, ordered according to the steps in the process, from the procurement of the raw materials, the shaping of preforms, to the discard of the rejuvenated tool. Thus an important result of the investigation is a well-documented analysis of the dynamic change of the lithic artefact types and a definition of the range of the formal tool types in the Palaeo-Eskimo groups of Greenland.

Because of the detailed knowledge of the different concepts of lithic productions achieved through the investigation, and the affinity between social traditions and technological knowledge, the results of the investigation is employed to discuss the cultural history of the eastern Arctic.

The conclusions from this discussion is that Saqqaq and Independence I must remain identified as two regional traditions, while Dorset I and Independence II should be understood as the same regional tradition, named Greenlandic Dorset in this study. The change in lithic technology from Saqqaq to Dorset I is abrupt, and there can therefore be no technological continuity between these two groups in Greenland, although they might have been present at the same time.

During the *chaînes opératoires* analysis of lithic inventories from the Thule regions, two so far unknown Palaeo-Eskimo groups in Greenland have been identified from distinct lithic technologies: the Pre-Dorset and the Early Canadian Dorset. The appearance of these groups, in the most western Thule region, suggests that the Palaeo-Eskimo cultural sequence of Ellesmere Island has to be mir-

rored in Northwest Greenland. The final Palaeo-Eskimo group in Greenland, the Late Dorset in the High Arctic, has a lithic technology in line with that of Middle Dorset. However, changes and lithic technological devolutions, among other reasons due to the first use of metal do appear in this period.

Because of careful selection, high standardisation, high precision and a long curation of the tools in the Palaeo-Eskimo lithic process, the stepwise intentions in the lithic production concepts are comparatively easily described. It is therefore finally concluded that the dynamic technological methodology is very well suited for the study of lithic technology in the Palaeo-Eskimo tradition, and that this methodology, e.g. in combination with spatial analysis, in the future can be an important method in the investigation of Palaeo-Eskimo cultural history, and for the understanding of behaviour and social aspects in the Palaeo-Eskimo traditions.

Acknowledgements

This monograph is based on a Ph.D. project carried out from March 2002 to November 2005, at SILA, The National Museum of Denmark's centre for Greenlandic Research. The project was financed by SILA, and should be seen as a component part of the extensive culture-historical research into Greenland that is carried out at the centre. My project has been running for more than three years, and I have been at SILA for the duration, and I would, in this connection, stress that it has been of great value to be surrounded by a lively, knowledgeable and, above all, open research environment. By being a 'member of SILA', and affiliated with this project from the beginning, I have been introduced to international Arctic research, which has been of great importance for initiating contacts and collaboration with researchers in both Greenland and North America. I wish to thank all my colleagues at SILA, and those at The National Museum of Denmark who have a connection to SILA, especially those from the Ethnographic Collections, for their openness, kindness and collaboration. The project has been formally attached to the University of Copenhagen's Department of Prehistoric Archaeology, The Saxo Institute, and I wish to thank Associate Professor Erik Brinch Petersen for supervision.

During four summers of travels and fieldwork in Greenland, I have been introduced to the Arctic landscape, Arctic nature and to Arctic culture and cultural history. This encounter has been a really great and positive experience for me, and I think I can also say that it has been a learning experience. The National Museum and Archive of Greenland has been an important collaborative partner during this project and I wish to thank especially Claus Andreasen for much help with access to the find material and for an introduction to field archaeology and survey in Wollaston Forland, northeast Greenland in 2003.

I wish to thank the geologist Karsten Secher for reading and correcting my text dealing with Greenland's geology. Thanks also to the Avataq Cultural Institute in Montreal, specifically Pierre Desrosiers and Daniel Gendron, for their hospitality. Finally I wish to thank my brother, photographer Jeppe Sørensen, for help with photography.

Chapter 1
Introduction

Aims

The main aim of this study is to bring the actions of people from prehistory into focus and thereby describe the prehistory in a new dynamic way. The prehistoric artefacts are in this work viewed as parts of series of processes, where the question of what the object comes from, and becomes, in the production process by the human hand, is more important than the description of the individual object's morphology. The work is thus a move away from the traditional stylistic and typological interpretation, which views prehistoric artefacts as either complete finished tools or as waste, and which exclusively interprets the 'finished' tool's morphology, and consequently often describes a static prehistoric situation. One of the main aims of this monograph is therefore to change the way in which we perceive artefacts – to move towards a dynamic understanding. More specifically, the aim is to introduce a French formulated methodology to Arctic archaeology, which has, until now, primarily utilized a normative-based processual methodology in a North American form.

In Europe, the application of the dynamic methodology has contributed to the interpretation of the culture-historical sequence, has shed light on social events in prehistory and has facilitated a discussion of prehistoric cognition. An important aim is therefore to examine what the potential is for the application of the dynamic methodology in Arctic archaeology.

Another aim is to give Arctic archaeologists a tool for achieving insight into Palaeo-Eskimo tool manufacturing and processes, including a definition of the functional tool types in each of the Palaeo-Eskimo cultural groups in Greenland. Such a definition has, until now, been absent, which has often led to great difficulty and confusion in the interpretation of the early Greenlandic and eastern Arctic typology and chronology. The presentation of the lithic technology in the Palaeo-Eskimo cultural groups will, in addition, allow the archaeologist the possibility of interpreting *what* took place at a settlement site, in terms of tool use and lithic technology.

The last aim is of a culture-historical nature and deals with a new interpretation of the relationship between the five 'current' Palaeo-Eskimo groups in Greenland and their North American/Siberian origins. By using the dynamic methodology, the mental concepts (called the production concepts) for the lithic production in the Palaeo-Eskimo groups can be described. Thus similarities and common conceptual ideas in the technology can be unravelled to argue for social and historical affinity.

Two observations

There are two important observations that have inspired this work. The first observation is of a technological character. I made this observation even before the beginning of this study, whereas the second observation, which is of a culture-historical character, came much more gradually during the analysis, through several scientific discussions.[1]

The first observation
The lithic tool assemblages from Greenland's Stone Age consist of extremely carefully worked, small, standardized tools of very varied raw materials. My first examination of the tools revealed that their manufacture, in spite of their tiny size, required many of the most skilful preparation techniques and methods that we know from the 'Old World' Stone Age cultures. I found that a standardized blade industry existed, of very regular small blades, as are known from technological complexes in Mesolithic Europe and North Africa (Sørensen 2001, 2006(a); Tixier 1963; Rahmani 2002). In addition, bifacial reduction for the production of very thin bifaces was observed, as it is known from the Late Neolithic in Europe and the Paleo-Indian cultures of North America, where this technique is perfected. I saw grinding of the lithic tools' edges and surfaces that otherwise is characteristic of many Neolithic cultures. I also observed that practically all the tools had a shaped base, which indicates that the lithic tools generally had been hafted.

The lithic assemblage from the Palaeo-Eskimo cultures, therefore, apparently reflects a higher technological 'curation' and specialisation than what I knew from my former studies of European Stone Age cultures.

The second observation
There is at the moment a reordering of the cultural history of the eastern Arc-

1 At SILA and at the conferences 'CAA, Hamilton 2003', 'SAA, Montreal 2004' and 'SILA/NABO, Copenhagen 2004'.

tic. Greenland's prehistory has been studied simultaneously in two regional areas by two of Arctic archaeology's great archaeologists, Jørgen Meldgaard in West Greenland and Eigil Knuth in North and northeast Greenland. This has led to the descriptions of parallel cultural sequences in these areas. Internal relationships between these cultural sequences have, on several occasions, been discussed but without any clear interpretation of the cultural succession being reached (Elling 1992, 1996; Appelt 1997). My impression was that in the academic discussion it was generally agreed that the current interpretation of Greenland's prehistory, consisting of five Palaeo-Eskimo groups (Gulløv 2004), seemed to be more a product of the history of research and lesser to be based on the actual prehistoric material.

A similar reordering is taking place in the interpretation of the prehistory of central eastern Arctic (Canada). Just ten years ago this area was considered fully described in terms of its cultural history (Maxwell 1985), but re-excavations and new absolute dates for classic sites like 'Tayara' (Desrosiers & Gendron 2004; Desrosiers et al. 2005) has shown that the settlements that had previously been considered typical for a culture often consist of accumulated material from settlement over a long period of time and over many cultural phases. Settlement sites have, in addition, been radiocarbon dated on unreliable material (marine), which has resulted in absolute dates that are far too early. An examination of the illustrations of the artefacts from the cultural groups, in the corpus work 'Prehistory of the Eastern Arctic' (Maxwell 1985), which has, since its publication, been the main reference work for this area, showed that the individual sites on which the work is based often consist of mixed assemblages. This means that the settlement sites that until now have been perceived as single cultural periods in fact have been utilised throughout a long period of time. Therefore, it is necessary in Arctic archaeology, in the central eastern Arctic, to redefine and reinterpret the cultural history for this region, in particular in regard to the emergence of the Dorset culture. The discovery of the 'chasms' that are opening in the current interpretation of eastern Arctic cultural history allows the possibility for new approaches, scientific discussion and new interpretation of the Arctic cultural sequence.

The problem

This monograph deals with two main problems. One is of a methodological character, while the other is of a culture-historical character.

The first problem is:
What new information and results can be achieved using a dynamic technological methodology in the analysis of the *chaînes opératoires* and the production concepts in the defined Arctic Palaeo-Eskimo cultures?

The second problem is:
How did the cultural history of the easternmost Arctic develop from 2500 BC–AD 1200?

The first problem is the most important, and leads to the second. One could perhaps see the second problem as a culture-historical case study that will show whether the method works for Arctic archaeology generally. If, on the other hand, the reader is primarily interested in the cultural history, the second problem will perhaps be seen as more important. In general this publication can therefore be read in two ways: 1) As a scientific project in which a well-defined French methodology is tried on previously untested Arctic archaeological material, 2) As an analysis and new interpretation of the early cultural history in the eastern Arctic.

Former technological analyses in Arctic archaeology

Blade technology in the Arctic
Hypotheses on the early migrations into North America and on the palaeo-Siberian tradition (8000 BP), and discussions concerning where the immigrations originated, involve an extensive discussion of blade technology in western Siberia and Alaska. In 1961, a particular microblade technology in Japan was defined, characterized by wedge-shaped cores and the use of pressure technique – 'The Yubetshu technique' (Yoshizaki 1961) and of circular cores with facetted platform, and the use of the pressure technique – 'The Horaka technique' (Morlan 1967). The Yubetshu method can be traced to Alaska (Hayashi 1968; Morlan 1970), and back in time to its presumed origin in Mongolia, at least to c. 20.000 BP (Inizan et al. 1992).

Technologically, the Yubetshu method is analyzed and described by J. Flenniken (1987), who argues for the Yubetshu method's cultural affinity. The method is connected to ASTt (Arctic Small Tool tradition) via 'the Denbigh Flint Complex' (4500 BP) in Alaska and is seen as a concept handed down from the palaeo-Siberian tradition in Siberia and Alaska (Anderson 1970; Morlan 1970). Research into pressure blades in prehistory can thus be roughly followed from 20.000 BP to ASTt, but blade technology within ASTt has only been dealt with sporadically (Morlan 1970).

In the Siberian Arctic, on Zhukov Island (7800 BP), a specialized blade production, of blades from cubic cores for the making of microblades as inserts for organic tools, were analyzed and described in a strongly Russian tradition for technological studies (Giria & Pitul›ku 1994). This technology, though, does not have any apparent association with ASTt.

In 1988 L. Owen carried out an extensive investigation into the microblade assemblage in ASTt. Her method was primarily descriptive and metric, so in spite of the fact that a large inventory of blades, blade cores and examples of hafting were treated, neither a full technological analysis nor an interpretation of what caused the differences observed in ASTt is achieved.

Technological studies in the Canadian Arctic

In eastern North America or 'French-speaking Canada', studies of the Dorset culture's lithic assemblage, in Nunavik, have been carried out, based on the French methodology. P. Plumet and L. Lebel were the first Arctic researchers to present a technological concept ('schématique de la réduction lithique des objets en métabasalte…') (Lebel & Plumet 1991: 166) for the utilisation of a lithic raw material in an Arctic cultural group. Later, they described the 'tip fluting' method (1997), and concluded that this method is carried out using the pressure technique, and that it can be taken as an indicator for the Dorset culture in the eastern Arctic (Plumet & Lebel 1997). In this discussion the *chaîne opératoire* concept is mentioned for the first time in association with ASTt. Also in 1999 and 2000 the *chaîne opératoire* concept is mentioned, in connection with the interpretation of Middle Dorset variability in Newfoundland (LeBlanc 1999, 2000) and in French-inspired work on the Dorset culture in Nunavik (Desrosiers 1999; Desrosiers & Rahmani 2003; Desrosiers et al. 2005).

Wear trace analyses, that can assist in an understanding of the tools' function, have only been carried out in a few instances in Arctic archaeology. Two examples can be given: G. Unrath's work (1987) concentrates on the usage of burins in pre-Dorset, and G. LeMoine's work with the bone and antler technology in the Thule culture (LeMoine 1991). LeMoine uses a North American methodology with roots in wear trace analysis (Semenov 1964; Keeley 1980) but operates, at the same time, with an independent terminology, i.e. the term 'design system' (Chippendale 1986) which is in many ways equivalent to the idea of the *chaîne opératoire*.

Technological studies of Greenland's prehistory

The first example of a technological study of a settlement site, carried out by means of refitting analysis in Arctic archaeology, was applied by S. Coulson and C. Andreasen. Their results were presented at a SILA/Nabo Conference 2004/6, Session 1: New Approaches to Dynamic Analysis of Palaeo-Eskimo Artefacts, and is partly published (Andreasen 2004: 131–136). In addition, refitting of the assemblage at IT in Disko Bugt has been carried out to examine the organisation of the settlement and to clear up questions of chronology (Stapert & Johansen 1996). The results show that, in Arctic archaeology, there are good possibilities for solving questions of contemporaneity between structures, to demonstrate the technology used and to identify individual people, using the refitting method. Methodologically, the lithic assemblages in the Arctic have an advantage, for refitting analysis, in that they often consist of different raw materials which can be sorted into clear knapping events and sequences, before the refitting is begun. This advantage is counterbalanced to a certain extent by the fact that the material is often tiny and therefore difficult to piece together. It appears that the methodology, in these studies, have drawn inspiration from French studies of social aspects in Palaeolithic settlements (e.g. Pigeot 1987, 1990; Bodu et al. 1990).

All in all it can be concluded that blade manufacture in the West Arctic was a subject of intense interest in the period 1965–75, and several technological studies of the characteristic manufacturing methods were published. In the eastern Arctic it is only within the last decades that examples of technological studies of lithic and bone assemblages are seen. The *chaîne opératoire* concept was applied in 1997 by archaeologists in Canada who had studied in France, but still only few studies that use the technological methodology are published. No studies of technology in the French tradition are known from Greenland. We are therefore still lacking studies that can explain which methods and production concepts were the basis for tool manufacture in ASTt in the eastern Arctic.

Chapter 2
Methodology

The terminology – the researcher's tools

In this monograph a finely tuned and precise terminology, in the analysis of the lithic material and the lithic tool manufacturing process, is used. This is because it is from the prehistoric choices, made in the manufacturing process, that knowledge, which has been handed down, can be defined as a manifestation of cultural and social relations. Neither is it therefore a coincidence that the terminology, which is most precise in relation to the analysis of the lithic tool manufacturing process, has primarily been defined by archaeologists, who have themselves had, or have, a detailed practical knowledge of the lithic technology. The terminology is based primarily on the work of three archaeologists, all of whom have a practical knowledge of the lithic tool manufacturing process: J. Tixier, who from the 1970s developed a school for modern scientific experiments in practical flint knapping and who in this work also defined the concepts and terminology that is today used in state of the art lithic analyses, as in this study (Inizan et al. 1992, 1999); J. Pelegrin, who was a student of Tixier, and who competently continued Tixier's modern scientific experiments with flint knapping, but has at the same time, as is described below, introduced terminology at the conceptual level of the lithic tool manufacture process; and B. Madsen, who was, like Pelegrin, partly educated in 'Tixier's school'. Madsen has worked with translating and introducing the French school's methodology to Scandinavian archaeology (Madsen 1986, 1992), and has developed methods for systematic and scientific analyses (e.g. Hansen & Madsen 1983; Madsen 1992, 1996).

The topic – the preconditions

Lithic technology

The word 'technology' comes from the Greek 'techne', which can be translated as 'the study of craft'. The terms 'technology' and 'lithic technology' have different meanings within different research traditions. In Europe (except in a French inspired tradition) and in North America, technology is primarily understood as the ability, by humans, to (re)shape nature: 'the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment' (Encyclopedia Britannica). 'Technology is the study of techniques and the science of interpreting and implementing the methods inherent in individual techniques' (Crabtree 1972: 50). Lithic technology is, in this tradition, often very precisely defined as the scientific examination of the practical process: 'Prehistoric lithic technology is the science of systematic knowledge of forming stone into useful cutting, chopping and other functional implements' (Crabtree 1972: 50).

In the French tradition, on the contrary, technology is defined within a more sociological/anthropological context, where technology is seen in close association with social traditions: 'Technology can be considered as a system in which techniques and socio-economic phenomena constitute the material basis of societies' (Inizan et al. 1992: 661). The sociological approach to archaeological technology studies, including the study of lithic technology, thus results in a humanistic/sociological study of the activities of people in prehistory.

In this study, the French understanding of technology is used; in other words, technology is not only understood as a modern insight into the material process, but is also an expression of knowledge and ability, exchanged between people in a prehistoric social context.

Over the last decades, the French understanding of technology, along with the *chaîne opératoire* concept, has found its way into the rest of the archaeology world, especially in relation to Stone Age studies. There are two main reasons why the timing has been right for the French understanding of 'technology' to break out into the rest of the archaeology world. By understanding technology as individual processes (*chaînes opératoires*) and using methods to explain these processes, for example refitting studies, aspects which are of interest in postprocessual archaeology, like social relations, variations and the individual's cognition, can be illustrated. This means that the French understanding of technology becomes relevant with the introduction of postprocessual themes. Another reason that the French understanding of technology and the term *chaîne opératoire* is increasingly used, especially in North America, is undoubtedly because new inspiration is sought after the collapse of 'New Archaeology'. Thus the *chaîne opératoire* concept is mentioned indiscriminately in North American lithic discussion groups ('the Archaeological Lithic Analysis Discussion List <lithics-l@listserv.buffalo.edu'), in academic literature (the journal *Lithic Technology*) and in Anglo-American literature (Andrefsky 1998). In some circles it is even being attempted to suggest that the *chaîne opératoire* concept is an American invention (Shott 2003).

The breakthrough for the dynamic understanding of technology happened, in the 1990s, on several fronts. A group of French researchers specialising in lithic technology was invited to Cambridge and published their research together, in English (*Archaeological Review from Cambridge*, vol. 9:1). Leroi-Gourhan's work *Le Geste et la Parole* from 1964–65, which is probably the most important background for the French archaeological understanding of technology, was translated into English (Leroi-Gourhan 1993). Several English language publications focus on cognitive archaeology, including lithic technology, as the basis of the studies (Renfrew & Zubrow 1994; Schlanger 1996).

There is, however, a *but* in this 'breakthrough'. The *chaîne opératoire* concept has become popular and has been on everyone's lips, *but*, as it is also stressed in the French understanding of technology, terms and theories can quickly be acquired while the procedure (method) remains the same (see later term definitions). In other words, the *chaîne opératoire* concept has become a part of discussions in North America and England, but it has not necessarily resulted in a change in methodology. In the processual archaeology tradition (New Archaeology) which has especially experienced popularity in North America, but also in Europe, the study of technology has, to a large extent, been based on natural scientific and statistical methods, and this is indeed still the case.

One could therefore be tempted to say that the word *chaîne opératoire* in North America has taken the place of 'technological organization' (Binford 1979), and that the methods of New Archaeology to a great extent still continue. In Europe, outside France, technology studies are often made scientific by the quantifying of selected characteristics and metric definitions called attributes (e.g. Madsen 1992; Ballin 2000; Weber 2000).

From the anthropological side the use of the word 'technology', in connection with hunter-gatherers, has been criticized (Ingold 2000). It is argued that the concept of 'technology' is in contrast to the 'individual', in that the technology concept has its origins in association with the machine during industrialisation and therefore has an external meaning in relation to people. Thus T. Ingold argues that technology in principle does not exist in a hunter-gatherer context. Instead it is argued that 'technique', in Mauss's original definition (Mauss 1947) – i.e. that technique is not necessarily connected to the physical material but to people's movements like swimming, dance, etc. – is a part of people's experience, in prehistoric times as well as today, and thus this term should substitute the term 'technology' in a hunter-gatherer context.

Ingold's suggestion of a change in terminology is not followed in this study. It is, in the analysis of the prehistoric production process, necessary to be able to divide the process into different levels. If the overall concept of 'technology' is dropped, and substituted with 'technique', the hierarchy that is today found between physical manufacture, method and cognition will collapse (see the following discussion). It should be pointed out though that there are archaeologists, both in France and in the rest of the archaeology world, who apply Ingold's interpretation of the 'technique' concept (Audouze 1999).

'Culture' and 'tradition' in the Arctic

As in all other branches of archaeological and anthropological research, the definition of cultures in the Arctic today lacks a precise meaning. In spite of this, the defining of archaeological cultures is used extensively in archaeological literature, probably because it is an old habit, and also perhaps because it is necessary to have a term to describe or name the human groups that manufactured the archaeological objects. As early as 1987, it was suggested in Palaeo-Eskimo research that 'cultures' should be replaced by the less loaded term 'groups' (Grønnow 1988(b)), but the suggestion was never followed. In different contexts in this work it has been impossible to avoid the word 'culture', but when it is used it is in F. Boas' cultural-anthropological definition, where a group of people are seen as a social unit in both time and space, and which has its historical root in a previous larger tradition (Boas 1887). In the attempt to avoid, as much as possible, the term 'culture' in this study, the previously defined 'cultures' in the eastern Arctic are generally named by their prefix, as in Saqqaq, Independence I, etc.

In terms of terminology, the main term for groups from the migration to the eastern Arctic from the Bering region in c. 3500 BC, and the developments in this area until c. AD 1200, is the 'Arctic Small Tool tradition' (ASTt) (Irving 1957). This description is most appropriate, as throughout ASTt clear material, technological and economic parallels, coincidences and developments can be seen, which altogether point to the possibility that ASTt has one traditional knowledge-base and 'world view'.

Regionally in the Arctic, though, differences are also seen in the archaeological material through time and space – differences that have previously led to definitions of different 'cultures' but which, in this work, are understood as regional developments and therefore *regional traditions* in the ASTt.

An important aim is to discuss these regional traditions in the eastern Arctic through studies of technology. Local and regional traditions are defined through the identification of specific knowledge and systematic actions, handed down through generations. It is through detailed studies of lithic technology that it is possible to determine whether a technology is passed on as knowledge and actions between generations. As is argued below, technological traditions also reflect social traditions.

The material – the physical level

Technique

Technique is, in the present work, defined as the way in which the flint knapper transfers energy to the stone. The definition is derived from Tixier's definition: 'Les techniques sont les modes d'exécution de la taille – modalités de détachment d'un fragment de roche dure' (Tixier 1967: 807). Technique is thus not a strategic or stepwise organized action, but is a term for the craftsman's specific contact with the material. As a result of Tixier's definition of technique, terms such as 'blade technique' and 'bifacial technique', where a strategy becomes part of the definition, does not exist, and these terms will therefore not be used.

The technique is dependent on a variety of physical factors, influenced by the material. Studies of the fracture dynamics of rocks that give conchoidal fractures show that they are often of a microcrystalline structure, and that they always split in an interplay between tensile and fracturing forces. People producing lithic tools by knapping choose, from these conditions, between a number of practical possibilities, here called 'techniques' when working the rock.

Often, a technique is described extremely simply, either as 'soft' or 'hard'. This is a far from acceptable description, as the technique chosen is dependent on many factors. A hammer stone is not either hard or soft, but can be something in between, called medium-hard, or elastic. In addition, the actual blow to the stone can be carried out in different ways, using different force and from different angles. The technical factors, which have an influence on the result, are:

1) The material that the hammer is made from (hard stone, medium hard and soft/elastic stone, antler, hard wood).
2) The shape and weight of the hammer.
3) The force of the blow.
4) The angle of the blow (the angle at which the striking platform is hit).
5) The position of the blow (working position, physical or mechanical fixation of the core, distal support of the core).

The following techniques are described as ways of transferring energy to the stone during reduction:

1) *Direct hard technique*: A blow directly onto the core with hard rock types, like for example hammer stones made from granite or quartz.
2) *Direct medium hard technique*: A blow directly onto the core with 'soft' stone like sandstone or limestone.
3) *Direct soft technique*: A blow with a billet of deer antler, tooth or hard wood.
4) *Indirect soft technique*: A blow carried out on an intermediate piece (punch) of antler. The piece is placed between the core and the blow from the hammer (is also named the 'punch' technique).
5) *Pressure technique*: Applying direct pressure, performed using a pressure tool of a soft material. The material can be antler, bone, tooth or a soft metal like copper. The pressure tool can be made from a single material, or it can be composed of several assembled materials, for example a 'soft' point and a wooden haft. Both blades and bifacial tools can be made using the pressure technique.
6) *Grinding*: Reduction by grinding of the object's surfaces. In addition, grinding can take place as a preparation of the striking platform/core front before flaking.

However, technique also incorporates the working position, and how the rock is held and even fixed, during the production process. It is often difficult to be sure of the prehistoric work position, and thus working position is not defined here. On the other hand, the fixing of the core can in many instances be interpreted:

1) *Basal support of the blade core at the moment of the blow*: In the making of blades, the blade core can be supported, which produces diagnostic characteristics (Bordes & Crabtree 1969; Pelegrin 1991).
2) *Mechanical fixing of the core*: A mechanical fixing can be used for example in situations where microblades are being made, but where the core's inertia is too low to hold in the actual flaking situation. Fixing of the core is often used when applying the pressure technique (Callahan 1985; Pelegrin 1988).

Another technique that should be considered is:

1) *Heat treatment of the raw material*. The purpose of heat treatment is to change the material's crystalline structure so that the fracturing properties are increased. Heat treatment of lithic material is a well-known phenomenon in ethnographic studies (Roux & Pelegrin 1989), but is also recorded in prehistoric contexts especially in situations where the pressure technique is being utilized (Crabtree & Butler 1964; Flenniken 1987; Eriksen 1997; Inizan & Tixier 2001).

The technique used can be determined from the following characteristics:

The shape of the bulb of percussion, the shape of the platform butt, the shape of the flake/core/tool/preform, bulbar scars, ripple marks, the regularity of the flake/core/tool/preform, diagnostic fractures. Many studies have analyzed the relation between technique and the lithic materials' fracture mechanics (e.g. Bordes 1969, 1970; Bordes & Crabtree 1969; Ohnuma & Bergman 1982; Madsen 1986, 1992; Pelegrin 1984b, 1988, 1991, 2000, 2002; Inizan et al. 1999). It is therefore, today, generally possible in technological analyses of flake morphology and attributes to determine which techniques were used in prehistory, in a prehistoric lithic assemblage.

Technique can also be identified from archaeological finds of tools used for lithic reduction, (e.g. hammer stones, organic billets and pressure tools). Due to the good state of preservation, there are several types of tools from Greenland's prehistory, e.g. different types of pressure points and hammer stones, which demonstrate the existence of a technique.

Method

Method is defined as the strategic procedure for the practical production, understood as the order in which the technique is changed, including how the platform is prepared, the choice of platforms and the points that are chosen for impact. In this way, method is the expression for how the work process is organized, and is superior to technique. This definition of method is in line with a general French definition: '… the method followed to create a prehistoric tool is thus an orderly sequence of actions carried out according to one or more techniques, and guided by a rational plan' (Inizan et al. 1999: 145).

The method, in this study, is ordered hierarchically in 'overall method' and 'sub-method'. The 'overall method' deals with the practical production method and the choices that are made, from start to end, in a process. 'Sub-methods' are the specific methods that are used in each production phase. This hierarchy is used to enable the analysis level to be specified.

The *chaîne opératoire*

As a consequence of the sociological understanding of technology, founded by Emile Durkheim and Marcel Mauss, among others, and from studies of biological evolution, Andre Leroi-Gourhan defined '*la chaîne opératoire*' in 1964: 'La technique est à la fois geste et outil, organisès en chaîne par une véritable syntaxe qui donne aux séries opératoires à la fois leur fixitè et leur souplessse' (Leroi-Gourhan

1964: 164). In the study of lithic assemblages this concept, in this study and in line with the current definition, covers every step in the process, from the procurement of the raw material, the making of preforms and tools, the usage, sharpening and finally the discarding of the artefact.

Generally, the term *chaîne opératoire* has been adopted in the English/American literature in its original French as the accepted term. There has been some confusion about the definition and understanding of the *chaîne opératoire* definition. Archaeologists have used the term to describe individual reduction sequences, while anthropologists have allowed the term to describe the concept behind the process. Archaeologists today unfortunately use the term for both meanings, as some archaeologists have been inspired by the anthropological viewpoint (Audouze 1999: 169).

It is therefore important to stress that I use the term *chaîne opératoire* to describe the physical reduction sequences that altogether consist of many artefacts. At the same time, however, it is important to understand that a *chaîne opératoire* is carried out on the basis of a conceptual concept called the 'production concept'. The production concept is argued to be handed down in the tradition or culture in which the artefacts are manufactured, and the *chaîne opératoire* analysis is therefore the archaeologist's method towards an interpretation of a traditionally based production concept. Finally, it is important to stress that the individual *chaîne opératoire*, as can for example be seen when refitting, is also a material expression for individual cognition, and personal preferences (Pelegrin 1995).

The *chaîne opératoire* has a central meaning, because it forms the basis for the methodology and the understanding that will in general be used. It is by this term that archaeological objects per definition are looked at dynamically. It thus becomes possible to structure humans' usage of the lithic material, using different archaeological methods, to place them in the different steps in the manufacturing process, or, in other words, in their technological context. These are the steps in the manufacturing process.

Steps in the manufacturing process

The *chaîne opératoire* is often divided into phases, as: procurement, production, usage and discard (e.g. Geneste 1985; Madsen 1986; Inizan et al. 1999; Eriksen 2000a). Moreover, a sub-division of the phases is seen, in steps, determined by which aims are favoured in the analysis and which material process has been chosen for investigation. That the manufacturing process can be divided into steps is an observation that modern flint knappers in general have, because a knapping sequence is experienced, conceptually, as consisting of stepwise intentions when it is carried out. The steps can in practice often, but not always, be defined as the points where technique and sub-methods change. But as it can also be seen in the examples above, the individual observation of when and how the different steps are defined is subjective. We should therefore be aware that there are probably steps in the process, but that the divisions made in the analyzed prehistoric working process are operative rather than reflecting the intentions and the experience that the prehistoric person had in mind.

I have in this study chosen to divide the *chaînes opératoires* for all the lithic artefacts analyzed into six general steps: Procurement (step 0), manufacture of roughout (step 1), manufacture of the tool (step 2), usage of the tool (step 3), re-sharpening (step 4), discard (step 5) (figure 2.1). In principle, the same division into steps is thus used for all *chaînes opératoires* analyzed. The reason for this choice is because it is most rational to compare the large number of *chaînes opératoires* which are analyzed on the basis of a common general framework. It should be pointed out that I include procurement, usage, re-sharpening and discard as steps and therefore only have two steps – manufacture of roughouts and manufacture of the finished tool – to explain the production of the artefact. Procurement, usage, re-sharpening

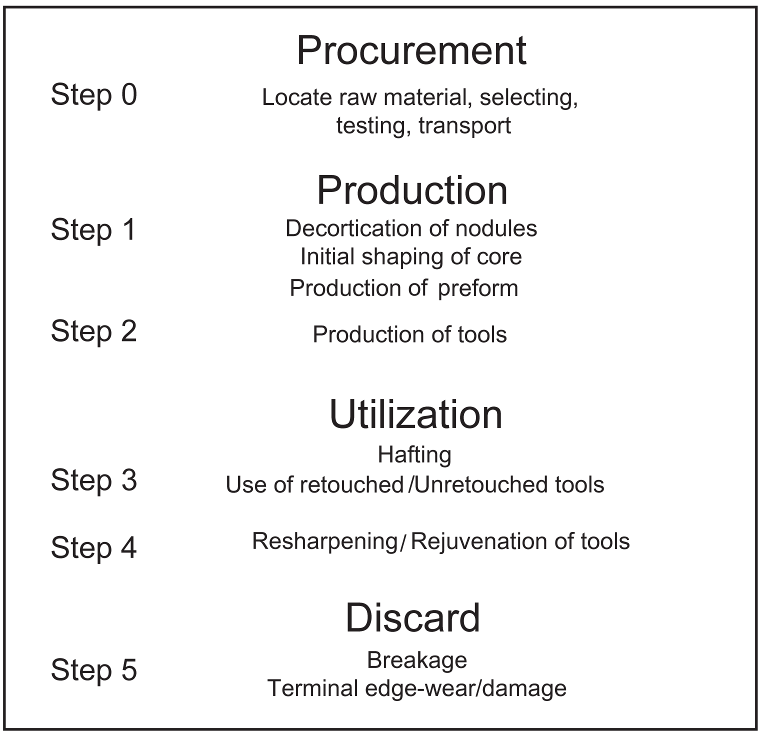


Fig. 2.1
The five steps in a general *chaîne opératoire* analysis. These steps are employed in the classification of the artefact material in the present study.

and discard are included as steps, as these steps contain many traditionally based choices, which it is advantageous to analyze. At the same time, I wish to stress that in the future more detailed studies can be carried out in terms of how (that is, using which methods, sub-methods and techniques) individual tools are manufactured in the Palaeo-Eskimo traditions than are described in this study.

The raw material

The choice of raw material is, as the first step in the *chaîne opératoire*, the basis of the process, and is at the same time a tradition-based choice. In the prehistoric eastern Arctic it is not unusual that a raw material has been transported over 1000 km from the source, before it is finally worked, used and discarded. The archaeological recognition of the prehistoric choice of raw material is very important, both because this choice is in some instances a marker for a specific tradition, and because the searching and finding of a source for a raw material can give us information on the Palaeo-Eskimo groups' mobility and network and thereby on important social aspects.

In the archaeology of Greenland there has been very little focus directed towards the identification of lithic raw material sources. It has only been over the last few decades that this specific problem has been taken up (Madsen & Diklev 1992; Jensen et al. 1998; Jensen & Petersen 2001; Sørensen & Pedersen 2005). Researchers in Canada have traditionally been better at describing typical raw material sources like for example the source at Ramah in Labrador (e.g. Gramly 1978; Nagle 1984; Loring 2002), 'Mugford Chert' in Labrador (Gramly 1978) and 'Cow Head chert' in Newfoundland (Tuck 1978). Current research in Nunavik (Desrosiers & Rahmani 2003), though, shows that only a tiny portion of the prehistorically utilized sources have been identified in the central eastern Arctic. Surveys to find raw material sources and interpretation of the provenance and the choice of raw material in the eastern Arctic are therefore topics that have great potential for an analysis of the prehistory of the region.

In the interpretation of the lithic raw materials used in prehistory there is a great problem in Arctic archaeology: there is no consensus on terminology for the lithic raw materials.

The main reason for this confusion is that the raw materials in principle should be analyzed and named after their geological context, but this is seldom possible in prehistoric material as the material through the operative process in prehistoric times is removed from the source area. Thus we lose, to a degree, the possibility for a scientifically based terminology for the lithic raw materials used in prehistory.

This problem has resulted in there being both regional and national terminologies and also that archaeologists use their own internal terminologies.

The North American archaeologists and geologists, when describing stone used for tools, in general call it chert, but they sub-divide the fine-grained characteristics into agate or chalcedony, and the terms basalt, meta-basalt and 'silicified slate' (for metamorphosed slates) appear. Archaeologists who work with Greenland's prehistory have generally tried to distinguish between agate, chalcedony, quartz, rock crystal, metamorphosed slate (called killiaq) and basalt, but have never used the term chert. Instead the term 'flint' is used, which is a badly chosen term as flint is formed from siliceous diatoms in chalk, a process that has not taken place in Greenland's geology. Some terms are also problematic because they are not fully agreed upon geologically (without destructive tests), e.g. the difference between agate and chalcedony.

As a solution to this problem, I have chosen (after advice from geologist Minik Rosing 2002) to describe the raw materials chalcedony, agate and chert as microcrystalline, abbreviated mcq, and subsequently to refer to them in relation to their characteristics (see the criteria below). A particular type of mcq is 'rock crystal' which is found in crystal form both in a transparent and a milky translucent variant. This material is so characteristic that it can in general be named 'rock crystal'. Another very special rock type used in West Greenland is a metamorphosed slate called 'killiaq'. The source for this rock type is found primarily at Qaarsut on the north side of Nuussuaq (Sørensen & Pedersen 2004, 2005) and it has such distinct characteristics that it can be referred to specifically as 'killiaq'. It should be pointed out, though, that the quality of killiaq at the source at Qaarsut is very different to the quality of another, locally used metamorphosed slate that is to be found at Grønne Ejland in Disko Bugt (Jensen 2000). In the Thule area, examples of metamorphosed slate used for tools can be found, which are also here given the name 'killiaq'. Basalt of different qualities is used for tools. A particular type of basalt is homogeneous, very fine-grained basalt that is to be found in East Greenland, for example at the source on Basalt Ø in Young Sund (Sørensen & Andreasen 2004) and at Kangerlussuaq south of Blossevillekysten. The colour of the material can vary from red to black, but it can also become grey through time when it lies exposed. An often used medium-grained brown volcanic rock, which is to be found in north and northeast Greenland, is called 'dolerite' (Henriksen 2003). In addition to the dolerite variation, volcanic rock types are named using the same procedure as for mcq (that is, a general name and a description). This is also the case for metamorphic sandstone, which gives conchoidal fractures, defined as quartzite, especially known in the Nuuk area, and for granular quartz, which can form in gneiss formations.

In this study, the following criteria are used to describe the Arctic raw materials:

1) Texture (fine to coarse flake surface, intrusions, homogeneous/heterogeneous)
2) Transparency (dark, i.e. no transparent as basalt, translucent, i.e. partly transparent like flint, chalcedony and agate and transparent, i.e. that it is fully transparent, like glass or crystal or semi transparent)
3) Colour (a description of the colours, nuances, patterning, zoning, spots, etc.)
4) Cortex (the existence of original surface (i.e. not removed) including its colour, texture, geology, etc.)

In Chapter 3, the different raw materials is described and an overview of where the different raw material sources that we currently know of, that either have been or can have been used, are situated in Greenland. The overview is based on both geological and archaeological surveys.

The ideas – the conceptual level

The production concept

To assist in the understanding of technology and the usage of the *chaîne opératoire*, the term '*la scheme opératoire*' (Pelegrin 1985, 1990) is helpful. In this study, the term is used, translated into English as *the production concept*. The production concept refers to the cognitive concept that the flint knapper works from in the production of tools. It includes, as in the *chaîne opératoire*, all phases of production, including knowledge of how the raw material is found, tested, procured and how tools are designed and rejuvenated. The concept is organized stepwise, and the individual steps consist of conceptual representations of geometric forms, needed for the production of the final intended tool.

To analyze the cognitive process, two additional fundamental concepts are defined, called 'knowledge' and 'know-how' (Pelegrin 1990). These definitions are important in the later discussion of how a social group can be identified on the basis of technology.

Knowledge

Knowledge ('connaissances') is defined as a purely conceptual aspect, that encompasses knowledge of form and material, and a register of actions with their accompanying expected practical results. In other words, 'knowledge' describes the individual's knowledge of the traditional production concept. But knowledge also encompasses 'personal preferences' for particular methods and sub-methods that can be utilized in particular situations in the process (Pelegrin 1990: 118, 1995: 31).

Know-how

Know-how can be divided into 'mental know-how' ('savoir-faire') and 'motor know-how' ('savoir-faire moteur'). Mental know-how can be defined as the ability to analyze the practical process and make the decisions that makes the individual knapper capable of carrying out the production concept. Mental know-how thus describes the individual's knowledge of the method and how mistakes and irregularities during production can be repaired such that the process is successful. The 'motor know-how' describes the body's physical ability in relation to a particular manufacturing process. 'Motor know-how' is about physical precision and coordination and must be learned hands-on, by proactive training or apprenticeship (Pelegrin 1990: 118, 1995: 31).

Direction – towards a technological recognition of a prehistoric society

There has been, and still is, a tendency to conceive studies of technology as marginal, in relation to archaeology as a whole. It is, with exceptions (e.g. Hansen & Madsen 1983; Bodu et al. 1990; Pigeot 1990; Apel 2001), seldom that we see technology studies contributing to the interpretation of cultural history and the structure of prehistoric society. This tendency is, among other reasons, attributable to the fact that archaeologists that have worked with technology previously, outside the French tradition, have considered their approach as scientifically specialized and 'narrow'. Also, these studies have generally only achieved an analysis of the manufacturing process, using the traditional definition of technology. Even archaeologists who have carried out technological studies in the French tradition and have achieved definitions of the conceptual strategies behind the manufacturing process, measured temporally and spatially, have not always associated their results with social aspects or craft traditions, nor have they been used to shed light on social or cultural questions. In this way several authors of technological analyses, including myself (Sørensen 2001), have constructed chronologies and partly avoided discussing the cultural and social angle in the conclusions. There are naturally examples where changes in technology are *only* an expression of local innovation and where we therefore cannot talk of the presence of, or influence from, other social complexes and technological traditions, but on the contrary there is no doubt that many of the 'techno-complexes' that we see in prehistory, especially in the Arctic where prehistoric mobility is generally seen as extensive, is also an expression of distinct regional or ethnic groups with their social traditions. Discussion of what the cause of technological differences and developments can be, in those instances where it is shown, must therefore be a central concern that technological studies should take as seriously as the demonstration of a technology, and thereby contribute to the interpretation of prehistory.

I wish therefore in the following to argue that a technological tradition, group, complex, or horizon reflects a social unit called e.g. a society, a people or a culture. My argument takes its basis in the theoretical analysis of a lithic tool production as described by J. Pelegrin (1990, 1995). As it has emerged, to carry out a standardized and specialized manufacturing process there must be: 1) Knowledge of the production concept and of how the process is carried out (termed 'knowledge'); 2) Knowledge of how the concept is executed and how problems are solved (termed 'know-how'); 3) Practical training, so that it is possible, physically, to carry out the process ('physical know-how' or 'motor skills').

To learn a standardized specialized manufacturing process these three terms are examined in relation to how they are learned. For 1) knowledge can be explained theoretically and can therefore be described explicitly, i.e. verbally between people, over a relatively short period of time. For 2) know-how is of both an explicit and intuitive nature. Intuitive because it is an assumption that the 'apprentice' has a practical and physical knowledge of the process, and also a degree of motor skill to be able to learn the know-how. But, at the same time, some of the strategies that are used in practice, for example when repairing mistakes, can be described explicitly. Know-how requires therefore that the 'apprentice' works practically for a period of time, and in that time is guided by an experienced craftsman (flint knapper). For 3) motor skills are a physical, intuitive, 'silent' ability which cannot be described verbally. Motor skills must be developed with practice (trial and error), and by visually observing experienced craftsmen (flint knappers).

The conclusion is that the learning of a specialized and standardized manufacturing process requires that the learner belongs to a social tradition, in which knowledge and ability is to be found, and can be communicated, watched and learned from regularly over long periods of time. Therefore, for specialized, standardized manufacturing processes to function or exist, there must be social traditions and social units in which specific knowledge and know-how can be communicated. Through using the dynamic technological methodology, it should be possible to analyze to what degree artefact assemblages are independent or related, and on that basis discuss, to what extent the technologies found represent a spe-

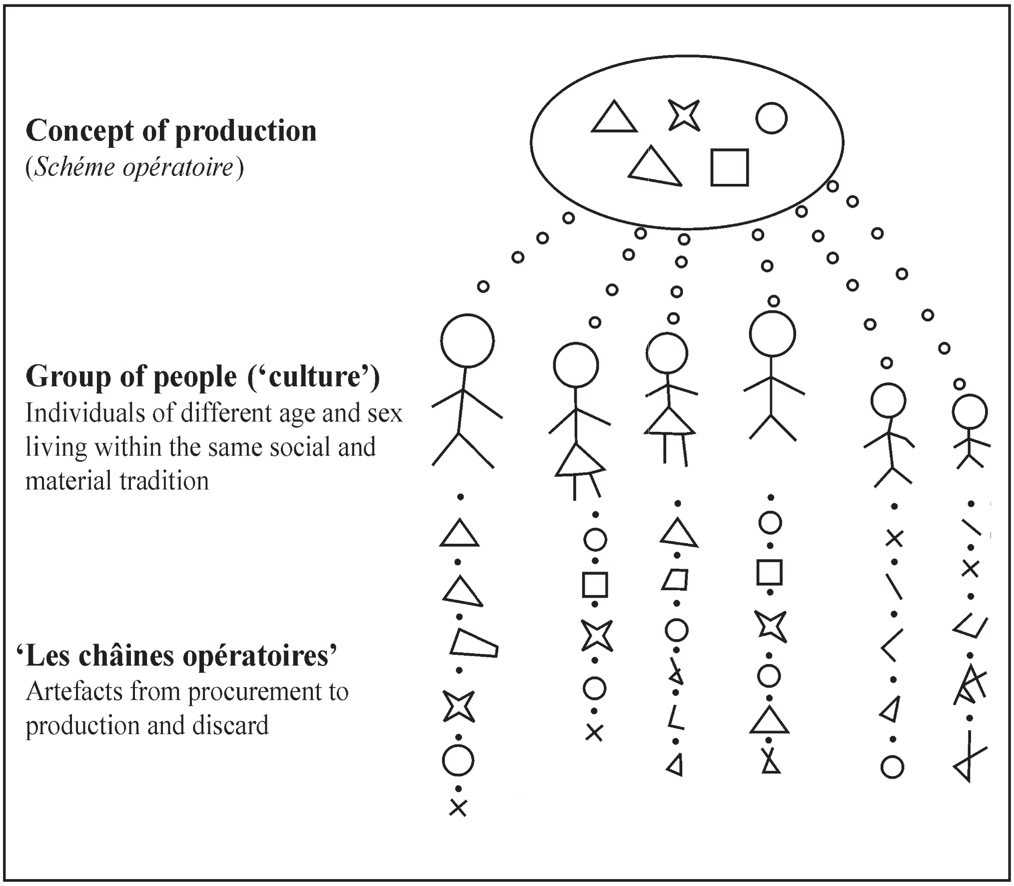


Fig. 2.2 The three main concepts employed in this study: the *production concept*, the *social entity/group* and the *chaîne opératoire*.

cific social group or are a part of other contemporary technological traditions and social groups (see figures 2.2 and 2.3).

The perspective – the way we perceive and the consequences

Archaeological research has been, and still is, dominated by a structuralist approach and by a positivist method where the 'material being examined' is looked at from above, that is, in an attempt not to be involved, and with the feeling of being 'mentally above the material being examined'. This research approach is also known

Fig. 2.3 Lithic craft and production is transmitted between people of different generations in a social relation and in particular social traditions. Technological traditions will therefore reveal social traditions.

from anthropology (Hastrup 1999: 166) (figure 2.4). Gradually though, mostly in anthropology but also in archaeology, a change towards a theoretical view develops, towards an increasing attempt to understand the prehistoric person, for example by becoming involved in the questions that the material examined poses. Hastrup explains the change as a shift in the 'theoretical view', moving from a structuralist approach to a hermeneutic view. By using the hermeneutic view, the researcher is to a greater degree on a level with 'the person being examined' in that it is attempted to establish overlapping horizons in relation to the investigated material (figure 2.4). The overall purpose of the hermeneutic view is therefore to facilitate the interpretation of aspects of the expectations, problems and worldview of 'the human context being studied'.

By asking the question, 'how are lithic materials transformed into tools?' and at the same time carrying out qualified studies of the material and the physical properties of lithics, studies of lithic technology and comparative studies of the prehistoric find material, a hermeneutic view is adopted. In archaeological research it is therefore, in spite of the enormous distance in time, possible to create overlapping horizons in technological studies. The reason that the hermeneutic view is well suited to lithic studies is first of all that lithic material is so well preserved. Thus there is no difference, in archaeological methodology, between studying lithic material that was manufactured yesterday or 1000 years ago. Both data and method of examination will be the same.

By changing the perspective on the find material from a descriptive one, where

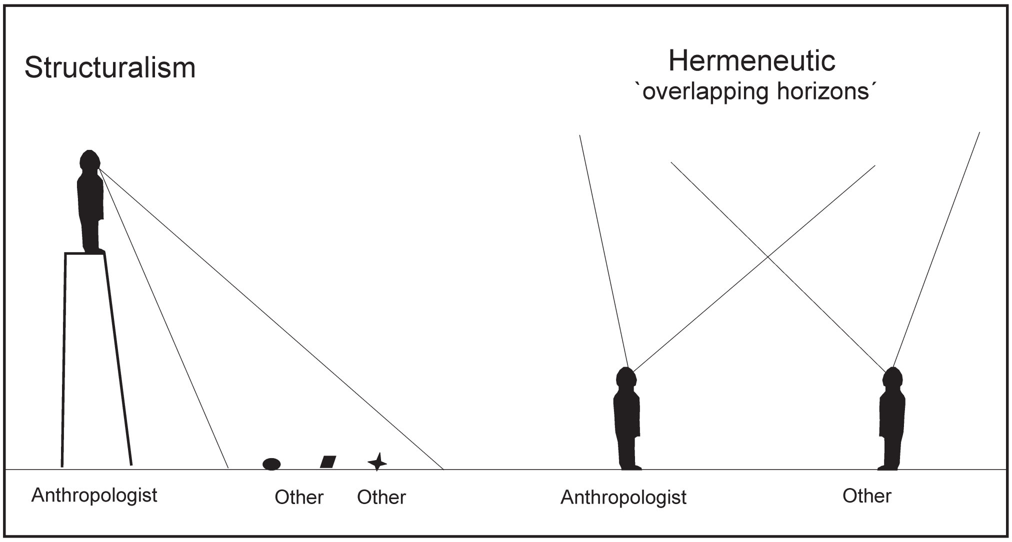


Fig. 2.4 Different 'theoretical views' typical of the structuralist and hermeneutic approach (after Hastrup 1999: 166).

account is not taken of the technology or the prehistoric function, to a hermeneutic perspective where the material manufacture and usage process is queried with a view to understanding, it is possible to share technological horizons with prehistoric people. This fundamental difference in the understanding of the archaeological find material means that we, from the definition of the find material, from the study of its manufacture and from the interpretation of its use, can avoid a lofty classification approach, and instead achieve understanding and interpretation.

The methods of examination

To study the prehistoric reduction method and thereby achieve an interpretation of the production concept, there are, in archaeology, several study methods that have shown to be effective, and which are used in this study:

Refitting of assemblages
Technological dynamic classification
Modern experiments with flint knapping
Technological study/mental refitting

Refitting of assemblages provides the most individual information on the different processes (Cziesla 1990). According to Cziesla three different types of refitting can be made: refitting of production sequences (1), refitting of tool modifications (2) and refitting of breaks (3). In this work the refitting of breaks are mainly carried out, and often on tool preforms, on finished and discarded tools. This type of refitting is prioritized because it gives important general information particularly on the preparatory shaping (step 1 and 2) and because it is the least time consuming refitting type to carry out. The latter is important when, as in this study, many objects are to be analyzed.

Technological dynamic classification is a second very useful study method for the prehistoric reduction method (Schild 1980). By classifying the lithic material after the type of production, for example blade production, adze production, bifacial production etc., in relation to the manufacturing process from start to end, it is possible to attain insight into the general prehistoric manufacturing method for the different productions. The method requires a deep insight into lithic technology and possible help from some of the other methods mentioned.

Modern experiments with flint knapping, that is, experimental archaeology, can, with targeted, well-documented and competent trials, give specific insight into the prehistoric methods (e.g. Madsen 1983; Rasmussen 2001; Kelterborn 2001). This insight, and the estimation of the prehistoric methods, is possible by carrying out detailed comparison between the original material and the experimental material. Technological studies of negative flake scars on cores and flakes (Audouze 1999 after Boëda 1997) are in the same family as 'mental refitting' (Tixier 1978). Both methods involve studying production sequences from cores and flakes. It is the order in which the flakes are struck, interpreted from the flake negatives on the dorsal side of flakes and cores, and the presence of cortex, that reveals the prehistoric production method. Common for the methods is that they require an established knowledge of lithic technology, preferably practical knowledge, as an understanding of the fracturing properties and possibilities of lithic material increases the understanding of the methods that can be used and of how these methods are recognized.

In this study, combinations of the methods mentioned are used. The technological dynamic classification is carried out on the basis of the refitting, and on the technological studies of the flakes and cores. The basis for the technological study and the dynamic technological classification comes from information derived from modern experiments with flint knapping and lithic assemblage analysis. In addition, statistical methods are used for the counting of functional tool types, describing sizes of flakes and blades and for the counting of selected blade attributes.

Drawings of lithic artefacts are made after guidance from Inizan et al. (1999)

and Johanssen (2000). The act of carrying out the drawing is in itself a form of lithic examination that makes it possible to discover details in the technology. In addition, Arctic archaeology in general is lacking in drawings of lithic artefacts as the basis for archaeological analysis. By drawing a large number of lithic artefacts from the Greenlandic Palaeo-Eskimo assemblages, it is my hope that this work also can be studied by archaeologists who are not as interested in, or agree with, the methodological focus.

The procedure

The analysis of the prehistory of Greenland is divided into six sections, one for each of the previously defined Palaeo-Eskimo groups and one for other Palaeo-Eskimo groups in Greenland defined in this work. Each cultural group is represented by the analysis of the lithic assemblages of two settlement sites, to ensure a reasonable representativity. It is in this connection important to show that the assemblages chosen, in all cases, are from the best excavated settlement sites in Greenland, within each period, that the assemblages are generally not mixed, and that the assemblages are rich in lithic artefacts. Each of the five cultural groups is studied according to the same procedure. First a description of the site and its location and of the excavation methods for the site and its assemblage is given. Then the *chaîne opératoire* analysis is started with an examination of the lithic raw material types and the prehistoric raw material choice for the different processes and tool types. Subsequently each and every one of the formal tool's manufacture, modification and discard (*chaîne opératoire*) is analyzed and presented and the flake material is analyzed. A layout is used where drawings of selected artefacts that are typical of each step in the *chaîne opératoire* are depicted vertically from above.[2] In this layout a specific numbering is used: Artefacts that are included in the vertically depicted *chaîne opératoire* analysis are marked with letters (A, B, C, …). Different tool types, functionally or stylistically, are on the other hand depicted horizontally with numerals (1, 2, 3, …). Artefacts that are not depicted in an operative or typological context are given Roman numerals (I, II, III, …). Incomplete artefacts, that are reconstructed as a result of the study, are marked with an asterisk (*).

In relation to the methods of analysis in chapter 4 the following principles of classification is employed: Fragments of tools and preforms are classified and counted as single tools or single preforms in the inventory of artefacts. Artefacts are classified as 'preforms' when they are found to belong to steps 1–2 and as 'tools'

2 I occasionally deviate from this principle due to the layout of the book.

when they are found to be from steps 3–5. Each material section finishes with a conclusion in which figures of the production concepts for tool production and blade production are presented. These figures are made on the basis of the drawings of the original artefacts. On the other hand, general reduction methods are explained with generalised schematic illustrations.

How the *chaînes opératoires* and the prehistoric reduction method is analyzed: Two examples

The basis for the analysis of the *chaînes opératoires* are the easily identifiable formal tool types with a complete morphology sorted out according to each type. The questions that are asked of the complete tools are subsequently: which morphology would this tool take on if it was modified, sharpened, rejuvenated and reduced or used and thereafter reworked? By analysing this question a classification of artefacts that derive from the specific tool types morphology begins. The next question posed to the formal tool type is: what form did the tool have in the manufacturing process *before* it was given its present morphology? On this question, preforms, which morphologically and technologically lead to the tool type, are classified in sequence. The method that is primarily used in this analysis is the technological study of the tool's negative fracture scars (mental refitting) supported by refitting. In many instances typical modification products can be found, which, together with the rejuvenated or sharpened tool, can be identified as the complete tool morphology. An example of this is that burin spalls are typical reductions of burins, and that bifacial flakes are typical reductions of bifacial end blades. When typical forms of the rejuvenated or sharpened tools are identified in the material, these are classified as 'sharpened/rejuvenated' tools (step 4 and 5).

Burins from Adam C. Knuth's site and end blades from the Kap Holbæk site

On burins from Adam C. Knuth's site (ACK) from the Independence I, negatives on rejuvenated burins and positive percussion bulbs on burin spalls are found showing that during the Independence I tradition, rejuvenation generally is made by detaching burin spalls in order to rejuvenate the burin edge. The technological classification of the rejuvenated burins shows that rejuvenations by burin spalls are executed repeatedly. As a result of the repeated rejuvenations, different 'types' of burins appear, e.g. dihedral burins, double burins and twin burins (see figure 2.5).

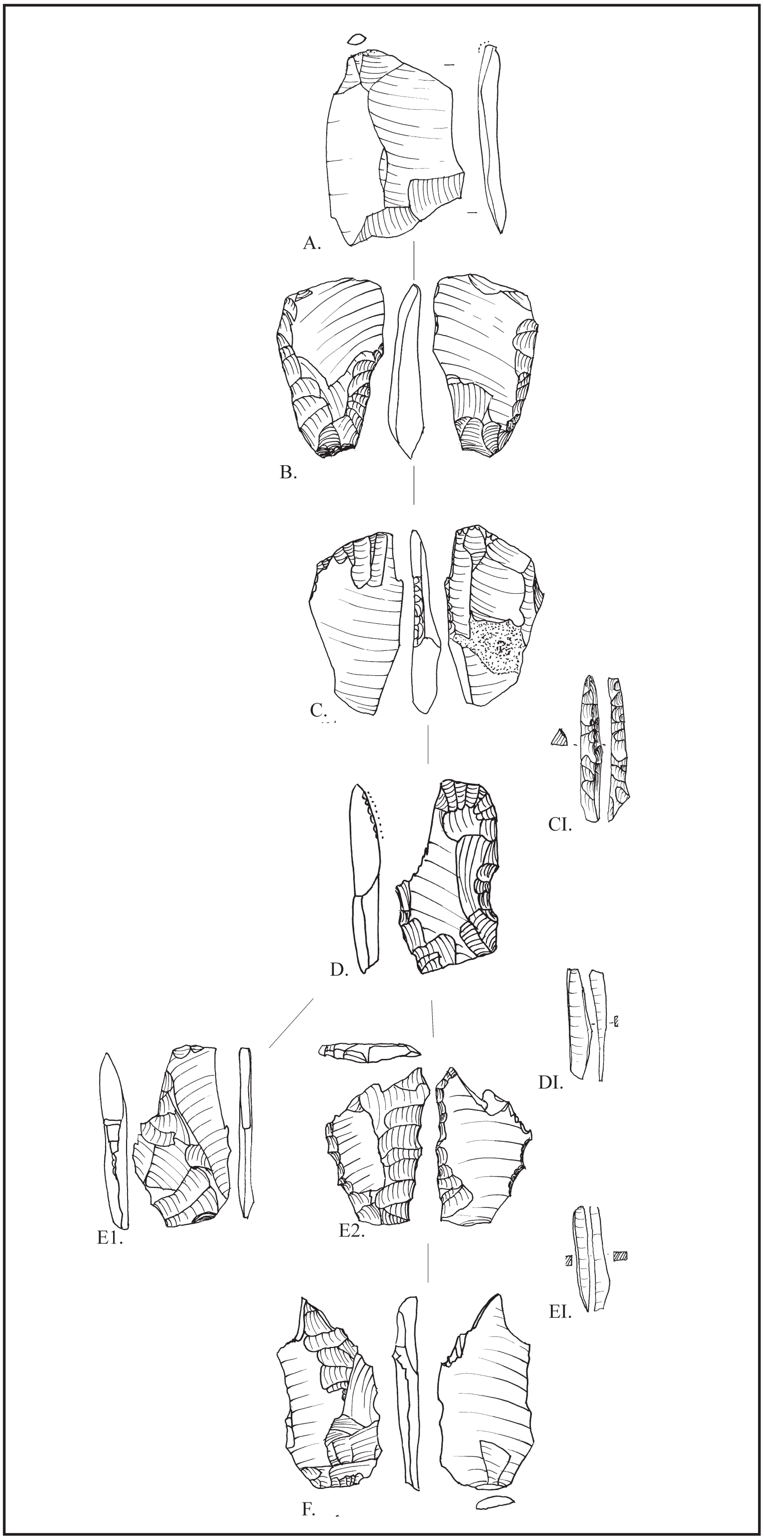


Fig. 2.5 A study of the burin's *chaîne opératoire* in the Independence I tradition. The burins are from the Adam C. Knuth site.

In the material from the Independence II site at Kap Holbæk a heavily sharpened end blade is found. The end blade illustrates that these often were reduced by sharpening the lateral edges, whereas the base of the tool stayed unchanged. The base of the sharpened end blade is fragmentary but it was refitted in the analysis, and it thus shows agreement between the complete tool and the sharpened (discarded) tool (see figure 2.6).

Tool preforms are identified similarly by a technological study and sometimes by refitting. In the case of some tool types, like bifacial end blades, there is a tendency that these break during manufacture and are discarded. These discarded fragments can be relatively easily refitted as typical examples of preforms (e.g. figure 2.6: C). Tool preforms are during production reduced by typical and identifiable flake products as for example 'fluting flakes' from the base. Other examples of diagnostic production flakes are: burin spalls, bifacial flakes and adze flakes. Together with the complete tools, these products can give an idea of typical pre-stages and roughouts. When the tool's typical preform is identified, these pieces can be

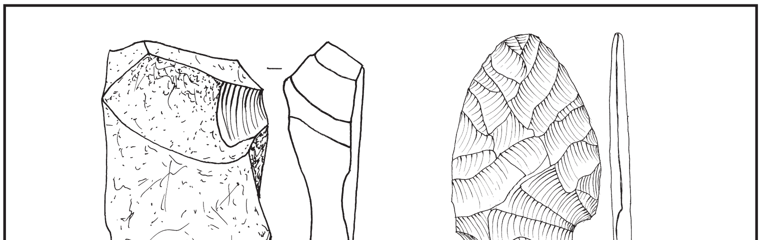


Fig. 2.6 A study of bifacial end blade's *chaîne opératoire* in Independence II (Greenlandic Dorset). The end blades are from the Kap Holbæk site assemblage.

classified in stage 1–2. Burin spalls with a triangular cross-section (figure 2.5: C1) together with preforms with a distinct worked, often notched base show the typical preform for burins in Independence I (see figure 2.5: B and C).

From the Kap Holbæk site a fragment of a bifacial preform could be refitted (figure 2.6: C), and an earlier bifacial preform with cortex was located (figure 2.6: A). Both pieces are characterized by the use of the bifacial reduction method and have dimensions and morphology that show that the pieces were made into bifacial end blades. The shape of the raw material blank that is used for the preform can often be defined from the technological analysis, as the identified preforms can have leftover surfaces like for example cortex, flake surfaces or positive bulbs of percussion that indicate the original blank morphology. Typical preforms and blanks can thus be identified and classified in the assemblages being studied.

All burins from ACK are made from large flakes. This can be deduced because the burins are characterized by having positive bulbs of percussion on one side, most often at the base (figure 2.5). Preforms of end blades from the Kap Holbæk site are found with distinct cortex, which shows that the original piece of raw material often was a small tablet shaped core (see figure 2.6: A and B). From the analysis it is now possible, by dynamic technological classification, to suggest the tool's transformation from raw material to finished and sharpened, rejuvenated tool. For purposes of explanation and illustration of the general process, typical examples from the *chaîne opératoire* are drawn.

Chapter 3
Geology and lithic raw material from a Palaeo-Eskimo perspective in Greenland

Greenland's underground is dominated by the *basement rocks* (primarily gneiss and granite), and there are also *sedimentary rock types*, and *basalt*. The basement rock types are metamorphosed by heat and pressure. The mountains in the northwestern, western, southern and southeastern parts of Greenland consist primarily of just such metamorphic rocks from up to 3800 million to 1500 million years ago.

The basalt cover is due to the flow from volcanoes over the basement rocks and the sedimentary rocks, c. 60 million years ago. Such areas are to be found in Greenland at Disko and Nuussuaq and on the east coast of Greenland, between Shannon and Kangerlussuaq. The *sedimentary rock types* are formed by the erosion of the basement rocks and subsequent metamorphosis, and are known, for example, as sandstone and slates. Areas where sedimentary rock types are to be found include northernmost Greenland, c. 600–250 million years at Nuussuaq, Disko, and in the region of Scoresby Sound, c. 260–60 million years. Locally, so-called *plutonic rocks* are found that were formed when melted material in the depths of the earth were pushed up through the basement rocks, c. 1200–600 million years ago. The plutonic rocks occur sporadically, for example in Southern Greenland (Secher et al. 1981) (see figure 3.1).

Five specific rock types have been used by the Palaeo-Eskimos for the manufacture of tools: 1) Microcrystalline quartz (mcq), in varying forms such as chalcedony, agate, chert, opal and jaspis, 2) quartz in crystalline form, known as rock crystal, 3) killiaq, which is a metamorphosed clay sediment (slate/schist), transformed by contact with lava into a fine grained homogeneous rock, 4) fine-grained quartzite, and 5) fine-grained basalt. Each of these five rock types split[3] with conchoidal fractures and therefore has a certain predictability in the way they fracture when they are worked. Rock types that give conchoidal fractures have natural sharp

3 The word 'split' is used in an archaeological context, that is, the stone can be split with a blow from a hammer or by applying pressure using a specific tool.

edges that generally make sharpening by grinding unnecessary. The rock types can, when they are being worked, and as happens in the Palaeo-Eskimo culture groups, be used both immediately after fracture, for cutting, or they can be shaped into cutting, scraping and perforating tools.

Localities and areas where lithic raw material outcrops are found, and have been exploited in prehistory, are of great importance archaeologically. It is for example through the analysis of the lithic material's origin and morphology that mobility and technology in prehistoric societies can be analyzed.

In the following section, the formation of the various prehistorically exploited rock types is described. Then the various sources for the raw material, which have in an assortment of ways been reported from Greenland, are described. Each site

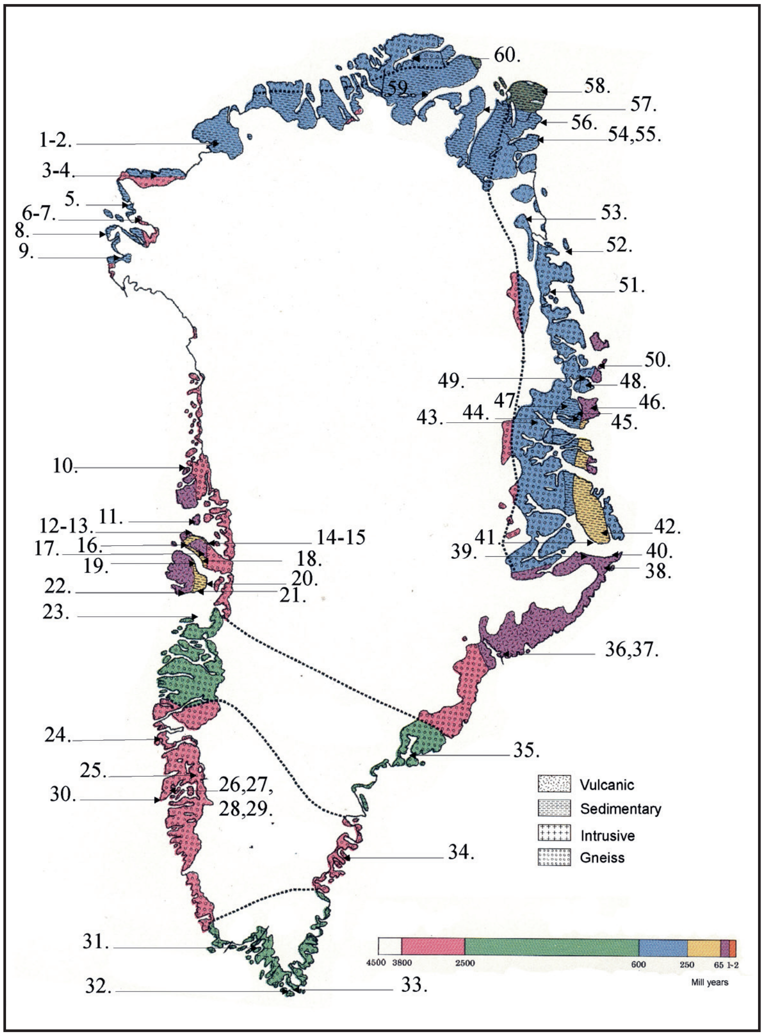


Fig. 3.1
The geology of Greenland (after Henriksen 2005), and the location of the lithic sources described in Greenland.

is summarily described in relation to the quality of the rock type after the criteria that are described above, and they are each given a number that refers to the geographical position of the source (see figure 3.1).

Microcrystalline quartz (mcq)

Mcq is characterized by being microcrystalline but consisting of siliciumoxide (SiO_2). During geological transformation processes a number of minerals are slowly dissolved. These mineral rich solutions can be transported away, or they can be redeposited. An example of this is that silicium from sedimentary rocks can dissolve and crystallize again in cavities in basalt or in sediments. These formations are often called agate nodules and they can be found in areas with a combination of younger sedimentary rocks and earlier volcanic activity (where basalt is present).

Mcq can also occur in large cavities in the basalt layer where dissolved silicium is deposited in layers and crystallizes. This results in flat tablet shaped nodules. Mcq can also occur between two basalt layers. This can happen if a sediment layer that has a high content of silicium (SiO_2) is formed over a horizontal basalt layer and is followed by a second basalt (lava) layer. In this process the sediment is heated to high temperatures and can therefore be transformed into mcq. Such sedimentary mcq layers can be quite extensive, such that large, relatively thick layers and tablet shaped nodules of mcq can appear. This type of material is known from the Scoresbysund area (S. Watt, (GEUS)) with variations in transparency and in green, red and pink colours.

Types of sedimentary mcq include the very dark black mcq (often called 'chert') and the light translucent blue-grey mcq (often called 'blue flint') that are found in the Ellesmerian Mountain folds in Northern Greenland. These two mcq types are formed where deposits of silicium rich sediments on the sea floor have been exposed to high pressure and heat. The seabed in which these types of mcq are found have been raised, broken apart and folded, and mcq can then be exploited when the sedimentary mcq, due to erosion and frost, are loosened from the bedrock.

Important factors are 1) how, 2) how quickly and 3) with which mineral contamination the crystallization has taken place. These factors determine the shape, colour, quality and translucency of the mcq from the individual sources.

Gathering of microcrystalline quartz

In the basalt bedrock it is particularly in the small cavities that are formed when air has escaped from the surface during the cooling of the basalt that mcq can be found. These cavities are often filled with light mcq minerals, often known as agate, chalcedony and quartz. Such types of mcq are to be found in basalt areas, e.g. where erosions appear (Secher et al. 1981).

The sedimentary mcq type (that is found as tablets between basalt layers and as ancient seabed) cannot easily be quarried from its primary context. Instead this material is gathered when it is released from the bedrock, at cliffs or steep slopes, which occurs from frost or erosion. The effects of frost splitting can also be a predominant cause of the shapes in which sedimentary mcq occurs, in rectangular tablet nodules.

Metamorphosed rock types (killiaq)

Killiaq is originally a Greenlandic word that means 'a hard grey stone that in ancient times was used for making tools' (after Kleinschmidt 1871 in Meldgaard 1996). Previously, this material was termed 'ammaaq' (Meldgaard 1996). In archaeological terminology the term refers to a specific metamorphosed slate. Geologically, killiaq consists of slates that have locally been transformed by metamorphosis during contact with deep rock types, in other words magma, which penetrates the clay sediments through passages and cavities. When contact is made with the glowing hot magma, the layered clay sediments are metamorphosed and become dense and hard and they fracture with conchoidal fracturing.

Some killiaq-like rock types are formed only by metamorphosis of sedimentary formations due to pressure, while not having exposure to extreme heat. These types of killiaq are typical of Northern Greenland.

Gathering of killiaq

As killiaq is locally formed after contact with magma in bedrock, it would not, without the help of powerful modern rock quarrying methods, be possible to exploit the sources directly. In prehistory, therefore, killiaq was gathered from secondary deposits, where killiaq is exposed in the ground by natural erosion, including frost and material transport, or if a river has eroded through a source area, and thereby has caused killiaq pieces to be loosened and transported. Another possibility is that the sea can have washed the killiaq out of the sediment after which it can be gathered in the coastal zone, as beach-rolled cores.

Other rock types that give conchoidal fractures

Basalt

A course-grained basic volcanic rock type is called gabbro, a material that cannot give conchoidal fractures. It is therefore not used in Palaeo-Eskimo contexts. Fine- and medium-grained volcanic rocks are often called dolerite. This material can give diffuse conchoidal fractures and is employed for specific uses in some regions of Greenland in the Palaeo-Eskimo tradition. Fine-grained to dense volcanic rocks are called basalt, and these types give conchoidal fractures and diffuse conchoidal fractures and were used by the Palaeo-Eskimos specifically on the East Greenland coast. Glass-like and semi-transparent very dense volcanic rock is called obsidian, and is not found in Greenland. Yet another volcanic rock type is fine-grained tuff, consisting of fused volcanic ash, which in several instances can give conchoidal fractures. This rock type occurs due to compressed volcanic ash, but can also have been affected by heat from later basalt formations.

Basalt can be found from a fine-grained to an almost 'glass-like' quality. The material is most often black, but around Skærgårdsfjord in East Greenland red varieties can be found. Tuff and basalt can only be found in areas that have had volcanic activity.

Dolerite is formed from lava in fissures and as intrusions into other rock types. It is difficult to work dolerite, due to its toughness and the material therefore has a limited usefulness. Dolerite is chiefly used in North Greenland, for the making of adzes and 'adze like tools' in Independence II.

Quartzite

A quartzite is a sedimentary rock consisting of quartz grains, but transformed by pressure and heat to a hard crystalline material. Quartzite is often semi-transparent of a whitish/grey or sometimes greenish colour, due to contaminating minerals. Quartzite is more course-grained and harder than mcq, but it can also be fractured conchoidally and is therefore used for tool making. In the Nuuk area particularly, quartzite of a very fine-grained and fine quality is to be found, and this has been used in prehistory.

Quartz

Quartz crystal can be found in several varieties. A frequently used type is the clear rock crystal that is known in crystal form. It is to be found in fissures and cavities where indeed so-called 'crystal cellars' can form, containing a large number of crystals. Crystalline granular quartz can be found in pegmatite veins in areas with gneiss and granite. Quartz is found in transparent, smoky coloured and whitish variations. Quartz material is often found in such small nuggets that it cannot be used for larger tools, but it is on the other hand often used for blades. The material is fine-grained and glass-like, and if it can be found in a very pure, often transparent quality, it has very fine fracturing properties. It has also been shown that sharp edges of rock crystal have a particular property, in that the edge becomes sharper with use (Gulløv & Rosing 1993).

Occurrences of lithic raw materials that give conchoidal fractures in Greenland

[Each of the raw material outcrops described in the following are marked by a number in figure 3.1]

North Greenland
(Map 7, Geological map of Greenland)
Northernmost Greenland is characterized by a mountain range with siltstone, limestones and slates, called the Ordovician slate formations in the Ellesmerian folding (Henriksen 2003). The formation is to be found in an east to west belt from the northern Peary Land to the northern Ellesmere Island. In this belt of folds are several types of characteristic mcq that were worked by Palaeo-Eskimos in the High Arctic (Knuth 1984; Sutherland 1996; Schledermann 1990).

An east to west running belt of sedimentary rocks consisting of sandstone, limestone and siltstone is found south of the Ellesmerian folding. The folds stretch from Danmark Fjord westwards along the inland ice down to Washington Land and further over to Ellesmere Island. In these sediments, several varieties of homogeneous, good quality mcq is found, often in the form of round nodules with sand-lime cortex.

1. From Washington Land's south side, in the river district down towards Wright Bugt and Cass Fjord (Christian Elv) and on Daugaard-Jensens Land several localities, including Poulsen Cliff, with mcq sources can be found. The quality of the mcq is typically slightly translucent with grey to blue colouration. The material has a matt sheen, feels often greasy on its surface and is found in rounded nodules up to the size of a baby's head, with a sand-lime cortex. This type of mcq was used by Palaeo-Eskimos in the whole Thule region (Madsen & Diklev 1992; Appelt & Gulløv 1999) (figure 3.2, to the left).

2. A second type of mcq from Washington Land is a lightly translucent mcq with whitish to brownish nuances. The material can be found in fist-sized nodules with sand-lime cortex. The brown-whitish colouration is in bands, often in concentric layers from the cortex, in towards the core (figure 3.2, to the right). Samples were collected by P. Dawes, S. Stouge (geologists, GEUS) and C. Andreasen (archaeologist, Greenland National Museum and Archive) (Andreasen 2000: 83).

Fig. 3.2
Source 1 and 2. Nodules of blue-grey translucent mcq with brown bands. Nodules have chalk in their cortex. The nodules in the photo are from southern Washington Land, the Thule region.

The Thule area
(Maps 5–6, Geological map of Greenland)
The geological bedrock in the Thule area, 'The Thule Supergroup', consists of both sedimentary, volcanic and metamorphic rock types (Dawes 1997). In the area, a rich variation of many different rock types that give conchoidal fracture are found, and in prehistory these have been used for making tools.

3. A green mcq is known from Rensselaer Bugt in Inglefield Land, described as an agate-chalcedony layer with green colouration (Bøggild 1953).

4. By Uunartoq in Rensselaer Bugt, Inglefield Land, is a quartz layer of coarse quality c. 30 metres above sea level. The layer is interpreted as having been exploited by the Palaeo-Eskimos for tools and is described as a 'quartz quarry' (Madsen & Diklev 1992).

5. There is a mcq source in Siorapaluk, Thule. The material is described as agate nodules that, on splitting, show white and brown nuances. In the middle of the nodule a group of rock crystal or grey-blue 'chalcedony' can often be found (Secher et al. 1981).

6. In Bowdoin Fjord a red-brown silicified slate can be found in the coastal zone that has been used for tools in the nearby early Palaeo-Eskimo settlement site of Qorlulasupaluk (Madsen & Diklev 1992).

7. From the area around Qaanaq a brown mcq appears (P. Dawes 2003, pers. comm.).

8. At Hoppner Næs/Ammaasiorfik in Stensby Land, marine-rolled nodules of black and grey killiaq-like slate have been located. The nodules can give conchoidal fractures (Madsen & Diklev 1992).

9. At Pittufik, Thule Air Base, a black mcq appears in the geological formation called the 'Narssârsuk Group' that consists primarily of limestone.

The Upernavik area
(Map 4, Geological map of Greenland, 1:500.000)
The northern area consists of metamorphic rocks including slate, while Svartenhuk Peninsula and Ubekendt Ejland consist primarily of basalt. In the coastal area around Karrat Fjord formations of quartzite can also be found. There should, in the southern area, due to the basalt formations here, be good possibilities for the presence of mcq and other rocks that can give conchoidal fractures. But very few sites where rocks have been exploited in prehistory is located, which is probably chiefly due to a lack of archaeological survey.

10. From Prøven, rock crystals of up to 2.5 cm in size are known (Bøggild 1953).

Fig. 3.3
Source 11. Green fine-grained translucent mcq from Ubekendt Ejland (the piece shown is from the National Museum of Greenland).

11. Green translucent mcq in fist-sized nodules are known from Ubekendt Ejland (Bøggild 1953; Secher et al. 1981) (figure 3.3).

Uummannaq – Disko Bugt
(Maps 3–4, Geological map of Greenland, 1:500.000)
The Nuussuaq Peninsula's western part and Disko Ø consist primarily of basalts. On the northern coast of Nuussuaq and on the east side of Disko Ø, the basalt is in contact with formations of clay slate and sandstone. In the eastern landlocked part of the area along Disko Bugt and out to Aasiat, the bedrock consists primarily of gneiss with some formations of schist and granite. The basalt area on the west side of Nuussuaq peninsula and on Disko Ø is known for many small sites with finds of mcq, but rock crystal is also known from the area.

12. Near Niaqornat mcq is found that varies in colour from white to brown to green. There is here also a mcq of a greyish semi-transparent type. Rock crystals of up to 3 cm in size have also been found here (Secher et al. 1981).

13. Particularly large rock crystals have been found near Narssarssunguaq in the Niaqornat area (Bøggild 1953).

14. On Vesterfjeld large pieces of mcq with rock crystal and also pieces of chalcedony with cavities of rock crystal have been found (Bøggild 1953).

15. On the north side of Nuussuaq near Qaarsut are three large killiaq outcrops: Østerfjeld, Slibestensfjeld and in a costal location near the former coal mine. It is certain

that the first two sites were exploited in prehistory. In Østerfjeld large deposits of killiaq lie in horizontal bands in the bedrock. The source is dissected by the Qaarsut Kussinersuat River and along the river valley towards the fjord many quarrying sites have been identified, that show that the Palaeo-Eskimos (probably primarily Saqqaq) have exploited the raw material source. Pieces collected in the river have typically a rounded form, while the pieces in the bedrock are tablet shaped (Rosenkrantz 1965; Jensen 1994; Sørensen & Pedersen 2005). The characteristics of this killiaq include a dark grey to bluish and black colouring, but also a light grey finely layered type with dark grey-blue layers can be found. A particular characteristic of the Østerfjeld source is the grey killiaq with blue spots (Sørensen & Pedersen 2004). On the east side of Slibestensfjeldet, killiaq emerges from an erosion zone and at this site a prehistoric primary knapping site covers 60.000 m^2 (Sørensen & Pedersen 2005). The pieces from Slibestensfjeldet are tablet shaped and up to c. 10 kilograms in weight. The killiaq characteristics are similar to that of Østerfjeldet, but here the spotted killiaq is not found. In addition, a homogeneous grey killiaq with a slightly reddish tone of very good quality is found here. The third source is in the coastal zone near the historic coal mine (Heim 1911). The area is today eroded at the coastal zone along Uummannaq Fjord. In the area, on the little promontory called Qaersuarsuk

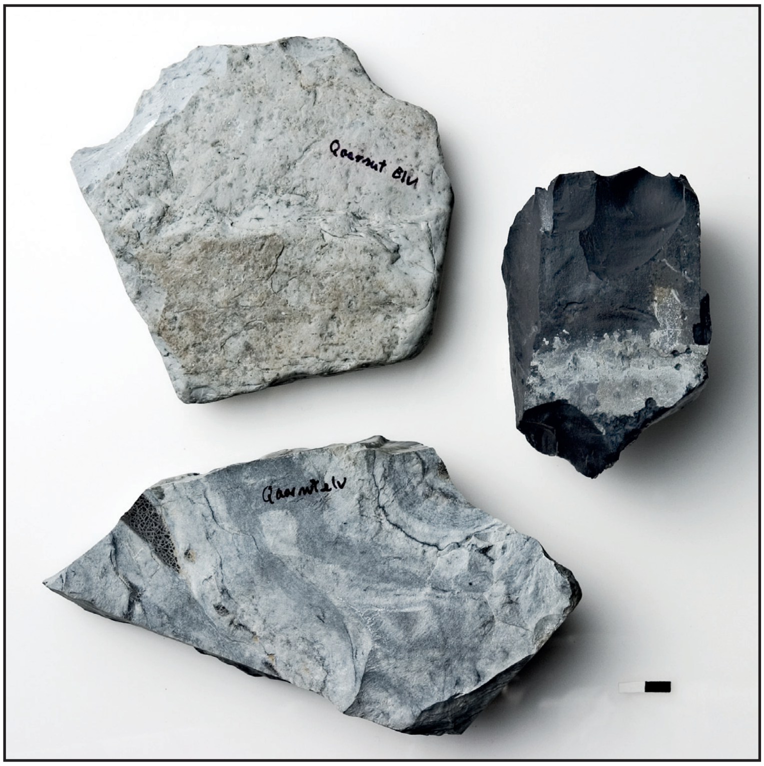


Fig. 3.4
Source 15a. Killiaq from Østerfjeld near Qaarsut, Nuussuaq. The two nodules to the left are found in the river bed of the Qaarsut River, which break through the outcrop. A grey spotted variation, a banded grey variation and a black variation is seen.

Fig. 3.5
Source 15b. Killiaq from Slibestensfjeldet ('the mountain of grinding stones'), Qaarsut, Nuussuaq. A black-blue variation, a banded grey-blue variation and a slightly red variation is seen.

Killeq, a settlement site has been found with mounds of knapping waste from both Østerfjeld/Qaarsut Kussinersuat and Slibestensfjeldet (Rosenkrantz 1965; Sørensen & Pedersen 2004, 2005). From analyses of the quality of the killiaq by Qaarsut, it has been shown that this killiaq was exported to extensive parts of the west coast, in the form of sizeable bifacial preforms during the Saqqaq period (figures 3.4 and 3.5).

16. In Marrat, on Nuussuaq, a translucent light blue to white mcq is found, in up to fist-sized nodules (collected by J.F. Jensen 2001) (figure 3.6).

17. In Agat Valley a black mcq with white cortex typically known from limestone deposits has been found. A blue-white mcq type has also been found (Secher et al. 1981).

18. At Saqqaq clear rock crystals can be found, and some crystals can be up to 4 cm in size (Bøggild 1953).

19. Near Qullissat mcq described as chalcedony of blue-white type containing crystals has been found (Bøggild 1953).

Fig. 3.6
Source 16. Blue fine-grained translucent types of mcq found as nodules often with crystal in their centre. The type is located several places in the basaltic areas of Nuusuaq and on the western Disco Island. The nodules photographed are from the south shore of Nuussuaq.

20. In Mudderbugten mcq of the same type as that from Qullissat appears. The mcq is found as round 10–15 cm sized rolled nodules with crystal cores. A collecting has been carried out by M. Rasch (pers. comm. 2005).

21. Near Per Dams Skib, south of Mudder Bugt on Disko Ø, layers of mcq are found in the basalt. The layers are described as containing chalcedony and a whitish opal (Bøggild 1953).

22. In the Godhavn area, south Disko, from Eqaluit, rolled stones of green and brown mcq have been found, called chalcedony (Bøggild 1953).

23. From Grønne Ejland, in the southern Disko Bugt region, a local source of killiaq, called 'Angisat killiaq', is found. Angisat killiaq is greyish to light yellowish, but develops a yellow patina and therefore is readily identified in Palaeo-Eskimo assemblages. Killiaq from here does not have such good fracturing properties as Qaarsut killiaq, and it is probable that it was seen as a second rate material in prehistory (Jensen & Petersen 1998) (figure 3.7).

Fig. 3.7 Source 23. Killiaq from Grønne Ejland, southern Disco bay. This type of killiaq is in a freshly procured state greyish striped but patinates with a typical yellow colour.

The Sisimiut area

(Map 3, Geological map of Greenland, 1:500.000)

The Sisimiut area consists primarily of gneiss but with some occurrences of mica schist. The geology of the area is such that mcq and killiaq would not be expected to occur. Coarse-grained, possibly local quartz is used in Sisimiut in the latest phase of the Saqqaq at the settlement site at Nipisat (Gotfredsen & Møbjerg 2004(b)). It should therefore be possible to locate different types of quartz in the area.

The Maniitsoq area

(Map 2, Geological map of Greenland, 1:500.000)

The Maniitsoq area consists primarily of gneiss and areas of granite and amphibolite. In addition, intrusions of gabbro-basalt are found, for example north of Kangerdluarssuk. As in the Sisimiut area, the geology of the Maniitsoq area means that deposits of mcq and killiaq are generally not expected. There is, though, the possibility that quartz crystal and local basalt as bands in the gneiss can be found, as it is known from the Nuuk area. A study of the Palaeo-Eskimo settlement site assemblages in the Maniitsoq area shows that some local basalt types have been tried out for tool making. The majority of the material though is imported killiaq (Hinnerson-Berglund 2000).

24. At the settlement site at Ikkamiut it is reported that a possible local source of a killiaq-like material is found (Petersen 1988). During excavation of the settlement site in 1963, 400 m southeast of the excavation, the geologist S. Bak Jensen found a crevice of up to 6–7 cm wide, in the gneiss, with a killiaq-like material, called mylonite. The material is described as a hard fine-grained bluish material that visually is similar to killiaq from Nuussuaq (Petersen 2005).

The Nuuk area
(Map 2, Geological map of Greenland, 1:500.000)
The Nuuk area consists primarily of gneiss and areas with granite and amphibolite. The area is, in addition, known for its soapstone and quartzite formations. There are some sites, including near Isukasia, where basalt is found. Around Nuuk Fjord and on Bjørne Ø there are crevices in the gneiss filled with metamorphosed sediments from volcanic and sedimentary formations that are not marked on the geological maps (own observation 2005). Such basalt-like sediments can in some instances be used for tool making. During the study of the assemblage from the Saqqaq settlement site 'Itinnera', in Nuuk Fjord, tools and flakes of this possibly local basalt-like material were found. Quartzite is known in bedrock and as loose blocks in the northern part of the Nuuk area. The material varies from white and pale greenish tinges to copper green colours. The density can be varied, as it occurs in a semi-transparent type without visible crystals to a grainy opaque type. Also, a few pieces can be heterogeneous with bands of green and white (Secher et al. 1981). In the archaeological material it has been observed that it is the fine-grained quartz that is chosen as the stone for making tools, regardless of the colour.

25. From inner Nuuk Fjord, near Isukasia, the rock type haematite has been found, which has often formed in association with a reddish mcq variant, called jaspis (Bøggild 1953). Whether this material can be used or has been used for prehistoric tools is not known.

26. A quartzite has been found at a mountaintop south of Sulgssutip Kangerlua, but it is uncertain precisely which form and quality this rock type has.

27. A deposit of white semi-transparent-grained quartzite has been reported by Jens Rosing, in the mountain opposite Nua Ameralla (Gulløv & Kapel 1988: 45).

28. Near the Kingitup Taseraasaa stream, a source of white quartz has been found. The source protrudes from the bedrock and is c. 15 m × 3–4 m long. Knapping waste has not been found at the source but a few tools from a nearby Saqqaq settlement site seem to be of a similar quality, which indicates that the source has been exploited in prehistory (Hinnerson-Berglund 2004: 74).

29. A site with several large flakes of quartzite, up to 6–7 cm long, has been found during a survey at the base of the Kanásut Fjord near Sarloq on the western side of Nuuk Fjord (pers. comm. H. Kapel 2003). These are stored at The National Museum of Denmark. The quartzite is the semi-transparent whitish type with green zones that is often used in prehistory. With the very large flakes that occur here, it is probable that the site is close to a source (figures 3.8 and 3.9).

30. In the area around Nuuk Fjord several sources of quartz and rock crystal have been reported that can have been used in prehistory. Northwest of Håbets Ø, a fine, slightly smokey coloured type of quartz is found (Gulløv & Kapel 1988).

Fig. 3.8
Source 29b. Nodule made from semi-transparent white quartzite, found at the Tuapassuit site in the Nuuk Fjord. The nodule is from a local outcrop in the Nuuk area.

Fig. 3.9 Source 29a. Quartzite from the site Sarloq in the Nuuk Fjord. This variation is semi-transparent often with green stripes.

Southern Greenland

(Map 1, Geological map of Greenland, 1:500.000)

The geology of Southern Greenland consists primarily of bedrock where gneiss and granite dominate. In some places though, for example at Narssaq, Ivigtut and Tingmiarmiut, are areas with basalt layers, where it should be possible to find mcq. From the settlement site assemblages it can be seen, however, that rock crystal is the dominant material used, followed by a few rare mcq types, which indicates that no suitable substantial deposits of mcq were known in the area in prehistory. At the Norse settlement sites Ø34 near Qassiarsuk (pers. comm. G. Nygård 2005) and Tarsermiut near Klosterdalen (pers. comm. K. Raahauge 2005), green, fine-grained mcq types have been found, used by the Norse groups as strike-a-lights. It is probable that the green mcq comes from the Narssaq area.

31. In Southern Greenland, in the areas around Narssaq and the Igaliko peninsula, in cavities in basalt layers, several varieties of mcq are found, called agates (Secher et al. 1981). It is not yet possible, from the Palaeo-Eskimo assemblages in Southern Greenland, to determine whether these sources have been used in prehistory or not (figure 3.10).

32. In the whole Tunugdliarfik area there are good chances of finding rock crystal. The crystals appear often in small fissures and cavities in the sandstone, along with basalt, in for example the Erik's Fjord formation. They can also be found in the coastal zone (Secher et al. 1981) (figure 3.11).

33. On the Dorset settlement site Qipisaqqoq, Qernertoq Ø in the Kap Farvel area, large amounts of roughouts and raw material of a local soft grey slate have been found (Raahauge 2004). The material only barely gives a conchoidal fracture, and in prehistory the material was primarily shaped by grinding, to make ground points and ground burin types (figure 8.2.32). In addition, at this settlement site and at another site, Itilleq, Eggers Ø, Kap Farvel, large amounts of roughouts and artefacts of quartz/rock crystal were found that show that this material could be found in reasonable quantities in the vicinity (Raahauge & Appelt 2002; Raahauge 2004; Raahauge et al. 2004) (figure 3.12).

Fig. 3.10
Source 31. Green fine-grained mcq of the Narsaq region. This type of mcq is used by the Norse for strike-a-lights, but is also used by the Palaeo-Eskimos. The piece photographed is from a Norse site in Klosterdalen, south Greenland.

Fig. 3.11
Source 32. Quartz crystal from the Narsaq region. Quartz crystal is typical of south Greenland, found here in different sizes and colours.

Fig. 3.12
Source 33. Local raw materials from the Dorset site Qipisaqqoq, Qernertoq Ø in the Cape Farwell region. Quartz, crystal and local slates are used for the production of lithic tool types.

Ammassalik – Skjoldungen
(Map 14, Geological map of Greenland, 1:500.000)
The geology from the Ammassalik area over Skjoldungen, to Tingmiarmiut Fjord in the south, consists of an area of different types of gneiss and granite. It is thus not probable that either killiaq or mcq can be found in this area. The best possibilities for appropriate raw material in the area are rock crystal and quartz. In the Ammassalik area, a 'killiaq-like' material of varying coarse quality was used, especially by Saqqaq (Møbjerg 1988). This rock type cannot, geologically, come

from the Ammassalik area. The nearest killiaq-like raw materials are, judged from geological information, tuff and basalt from the Hængefjeldet formation and from Skærgårds Fjord.

34. In the Skjoldungen area local quartz types are to be found, especially rock crystal. Also, local deposits of amphibolite were possibly utilized, whereas mcq and basalt generally should be considered to be imported, probably from the basalt areas near Blossevillekysten (Gotfredsen et al. 1992).

35. In the Ammassalik area deposits of coarse-grained quartz have been confirmed (pers. comm. Troels Nielsen 2003, Geological Institute, Copenhagen), but this raw material has not been recorded as having been used in prehistory.

Kangerlussuaq – Ammassalik
(Map 13, Geological map of Greenland, 1:500.000)
The area north of Kangerlussuaq is characterized by lava formations and lava fills. There are therefore, in this area, the presence of fine-grained killiaq-like basalt types, and the possibility of mcq deposits. South of Kangerlussuaq, in the Ammassalik area, gneiss formations are primarily found, alongside a few areas with quartzite. The only useful rock types in this area are local deposits of quartzite, granular quartz deposits and rock crystal.

36. At the southern Blossevillekysten in the Hængefjeldet formation, a baked tuff stone is found that gives conchoidal fractures (Nielsen et al. 1981).

37. During survey of the Kangerlussuaq area, that is at the Skærgårds peninsula and at Mikis Fjord, especially at the bend of Mikis Fjord at a promontory of land on the northern shore called 'Eskimonæs', finds of worked raw material have been made at several neo-Eskimo settlement sites and ruins (Kapel 1989). These raw materials are characterised by being relatively fine-grained, homogeneous, hard and dark, non-translucent rock types that can give conchoidal fractures, identified by K. Secher (2003) as all being different types of basalt. The basalts in the area are very varied: a red to red-brown fine-grained type, a black, nearly glass-like type, grey-black and grey types. A few pieces have flow banding. The reason for the varied basalt types is due to a complicated geology, in that several lava flows of different mineral composition have covered the area, and thus the lava in its hardened form attained different characteristics. In addition, some basalt layers seem to have been reheated by later lava flows, whereby the lower basalt layer can have changed. An example is the red

basalt that has had a mineral content that on secondary heating was oxygenated giving a red colouration. The worked basalts from Mikis Fjord in the Skærgårds area illustrates that the Thule culture in East Greenland knapped lithic materials for tool production.

Scoresby Land to Kangerlussuaq
(Map 12, Geological map of Greenland, 1:500.000)
Jameson Land's eastern side consists primarily of gneiss and granite, while the western side consists of sedimentary rocks. It is therefore probably not rich in potential raw materials for Palaeo-Eskimos.

South of Scoresby Sound down along the Blossevillekysten and westwards to Gåse Fjord and Milne Land are areas with massive basalt deposits where mcq is found extensively. Mcq and rock crystal can here have been formed in cavities but mcq is also found in this area as 'large' tablet shaped blocks, which indicates a sedimentary formation process (pers. comm. S. Watt Geological Survey of Denmark and Greenland (GEUS)).

In two areas sedimentary rocks are in contact with basalt layers, and at these places it should be possible to find mcq. One area is just south of Kap Brewster, where mcq has been observed (see below). The second site is at Kap Dalton around which, to my knowledge, has not been surveyed with these questions in mind. Generally, the southern areas of eastern Scoresbysund and along the Blosseville-kysten are seen as potentially rich in lithic raw material that gives conchoidal fractures.

A whole 92% of the stone tools from the Palaeo-Eskimo settlement sites, both Saqqaq and Dorset, in the Scoresbysund area are made from mcq. Of these, 45.5% are classified as dark mcq, 43.5% are classified as translucent mcq and 11% are classified as transparent mcq. Only 5% of the artefacts from this area were made from a killiaq-like material, probably basalt (Sandell & Sandell 1999).

38. On Steward Ø, the northern Blossevillekysten, a large concentration of fine mcq is to be found. The nodules are up to fist size. The deposits lie in a ravine c. 100 m over sea level, and c. 500 m from the coast. In the area, there are traces that the deposit was used in prehistory, so the site can be described as a regular source for this raw material (Sandell & Sandell 1999).

39. On the south coast of Scoresbysund tablet shaped mcq blocks weighing up to a kilo with reddish and greenish colouration, have been found. The blocks derive from

mcq layers that, due to frost, have come loose and have fallen down from the mountain slopes (collected by S. Watt , Geological Survey of Denmark and Greenland (GEUS)).

40. Near Kap Brewster mcq in grape sized mcq nodules have been found, defined as chalcedony (Bøggild 1953).

41. The south side of Jameson Land consists of sedimentary rocks with intrusions of basalt. The area therefore has potential for the finding of mcq and fine-grained basalt. At the Independence I settlement site Røde Hytte extensive primary knapping of large mcq blanks has been identified by more than 2500 flakes, of several varieties of mcq (Sandell & Sandell 1999). The material is probably to be found in the vicinity of the site (figure 3.13).

Fig. 3.13 Source 41. The south shore of Jameson Land. From the Independence I site Røde Hytte local types of mcq have been exploited. The material is fine-grained and multi-coloured.

Fig. 3.14 Source 42. Basalt from Jameson Land, found at the site near Konstable Pynt, (Sandell and Sandell 1985).

42. North of Constable Pynt in Hurry Inlet, Jameson Land, a knapping site has been found where fine-grained basalt has been worked. A total of 125 flakes and two cores have been retrieved indicating that large bifacial cores had been made. Flakes are from bifacial knapping, over 4 cm, of the Saqqaq type, with light grinding of the platform edge. It is probable that a basalt source exists locally. The find is probably a Saqqaq knapping site, for the manufacture of large cores (find no. (KNK) 70 Ø1-5) (Sandell & Sandell 1985) (figure 3.14).

Kuhn Ø – King Oscar's Fjord
(Maps 11–12, Geological map of Greenland, 1:500.000)
On Kuhn Ø, sedimentary rock types are found, as mudstone and sandstone. A belt of sedimentary rocks continues to the south over Wollaston Forland, where it comes in contact with basalt layers at several places: At Kap Berlin, Sabine Ø, Lille Pendulum Ø, Bass Rock, inner Wollaston Forland and along Dronning Augusta

Valley. All these places are potentially sites where finds of mcq and killiaq/basalt can be made.

On the eastern part of Clavering Ø, a mix of basalt and sedimentary rocks are found, meaning that there is the potential for finding raw material for lithic tools here.

The basalt formation continues down over Hold With Hope, the eastern Geographical Society Ø and Trail Ø. At several places the basalt is in contact with the bedrock of mudstone and sandstone, which gives good possibilities of finding both mcq and killiaq/basalt-like materials.

The inland areas in the western portion of the region are characterised by alternating bedrock of gneiss, mudstone, sandstone, dolomite and areas with limestone and marble. Generally, the area is without basalt. In the Geolog Fjord area, the bedrock consists of a mix of dolomite, limestone, mudstone and sandstone. This formation can thus be favourable for raw materials that can fracture conchoidal. The formation extends north–south, from inner Hudson Land to King Oscar's Fjord. The whole area must, due to the sedimentary rock types, be seen as a good area for finds of mcq and basalt. But until now only the coastal areas around Wollaston Forland and the northern Clavering Ø have been surveyed systematically for Palaeo-Eskimo activity, which is probably the reason for the dearth of sources between Clavering Ø and Scoresbysund.

43. In Geologfjord, Spiralkløften west of Hold With Hope, blocks of brown-red mcq have been found, called jaspis (Bøggild 1953).

44. On Hold With Hope collecting of rock crystals has been carried out (S. Watt, Geological Survey of Denmark and Greenland (GEUS)).

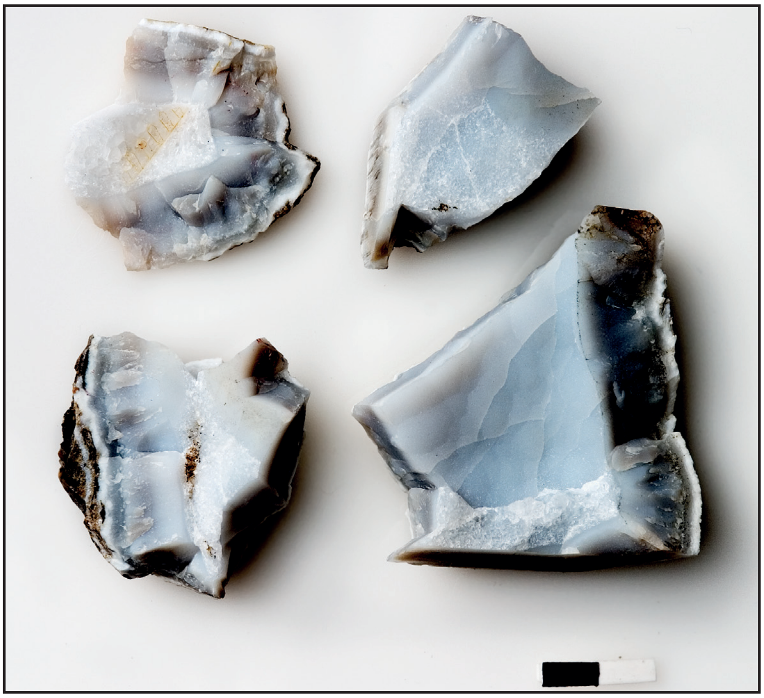
45. At the base of the Loch Fyne fjord on Hold With Hope, large flakes of semi-transparent light yellow fine-grained mcq have been found. It is probable that the material comes from the local area (find no. (KNK) 73 Ø1-4. Greenland's National Museum and Archive) (figure 3.15).

46. Near Carlshavn by Hold With Hope, a stone block has been found (3 kg) in which is a grey mcq in bands of up to 4 cm (Bøggild 1953).

47. On Hudson Land, south of Clavering Ø, a bluish fine-grained translucent mcq has been found. This deposit is found in round nodules with white silicate-cortex and crystal in the middle (collected by K. Secher, GEUS) (figure 3.16).

Fig. 3.15
Source 45. Different types of translucent mcq from a prehistoric site at Hold with Hope (material stored at the National Museum of Greenland).

Fig. 3.16
Source 47. Translucent blue mcq from Hudson Land. This material is found as nodules and often has crystal quartz in the centre.



48. During survey on Basalt Ø in Young Sound in 2003, a source of fine-grained 'glass-like' black, opaque basalt was located. The basalt has very fine fracturing properties and visually resembles the killiaq that is known from West Greenland. The blocks are rectangular and are plentiful, and in examples of up to a ton in weight. The

source has definitely been used by the Thule culture for tool making (Sørensen & Andreasen 2004). The basalt from Basalt Ø have probably also been used by the Palaeo-Eskimos. A similar basalt material is used in Independence II contexts for burins, in an area that extends as far as Nordostrundingen (figure 3.17).

Fig. 3.17
Source 48. Fine-grained basalt from Basalt Ø in Young Sund.

Fig. 3.18
Source 49. Semi-transparent light mcq from the Kuhn Passet at Wollaston Forland.

49. Rich deposits of a milky semi-transparent mcq in fist-sized pieces have been reported, from Kuhn Passet, on the central Wollaston Forland (Sørensen & Andreasen 2004) (figure 3.18).

50. On Sabine Ø and Pendulum Ø, mcq is located in the form of a 'common' chalcedony and a red 'jaspis' (Bøggild 1953).

Jøkel Bugt – Shannon
(Map 10, Geological map of Greenland, 1:500.000)
The area from Jøkel Bugt, Dove Bugt, and down to Hochstetter Forland is characterised by the 'Caledonian folds' that consist of gneiss with a few areas of amphibolite and marble. From Store Koldeway's east coast formations of sedimentary rock types, slates and sandstones are found, which in principle could contain varieties of rocks, for example quartzite that could have been worked in prehistory. The best possibility for finds of mcq and killiaq are at Shannon Ø. In this area basalt layers can be found, and on the south coast are sedimentary rocks under basalt. It is probable that at this site killiaq-like rock types can be found, but no archaeological surveys have confirmed this possibility. Archaeological surveys between Shannon and Île-de-France document that there is a limit to the extent of the prehistoric use of quartz and rock crystal for tools in Independence II (Andreasen & Elling 1990). On Germania Land and northwards, quartz and rock crystals are often used, whereas south of here, the primary materials used are different forms of mcq. This

Fig. 3.19
Source 51.
Quartzite with light coloured bands from Daniel Bruun Land, Dove Bugt.

information fits partially with the geological conditions. In the area of Germania Land it is probable that mcq is imported from the volcanic areas at Shannon. Crystal is found locally in the whole area.

51. On Daniel Bruun Land, in Dove Bugt, a translucent, white to grey quartzite is found. It fractures with rough breaks and diffuse bulbs of percussion. The material is found on a Palaeo-Eskimo settlement site, probably from Independence I. At the site it has been attempted to make large bifacial blades from this material. The material is probably local (find no. KNK 76 Ø1-80) (figure 3.19).

52. On Île-de-France large volumes of worked quartz have been found. The material is often as transparent as glass or just a little milky. Nodules can be found of up to 5 × 5 × 5 cm in size in rectangular form. These large quartz nodules allowed Dorset groups the possibility of making bifacial tools, scrapers and blades of quartz. Often the material from Île-de-France is described as rock crystal, which is not quite cor-

Fig. 3.20
Source 52. Large quantities of small nodules from granular quartz excavated from the palaeo-Eskimo site at Île-de-France, probably deriving from a local source.

Fig. 3.21
Source 53. Green-black quartzite from Søndre Mellem Land in Jøkel Bugt.

rect, as crystal surfaces are not found on the nodules. The material should therefore, geologically, be described as granular clear fine quality quartz. It is probable that the many quartz nodules on Île-de-France come from a local quartz source, but this has not been confirmed (figure 3.20).

53. On Søndre Mellem Land in Jøkel Bugt a dark striped green and black quartzite is found. The material is translucent. It fractures with rough breaks and diffuse bulbs of percussion. The quartzite is retrieved from an Independence I settlement site where it has been worked into large bifacial cores. It is probable that the material can be found locally at Søndre Mellem Land (find no. KNK 78 Ø1-2) (figure 3.21).

Northeast Greenland
(Map 8, Geological map of Greenland, 1:500.000)
The Ellesmerian folding of former large sea basins in North Greenland continues to the northern part of northeast Greenland, northwest of Danmark Fjord (see above). On the other hand, from Nordostrundingen and southwards, the geology consists primarily of gneiss, without deposits of basalt or sedimentary rock types.

54. On Holm Land, near Eskimonæs, a deposit of mcq is located. The quality is a grey-blue slightly translucent mcq that can be found in round fist-sized nodules with lime cortex (collected by C. Andreasen, the National Museum, Nuuk) (figure 3.22).

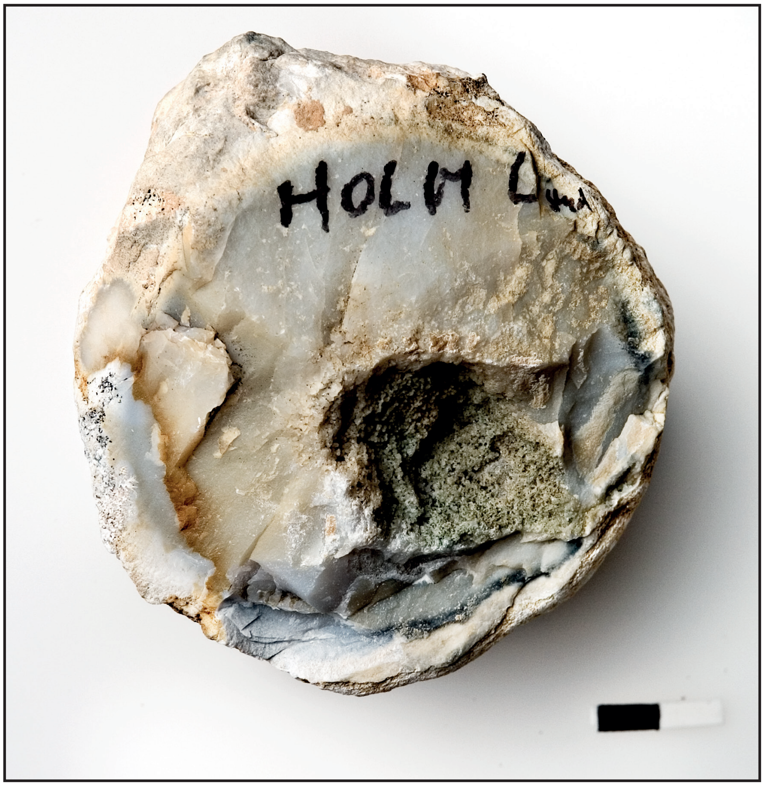


Fig. 3.22
Source 54. Nodules of light blue fine-grained mcq, located at Eskimonæs on Holm Land.

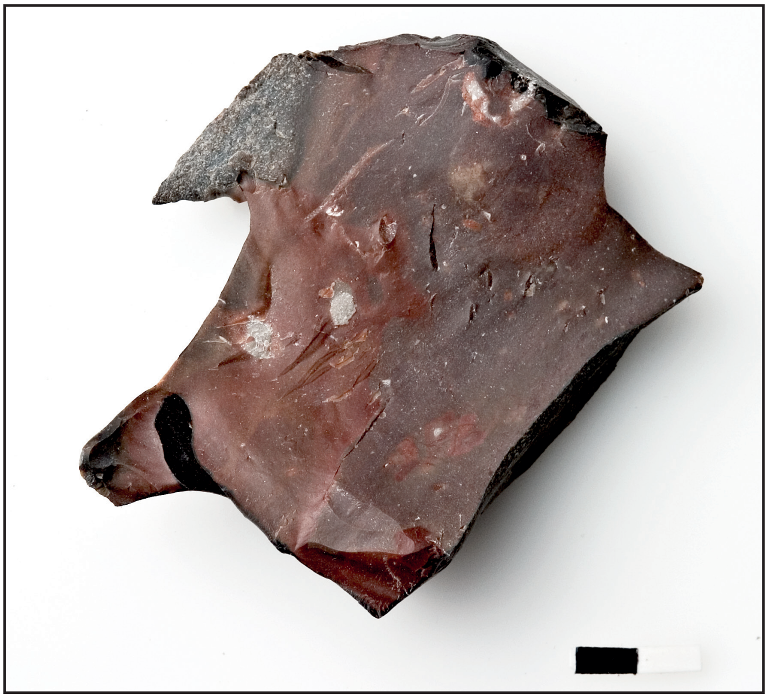


Fig. 3.23
Source 55. Nodules of fine-grained red and red-brown mcq, located in an outcrop on the north side of Holm Land. The material patinates with a black colour.

55. On the north side of Holm Land, near Eigil Knuth site (KNK 2076), a fine quality of red mcq is found. The red mcq can have a smooth shiny and a darker red-brown matt quality. The material is found in nodules up to the size of a baby's head. The cortex consists of an up to several cm thick grey coarse rock type (collected by C. Andreasen, the National Museum, Nuuk) (figure 3.23).

56. On the northern point of Amdrup Land a white mcq with light and dark blue parts is found. It is of a fine and matt to slightly translucent quality. The material has been identified at a knapping site where two large roughouts for wedge-shaped microblade cores of Independence I type have been made. From the block and flake material we can deduce that the material is found in tablet-shaped raw blocks in the local area (find no. 80 Ø1-19, Greenland's National Museum and Archive) (figure 3.24).

Fig. 3.24 Source 56. Large wedge-shaped preforms of whitish to blue fine-grained types of mcq have been located at Amdrup Land, probably near to an outcrop that has not yet been found.

57. In the area between Independence Fjord and Danmark Fjord a high lying basalt layer is to be found, the 'Zigzag basalt', formed by c. 50 lava flows (Henriksen 2003). In the Zigzag basalt it has been possible to collect different types of basalt and dolerite (fine- to medium-grained basalt) for tool making. The basalt types have been used for making adzes in Independence I and II, for example at the Eigil Knuth site.

58. On Nordostrundingen, Kronprins Christian Land, extremely large rock crystals of clear quartz have been found (pers. comm. S. Watt 2002 (GEUS)). This material, however, interpreted from the tool assemblage, has not been used in prehistory, possibly because the source was not accessible in the prehistoric period.

59. In southern Peary Land, dolerite has been found used in Independence II for making adzes/wedges. Fissure and cavities filled with dolerite are found near Midsommersøerne, and at several other locations in the whole Independence Fjord area. The

Fig. 3.25 Source 60. Black shiny mcq from outcrop near Adam C. Knuth site in Frigg Fjord. The material is found in tabular sizes with a black-brown cortex.

Fig. 3.26
Source 61. Semi-transparent mcq with dark bands from Ramah Bay, Labrador (Ramah Chert). This type of material can be confused with quartzites from the Nuuk region.

dolerite deposits are found in this area both as intrusions through sandstone layers (Midsommersø Dolerite) and in mudstone layers (Henriksen 2003: 181–82).

60. A dark flint-like mcq with a dark grey-black colour and a homogeneous quality can be collected in tablet-shaped fist-sized pieces on the surface of the terrain at Adam C. Knuth site in Frigg Fjord (Jensen and Pedersen 2002) (figure 3.25).

Conclusion

Due to the geological circumstances in Greenland, the geological conditions are to a certain degree repeated on both sides of Greenland, along the coasts from north to south (see figure 3.1).

Northern Greenland is well supplied with mcq formed in sedimentary rocks and folded up in the North Greenland mountain chain/Ellesmerian Folding. Deep-sea sedimentary rocks are found furthest north through Peary Land and in the northern Ellesmere, and in this formation, black quality mcq is found. Low-water sedimentary rocks are found from the base of Danmark Fjord to Washington Land and to Ellesmere, where light types of mcq are found, especially the blue-grey type that is used intensively in all of North Greenland. In northern Greenland in addition, both volcanic rock types and sedimentary rocks are found in the bedrock, for example in the Thule area and in the area around Danmark Fjord and further south. In these areas there are therefore local varieties of mcq, basalt and killiaq.

In a belt from Shannon on the east coast to the Uummannaq area on the west coast and down to Kangerlussuaq on the east coast and Disko Ø on the west coast, a basalt layer is found, often in combination with sedimentary rock types, which means that these areas are rich in lithic raw materials that give conchoidal fractures (mcq, killiaq and basalt) (figure 3.1).

Southern Greenland (south of the above-mentioned basalt area) and the northern regions around Jøkel Bugt and Upernavik consist primarily of different types of old bedrock, and do not have many suitable lithic materials. In these areas, as in the rest of Greenland, deposits of quartz and rock crystal can be found that can be collected and utilised. Southern Greenland is especially characterised by the use of these types of raw material. In the Nuuk area, quartzite is found which was used locally especially by the Saqqaq.

Northern Greenland and 'Middle Greenland' are thus Greenland's primary source areas for usable lithic raw material, especially mcq, killiaq and basalt, and it is also here that the majority of the sources, used in prehistory, are found. Outside these areas the Palaeo-Eskimo cultural groups had to make tools of quartz, or quartzite, and of local raw materials of an inferior quality, or they relied on different imports of raw material from the basalt regions.

Chapter 4
Lithic technology in the Palaeo-Eskimo cultural groups in Greenland

4.1. Lithic technology in Saqqaq

Sites and assemblages chosen for analysis

In order to investigate the Saqqaq lithic concepts, inventories from two sites, Itinnera in the Nuuk fjord and Qeqertasussuk (QT) in southern Disko Bay, were analyzed (figure 4.1.1 a, b). The two sites are rich in artefacts and professionally excavated, and moreover both sites are characterized by good preservation conditions and therefore yield many organic artefacts. However, the difference between the two sites does shed light on Saqqaq society. Itinnera is dated to the latest phase of Saqqaq while QT includes some of the earliest known Saqqaq occupations. QT is a coastal site, while Itinnera is an inland site. By choosing these two sites, diachronous variations within Saqqaq, as well as differences between inland and coastal sites, are investigated in terms of the lithic production.

The inventory from Itinnera is stored at The National Museum of Denmark while the inventory from QT is stored at the local museum in Qasiannugiut, Disko Bay, Greenland.

Itinnera

Geography

The site Itinnera is named after the local place name and it means 'the place you can walk over (with your boat from one fjord system to the next)'. The site is situated in the bottom of the Nuuk fjord system, and is low lying, between two large land areas.

Excavation

The former caribou farmer Jens Rosing discovered Itinnera during the 1950s. The first excavation was conducted in 1958, by H. Larsen from The National Museum of Denmark in collaboration with Rosing (Meldgaard 1961). This excavation was carried out close to the coast. In all 36 m^2 were excavated. The excavation revealed a prehistoric habitation area in which preserved organic material and considerable amounts of lithic artefacts were found. During the summer of 1964, J. Meldgaard established an excavation campaign at Itinnera to follow up on Larsen and Rosing's results. Six excavators from The National Museum of Denmark and five student teachers from the teacher training college in Nuuk participated, in total eleven persons. Three excavation areas on respectively 71 m^2 (area A), 95 m^2 (area B), and 24 m^2 (area C) were opened and excavated (see figure 4.1.2). The excavation was continued during the summer of 1963, also by Meldgaard. During this season, an additional 16 m^2 were excavated. From the spatial analysis it can be determined that the lithic concentrations were never completely excavated (see figure 4.1.4).

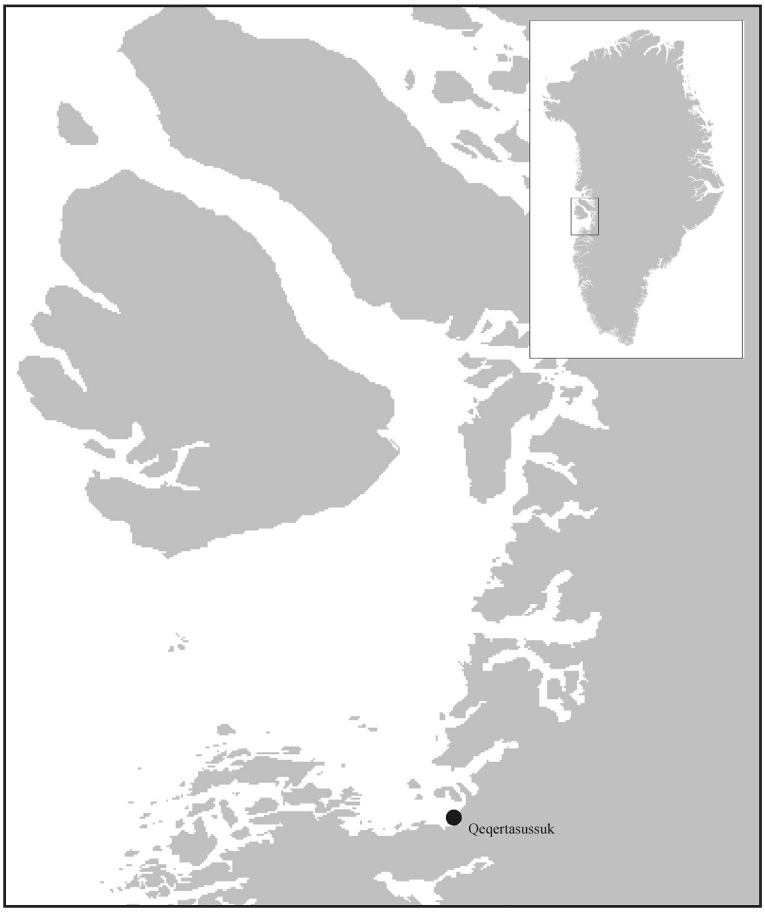


Fig. 4.1.1 a
The location of the investigated Saqqaq.

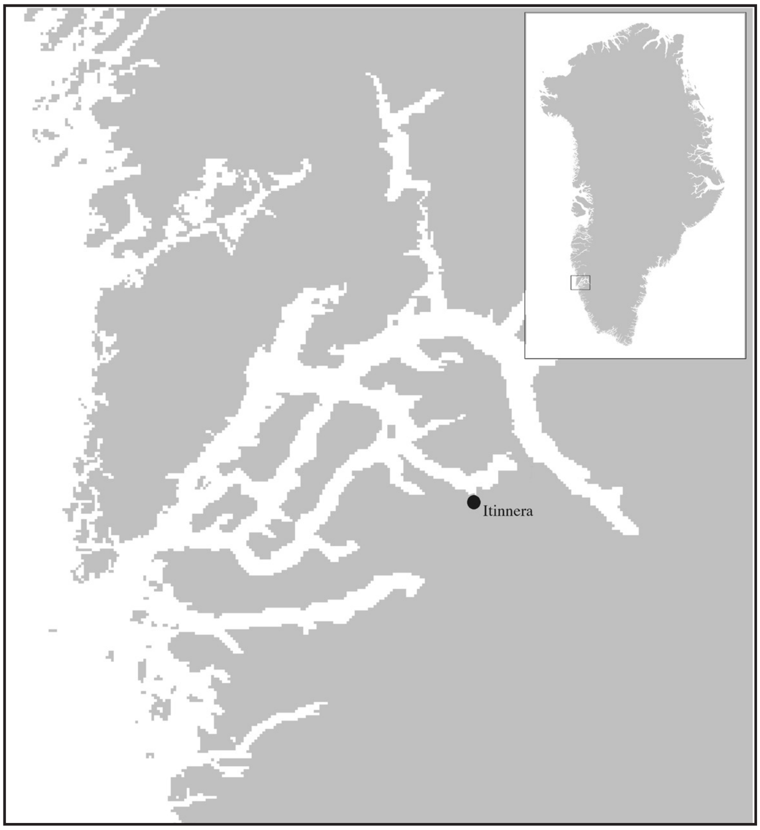


Fig. 4.1.1 b
The location of the investigated Saqqaq.

The excavation was carried out in one-metre squares and all artefacts were registered. Features and structures were drawn in scale 1:50 for each excavation area (see figure 4.1.3).

Former investigations and publications

All artefacts from Itinnera were brought to The National Museum of Denmark and H. Berg redraw the excavation plans. When the plans were studied, several fireplaces, seen as stone circles with smaller stones inside, were discovered. No clear picture of habitation structures, i.e. tent rings, is visible, which can probably be explained by prehistoric reuse of many latent structures at the site. The large amounts of artefact materials and cultural layers suggest that the site was used repeatedly during Saqqaq. Artefacts made from organic materials were in several cases drawn by Rosing and the bone material was investigated and published by U. Møhl (Møhl 1972). The Investigations of the bone material showed that mainly caribou had been brought to the site (95% of all the bones), and that these animals were primarily killed during the autumn. Moreover, Møhl also determined the bone marrow splitting method used on the site. The artefact material from Itin-

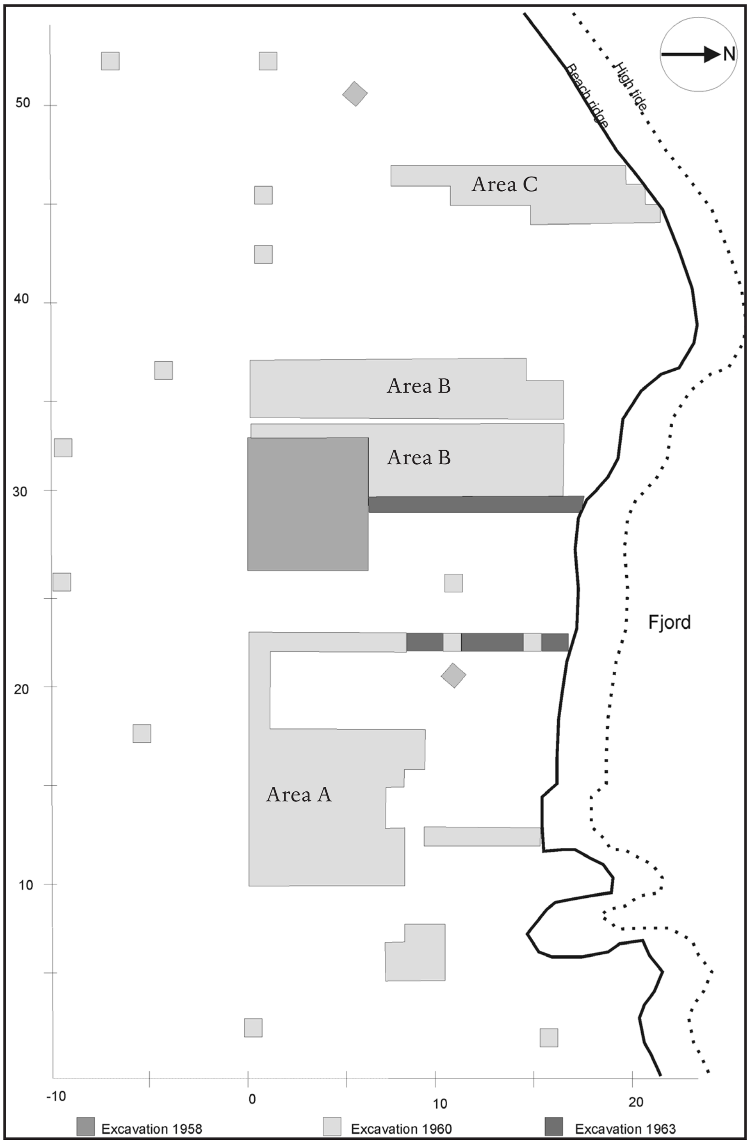
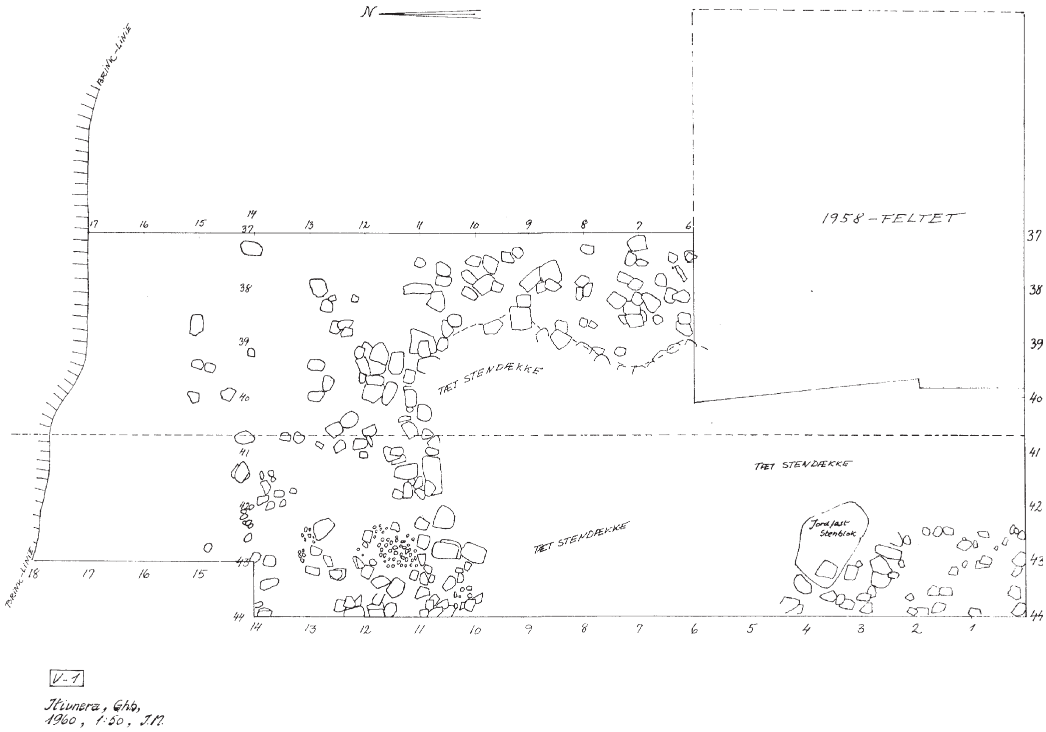


Fig. 4.1.2
The excavated areas of the site Itinnera, the seasons from 1958 to 1963.

nera has been illustrated as typical for the Saqqaq Culture in many publications (Birket-Smith 1962; Rosing 1978; Maxwell 1985). The site, however, never received the publication it deserved.

Dating

Five radiocarbon dates were made from Itinnera and four of these are of archaeological interest. Two of the dates are from the cultural layer. Both of these dates are made on samples of wood (K-588, K-1193). One dating is made on a turf sample



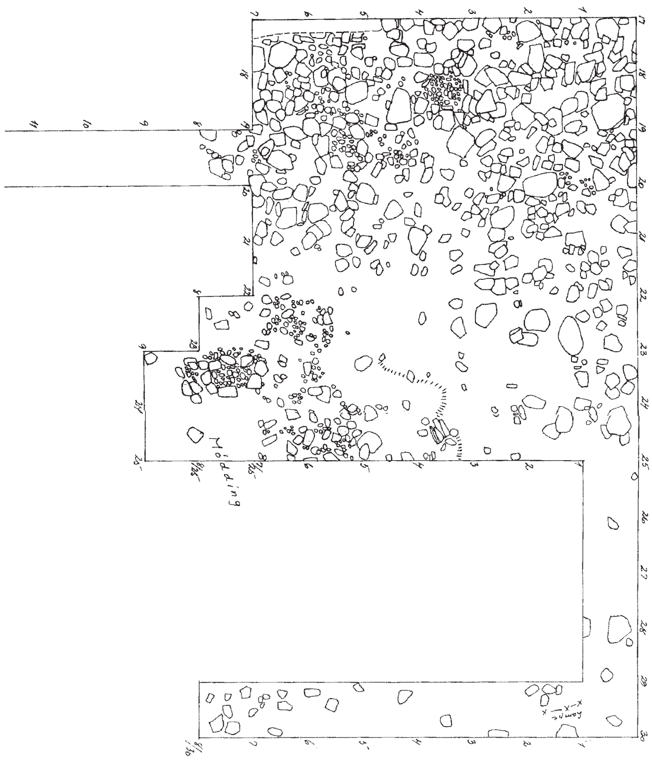


Fig. 4.1.3
Drawings of excavated areas A (below) and B (above) at the Itinnera site, 1960.

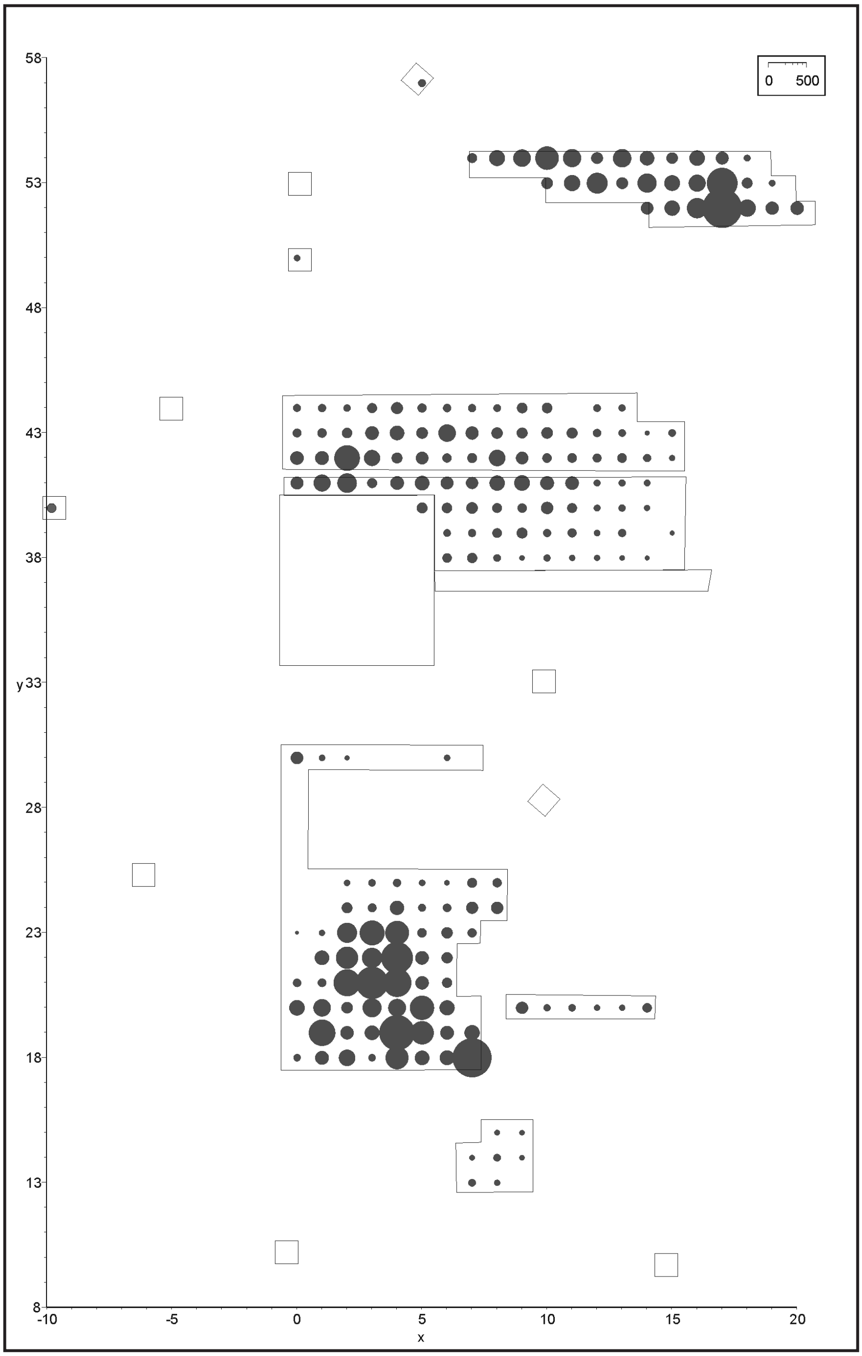


Fig. 4.1.4
The spatial distribution of the lithic inventory at Itinnera, season 1960. The inventory is excavated and plotted in m^2. Concentrations are seen in area A and C. It can be observed that the site is not completely excavated.

from under the cultural layer (K-1192) and one is made on a turf sample above the cultural layer (K-1194) (see table 4.1.1). The radiocarbon dates are made early in the history of radiocarbon analysis, which probably explains why samples of turf and wood (which today are considered as less precise materials for dating on Greenland) were chosen, instead of caribou bone. An absolute dating of the cultural layer to around 1200 cal. BC is probable, when the dates are considered. However, when considering the site layout and the thickness of the cultural layer, the site was probably in use over an extended length of time throughout the Saqqaq period. According to the dating, the site belongs to the middle-later phase of the Saqqaq, a dating which is supported by the appearance of soapstone lamps primarily known from the later phase of Saqqaq (Kramer 1992, 1996; Møbjerg 1999; Gotfredsen & Møbjerg 2004, 2005).

Lab. No.	Material	^{14}C. BP	Calibratetd BC*1	Remarks	Reference
K-1192	Turf	3200 ±120	1680–1310	Pre-dating	(Gulløv 1986)
K-1193	Charcoal	3140 ±120	1600–1210	Cultural layer	-
K-588	Juniper wood (Juniperus sp.)	2960 ±110	1370–1020	Cultural layer	-
K-1194	Turf	1840 ±100	AD 60–330	Post-dating	-

Table 4.1.1 Radiocarbon dates, Itinnera
*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998).
Calibration by 1 standard deviation (68.2 %).

Inventory

When classifying the inventory, bifacial artefacts are separated into large and small lance heads and bifacial knives. This distinction is made on the basis of the hafted inventory from the QT site. Nevertheless, the distinction must be regarded as problematic and made with some degree of caution, as it is difficult to separate these artefact morphologies from each other. The inventory list is compiled for all excavations (table 4.1.2) (figure 4.1.5).

End scrapers	33	Arrow point preforms	169
Side scrapers	27	Arrow points	89
Burin preforms	18	Harpoon points	16
Burins	239	Awls	7
Bifacial preforms, large	56	Saws	3
Knife blades	16	Adzes	8
Lance points, small	5	Microblades	70
Lance points, large	10	Microblades, retouched	3

Table 4.1.2 Inventory list, Itinnera

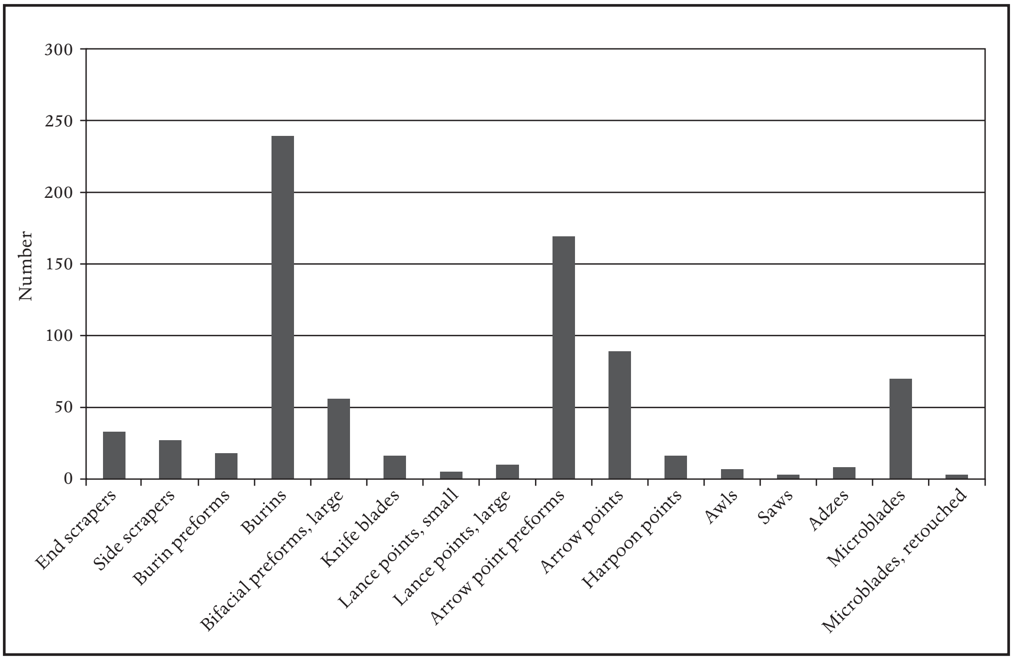


Fig. 4.1.5
The quantitative distribution of all the formal lithic tool types excavated at Itinnera.

Qeqertasussuk

Geography

The site QT is named after the island on which it is located – in the southeastern part of Disko Bay. Qeqertasussuk means 'the relative large island'. The site is situated on a promontory on the northern end of the island (see figure 4.1.6).

Excavation

B. Grønnow and A. Magnussen discovered QT during a survey in 1983. From 1984 onwards, eight seasons of excavations, including both archaeological and natural science investigations, were conducted (Grønnow 1988(a), 1988(b), 1994, 1996(b)). Within the site a permafrozen midden near the coast was partly excavated (area B (10 m²)) and two habitation areas were partly excavated on the promontory (area C

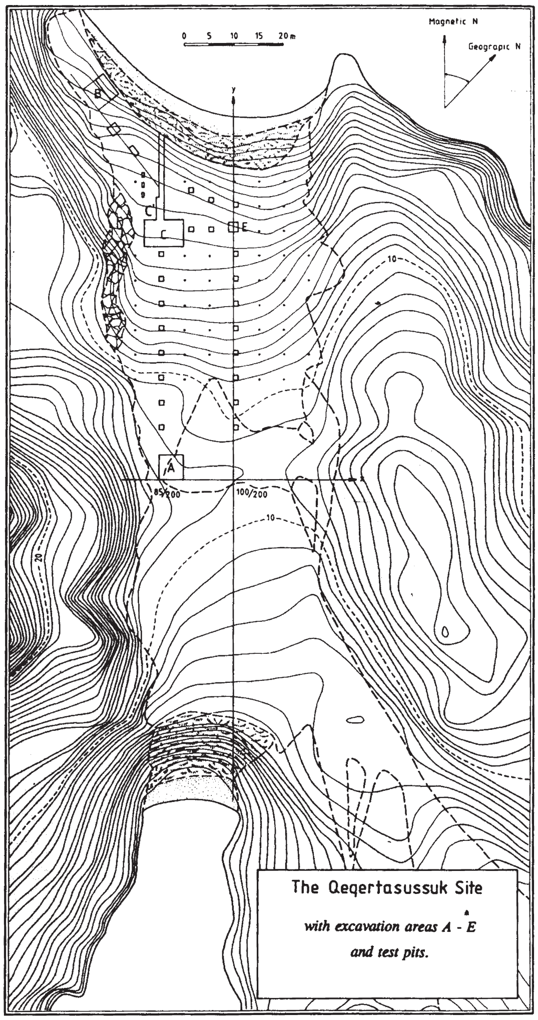


Fig. 4.1.6
The tombolo at the island Qeqertasussuk in eastern Disko Bay, where the Qeqertasussuk is located (after Grønnow 1988a).

(45 m²) and area A (10m²)). The midden and the habitation area C revealed a large area of extremely well preserved organic material, including many composite artefacts. The habitation area yielded several midpassage structures, cooking pits and fireplaces. However, since the site is not completely excavated, it is uncertain how many structures actually existed here. The layers within the midden, from which the radiocarbon dating material was extracted, suggests that the site was used up to 1000 years during Saqqaq, and that it reflects a palimpsest of habitations. The excavation was carried out in ¼ m² in up to 18 layers, and the results suggest that these contain five habitation phases (called components).

Dating

Eleven conventional radiocarbon dates are made from the layers and most of these are made on turf or local wood. Three dates were made from marine mammals (seal) and can therefore be excluded (table 4.1.3).

The dating suggests that QT was inhabited very early in the Saqqaq, possibly already around 2500 cal. BC and that the habitations continued until around 1400 cal. BC.

Lab. No.	Material	^{14}C. BP	Calibrated BC*1	Remarks	Reference
K 4823	Turf	3980 ±85	2630–2310	Layer 18, lower part	(Grønnow 1994)
K 4819	Turf	3780 ±85	2400–2030	Layer 15a, upper part	-
K 4822	Heather (Ericaceae sp.)	3640 ±75	2140–1890	Layer 16	-
K 4821	Heather (Ericaceae sp.)	3760 ±80	2300–2030	Layer 16	-
K 4818	Heather (Ericaceae sp.)	3650 ±85	2140–1890	Layer 16	-
K 4817	Turf	3680 ±85	2200–1940	Layer 15, lower part	-
K 4816	Turf	3310 ±80	1690–1500	Layer 15, upper part	-
K 4820	Turf	3150 ±80	1520–1310	Layer 11, lower part	-

Table 4.1.3 Radiocarbon dates, Qeqertasussuk area C

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

Inventory

The inventory list is compiled on the basis of B. Grønnow's classification of area C. Due to this classification preforms are counted as finished tools, and arrows and lance blades are classified as one category. Flakes with retouch are classified, and blades are classified metrically (table 4.1.4) (figure 4.1.7).

Flakes with retouch (knives)	308	Arrow points/lance points	61
End scrapers	48	Harpoon points	65
Side scrapers	27	Awls	3
Burins	245	Saws	3
Drills	9	Adzes	10
Bifacial knives	44	Microblades	104

Table 4.1.4 Lithic inventory list, Qeqertasussuk area C

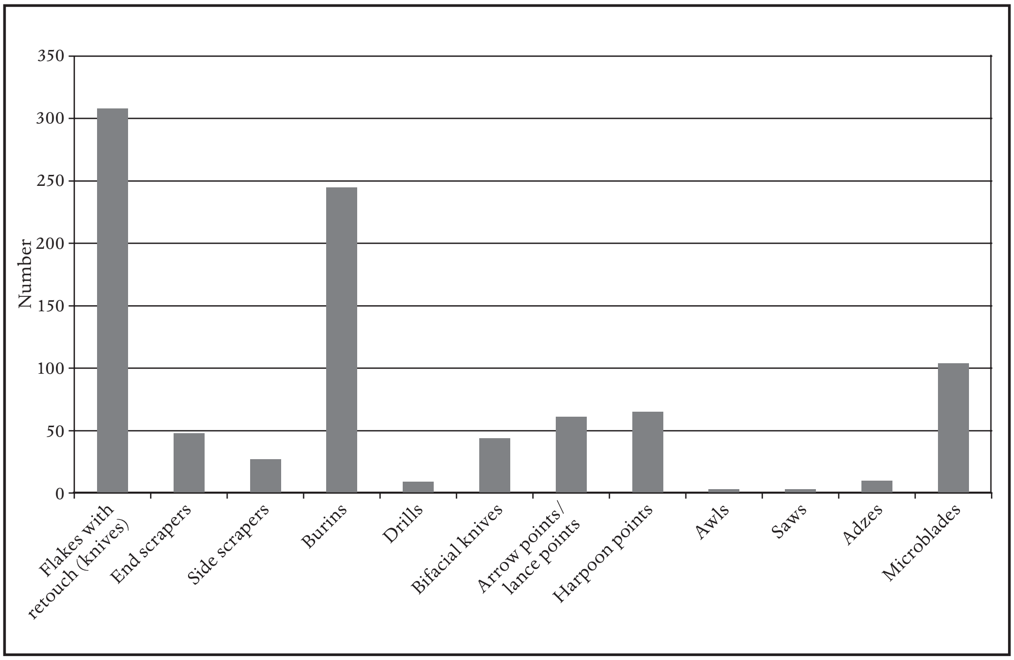


Fig. 4.1.7 The quantitative distribution of all the formal lithic tool types excavated at Qeqertasussuk.

The *chaînes opératoires*

The raw material

The raw material from Itinnera

A count of the different raw material types from Itinnera, including both artefacts and flake material, shows that nearly equal quantities of killiaq and quartzite have been used, while mcq and quartz crystal constitute a minor part of the material (figure 4.1.8). Tied in with this observation it seems significant to point out that neither killiaq nor mcq are available in the local or regional area, but must have been imported over long distances. From visual as well as from microscopic analysis (Jensen 2000; 2004(b)) it can be determined that the killiaq from Itinnera generally derives from the killiaq outcrop at Qaarsut, on northern Nuussuaq (Rosenkrantz 1965; Sørensen & Pedersen 2004; 2005) and to a lesser degree from Angisat in southern Disko Bay. Mcq must be imported from small locally found outcrops in the basaltic areas, e.g. in western Disko Bay (see chapter 3). Killiaq and mcq, which constitute approximately half of the raw material at Itinnera, are thus imported across a distance of more than 700 km as the crow flies. Quartzite outcrops, from which appropriate quartzite materials can be collected, are common several places in the Nuuk fjord region. Quartz crystal and different quartz types are also available within the Nuuk fjord region. Moreover, a small frequency of a basalt-like material, less than 1%, is used in particular for the production of arrowheads at Itinnera. This material is known from several thin bands through the gneiss rocks within the region.

From the analysis it can be seen that the percentage of tools compared to debris of killiaq and mcq is higher than for the regionally found raw materials (figure

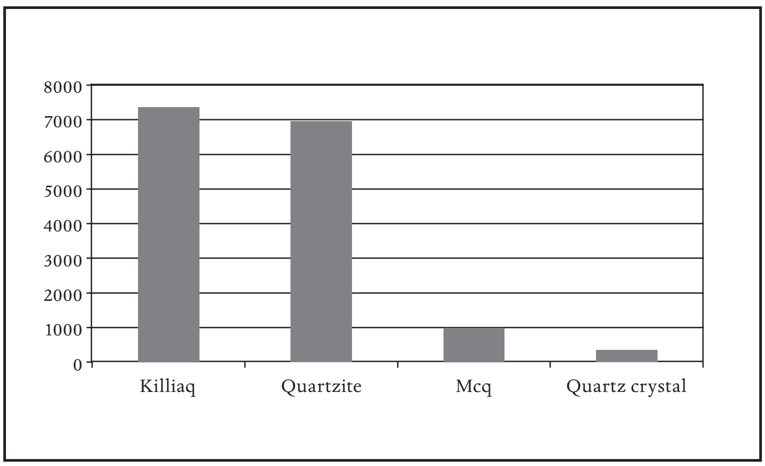
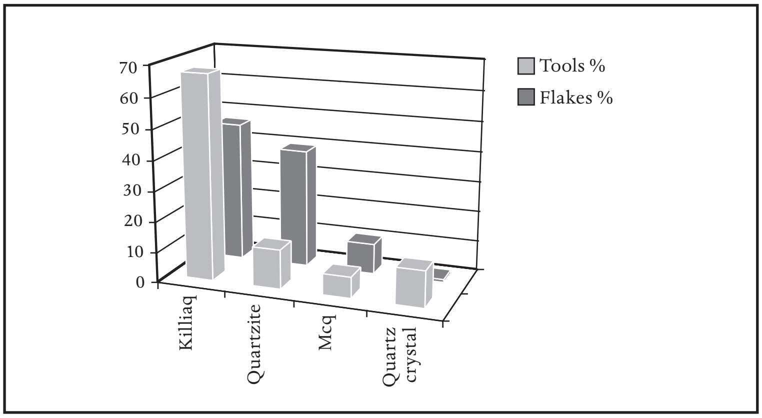


Fig. 4.1.8 Frequencies of the different raw material types at Itinnera, excavations 1958 and 1960 (after Gulløv and Kapel 1988).

4.1.9). Only 13% of the tools are made of quartzite, while the flake remains of this material constitutes 39% of all the debris. In comparison 67% of the tools are made of killiaq, while 46% of the flake material is killiaq. Thus it can be concluded that the imported raw materials were used more economically by the Saqqaq people than the raw materials from within the region, i.e. quartzite.

When the relation between raw material type and artefact type is analyzed, it becomes evident that the Saqqaq people had significant preferences for which raw materials should be used for which artefact types (figure 4.1.10). Adzes, saws, awls and harpoon points are exclusively made from killiaq. More than 90% of the

Fig. 4.1.9
The degree of exploitation of the different types of raw materials at Itinnera.



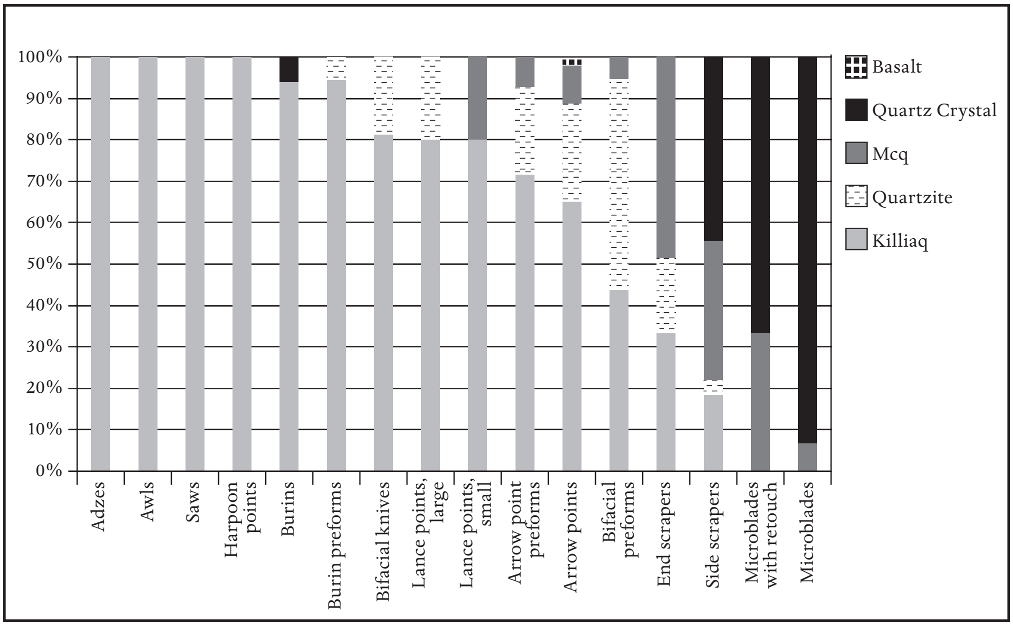


Fig. 4.1.10 Raw material choice for the different lithic tool types at Itinnera.

burins are made from killiaq, while the majority of the bifaces are made from this material. The end and side scrapers are generally made from mcq or crystal. Microblades are exclusively made from either mcq or crystal.

The spatial analysis of the raw materials at Itinnera show that all the materials are found evenly distributed on the site. However, a slight majority of killiaq is found within area C (figure 4.1.11). The spatial analysis indicates that all raw material types have been present during all the habitation episodes at Itinnera. The slight differences between the raw material frequencies in the different areas, however, could indicate that the amounts of imported raw materials changed during the Saqqaq habitation period. This situation provides hope for the interpretation of relations or contacts between different regions during the Saqqaq period.

The raw material at QT

At QT only killiaq, mcq and quartz crystal have been used for the lithic artefact production. These materials are all found within the Disko region, though mostly in the western part. Killiaq is the most used material and it must be noted that this material becomes increasingly frequent, through time, at QT (figure 4.1.12).

Concerning the relation between tools and flakes for the different raw materials (figure 4.1.13), it can be stated that there is a small overrepresentation of mcq tools compared to flakes. However, the somehow equal relation in frequencies of tools and flakes for the different raw materials indicates good access to all the raw materials from QT. The choice of raw material type in relation to artefact type displays the same tendencies as observed for the Itinnera assemblage, but at Itinnera quartzite partly substitutes killiaq.

Discussion

The tendency of increased use of killiaq through early Saqqaq, as seen on QT, could indicate that a network in which killiaq was procured in the Disko bay region was established during the early Saqqaq phase. Dating of the site Qaarsut Killeq (lowest layer), the site next to the killiaq outcrop on Nuussuaq, suggests that this site was established permanently around 1900 cal. BC (Sørensen & Pedersen 2005). The increasing frequencies of killiaq during early Saqqaq at QT could thus be explained by a permanent settlement at Qaarsut and the existence of a network in which killiaq was regularly exported to Saqqaq sites in West Greenland. In the Sisimiut region a decrease in killiaq is seen during the later phases of Saqqaq (Kramer 1996(b); Gotfredsen & Møbjerg 2004(b)), indicating somehow a breakdown in the Saqqaq network during this period. Thus it can be concluded that raw material investigations through time have a potential for the interpretation of regional relations and the building of networks in Saqqaq.

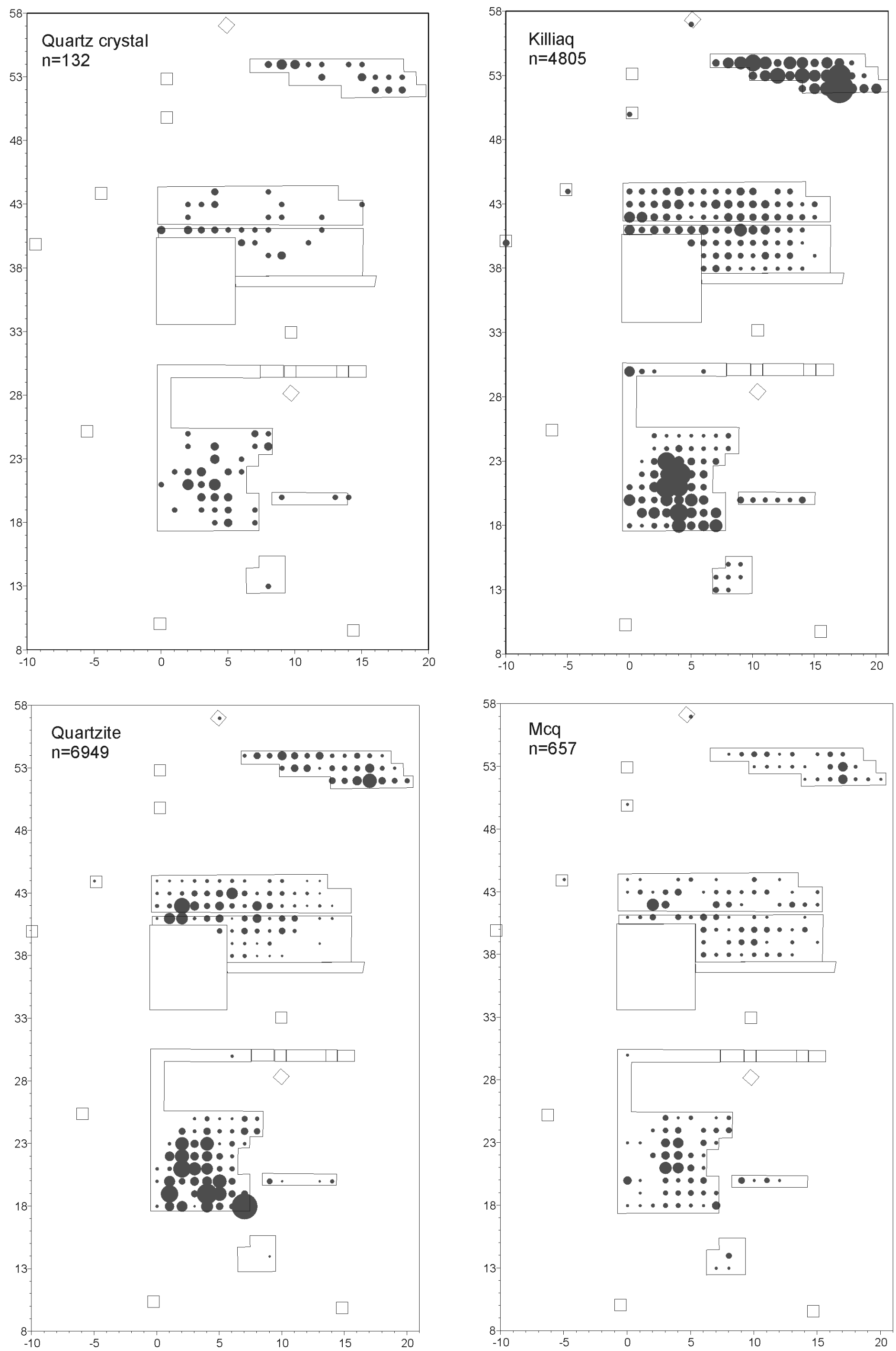


Fig. 4.1.11
The spatial distribution of crystal, killiaq, quartzite and mcq in the excavated area of the Itinnera site.

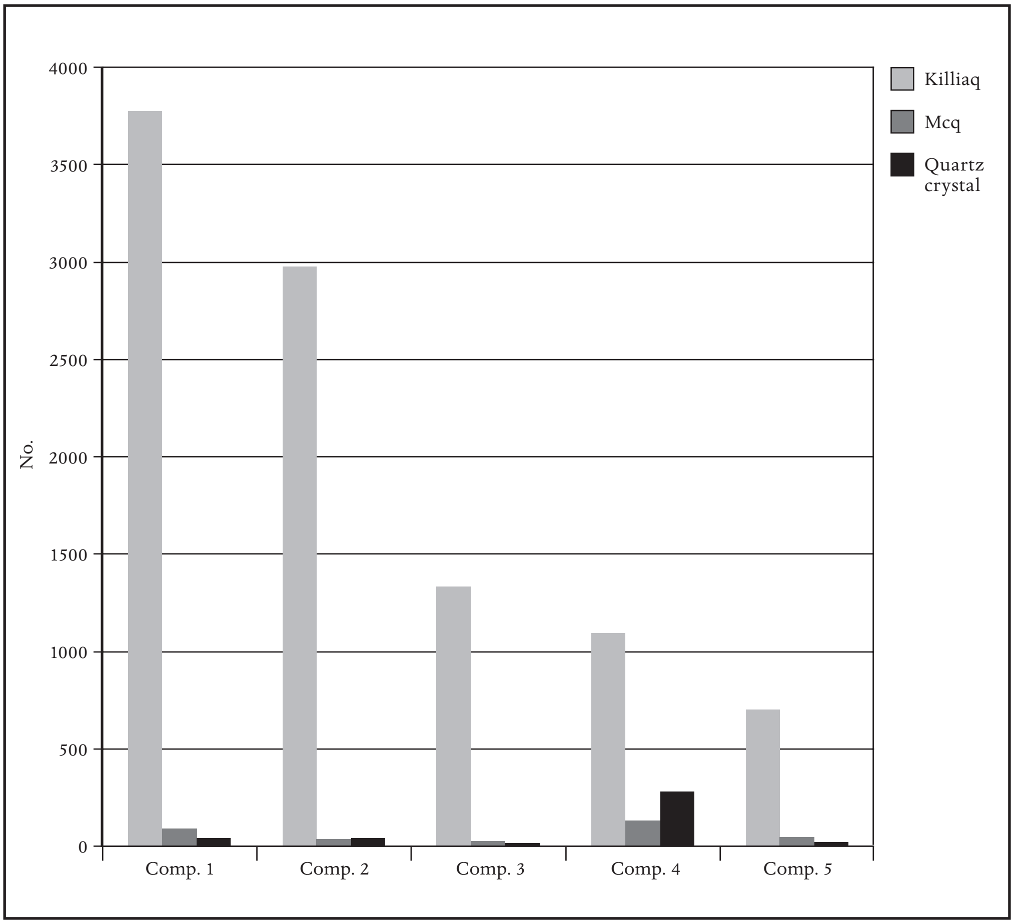


Fig. 4.1.12 The amount of flakes from the different raw material types through time at the Qeqertasussuk site. A tendency to an increase in killiaq use is seen during the prehistoric use of the site.

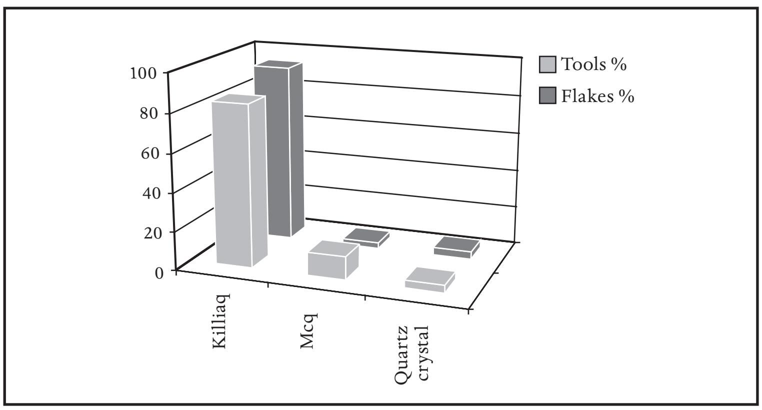


Fig. 4.1.13 The frequency of the different raw material types compared for tools and flakes at Qeqertasussuk.

Preforms

Burins, awls, saws, harpoon points, scrapers and flakes with retouch (expedient knives) are in Saqqaq produced from big flakes primarily of killiaq (figure 4.1.14: I). From Itinnera only a few used-up cores of killiaq are found, while on QT several large bifacial killiaq cores are present (figure 4.1.14: II). Large killiaq flakes are characterised as typical bifacial flakes with acute angles between platform and

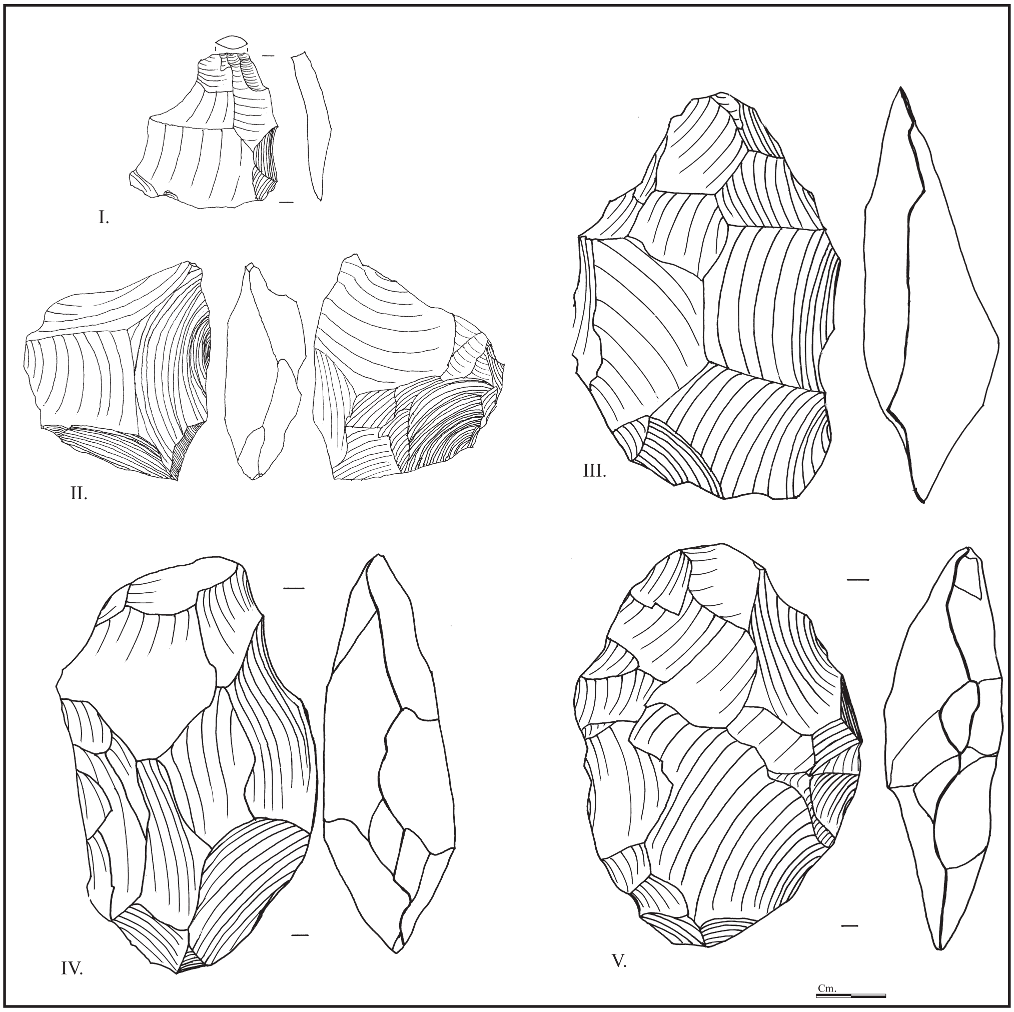


Fig. 4.1.14 Preforms from Itinnera are made on large flakes (I), but must also have existed as large bifacial cores reduced into small bifacial cores (II), as found at Itinnera. From the Saqqaq site Qeqertasussuk (III, VI) and Sermermiut (V) large bifacial preforms made from killiaq have been exploited as cores from where large flake preforms systematically have been produced.

dorsal side and dorsal sides with negatives from previous removals from many directions (figure 4.1.15). These types of bifacial flakes are typically produced from oval bifaces with oval cross-sections, a core type which is known from Saqqaq sites in the Disko region, e.g. QT, Sermermiut and in particular from Qaarsut Killeq (figure 4.1.14: III, IV, V). Due to its abundance at the quarry site 'Qaarsut Killeq' on northern Nuussuaq this core can be termed the 'Nuussuaq core type'. The 'Nuussuaq core type' must be perceived as a standardized preform for the production of killiaq flake blanks. Important information relating to the procurement systems in Saqqaq therefore concerns the 'Nuussuaq core type' (see chapter 5).

Core preforms of other materials than killiaq in Saqqaq generally do not exist in West Greenland. However, in East Greenland basalt materials are treated like killiaq in West Greenland. Another exception is microblade cores made from mcq and crystal.

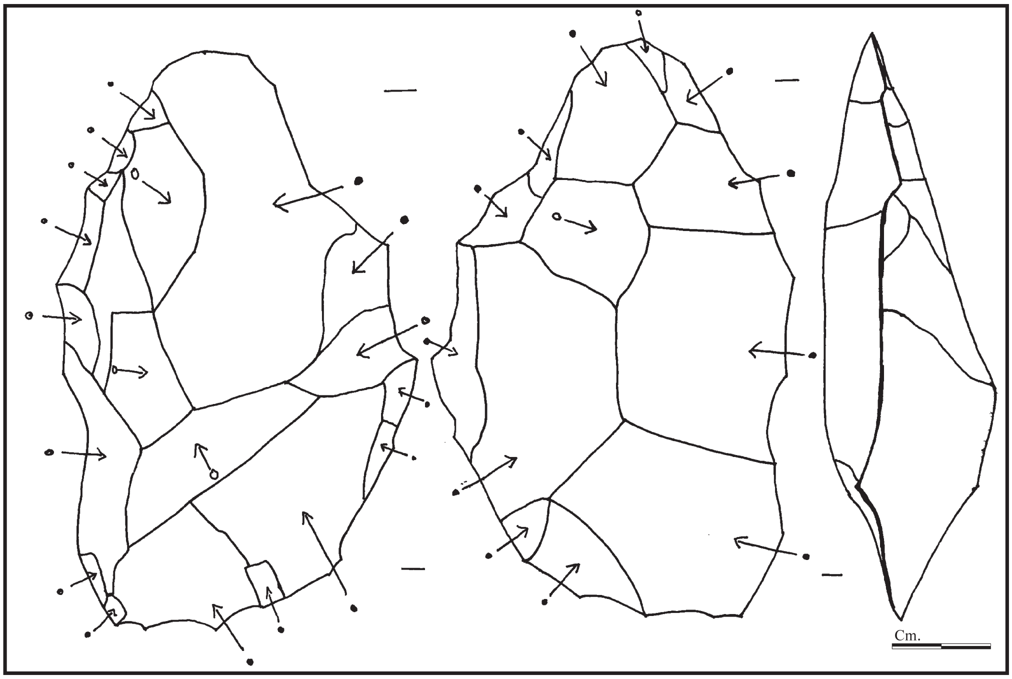


Fig. 4.1.15
The production of a typical 'Saqqaq' core preform made from killiaq. It is seen that the core is exploited at both sides and circular around the core.

Flake knives

Step 1

From a thick bifacial killiaq core, flakes are serially produced (figure 4.1.15). The flakes become broad, short and thin with light curvature (figure 4.1.16). Furthermore, a pronounced lip formation, a diffuse bulb of percussion and an oval platform characterize the flakes. For the production of the flakes, it is therefore likely that a large soft hammer must have been employed.

Step 2

Flakes with straight regular edges are sorted out.

Step 3

The appearance of irregular retouch on large flakes can be interpreted as wear from use (4.1.16: II, III, V). Thus flakes might have been used for cutting, as knifes,

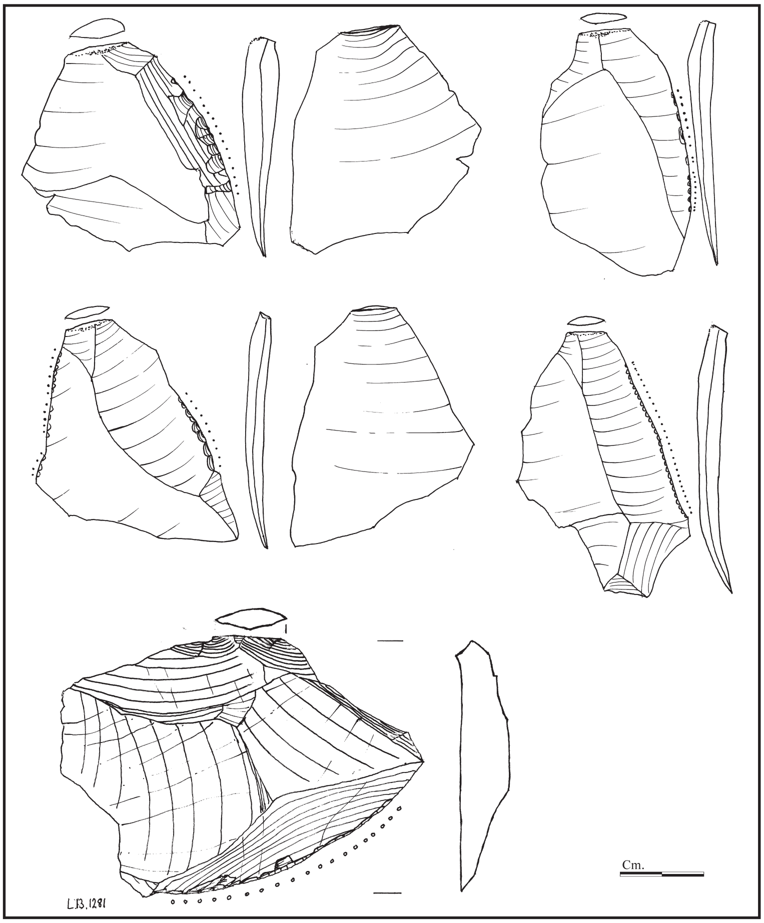


Fig. 4.1.16 Large bifacial flakes from the site Itinnera is seen with macroscopic use wear at their lateral edges. The flakes have probably functioned as flake knives.

possibly in soft organic materials. A regular unifacial retouch on some flakes can be interpreted as either the production of a more solid cutting edge or the modification of the flake in order to produce a formal tool type (figure 4.1.16: I, IV).

Steps 4–5
The flake knife was probably discarded when the edge was worn out, or it could have been used as a preform for a formal tool type.

Discussion
An examination of flakes from Itinnera shows that they often have macroscopic wear. This observation is confirmed at QT where 308 flakes are recorded with irregular retouch (use wear). The amount of flake knives at QT thereby outnumbers any of the known formal tool types at the site. Compared to the other Palaeo-Eskimo sub-traditions in the eastern Arctic, Saqqaq has a very limited production of microblades. One reason for this fact could be that large killiaq flakes in Saqqaq substitutes the need for blade cutting edges during this period.

End scrapers

End scrapers are characterized by a transversal edge at the opposite end of the base. From Saqqaq three scraper types are known (figure 4.1.17). The triangular scraper (1) is characterized by a pointed base. This scraper type is generally the most well-worked type, and it is often made from mcq. The quadratic scraper (2) has an un-worked base, which gives this scraper a square morphology. Often this scraper type is made from mcq. Scraper with narrow edge (3) has a typical narrow scraping edge, often 5–6 mm wide. The edge is made narrow by lateral retouch. Some scrapers of this type have a ground scraper edge. This scraper type is often made from killiaq.

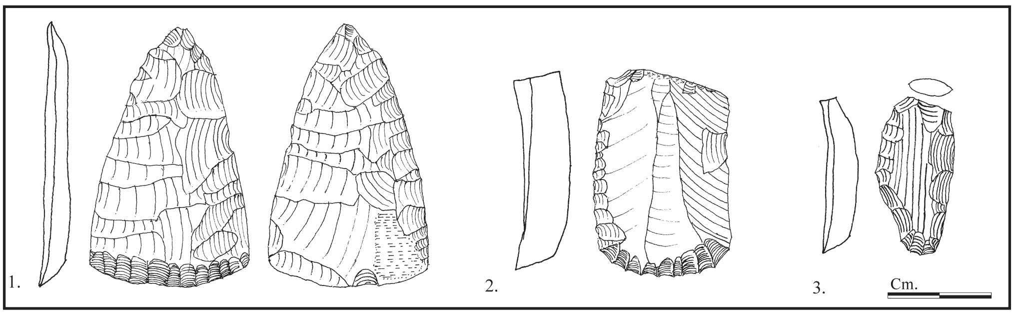


Fig. 4.1.17 The different types of end scrapers identified in the Saqqaq inventories.

Steps 1–2

All the end scraper types are produced from flakes (figure 4.1.18: A). The end scrapers' working edges are always made in the distal end of the flake. The scraper edges are made by serial pressure retouch from the ventral side of the flake onto the dorsal. The edge angle is typically 50–60 degrees.

Step 3

End scrapers are found hafted at QT. The haft type used was certainly a lot more sophisticated than one could expect. The haft is a right-angled double haft, made from driftwood (figure 4.1.19). Each end is grooved out and has a scraper attached. In one end, the haft is pointed and has a triangular scraper type attached. In the other end, the haft is angled and has a quadratic scraper attached. In this way the

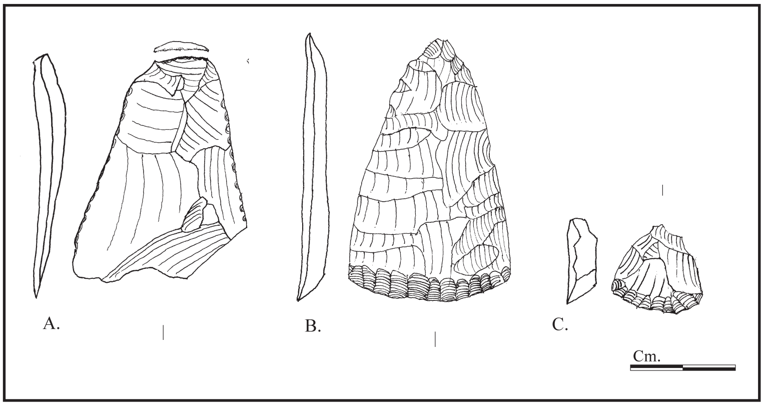


Fig. 4.1.18
The *chaîne opératoire* for end scrapers. Examples are from Itinnera and are made from mcq except (A), which is made from killiaq.

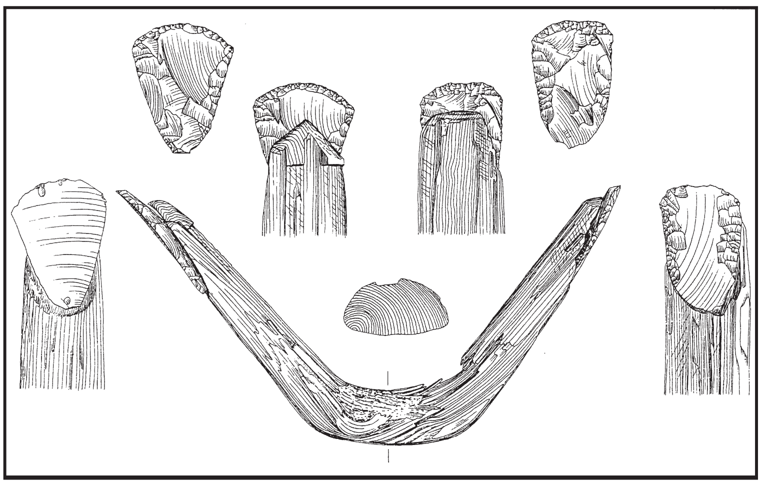


Fig. 4.1.19
The double end scraper handle from Qeqertasussuk (Grønnow 1994).

scraper haft reflects the two different scraper types. It therefore seems possible that the two scrapers had different functions and that by hafting the scrapers in a double angle one could change the function by turning the haft. It is very likely that this haft reflects a standardized Saqqaq technology.

Step 4
The scraper edges are re-sharpened by new series of pressure retouch flakes. In this way the scrapers are gradually shortened down (figure 4.1.18: B, C).

Step 5
End scrapers are discarded when their length becomes reduced to a size that makes it impossible to attach it to the haft.

Discussion
Different edge angles on the end scrapers are seen. This, however, does not necessarily have to do with function, but could also reflect the last rejuvenation of the edge.

Side scrapers

Step 1
Flakes primarily of quartz crystal or mcq are chosen for the production of side scrapers (figure 4.1.20: A). The flakes chosen are oblong and are oriented so that the bulb of percussion becomes the base of the scraper.

Step 2
The scraper preform's lateral edges are retouched from the ventral side, which is conducted to achieve an oblong morphology with parallel edges (figure 4.1.20: B). The base is in several cases worked on the ventral side to remove the bulb and create a regular morphology. Often the lateral edges of the bases are slightly ground, probably to improve the hafting.

Step 3
The precisely worked bases of the side scrapers indicate that they generally have been hafted, probably in a wooden handle similar to the burins at QT. The side scrapers are used to scrape on the one lateral edge, probably by pulling this edge over the worked material in a motion towards the body.

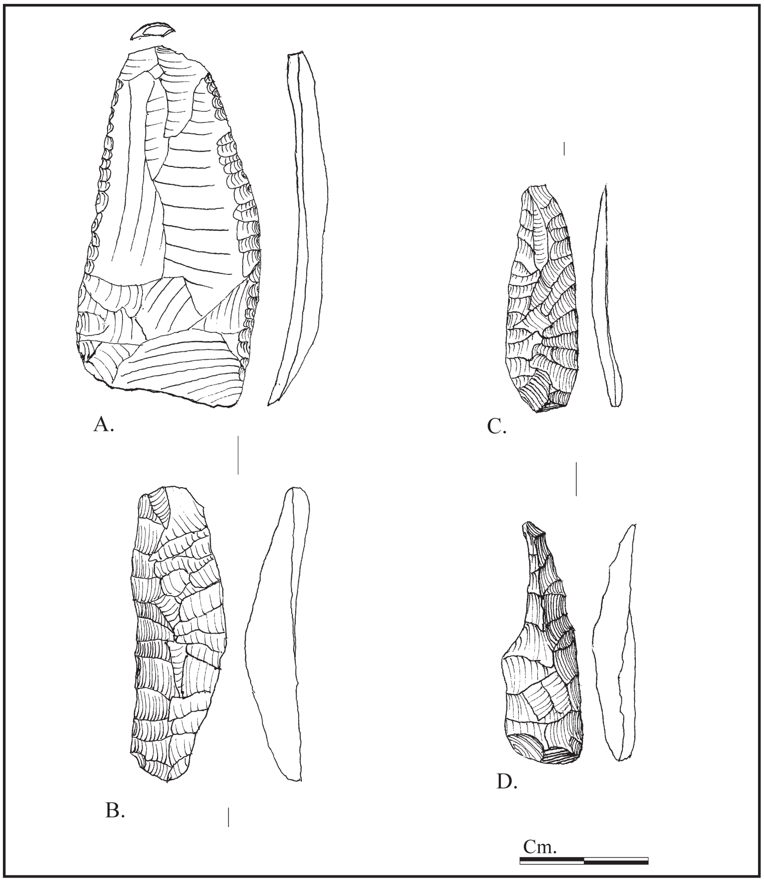


Fig. 4.1.20
The *chaîne opératoire* for side scrapers.

Step 4
The scraper edge is rejuvenated by a series of pressure flakes, which currently gives the tool a typical concave asymmetrical distal morphology (figure 4.1.20: D).

Step 5
The side scraper is discarded when its distal end gets as narrow as 5 mm and the edge becomes 90 degrees.

Discussion
Due to the specific use of this tool and its asymmetrical morphology when rejuvenated, it is most possible that right-/left-handedness of the user can be determined: If the concave edge is to the left, seen with the scrapers ventral side down, and the scraper is used in a motion towards the body, the user must have been right-handed (figure 4.1.20: C, D).

Burins

Step 1

Killiaq is primarily chosen for the burin production in West Greenland. In East Greenland killiaq is substituted by fine-grained qualities of basalt, e.g. from the Kangerlussuaq area.

Large, relatively thin flakes, are chosen (figure 4.1.21: A), which are reduced along the lateral edges (figure 4.1.21: B). The flake is worked into an approximately 30 mm long preform, with a base width of approximately 12 mm and a thickness of 4 mm. It is probable that both direct percussion technique and pressure retouch is used during shaping. The preform achieves a distinct beak-shaped morphology because the distal end of the preform is widening out from the base (figure 4.1.21: C, D, E).

Step 2

The beak-formed preform is ground on both its distal faces. Moreover, the angled distal edge is ground and often the lateral edges on the base are slightly ground too. The latter is probably in order to secure the hafting. After the grinding one must assume that the preform is hafted and then is ready for spalling (figure 4.1.21: E). Deduced from the morphology of the burin spalls and modern experiments with burin production (figure 8.1.9), it can be suggested that burin spalls generally are detached by means of the pressure technique. The first burin spall will have a triangular cross-section and a worked crest (figure 4.1.21: F1).

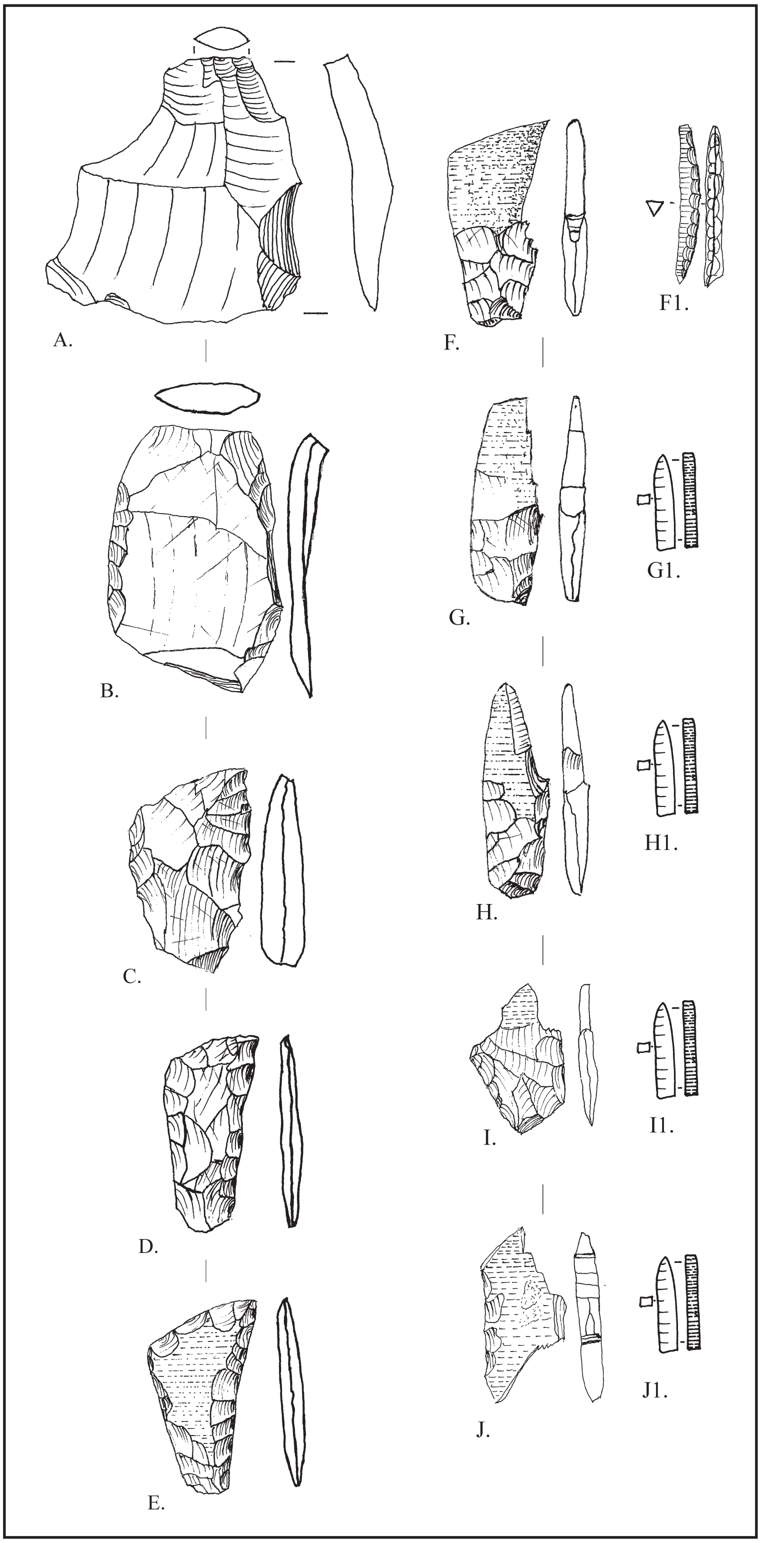
Step 3

Burins have been hafted in hafts made from driftwood as they are found at QT (figure 4.1.22). Often a macroscopic use wear can be detected at the burin edge, but not at the distal corner. It therefore seems most possible that it is the right-angled spalled edge that is the primary working edge.

Step 4

When the burin edge gets dull the burin is rejuvenated by means of 1) spalling of secondary spalls and 2) grinding the faces of the distal end. Secondary spalls are characterized by a quadratic cross-section. Due to the fact that the burin spalls generally have a broader proximal end than distal end, the distal beak-form of the burin will gradually decrease and change into a pointed morphology, as the burin is rejuvenated (figure 4.1.21: F–J). Counts of the hinges from the spalls on the burin reveal that typically 5–10 hinges are seen. When the relation between primary and secondary spalls is evaluated at Itinnera, the relation is 1:7, indicating that eight spalls were produced on average from each burin.

Fig. 4.1.21
The *chaîne opératoire* for burins in the Saqqaq tradition. The burins are from the Itinnera site and are made from killiaq.



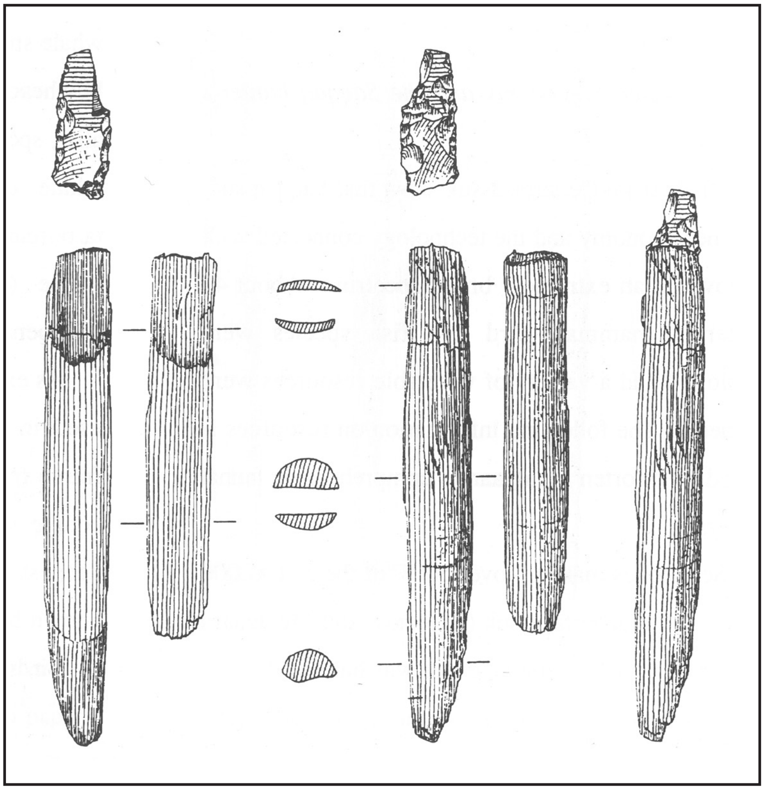


Fig. 4.1.22
Burin made from killiaq in its original handle made from driftwood. The handle has been split and a groove has been made in its lateral end to fit the base of the burin. Length of handle is 12.1 cm. (Drawing E. Koch in Grønnow 1996).

Step 5
Discarded burins are characterized by an extremely reduced distal end, and therefore lack the possibility for rejuvenation. However, three alternative forms of rejuvenations can occasionally be observed: 1) dihedral burins, 2) double burins and 3) burins on the lateral edge.

Discussion
The width of the burin base reflects a standard in the hafting system. On QT, however, it has been proven that the width has a chronological significance during early Saqqaq (Grønnow 1994). Conversely, the distal end reflects an economy, that is, the broader the distal end, the more the burin can be rejuvenated. Grinding of the distal edge gives a platform for the pressure detachment of the spall, while the grinding of the faces produces regular strong burin edges.

Burin preforms (figure 4.1.21: C, D, E) have previously been interpreted as independent tool types: 'transversal scrapers' (Hinnerson-Berglund 2004), specialised knives (Gotfredsen & Møbjerg 2004(b); Jensen 2005). However, when the *chaîne* *opératoire* for the burin is investigated it becomes clear that these 'types' generally should be understood as preforms for burins.

It has been suggested that burin spalls were hafted and used for incising (Gynther & Meldgaard 1984). A macroscopic investigation of the burin spalls from Itinnera shows only one burin spall with use wear which could be secondary to the burin use. The rest (177 specimens) might have use wear, which could be the result of use before the spall was detached. This limited investigation points to the fact that the spalls generally were not used as 'independent' tools during Saqqaq. To reach a convincing conclusion on this matter, microscopic analysis will have to be carried out.

Bifacial knives

Step 1

Killiaq is primarily chosen for the bifacial knife production in West Greenland. It is very possible that the typical 'Nuussuaq cores' when reduced bifacially become preforms for large bifaces. This could explain the lack of used-up cores, in combination with the vast flake material on the Saqqaq sites. However, there is also evidence that single preforms, manufactured in the killiaq outcrop area and large flakes have been used as preforms for large bifaces.

The preform is worked bifacially from the beginning of the process (figure 4.1.23: A). In cases where the blank is a large flake, it has been observed that the flake is oriented so that the proximal end of the flake becomes the base of the knife blade. The preform is fashioned into a pointed morphology, while no flakes are removed from the basal end. Deduced from the flake and core attributes, direct soft hammer is used during this process. Preforms for bifacial knives and lance heads cannot be archaeologically separated during this step.

Step 2

The bifacial process is refined and smaller thinner flakes are removed in order to thin down the preform (figure 4.1.23: B). Several knife blades are seen with partially ground faces. The grinding must have been carried out to thin down the bifaces and remove hinges. The lateral edges on the bases are often subjected to grinding as well, probably to secure the hafting.

Step 3

The knife blade is hafted in a haft made from driftwood, as can be seen from specimens excavated at QT (figure 4.1.24). No microscopic use wear analysis has as yet been successful, but from the edge morphology it can be suggested that the knives have been used to cut soft organic materials.

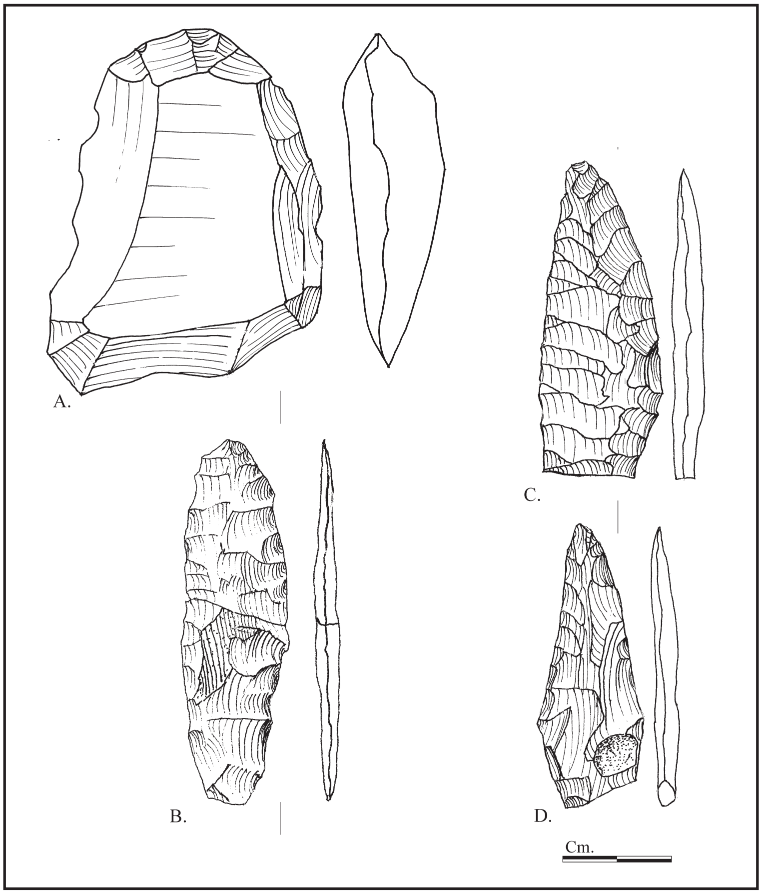
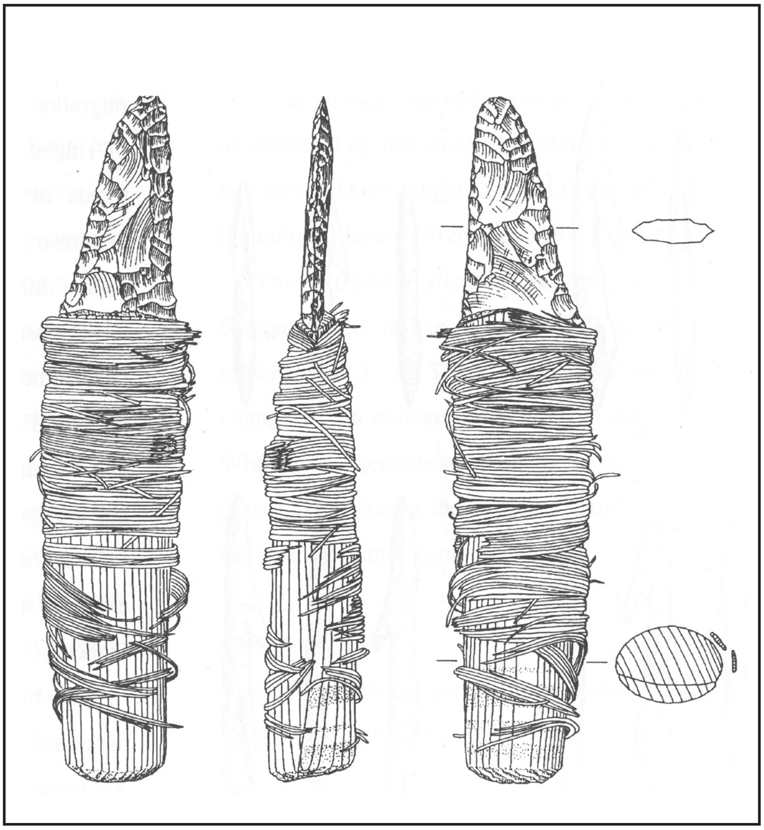


Fig. 4.1.23
The *chaîne opératoire* for bifacial knives in the Saqqaq tradition. Artefacts are from Itinnera. Killiaq has been used.

Step 4
The knife blades are generally rejuvenated thoroughly, which results in many asymmetrical morphologies (figure 4.1.23: C, D). The re-sharpening is generally carried out by means of pressure technique.

Step 5
The bifacial knives are discarded when the distal end is rejuvenated into a small inefficient size or when the knife blade breaks. Breaks are often seen just above where the haft has ended, as seen from the preserved hafted specimens.

Fig. 4.1.24
Hafted bifacial knife made from killiaq. The handle is fitted together from two pieces of shaved driftwood held together around the knife blade by a baleen string. Length of handle is 16.5 cm. (Drawing E. Koch in Grønnow 1996).



Lance points

Step 1

Lance point preforms are produced similarly to bifacial knife preforms (figure 4.1.25).

Step 3

Lance points are hafted in the base in that they are placed into a grooved haft end and tied (Grønnow 1994: figure 21). Lances are probably used for hunting of large mammals.

Step 4

In principle, a broken lance tip can be rejuvenated. However, this situation is not yet documented.

Step 5
Generally, lance points are discarded when broken. Breaks are typically seen as bending fractures or impact fractures from the tip.

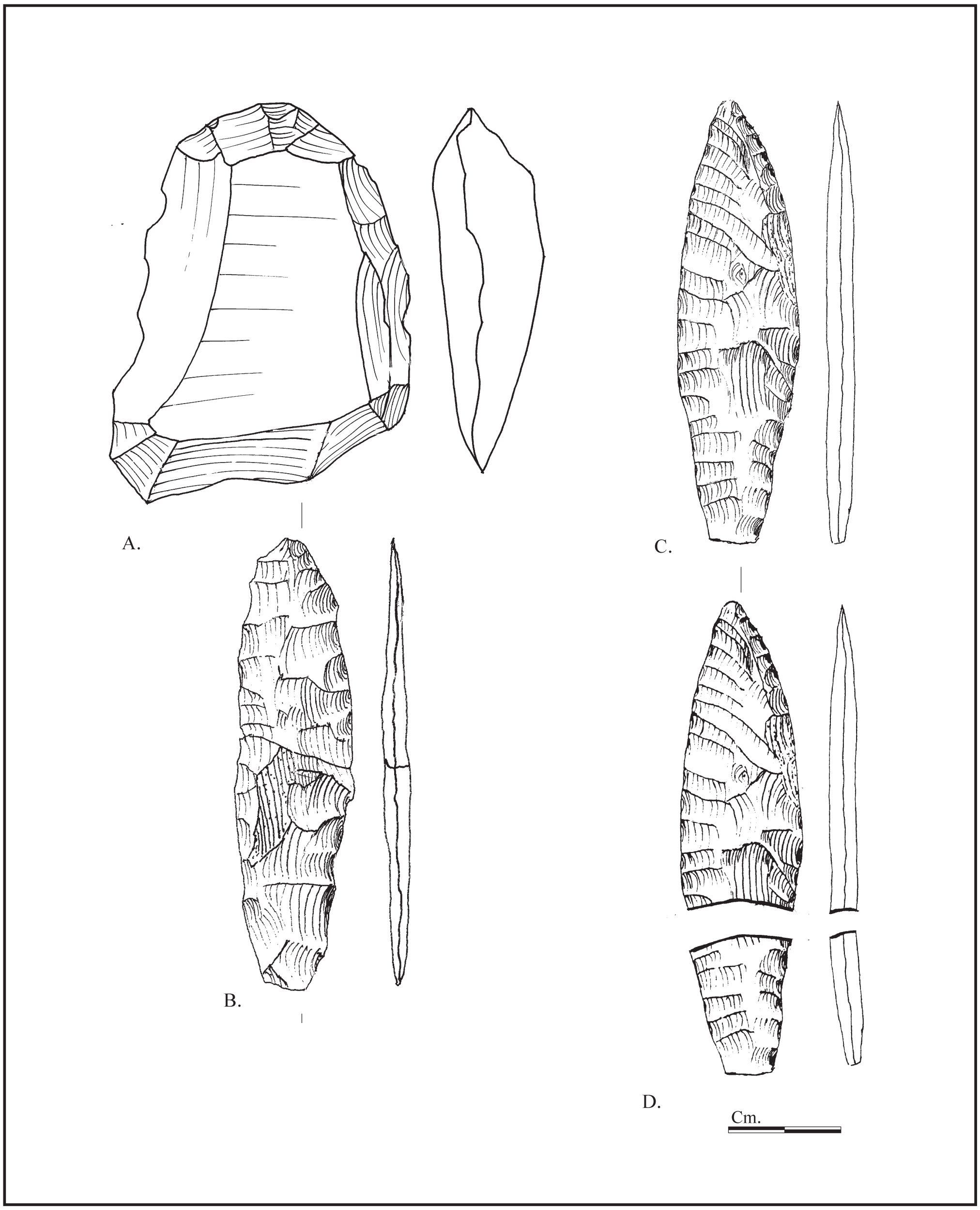


Fig. 4.1.25
The *chaîne opératoire* for lance blades. Examples are from Itinnera, made from killiaq.

Arrowheads

Step 1

Flakes of killiaq made from 'Nuussuaq cores' are selected as blanks for the arrowheads. The flakes have to be thin and without curvature (figure 4.1.26: A). Sometimes, but rarely in West Greenland, flake blanks made of basalt, mcq, crystal or quartzite are used. The flake blank is bifacially worked, and sometimes it can be noticed that the proximal end of the flake becomes the distal point of the arrowhead (figure 4.1.26: B). The preform is shaped into a symmetrical pointed oval morphology with an oval cross-section (figure 4.1.26: B, C).

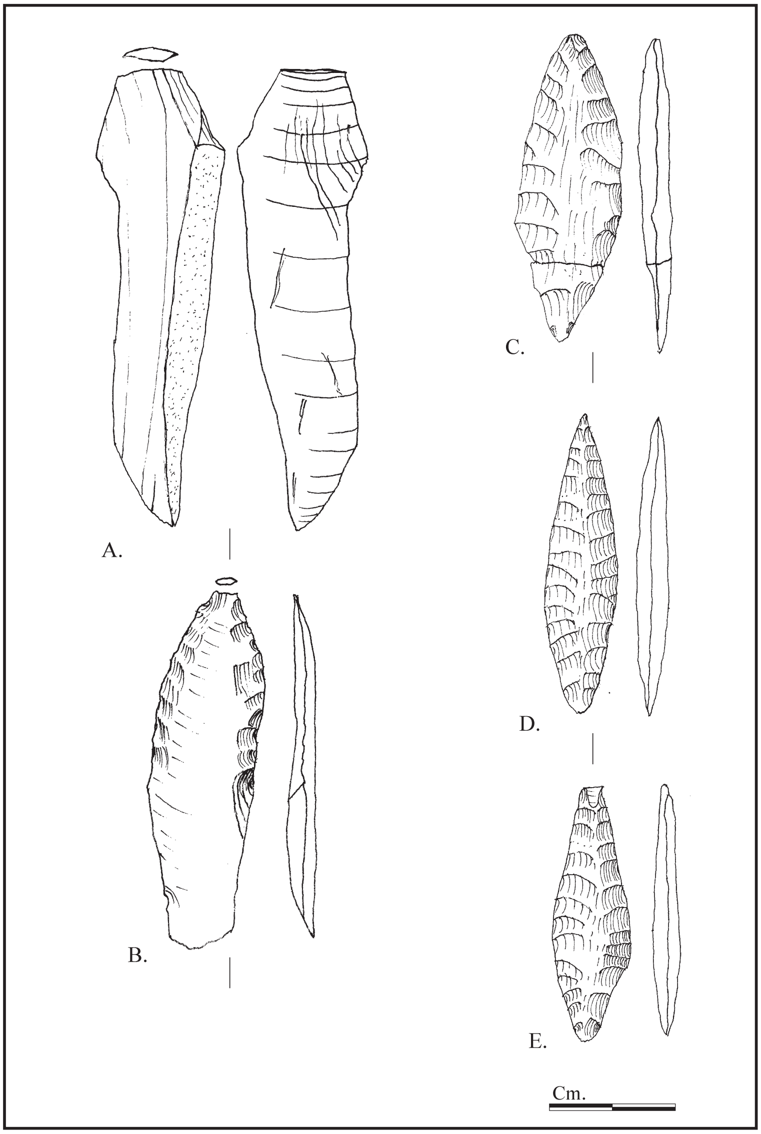


Fig. 4.1.26
The *chaîne opératoire* for arrow points. Examples are from Itinnera, made from killiaq.

Step 2
The preform is refined by pressure technique and it thereby becomes thinner and gets a double conical morphology (figure 4.1.26: C). If the arrowhead is too thick it is common to grind the two faces. A few arrowheads are even seen with a ground tip. The basal lateral edges are often ground in order to improve the hafting.

Step 3
It is probable that arrowheads have been hafted in a fore shaft bound to the arrow, as seen from preserved specimens at QT. Arrowheads have most probably been used for the hunting of land mammals, especially caribou. This could explain the relatively high frequency of arrowheads at inland sites, e.g. at Itinnera (figure 4.1.5).

Steps 4–5
The arrowheads are found discarded with typical impact fractures (Fischer et al. 1984). In principle, small tip fractures can be repaired by rejuvenation. However, this is not documented.

Discussion
When the amount of broken preforms are compared to the amount of finished or impact-damaged arrowheads in the Itinnera assemblage, it can be seen that the amount of broken preforms are double that of the finished and discarded arrowheads. Modern experiments indicate that it is common to break two preforms before one complete thin biface is produced by pressure technique, depending on the experience and skill of the knapper (Whittaker 1994). The many broken arrowhead preforms at Itinnera indicates that the arrowheads were generally made at the site.

Harpoon points

Step 1
For the production of harpoon points in West Greenland, killiaq is used exclusively. Thin straight flakes are chosen as blanks for the production (figure 4.1.27: A). The preform is fashioned into a triangular pointed morphology by pressure retouch.

Step 2
The harpoon point is given its final morphology with great precision. Hereafter both faces of the point are thoroughly ground until the thickness is approximately 1 mm. Only the edges of the point are left un-ground (figure 4.1.27: C).

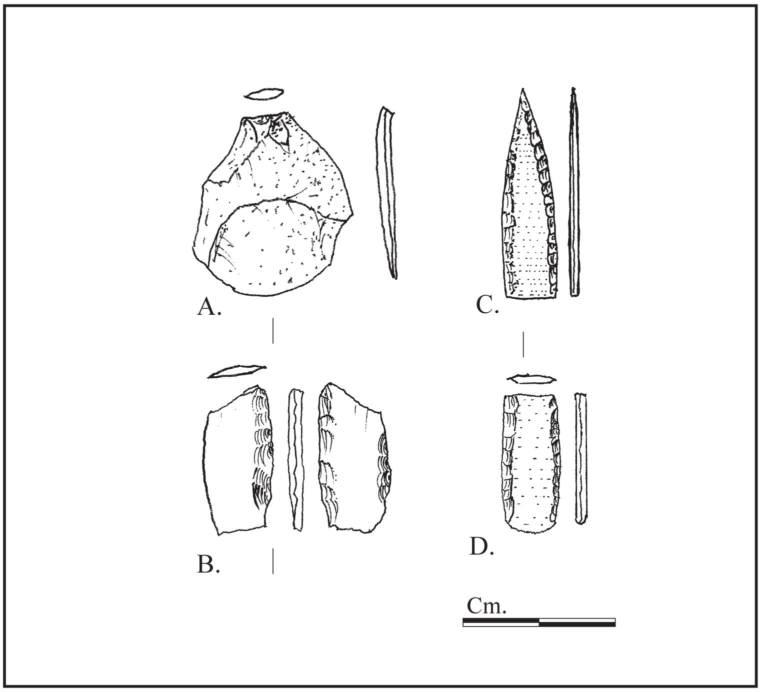


Fig. 4.1.27
The *chaîne opératoire* for harpoon points. Examples are from Itinnera, made from killiaq.

Step 3
The harpoon point is fitted into a 1 mm wide slot in the harpoon head, without the use of any glue or binding. The harpoons have probably been used for the hunting of sea mammals.

Steps 4–5
Harpoon points can in principle be rejuvenated. However, due to their thin cross-section it is most possible that they break during use, and thereafter are discarded.

Awls

Step 1
Thin straight flakes made of killiaq (or basalt on the east coast) are chosen for the production of awls. The lengths of the flakes have to be a minimum of 5–6 cm (figure 4.1.28: A).

Step 2
The preform is reduced to an oblong narrow morphology by pressure retouching

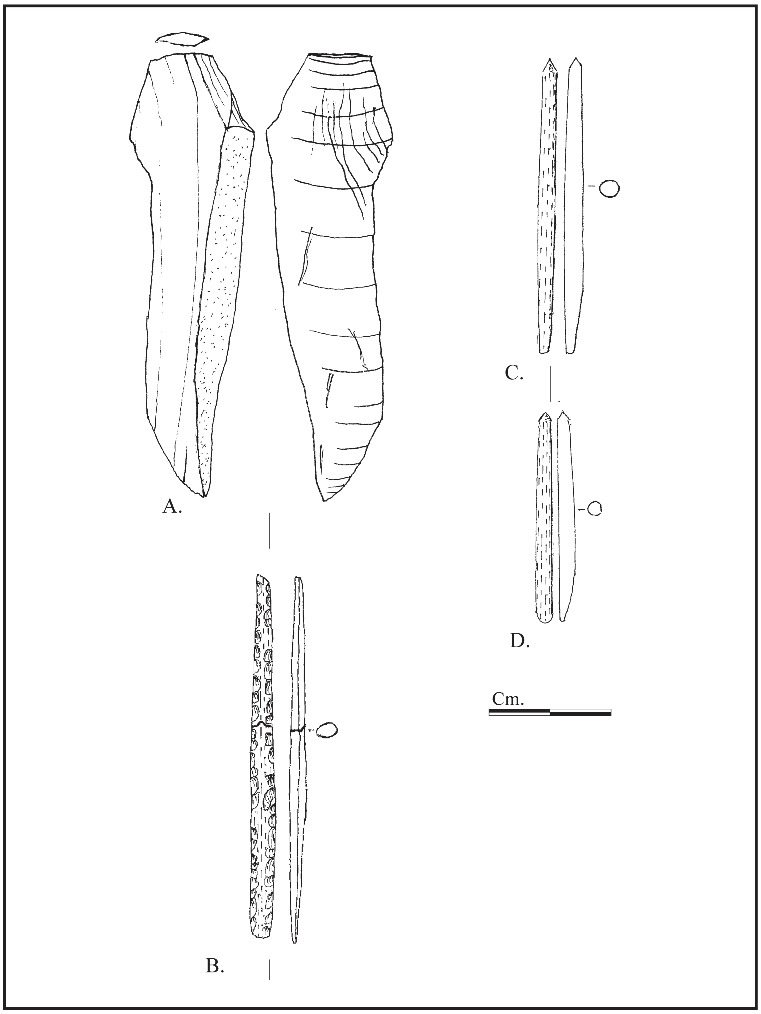


Fig. 4.1.28
The *chaîne opératoire* for awls. Examples are from Itinnera, made from killaq.

the lateral edges of the flake blank. It is very difficult to produce such narrow thin lithic tools as the Saqqaq awls. Four broken fragments of preforms from Itinnera demonstrate these difficulties among the Saqqaq knappers (figure 4.1.28: B). The preform is ground on both edges and faces in order to produce a circular cross-section (figure 4.1.28: C). The distal end of the awl is then ground symmetrically to a point, while the base is given a ground facet.

Step 3
The ground facet at the base is probably made in order to improve the hafting. Due to its faceted end, the awl will not turn in a haft. No awls have been found hafted, but a possible haft was found, in the form of a circular, extremely well-made haft

from Itinnera, made from walrus tusk (Birket-Smith 1962). This haft has a circular hole in its distal end, which fits with the diameter of the awls. The awl could have been used for perforating skins when sewing.

Step 4
The distal end of the awl can be rejuvenated by grinding, which will gradually reduce the length of the awl (figure 4.1.28: D).

Step 5
The awl is discarded when broken or when re-sharpened so that it becomes too short.

Saws

Step 1
Large straight flakes made of killiaq are chosen as blanks for the production of saws (figure 4.1.29: A).

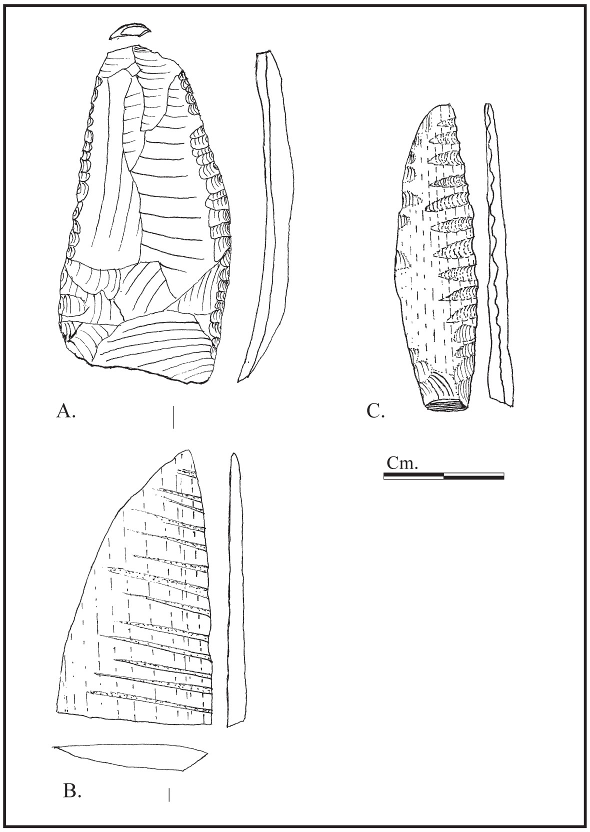


Fig. 4.1.29
The *chaîne opératoire* for saws. Examples are from Itinnera, made from killiaq.

Step 2
The preform is shaped into half-moon morphology by unifacial retouch. The cross-section of the preform becomes triangular and asymmetrical. The distal end of the preform is completely ground, while the base is not ground. The ventral face of the preform is kept flat and the dorsal is given an angled facet where the sawing edge is made. Grooves are made for every 3 mm, ground into the ventral face at a right angle to the edge (figure 4.1.29: B). The grooves give the tool a regular denticular sawing edge.

Step 3
It is possible that the saw has been hafted, since the base is shaped into a standardized morphology. However, no possible hafts are yet excavated. Considering the specific morphology of the saw, it seems possible that it had a very specific function. The fragile denticulation suggests that the material worked must have been a soft organic material, e.g. meat or blubber.

Step 4
The saw is rejuvenated by enlarging the grooves by grinding, whereby the denticulation is sharpened and the blade is narrowed down (figure 4.1.29: C).

Step 5
The saw is often discarded due to breakage, but sometimes also due to reduction caused by repeated re-sharpening.

Discussion
The possible knife function of the saw means that a more appropriate terminology for this tool would be ‘knife with denticular edge’.

Strike-a-lights

Steps 1–2
Strike-a-lights are most often produced from small, used-up killiaq cores (figure 4.1.30: A).

Steps 3–4
The shaping of this tool type is generally generated during use, i.e. by hitting the stone repeatedly onto pyrite. In this manner the strike-a-like is rounded. The specimens investigated had a partially polished surface, which could be a result of long-

Fig. 4.1.30
The *chaîne opératoire* for strike-a-lights. Examples are from Itinnera, made from killiaq.

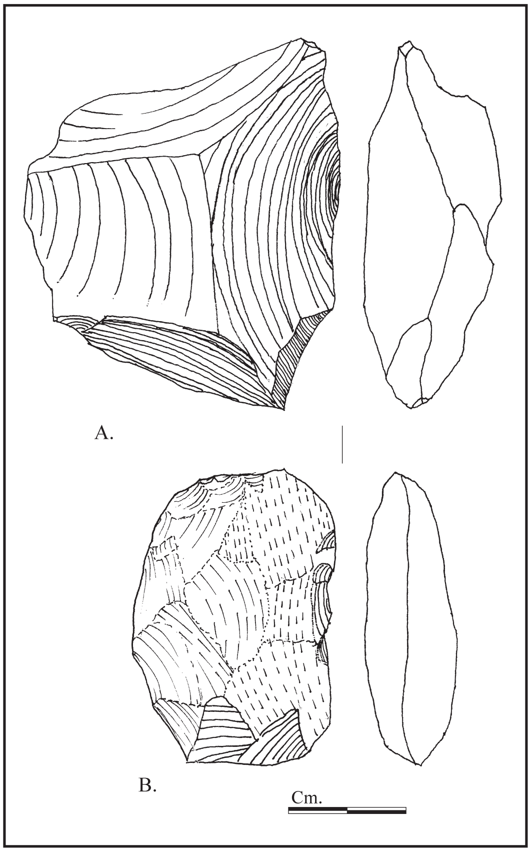
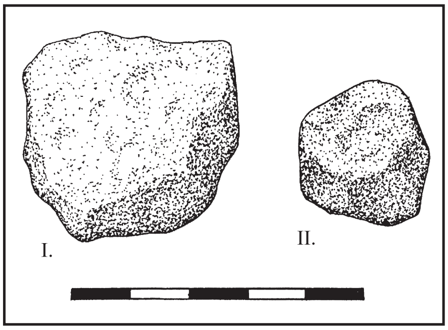


Fig. 4.1.31
Pieces of pyrite, probably for making fire, found at Qeqertasussuk.



term use and from being carried around (figure 4.1.30: B). From QT, examples of pieces of pyrite have been excavated (figure 4.1.31).

Step 5
The strike-a-light is probably discarded when its edges are so rounded that it cannot release sparks from the pyrite.

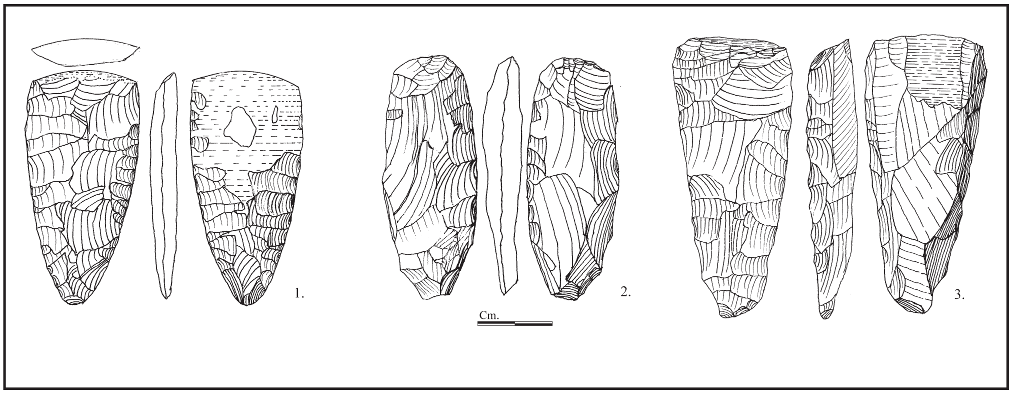
Discussion
Within the Palaeo-Eskimo period the stone-pyrite technology is used, while nothing is known about the wood on wood technology for making fire (Stapert & Johansen 1999). The morphology of the strike-a-lights differs between the Palaeo-Eskimo traditions.

Adzes

Three technologically and morphologically different productions of adzes can be described from Saqqaq (figures 4.1.32 and 4.1.33):

1) A thin bifacial adze type with a broad edge (30 mm)
2) A bifacial adze type with a narrow edge (15 mm)
3) A unifacial adze type

All the adzes have slightly convex lateral edges. The cutting edges on all adzes are asymmetrical and most often thoroughly ground. The face/side of the adze on



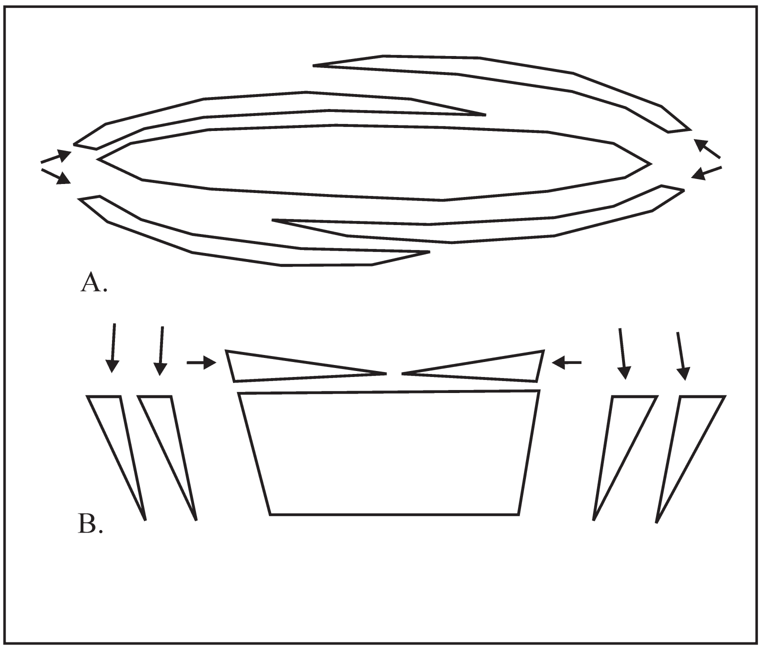


Fig. 4.1.32
Different types of adzes, made from killiaq, from the site Itinnera:
1) broad bifacial adze, 2) narrow bifacial adze,
3) unifacial adze.

Fig. 4.1.33
Cross-sections of adzes produced bifacially (A) and unifacially (B).

which the cutting edge is situated is normally very ground, while the lateral edges are slightly ground. The cutting edge angles vary from 40 to 70 degrees, thus sometimes the edge is extremely steep.

Step 1 (bifacial adzes)
Adzes from West Greenland are made from killiaq, and in East Greenland from basalts. Blank types must have been single cores, perhaps a 'Nuussuaq core' type. The core is worked roughly into a thick bifacial preform.

Step 2 (bifacial adzes)
The preform is bifacially worked by soft hammer technique into a symmetrical adze morphology with a symmetrical oval cross-section (figure 4.1.34: B). The cutting edge is made unifacial and therefore becomes asymmetrical. The cutting edge and the cutting edge face are thoroughly ground, and the lateral edges are slightly ground too.

Step 1 (unifacial adzes)
The unifacial-worked adzes are made from flat or tabular core pieces, or some-

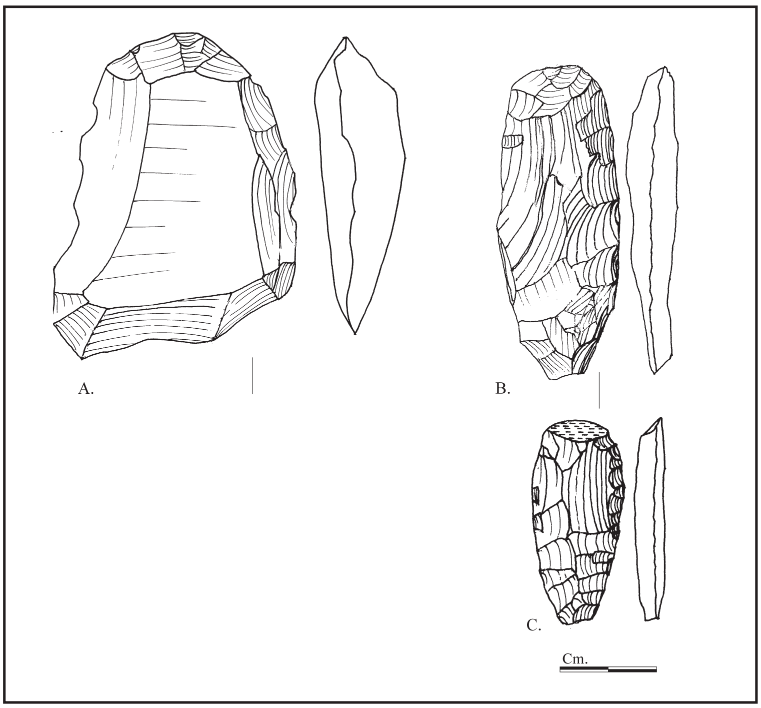


Fig. 4.1.34
The *chaîne opératoire* for bifacial narrow adzes. Examples are from Itinnera, made from killiaq.

times from large flakes. In West Greenland the chosen raw material is killiaq. The shaping of the adze is achieved by knapping off flakes solely from one face, and then thinning the adze by a series of flakes from this edge (figure 4.1.33).

Step 2 (unifacial adzes)
The cutting edge is made as on the bifacial adzes and the grinding is similar also.

Step 3
Broken fragments of adzes and preforms indicate that the length of these tools normally must have been at least 10 cm from the beginning of their use. Stray finds of finished bifacial adzes are as long as 15 cm. Since the cutting edges generally are asymmetrical, the adzes must have been hafted in some kind of a standardized haft type. No such adze hafts are found in Saqqaq. Judging from the steep cutting edge angles, the adzes have been used in hard organic materials, i.e. driftwood. But it is also possible that the adzes have been used during early steps of soapstone working.

Step 4
The cutting edge is ground repeatedly during their use phase, which shortens down their length (figure 4.1.34: C).

Step 5
The adzes are discarded when they are too short for the haft, or due to breakage. The large bifacial adze type is discarded at a length of 6 cm, while the small bifacial adze is discarded at a length of 4 cm. These discard lengths must reflect the haft type for the two bifacial adze types.

Discussion
The appearance of different technological principles for the adze production probably has to do with both function and preferences. A narrow cutting edge has obvious advantages for finer working processes. However, the unifacial adze production method does not result in a different functional product than the bifacial adze type. This method could therefore reflect a personal or a regional preference.

Blades
Metrically it can be seen that the width of the blades is between 3 and 6 mm (figure 4.1.35), while the length generally is between 20 and 40 mm (figure 4.1.36). A relatively high percentage of the blades are complete, probably due to their short

length. Meridial breaks and proximal breaks seem to be dominant in the assemblage (figure 4.1.37).

Fig. 4.1.35 Width of microblades from the Itinnera assemblage.

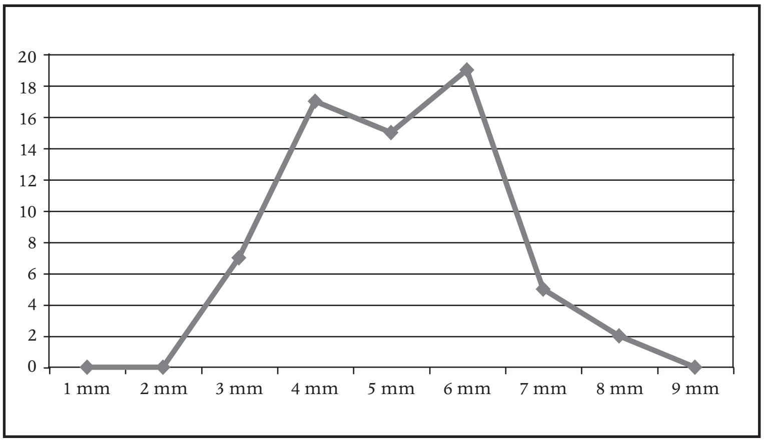


Fig. 4.1.36 Length of complete microblades from the Itinnera assemblage.

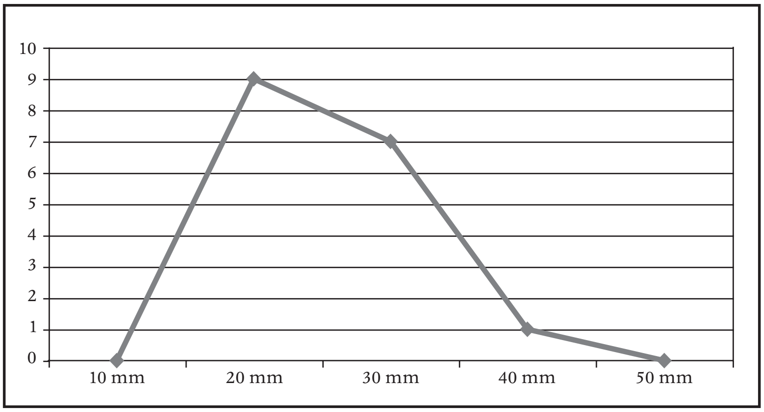
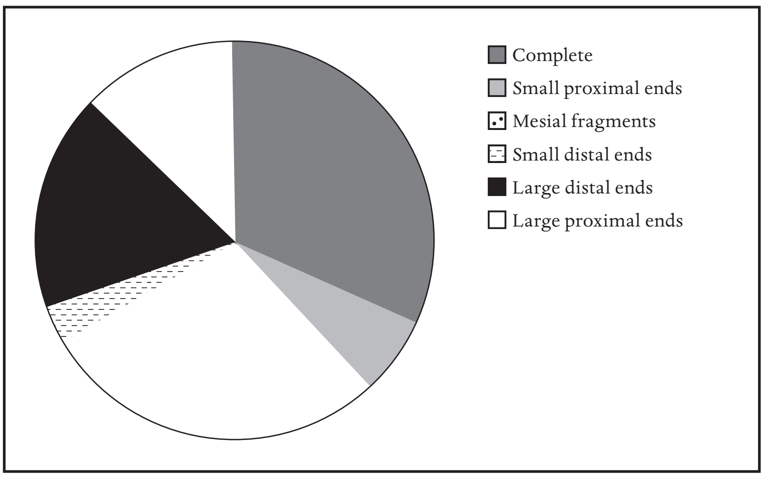


Fig. 4.1.37 The fragmentation of microblades from the Itinnera assemblage.



Step 1

Quartz crystal or mcq are chosen for the production of microblade cores in Saqqaq. Blade cores are produced by three different methods depending on technology and raw material:

Quartz blanks are seen as crystals, a morphology that does not need much preparation before the first blade can be detached. Most often the core is ready after the production of a platform by a single platform flake (figure 4.1.38: B1).

At Itinnera, examples of the 'Yubetshu method' for blade production are found. A core of mcq is bifacially worked and a platform flake is detached along one side. The core is then prepared for the first blade detachments (figure 4.1.38: B2).

Keeled mcq cores are produced in a way so that a natural blank surface can be used as a platform during the first sequence of blade production, after which it is faceted.

Step 2

The core types are in all probability uni-polar and single-fronted. When method 2 and 3 are used, the first blades detached can be crested blades (figure 4.1.38: C2). The width of the core fronts are only c. 1 cm. Blades are produced in a similar way for all the core preparation methods. The blades are serially produced from one narrow front, while the platform is prepared and faceted repeatedly during the process. In this way the blade core gradually becomes smaller and shorter as the blades are produced. The regularity of the blades and the cores and the very small size of the cores indicate that the blades are produced by means of pressure technique and that the cores have been fixed mechanically during the blade production. The blade cores are reduced until they are about 2 cm high (figure 4.1.38: B1, B2, B3).

Step 3

The edges of the blades become working edges for cutting. The unmodified microblade edge has a greater sharpness than any other lithic edge type. Several of the blades have lateral retouch, which could indicate the existence of a hafting system. One excavated haft, from QT, of a microblade suggests that these have been hafted in their proximal ends (Grønnow 1994).

Step 4

Microblades cannot be re-sharpened, but will typically be changed and discarded when dull. A microscopic study of quartz crystal blade edges, however, indicates that these have a tendency to become sharper during use due to microscopic flaking of the edges (Gulløv et al. 1993).

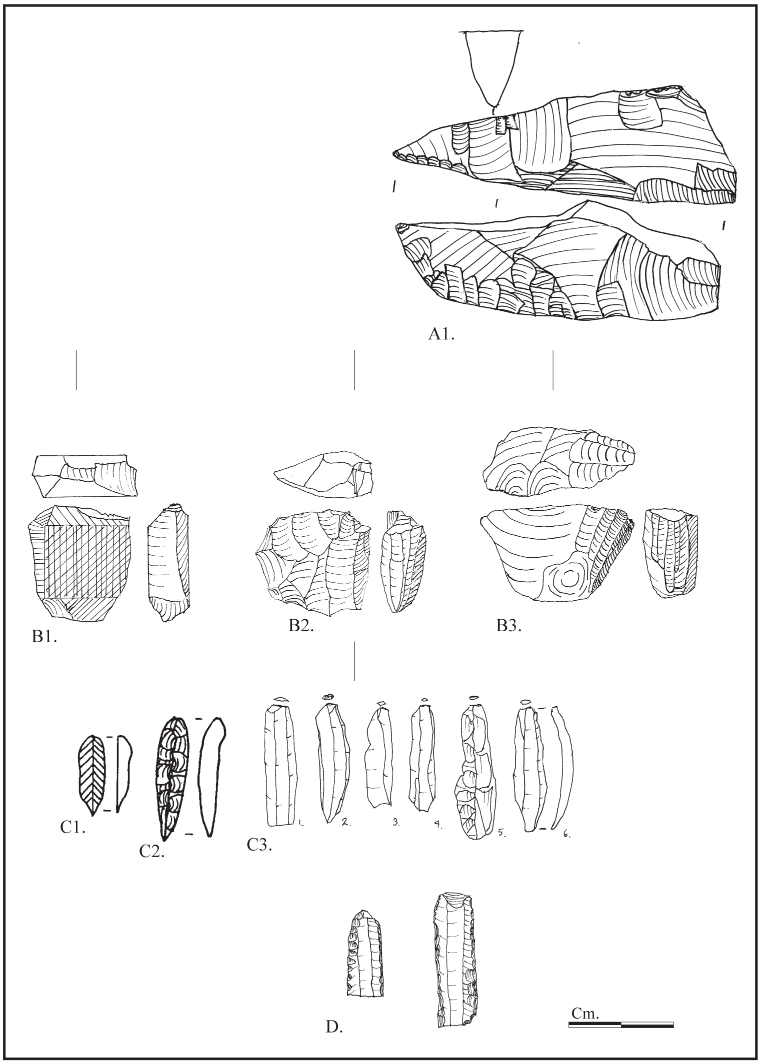


Fig. 4.1.38
The *chaîne opératoire* for the production of microblades in the Saqqaq tradition. Three variations of the method are seen:
1) Production from naturally formed quartz crystal,
2) Preform made as bifacial core (Yubetshu method),
3) Wedge shaped, single fronted preform.

The flake material

Metrical analysis

The majority of the flake material from Itinnera is smaller than 3 cm. Only few flakes made of mcq or quartz crystal are larger than 3 cm. Killiaq is the raw material with the largest frequency of big flakes, despite its long export distance (figure 4.1.39).

Morphological analysis

Large flakes of killiaq (figure 4.1.40: I–IV) generally display characteristics such as:

several dorsal negatives, irregularity, a slight curvature, approximately 1:1 relation between width and length, an oval butt which often has several facets, an angle between butt and ventral side from 40 to 75 degrees, diffuse bulbs and pronounced lip formations. Moreover, the preparation of the platform edge is most often very ground (figure 4.1.41). The preparation of the smaller mcq flakes is characterized by moderate abrasion.

The larger flake types generally derive from early steps of a bifacial reduction process. These flakes can be termed 'interior flakes' and 'early bifacial thinning flakes' (figure 4.1.40: I, II) (Yerkes & Kardulias 1993). The majority of the small flake material, from all the raw material types, is typically from the later process of bifacial thinning (figure 4.1.40: III, IV), but alternate flakes are found too (figure 4.1.40: V, VI). Flakes smaller than 1 cm probably typically derive from preparation of the tools or from their re-sharpening. Flake X (figure 4.1.40) is made from mcq and is a typical example of a 'tensile' fracture from a bifacial working process. Its butt is faceted and isolated and has probably been too strong, which has resulted in breakage behind the platform. This flake type is a typical result of direct soft hammer technique (Roche & Tixier 1982). Moreover, the flake type can be fatal due to its reduction of the width of the (unfinished) tool. Flake XI (figure 4.1.40) is

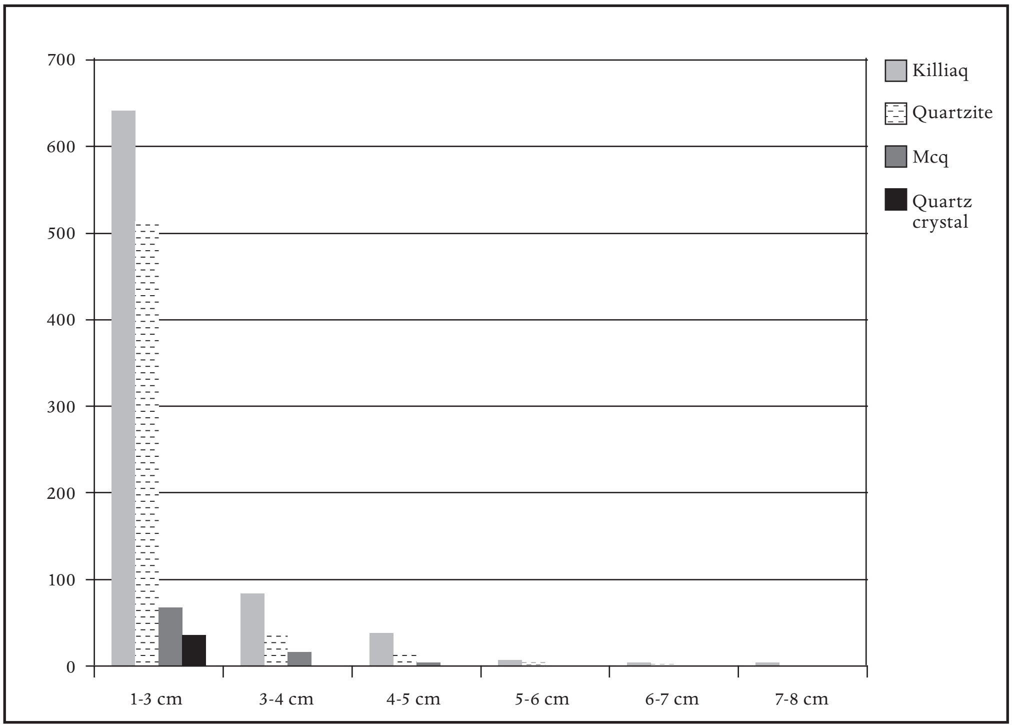
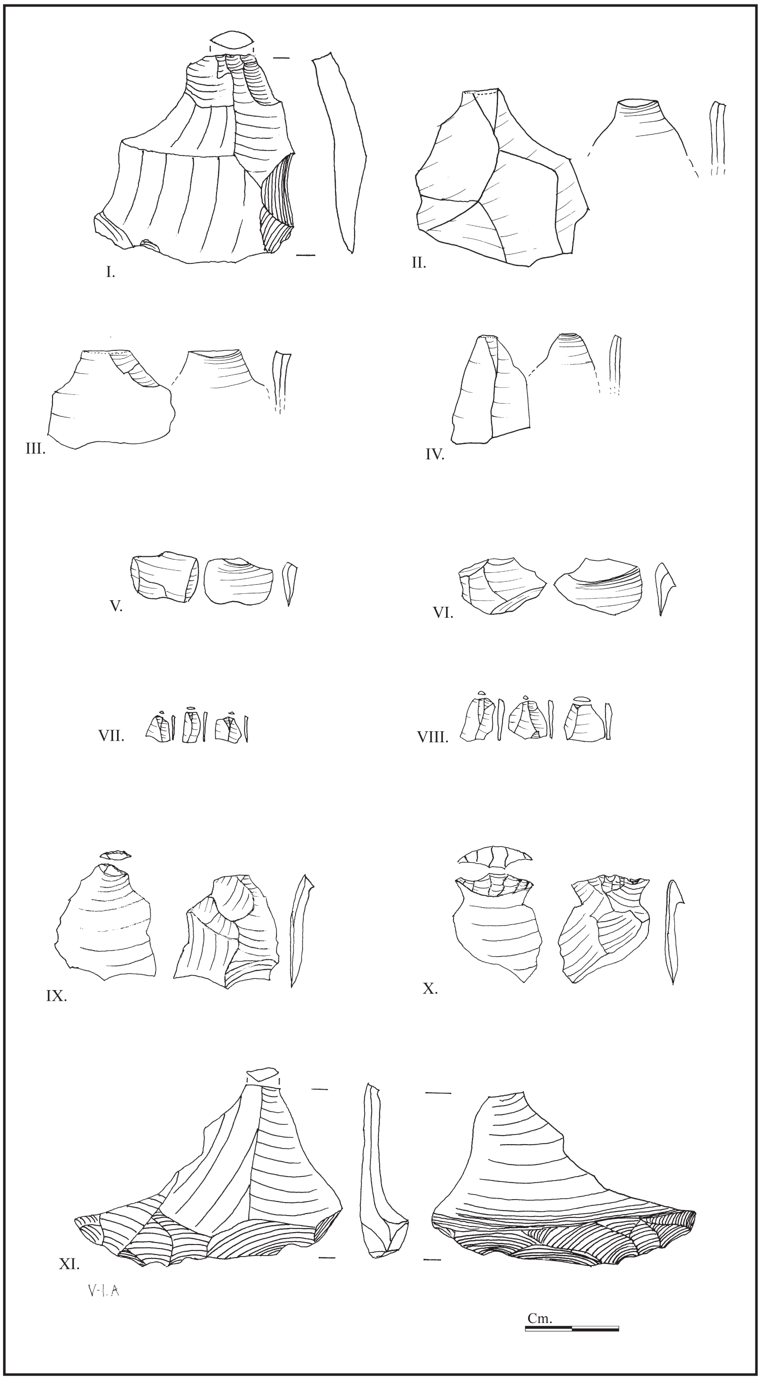


Fig. 4.1.39 Sizes of flakes in relation to raw material types in the Itinnera assemblage.

Fig. 4.1.40
Typical types of flakes from the Saqqaq tradition. Examples are from the Itinnera assemblage. Flakes I–IIIV are made from killiaq, while flakes IX–XI are made from mcq. Flake X is an example of how the flake platform has broken a large piece off the core. Flake XI is a plunging flake. Both flakes are examples of typical accidents related to bifacial knapping. Flake IX is an example of a perfect detachment made by direct soft percussion in a bifacial production. Flakes are from the Ittinera site, made from mcq.



made out of mcq and is a typical bifacial knapping mistake called a plunging flake (Inizan et al. 1999). This flake has probably been fatal to the production of a large biface preform, due to its reduction of the width of the preform (figure 4.1.42).

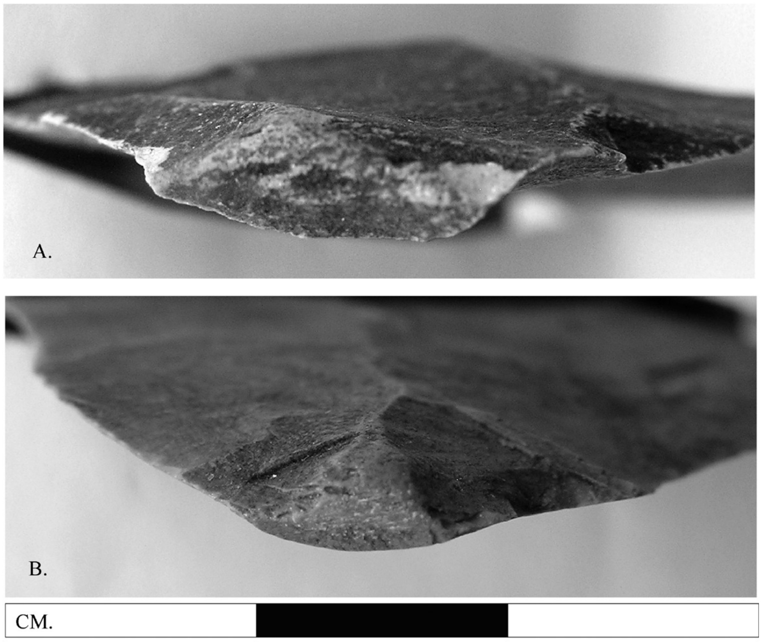


Fig. 4.1.41 Macroscopic photo of platform remnants on bifacial flakes made from killiaq. A heavy abrasion is seen on the platform edge, made as a preparation before the flake is detached from the core. The example is from the site Qaarsut Killeq.

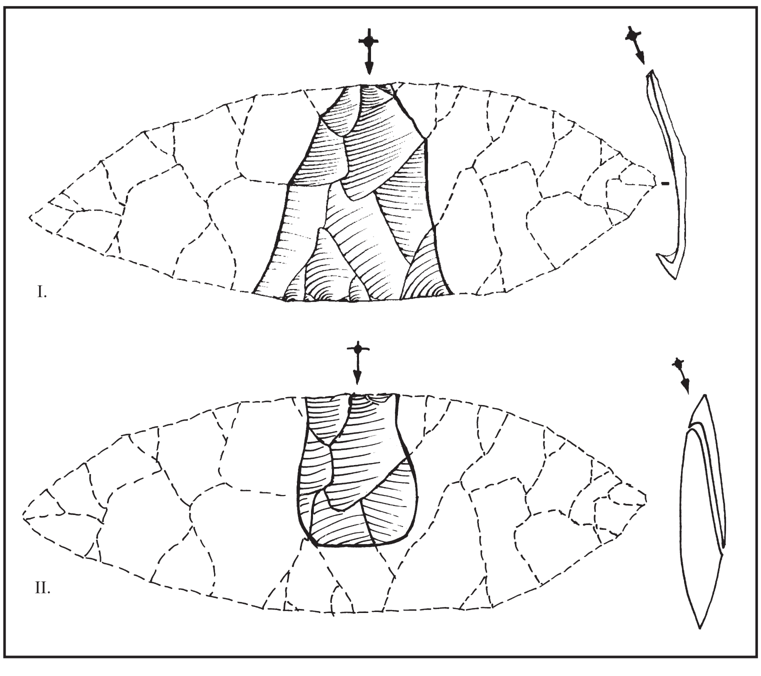


Fig. 4.1.42 A schematic drawing of the typical accidents related to a bifacial knapping method: platform collapse (II) and plunging (I). Both accidents reduce the width of the biface.

Tools used for lithic reduction

Pressure flakers
In total, 43 pressure flakers from Itinnera are investigated and compared to the published pressure flakers from Nipisat (Gotfredsen & Møbjerg 2004).

Morphology
Pressure flakers are 22–48 mm long, with a width from 6–11 mm and they normally have an oblong cross-section. Typical for the pressure flakers are that their distal ends are rounded and have a pronounced wear, seen as striations. The basal ends are often thin and not worked, compared to the used ends. In few situations the pressure flakers have been used in both ends (figure 4.1.43).

Use wear
On well-preserved pressure flakers, a use wear consisting of 1–2 mm long scratch marks and striations are seen in the distal ends. The direction of these marks is nearly right angled to the length of the pressure flakers and must reflect the user's original holding position (figure 4.1.44). The use wear observed suggests that it is the sides of the rounded tip in particular that are subjected to contact with the lithic material. Most of the pressure flakers found have extremely rounded distal ends, which probably reflects a worn out morphology. It is likely that the pressure flakers, during use, had more pointed distal ends as seen on only few original specimens (Gotfredsen & Møbjerg 2004: no. 12161).

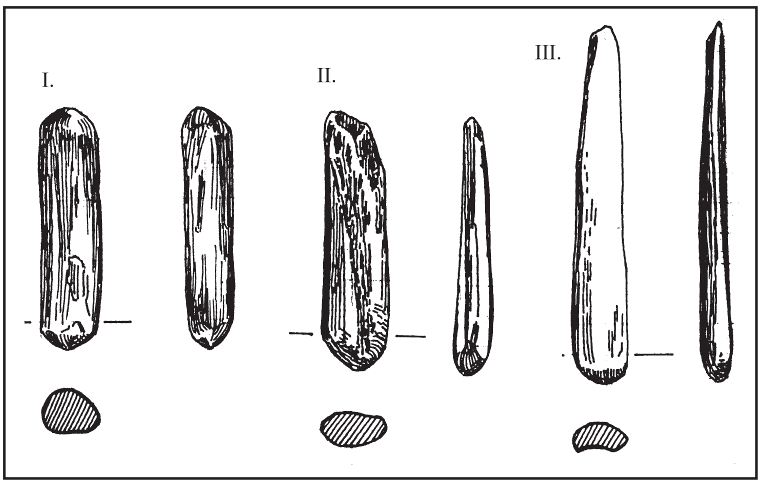


Fig. 4.1.43
Pressure tool points from the Itinnera site.

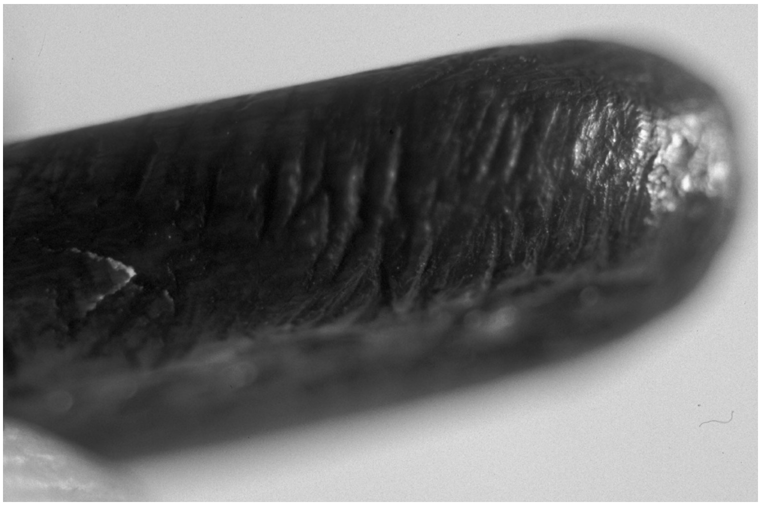


Fig. 4.1.44 Macroscopic use wear on distal end of a pressure point from the Itinnera assemblage.

Material

The Saqqaq pressure flakers are produced from the elbow bone of seals or of caribou antler (Gotfredsen & Møbjerg 2004), from walrus rib bone (Rosing 1978) or from tusk of walrus (Gulløv & Kapel 1988).

Production

It is the most compact part of the bone or antler that is used for the tip of the pressure flakers. Bone or antler material is split longitudinally and lamellas made from dense outer layers are preferred. The inside, porous material in a bone or antler is soft and not suitable. The bone/antler lamella's most solid end is chosen as the tip, and this end is rounded thoroughly.

Possible hafts for pressure flakers have been excavated at QT. One of these specimens is made from juniper. It has a rounded basal end while in the other end there is a large round groove, possibly used as a 'bed' for the pressure flakers (figure 4.1.45). Two other specimens from QT could well be interpreted as similar pressure flaker hafts (Grønnow 1996: 24). Modern replications of this haft type with inserted hafted pressure flakers have been used for bifacial pressure retouch, and are found to be highly functional (appendix 8.1).

Discard

Pressure flakers are discarded when they, due to use and rejuvenations, are too short for the hafting.

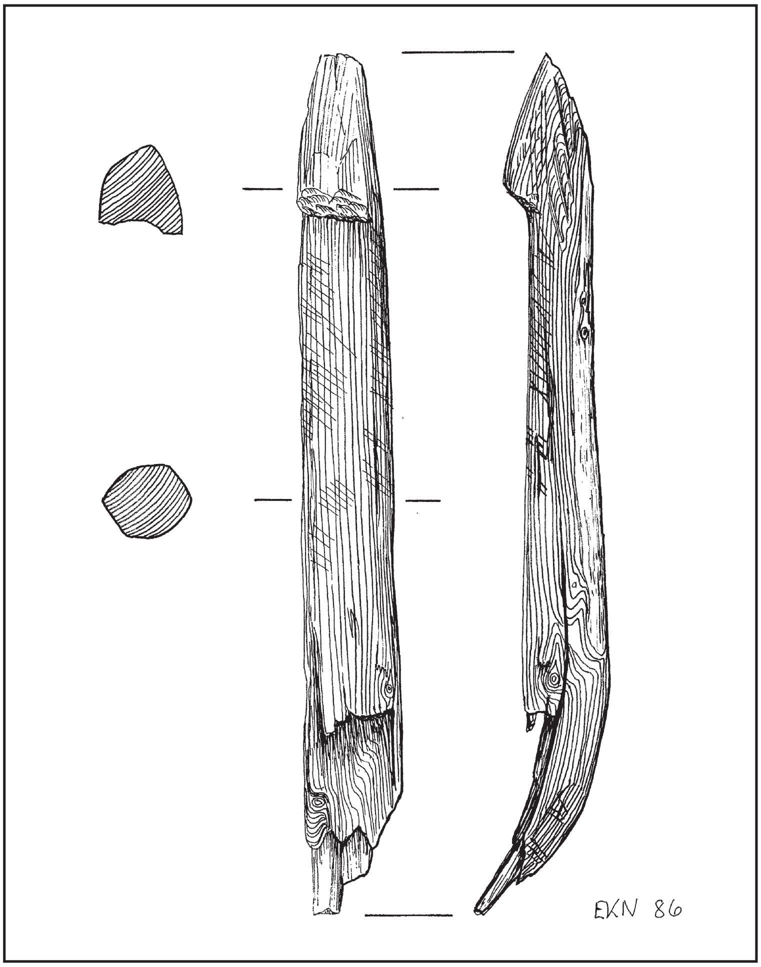


Fig. 4.1.45
A possible handle for a pressure tool point made from juniper. Length 11.4 cm. (Drawing E. Koch).

Hammers and punches
At Itinnera, an artefact made from walrus tusk can be interpreted as either a hammer or punch for lithic reduction (Rosing 1978) (figure 4.1.46). The heavy end of the tool is rounded and has several impact marks, presumably from knapping a lithic material. The basal end is straight cut but has pronounced polished edges and surfaces. Moreover, from the base a piece of tusk is split off – possibly due to hammering of this end.

From QT, two specimens can be interpreted as a hammer and a punch. The punch-like artefact has a very similar morphology to the specimen from Itinnera. It is made from a hard organic material, perhaps bone or tusk. Unfortunately, the piece is badly preserved (figure 4.1.47). The other piece is made from sperm whale tooth and must be interpreted as a hammer. This piece has a rounded distal end with several impact marks, indicating that it has been used for lithic reduction. The basal end has its natural hollow morphology, and shows no use wear. Replication and experimentation, by the author, with a similar sperm whale tooth hammer documents that this tool type is very appropriate as a soft hammer in a bifacial knapping process (chapter 8, figure 8.1.7).

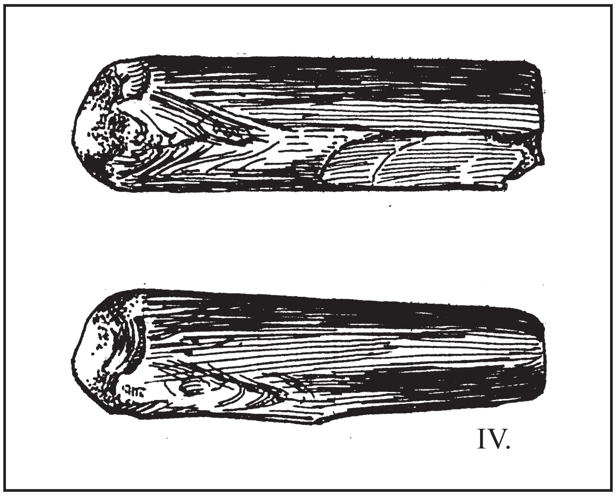


Fig. 4.1.46
A possible impactor for direct lithic percussion made from walrus tusk. Length 6.2 cm. (Drawing J. Rosing).

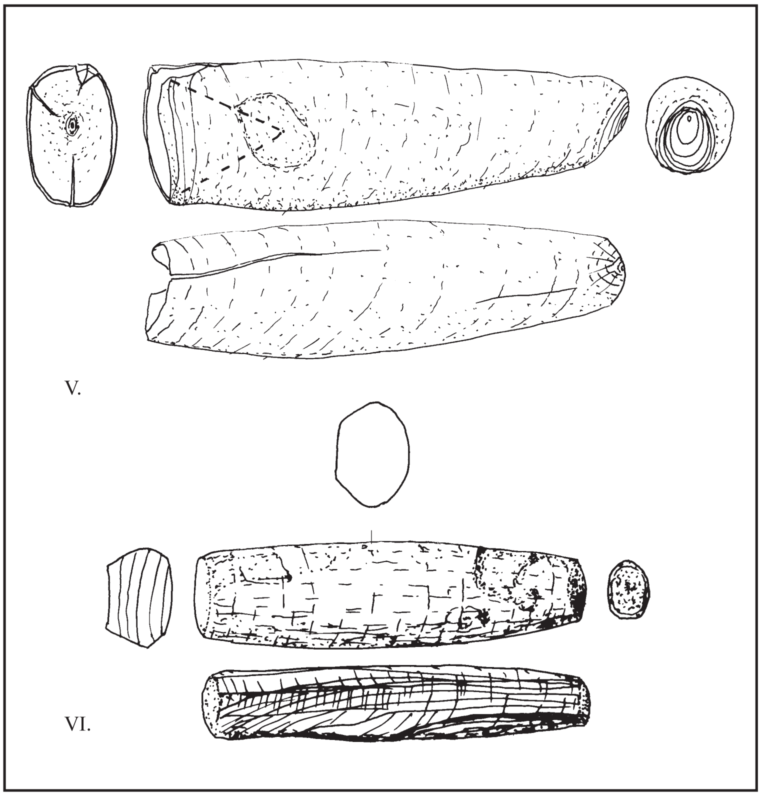


Fig. 4.1.47
Possible lithic percussion impactors from the Qeqertasussuk assemblage. Impactor V is made from a sperm whale tooth (8.2 cm long). The material of impactor VI is unidentified (6.6 cm long).

Hammer stones

Three possible hammer stones at Itinnera have been located (figure 4.1.48). One made of quartzite has the size of a child's hand (1), weighing 177 g. A second is a round granite stone the size of a man's fist (2), weighing 512 g. Finally, there is a smaller rounded granite stone (3), weighing 325 g. All the stones have obvious impact marks, mostly subjected to their pointed ends.

At the site Qaarsut Killeq, a hammer stone made from gneiss was located (figure 4.1.49). The stone has pronounced traces of hammering and is partly split in both pointed ends. It is very likely that this hammer stone has been used for the production of 'Nuussuaq cores' from killiaq, due to the killiaq outcrop nearby and the vast amounts of killiaq flakes and cores found at this site (Sørensen & Pedersen 2004, 2005).

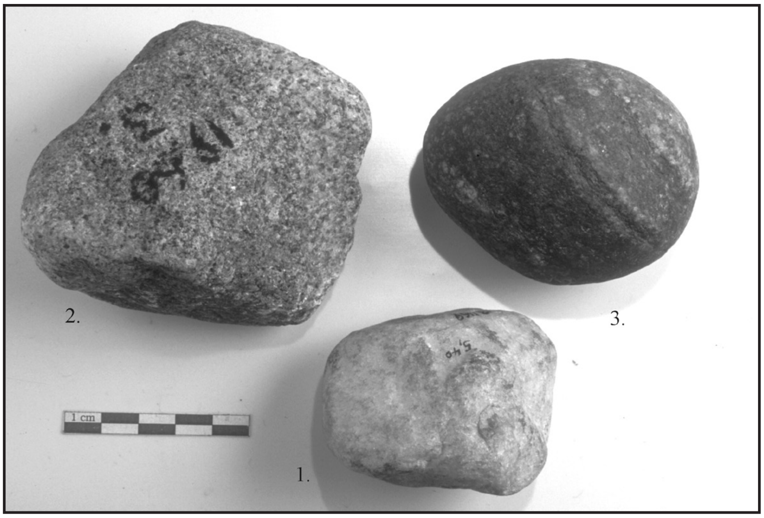


Fig. 4.1.48 Hammer stones from the Itinnera assemblage.

Fig. 4.1.49 Hammer stone made from gneiss from the Saqqaq site at Qaarsut Killeq. The stone is 9.0 cm long.

Discussion

Comparison of technology and typology between QT and Itinnera (figure 4.1.50): It is significant that all tool types at the two sites have been produced similarly, with the same strict respect to morphology and technology. The few differences in technology that can be listed are: 1) quartzite is to some extent used as killiaq at Itinnera, 2) At Itinnera there are a few examples of quartzite bifaces with notches, a morphology that does not appear at sites in the Disko region.

When frequencies of the lithic tool types are compared for the two sites, few and pronounced variations are seen.[4] At Itinnera arrows and lances are nearly twice as common as on QT. However, on QT three times as many harpoon points are seen. This difference has to be explained functionally: Itinnera is an inland site where caribou have been hunted with arrow and lance, while QT is a coastal site where marine mammals often have been hunted with harpoons.

However, it can still be concluded that all the same tool types appear at the two sites and that the technology and morphology is extremely similar, despite the distance in time and space between the two sites.

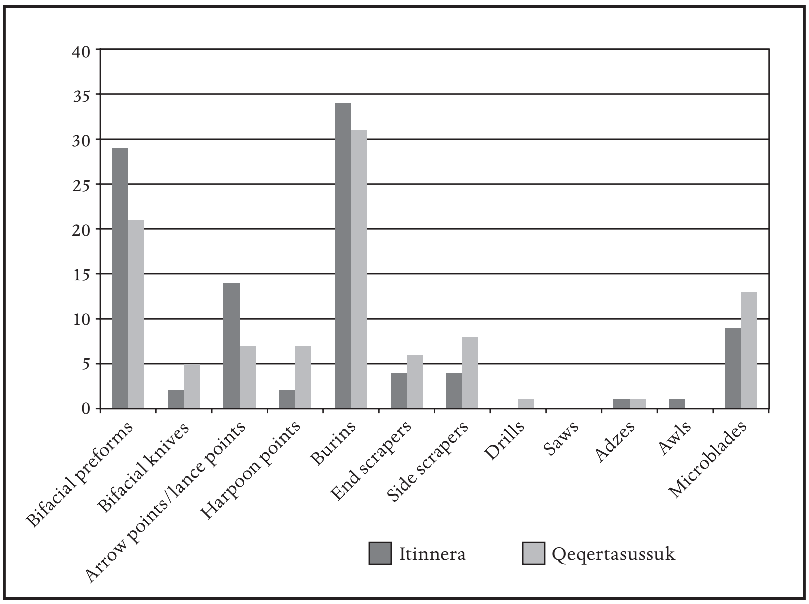


Fig. 4.1.50
A quantitative comparison of formal tool types from Itinnera and Qeqertasussuk.

4 Concerning the classification of the tool types a few precautions have to be taken: at QT, B.Grønnow's original classification is used, which does not separate lances and arrowheads. Microblades are classified metrically by Grønnow and technologically by the author (Sørensen 2006c).

Conclusion: The Saqqaq lithic concept

Choice of raw material

The primary choice of raw material made by the Saqqaq people in West Greenland is killiaq from Qaarsut, northern Nuussuaq. This material is used systematically for the production of lance heads, arrowheads, bifacial knives, adzes, saws, burins, and strike-a-lights. Only for the scraper and blade production, materials like quartz and mcq are preferred. In the Nuuk region some substitution of killiaq is made with quartzite. On the east coast of Greenland a 'killiaq-like material' is reported used in the Ammasalik region (Møbjerg 1988: 84). However, when analyzed in collaboration with geologists, this material is probably a basalt type that can have been imported from the Kangerlussuaq region on the central east coast. Similarly, the term 'killiaq' in the Scoresbysund region (Sandell & Sandell 1999: 143) has to be corrected and understood as fine-grained basalt, which appears several places in this region. However, the Saqqaq people worked the material as if it was killiaq.

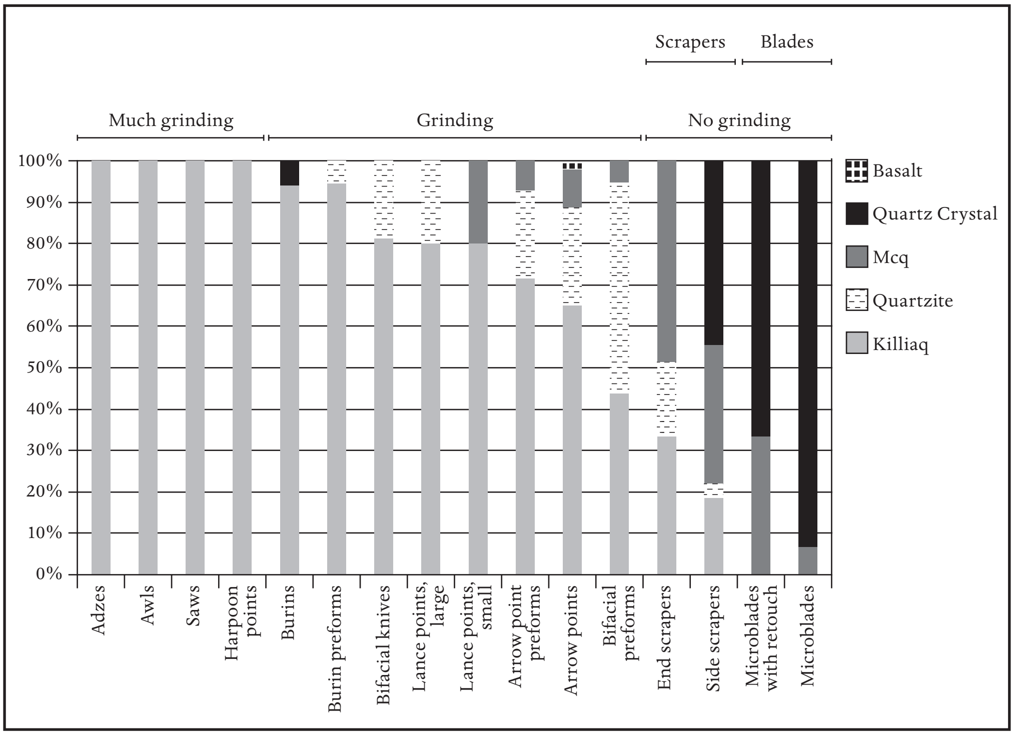


Fig. 4.1.51 A quantitative comparison of which formal tool types are ground in relation to the raw material choice.

When the Saqqaq raw material choice is analyzed, clear functional aspects can be discovered (figure 4.1.51). Four reasons seem to be essential to the choice of killiaq, quartzite, quartz and mcq in relation to the tool type: 1) Tool types with scraping edges (i.e. scrapers) are produced from mcq and quartz rather than from killiaq because these materials are harder than killiaq and therefore will have more durable edges; 2) Large tool types (i.e. large bifacial tools and adzes) are produced from killiaq or basalts maybe because these raw materials are the only appropriate materials that have a large nodule size; 3) Tools that are thoroughly ground are most often made from killiaq, this material is softer and appropriate for grinding; 4) The blade production is dependent on raw materials with the absolute best flaking properties – in West Greenland these materials are quartz crystal and mcq.

Choice of reduction method

Flakes and cores of killiaq demonstrate that a large thick bifacial core (the 'Nuussuaq core type') is the starting point for the majority of the lithic production during Saqqaq. This core type can be perceived as a standardized preform, which is transported and possibly traded, from the northern Nuussuaq peninsula to most of West Greenland (Jensen 2000, Sørensen & Pedersen 2005). Thus the 'Nuussuaq core' can be understood as a preform from which flake blanks can be serially produced. The core itself can be reduced into a large bifacial tool (figure 4.1.52).

Each detachment of a large flake is prepared by thorough abrasion/grinding of the platform edge, while the platform is left un-ground but often largely faceted. The detachments of large killiaq flakes from 'Nuussuaq cores' have been replicated to investigate this method (chapter 8.1, figure 8.1.4). Large killiaq flakes can be used as expedient knives or chosen for the production of the small tool types made from killiaq. The production of most tools is conducted in a bifacial method. However, scrapers with asymmetrical edges are produced unifacially.

The appearance of knapping floors consisting of masses of small bifacial flakes in the vicinity of the killiaq outcrop on Nuussuaq indicates that single preforms for large bifacial tool types also have been exported to Saqqaq sites in West Greenland.

Flake blanks made of mcq are, judged from their morphology, not serially produced, and no large cores of this material are known. It is therefore most possible that single flake blanks have been produced in the western Disko region from small cores and that these have been exported.

It is typical of the Saqqaq technology that each tool type is precisely made, even more precisely than can be functionally explained. The very precise technology and morphology, including the bases, of the lithic inventory in Saqqaq indicates that each tool type had a specific hafting and a specific function. Moreover, because

Fig. 4.1.52
The reduction method of large bifacial killiaq cores in the Saqqaq tradition.

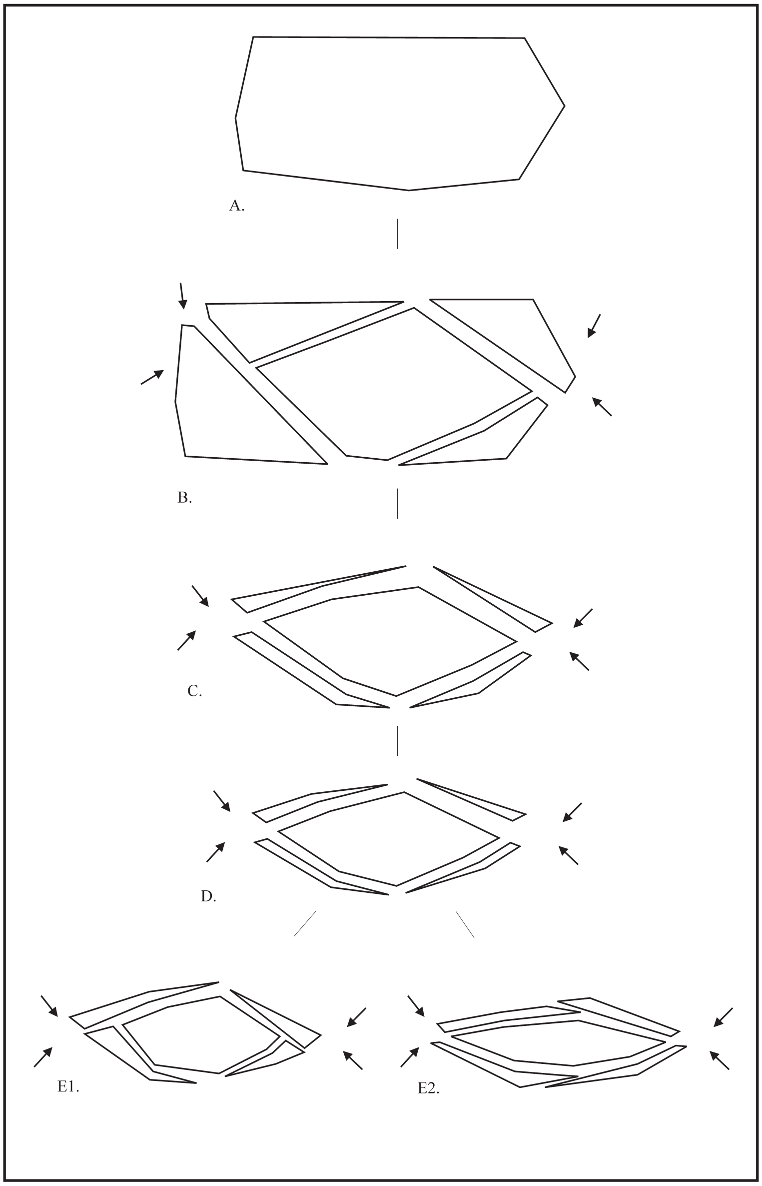
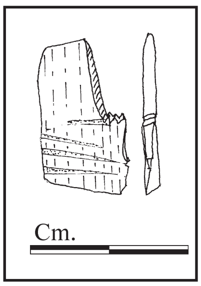


Fig. 4.1.53
Fragment of saw made from killiaq reused as a burin, from the Itinnera assemblage.



of the specific tool technology, it also seems probable that each tool type was used in a specific manner, e.g. movement, motor control, holding position, etc.

The Saqqaq tool inventory is generally rejuvenated and re-sharpened repeatedly, and sometimes extremely (e.g. burins and scrapers). Thus the tools must be con-

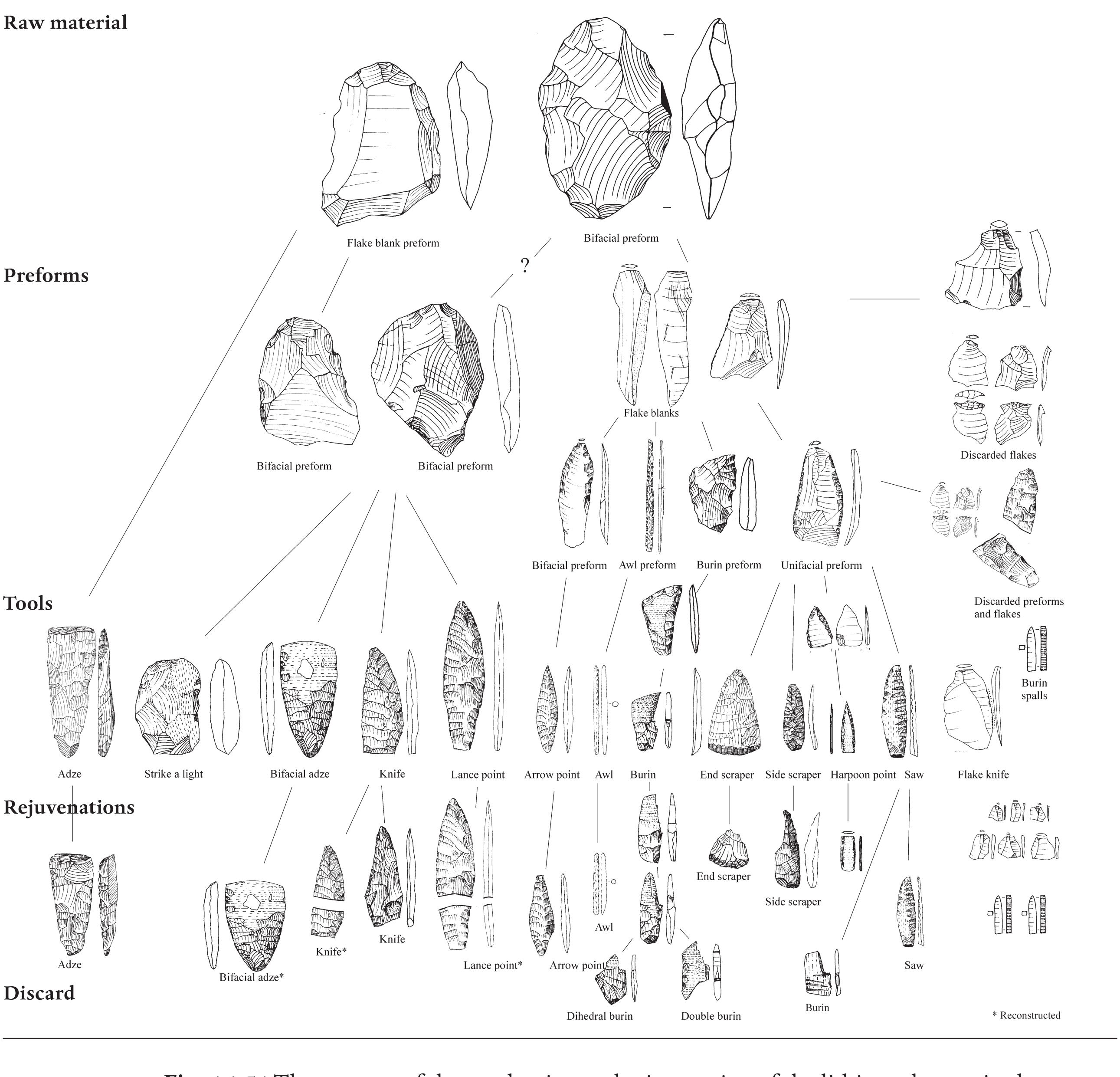


Fig. 4.1.54 The concept of the production and rejuvenation of the lithic tool types in the Saqqaq tradition. Artefacts are from the Itinnera and Qeqertasussuk assemblages.

sidered as very curated. Tool types seldom change function and type through use and rejuvenation. However, in a few examples, saws have been reused as blanks for burins (figure 4.1.53).

The generalized method of lithic reduction, production of tool types and their rejuvenation can be described as the Saqqaq concept of lithic production (figure 4.1.54).

Blade production method

The production method for blades can briefly be described as a unipolar, single-fronted production concept, where cores are small, keeled and maintained by a small faceted preparation of the platforms.

More specifically three methods are described:

1) The Yubetshu method (Kobavashi 1970; Akazawa et al. 1980; Inizan et al. 1999) (figure 4.1.55).

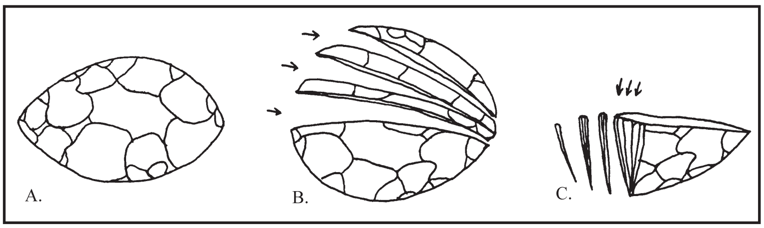


Fig. 4.1.55
Metod 1) The 'yubetshu method' for blade production (after Kobavashi 1970).

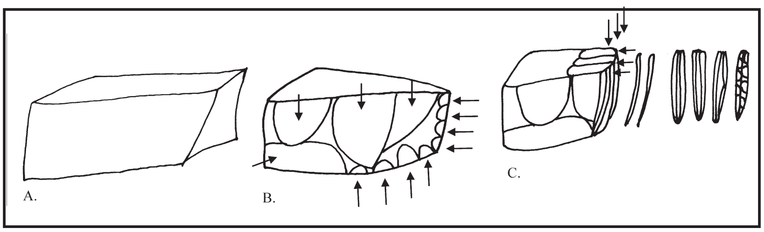


Fig. 4.1.56
Method 3) The shaping of a wedge shaped core from the platform, bottom and front (B). Preparation and blade detachment (C).

2) Quartz crystals prepared only by creation of a platform in one end of the quartz crystal.

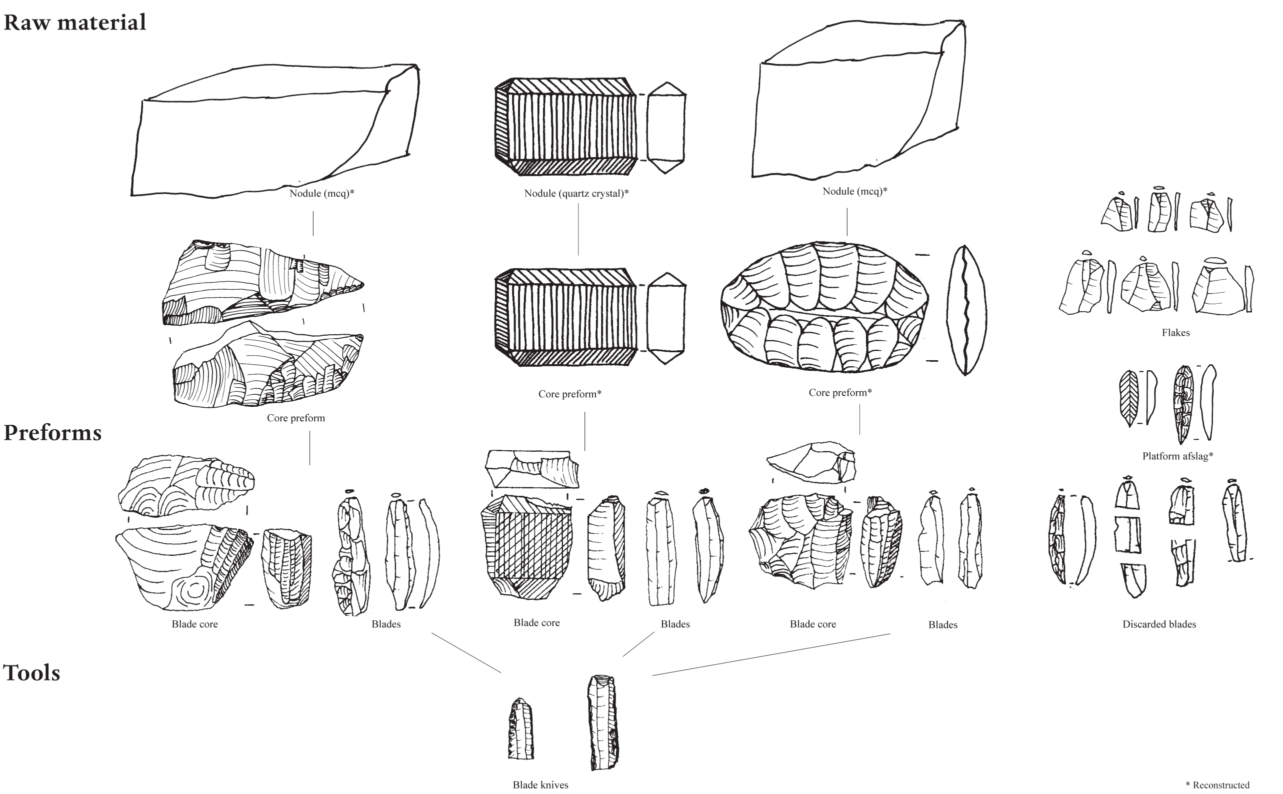


Fig. 4.1.57 The concept of the production and modification of blades in the Saqqaq tradition.

3) By the preparation of a one-fronted keeled core of mcq (figure 4.1.56).

The blade production is conducted from one narrow front. The platform angle is 80–90 degrees and the platform is repeatedly prepared by facets between the blade detachments. In using this method cores are gradually shortened down. Blade cores are discarded at a size of about 2 cm. Their width is kept constant around 10 mm. Straight, un-fragmented blades are selected for the use as knives. The generalized method of lithic blade production and use can be described as the Saqqaq concept of lithic blade production (figure 4.1.57).

Choice of hafting method

Due to the good preservation conditions at QT, it is possible to define several hafting principles of lithic inventory in Saqqaq. The result of an investigation of these

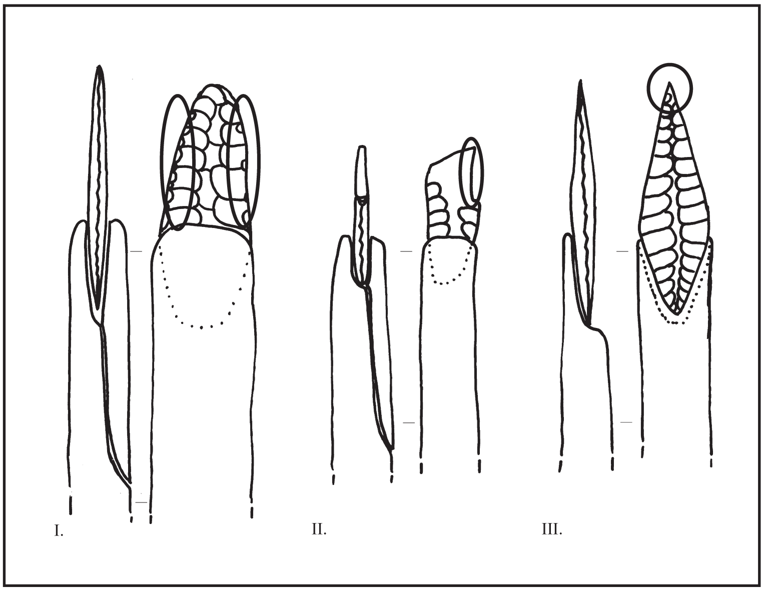


Fig. 4.1.58
Methods of lithic tool hafting in the Saqqaq tradition in relation to how the tool is constrained during use.

materials has led to the definition of two general principles for the hafting in the Saqqaq: When tools have lateral working edges these are hafted by lamination of two wooden pieces tied together (figure 4.1.58: I, II). Tools with use and strain on the tip (armatures and end scrapers) are generally hafted in a one-sided groove, tied to the haft (figure 4.1.58: III).

Choice of reduction technique

Direct hard technique
This technique is used in the early reduction stage, e.g. for roughing out bifacial cores of killiaq or bifacial preforms of quartzite.

Direct soft technique
It is most possible that a large soft hammer has been used for the production of bifacial flake blanks of killiaq. Smaller soft hammers, as the one from QT, have been used for bifacial reduction of bifaces during the later production steps.

Pressure technique
The existence of pressure flakers from Saqqaq sites documents that this technique was often in use. Judging from the flake material and tools, pressure has been applied during the finishing and rejuvenation of generally all tool types. Moreover, pressure technique has been used for the detachments of blades.

Indirect technique

Examples of what can be interpreted as punches are seen from the investigated Saqqaq sites. However, through the analysis of flake material and lithic tools this technique has not yet been documented in the Saqqaq lithic material.

Grinding

Artefacts made from killiaq have often been ground as part of their production process. Grinding is used for the fabrication of sharp edges, to dull basal edges before hafting and binding, for bifacial faces and as a part of a preparation method before flaking.

4.2. Lithic technology in Independence I

Sites and assemblages chosen for analysis

The primary site investigated for the interpretation of the Independence I lithic technology is the Adam C. Knuth site (ACK). This site is one of the largest, richest and most well-excavated Independence I sites. In all, 14 habitation structures have been located and two of these are excavated. Moreover, ACK is situated close to a lithic outcrop and the inventory therefore yields artefacts from the entire lithic process, including steps of procurement and testing of raw materials. ACK was discovered and initially investigated by Knuth (Knuth 1983; Grønnow & Jensen 2003), but was revisited and re-excavated by archaeologists from the Royal Geographical Society expedition to 'Midgaard' in 2001 (Jensen & Pedersen 2002). Artefacts from ACK are stored at the National Museum of Greenland. To compare the lithic technology from ACK, the Independence I site, Solbakken, situated in Hall Land, has been investigated. Solbakken yielded, like ACK, one of the largest inventories from Independence I. However, in order to analyze the *chaîne opératoire* for the adzes, inventory from the site Peary Land Ville has been added to the investigation. Finally, inventory from the Independence I sites in Danmark Fjord, 'Kap Holbæk' and 'Den blå flints boplads' have been inspected to reveal variations within the lithic industry.

Adam C. Knuth site

Geography

ACK is located in a small fjord, 'Frigg Fjord', in Johannes V. Jensen Land (figure 4.2.1). The site is situated on a promontory in what is today a fossil cove named 'Midgaard'. On the southern side of Midgaard is situated an Independence II site termed 'Hvalterrasserne'. Since the Independence I site was in use, the land has been raised about 10 metres and the cove 'Midgaard' has dried out. The promontory where ACK is situated consists of four beach terraces, all with structures from Independence I (figure 4.2.2). The lowest beach terrace (I) lies 11–12.5 m above sea level, the second (II) 16–16.6 m above sea level, the third (III) 22–23 m above sea level and the fourth (IV) 24 m above sea level. A slightly lower terrace to the south is called the 'mezzanine' and lies 10 m above sea level.

In contrast to most other sites in northern Greenland the structures from ACK

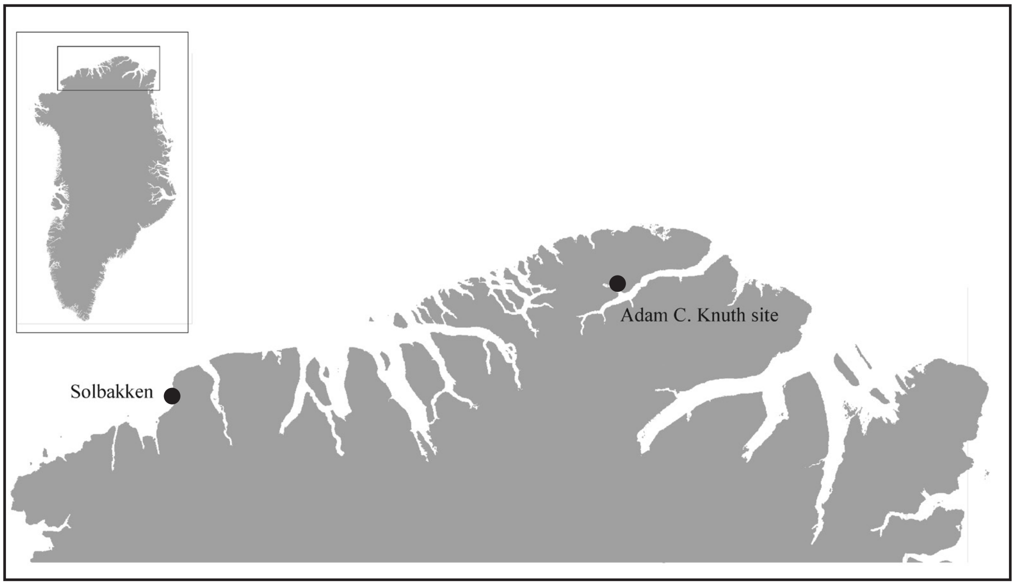


Fig. 4.2.1 The geographical position of the investigated Independence I sites: Adam C. Knuth site and Solbakken.

are placed on several beach terraces at different elevations, despite the fact that no chronological significance exists between the structures. It is possible that the Independence I people preferred different elevations for their settlements according to season or other factors at ACK.

Site analysis

Eigil Knuth discovered ACK in 1983 and returned during 1984–85 with an assistant (H. Elling) to investigate and excavate habitation structure RII,1. However, Knuth also surface collected artefacts from the other structures, labelling these artefacts with a number referring to each structure. In all, 28 structures were located, 14 of these were interpreted as habitation structures, 13 as caches and one as an outdoor fireplace.

During a visit in 2001, habitation structure RIII,1 was excavated while Knuth's former excavated RII,1 was re-excavated (Jensen & Pedersen 2002). ACK is interpreted as a site that was repeatedly visited by family groups during Independence I. The lower beach terraces seem to yield the lightest constructions and shortest occupations, compared to the higher lying terraces. This had led to the interpretation that the lower terraces represent summer occupations while the higher are

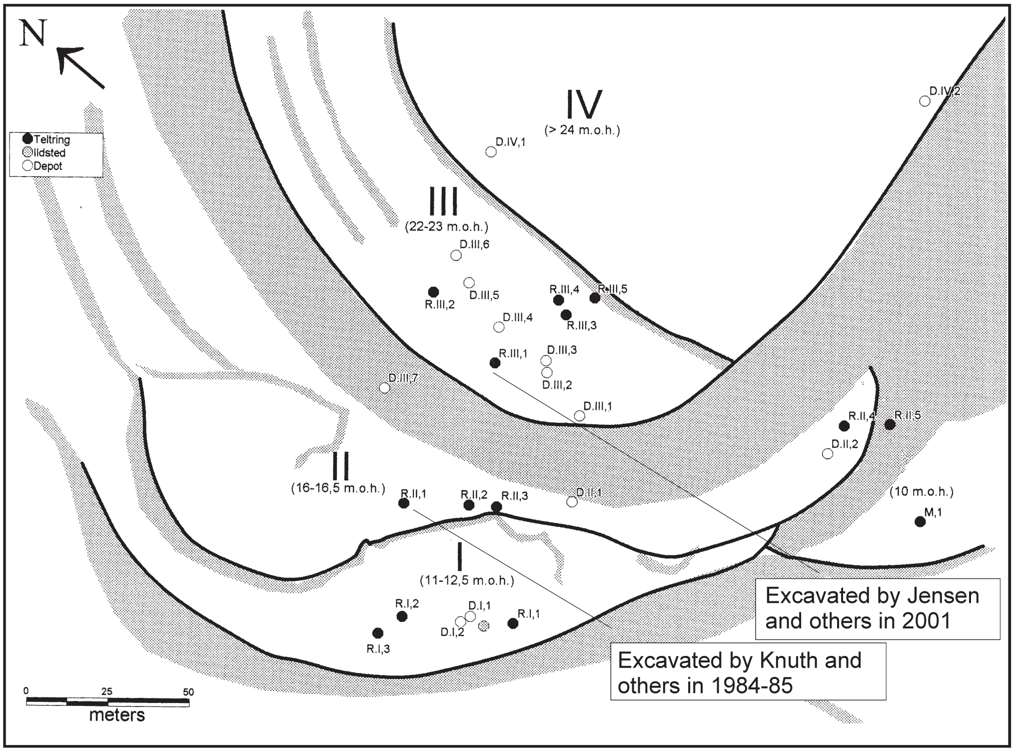


Fig. 4.2.2 Site map of Adam C. Knuth site (after Jensen & Pedersen 2002).

winter occupations. Analysis of ACK has been published by Knuth (1984), Jensen & Pedersen (2002) and Grønnow & Jensen (2003).

Excavation methods

Knuth excavated the ruin RII,1 in sectors by triangulation (Grønnow & Jensen 2003: 30). The back dirt, however, was not sieved. During 2001 this ruin was re-excavated and the back dirt was sieved through a 4 mm mesh. Ruin RIII,1 was in 2001 excavated in ¼ m^2, all tools were recorded precisely in the plan, and the back dirt was sieved.

Dating

Three radiocarbon dates have been made from ACK, ruin RII,1 (two dates) and RIII,1 (one dating) (table 4.2.1). All radiocarbon dates were achieved from terrestrial bone or antler material from clear independence I contexts and they can therefore be considered as reliable. The three dates all overlap by one standard deviation suggesting that the two ruins were used between 2000–2200 cal. BC.

Lab. No.	Material	^{14}C. BP	Calibrated BC*1	Context	Reference
K-4676	Caribou antler (Rangifer rangifer)	3780 ±80	2340–2030	RII,1	(Knuth 1984; Grønnow & Fog Jensen 2003)
K-3532	Musk ox bone (Ovibos moschatus)	3630 ±80	2140–1880	RII,1	(Knuth 1984; Grønnow & Fog Jensen 2003)
K-3531	Musk ox bone (Ovibos moschatus)	3670 ±80	2200–1930	RIII,1	(Knuth 1984; Grønnow & Fog Jensen 2003)

Table 4.2.1 Radiocarbon dates, ACK ruins no. RII,1 and RIII,1.

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

Inventory

The inventory list is compiled by the author, from Knuth's excavation and the excavations in 2001. Preforms are classified separately for the different tool types (figure 4.2.3 and table 4.2.2).

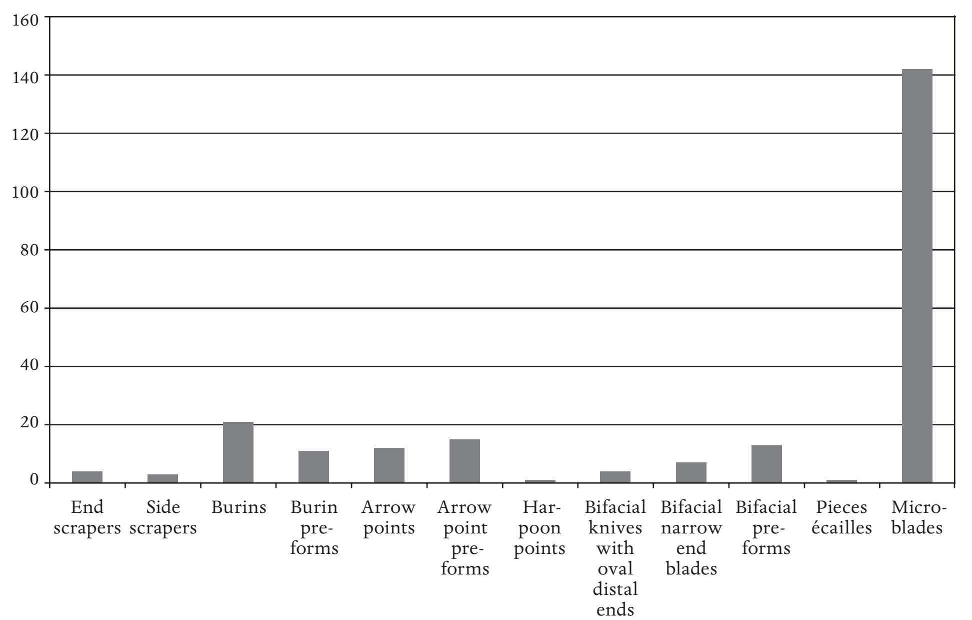


Fig. 4.2.3 A quantitative description of the tool inventory in the Adam C. Knuth site assemblage.

	Knuth 1985	Jensen et al. 2001	Total
End scrapers	6	1	7
Side scrapers	3	0	3
Burin, preforms	6	5	11
Burins	12	9	21
Burin spalls	35	40	75
Bifacial preforms	9	4	13
Bifacial knives with oval distal end	5	0	5
Bifacial narrow end blades	4	2	7
Arrow points	7	7	14
Arrow point, preforms	6	9	15
Harpoon points	0	1	1
Pieces écailles	0	1	1
Microblades	111	31	142
Flakes	718	–	–
Large bifacial preforms	6	0	6
Large cores (> 5 cm)	5	9	14
Large flakes (> 5 cm)	4	1	5

Table 4.2.2 Inventory list, ACK (excavations 1985 and 2001)

Solbakken

Geography

Solbakken is located on the west coast of Hall Land, north of Atka Elv (figure 4.2.1). From Solbakken there is a view across Robeson Channel to Ellesmere Island (25 km distance). The site is situated on several 200-metre long beach terraces, from 19–21 m above sea level.

Site analysis

E. Knuth discovered Solbakken in 1958. During this season Knuth made plan sketches of the site and excavated one habitation structure (ruin 6). In 1965 he returned with an assistant (J. Møhl) and excavated habitation structure 8 and 13. In total, 13 structures are located at Solbakken, 12 of these are situated along the 21-metre terrace, while one structure (ruin 13) is situated at the lower 19-metre

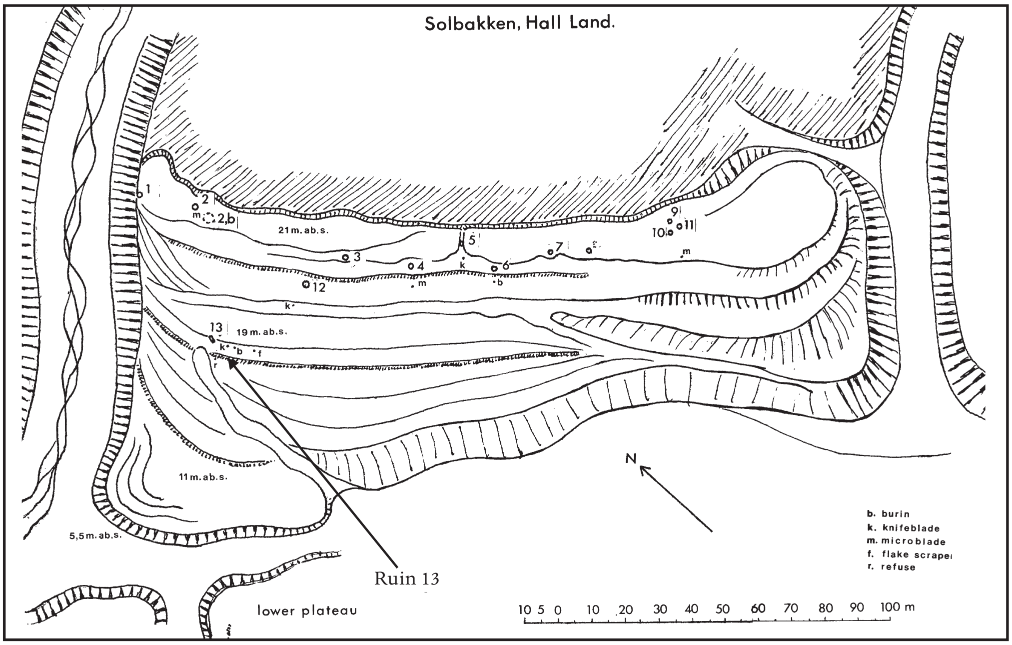


Fig. 4.2.4 Site map of the Solbakken site. Notice that ruin 13 is located at a lower beach ridge (after Jensen & Grønnow 2003).

terrace (figure 4.2.4). In chapter 4.6, it will be argued that ruin 13 at the Solbakken site belongs to a different Palaeo-Eskimo tradition than Independence I.

Of the 13 structures seven are perceived as habitation structures, two of these are of midpassage type, four structures have stone pavements and one is seen as only a slight depression into the terrace. Four isolated box hearths are located, which could be parts of latent habitation structures. In addition, a cache and a pit were located there. Lithic artefacts, bone and teeth fragments were scattered on the 21-metre terrace and many of these were surface collected by Knuth.

Analysis of the site is published by Knuth (1983) and Grønnow & Jensen (2003).

Excavation methods

The position of surface collected tools is marked on a drawn plan of the site. During the excavation of the structures, tools were measured on to the plan while flakes were collected with reference to the structure. The back dirt was not sieved.

Dating

A single radiocarbon dating made on a cranial fragment of musk ox, found in cache no. 2D, was carried out. This dating suggests that the Solbakken site was in use sometime during early Independence I, 2500–2200 cal. BC (table 4.2.3).

Lab. No.	Material	14C. BP	Calibrated BC*1	Context	Reference
K-3366	Musk ox bone (Ovibos moschatus)	3870 ±85	2470–2200	Structure 2,D	(Knuth 1984; Grønnow & Fog Jensen 2003)

Table 4.2.3 Radiocarbon dates, Solbakken

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

Inventory

The inventory list is compiled by this author. All artefact materials from Solbakken, except from ruin 13, are included (figure 4.2.5 and table 4.2.4).

End scrapers	2
Side scrapers	3
Burin preforms	3
Burins	13
Bifacial preforms	7
Bifacial knives with oval distal ends	3
Bifacial narrow end blades	4
Arrow point preforms	0
Arrow points	1
Harpoon point preforms	1
Microblades	68

Table 4.2.4 Inventory list, Solbakken

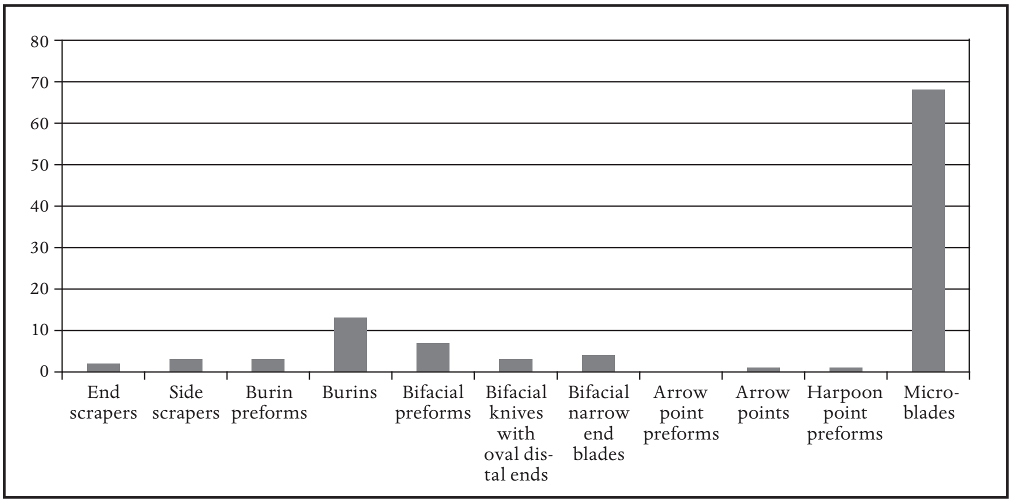


Fig. 4.2.5 A quantitative comparison of the lithic tool types in the Solbakken assemblage.

The *chaînes opératoires*

The raw material

ACK

Several large preforms and tested nodules are made of black, opaque, glassy and shiny mcq, some with rough black cortex. The morphology of this type of mcq nodules seems to be tabular. Some nodules are slightly blue with black lines through the material, but seem otherwise to have the same qualities and characteristics as the black mcq. These two qualities of mcq most likely derive from a nearby outcrop on Johannes V. Jensen Land, and originate geologically from the former deep-sea sediments in the northern 'Ellesmerian folding', found in North Greenland and on northern Ellesmere Island (source 60, chapter 3).

A few artefacts and a blade cores are made from a clear, blue, clean, shiny mcq. This type of raw material probably derives from sea sediments known from the southern part of the Ellesmerian folding (source 1–2) – thus they must be imported from somewhere between southern Peary Land and southern Ellesmere.

Solbakken

The inventory at Solbakken is made from high quality, glossy, fine-grained mcq of different colours. The raw materials are probably, with few exceptions, variations deriving from sea sediments in the southern part of the Ellesmerian folding.

The following raw material variation is seen at Solbakken:

1) A shiny, translucent, blue-grey, fine-grained mcq, sometimes with a cortex of quartz-like sand.
2) A shiny, translucent, brown mcq of very clean quality.
3) A shiny, translucent, dark blue and sometimes dotted mcq.
4) A semitransparent, light brown mcq of high quality.
5) A translucent, grey mcq, probably the same type as 1.
6) A translucent, green mcq of high quality, sometimes with dots.
7) A translucent, yellowish – sometimes referred to as 'honey coloured' – type of clean mcq.
8) A translucent, banded mcq in red, green, brown and orange colours.

The most used raw material type is the blue-grey mcq (1) (figure 4.2.6).

When flake percentages are compared with tool percentages for the different raw materials it is noticed that especially the blue-grey type of mcq (1) has a large flake proportion (figure 4.2.7). This raw material therefore probably has the shortest distance of procurement and the largest nodule size of the used raw materials. The green type of mcq (6) could possibly have been imported from Rensselaer bay, where this type is known. The geological sources for the yellow, the blue and the red types of mcq have not yet been identified with certainty, but it is likely that they derive from locations in the Washington land region. The shiny, often glossy surfaces of the raw materials could indicate that the mcq generally have been subjected to heat treatment. However, no certain proof of this technique could be documented within the assemblage.

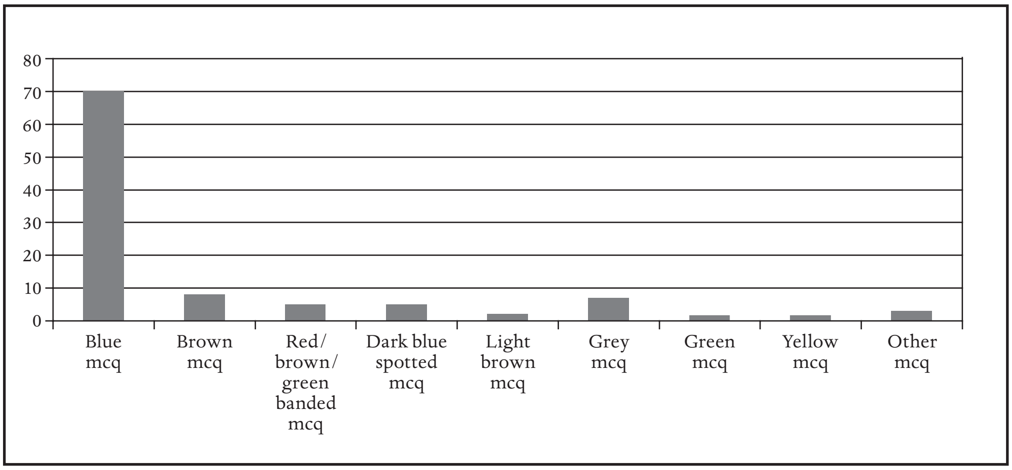
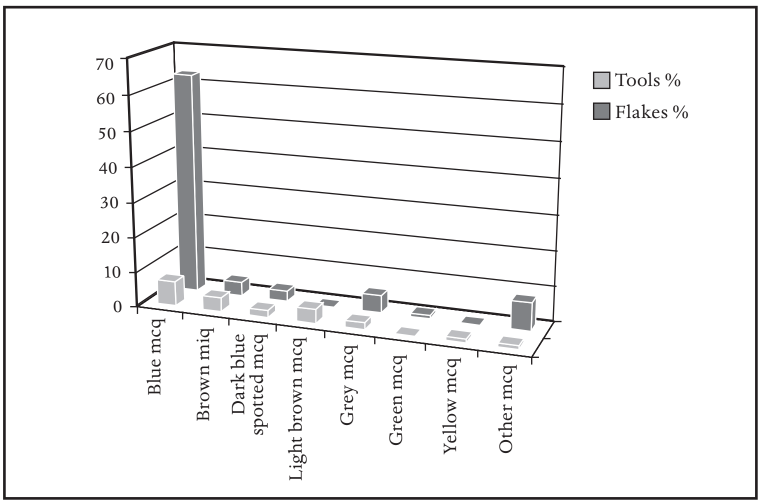


Fig. 4.2.6 A quantitative comparison between the different raw materials used in the lithic production within the Solbakken assemblage.

Fig. 4.2.7
The frequency of the raw materials in relation to tool type and flake material in the Solbakken assemblage.



Preforms

Large refitted preforms from ACK indicate that the nodules were tabular and with sizes around 10 × 10 × 4 cm (figure 4.2.8: I, II, IV). This morphology and size of procured nodules seems to be similar at Solbakken (figure 4.2.8: III). The initial test and reduction of the tabular nodules are typically conducted by the detaching of large flakes from the faces, by direct hard technique. The following process depends on the final intention. Many of the tabular nodules are worked in a quadratic method in which the tabular morphology is maintained by detachments of flakes from the right-angled edges. This method is similar to the production of squared axe preforms during the Neolithic Period in southern Scandinavia (Hansen & Madsen 1983). An investigation of attributes on flakes from this process suggests that an indirect method has been employed (figure 8.1.4). The intention during this step could be twofold: to produce large flake blanks as preforms for the small lithic inventory, and to produce a single large preform for a large bifacial tool type.

Large refitted preforms (figure 4.2.8: IV) indicate that the square cross-section is maintained until the preform has a thickness of 1–2 cm. Hereafter the preform is changed into a large biface by transforming the squared edges.

Some large bifacial preforms from ACK are made from large flakes (figure 4.2.8: VI, VII). Such flakes must have been produced by means of direct hard percussion.

Blade cores are made from tabular nodules. The Independence I knappers take advantage of the original square morphology of the raw material by establishing the blade core platform on a narrow face of the nodule, while fashioning a blade core (figure 4.2.8: II).

Flake knives

A high frequency of large flakes from both ACK and Solbakken is seen with irregular retouch types on the edges. In many situations this retouch seems to be use wear (figure 4.2.9: I, II). It is therefore possible that the large flakes often have been used as expedient knives during the Independence I tradition.

End scrapers

Not many end scrapers are available for the investigation. However, three different end scraper morphologies are seen (figure 4.2.10): 1) the scraper is made from a flake, but the base is not typical due to its irregularity, 2) the scraper is a seldom seen expedient type of end scraper or 3) the scraper is made from a bifacial knife base and represents a rare example of reuse during Independence I.

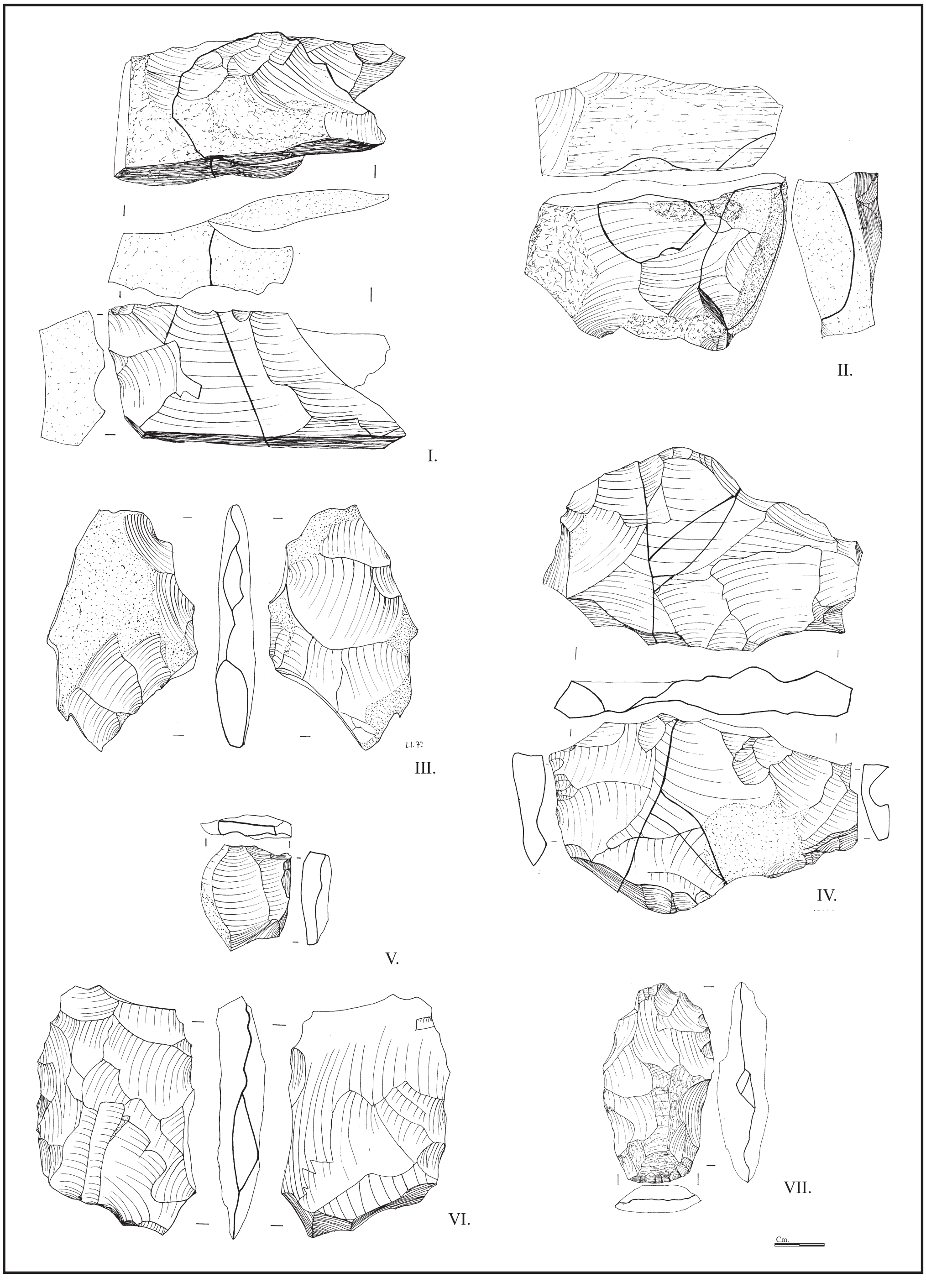


Fig. 4.2.8 Typical large preforms from the Independence I tradition. No. I, II, IV, VI, VII are from the Adam C. Knuth assemblage. No. III, V are from the Solbakken assemblage.

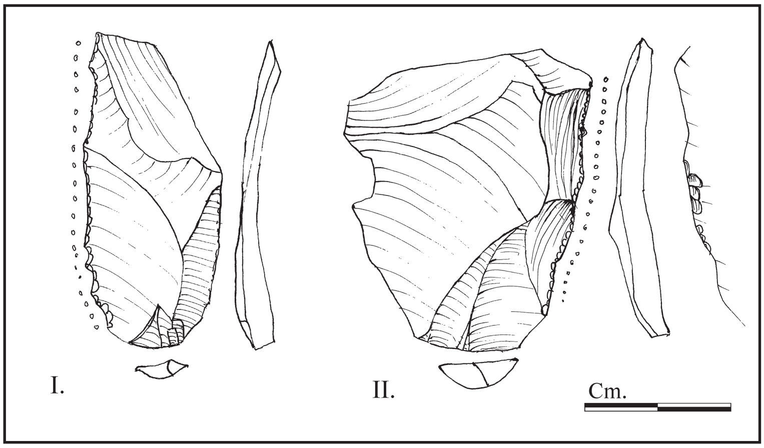


Fig. 4.2.9 Large flakes with lateral macroscopic use wear, probably used as flake knives. Flakes are from the Adam C. Knuth site assemblage.

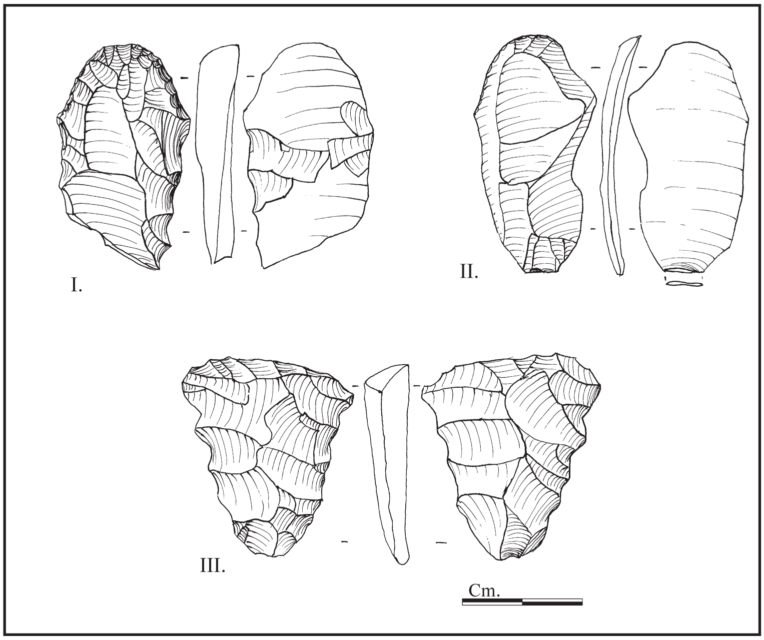


Fig. 4.2.10 Three types of end scrapers:
1) End scraper with wide base and notches,
2) End scraper on flake with simple end retouch,
3) Triangular end scraper. The no. 3 specimen is produced from a broken base of a knife blade.

Step 1
A large flake with slight curvature of high quality mcq is chosen as a blank for the end scraper production (figure 4.2.11: A).

Step 2
The scraping edge is produced in the distal end of the flake blank by a series of pressure retouch flakes. A regular unifacial convex scraping edge is produced. On the lateral basal edges three notches are produced on each side of the base. In a

few instances the ventral face of the flake blank is pressure retouched, probably to produce a slight curvature and to remove the bulb of percussion (figure 4.2.11: B).

Step 3
The morphology of the base indicates that the end scrapers generally have been end hafted. However, no hafts are preserved from Independence I.

Step 4
The end scraper edges are rejuvenated repeatedly by unifacial detachments of series of pressure flakes.

Step 5
End scrapers are discarded at a length of approximately 35 mm. This length must correspond to the part of the scraper, which is attached in the haft.

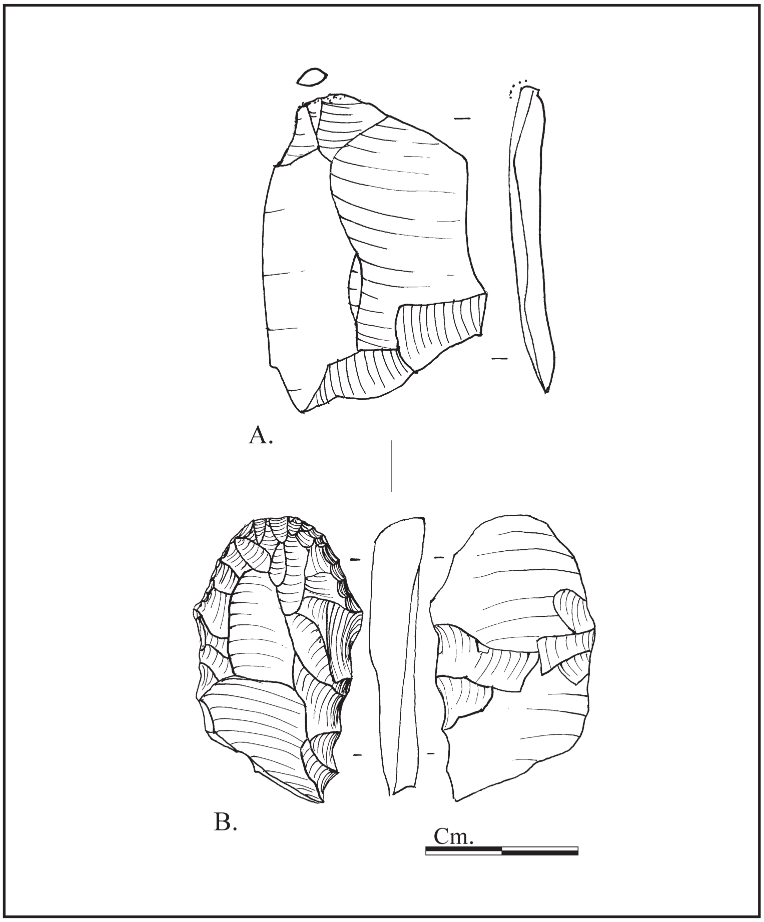


Fig. 4.2.11
The *chaîne opératoire* for end scrapers with wide base and notches. The example is from the Adam C. Knuth site.

Side scrapers

Step 1

Oblong straight flake blanks of high quality mcq are selected for the production of side scrapers (figure 4.2.12: A). The flake blanks are oriented so that their proximal ends become the bases of the scraper. The lateral edge of the flake blank is reduced unifacially from its ventral face. The cross-section of the preform thereby becomes triangular.

Step 2

Two notches are produced on each lateral side of the base. On several side scrapers the ventral face of the base is pressure retouched, probably in order to remove the bulb of percussion from the flake blank. In a few examples a ground facet is seen on the base of the scraper, perhaps to improve the hafting (figure 4.2.12: B).

Step 3

The precisely worked morphology of the base indicates that the side scraper has been hafted. Side scrapers from Independence I are considered used similarly to side scrapers in Saqqaq.

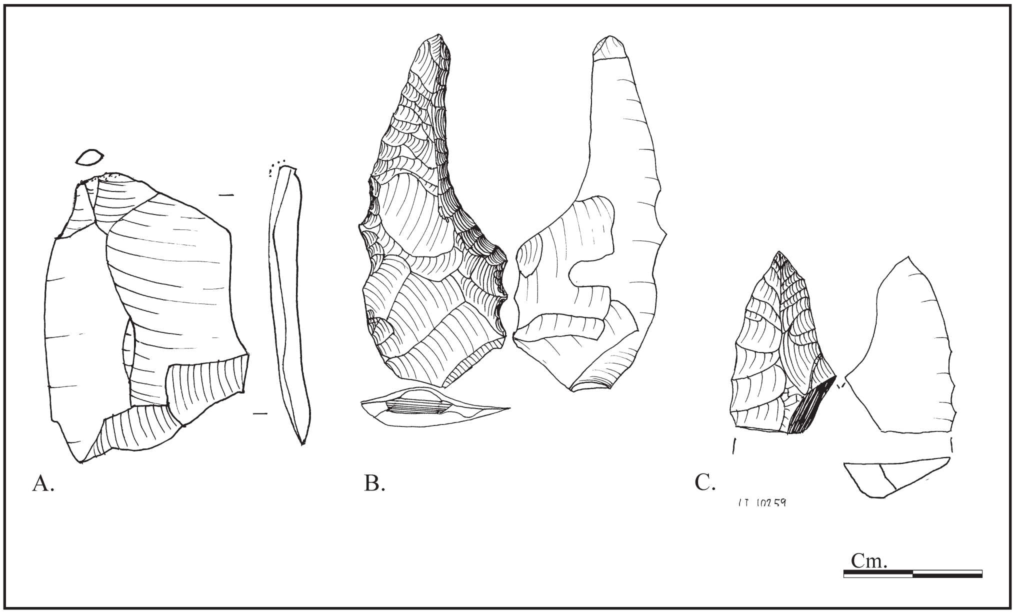


Fig. 4.2.12 The *chaîne opératoire* for side scrapers. The example is from the Adam C. Knuth site.

Step 4
The side scraper is rejuvenated repeatedly from the same lateral edge. The rejuvenation results in a characteristic concave beak morphology and a triangular cross-section.

Step 5
The side scrapers are discarded when their distal ends are reduced to less than 1 cm, or due to breaking during use or rejuvenation.

Burins

Step 1
Thin flake blanks made from high quality mcq are selected for the burin production. Most often the flake blank is oriented so that the bulbar end becomes the basis of the burin, but in some cases the opposite is seen (figure 4.2.13: A, B).

Step 2
The flake blank is bifacially worked and the bulb on the flake blank is reduced by pressure retouch. In a few cases the bulb is removed by thinning from the base resulting in typical 'channel flakes'. Generally, the burin preforms are only lightly worked. The bases are fashioned into a standardized size often with 2–3 notches on each side (figure 4.2.13: C). The lateral edge from where the first spall is detached is most often worked bifacially resulting in a thoroughly crested first burin spall. The distal end of the preform is wider than the base. The burin's distal edge has a right angle to the lateral edge from where the first spall is detached. The distal edge is made by pressure retouch followed by light grinding. From the morphology of the burins and the burin spalls it can be argued that burin spalls are detached by means of pressure technique (figure 4.2.13: D1, E1–H1).

Step 3
Macro wear on the burin edges indicates that these generally have been in use. Due to the steep cutting/shaving angle of the burins' edges, the burins probably worked hard organic materials, e.g. bone, antler and tooth. The well-shaped bases indicate that the burins have been hafted (figure 4.2.13: E).

Step 4
The burins are repeatedly rejuvenated by spalling. The common burin type is the single burin, but in some cases dihedral burins and double burins are made during rejuvenation (figure 4.2.13: F, G). When the relation between primary and second-

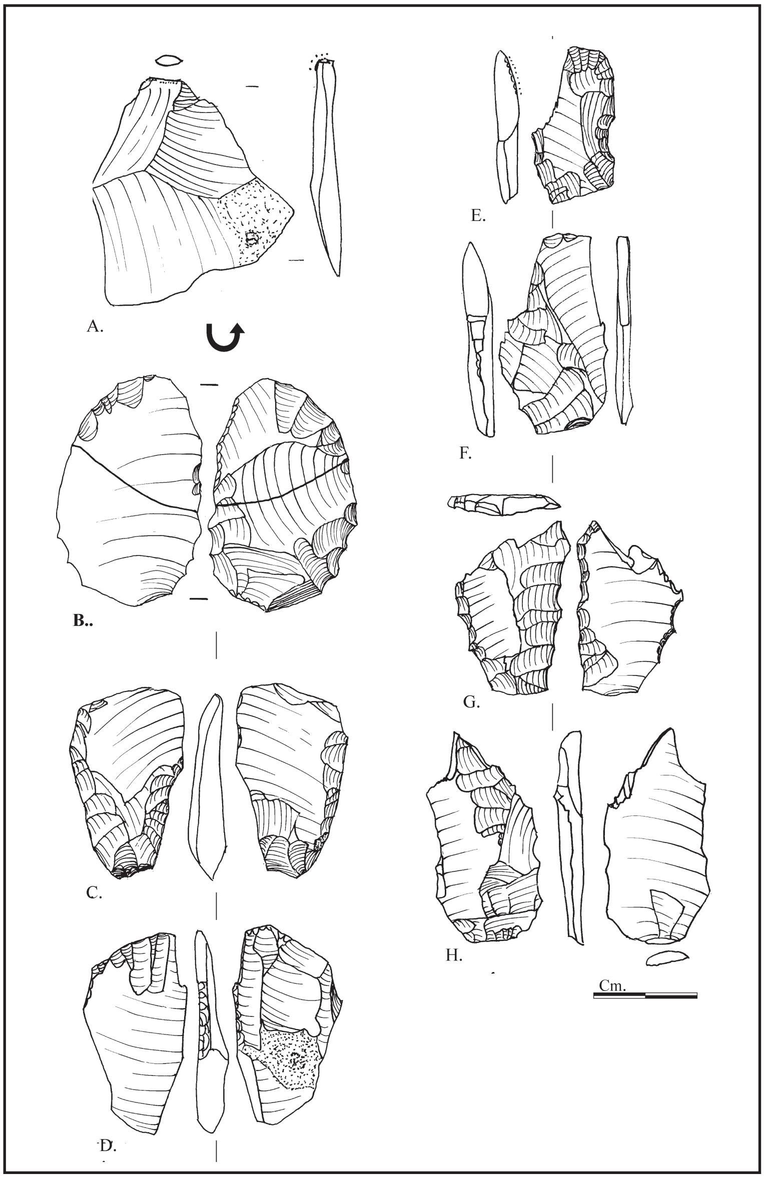
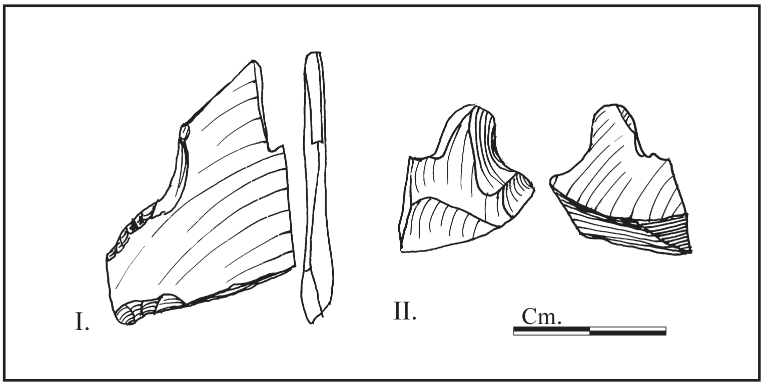


Fig. 4.2.13
The *chaîne opératoire* for burins and their modification products, i.e. burin spalls (D1, E1–H1). The example is from the Adam C. Knuth site.

ary spalls are analyzed, the ratio is counted to 1:4. This suggests that rejuvenations of burins in Independence I happened about five times per burin. This observation is generally confirmed by the counting of hinges from spalls on the burins.

Step 5
Burins are discarded when the distal ends become reduced into a short narrow morphology. Only few examples of broken burins are seen.

Fig. 4.2.14 The burin with the narrowed distal end is a variation within the Independence I burin morphology.



Discussion
A special burin type found at ACK is the burin with a narrowing distal end. This burin type has a retouch opposite to the burin edge, which gives the distal end a characteristic narrow morphology (figure 4.2.14). It is possible that the narrowing down of the distal end is a secondary modification made to create a burin that could produce a slot or a groove of a certain width.

Arrowheads

Step 1
Thin straight flake blanks are selected for the production of arrowheads. The bulb of percussion on the flake blank can appear in either end of the arrowhead preform, thus the flake blank can be turned each way (figure 4.2.15: A).

Step 2
The flake blank is worked bifacially into a symmetrical preform with an oval cross-section. A tanged base is produced (figure 4.2.15: B, C, D, E). The final morphology of the arrowhead is worked with high precision. Pressure technique has probably been used during this step. In some examples a fine denticulation, with up to seven denticulations on 10 mm, is seen on the lateral edges. A special type of pressure flaker with an extremely thin edge, e.g. made from dentine, must have been used for this purpose.

Step 3
The arrowhead is hafted to an arrow, probably in a fore-shaft. Impact fractures demonstrate the function of this tool type.

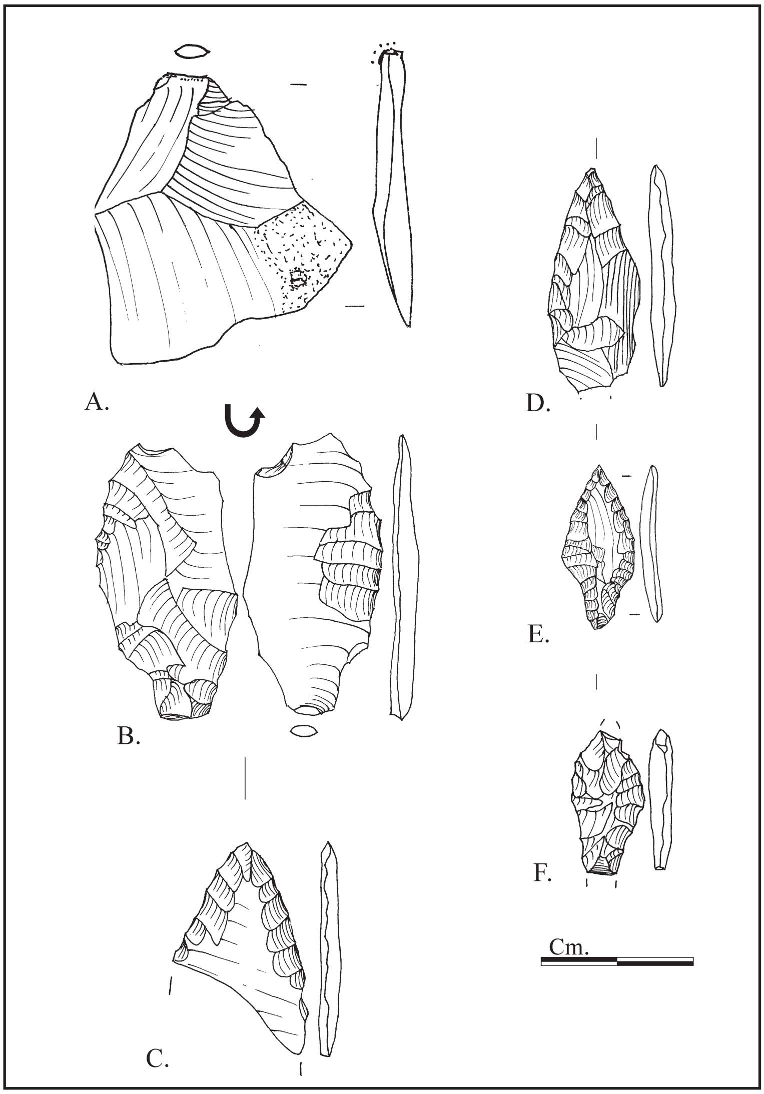


Fig. 4.2.15
The *chaîne opératoire* for arrow points. The example is from the Adam C. Knuth site.

Steps 4–5
No rejuvenations of arrowheads are documented. The arrowheads are typically discarded with different kinds of impact fractures, e.g. impact burination, bending fractures etc. (Fisher et al. 1985; Kelterborn 1999).

Discussion
The arrowhead is the only lithic tool type that can be associated with the hunting and killing of land mammals i.e. musk ox and caribou, in Independence I. It can therefore be concluded that this small lithic tool type must have been most essential for the Independence I economy.

Harpoon points

Only one lithic harpoon point has been found at ACK, and one possible preform at Solbakken (figure 4.2.16). The harpoon point from ACK is a thoroughly made, triangular end blade. It is 33 mm long, 18 mm wide and 2 mm thick. It is made from a flake blank that had its bulb of percussion in the distal end of the point. Both specimens are bifacially worked, probably by pressure technique. The point from ACK had its base thinned, while the central part of the faces has been subjected to grinding. The grinding has probably been conducted in order to establish the right thickness and thereby a thorough hafting in a slot in the harpoon head.

Only few harpoon points are known from Independence I in Greenland. These are, however, the only lithic evidence of marine hunting during this tradition. From Canada several harpoon points and harpoon heads are found in the Independence I context at Port Refuge (McGhee 1979). The harpoon heads are made from walrus tusk and have a slot for the hafting of the harpoon point (figure 4.2.17).

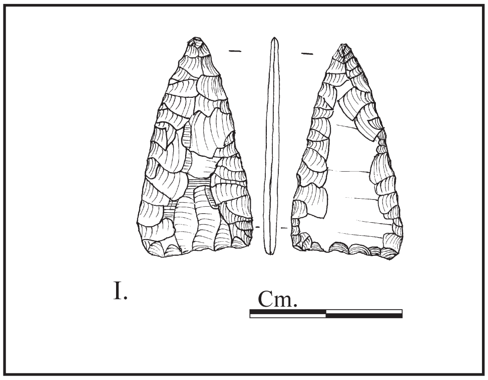


Fig. 4.2.16 The *chaîne opératoire* for harpoon points. The example is from the Adam C. Knuth site.

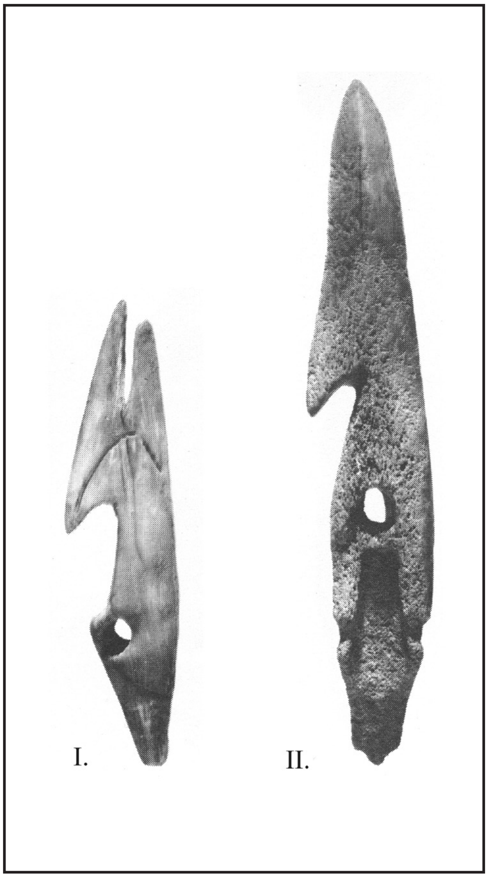


Fig. 4.2.17 Harpoon heads from the 'upper beach component' and 'cold component' from the Port Refuge site, Canada. Harpoon head I has a sloth for a lithic harpoon point. No. II is self-tipped, but has a groove in its distal end which indicates the possible beginning of a sloth (after McGhee 1979).

Bifacial knives with oval distal end

Step 1

Large flakes or tabular nodules made of high quality mcq are chosen for the production of bifacial knives. The tabular nodules are reduced quadratically during initial thinning, while during later stages, reduction is carried out bifacially (figure 4.2.18: A).

Step 2

Early during the bifacial process the final morphology and orientation of the preform is decided. This is seen on early stage preforms where one edge is left unmodified and this end will become the base of the finished tool. Relatively early in the process notches on the bases are marked. The distal end of the knives is given an angular morphology, thus the knives are never pointed. Sometimes the faces are thinned from the distal edge as well as from the lateral edges. At the base, three lateral notches are made on each side. Finally, the lateral edges are thinned regularly, probably by means of pressure retouch (figure 4.2.18: B, C).

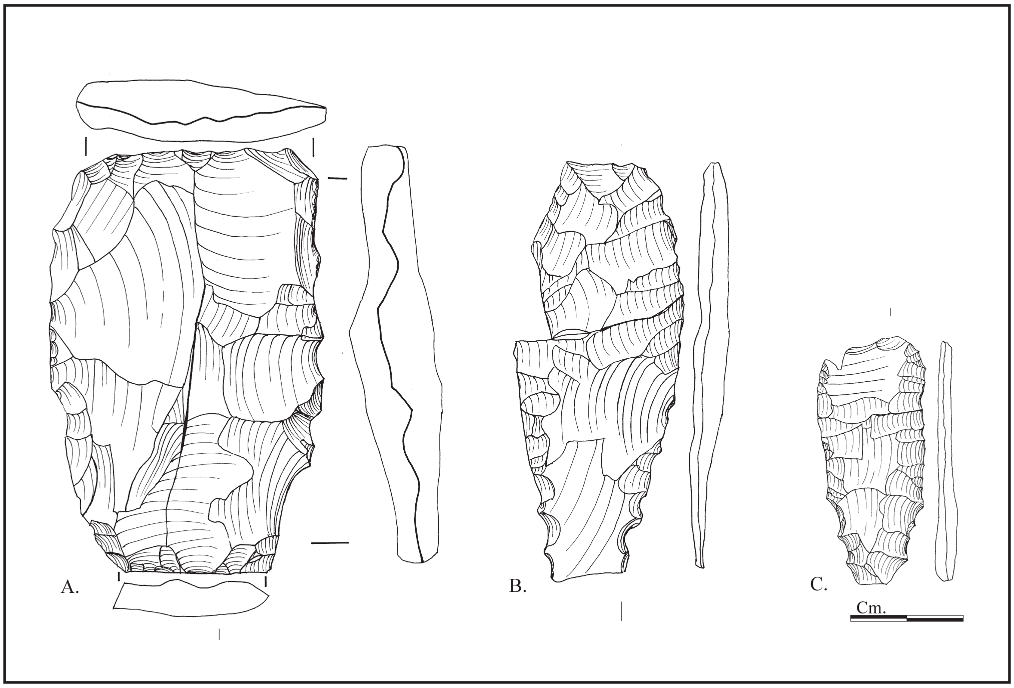


Fig. 4.2.18 The *chaîne opératoire* for bifacial knives with oval distal end. The example is from the Adam C. Knuth site.

Step 3

The thin sharp lateral working edges and the unpointed morphology suggest that the tool has been used in a cutting manner. Moreover, the thoroughly fashioned base indicates the use of a standardized haft type.

Step 4

Rejuvenations of the edges are made by pressure retouch, thus during the use phase the distal end of the blade gradually achieves a more narrow and pointed morphology.

Step 5

Knives with oval distal ends are discarded due to either breakage or repeated rejuvenation and downsizing.

Discussion

At ACK a fragment of probably the largest bifacial lithic tool in the eastern Arctic has been found (figure 4.2.19). The tool is a base of a knife with a distal end. The width is 6.5 cm and the thickness is 0.7 cm. The width/thickness index is approximately 10:1. An investigation of the artefact showed that the edges were thinned and probably rejuvenated, thus the tool was finished and used. The tool broke along a fissure in the raw material.

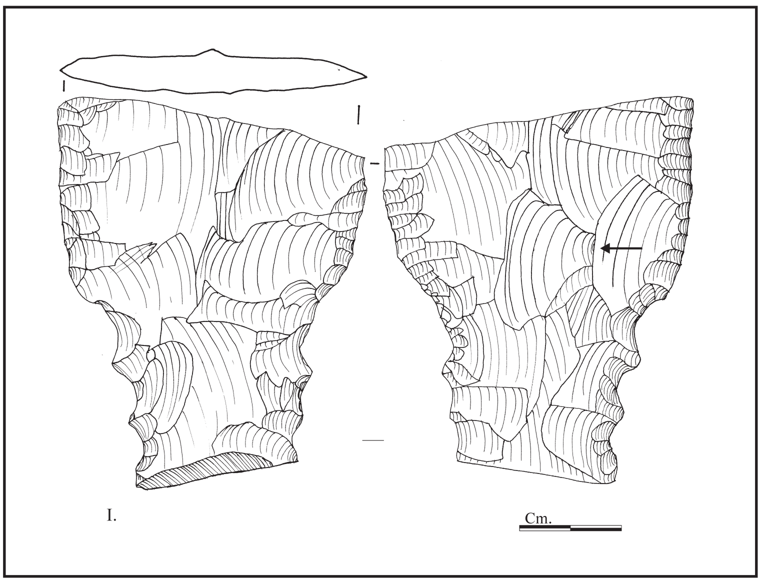


Fig. 4.2.19
The largest bifacial end blade is probably made from mcq in the High Arctic. Notice that the knapper has detached a flake from the centre of the biface using a ‘trick’. The example is from the Adam C. Knuth site.

At the centre on one face of the tool, the craftsman has performed a 'technical trick' to thin down the biface. One flake detachment has hinged centrally on the face, causing a problem. However, a negative bulb of percussion behind the hinge shows that, by putting the hinge flake back in its negative and hitting it again, a flake centrally on the face has been detached, and has solved the problem (figure 4.2.19, see arrow).

This bifacial artefact documents that the Palaeo-Eskimo craftsmen occasionally could produce large thin bifaces, but that they only did this when the access to large raw materials were abundant, as on the ACK site.

Bifacial narrow end blades

Step 1

Tabular blanks or large flakes of high quality mcq have been chosen for the production. The blank is worked bifacially into a preform. Early during the process the basal end is chosen. This basal end is, in contrast to the oval knives, thoroughly worked by bifacially thinning, already during step 1 (figure 4.2.20: A, B).

Step 2

Using a bifacial knapping method and final pressure retouch of the edges finishes the preform. The lateral edges on some specimens are finished with fine lateral denticulation, produced by a sharp pressure flaker. The basal edge is thinned from the base by channel flakes and thoroughly worked into a straight regular morphology.

Step 3

No finished complete specimens of this tool type are located in the analyzed assemblages and no refitting of finished fragments could be accomplished (figure 4.2.20: C): However, from the site 'Scoresbysund' a complete bifacial narrow end blade has been revealed from feature III (Sandell and Sandell 1999: 70). Distal ends are generally not sharp pointed, and one might therefore think that the lateral edges of this tool had the primary function: i.e. used as a cutting tool. On the other hand, bases are thinned and have sharp lateral edges, which indicate that the tool was hafted in some kind of slot, i.e. used as a lance point. Thus, the function of the tool cannot be precisely identified.

Steps 4–5

Generally, all the specimens of this tool type are fragmented pieces. No particular rejuvenation of the lateral edges is observed. No impact fractures on the tool type

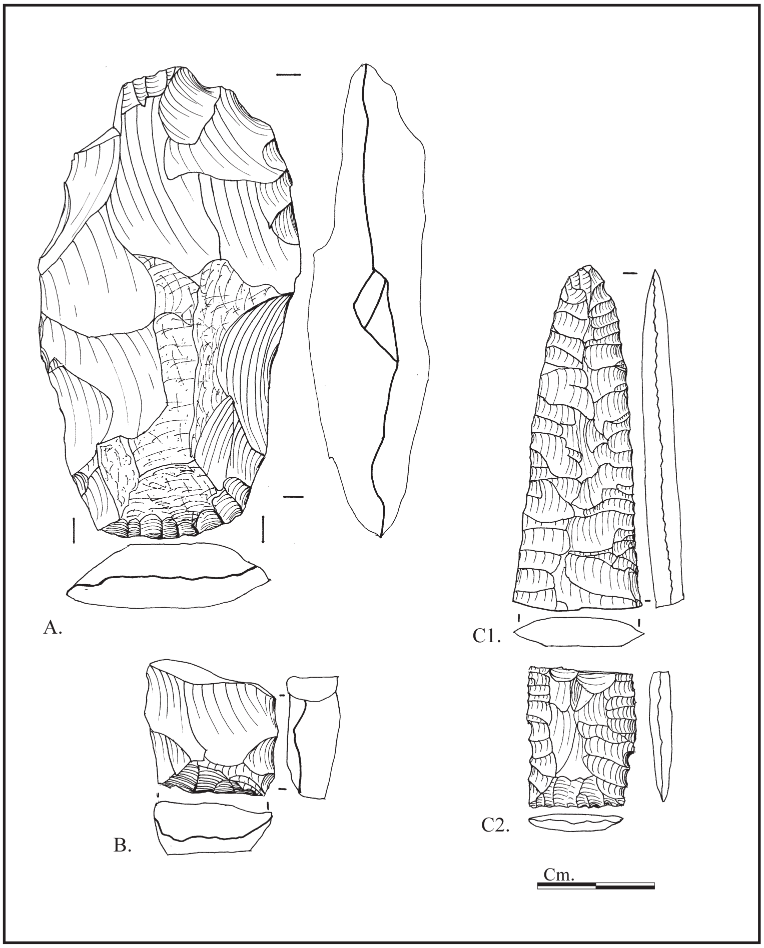


Fig. 4.2.20
The *chaîne opératoire* for narrow bifacial knives. The example is from the Adam C. Knuth site.

are observed. The tools are generally discarded after breakage of the central part of the distal end.

Lithic wedge tool

At ACK a single wedge type tool was found (pieces écailles) (figure 4.2.21). The specimen is 61 × 32 × 12 mm, produced from the local high quality mcq. The blank is either made from a large frost fracture or a large flake. All fashioning of this tool is made through use: two parallel lateral edges have hinge fractures from hammering the edges. It is possible that the piece has been used to split an organic material, e.g. driftwood or bone. Wedges made from organic material are known from other Palaeo-Eskimo traditions, e.g. Saqqaq (Gotfredsen & Møbjerg 2004(b)).

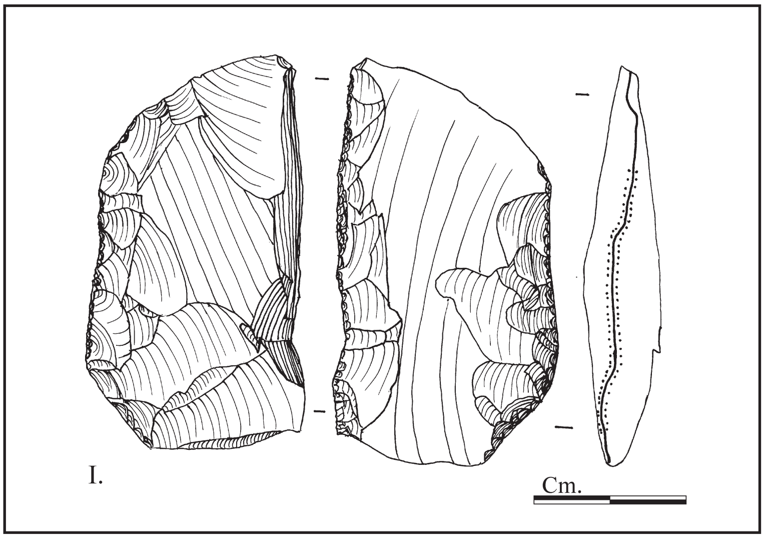


Fig. 4.2.21
Pieces écailles probably used as wedges when splitting organic materials. The example is from the Adam C. Knuth site.

The reason why a lithic wedge is found at ACK in North Greenland could be due to lack of appropriate large organic materials, e.g. whale bone or antler.

Adzes

Step 1

For the production of adzes fine-grained black basalt is chosen (figure 4.2.22). This material is tougher than the mcq used for all other lithic tool types in Independence I and probably therefore more appropriate for a chopping tool. The adzes are produced from flat nodules.

Step 2

Adzes are produced by several methods: I. unifacially, II. bifacially and III. bifacially followed by unifacial reduction (figure 4.2.23). Deduced from their morphology and attributes, it is most probable that the adzes have been fashioned by direct soft percussion. The finished cutting edges are asymmetrical and thoroughly ground. The edge face of the adze is lightly ground and polished, perhaps due to use. The lateral edges are on some specimens lightly ground and the basal end is sometimes also ground, in both situations probably to improve the hafting.

Step 3

The standardized morphology of the basal ends, and a use polish on these, suggests that the adzes generally have been hafted. Several of the investigated adze

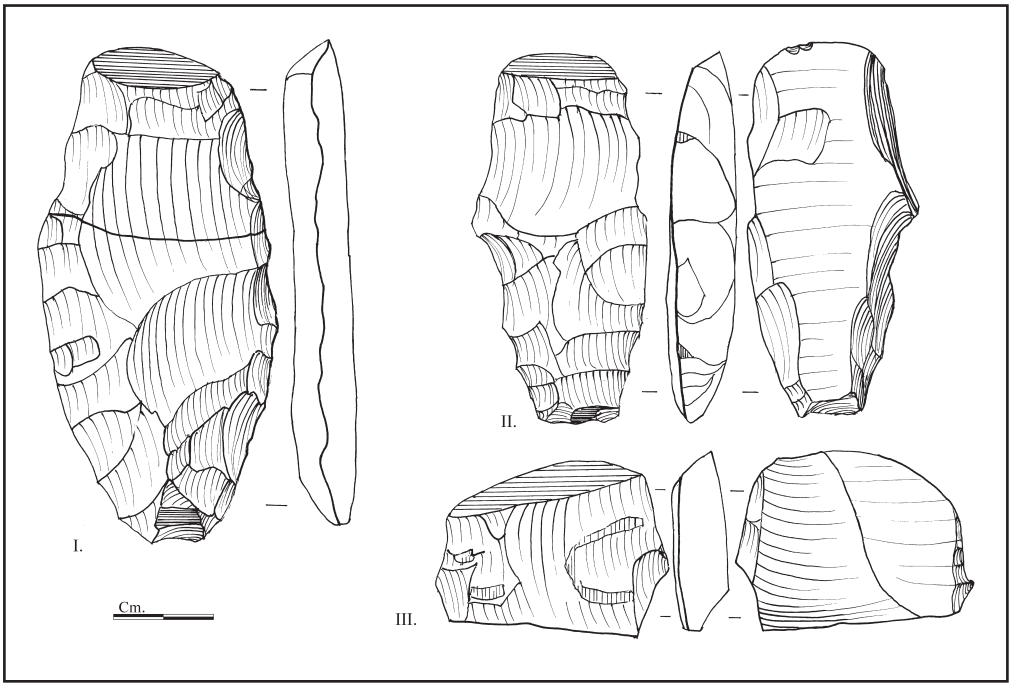


Fig. 4.2.22 Adzes and adze fragments from the Independence I Peary Land Ville assemblage. The adzes are made from fine-grained basalts and have ground edges.

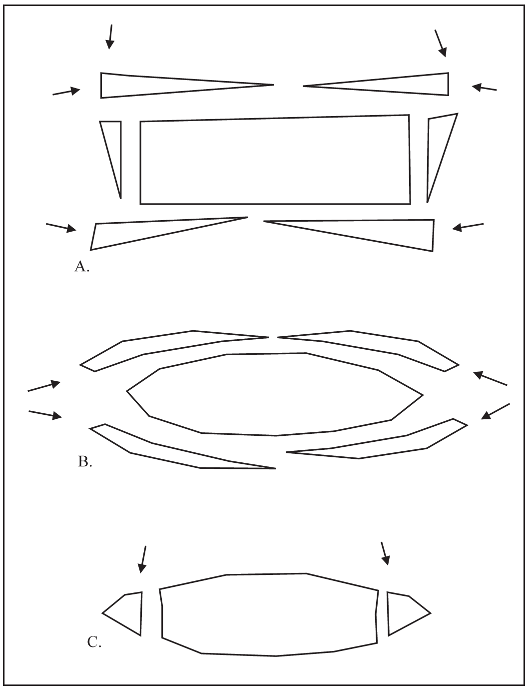


Fig. 4.2.23 Three methods of producing adzes in the Independence I tradition: I) unifacially, II) bifacially, III) bifacially followed by unifacially knapping of the lateral edges.

fragments are results of typical accidents of heavy use, e.g. fractures caused by strong tensile forces. This fracturing indicates that the adzes have been subject to forceful contact with organic materials, e.g. driftwood.

Step 4
A fragment of an adze has a larger width than complete 'exhausted' specimens (figure 4.2.22: III). This fragment thereby shows that adzes can have been reduced in both length and width when sharpened and rejuvenated. Moreover, the narrowing of distal ends (the end with the cutting edge) of the adzes suggests that this end is narrowed through reduction while hafted.

Step 5
The usual reason for the discard of the adze seems to be a heavy fragmentation (figure 4.2.22: I, III), probably due to use. Few specimens are discarded due only to rejuvenation and reduction of size.

Blades

Morphology and metrics
Blades from Independence I are generally regular and prismatic and only slightly curved. Butts are oval and sometimes faceted (figures 4.2.27 and 4.2.28). The width of Independence I blades is typically 8–9 mm, but blades with a width as large as 15 mm have been observed. The variation is from 4–15 mm (figure 4.2.24). The length of complete and mended blades indicate an average length of c. 5 cm. However, some blades are up to 7 cm long (figure 4.2.25).

Fragmentation
Only few blades investigated are found complete (figure 4.2.26). At Solbakken there is a relatively large proportion of large fragments compared to ACK. This relation can possibly be explained by the fact that the back dirt at ACK was sieved and that a lot of small fragments were therefore found. Sieving was not carried out at Solbakken.

Step 1
Tabular nodules of the highest possible quality mcq are chosen for the blade production. A thin square face on the nodule is prepared as a platform and the core is worked into a preform (figure 4.2.29: A). The rear end of the core is left with a square end or shaped into a square morphology by detachments of flakes from one face. The preformed blade core has a conical cross-section and an oblong morphol-

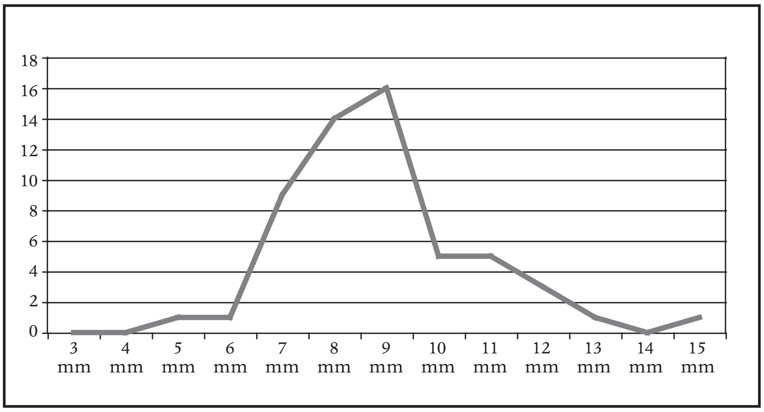


Fig. 4.2.24 Width of microblades from the Solbakken assemblage.

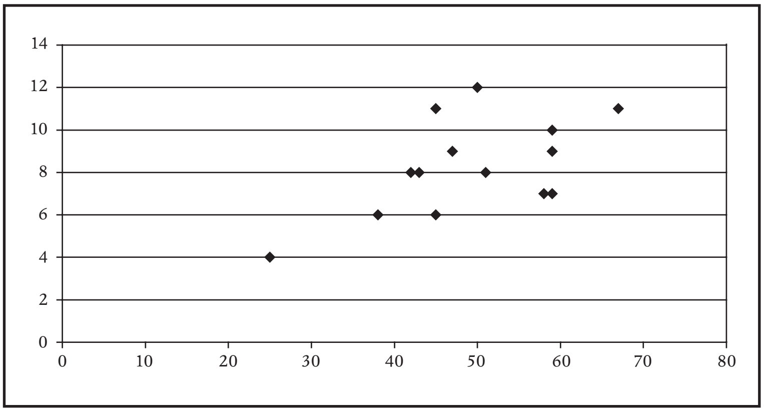


Fig. 4.2.25 Length–width relation of complete blades from the Solbakken and Adam C. Knuth assemblages.

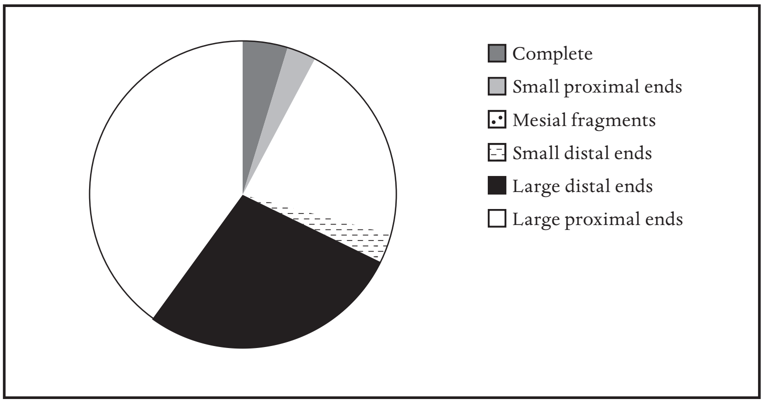


Fig. 4.2.26 Fragmentation of blades from the Solbakken assemblage.

ogy, i.e. a keeled core. The front is given a width of 2.0–2.5 cm. Often the front is shaped bifacially and by the subsequent detachment of a crested blade. The platform is prepared by faceting with small flakes. Both the preparation of the frontal crest and the faceting of the platform could most possibly have been conducted by means of indirect technique, i.e. with a thin punch.

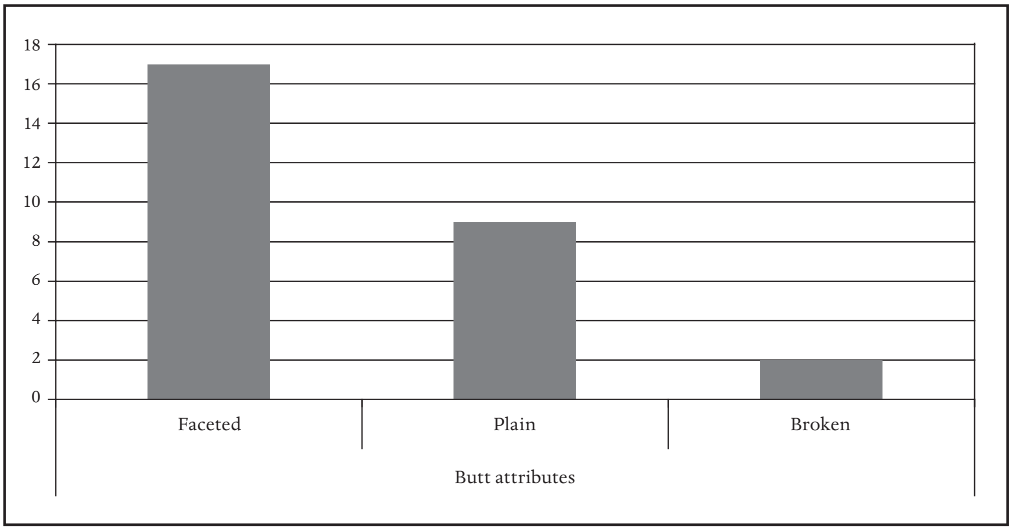


Fig. 4.2.27 Attributes on blade butts from the Solbakken assemblage.

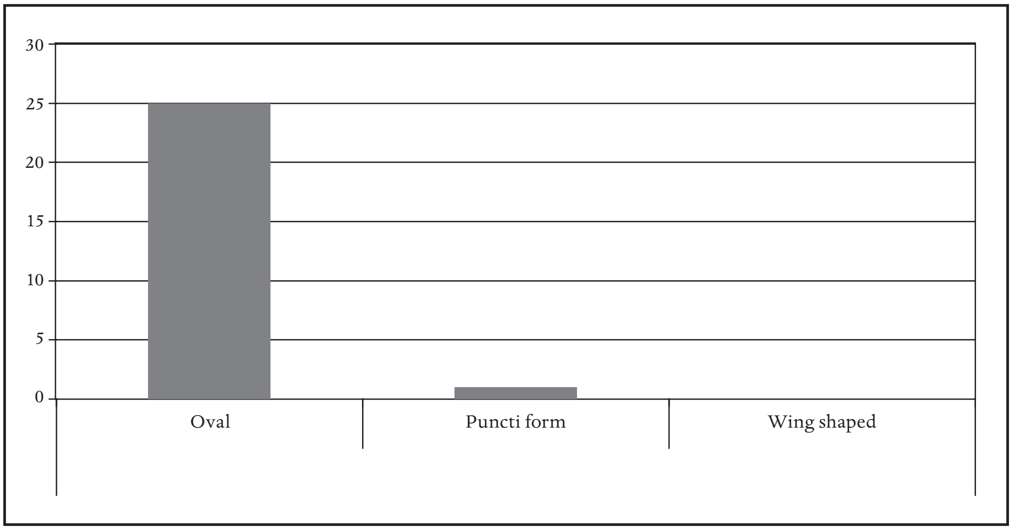
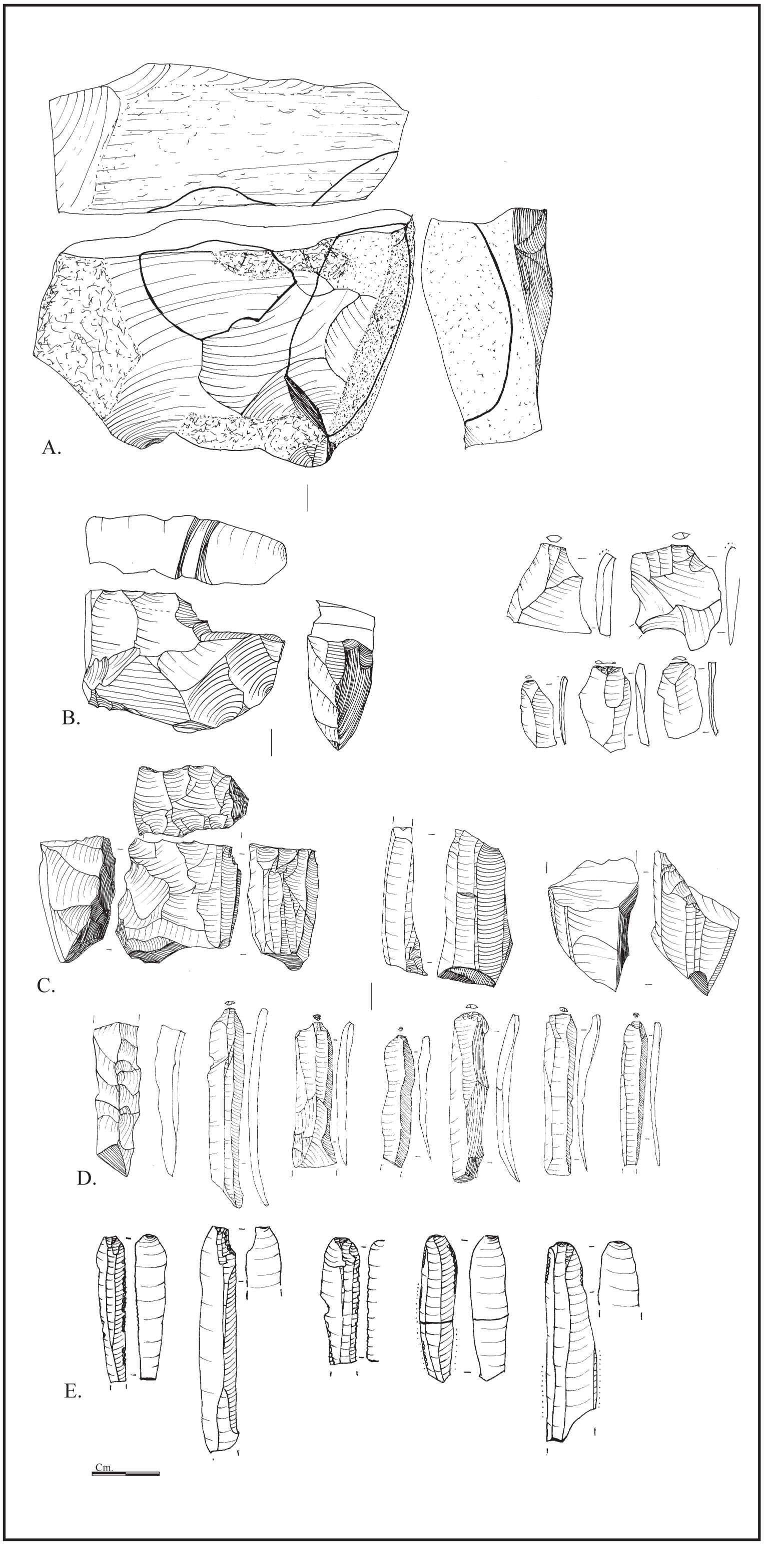


Fig. 4.2.28 The morphology of the blade butts in the Solbakken assemblage.

Step 2

The angle between front and platform is controlled by detachments of small flakes from the platform (figure 4.2.29: C). The blade is further prepared by slight abrasion of the core edge. The blade is detached by means of pressure technique (Pelegrin 1984(a); Flenniken 1987; Tabarev 1997; Sørensen 2006(a)), either by placing the pressure tool on a facet or on a small ridge c. 1 mm from the edge on the

Fig. 4.2.29
The *chaîne opératoire* for the blade production in the Independence I tradition. The example is from the Adam C. Knuth site.



platform. Due to a need for mechanical stability of the core during blade production it is probable that the core have been hafted or hold mechanically during blade production.

Step 3
Few blades are observed with lateral retouch for hafting. One example of this type of modification is a concave retouch on one side of a proximal blade end (figure 4.2.29: E, no. 2 from left), other examples have fine lateral retouch in their proximal ends. However, no standardized modification of the blades seems to appear and no standardized hafting system can therefore be suggested, but it is also possible that the blades were used as inserts. The thin sharp edges of the blades make them appropriate for cutting soft organic materials, e.g. meat or fresh skin.

Steps 4–5
Blades are discarded when dull or fragmented.

The flake material

To analyze the flake material systematically, flakes larger than 1 cm, from 8 m² at

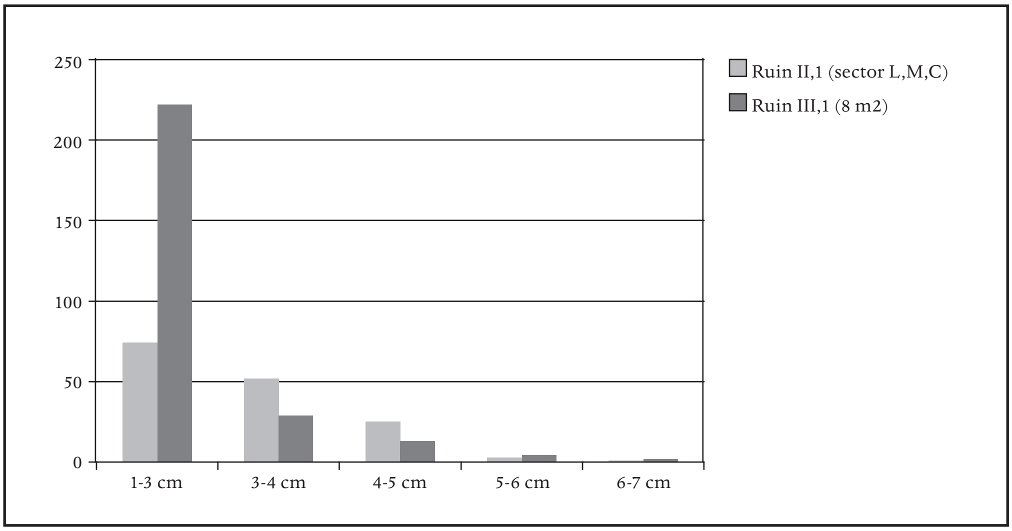


Fig. 4.2.30 A quantitative investigation of the flake material sizes from the Adam C. Knuth site. In Ruin II,1 (excavated in 1985) fewer small flakes are found and collected than in Ruin III,1 (excavated in 2001).

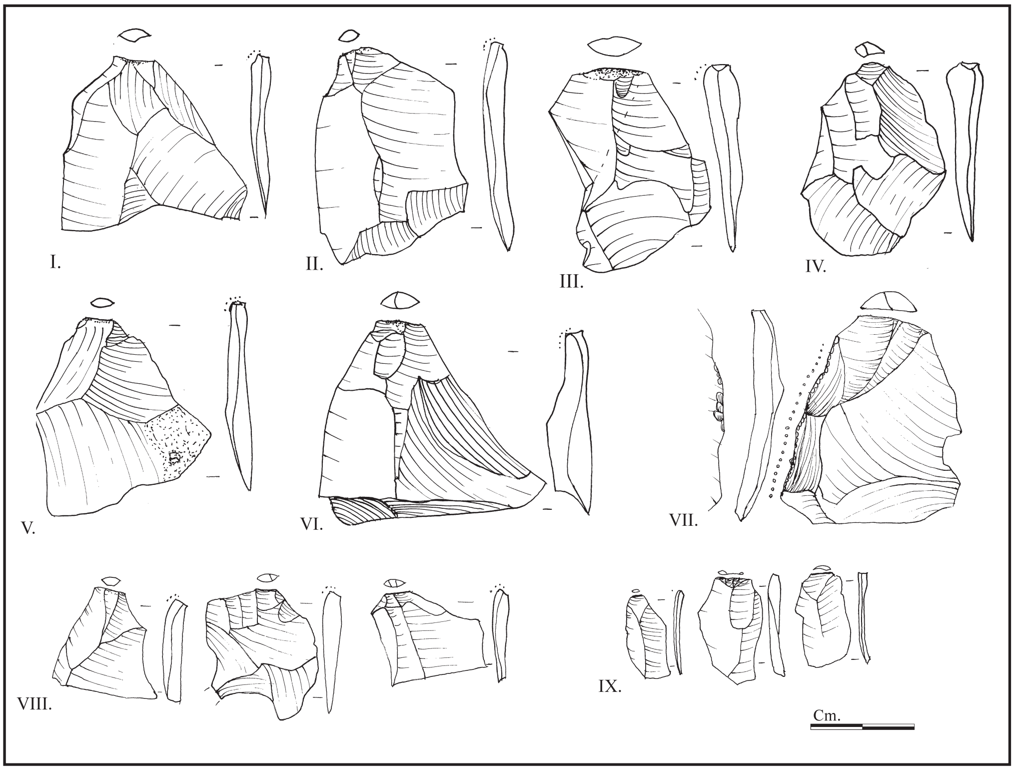


Fig. 4.2.31 Typical flake products from the Adam C. Knuth site assemblage.

RIII,1[5] and sectors L,M,C from ruin RII,1 (both structures from ACK), were chosen. This totalled, in all, 270 and 154 flakes. All flakes were made from the local high quality mcq.

Metrics

The majority of flakes were in the size group between 1–3 cm (figure 4.2.30). The relative frequency of small flakes from RII,1 is lower than from RIII,1. This fact can be explained by different excavation methods used on the two structures.

Flake attributes

Flakes larger than 3 cm generally have a platform angle close to 90 degrees and oval butts that are sometimes faceted (figure 4.2.31: I–IV). The bulb of percussion is often found pronounced and in combination with a lip formation. However, flakes with only bulb or only lip formation also appear. The flake attributes of the

5 Square metres: 46/104, 46/105, 46/106, 46/107, 47/103, 47/104, 47/105, 47/106.

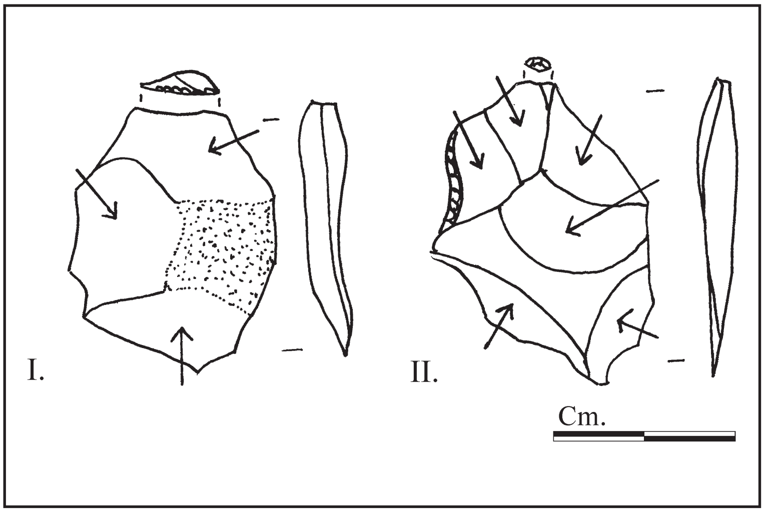


Fig. 4.2.32
The flake material in the Adam C. Knuth assemblage is in many cases characteristic of being produced in a four-sided core concept by indirect percussion.

large flakes suggest that this material most often was produced from tabular cores by means of indirect percussion (figure 4.2.32). The small flake sizes (1–3 cm) have, judged from their attributes, been produced bifacially by means of the soft hammer technique (figure 4.2.31: V–VII).

From structure II,1 there is a series of flakes prepared by pronounced abrasion (grinding) of the platform edge. This flake material is not typical for Independence I flakes seen in the other assemblages analyzed, and might reflect a personal preference during a knapping sequence.

Tools used for lithic production

Pressure flakers

Three pressure flakers from Solbakken (figure 4.2.33: I) and 'Den blå flints boplads' ('Blue flint site') are investigated (figure 4.2.33: II, III). The pressure flakers are from 32 to 51 mm long. The width of the distal ends is from 6 to 10 mm. All the pressure flakers are made from walrus tusk. The basal ends are generally only lightly worked, narrowing in from the distal ends. The distal ends are rounded and have evident use wear, seen as striations. This use wear thus supports the view that these tools were subjected to hard (lithic) materials during a working process. One of the pressure flakers, the shortest (no. II), has a nearly flat distal end, which must be interpreted as the morphology of an extremely used and reduced pressure flaker.

Fig. 4.2.33 Pressure point tools from the Independence I tradition. Pressure points from Solbakken (I) and from 'Den blå flints bopplads' (the blue flint site) (II, III) are investigated. The three points are heavily used and possibly discarded due to wear. No. I is 4.0 cm long.

Punches

From Solbakken a tool made from walrus tusk can be perceived as a punch (figure 4.2.34). The specimen is 10.1 cm long and has a rounded distal end with pronounced use wear seen as small impact marks into the material (figure 4.2.35). The specimen is partly fractured from the distal to the proximal end and the fracture can be interpreted as an accidental result of forceful use.

Evidence of punch techniques is found within the lithic artefact material. From a tabular core large flakes have been detached from the square edges, but sometimes also from extremely concave platforms (figure 4.2.36). The fact that the platform has a pronounced concavity makes it unlikely that the flake has been detached by any means of direct percussion (i.e. soft or hard), due to the volume and size of such percussion tools. Possibly only a punch with a small rounded distal morphology would work in this concavity.

Direct percussion

From the artefact material it seems most likely that soft hammers were in use during the production of large bifaces. However, no such tool types have yet been located from Independence I. It is also possible that hard hammers have been used, but possibly only when testing and during initial shaping of raw material nodules, e.g. in lithic outcrop areas.

Fig. 4.2.34 A possible punch for indirect percussion made from walrus tusk. The piece is from Solbakken site and has a length of 10.1 cm.

Fig. 4.2.35
The distal end of a possible punch from the Solbakken site. Notice the use wear.

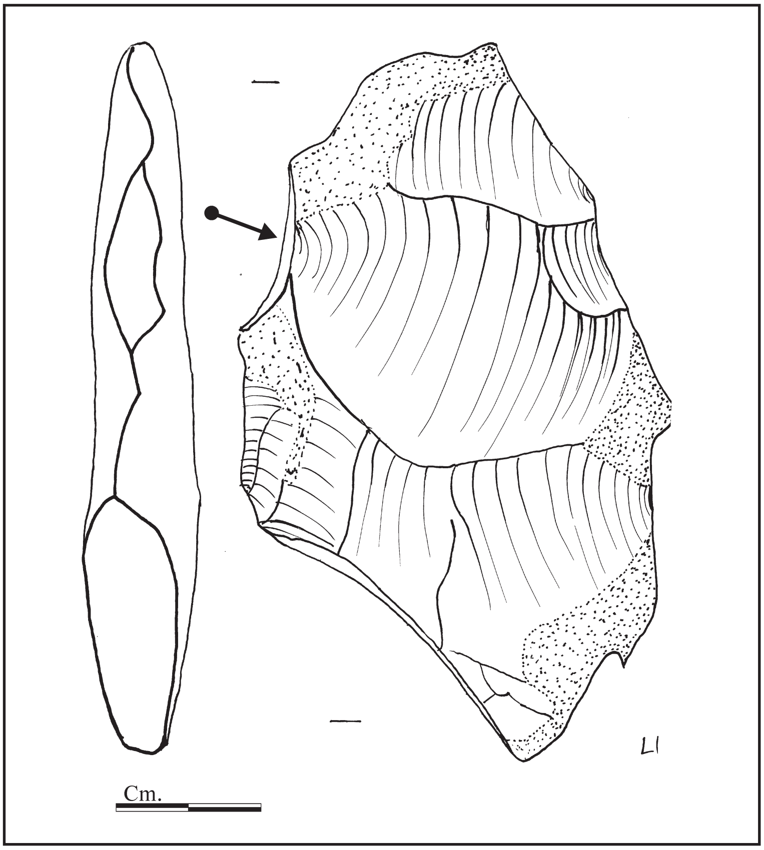


Fig. 4.2.36 Core which shows detachments from concave platforms, a sign of indirect percussion.

Discussion

When the relative frequencies of the tool types are compared for ACK and Solbakken, great similarities are seen (figure 4.2.37). One difference, though, is that only few arrowheads, and preforms of these, are found at Solbakken. It is possible that the Solbakken site represents less hunting of terrestrial animals than ACK, due to its location near the Robeson channel. However, the zoological analysis of the bone material at Solbakken does not support this argument (Grønnow & Jensen 2003).

Conclusion: The Independence I lithic concept

Choice of raw material

Only high quality raw materials of mcq are chosen for all lithic productions except for adzes, where tougher basalt materials are preferred. The choice of raw materi-

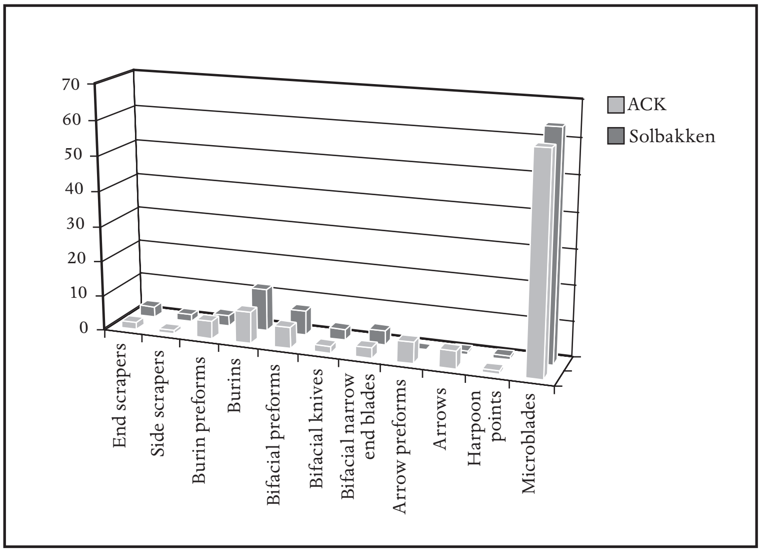


Fig. 4.2.37 Quantitative comparison of tool types from the Adam. C. Knuth and the Solbakken assemblage.

als can only partly be explained by regional geology and the available raw materials within the Independence I occupation areas. In northeast Greenland, between Nordostrundingen and Wollaston Forland where high quality mcq is generally not available, this material is still used by Independence I – which suggests that export of large preforms took place during this period, e.g. from the Scoresbysund region.

Choice of reduction method

The starting point for most of the lithic production are tabular nodules. Such tabular nodules are often worked in a quadratic method where flakes are detached from the narrow sides onto the faces (figures 4.2.38 and 4.2.39). As within the Saqqaq concept, Independence I serially produces flake blanks from cores. The intention during the reduction of the large tabular cores thereby seems to be twofold: to produce flake blanks for the small lithic inventory and to produce a single large biface. When the core is reduced down to a thickness of about 2 cm, the knapping method is changed. The square edges are then worked by alternate flaking and the preform becomes bifacial (figure 4.2.38: D). From this stage of reduction, bifacial knapping is conducted in order to produce a large bifacial tool. A few large bifacial tools from Solbakken have cortex left on both faces, which shows that the original nodule had a thin plate-like morphology. Thus in some cases thin nodules were solely bifacially fashioned into large bifaces. Adzes are reduced both bifacially, unifacially and in a combination. Arrowheads, harpoon points, burins and scrapers are all produced from flake blanks, mostly detached from tabular cores.

The generalized method of lithic reduction, production of tool types and their rejuvenation can be described as the Independence I concept of lithic production (figure 4.2.40).

Blade production method
Blades are produced from keeled single fronted cores with small faceted platforms. The blade core is generally produced from a tabular nodule of high quality mcq. One of the narrow faces of the nodule is selected as the platform and the core is shaped in respect to this platform. The front of the core and the core's conical cross-section is often shaped bifacially by the production of a single crest centrally

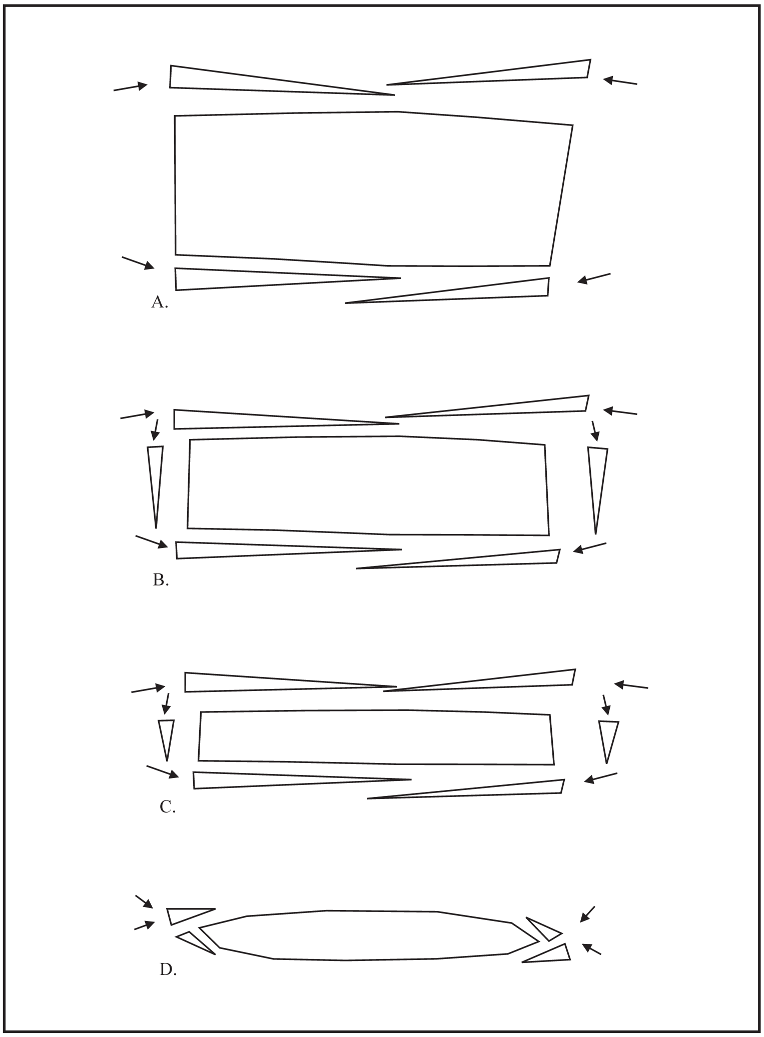


Fig. 4.2.38
The core reduction method in the Independence I tradition. The process often starts with tabular nodules (A) which during the process of the flake preform production is gradually reduced into bifaces (D).

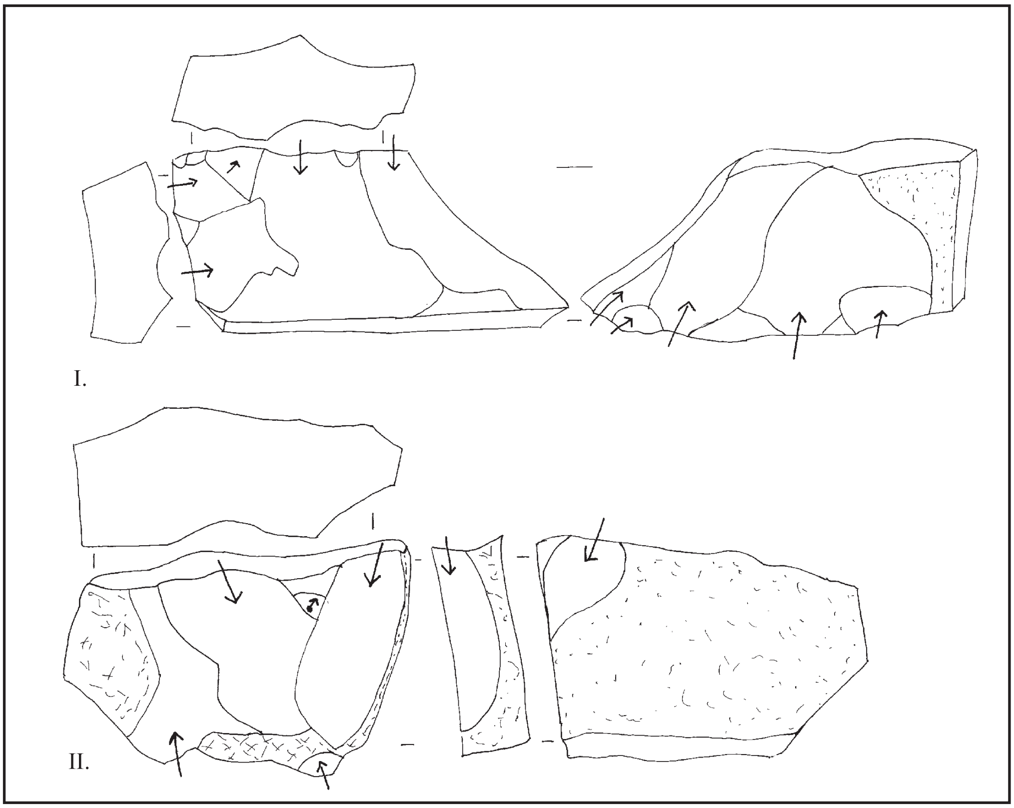


Fig. 4.2.39 An analysis of two cores from the Adam C. Knuth site. The reduction starts from the narrow sides of a tabular core. Using this method blade core preforms as well as cores for flake preform production is produced.

on the front. The bottom of the core sometimes has a crest from which the cross-section of the core also can be controlled. In other situations the bottom is flat and left un-worked. The width of the core is during production kept constantly between 2–2.5 cm. The core can be up to 7 cm high during the initial step of production. The angle between front and platform is generally right-angled during blade production. Prismatic regular relative straight blades are serially produced. The core is most likely mechanically fixed during production due to its low inertia. The platform of the core is repeatedly faceted during blade production, and a large amount of blades, probably up to 50, can be produced from a core. Blades have an average width from 8–9 mm and a thickness of c. 2 mm, the length of the blades are generally 4–6 cm. The generalized method of lithic blade production and modification can be described as the Independence I concept of lithic blade production (figure 4.2.41).

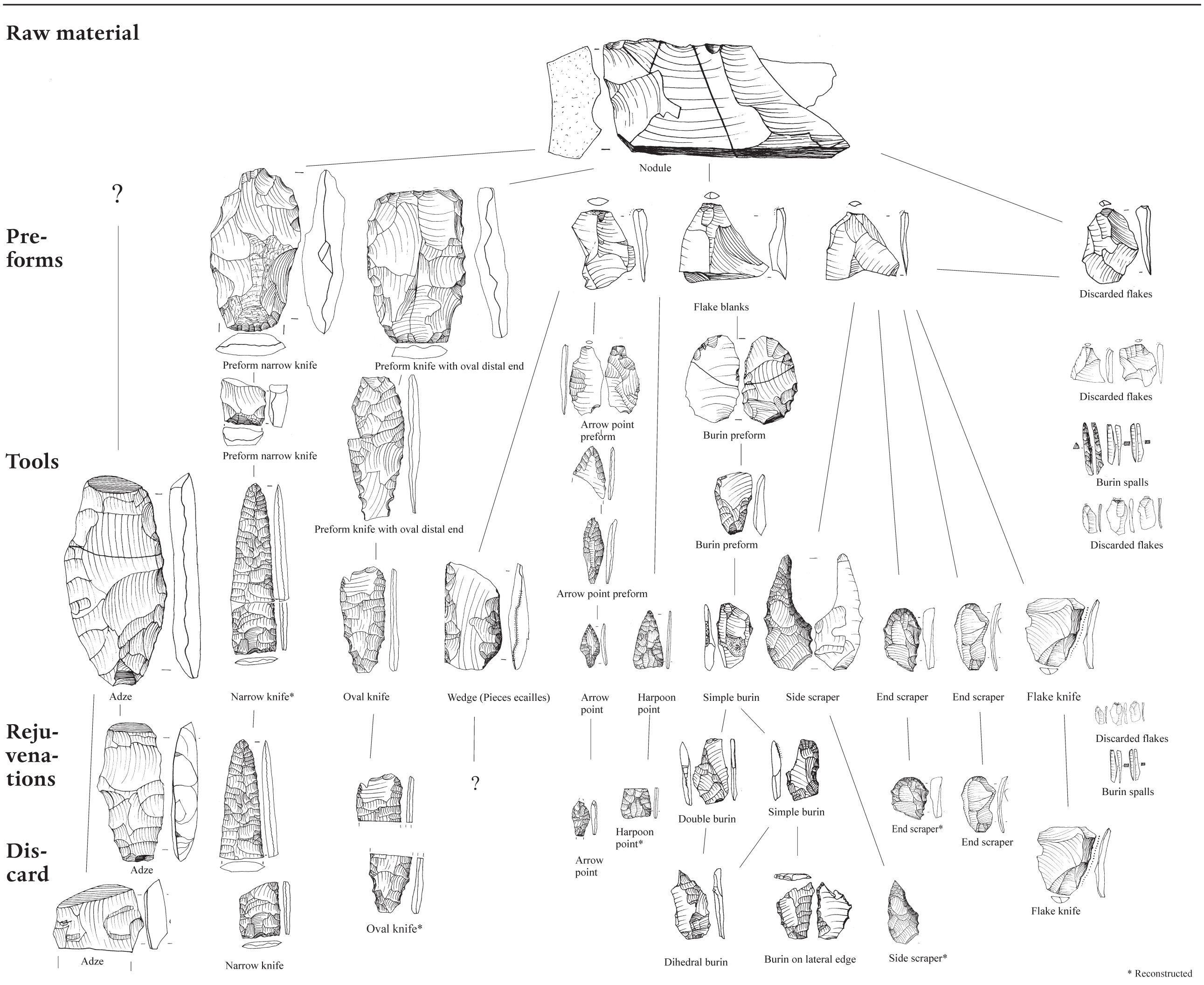


Fig. 4.2.40 The concept of the lithic tool type production in the Independence I tradition.

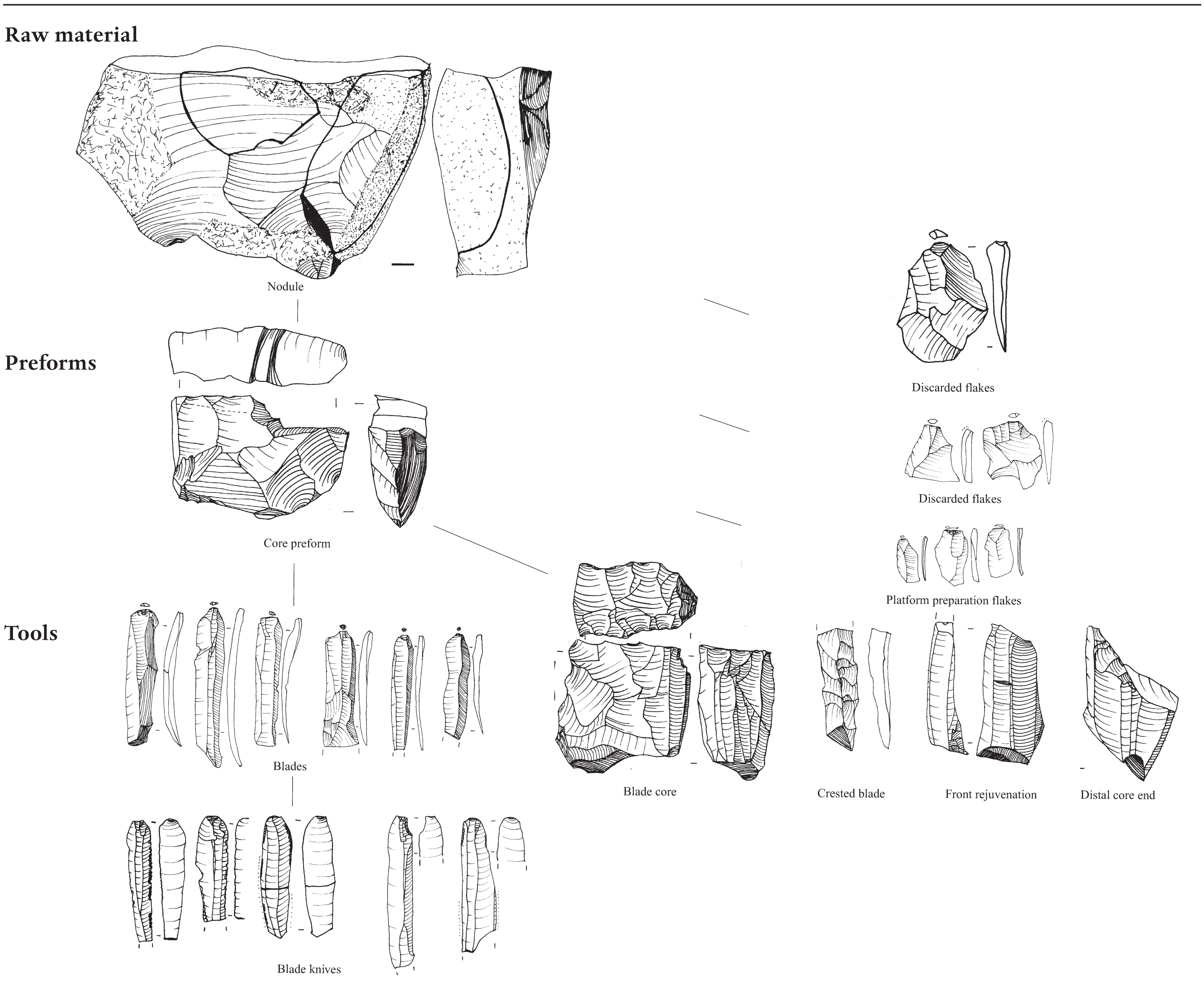


Fig. 4.2.41 The concept of the blade production in the Independence I tradition.

Choice of hafting method

The only type of preserved haft from the Independence I tradition, the harpoon head, shows that harpoon points generally were hafted in a slot.

Choice of reduction technique

Direct hard technique

From sites near lithic outcrops, nodules are tested and initially reduced using a hard hammer.

Direct soft technique

During reduction of large bifacial tool preforms, artefacts and flake material suggests the use of the soft hammer technique. However, no soft hammers have so far been identified in the assemblages.

Indirect technique

From reduction of tabular cores, flake attributes indicate use of indirect technique. Detachments of flakes from strongly concave platforms further suggest the use of a punch. A straight heavy punch, made from walrus tusk, was located at Solbakken. It seems most likely that the punch technique therefore was applied in lithic production during Independence I.

Pressure technique

The precise thin morphology of the tools, and the many small flakes found, suggests that the pressure technique was often applied. Moreover, several specimens of pressure flakers have been located. Special attention should be given to the fine serration of edges, which must have been conducted by means of a specialized thin pressure flaker in Independence I.

Grinding

Grinding in Independence I is seen extensively only on adze edges. However, in order to create a dull platform for the production of the burin spall an abrasion of the distal edge on the burins is often produced.

4.3. Lithic technology in Dorset I

Site assemblages chosen for analysis

To investigate the lithic concepts in Dorset I, inventories from the sites Annertusuaqqap Nuua (AN) and Ikkarlussuup Timaa (IT) have been analyzed. Both sites are located in 'Sydost bugten', the southeastern inner part of Disko Bay, West Greenland (figure 4.3.1). AN was interpreted as a site used during winter, with two habitation structures. IT is more complex. Three habitation structures of different type, and probably age and season, were excavated, and also some artefacts of Saqqaq type were found at IT. However, due to the isostatic rebound it is very probable that the Saqqaq and the Dorset I did not use the same site. The Saqqaq artefacts could thus have been brought with turf, for house building, to the site by Dorset I people.

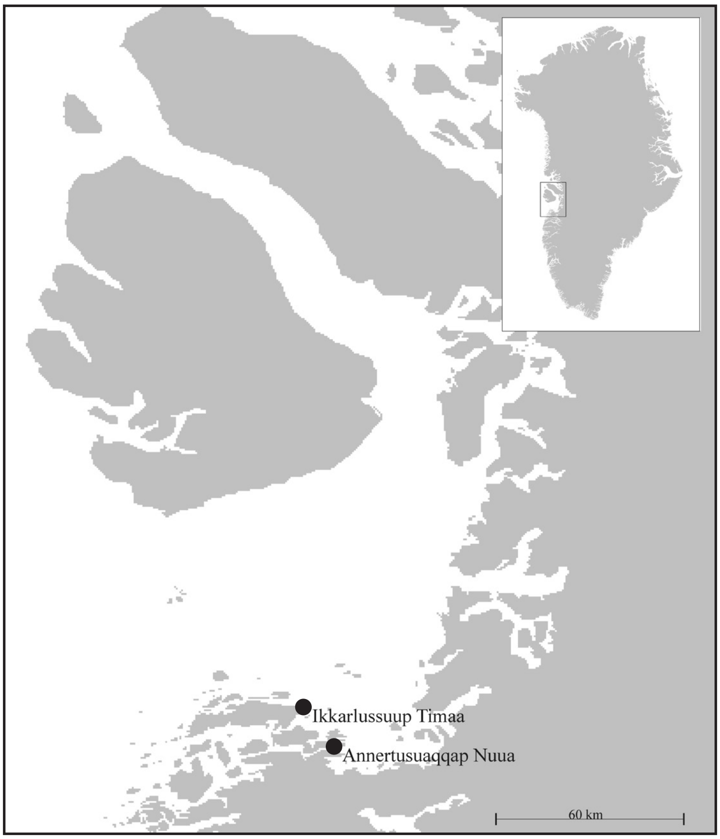


Fig. 4.3.1
The geographical location of the studied Dorset site assemblages.

Both analyzed sites are rich in artefacts and have preserved organic materials. Furthermore, both sites are coastal and can be dated, either relatively or absolute, to the period 800–400 BC. AN and IT are today stored at the Saxo Institute, University of Copenhagen.

An advantage for the investigation is that the two chosen sites (AN and IT) have rich inventories, which makes it possible to describe each tool type production thoroughly and precisely. Furthermore, the excavations and their documentation make it possible to interpret the internal organization of the sites. The inventory from AN was analyzed first, and most thoroughly, hereafter analyses of the inventory from IT could supplement or confirm the results.

Annertusuaqqap Nuua

Geography

AN is situated approximately 10 km south of the village Ikkamiut, in the 'Sydost bugt', Disko Bay. Annertusuaqqap Nuua translated means 'the little foreland, beside the cape'. This place name is a precise description of the site's location beside a cape called 'Annertussoq'. Today AN is situated 0–1.5 m above sea level, thus parts of the midden is flooded at high tide.

Excavation

AN was discovered in 1988 by K. Hansen and M. Stenholdt during a survey for Qasigiannuguit Museum (Hansen & Petersen 1989). During the summer of 1994, a team of five persons excavated a habitation structure with a 10–15 cm cultural layer (Jensen 1995, 1998). Two excavation areas (area A and B) were opened and excavated. Area A was 50 m^2 and revealed a habitation structure and part of a midden. Approximately 60 m west of this area, area B was opened. This area was 12 m^2 and contained ashes and artefacts but no evident structures. The main conclusions of this site therefore derive from area A.

The habitation structure in area A consisted of an oval paved, 5 × 3 m sized area. The pavement was laid upon a former boulder beach. Towards the sea the terrain dropped 0.5 m and towards land, the pavement was dug into the terrain. In front of what was interpreted as the entrance, towards the sea, a midden, rich in artefacts, was excavated. The features in area A are interpreted as a winter house ruin of midpassage type, with a midden in front of the entrance towards the sea (figure 4.3.2).

Excavation method

The cultural layer was recovered by moving turf from the earth surface. Perma-

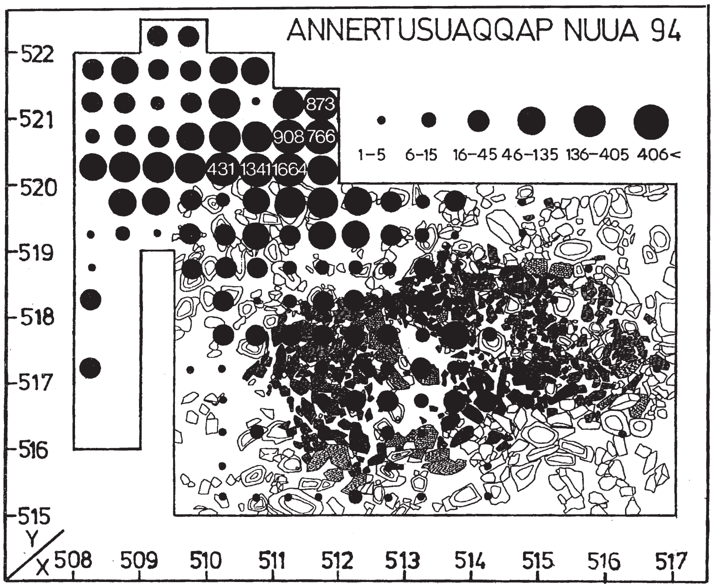


Fig. 4.3.2 Excavated area of the site Annertusuaqqap Nuua, area A. The concentration of the lithic inventory in ¼ m² is plotted on the plan (Jensen 1995).

frost made the excavation slow and difficult at the bottom of the cultural layer. The excavation was carried out in ¼ m². All artefacts were numbered in relation to the ¼ m², and with an individual number.

Publication

AN is published by Jensen (1995, 1998, 2004) as parts of inter- and intra-site analyses of Palaeo-Eskimo sites in Disko Bay. Moreover, the site is published in relation to analysis of Holocene sea level changes in Disko Bay (Jensen & Rasch 1997).

Dating

Two radiocarbon dates have been carried out, one on caribou bone and one on charcoal. Both dates place the site in the calibration plateau between 760–410 cal. BC (table 4.3.1). However, the date on the charcoal material is slightly older than the one on the caribou bone. This is probably due to the growing age of the tree and from the period from when the tree stopped growing until it was burned. Thus the dating of the bone seems most reliable.

A harpoon head made from bone was found at AN. The harpoon type is similar to what was found at the 23-metre terrace at Igloolik, related to the early Dorset period, around 800 BC (Meldgaard 1968).

Inventory

AN has a large collection of lithics. In all 11,436 artefacts, of which 456 have been classified as being tools (table 4.3.2 and figure 4.3.3).

Lab. No.	Material	14C. BP	Calibrated BC*1	Context	Reference
AAR-2343	Caribou bone (Rangifer rangifer)	2460 ±70	760–410	Area A	(Jensen 1998)
AAR-2351	Charcoal, (Salix arctica & Betula nana)	2530 ±75	800–520	Area A	(Jensen 1998)

Table 4.3.1 Radiocarbon dates, Annertusuaqqap Nuua

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

Flakes with retouch	6	Bifacial end blades	56
End scraper preforms	1	Side blades	5
End scrapers	26	Adzes, preforms	10
Side scrapers	4	Adzes	5
Burin preforms	6	Microblade knives	254
Burins	44	Microblades	65
Bifacial preforms	30	Flakes	10,980

Table 4.3.2 Inventory list, Annertusuaqqap Nuua

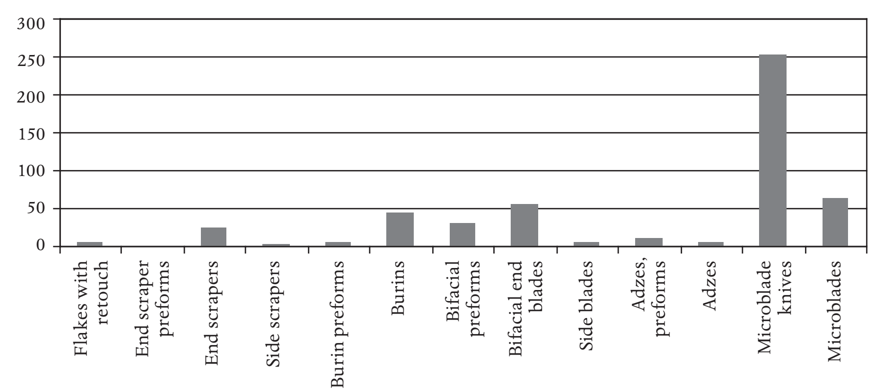


Fig. 4.3.3 The quantitative distribution of the lithic tool types at Annertusaqqap Nuua.

Ikkarlussuup Timaa

Geography

Ikkarlussuup Timaa is situated in 'Sydost bugten', Disko Bay, c. 30 km northwest of AN (figure 4.3.1). Ikkarlussuup Timaa translated means 'the beach behind the cape', a place name which describes the site's location in 'Sydost bugten'. IT is today situated only 1.5 m above sea level.

Excavation

IT was excavated in 1993, in a joint project by archaeologists from Aasiaat Museum, University of Copenhagen, and Memorial University, Newfoundland. In 1995 and 1996 the excavation was continued, but with less people. The excavation in 1993 uncovered three habitation structures (figure 4.3.4) (Stapert & Johansen 1996):

1. In the central part of the northern excavation area a large habitation structure was uncovered. The outline of the structure was made from a partly preserved ring of stones. A dugout central fireplace was found. This fireplace had a large content of burnt bone and blubber. On both sides of the fireplace paved platforms made from stone slabs and round stones were revealed. In the western part of the structure a square fireplace made from stone slabs was uncovered, and in the front of the structure two caches were found. The habitation structure is interpreted as a midpassage dwelling, built from turf and stone, probably used during winter.

2. In the northeastern excavated area a tent ring made from large stones was uncovered. Centrally in the tent ring a fireplace was situated, while in the northern part an area was perceived as a sleeping area. In front of the tent ring a cache made from stones was found. Area 2 is interpreted as yielding a Dorset I tent structure and a cache.

3. In the southern part of the excavated area a stone pavement, interpreted as a former floor in a habitation structure, was found. Around this pavement a periphery of stones was discovered. Inside the stone periphery three stone-built fireplaces were found, but only the central fireplace can be interpreted as synchronous with the stone periphery. South of this structure, a stone-built cache was found. Area 3 can be interpreted as a habitation area, including a dwelling and a meat cache. Unfortunately the area was disturbed by later settlements at the site.

It is not likely that any of the excavated habitation structures are synchronous. Stones are used from area 1 and 3 to build area 2, which contains the most undisturbed and therefore probably latest settlement. Furthermore, the different habitation constructions and types indicate a different seasonal use of the areas.

Excavation method
IT was excavated in ¼ m². All tools are measured in three dimensions, and with an individual number.

Dating
No radiocarbon dating has been made. From relative dating based on the morphology of the tool types the site is attributed to the Dorset I. Moreover, the location of the site, only 1.5 m above sea level, is due to the isostatic rebound in Disko Bay, also typical for a Dorset I occupation.

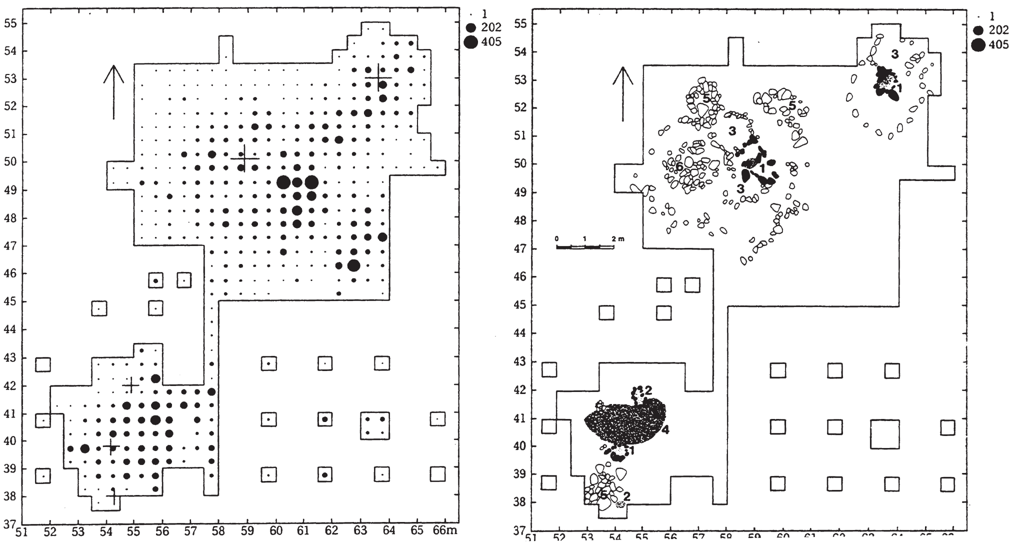


Fig. 4.3.4 Excavated area at Ikkarlussuup Timaa. To the left: distribution of the lithic material in ¼ m². To the right: the features in the excavated area.

The inventory list

The inventory list is compiled only of artefacts from the 1993 excavation (Stapert & Johansen 1996) (figure 4.3.5).

Flakes with retouch	7	Ground end blades	11
End scrapers	66	Adzes	8
Side scrapers	8	Microblades	657
Burins	38	Microblade knives	228
Bifacial end blades, preforms	64	Cores	40
Bifacial end blades	124	Flakes	1657
Side blades	28	Chips <1 cm	12,916
		Total	15,852

Table 4.3.3 Inventory list, Ikkarlusuup Timaa

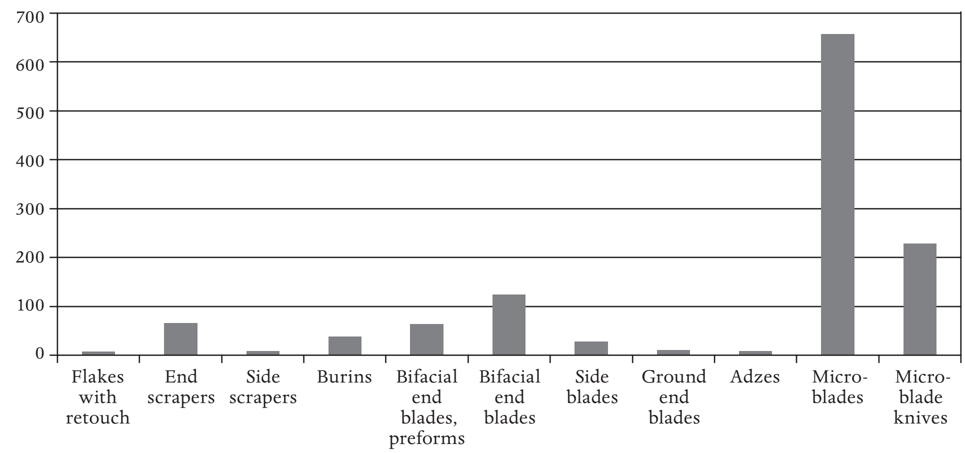


Fig. 4.3.5 The quantitative distribution of the lithic tool types at Ikkarlusuup Timaa.

The *chaînes opératoires*

The raw material

Four general raw material types are used at AN and IT: Nuussuaq killiaq, Angisat killiaq, mcq and quartz crystal. Killiaq and mcq can principally be separated into many sub-types in relation to colour and texture. As an example of this Johansen operates with 15–25 sub-types of mcq in the inventory from IT (Stapert & Johansen 1996). The many sub-types can be explained by the heterogeneous qualities of the mcq, but also by the fact that mcq is heat treated in Dorset I and that the material, due to this process, changes colour and texture. In all probability it has not yet been possible to attribute any of the sub-qualities of the mcq to specific geological sources more specifically than the western part of the Disko Bay region.

At AN, the majority of the flakes are made from mcq (56%). However, Nuussuaq killiaq was used abundantly too (44% of the flakes). Angisat killiaq and quartz crystal make up less than 1 per cent of the flaked material (figure 4.3.6). Approximately the same frequencies of raw material qualities are seen at IT. It is thus interesting that the local raw materials Angisat killiaq and quartz crystal are least used at the two sites. This can be explained by the fact that the quality of the regional raw materials are better than the local raw materials, and that Dorset

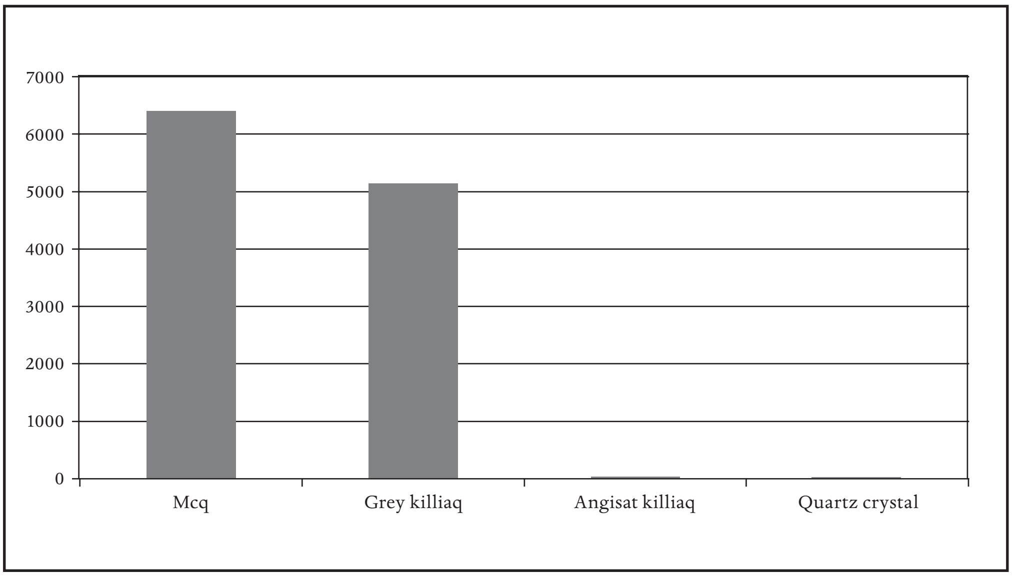


Fig. 4.3.6 The quantitative distribution of the different raw material types at Annertusaqqap Nuua.

I had no problems procuring the regional materials, either from trade or direct procurement.

The raw material choice in relation to tool type is invariable at the two sites (figure 4.3.7). Adzes and burins with ground edges are nearly always produced from killiaq, while microblades, side scrapers, side blades and thin bifacial tool types are produced from mcq. End scrapers are generally produced from mcq. However, about 15% are made from killiaq. A small proportion of the microblades are made from quartz crystal. Generally, the thin bifacial tools are made from a bluish 'milky' semi transparent mcq (70%). This material is a heat treated type of blue mcq (chapter 8.1), which is found many places in the western part of Disko Bay (localities 16, 17, 19, 20, 21 in chapter 3). The rest of the thin bifacial tools consist of a variety of mcq materials, e.g. red, transparent, green, white and grey qualities. The heat treated blue mcq is also preferred for the blade industry and only a minority of other types of mcq are used. A few blades are made from quartz crystal and killiaq.

When comparing the relation of tools and tool preforms to flakes for the different raw materials, it is seen that the relation of flakes versus tools is higher for killiaq than for mcq (figure 4.3.8). The uneven relation between killiaq and mcq has to be explained by the fact that the production of microblade knives (microblades with basal retouch) is a technology which produces only few flakes compared to

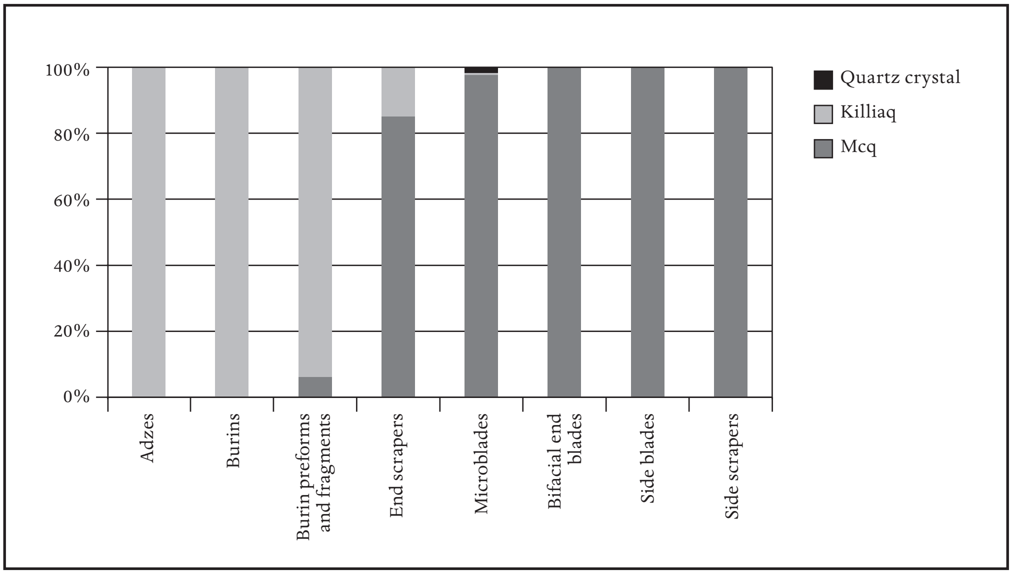


Fig. 4.3.7 The quantitative relation between raw material type and lithic tool type demonstrates the specific raw material choice at the Annertusaqqap Nuua site.

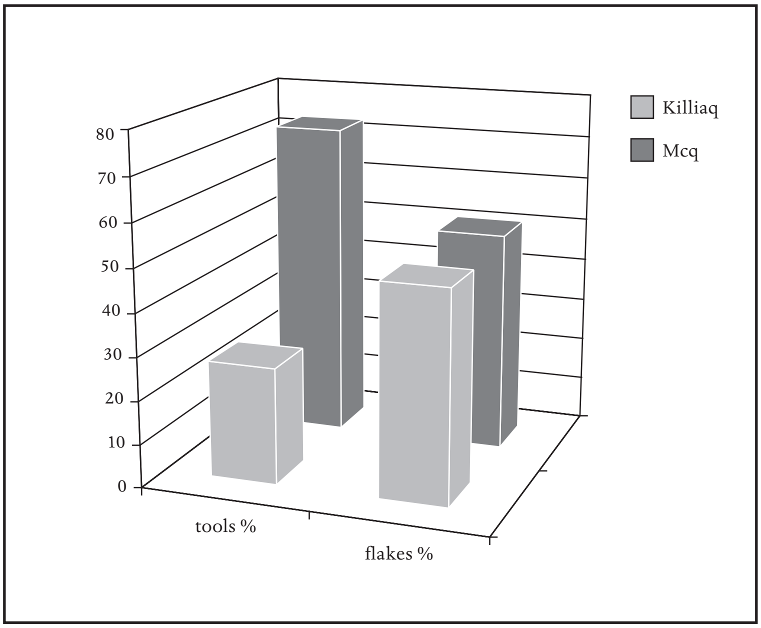


Fig. 4.3.8 A comparison between flakes and tools and the choice of raw material. It is seen that 23% of the total amount of tools are made from killiaq, 77% are made from mcq. The total amount of flakes consist of approximately 50% killiaq and mcq.

the bifacial technologies. The productions of killiaq tools are all made employing a bifacial method, which produces large frequencies of flakes.

Heat treatment of lithic raw materials

Heat treatment of mcq is a controlled process in which the lithic material is slowly heated up to 250–350 degrees centigrade, and thereafter cooled slowly down (Crabtree & Butler 1964; Inizan et al. 1999). The goal of the heat treatment is to increase the flaking properties of the raw material. Physically, it is a change in the crystal structure within the mcq material during heat treatment which improves the flaking of mcq. It is generally only with fine-grained lithic materials such as mcq that heat treatment is advantageous. Such materials become more glass-like when subjected to controlled heat. Flake scars made on a heat treated mcq will most often appear lustrous, even greasy and shiny. Often the heat treatment will also change the colour of the lithic material, often into reddish nuances.

It is, however, difficult to determine whether a prehistoric lithic artefact has been subjected to a heat-treating process, or if it is just a natural property of the raw material to be e.g. glassy and reddish. In fact, the heat treating can only be diagnosed for certain if scars appear from flaking, both before and after heat treatment, on the same artefact. In this case, the discrepancy between the lustrous flake scar and the former coarser scar proves the heating process.

Another problem in diagnosing heat treatment is that some lithic materials could have been naturally subjected to heat of geological origin. This could be the case e.g. in Disko bay, where basaltic activity has been extensive.

At AN there exists several diagnostics of controlled heat treatment of lithic materials. Certain evidence of this process is found on an end scraper preform (figure 4.3.9). The preform is made from a curved flake, produced while the material was not yet heat treated. Thereafter the preform was retouched at its distal end, and the flake scars from this process is obviously shiny and lustrous. Moreover, the preform is clearly reddish. It is thus certain that the preform was heat treated after detachment of the flake blank but before the distal retouch.

Another example of heat treatment is found on a reddish bifacial preform (figure 4.3.10). The preform has few shiny glossy flake scars, compared to former coarser scars. Moreover, this preform has several 'pot lids', which shows that the preform actually had too much heat. In this case, the heating process did not succeed and the preform was therefore discarded after a test.

In relation to understanding and identifying heat treatment of lithic materials from Disko Bay some modern collected types of mcq from Nuussuaq were experimentally heat treated (chapter 8.1, figure 8.1.2). The experiment demonstrated that especially the bluish mcq from the Disko Bay area, often known as chalcedony, improves considerably from heat treatment. The experiment also shows that the bluish mcq changes into a glassy-like semi-transparent 'milky' material. This type of material is very often found used for microblade and bifacial production in a

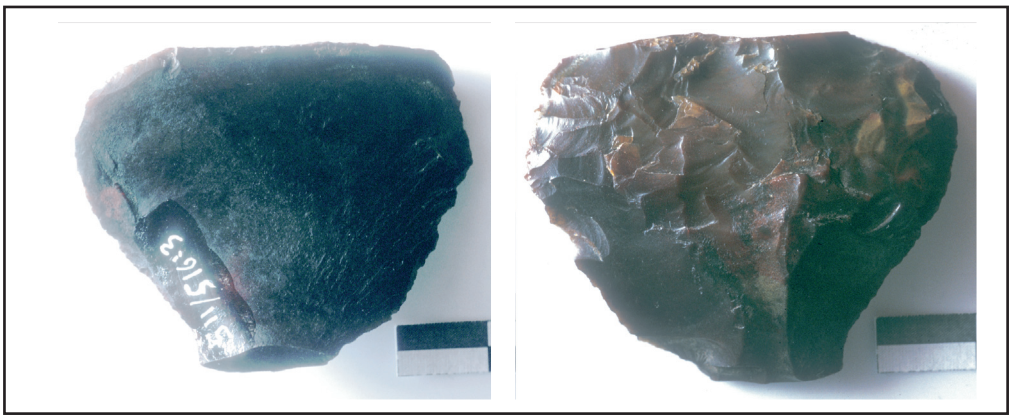


Fig. 4.3.9 A heat treated end scraper preform from the Annertusaqqap Nuua assemblage. On the retouch on the dorsal face a shiny lustrous surface can be seen, indicating heat treatment before the retouch but after the rough preform was made.

Fig. 4.3.10
A heat treated preform from the Annertusaqqap Nuua assemblage. The heat treatment is documented by the lustrous retouch on the upper face and the red colour.

Dorset I context, in central West Greenland. This suggests that this kind of bluish mcq generally always was heat treated before use by Dorset I.

Discussion
Heat treatment of lithic materials was conducted as early in prehistory as 20,000 BC, e.g. by the Solutrean culture in Western Europe (Bordes 1969). This technique was probably developed in connection with pressure flaking and pressure debitage, due to its appearance with the lithic pressure technique (Inizan et al. 1992; Inizan & Tixier 2001). Already around 15,000–20,000 BC heat treatment was used in Siberia (Flenniken 1987; Inizan & Tixier 2001). Thus the probable predecessors to the ASTt were well aware of the heat treatment process, and it seems possible that this knowledge somehow was transmitted to the ASTt, as part of traditional technological knowledge, and brought into the eastern Arctic. Possibly future studies of heat treatment in the ASTt will enlighten this problem.

Preforms

At AN, about 100 large core fragments and large flakes made from killiaq, together with 80 core fragments and large flakes made from mcq, can be considered as preforms for tool production. No large cores are found at the site, thus the preforms must have been imported. By way of mending preforms and analyzing the preform morphology in relation to the raw material choice, it is seen that the preforms already from the beginning have been selected for the production of specific tool types. Preformed cores made from killiaq are probable adze preforms (figure 4.3.11: I, II). Small thin core preforms made from mcq are typical preforms for bifacial tool types (figure 4.3.11: III), while from large flat mcq flakes side scrapers, side blades, and flake knives can be produced (V). Preforms for end scrapers are produced from large curved flakes (figure 4.3.11: IV).

At AN and IT, we generally do not find systematic serial productions of preforms. Only the end scraper preforms are different from other preform types by being serially produced from special cores. In this way Dorset I is different to Saqqaq and Independence I, which use serial production of preforms from large cores as a standard procedure.

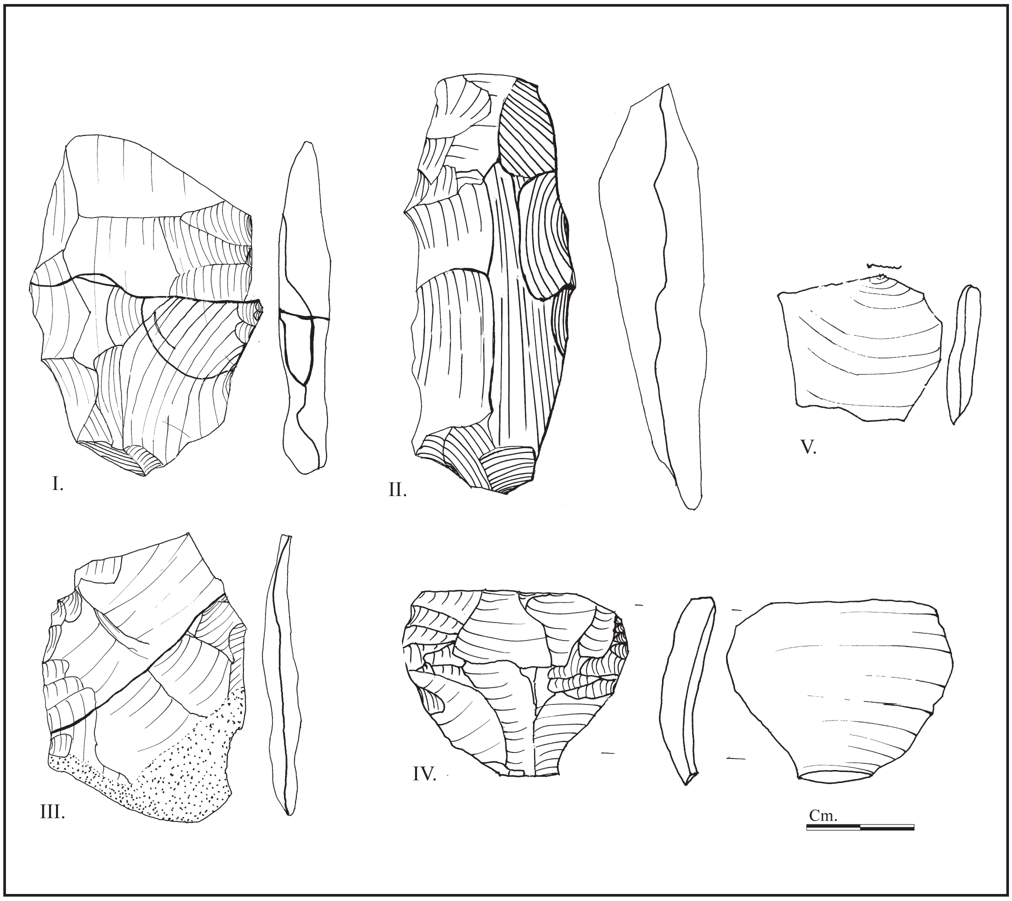


Fig. 4.3.11 Different types of preforms from the Annertusaqqap Nuua assemblage. I and II) adze preforms made from killiaq. III) a biface preform. IV) a large curved flake made from mcq chosen as a preform for an end scraper. V) large mcq flakes are often used for many of the small tool types.

End scrapers

End scrapers from Dorset I typically have flaring edges and an un-pointed base. Lateral edges are most often shaped by precise retouch. All end scrapers are made from flakes and have their edges in the distal end of the flake preform. The scraping edges are produced by a serial retouch from the ventral side of the flake preform onto its dorsal distal side. The edge angle is typically 50–60 degrees.

Step 0

Mcq or quartz crystal is typically chosen for the scraper production.

Step 1

The mcq flakes, which are used as preforms for end scrapers, often have a flat distal facet (figure 4.3.12: A). This facet derives from a tabular core type, from which the scraper preforms were detached. As can be deduced from the end scraper preforms, these scraper cores must have been flat fronted, 3–6 cm high, at least 5 cm wide, tabular cores (figure 4.3.13). After the detachment of a mcq flake preform this was typically heat treated (figure 4.3.9).

Step 2

The facet at the distal end is retouched away. Lateral edges are shaped by detachments across the ventral side of the flake preform (figure 4.3.12: B, C, D), followed by serial retouch of the dorsal side. The basal ends of the end scrapers thus often become bifacial. In some situations the basal end of the end scraper is fluted (figure 4.3.12: C). Towards the distal end, the lateral edges are made flaring (B). The edges of the scrapers are made in the distal end of the flake preform by serial retouching from the ventral side onto the dorsal side of the preform. The edge angle is typically 50–60 degrees. Most of the reduction in this step is probably made by means of pressure retouch.

Step 3

The specific standardized made morphology of the basal ends suggests that the end scrapers generally were hafted. This could have been carried out by attaching the basal scraper end to a wooden haft, as is the case in Saqqaq. Future use wear analysis of the basal scraper ends as well as the scraping edges could explain how the Dorset I end scrapers were used. It can be assumed that the end scrapers generally were used for the scraping of hide and skin.

Step 4

When the edges are examined macroscopically, it is seen that they often are

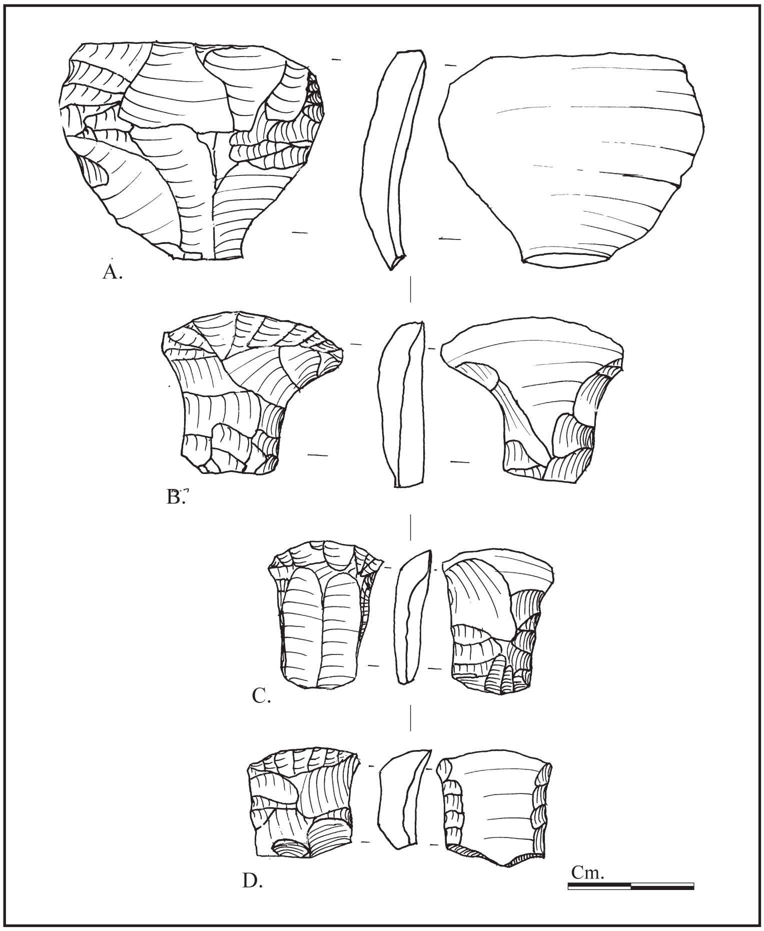


Fig. 4.3.12
The *chaîne opératoire* for the end scraper production in the Dorset I tradition. Examples are from the Annertusaqqap Nuua assemblage.

rounded considerably from use. In order to rejuvenate the edge a serial retouch of the edge is made. Using this method, the edge can be rejuvenated several times, whereby the scraper gradually becomes shorter and the flaring lateral edge disappears (figure 4.3.12: C, D).

Step 5
The end scraper is discarded when its length is reduced considerably and it therefore probably no longer can be hafted. In this step the flaring edges are typically retouched away, thus the scraper's (stylistic) morphology changes. Normally end scrapers are not found fragmented, probably due to an un-forceful type of use.

Discussion
The existence of standardized 'scraper preform cores' is not confirmed archaeo-

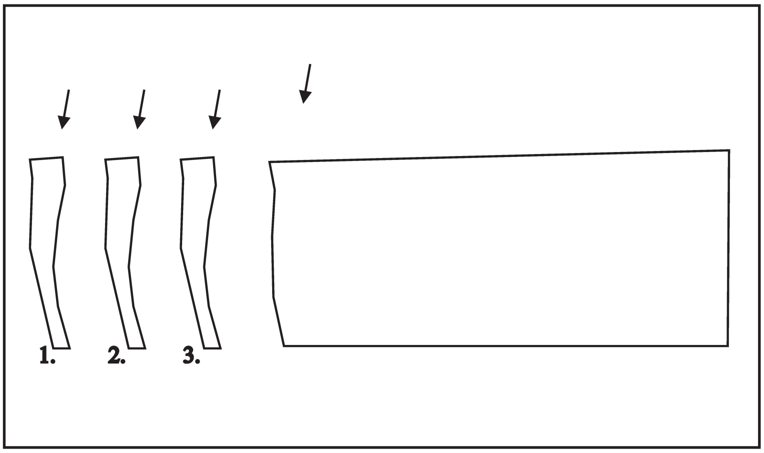


Fig. 4.3.13
Standardized scraper preforms in the Dorset I assemblages indicate that these have been serially produced as flakes from tabular single platform cores.

logically. It can be expected that this core type will be used up. However, maybe in mcq source areas, where scraper preforms would be serially produced, exhausted scraper cores could be found.

Side scrapers

Step 1
Flat oblong flakes are produced and sorted out for the production of side scrapers. The flake preforms are oriented so that the bulbar ends become the basal end of the scraper (figure 4.3.14: A, B).

Step 2
The lateral edges of the flake preform are retouched from the ventral side. The preform is shaped to an oblong morphology with parallel lateral edges. The cross-section becomes triangular, while the ventral side is kept flat. On the base two large slender notches are made, one on each side (B). The bulb on the flake preform is reduced, probably to enable hafting. From the basal edge, thinning by fluting can occasionally be observed (figure 4.3.14: C).

Step 3
The accurately shaped basal end of the side scrapers suggests that they generally were hafted. Possibly the side scrapers were hafted as burins (see below), in a wooden haft. Due to the morphology of the side scraper and its asymmetric scraping edge, it can be suggested that the side scraper was used in a motion towards the

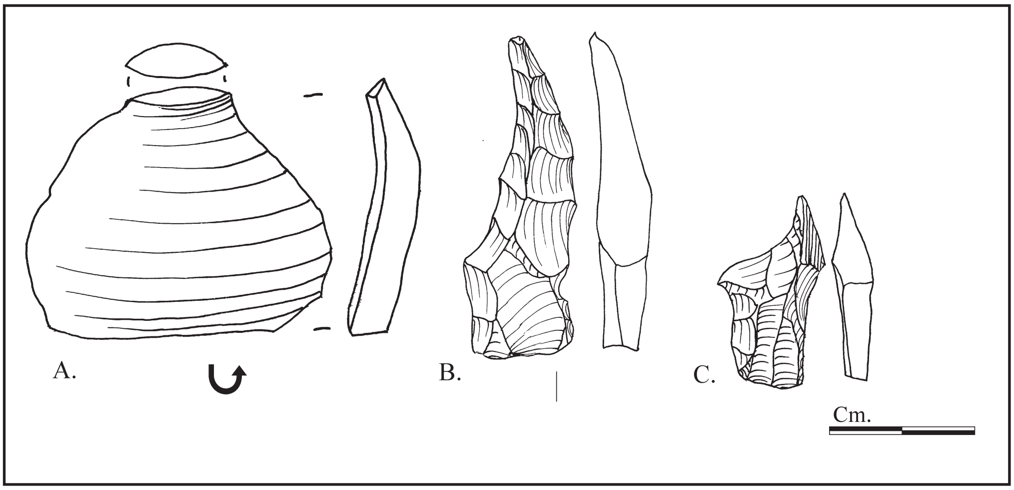


Fig. 4.3.14 The *chaîne opératoire* for the side scraper production in the Dorset I tradition.

body, with the flat side of the tool down against the worked material. In this way, the edge could cut, scrape and reduce a hard organic material.

Step 4

From the repeated unifacial rejuvenation of the scraping edges it can be suggested that the side scrapers generally were used intensively and for a long time. The unilateral unifacial rejuvenation results in an asymmetrical distal 'beak-like' form (figure 4.3.14: C).

Step 5

The side scraper is discarded when its distal end is shortened down to a size of around 1 cm. In this stage the edge angle is steep, sometimes more than right angled.

Discussion

All side scrapers from AN are rejuvenated from the left side of the edge, seen with the ventral flat side down. If the side scrapers were used against the body, as described in step 3, all of the users at AN must have been right handed. This observation is confirmed by the burins which, by a similar analysis, are made exclusively for right-handed persons at AN.

Burins with ground edges

Step 1

At AN and IT, killiaq is generally chosen for the burin production. Only few burins are made from mcq, e.g. 6% at AN. In the Disko region, killiaq from Nuussuaq is primarily used at the Dorset sites, while on the east coast and partly in South Greenland killiaq is substituted with fine-grained basalts for the production of burins. Small cores and core fragments of killiaq are selected as preforms for burins at AN and IT.

Step 2

The preform is shaped unifacially possibly by direct percussion. One side becomes flat and the cross-section becomes asymmetrical (figure 4.3.15: A). The morphology of the preform is made oblong. The edge is formed by a unifacial serial production of small flakes from the flat face. In this way, the edge becomes regular and with an angle of around 80 degrees. The basal edge is made slightly angled from the corner under the burin edge towards the opposite lateral edge. Two large slender notches, one on each lateral side of the base, are produced. The base is often fluted on both sides. Hereafter, the distal end of the burin is ground. The ventral face is ground flat, the edge is ground in an 80-degree facet to the ventral face, and the dorsal side is ground in two facets (figure 4.3.15: B). Thus the cross-section of the burin becomes trapezoid.

Step 3

Hafted burins with ground edges are known from the site Nunguvik (Mary-Rousselière 2002), dated to middle and late Dorset (see description of these burins under 'Lithic technology in Late Dorset' in chapter 4.5).

Burins are often seen snapped in their medial section, just above the basal end (figure 4.3.15: B). Such fractures probably relate to use wear and working of hard or tough (organic) materials. When the burins are analyzed it can be seen that they must have been used with the flat side down against the worked material so that the edge could cut and shave at a right angle to the material. The burin will then work nearly as a plane and due to its straight and even edge it can produce very precise and even surfaces on tools and carvings. The use of burins with ground edges can also be described from historical sources. In Canada the word *kingusasak* is still remembered for a tool used to work and shape hard organic materials such as bone or driftwood (Petersen 1979).

Step 4
Burins are rejuvenated by different methods: 1) A unifacial reduction of the working edge is made (figure 4.3.15: C1) followed by grinding; 2) the working edge as well as dorsal and ventral surface of the burins distal end is ground (figure 4.3.15: C2, D1, D2, E1, E2); 3) a burin spall is detached followed by grinding of the edge. This latter method, however, is seldom seen.

Step 5
Most of the analyzed burins are discarded due to repetitive rejuvenations and size reduction. However, a good deal of the burins are discarded when broken in their medial section.

Discussion
Several morphological variations of burins are seen within the Dorset I assemblages. The width of the bases can vary, but also their morphology, length and the size of the notches varies. Finally a special form of completely ground, double conical burin is seen (figure 4.3.15: D1, E1). The latter type is so different from the other ground burins that a special function must be supposed. One suggestion to their function, which corresponds with their narrow morphology, is that they were used for the production of the hole in the base of the typical Dorset I harpoon head.

The working edges on the burins from AN are all at the left side of the burins, when the burin is seen with its ventral (flat) side down. At site IT, 21 burins have their edges at the left side while two burins are right sided. The symmetry of the burins is probably related to their function and to right/left handedness. A right-handed person would use a left side burin if the burin were used as described (step 3). From this interpretation it can be suggested that the persons using burins at AN were all right-handed, while at least one person at IT was left-handed. This information corresponds nicely with the spatial information and the general interpretation of IT, which involves several occupations, settlements phases and therefore most likely different persons.

To conclude this discussion, it has to be emphasized that burin morphology in Dorset I cannot alone be explained as a result of one technological method and one ideal *chaîne opératoire*. Variations are seen due to right-left handedness, but there seems also to exist a special double conical, completely ground burin type in Dorset I.

Bifacial end blades

A right-angled base with two wide notches characterizes bifacial end blades. At AN

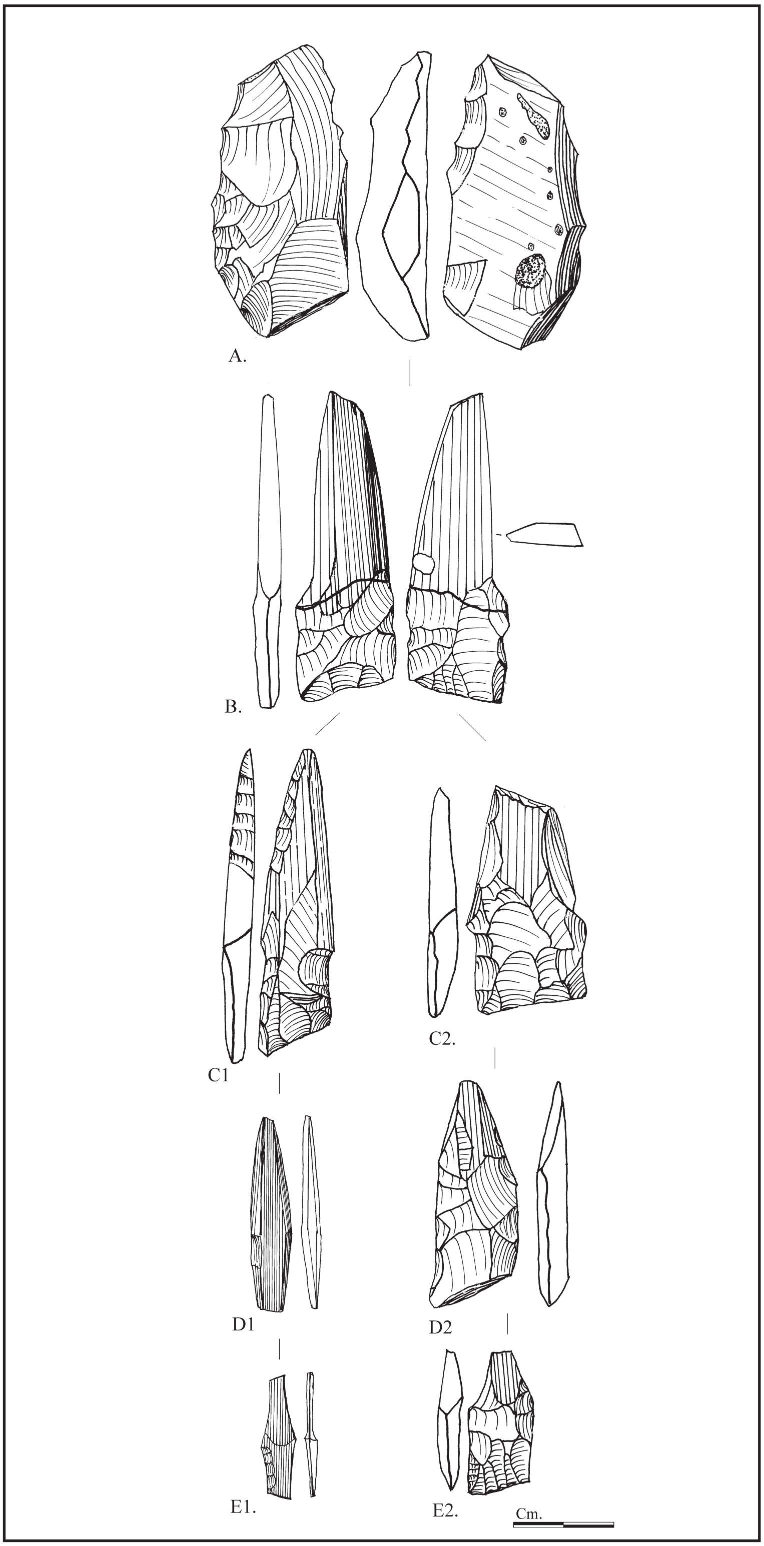


Fig. 4.3.15
The *chaîne opératoire* for burins in Dorset I. The burin edges are gound. There seem to be two types of burins: a narrow full ground type and a broad type. Examples are from the Annertusaqqap Nuua and the Ikkarlussuup Timaa assemblages.

and IT the majority of the end blades are laterally rejuvenated and they often have an asymmetrical distal end. It can therefore be concluded that they must have been used as knives. A few end blades and a distal fragment can be interpreted as projectile points due to their symmetry and use wear in the form of impact burination damage. However, there is generally no morphological difference between the two functional types, so their production can therefore be described as one method.

Step 0

The bluish translucent mcq is the dominant choice for the production of end blades at the analyzed Dorset I sites. At AN, 70% of the end blades are made from this material. In all probability a fine-grained high quality mcq is chosen.

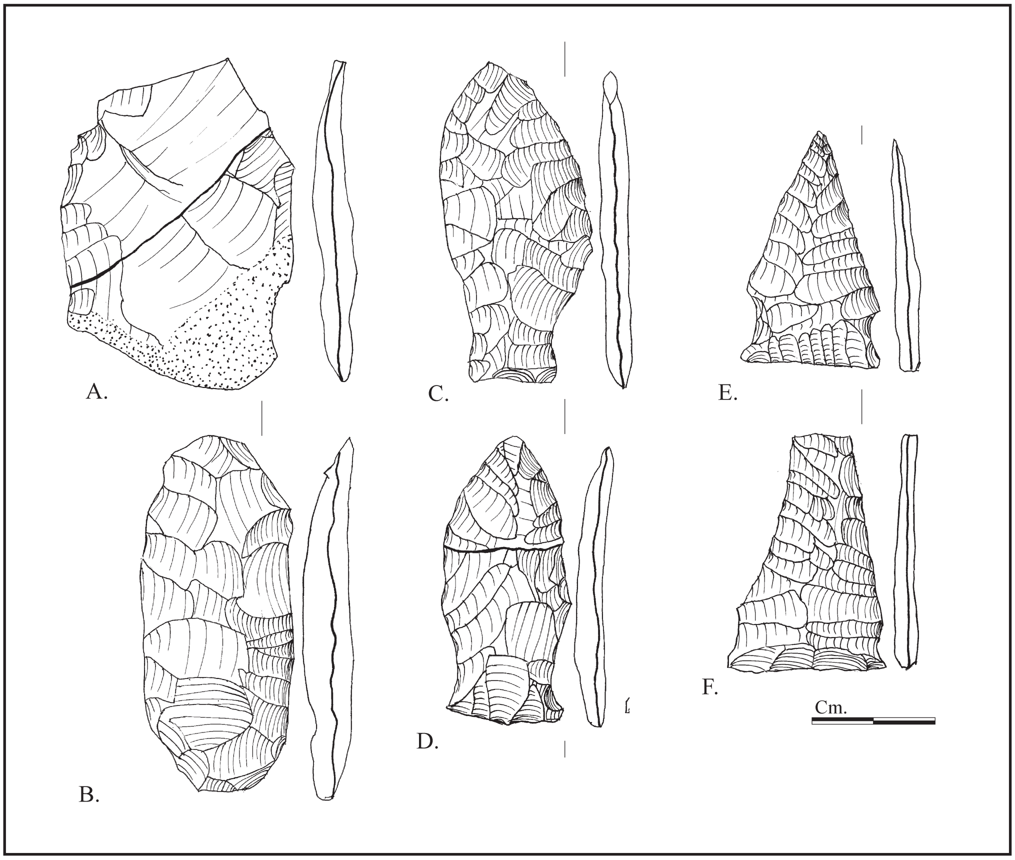


Fig. 4.3.16 The *chaîne opératoire* for bifacial end blades in Dorset I.

Step 1

Flat and small tabular core fragments are most often chosen as blanks for the production (figure 4.3.16: A). The choice of the form of the raw material is very specific, so that only a minimum of reduction is required in the first step of production. In Dorset I, in the Disko Bay region, the mcq preforms are generally heat treated before bifacial reduction.

Step 2

During step 2, the preform is worked by bifacial reduction using mainly pressure technique into a thin preform with an oval cross-section (figure 4.3.16: C). Most often both faces of the end blade will be covered with negative scars from the bifacial process, but some preforms are already so thin that only the edge is retouched. The final morphology is achieved by: 1) production of two wide notches at the lateral edges of the base and 2) a thinning of the base by fluting (figure 4.3.17).

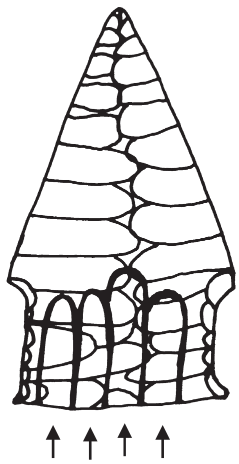


Fig. 4.3.17
Fluting of the base of an end blade.

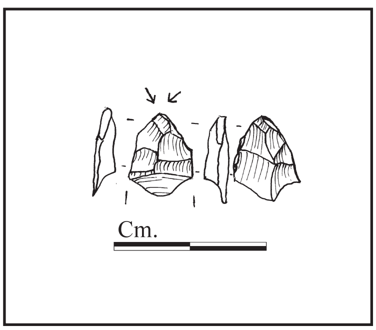


Fig. 4.3.18
Distal point of end blade showing impact burination fractures, typical of damage/use wear on armature points.

The end blade has in its first use phase an oblong pointed morphology, the base ends are right angled and it has two notches (figure 4.3.16: C, D). When the frequency between preforms and finished and discarded end blades is analyzed at AN, it is seen that around 30% of the preforms broke during bifacial reduction. It can therefore be concluded that there has been an intensive production of end blades at this site.

Step 3

The length of the end blades varies from 30 to 50 mm, the thickness from 3 to 8 mm and the width of the bases from 12 to 26 mm. As can be concluded from the morphology of their bases, the end blades used as knives must have been end hafted, e.g. as known from the Canadian Dorset sites: Tannfield site at Lake Harbour (Maxwell 1985: 143) and Nunguvik (Mary-Rousselière 2002: 145). Due to their thin sharp edges, the knives must have been used in soft organic materials.

End blades used as projectile points can have been hafted into cloven foot lances as they are found from Igloolik, type A2310 (Meldgaard 1968) (figure 4.3.21). It is possible that the lances have been used for the hunting of land mammals. A distal fragment from AN (510/518:2) is broken and has, from its tip, a burination fracture (figure 4.3.18). This fracture type is typical for projectile points.

Step 4

End blades used as knives are rejuvenated by lateral retouch and their distal morphology thereby changes from oval to pointed, triangular and even to have concave lateral edges. End blades used as projectile points fracture during use and are therefore generally not rejuvenated.

Step 5

End blades used as knives are discarded due to repetitive rejuvenation. However, many are also discarded due to medial fragmentation of the blade. Impact fractures are typical for end blades used as points.

Discussion

At AN and IT several atypical end blades are seen (figure 4.3.19). Most often they are found as single specimens and they can therefore not be described in general. One of these types is the end blade with the curved distal end (1). Other end blade morphologies seem more coincidental but are always characterized by a base with notches (2, 3). The latter types can be regarded as expedient tools or pseudo tools, which may have been made for children.

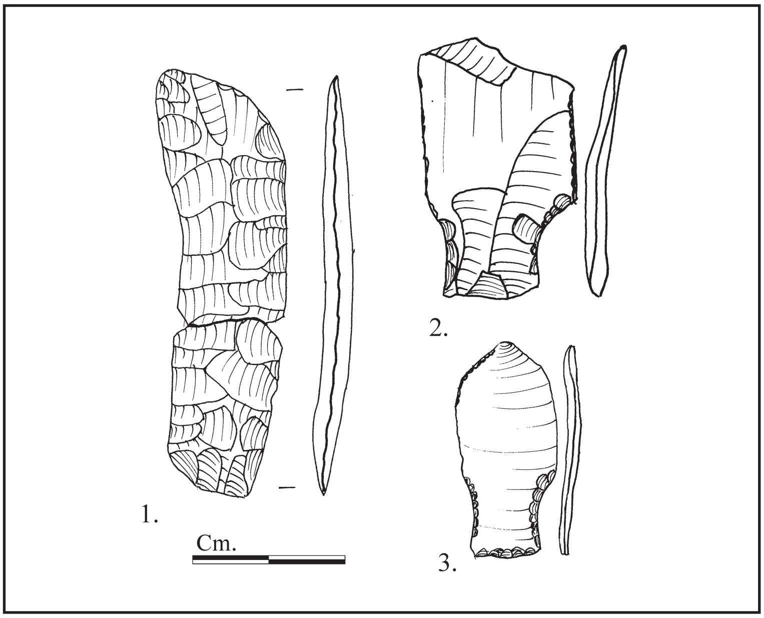


Fig. 4.3.19
Atypical end blades of Dorset I.

Side blades

Step 1
Flat thin flakes made from fine-grained mcq are chosen as preforms for side blades (figure 4.3.20: A). The preform is often heat treated.

Step 2
The preform is bifacially retouched by means of the pressure technique into an oval morphology. The edges become thin and sharp (figure 4.3.20: B).

Step 3
Side blades are hafted laterally into lance heads (Meldgaard 1968; McGhee 1981) or harpoon heads (figure 4.3.21). This is accomplished by inserting the blade into a 2 mm wide slot, the same width as the thickness of the blade. The side blade cuts rather than perforates in use.

Steps 4–5
In principle, the side blade can be rejuvenated. However, this is seldom seen. Most side blades are found discarded due to use and fragmentation.

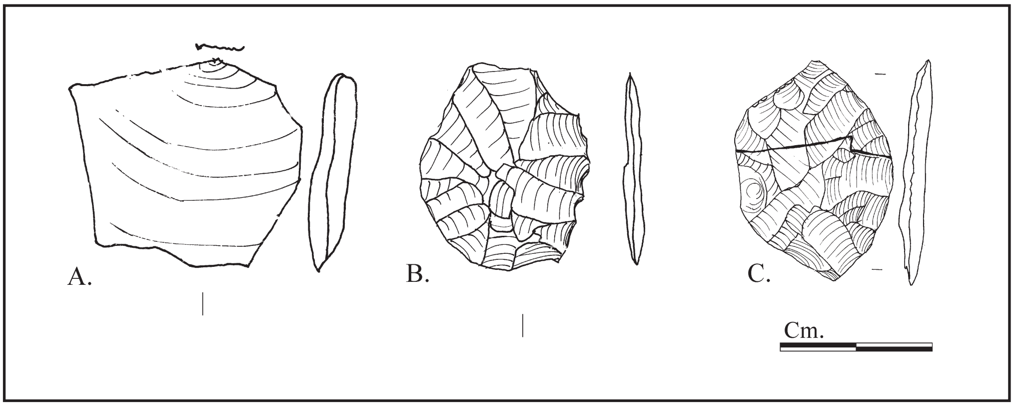


Fig. 4.3.20 The *chaîne opératoire* for side blades in Dorset I. Examples are from the Annertusaqqap Nuua assemblage.

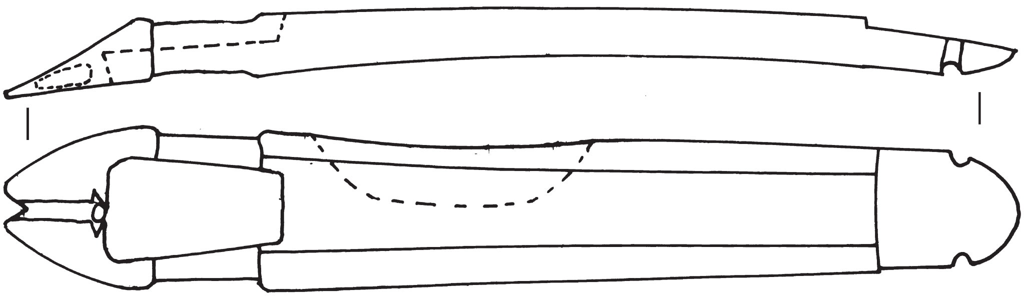


Fig. 4.3.21 Lance type no. A-2310. No. 6. from the Igloolik investigations. The lance is made from caribou antler. Length 16.4 cm (after Meldgaard 1968).

Strike-a-lights

Strike-a-lights are most often made from discarded tools and preforms from other tool productions such as the burin production. On the west coast of Greenland, strike-a-lights are generally made from killiaq.

Step 1

Broken preforms (figure 4.3.22: A1, B1) and fragments of discarded tools (B2) made from killiaq are chosen as preforms for strike-a-lights.

Step 2

The preform is minimally shaped or simply just used as strike-a-light.

Step 3
The strike-a-light is hit against pyrite, so that sparks are produced. It is the pointed end of the strike-a-light which is used (Stapert & Johansen 1999).

Step 4
When the strike-a-light is used, its pointed ends become rounded with impact marks (figure 4.3.22: B1, B2).

Step 5
The strike-a-light is discarded when its distal end is so rounded that it no longer produces sparks.

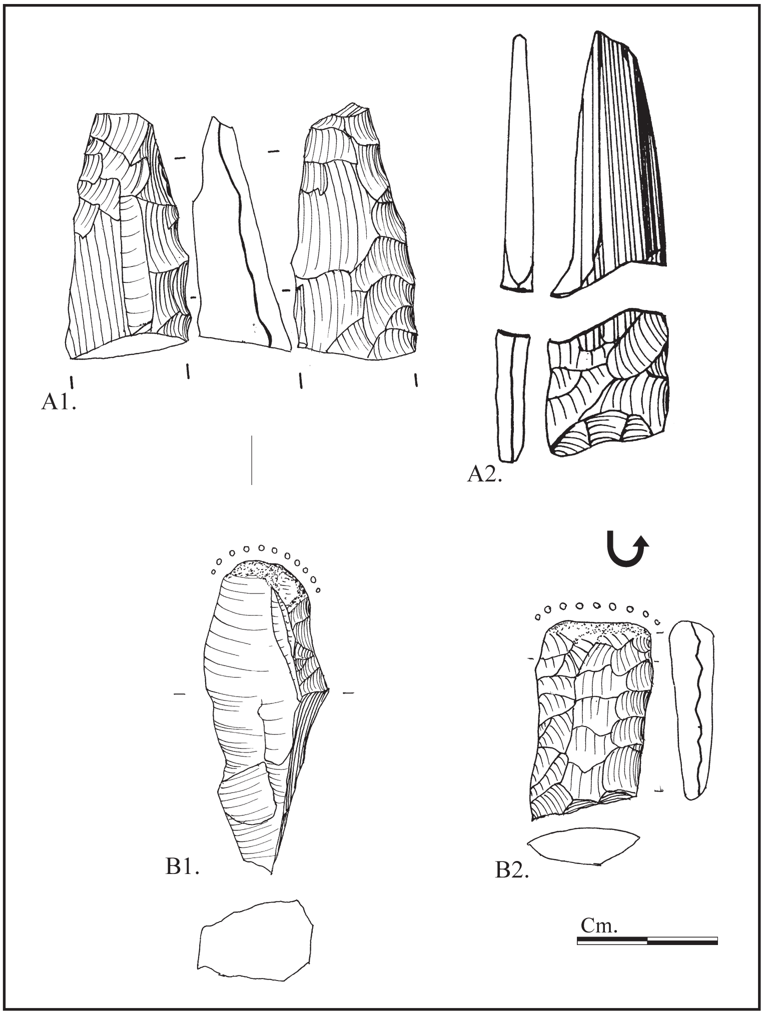


Fig. 4.3.22
The *chaîne opératoire* for strike-a-lights in Dorset I. Examples are from the Annertusaqqap Nuua assemblage.

Ground points made from killiaq (bevelled points)

In Dorset I, several variations of ground points made from killiaq occur (figure 4.3.23). From IT a completely ground bifacial end blade made from killiaq is seen (1). Its lateral edges are rejuvenated intensively by grinding. At IT a completely ground tanged point made from killiaq exists (2). However, this type is typical of the late Saqqaq tradition in West Greenland (Møbjerg 1999; Gotfredsen & Møbjerg 2004) and must therefore be regarded as not deriving from Dorset I.

At AN and IT, examples of knives made from killiaq, with angled ground edges (3, 4) exist. The edge is at an angle of 50–60 degrees. These kinds of knives are generally produced as ground burins, but the working edge is made less steep and they bend along their length, where the burins are straight. Due to the low edge angle,

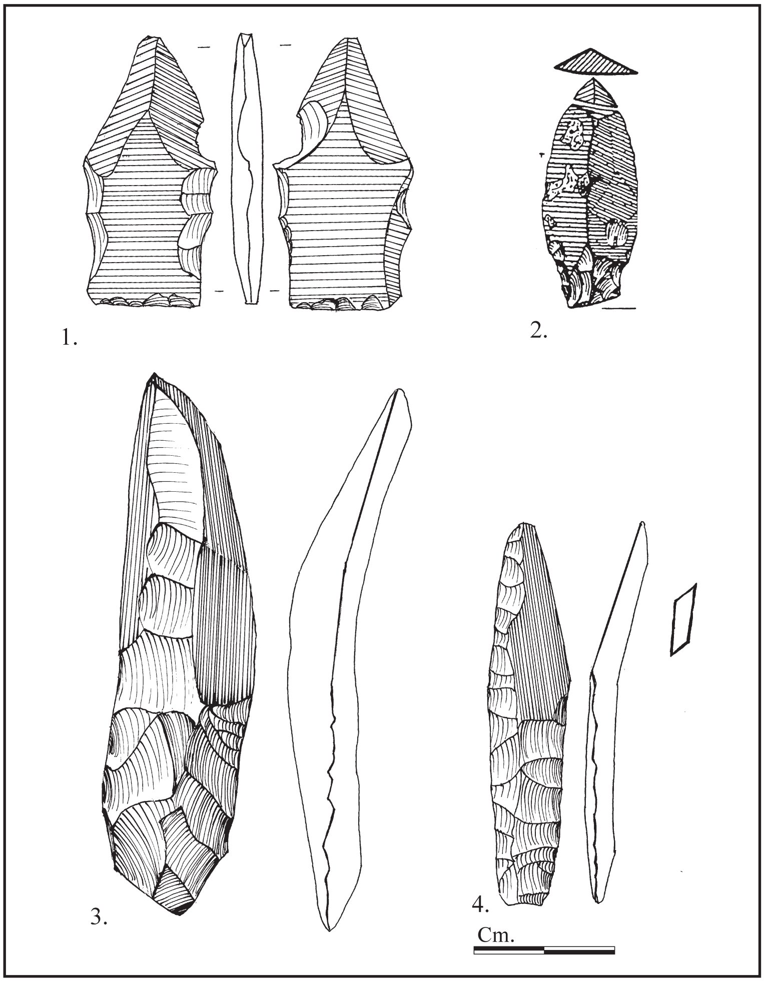


Fig. 4.3.23 Different types of ground end blades made from killiaq: 1) knife blade, 2) lance point (this artefact may be a late Saqqaq tool type!), 3, 4) curved knife blades. Examples are from the Annertusaqqap Nuua and the Ikkarlussuup Timaa assemblages.

this tool type must have had a cutting function in a somewhat softer material than the burins. The well-formed base of this tool type suggests that it has been hafted.

Discussion
Early and Middle Dorset in Canada are characterized by the production of large completely ground knives made from schist (Meldgaard 1962). Thus the bevelled points and large ground knives made from killiaq in West Greenland from around 800 BC can be interpreted as a trait of a central eastern Arctic technology communicated or brought into Greenland by the Dorset.

Adzes

During Dorset I, adzes are produced both bifacially (figure 4.3.24: 2) and unifacially by edge flaking (figure 4.3.24: 1). Characteristic for all the adze products analyzed is that they are defined by an imprecise morphology and a rough final production, probably by means of direct hard technique followed by grinding of the working edge.

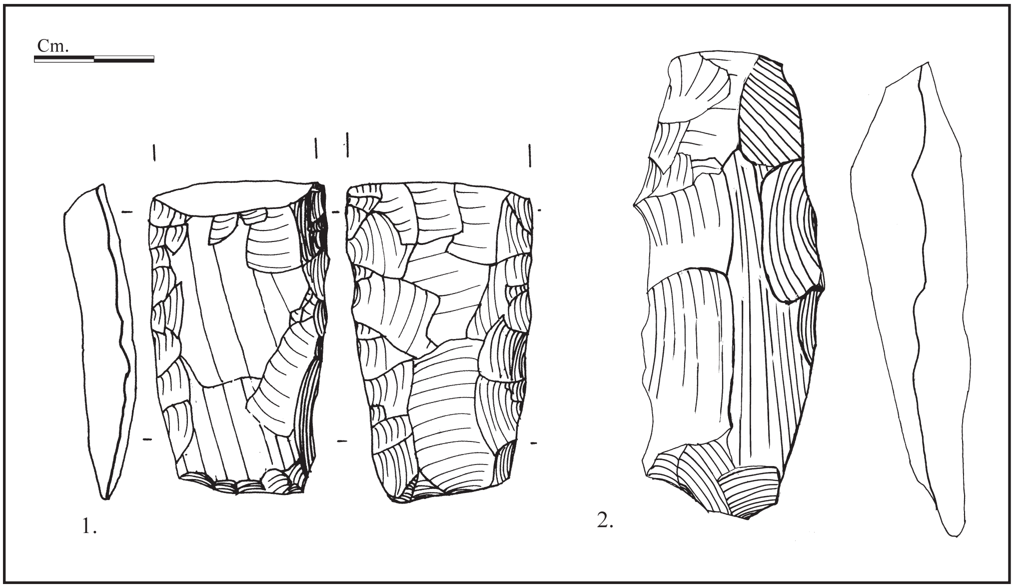


Fig. 4.3.24
Adzes produced unifacially (1), and bifacially (2). Examples are from the Annertusaqqap Nuua assemblage.

Step 0
The raw material used in West Greenland is killiaq from Nuussuaq, while at the east coast basalts are used.

Step 1
Adzes are produced both bifacially (14 examples at AN) and unifacially by edge flaking (2 examples at AN). The bifacial adzes are produced as core tools from small nodules by direct hard technique. Large flakes or flat core pieces are used for the production of flake adzes (figure 4.3.25: A).

Step 2
The working edges are produced by direct percussion, followed by grinding (figure 4.3.25: B). No edge flakes are therefore produced. The edge angles vary from 45 to 70 degrees. Preforms of adzes indicate that the adzes can have a length up to 11 cm.

Step 3
Due to their asymmetrical working edges the adze must have been hafted with the working edge at a right angle to the haft. At the sites Nunguvik and Tannfield holders for adzes made from antler are known. The holders can have been tied to an angled wooden haft (Maxwell 1985; Mary-Rousselière 2002: 143, 189).

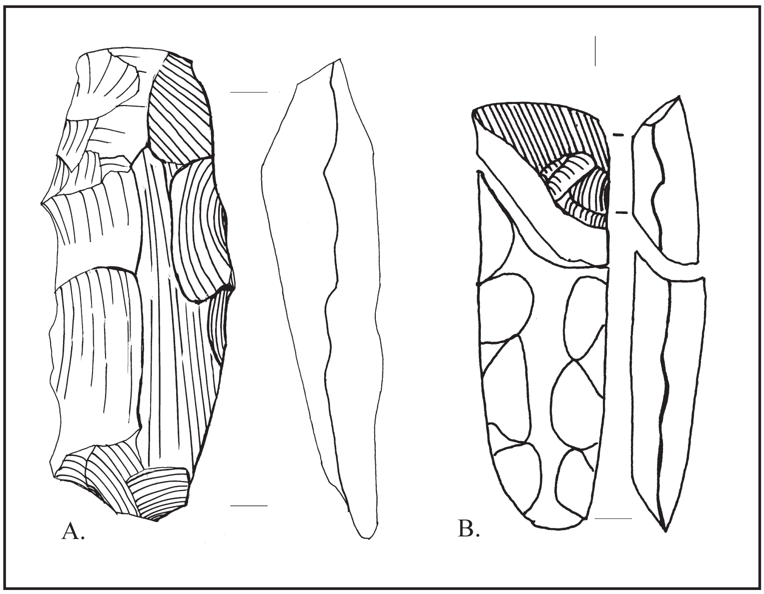


Fig. 4.3.25
The *chaîne opératoire* for adzes in the Dorset I. Examples are from the Annertusaqqap Nuua assemblage.

Step 4
The adze edge is ground repetitively during re-sharpening. Thereby the adze gradually becomes shorter.

Discussion
The adze production method in Dorset I is different from Saqqaq and Independence I. Adzes in Dorset I are produced by means of direct hard hammer and are therefore more irregular and have thicker cross-sections than adzes from Saqqaq/Independence I, which are produced by a direct soft hammer technique. Generally, adzes in Dorset I are minimally ground compared to adzes from Saqqaq/Independence I. Identification of diagnostic bifacial adze flakes at the AN site demonstrates that adzes have been produced at this site.

Blades

Morphology and metric
In all, 247 blades from AN have been analyzed. Thirty-four blades have proximal retouch and can therefore be defined as knives, which must have been hafted. The complete blades (68 pieces) have a length between 25 and 50 mm, with an average of 35 mm (figure 4.3.26). The width of the blades is generally between 5 and 8 mm. The thickness is around 2 mm.

When analyzing the fragmentation of the blades it is seen that there is an equal frequency of large proximal ends, large distal ends, meridiale fragments, and complete blades. Only a small proportion of small proximal and distal ends are seen. (figure 4.3.27).

The blades are regular and prismatic. The proximal ends have generally a little bulb and a small lip formation. Bulbar scars are frequently seen. The butts are most often plain and oval (figures 4.3.28 and 4.3.29). The widths of the butts are from 1 to 4 mm. The distal ends of the blades are most often feathered but some distal ends are right-angled.

Blade cores
The blade cores are oblong, single-platformed with a conical cross-section. Most often blades are produced from a single front, but some blade cores are reused from the same platform in their opposite end. The platforms are most often finely faceted. The angle between front and platform varies between 45 and 70 degrees. The width of the front is constantly around 20 mm. During reduction the blade core becomes shorter and the platform becomes smaller but maintains its width.

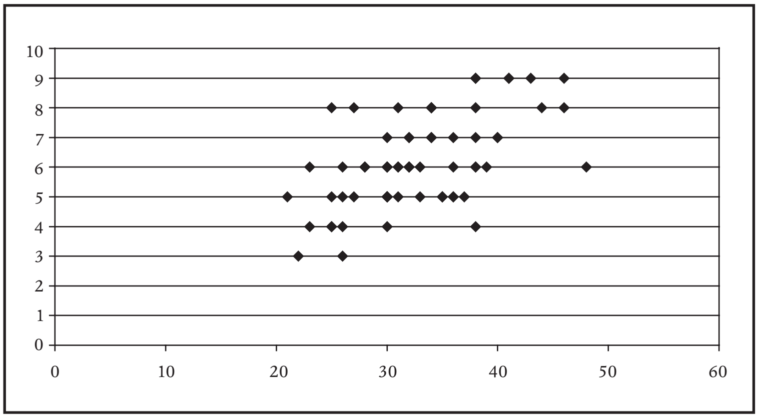


Fig. 4.3.26 Length and width of complete microblades (n:68). Examples are from the Annertusaqqap Nuua assemblage.

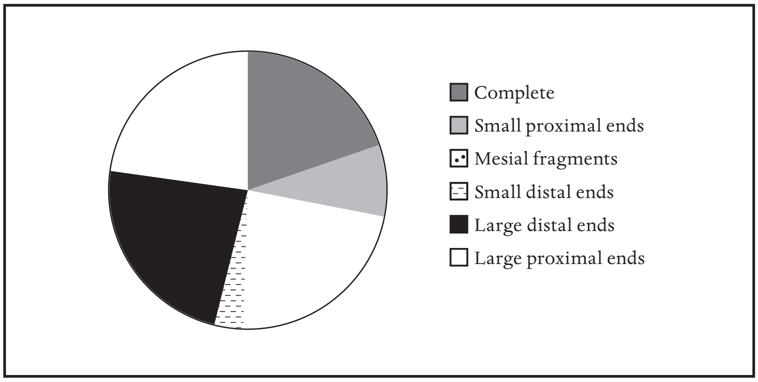


Fig. 4.3.27 The fragmentation of microblades. Examples are from the Annertusaqqap Nuua assemblage.

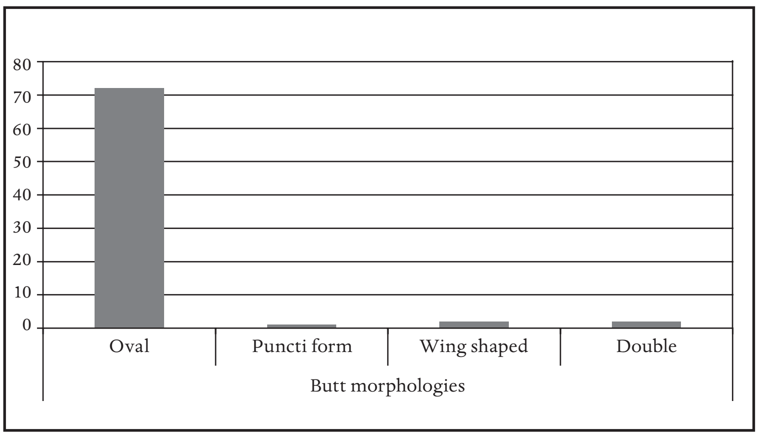
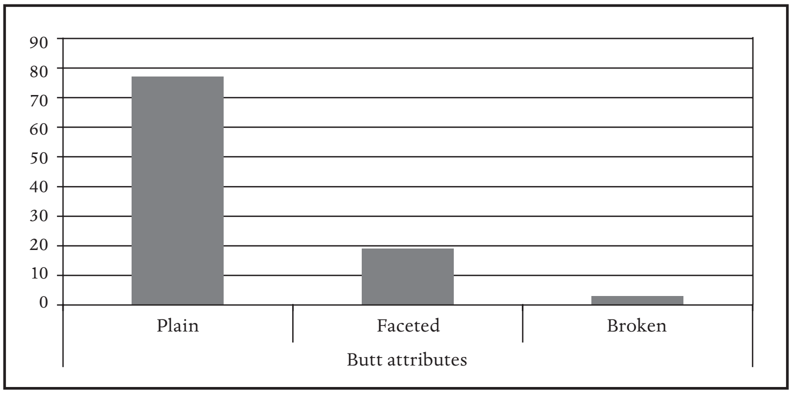


Fig. 4.3.28 The butt morphology on the microblades. Examples are from the Annertusaqqap Nuua assemblage.

Fig. 4.3.29
The preparation of the butts. Examples are from the Annertusaqqap Nuua assemblage.



Blade knives

There exists only one blade knife type in Dorset I: the tanged microblade. This type is characterized by a minimal retouch of the lateral edges in the proximal end of the blade.

Step 0

In West Greenland a bluish translucent mcq is most often chosen for the blade production, but a small production made from quartz crystal is also seen. When investigating assemblages from south Greenland it is seen that the use of quartz crystal increases. In East Greenland a great variety of mcq is used, especially from the Scoresby region.

Step 1

Squared core pieces, probably often deriving from larger mcq nodules are chosen as preforms for blade cores. The cores are shaped from the platform, the bottom and from the front into an oblong single platformed core with a conical cross-section (figure 4.3.30: B). The platform is prepared from the side. The front is formed by the production of a crest or by irregular opening blades.

Step 2

Several informative studies of experiments with pressure technique and blade production have been published (Pelegrin 1984a, 1984b, 1988; Callahan 1985; Flenniken 1987; Tabarev 1997; Sørensen 2003, 2006(a)). The results of the experiments and the attributes of blades produced by pressure suggest that pressure technique was in use when blades were produced in Dorset I. The pressure tool can have had a tip made from tooth, bone or antler. In order to produce blades the size of that which is known from Dorset I, an estimated pressure of around 30 kilos in weight would be necessary. If the production had to succeed, the blade core had to be fixed completely during the blade detachment. Thus, some kind of device or haft for the blade core has most likely existed during the Dorset I period.

The production of the blades can be described in four stages:

1. Each blade has to be prepared. The platform is prepared by creating a facet for the pressure tool to stand on. The facets will also correct the angle between front and platform.
2. The core edge is thereafter lightly abraded with a soft stone, so that the previous blade's negative bulb is removed.
3. The pressure tool is placed above two arises at the prepared platform.
4. Weight is applied to the pressure stick, probably from the arm and the upper body, so that the blade detachment initiates and the blade is produced.

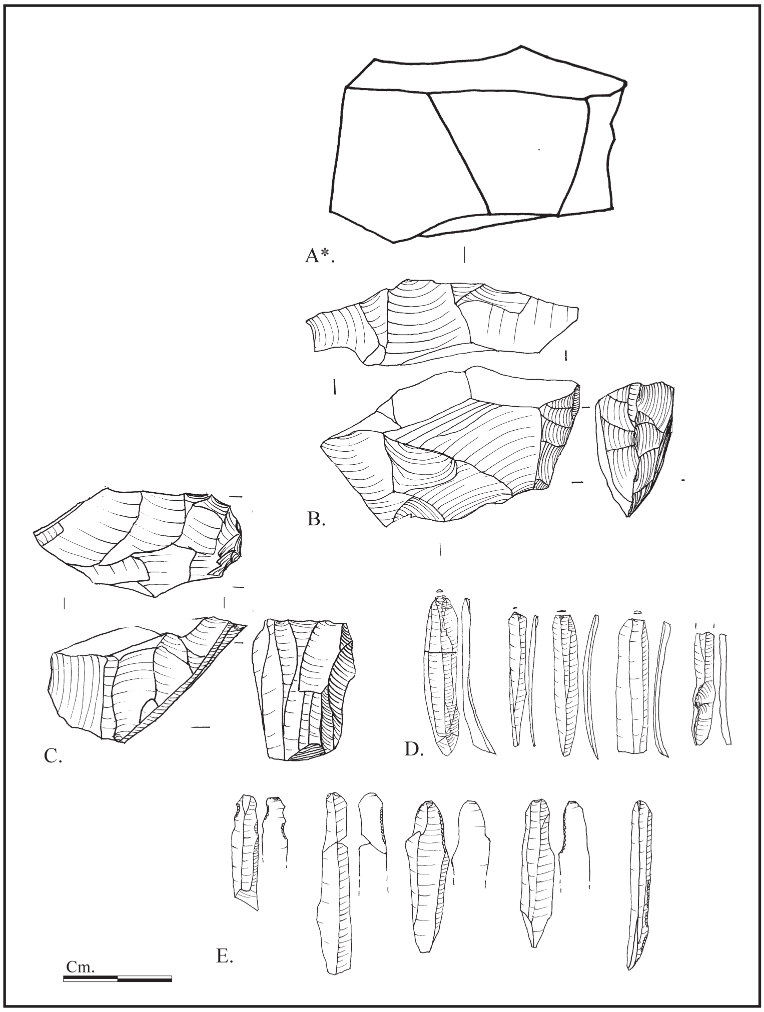


Fig. 4.3.30 The *chaîne opératoire* for blade production and use in Dorset I. Examples are from the Annertusaqqap Nuua assemblage.

The blade production stops when the blade cores become too small to haft, the fronts are shortened down due to rejuvenation and faceting of the platform. At this stage some blades will eventually also start to hinge.

The blades are generally thin (2 mm) and it is therefore most possible that many of them will break during production (figure 4.3.27). Complete blades are selected for the production of blade knives (figure 4.3.30: D). These blades are delicately retouched in their proximal ends, so that they become tanged. The retouch can be made both from the ventral and dorsal side of the blade (figure 4.3.30: E) and it seems to be made by a pressure tool.

Step 3
The standardized retouch of the blade knives suggests that within Dorset I there existed a standardized haft for microblades so that they could easily be changed. However, preserved blade hafts are unknown from Dorset I.

Step 4
Microblade knives are not re-sharpened, since their edges are unmodified when used. Instead the microblade knives are quickly substituted by new blade knives when dull, indicated by macro wear at their edges and the vast amounts of this tool type found at the sites.

Step 5
Microblade knives are discarded when dull or fragmented.

Discussion
A characteristic attribute in Dorset I blade technology is that the edge angle between the front and the platform is a c. 50–60 degree angle. This characteristic attribute is a result of a special blade preparation system in the Dorset I period: Each blade is prepared from the front by faceting the platform, and the low angle ensures that the facets do not hinge. This technology does, however, also result in very reduced microblade cores as the blade production progresses.

The flake material

Generally the flakes at the analyzed sites are smaller than 3 cm in size (figure 4.3.31). Only at AN were a few flakes made from killiaq larger than 3 cm found. From their morphology these large flakes either derive from the adze production (figure 4.3.32: VII–X) or are imported as preforms.

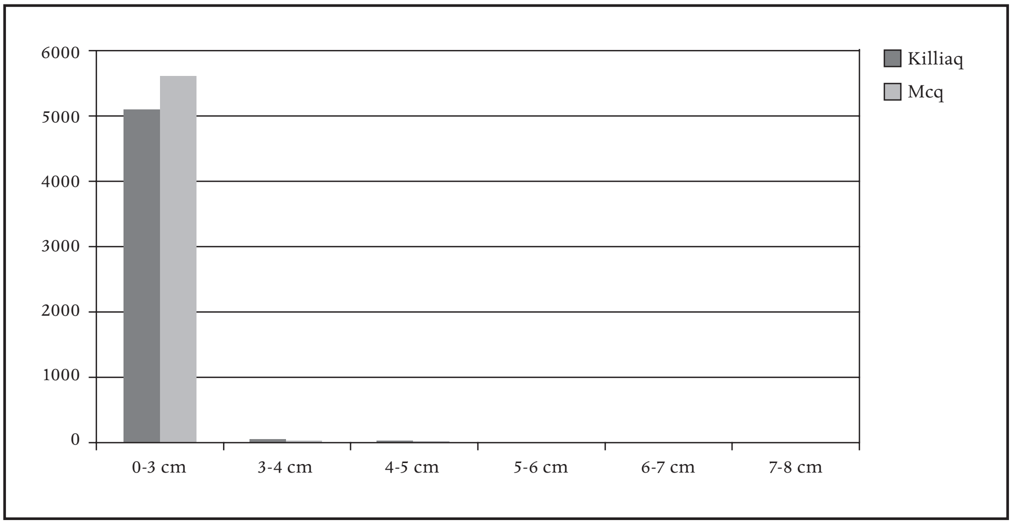


Fig. 4.3.31 Quantitative analysis of flake sizes in comparison to raw material type. Examples are from the Annertusaqqap Nuua assemblage.

Bifacial flakes

The majority of the flake material has broad and irregular dorsal faces, small lenticular butts, a little bulb and lip formation and an angle between dorsal side and butt at 70–80 degrees (figure 4.3.32: I, II). These types of attributes suggest that the flake material generally was produced in a bifacial knapping process, using direct soft percussion or pressure.

Fluting flakes

Oblong flakes with right-angled negatives at their dorsal faces are typical remnants of the fluting process (figure 4.3.32: IV). Fluting is made from the bases of most of the bifacial tool types in Dorset I, probably to thin the bases for the haft.

Adze flakes

Thick curved flakes made from killiaq with pronounced bulbs and large butts are typical adze production flakes produced by a direct hard technique (figure 4.3.32: V–X). Several of these flakes have negative removals at their dorsal faces coming from their distal end, which is a sign of a bifacial core reduction process (figure 4.3.32: VIII–X).

Discussion

The flake material at the analyzed sites indicates that it is primarily the small lithic

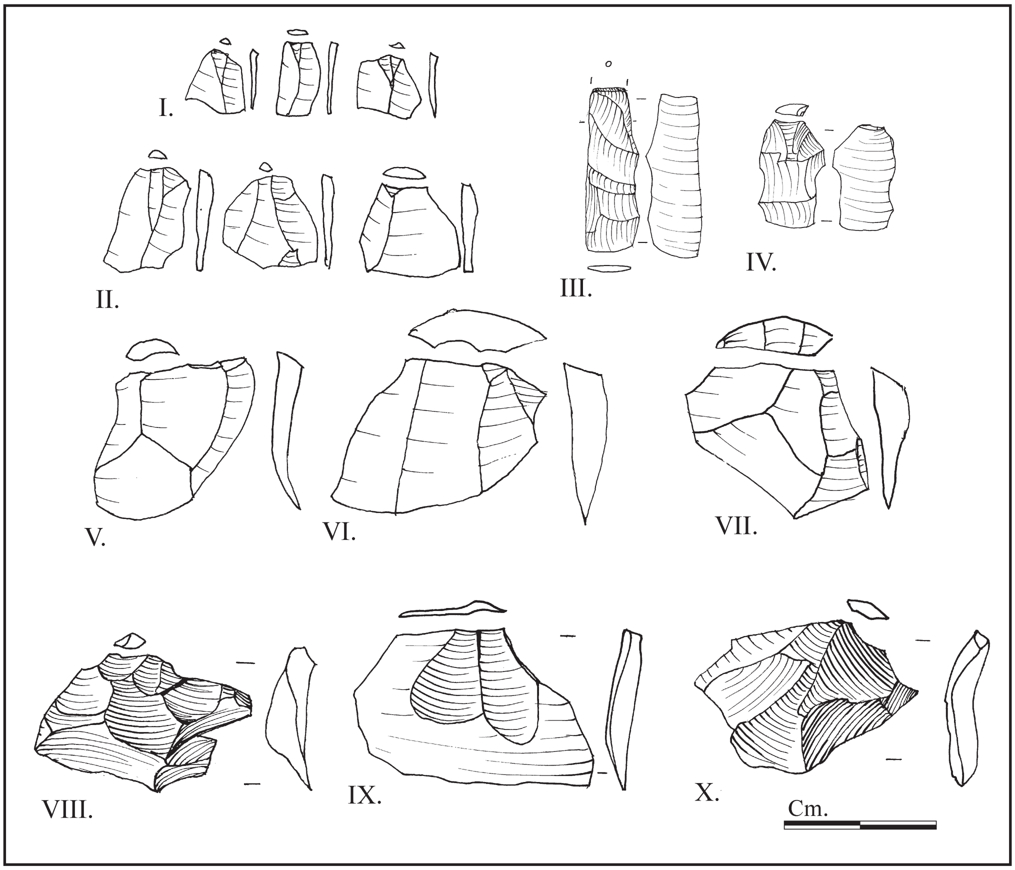


Fig. 4.3.32 Different flake types of Dorset I: I, II) small bifacial flakes (mcq), III, IV) fluting flakes (mcq), V–X) adze production flakes (killiaq).

tool types that are produced on site. Only few cores for the production of adzes have been imported, while most of the production is based on very small fragments and nodules. This strategy is clearly different from Saqqaq and Independence I, which import large preformed cores to their sites in order to produce blanks for their lithic tool inventory.

Tools used for lithic reduction

From the site Malmquist site in Søndre Strømfjord there are preserved examples of pressure points from Dorset I (Bundgård 1977). Two points with different morphology are seen: (figure 4.3.33: I) a complete pressure point is 64 mm long cut from a larger piece of bone, probably walrus penis bone. It has a quadratic cross-section and its edges are finely rounded. Its impact point is made centrally in its cross-section. A broken pressure point is broader with a rectangular cross-section and its point is well preserved (figure 4.3.33: II). Both pressure points have striations from the tip along their length.

The two different pressure point morphologies could indicate two different pressure processes carried out in Dorset I. One process, in which the point was used for the production of blades (squared type?), and one for bifacial pressure flaking (rectangular type?). The quadratic pressure point type does characterize the early Dorset assemblages in the Igloolik area, where it is found at the 23-metre terrace (Meldgaard 1962). This type is also seen at Shelf site on Ellesmere Island (Schledermann 1990: 327).

No hafts for pressure points are found in Greenland, but at the Tannfield/Morrison site, a pressure point is put into a notch in a wooden haft and tied. The notch is conical so that the pressure point will fixate when pressed (Maxwell 1985: 151).

Fig. 4.3.33 Pressure tool points from the Malmquist site (Dorset I). No. I is made from walrus penis bone. No. II is unknown.

Discussion

When the lithic technology at AN and IT is compared, large similarities are seen. Generally, the same technological choices, from raw material to finished discarded tool, are noticed. Even the tool frequencies are nearly the same at the two sites; only the frequencies for microblades and burins vary a little (figure 4.3.34).

Both sites have structures perceived as winter dwellings and habitations of at least half a year's duration. Moreover, the sites can have been used several times in Dorset I.

So far no diachronic development in tool inventory or technology within Dorset I has been noticed; thus, the Dorset I must be characterized as having an extremely constant and conservative lithic tradition.

Conclusion: The Dorset I lithic concept

Choice of raw material

In Disko Bay, killiaq is chosen for tools with ground edges, i.e. burins and adzes, while for the production of thin bifaces and for the blade production, mcq and quartz crystal is used. In the Sisimiut region mcq is often substituted by quartz crystal, while the burin production is still based on killiaq from the Nuussuaq outcrops (Kramer 1996b). In the Maniitsoq and Nuuk regions this raw material choice

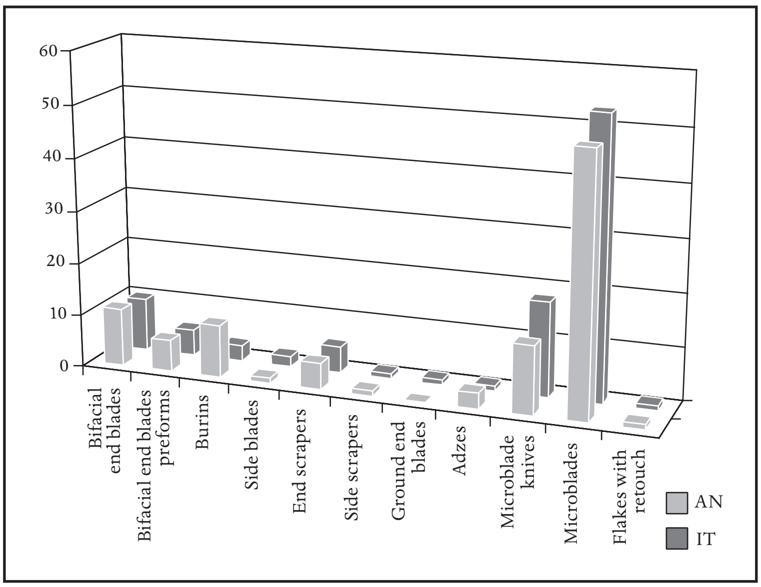


Fig. 4.3.34
Comparison of tool types between the Annertusaqqap Nuua and the Ikkarlussuup Timaa assemblage.

is maintained (Hinnerson-Berglund 2000, 2004). In South Greenland many local materials are in use for lithic production, e.g. quartz crystal, quartz and quartzite. A local schist is used at the site Itilleq for burins and ground knives (Raahauge & Appelt 2002; Raahauge et al. 2005). However, on the same site, rejuvenation flakes made from basalts, probably from the Kangerlussuaq region in East Greenland, are used. Moreover, a few flakes exist that could be killiaq from Nuussuaq. Microanalysis can perhaps confirm this in future studies. The rejuvenation flakes from burins at Itilleq suggest that single tools have been brought from up to 1500 km away, but that the majority of tools are made in local and regional raw material types in South Greenland. From the Skjoldungen region, local quartz, quartz crystal and basalt-like materials have been used in Dorset I (Gulløv & Jensen 1991; Feldbo et al. 1992). Fine-grained black basalt qualities, used for burins in the Skjoldungen region, are possibly imported from the Kangerlussuaq region. Moreover, a few small flakes could derive from killiaq from Nuussuaq. These exotic raw materials probably reflect that single tools, e.g. burins with ground edges have been transported, embedded in the Dorset I seasonal mobility.

In the Scoresbysund region, a great variety of lithic raw materials exist in the basaltic underground. Basalts are used for burins while mcq is used for thin bifaces and blade production, as seen in the Disko region (Sandell & Sandell 1999). The same situation is seen on the east coast up to Wollaston Forland (Sørensen & Andreasen 2006). In Dove Bugt, local transparent quartz is used for the total production, except for burins, which are made from black basalt, probably imported to the region from basaltic areas south of Dove Bugt.

To conclude: Dorset I uses tough basalts or basalt-like materials (e.g. killiaq) for the production of burins, ground knives and adzes, while for the rest of the production more fragile types of mcq, including quartz, crystal are used. This choice seems to reflect functional relations: large tool types are produced from large raw material nodules (e.g. basalt and killiaq), while smaller tool types are produced by pressure from small mcq nodules which have the best fracturing properties. Often these materials (mcq) are further improved by heat treatment, which makes them even more fine-grained and fragile. Scrapers, which need the hardest edges, are made from mcq and quartz. This raw material choice is maintained throughout the Dorset I tradition in Greenland.

The procurement of raw materials is related to the raw material choice. No large cores, as it is seen in Saqqaq and Independence I, are imported/exported in Dorset I. Instead, rejuvenated single tools, microblades and microblade cores seem to indicate that these tool types travel with Dorset groups into areas where the raw material that they are made from does not exist.

Choice of reduction method

The analysis of cores, preforms and flakes, of both mcq and killiaq, indicates that small preforms are imported to the sites. For the production of side scrapers and side blades flakes made from mcq are imported. However, for the production of end scrapers there seems to have existed a standardized core for serial production of flake preforms. From analysis of the preforms, these scraper cores can be described as single fronted unipolar cores with plain platforms. So far none of these cores have been found. Possibly they are to be found at sites near where lithic raw material is abundant, i.e. near lithic outcrops.

End scrapers and side scrapers are made from one side, normally from the ventral flake face. Adzes are produced bifacially and unifacially. The adze production is characterized by unstandardized and imprecise morphologies. End blades and side blades are made by bifacial knapping methods. Bases of end blades and sometimes also side scrapers are made fluted by series of fluting flakes. Burins are shaped asymmetrically and the edge is made unifacially. Adzes and burins are ground.

Occasionally large flakes are used as expedient knives, and some of these have a simple haft retouch. The reuse of tools for other tool types is rare but strike-a-lights are mostly made from discarded tools or preforms of killiaq, i.e. burins or adzes (figure 4.3.35: I). Platform rejuvenations have been used for the production of end scrapers, and blade cores are in a few situations seen reused for end scrapers (figure 4.3.35: II).

The generalized method of lithic reduction, production of tool types and their rejuvenation can be described as the Dorset I concept of lithic production (figure 4.3.39).

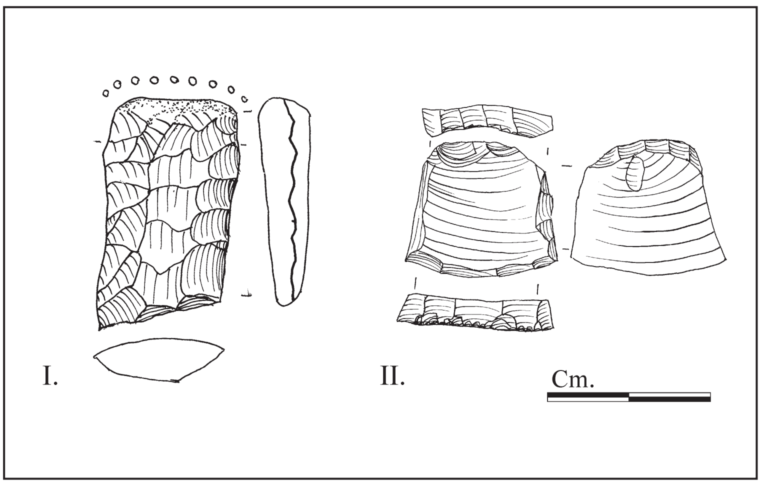


Fig. 4.3.35 Examples of lithic recycling of artefacts in Dorset 1:
I) burin base recycled as strike-a-light,
II) platform rejuvenation reused as end scraper.

Blade production

The concept for the blade production is characterized by a serial production from unipolar, unifacial wedge shaped cores by pressure technique. The blade production is generally produced from mcq. However, quartz crystal has been used regularly too, especially in areas where mcq is not available.

Tabular blanks of mcq are selected as preforms for blade cores (figure 4.3.36: A). The core preform is transformed into a wedge shape (figure 4.3.36: B). The

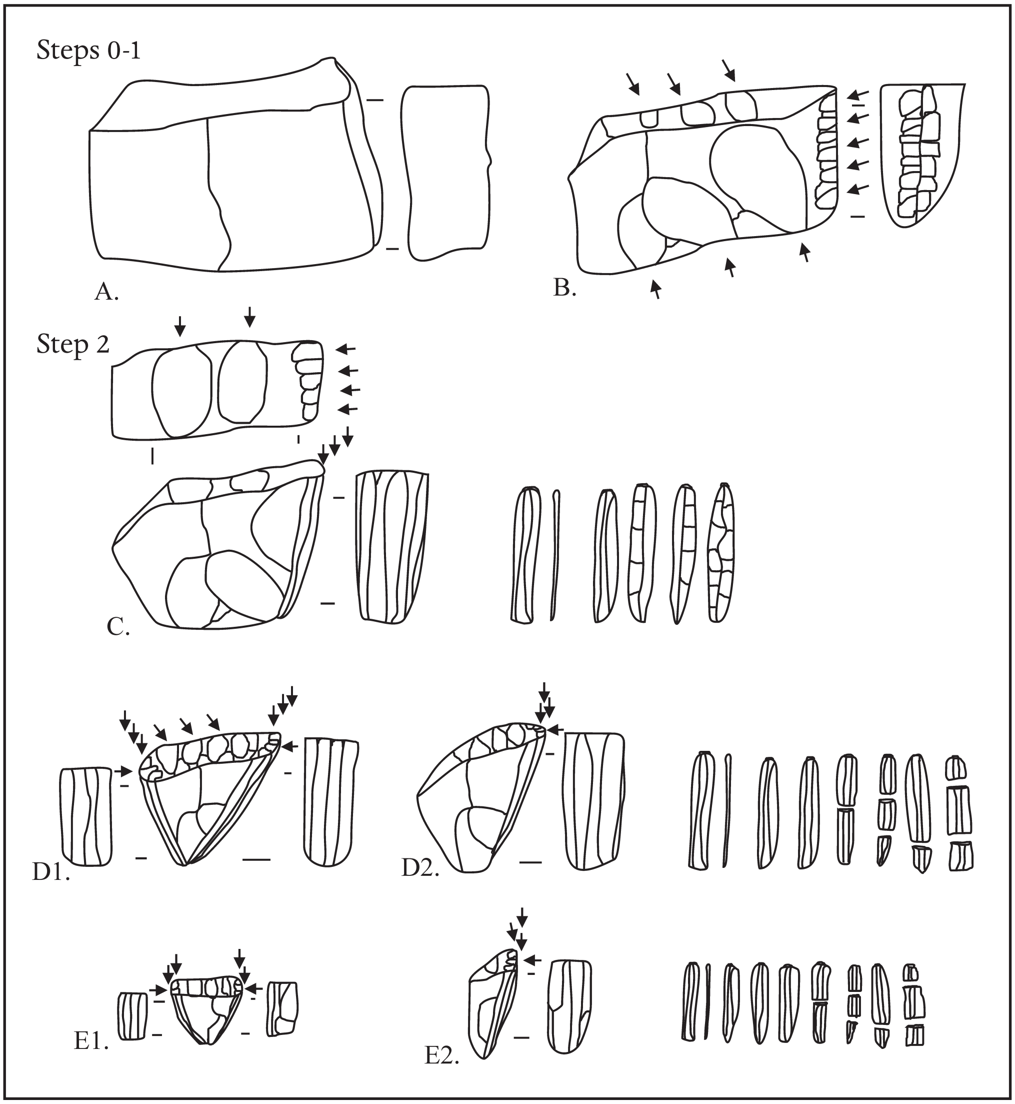


Fig. 4.3.36 The method of blade production from mcq nodules in Dorset I.

width of the core is from 1.5 to 2 cm. Occasionally a crested front is created, but it seems more common just to shape the core front by the first blade series. Cores from quartz crystal are produced either by creating a platform at the top with a platform flake (figure 4.3.37: A1*) or by exploiting the crystal from the bottom (figure 4.3.37: A2*). Modern experiments with blade production from quartz crystal demonstrate that it is only the transparent part, most often the distal end of the crystal, which can fracture regularly. The crystals are often milky white and internally fractured at the bases (Jensen & Sørensen in prep.). The front of the core is therefore often situated at the distal end of the core. The production method and technique of the blades is the same for all the employed raw materials. In step 2 the platform is prepared from the side. The angle between the front and the platform is only 50–60 degrees, which is typical for the Dorset blade concept. The platform is prepared from the front by small flakes (figure 4.3.36, 37 C and B*). Blades are serially produced (figure 4.3.36, 37). Between each blade sequence the platform is

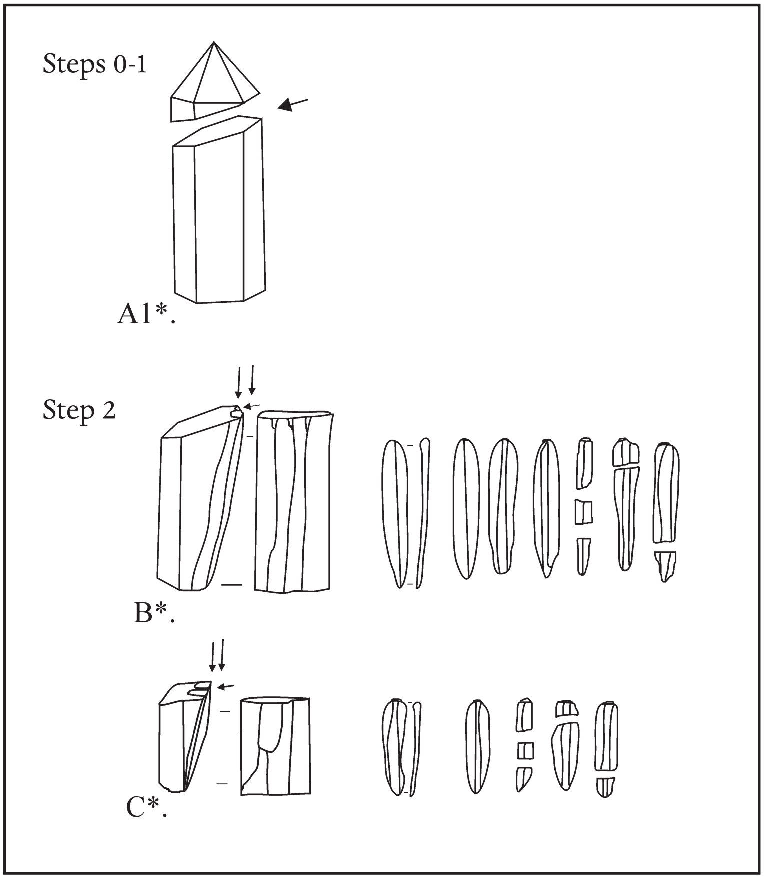


Fig. 4.3.37
The method of blade production from rock crystal cores in Dorset I.

prepared as in step 2. When the core is prepared during production, its width is not reduced. In several cases a second front is established at the core's rear end using the same platform. Hereby the core will become triangular (figure 4.3.36: D, E). The blade production stops when the core is too small and the platform cannot be further prepared.

The generalized methods of lithic blade production and production of blade tools can be described as the Dorset I concept of lithic blade production (figure 4.3.40).

Choice of hafting method

No hafts are preserved from Dorset I. In order to analyze the hafting method, analogies can be made to Dorset material in Canada and an analysis of the bases of the lithic tool types in Dorset I can be undertaken to examine possible hafting systems. Bifacial end blades and the different knife types have right-angled bases with broad notches, which suggests that these have been end hafted. Hafts from Dorset sites in Canada (Maxwell 1985; Mary-Rousselière 2002) of organic material, e.g. wood, have been produced with either a slot or by grooving out a hole for the lithic tool from one side of the haft. The base of the end blades are often thinned by fluting to make them thin and even, so that they will fit into a slot in the haft. The haft is formed so that it has the same diameter as between the notches of the end blade. In this way, a lashing will secure the stone tool firmly. Harpoon heads are often self-tipped, but when harpoon points are used these are hafted in grooves (figure 4.3.38). Side blades are hafted in slots in the lateral part of a lance or harpoon head, thus they will have a cutting rather than penetrating function. Both end scrapers, side scrapers and burins all have standardized bases, which probably have been end hafted in wooden hafts. From Nunguvik two hafts of burins with ground edges have been found, both are wooden and show clear marks from lashing (Mary-Rousselière 2002). One of these hafts has an extra wooden support for the burin lashed into the haft. Hafted adzes from a Dorset context are found at the Tannfield site. These are inserted into a socket of antler that is lashed to an angular wooden haft (Maxwell 1985: 151).

It is interesting that none of the known Dorset hafts are made by splitting the haft or by fitting two haft parts together, as it is seen in the Saqqaq tradition. Characteristic to Dorset is, on the other hand, the careful shaping of the distal haft including a groove with a diameter that reflects the width of the stone tool between the notches. Thus it seems that the hafting methods are different between e.g. Saqqaq and Dorset.

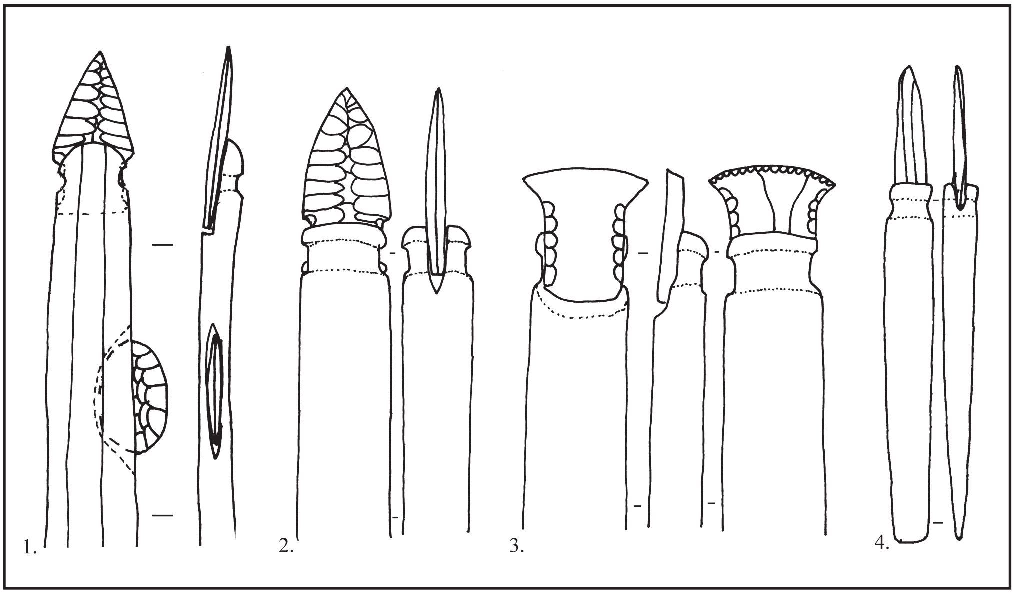


Fig. 4.3.38 The general principles of hafting methods of the lithic tool types in Dorset I.

Choice of reduction technique

Single large flakes imported to the Dorset I sites, probably as preforms for the tool production, are generally produced by means of direct hard percussion during Dorset I. Adzes are also produced by this technique. However, no hammer stones are yet recorded from Dorset I sites in Greenland.

Preforms of mcq for tools and blade cores are very often heat treated before the final shaping. Tools made from mcq are generally produced by direct soft technique followed by pressure technique. However, it is difficult to separate these techniques in material studies, but due to the abundance of very small flakes, pressure technique seems to be the most dominant technique at the Dorset I sites. At Dorset I sites two types of pressure points have been found: a short flat type and a longer more solid quadratic type. It is possible that the two types represent two types of reduction methods, that is, bifacial thinning and blade production. Grinding is often seen carried out on tools such as adzes and burins made from slate, killiaq and basalt materials. Tools made from mcq are only seldom ground in Dorset I contexts.

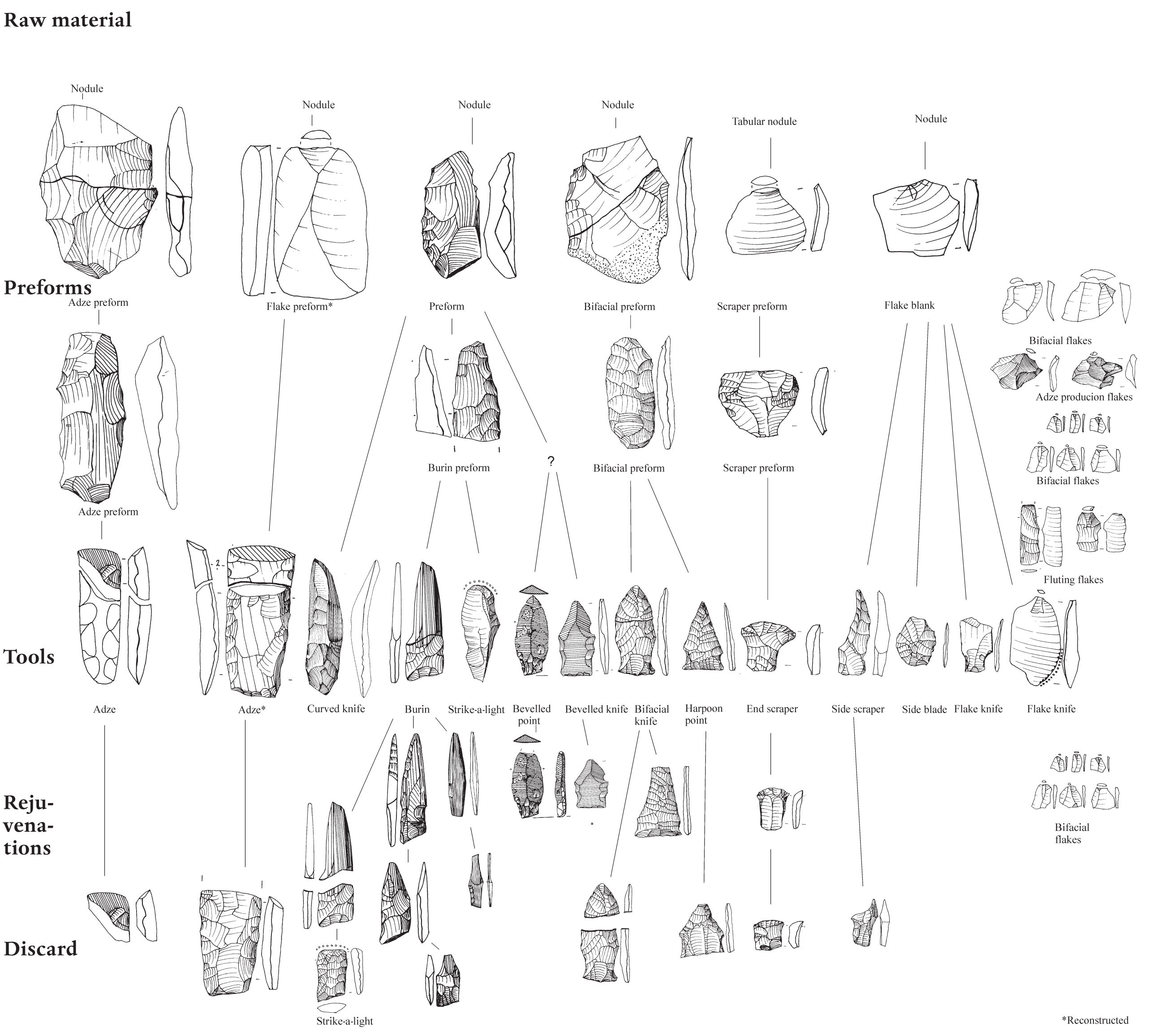


Fig. 4.3.39 The concept of lithic tool production in the Dorset I tradition. Examples are from the Annertusaqqap Nuua and the Ikkarlussuup Timaa assemblages.

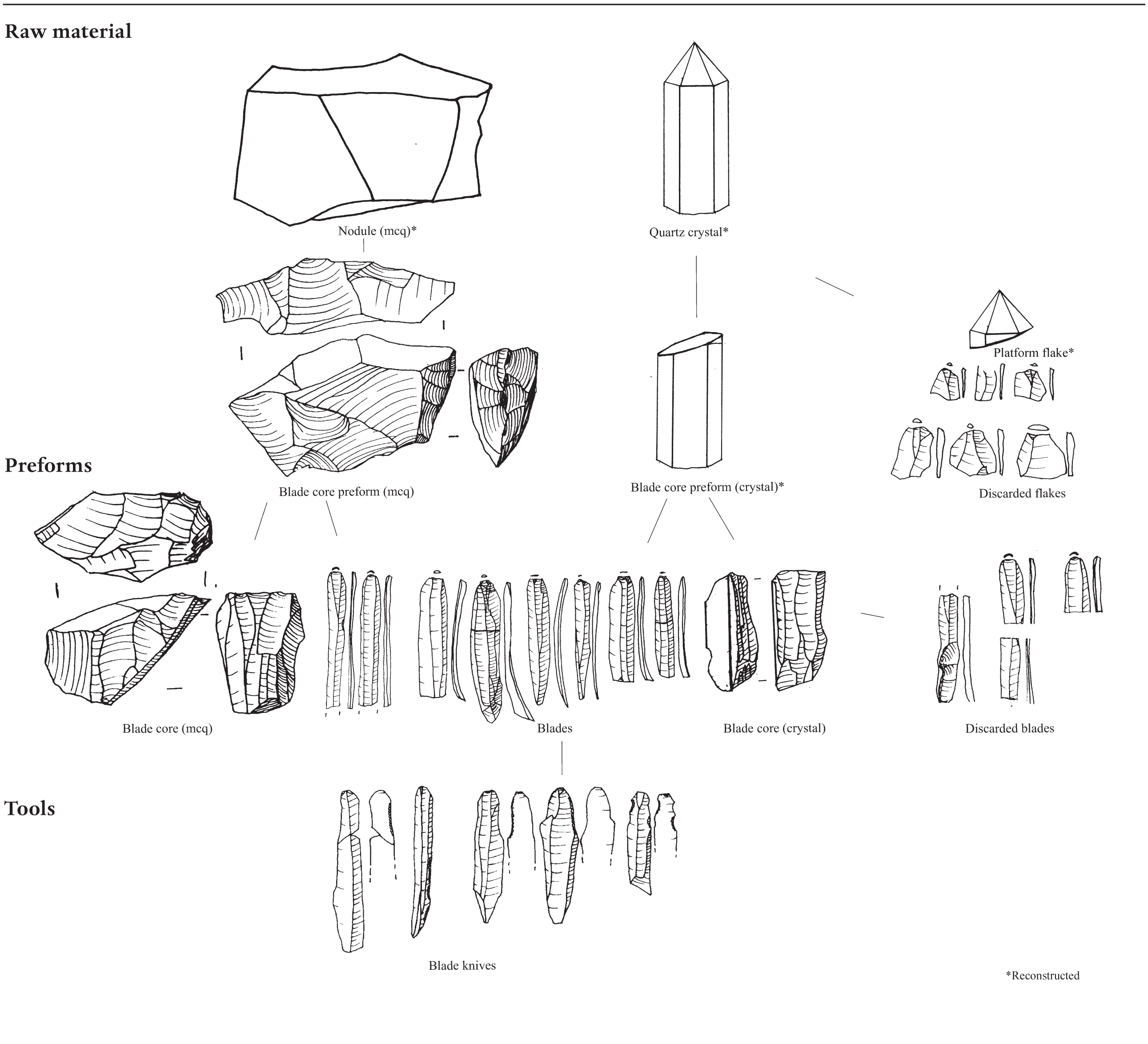


Fig. 4.3.40 The concept of lithic blade production in the Dorset I tradition. Examples are from the Annertusaqqap Nuua and the Ikkarlussuup Timaa assemblages.

4.4. Lithic technology in Independence II

Sites and assemblages chosen for analysis

The site assemblages investigated in Independence II are from the 'Kap Holbæk' and 'Vandfaldsnæs' sites. Kap Holbæk site is located in Danmark Fjord and Vandfaldsnæs in Jørgen Brønlund Fjord, in the most northeastern part of Greenland (figure 4.4.1). At both sites, settlements from the Independence I tradition are found too. However, due to the isostatic rebound within the region, the different settlement phases are clearly separated at different elevations.

Generally, the Independence II tradition is only sparsely represented in Greenland, both in relation to sites and artefacts (Grønnow & Jensen 2003). The sparse amount of inventory from this tradition makes it difficult to analyze the *chaînes opératoires* for the different lithic tool types, due to the lack of examples of the different production steps. In order to supplement the analysis with more artefacts,

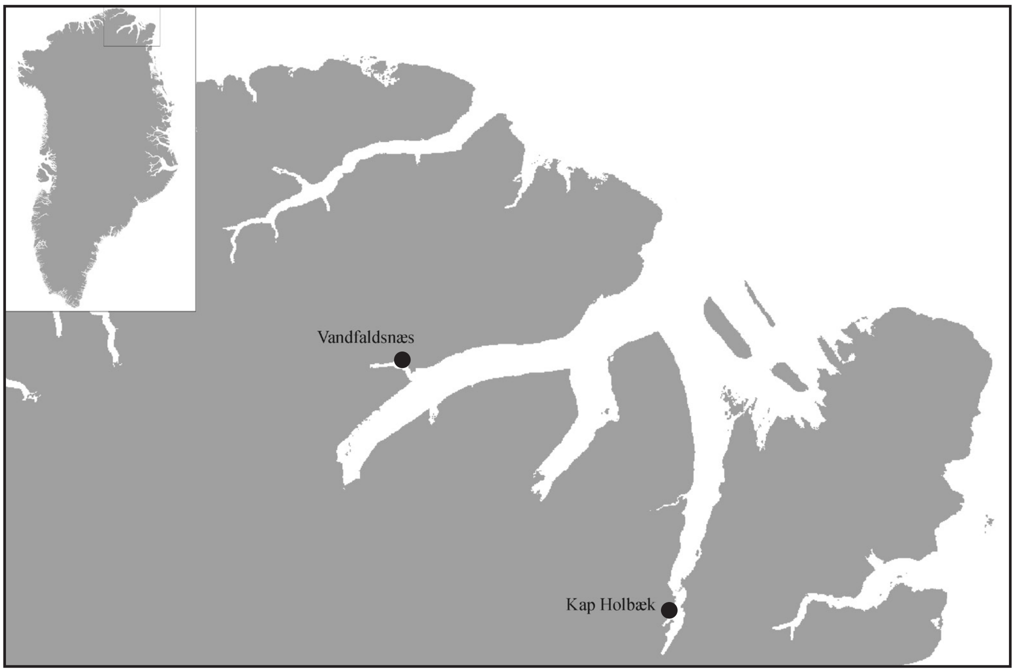


Fig. 4.4.1 The geographical location of the studied Independence II sites.

inventory from the Independence II sites Eigil Knuth site and Mågefjeldet is added to the investigation. Both these sites are located at Holm Land, just south of Nordostrundingen.

Vandfaldsnæs

Geography

The Vandfaldsnæs site is located on a small promontory at the southern coast of Jørgen Brønlund Fjord. A small river, Arkæolog Elv, with a nearby waterfall gives the site its name (which in Danish means 'waterfall-promontory ness'). The promontory on which the site is located is about 50 m above sea level, made from raised beach terraces. The settlements are found at these terraces (figure 4.4.2). At the

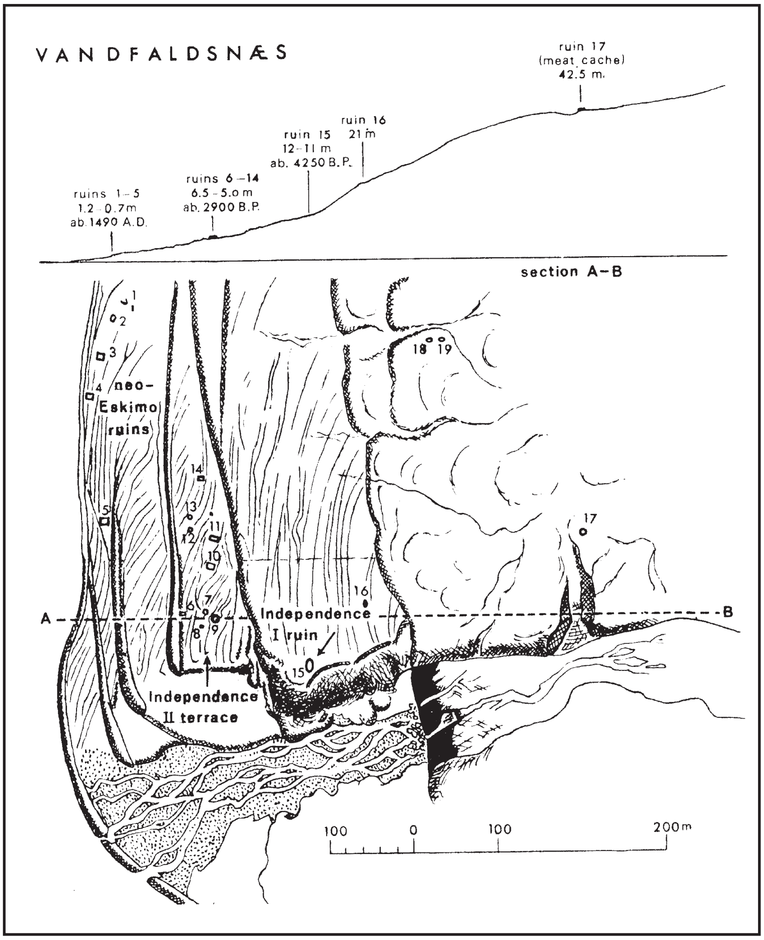


Fig. 4.4.2
Site plan of structures on the Vandfaldsnæs site (after Grønnow & Jensen 2003).

lowest terraces, 0.7–1.2 m above sea level, tent rings and fireplaces from the Thule culture are found. At the terrace between 5.0–6.5 m above sea level, the Independence II settlement is situated. The settlement consists of two tent rings (structure 10 and 11), a midpassage structure (structure 9), stone peripheries (structure 6, 7, 13, 14), a fireplace (structure 8) and a pavement (structure 12).

At the terraces from 11 to 21 m, an Independence I habitation structure and a cache were found. At 42 m another cache was found.

Excavation

In 1948, Knuth's research station 'Brønlundhus' was built and in 1973 the station 'Kap Moltke' was built, including an airstrip. Thus Knuth had an excellent logistic setting for carrying out surveys and research in the areas adjacent to Jørgen Brønlund Fjord. The excavations of Independence II settlements at the 5-metre terrace at Vandfaldsnæs were continued for several seasons during the period 1950 to 1973; structure 9 in 1950, 1963, 1970 and 1971; and structure 11 in 1963, 1964, 1968 and 1971.

Excavation method

It is not explicitly described how excavations were carried out at Vandfaldsnæs. A drawn plan of structure 9 does not show the precise position of the artefacts or tools found, and descriptions of artefacts, in files at The National Museum of Den-

Lab. No.	Material	^{14}C. BP	^{13}C.	Calibrated BC*1	Remarks	Reference
K-933	Charcoal (larix sp)	3180 ±110		1610–1310	Structure 9	(Knuth 1984)
K-934	Charcoal (picea sp)	2740 ±100		1010–800	Structure 9	(Grønnow & Jensen 2003)
K-5009	Musk ox bone (Ovibos moschatus)	2570 ±70	-19.5	820–540	Structure 9	(Grønnow & Jensen 2003)
K-5008	Musk ox bone (Ovibos moschatus)	2430 ±70	-20.4	760–380	Structure 11	(Grønnow & Jensen 2003)

Table 4.4.1 Radiocarbon dates, Vandfaldsnæs

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

mark, 'only' relate artefacts to single structures. It can therefore be suggested that Knuth excavated single structures and related the artefacts to these. Structure 11 is, in the files, described as 11, 11a and 11b. The numbers 11 and 11a relate to what Knuth interprets as an indoor habitation area, while 11b relates to an area 3–4 m in front of the structure.

Publications

Vandfaldsnæs site is mentioned by Knuth several places in his publications, especially in relation to preserved organic artefacts from Independence II contexts (Knuth 1968, 1981). Plans, artefacts and documentation from the site were compiled and summarized by Grønnow and Jensen (2003).

Dating

Four radiocarbon dates have been made of material from Independence II context at Vandfaldsnæs (table 4.4.1). However, two of these are made on driftwood and must be regarded as imprecise (too old). The latter two dates are made on musk ox bone and date the Independence II settlement to the calibration plateau between 800 and 400 BC.

Inventory

The Independence II sites have generally small lithic assemblages, with only few representatives of tools from the different *chaînes opératoires*. In total, 413 artefacts are retrieved from Vandfaldsnæs, and 42 of these are classified as tools (table 4.4.2 and figure 4.4.3).

End scrapers	9	Bifacial end blades	4
Side scrapers	1	Adzes	2
Burin preforms	2	Microblades	18
Burins	3	Microblade knives	1
Bifacial end blade preforms	2	Flakes	371

Table 4.4.2 Inventory list, Vandfaldsnæs

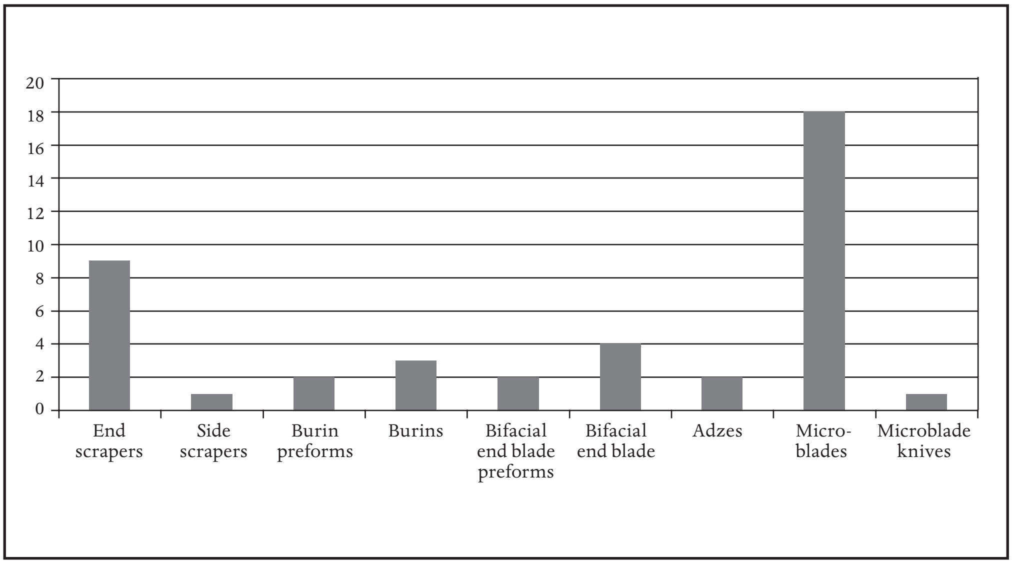


Fig. 4.4.3 A quantitative comparison of the lithic tool types in the Vandfaldsnæs assemblage.

Kap Holbæk

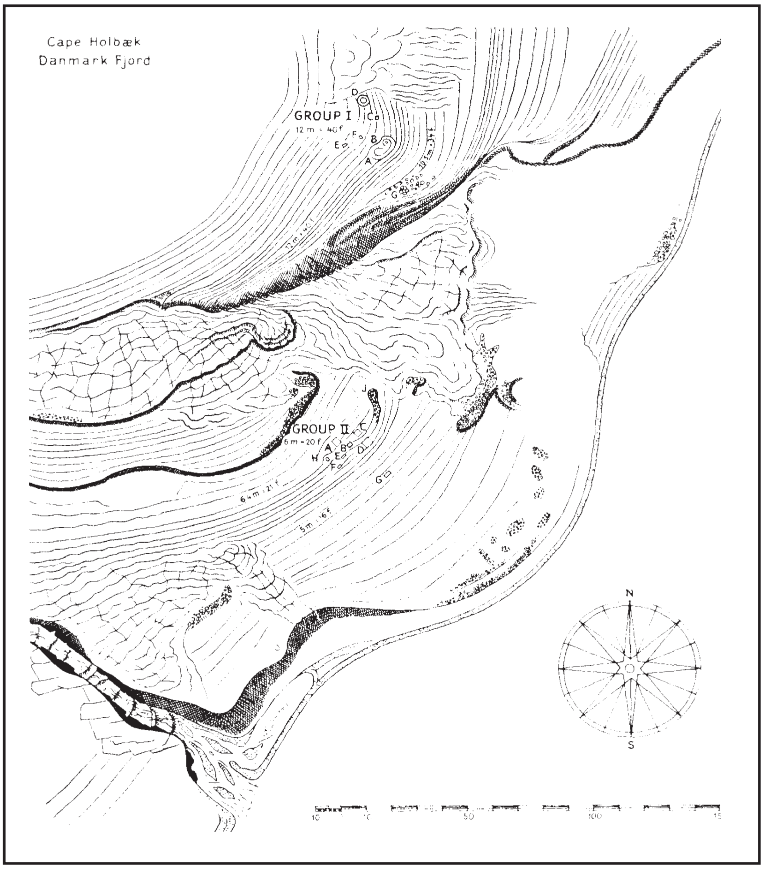
Geography

The Independence II site of Kap Holbæk is found deep in Danmark Fjord, on a promontory on its western coast. At the promontory, Danmark Fjord is separated into two smaller fjords called Holbæk Fjord and Næstved Fjord. The promontory Kap Holbæk is characterized by raised beach terraces and rises more than 100 m above sea level. In total, five ruin groups are described at the site. Group I, II and V are located on its southern part, 12 m, 5 m and 1 m above sea level respectively. At the northern side of the promontory the ruin groups III and IV are located, 6 m and 17–20 m above sea level respectively (figure 4.4.4). The ruin groups II, III and IV are described by Knuth as belonging to the Independence II culture.

Excavation

Eigil Knuth discovered the site Kap Holbæk in 1954 and he returned in 1955 to conduct excavations. The surveys and investigations of the area revealed an intensively used habitation area, with High Arctic standards. Besides the five ruin groups at Kap Holbæk, three ruin groups were located at the nearby Næstved Fjord, called respectively: Lolland Sø, 'Den blå flints boplads' ('the blue flint site') and 'Islandssletten'.

Fig. 4.4.4
Site plan of structures on the Kap Holbæk site (after Grønnow & Jensen 2003).



The largest Independence II site at Kap Holbæk is Group II, which consists of three midpassage structures, a tent ring, two fireplaces and a cache. Group III consists of a midpassage structure, a box hearth and a paved area. Group IV consists of three tent rings, three caches and a box hearth (Grønnow & Jensen 2003).

Excavations of structures and concentrations of artefacts were carried out. From Group II and III all structures were excavated. In group IV, the midpassage structure was excavated. Artefacts are described and catalogued in relation to: 1) the ruin group number, 2) the structure or area from where they were excavated and 3) an individual number. If an artefact was found outside or between structures it is related, by ruin group number, to the nearest structure number, a letter and a number. Drawings and photographs document the structures.

Publications

The Kap Holbæk site was of major concern for the recognition and the separation

Lab. No.	Material	14 C. BP	13C.	Calibrated BC*1	Remarks	Reference
K-142	Charcoal	3030 ±130		1430–1050	Structure IIA	(Knuth 1984)
K-565	Charcoal	3000 ±120		1400–1050	Structure IIA	(Grønnow & Jensen 2003)
K-4259	Musk ox bone (Ovibos moschatus)	2450 ±70	-20.6	760–400	Structure IIA	(Grønnow & Jensen 2003)
K-5077	Musk ox bone (Ovibos moschatus)	2460 ±70	-18.1	760–410	Group IV	(Grønnow & Jensen 2003)

Table 4.4.3 Radiocarbon dates, Kap Holbæk

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

of the Palaeo-Eskimo cultures (Independence I and II (Early Palaeo-Eskimo/Dorset)) of the eastern Arctic. Thus, Knuth had been writing repeatedly about his discoveries and thoughts about this site (Knuth 1955, 1956, 1958, 1968, 1981). However, the best overview of the site was published by Grønnow and Jensen (2003).

Dating

Four radiocarbon dates were made from material of Independence II context at Kap Holbæk. Two of these are made from driftwood and must be considered as imprecise (too old). However, two dates, produced from musk ox bone, dating structures in Group II and IV to the calibration plateau between 800–400, can be considered as reliable (table 4.4.3).

Inventory

From Kap Holbæk 684 lithic artefacts were classified, and 48 of these are defined as tools and preforms (table 4.4.4 and figure 4.4.5).

End scrapers	1
Side scrapers	1
Burins	1
Burin preforms	2
Bifacial end blade preforms	10
Bifacial end blades	6

Side blades	3
Adzes	1
Adze preforms	5
Microblade knives	2
Microblades	18
Flakes	636

Table 4.4.4 Inventory list, Kap Holbæk ruin groups II, III, IV

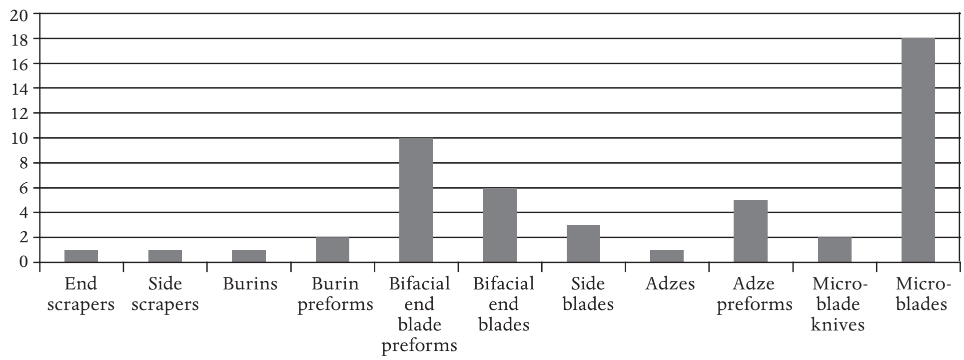


Fig. 4.4.5 A quantitative comparison of the lithic tool types in the Kap Holbæk assemblage.

The *chaînes opératoires*

The raw material

Vandfaldsnæs

At Vandfaldsnæs, four types of raw materials were used for lithic tools. Three of these have been worked at the site (figure 4.4.6). The dominant raw material is the blue, fine-grained mcq, found in the southern part of the Ellesmerian Folding. The material has excellent flaking properties. Its surface is often lightly shiny, which in several cases could have been enhanced by wind polish. This material has been used for blade production as well as for the production of scrapers and burins.

The second material used is a black, opaque mcq. This material probably derives from the northern part of the Ellesmerian Folding, and is thus imported from

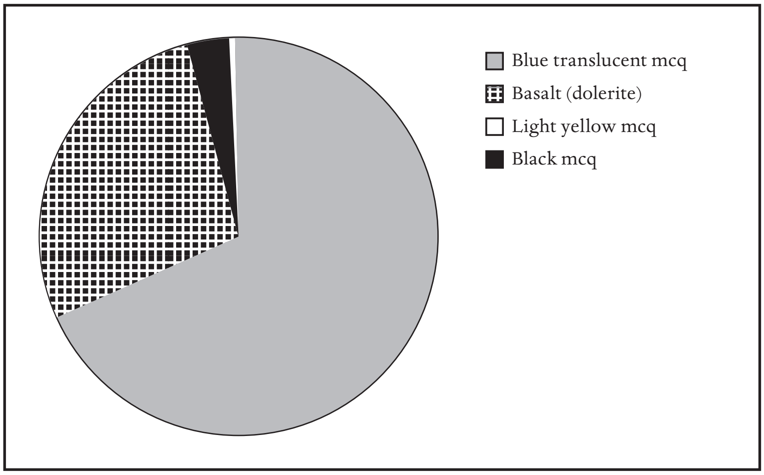


Fig. 4.4.6
A quantitative comparison of the different lithic raw material types in the Vandfaldsnæs assemblage.

quite a distance. The black mcq is used for three tools: a burin and two scrapers. The third type of mcq is a light yellow, semi-transparent mcq, whose origin is unknown. The material has excellent flaking properties. It is used exclusively for three tool types: a scraper, an end blade and a burin. No flakes are found from this material at the site and the material must thus have been imported as finished tools to the site.

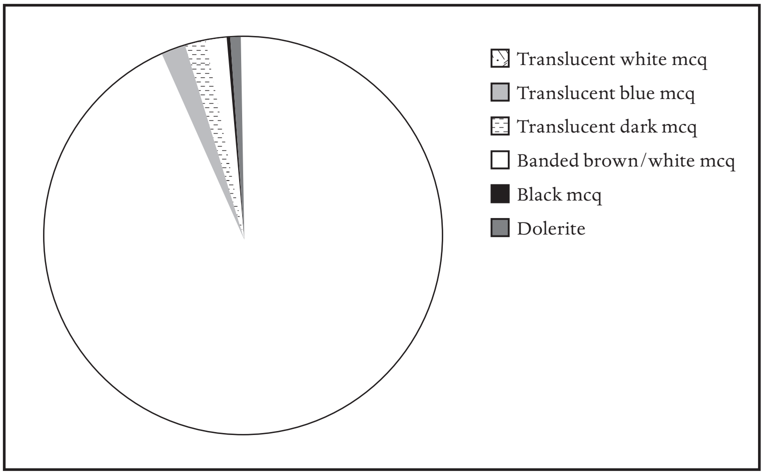
The last used raw material is a brown to black dolerite. The material is coarse and it flakes with diffuse conchoidal fractures. The dolerite is exclusively used for the production of adzes. A large amount of flakes from this material indicates that adze production has taken place at the site.

Kap Holbæk

A light white to grey, often striped, fine-grained and translucent mcq is generally used for the lithic production at the Independence II site at Kap Holbæk (figure 4.4.7). This raw material varies in colour and texture. At the site, it is primarily found as flakes and small tested blanks. The morphology of the blanks are tabular, and down to a ½ cm in thickness. The amount of tested blanks and the large percentage of this material suggests that it has been procured from the local area, e.g. from Kronprins Christian Land or Amdrup Land. At the Amdrup Land a similar type of mcq is known.

The remaining lithic raw materials are: 1) a blue translucent mcq, known from the southern part of the Ellesmerian Folding, 2) black to brown translucent types of mcq, 3) dolerite (mostly as preforms) and 4) tools made from a black mcq, probably deriving from the northern part of the Ellesmerian Folding.

Fig. 4.4.7
A quantitative comparison of the different lithic raw material types in the Kap Holbæk assemblage.



Discussion

At Kap Holbæk, where both Palaeo-Eskimos from Independence I and Independence II settled, pronounced differences are seen in the raw material choices between the two traditions. In the Independence I assemblage, the blue mcq from the Ellesmerian Folding is very dominant. This material is probably imported from southern Peary Land, suggesting that the Independence I group came from the north when arriving at Kap Holbæk. The dominant raw material used in the Independence II assemblage are local (Kronprins Christian Land/Amdrup Land), and suggests therefore that the Independence II group used local materials and most possibly came to Kap Holbæk from the south.

End scrapers

Steps 0–1
Large flakes (figure 4.4.8: A) are produced from cores of high quality mcq. In the High Arctic region, the blue or black mcq from the Ellesmerian Folding has often been used. Moreover, a light yellow mcq, whose provenance is not yet identified, is used in this area. Along the northeast coast of Greenland, transparent quartz and different types of mcq are used for scraper production. Large percussion bulbs on the flake blanks suggest that a direct hard technique has been used for the production of the scraper blanks.

Step 2
The flake blanks' dorsal face is formed by flake reduction and retouch of the lateral edges. The ventral side of the flake becomes the underside of the scraper (figure

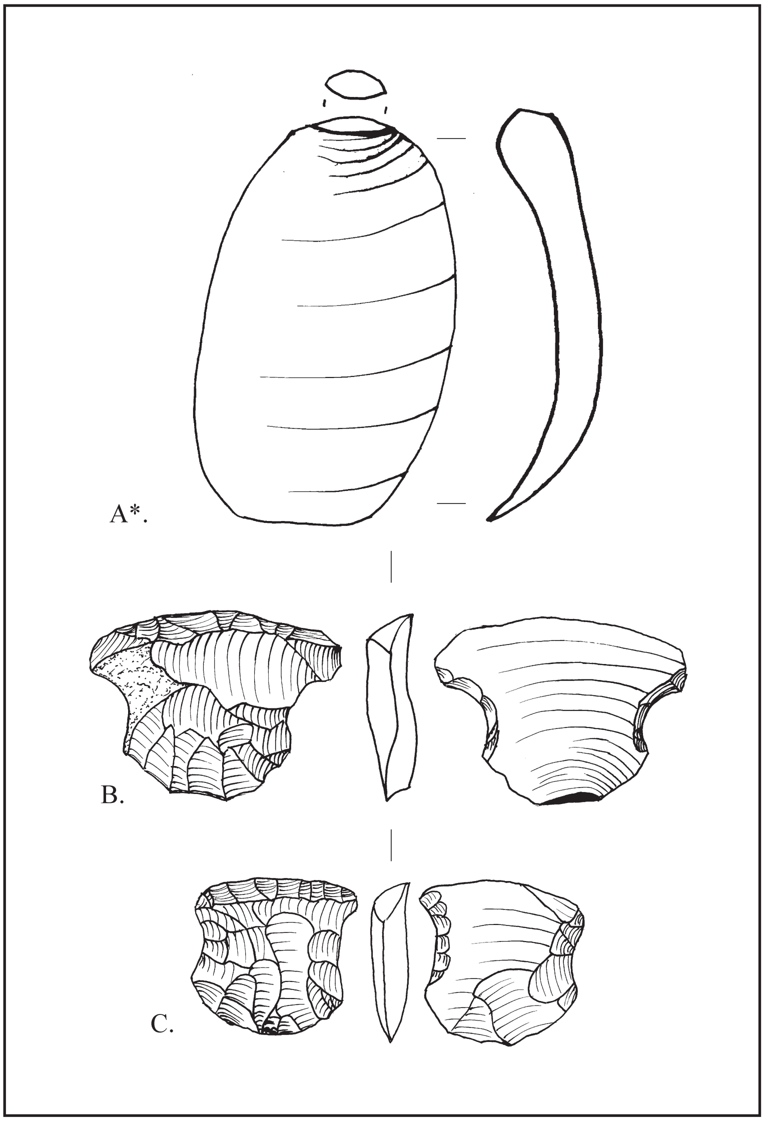


Fig. 4.4.8 The *chaîne opératoire* for end scrapers in Independence II. Examples are from the Vandfaldsnæs assemblage.

4.4.8: B, C). The curvature of the flake is ideal for the scraping function, because the scraping edge will have a 'natural' angle against the worked material during the working process (B). The base of the scraper is produced in the proximal end of the flake blank. From each corner of the base the dorsal face of the base is pressure retouched, into a triangular morphology (B, C). A concave retouch shapes the lateral edges of the end scrapers, so that the scraper gets a flaring scraping edge (B). The scraping edge is produced unifacially from the ventral side of the flake blank by regular series of pressure retouch flakes. The edge becomes regular and convex with an angle of 50–60 degrees.

Step 3
Considering the end scrapers' regular and well-shaped bases it is most possible that the scrapers have been hafted in a standardized haft type. From the macroscopic wear of the scraper edges, showing a slight rounding and lack of even small use wear fractures, it seems reasonable to suppose that the scrapers have been used for scraping soft organic materials.

Step 4
When the scraper edges become dull, they are rejuvenated by a series of pressure retouch. Due to this process the scrapers are gradually reduced in their length. The scraper is discarded when its convex flawing edge is reduced and its length is reduced to about 23–24 mm. In some cases it is seen that the scraper edges are up to 90 degree steep in this stage.

Side scrapers

In the investigated assemblages only two artefacts can be interpreted as side scrapers. The studied material for this *chaîne opératoire* is therefore not representative. Moreover, the two artefacts are rather atypical for side scrapers from e.g. Dorset contexts.

Step 0
The artefacts studied are made from high quality mcq.

Steps 1–2
Oblong flakes are produced and chosen for production of side scrapers. The proximal end of the flake blank becomes the base of the scraper (figure 4.4.9: A). The lateral edges are retouched unifacially at the dorsal flake blank face, so that the edges become parallel and straight (figure 4.4.9: B, C). The cross-section thus becomes half-moon shaped. The morphology of the bases cannot be studied due to lack of material.

Steps 3–4
Both artefacts studied are discarded before step 3 and this step can therefore not be studied.

Discussion
None of the studied side scrapers have edges with use wear and the edges have not been rejuvenated, nor have they developed a concave scraping edge as it is

normally seen for side scrapers in the ASTt. Thus the two studied specimens have probably been left in step 2.

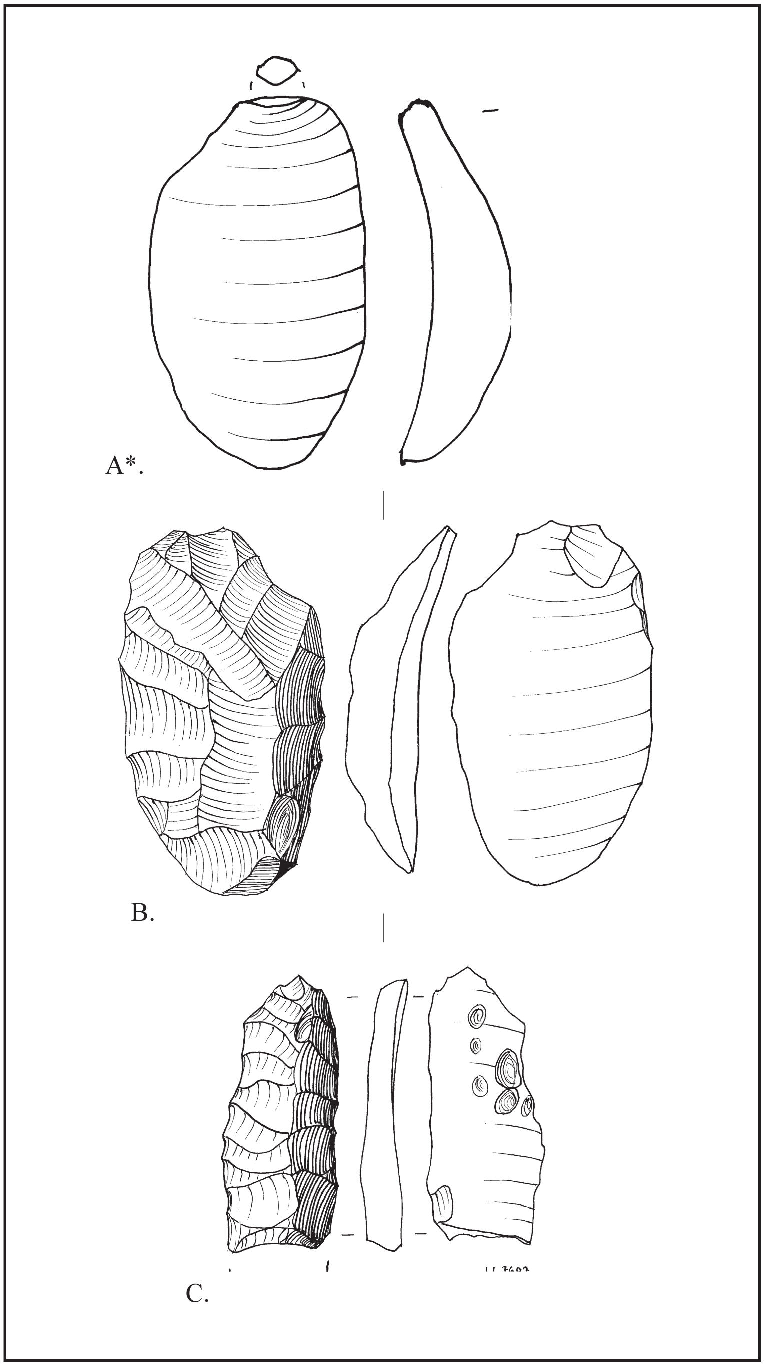


Fig. 4.4.9 The *chaîne opératoire* for side scrapers in Independence II. Examples are from the Vandfaldsnæs and Kap Holbæk assemblages.

Burins with ground edges

Step 0

In High Arctic Independence II, blue and black mcq from the Ellesmerian Folding has been chosen as the raw material for burin production. From central East Greenland up to Nordostrundingen burins are generally made from basalts, probably deriving from the basaltic areas between Shannon and Clavering Island.

Step 1

A preform from Vandfaldsnæs has a large flake scar at its one face, which documents that this blank originally must have been a large flake (figure 4.4.10: A). On the other hand, a preform from Kap Holbæk has natural surfaces and the blank must therefore have been a thin tabular core piece. Thus preforms can both be made from flakes and core pieces. The preform is produced bifacially, most likely by a direct soft technique and by pressure retouch. The cross-section is made triangular. The coming lateral edge side is high while its opposite edge is thinner. The underside of the tool is plain (figure 4.4.10: B).

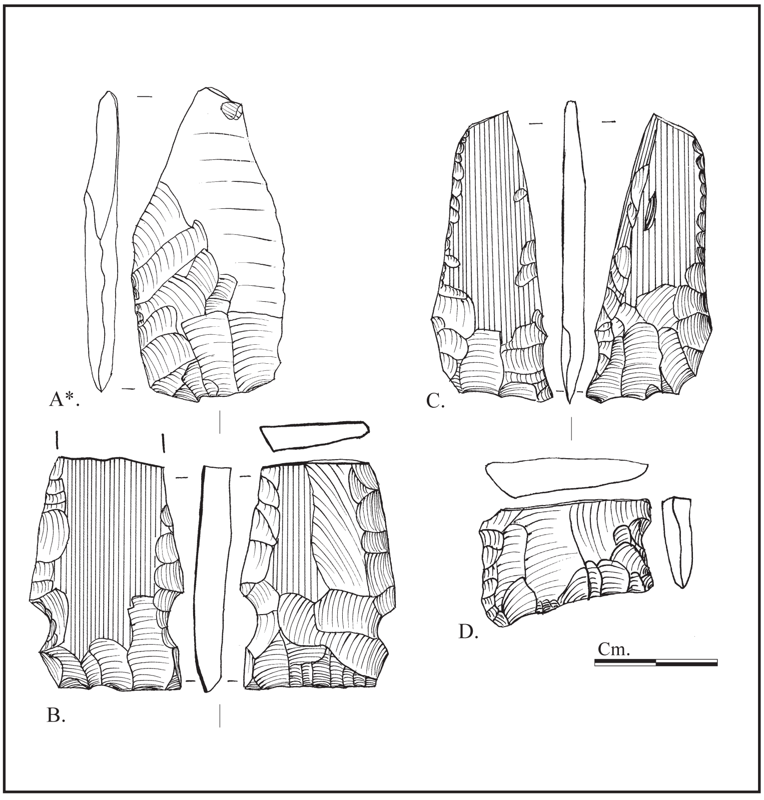


Fig. 4.4.10
The *chaîne opératoire* for burins with ground cutting edge in Independence II. Examples are from the Vandfaldsnæs and the Kap Holbæk assemblages.

Step 2
The base of the burin is fluted and formed by pressure retouch. The basal edge is approximately 70 degrees compared to the length-direction of the tool. The basal corner opposite to the cutting edge is often seen retouched away, and two large notches are made on each lateral edge of the base. The cutting edge is produced at the thick lateral edge of the tool in an 80-degree angle to the plain underside. The cutting edge, as well as the underside and upper side of the distal part of the burin, is thoroughly ground (figure 4.4.10: C).

Step 3
The burin must have been hafted in the end of a wooden haft, as it is known from Dorset contexts in Canada (Maxwell 1985; Mary-Rousselière 2002). On all investigated burins from Independence II the cutting edge is made at the left side of the burin, seen with the plain (under)side down. This must be explained by the fact that all producers must have been right-handed, i.e. the burin was used in a motion against the body with the plain side downwards. Due to the straight, ground cutting edge and its steepness, the burin can produce fine regular surfaces in hard organic materials. Moreover, the distal corner of the burin can have been used for grooving, when producing oblong holes and splitting organic materials.

Step 4
A few discoveries of completely ground burin spalls demonstrate that burins occasionally have been rejuvenated by spalling. However, since only burins with ground edges have been found within the Independence II context, the spalled burin facet must in all cases have been ground before use. Fragments of discarded ground burins show that the cutting edge is rejuvenated by grinding and that the underside is ground too during this process. The distal end of the burin is thus gradually reduced during steps 3–4.

Step 5
Several of the studied burins are broken just above the base, and only the distal end or the base is found (figure 4.4.10: D). This fragmentation must be explained by forceful use, combined with a twist when using the burin. Reduced distal ends are in steps 4–5 sometimes seen with a steep edge angle, about 90 degrees.

Bifacial end blades

End blades have probably functioned as both knives and armature points in Independence II. Thus it can be difficult to separate end blades with either function.

However, end blades defined as armature points are characterized by being symmetrical and pointed, with no lateral rejuvenation. Moreover, distal impact fractures can sometimes be found on this tool type. In contrast, end blades defined as knives are asymmetrical and laterally rejuvenated and they often have an oval distal morphology with no sharp point.

Step 0

All bifacial end blades from Independence II contexts are produced from high quality mcq.

Step 1

At Kap Holbæk, blanks and preforms are found, which indicates that approximately 1 cm thick tabular blanks have been selected for the production of preforms (figure 4.4.11: A, B). The blanks are reduced bifacially, probably using a direct soft percussion technique.

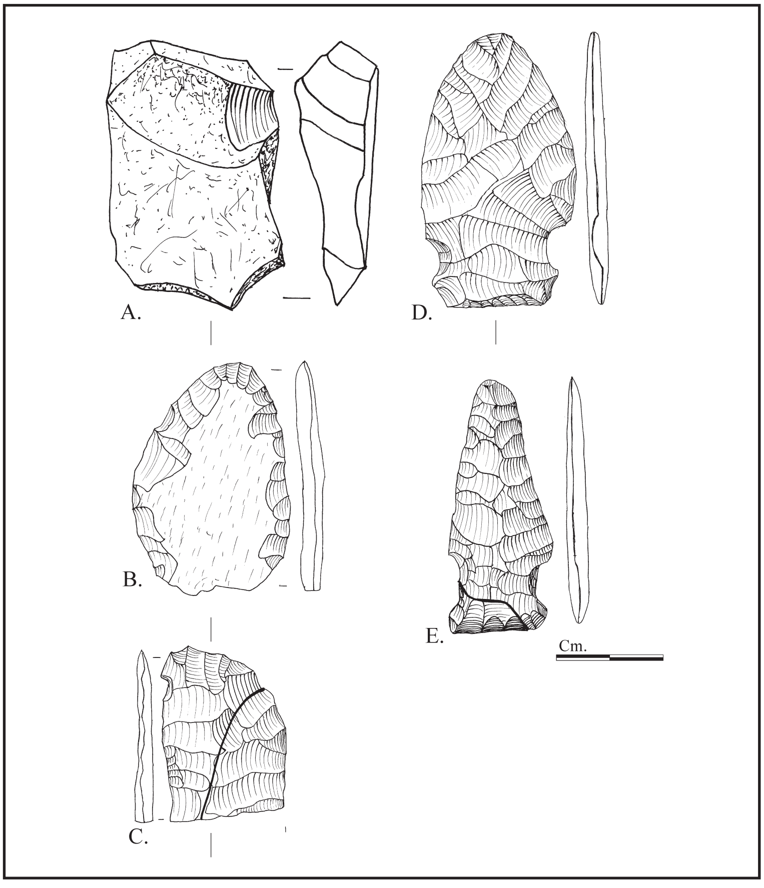


Fig. 4.4.11
The *chaîne opératoire* for bifacial end blades in Independence II. Examples are from the Vandfaldsnæs and the Kap Holbæk assemblages.

Step 2

The intention of the reduction in step 2 is to produce an oval preform with a symmetrical, thin, oval cross-section (figure 4.4.11: B). The basal end is made straight and right-angled, and the blade is often fluted from the base (figure 4.4.11: E). At each lateral edge of the base, a large notch is made (figure 4.4.11: D, E). The lateral edges of the distal blade are shaped to produce an even, symmetrical and sharp edge for cutting materials, probably by means of pressure flaking. If a knife is produced the blade will be shaped into an oval morphology, while armature points will be given a pointed triangular morphology.

Step 3

End blades used as knives, similar to Independence II types, have, in Canadian Dorset contexts, been end hafted in wooden hafts (see description for Dorset I). The knives have probably been used on soft organic materials such as meat and skin.

End blades used as armature points have been hafted into cloven shaped lances during Independence II, e.g. at Lolland Sø (Knuth 1968). Cloven foot lances are also known from Dorset contexts, e.g. at Igloolik (Meldgaard 1968). However, many of these are self-tipped. Generally, symmetrical end blades used as armature points are rare in Independence II contexts (figure 4.4.12).

Step 4

Knife blades are rejuvenated laterally by pressure retouch. Thus, the morphology of the knife blades gradually changes from oval to more narrow and triangular

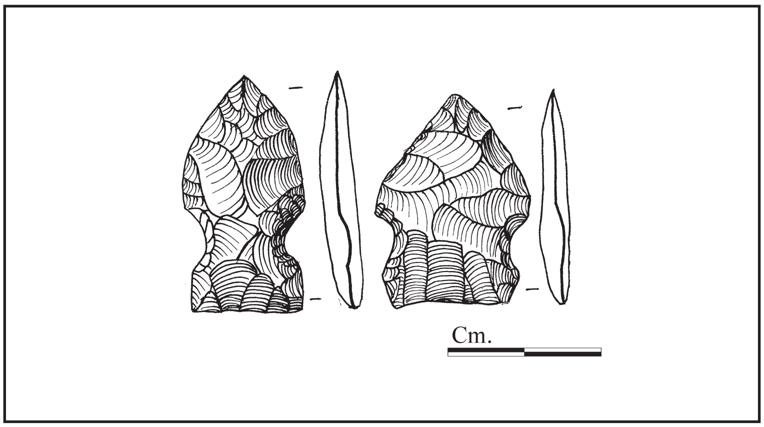


Fig. 4.4.12
Bifacial end blades can have functioned as both harpoon points and knife blades. Examples are from the Mågefjeldet (KNK 2077) assemblage.

during the use stage. In contrast, the bases are not altered during use or rejuvenation. No examples of rejuvenated armature points have been found in Independence II assemblages.

Step 5
Knife blades are most often discarded due to breaks right above the base (figure 4.4.11: D, E), but several distal ends are also seen reduced severely due to use and rejuvenation (E). End blades used as armature points are seen discarded with different kinds of impact fractures (Fischer et al. 1984).

Side blades

Step 0–1
Thin straight flakes made from mcq are chosen as blanks for side blades (figure 4.4.13: A).

Step 2
The blank is reduced bifacially against its centre all around the edges. The bulb of percussion is removed first. The preform becomes even and oval or slightly double pointed (figure 4.4.13: B). The thin preforms with their thin sharp edges suggest that pressure technique has been applied during this step.

Step 3
Side blades are hafted laterally into a groove into cloven foot lances or harpoon

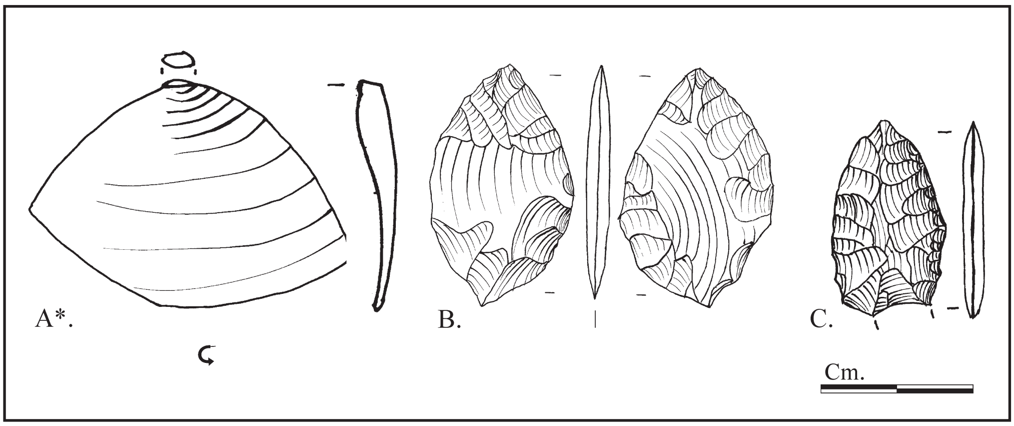


Fig. 4.4.13 The *chaîne opératoire* for side blades in Independence II. Examples are from the Kap Holbæk assemblage.

heads. The groove has a width of approximately 2 mm, thus the side blade fits perfectly. Side blades function as sharp cutting edges in the lances rather than as points.

Steps 4–5

The lances with side blades are used with sudden force and the side blades will most probably break in use (figure 4.4.13: C). Thus the side blades will generally not be rejuvenated, but rather be changed if they are damaged during use.

Adzes

Step 0

Raw materials for adzes are made from dolerite at Kap Holbæk and Vandfaldsnæs, i.e. homogeneous basalt that only barely fractures conchoidally. Dolerite is accessible at several places within the Independence fjord region, where it intrudes into sediments (e.g. 'Midsommersø dolerite') and occurs as layers in sedimentary rocks (Henriksen 2003: 181–182).

Step 1

Rectangular tabular blanks are chosen as preforms for the adze production. These are worked unifacially from two opposite lateral edges to create a rectangular symmetrical preform with a square cross-section (figure 4.4.14: A, B). Flakes, which are detached during this process, are generally short and wide, with diffuse bulbs, and can be classified as typical 'wing-shaped flakes' as described from the production of flake axes (Sørensen & Sternke 2004).

Flakes detached from the lateral edges thin the upper face of the adze, thus this face becomes characterized by large negative flake scars and hinges. Knapping is generally conducted by means of direct hard percussion.

Step 2

In order to produce a functional adze, the distal edge is shaped by knapping followed by grinding. The working edge is made asymmetrical during its production and after it is ground it has an angle from 40 to 60 degrees. The adze is then trimmed into a regular morphology to fit the hafting. This process is carried out by reducing the edges, as in the earlier step. The lateral edges will often be crushed and the faces have many negative hinge scars (figure 4.4.14: D).

Step 3

Preforms for adzes (steps 1 and 2) can have been used as wedges for flaking up materials such as bone and driftwood. A preform (figure 4.4.14: C) that has a slight grinding of its edge and a flat base would make an appropriate wedge. However, the piece could also be an unfinished preform for an adze. The hafting of adzes within Independence II is yet unknown. However, due to their asymmetrical edges it seems most possible that they were hafted as adzes (i.e. with the working edge rectangular to the shaft direction). The adze could have been hafted, as it is known from the Dorset and Thule Culture in a socket tied to an angular haft of antler or wood.

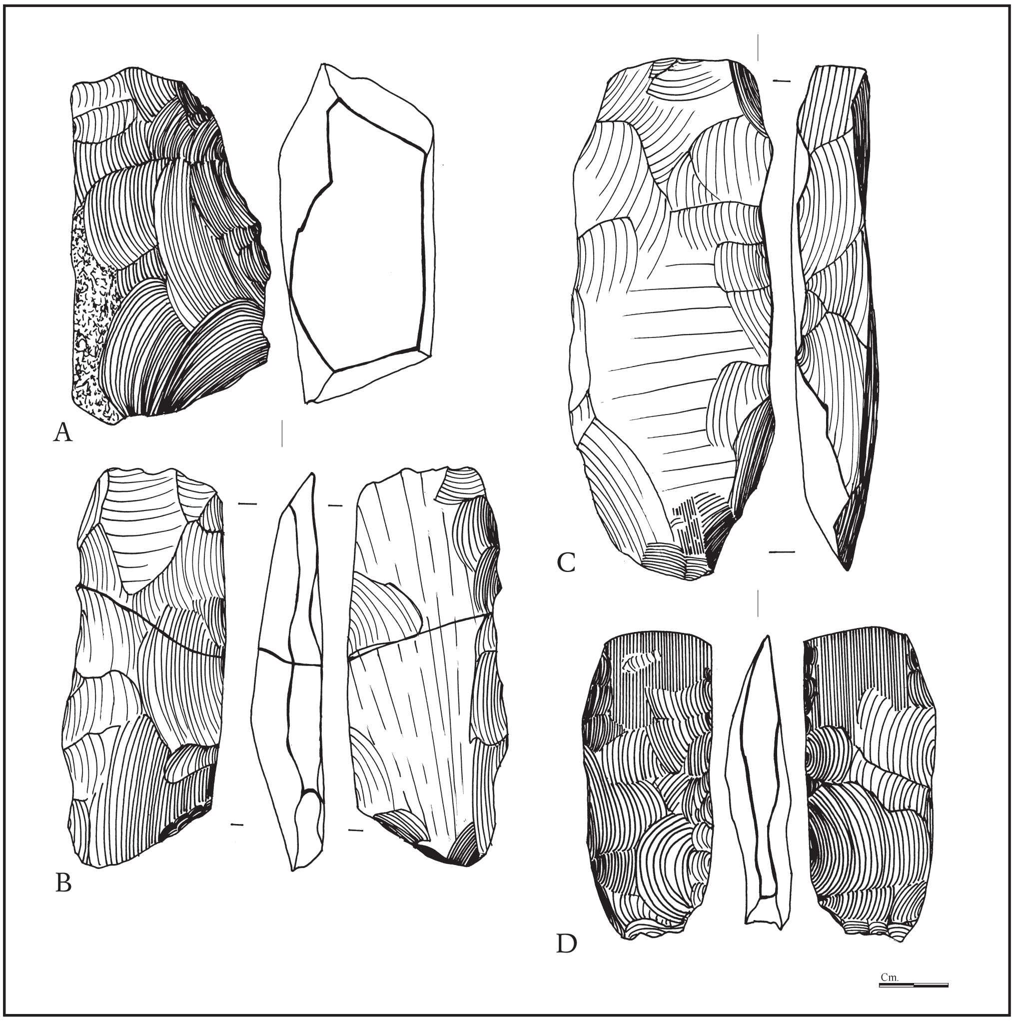


Fig. 4.4.14 The *chaîne opératoire* for the adzes in Independence II. Adzes are made from dolerite. Examples are from the Vandfaldsnæs and Kap Holbæk assemblages.

Steps 4–5

Adzes are ground when rejuvenated. Due to the toughness of the dolerite material it is possible that an Independence II adze has a very long-lasting usage. Adzes are seen discarded at a length of 6–7 cm.

Discussion

Adzes in Independence II are reduced to the finished stage by unifacial knapping of the edges and the upper face by direct hard percussion. This method results in irregular adze morphologies. During the Early Palaeo-Eskimo periods adzes are mostly produced bifacially and by means of direct soft percussion, which results in regular adze morphologies. Thus, there are substantial differences between the adze production concepts and results, from Saqqaq and Independence I to Independence II and Dorset.

The preforms for adzes made from dolerite and the dolerite flake material from Vandfaldsnæs suggest that an adze production took place at this site. Moreover, dolerite outcrops are found in the vicinity of Vandfaldsnæs. The six adze preforms found at Kap Holbæk are made from the same raw material quality as on Vandfaldsnæs. However, on this site no flake material from dolerite has been located and dolerite outcrops are not known from this area. The six preforms should therefore be interpreted as an imported cache, possibly coming from the Independence Fjord area. Adze preforms thus seem to be one of the few stone tool types which are systematically imported/exported within Independence II contexts.

Blades

Morphology

Blades from Independence II are generally regular and prismatic. Proximal ends are seen with a small bulb and a lip formation, and bulbar scars are only seldom seen. Butts are plain and most often lenticular (figure 4.4.15) with a width/thickness ratio of approximately 2:1. The thicknesses of the butts are 1–2 mm. Distal ends of the blades are often pointed (feathered), but some are wide and angular. The lengths of the complete blades are between 20 and 40 mm and their width is from 4 to 9 mm (figure 4.4.16). More blades can be analyzed when only the width is compared (figure 4.4.17).

The analysis of the blade fragmentation from Kap Holbæk documents that the distal ends of the blades most often are broken, which is probably due to damage from production. At Vandfaldsnæs a larger proportion of the blades are complete (figure 4.4.18).

inventory in Independence II consists of adzes, bifacial knives, harpoon points, burins with ground edges, side blades, end scrapers, side scrapers and microblade knives. As in Dorset I, no lithic tools can be interpreted as arrowhead points. The lithic production is systematically conducted from standardized concepts in which stepwise intentions carried out in the lithic material result in standardized tools and rejuvenation methods.

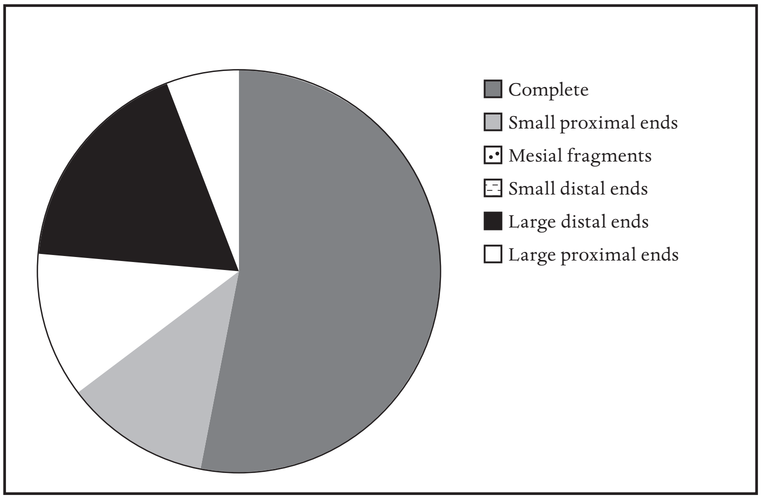
Adzes are made using a unifacial knapping method, shaping and thinning the preform from the two parallel lateral edges by means of direct hard percussion. End blades are produced bifacially, mainly by direct soft hammer and pressure technique, and shaped with two large notches at the bases. Burins are shaped asymmetrically with a triangular cross-section and one ground lateral cutting and shaving edge. Their bases are carefully shaped with notches. End scrapers are unifacially produced and shaped with flawing lateral edges. Side blades are produced bifacially from thin flakes and shaped into an oval morphology.

The generalized method of lithic reduction, production of tool types and their rejuvenation can be described as the Independence II concept of lithic production (figure 4.4.24).

Blade production

For the production of microblades in High Arctic Independence II, mcq is generally used. However, in the area between Nordostrundingen down to Germania Land, transparent quartz is primarily seen in use for this production. South of Germania Land variations of fine-grained, often heat treated mcq is used. Blade core preforms are made from natural tabular blanks, which are shaped into keeled core preforms. A typical blade core is initially about 4 cm high and 1.5 cm wide. The core platform is, during exploitation, often prepared from one lateral platform edge, resulting in a small faceted platform type. Facets are also produced from the front during exploitation in order to adjust the angle between front and platform and to produce individual platforms for the pressure tool point. The angle between front and platform is low, typically 50–70 degrees. Thus the front 'disappears' under the platform and no abrupt stop of the blades will appear. Using this core morphology the blades achieve a slight distal curvature.

The blade morphology is prismatic and very regular, characterized by oval and most often plain butts. Metrically the production is homogeneous, between 3–4 cm in length and 6–7 mm in width and 2 mm in thickness. From the blade production, complete blades are sorted out as preforms for blade knives. These are retouched minimally at the proximal lateral edges. This retouch is seen from both the ventral and dorsal face and it results in a tanged blade.



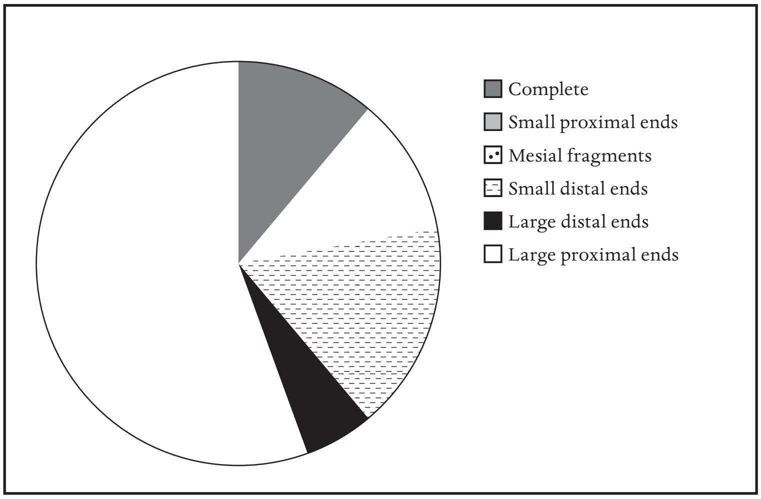


Fig. 4.4.18
The fragmentation of microblades in the Vandfaldsnæs and the Kap Holbæk assemblages.

The chaîne opératoire

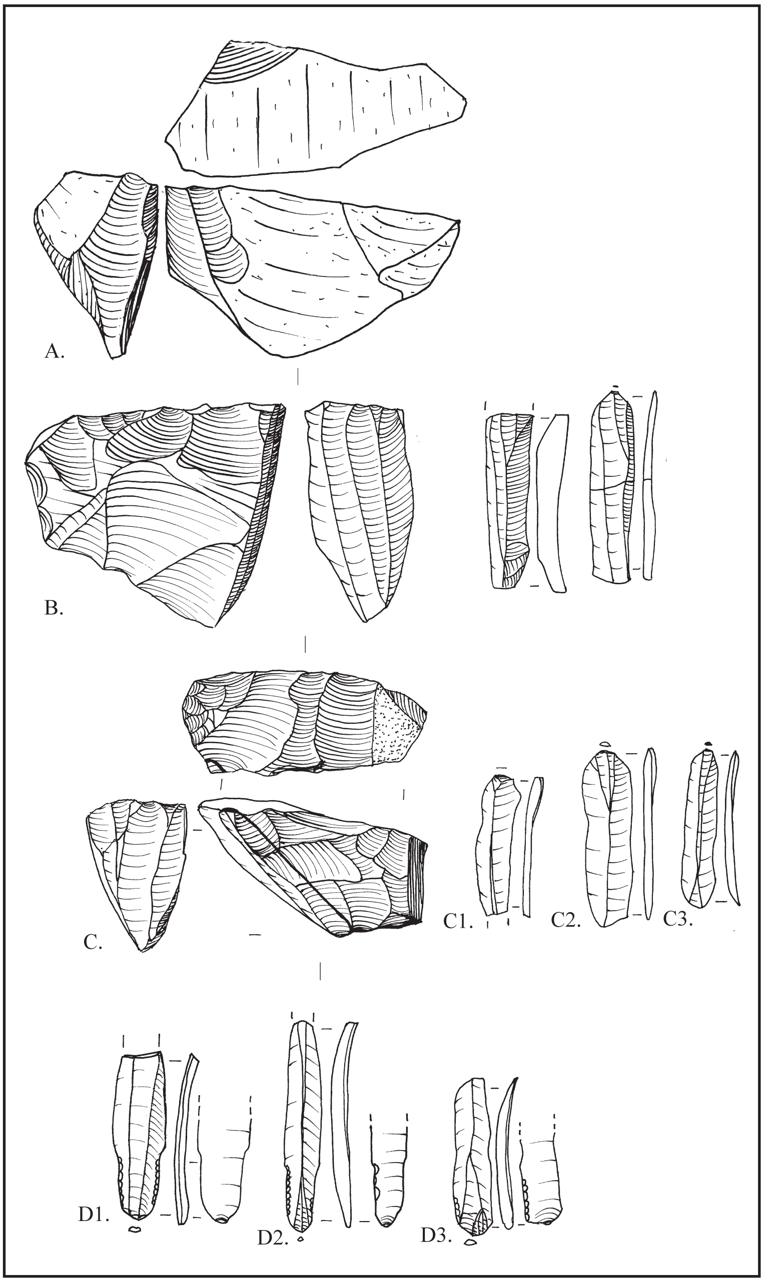
Step 0

In Independence II, the blade production is made from high quality, fine-grained mcq. At Kap Holbæk the local white, translucent mcq is favoured. At Vandfaldsnæs the regional blue mcq from the Ellesmerian Folding is used.

Step 1

From a blade core in its first phase of exploitation, found at the Independence II site 'Mågefjeldet' (figure 4.4.19: B) (Knk 2077 x63) and from a blade core preform from Kap Holbæk (figure 4.4.19: A), it is seen that small tabular core pieces are chosen as blanks for the blade core preforms.

Fig. 4.4.19
The microblade production method in Independence II. Examples are from the Vandfaldsnæs, Kap Holbæk and Mågefjeldet assemblages.



The cores are shaped from the platform, the bottom and the front into an oblong single platformed core with a conical cross-section (B). The platform is prepared from the side. The front is formed both by ridge flakes and the first irregular opening blades.

The production of the blades can be described in four stages:

1. Each blade has to be prepared. In Independence II the platform is prepared by creating a facet for the pressure tool to stand on. The facets will also correct the angle between front and platform.
2. The core edge is thereafter lightly abraded with a soft stone, so that the previous blade negative bulb is removed.
3. The pressure tool is placed above two arises at the prepared platform.
4. Weight is applied to the pressure tool, probably by the upper body, so that the blade detachment initiates and the blade is produced.

The blade production stops when the blade core becomes too small to haft, the fronts are shortened down due to rejuvenation and faceting of the platform. At this stage some blades will probably also start to hinge.

The blades are generally thin (2 mm) and it is therefore most possible that many of them will break during production (figure 4.4.18). Complete blades are selected for the production of blade knives (figure 4.4.19: C). These blades are lightly retouched in their proximal ends, so that they become tanged. The retouch can be made both from the ventral and dorsal side of the blade (figure 4.4.19: D) and are made with a pressure tool.

Step 3

The standardized retouch of the blade knives suggests that, within the Independence II, a standardized haft for microblades existed so that they could easily be changed. However, preserved blade hafts are not known from Independence II.

Step 4

Microblade knives are normally not re-sharpened, since their edges are unmodified when used. New blade knives can quickly substitute the microblade knives, when dull.

Discussion

From the 'Eigil Knuth site' many of the broken blades are seen with macroscopic wear on their edges. These have been interpreted as blades deliberately broken and used as inserts for producing longer cutting edges (Andreasen 2004: 134). However, this tool type is difficult to document in the lithic inventory since no systematic retouch or modification has been made to produce it and no hafts of organic materials for blades are found. Moreover, many blades break during production.

From Late Dorset, organic hafts for inserts existed, and it is very possible that these were invented earlier in the Palaeo-Eskimo tradition.

The flake material

The flake material from Kap Holbæk and Vandfaldsnæs, in all 661 and 347 flakes respectively, was investigated.

Metric

Only few flakes made from mcq are larger than 3 cm in the two assemblages (figure 4.4.21). Flakes made from basalt at Vandfaldsnæs are up to 4 cm large (figure 4.4.20: VII–XI).

Diagnostics

Large flakes made from mcq (3–5 cm) (figure 4.4.20: I–II)

The few large flakes from mcq have large plain butts, pronounced bulbs and no lip

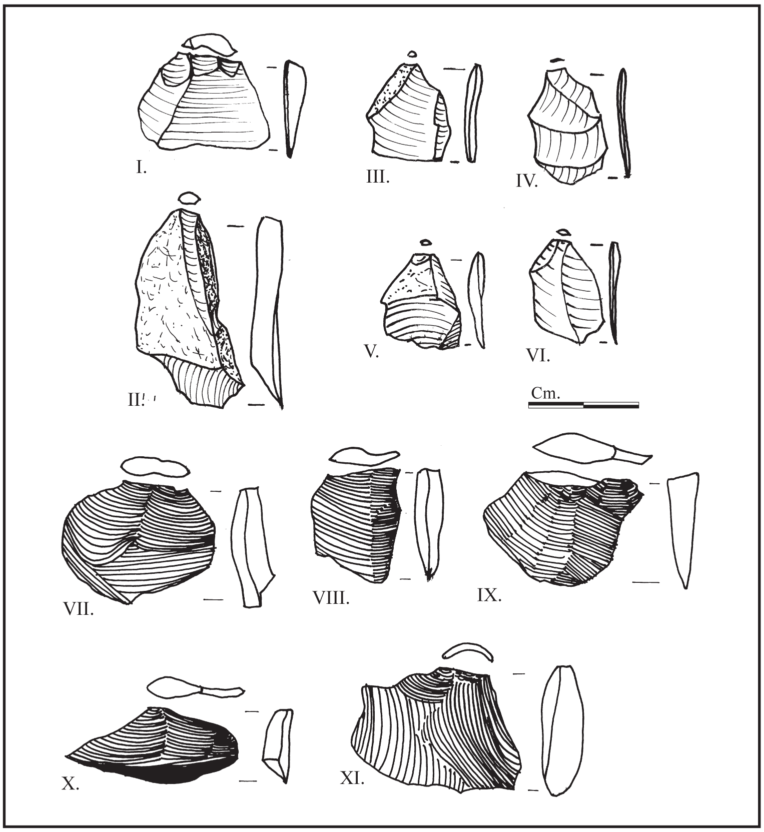
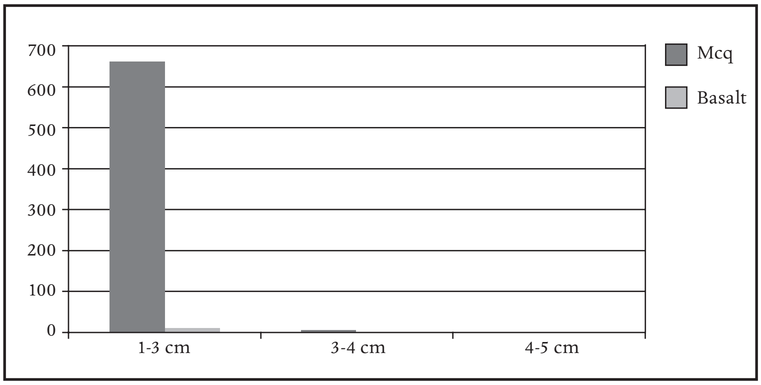


Fig. 4.4.20
Flake types typical of the Independence II lithic technology. I, II) blade core preform flakes, III–VI) bifacial flakes, VII–XI) adze production flakes (dolerite).



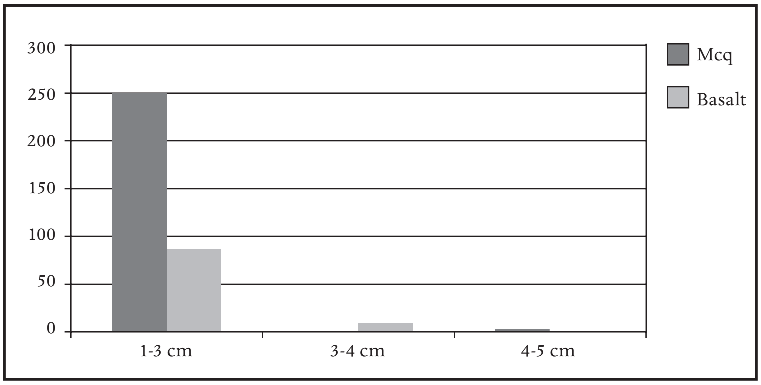


Fig. 4.4.21 Comparison of flake sizes from Vandfaldsnæs (above) and Kap Holbæk (below) assemblages.

formation. These are most possibly produced by means of direct hard percussion. The large flakes are characterized by the appearance of cortex at their dorsal faces, which suggests that they have been produced from large cores.

Small flakes made from mcq (1–3 cm) (figure 4.4.20: III–VI)
The majority of this flake material is small and thin flakes. Generally these flakes have lenticular butts, a minimal bulb and a minimal lip formation. The dorsal butt edges are often lightly prepared by small hinging flakes. Flakes in this size group are generally produced in a bifacial process by either direct soft percussion or pressure technique.

Flakes made from dolerite (figure 4.4.20: VII–XI)
The dolerite flakes are generally thick, short, and wide and are often hinged. They have diffuse bulbs. Butts vary in size and morphology, but they are generally unprepared. Among the flakes typical wing-shaped flakes are seen, diagnostic of unifacial production from thin tabular blanks. Two flakes made from dolerite at Kap Holbæk have ground dorsal faces, and must have been produced during reju-

venation of adze edges. Attributes in this material suggest that it has been produced by means of direct hard percussion.

It can be concluded from the flake material at Kap Holbæk that it reflects a production from local mcq, brought as small tabular blanks to the site. From these blanks all lithic tool types except adzes have been produced. Nearly no flakes made from dolerite are found. The preforms for adzes in the assemblage must therefore be regarded as imported.

The flake material from Vandfaldsnæs, consisting mainly of small flakes of mcq, suggests that many small bifacial tools have been finished and rejuvenated at the site. No flake types indicate primary core reduction at the site. Thus, large flake blanks, preforms or finished tools were brought to the site. A relatively large proportion of dolerite flakes found at the site are typical of the adze production, and it thus seems possible that adze preforms were produced here and exported from the site.

Tools used for lithic reduction

From Vandfaldsnæs several organic artefacts can be related to the lithic production (figure 4.4.22): 1) A pressure point (I) of wide and broad type, this piece is 30 mm long, 9 mm wide, 6 mm thick and has a carefully rounded distal end, and 2) a pressure point (II) with a square cross-section. This piece is 40 mm long and 9 mm

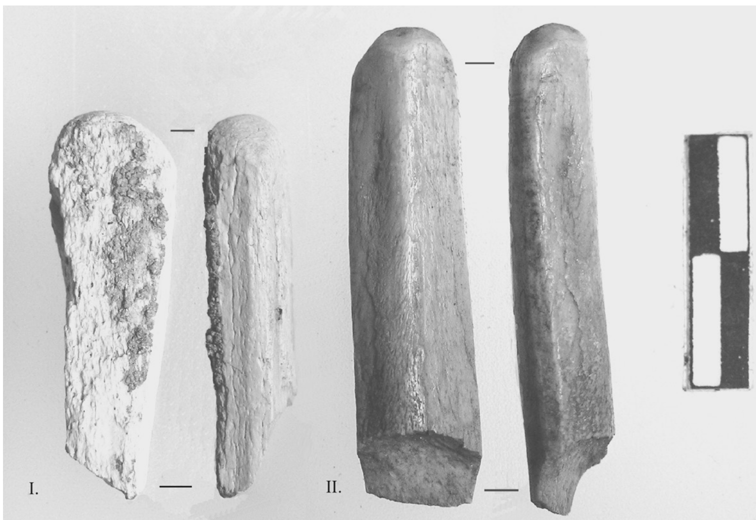


Fig. 4.4.22 Pressure tool points from the Vandfaldsnæs assemblage.

thick. It has a carefully rounded distal end and a broken proximal end. The material is described as walrus rip (Knuth 1968). The two pressure points have probably been used for the reduction of bifacial tools, preforms and for the blade production.

No hammer stones or billets from organic materials have yet been recognized in Independence II contexts.

Discussion

The High Arctic area west of Nordostrundingen is, judged from the amount of described sites from Independence II (14 sites), structures (73 ruins) and lithic material (1759 artefacts), interpreted as being inhabited by only one or few groups of Independence II people, as they migrated eastwards from Ellesmere Island (Grønnow & Jensen 2003: 239). The limited artefact material is the main reason for problems concerning the technological investigation and analysis of Independence II. Some problems are quantitatively related, e.g. when trying to compare frequencies of tool types between sites and assemblages. While others are qualitatively related, e.g. when different supposedly typical production stages cannot be described due to lack of artefacts. In order to solve the latter problem, artefacts from Independence II assemblages south of Nordostrundingen, from the assemblages of Mågefjeldet (KNK 2077) and Eigil Knuth site (KNK 2076), both on Holm Land, have been included in the investigation.

When comparing the two investigated assemblages it is seen that they both have approximately the same types and frequencies of tool types (figure 4.4.23).

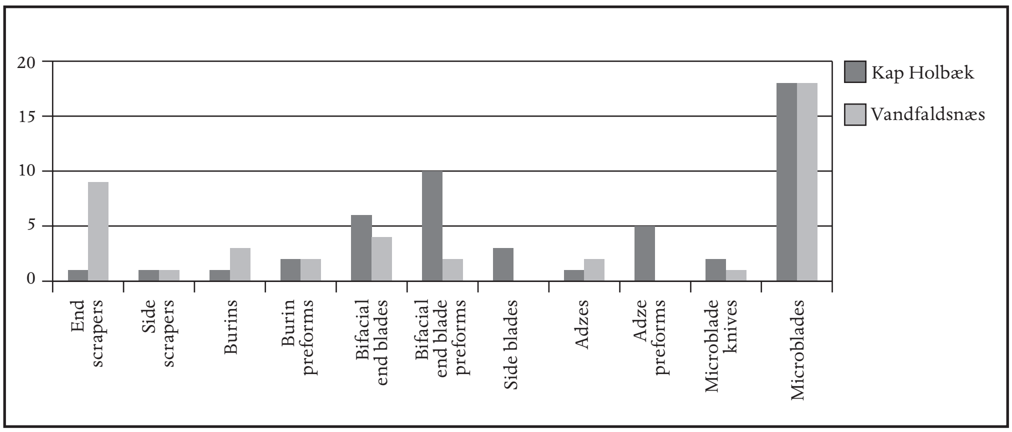


Fig. 4.4.23 Quantitative comparison of lithic tool types between the Vandfaldsnæs and Kap Holbæk assemblages.

However, also some differences can be noted: more bifacial preforms have been produced at Kap Holbæk and more end scrapers were in use at Vandfaldsnæs. The local mcq materials' properties and abundance in the Kap Holbæk area probably explains why a surplus of bifacial preforms was made here, while at Vandfaldsnæs the amount of end scrapers could be related to successful hunting followed by scraping of skins. But as earlier mentioned the small ratios of tool types in the assemblages makes comparison of frequencies problematic.

When the lithic *chaînes opératoires* are compared between Independence II and Dorset I, a great similarity is noticed. However, some tool types are known from Dorset I, which are not yet seen in the Independence II context, e.g. ground end blades and strike-a-lights. The inventory from Independence II compares to what is found at the less intensively used Dorset I sites, where inventory is sparse in both number and type. Thus, one explanation for the difference in artefact types could be that long-term used winter sites are lacking in Independence II from north Greenland. This problem will be dealt with in chapter 5.

Conclusion: The Independence II lithic concept

Choice of raw material

The raw materials chosen for the lithic production are primarily variants of mcq from the High Arctic region. Adzes, though, are produced from tougher materials such as basalts, e.g. dolerite. High quality mcq is accessible several places in the High Arctic in relation to basalts and, specifically, in the Ellesmerian Folding. South of Nordostrundingen to Dove Bugt and Germania Land, various materials such as quartz, quartzite, fine-grained basalts and mcq are used. Basalts, used for burins, and possibly also mcq, must have been imported from the basaltic regions south of Shannon. From Germania Land down to Scoresbysund quartz and quartzites are seldom used. Instead we see a preference for mcq (for the bifacial and the blade production) or high quality and fine-grained basalts (for adzes and burins), found in these regions.

Choice of reduction method

During Independence II small tabular cores and large flakes are used as blanks for the bifacial production. Scrapers and side blades are generally produced from large flakes. However, at the Independence II sites no systematic serial production of large flakes has been recognized. Instead these must have been produced as single pieces from cores near outcrops and imported to the sites. The formal lithic tool inventory in Independence II consists of: adzes, bifacial knives, harpoon points, burins with ground edges, side blades, end scrapers, side scrapers and microblade knives. As in Dorset I, no lithic tools can be interpreted as arrowhead points. The lithic production is systematically conducted from standardized concepts, in which stepwise intentions carried out in the lithic material result in standardized tools and rejuvenation methods.

Adzes are made using a unifacial knapping method, shaping and thinning the preform from the two parallel lateral edges by means of direct hard percussion. End blades are produced bifacially, mainly by direct soft hammer and pressure technique, and shaped with two large notches at the bases. Burins are shaped asymmetrically with a triangular cross-section and one ground lateral cutting and shaving edge. Their bases are carefully shaped with notches. End scrapers are unifacially produced and shaped with flawing lateral edges. Side blades are produced bifacially from thin flakes and shaped into an oval morphology.

The generalized method of lithic reduction, production of tool types and their rejuvenation can be described as the Independence II concept of lithic production (figure 4.4.24).

Blade production

For the production of microblades in High Arctic Independence II, mcq is generally used. However, in the area between Nordostrundingen down to Germania Land, transparent quartz is primarily seen in use for this production. South of Germania Land variations of fine-grained, often heat treated mcq is used. Blade core preforms are made from natural tabular blanks, which are shaped into keeled core preforms. A typical blade core is initially about 4 cm high and 1.5 cm wide. The core platform is, during exploitation, often prepared from one lateral platform edge, resulting in a small faceted platform type. Facets are also produced from the front during exploitation in order to adjust the angle between front and platform and to produce individual platforms for the pressure tool point. The angle between front and platform is low, typically 50–70 degrees. Thus the front 'disappears' under the platform and no abrupt stop of the blades will appear. Using this core morphology the blades achieve a slight distal curvature.

The blade morphology is prismatic and very regular, characterized by oval and most often plain butts. Metrically the production is homogeneous, between 3–4 cm in length and 6–7 mm in width and 2 mm in thickness. From the blade production, complete blades are sorted out as preforms for blade knives. These are retouched minimally at the proximal lateral edges. This retouch is seen from both the ventral and dorsal face and it results in a tanged blade.

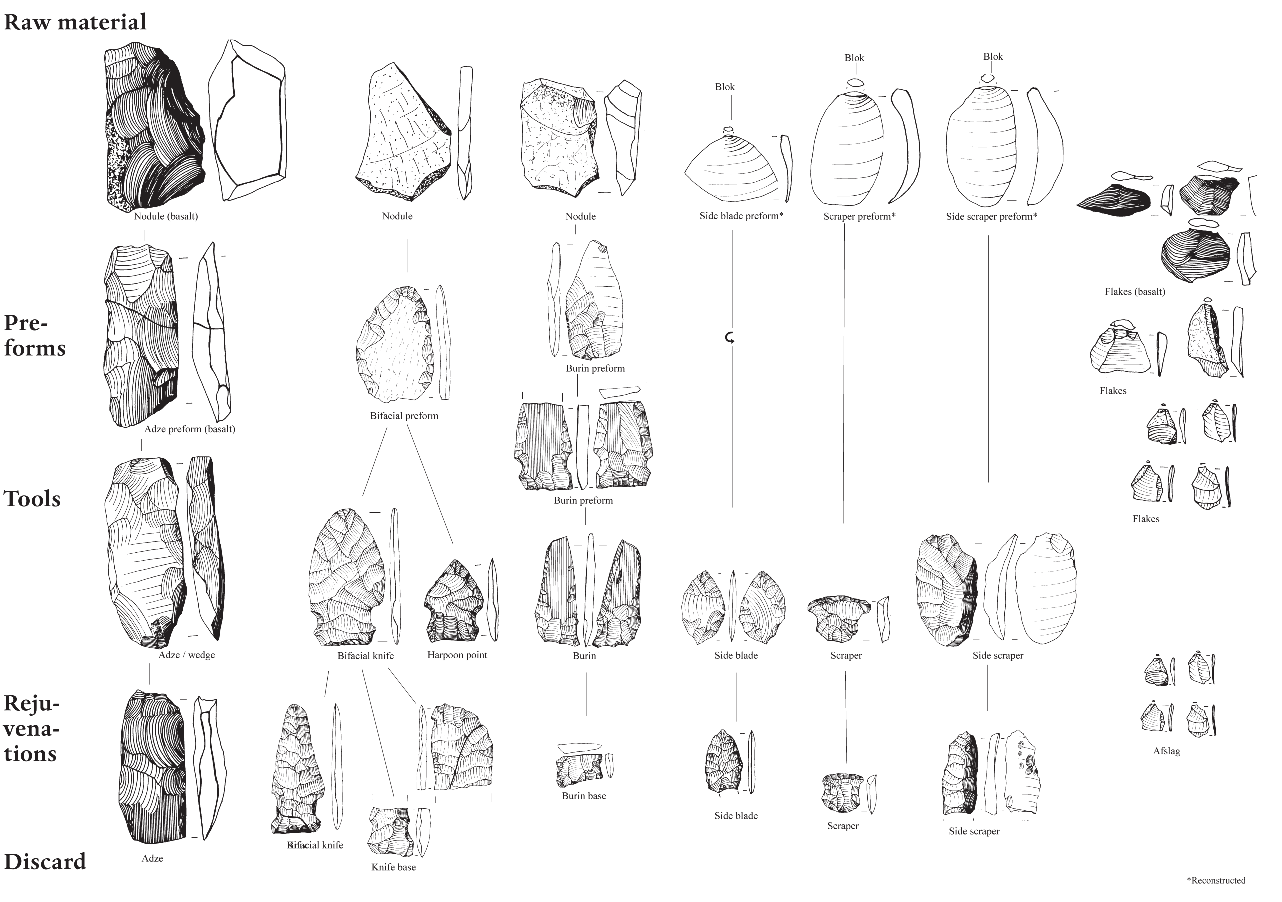


Fig. 4.4.24 The concept of lithic production in Independence II. Examples are from the Vandfaldsnæs and Kap Holbæk assemblages.

The generalized method of lithic blade, and blade tool, production can be described as the Independence II concept of lithic production (figure 4.4.25).

Choice of hafting method

Preserved harpoon heads made from bone material demonstrates that these often were self-tipped during Independence II, and only some had a lithic point (Knuth 1968). Harpoon heads made for lithic points have a groove made that will fit a small bifacial end blade with notches and this same type of point fits into the clo-

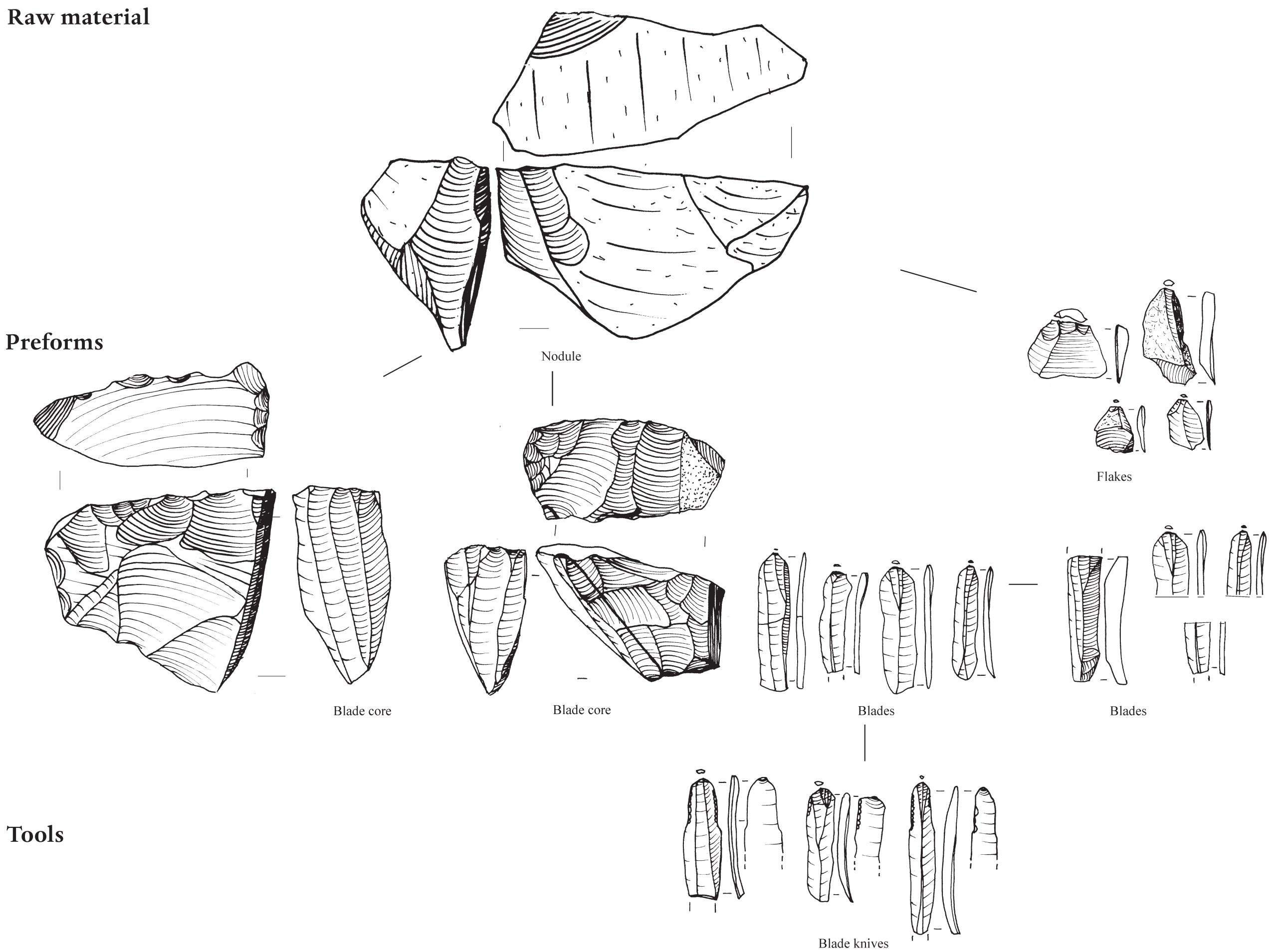


Fig. 4.4.25 The blade production concept in Independence II.

ven foot lance heads, found in the Independence II context. However, in the cloven foot lances there are also lateral grooves made for inserting lithic side blades (Knuth 1968).

Hafts for the remaining lithic inventory has not yet been excavated or recognized in Independence II. On the basis of prehistoric hafts from Dorset sites in Canada the same principal hafting methods as in Dorset I can be suggested for Independence II (figure 4.3.38).

Choice of reduction technique

The production of large flake blanks for scrapers and side blades and the reduction of adzes made from dolerite or basalt can be interpreted as having been conducted by means of direct hard technique. The first steps of reduction of bifacial end blades have most probably been conducted by means of direct soft technique, while the later steps, i.e. the production of the edges and notches, happened by means of pressure technique. The identification of organic pressure points from Independence II documents this technique. The regularity of the blade production and the small regular blade cores indicates that pressure technique has been employed for blade production. The blade cores must, due to their size, have been fixed mechanically during the production. Grinding is employed while producing the adze cutting edge and for the distal ends of the burins. No hammer stones or billets have yet been identified from Independence II contexts.

4.5. Lithic technology in Late Dorset

Sites and assemblages chosen for analysis

There are several reasons why the investigation of Late Dorset technology partly differs from the previous investigations. Late Dorset was discovered late in prehistoric Arctic research (Holtved 1944), and was first systematically excavated and studied with 'The gateway to Greenland project' (Appelt et al. 1998(a), 1998(b), 1998(c); Appelt & Gulløv 1999). Further, Late Dorset in Greenland is only found in the Thule region (Appelt 2004). This is why only few excavations of Late Dorset contexts in Greenland have been conducted and a limited amount of artefacts can be studied. Thus, in some cases the lithic *chaînes opératoires* from Late Dorset have been difficult to analyze and document. This problem is partly solved by studies of published material from the Canadian Arctic (Schledermann 1990, 1996; Mary-Rousselière 2002; Maxwell 1985). However, technological studies of published materials are never optimal, since dimensions, material properties, use wear, etc., are hard to study from two-dimensional reproductions. Late Dorset materiality is in many ways different from previous Palaeo-Eskimo cultures. The Late Dorset habitation structures are larger and more solidly build, thus the degree of sedentarism seems greater in Late Dorset. Moreover, large megalithic structures and considerable amounts of 'mobile art' are known from the Late Dorset context in contrast to the previous cultures.

To investigate Late Dorset lithic technology, two assemblages from excavated semi-subterranean habitation structures on Late Dorset sites have been studied. The first is Qeqertaaraq (House 1) (Appelt et al. 1998(a), 1998(b), 1998(c); Appelt & Gulløv 1999). The second is Polaris Site (Grønnow 1999). Both assemblages are studied at SILA-The Greenland Research Centre at The National Museum in Denmark.

Qeqertaaraq

The site Qeqertaaraq (QR), means 'island-like' in Greenlandic and refers to the peninsula on which the site was found in Hatherton Bay, northwest Thule (figure 4.5.1). The site is situated on raised beach terraces and contains 315 structures from different contexts including the Thule culture.

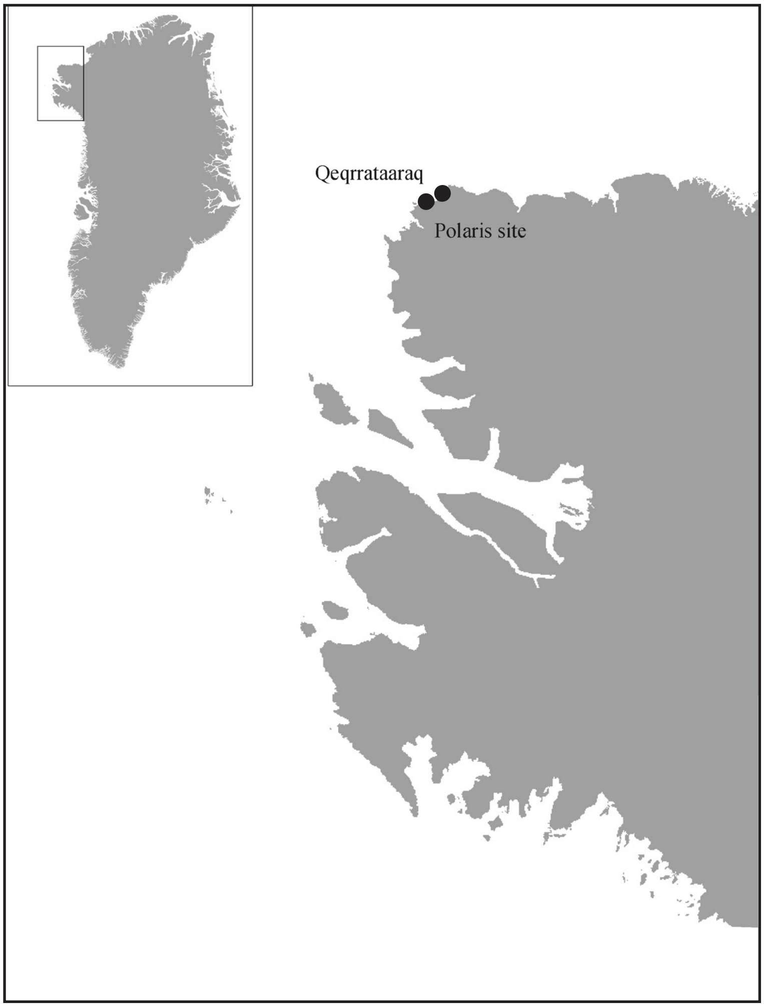


Fig. 4.5.1
The geographical location of the studied Late Dorset sites.

Excavation

The site QR was investigated in 1996 as a part of 'The gateway to Greenland project'. Six semi-subterranean houses from Late Dorset were located (figure 4.5.2), and two of these, House 1 and House 4, were excavated. The studied assemblage is from House 1, since this lithic material was most numerous. House 1 was found approximately in the middle of the Late Dorset settlement, 5.5 m above sea level. In relation to House 1, a midden was found, which was also excavated. The house had a complicated stratigraphy including 11 cultural layers, interpreted as three settlement phases (figures 4.5.3 and 4.5.4). The midden was interpreted as mainly deriving from the first and second settlement phases. In all 22.25 m^2 were excavated

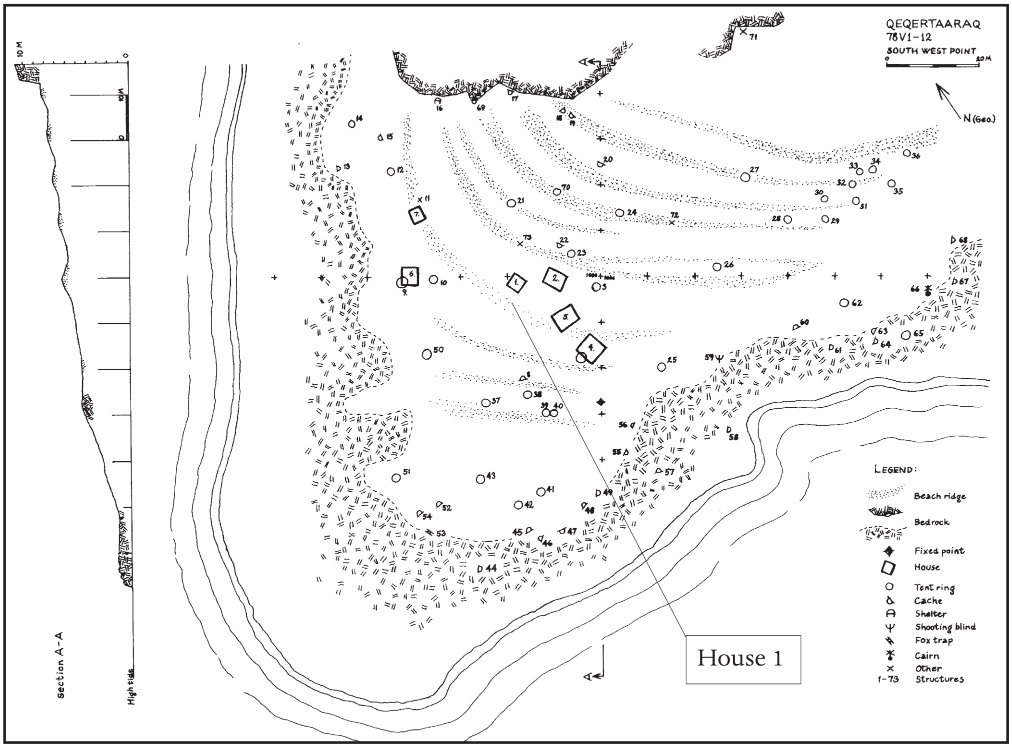


Fig. 4.5.2 Plan of the Qeqertaaraq site. House 1 is located at the centre of the site (after Appelt et al. 1998(b)).

in ¼ m^2 and in respect of the individual cultural layers. 6858 lithic artefacts were unearthed, of which 208 were classified as tools. Moreover, six pieces of meteoritic iron were found (Buchwald 1998). In the lower cultural layers there was good preservation of organic artefacts due to permafrost, and artefacts made from wood, bone, tooth, etc. were excavated (Bendix 1998). Artefacts were numbered by individual numbers and recorded in relation to layers and the excavated ¼ m. The first settlement phase had a house construction dug to a depth of approximately 40 cm and measuring 3 × 3.6 m in width/length (figure 4.5.4). During the second settlement phase, the house was extended to a rectangular form measuring 4 × 6 m. Reasoned by observations of the stratigraphy the second settlement phase was interpreted as immediately following the first; however, there appeared a period with no occupation before the third habitation phase. The different settlement phases resulted in clearings where inventory from previous settlements have been re-deposited along the wall and on the midden. When the spatial distribution of the lithic inventory is studied it can be seen that the excavation did not cover the

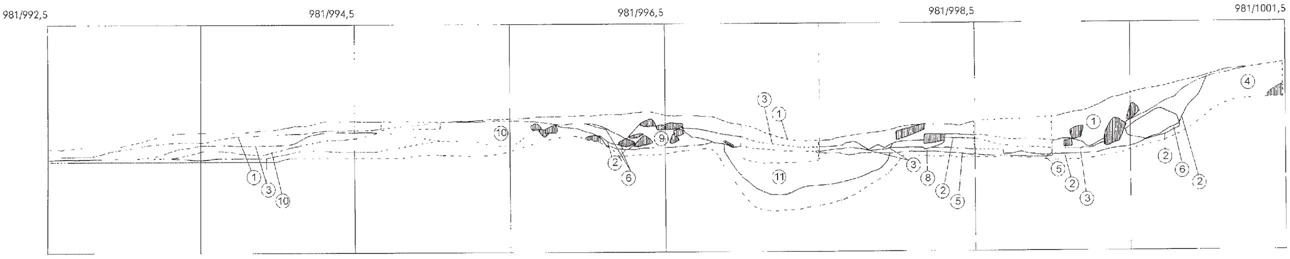


Fig. 4.5.3 The excavated north–south profile in House 1 (after Appelt et al. 1999).

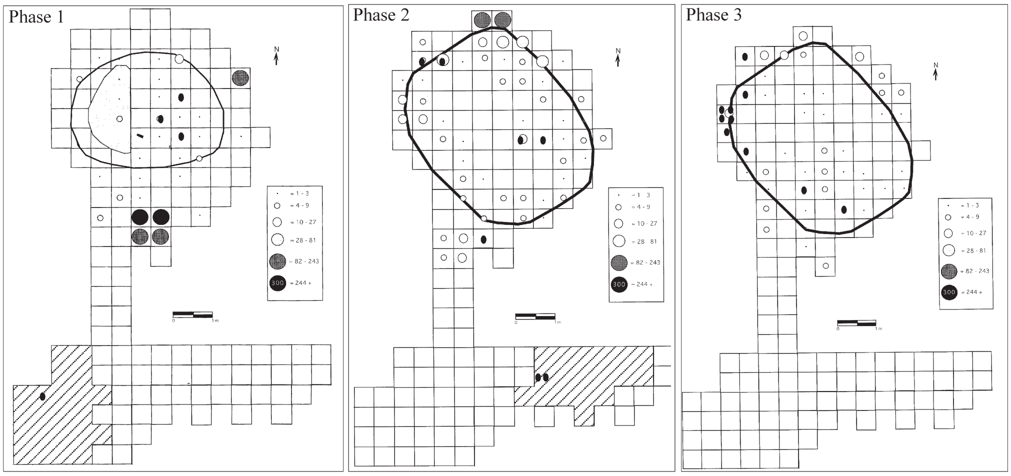


Fig. 4.5.4 Excavation plan of House 1. Distribution of flakes and cores are seen in three habitation phases. The excavation is made in ¼ m².

entire cultural layer. Along the house walls, especially against the north, concentrations of artefacts are seen near the limitation of the excavation (figure 4.5.4). The spatial distribution, in the midden and along the walls, of the lithic material suggests clearings but knapping of lithic materials could also have been conducted outside the house, near the walls. However, when analysis of the lithic material was carried out it became clear that very few refits could be made and that the material in general seemed disturbed in prehistory.

Radiocarbon dating

From House 1, three radiocarbon dates were made of musk ox bone from the first settlement phase (layer 3) (table 4.5.1). From these it can be stated that the house was in use from the end of the 11th century or beginning of the 12th century. Phase 2, which probably follows directly, is thus from the 12th century, while the

Lab. No.	Material	^{14}C. BP	Calibrated AD*1	Remarks	Reference
K-6702	Musk ox bone (Ovibos moschatus)	950 ±45	1140–1165	Layer 3	(Appelt & & Gulløv 1999)
K-6703	Musk ox bone (Ovibos moschatus)	985 ±45	1015–1155	Layer 3	(Appelt & & Gulløv 1999)
K-6704	Musk ox bone (Ovibos moschatus)	920 ±45	1030–1190	Layer 3	(Appelt & & Gulløv 1999)

Table 4.5.1 Radiocarbon dates, Qeqertaraaq 'House 1'

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998).
Calibration by 1 standard deviation (68.2 %).

third phase occurs during the late or the terminal Late Dorset (14th or 15th centuries).

Inventory

House 1 was thoroughly excavated and a comprehensive lithic material was unearthed. The material, though, differs from earlier investigated assemblages by having an extremely low tool ratio compared to flakes. In all 6639 flakes were classified and only 135 lithic artefacts could be classified as tools and preforms (table 4.5.2 and figure 4.5.5).

End scraper	4
Side scraper	1
Burin	2
Bifacial preform	26
Bifacial end blade with notches	9
Bifacial corner notched end blade	2

Harpoon points	13
Unifacial knives	10
Microblades	63
Microblade knives	4
Flakes	6639

Table 4.5.2 Inventory list, Qeqertaraaq, House I

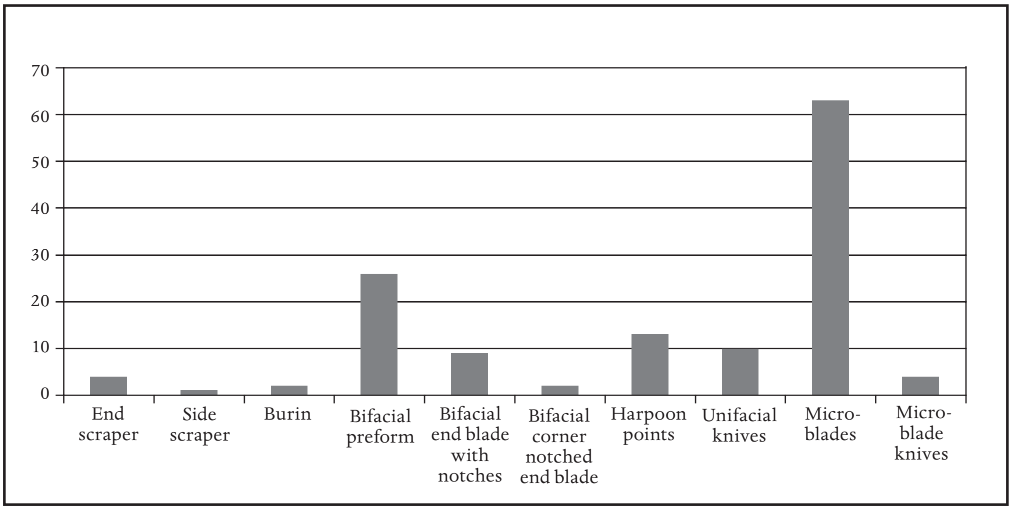


Fig. 4.5.5 A quantitative comparison of the lithic tool types in the Qeqertaaraq assemblage.

Polaris site/Qallunatalik

Geography

Polaris site is located at the peninsula Qallunatalik, in southern Hatherton bay, northwest Thule (figure 4.5.1). The site contains four or five semi-subterranean habitation structures from Late Dorset. These are found at beach terraces 5–8 m above sea level.

Excavation

In 1993, B. Madsen and D. Qaaviaq from Thule Museum surveyed Qallunatalik, and the house ruins were discovered. As a part of 'The gateway to Greenland project' one house structure (structure 1) was excavated in order to analyze a spatial organization of a Late Dorset house (Grønnow 1999). The excavation unearthed a rectangular semi-subterranean house structure with a midpassage (figure 4.5.6). Internally, the structure measured 3.6 × 5.1 m. In total, nine layers inside the ruin were described, and three of these were defined as cultural layers. The structure is interpreted as having been in use during only one settlement phase. The spatial analysis of the lithic inventory demonstrates that this material primarily is found in the wall areas where the excavation ends (figure 4.5.7). Structure 1 was excavated in ¼ m² in relation to the recorded layers. All artefacts were measured in three dimensions, individually numbered and described in relation to layer and ¼ m² excavated. Sieving was not carried out.

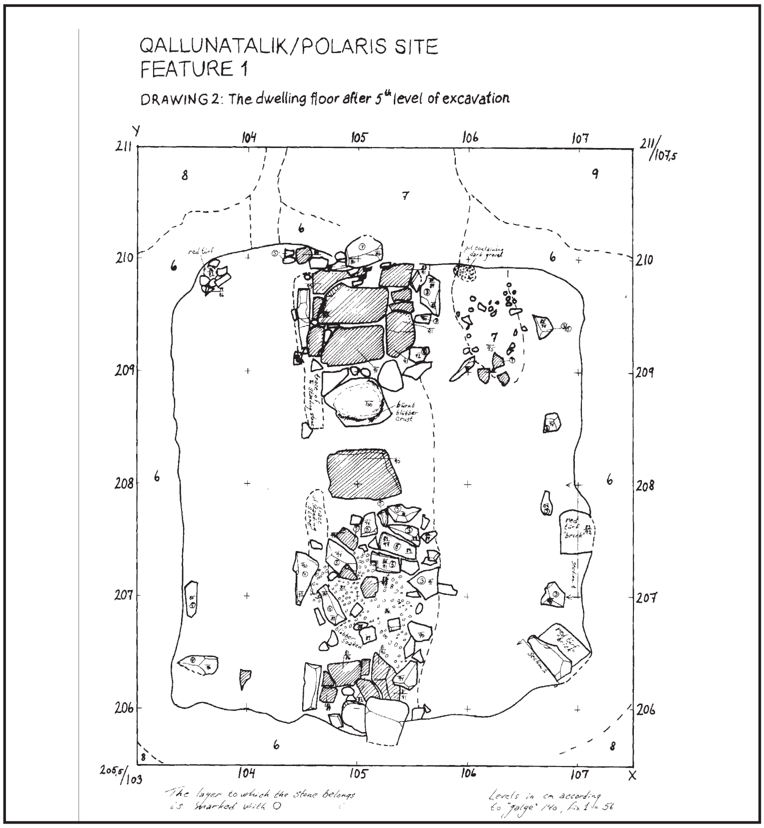


Fig. 4.5.6 Structure 1 at Polaris site after excavation of layer 5 (after Grønnow 1999).

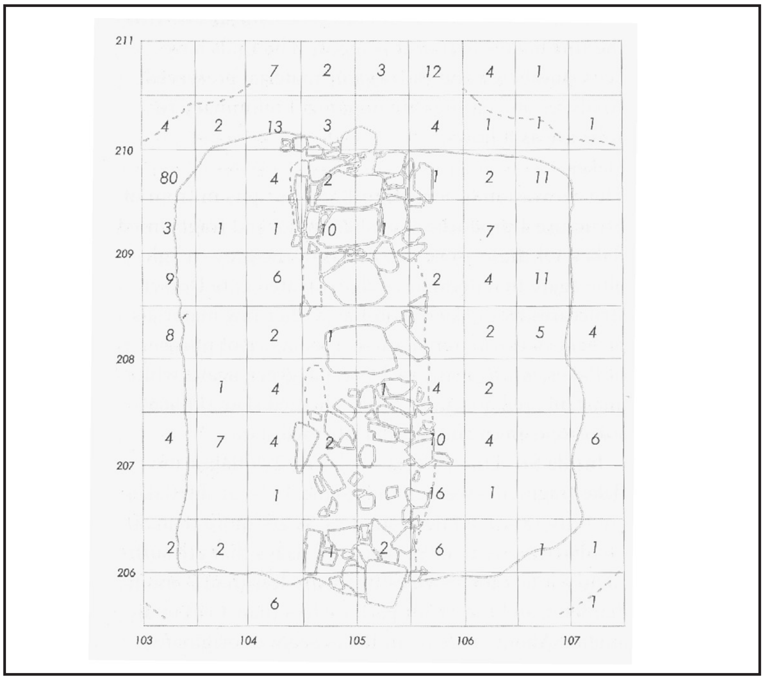


Fig. 4.5.7 Distribution of flakes in ¼ m², in structure 1, Polaris site (after Grønnow 1999).

Radiocarbon dating

One dating was made on twigs of local willow from a presumed sleeping platform inside structure 1. The dating demonstrates that the structure was in use some time during the 11th and 12th centuries (table 4.5.3).

Lab. No.	Material	Calibrated AD*1	Context	Reference
K-6969	Arctic willow (Salix arctica)	1045–1215	Layer 3	(Appelt & & Gulløv 1999)

Table 4.5.3 Radiocarbon dates, Polaris site structure 1

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

Inventory

From the Polaris site structure, 332 lithic artefacts were classified. In total, 33 of these were defined as tools or preforms (table 4.5.4 and figure 4.5.8).

End scrapers	4	Unifacial knives	2
Bifacial preforms	9	Microblades	11
Harpoon points	7	Flakes	299

Table 4.5.4 Inventory list, Polaris site, structure 1

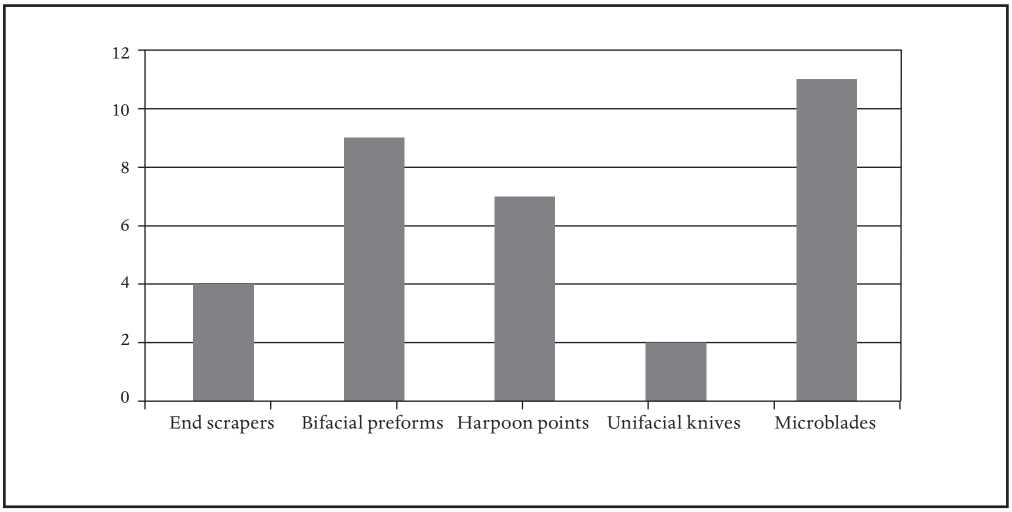


Fig. 4.5.8 A quantitative comparison of lithic tool types, House 1, Qerqetaaraq.

The *chaînes opératoires*

The raw material

The blue to grey fine-grained translucent mcq, of the same quality that is recorded from Washington Land, is the most numerously used lithic material in both studied assemblages (figure 4.5.9 and 4.5.10). Generally this material is of one colour, but some pieces can have different nuances, while another type has white spots. Cortex of this material can be from either several millimetres thick chalk-rich sand or be thin and white. Often it is seen that the surface is shiny, which can be caused by deposition in midden layers with organic materials such as grease and meat. However, the shiny surfaces could also be caused due to heat treatment in order to improve the mcq quality before reduction, namely before pressure technique was applied (see discussion in chapter 5).

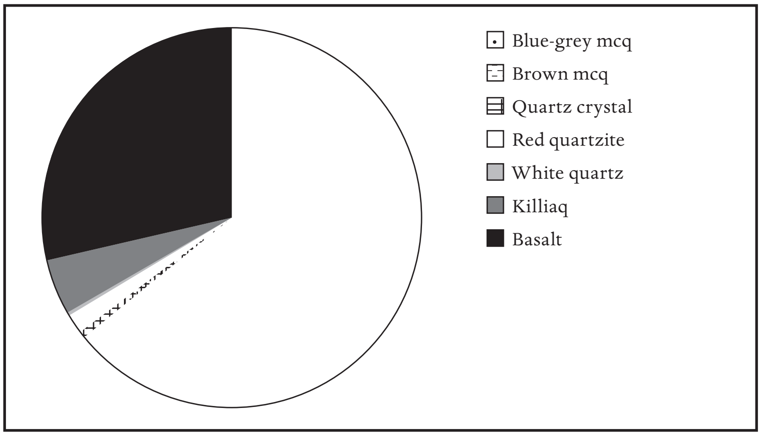


Fig. 4.5.9
A quantitative comparison of the lithic raw material types in the Qeqertaaraq assemblage.

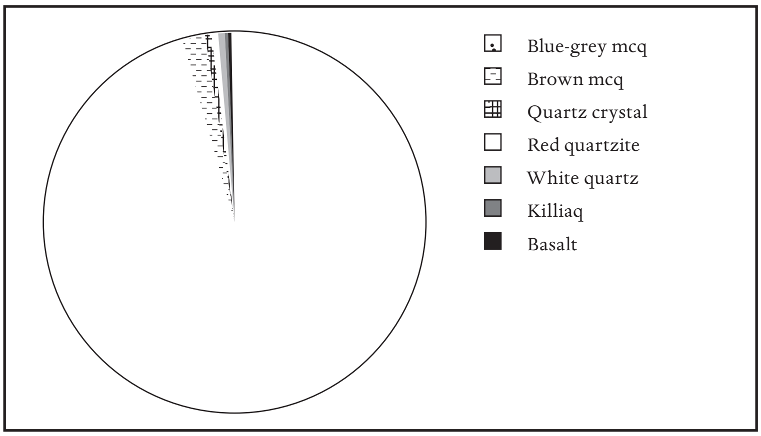


Fig. 4.5.10
A quantitative comparison of the lithic raw material types in the Polaris site assemblage.

Another raw material is a light brown, homogeneous coloured mcq material, probably a variation of the material from Washington Land. A fragment of a ground burin from QR is made from a white marble-like material. This material has yet no known provenance in Greenland, but could be imported from a long distance, in its burin form. Also a red-brown opaque mcq found at QR is from an unknown source. Quartz crystals have been used for tool productions in both assemblages. This material can be found locally many places in the Thule region. Quartzite plays a minor role on both sites. White to red colour variations is seen in this material. A killiaq-like material of red colour with white dots can be observed. The material varies from coarse to fine-grained. Killiaq materials are described from the Thule region, thus this material is probably found regionally or locally. From QR House 1, large amounts of basalt have been found. This material is of various qualities, in a black to dark grey colour. It is judged from its size and wasteful reduction to be of local origin.

End scrapers

Generally end scrapers are characterized by flawing lateral edges and square bases. However, some scrapers have straight lateral base edges (figure 4.5.11: 1), while another type has an hourglass-shaped base (figure 4.5.11: 2).

Step 0

The raw material selected for end scrapers is, in all cases, of a high quality mcq, most often the blue type from Washington Land. This material seemingly has the best quality and duration for edges that are used for scraping, compared to e.g. killiaq and basalts.

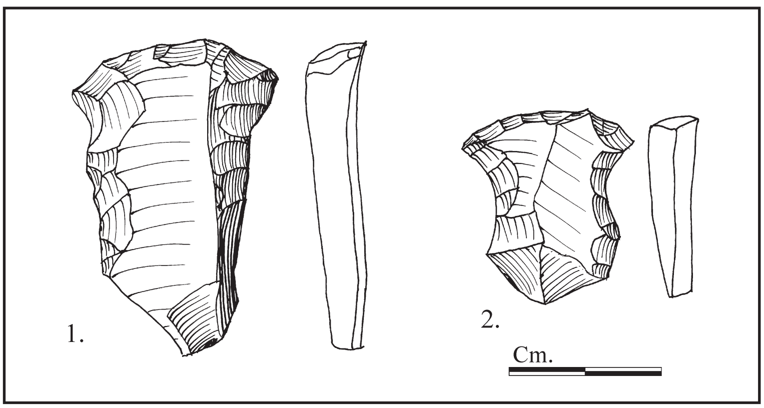


Fig. 4.5.11 Two types of end scrapers: with parallel lateral edges (1), and with concave lateral edges (2).

Step 1
No end scraper preforms have been recognized in the assemblages. However, from finished end scrapers it can be seen that they are all produced from thin flat flakes with a slight curvature (figure 4.5.12: A, B). No primary production of large flakes is seen in the assemblages. Thus large flakes or finished end scrapers were probably imported to the sites investigated.

Step 2
The end scrapers are produced by pressure retouch from the ventral side of the flake, onto the dorsal edges. The scraping edge is produced in the distal end of the flake as a unifacial regular convex edge. Its angle is about 60 degrees. The lateral edges are shaped with flawing edges so that the scraping edge becomes wider than the base. In some cases the bases are shaped on both ventral and dorsal sides (figure 4.5.12: B, C). Generally, the bulb of percussion is preserved on the scraper, probably because its mass and morphology facilitates the hafting.

Step 3
End scraper edges are rounded and polished from use, which can be seen macroscopically. This use wear suggests that the edges have been used on soft organic materials in long delicate working processes. The precisely shaped bases imply that the end scrapers generally were hafted. The morphology of the end scrapers

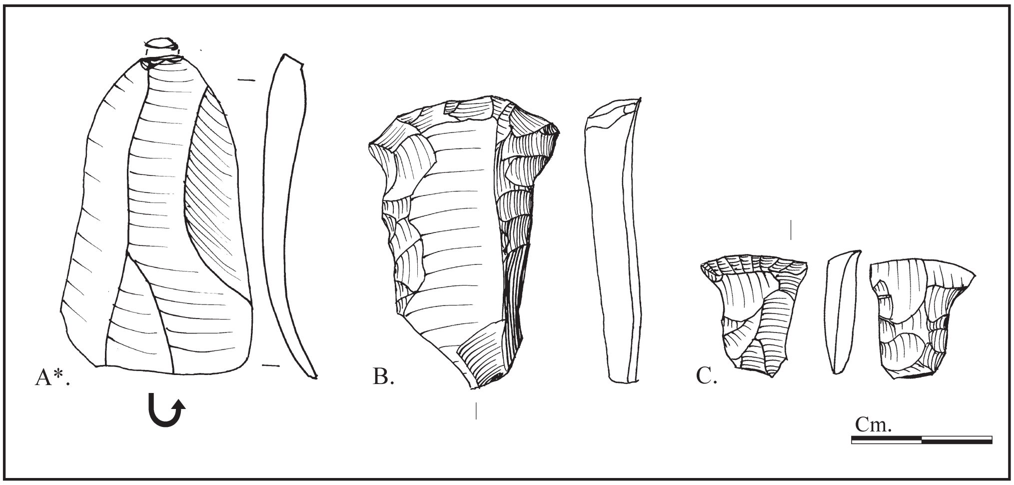


Fig. 4.5.12 The *chaîne opératoire* for end scrapers in Late Dorset. Examples are from the Qeqertaaraq assemblage.

further implies that some kind of end hafting was in use, as is known from earlier Palaeo-Eskimo periods (Grønnow 1994).

Steps 4–5

The rejuvenation of the scraping edge is performed similarly to when it was originally produced, by means of pressure retouch. Generally, it is seen that the end scrapers are rejuvenated until their length is about 15 mm. After this the scraper is discarded. No fragmentation of end scarpers are seen, which indicates that they generally were not used forcefully.

Discussion

The end scrapers with hourglass shaped bases are also seen at the site Saatut in Canada (Mary-Rousselière 2002), from Longhouse Interior Component and Franklin Pierce site (Schledermann 1990). Thus, this type could be a chronologically specific and functionally specific variation in the Late Dorset period.

Side scrapers

From the investigated assemblages only one side scraper is recognized. Compared to side scrapers from Late Dorset assemblages in Canada this specimen is typical of Late Dorset (Mary-Rousselière 2002; Schledermann 1990).

Step 0

The raw material used for side scrapers is made from light brown translucent mcq.

Step 1

The side scraper is made from a thin straight flake (figure 4.5.13: A).

Step 2

The base of the scraper is made in the proximal end, and at the distal flake end, the scraping edge is produced. The edge is produced unifacially in a diagonal direction to the distal end. The edge is made by means of pressure retouch from the ventral side onto the dorsal side of the flake blank. The edge angle is steep, between 60–70 degrees. The lateral edge, opposite the scraping edge, is made straight by retouch and two lateral notches shape the base (figure 4.5.13: B).

Step 3

Due to the notches and the well-formed base it is most possible that side scrapers were end hafted in a wooden shaft. The side scraper can have been hafted in a

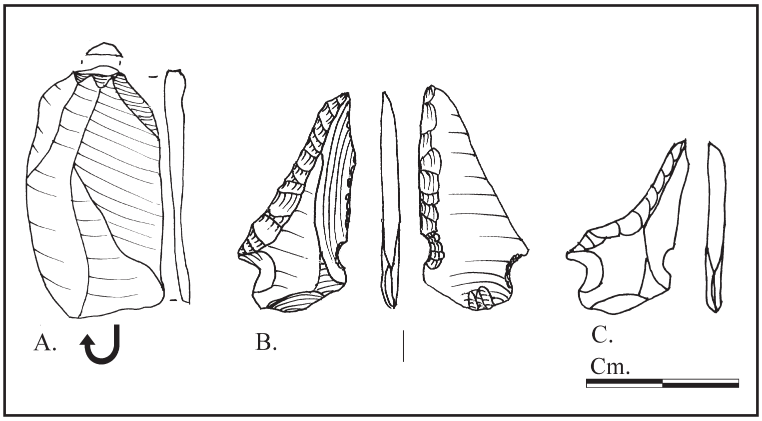


Fig. 4.5.13
The *chaîne opératoire* for side scrapers in the Late Dorset. Examples are from the Qeqertaaraq assemblage.

slot and tied between the notches. The asymmetrical working edge suggests that side scrapers were made deliberately for right- and left-handed persons. If the side scrapers were used with the flat side down in a movement against the body, as was earlier suggested for burins with ground edges, the presented specimen is made for a right-handed person (figure 4.5.13: B).

Steps 4–5
The scraping edge is worn and rounded by scraping and cutting and must regularly be rejuvenated in order to be functional. Side scrapers are rejuvenated by retouch of the edge. The original edge was produced in the same way. Thus the distal end gradually becomes more narrow, concave and asymmetrical from reduction (figure 4.5.13: C). Rejuvenated side scrapers are known from Late Dorset contexts in Canada (Mary-Rousselière 2002). Generally, side scrapers are discarded complete but strongly rejuvenated.

Burins with ground edges

In the investigated assemblages only two fragments of burins with ground edges are located (figure 4.5.14: I, II). Compared to burins from Late Dorset contexts generally, e.g. from Nunguvik, Saatut (Mary-Rousselière 2002) and Oldsquaw Site (Schledermann 1990), these fragments are typical of the Late Dorset burin morphology. Distal ends are fully ground and the bases are characterized by a single large notch at the same lateral side as the working edge (figure 4.5.15).

Steps 0–1
The first steps of the production cannot be investigated from the fragments. How-

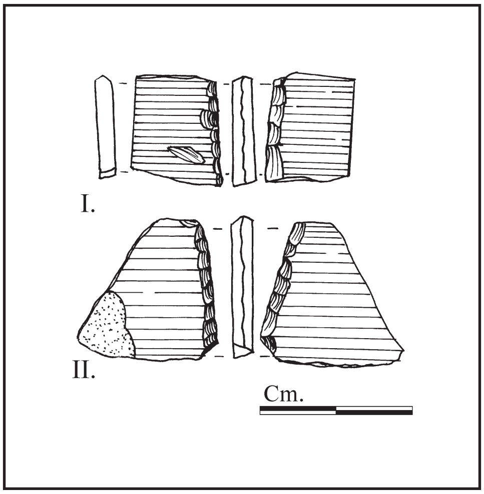


Fig. 4.5.14 Fragments of squared ground distal burins ends from Late Dorset. Examples are from the Qeqertaaraq assemblage.

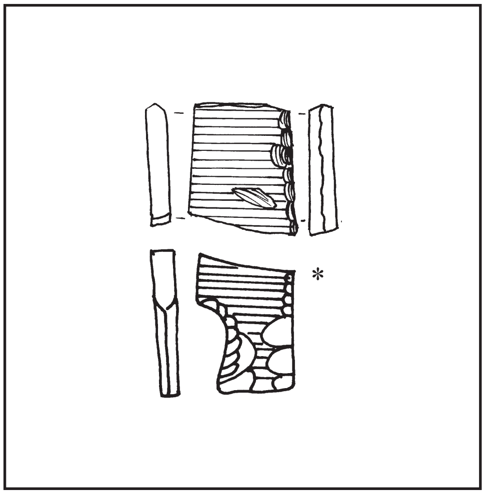


Fig. 4.5.15 Reconstruction of the Late Dorset burin morphology. The distal end is a fragment from Qeqertaaraq and the base of the burin is reconstructed from specimens found at Late Dorset sites at Ellesmere Island, Canada.

ever, the raw material is in both cases mcq, of which one is the blue type from Washington Land. The other burin is made from an unusual white mcq, whose provenience is not known.

Step 2

The burin blade is shaped into a square form with a rectangular cross-section and both faces are completely ground. Only the edge opposite the working edge has preserved negatives from retouch. The edge is rectangular and unifacial, hence the burins are made specifically for right- or left-handed persons and for a specific use. One burin blade is 11 mm wide, while the other is 18 mm. Thus, burin blades were at least up to 18 mm during their initial use phases.

Step 3

A burin from Late Dorset is found hafted from Nunguvik (Mary-Rousselière 2002). The specimen is end hafted in a wooden haft and further fixed in the haft by a wooden support along its one distal side. The burin is tied to the haft through the notch on the base and around the haft.

Steps 4–5

The burin edge and faces are ground when the burin becomes dull from use. In this way the burin blade gradually becomes thinner and narrower. The distal edge of the burin blade is also ground. At QR, a small square wheat stone, made from sandstone used on all four sides, has been recovered. It is possible that this kind of wheat stone has been used for the grinding of burins in Late Dorset. From the specimens analyzed it can be stated that burins often broke before they were discarded.

Discussion

When only few burins are found from Late Dorset contexts it probably has to do with the emergence of a different burin technology and the use of new types of raw materials during Late Dorset. In the Thule region, meteoritic iron starts to be used in Late Dorset, e.g. found at QR. On the organic artefact material from this period it is seen that the grooves and slots that were made often appear extremely thin and deep. Thus, they do not generally reflect burins made from lithic materials. Instead, knives and burins made for cutting organic materials possibly have been made from iron. Iron blades for knife blades in Late Dorset are known from the Thule region (Holtved 1944: plate 1).

Bifacial end blades

Bifacial end blades are, in Late Dorset contexts, characterized by being symmetrical with notches at the bases. Distal ends are generally oval, not pointed. Bifacial end blades are, due to their rejuvenation and hafting, interpreted as knives. A second type of bifacial end blade is the harpoon point, which has a different morphology. This type and the end blade with rounded base are dealt with separately.

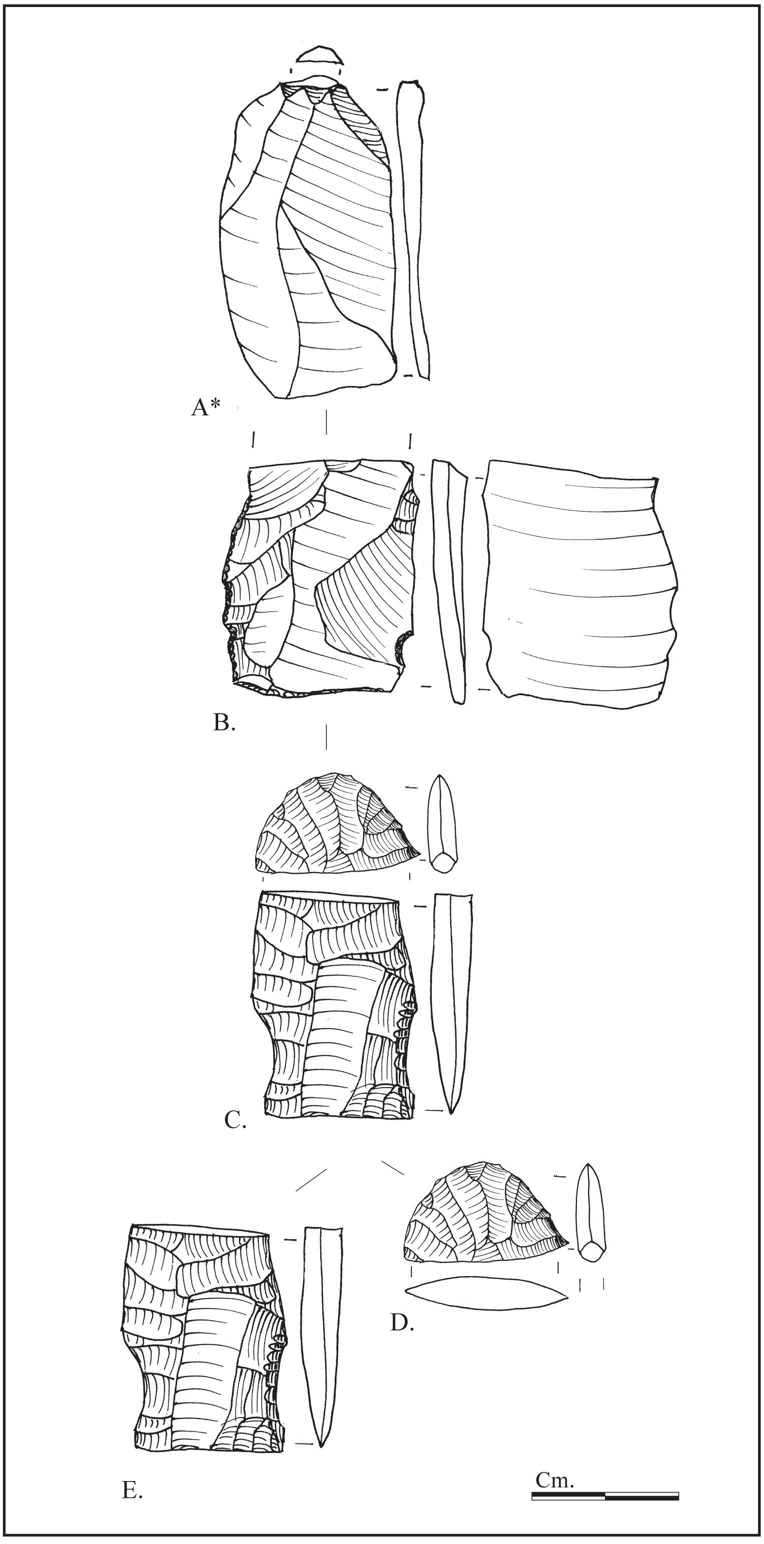
Step 0

Normally, the blue mcq from Washington Land is chosen for the end blade production in the assemblages. However, also basalts have been used and occasionally pieces of red killiaq and quartz crystal. Thus many materials are favoured for this tool type.

Step 1

Examples of preforms demonstrate that thin blanks were selected as preforms. Often large flakes, thinner than 1 cm, have been chosen (figure 4.5.16: A). Interestingly, no production of large flakes is seen in the two assemblages, which means

Fig. 4.5.16
The *chaîne opératoire* for bifacial end blades with basal notches in Late Dorset. Examples are from the Qeqertaaraq assemblage.



that preforms generally have been produced on other sites, probably near lithic sources and outcrops.

Step 2
Preforms are shaped into a thin end blade with an oval cross-section by means of direct soft technique and pressure technique (figure 4.5.16: C). The faces become covered with negatives from detachments. The final shaping is achieved by the production of two large basal notches and thinning of the base by fluting. When the frequency of bifacial preforms and finished discarded end blades are compared between the two assemblages it is seen that bifacial end blades were produced at both sites. This observation is confirmed when studying the flake material with its large proportion of bifacial flake types.

Step 3
Bifacial end blades have been end hafted as knives in wooden hafts, found at several Late Dorset sites in Canada (Mary-Rousselière 2002). From QR a wooden haft with a slot for an end blade was excavated also (Appelt et al. 1998(b)). The end blades must have been used in soft organic materials, due to their thin, sharp and fragile edges.

Steps 4–5
End blades are rejuvenated by pressure retouch of their lateral distal edges. Discarded end blades are generally seen broken just above the bases. No complete end blades are found in the assemblages.

Stemmed corner notched end blades

From Late Dorset contexts, symmetrical end blades with corner notched bases have been described (Schledermann 1990). However, in the assemblages investigated only one fragment of this tool type has been recovered (figure 4.5.17), while from the Thule region two more specimens are known (Holtved 1944: plate 1). When Canadian and Greenlandic specimens are analyzed, it is seen that distal ends are symmetrical, triangular, and often have slight convex edges. In some cases the edges have been rejuvenated, which has resulted in a knife interpretation (Maxwell 1985: 225). However, others interpret the tool type as armature points (Holtved 1944; Schledermann 1990). In principle, the tool type can have had both functions, as it is also suggested for the bifacial end blades in Dorset I/Independence II. Due to the limited examples of this tool type no principal *chaîne opératoire* can be presented here. However, the production and

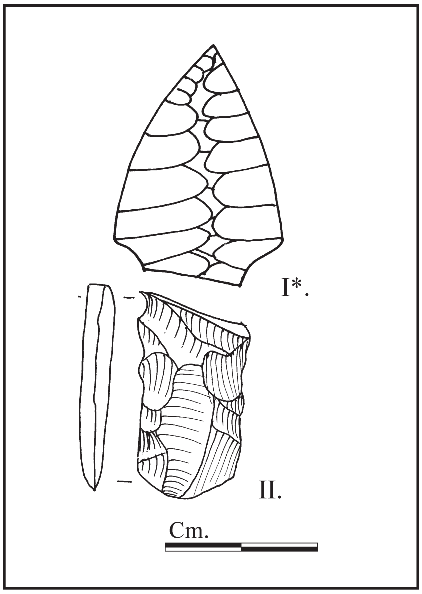


Fig. 4.5.17 Reconstruction of a bifacial stemmed end blade (convex base), made on the basis of fragments from Qeqertaaraq and distal ends from Late Dorset sites at Ellesmere Island, Canada.

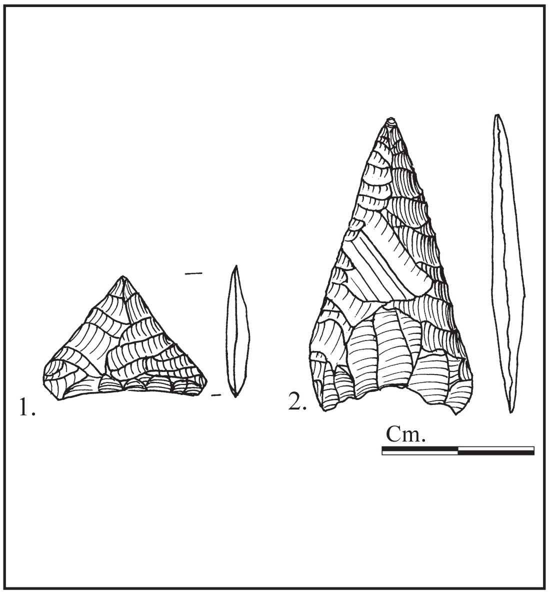


Fig. 4.5.18 Two types of harpoon points from Late Dorset. Examples are from the Qeqertaaraq and the Polaris site assemblages.

techniques applied seem to reflect the general production of end blades in a Late Dorset context.

Harpoon points

Harpoon points can be described as symmetrical, triangular end blades with concave bases. However, they vary considerably in length/width relations (figure 4.5.18): (1) and (2).

Step 0

The raw material chosen for this tool type is the blue mcq from Washington Land.

Step 1

Several discarded preforms for harpoon points still have large positive bulbs of percussion (figure 4.5.19: B1, B2), which demonstrates that the blanks originally were large triangular flakes (figure 4.5.19: A1, A2). The flakes are, interpreted from their diagnostics, made from cores with broad fronts and plain platforms, by means of a direct hard or medium hard technique. The angle between platform and front has been around 80 degrees. Cores of this type have not been recovered from the investigated sites, thus blanks for harpoon points must have been produced at other sites, probably on Washington Land where the raw material that was used is found.

Step 2

The flake is turned so that the bulb becomes one basal corner of the point and the distal flake corner becomes the tool point (figure 4.5.19: B1, B2). The lateral edges are worked bifacially by pressure retouch to produce straight even edges and a sharp point. The base is also pressure retouched, but differently in relation to the length of the point. Short points are given a solid thick basal edge while long specimens are thinned by fluting (figure 4.5.19: D1, D2, E1, E2). In all situations the basal edges are made concave.

Step 3

The harpoon points' concave bases relates to Late Dorset harpoon heads with a convex base support for points (type E, no. 19 & 20 and type G) (Meldgaard 1968). The type E harpoon heads, which fit these points, are solid and their line holes penetrate the middle of the harpoon heads. Type G harpoon heads are more delicate and the line is attached through two small holes. It therefore seems possible that the two types of harpoon heads and possible hafting for harpoon points reflect different hunting techniques and prey. The solid type E could be for large marine mammals such as walrus and whale, while type G could be for smaller game.

Steps 4–5

The harpoon points analyzed occasionally have impact fractures on their distal points and sometimes also at their bases (figure 4.5.19: E1, E2). These types of fractures are typical of forceful contact with an organic material in a movement directly to the point in its length direction (Fischer et al. 1984). Generally no rejuvenation of the points is seen.

Discussion

It is tempting to relate the long and the short type of harpoon points to the two different harpoon heads. From historical Thule Inuit contexts it has been reported by J. Rosing that short wide harpoon points were used for marine mammals that

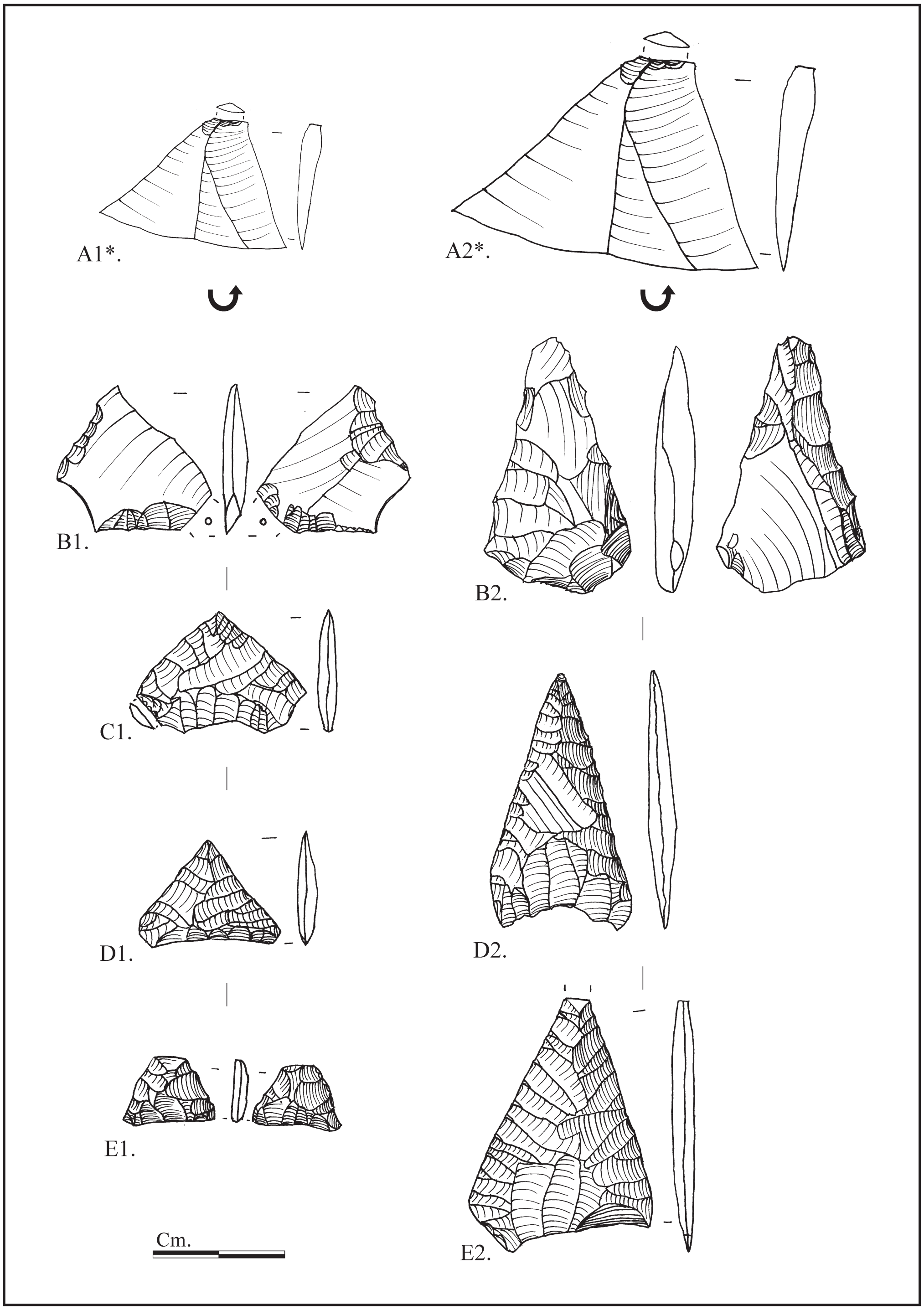


Fig. 4.5.19 The *chaîne opératoire* for the two types of harpoon points in Late Dorset. Examples are from the Qeqertaaraq and the Polaris site assemblages.

had a thick skin, while more pointed armature points were used for terrestrial mammals, such as caribou and musk ox with relatively thinner furs. Thus the short type of harpoon points could, in Late Dorset, have been used in the type E harpoon head for large marine mammals, while the long points were placed in type G harpoon heads for smaller and maybe terrestrial mammals.

Unifacial knives with notches

Unifacial knives are characterized by being worked only on the dorsal face. The knife type is produced from large flakes or blades, most often by unilateral retouch of the edge. At the base two lateral notches are produced. From QR and Polaris site, no complete unifacial knives have been recovered. However, complete specimens of the type are known from Canadian Late Dorset sites such as Nunguvik (Mary-Rousselière 2002: 131) and from Longhouse Interior Component (Schledermann 1990: 270).

Step 0

Most examples of unifacial knives from the assemblages are made from blue mcq from Washington Land. One specimen, though, is of a light brown mcq and is probably a variation of mcq from Washington Land.

Step 1

Generally, large regular prismatic blades have been chosen as blanks for preforms (A1). How this blade production has been conducted is dealt with below. In a few cases preforms are made from large oblong flakes (figure 4.5.20: A2).

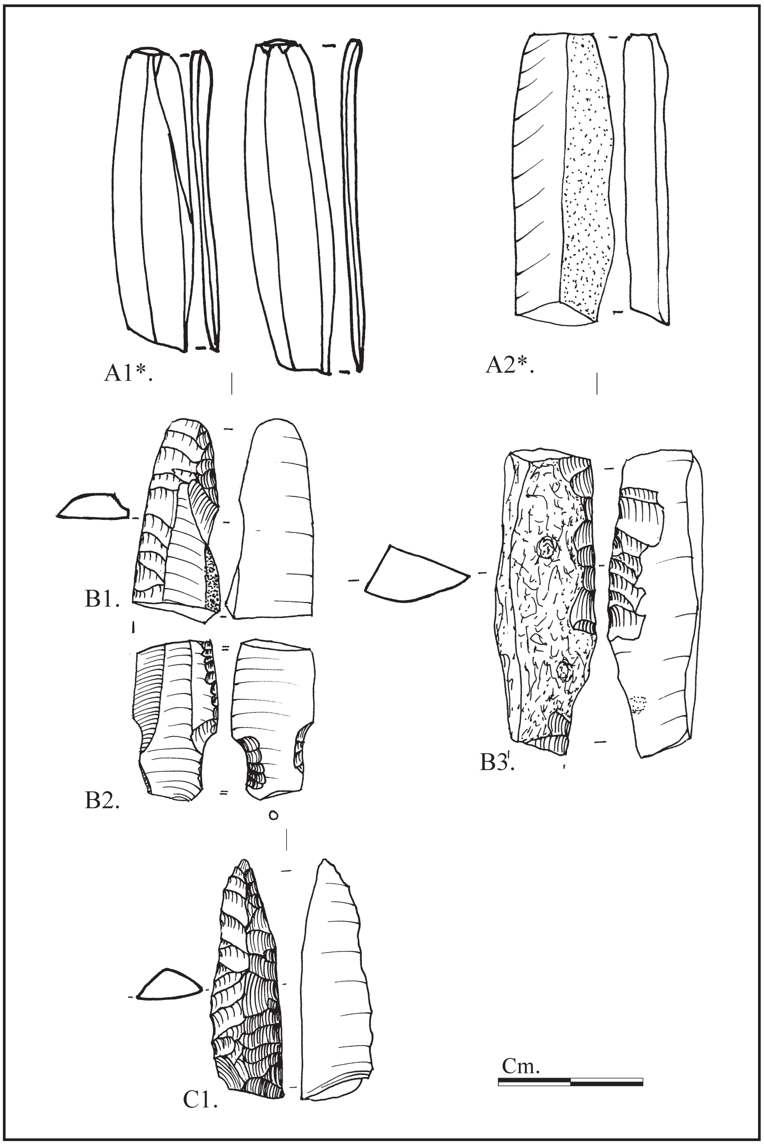
Step 2

The production of the knives is carried out by unifacial retouch of the dorsal side of the blade or flake (figure 4.5.20: B1, B2, B3). In this manner a straight even edge is produced. The ventral side of the preform is most often left un-worked. The edge angle becomes low, about 20–30 degrees. The base is produced in the proximal end of the blade/flake by two lateral notches.

Step 3

Hafting of unifacial knives are not known from the Arctic, but the morphology of the bases suggests that they were end hafted similarly to the bifacial knife types. The cutting edge is solid but its angle is still low, which suggests that it has been used for cutting organic materials.

Fig. 4.5.20
The *chaîne opératoire* for the unifacially worked blade knives in Late Dorset. Examples are from the Qeqertaaraq assemblage.



Step 4

The cutting edge is rejuvenated by unifacial pressure retouch and the distal end of the knife becomes smaller, narrower and more pointed (figure 4.5.20: C1).

Step 5

The knife blades are generally discarded due to fragmentation of the distal end (figure 4.5.20: B1, B2, C1). This fragmentation must have been caused by forceful use in organic materials.

Discussion

It seems a compromise that unifacial knives are made from both large blades and flakes. Such an inconsistency in the choice of blank type is otherwise generally not seen in the Palaeo-Eskimo traditions of Greenland.

Adzes

No adzes have yet been recovered from Late Dorset contexts in the Thule region. However, they have certainly existed since sockets to their hafting is known, e.g. from QR (figure 4.5.21). Similar sockets are known from other Late Dorset sites in Canada, e.g. from Saatut (Mary-Rousselière 2002), and Abverdjar (Maxwell 1985). Due to lack of material the *chaîne opératoire* for adzes in Late Dorset is not described.

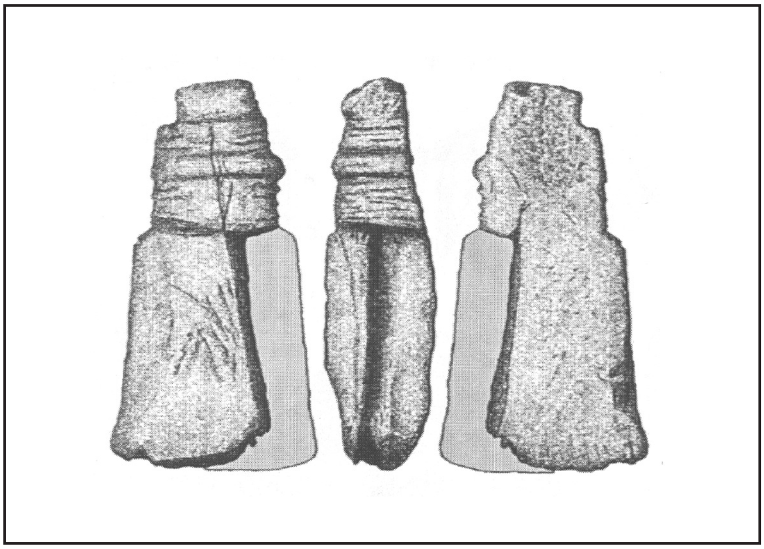


Fig. 4.5.21
An adze socket excavated from the Qeqertaaraq site demonstrates the appearance of adzes in Late Dorset. The socket is 4.9 cm long (after Appelt et al. 1998(b)).

Blades

The microblade production in Late Dorset has been analyzed by means of studying the assemblage from QR, House 1 and Polaris site. From these assemblages three different productions of microblades (figure 4.5.22) and one macroblade production can be described:

The 'A' production. A production of long, narrow prismatic microblades made from mcq. Generally this blade type is fragmented (28 specimens in all).

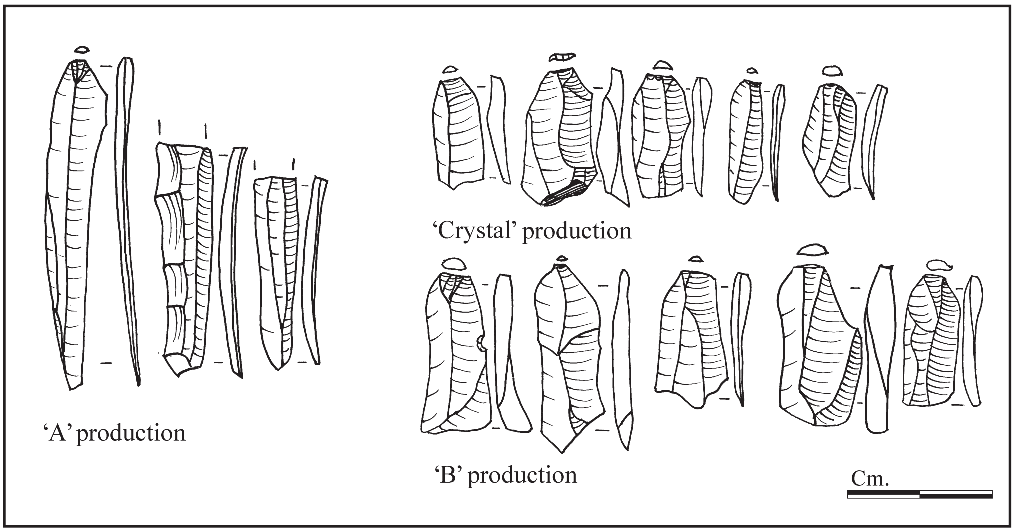


Fig. 4.5.22 Three types of microblade productions the Late Dorset: 'A' Production, 'B' production and the 'crystal' production.

The 'B' production. A production of short irregular blades. The blades are generally thick and complete in contrast to the 'A' production (18 specimens in all).

The 'crystal' production. This production is made from rock crystal and consists of small, short, irregular, complete blades (15 specimens in all).

The 'macro' production. From Polaris site a few large irregular blades are present with a width of up to 14 mm. Populations of macroblades are also known from Middle and Late Dorset in Canada (Owen 1988).

Metrical analysis (figure 4.5.23)
The 'A' production: The width of the blades is 3–11 mm, average from 6 to 7 mm. Only one blade is complete, measuring 46 mm in length. Thickness is 1–2 mm.

The 'B' production: The width of the blades is 6–11 mm, average from 7 to 8 mm. Blades are up to 26 mm in length, average is 20 mm. Thickness is 1–3 mm.

The 'crystal' production: The width of the blades is 3–9 mm, average from 4 to 7 mm. Blades are up to 17 mm in length, average is 15 mm. Thickness is 1–2 mm.

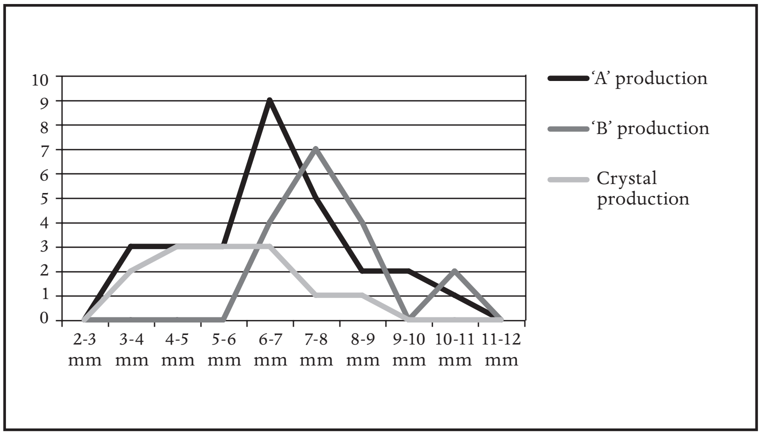


Fig. 4.5.23
A Comparison of microblade width in the three types of microblade productions.

Morphology
The 'A' production: The blades are prismatic. Proximal ends are characterized by small bulbs and small lip formations. Butts are small, narrow and oval. The blades are trimmed delicately, but no abrasion is seen. The distal ends are both pointed and angular.

The 'B' and the 'crystal' production: The blades are irregular. Proximal ends are characterized by small bulbs, and small lip formations. Only few bulbar scars are seen. Butts vary in size but are generally plain and oval. The blades are trimmed roughly. No abrasion is seen.

Fragmentation
The 'A' production is generally extremely fragmented, which can be due to both production accidents and a secondary modification (see discussion below). The 'B' and the 'crystal' production have generally many complete blades (about 80%). These blade productions have obviously not been modified or broken deliberately before used.

Diachronic differences in the blade production
To investigate if there is a diachronic difference in the blade technology in Late Dorset, the three productions from QR, House 1, were stratigraphically and spatially analyzed (figure 4.5.24). It was seen that the 'A' production generally was produced in the second settlement phase, that the 'B' production was produced in all phases and that the 'crystal' production was generally found at the left side of the midden, which should be related to the first settlement phase (Appelt & Gulløv 1999). It is not possible from the analyzed material to see a clear change of the

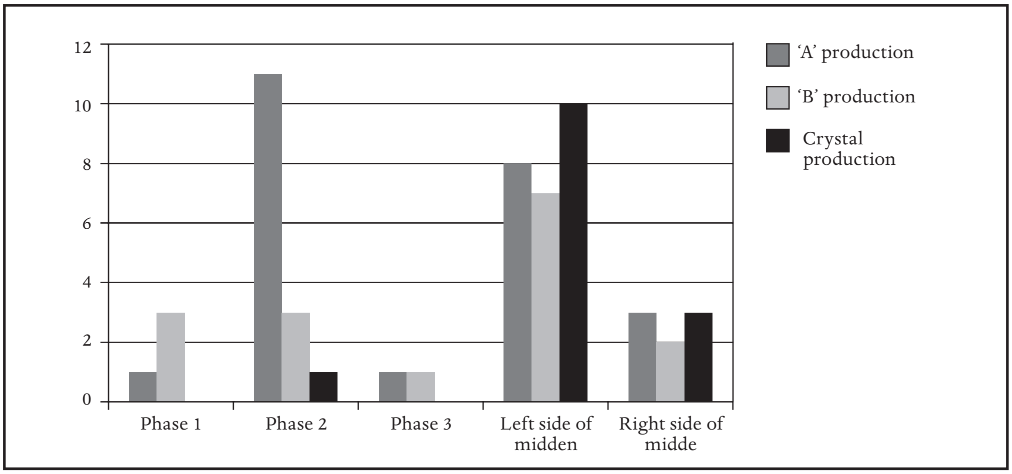


Fig. 4.5.24 A comparison of the blade productions in the three layers and at the midden of House 1, Qeqertaaraq.

blade technology in House 1. However, the 'A' production seems to have been made during the 11th–12th centuries.

Microblade cores

From QR only one blade core has been recovered. This core is made from quartz crystal. It has one platform and an angle between platform and front of 50 degrees. The width of the core front is 11 mm and the height is 18 mm. The core is used up and discarded, its platform is minimal and the last detached blades have hinged at the front. This core morphology is found in other Late Dorset contexts (Mary-Rousselière 2002), but it is also similar to what is known from Dorset I and Independence II contexts.

Microblade technology in Late Dorset

All blade productions seem to have been produced by the same overall method: serial production from single platformed, single fronted cores (figures 4.5.25 and 4.5.26). This production concept is typical of the Dorset tradition in general. The material difference, especially in the quality and size of the blade productions, can be explained by different factors: lack of high quality raw materials, decreasing demands for a high quality production and extreme (re)use of the blade cores. At Polaris site, as well as on other Late Dorset sites in Canada (Mary-Rousselière 2002), macroblades are seen (figure 4.5.25: B1). In the case of Polaris site the blades must have been imported. The macroblade production cannot be described technologically due to lack of material in the investigated assemblages. However, the

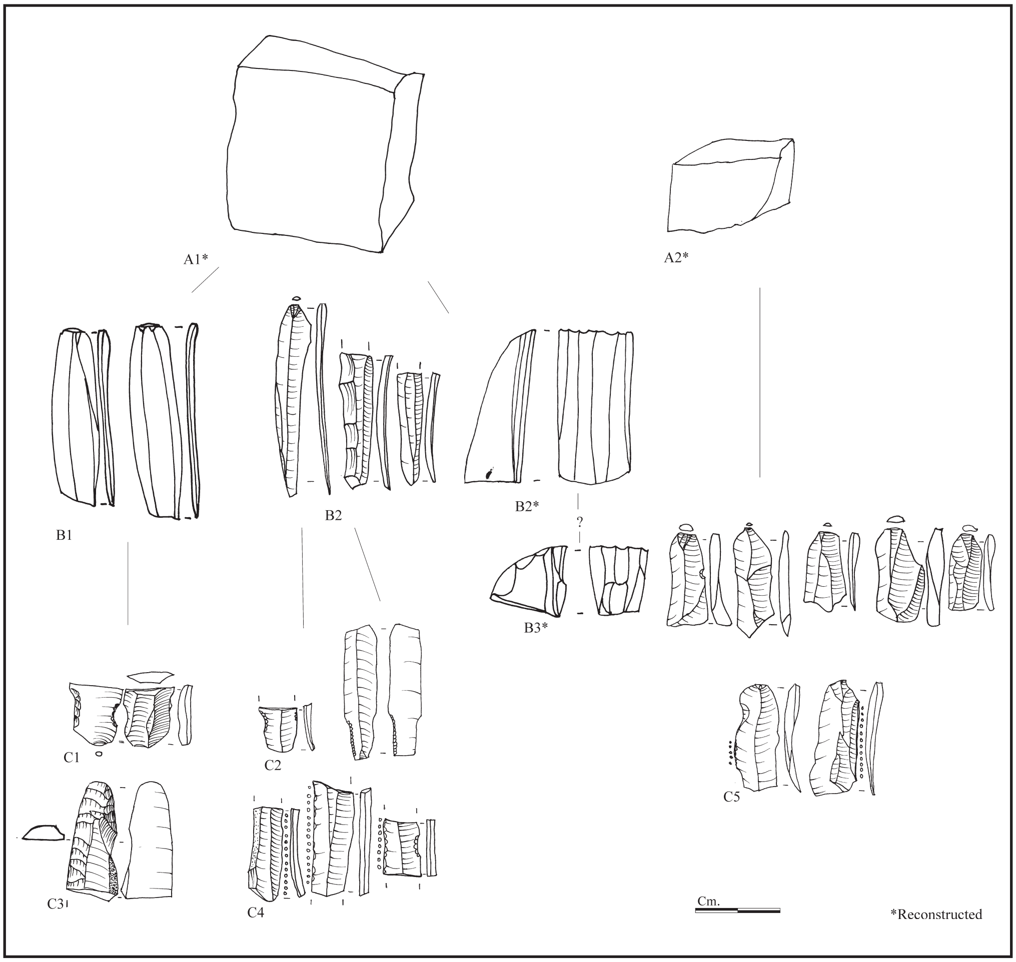


Fig. 4.5.25 The *chaîne opératoire* for the microblade production in Late Dorset.

thickness and the morphology of the blades suggest that they were produced using an indirect technique (punch).

Microblade knives

Microblades of all the described productions typically have use wear on their lateral edges, seen as irregular micro retouch on both the ventral and dorsal sides of the blades (figure 4.5.25: C4, C5). Blades of the 'A' production with use wear are most often medial fragments. However, some of these are modified with a unilateral or double lateral basal tang (C2). In some cases the tanged retouch is made from the ventral and dorsal side of the blade respectively (C2). Moreover, a few blades with

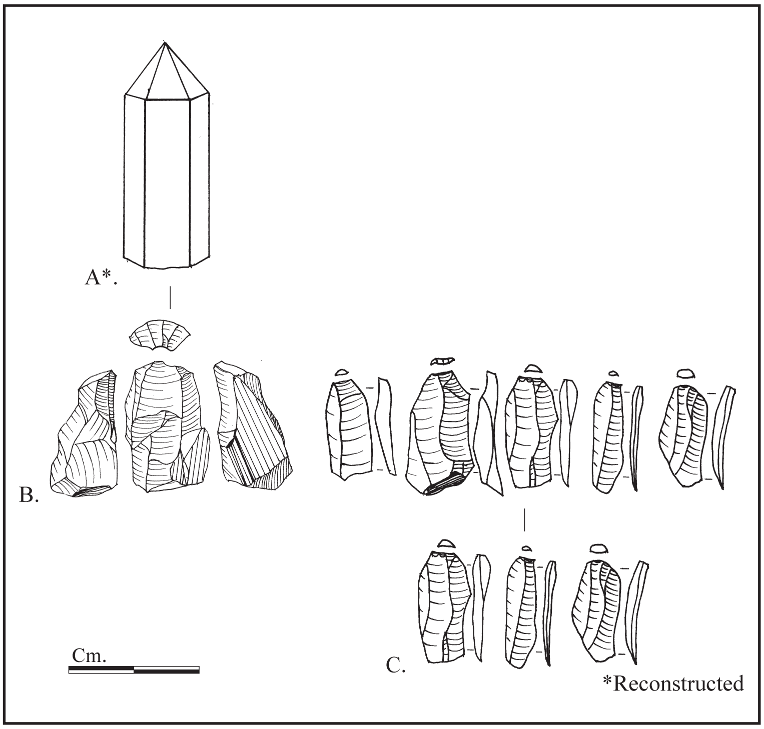


Fig. 4.5.26
The *chaine operatoire* for the rock crystal microblade production in Late Dorset.

unilateral concave retouch are seen (C2). In total, four types of modified microblades can be defined (figure 4.5.27: I–IV).

Hafting of microblades
Principles for hafting of microblades in a Late Dorset context is well known due to good preservation of Late Dorset material in both Greenland and Canada. Medial blade types have probably been hafted as inserts in handles as they are known from Saatut, Nunguvik and Abverdjar site (Owen 1988; Mary-Rousselière 2002; Maxwell 1985) (figure 4.5.27, type 5). The medial fragments can be fitted together, three specimens in a row, held in a groove with a glue. However, single blades can also be hafted using a small wooden holder tied to the haft, holding the microblade (figure 4.5.27, type 1). A holder for microblades was recovered from QR (Appelt et al. 1998(b)).

Blades with a single concave retouch can have been hafted in a groove and tied through the concavity (figure 4.5.27, type 2), while blades with a unilateral retouch can have been laterally end hafted (figure 4.5.27, type 3). Examples of this haft type are known from QR and from Nunguvik (Owen 1988: 237). Tanged blades (II) can be end hafted in a groove. The ventral side of the tange fits into the groove and

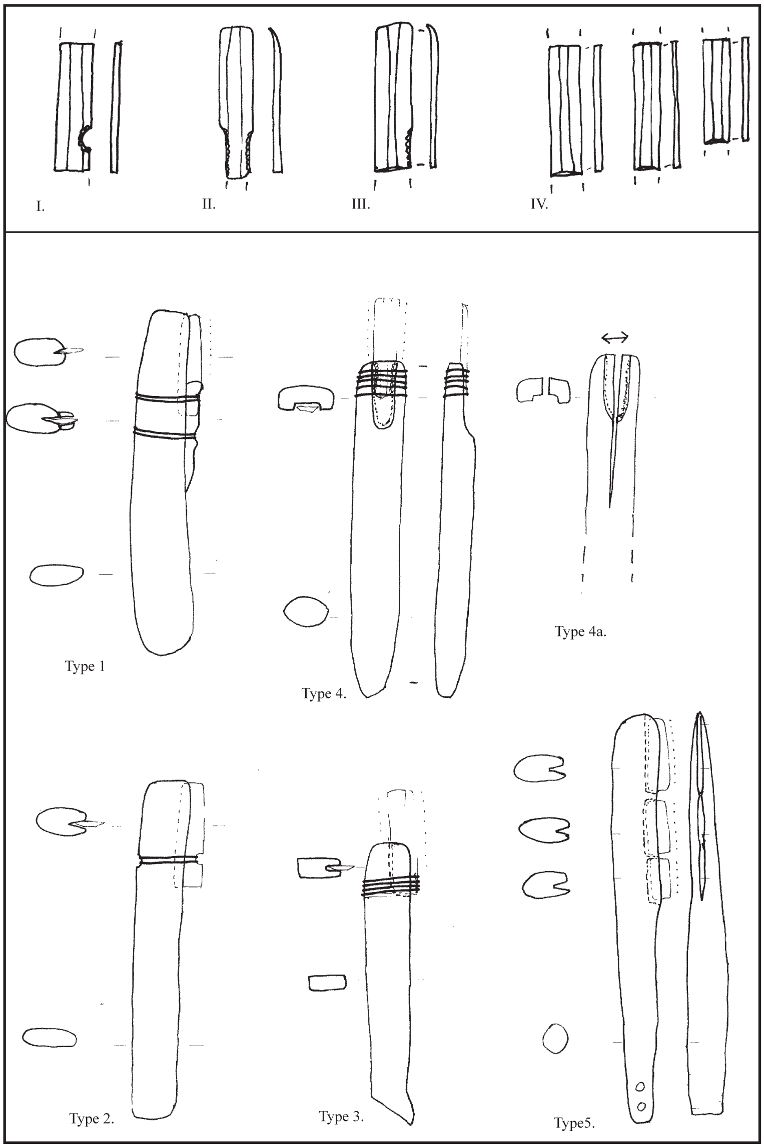


Fig. 4.5.27 Types of modified microblades, i.e. microblade knives (above), and the five different hafting principles found in Late Dorset assemblages.

the tang is tied to the haft (figure 4.5.27, type 4) (Owen 1988: 238). In a variation of this haft, a groove is cut through the distal end of the haft, so that this part will be pressed together around the microblade tange when tied (figure 4.5.27, type 4a) (Appelt et al. 1998(b)).

Discussion

Blades are manufactured in order to produce sharp cutting edges. By inserting blades into grooves in wooden hafts durable knives have been produced. However, inserts have to be straight and even to fit into the groove, which explains why a large percentage of the 'A' production has had their bulbs and their curved distal ends removed (60% of this production are medial fragments).

When the Late Dorset microblade production method is compared to other methods in Greenland's Palaeo-Eskimo tradition, it is seen that it is very similar to the Dorset I and Independence II production method. However, differences are also noticed: more production of small irregular blades are seen in Late Dorset and the diversity of hafting principles seemingly varies a lot in Late Dorset compared to earlier Dorset groups. The decrease in the quality of the blade production can technologically be explained by lack of good quality raw materials at the Late Dorset sites. However, the question as to *why* no quality raw materials for the blade production are procured is a cultural question. Larger sedentism and less mobility during the Late Dorset might to a degree explain this. However, above all the demand of quality in the blade production seems to decrease in the Late Dorset compared to earlier Palaeo-Eskimo periods. The most logical explanation for this decrease is the introduction of meteoritic iron in Late Dorset, which means that lithic technology loses function, status, meaning and therefore quality.

The flake material

The flake material from the midden at QR, House 1, is investigated. This flake material is generally smaller than 3 cm, except for the basalt production, which

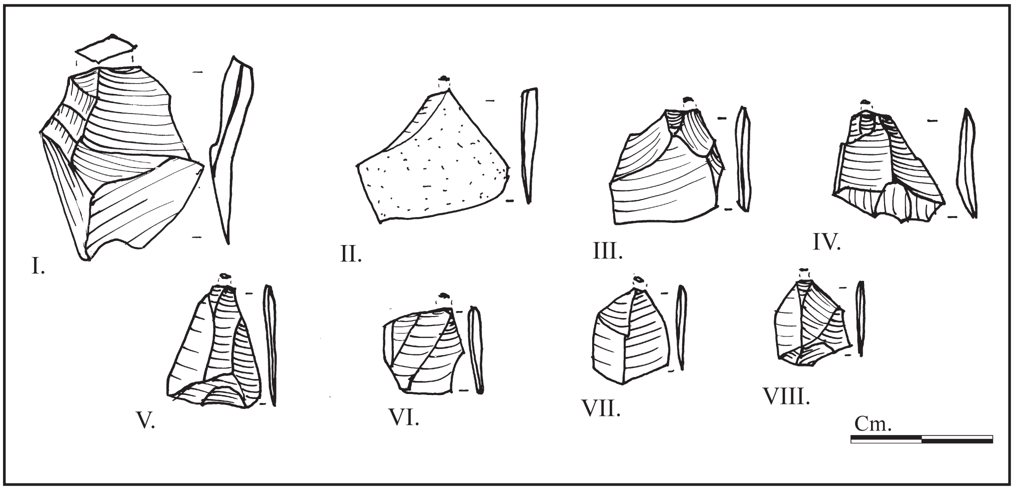


Fig. 4.5.28 Typical flake products of the Late Dorset lithic technology: I) blade core preform flake, II–VIII) bifacial flakes.

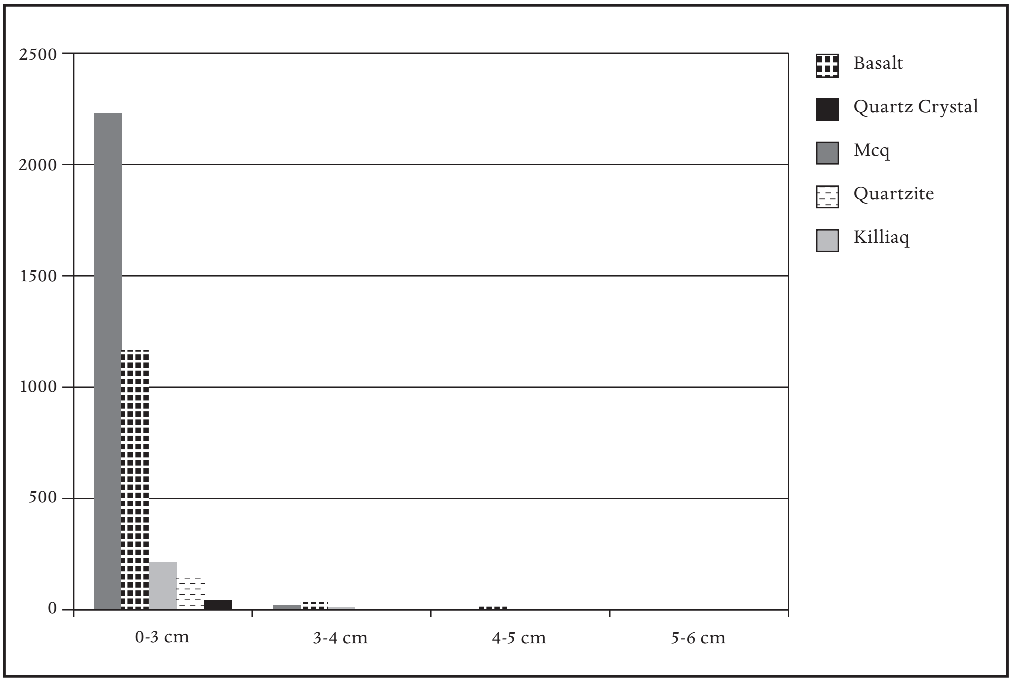


Fig. 4.5.29 A comparison of the flake sizes in relation to the number of flakes of each raw material type. The Qeqertaaraq assemblage.

exceeds this size (figure 4.5.29). The size of the material suggests that only the basalt was collected in the vicinity of QR.

Attributes

The flake material of mcq has the following attributes: Some of the largest flakes have plain triangular butts, pronounced bulbs and an angle between butt and dorsal side at about 90 degrees. Dorsal sides are seen without negatives of previous detachments. These flakes must be perceived as products of primary reduction, made by means of direct hard technique.

The most numerous material is the 1–2 cm large flake category. This material is characterized by being thin and with a length/width relation of 1:1–2:1 (figure 4.5.28: II–VIII). The flakes have small oval butts and a small bulb with a lip formation. The butts are both plain and faceted. The flakes are trimmed by small detachments of the platform edge. This flake material is produced in a bifacial method employing a soft technique, most probably directly. Flakes smaller than 1 cm generally have many of the same attributes, but are often fragmented. This material generally derives from the final bifacial reduction and is probably produced by pressure technique.

The flake material of basalt has the following attributes: large flakes more than 3 cm, are thick and have a length/width relation of about 1:1 or below. Their butts are large and oval. They have a diffuse positive bulb and many of the flakes are hinged. The angle between butts and dorsal sides is about 90 degrees. Dorsal sides are often without previous negatives. This material must be perceived as primary detachments from a bifacial reduction. The attributes suggest a soft technique. However, no experiments have yet been conducted with this basalt material and thus its fracture mechanics is unknown. The basalt flake material with a size from 1 to 2 cm is numerous. This material is similar to the mcq material of the same size. However, the basalt flakes are generally shorter. The material is probably produced in a bifacial reduction process by means of direct soft technique. The flake material of quartz crystal is very small and few and can generally be related to the blade production or a bifacial production. The few flakes found of killiaq do not differ in attributes from small flakes made from mcq, thus the material is probably produced in a similar process.

Tools used for lithic production

In QR, a large pressure tool made of penis bone from walrus has been identified (figure 4.5.30). The piece is 15.2 cm long and has an oval cross-section of 2 × 1.3 cm. The tool is made from a split bone and has a carefully made pointed distal end. The use wear at the point suggests that it has been used for lithic material. Along the lateral edges small notches are cut into the material. The notches have probably enhanced a fixed holding position of the hand while using the tool. From the Late Dorset Shelter site on Ellesmere Island a similar pressure tool has been recog-

Fig. 4.5.30 Pressure tool made from walrus penis bone, Qeqertaaraq assemblage.

nized (Schledermann 1990). Thus, the type of pressure tool where the handle and point is made from one large piece of bone or tusk must be considered as a special type from Late Dorset. However, from other Late Dorset sites, e.g. Dorset House Component 1 (Schledermann 1990), short pressure points for compound hafting are found that are similar to pressure points described in earlier Palaeo-Eskimo groups. No hammer stones or billets from organic material have yet been recognized in the Late Dorset assemblages.

Discussion

The total inventory from Polaris site is generally too low in number for a statistical analysis. Many tool types are not present at the site. However, when frequencies of tool types are compared between QR, House 1 and Polaris site structure 1, large similarities are seen despite these problems (figure 4.5.31). Blades, bifacial preforms and harpoon points dominate both assemblages. Moreover, it is seen that unifacial knives and end scrapers are present in small numbers in both assemblages. The similarity in inventory points to the fact that both sites have been used for similar functions, and also the excavated structures are of a similar type. From the excavations and the inventory it can be suggested that the structures were used during the winter period and that it was mainly walrus that was hunted at the sites.

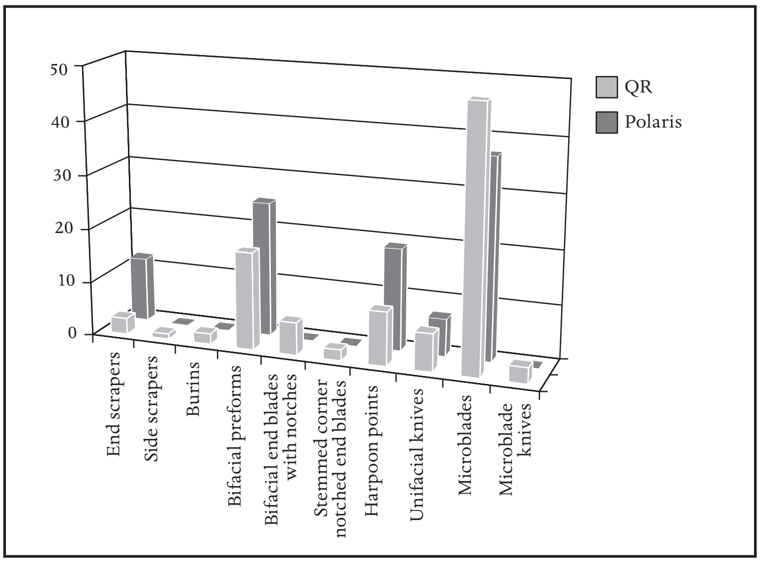


Fig. 4.5.31
A quantitative comparison of the lithic tool types in the Qeqertaaraq (House 1) and Polaris site (structure 1) assemblages.

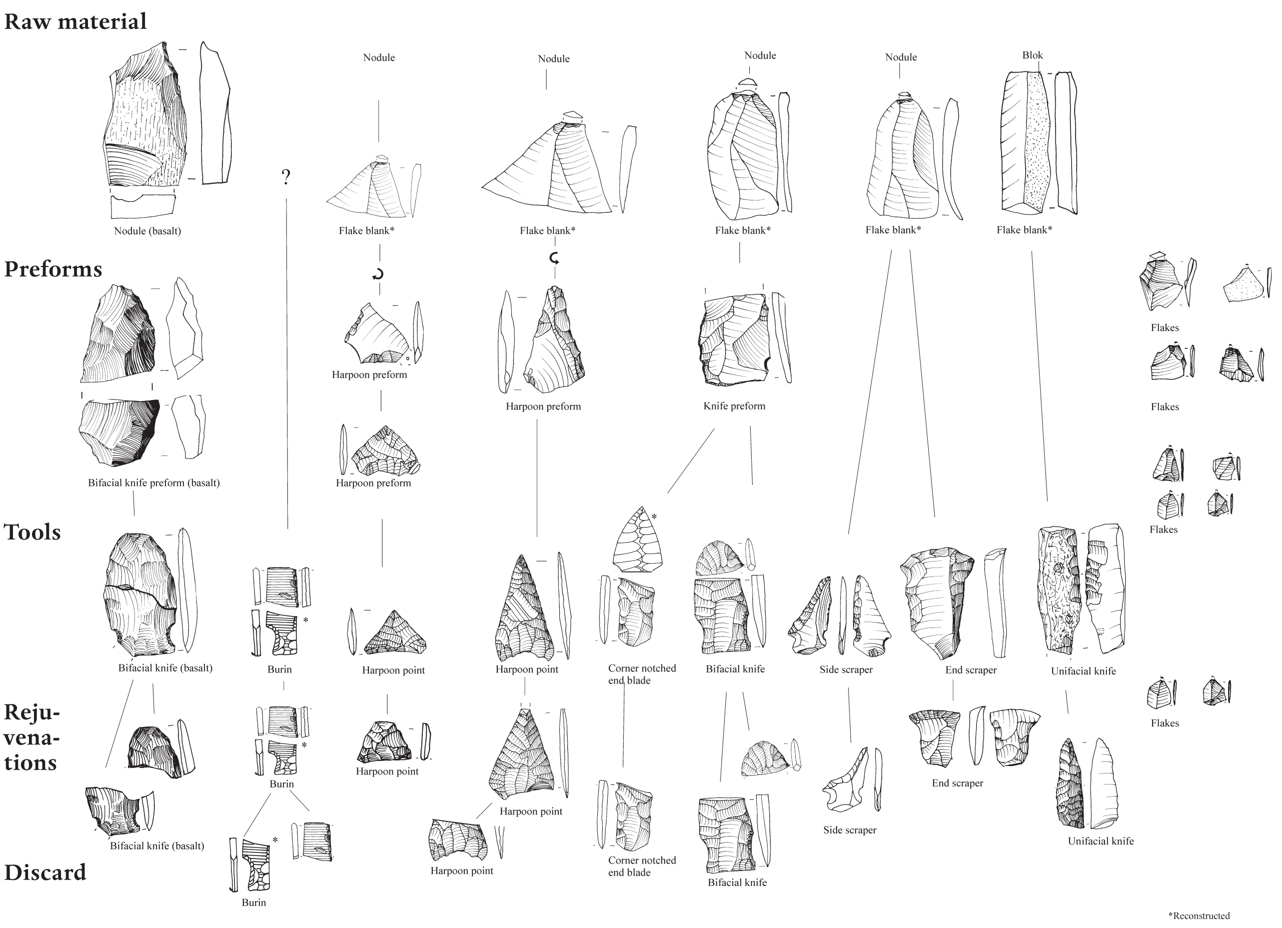


Fig. 4.5.33 The concept of lithic production in Late Dorset.

haft in a large slot. The end blade notches fit with a narrowing in the wooden haft, in which the tie is made. Scrapers are end hafted in wooden hafts with a cut groove and tied to the haft. Also these hafts have a cut narrowing for the tie. Burins are end hafted in wooden hafts with a cut slot, and a wooden support is tied onto the haft to fix the distal burin end.

Microblades are hafted, both as inserts and by end hafting. At least five different hafting methods have been employed in Late Dorset. Hafts for microblades are both composite and made from a single material. The components are made from both wood and bone material.

Adzes are hafted in a socket made from bone or antler material. The socket is tied to an angular haft.

their rejuvenation can be described as the Late Dorset concept of lithic production (figure 4.5.33).

Blade production
Blades are serially produced from single platformed, single fronted blade cores. The angle between front and platform is generally from 50 to 70 degrees and the platform is made small-faceted during the production. The blade production is characterized by blade frequencies with a great variation in size and quality. This variation can be explained by a decreasing demand for blade quality during Late Dorset, and a low quality in size of raw materials selected for blade cores.

During Late Dorset a blade production of macroblades is seen. This production is not yet analyzed and described due to its scarcity in the investigated assemblages. The generalized method of lithic blade and blade tool production can be described as the Late Dorset concept of lithic blade production (figure 4.5.34).

Choice of hafting method

Hafts from Late Dorset contexts found in the Thule region (Appelt et al. 1998(b)) and in Canada (Mary-Rousselière 2002) document the general hafting methods during this period (figure 4.5.32).

Harpoon points with concave bases are fitted to harpoon heads with a convex cut groove, which match the point. Bifacial knives are end hafted into a wooden

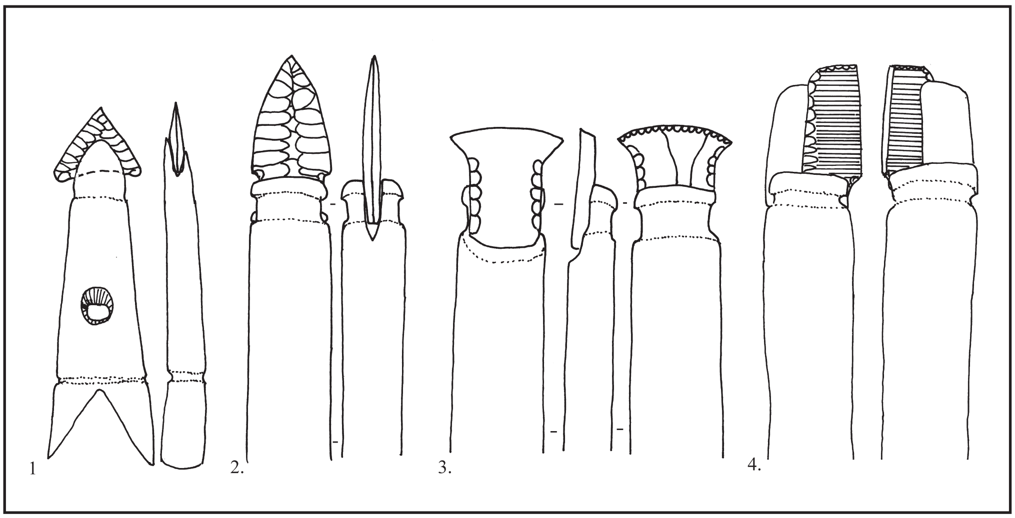


Fig. 4.5.32 Hafting principles for the lithic tool types in Late Dorset.

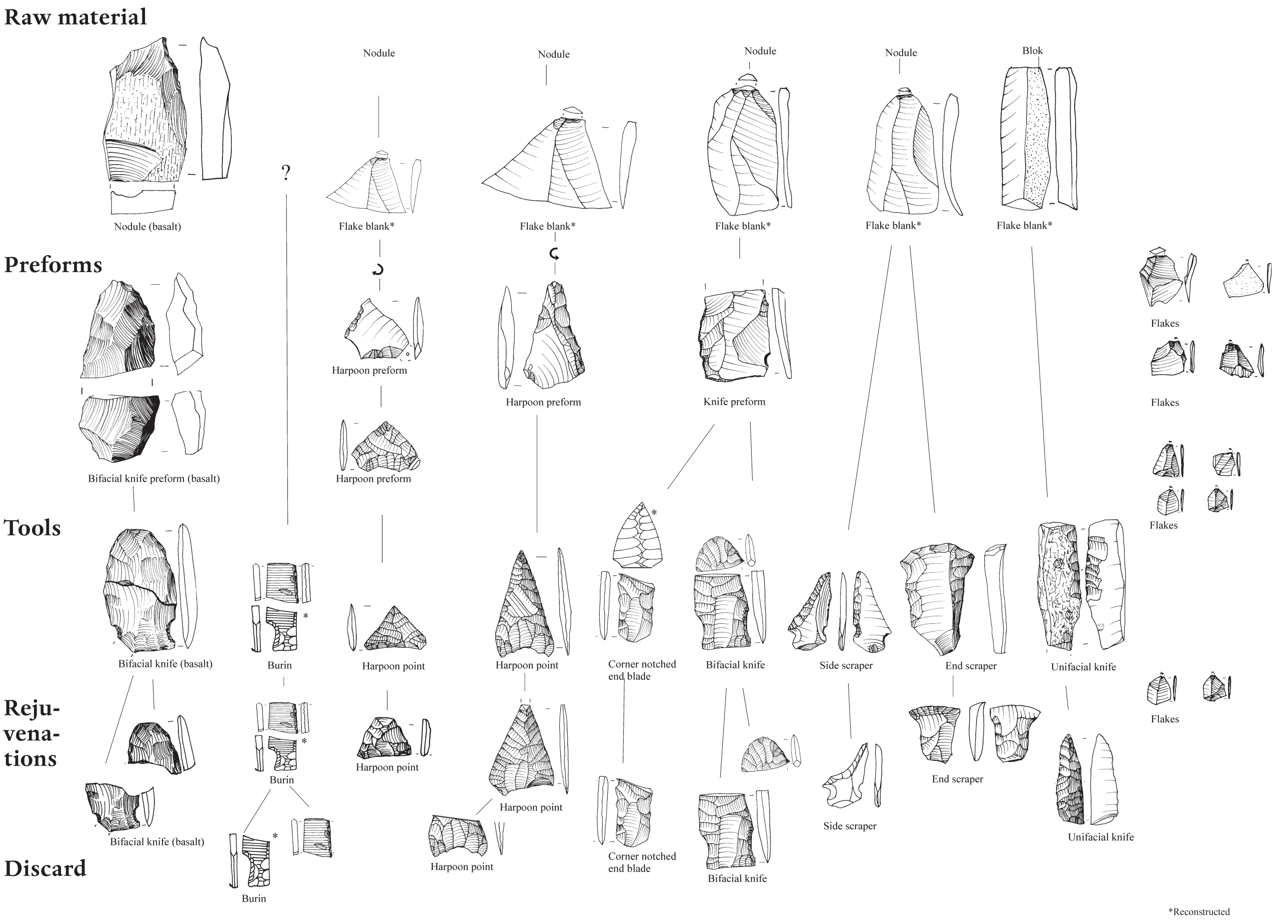


Fig. 4.5.33 The concept of lithic production in Late Dorset.

haft in a large slot. The end blade notches are matched a narrowing in the wooden haft, in which the tie is made. Scrapers are end hafted in wooden hafts with a cut groove and tied to the haft. Also these hafts have a cut narrowing for the tie. Burins are end hafted in wooden hafts with a cut slot, and a wooden support is tied onto the haft to fix the distal burin end.

Microblades are hafted, both as inserts and by end hafting. At least five different hafting methods have been employed in Late Dorset. Hafts for microblades are both composite and made from a single material. The components are made from both wood and bone material.

Adzes are hafted in a socket made from bone or antler material. The socket is tied to an angular haft.

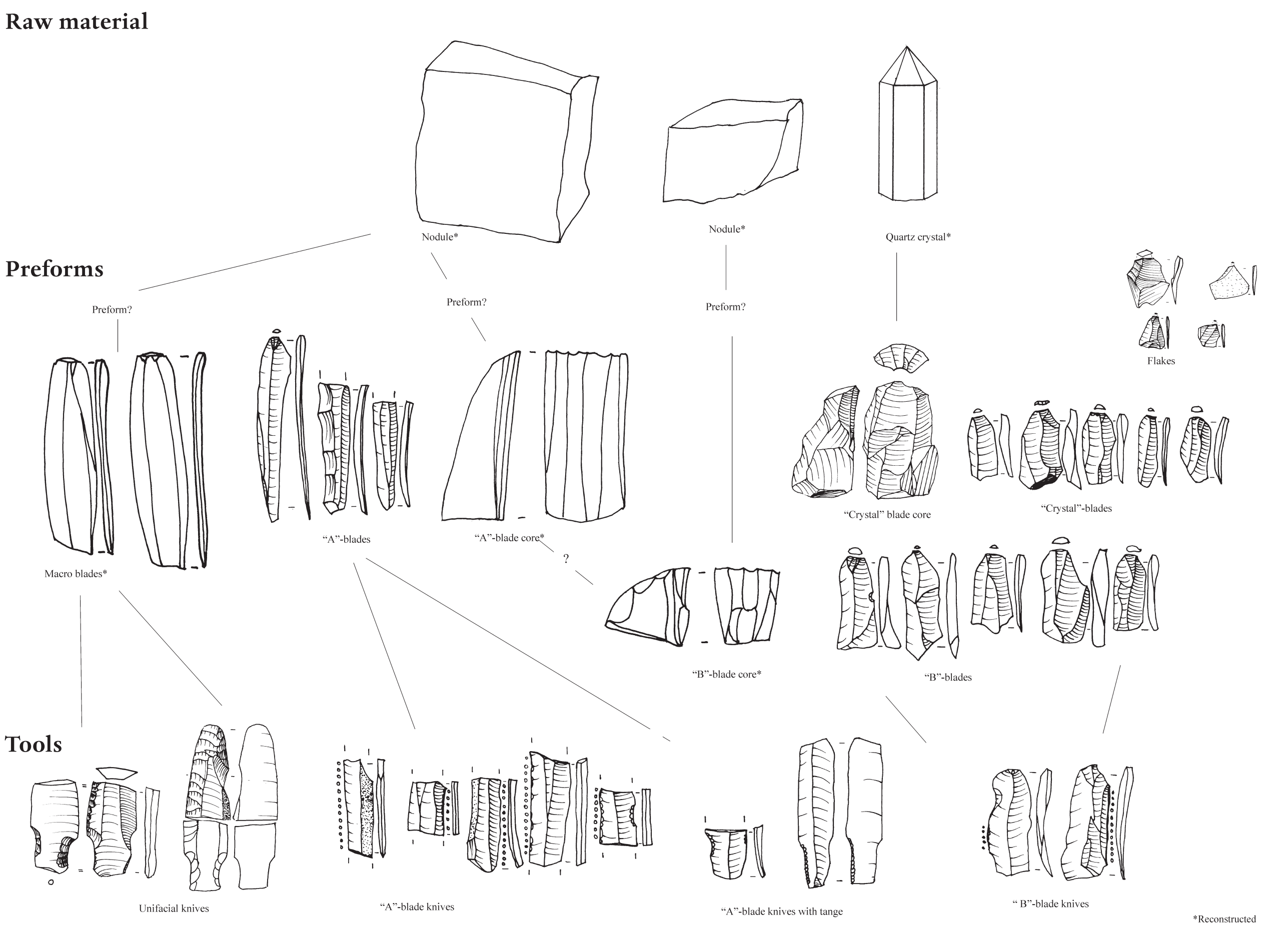


Fig. 4.5.34 The concept of microblade production in Late Dorset.

Choice of reduction technique

Large flake blanks of mcq are characterized by large bulbs, which suggests that these have been produced by means of direct hard technique. The analysis of the basalt production at QR similarly suggests that this production, in its first steps, have been conducted directly by hard hammers, while the later thinning and shaping have been conducted by means of a direct soft technique.

During step 1, bifacial end blades made from mcq have probably mainly been shaped by direct soft percussion, while the following final shaping and thinning has been conducted by means of pressure technique. The shaping of scrapers and their edge productions are also conducted by means of pressure technique. Grinding is employed for manufacture of burins and probably also for adze edges.

The microblade production is generally produced by means of pressure technique, while the core has been mechanically fixed. However, there is also a frequency of macroblades, which most probably have been produced by means of indirect technique.

Pressure points of e.g. walrus penis bone document the use of pressure technique during Late Dorset, while grinding stones enlighten the grinding technique. No billets or hammers that can be associated with lithic reduction from Late Dorset have yet been recognized.

4.6. Other Palaeo-Eskimo traditions in Greenland

Introduction

During an investigation of the assemblages from the northern Thule area, i.e. Daugaard Jensen Land, Washington Land and Hall Land, indications of two, in Greenland hitherto unknown, Palaeo-Eskimo traditions were found. The two traditions are pre-Dorset and Early Canadian Dorset. These two traditions are identified, in particular on their burin technology, by employing the technological methodology of this study. Moreover, the isostatic uplift in the northern Thule area can be used in order to suggest a dating for the sites (Andreasen 2000).

Pre-Dorset

Structure 13, Solbakken

Structure 13 at the site Solbakken on Hall Land is located in isolation on the 19-metre terrace, while the remaining structures on the site are placed at the 21-metre terrace (figure 4.6.1). The latter are dated to 2470–2200 cal. BC and attributed to the Independence I tradition (Grønnow & Jensen 2001: 37ff.; Knuth 1983).

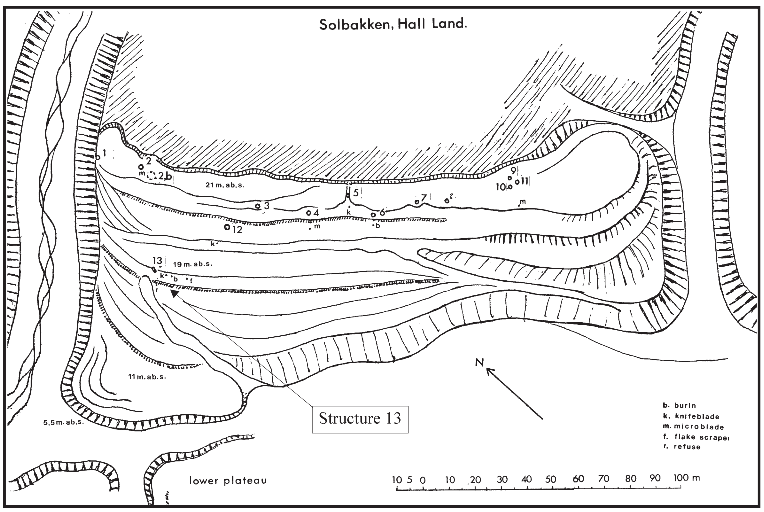
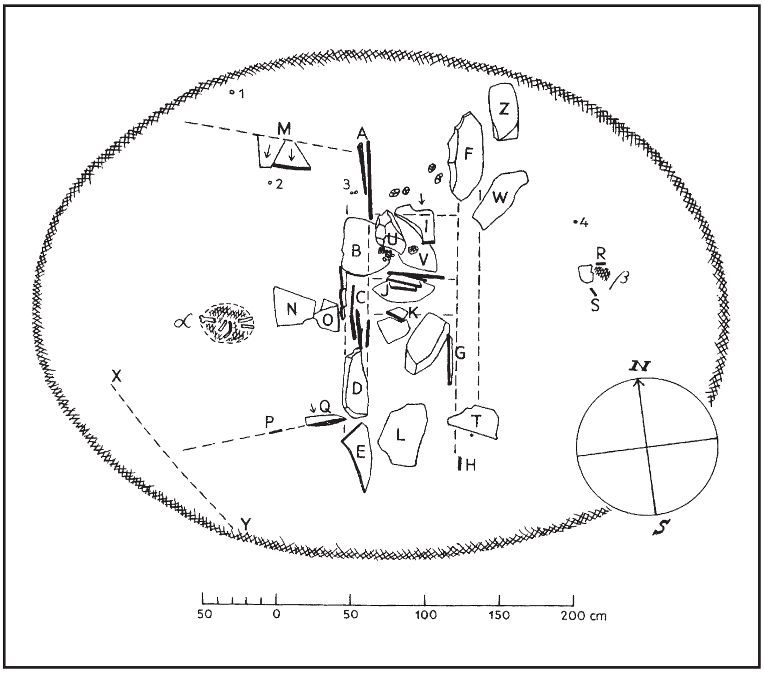


Fig. 4.6.1
Plan of the Solbakken site including the location of the 13 different archaeological structures (Grønnow & Jensen 2003).

Fig. 4.6.2
Structure 13, Solbakken site (after Grønnow & Jensen 2003).



Structure 13 can be described as a midpassage construction, made as a slight 3.5 × 4.5-metre depression (figure 4.6.2). Inside the structure several stone slabs were found. Moreover, a pit was found in the structure containing burnt bones (figure 4.6.2: α). The structure was excavated and artefacts were surface collected in front of the structure, and this area was later also excavated. The lithic inventory from the structure consists today of nine artefacts (figure 4.6.3), but in addition three pieces of musk ox teeth, a needle and a piece of worked walrus tusk were unearthed. The lithic inventory consists of a burin (I), a discarded flake preform (II), two broad medial fragments of microblades (III), a unifacial core (IV), three microblades and three flakes.

Cultural attribution of structure 13, Solbakken

When the burin from structure 13 is compared with the *chaîne opératoire* for burins in Independence I and Saqqaq, it is seen that the rejuvenation method for the burin is different to the technology in Saqqaq and Independence I. From the spalled burin edge a series of flakes are systematically detached (figure 4.6.5). This re-sharpening method is typical of pre-Dorset burins and is found on pre-Dorset sites, e.g. Ridge Site on Ellesmere Island (Schledermann 1990: 348) (figure 4.6.6). Morphologically the burin is also different from burins in Independence I and in Saqqaq, due to its wide base, its lack of notches and lack of grinding on its distal faces. Relatively

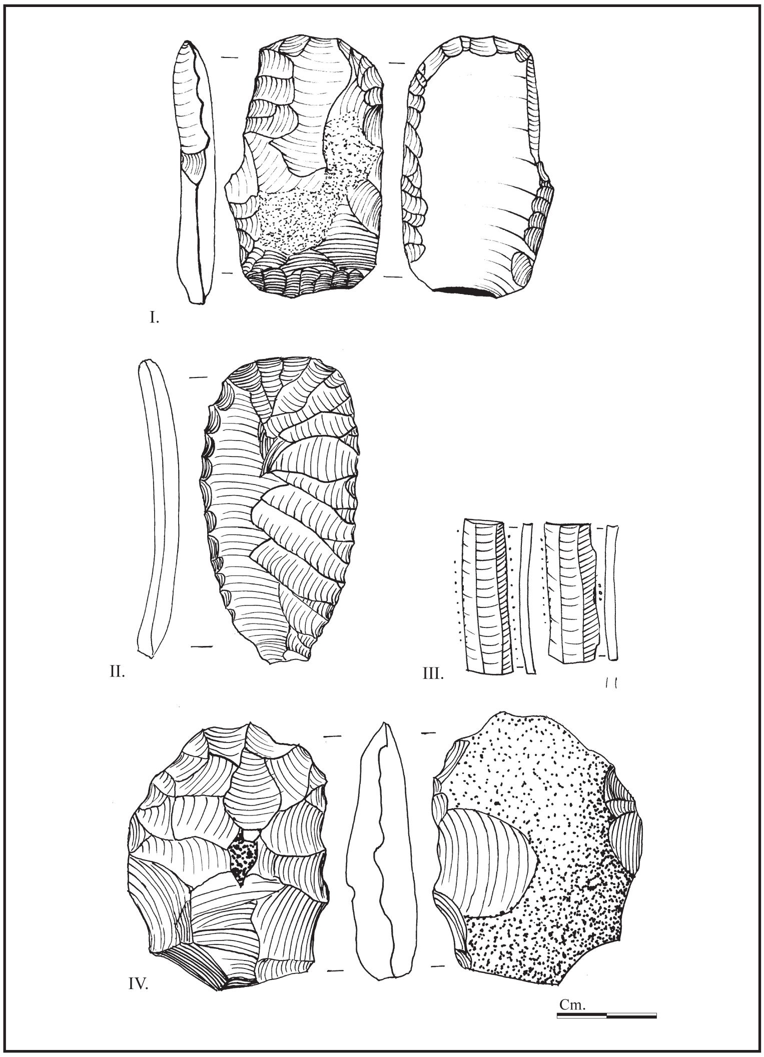


Fig. 4.6.3
The lithic assemblage of structure 13, Solbakken site:
I) burin modified from the burin edge by flake series,
II) preform,
III) mid-parts of microblade with macroscopic use wear,
IV) unifacial flake core. The burin is 3.8 cm long.

wide bases of burins are on the other hand typical of pre-Dorset. The two medial fragments of blades from structure 13 are prismatic and relatively wide and could as such belong both to the Independence I and pre-Dorset traditions. The unifacial core is not typical to either the Saqqaq or Independence I technology. Whether or not it is typical of pre-Dorset is as yet unknown as technological analysis of this tradition is currently lacking. Thus, it can be concluded that structure 13 at Solbakken most likely constitutes the remains of a pre-Dorset occupation. Due to the isostatic uplift and by comparison to the dated structures at the 21-metre terrace it can be suggested that structure 13 was in use around 2000 BC.

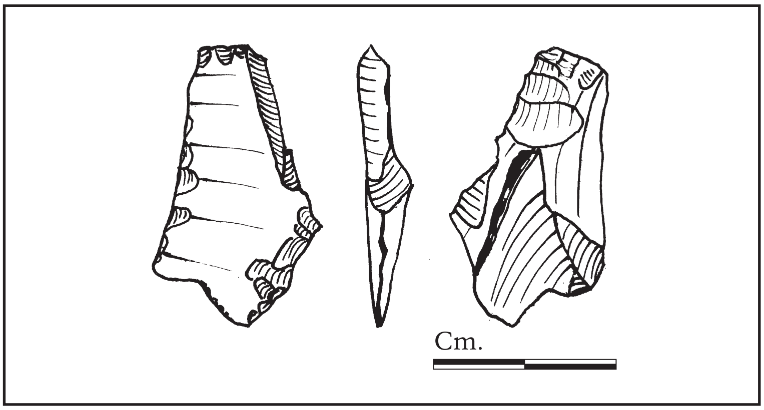


Fig. 4.6.4
Burin of pre-Dorset type from the Pullersuaq site. The burin is 3.1 cm long.

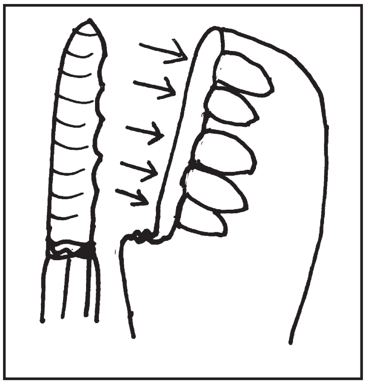


Fig. 4.6.5 The rejuvenation of burins in pre-Dorset is typically conducted by way of detaching series of flakes from the burin edge before detaching the burin spall.

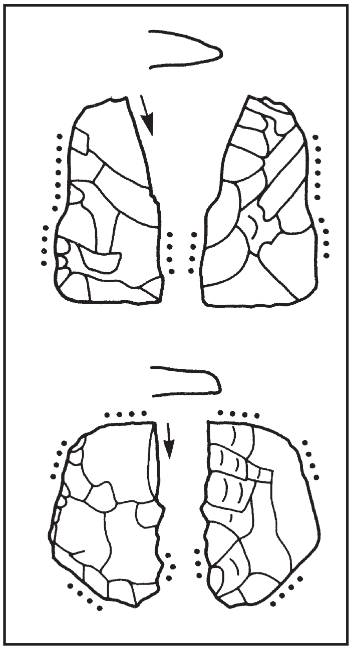


Fig. 4.6.6
Two burins from structure 1a, at the Ride site belonging to pre-Dorset (Schledermann 1990).

Pullersuaq

During a survey on the island Pullersuaq, outside Washington Land in Kane Basin (figure 4.6.7), a burin re-sharpened using the pre-Dorset method was found (figure 4.6.4) (Andreasen 2000). The burin can also in this case be seen as an indication of pre-Dorset presence at Pullersuaq.

Early Canadian Dorset

Winstedt site 'level 1'

During a survey of Washington Land (Andreasen & Lange 2000), just north of the Humboldt Glacier on a peninsula, named Cape Winstedt, a Palaeo-Eskimo settlement area was found on raised beach terraces (figure 4.6.7). The site was termed 'Winstedt Site' and divided into three levels. The highest level, the presumably oldest settlement (Early Palaeo-Eskimo groups), was found 20 m above sea level. At the 11-metre terrace, the next level was located (level 1). On this level harpoon head types typical to the Early Dorset period and a burin with partially ground edge and ground distal face were among the finds (Andreasen 2000: fig. 56) (figure 4.6.9: I). The inventory at this terrace can be attributed to the late pre-Dorset–Early Dorset transition, dated relatively to 700–800 BC.

Just below this level, 9–10 m above sea level, harpoon heads and burins of Independence II type were found (Andreasen 2000: fig. 56). Thus, this occupation must be dated to 800–400 BC.

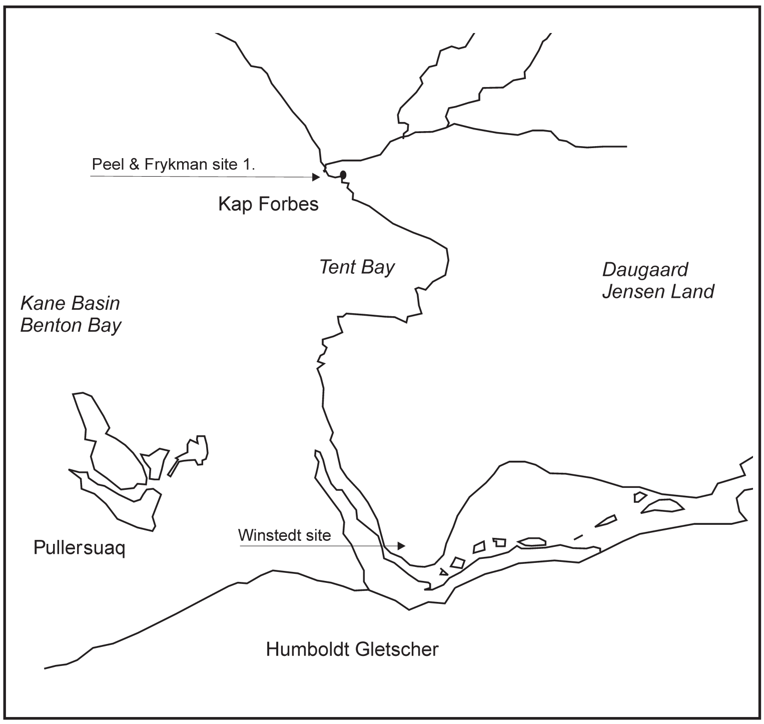


Fig. 4.6.7
The area north of the Humbolt glacier includes the prehistoric sites Winstedt site, Peel & Frykman site and Pullersuaq.

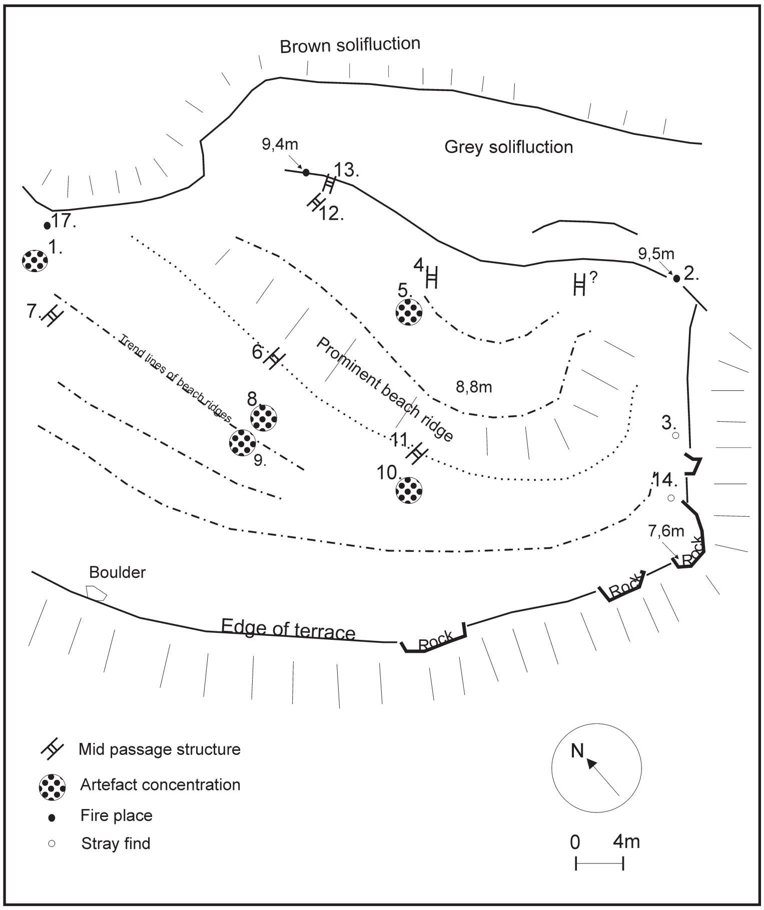


Fig. 4.6.8 Plan of the Peel and Frykman site (after Peel & Frykman 1975).

Peel and Frykman site

In 1975 the geologists J. S. Peel and P. Frykman found and described a Palaeo-Eskimo site at Cape Forbes in Tent Bay, just north of the Humboldt Glacier (Peel & Frykman 1975) (figure 4.6.8). The site was located at a beach terrace 8–10 m above sea level. At the site seven midpassage structures, four lithic concentrations and two stone built fireplaces were found. Artefacts were surface collected at the site and among these were end blades with angled bases and large notches, end scrapers with concave lateral edges and burins with ground faces and partially ground edges. All artefacts were made from fine-grained mcq (Figure 4.6.9: III–VII).

Pullersuaq

During a survey on the Island Pullersuaq west of Washington Land, a short well-formed burin with ground faces and a partially ground edge was found (Andreasen

& Lange 1999) (figure 4.6.9: II). The burin reveals the same technology and morphology as the burins from Winstedt site at the 11-metre terrace and Peel and Frykman site.

Cultural attribution of Winstedt site 'level 1', Peel and Frykman site and the ground burin from Pullersuaq

A technological investigation of the burins from the sites reveals that their work-

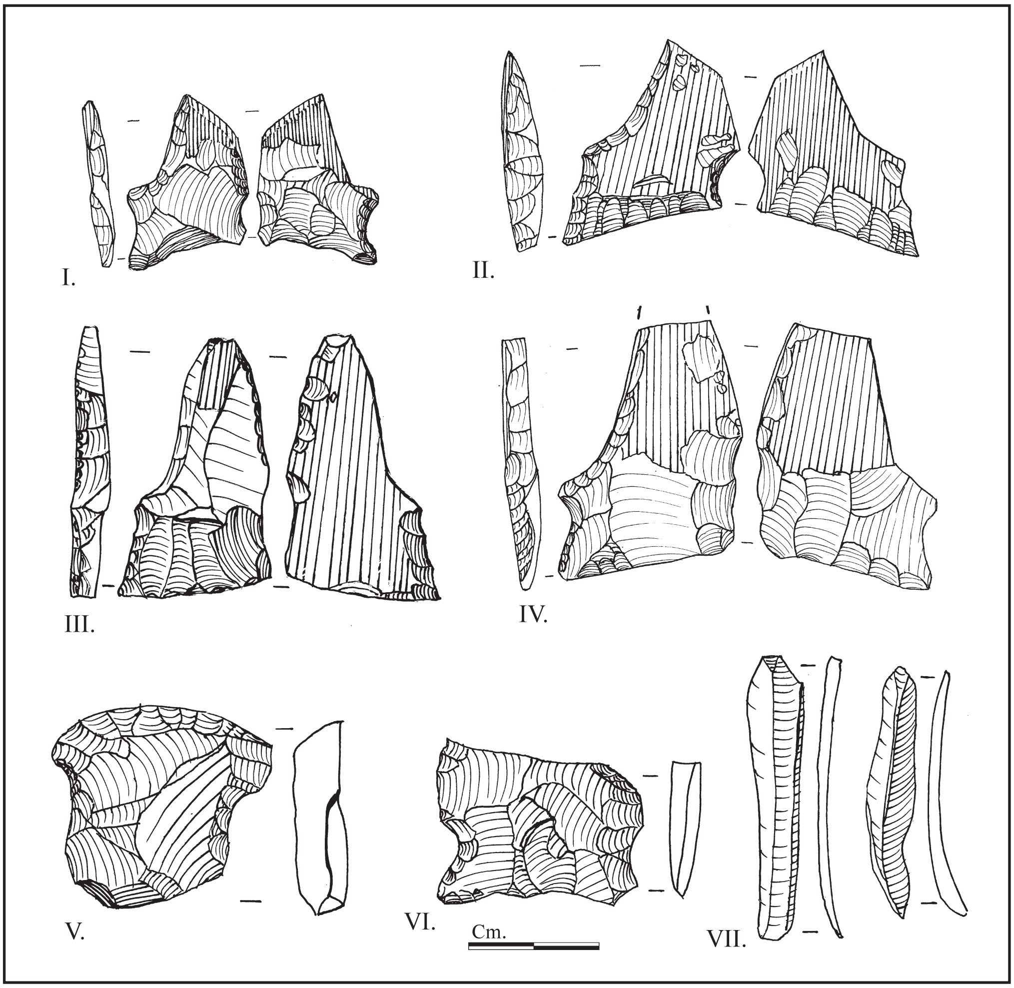


Fig. 4.6.9 Lithic artefacts from Palaeo-Eskimo sites in the area north of Humbolt glacier: I) burin from Winstedt site level 1, II) burin from Pullersuaq site, III, IV) burins, V) end scraper, VI) base from bifacial end blade preform, VII) microblades, III–VII) artefacts are from the Peel & Frykman site.

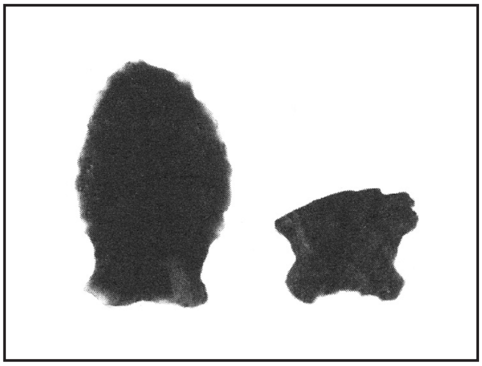


Fig. 4.6.10 Wide bifacial end blades with notches and concave bases from the Baculum site (Schledermann 1990).

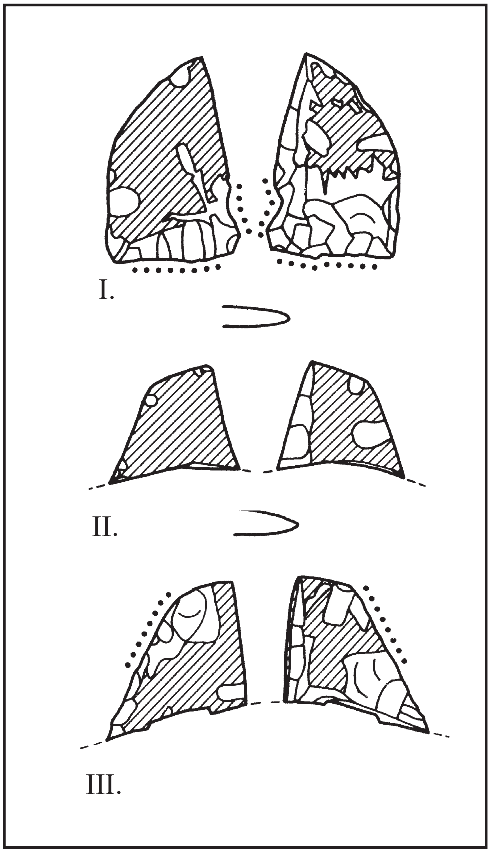


Fig. 4.6.11 Burins from the Baculum site are characterized by short, completely ground distal ends and slightly ground burin cutting edges (Schledermann 1990).

ing edges are made by unifacial pressure retouch followed by minimal grinding. The distal faces of the burins are vastly ground and the bases are wide and precisely shaped with notches. The technology of the burins is similar to burins from Baculum site on Bache Peninsula (Schledermann 1990) (figure 4.6.11). Accordingly, the wide end blades from the Peel and Frykman site are similar to end blades from the Baculum site (figure 4.6.10). The Baculum site is attributed to the Early Dorset and dated by local plant material to 1130–800 cal. BC (Schledermann 1990). Neither end blades nor burins of a similar technology and morphology are to be found in the defined Palaeo-Eskimo traditions of Greenland. Thus it can be concluded that the assemblages from the above-described sites belong to an Early Canadian Dorset tradition that visited northwest Greenland.

Chapter 5
Discussion

Choice of raw materials

In their first encounter with the killiaq sources near Qaarsut in West Greenland, c. 2500 BC, the Palaeo-Eskimos chose to use killiaq in the manufacturing of their lithic tools and sandstone from Slibestensfjeldet near Qaarsut for grinding the killiaq tools. This choice became characteristic to the regional Palaeo-Eskimo tradition that we today call Saqqaq, for the 1700 years they inhabited West Greenland. On East Greenland's coast, like for example at Ammassalik, where killiaq could not be found in such quantities, generally a fine-grained basalt was chosen, for example that from the Kangerlussuaq area, which has many similarities to killiaq. Only for the scrapers, that need a harder and stronger edge, were microcrystalline raw materials like mcq and rock crystals preferred in Saqqaq. As a result of the choice of killiaq and this material's inferior properties for making blades using the pressure technique, blade production decreased considerably in Saqqaq, in comparison to the other ASTt groups.

In Saqqaq, the production concept required that killiaq or materials with similar properties were used. The choice of killiaq and the grinding of lithic tools, including burins, became a traditional, specific choice and thereby a marking characteristic for Saqqaq. As an example of this choice it is seen that Saqqaq in the Thule area and on Ellesmere, after Saqqaq had found the source at Qaarsut, chose killiaq-like materials that are ground, in spite of the many high quality microcrystalline raw materials that can be found in the High Arctic.

In Independence I mcq was chosen for the manufacturing of their lithic tool assemblage. The choice seems understandable both because the types of raw materials that were chosen in the preceding Denbigh are of a similar quality, and because mcq is found widely in the Ellesmerian Folding chain in northern Greenland, where Independence I settled. Only adzes are made from harder and tougher fine-grained basalt, which probably has a functional advantage. On Independence I settlement sites along Greenland's east coast, mcq was also chosen for the lithic industry. These types of mcq are generally from the basalt regions between Shannon and Scoresbysund. As in Saqqaq, a fine culturally determined preference for

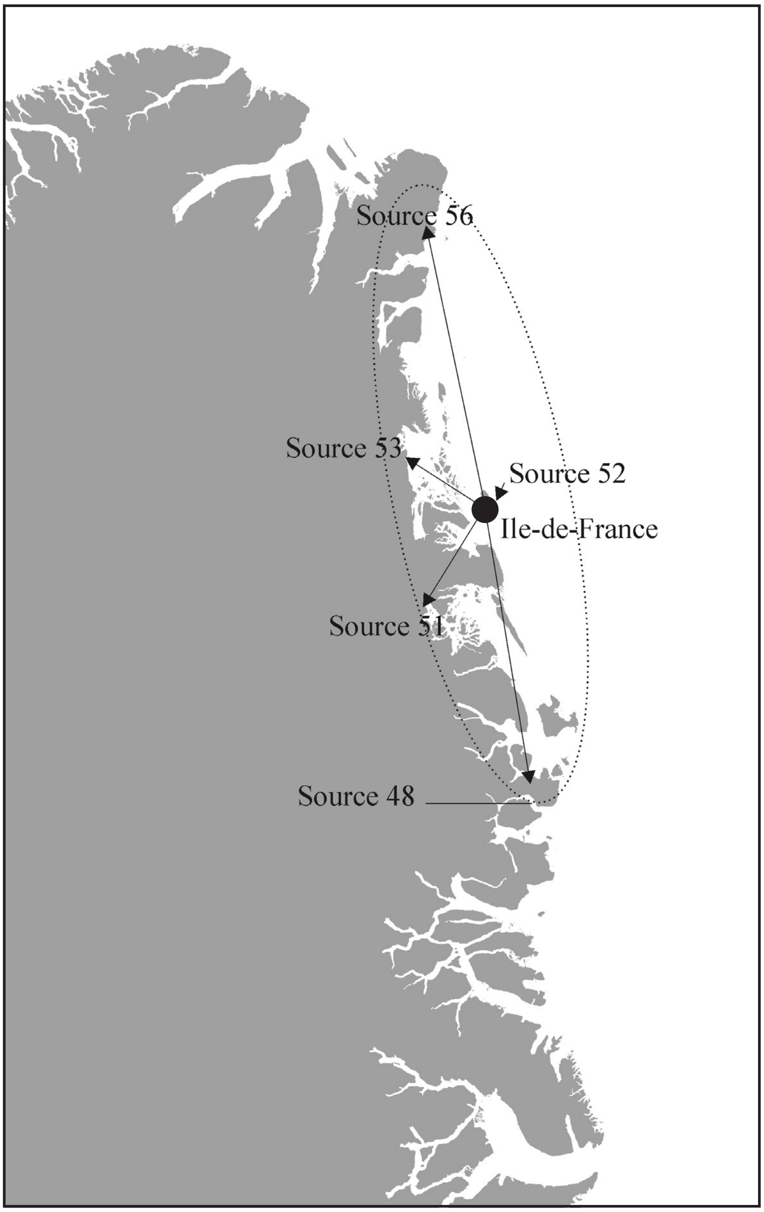


Fig. 5.1 A study of the provenance of lithic raw materials used at the Île-de-France site. It is seen that lithic raw materials were brought to the site from sources between Holm Land and Shannon Island, suggesting the range of the yearly mobility of the Dorset groups arriving to the Île-de-France site.

a special raw material type is seen: fine-grained mcq found in large tabular cores. This type of mcq is transported to areas outside the mcq source region. In Independence I, rock crystal, quartz and killiaq-like materials are not, or very seldom, used.

In Dorset I clear preferences can be seen in the relationship between the choice of raw materials, the process of tool making and the tool type. As in Saqqaq, Dorset I's encounter with the killiaq material at Nuussuaq has consequences, but quite different consequences, though, than for Saqqaq. Only adzes, burins with ground edges, and bevelled knives are consistently made from killiaq. The rest of the assemblage, bifacial blades, scrapers, side blades and a specialized blade production, are made from mcq or transparent quartz. The choice of killiaq specifically for ground burins becomes a marker for Dorset I. Burins in all of Dorset I's settlement areas including on the east coast as far as Dove Bay are made from killiaq or a killiaq-like material like fine-grained basalt (figure 8.2.33). In Canadian Dorset and in the High Arctic Independence II, burins are, in contrast, made of mcq. In southern Greenland local slate is chosen for burins and ground end blades (figure 8.2.32) (Raahauge et al. 2005). In this area, and in Skjoldungen, burins of basalt are found, probably deriving from Kangerlussuaq on the east coast, although amphibolite can also have been used in the Skjoldungen area (Gulløv & Jensen 1991; Gotfredsen et al. 1992). In areas where there are natural deposits of mcq, between Uummannaq and Disko Bugt and between Scoresbysund and Shannon, this material is preferred. But when mcq is not to be found locally it is substituted with quartz, often in the form of rock crystal, which is generally found over the whole of Greenland. In addition, quartzite is used, which is typically found in southwest Greenland and northeast Greenland. In southern Greenland, on Greenland's east coast between Kap Farvel and Ammassalik, and north of Germania Land, a dominance of rock crystal and quartz is seen in the tool assemblage.

We can finally conclude that: 1) In Dorset I, burins with ground edges, adzes and ground blades are made from killiaq or similar material, while the rest of the lithic production is made of mcq and quartz, and 2) The choice of raw material in Dorset I is more locally based than in the earlier cultural groups, and is characterized by the observation that smaller pieces of the raw material are chosen for usage.

In Independence II in northern Greenland mcq from the Ellesmerian Folding is used for the manufacture of the lithic assemblage including burins with ground edges. Only the manufacture of adzes diverges as, for this tool type, dolerite is chosen. Compared with Independence I, who settled in the same area, there are numerous differences in the choice of raw material: In Independence II smaller pieces of the raw material are used, in the form of small blanks and tabular fragments, whereas in Independence I large blocks are chosen, which are reduced to preforms and exported. This means that the Independence II people can be less particular about the choice of mcq and therefore use local mcq sources. This contrast can be clearly seen at the settlement site Kap Holbæk, by Danmark Fjord, where the choice of raw material on Independence I and II settlement sites can be compared (see chapter 4.4).

In northeast Greenland, south of Nordostrundingen, local raw materials, often clear quartz, are used for lithic tool production. The large Independence II aggregation and settlement site on Île-de-France should be given special attention. At this settlement site, granular clear quartz of a high quality is the predominant choice, often mistakenly described as rock crystal. The quartz material, concluded on the basis of its shape, its usage phase and its distribution in northeast Greenland, is from a local or near source, but the actual source, or source area, has not, as yet, been found. It can be seen that the choice of material for the burins from Île-de-France is generally fine-grained basalt, and that bifacial tools, found used up (step 5), are of semi-transparent greenish quartz, white quartzite or blue-white mcq. It is probable that the basalt for the burins comes from sources in the basalt layer between Shannon and Scoresbysund, e.g. from Basalt Ø (source 48). The green quartzite is known from a source in the nearby Jøkel Bugt (source no. 53), the white quartzite can be from a source in Dove Bugt (source no. 51) and the blue-white mcq is known from Amdrup Land (source no. 56). By describing the choice of raw materials for tools on Île-de-France, it is thus possible to attain a view of where the Palaeo-Eskimos, in this period, at this site, came from (figure 5.1). The raw material for the burins supports the argument that East Greenland up to Nordostrundingen was populated from the south of Greenland. Earlier Dorset groups from Canada utilized mcq for the manufacture of burins, and this choice, after a probable migration, continued in High Arctic Greenland, defined by Knuth as Independence II. In contrast it is seen that the Dorset group that moved down through West Greenland began to use killiaq and killiaq-like materials for burins, and this choice was transferred to South and East Greenland. In other words, the Dorset groups that come from a 'Canadian tradition', from the north of Greenland, chose mcq for burins, while Dorset groups that came through Disko Bugt, from a 'West Greenland tradition', chose killiaq and killiaq-like materials for burins. Another observation that gives weight to the supposition that Île-de-France was populated from central East and South Greenland is that, at this site, no finds of lithic material from North Greenland have been made (figure 8.2.36).

In Late Dorset in the Thule area, the choice of blue mcq that is known from Washington Land dominates over the whole lithic tools production. Very few other raw materials reach these settlement sites. When atypical material is found it is often as finished tools. Additionally, it has been observed that attempts to use local basalt for bifacial tools on Qeqertaaraq were made. This raw material choice should be seen as an atypical attempt in terminal Late Dorset. It is puzzling that Late Dorset does not to a greater extent exploit the local killiaq that Saqqaq find in the area. The reason must be that Late Dorset comes from a western area, and from a tradition that does not include the use of killiaq. That Late Dorset nearly exclusively manufactures their tools from mcq must therefore be characterized as a traditionally determined choice.

Heat treatment

From all the Palaeo-Eskimo regional traditions in Greenland there are worked lithic artefacts that from a superficial examination seem to be heat treated. However, a definite identification of heat treatment is difficult to make, for two reasons. Firstly, because there must be negative flake scars from both before and after the heat treatment on the same object before a definite identification of heat treatment can be achieved. Secondly, because the mcq can have been exposed to heat naturally, where magma repeatedly has flowed in the Greenland bedrock.

To attain an idea of the colours, textures and microcrystalline changes that some of the characteristically used Palaeo-Eskimo lithic materials in the Greenland bedrock can get from heat treatment, a number of experiments have been carried out (chapter 8.1). The experiments show that the fine-grained glossy translucent blue types of mcq that are most often used for tools in West Greenland must be due to heating of the characteristic bluish matt mcq types that are found in round nodules in the basalt areas of Nuussuaq and Disko Ø (often termed chalcedony). The blue mcq fracturing properties are increased considerably by heat treatment. The experiments show also that brownish types of mcq often get a reddish colour from heat treatment, and it is thus presumed that the red, fine-grained and glossy types of mcq used for tools in Greenland were typically heat treated. The blue mcq from the Ellesmerian Folding in North Greenland changes as a result of heat treatment. The colour does not, but its shine. Thus the heat treated example is a lot glossier on its surface after flaking. In addition, the fracturing quality of North Greenland blue mcq is improved considerably after heat treatment. However, there are in fact only few of the lithic materials from Greenland that increase fracturing quality after heating. Materials like basalt, quartz, quartzite and killiaq-like materials do not increase fracturing quality with heat (Inizan et al. 1999).

Inizan and Tixier (2001) argue that heat treatment and pressure reduction are an Upper Palaeolithic Siberian-Mongolian innovation that spread to Europe as early as in the Upper Palaeolithic. The two techniques are carried out together because the increased fracturing quality is necessary for a successful pressure reduction for many microcrystalline raw material types.

It is probable that heat treatment of lithic raw materials in ASTt has been a part of a traditional knowledge of pressure reduction that goes back to the Palaeo-Siberian culture in Siberia. It is thus probable that all the Palaeo-Eskimo regional traditions in Greenland's prehistory knew the heat treatment technique, and that they have used it on the raw materials which benefited from it, before applying the pressure technique. The general recognition of heat treatment in ASTt is new in the eastern Arctic and sheds light on yet another nuance in the knowledge that the Palaeo-Eskimo people must have had of the treatment of their raw materials. The recognition also has consequences for the analyses of settlement sites in the eastern Arctic, as we now must assume that at some of these sites, structures must exist that for example consist of pits with sand and charcoal, in which the heat treatment was carried out.

Procurement of the lithic raw materials

Theory and models

Neglecting to include technology in the theoretical discussion of lithic procurement can and should be criticized. C. Renfrew and P. Bahn's definitions of the principles of procurement and reciprocity and related 'fall off' curves are the general basis for analysis of lithic procurement (Renfrew 1984; Renfrew & Bahn 1996). However, the work never includes a qualitative relation to reduction and technology. This has meant that analyses of lithic procurement, also in the context of Arctic archaeology, generally concern just one parameter, 'quantity', expressed either in number or weight, while a systematic incorporation and analysis of lithic technology is left out (e.g. Nagle 1984; Jensen & Petersen 1998).

Models

To be able to discuss the procurement in ASTt in relation to the technology, in line with the focus in this study, two models are suggested. The models are based on the analysis of the Palaeo-Eskimo groups in Greenland (figure 5.2). Instead of matchstick men, the symbol for lithic material according to its reduction stage is used. Thus the models are immediately applicable to the archaeological material. To what extent the material is exchanged or transported due to a group's mobility ('embedded procurement') can be discussed when the spread of the material in the landscape is defined. The models are characterized by an axis that shows the distance to the source, as is also known in Renfrew and Bahn, but in addition to this, there is a 'y-axis' that reflects the reduction in steps. In model 2 several small sources are included, in relation to distance, because the Dorset groups generally used many small local sources rather than a few large ones. The question that is posed by the two models is to what extent the lithic material is spread due to a group's mobility, defined by Binford (1983) as 'embedded procurement' possibly combined with direct procurement, or due to exchange between groups in a 'down the line' system (Renfrew & Bahn 1996).

The two models reflect Independence I/Saqqaq's reduction strategy respectively, where large cores, made at a few sites, are transported and subsequently worked

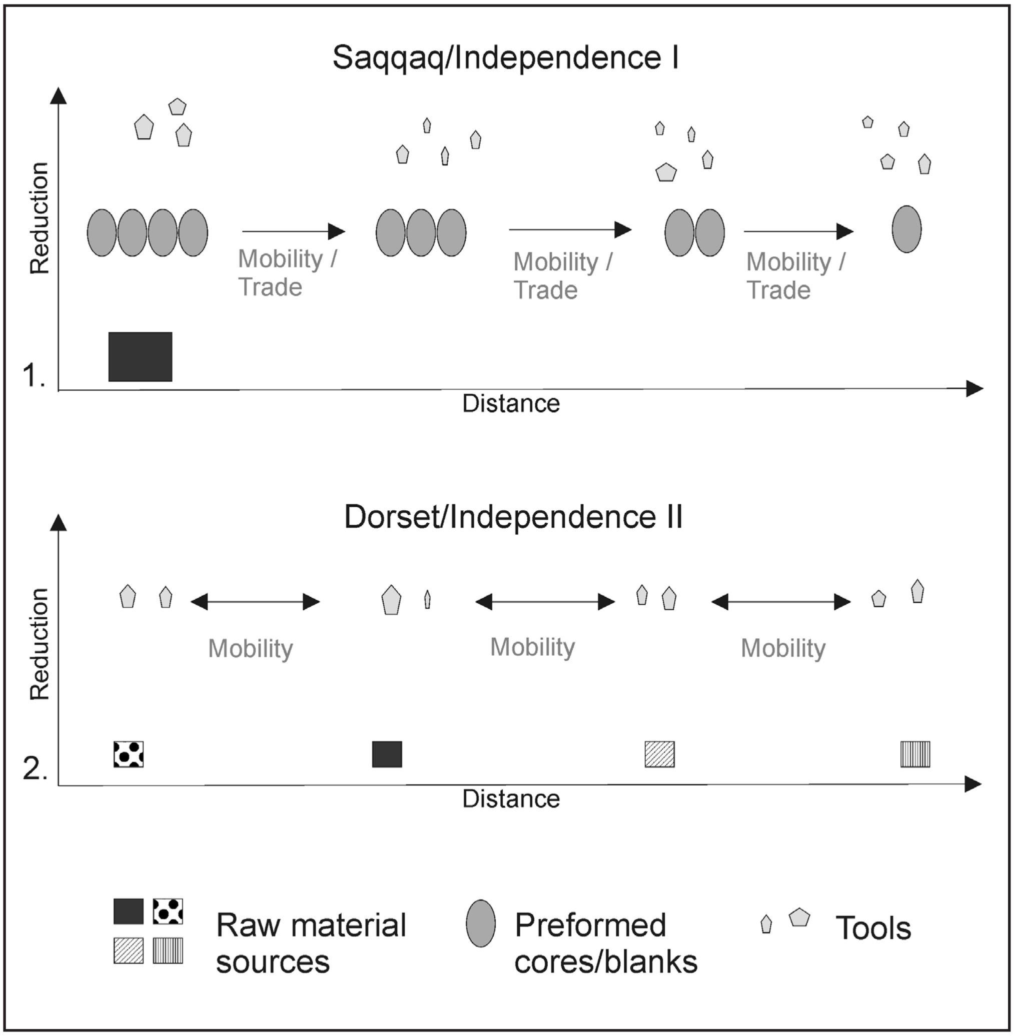


Fig. 5.2 Principles of lithic procurement in relation to lithic reduction technologies concerning the Palaeo-Eskimo groups of Greenland. The Saqqaq/Independence I groups procure large lithic preforms from few lithic sources, and transport this material embedded (within the groups mobility) or by trade. Dorset/Independence II procures small nodules of lithic raw materials from many local sources and transports these only within the group's yearly mobility.

with the aim of the manufacture of the general tool assemblage (model 1, figure 5.2), and Dorset's reduction strategy where the manufacture of tools is carried out from small blanks and fragments, and where many local sources are used (model 2, figure 5.2)

Mobility or exchange: Criteria and arguments

To try to distinguish between the two procurement possibilities in the archaeological material it is worth discussing which material remains the two procurement strategies can be expected to have left. It should in this context be stressed that the criteria that are discussed here are simplified in relation to the complexity that in reality must have existed in the prehistoric period.

Mobility

It is reasonable to assume that a lithic assemblage procured from the source area by 'embedded' procurement will contain those tools that are needed in a situation plus a surplus of tools and preforms. A settlement site close to a raw material source will in this situation therefore not necessarily be characterized by large-scale production of systematically manufactured preforms.

Lithic raw material procured 'embedded' would also be characterized by only being found within the group's annual mobility area, in that it is assumed that lithic tools generally have a usage period of under a year. Another form of procurement by mobility that can be discussed is the direct procurement. If lithic raw material were acquired by direct procurement over long distances, in that individuals make the journey to the source, then the settlement form that is found in the source area would be characterized by short-term settlements. An argument for direct procurement would therefore be that the source area is characterized by volumes of knapping waste, but that the settlement of the area would be characterized by light dwelling structures without middens and a limited, functional assemblage. It is in addition also suggested that direct procurement would be characterized by storage sites, far from the source (Loring 2002).

Exchange

Lithic artefacts that are exchanged are, in a prehistoric context, often standardized preforms or rough outs made from nodules, in other words objects that have not yet reached their usage phase, but are at the same time shaped enough that the weight is reduced, and the material is tested and prepared. Exchanged preforms are known from the Early Neolithic in southern Scandinavia, where the production and export of axe preforms took place (Jensen 2001; Hansen & Madsen 1983).

In the Late Palaeolithic in Poland a production of blade cores took place in the flint-rich 'Holy Cross' mountains that was exported to valley regions further north, probably as a result of exchange (Schild 1980). A possible criterion for exchange is thus the existence of systematically manufactured preforms. The difference in the settlements where preforms are manufactured specifically for exchange, and where there is only produced material for the single settlement, would be an intense manufacture of preforms in the first example. It is, in addition, probable that such preforms can be found in storage deposits.

Another indicator of exchange can be that the raw material source has been exploited and controlled by a single group. The reasoning is that exchange systems rely on a network and need to be stable over longer periods to function. Therefore a single group might be responsible for a stable supply of the material to the network. The archaeological indicator for this would be characterized by a seasonal or a permanent settlement site close to the raw material source. The permanent settlements would reflect a broad range of functional lithic types, dwellings and middens.

A last argument for exchange is that the spread of an exchanged material, in contrast to that spread by mobility and direct procurement, would be spread evenly over the area. This relation must be expected in that the exchange systems are stable over longer periods and large amounts of material are exchanged over long distances.

Mobility or exchange: The Palaeo-Eskimo traditions in Greenland

From the above-mentioned arguments it is possible to suggest that, in the Palaeo-Eskimo traditions generally, procurement has been through mobility and direct procurement. Only on the west coast of Greenland from Uummannaq to Nuuk, in Saqqaq, c. 2000–1000 BC, where we see the systematically manufactured 'Nuussuaq cores' from the settlement at Qaarsut Killeq, beginning around 2000 BC, the long procurement distances and the uniform distribution from the sources, can we argue for exchange through a 'down the line' exchange system (Jensen et al. 1997; Jensen & Petersen 1998; Sørensen & Pedersen 2005). This means that a network in which systematically manufactured killiaq preforms were exchanged can have begun in Saqqaq along the west coast. It is interesting that in Saqqaq different forms of formalized exchange at specific sites in the West Greenland coastal landscape can have existed, that is also known from the Thule culture (Gulløv 1997, 2005).

Adam C. Knuth site is an example of a settlement site with a raw material source from Independence I. From the volumes of large knapping waste and discarded cores found near the individual dwellings it is probable that at this settlement site preforms were made for the population's own needs, during the habitation by the Independence I families. Procurement of black mcq is limited, in Independence I, to Peary Land, which could represent the Independence I groups' annual mobility zone.

In Dorset I and Independence II it appears that the production concept for the lithic production works against systematic exchange, as standardized preformed cores, from which several tools types can be made, are not produced. At the same time it seems that Dorset I is a lot less dependent on specific raw materials and single sources than the earlier Palaeo-Eskimo traditions, as they adapt their technology to local raw materials, such as quartz, rock crystal and local slate. This means that the Dorset I groups, more readily than the Saqqaq, can fulfil their raw material needs within the group's annual mobility zone. Raw materials in Dorset/Independence II are most often transported as tools, typically as burins of killiaq or basalt and as blades or blade cores of mcq. As Dorset I/Independence II burins, as a result of the grinding of the edges, must have a long period of usage and blades that can be made from blade cores that they carry, it is obvious to assume that such tools are transported due to the group's mobility.

In Late Dorset in the Thule area, a marked economizing of the material is seen, and there is a tendency to use the lithic material optimally, in spite of good regional sources for mcq. One of the reasons for this paradox can be that the sedentism increases in Late Dorset, so that it is seldom that the sources are visited. In addition, it can be seen that other exchange systems, with meteoric iron and copper, appear in Late Dorset (Appelt 2004).

As an example of how local raw material is exploited intensively while at the same time individual tools from regional raw materials appear in the settlement sites due to mobility in Dorset I/Independence II, the procurement on Île-de-France can be highlighted.

The provenance of the procured raw material is generally between Amdrup Land and Wollaston Forland, an area c. 600 km long. As Île-de-France is positioned in the middle of this area, and many Dorset families have been gathered at the site, it is probable that the mobility zone that is reflected in the material has an annual range of c. 300 km (figure 5.1). Generally, it is seen that the regional raw materials are found as discarded tools, rather than as preforms. However, some preforms for burins of basalt have been found (figure 8.2.36). The local quartz raw material is found as small nodules and as flakes. If a systematic exchange had taken in the region we should expect a larger number of preforms of a single regional material. The local and regional material, and the late reduction stage that is seen at the Île-de-France site, agree with the criteria for a raw material acquired through mobility, and the use of many local sources.

The manufacture of the lithic tool assemblage: Typology

The tool types

In Saqqaq, 13 formal morphologically and functionally different lithic tool types have been found: knives, large and small lance points, arrowheads, harpoon points, burins, end scrapers, side scrapers, adzes, awls, saws, strike-a-lights and blade knives (see figures 4.1.54 and 4.1.57). Most of these tools are known hafted from Qeqertasussuk. From Independence I, nine formal morphologically and functionally different tool types have been found: narrow end blades, broad knives, arrowheads, harpoon points, burins, side scrapers, end scrapers, adzes and blade knives (see figures 4.2.40 and 4.2.41).

In Dorset I, 12 formal morphologically and functionally different lithic tool types have been found: bifacial knives, harpoon points, ground curved knives, ground knives, ground tanged points, side blades, burins with ground edges, end scrapers, side scrapers, adzes, strike-a-lights and blade knives (see figures 4.3.39 and 4.3.40).

In Independence II, eight formal morphologically and functionally different lithic tool types have been found: bifacial knives, harpoon points, side blades, burins with ground edges, end scrapers, side scrapers, adzes and blade knives (see figures 4.4.24 and 4.4.25).

In Late Dorset, nine formal morphologically and functionally different lithic tool types have been found: bifacial end blades with notches, bifacial end blades with rounded base, harpoon points, burins with ground edges, end scrapers, side scrapers, one-sided worked knives, adzes and blade knives (see figures 4.5.33 and 4.5.34).

Similarity and variation in typology

Knives, burins and scrapers are the basic inventory in all the Palaeo-Eskimo regional traditions in Greenland. In addition we see that harpoon points and adzes also exist as a general rule in all the regional traditions. If we look at the differences it might be pointed out that only Saqqaq and Independence I make and use lithic arrowheads. Arrowheads of organic material can have existed in the Dorset groups but it seems that, as we are missing the arrow and the drilled round holes, it is reasonable to assume that bow technology for some reason was not used in Dorset.

We see also that Saqqaq and Dorset I, in comparison with the contemporary more northerly Independence I and II, have more types of formal tools. Tools like saws, awls and bevelled points and curved knife types are not found in the High Arctic groups. In addition, neither lamps nor strike-a-lights are known from the northern groups.

The relation between settlement intensity and the formal tool types

In order to discuss why there is a large difference between the number of formal tool types between sites in the High Arctic and the Low Arctic a model that describes settlement intensity and the appearance of different formal tool types is applied (Löhr 1979). H. Löhr has compared the Late Palaeolithic assemblages and settlement plans in Europe and found a relation between the sites' settlement intensity and the number of formal tool types. Löhr shows that when the settlement intensity increases, so does the settlement's extent, the quantitative size of the assemblage and the number of formal tool types (see figure 5.3). This model can be applied to the Palaeo-Eskimo material, e.g. the difference in the lithic assemblage between Dorset I and Independence II can be discussed. The small and probably short-term inhabited High Arctic Independence II sites have few of the most common formal tool types and a very small general lithic production. These sites resemble the short-term inhabited sites in Löhr's model and the short-term inhabited sites in Disko Bugt (Jensen 2004(a): 135). In contrast, the artefact-rich Dorset I settlement sites in the Low Arctic are equivalent to Löhr's intensely inhabited sites. In Dorset I, such sites have a large general production and many different formal tool types (see figure 5.3). As the lithic assemblages in both Independence II and Dorset I are manufactured employing the same technology and production concept, the differences between the two groups, according to Löhr's model, might be explained in that the settlement intensity is much greater in the Low Arctic than in the High Arctic.

In this way Löhr's model points out that the presence or absence of particular tool types alone cannot be used to argue for a cultural attribution. In this light many of the previous typological arguments, based on absence or presence of specific tool types, can be criticized or rejected for Greenland's early cultural history.

Another important observation to be made when the model is applied is that short-term repeatedly inhabited settlement sites do not achieve the same spatial

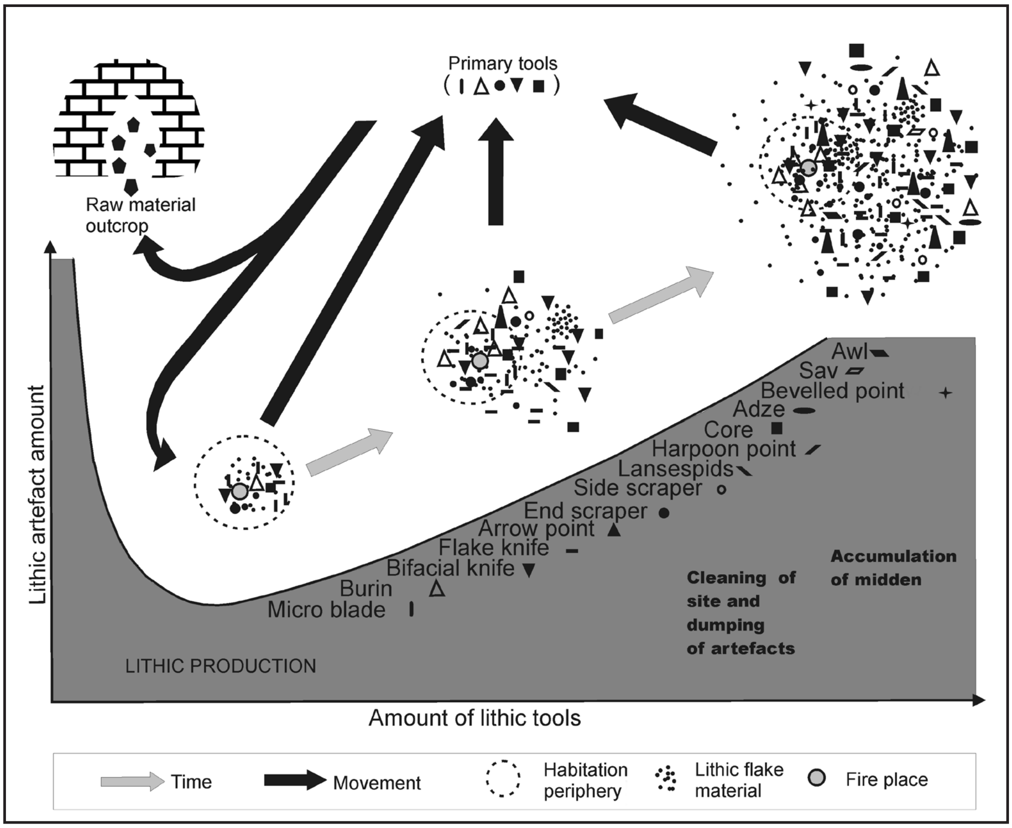


Fig. 5.3 The relation between settlement intensity and the size of the lithic production, the no. of lithic tool types and the spatial distribution of the site (after Löhr 1979).

distribution or the same development of formal tool types that long-term settled sites do. This observation is confirmed by ethnoarchaeological analyses of repeated short-term utilized trout-fishing sites in West Greenland (Petersen 2000). One positive feature of Löhr's model is therefore that we can challenge the archaeological dogma that repeated short-term settlement sites archaeologically should resemble long-term intensively utilized sites.

Reduction: Method, technique, hafting and tradition

Saqqaq – Independence I

The Saqqaq reduction method is characterized by the manufacture of bifacial killiaq cores as the basis for the lithic reduction. The core is struck alternately from each side so that tabular edges of the core are broken down and a typical symmetrical bifacial morphology is formed. This preform is a technological precondition for the later production of most of the tool types, but is in addition an export/import product in the Saqqaq society in West Greenland.

A similar strategy is found in Independence I, in that tabular blocks from the Ellesmerian Folding in North Greenland are shaped into large preforms; however, in Independence I the reduction method is different. The preform is struck using a quadratic principle, so that the preform becomes four-sided. The four-sided Independence I preform is the basis for the Independence I lithic industry, but the distribution of these cores in Independence I indicates that this preform was not traded or exchanged systematically.

In both Saqqaq and Independence I, series of large flakes are manufactured from the preformed cores. These flakes are used as small blanks and preforms for burins, arrow and harpoon points, and not least as expedient knives. In Independence I, scrapers are also made from these flakes. The actual cores, both the bifacial and the four-sided, are reduced to large bifacial end blades, like knives and lances. In addition to the manufacture of the preformed cores and flake preforms, bifacial roughouts solely for large end blades are made, in both groups.

It might be suggested that there are general features in common in the strategy for the reduction of roughouts in Saqqaq and Independence I, and similarities in the function of the formal tools. However, there are also numerous differences in the final morphology of the formal tools in Saqqaq and Independence I. In Independence I notches are added on the base of the end-hafted tools such as knives, burins and scrapers. In addition, serration of the edges of the cutting tools like arrowheads and knives is often carried out. In Saqqaq the use of notching is seldom seen, like on knives of quartzite from Itinnera (Meldgaard 1961). Serration of edges is also seldom seen, like on an arrowhead at Umiatsialivinnguaq (Kramer 1996b). In contrast to Independence I, on the other hand, grinding of the distal faces is seen as a normal part of the work process in Saqqaq. The burin in particular is ground in Saqqaq, in contrast to the other Early Palaeo-Eskimo groups. However, knives, arrowheads and harpoon points are often ground too in Saqqaq. It would be mistaken, though, to assume that tools are not ground in Independence I. Rigorous grinding is seen on adzes, but grinding is also a part of the manufacturing process in the preparation of bifacial flakes and in the preparation of the striking platform before the striking of burin spalls. One can therefore conclude that there has been knowledge of the same techniques and shaping elements in Saqqaq and Independence I, but that these have a very different priority in the two traditions.

When method and technique of reduction of large cores in Saqqaq and Independence I are analyzed, we see in both groups the preparation by grinding of the core edge before flakes are struck. The method though is a lot more rigorous and frequent in Saqqaq. In Saqqaq, by comparing to modern experiments with flint knapping, large flakes have attributes that show that they probably were struck with a heavy soft hammer by the direct technique (chapter 8, figure 8.1.4). Morphology and attributes on large flakes from Independence I indicate in contrast that they are often made by the indirect technique, using a heavy intermediate piece ('a punch') (figure 8.1.6). Finally, there are great differences in the intensity and quality of blade production between Saqqaq and Independence I. Characteristic of the difference in blade production between the two groups is simply that it has a lower priority in Saqqaq.

When the reduction methods in Saqqaq and Independence I are compared, strategic and qualitative similarities appear, but at the same time different prioritizing of the manufacturing processes and morphology of the individual tool types is also seen. Thus, there are several technological similarities between Saqqaq and Independence I than one, on the basis of a typological examination of the material, might realize. My conclusion is that Saqqaq and Independence I have related but different production concepts for the reduction of the lithic material. This means that Saqqaq and Independence I, from a study of their lithic production concepts and work methods, should be considered as two independent social traditions, but that they probably have their roots in the same tradition, immediately before they develop regionally in Greenland.

Dorset I – Independence II

In Dorset I and Independence II the lithic assemblage is produced from small blanks and block fragments, or from single flakes struck using a direct hard technique. The general reduction of the small cores and blades produces smaller tools than in Independence I/Saqqaq, and a less lithic material. The specialized treatment of the small preforms in Dorset I certainly includes controlled heat treatment of mcq preforms. For the manufacture of bifacial end blades where flat thin and broad bifacial flakes are struck, the direct soft technique is used. The edges of the preforms are prepared by light trimming before flaking. Relatively early in the bifacial work process there is a change to the pressure technique and this technique is used until the final shaping and also when sharpening of the tools.

In addition to the manufacture of the smaller tool types of mcq in Dorset I and Independence II, a production of adzes of rougher stone types, such as basalt, dolerite and killiaq, takes place. The reduction is carried out either by bifacial knapping or by unifacial edge knapping, until the adze can be ground. A direct hard technique is used. The final adze morphology appears to have been formed without a precise morphological standardization. This is in contrast to what we see in the two earlier Palaeo-Eskimo traditions, where adzes are made with great morphological precision, using a direct soft technique and subsequent grinding. The differences in the reduction methods and morphology between the early Palaeo-Eskimo period and Dorset mean that the adzes can be dated relatively between the early and the late Palaeo-Eskimo groups of Greenland. The reason that Independence II and Dorset I do not have a precise morphological standardization of the adzes could be that, in contrast to Saqqaq and Independence I, they are not used to handling large raw materials and they therefore lack both the knowledge and the tools (a heavy hammer of organic material) for a precise reduction of large sized raw material blanks and nodules.

The reduction methods and the production concepts are identical in Dorset I and Independence II. The microblade industry is, in terms of method, size of blades and cores, technique and intensity, very similar in the two groups. Similarly, the manufacture of knives, side blades, scrapers and adzes seems to incorporate the same technological and morphological choices. This applies also to burins, with the exception of the choice of the raw material. The lithic technological difference between Independence II and Dorset thus seems to narrow down to the raw material choice for burins and the number of formal tool types. The latter, though, in my opinion, should be explained in terms of the intensity of the settlement in the two different geographic regions, as discussed above.

The comparison of the lithic reduction methods shows that Independence II and Dorset I have the same material and social tradition. Therefore Independence II and Dorset I can in the future be regarded as the same regional tradition, named Greenlandic Dorset (Grønnow & Sørensen 2006).

Saqqaq – Dorset transition?

Chronologically, from ^{14}C dating, it can be argued that there is an overlap between Saqqaq and Dorset I in central West Greenland (Jensen 2004; Gotfredsen & Møbjerg 2004(b)).

Comparison of the technologies for Saqqaq and Dorset I indicates great differences in the *chaînes opératoires* between the two groups: The choice of raw materials, the prioritizing of blade production over the production of killiaq cores, the shaping of the formal tools, the manufacturing technology and the shaping of handles and hafts are different between Saqqaq and Dorset. It should be highlighted that the burin technology is different, and that bow technology and arrowheads seem not to be found in Dorset I. Only two types of tool manufacture and design are identical in Saqqaq and Dorset I: the manufacture of the side scrapers and of bevelled killiaq blades in late Saqqaq in central West Greenland. The side scrapers are a universal form throughout ASTt and can therefore not be used as a marker of any cultural transition. The bevelled blades are known from Dorset in Canada (Meldgaard 1962; Desrosiers & Gendron in press). It seems therefore reasonable to envisage that Dorset migrated with this technology to West Greenland and used killiaq for their tool making. Saqqaq can independently have begun the making of bevelled blades, but it is more probable that they were inspired by meeting the Dorset groups either in West Greenland or during travels to the High Arctic around 800 BC. From the technological analysis no transformation of lithic technology is found between Saqqaq and Dorset in West Greenland and a transition between the two groups thus seems to be unlikely. A technological transformation from early ASTt to Dorset seems on the other hand to have taken place in the central eastern Arctic region, within the Late Pre-Dorset group, which we will get back to below. To conclude, it does not from a technological point of view seem possible that the Dorset emerged from Saqqaq in central west Greenland.

Late Dorset

When the Late Dorset reduction method is compared with that of Greenlandic Dorset, fundamental similarities are seen. Firstly, characteristic of both groups is the import and use of small blanks and large flakes as preforms for the tool inventory. Secondly, the manufacture of bifacial knives and end scrapers is carried out using the same technology and stepwise morphology. The making of burins and blades is carried out using the same technology but with morphological differences. On the other hand, new morphologies are seen, in the form of harpoon points with concave base, bifacial knives with round base, a new burin technology, large tanged end blades and a new hafting system for microblades. We see in addition that side blades are not used in Late Dorset. The blade production in Late Dorset is characterized by a blade production of large metrical diversity, with some series of heavier blades that are probably made using an indirect technique. The difference in the tool morphology between Dorset I and Late Dorset shows clearly that a development of the technology happened outside Greenland. Last but not least, meteoric iron is introduced during Late Dorset, which probably results in parts of the lithic production being given lesser importance.

From the lithic analyses we can thus conclude that in the Late Dorset technology, clear links can be made back to the Early Dorset tradition in Greenland but, as in the case for Saqqaq-Dorset I, there is no transition apparent between the Greenlandic Dorset and Late Dorset production concepts in Greenland. The transition in fact, as we will get back to below, is found in Early-Middle Dorset in the central eastern Arctic.

Burin technology: The technological marker of the Palaeo-Eskimo traditions

Burin morphology has, since Meldgaard's (1952) recognition of burins in Arctic archaeology played an important role in typological analysis. Generally, with Taylor's work (1968) and after, it has been the consensus to consider burins with ground edge, often called burin-like tools, to be later than burins made by spalling. It has equally been accepted that grinding of the burins' distal ends began as early as in pre-Dorset. Maxwell (1973) tried, in analyses of the Lake Harbour material, to suggest a typology for burins that could be used chronologically. The typology, though, did not take account of the dynamic aspects of the burin technology and Maxwell also doubted the typological analysis' chronological validity (Maxwell 1985: 92). Instead, possibly inspired by the typology and functionality discussion between Binford and Bordes, Maxwell stressed the functional aspects as the cause of the morphological differences. Schledermann (1990), on the basis of analyses of inventory from settlement sites from Bach Peninsula, Ellesmere, introduced a renewed understanding of the burins' morphology and grinding as chronological indicators in the eastern Arctic (Schledermann 1990, 1996: 55). The High Arctic assemblages seem to be suitable for relative chronological analysis because of the presence of small limited settlements, the cultural diversity around 'the North Water' and the isostatic movements since 2500 BC in the Ellesmere region. Schledermann's presentation is exclusively morphological while the manufacturing technology and the dynamics in the burin technology are not incorporated. But as Schledermann points out (1990: 19), the potential for an overall understanding of burins as a tool group, morphologically, technologically and chronologically, is not yet exploited. Schledermann's description shows, though, that burin morphology alone has the potential as a marker for the Palaeo-Eskimo regional traditions (Schledermann 1990: 344 ff.).

Nagy (1997), in her analyses, uses the burin as a chronological indicator, in that she divides the burins up into 'expedient burin', 'spalled burin', 'polished burin' and 'burin-like-tool'. Nagy sees the changes in the frequencies, between the different burin types as an indication of a gradual transition between pre-Dorset and Dorset in Nunavik. Like Schledermann, Nagy takes no consideration of the morphological changes the individual burins can indicate, as a result of usage, sharpening and rejuvenation.

In this study it has emerged that it is precisely burins that are subject to severe morphological changes when they are sharpened and rejuvenated. The current view of burins must therefore be criticized for being fixed in a static morphological approach, where burins are viewed typologically without justified attention to their *chaîne opératoire*. The burin preforms from Saqqaq have, for example, been misunderstood as finished tools interpreted as 'transversal knives', 'transversal scrapers' and 'stanley knives' (Gotfredsen & Møbjerg 2004(b); Hinnerson-Berglund 2004; Jensen 2005).

The technological analysis of burins has shown that burins are made from standardized production concepts. The way in which the burin blade and the edge is sharpened seems to be a very important criterion in order to be able to define and differentiate between the burin technologies of the Palaeo-Eskimo groups in the eastern Arctic. In addition, the choice of raw material, the raw material's form and the form of the base contain significant information that can help the analyst to formulate a relative typological and technological dating of the lithic assemblages (figure 5.4) (Sørensen & Desrosiers 2004; Sørensen 2006(b); Grønnow & Sørensen 2006).

The potential for the analysis of the burin's *chaînes opératoires* in ASTt can be compared to the importance which has been accorded to the results of the analysis of blade production in Europe's Palaeolithic as a relative chronological marker (e.g. Hartz 1987; Boëda 1994; Pelegrin 1995; Madsen 1992, 1996).

An important advantage with the burin as a regional group identifier is that it generally is the most abundant tool type in ASTt, apart from the microblades. Thus, the possibility of achieving a cultural attribution or a relative dating from

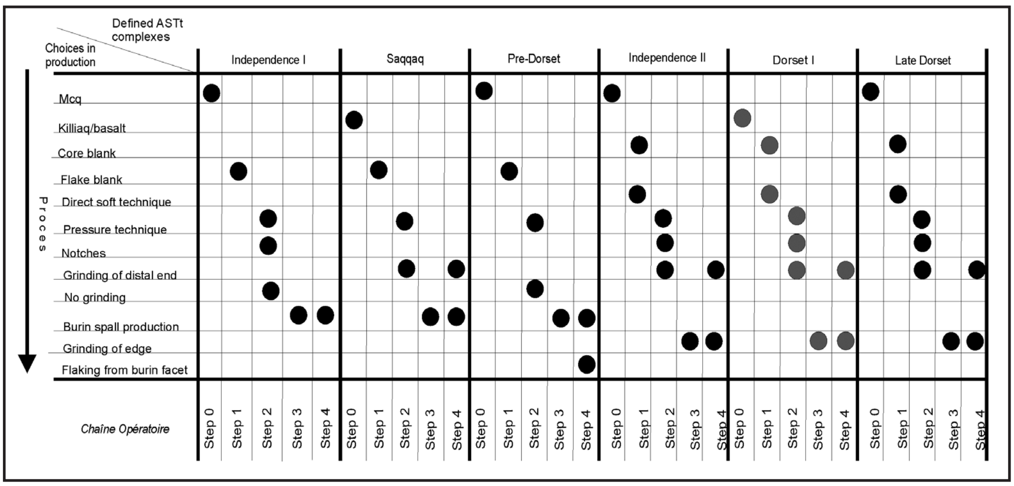


Fig. 5.4 Different characteristic technological attributes and techniques in the lithic production process (vertical) are plotted against the lithic technological choices in the *chaîne opératoire* of the Palaeo-Eskimo traditions found in Greenland (vertical).

the burin technology is possibly the best chance in the ASTt assemblages. Harpoon heads seem to have a finer seriation and typology (Meldgaard 1968), but are much less well preserved. It should be pointed out though that the relative proportion of burins falls in the transition to Dorset, which means that the best possibility for a cultural attribution, using burin technology, is when we are dealing with the early Palaeo-Eskimo regional traditions. The fall can be explained in that ground burin edges can be sharpened almost with no loss of material, so that they achieve a considerably longer usage than burins rejuvenated by burin spalls (see also Nagy 1997: 104).

Regional traditions or 'cousins'?

The attempt to either split or lump ASTt into *cultures* has happened within Greenland's early prehistory several times (Elling 1992, 1996; Appelt 1997; Jensen 2004(b), 2005; Grønnow & Sørensen 2006). The use of the word *culture* is problematic here, though, because it often includes an understanding that the group defined is an independent unit in time and space. This is not the case in the Arctic, as the whole ASTt is bound together by a common knowledge, tradition and technology. It seems therefore much more reasonable to understand ASTt in a time perspective where regional sub-traditions develop, evolve and disappear. Another problem has been that the cultures have often been defined on the basis of single typological elements, typically the absence or presence of specific tool types. At the same time there is a lack of a complete presentation of, for example, the lithic industry or of settlement forms on which the definitions of the cultures might be based.

The problem that is tackled in this study is also concerned with the cultural history of the eastern Arctic. It has, however, been chosen to perceive Arctic cultural history as consisting of regional traditions with historic connections to each other, and to carry out and present systematic analyses of the lithic technology in the Palaeo-Eskimo traditions as a background for the analysis of the cultural history questions. Thereby the rigid perception of culture is softened and a new method and a new set of information is presented that can be included in the discussion.

We are still left with the question as to what the differences and similarities in the lithic technology between the Palaeo-Eskimo regional traditions reflect. As the differences are consistent and general, they represent, in line with this study's methodology, different production concepts. This means that the knowledge of how a process is carried out has been passed down in a tradition between people, here called a regional tradition. The regional traditions should thus be understood as social units with their own variations in ways of expression and their own ways to carry out the manufacturing process. We can only guess at how great the differences between the different regional traditions have been, but in those cases where the regional traditions might have a common history immediately before they develop, as for example in Saqqaq, Independence I and pre-Dorset, or Greenlandic Dorset and Early Canadian Dorset, the differences are probably relatively small. If we transfer the differences we see in the lithic production concepts to other materials and technologies, it seems reasonable to assume that the regional traditions have differed from each other, for example, in variations in their clothing, hunting equipment and language dialects.

There are both similarities and differences between the production concepts in the regional traditions. The differences mean that the regional traditions can be differentiated on the basis of the material culture and thus archaeologically, even when they populate the same areas (e.g. the Thule area). I am of the opinion therefore that from an analysis of the lithic production concepts we should retain the greatest possible social and cultural resolution in the eastern Arctic – both because it is archaeologically possible and reasonable, and because it gives many possibilities for the interpretation of the historical developments which we would be without, if we did not accept even small differences in technology at the conceptual level between the regional traditions.

The methodology: Advantages and problems

There are several advantages by changing the focus from a typological view of the lithic material in which a division of the lithic assemblage into 'waste' and 'tools' is seen to a dynamic view where every single lithic object is seen as a part of a dynamic process, coming from a morphology on its way to becoming a new morphology. First and foremost, the lithic material is made to tell a 'new story' dependent on the dynamic process and the prehistoric peoples' thoughts and actions. The changed view of the artefact material therefore adds a rewriting of the story with the potential of being much more 'human'.

In this study, the lithic material is studied with the aim of examining the sequence of the early cultural history in the eastern Arctic. Therefore, the primary interest is concerned with the general operative production concepts for the lithic production, their development and internal relations. In the analysis of these relationships, dynamic technological classification is used, set up on the basis of technological reading, refitting of preforms and modern controlled experiments with lithic reduction. The dynamic technological classification has been highly suitable for the analysis of the lithic material from ASTt because every single functional artefact type in this tradition was made using very precise technological, morphological and often raw material standards. When the artefact types generally are very precisely worked, often through a long process, then the roughouts and preforms are also precisely worked and chosen, which means that they can be morphologically and technologically defined and they can therefore be identified relatively easily. The lithic materials from the Palaeo-Eskimo groups are therefore especially suitable for dynamic technological classification and for the questions that can be tackled using this methodology (see also Sørensen 2006(b)).

The *chaînes opératoires* are documented by drawings of the original individual artefact's morphology. This documentation is not problematic for the Low Arctic regional traditions in West Greenland because the assemblages from these traditions are numerous. More problematic is the documentation of the *chaînes opératoires* in the High Arctic because the amount of material found in even the largest settlements is often restricted. To be able to attain an interpretation of the *chaînes opératoires* for the High Arctic groups, it has therefore been necessary to compare lithic artefact material from several settlement sites. To find documentation for the individual steps, almost every assemblage from Independence I, Independence II and Late Dorset have been checked at The National Museums in both Copenhagen and in Nuuk. For the Late Dorset, the material in the above-mentioned institutions is so limited that it has also been necessary to look into the published Canadian material to be able to understand and document the *chaînes opératoires* for this tradition. Technological analyses carried out on the basis of published material, especially with the photographic reproduction that characterizes the Canadian research tradition, are not optimal as the artefacts' full morphology and technology are difficult to study from photographs.

The analysis of the technique that is used in the manufacture of the stone tools in the eastern Arctic is primarily carried out on the basis of qualitative observations of flake material preforms and presumed prehistoric tools for flint knapping. The analysis of the technique is thus to a certain extent given lower priority in relation to the analysis of the reduction methods. This choice was made because the analysis of the reduction method is the direct way to analyze the production concepts that this study deals with. In the future, there will be many possibilities to carry out analyses where many more attributes can be included and where more detailed interpretation of the techniques used in the East Arctic can be presented. However, it also has to be remembered that the interpretation of the applied prehistoric techniques will always be based on analogy to experimental materials, while the reduction methods can be demonstrated through dynamical technological classification and refitting. Thus, the reduction method can be described with the largest scientific certainty.

Source criticism

Different people excavated the analyzed settlement site assemblages, in different times with different research questions and different methods. In relation to the technological analysis the spatial distribution of the assemblage plays a less important role. Settlement sites excavated by Knuth, where the artefact material was 'only' recorded in relation to the construction it came from, can therefore still be used in the analysis. On the other hand, it is strictly necessary to be sure that the settlement site assemblages analyzed are not mixed. In this study, this aspect is accounted for in the introduction to each material section. Only one of the settlement sites analyzed, Ikkarlussuup Timaa, has a slight mixing from a different culture group. In this context the contamination is judged to be of little importance, as the artefacts must have been introduced with turfs from another settlement phase. Moreover, the material is compared with a similar Dorset I settlement from the same region.

In addition to different types of spatial documentation, the different excavation methods are reflected in the representativity of the assemblages collected. It is particularly obvious whether sieving was used or not during the excavation. If a sieve was used the proportion of small flakes rises, and thus the proportion of flakes to worked artefacts rises. This phenomenon is most distinct in the re-excavations of Adam C. Knuth site. In the technological analysis, though, the proportion of flakes to worked artefacts is practically not of great significance, because the methods in this study are generally qualitative. Settlement sites excavated without the use of sieves are therefore used without reservations in this study.

Chapter 6
Greenland's prehistory interpreted on the basis of analyses of lithic technology

In the study of Greenland's early cultural history it is far from enough to look at the archaeology of Greenland. Both the material remains and the migration of the later Thule Culture tells us that the hunter-gatherer societies in the Arctic have had an almost incomprehensible mobility. Researchers that work within local areas can have a tendency to consider 'their area' as a 'closed system', which can lead to improbable culture-historical interpretation seen from a wider Arctic perspective. When we find it difficult to understand mobility in Arctic cultural history it is probably due to our own limitations. Archaeology is carried out today primarily by Europeans or migrated Europeans who have roots in an at least 6000-year long agrarian ancestry, where, from an Arctic perspective, a lifetime's ownership of a very small piece of land has been the norm.

Arctic Small Tool tradition: The Denbigh flint complex

The interpretation of cultural history in Greenland will in this section start with the first populating of the Arctic, 'the Arctic Small Tool tradition' (ASTt).

Generally, it is agreed that ASTt developed in the Bering area, with roots in the palaeo-Siberian cultures in the Upper Palaeolithic in Central Asia. Two technological arguments have formed the basis for the postulation of the ASTt's palaeo-Siberian origins: the concept for the manufacture of microblades using the pressure technique from wedge-shaped cores, and the burin technology. These two technologies also today define ASTt (Meldgaard 1952; Maxwell 1985; Dumond 1987; McGhee 1996).

As ASTt develops and adapts to marine prey in the Arctic with a technology that makes this possible, a lithic technology also develops that consists of very small and very finely worked tools. The tradition has been named ASTt due to the fact that the tools are generally small and well shaped (Irving 1957). Technically the small and very precisely made tools can be explained in that ASTt, in contrast to other Stone Age cultures, uses the pressure technique in the manufacture of their entire lithic tool assemblage. The usage of the pressure technique gives an optimal control in the manufacturing process, and thereby precise standardized morphological characteristics, even on very small tools.

The early phase of ASTt in Alaska is named 'the Denbigh flint complex' (Denbigh) after excavations at Cape Denbigh, of the site 'Iyatayet'. Iyatayet was dated in the early years of the ^{14}C method to the period around 2000 cal. BC (Giddings 1964). It is a problem that only very few settlement sites in Alaska/Beringia can be dated with certainty to an early ASTt phase, c. 3000 BC, and that those that have been found are small inland sites without many finds (for example Kuzitrin Lake dated to the middle of the 4th millennium BC (Harritt 1998)). In addition, early settlement sites from Denbigh are generally not well researched, dated or well published. It is therefore difficult to study the early assemblages that are taken to be the origin of ASTt.

The lithic technology and morphology of the lithic artefacts from Denbigh, at Iyatayet, apart from the very small side blades with fine parallel pressure retouch and bifacial points with concave base, does not stand out significantly from the

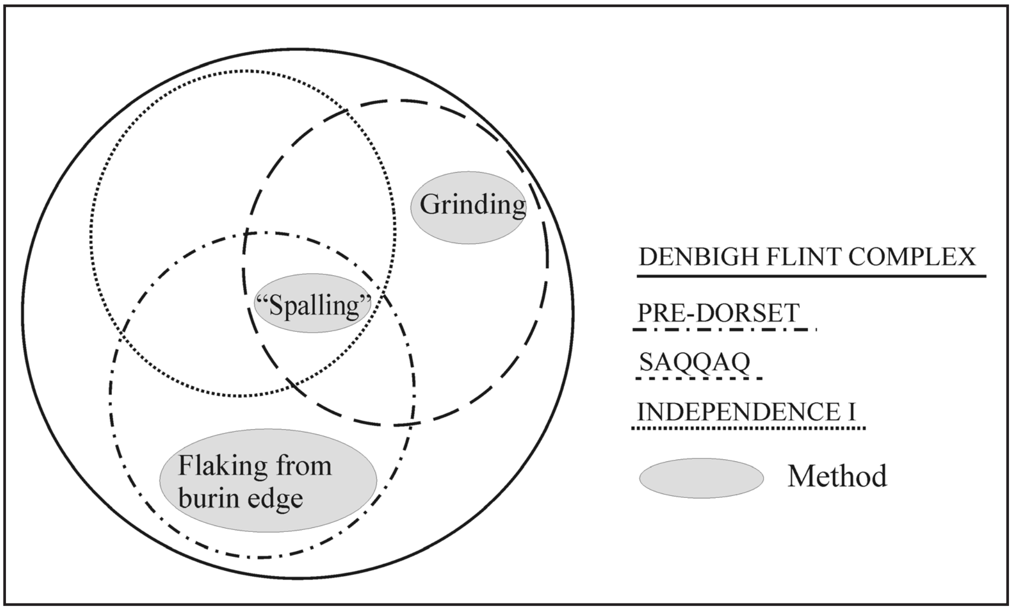


Fig. 6.1 Burin rejuvenation methods in the early Palaeo-Eskimo groups. The 'Denbigh flint complex' uses all the burin rejuvenation methods found in the early Palaeo-Eskimo groups.

Early Palaeo-Eskimo groups' lithic technology and typology in the Central and East Arctic (pre-Dorset, Independence I and Saqqaq). If the burin technology is analyzed, which is perhaps the most important Palaeo-Eskimo group marker, we see that all the burins at Iyatayet are made by spalling. The sharpening method for the Denbigh burins consists of three methods: grinding of the burin face, pressure retouch across the face from the spalled edge and no reduction. This observation is interesting because it shows that the Denbigh burin technology encompasses all the burin sharpening methods that Saqqaq, Independence I and pre-Dorset use, and which distinguishes these (see figure 6.1). In all, the analysis of the burin technology in Denbigh seems thus to confirm that Denbigh is the root of the other regional traditions in the eastern Arctic. Yet another observation concerning burin technology in Denbigh is that only burins of basalt have ground faces. Burins of mcq are sharpened differently, which is an argument for the suggestion that the choice of raw material is the original determinant for the choice of the sharpening method of the burin. This observation is interesting because this technological choice can explain the background to the fact that Saqqaq grind their burins' distal faces when they choose to use killiaq in West Greenland.

The Early Palaeo-Eskimo regional traditions in the easternmost Arctic: Independence I and Saqqaq

From the technological analyses great similarities are found between Independence I and Saqqaq. Both groups master, and carry out, the same methods and techniques and they use the same functional tools, with the exception of a very few rare tools in Saqqaq (saw, awl and strike-a-light). The lithic tools are indeed often executed even with the same morphology. As mentioned in the previous chapter, neither the blade industry, the idea of bringing preformed cores for the manufacture of the tool inventory or the manufacture of serrated edges and notches, are unique for Independence I or Saqqaq. These are all found in both regional traditions. Some of the few technological characteristics that differ in the two traditions are the knapping method of the large cores and the sharpening method for the burins, mentioned above.

That I am still of the opinion that we should maintain that the two complexes are two regional traditions is primarily because of three arguments: 1) The different choice of raw material, 2) the choice of the intensity by which the different technologies are carried out, and 3) that the two groups are found separately during the same time, in regional areas of Greenland.

In terms of the choice of raw material, which in West Greenland is dominated by killiaq and in North Greenland by mcq, differences cannot be explained by the local or regional geology. Killiaq and basalt types are found in northwest Greenland, just as in West Greenland rich sources of mcq are found which Dorset I later exploited. Therefore a significant difference between the two groups is that they basically have difference choices of raw material. The argument can be stressed by pointing out that when Saqqaq is found in North Greenland, the same choice of raw material (killiaq) is made in this region as in West Greenland.

In terms of the intensity of the technology utilized, it can be stated that blade production and the making of notches and the serrated edges is prioritized much higher in Independence I than in Saqqaq. The variable blade production and the grinding of the burins in Saqqaq can, as it has previously been suggested (Elling 1996), derive from the choice of raw material whereas the intense use of serration and notching in Independence I cannot be due to this, and must alone be a product of different traditionally favoured habits.

That the two groups have their core areas in different regional areas of Greenland during the same time indicates that they have kept their own social traditions in each of their 'core areas'.

Whether this logic holds water lies in the test as to whether the two groups' settlement sites and assemblages can be differentiated when they are found in the same area. In the Thule area both groups are found and they can in fact reasonably easily be differentiated by their different burin technology and raw material choice (Schledermann 1990). There seems therefore to be no reason not to keep the Saqqaq and Independence I as two contemporaneous social groups and traditions in the eastern Arctic.

The origin of Saqqaq and Independence I

An interesting question then is: where and when did Saqqaq and Independence I emerge? As neither Saqqaq nor Independence I are known from before 2600 BC, can we, from the above considerations, take it as probable that they were part of the same group between c. 2700–2600, probably an early form of the Denbigh that split up either in Alaska, in the central eastern Arctic area or in the Thule area. As Saqqaq has not been recognized west of Ellesmere Island and at the same time has its earliest dates in West Greenland (earliest Saqqaq dating is from the settlement site Qivitup Nuua in the Sisimiut area, dated to 4010±90 BP (uncalibrated) on Betula nana, calibrated 2620–2410 BC (Kramer 1996b)), it is reasonable to presume that Saqqaq developed in West Greenland. Around c. 2600 BC an early ASTt group, either pre-Dorset, Denbigh or Independence I, must have migrated down in West

Greenland from 'the Gateway to Greenland' (the Thule area). The group must have quickly discovered the rich West Greenland resources including the killiaq sources near Qaarsut, northern Nuussuaq. One of the reasons that we do not know which regional tradition the Saqqaq came out of is that the transition to Saqqaq must have happened quite quickly. Until now, the only example of a possible transitional site is the settlement site of Ikerasak, which has the earliest dating in Disko Bay ((Ka-6990) 3980±70 BP, on locally grown wood, calibrated to 2570–2410 BC). The assemblage includes a burin of mcq that has not been ground and has a trace of notches (Jensen 2004(a): 61). The settlement site's dating, though, can be e.g. 100 years too old, due to the possible age of the locally grown wood. The settlement site of Asummiut (SIK 173) in Sisimiut Kommune should also be mentioned. The settlement site has not been ^{14}C dated, but its position 12–13 m above sea level and 120 m from the fjord indicates an early date (Kramer 1996(b)). In the assemblage are both arrowheads and harpoon points with serration, which is an Independence I/Denbigh characteristic (Gotfredsen & Møbjerg 2004(b): figure 200).

Lab. No.	Site name	Material	^{14}C. BP	Calibrated BC*	Reference
AAR-1182	Røde Hytte	Charcoal (Salix arctica)	4000 ±75	2850–2340	B. Sandell, unpublished information 2005
AAR-1184	Røde Hytte	Charcoal (Salix arctica)	4030 ±90	2860–2460	B. Sandell, unpublished information 2005
K-938	Pearylandville	Charcoal (Salix arctica)	3950 ±120	2620–2210	(Grønnow & Jensen 2003)
TO993	Lake view F 30	Charcoal (Salix arctica)	3940 ±70	2570–2300	(Schledermann 1990)
K-5075	Kettle Lake, N4	Musk ox bone (Ovibos moschatus)	3920 ±85	2570–2280	(Grønnow & Jensen 2003)

Table 6.1 Radiocarbon dates, selected Independence I sites

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

The earliest screened[6] Independence I dates are from around 2500 BC and are from the settlement site Røde Hytte on Jameson Land (*Salix*), Pearylandville, N24 (*Salix*), Lake View F 30 (*Salix*) and Kettle Lake, N4 (*Ovibos*) (table 6.1). The date from the southernmost Independence I settlement site, Røde Hytte, is Greenland's earliest screened dating (BP uncalibrated). The dating is remarkable as it shows that Independence I, during its pioneer phase, possibly within few generations spread from Ellesmere to Scoresbysund. Two small long bifacial end blades made from mcq were found at Røde Hytte (Sandell & Sandell 1999). This tool type is unique in Greenland, but comparable to material from Alaska. The explanation for this must be that a technological knowledge of tool types in the western Arctic partly existed in earliest Independence I. From the typology and the technology in Independence I we must maintain the conclusion that the group is closely related to Denbigh in Alaska and that it thus must have come to Greenland from the west, over the Thule area.

Saqqaq's regional settlement

Saqqaq developed a permanent and growing human and social tradition in West Greenland – a tradition in which their own habits and priorities for the manufacture of the lithic inventory also existed and the group can therefore today be defined as Saqqaq. However, the group also migrated into East Greenland. During a survey of Wollaston Forland and through an examination of material from this area, stored at Greenland's National Museum and Archive, the northernmost find material from Saqqaq in northeast Greenland is now known. The finds consist of a single burin of basalt with ground distal end of Saqqaq type found in the estuary of Young Sund at Kap Berghaus (figure 6.2 and 8.2.34), and several large bifacial cores of Saqqaq type made from the local basalt, found at Kap Berghaus and Grønlænder Huse (figure 8.1.2.30: P) (Andersen 1975; Sørensen & Andreasen 2004). Material from Saqqaq on the east coast is known also from the area around Scoresbysund (Sandell & Sandell 1999) and Ammassalik (Møbjerg 1988). At the same time we find Saqqaq in northwest Greenland (Madsen & Diklev 1992) and on Ellesmere (Schledermann 1990). In South Greenland, until now, the Saqqaq material has only turned up as stray finds (pers. comm. G. Nygård and H.C. Gulløv, 2005).

6 Screened means that the dating has been carried out on material from an archaeological context and that the material is either bone from an animal with a terrestrial diet or is of locally grown wood.

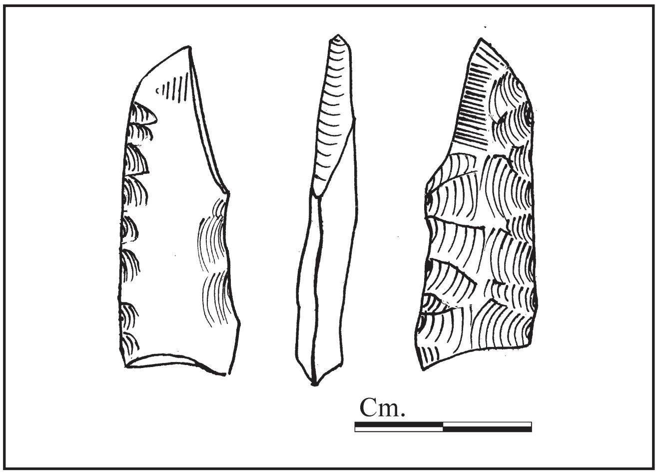


Fig. 6.2 Burin made from fine-grained basalt. It has a ground distal end and a narrow morphology, both typical in the Saqqaq tradition. The burin was found at the Kap Berghaus site on Wollaston Forland. This burin is hitherto the most northern indication of Saqqaq in Northeast Greenland.

Independence I's regional settlement

Finds typical for Independence I are found at Port Refuge on Devon Island (McGhee 1979) in the west, over Ellesmere (Schledermann 1990), in North Greenland (Grønnow & Jensen 2003) and along the coast of East Greenland to Scoresbysund (Sandell & Sandell 1999).

Overlap in the geographical settlement between Saqqaq and Independence I

Saqqaq and Independence I are divided in Greenland in that Independence I is found in North and northeast Greenland, while Saqqaq is found in West, South and southeast Greenland and up along the east coast to Wollaston Forland. There are therefore two areas where Saqqaq and Independence I can have lived 'side by side': In North Greenland and in central northeast Greenland.

At the settlement site 'Store Sten', by Scoresbysund, tools typical of both Independence I and Saqqaq, and tools from Dorset I, are found (Sandell & Sandell 1996, 1999). The settlement site was excavated in single structure contexts but characteristic tools from both Saqqaq and Independence I have been found in several of these structures. In structure B2, a light c. 3-metre-wide depression with some kerb stones, several find concentrations were found, including a ground awl and burin spalls of a killiaq-like material with grinding, tools typical of Saqqaq. In the same structure, wide end blades, broad microblades and burins and burin flakes of mcq without grinding were found, all characteristic of Independence I. Similarly, structure 9, interpreted as a tent ring, contained a large assemblage characteristic of Independence I, including 11 mcq burins without grinding but at the same time the structure contained a ground awl of killiaq, characteristic of Saqqaq.

The constructions and finds from 'Store Sten' raise the question as to whether there existed a mixing of Saqqaq and Independence I in northeast Greenland, as suggested by H. and B. Sandell (1999: 145), or whether the constructions had been used several times by different groups. The latter is certainly the case for structure 6, interpreted as a tent ring, in that it contained finds typical of Independence I and Dorset I and has two dates from the Dorset I settlement phase (AAR-2390 (*salix*) 2370 ±75 BP and AAR-2391 (*salix*) 2180 ±70 BP (uncalibrated) (Sandell & Sandell 1999: 99)).

In this connection the settlement site Grønnedal, on the north side of Clavering Ø, Young Sund should be mentioned (Sørensen & Andreasen 2004). In structure 5 from this settlement site a burin made from a killiaq-like material was found. The burin had both notches and grinding of the distal end and is made from a killiaq-like material (figure 6.3 and figure 8.2.35). Thus the burin is an indicator of a technological choice that is typical for both Saqqaq and Independence I. The burin can therefore be seen as a product of the meeting of Saqqaq and Independence I in central northeast Greenland. But probably more likely, it is an example of Independence I, in rare cases, choosing killiaq-like material for burins and using grinding in the manufacturing process, as their predecessors, the Denbigh in Alaska, had done.

The problem with the overlap and the possible mixing of Saqqaq and Independence I on Greenland's central northeast coast cannot be solved without archaeo-

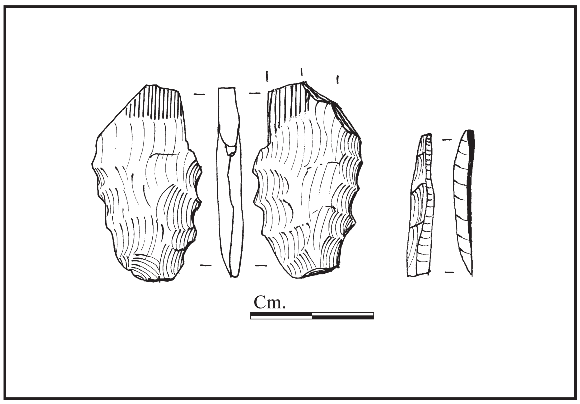


Fig. 6.3
Burin with notches and grinding of the distal end made from schist. The burin was found in structure 5, the Grønnedal site (Sørensen & Andreasen 2004). This burin is probably an atypical Independence I product.

logical analyses of the area between Jameson Land and Young Sund. In addition, we are missing radiocarbon dating of Saqqaq and Independence I between Scoresbysund and Wollaston Forland. Today, the northernmost Saqqaq dating is from the east coast at Ammassalik (Møbjerg 1988).

On Ellesmere, the overlap between Saqqaq and Independence I can be examined on the basis of only two reliable dates. The dates are, respectively, from the Independence I settlement site Lake View F 30 site (*salix*) 3940 ±70 BP (uncalibrated) and the Saqqaq settlement site Bight Site F.2 (*Ovibos*) 3840 ±70 BP (uncalibrated) (Schledermann 1990) (table 6.2). The relatively few short-lived settlements that have until now been found, and the large spread in time, means that the likelihood that Saqqaq and Independence I were present in the same season is very slim. Future fieldwork on Ellesmere and particularly in the Thule region and absolute dating of Saqqaq and Independence I settlement sites will decide whether there really has been contact between the two groups.

Lab. No.	Site name	Material	^{14}C BP	Calibrated BC*	Reference
TO1556	Bight, F2	Musk ox bone (Ovibos moschatus)	3840 ±70	2460–2200	(Schledermann 1990)
TO993	Lake view F 30	Charcoal (Salix arctica)	3940 ±70	2570– 2300	(Schledermann 1990)

Table 6.2 Radiocarbon dates, Saqqaq and Independence I sites on Ellesmere Island

*1) Calibration by Stuiver et al. (Stuiver, M., P.J. Reimer et al. 1998). Calibration by 1 standard deviation (68.2 %).

Saqqaq's development

Technologically, only few changes materially take place during the c. 1700 years that Saqqaq is found in Greenland. The introduction of the soapstone lamp is one of the few distinct features that has a clear chronological significance, in that the lamp defines the Later Saqqaq (Møbjerg 1999). In addition a gradual reduction in the width of the burin base is seen during the Early Saqqaq, and an increase in the use of Qaarsut killiaq in the Disko region, also during the Early Saqqaq (Grønnow 1996). Additionally, the latest phase of Saqqaq is characterized by the use of bevelled killiaq knives, a feature that can be interpreted as inspired by the Dorset tradition (Gotfredsen & Møbjerg 2004(b)). In the latest phase of Saqqaq, at Nipisat in Sisimiut Kommune, a change in the choice of raw material is seen, from around 90% killiaq in phase 2 (1860–1325 cal. BC), to 70% killiaq and 25% quartzite in phase 3 (1370–810 cal. BC). It seems probable that the reduction in the proportion of killiaq is due to changes in a Saqqaq exchange network, linked to do with a depopulation of the Disko region (Jensen 2004).

In spite of the introduction of a later Saqqaq phase and a possible transition phase between Early and Late Saqqaq (Gotfredsen & Møbjerg 2004(b)), Saqqaq must be described as the most conservative Palaeo-Eskimo regional tradition in the Arctic in terms of the material. The problem deserves to be studied. Because of the geography of the Arctic, where Greenland is 'the last island in the eastern Arctic', and considering the limited High Arctic accessibility, the possibilities for regular contact to Palaeo-Eskimo groups in central Arctic was difficult (Meldgaard 1976). A geographically isolated position in West Greenland and thereby a limited communication with other Palaeo-Eskimo groups can be an important factor in Saqqaq's conservatism.

Dorset: The Canadian connection and the second circum-population of Greenland

The second circum-populating of Greenland occurs with Greenlandic Dorset. While Saqqaq maintained their lithic technology almost unchanged for over 1700 years, pre-Dorset in Canada developed their technology in several ways. Firstly, microblade production was maintained and perfected to a concept where blades were mass-produced with a very standardized morphology (Owen 1988). The pre-Dorset microblade production is both methodologically and metrically similar to the microblade production in Greenlandic Dorset. In addition, in late pre-Dorset, as in Greenlandic Dorset, bifacial end blades with a right-angled base and distinct wide notches were developed. However, also side blades and the end scraper morphology with flawing edges seems to be a Late pre-Dorset inventions (e.g. Port Refuge, Pita Site, Killilugak Site, Ridge Site (Maxwell 1973; McGhee 1976, 1979; Schledermann 1990; Harp 1997; Nagy 1997)). A gradual development from burins with struck edges in Early pre-Dorset to burins with partially ground edges and distal end in Late pre-Dorset is seen (e.g. Pita Site, Killilugak Site, Nukasusotok 2, Tuurngasiti 2 (Maxwell 1973; Harp 1997; Nagy 1997; Fitzhugh 2002; Sørensen & Desrosiers in prep.). The development in the burin morphology and technology in Late pre-Dorset results in burins with ground distal surfaces and edges, like those known in Early Dorset and in Greenlandic Dorset. At the same time the irregular burin base in Early pre-Dorset becomes a broad well-shaped asymmetrical burin base with notches in late pre-Dorset, Early Dorset and in Greenlandic Dorset. The development of the lithic technology in the central eastern Arctic, and namely the burin technology, thereby implies that Greenlandic Dorset developed from Late pre-Dorset. Apart from the lithic assemblage, the harpoon typology between Late pre-Dorset and Early Dorset/Greenlandic Dorset also shows a gradual development that can confirm a continuous development in the central eastern Arctic (Meldgaard 1962, 1968). Other non-lithic characteristics for Dorset are the remarkable absence of the use of bow and arrow, and of drilled holes. The latter can possibly be connected with bow technology, as a bow for drilling is missing (Gulløv 2004: 21). Technologically as well as typologically, Greenlandic Dorset is the equivalent, to a great degree, to Late pre-Dorset and the earliest Dorset in the central eastern Arctic.

The earliest screened ^{14}C dating of Greenlandic Dorset is from Phalarope site on Sommerset Island, dated on a caribou bone to 2610 ±25 BP, calibrated 810–785 BC, that is, just before the calibration plateau between c. 800 and 400 BC (Damkjar 2003). The early dates of Greenlandic Dorset in Greenland fall between 800 and 400 BC (Jensen 2004(a), 2004(b)). Thus, evidence from radiocarbon dating indicates that Greenlandic Dorset has a Canadian eastern Arctic origin.

All in all, it therefore seems sensible to understand Greenlandic Dorset as a development of Late pre-Dorset, which, around 800 BC, migrated from central eastern Arctic through the Thule area, and from there both north and south into Greenland. The northern migration resulted, on the basis of the sporadic archaeological material and radiocarbon dating, in a short settlement phase, perhaps only lasting for one generation. The Low Arctic coasts along West Greenland, South Greenland and in East and northeast Greenland, however, were used for up to 800 years.

Greenlandic Dorset's immigration route to East Greenland

It has until now been difficult to say with certainty as to whether the migration route to East Greenland was south or north of Greenland, not least because E. Knuth per definition excavated Independence II in northeast Greenland. It was not until the full publication of Knuth's work in northeast Greenland that it became clear that the northern Dorset migration was of a short and sporadic character, and took place in as a pioneer phase within the first calibration plateau, between 800 and 400 BC (Grønnow & Jensen 2003; Andreasen 2004). The dating of Greenlandic Dorset in Jøkel Bugt and Dove Bugt are on the other hand often later and fall typically around 400 and 100 BC (Andreasen 2004: 115). As discussed above, the choice of material for Dorset burins in Jøkel Bugt and Dove Bugt, including the aggregation camp Île-de-France, reveals that the migration to this area is characterized by the same choice as in Disko Bugt. The migration to central East and northeast Greenland must therefore have taken place south of Greenland. This hypothesis is supported by the fact that in Jøkel Bugt and Dove Bugt no raw materials from the Ellesmerian Folding, that might indicate migration from the North, have been found.

Thus, from artefact material and radiocarbon dating it seems reasonable to assume that northeast Greenland south of Holm Land was populated from the south; however it cannot be excluded that few Dorset groups can have come into the area from the north in the early phase and that they can have met with Greenlandic Dorset groups coming from the south of Greenland.

It should in this connection be mentioned that at the 'Independence II' settlement site Eigil Knuth Site, Holm Land, dating to 800–400 BC, remains of structures marked with black stones were found. These might have been a kind of territorial or ownership marker (Andreasen 1998, 2004). A similar construction marking was found with red stones in the Thule area on Peel and Frykman site, belonging to the Early Dorset (Peel & Frykman 1975). As the Thule area is characterized by great cultural diversity, the idea of ownership markings here is taken to be a reasonable interpretation. The marking of the constructions at Holm Land can be a symbolic marking for other Dorset groups in the area. It should be stressed, however, that there are several other possible interpretations as to the meaning of the marked structures (Andreasen 1998: 206, 2004: 133).

Greenlandic Dorset's development

Internal absolute radiocarbon dating of the Dorset period are difficult to attain because of the above-mentioned calibration plateau, but the assemblage's uniformity in the whole of Greenland is striking, and does not lend itself to many changes in the lithic technology, neither regionally nor diachronically. The Greenlandic Dorset assemblages indicate, as in Saqqaq, great conservatism.

Over the period where Greenlandic Dorset is found, there is on the other hand a distinct development of Dorset in the Canadian Arctic. From around 500 BC, Middle Dorset is defined by new tool typologies and an architecture that indicates larger and more permanent settlements in Low Arctic Canada (Maxwell 1985; Murray 1999). The cultural history of Greenland is thus repeated from the earlier

Palaeo-Eskimo groups in the eastern Arctic to a certain degree: A Palaeo-Eskimo group, here Greenlandic Dorset, inhabits Greenland and remains technologically unchanged over a long period while a development of the Dorset lithic technology continues in the central eastern Arctic.

Late Dorset: The last Palaeo-Eskimo society in the Arctic

Late Dorset's lithic technology indicates both a traditional ASTt tradition, and in Greenland a new variation with an emphasis on new morphologies and technologies. Microblade production by pressure technique and a very fine bifacial production by bifacial reduction and pressure technique are the basic elements from earlier ASTt. However, we see, in addition, technological habits that clearly confirm the association with Late pre-Dorset, Early and Middle Dorset, namely the ground burin edges and flawing lateral edges on the end scrapers. The choice of fine-grained mcq as raw material, and the exploitation strategy and shaping of individual preforms, rather than large cores, is typical for both Greenlandic Dorset and Late Dorset. Finally, we see that holes are still not bored and that no arrow armatures are produced. Bow technology is probably thus absent throughout all of Dorset.

The new lithic reduction methods and characteristics that are introduced to Greenland by the Late Dorset include: 1) The manufacture of large blades probably by indirect technique, 2) The manufacture of bevelled square burin blades with square cross-sections and ground edges, 3) The manufacture of harpoon points with a concave base, and 4) The manufacture of end blades with rounded bases.

These characteristics and methods are different from Greenlandic Dorset but are known, on the other hand, from Middle Dorset, in the southern and central eastern Arctic.

One element of Late Dorset technology that is fairly unique in ASTt is the beginning of the use of metal, particularly meteoric iron from the Thule region. The metal is hammered out to small blades that have superior breaking strength and durability compared to the lithic material. The use of iron means that small cutting tools like blades and burins could advantageously be produced in iron. The thin metal blades make it possible to cut very thin grooves in organic materials, and we see several hafting methods of microblades into slots (Owen 1988; Mary-Rousselière 2002) (figure 4.5.27). Finally, meteoric iron can be a reason that especially burin and microblade production degenerates or minimizes respectively in Late Dorset. A parallel to this development is found in the European Bronze Age for several lithic tool types, with the introduction of bronze. It should be noted that the meteoric iron apparently has no influence on the making of large bifacial lithic blades, harpoon points and large knives. These tools are still made with great quality, presumably because the meteoric iron cannot be used for these tool types.

The gateway to Greenland: The region with the greatest diachronic cultural diversity in the eastern Arctic

The interim archaeological and technological analysis of the lithic assemblages from the Thule region shows that apart from Saqqaq, Independence I, Greenlandic Dorset and Late Dorset, two previously unknown Palaeo-Eskimo regional traditions are to be found. The two 'new' Palaeo-Eskimo regional traditions in Greenland are both located just north of Humboldt Gletscher on Washington Land. The first is Canadian pre-Dorset, recognized on the settlement site Solbakken, structure 13 and by stray finds from Pullersuaq. The second group is Early Canadian Dorset, characterized by a special burin technology, from structures on Winstedt Site and Pullersuaq. The Thule region has thus a special status as the most culturally diverse land area in prehistoric Greenland, with a diachronic presence of six Palaeo-Eskimo regional traditions: Saqqaq, Independence I, Pre-Dorset, Early Canadian Dorset, Greenlandic Dorset and Late Dorset. The remaining part of Greenland is during the same time period 'only' inhabited by two–three Palaeo-Eskimo regional traditions, Saqqaq/Greenlandic Dorset (West and South Greenland) or Independence I/Saqqaq/Greenlandic Dorset (North and northeast Greenland).

The productive 'North Water' polynya between northern Canada and Greenland attracted Palaeo-Eskimo groups from the enormous land/coast areas in both Greenland and Canada (Schledermann 1990, 1996; Sutherland 1996). Modern satellite photos show that the 'North Water' has a tendency to open at Greenland's and Ellesmere's coasts respectively, depending on currents and wind conditions (Schledermann 1980). If this was also the case in prehistory it can explain that the prehistoric groups inhabiting the area utilized the coasts in both the Thule area and on Ellesmere for hunting and settlement. Ellesmere's cultural history is thus mirrored in Greenland. This is an important factor for our understanding of the Thule region, which over prehistory was visited by several central eastern Arctic Palaeo-Eskimo groups from regional traditions that otherwise are not known from the rest of Greenland. It is reasonable to regard the 'North Water', between Thule and Ellesmere, as a magnet that attracts people to the extreme eastern High Arctic. The 'North Water' can therefore be described as the natural reason for Greenland's repeated discovery and population by the Palaeo-Eskimos.

Conclusion

From the lithic technological focus that this study takes, Greenland must be described as a land that is circum-populated twice by Saqqaq/Independence I and Greenlandic Dorset respectively. The Thule area is inhabited, on the other hand, diachronically by as many as six ASTt regional traditions: Saqqaq, Independence I, Pre-Dorset, Early Canadian Dorset, Greenlandic Dorset and Late Dorset.

The two circum-populations of Greenland in ASTt both happen along the same lines: After discovering Greenland the High Arctic Greenland was abandoned relatively quickly after which the group consolidated in Low Arctic Greenland. Particularly Disko Bugt and the West Greenland coast seem, from the archaeological studies, to have been intensively settled in prehistoric times. In these areas the technology was maintained in Saqqaq and Greenlandic Dorset respectively, unchanged over long time epochs, while the development of the technology continued in the Palaeo-Eskimo traditions in the central eastern Arctic. In this way Greenland, with the exception of the Thule region, is an Arctic area characterized by few cultural units and great cultural conservatism during its early prehistory.

Due to the few migrations and the technological conservatism that dominated, Greenland's early cultural history, with the exception of the Thule region, was relatively simple in comparison with the Central and West Arctic. Only the transition to Saqqaq and possibly Independence I happened in Greenland. No other technological transitions or transformation phases need to be studied and understood to attain a description of the culture-historical development in Greenland's prehistory. The Thule region is, due to its cultural diversity, more difficult to understand and interpret. The settlement of the area seems, with the exception of Late Dorset, to be characterized by sporadic activity of all the eastern Arctic regional traditions except Middle Dorset. The challenge in this region is most importantly to be able to distinguish between the different groups and regional traditions in the archaeological context. ^{14}C dating is of limited help in this context, both because of the method's inaccuracy and because several of the ASTt regional groups apparently inhabited the area within the same time periods. However, the technological analyses of the lithic assemblages and the variations that exist between the regional traditions particularly in terms of burin technology seem to be the best way to identify the different ASTt regional traditions in this area.

Chapter 7
The usefulness of the technological methodology and future possibilities in Arctic archaeology

The cultural history

By using the dynamic technological methodology in the study of the lithic assemblages in the defined Palaeo-Eskimo cultural groups in Greenland, it has been possible to make a number of new observations, bring a new set of information into play and thereby revise Greenland's early cultural history.

The primary cultural historical conclusions are that Saqqaq and Independence I should be considered as two contemporaneous regional traditions in Greenland. The two traditions have occupied Low and High Arctic respectively, but are found together in the Thule region and in central East Greenland. As to whether they have been present simultaneously in these areas cannot be asserted today with certainty, but it should be mentioned that there is a possibility that the two traditions met in central northeast Greenland.

Studies of the lithic technology in Dorset I and Independence II show that the lithic production concepts are identical for the two groups, and they may therefore be considered to be part of the same social and material regional tradition, called 'Greenlandic Dorset'. The studies also show that the High Arctic was probably populated with Greenlandic Dorset directly from Canada, as expressed in the typical 'Canadian choice of raw materials', whereas northeast Greenland up to Amdrupland was populated from the south, as the choice of raw material in this area is typical for Greenlandic Dorset in West Greenland.

From the technological studies of the lithic assemblages from the settlement sites in the Thule region, the presence of pre-Dorset and Early Canadian Dorset has been identified in Greenland for the first time. This pre-Dorset identification has also been confirmed in the re-analysis of the 'Old Nuulliit site' discovered by E. Knuth at Steensby Land in the southern Thule area (Knuth 1977/78, Sørensen 2010). These identifications indicate that the High Arctic cultural sequence in Canada (Schledermann 1990) is mirrored into the Thule area, such that Ellesmere and the Thule area should be seen as *one* Palaeo-Eskimo region (Grønnow & Sørensen 2006, Sørensen 2010). All in all these observations mean that there are now six Palaeo-Eskimo regional traditions identified as actors in Greenland's prehistory, as Independence II and Dorset I are defined as one regional tradition. These discoveries, it must be said, add considerably to the most recently published cultural survey of Greenland's prehistory (Gulløv 2004).

The use of the technological methodology has resulted in a presentation of the general *chaînes opératoires*, reduction methods and production concepts for the Palaeo-Eskimo regional traditions in Greenland. This presentation means that we, in the future, will have the possibility of defining characteristic roughouts and preforms and to determine in which phase a tool is found. The incorporation of a dynamic factor in the artefact classification means that roughouts, preforms, a typical raw material choice and typical working methods can now be used in the identification of Palaeo-Eskimo regional traditions, and thus also allowing a relative dating. More important though, with the dynamic presentation of the lithic industry, there will now be a better possibility for understanding peoples' actions and work processes from the lithic assemblage. A consequence of the use of the technological methodology is therefore that we to a greater extent can describe human actions and people in Greenland's prehistory.

As every type of lithic tool manufacturing is analyzed from a dynamic technological methodology, the usage phase of every lithic tool type can be defined and at the same time several previously statically defined tool forms can be 'revealed' as typical roughouts and thereby be removed from the formal lithic typology. A consequence of the presentation of the general *chaînes opératoires* and production concepts is therefore that a lithic typology is presented for the formal functional tool types in the Palaeo-Eskimo regional traditions in Greenland. The presentation of a functional lithic typology means that there is now a systematic comparable basis for all formal lithic tool types that can be applied in studies of each of the Palaeo-Eskimo regional traditions.

Culture-historical perspectives

In the eastern Arctic there are several unanswered culture-historical questions that, using the technological methodology, should be analyzed in the future, to achieve a more complete interpretation of eastern Arctic cultural history.

Saqqaq's origin is, as discussed previously, still not clear. No transition phase for Saqqaq has as yet been identified. We cannot therefore today say whether Saqqaq has its origins in Denbigh, pre-Dorset or Independence I. The choice of killiaq as the stone for tool production and the transformation of the lithic technology to this material indicate that the earliest phase of Saqqaq should be located in the Disko/Uummannaq/Nuussuaq areas, where the West Greenland killiaq sources are found (Sørensen & Pedersen 2005). A systematic analysis of the earliest dated Saqqaq assemblages will possibly give an indication of Saqqaq's transition and origin. At the same time, the group that reached Nuussuaq c. 2500 BC must have come through the Upernavik area. Therefore, in future studies, investigations of the Upernavik area should aim to identify which ASTt group, Denbigh, pre-Dorset or Independence I, came through the area in c. 2500 BC.

As in the case of Saqqaq, the origin of Independence I is also unknown. The typology and technology in the lithic assemblages indicate a close similarity to Denbigh and the western Arctic. On the other hand, Independence I is not identified west of Port Refuge, Devon Island (Andreasen 2004). As Independence I at Port Refuge is not sufficiently well dated it is difficult to conclude whether the Independence I settlement sites at Port Refuge represents the group that first migrated into Greenland or whether the settlement sites represent a return from Greenland towards the central eastern Arctic.

The transition to Dorset, and the definition and terminology for Dorset, is still one of the most difficult and most interesting problems in the eastern Arctic. Some unknown culture-historical upheaval, around the year 800 BC, resulted in a sudden and widespread cultural expansion to the eastern Arctic margins. The expansion resulted further in a second circum-population of Greenland by Greenlandic Dorset, and in a Palaeo-Eskimo population of Newfoundland by Grosswater Dorset (Fitzhugh 1972, 2002). On the basis of Meldgaard's earlier examination of Igloolik near Jens Munk Site, he presents a significant shift in the assemblage and settlement form between the 22–23-metre terrace, and suggests that the change represents a transition from pre-Dorset to Dorset. At the same time he introduces the idea of influences from the North American Indians, 'the smell of forest', as the reason for the changes (Meldgaard 1962). However, since Taylor's work (1968) (see also Nagy (1994, 1997)), it has been found that Dorset generally developed out of pre-Dorset in the eastern Arctic, and not through the influence of Indian culture. One of the theories is that it developed through 'impulses' from Palaeo-Eskimos in Alaska (Le Blanc 1994; Pilon 1994). Taylor's view of Early Dorset is problematic, though, in that it is based on radiocarbon-dated material with marine contamination, from the settlement site 'Tayara' in Nunavik (Desrosiers & Gendron 2005). The ruling out of a transition to Dorset in Greenland and of Independence II as an independent culture rules out Greenland as Dorset's area of origin, and thus moves the problem back westwards to the central eastern Arctic. We are left therefore with the question, what is Dorset and how did Dorset emerge?

Current studies of the lithic assemblage, particularly the burin technology, from the central eastern Arctic (Harp 1997; Nagy 1997; Fitzhugh 2002; Sørensen & Desrosiers in prep.), show that from pre-Dorset to Dorset a gradual transition occurred, from burins with a struck edge to the ground edge. This observation means that the transition in the lithic technology to characteristic Dorset technology can be identified from the burin technology. It would, in connection with this, be interesting to carry out an archaeological analysis to identify in which areas settlement sites with this type of burin are found, where the earliest are found, and carry out a technological analysis of the lithic assemblage from this period with the aim of identifying possible influence from other regional traditions outside the eastern Arctic. It should in connection with this be mentioned that the only area in the eastern Arctic with solid continuity between pre-Dorset and Dorset is in the Igloolik area, and that the excavated lithic assemblage from the settlement sites in this area has as yet not been systematically examined. A considerable step closer to an understanding of Dorset's development in the eastern Arctic would therefore be to carry out systematic and well documented technological studies of the lithic assemblages from the settlement sites at Igloolik in the Fox Basin area.

In East Greenland, studies of Palaeo-Eskimo prehistory are still insufficient. While West Greenland has been extensively surveyed, there are still large areas that are not surveyed for Palaeo-Eskimo presence on the east and northeast coast. One of these areas is from Kong Oskar's Fjord to Clavering Ø, a c. 250 km long coastal area. The survey of Wollaston Forland, just north of this area, shows that there is Palaeo-Eskimo activity from Saqqaq, Independence I and Greenland Dorset (Sørensen & Andreasen 2004, Bennike et al. 2008). An analysis of the settlement site at the Wollaston area, in addition, indicates that the Palaeo-Eskimo activity is in particular to be found outermost, in the large fjords on the northeast coast, probably because these hold polynyas, which thereby give good possibilities for ice edge hunting of marine mammals. As previously mentioned, we still do not know the prehistoric sequence in East Greenland. Questions concerning Saqqaq and Independence I's possible meeting and mixing in East Greenland, and the duration and intensity of the Greenlandic Dorset's settlement, are still unanswered. A future research project would therefore be to survey the mouths of the large fjords between Kong Oskar's Fjord and Clavering Ø for Palaeo-Eskimo activity. The result of the surveys, along with earlier data from the east coast, could then be analyzed, interpreted and published as a full overview and discussion of northeast Greenland's early cultural history, as has recently been done for Disko Bugt and North Greenland (Jensen 2004; Grønnow & Jensen 2003).

The methodology

The technological methodology in this analysis of the lithic material from ASTt in Greenland has proved to be suitable. Firstly, because ASTt groups shaped and worked their tools much more precisely than in other Stone Age cultures. Secondly, because the choice of raw material in ASTt in Greenland is specific in relation to the type of working process and the tool type. This means that it is readily possible, in ASTt, to identify roughouts and preforms as parts of specific *chaînes opératoires*, and thereby determine which processes have taken place and which regional tradition has been in action (Sørensen 2006(b)). In addition, the choice of specific raw materials for specific tool types and the choice of the lithic raw material's morphology, size and use contain information about the actual tool production that can reveal both the prehistoric production processes and the social technological tradition.

By considering the Palaeo-Eskimo lithic artefacts as parts of processes, we can therefore attain knowledge about specific prehistoric events and about the cognition that lies behind the tool production. An interesting and important aspect is thus that the results that are achieved using this methodology reflect the Palaeo-Eskimo person's craft process and to a degree the skill, cognition and his technical intelligence.

Methodological perspectives

This study has primarily dealt with the manufacture of the formal tool types, because it is through the technological understanding of these that traditional production concepts can be described.

Unfortunately, only few studies have been carried out in Arctic archaeology where wear trace analyses have been attempted (Unrath 1987; LeMoine 1991; Skriver 2002). Many of the formal tool types must have, due to their distinct morphology and from finds of their hafting, a distinct function. This is, however, not the case for the bifacial end blades that can be interpreted as both knives and points, and the informal tool types. To attain a more precise and complete functional typology, and a more nuanced idea of the use of the functional lithic tool types in ASTt, it would be necessary in the future to carry out studies of wear traces, both microscopic and macroscopic. A distinct improvement of the methodology that is presented and used here would therefore be attained if it was combined with wear trace analysis.

As mentioned previously, the technological methodology and the technological study are used to investigate a diachronic culture-historical problem. At the same time, it seems that many questions in archaeology today have a tendency to be directed towards social aspects. Examples of studies of synchronous social aspects include S. Coulson and C. Andreasen's (Andreasen 2004: 133ff.) and Stapert and Johansen's work (1996). Studies show that refitting analysis can be used on the Arctic tool material, as it is known for example from studies of the European Stone Age (Coulson 1986; Pigeot 1987, 1990; Bodu, Karlin et al. 1990; Johansen 2000(b)). Dynamic technological classifications have previously proved to be suitable in the analysis of social and synchronous questions, both in intra-site analyses (Schild 1980; Sørensen & Sternke 2004; Sørensen 2006(c)) as with regional analyses (Schild 1980; Fiedorczuk 1995; Sulgostowska 1995).

With a dynamic approach, as argued for in the introduction, and by virtue of definitions of tools and by-products from different phases in different productions, given in the analysis, it should, in the future, be possible to answer new questions concerning Greenland's prehistory. Technological studies combined with spatial analyses might be the next methodological step to take in research into Greenland's prehistory, because with a merging of these two methodologies we can reveal strategic behaviour and synchronous social questions in Greenland's Stone Age.

Chapter 8
Appendix

1. Scientific experimental studies of palaeo-Eskimo lithic technology

Experiments with heat treating of microcrystalline lithic materials from Greenland

Test material

Lithic material from three different sources was chosen for heat treatment:

1. Source 1–2 (Washington Land, Thule). Blue-grey striped and light brown fine-grained translucent mcq.
2. Source 16 (south coast of Nuussuaq). Translucent light blue fine-grained mcq.
3. Source 49 (Wollaston Forland). White to grey translucent/semi transparent mcq.

The heat treatment

The material was laid in a tray in a 10 cm thick layer of sand. The oven was heated gradually up to 180 degrees (Celsius) for 1½ hour. The temperature was then increased to 350 degrees for 1½ hour, and the oven was then turned off. The material was removed when the temperature had decreased to 20 degrees.

Results

The material from Washington Land partly changed colour – especially the brown colours changed to reddish colours. After flaking the material, the scars showed a lustrous, often red, shiny and more fine-grained texture than before heat treatment (fig. 8.1.1). It was estimated that the material after heat treatment had improved its flaking ability and knapping suitability considerably.

The Nuussuaq mcq material did not change colour after heat treatment. However, when the material was flaked it was seen that considerable changes had occurred. The material had become semi-transparent, extremely shiny and nearly glassy in its texture. It was estimated that the material after heat treatment had improved its

Fig. 8.1.1
Heat treated mcq from the Thule region (source 1 and 2) (photo J. Sørensen).

Fig. 8.1.2
Heat treated mcq from southern Nuussuaq (source 16) (photo J. Sørensen).

flaking ability and knapping suitability substantially (fig. 8.1.2). From the experiments it can be concluded that this particular heat treated mcq type is identical to much prehistoric artefact material, especially concerning blade and biface productions in Greenlandic Dorset in the Disko Bay region.

The Wollaston Forland material did not change colour from the heat treatment. However, when the material was flaked it was seen that the material had become shiny, semi-transparent and glassy fine-grained in its texture. It was estimated that the material after heat treatment had improved its flaking ability and knapping suitability substantially (fig. 8.1.3). From the experiments it can be concluded that the heat treated material was identical to lithic artefact materials from Greenlandic Dorset assemblages in the Wollaston Forland region.

Fig. 8.1.3
Heat treated mcq from Wollaston Forland (source 49) (photo J. Sørensen).

Experiments with Palaeo-Eskimo lithic reduction technology

Experiment 1
A tabular nodule made of killiaq, collected in the riverbed at the Qaarsut River, Nuussuaq, was worked. The nodule was bifacially reduced into a large preform of Saqqaq type. The reduction was conducted using a hard hammer stone made from quartzite (fig. 8.1.4). This reduction process is typical to the Saqqaq technology in the killiaq outcrop area, e.g. in northern Nuussuaq.

Fig. 8.1.4 Experiment no. 1. Production of a 'Nuussuaq core' made from killiaq by means of hard hammer percussion (photo J. Sørensen).

Experiment 2

A killiaq preform of Saqqaq type is reduced into a large bifacial preform by way of direct soft percussion using an antler hammer. The platform edge is prepared by way of thorough abrasion before each bifacial flake is detached. Employing this method, large bifacial flakes, which can be used as preforms for small tool types, and a large biface is made in the same process (fig. 8.1.5). This method and process is typical to the Saqqaq in West Greenland.

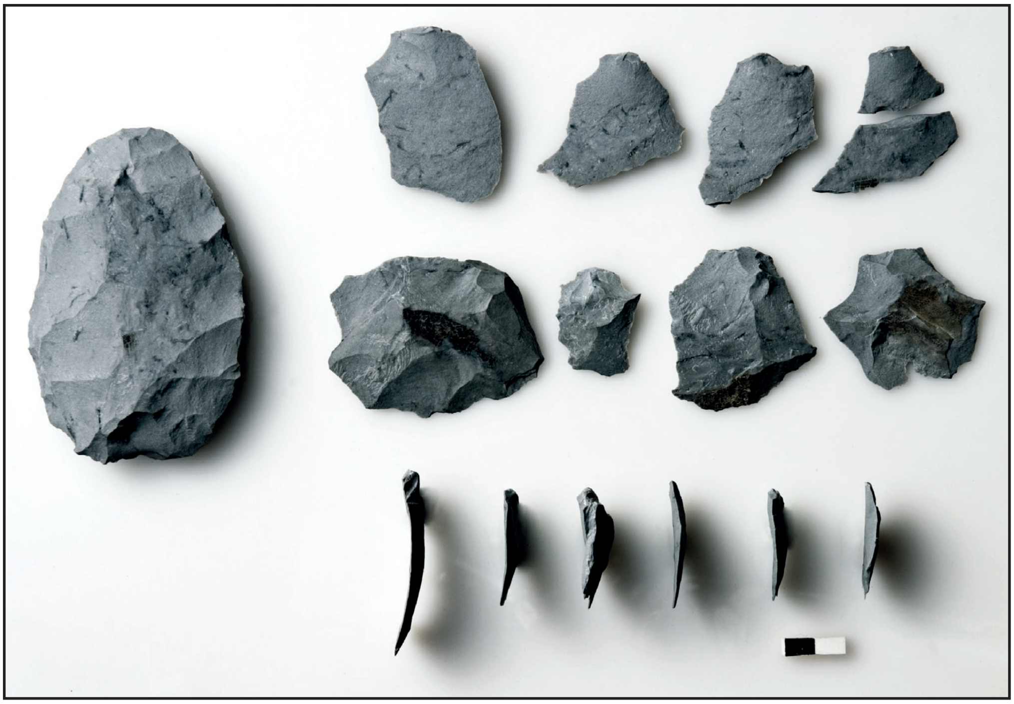


Fig. 8.1.5 Experiment no. 2. Production of a large biface of killiaq by means of direct soft hammer percussion (photo J. Sørensen).

Experiment 3
A tabular core is reduced employing a squared reduction method, detaching flakes by indirect percussion. The punch is made from antler. Employing this method, large bifacial flakes, which can be used as preforms for small tool types, and a large blank, which can be made into a biface, is produced in the same process (fig. 8.1.6). The squared reduction process is typical to the Independence I tradition.

Fig. 8.1.6 Experiment no. 3. Production of an Independence I type tabular core preform made from mcq by means of indirect technique (photo J. Sørensen).

Experiment 4

A large bifacial knife blade of Independence I type is manufactured. A bifacial method is employed by way of direct percussion, using a soft hammer made from sperm whale tooth. The notches on the base are made by pressure technique (fig. 8.1.7). Maastrichtien flint from south Scandinavia was used. This material has similar properties as the mcq from the 'Ellesmerian Folding' in North Greenland.

Fig. 8.1.7 Experiment no. 4. Production of an Independence I type biface made from mcq by means of direct soft percussion using a whale tooth (photo J. Sørensen).

Experiment 5
A bifacial lithic armature point of Palaeo-Eskimo type is produced by way of pressure technique. The pressure tool consists of a pressure point made from antler tied to a wooden handle. The shape of the handle is known from finds of the Saqqaq tradition in West Greenland (fig. 8.1.8).

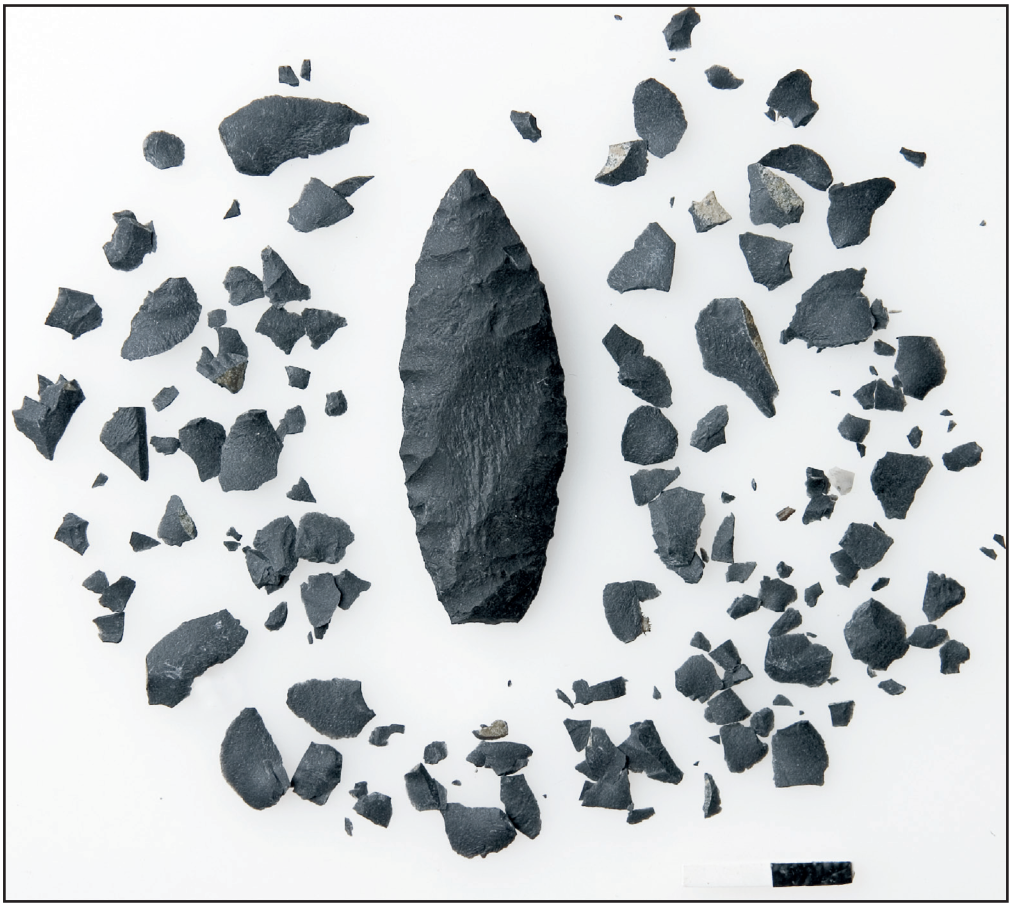


Fig. 8.1.8 Experiment no. 5. Production of a small biface made from basalt by means of pressure technique (photo J. Sørensen).

Experiment 6
Experiments with early Palaeo-Eskimo burin technology. Burin spalls are detached from the corner of the distal burin end. Employing this method a large number of spalls (up to 12) can be detached from the same burin corner (fig. 8.1.9). The experiment was carried out using maastrichtien flint from southern Scandinavia.

Fig. 8.1.9 Experiment no. 6. Production of burin by spalling the edge by means of pressure technique (photo J. Sørensen).

The tools

The tools employed in the experimental study. From the left: Two quartzite hammer stones, a hammer made from sperm whale tooth, a hammer/punch made from antler, a large hammer made from antler, a pressure tool for pressure blade production (the point can be made from walrus penis bone or antler), and two pressure points in wooden hafts made for bifacial pressure flaking (fig. 8.1.10).

Fig. 8.1.10 Modern knapping tools used in the experimental study (photo J. Sørensen).

2. Catalogue – studied lithic artefacts

Figures 8.2.1–8.2.30
Drawings of the analyzed lithic artefacts

Figure 8.2.1 Itinnera

A. End scraper, narrow edge, killiaq
B. End scraper, squared, mcq
C. End scraper, triangular base, mcq
D. End scraper, atypical, killiaq
E. End scraper, triangular and rejuvenated, mcq
F. Side scraper preform, mcq
G. Side scraper, mcq
H. Side scraper, rejuvenated, mcq
I. Burin preform, killiaq
J. Burin preform, killiaq
K. Burin preform, killiaq
L. Burin, killiaq
M. Primary burin spall, killiaq
N. Burin, killiaq
O. Burin, killiaq
P. Double burin, killiaq
Q. Dihedral Burin, killiaq
R. Arrow point preform, killiaq
S. Arrow point preform, killiaq
T. Arrow point, killiaq
U. Arrow point with use wear, killiaq

Figure 8.2.2 Itinnera

V. Biface, killiaq
W. Biface, killiaq
Z. Biface preform, killiaq
X. Knife blade, killiaq
Y. Knife blade rejuvenated, killiaq
Æ. Saw, killiaq
Ø. Saw rejuvenated, killiaq
Å. Burin made from fragment of saw blade
AA. Harpoon point preform, killiaq
AB. Harpoon point fragment, killiaq
AC. Harpoon point, killiaq
AD. Awl preform fragment, killiaq
AE. Awl, killiaq
AF. Awl rejuvenated, killiaq

Figure 8.2.3 Itinnera

AG. Adze preform, killiaq
AH. Adze, killiaq
AI. Bifacial adze, killiaq
AJ. Bifacial adze, rejuvenated, killiaq

Figure 8.2.4 Itinnera

AK. Blade core, mcq
AI. Blade core, quartz crystal
AM. Blade core, mcq
AN. Blade core, mcq
AO. Blades, quartz crystal and mcq
AP. Blade knives, quartz crystal
AQ. Core, killiaq
AR. Core, killiaq
AS. Strike-a-light, killiaq

Figure 8.2.5 Itinnera

AT. Flake, killiaq
AU. Preform, killiaq
AV. Flake knife, killiaq
AW. Flake knife, mcq
AX. Flake, mcq
AY. Flake, killiaq
AZ. Flake knife, killiaq
AÆ. Flake, killiaq
AØ. Bifacial flake, mcq
AÅ. Flake, basalt (ca. 70% size)

Figure 8.2.6 Qeqertasussuk

A. Flake, killiaq
B. Flake, killiaq
C. Flake, killiaq
D. Flake, killiaq
E. Flake, killiaq
F. Flake knife, killiaq
G. Flake knife, killiaq
H. Flake knife, killiaq
I. Flake knife, killiaq
J. Bifacial preform, killiaq
K. Bifacial preform, killiaq
L. Blade core, mcq
M. Harpoon point preform, killiaq
N. Blade core preform, mcq

Figure 8.2.7 Qeqertasussuk

O. Bifacial preform, killiaq
P. Core of 'Nuusuaq type', killiaq

Figure 8.2.8 Sermermiut, lower layer and Qaarsut Killeq

Q. Core of 'Nuussuaq type', killiaq
R. Core of 'Nuussuaq type', killiaq

Figure 8.2.9 Adam. C. Knuth site

A. End scraper, mcq
B. End scraper, mcq
C. End scraper (atypical), mcq
D. Side scraper, distal fragment, mcq
E. Side scraper, mcq
F. Flake preform, mcq
G. Burin preform, mcq
H. Burin, mcq
I. Burin spalls, primary and secondary types
J. Double burin, mcq
K. Burin, mcq
L. Dihedral burin, mcq
M. Burin, mcq
N. Burin with narrow distal end, mcq
O. Burin with narrow distal end (fragment), mcq
P. Bifacial preform, mcq

Figure 8.2.10 Adam. C. Knuth site

Q. Bifacial preform, mcq
R. Bifacial preform fragment, mcq
S. Knife with oval distal end, mcq
T. End blade small type, mcq
U. Knife with oval distal end, mcq
V. Knife with oval distal end, mcq
W. Arrow point preform, mcq
X. Arrow point preform, mcq
Y. Arrow point preform, mcp
Z. Arrow point preform, mcq
Æ. Narrow end blade, mcq
Ø. Narrow end blade, mcq
Å. Arrow point preform, mcq
AA. Arrow point fragment, mcq
AB. Arrow point, mcq
AC. Arrow point, mcq
AD. Arrow point with use wear, mcq
AE. Harpoon point, mcq

Figure 8.2.11 Adam. C. Knuth site

AF. Crested blade, mcq
AG. Blade, mcq
AH. Blade, mcq
AI. Blade, mcq
AJ. Blade, mcq
AK. Blade, mcq
AL. Blade, mcq
AM. Blade core front rejuvenation, mcq
AN. Blade core fragment, mcq
AO. Blade core preform, mcq
AP. Blade core, mcq
AQ. Refitted core, mcq

Figure 8.2.12 Adam. C. Knuth site

AR. Flake, mcq
AS. Flake, mcq
AT. Flake, mcq
AU. Flake, mcq
AV. Flake, mcq
AW. Flake, mcq
AX. Flake knife, mcq
AY. Flake, mcq
AZ. Flake, mcq
AÆ. Flake knife, mcq
AØ. Pieces ècaillies, mcq

Figure 8.2.13 Adam. C. Knuth site

AÅ. Core, mcq

Figure 8.2.14 Adam. C. Knuth site

BA. Refitted core, mcq
BB. Core, mcq

Figure 8.2.15 Solbakken site

A. Blade knife, mcq
B. Blade knife, mcq
C. Blade knife, mcq
D. Blade knife, mcq
E. Blade knife, mcq
F. Core, mcq
G. Refitted blade core, mcq
H. Core, mcq

Figure 8.2.16 Solbakken site, structure 13 (I–L) and Pearyland ville site (M–O)

I. Burin, mcq
J. Blade knife, mcq
K. Preform, mcq
L. Core, mcq
M. Adze edge fragment, basalt
N. Adze, basalt
O. Refitted adze, basalt

Figure 8.2.17 Annertusuaqqap Nuua

A. End scraper preform, mcq
B. End scraper, mcq
C. End scraper, mcq
D. End scraper, mcq
E. Side scraper, mcq
F. Side scraper, mcq
G. Burin preform, killiaq
H. Burin preform fragment, killiaq
I. Burin preform fragment, killiaq
J. Burin, killiaq
K. Burin, killiaq
L. Burin, killiaq
M. Burin preform fragment, killiaq
N. Burin, killiaq
O. Burin, killiaq
P. Ground burin, killiaq
Q. Ground burin, killiaq
R. Curved knife, killiaq
S. Curved knife, killiaq
T. Preform, mcq
U. Knife preform, mcq

Figure 8.2.18 Annertusuaqqap Nuua

U. Knife, mcq
V. End blade, mcq
W. End blade with distal fracture, mcq
Z. Knife preform, mcq
Æ. Knife rejuvenated fragment, mcq
Ø. Armature point with 'impactburination', mcq
Å. Knife, atypical, mcq
AA. Knife, atypical, mcq
AB. Side blade, mcq
AC. Side blade, mcq

Figure 8.2.19 Annertusuaqqap Nuua

AD. Blade core preform, mcq
AE. Blade core preform, mcq
AF. Blade core mcq
AG. Blade core mcq
AH–AQ. Blades, mcq
AR–AV. Blade knife, mcq

Figure 8.2.20 Annertusuaqqap Nuua

AW. Flake scraper preform, mcq
AX. Flake, mcq
AY. Flake knife, mcq
AZ–AÅ. Flake, mcq
BA. Adze preform, killiaq
BB. Adze preform, killiag
BC–BF. Adze flakes, killiaq

Figure 8.2.21 Ikkaarlusuup Tima

A. Bifacial knife, 'curved type', mcq
B. Ground knife, killiaq
C. Fluting flake, mcq
D. Fluting flake, mcq
E. Side blade, mcq
F. Strike-a-light, killiaq
G. Strike-a-light, killiaq
H. Blade core, quartz crystal
I. Blade core, quartz crystal
J. Platform flake reused as scraper, mcq

Figure 8.2.22 Kap Holbæk

A. Core, mcq
B. Core, mcq
C. Bifacial preform, mcq
D. Knife, mcq
E. Knife rejuvenated mcq
F. Preform, mcq

G. Side scraper preform, mcq
H. Side blade, mcq
I. Side blade fragment, mcq
J. Blade, mcq
K. Blade, distal fragment, mcq
L. Blade, refitted, mcq
M. Blade knife, mcq
N. Blade knife, mcq
O. Blade core, mcq

Figure 8.2.23 Kap Holbæk

P. Flake, mcq
Q. Flake, mcq
R. Flake, mcq
S. Flake, mcq
T. Flake, mcq
U. Adze/wedge preform, dolerite

Figure 8.2.24 Vandfaldsnæs

A. End scraper, mcq
B. End scraper, rejuvenated, mcq
C. Side scraper, mcq
D. Bifacial blade, distal fragment, mcq
E. Knife preform, distal fragment, mcq
F. Burin preform, mcq
G. Burin, mcq
H. Burin base fragment, mcq
I. Burin base fragment, mcq
J. Blade, mcq
K. Blade knife, mcq
L. Blade core with two platforms, mcq

Figure 8.2.25 Vandfaldsnæs

N. Adze/wedge preform, dolerite
O. Adze/wedge preform, dolerite
P–T. Adze flakes, dolerite

Figure 8.2.26 Mågefjeldet site and Eigil Knuth site

A. Biface, mcq
B. Biface, mcq
C. Blade core, mcq
D. Blade core, mcq
E. Adze, basalt

Figure 8.2.27 Qeqertaaraq

A. End scraper, mcq
B. End scraper, mcq
C. Side scraper, mcq
D. Ground burin distal fragment, mcq
E. Ground burin distal fragment, mcq
F. Preform fragment, mcq
G. Knife, basalt
H. Knife, distal fragment, mcq
I. Knife, base fragment, mcq
J. Knife, base fragment, mcq
K. Knife fragment with convex base, mcq
L. Knife fragment with convex base, mcq
M. Harpoon point preform, mcq
N. Harpoon point, mcq
O. Harpoon point, mcq
P. Harpoon point, mcq
Q. Harpoon point distal fragment with use wear, mcq
R. Blades, A-type, mcq
S. Blades, B-type, mcq
T. Blades, quartz crystal
U. Blade core, quartz crystal
V. Blade knife, mcq
W. Blade knife, mcq
X. Blade knifes (inserts), mcq
Y. Knife, mcq
Z. Blade knife, mcq
Æ. Blade knife preform, mcq
Ø. Blade knife base fragment, mcq
Å. Blade knife base fragment, mcq

Figure 8.2.28 Qeqertaaraq

AA.–AH. Flakes, mcq
AI. Core, basalt
AJ. Core, basalt
AK. Core, basalt
AL. Core, basalt
AM. Core, basalt

Figure 8.2.29 Polaris site

A. End scraper, mcq
B. End scraper, mcq
C. Harpoon point preform, mcq
D. Harpoon point with distal and proximal fracture (use wear), mcq
E. Harpoon point, mcq
F. Knife preform, mcq

Figure 8.2.30 Young sound area

Kap Berghaus site (A–D), Grønnedal site (E–G), Sandøen (H), Grønlænderhuse site (I–P)

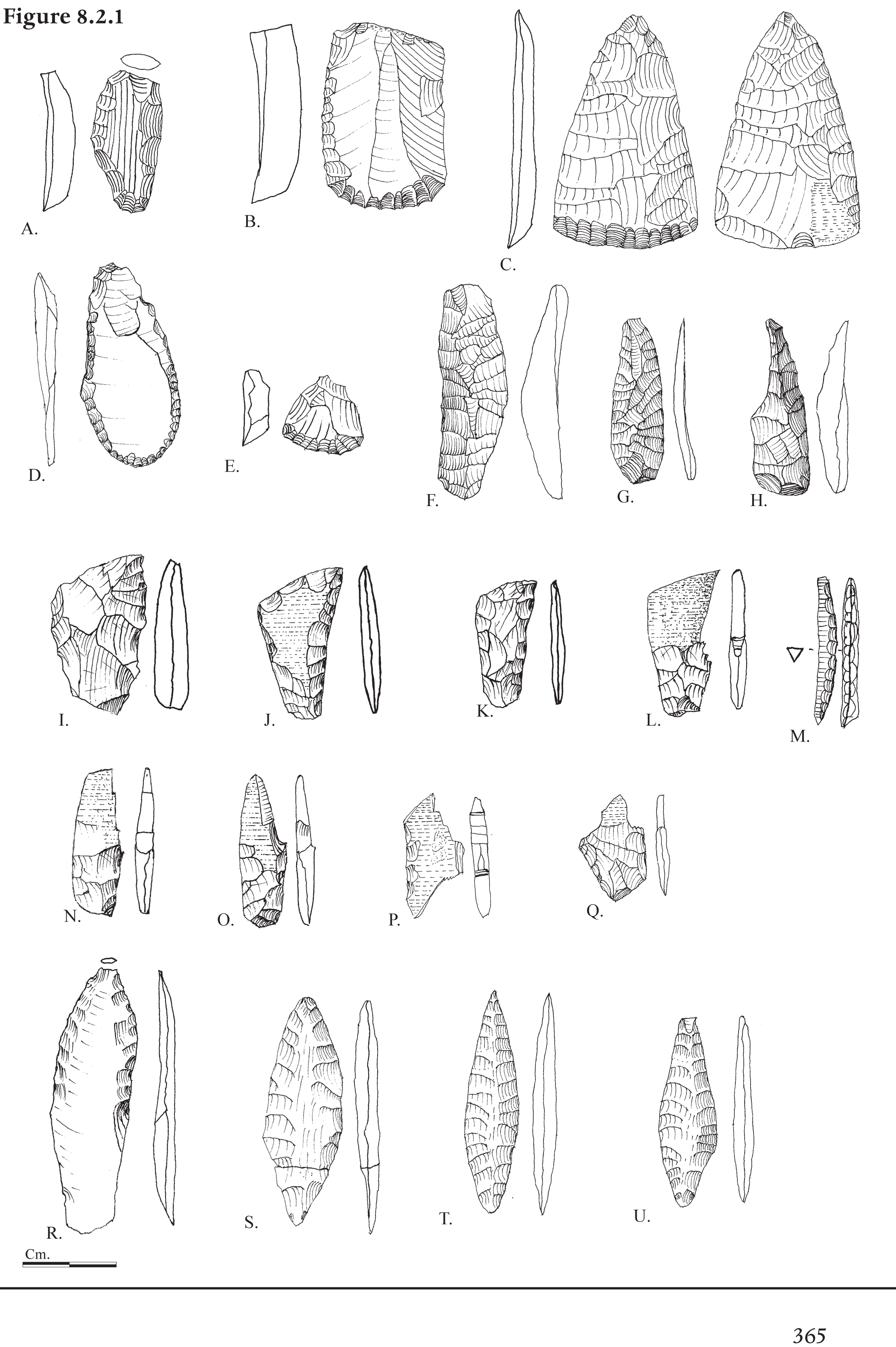
A. Flake, mcq
B. Adze, basalt
C. Burin preform, mcq
D. Burin, basalt
E. Burin, 'mudstone'
F. Burin, mcq
G. Burin spall, mcq
H. Biface distal fragment, mcq
I. End scraper, mcq
J. Knife blad, mcq
K. Burin, basalt
L. Burin, basalt
M. Blade core, mcq
N. Blade knife, mcq
O. Blade knife, mcq
P. Core fragment, basalt

Figure 8.2.31 Northern Thule region

Peel & Frykman site (A–F), Pullersuaq site (G–H) and Winstedt site level 1 (I).

A. End scraper, mcq
B. Burin fragment, mcq
C. Burin, mcq
D. Biface preform, mcq
E. End blade base fragment, mcq
F. Blades, mcq
G. Burin, mcq
H. Burin, mcq
I. Burin, mcq

Figure 8.2.1



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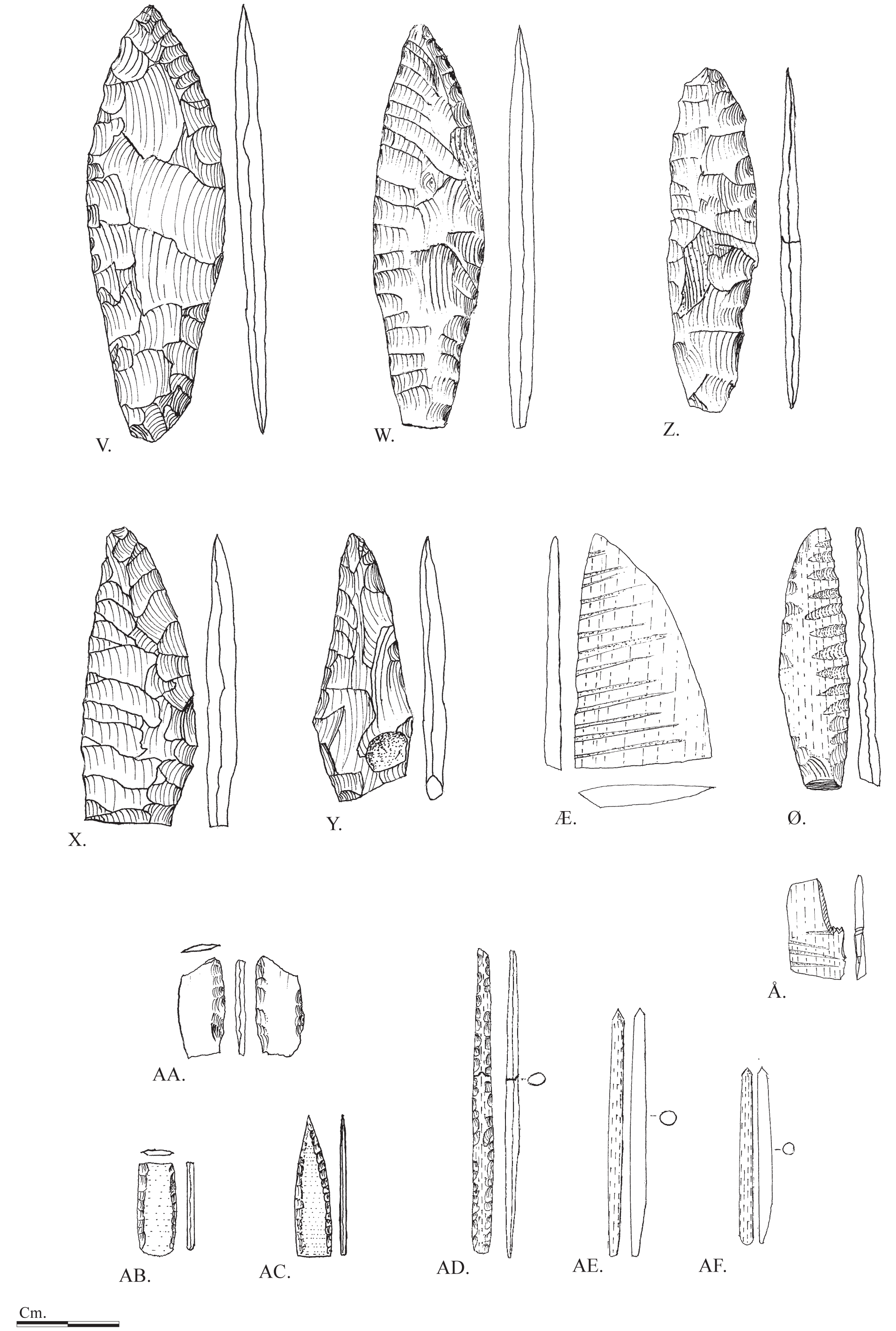

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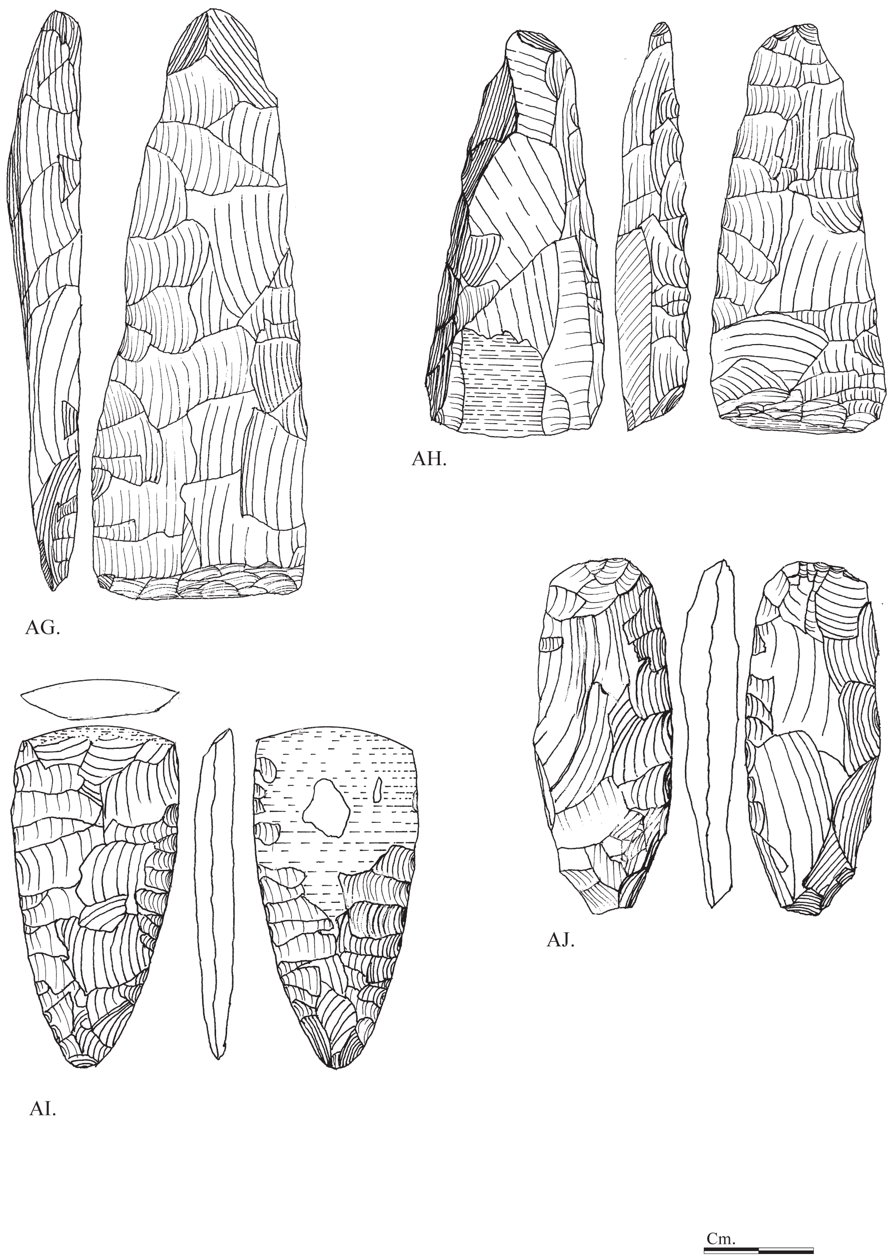

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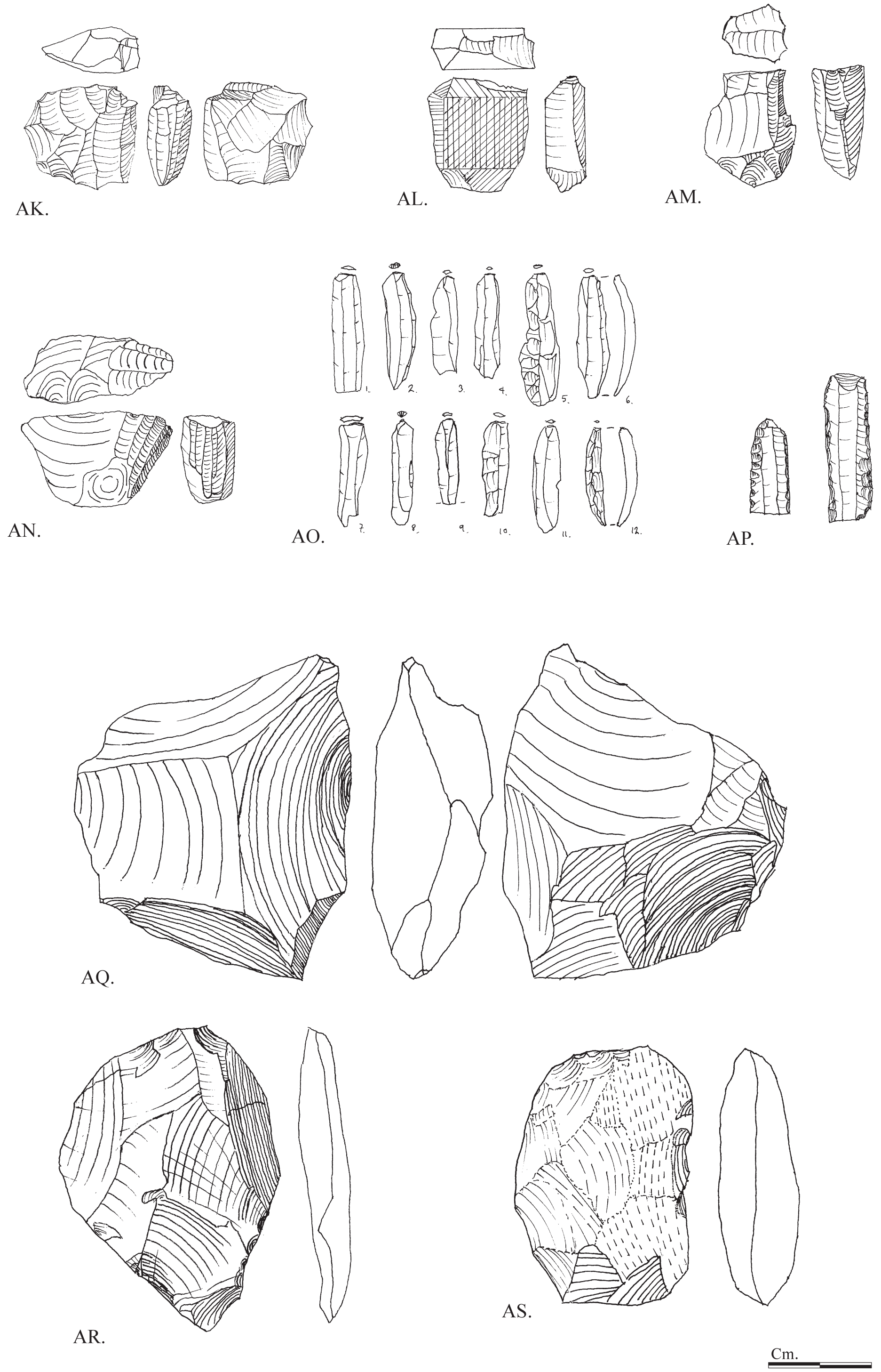

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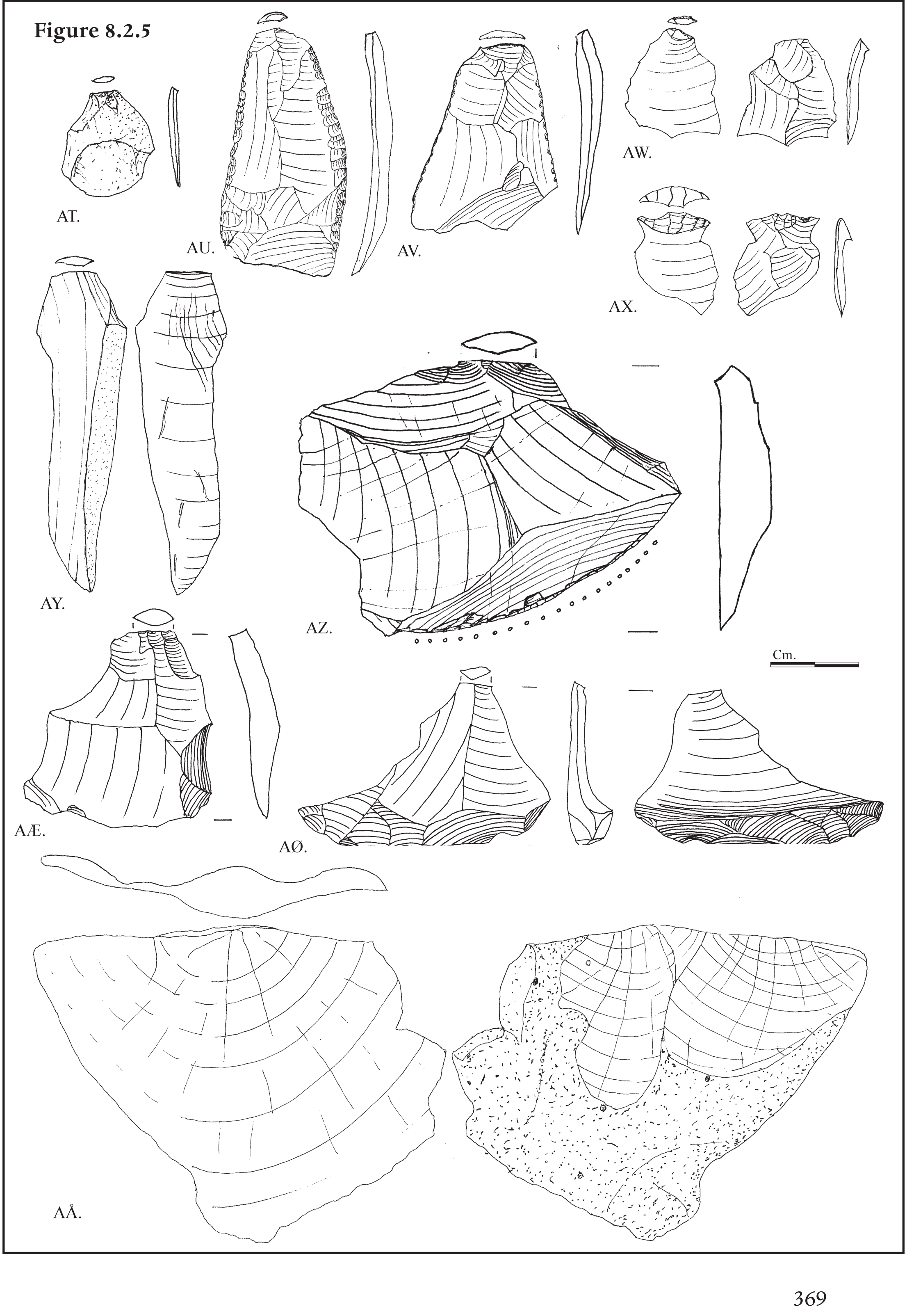

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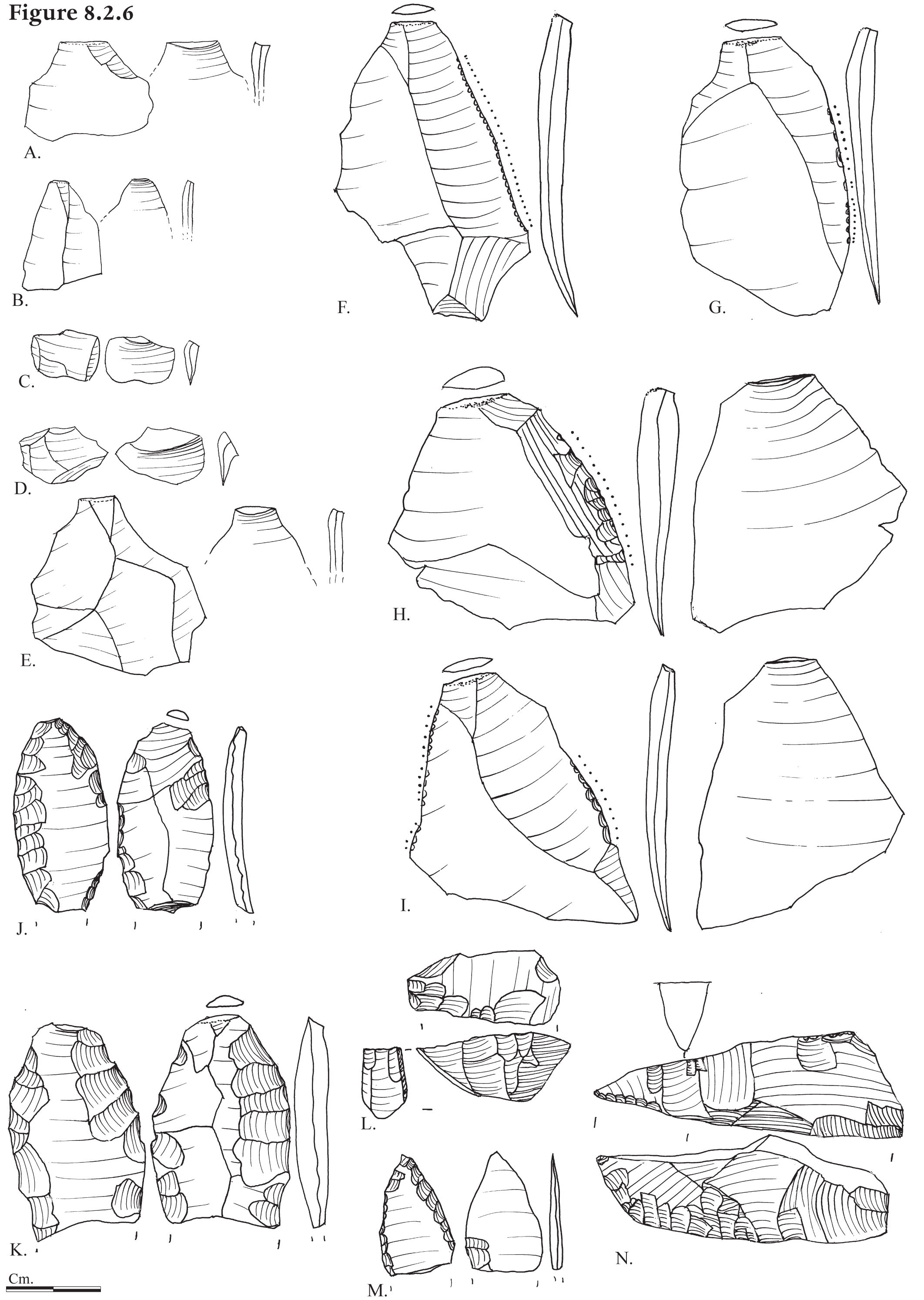

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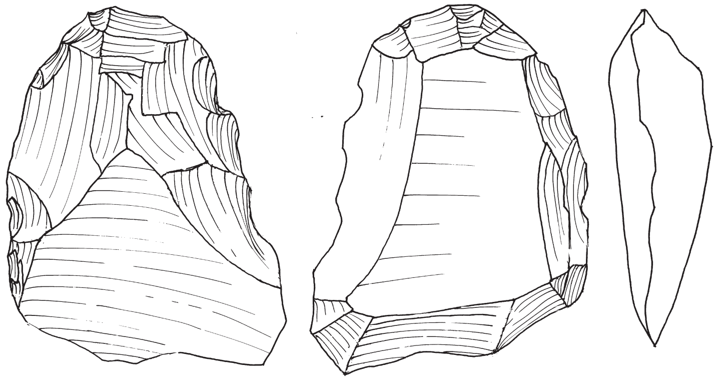
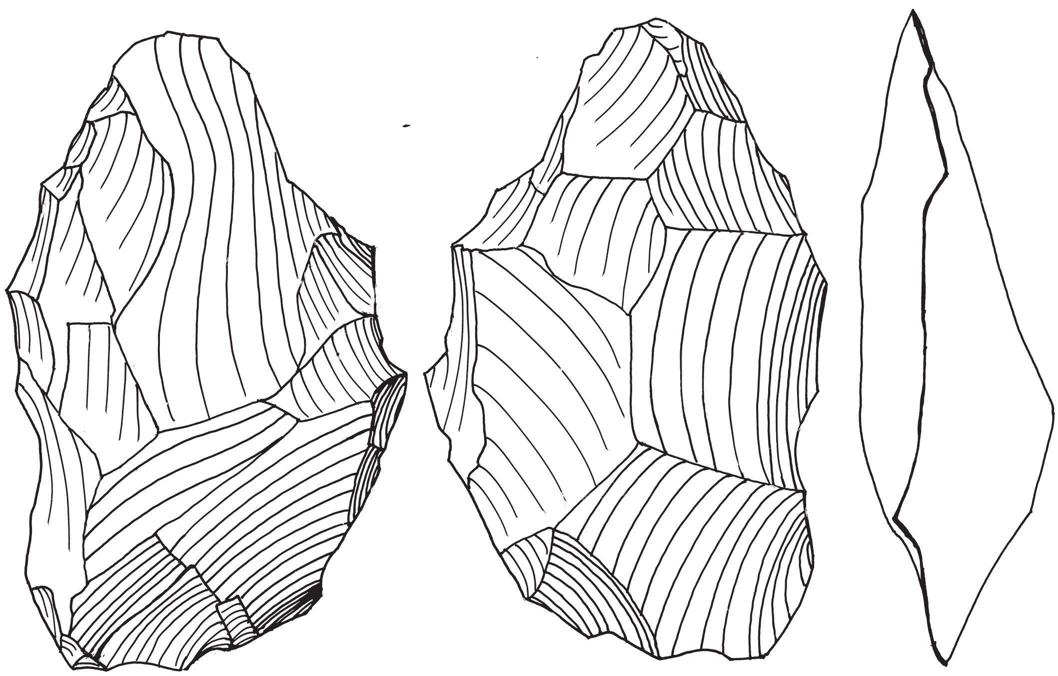
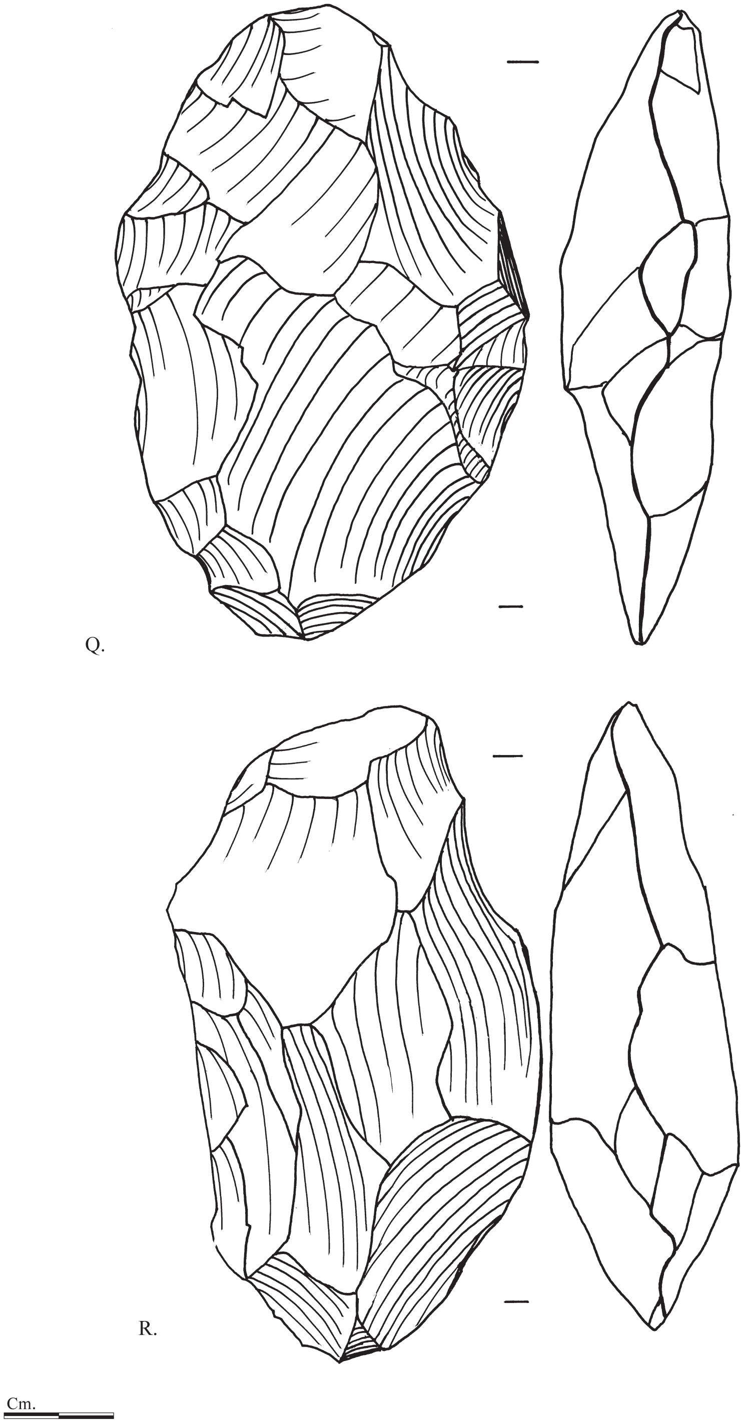


O.



P.

Figure 8.2.8



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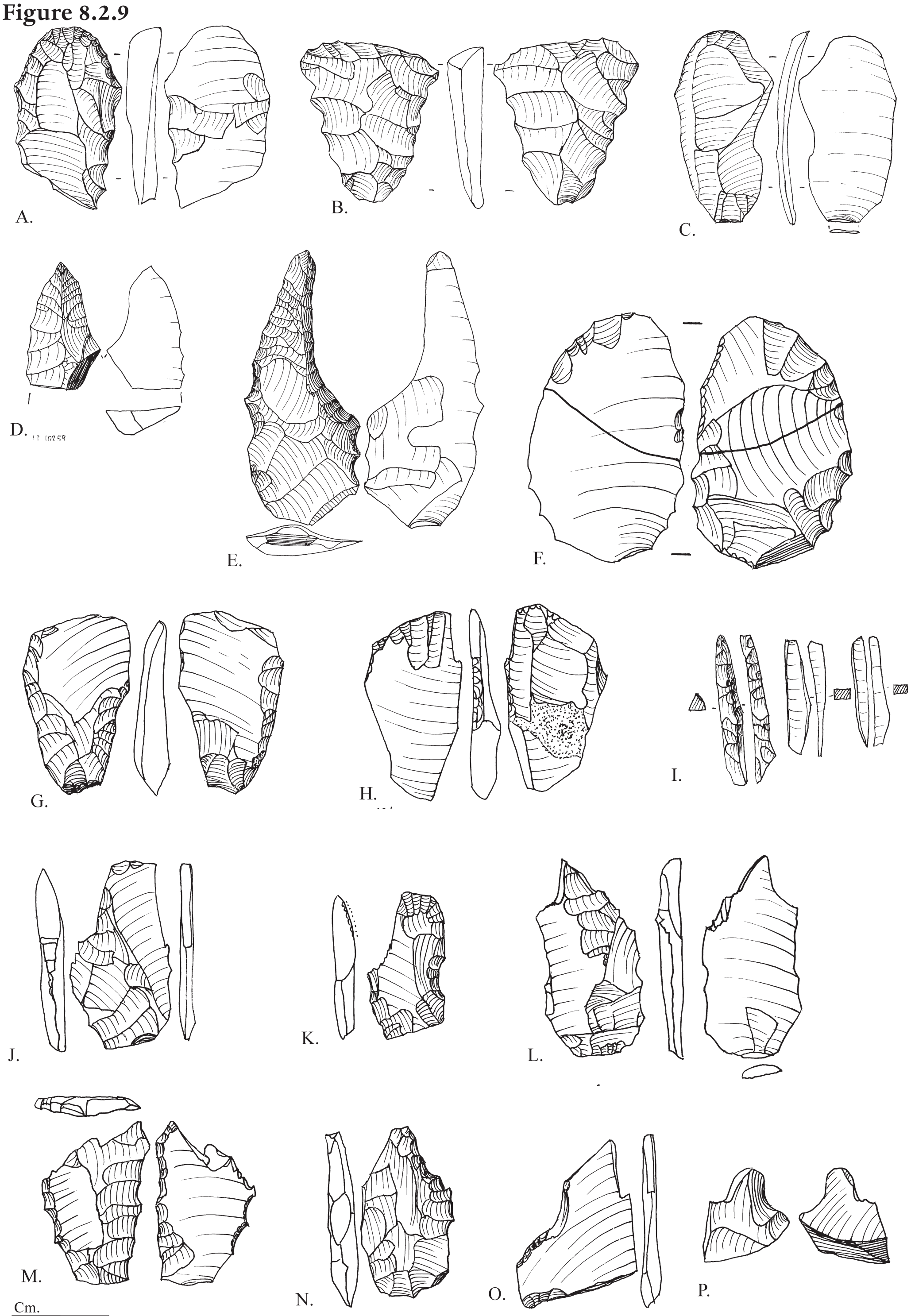

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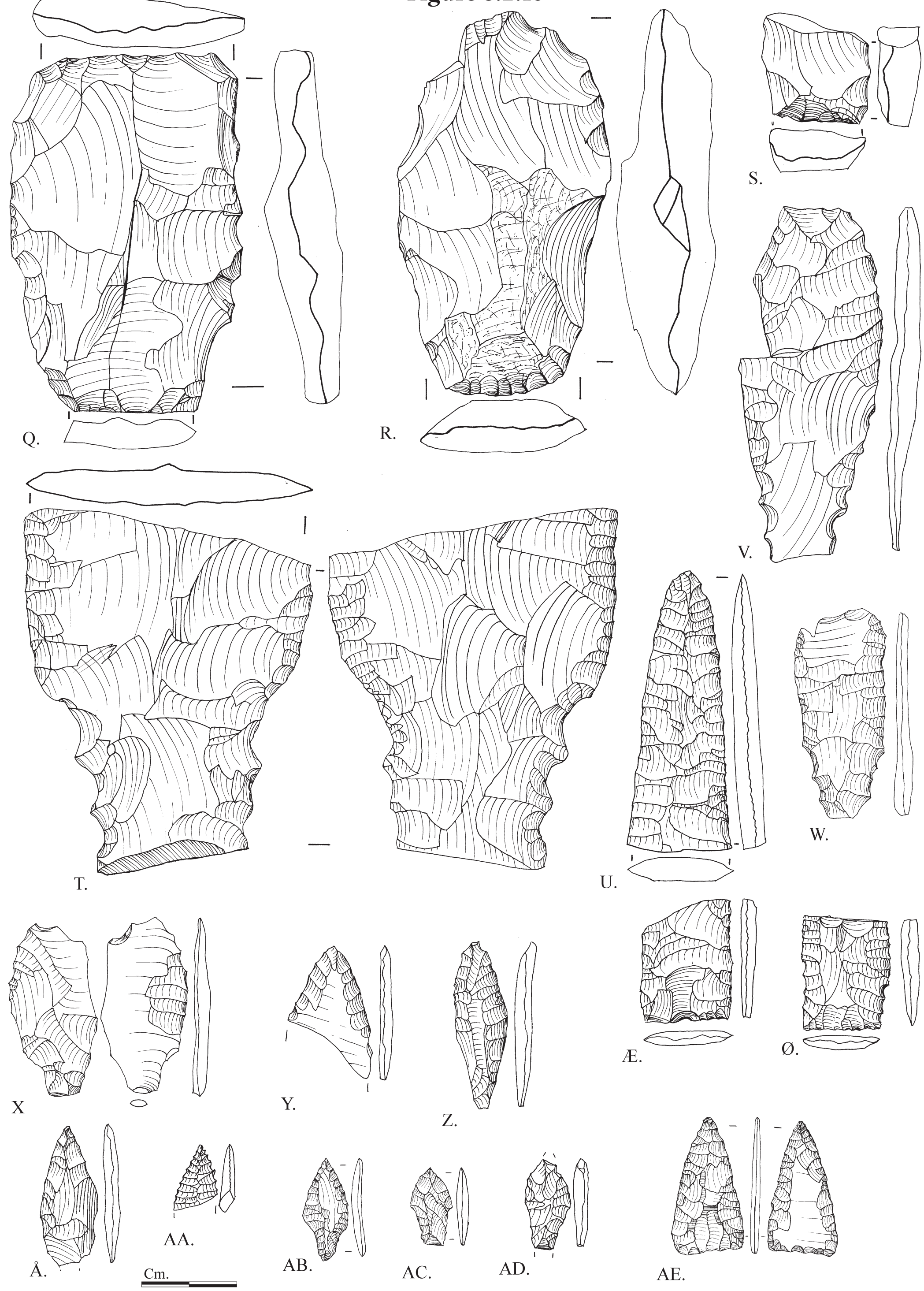

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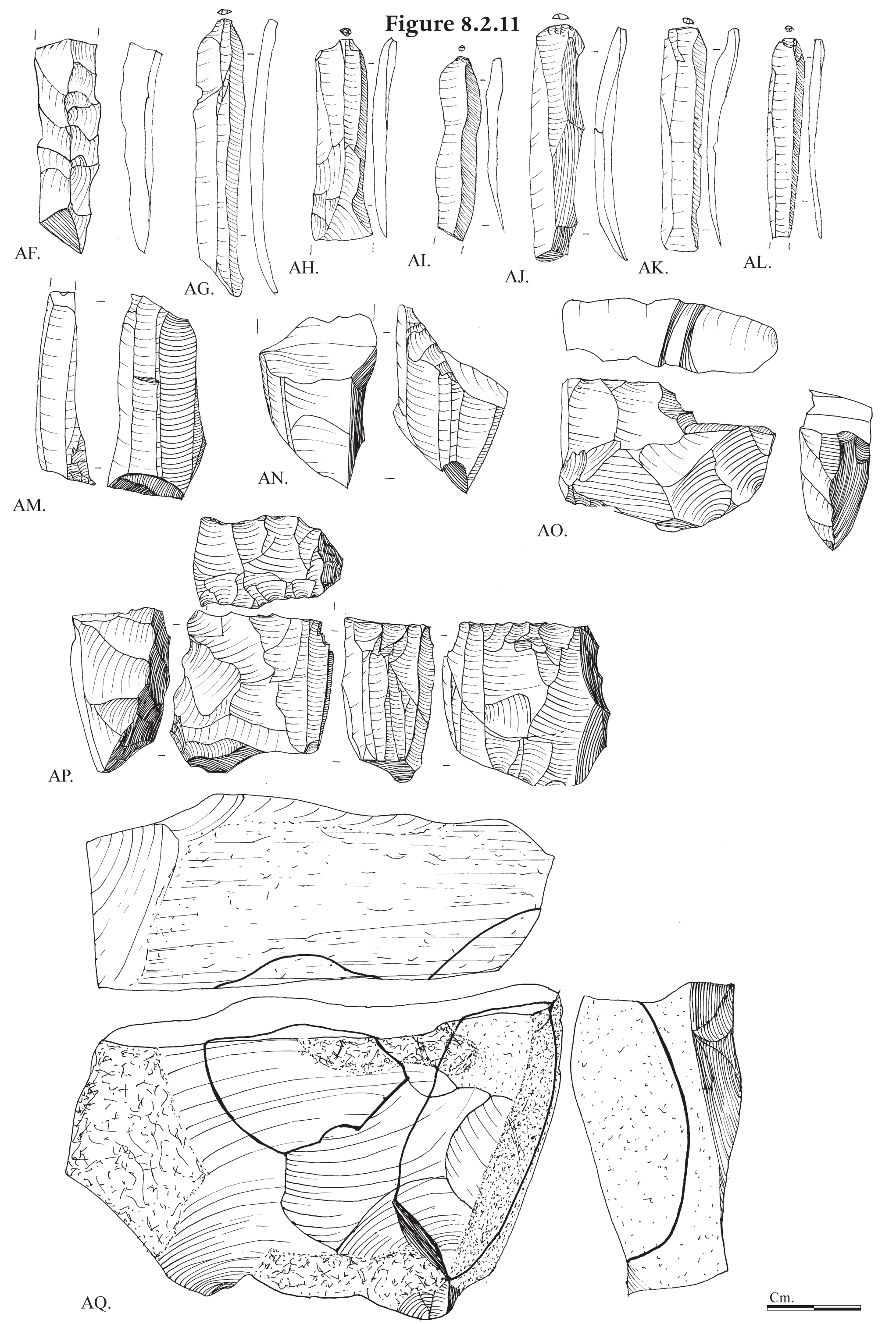

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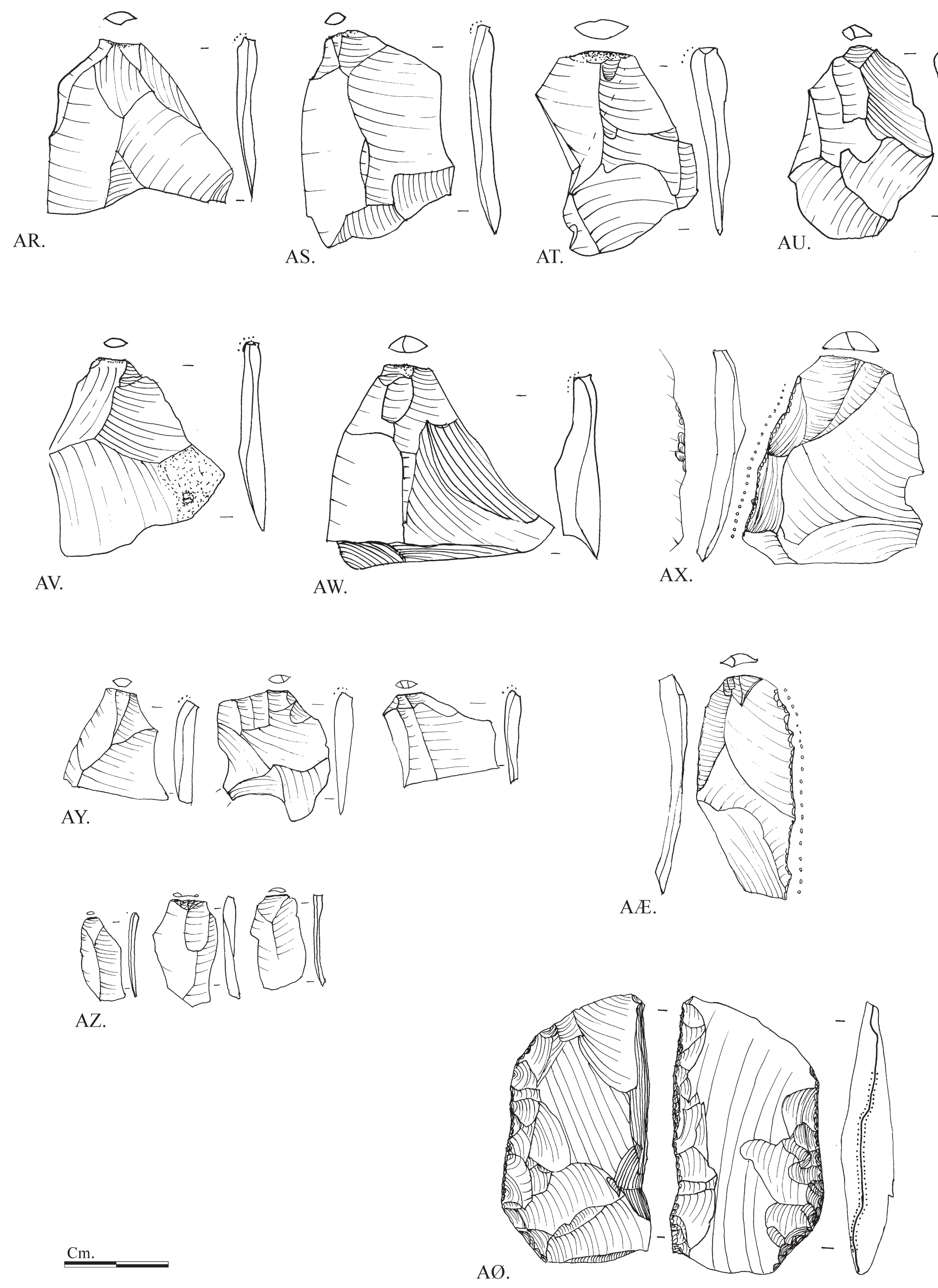

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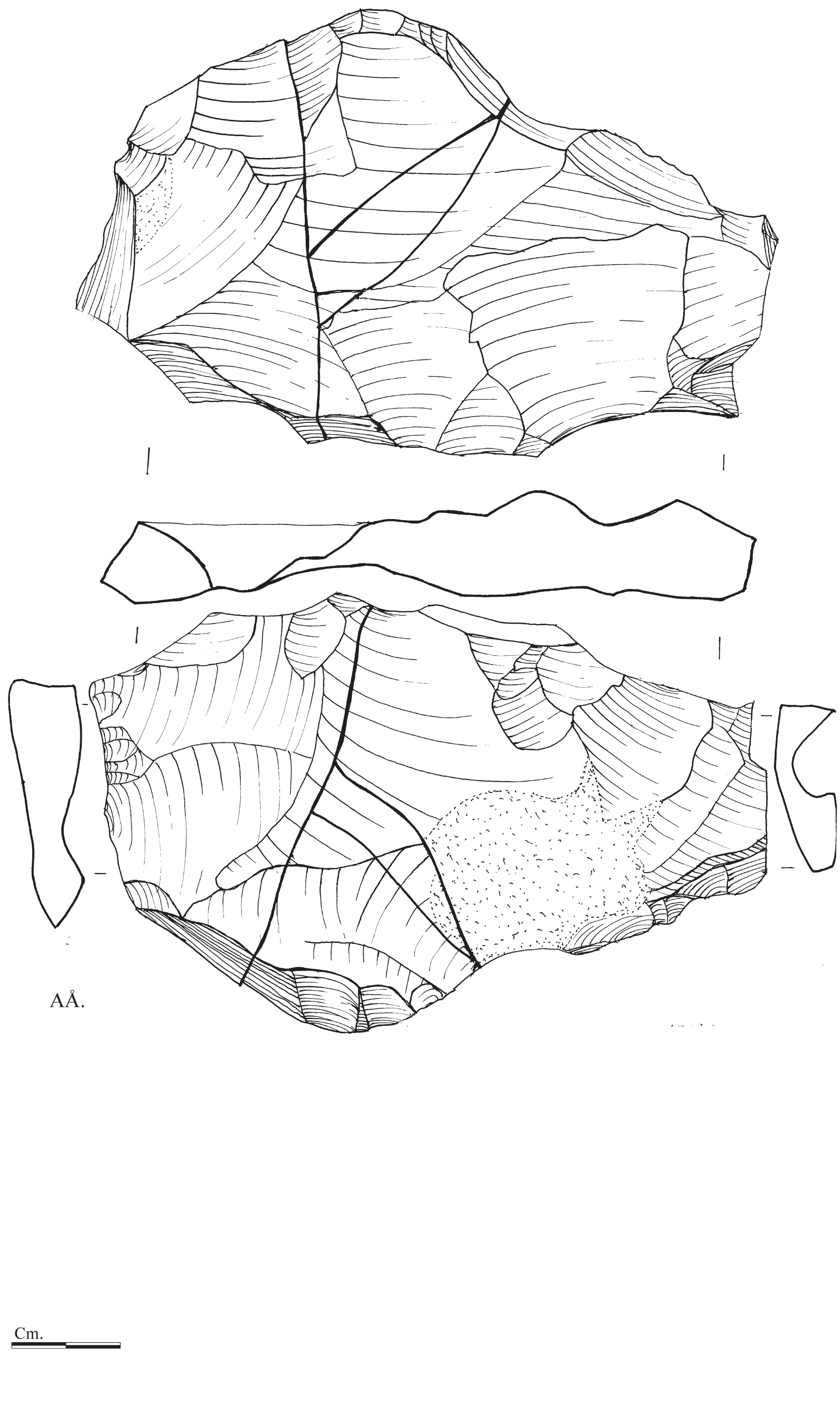

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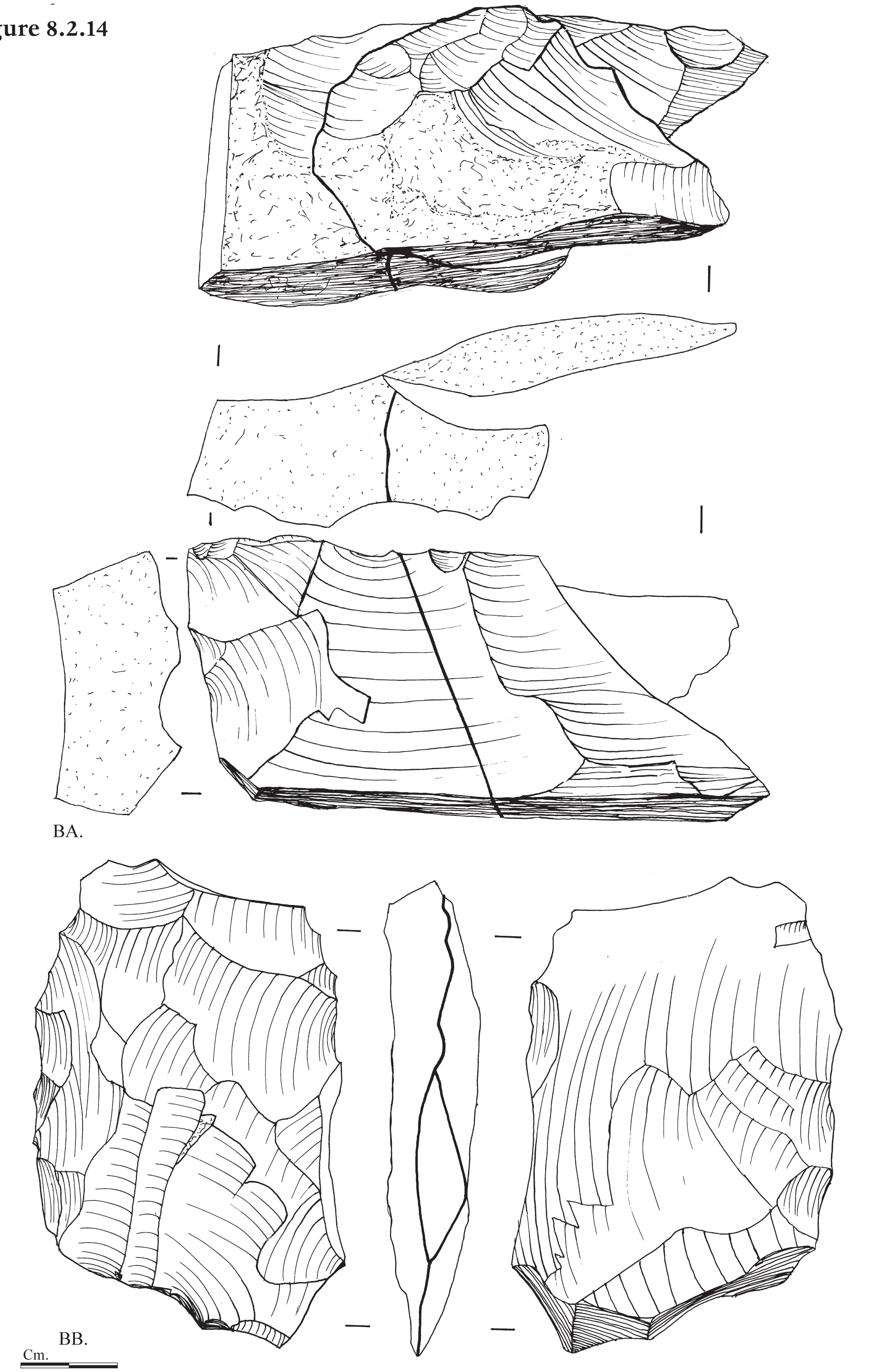

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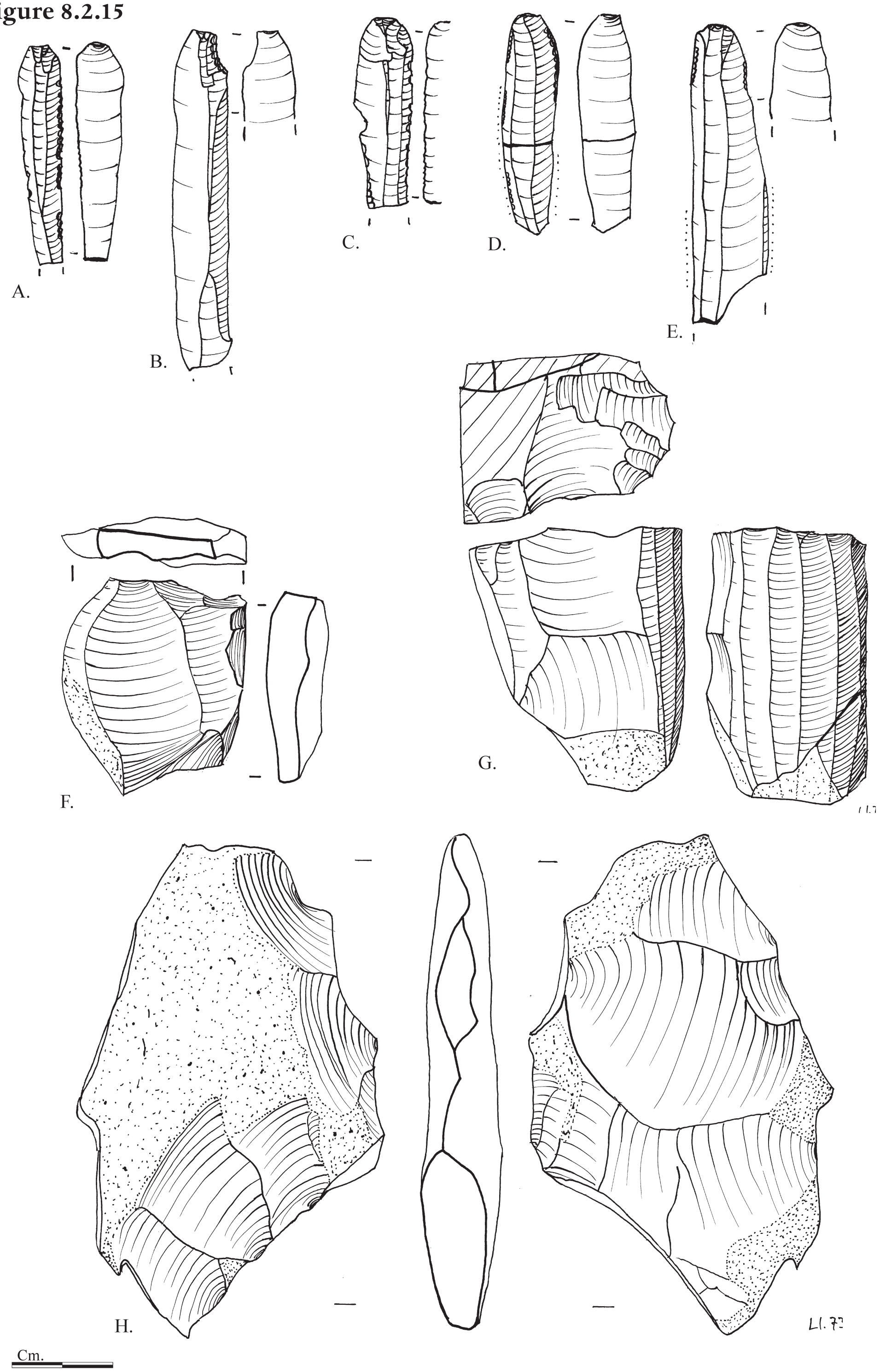

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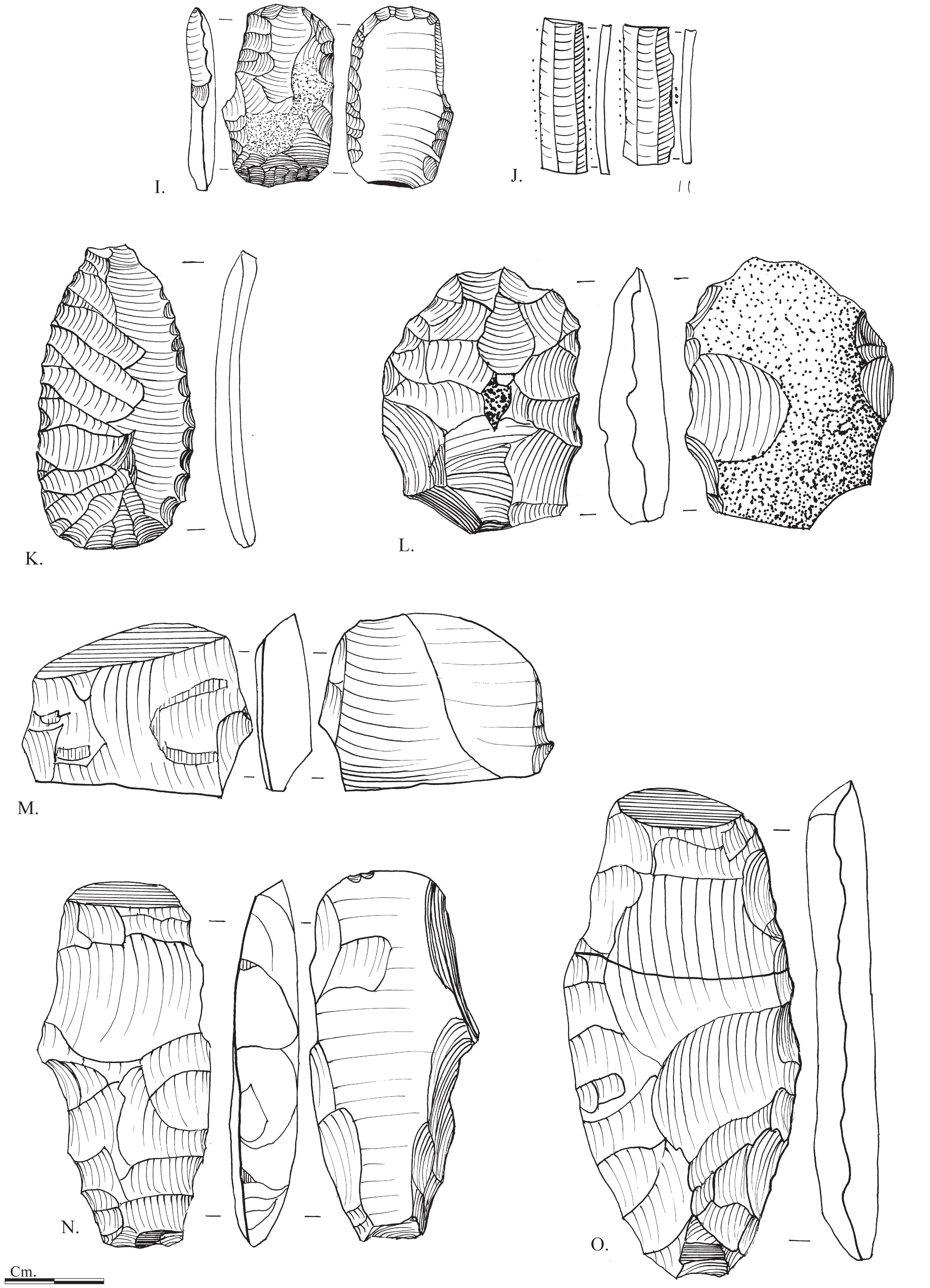

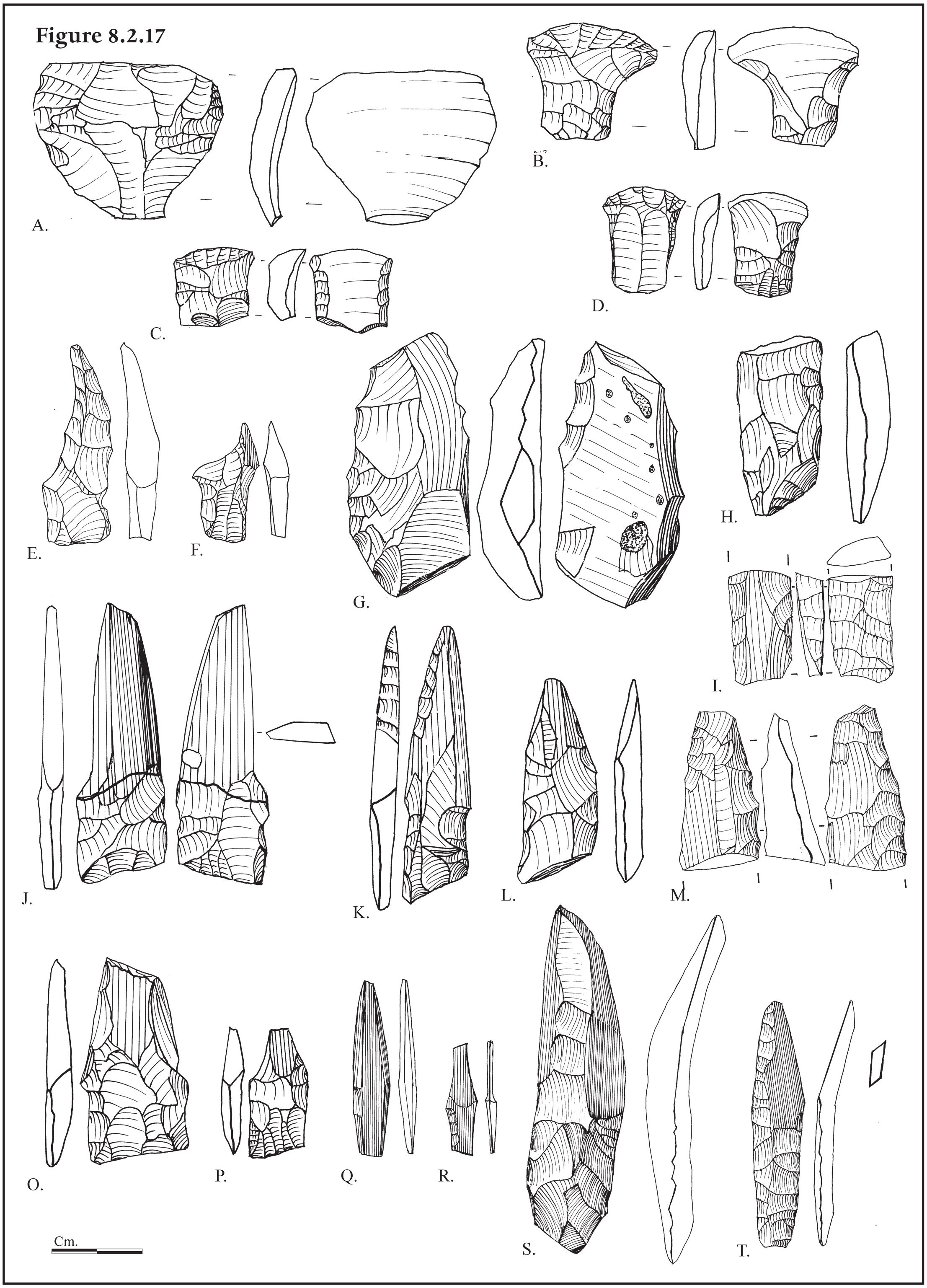
Figure 8.2.17
A.
B.
C.
D.
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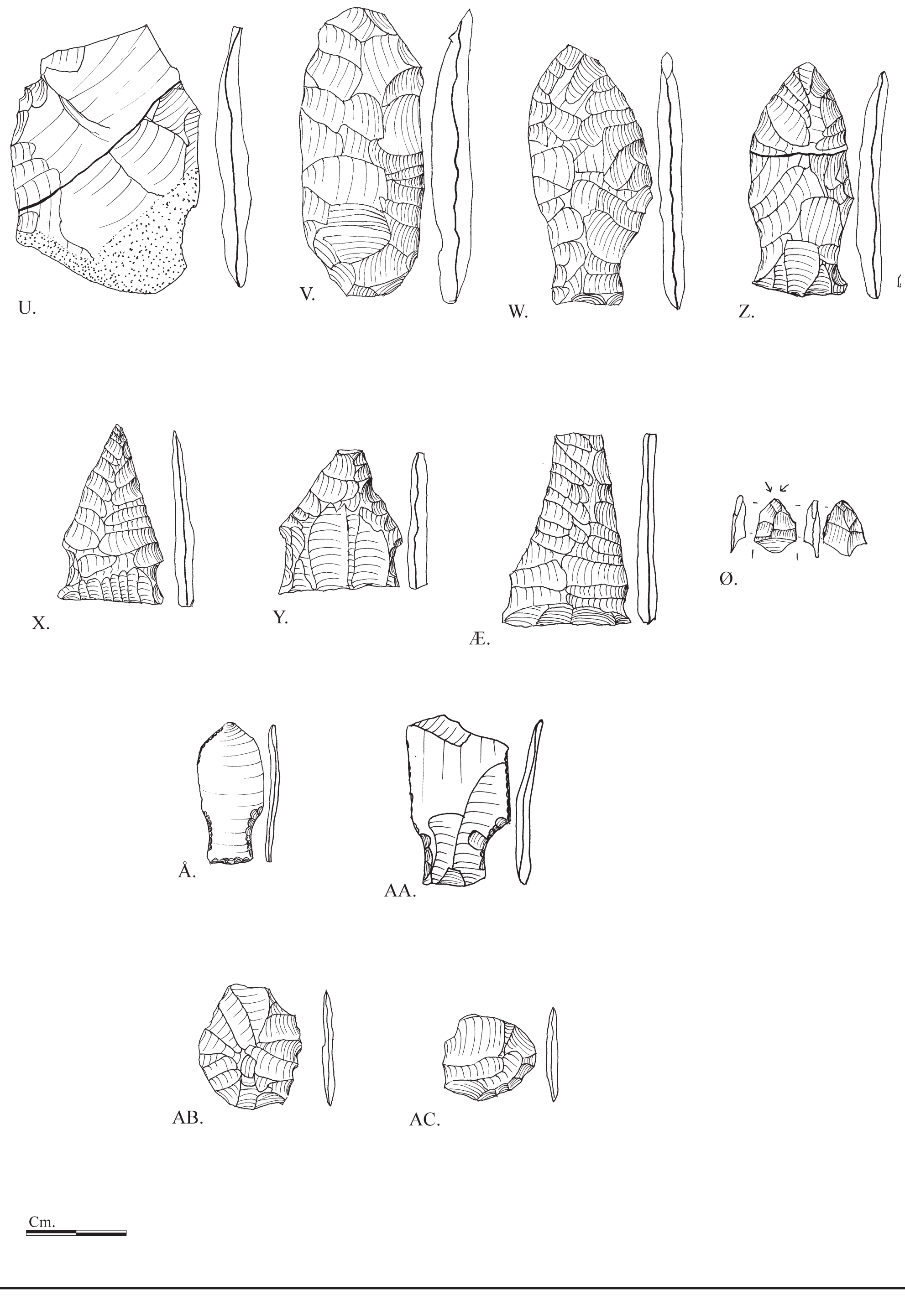
Cm.

Figure 8.2.18



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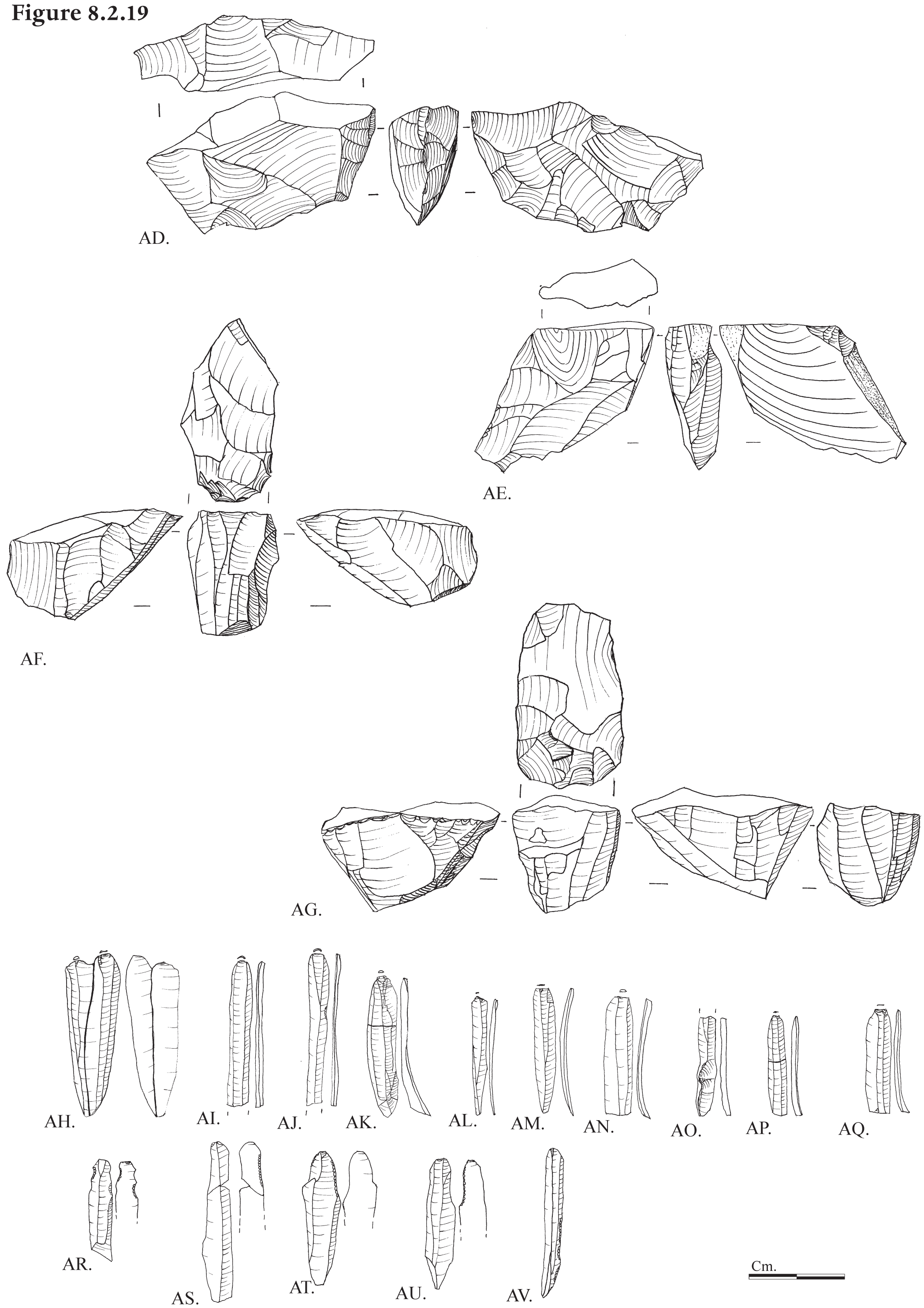

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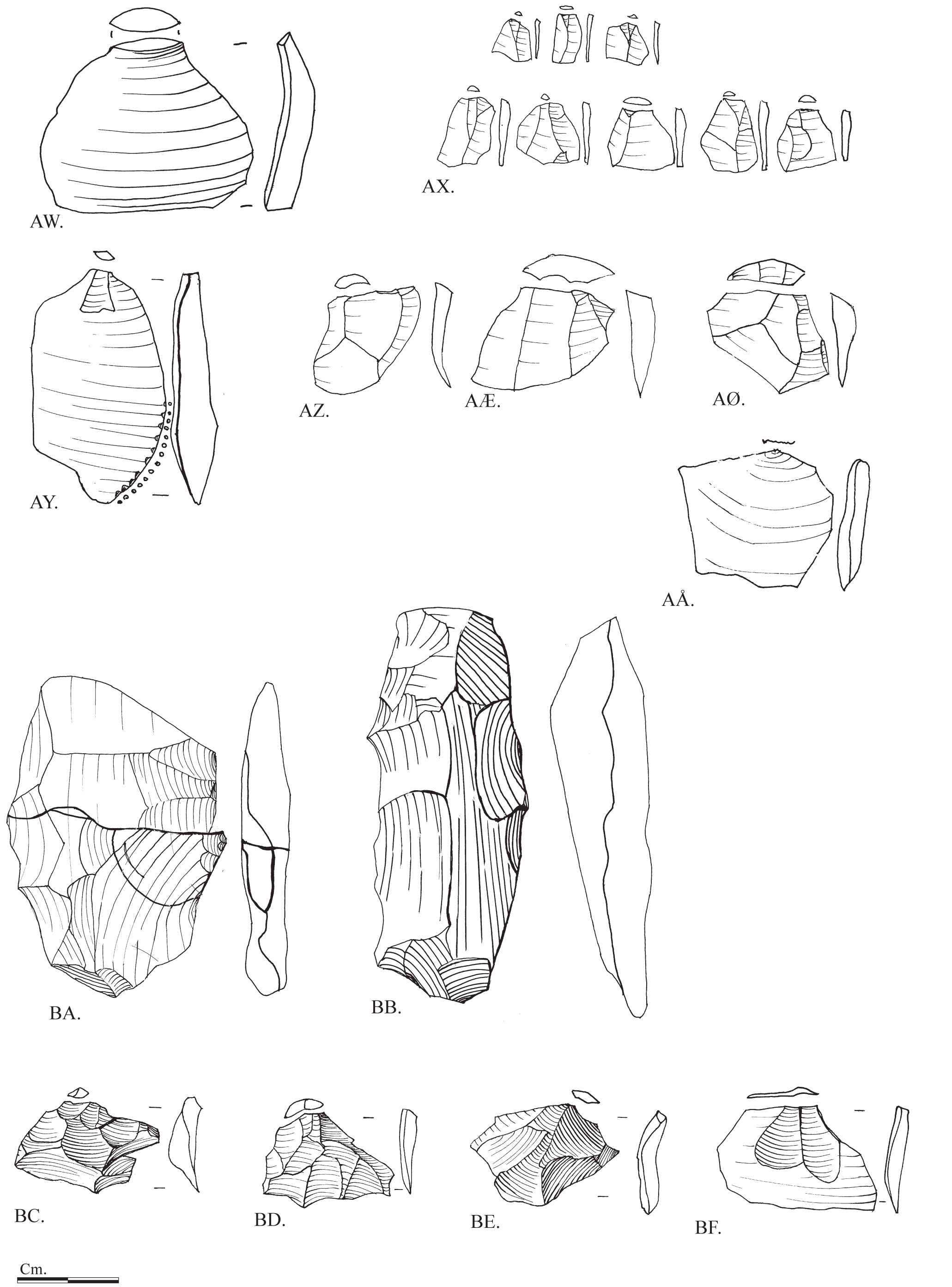

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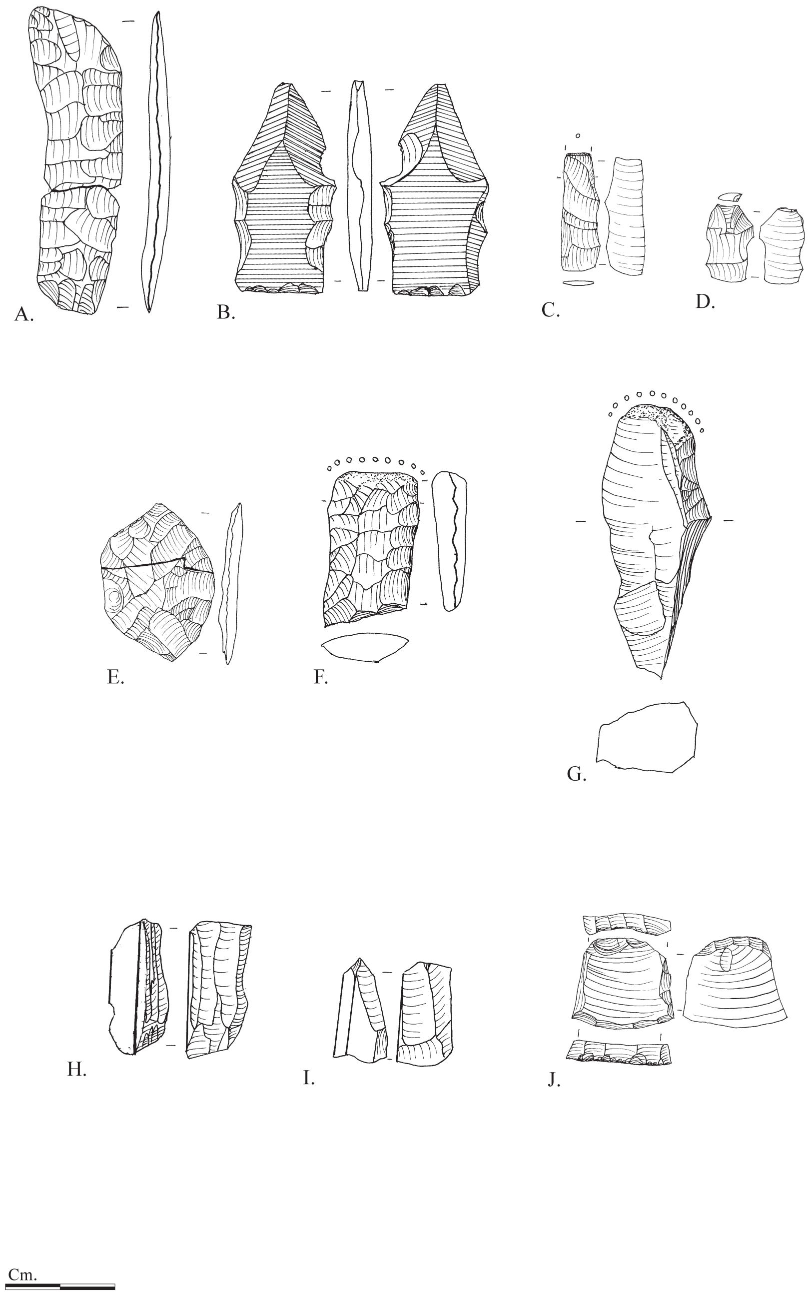


Figure 8.2.22

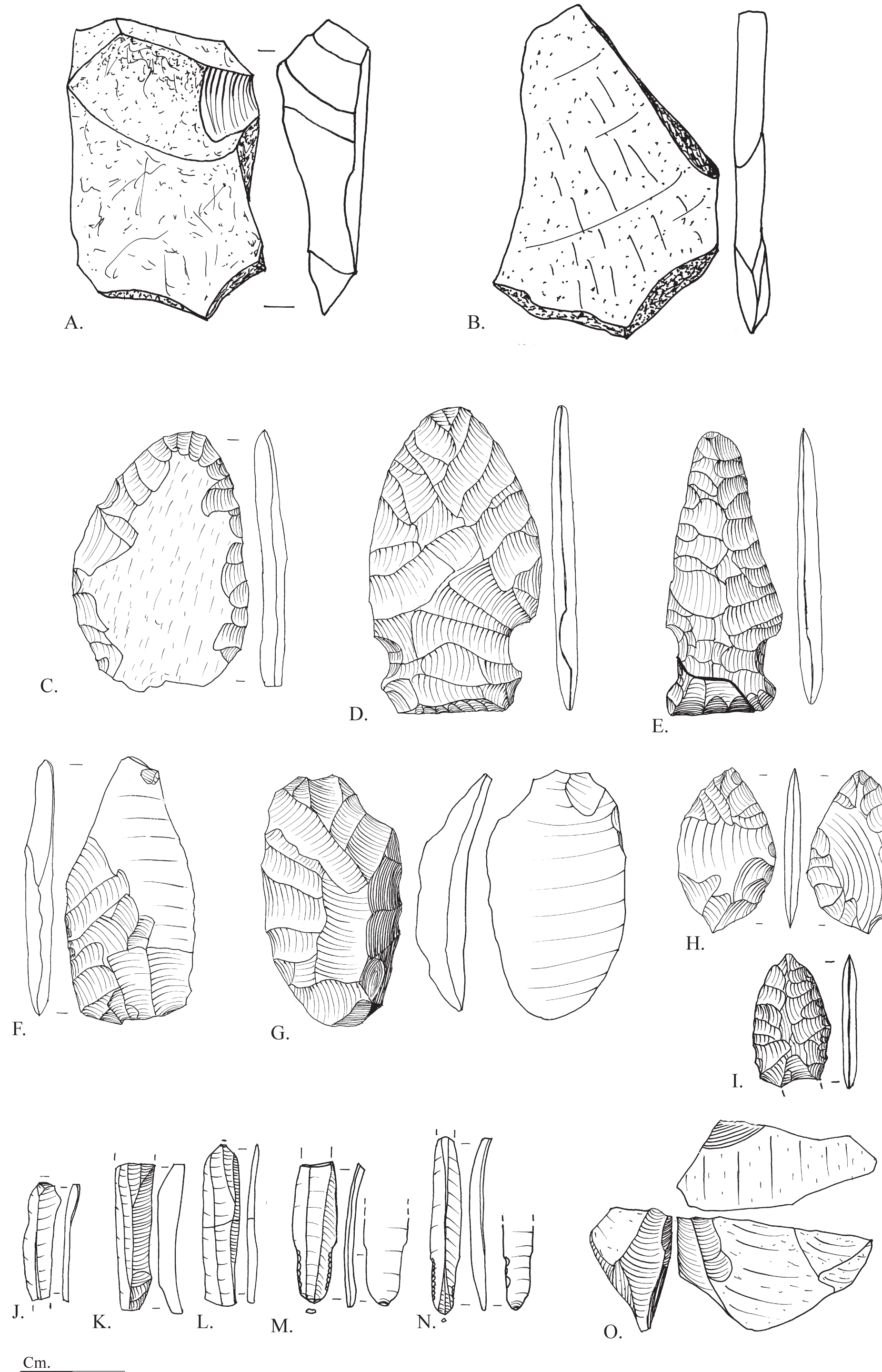
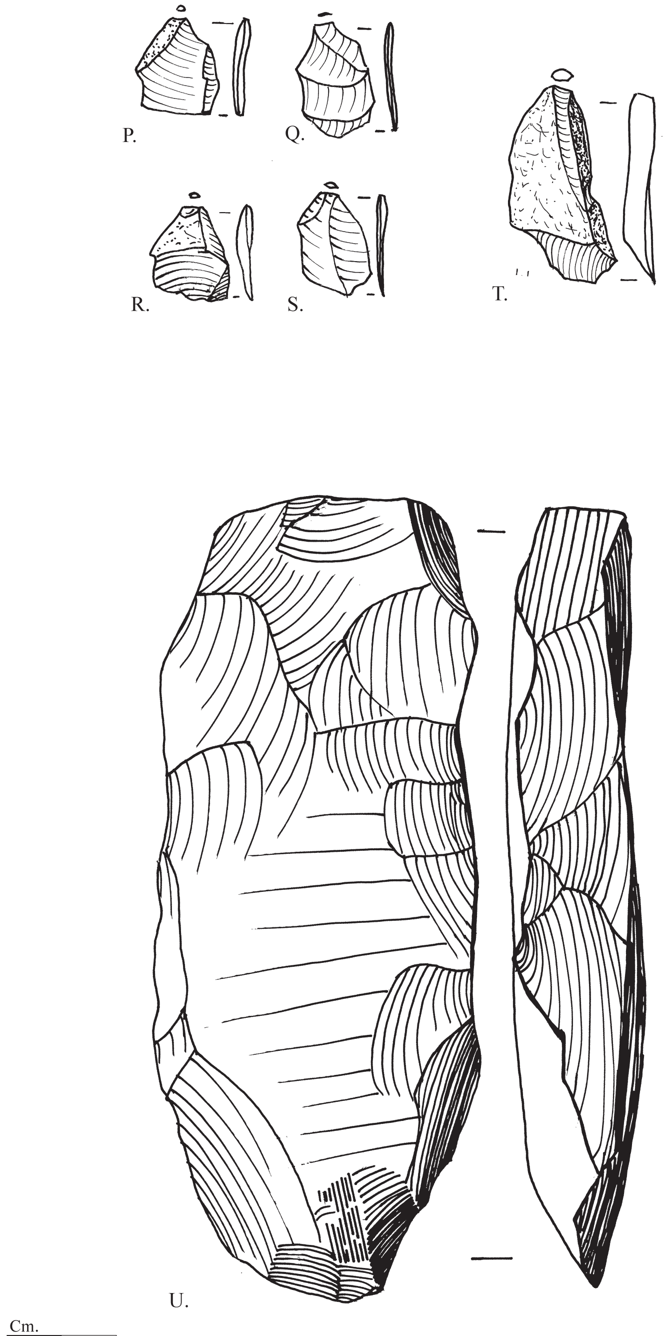


Figure 8.2.23



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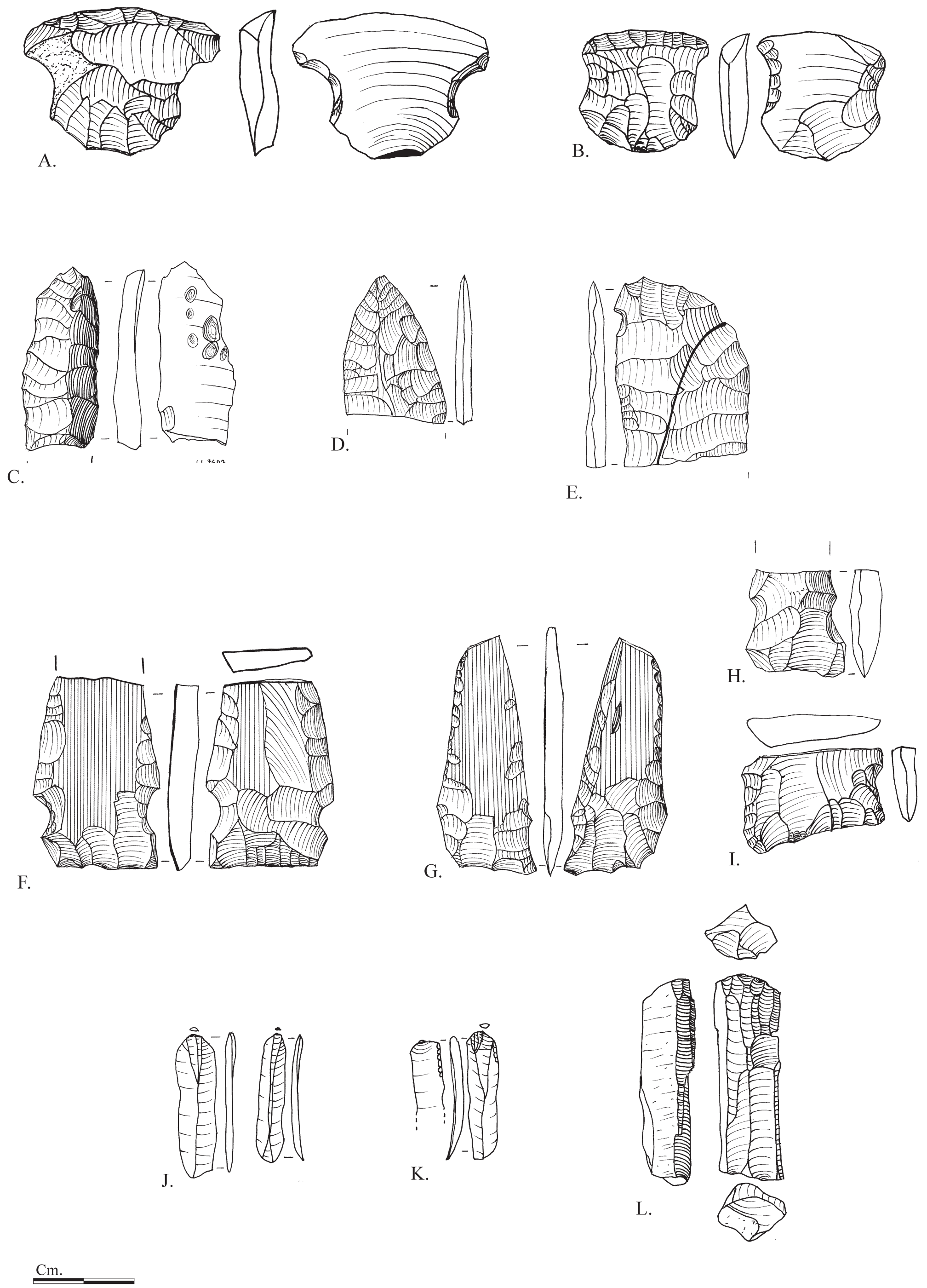

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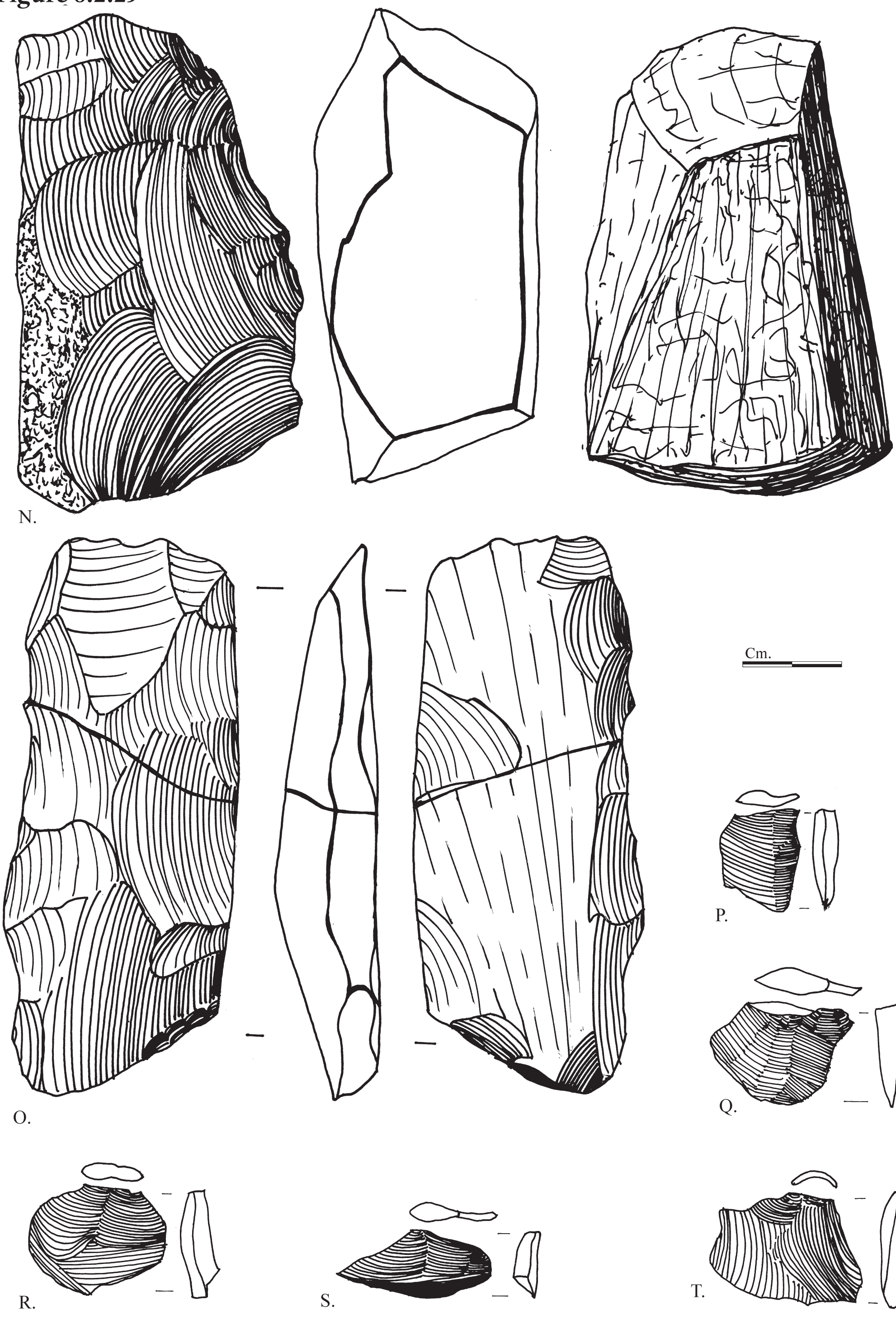

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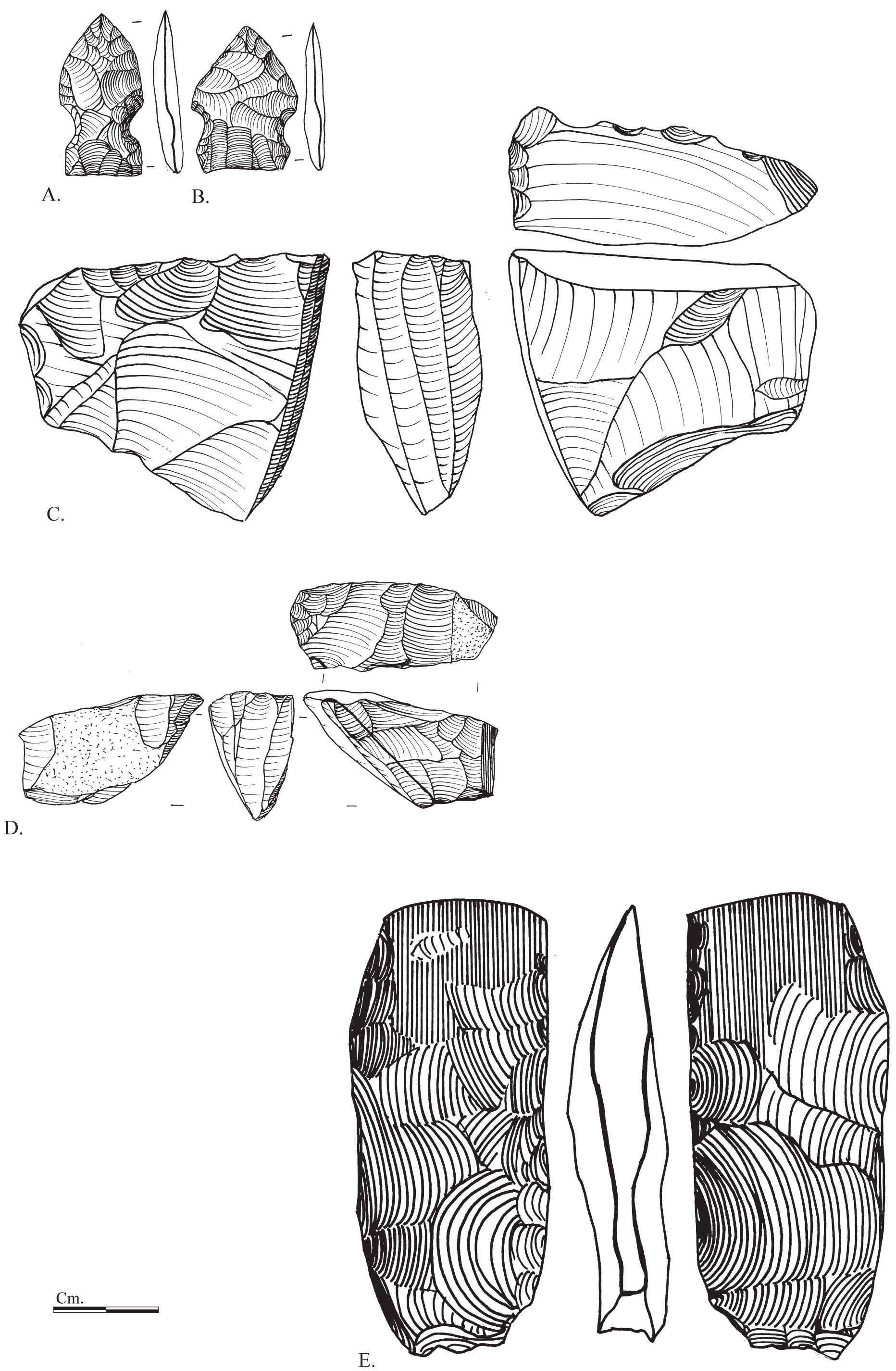

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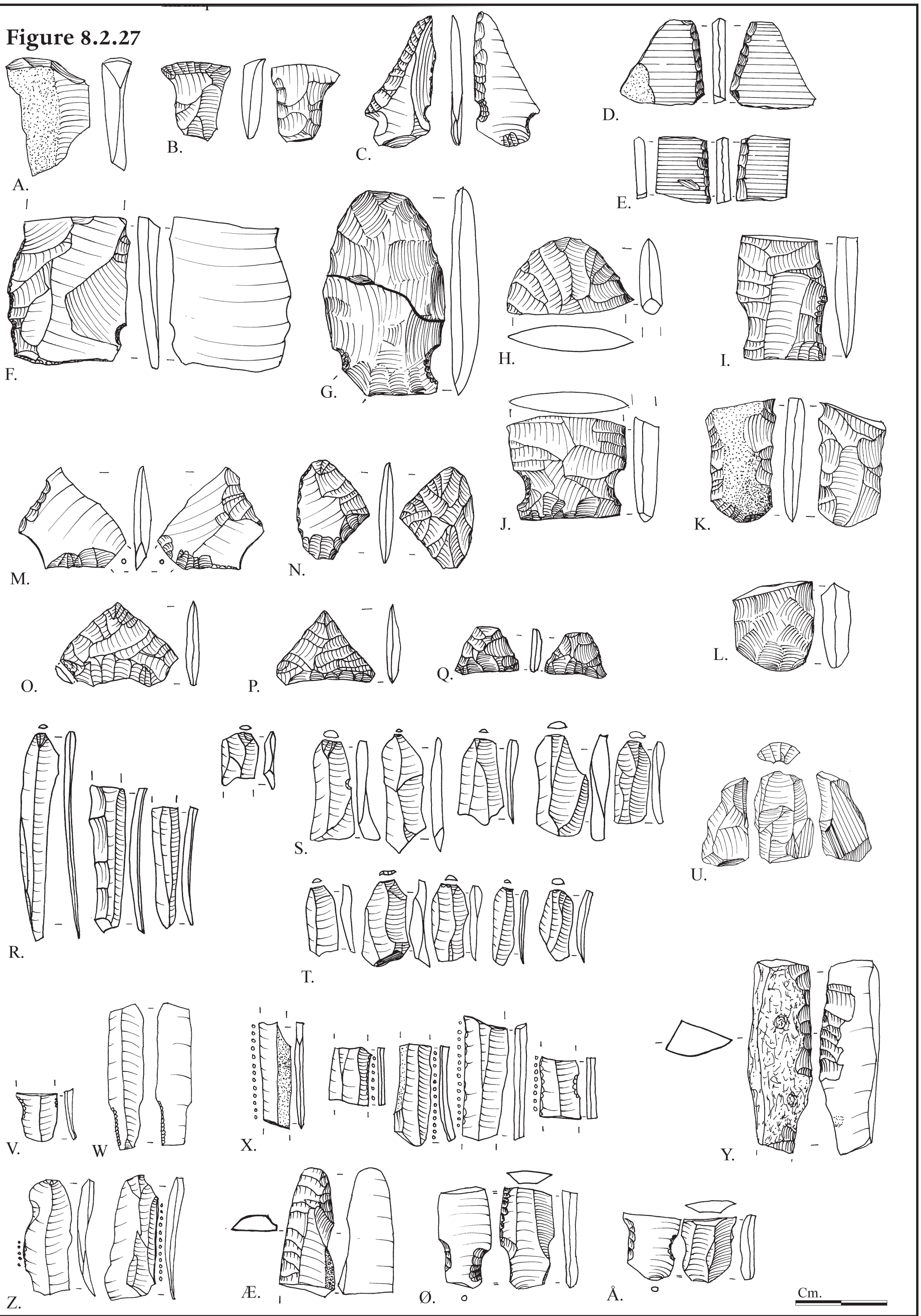

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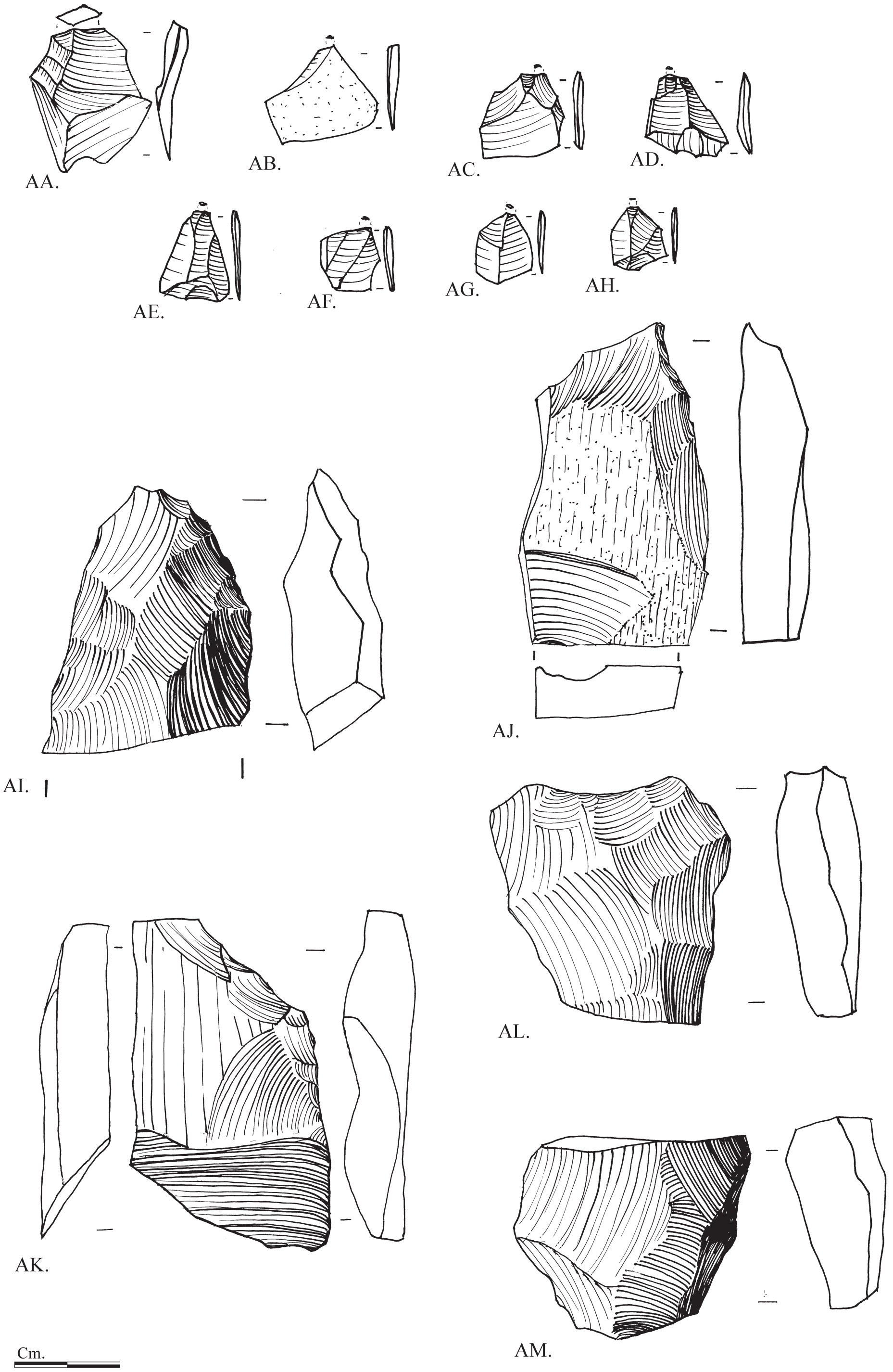

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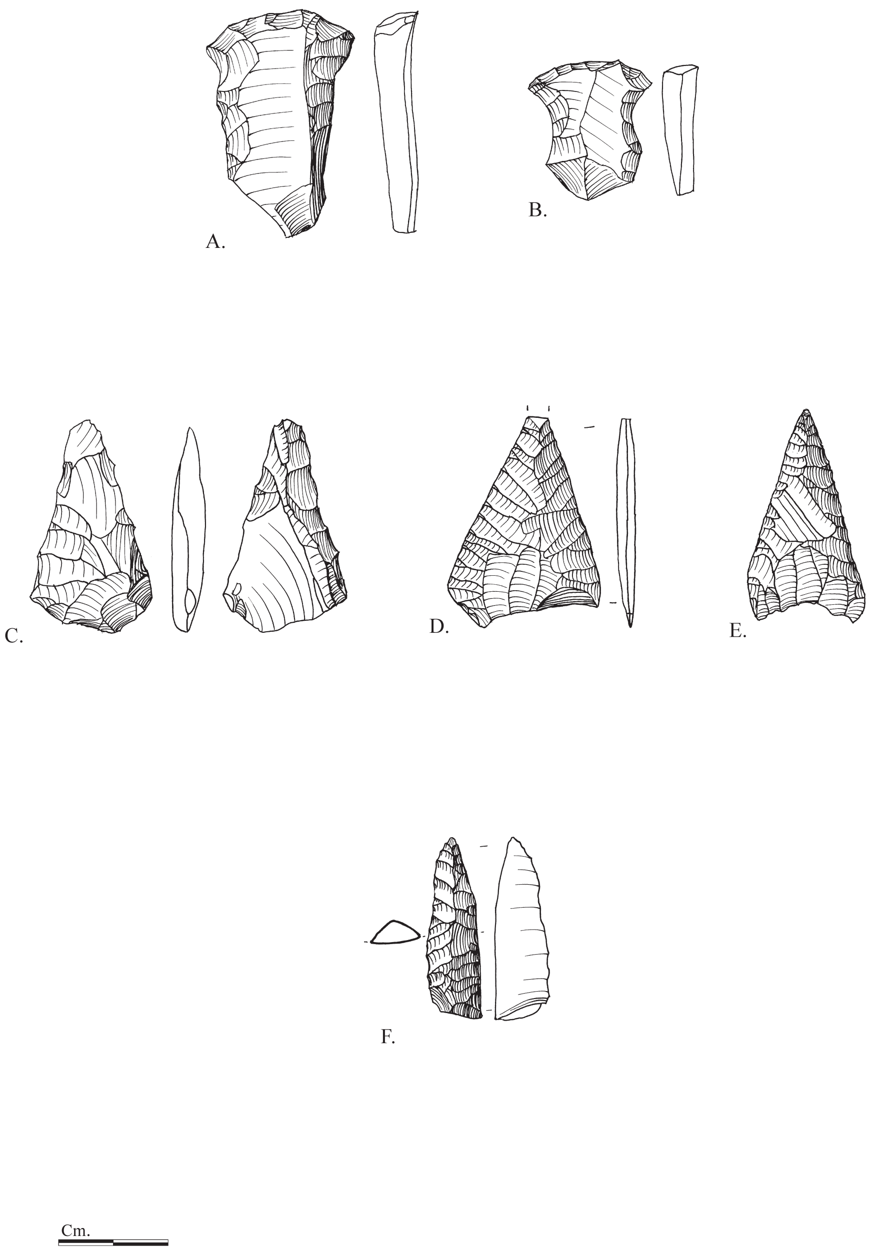

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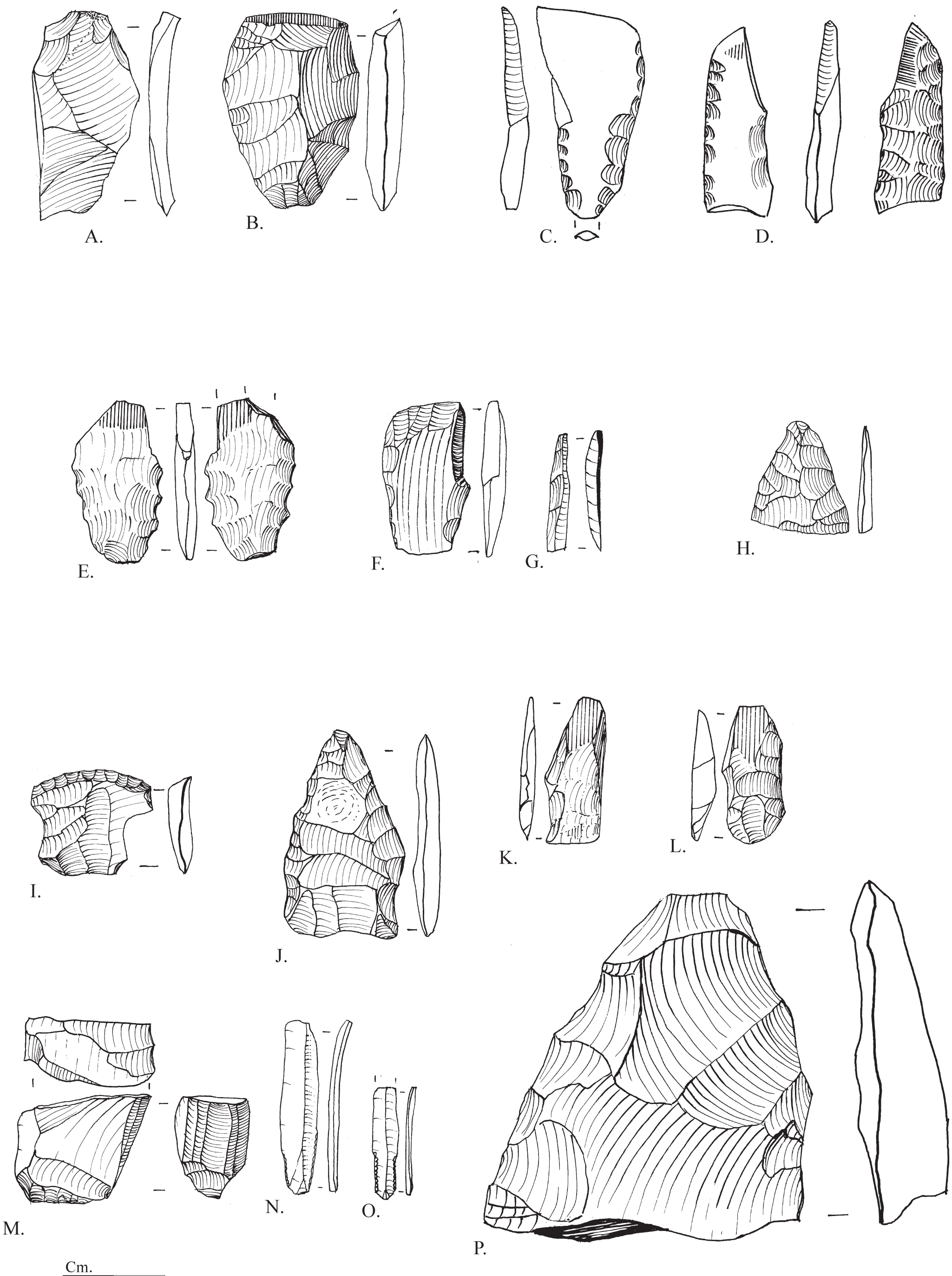

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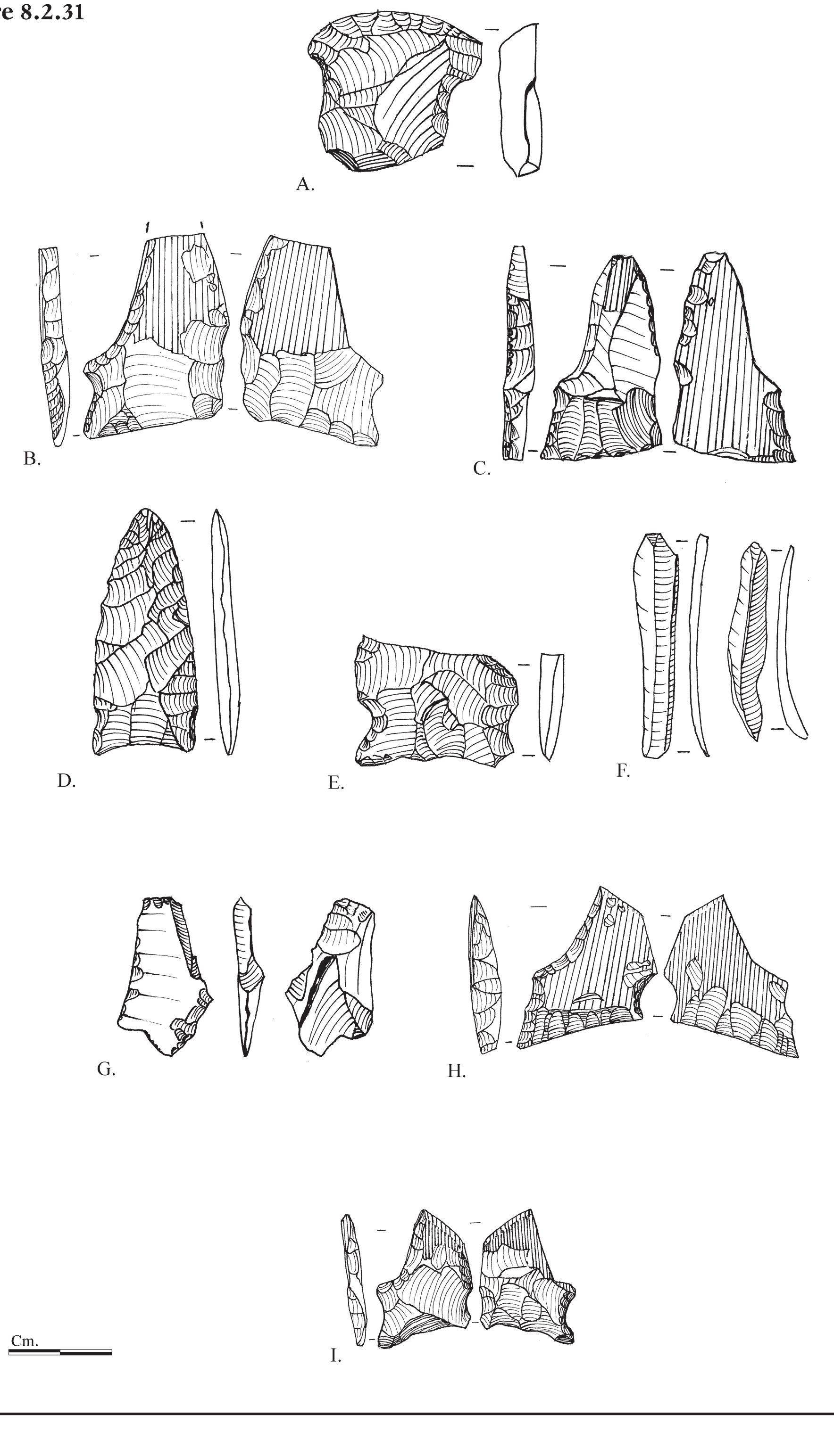

Figures 8.2.32–8.2.36
Photo documentation of selected lithic assemblages

Fig. 8.2.32 Ground lithic artefact types from the Greenlandic Dorset site Orpissoq in the Cape Farewell District.

Fig. 8.2.33 Lithic artefacts from Greenladic Dorset sites in the Wollaston region (central northeast Greenland). The reddish mcq types have been heat treated (A, E, F, G, H, I, J, K). The three ground burins are made from basalt (B, C, D), probably from the 'basalt Ø' source. This particular raw material choice is typical for burins made by the Greenlandic Dorset up to the Nordostrundingen area. Also the steep platform angle of the blade core (F) and the tanged microblades (G, H, I) are typical to the Greenlandic Dorset.

Fig. 8.2.34 Burins from the Kap Berghaus site, in the estuary of Young Sound (central northeast Greenland). The burin made from basalt has a ground distal end. Raw material choice, morphology and technology for the burins are typical to the Saqqaq tradition. These burins are the most northern evidence of the Saqqaq in East Greenland.

Fig. 8.2.35 Burin from structure at the Grønnedal site, in the estuary of Young Sound (central northeast Greenland). The burin is made from a metamorphosed schist. It is probably the only known burin in Greenland that has the combination of a ground distal end and proximal notches.

Fig. 8.2.36 Lithic artefacts from the large Greenlandic Dorset site at Île-de-France in northeast Greenland. From upper left an end blade made from the blue-white mcq from Amdrup Land is seen (source 56). To its right two end blades made from a local granular quartz is seen. At the upper right, two end blades are made from quartzite, a material that is known from the Dove Bugt (source 51). Lowest to the left, two preforms for burins are made from basalt, probably from the basalt areas south of Shannon Island. Lowest to the right three end blades made from a quartzite typical to Jøkel Bugt (source 53) is seen.

Bibliography

Akazawa, T., S. Oda, et al. (1980). *The Japanese Paleolithic: A techno-typological study*. Tokyo, Rippu Shobo.

Anderson, D. D. (1970). 'Microblade Traditions in Northwestern Alaska'. *Arctic Anthropology* VII.2: 2–17.

Andreasen, C. (1998). NEWland: settlement patterns, social organization and economic strategies at a High Arctic polynya. In: *Man Culture and Environment in Ancient Greenland*, ed. J. Arneborg & H. C. Gulløv. Copenhagen, Danish Polar Center, no. 4: 198–212.

Andreasen, C. (2000). 'Palaeo Eskimoes in Northwest and Northeast Greenland'. In: *Identities and Cultural Contacts in the Arctic*, ed. M. Appelt, H. C. Gulløv & J. Berglund. Copenhagen, Danish Polar Center: 82–93.

Andreasen, C. (2004). 'Independence II-kulturen'. In: *Grønlands Forhistorie*, ed. H. C. Gulløv. Copenhagen, Gyldendal: 112–140.

Andreasen, C. & H. Elling (1990). 'Arkæologisk kortlægning mellem Shannon (74°55′N) og Île de France (77°41′N), sommeren 1990'. Nuuk, Grønlands Hjemmestyre, Miljø- og Naturforvaltningen Teknisk Rapport nr. 18.

Andreasen, C. & H. Lange (2000). 'Arkæologiske undersøgelser, Washington Land, Vestlige Nordgrønland, sommeren 1999'. Nuuk, Rapport, Grønlands Nationalmuseum og Arkiv.

Andrefsky, W. (1998). *Lithics. Macroscopic approaches to analysis*. Cambridge, Cambridge University Press.

Apel, J. (2001). *Dagger Knowledge & Power*. Uppsala, Uppsala University.

Appelt, M. (1997). 'The Construction of an Archaeological "Culture". Similarities and differences in early Paleo-Eskimo cultures of Greenland'. In: *Fifty Years of Arctic Research*, ed. R. Gilberg & H. C. Gulløv. Copenhagen, The National Museum of Denmark: 33–41.

Appelt, M. (2004). 'De sidste Dorsetfolk'. In: *Grønlands Forhistorie*, ed. H. C. Gulløv. Copenhagen, Gyldendal: 177–217.

Appelt, M. & H. C. Gulløv (1999). 'Qeqertaaraq'. In: *Late Dorset in High Arctic Greenland. Final report on the gateway to Greenland project*, ed. H. C. Gulløv. Copenhagen, Danish Polar Center, no. 7: 7–20.

Appelt, M., H. C. Gulløv & H. Kapel (1998(a)). 'De sidste palæoeskimoer i Grønland'. *Nationalmuseets Arbejdsmark*: 11–27.

Appelt, M., H. C. Gulløv, D. Hanna, H. Kapel G. Lemoine & J. Møhl (1998(b)). 'Appendix 1: Archaeology'. In: *Man, Culture and Environment in Ancient Greenland*, ed. J. Arneborg. Copenhagen, Danish Polar Center, no. 4: 154–188.

Appelt, M., H. C. Gulløv & H. Kapel. (1998(c)). 'The Gateway to Greenland, Report on the field season 1996'. In: *Man, Culture and Environment in Ancient Greenland*, ed. J. Arneborg & H. C. Gulløv. Copenhagen, Danish Polar Center: 136–153.

Audouze, F. (1999). 'New advances in French prehistory'. *Antiquity* 73 : 167–175.

Bendix, B. (1998). 'Appendix 2: Quartenary zoology'. In: *Man, Culture and Environment in Ancient Greenland*, ed. J. Arneborg & H. C. Gulløv. Copenhagen, Danish Polar Center, no. 4: 188–191.

Bennike, O., M. Sørensen, B. Fredskild, B. H. Jakobsen, J. Böcher, S. L. Amsinck, E. Jeppesen, C. Andreasen, H. H. Christiansen, O. Humlum (2008). *Late Quaternary Environmental and Cultural Changes in the Wollaston Forland Region, Northeast Greenland (chapter 3)*. In: *Arctic Climate and Climate Change with a Focus on Greenland*. In: (eds): High-Arctic Ecosystem Dynamics in a Changing Climate. – Advances in Ecological Research, ed. H. Meltofte, T. R. Christensen, B. Elberling, M. C. Forchhammer and M. Rasch. New York, Elsevier. 40**:** 45–76.

Binford, L. R. (1979). 'Organization and Formation Processes: Looking at Curated Technologies'. *Journal of Anthropological Research* 35: 255–273.

Binford, L. R. (1983). *In pursuit of the past: Decoding the archaeological record*. London, Thames & Hudson.

Birket-Smith, K. (1962). 'Nationalmuseets Etnografiske Samling 1960 (Annual Report of the Ethnographical Department of the Danish National Museum for 1960)'. *Folk* 4: 165–179.

Boas, F. (1887). 'Museums of Ethnology and Their Classifications'. *Science* 9: 587–589.

Bodu, P., C. Karlin & S. Ploux (1990). 'Who's who? The Magdalenian Flintknappers of Pincevent (France)'. In: *The Big Puzzle. International Symposium on Refitting Stone Artefacts, Mon Repos, 1987*, ed. E. Cziesla, S. Eickhoff, N. Arts & D. Winther. Bonn, Holos: 143–163.

Boëda, E. (1994). *Le concept Levallois: Variabilité des méthodes*. Paris, C.N.R.S.

Bordes, F. (1969a). 'Reflections on typology and techniques in the Palaeolithic'. *Arctic Anthropology* vol. VI.1: 1–30.

Bordes, F. (1969b). 'Traitement thermique du silex au Solutréen'. *Bull. Soc. Préhist. Fr.,* vol 66: 197.

Bordes, F. (1970). 'Observations typologiques et techniques sur le Périgordien supérieur de Corbiac'. *Bull. Soc. Préhist. Fr.*, vol. 67: 105–113.

Bordes, F. & D. E. Crabtree (1969). 'The Corciac Blade Technique and Other Experiments'. *Tebiwa* 12(2): 1–20.

Buchwald, V. F. (1992). *Meteoritter – nøglen til Jordens fortid*. Copenhagen, Gyldendal.

Buchwald, V. F. (1998). 'Appendix 3: Metal analysis'. In: *Man, Culture and Environment in Ancient Greenland*, ed. J. Arneborg & H. C. Gulløv. Copenhagen, Danish Polar Center: 191.

Buchwald, V. F. & G. Mosdal (1985). 'Meteoritic iron, telluric iron and wrought iron in Greenland'. Meddelelser om Grønland. Man & Society 9: 3–49.

Bundgård, J. (1977). 'Enestående dobbeltfund ændrer Grønlands historie'. *Berlingske Tidende*, 18 September 1977: 32.

Bøggild, O. B. (1953). 'The mineralogy of Greenland'. Meddelser om Grønland 149, no. 3: 442.

Callahan, E. (1985). 'Experiments with Danish Mesolithic Microblade Technology'. *Journal of Danish Archaeology* 4: 22–39.

Carpenter, E. (1973). *Eskimo Realities*. New York, Chicago, San Francisco, Holt, Rhinehart and Winston.

Chippendale, C. (1986). 'Archaeology, Design Theory, and the Reconstruction of Prehistoric Design Systems'. *Environment and Planning B: Planning and Design 1986*: 445–485.

Coulson, S. (1986). 'Refitted Flint Nodules from Songa, Telemark'. Universitets Oldsakssamling Årbok 1984/1985.

Coulson, S. (2004). 'It all depends on how you approach them: The Independence II localities from the Eigil Knuth site. In: *Presentation at the international Sila/Nabo conference 'Dynamics of Northern Societies', May 2004. Session 1 (Chairs: S. Coulson and M. Sørensen)*. Copenhagen.

Crabtree, D. E. (1972). *An Introduction to Flintworking.* Pocatello, Idaho.

Crabtree, D. E. & B. R. Butler (1964). 'Notes on Experiments in Flint Knapping: 1. Heat Treatment of Silica Minerals'. *Tebiwa* vol. 7(1): 1–7.

Cziesla, E. (1990). 'On Refitting Stone Artefacts'. In: *The Big Puzzle. International Symposium on Refitting Stone Artefacts, Mon Repos, 1987*, ed. E. Cziesla, S. Eickhoff, N. Arts & D. Winter. Bonn, Holos: 9–44.

Damkjar, E. (2003). 'Transitional Occupations of Southeastern Somerset Island, Nunavut'. *Inuit Studies* 2003, 27(1–2): 213–238.

Dawes, P. (1997). 'The Proterozeric Thule Supergroup, Greenland and Canada: History, lithistratigraphy and development'. *Geology of Greenland Survey Bulletin* 174.

Desrosiers, P. (1999). 'Les traditioins lithiques au Paléoesqimau. Approche technologique préliminaire de l´industrie du Dorsétien moyen de Kuujjuuarapik (GhGk-63)(Nunavik, Canada). Caractérisation du débitage lamellaire'. *Mémoire de D.E.A de Préhistoire-Ethnologie-Anthropologie.* Paris, Université de Paris 1, Sorbonne: 59.

Desrosiers, P. & D. Gendron (in press). 'Étude de la production d'outils en schiste Dorsétiens et Thuléens au Nunavik. Hypohtéses préliminaires sur les schemas techniques'.

Desrosiers, P. & D. Gendron (2004). *The Tayara Site and the Concept of 'Early Dorset'*. Montreal, Abstract from SAA 2004.

Desrosiers, P., D. Gendron & N. Rahmani (2005). 'Harpoon Head Seriation and the Dorset Phases: About the Tayara Sliced and Other Types'. In: *Dynamics of Northern Societies*, ed. J. Arneborg & B. Grønnow. Copenhagen, The National Museum of Denmark: 129–143.

Desrosiers, P. & N. Rahmani (2003). 'Le quartzite dit "de Diana": apport des nouvelles recherches sur la carriére de Kangiqsualuk, JfEj-3 (Quaqtaq, Nunavik)'. *Archéologiques* no. 16: 1–13.

Dumond, D. E. (1987). *The Eskimos and Aleuts*. London, Thames and Hudson Ltd.

Elling, H. (1992). 'De Palæoeskimoiske Kulturer i Nordgrønland og Nordøstgrønland i relation til de Vestgrønlandske'. *Grønlandsk Kultur og Samfundsforskning 92*: 50–70.

Elling, H. (1996). 'The Independence I and the Old Nuulliit Cultures in Relation to the Saqqaq Culture'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 191–198.

Eriksen, B. V. (1997). 'Implications of thermal pretreatment of chert in the German Mesolithic'. In: *Man and Flint. Proceedings from the VII International Flint Symposium*, ed. Z. Sulgostowska. Warsaw, Institute of Archaeology and Ethnology, Polish Academy of Sciences: 325–329.

Eriksen, B. V., ed. (2000a). *Flintstudier*. Aarhus, Århus Universitetsforlag.

Eriksen, B. V. (2000b). 'Chaine opératoire'. In: *Flintstudier*. Aarhus, Århus Universitetsforlag: 75–100.

Eriksen, B. V. (2000c). 'Squeezing blood from stones'. In: *Flintstudier*. Aarhus, Århus Universitetsforlag: 231–267.

Feldbo, M., J. F. Jensen, A. B. Gotfredsen & H. C. Gulløv (1992). 'Rapport om det arkæologiske arbejde i Skjoldungen, Ammasalik kommune, Sydøstgrønland, sommeren 1991'. Copenhagen, Institute of Archaeology, University of Copenhagen, Zoologisk Museum, The National Museum of Denmark.

Fiedorczuk, J. (1995). 'Processing workshops and habitation sites of the Final Palaeolithic Mazovian Complex. A view from the perspective of flint artefacts refitting'. In: *Man and Flint*, ed. R. Schild & Z. Sulgostowska: 201–209.

Fischer, A., P. Vemming Hansen & P. Rasmussen (1984). 'Macro and Micro Wear Traces on Lithic Projectile Points. Experimental Results and Prehistoric Examples'. *Journal of Danish Archaeology* vol. 3: 19–46.

Fitzhugh, W. W. (1972). 'Environmental Archaeology and Cultural Systems in Hamilton Inlet, Labrador'. *Smithsonian Contributions to Anthropology*. Washington, Smithsonian Institution, no. 16.

Fitzhugh, W. W. (2002). 'Nukasusutok 2 and the Paleoeskimo Tradition in Labrador'. In: *Honoring Our Elders*, ed. W. W. Fitzhugh, S. Loring & D. Odess. Washington, Smithsonian Institution: 133–163.

Flenniken, J. J. (1987). 'The Paleolithic Dyukai pressure blade technique of Siberia'. *Arctic Anthropology* 24(2): 117–132.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York, Basic Books, cop. 1983.

Gendron, D. & C. Pinard (2000). 'Early Paleo-Eskimo Occupations in Nunavik: A Re-Appraisal'. In: *Identities and Cultural Contacts in the Arctic,* ed. M. Appelt, J. Berglund & H. C. Gulløv. Copenhagen, Danish Polar Center: 129–143.

Geneste, J. M. (1985). 'Analyse lithique d'industries Moustériennes du Périgord: une approche de technologique du comportement des groupes humains de Paléolithique Moyen'. Thése de Doctorat, Bordeaux, Université de Bordeaux.

Giddings, J. L. (1964). *The Archaeology of Cape Denbigh*. Provindence, Rhode Island, Brown University Press.

Giria, E. Y. & V. V. Pitul'ku (1994). 'A High Arctic Mesolithic industry on Zhokov Island: Inset tools and knapping technology'. *Arctic Anthropology* 31(2): 31–44.

Gotfredsen, A. B. & T. Møbjerg (2004(a)). 'Saqqaq-Folket på Nipisat'. *Naturens Verden* 11/12: 2–24.

Gotfredsen, A. B. & T. Møbjerg (2004(b)). 'Nipisat – a Saqqaq Culture Site in Sisimiut, Central West Greenland. Meddelser om Grønland, Man & Society. Copenhagen, Sisimiut Museum and SILA, Vol. 31.

Gotfredsen, A. B., H. C. Gulløv & M. Rosing (1992). 'Østgrønlandske ressourcer – rapport fra projekt Skjoldungen'. *Tusaat* 1/92: 19–21.

Gramly, R. (1978). 'Lithic source areas in northern Labrador'. *Arctic Anthropology* XV.2: 36–47.

Grønnow, B. (1988(a)). 'En orientering om de tværfaglige undersøgelser på bopladsen Qeqertasussuk, Christianshåb kommune'. In: *Palæoeskimoisk forskning i Grønland*, ed. H. Schultz Lorentzen. Aarhus, Århus Universitetsforlag: 21–39.

Grønnow, B. (1988(b)). 'Paleoeskimo Cultures in Greenland. Summary of final discussion'. In: *Palæoeskimoisk forskning i Grønland*, ed. H. S. Lorentzen. Aarhus, Århus Universitetsforlag: 95–99.

Grønnow, B. (1994). 'Qeqertasussuk – the Archaeology of a Frozen Saqqaq

Site in Disko Bugt, West Greenland'. In: *Threads of Arctic Prehistory: Papers in honour of William E. Taylor*, ed. J.L.Pilon. Quebec, Canadian Museum of Civilization: 197–239.

Grønnow, B. (1996(a)). 'The Paleo-Cultures of Greenland – Current Research'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 9.

Grønnow, B. (1996(b)). 'The Saqqaq Toolkit – Technological and Chronological Evidence from Qeqertasussuk'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 17–35.

Grønnow, B. (1999). 'Qallunatalik/Polaris Site'. In: *Late Dorset in High Artic Greenland*, ed. M. Appelt & H. C. Gulløv. Copenhagen, Danish Polar Center, no. 7: 42–62.

Grønnow, B. & J. Fog Jensen (2003). *The Northernmost Ruins of the Globe*. Copenhagen, Sila & Danish Polar Center.

Grønnow, B. & M. Sørensen (2006). 'Palaeo-Eskimo Migrations into Greenland: The Canadian Connection'. In: *Dynamics of Northern Societies. Sila/Nabo conference, May 2004*, ed. B. Grønnow, H. C. Gulløv & J. Arneborg. Copenhagen, The National Museum of Denmark: 59–74.

Gulløv, H. C. (1986). *Grønland 1945-1985. Kulturhistorisk Forskningsoversigt*. Copenhagen, The National Museum of Denmark.

Gulløv, H. C. (2000). 'Østgrønlandsk kartografi og xylografi'. In: *Topografisk Atlas Grønland*, ed. B. H. Jakobsen, J. Böcher, N. Nielsenet et al. Copenhagen, Det Kongelige Danske Geografiske Selskab og Kort og Matrikelstyrelsen (in commission at C.A. Reitzels Forlag): 170–172.

Gulløv, H. C. (2005). 'Aasiviit as focal places in historical Greenland'. In: *Dynamics of Northern Societies,* ed. J. Arneborg & B. Grønnow. Copenhagen, The National Museum of Denmark: 207–212.

Gulløv, H. C., ed. (2004). *Grønlands Forhistorie*. Copenhagen, Gyldendal.

Gulløv, H. C. & H. Kabel (1988). 'De palæoeskimoiske kulturer i Nuuk Kommune. Bosætningsmønstre og materialevalg'. In: *Palæoeskimoisk Forskning i Grønland*, ed. H. S. Lorentzen. Aarhus, Århus Universitetsforlag: 39–59.

Gulløv, H. C. & J. F. Jensen (1991). *Rapport om de arkæologiske registreringer og undersøgelser i Søndre Skjoldunge Sund, Ammasalik kommune, Sydøstgrønland, sommeren 1990*. Copenhagen, The National Museum of Denmark, Department of Archaeology, University of Copenhagen.

Gulløv, H. C. & M. Rosing (1993). 'Kong Frederik den Sjettes Kyst – glimt fra tre somres undersøgelser i Østgrønland'. *Nationalmuseets Arbejdsmark 1993*: 70–82.

Gynther, B. & J. Meldgaard (1984). *5 kapitler af Grønlands Forhistorie*. Godthåb, Pilersuiffik.

Hansen, K. M. (1990). 'Rekognoscering i Aasiaat Kommune sommeren 1990'. *Report on File*. Aasiaat, Aasiaat Katersugaasivia: 1–98.

Hansen, K. M. & E. B. Petersen (1989). 'Rekognosceringsrapport Sommeren 1988. Rekognoscering af kyststrækningen i området Nivap Suvdlua, Nivap Pa, Skærgården i Nivap Pa. Den Sydvestlige del af Sydostbugten i Qasigiannguit Kommune'. Rapport. Qasigiannguit Kommune, Qasigiannguit Museum.

Hansen, P. V. & B. Madsen (1983). 'Flint Axe Manufacture in the Neolithic. An Experimental Investigation of a Flint Axe Manufacture Site at Hastrup Vænget, East Zealand'. *Journal of Danish Archaeology* 2.

Harp, E. (1997). 'Pioneer Settlements of the Belcher Island, N.W.T.' In: *Fifty Years of Arctic Researh*, ed. R. Gilberg & H. C. Gulløv. Copenhagen, The National Museum of Denmark: 157–168.

Harritt, R. K. (1998). 'Paleo-Eskimo beginnings in North America: A New discovery at Kuzitrin Lake, Alaska'. *Études/Inuit/Studies* 22(1): 61–81.

Hastrup, K. (1999). *Viljen til viden: en humanistisk grundbog.* Copenhagen, Gyldendal.

Hayashi, K. (1968). 'The Fukui Microblade Technology and its relationships in Northeast Asia'. *Arctic Anthropology* V.2: 128–191.

Heim, A. (1911). 'Über die Petrographie und Geologie der umgebungen von Karsuarsuk'. Meddelelser om Grønland XLVII (47): 171–228.

Henriksen, N. (2003). 'Peary Lands geologi – historien om fjeldene der blev født i troperne'. In: *Peary Land*, ed. H. Meltofte. Nuuk, Forlaget Atugkat: 179–189.

Hinnerson-Berglund, M. (2000). *Palæoeskimoiske fundpladser i Maniitsoq Kommune, Rapport*. Nuuk, Grønlands Nationalmuseum og Arkiv.

Hinnerson-Berglund, M. (2004). *Mobilitet och Estetik*. Gothenburg, Arkelogiska Institutionen, Göteborgs Universitet.

Holtved, E. (1944). 'Archaeological Investigations in the Thule district. I-II'. Meddelelser om Grønland 141 (1–2): 1–308.

Högberg, A. (1999). 'Child and Adult at a knapping area….' *Acta Archaeologica* vol. 70: 59–79.

Ingold, T. (2000). 'Society, nature and the concept of technology. In: *The Perception of the Environment*, ed. T. Ingold. London and New York, Routledge: 312–322.

Inizan, M. L. & J. Tixier (2001). 'L'Émergence des arts du feu: le traitement thermique des roches siliceuses'. *Paléorient* 26/2: 23–36.

Inizan, M. L., M. Lechevallier & P. Plumet. (1992). 'A technological marker of the penetration into North America: Pressure microblade debitage. Its origin in the Paleolitihic of North Asia and its diffusion. In: *Materials Issues in Art and Archaeology, III*, ed. P. Vandiver, J. Druzik, G. Wheeler & I. Freestone, Mat. Res. Symp. Proc. vol. 267: 661–681.

Inizan, M. L., H. Roche & J. Tixier (1992). *Technology of Knapped Stone*. Meudon, C.R.E.P.

Inizan, M. L., M. Reduron-Ballinger, H. Roche & J. Tixier (1999). *Technology and Terminology of Knapped Stone*. Nanterre, CREP.

Irving, W. (1957). 'An archaeological survey of the Sustina valley'. *Anthropological Papers of the University of Alaska* 6(1): 37–52.

Jensen, J. F. (1994). 'Besigtigelse af områder udlagt til lufthavn ved Qaarsut, Uummanaq kommune'. Qasigiannguit, Christianshåb lokalmuseum.

Jensen, J. F. (1995). 'Annertusuaqqap Nuua – en boplads i Sydostbugten, Vestgrønland'. *Tidsskriftet Grønland* no. 6: 225–240.

Jensen, J. F. (1998). 'Dorset dwellings in West Greenland'. *Acta Borealia* 2: 59–81.

Jensen, J. F. (2000). 'West Greenland Palaeo-Eskimo raw material procurement elucidated by geological analysis'. In: *Identities and Cultural Contacts in the Arctic*, ed. J. Berglund. Copenhagen, The National Museum of Denmark and Danish Polar Center: 71–77.

Jensen, J. F. (2003). 'Moskusoksevejen – en arktisk ørkenvandring'. In: *Peary Land*, ed. G. Martens, J. Fog Jensen, M. Meldgaard & H. Meltofte. Nuuk, Atuagkat: 147–173.

Jensen, J. F. (2004(a)). 'Dorsetkulturen'. In: *Grønlands Forhistorie*, ed. H. C. Gulløv. Copenhagen, Gyldendal: 142–172.

Jensen, J. F. (2004(b)). 'Tent Rings and Stone Tools'. Ph.D. diss. Copenhagen, The Faculty of Humanities, University of Copenhagen.

Jensen, J. F. (2005). 'Palaeo-Eskimo Continuity and Discontinuity in West Greenland'. *Contributions to the Study of the Dorset Palaeo-Eskimos*, ed. P. Sutherland. Hull, Canadian Museum of Civilisation. Mercury Series 167: 93–103.

Jensen, J. F. & K. B. Pedersen (2002). 'Jordens nordligste stenalder'. *Nationalmuseets Arbejdsmark*: 71–84.

Jensen, J. F. & M. Rasch (1997). 'Ancient Eskimo dwelling sites and Holocene relative sea level changes in southern Disko bugt, Central West Greenland'. *Polar Research* 16(2): 101–105.

Jensen, J. F. & E. B. Petersen (1998). 'Raw material distribution – social space, social interaction'. *Acta Borealia* 2: 139–153.

Jensen, J. F., L. Johansen & E. B. Petersen (1997). 'Grønlands ældste minedrift'. *Tidsskriftet Grønland* no. 4: 137–149.

Jensen, J. F. & M. Sørensen (in prep.). 'Forsøg med fremstilling af microblades af bjergkrystal'. Forsøgsrapport. Lejre, Historisk Arkæologisk Forsøgscenter.

Johansen, L. (2000(a)). 'Tegning af flintgenstande'. *Flintstudier*, ed. B. V. Eriksen. Aarhus, Århus Universitetsforlag: 51–58.

Johansen, L. (2000(b)). 'Fitting Facts. Refitting analysis of lithic materials from Stone Age sites in the Netherlands, Denmark and Greenland'. Ph.D diss., Institute of Archaeology and Ethnology, University of Copenhagen: 505.

Kapel, H. (1989). 'Kulturhistorisk forskning omkring Kangerlussuag – tilbageblik og perspektiver'. *Tusaat* 1-2: 65–74.

Keeley, L. (1980). *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. Chicago, University of Chicago Press.

Kelterborn, P. (1999). 'Analysen und Experimente zu Herstellung und Gebrauch von Horgener Pfeilspitzen'. *Jahrbuch der Schweizerrischen Gesellschaft für Ur- und Frühgeschicte* 83: 37–64.

Kelterborn, P. (2001). 'Die Wissenschaftlichen Experimente in der experimentellen Arcäologie'. *Zeitschrift für Schweizerische Archäologie und Kunstgeschichte* 58: 21–24.

Knuth, E. (1955). 'Danish Archaeological Expedition to Danmark Fjord, summer 1955'. *The Arctic Circular* vol. VIII, 4.

Knuth, E. (1956). 'Danmark Fjord'. *Nationalmuseets Arbejdsmark*: 71–78.

Knuth, E. (1958). *Det mystiske × i Danmarks Fjord*. Copenhagen, Munksgaard.

Knuth, E. (1968). 'The Independence II bone Artifacts and the Dorset evidence in North Greenland'. *Folk* 10: 61–80.

Knuth, E. (1977/78). 'The "Old Nudglit Culture" site at Nudglit Peninsula, Thule District, and the "Meso-Eskimo" site below it'. *Folk* 19-20: 15–47.

Knuth, E. (1981). 'Greenland News from between 81 and 83 North'. *Folk* 23: 91–112.

Knuth, E. (1983). 'The Northernmost Ruins of the Globe'. *Folk* 25: 5–22.

Knuth, E. (1984). *Reports from the Musk-ox Way. A compilation of previously published articles with insertion of some new illustrations and with a slightly altered radiocarbon dating list*. Copenhagen.

Kobavashi, T. (1970). 'Microblade Industries in the Japanese Archipelago'. *Arctic Anthropology* VII.2: 38–59.

Kramer, F. E. (1992). 'The Paleo-Eskimo Cultures in Sisimiut District'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 39–65.

Kramer, F. E. (1996(a)). 'Akia and Nipisat I: Two Saqqaq Sites in Sisimiut District, West Greenland'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 65–97.

Kramer, F. E. (1996(b)). 'The Paleo-Eskimo Cultures in Sisimiut District, West Greenland: Aspects of chronology'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 39–65.

Lebel, S. & P. Plumet (1991). 'Étude Technologigue de l'Exploitation des Blocs et des Galets en Métabasalte par les Dorsétiens au Site Tuvaaluk (DIA.4 JfEl-4)'. *Canadian Journal of Archaeology* vol. 15: 143–170.

LeBlanc, R. J. (1994). 'The Crane site and the Paleoeskimo period in the Western Canadian Arctic'. Mercury Series 148.

LeBlanc, S. (1999). 'Middle Dorset (1900-1100 BP) Regional Variability on the Island of Newfoundland and in Saint-Pierre et Miquelon'. In: *Identities and Cultural Contacts in the Arctic*, ed. M. Appelt, B. E. Berglund & H. C. Gulløv. Copenhagen, DPC: 97–105.

LeBlanc, S. (2000). 'Groswater Technological Organization: A Decision-Making Approach'. *Arctic Anthropology* vol. 37, no. 2: 23–37.

LeMoine, G. (1991). 'Experimental Analysis of the Manufacture and Use of Bone and Antler Tools among the Mackenzie Inuit. Calgary, Alberta, Department of Archeology, University of Calgary: 427.

Leroi-Gourhan, A. (1964). *Le Geste et la Parole I – Technique et Langage*. Paris, Albin Michel.

Leroi-Gourhan, A. (1993). *Gesture and Speech*. Cambridge, MA, MIT Press.

Loring, S. (2002). 'And They Took the Stones from Ramah'. In: *Honoring Our Elders*, ed. W. W. Fitzhugh, S. Loring & D. Odess. Washington, Smithsonian Institution: 163–187.

Löhr, H. (1979). 'Der Magdalenien-fundplatz Alsdorf Kreis Achen-land. Ein Beitrag zur Kenntnis der funktionalen Variabilität jungpaläolitischer Stationen'. Doctoral Dissertation, Tübingen, Eberhard-Karls-Universität.

Madsen, B. (1986). 'Nogle nomenklatoriske bemærkninger til studiet af flintteknologi – eksperimentelt og arkæologisk'. *Fjølnir* 5(1).

Madsen, B. (1992). 'Hambugkulturens flintteknologi i Jels'. In: *Istidsjægere ved Jelssøerne*, ed. J. Holm & F. Reick. Haderslev, Haderslev Museum. Skrifter fra Museumsrådet for Sønderjyllands Amt 5.

Madsen, B. & T. Diklev (1992). *Arkæologisk Berejsning i Thule 1991*. Thule, Thule Museum: 42.

Mary-Rousselière (2002). *Nunguvik et Saatut. Site paléoeskimaux de navy Board Inlet, Ile de Baffin*. Hull, Quebec, Museum of Civilisation.

Mathiassen, T. (1933). *Prehistory of the Angmagssalik Eskimos*. Meddelelser om Grønland 92(4).

Mathiassen, T. (1958). The *Sermermiut Excavations 1955*. Meddelelser om Grønland 161, 3.

Mauss, M. (1947). *Manuel d'etnographie*. Paris, Payot.

Maxwell, M. S. (1973). 'Archaeology of the Lake Harbour District, Baffin Island'. Mercury Series 6.

Maxwell, M. S. (1985). *Prehistory of Eastern Arctic*. Michigan, Department of Anthropology, Michigan State University.

McGhee, R. (1976). 'Paleoeskimo occupations of central and high Arctic Canada'. In: *Eastern Artic Prehistory: Paleoeskimo problems*, ed. M. S. Maxwell. The National Museum of Canada/The School of American Research. Memoirs of the Society for American Archaeology, no. 31: 15–40.

McGhee, R. (1979). The Palaeoeskimo occupations at Port Refuge, High Arctic Canada. National Museum of Man, Archaeological Survey of Canada, Mercury Series no. 92.

McGhee, R. (1981). *The Dorset occupations in the vicinity of Port Refuge, High Arctic Canada*. National Museum of Man, Archaeological Survey of Canada, Mercury Series 105.

McGhee, R. (1996). *Ancient People of the Arctic*. Vancouver, UBC Press.

Meldgaard, J. (1952). 'A Paleo-Eskimo Culture in West Greenland'. *American Antiquity* 17(3).

Meldgaard, J. (1959). *Eskimo skulptur*. Copenhagen, Schultz.

Meldgaard, J. (1961). 'Saqqaq folket ved Itivnera'. *Grønland* 1961: 15–23.

Meldgaard, J. (1962). 'On the formative period of the Dorset culture'. In: *Prehistoric Cultural Relations Between the Arctic and Temperate Zones of North America*, ed. J. M. Campbell. Montreal, Arctic Institute of North America. Technical Paper no. 11: 92–95.

Meldgaard, J. (1968). *Harpoons and Lances from Iglulik, NWT, Canada. Sketch Book 1968*. Copenhagen, Unpublished.

Meldgaard, J. (1976). 'Prehistoric Cultures in Greenland. Discontinuities in a Marginal Area'. In: *Continuity and Discontinuity in the Inuit Cultures of Greenland*, ed. H. P. Klystra. Groningen: Arctic Center, University of Groningen: 19–52.

Meldgaard, J. (1996). 'The Pioneers: The Beginning of Paleo-Eskimo Research in West Greenland'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 9–17.

Mithen, S. (1996). *The prehistory of the mind: A search for the origins of art, religion and science*. London, Thames & Hudson.

Morlan, R. E. (1967). 'The Preceramic Period of Hokkaido: An Outline'. *Arctic Anthropology* vol. 4, no. 1: 180–211.

Morlan, R. E. (1970). 'Wedge-shaped core technology in Northern North America'. *Arctic Anthropology* VII.2: 17–38.

Murray (1999). 'Local heroes. The long-term effects of short-term prosperity – an example from the Canadian Arctic'. *World Archaeology* vol. 30, no. 3: 466–484.

Møbjerg, T. (1988). 'De palæoeskimoiske kulturer i Ammassalik distrikt'. In: *Palæoeskimoisk forskning i Grønland*, ed. T. Møbjerg, B. Grønnow & H. S. Lorentzen. Aarhus, Århus Universitetsforlag: 81–94.

Møbjerg, T. (1999). 'New adaptive strategies in the Saqqaq culture of Greenland, c 1600–1400 BC'. *World Archaeology* vol. 30(3): 452–465.

Møhl, U. (1972). *Animal bones from Itivnera. A Reindeer Hunting Site of the Saqqaq Culture*'. Meddelelser om Grønland 191.6.

Nagle, C. L. (1984). *Lithic Raw Material Procurement and Exchange in Dorset Culture along the Labrador Coast*. Ph.D. Dissertation, Brandeis University.

Nagy, M. I. (1994). *A Critical Review of the Pre-Dorset/Dorset Transition*. In: *Threads of Arctic Prehistory: Papers in Honour of William E. Taylor Jr.*, ed. D. Morrison & J. L. Pilon. Hull, Canadian Museum of Civilisation 149: 1–14.

Nagy, M. I. (1997). *Palaeoeskimo Cultural Transitions: A case study from Ivujivik, Eastern Arctic*. Québec, Avataq Cultural Institute.

Nielsen, T. F. D., N. J. Soper, et al. (1981). *The Pre-Basaltic Sediments and the Lower Basalts at Kangerdlugssuaq, East Greenland: Their stratigraphy, lithology, palaeomagnetism and petrology*. Meddelelser om Grønland, Geoscience 6: 1–29.

Ohnuma, K. & C. Bergman (1982). 'Experimental studies in the determination of flaking mode'. *Bulletin of the Institute of Archaeology* 19: 161–170.

Owen, L. R. (1988). *Blade and Microblade Technology. BAR* 441: 393.

Peel, J. & P. Frykmann (1975). *Archaeological observations in southern Washington Land, July–August 1975*. Copenhagen, The National Museum of Denmark.

Pelegrin. J. (1984a). 'Approche technologique experimentale de la mise en forme de nucleus pour le debitage systematique par pression'. In: *Prehistoire de la Pierre Taille II*, ed. J. Tixier. Paris, CRES.

Pelegrin, J. (1984b). 'Debitage par pression sur silex: nouvelle experimentations'. *Prehistoire de la Pierre Taille II*, ed. J. Tixier. Paris, CRES.

Pelegrin, J. (1985). 'Réflexions sur le comportement technique'. In: *La signification culturelle des industries lithique*, ed. M. Otte. Oxford, B.A.R. S 239. Studia Praehistorica Belgica, 4: 72–91.

Pelegrin, J. (1988). 'Debitage experimental par pression "du plus petit au plus grand"'. *Technologie prehistorique*. Paris, CRES.

Pelegrin, J. (1990). 'Prehistoric Lithic Technology: Some aspects of research'. *Archaeological Review from Cambridge* vol. 9:1 (Technology in the humanities): 116–126.

Pelegrin, J. (1991). 'Sur une recherche technique experimentale des techniques de debitage laminaire'. *Archeologie Experimentale* Tome 2: 118–167.

Pelegrin, J. (1995). 'Technologie Lithique le Chattelperronien de Roc-De-Combe (Lot) et de La Côte (Dordogne)'. *Cahiers du Quarternaire* no. 20.

Pelegrin, J. (2000). 'Les techniques de débitage laminaire au Tardiglaciaire: critéres de diagnose et quelques réflexions'. In: *L'Europe Centrale et Septentrionale au Tardiglaciaire. Actes de Table-ronde internationale de Nemours, 13-16 mai 1997*, ed. B. Valentin, P. Bodu & M. Christensen. Nemours, A.P.R.A.I.F. Mémoires du Musée de Préhistoire d'Ile de France, 7: 73–87.

Pelegrin, J. (2002). 'Principes de la reconnaisance des méthode et techniques de taille'. In: *Tell'Atij Tell Gueda. Analyse technologique et fonctionelle*, ed. J. Chabot. Quebec, Universite Laval. Cahiers d'arhéologie du CELAT no. 13: 216–225.

Petersen, H. C. (1979). 'Terminologi for våben- og værktøjssten fra eskimoisk stenalder'. *Forskning/Tusaat* 1/79: 22–24.

Petersen, R. (1988). 'Palæoeskimoiske fund i Manitsoq kommune'. In: *Palæoeskimoisk forskning i Grønland*. In: B. Grønnow, T. Møbjerg & H. S. Lorentzen. Aarhus, Århus Universitetsforlag: 59–69.

Petersen, R. (2005). Letter to The National Museum of Denmark. M. Sørensen. Copenhagen.

Pigeot, N. (1987). 'Magdaléniens d'Etoilles: économie de débitage et organisation sociale (l'unité d'habitation U5)'. *XXV Supplément á 'Gallia Péhistoire'*, CNRS.

Pigeot, N. (1990). 'Technical and social actors – flintknapping specialists and apprentices at Magdalenian Etoilles'. *Archaeological Review from Cambridge* 9/1: 126–141.

Pilon, J. L. (1994). 'The Inuvik Phase of the Artic Small Tool Tradition'. In: Threads of Arctic Prehistory: Papers in honour of William E. Taylor Jr., ed. D. Morrison & J. L. Pilon. Hull, Canadian Museum of Civilisation. Mercury Series: 57–86.

Plumet, P. & S. Lebel (1997). 'Dorset Tip Fluting. A second "American" Invention.' *Arctic Anthropology* vol. 34, no. 2: 132–162.

Rahmani, N. (2002). 'Le Capsien Typique et le Capsien Supérieur: Évolution ou contemporanéite; les donnéestechnologique'. *Préhistoire et Géologie du Quaternaire*. Bordeaux, Université Bordeaux I.

Rasmussen, M. (2001). 'Experiments in archaeology – A view from Lejre, an "old" experimental centre'. *ZAK* Heft 1/01: 3–10.

Renfrew, C. & P. Bahn (1996). *Archaeology: Theories, Methods and Practice*. London, Thames and Hudson.

Renfrew, C. (1984). *Approaches to Social Archaeology*. Edinburgh, Edinburgh University Press.

Renfrew, C. & E. B. Zubrow, eds. (1994). *The Ancient Mind. Elements of Cognitive Archaeology*. Cambridge, Cambridge University Press.

Roche, H. & J. Tixier (1982). 'Les accidents de taille'. In: *Tailler! Pour quoi faire : Préhistorie et technologie lithique II.* Tervuren, Musée Royal d'Afrique Centrale. Studia Praehistorica Belgica 2: 65–76.

Rosenkrantz, A. (1965). Brev til Helge Larsen. Om Qaersuarssuk. Copenhagen, The National Museum of Denmark.

Rosing, J. (1978). 'Grønlands historie indtil Hans Egede. Palæoeskimoerne'. In: *Bogen om Grønland. Fortid, Nutid og Fremtid*, ed. Hjalmer Petersen & E. Staffeldt. Copenhagen: 77–87.

Rosing, J. (1988). 'Rensdyrjægere i Itinnera'. In: *Palæoeskimoisk forskning i Grønland*, ed. T. Møbjerg, B. Grønnow & H. S. Lorentzen. Aarhus, Århus Universitetsforlag: 69–81.

Roux, V. & J. Pelegrin (1989). 'Taille des perles et spécialisation artisan. Enquête ethnoarchéologique dans le Gujarat'. *Techniques et Culture* vol. 14: 23–49.

Raahauge, K. (2004). *Nanortalik museums årsberetning for 2004*. Nanortalik, Nanortalik Museum.

Raahauge, K. & M. Appelt (2002). 'Itilleq og palæoeskimoerne i Sydgrønland'. *Tidsskriftet Grønland* no. 4: 113–124.

Raahauge, K., E. Lund Jensen, B. Grønnow & H.C. Gulløv. (2004). 'Bopladser langs konebådsruten melllem Vest- og Østgrønland. Copenhagen, SILA – Nationalmuseets Center for Grønlandsforksning. Feltrapport no. 19.

Sandell, H. T. & B. Sandell (1999). *Paleo-Eskimo Settlements in Scoresby Sund, Northeast Greenland*. Copenhagen, Danish Polar Center.

Sandell, B. & H. Sandell (1985). 'Kortlægning af kulturhistoriske interesser i Jameson Land og Scoresbysund 1982-84'. Rapport til Grønlands Nationalmuseum og Arkiv. Nuuk, Grønlands Nationalmuseum og Arkiv.

Schild, R. (1980). 'Introduction to Dynamic Technological Analysis of Chipped Stone Assemblages'. In: *Unconventional Archeology*, ed. K. Plater: 57–87.

Schlanger, N. (1994). 'Mindful technology: Unreleasing the chaîne opératoire for an archaeology of mind'. In: *The Ancient Mind. Elements of Cognitive Archaeology*, ed. C. Renfrew & E. B. Zubrow. Cambridge, Cambridge University Press: 143–151.

Schlanger, N. (1996). 'Understanding the Levallois: Lithic Technology and Cognitive Archaeology'. *Cambridge Archaeological Journal* vol. 6(2): 231–254.

Schledermann, P. (1980). 'Polynias and Prehistoric Settlement Patterns'. *Arctic* vol. 33, no. 2: 292–302.

Schledermann, P. (1990). *Crossroads to Greenland*. Calgary, University of Calgary.

Schledermann, P. (1996). *Voices in Stone*. Calgary, The Arctic Institute of North America, University of Calgary.

Schott, M. J. (2003). 'Chaine operatoire and reduction sequence'. *Lithic Technology* vol. 28(1): 95–105.

Secher, K., B. Nielsen & N.Ø. Knudsen (1981). 'Grønlands smykkesten'. *Grønland* 29(4–5): 105–152.

Semenov, S. A. (1964). *Prehistoric Technology*. London, Cory, Adams and Mackay.

Skriver, C. (2002). 'Usewear on lithic artefacts from Qeqertasussuk'. Internal report, SILA, file no. 4067. Copenhagen, SILA.

Stafford, M. (1998). 'In search of Hindsgavl: Experiments in the production of Neolithic, Danish flint daggers'. *Antiquity* 72: 338–349.

Stapert, D. & L. Johansen (1996). 'Ring & Sector Analysis, and site "IT" on Greenland'. *Paleohistoria* 37/38: 29–69.

Stapert, D. & L. Johansen (1999). 'Flint and Pyrite: Making fire in the Stone Age'. *Antiquity* 73: 765–777.

Stuiver M., P.J. Reimer E. Bard, J.W. Beck, G.S. Burr, K.A. Hughen, B. Kromer, G. McCormac, J. van der Plicht & M. Spurk (1998). 'INTCAL98 Radiocarbon Age Calibration, 24000-0 cal BP'. *Radiocarbon* 40(3): 1041–1083.

Sulgostowska, Z. (1995). 'The phenomenon of chocolate flint distribution on the Northeuropean plain during the final Palaeolithic'. In: *Man and Flint. Proceedings from the VII International Flint Symposium*, ed. R. Schild & Z. Sulgostowska. Warsaw, Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Sutherland, P. (1996). 'Continuity and Change in the Paleo-Eskimo Prehistory of Northern Ellesmere Island'. In: *The Paleo-Eskimo Cultures of Greenland*, ed. B. Grønnow. Copenhagen, Danish Polar Center: 271–295.

Sørensen, M. (2000). 'Flinthugning og flækkefremstilling i den tidlige Maglemosekultur'. *Kulturhistoriske Studier*: 29–36.

Sørensen, M. (2001). 'Det operative skema i Maglemosekulturen. En diakron flintteknologisk analyse af flækkeindustrien i Maglemosekulturen, ud fra en undersøgelse af seks bopladser på Sjælland'. MA thesis. Copenhagen, Institute of Archaeology, University of Copenhagen.

Sørensen, M. (2003). 'Experiments with the "Tågerup pressure tool"'. In: *The Tågerup Excavations*, B. Knarrström. Lund, National Heritage Board: 146–150.

Sørensen, M. (2006a). 'Teknologiske traditioner i Maglemosekulturen. En diakron analyse af maglemosekulturens flækkeindustri'. In: *Stenalderstudier*.

Tidlig mesolitiske jægere og samlere i Sydskandinavien, ed. B. V. Eriksen. Aarhus, Jutland Archaeological Society: 19–77.

Sørensen, M. (2006b). 'The Chaîne Opératoire Applied to Arctic Archaeology'. *Conference Proceedings: Dynamics of Northern Societies*, ed. B. Grønnow & J. Arneborg. Copenhagen, Sila/Nabo: 31–44.

Sørensen, M. (2006c). 'Rethinking the Lithic Blade Definition – Towards a Dynamic Understanding'. In: *Skilled Production and Social Reproduction – Aspects on Traditional Stone Tool Technologies*, ed. J. Apel & K. Knutsson. Stockholm, Societas Archaeologica Upsaliensis: 277–299.

Sørensen, M. (2008). 'Spatial Analysis by Dynamic Technological Classification: A Case Study from the Palaeolithic-Mesolithic Transition in Scandinavia'. In: *Technology in Archaeology*, ed. M. Sørensen & P. Desrosiers. Copenhagen, Publications from The National Museum of Denmark. Studies in Archaeology & History vol. 14: 107–125.

Sørensen, M. (2010). 'The Archaeology of Old Nuulliit: Eigil Knuth's investigations in the Thule region, North Greenland, 1952–1990'. Monographs on Greenland Vol. 39, Man & Society. Copenhagen, Museum Tusculanum Press.

Sørensen, M. & C. Andreasen (2004). 'Ekspedition "Geo-Ark". Arkæologisk rekognoscering af området Wollaston Forland'. Copenhagen, The National Museum of Denmark, Grønlands Nationalmuseum og Arkiv.

Sørensen, M. & F. Sternke (2004). 'Nørregård VI. – Late Glacial Hunters in Transition. In: *Hunters in a Changing World*, ed. T. Terberger & B. V. Eriksen. Greifswald, Commission XXXll for the Final Palaeolithic of the great European Plain.

Sørensen, M. & K. B. Pedersen (2004). 'Killiaq Kilder og Palæo-Eskimoer: Arkæologisk rekognoscering af Nordkysten af Nuussuaq, fra Serfat til Qaarsut, Uummannaq Kommune'. Copenhagen, Sila-Nationalmuseets Center for Grønlandsforskning no. 17.

Sørensen, M. & K. B. Pedersen (2005). 'Killiaq kilden på Nuussuaq: på sporet af Saqqaqkulturens redskabssten'. *Tidsskriftet Grønland* no. 2–3: 105–119.

Sørensen, M. & P. Desrosiers (in prep.). 'Burin and burin-like: A technological perspective on the history of the Palaeoeskimos'. Montreal, Conference Abstracts, SAA 2004.

Tabarev, A. V. (1997). 'Paleolithic wedge-shaped microcores and experiments with pocket devices'. *Lithic Technology* vol. 22, no. 2: 139–148.

Taylor, W. E., ed. (1968). 'The Arnapik and Tyara Sites. An archaeological study of Dorset Culture origins'. *Memoirs of the Society for American Archaeology* no. 22. Salt Lake City, University of Utah.

Taylor, W. E. & G. Swinton (1967). 'The Silent Echoes. Pre-Historic Canadian Eskimo Art'. *The Beaver* 298.

Tixier, J. (1963). *Typologie de L'Epipaléolithique de Maghreb*. Paris, A.M.G.

Tixier, J. (1967). 'Procédés d'analyse et questions de terminologie concernant l'étude des ensemples industriel du Paléolithique récent et de l'Epipaléolithique dans l'Afrique du Nord-Oest'. In: *Background to evolution in Africa*, ed. W. W. Bishop & J. Desmond-Clark. Chicago, University of Chicago Press: 771–820.

Tuck, J. A. (1976). 'Paleoeskimo Culture of Northern Labrador'. *Memoirs of the Society for American Archaeology* no. 31: 89–103.

Tuck, J. A. (1978). 'Excavations at Cow Head, Newfoundland, an interim report'. *Inuit Studies* vol. 2, no. 1: 138–141.

Unrath, G. (1987). 'The burins from Umingmak. How to use thumbnail sized tools'. *La Main et l'Outil: manches et emmanchements préhistorique. Travaux de la Maison de L'Orient* no. 15: 145.

Weber, T. (2000). 'Flintteknologiske attributanalyser'. *Flintstudier*, ed. B. V. Eriksen. Aarhus, Århus Universitetsforlag: 141–156.

Whittaker, J. C. (1994). *Flintknapping. Making and understanding stone tools*. Austin, University of Texas.

Yerkes, R. W. & N. P. Kardulias (1993). 'Recent Development in the Analysis of Lithic Artifacts'. *Journal of Archaeological Research* vol. 1, no. 2: 89–119.

Yoshizaki, M. (1961). 'Shirataki iseki to Hokkaido no Mudoki bunka (The Shirataki Sites and the Preceramic Culture in Hokkaido)'. *Minzikugaku* vol. 26, no. 1: 13–23.

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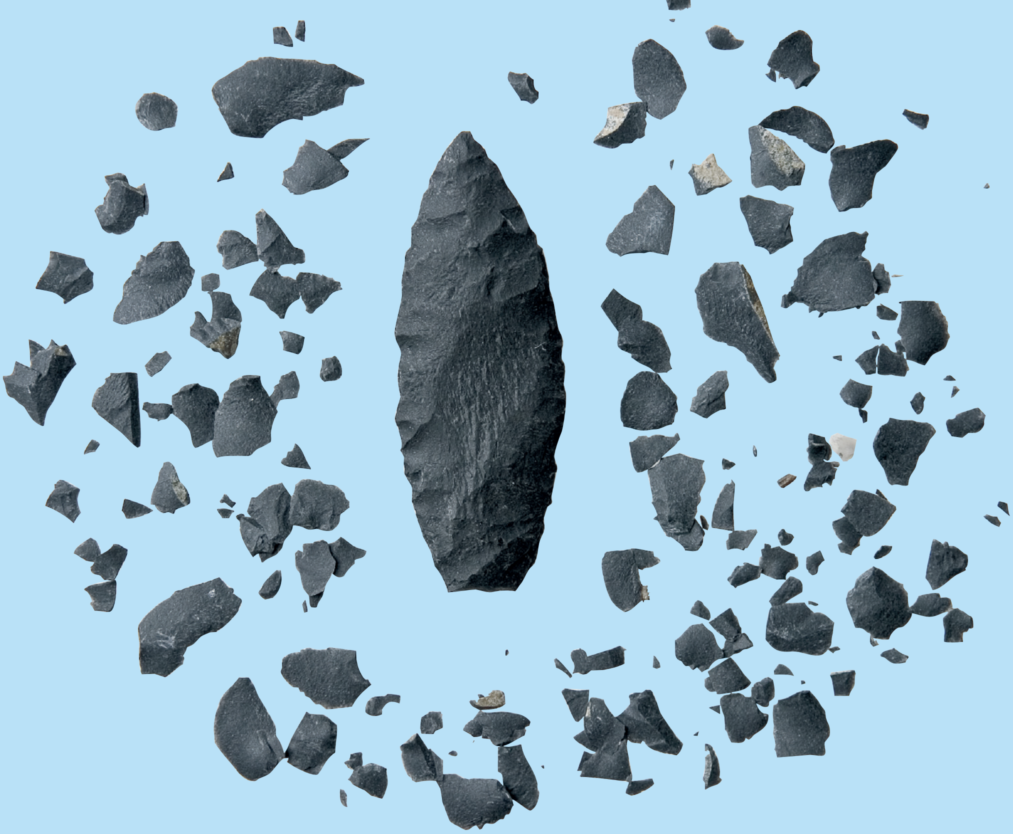

This study concerns the cultural history of the Palaeo-Eskimo cultures in Greenland, building upon the identification of an Arctic Stone Age in Greenland through studies of lithic artefacts. It does so by introducing a new dynamic technological methodology to Arctic Archaeology that allows the author to investigate the lithic *chaînes opératoires* and lithic concepts of production. Important insights into Palaeo-Eskimo tool manufacturing and processes are thus offered, including a definition of the functional tool types in the five Palaeo-Eskimo cultures in the easternmost Arctic in the period 2500 BC–AD 1200.

The lithic *chaînes opératoires* are documented and explained through numerous photographs and drawings, ordered in process steps from procurement of raw materials, shaping of preforms to the discarding of the rejuvenated tool. As a precondition for these analyses, a study of outcrops of lithic materials suited for knapping (microcrystalline quartzes, metamorphosed slates, fine-grained basalts, quartz and quartzite, etc.) found in Greenland is conducted. Thus an important result of the investigation is a well-documented analysis of the dynamic change of the lithic artefact types and a definition of the range of the formal tool types used by the Palaeo-Eskimo groups of Greenland. As a consequence of this systematically technological study, a new interpretation and reordering of the easternmost Arctic cultural sequence is proposed and two previously unknown Palaeo-Eskimo groups in Greenland have been identified: the Pre-Dorset and the Early Canadian Dorset.

The volume demonstrates how the dynamic technological methodology is very well suited for the study of lithic technology in the Palaeo-Eskimo tradition, and that this methodology, in combination with spatial analysis, in the future can be an important method in the investigation of Palaeo-Eskimo cultural history, and for the understanding of behaviour and social aspects in the Palaeo-Eskimo traditions.

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