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THE UNIVERSITY OF ALBERTA

ARCHAEOBOTANICAL ANALYSIS OF THE SVALBARD NORSE MIDDEN, NORTHEAST ICELAND

BY

CYNTHIA MARNIE ZUTTER ©

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF ARTS

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled ARCHAEOBOTANICAL ANALYSIS OF THE SVALBARD NORSE MIDDEN, NORTHEAST ICELAND, submitted by Cynthia Marnie Zutter in partial fulfillment of the requirements for the degree of Master of Arts.

Charles Schweger
(Supervisor)
....
Edgar L. Jackson
....
....

Date: 18 Aug. 1989

ABSTRACT

Agricultural systems directly impact natural ecosystems and are also highly sensitive to climatic changes. This is especially true in the agriculturally marginal areas of the North Atlantic region. Iceland, settled by Viking-age Norse in the 9th Century, is a case in point. Norse agricultural practices directly altered the delicately balanced ecosystem of Iceland (ie. deforestation and increased soil erosion). In turn, these agricultural practices led to a negative feedback between Norse culture and Iceland's environment.

The Icelandic Paleoeconomic Project (I.P.P.) is focused on the Norse subsistence economy for the 1000 year history of Iceland. The botanical component of the I.P.P. is provided by archaeobotanical analysis of the macrofloral remains from a Norse midden on the Svalbard farmsite in NE Iceland (Thistilfjordur district). In total, thirty-four 1 liter samples were collected, screened and identified from the Svalbard midden. Both culturally deposited plants and those growing naturally in the area were represented in the midden botanical remains. The majority of macrofloral remains were deposited during 1050-1150 AD and in a charred state. Limited amounts of macrofloral remains were deposited during 1150-1800 AD.

Sources, such as present day plant assemblages of Norse land-use areas, historical documents (e.g. Icelandic sagas)

and previous Norse midden archaeological investigations were used to assist in the interpretation of the macrofloral material. From these interpretations it was concluded that the archaeobotanical data provided evidence for a variety of Norse plant utilization patterns (i.e. dung and peat used for fuel) and information on midden formation processes. The impact of Norse agricultural practices on the Icelandic environment and the effects of climatic changes on Norse subsistence practices were not clearly evident from the macrofloral remains.

In order to elucidate clearly the effects of climate change and human impact in NE Iceland, further paleoecological analysis (e.g. palynology, hydrology) is required. The combination of paleoecological and archaeological data will aid in the reconstruction of the complex inter-relationships that existed between the Norse culture and the Icelandic environment. In turn, by knowing how past cultures have adjusted to environmental fluctuations, stresses on modern societies can be viewed in a historical context.

Acknowledgements

Initially, I'd like to thank my advisor, Dr. Charlie Schweger. His enlightenment and support helped to make this thesis a successful endeavor. Throughout my Master's degree Charlie was the source of my intellectual advancement. Additionally, I extend my thanks to my thesis committee members; Dr. Cliff Hickey, Dr. Art Bailey and Dr. Ed Jackson.

Secondly, this project would not have occurred without the help of Tom Amorosi and Dr. Tom McGovern, C.U.N.Y., Hunter College. I'd like to thank them for the opportunity to participate in the Icelandic Paleoeconomic Project and I hope to continue my future research as a member of the I.P.P. My thanks are also extended to Dr. Paul Buckland, U. of Sheffield for his guidance in all factors of Icelandic paleoecology. The carpentry skills of Dr. Gerry Bigelow, Bowdoin College, were very helpful and the entire archaeological crew from the Svalbard excavation made my research much easier.

PLEASE NOTE: Due to the current limitations of software and printer, this thesis uniformly anglicizes Icelandic names. I apologize for the present orthographic inaccuracy.

Thirdly, Gudmundur Olafsson, Guthrun Sveinbjarnardottir and Mjoll Snaesdottir made my first Icelandic excursion a very enjoyable experience and their hospitality was very much appreciated. Also, I'd like to thank the hosts of Svalbard, Vigdis Sigurdardottir, Sigtryggur Thorlaksson and their son, Thorlak Sigtryggursson.

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TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHIC PLATES

CHAPTER I

Introduction

Northeastern Iceland typifies many North Atlantic environments with its barren landscape, scarcely vegetated hummocky terrain, wetland mires and arctic-like climatic conditions. Despite such seemingly harsh conditions, humans have persevered in NE Iceland at the Svalbard farmsite since it was settled by Viking-age Norse in the 10th Century (Amorosi & McGovern 1989). Norse agrarian practices have not only adjusted to this agriculturally marginal area but also directly altered the sensitive NE Iceland environment. Climatic changes further affected this landscape and its occupants during the first millenum of settlement (Bergthorsson 1988).

The Icelandic Paleoeconomic Project (I.P.P.) was established in order to reconstruct the changing Norse subsistence economy on Icelandic farmsites, including Svalbard (McGovern & Amorosi 1988). Such a reconstruction requires a combination of historical, archaeological and paleoecological evidence documenting the Norse subsistence economy.

The Svalbard midden in NE Iceland, with its deeply stratified cultural deposits that date back to the 11th

Century, was chosen as the 1988 I.P.P. research/excavation site for reconstruction of the Norse subsistence economy. This thesis contributes to the I.P.P. through an archaebotanical analysis of the Svalbard midden material, an integral part of this ecologically-oriented archaeological research project.

The recovery and identification of botanical materials from the Svalbard midden can potentially provide information on;

1) how the midden was formed (Schiffer 1987);
2) the plant use of the Norse (Berglund 1985);
3) Norse subsistence practices;
4) the impact of the animal husbandry practices on the NE Icelandic landscape (INQUA 1989);
5) effects of climate change on the environment and Norse agriculture; and
6) the interactions of cultural activities and climatic changes on an environment and people.

In this way, the Svalbard archaeobotanical material can provide a historical example, albeit on a small scale, of the modern day Global Change scenario.

Global change

As part of the biosphere of the earth, humans have lived within a system of dynamic interdependence with other organisms, constantly adjusting and re-adjusting to their external environment for thousands of years (Ellen 1982).

The human impact on the global landscape has increased dramatically since the advent of agricultural activities which have altered some natural environments around the world. The extent of impact on the natural landscape has been particularly great in areas climatically marginal for agriculture. Desertification of the Sahel region in Africa , reduction of natural prairie communities in North America and loss of natural woodland areas in Northern Europe (Berglund 1986) represent three examples of irreversible human impact on the natural environment. On a larger environmental scale, burning of fossil fuels has resulted in CO^2 emission rates that have the potential to change the global climate through the 'Greenhouse effect.' Higher average global temperatures will bring about large scale changes to the landscape of the earth through secondary effects of climate change.

Agricultural impacts on the environment are not merely one-way cause-and-effect relationships (Gumerman 1988). Instead, feedback systems exist between culturally influenced environmental changes and environmental influences on culture (Figure 1). All social activities impinge directly or indirectly on ecological processes and are themselves affected by those same processes (Ellen 1982). Long-term survival often requires adjustments to environmental changes, whether culturally induced or not. The increased rate and extent of environmental changes can create drastic stresses on agrarian subsistence practices.

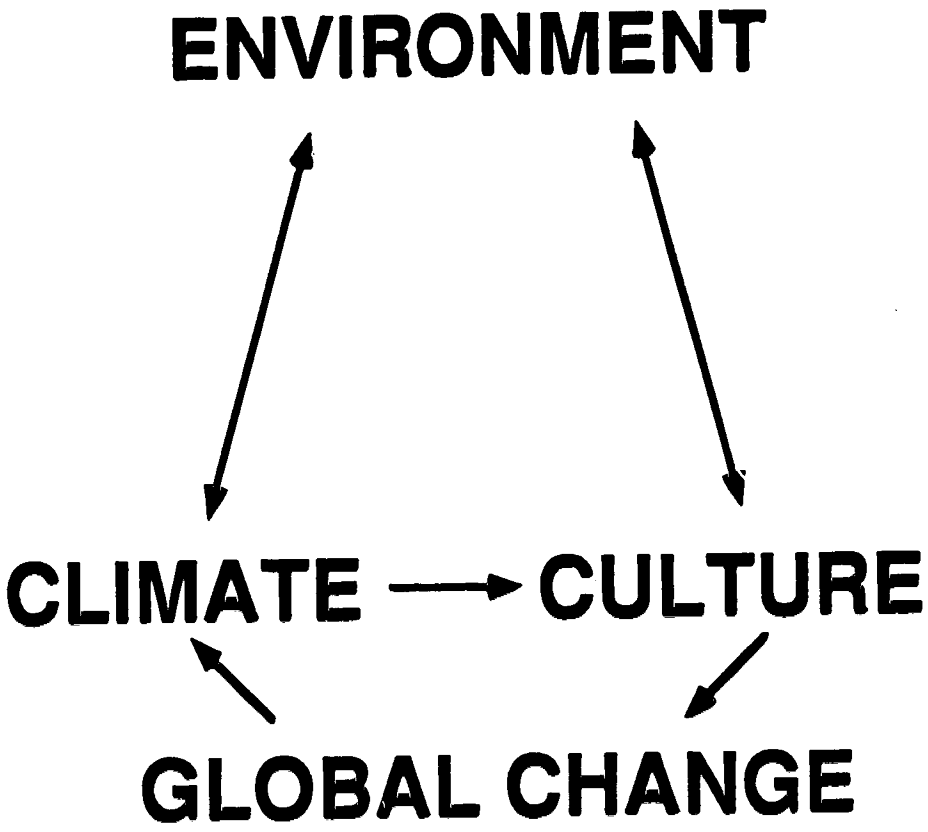


Figure 1. Model of
Global Change, Culture and
Environmental Interaction

By understanding how past human cultures have adjusted to environmental fluctuations, stresses on modern societies can be viewed in a historical context. Models based on paleoenvironmental and archaeological records increase the comprehension of human-environmental interactions, aiding in the planning of human responses to future environmental changes.

Archaeological Examples

In order to document long-term patterns of interaction between humans and their environment, the historical and archaeological record of agrarian cultures should be placed in a paleoenvironmental context (Berglund 1986; Gumerman 1988). Human responses to the stresses caused by fluctuating environmental conditions are likely to be 'more visible' in archaeological and paleoecological records from areas with climates marginal for agrarian practices. The arid American Southwest and the cool regions of Scandinavia are two such areas. Therefore, these areas have attracted interdisciplinary research projects focusing on human-environmental relationships.

The American Southwest Paleoenvironmental Project

Interaction between humans and their environment can be explained through the combined use of a thousand-year record of the environment on the Colorado Plateau and the demography and cultural changes of the Anasazi culture in the American Southwest (Haas 1988). Living within an area marginal to agrarian subsistence practices, the Anasazi were constantly undergoing subsistence stress created by their population size and the heterogeneous environment of the Colorado Plateau (Gumerman 1988). To reduce the stress of natural environmental perturbations, the Anasazi adapted culturally-specific demographic, productive and organizational strategies (Gumerman 1988:17). Even so, the subsistence technology of the Anasazi and the prevailing environmental conditions of the American Southwest limited the number of individuals that could be supported ('the carrying-capacity') (Dean 1988:29). Breaching the thresholds of these adaptive strategies occurred when the carrying capacity was drastically lowered by changes to "low frequency" environmental processes (ie. climate, erosion) (Dean 1988). These environmental changes created extreme stress on the extant Anasazi cultural system requiring major adaptive changes to the society (Dean 1988). As a result, environmental reconstructions from the paleoecological record combined with the Anasazi archaeological information provide pre-historical examples of behavioral responses to the changing environmental conditions of the American Southwest.

Scandinavian Paleoenvironmental Studies

The use of environmental data to study human impact on the landscape began in Scandinavia with Johannes Iversen's study of the Neolithic landnam in Denmark. Palynological research was utilized to document environmental changes interpreted as the beginnings of Neolithic agriculture (the'landnam' phase) (Iversen 1941). Modern paleoecological investigations have combined pollen-analytical methods with theories of vegetation dynamics to establish five phases of vegetation expansion/regression that are thought to represent changes in patterns of human land-use in southeastern Sweden (Berglund 1985). An expansion phase corresponds to a period of intensive land-use and human impact (e.g. larger areas under cultivation) while a regression phase represents decreased human land-use activities.

Since 1970, interdisciplinary paleoecological-archaeological studies (e.g. the Ystad Project, Berglund 1986) have been established to document culture and environmental changes since the beginnings of agriculture in Scandinavia. A dynamic multicausal model has been formulated to explain changes that have occurred in the cultural landscape of southern Sweden. The Ystad project will utilize vegetation, hydrological, climatic and pedological data to reconstruct the paleoenvironment of southern Sweden.

Information on population size, social organization, economy and technology will be amassed from specific archaeological sites and historical sources, documenting the past 6000 years of Swedish culture (Berglund 1986). Correlating the paleoenvironmental and cultural data facilitates the construction of a holistic model to describe the settlement and the environmental history of SE Sweden. This model can in turn be used to research in detail the long term changes to the cultural landscape in Scandinavia.

North Atlantic Islands

Scandinavian Norse cultures spread into the North Atlantic region beginning with the Viking Period (800-1100 AD), colonizing areas such as the Shetland Islands, the Orkneys, the Faroes, Ireland, Iceland and Greenland. In the years following the Viking period, the Norse have undergone population stabilization and then demographic contraction within this region as a result of their influence on the environment and climatic changes (Jones 1984; McGovern et al 1988a). North Atlantic islands are optimal locations for the study of human-environmental interactions between the Norse and the Northern European environment (Buckland et al in press). Islands make ideal laboratories for the study of human ecology, since both the cultural and environmental components of the ecosystem are isolated from external influences (Thompson 1949). Also, the relatively short timespan for marked human impact as a result of Norse agrarian practices on these islands creates paleoecological records where traces of human impact are highly 'visible' (Buckland et al in press; Hallsdottir 1987). Lastly, the North Atlantic islands are areas with marginal climates for agrarian practices (Carter & Parry 1984; McGovern et al 1988). Consequently, these areas are the first to be affected by climatic anomalies, influencing interactions between the environment and Norse culture (Thorarinsson 1961). Combining these factors with paleoecological, archaeological and historical records facilitates modeling of the Norse human ecosystem in the North Atlantic region. Interdisciplinary paleoecological-archaeological studies of these islands, in particular, the Faroes, Greenland and Iceland, have documented intensive anthropogenic influences on the sensitive northern environment (Buckland et al in press; Johanssen 1974; McGovern et al 1983; Sveinbjarnardottir et al 1980).

Iceland offers a unique opportunity to study Norse-environmental interactions. The pristine sub-arctic environment of Iceland had not been intensively settled by humans prior to 874 AD and the environment was extremely sensitive to Norse agrarian land-use practices (McGovern et al 1988a; Ogilvie 1981; Thorsteinsson 1986). It is estimated that through the clear-cutting of the natural birch woodland and overgrazing by domesticate herbivores, 60% of the original natural vegetation cover was destroyed or greatly altered (Thorsteinsson 1986). This, in turn, dramatically increased erosion of Iceland's loessal soils leading to a complete transformation the Icelandic environment over the 1000 years of occupation (McGovern et al 1988; Ogilvie 1981; Thorarinsson 1961). The environmental degradation of Iceland was further exacerbated by cooling climatic conditions whereby the Norse cultural system underwent severe stress. As a result of both of these factors, Norse culture-including subsistence practices and demography-was directly affected (Jackson 1970; McGovern et al 1988; Ogilvie 1981).

Throughout the thousand year history of human occupation in Iceland, dynamic interactions have existed between the Icelanders and their environment. In order to illustrate these interactive processes, an Icelandic systems model employing archaeological and paleoenvironmental data combined with Icelandic historical records (i.e. the Sagas) will be constructed. These data sources supply an abundance of information for the analysis of anthropogenic impacts on the landscape and the consequential environmental feedback on the Norse culture.

Icelandic Systems Model

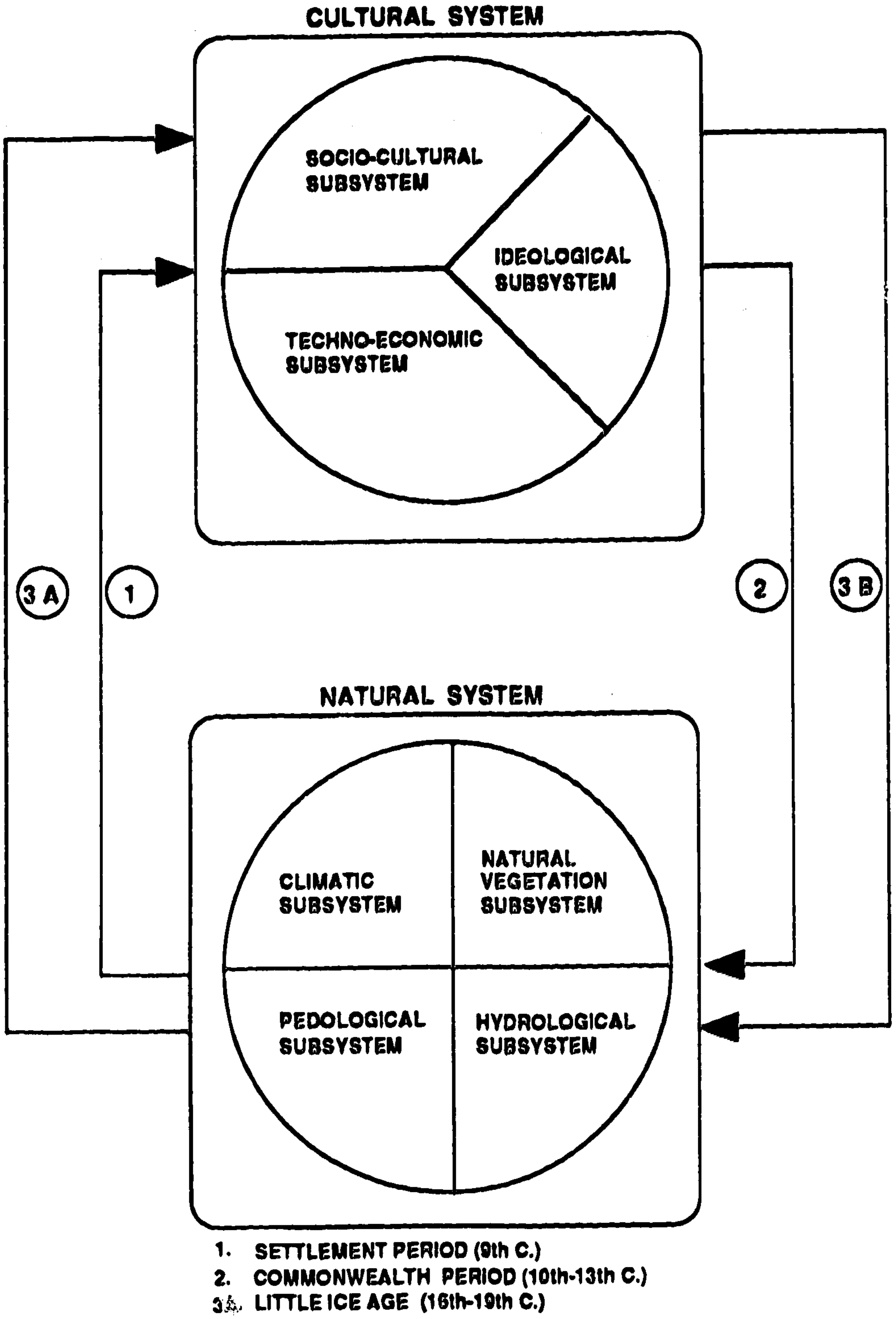
Theories on human ecology stress the necessity of a holistic point of view, utilizing a systems approach to reconstruct the complex networks of mutual causality that exist within the interactions of a human culture and its environment (Ellen 1982). For the reconstruction of prehistoric human ecosystems,

> Archaeologists should regard human societies as elements of specific ecosystems, the pattern of culture prevailing at any given time...being the product of adjustment and interaction between specific social needs and the possiblities of relevant climate, soil, and animal and plant life. (J.D. Clark 1954)

In Iceland, humans, fauna, vegetation, soil structure and microclimates are all mutually interdependent subsets of a dynamic holistic environmental system. Alterations to any of these variables, such as climatic cooling, increased soil erosion or settlement/abandonment of farms, influence other components of the system.

A simplified example of an Icelandic ecosystemic model is presented (Figure 2). The <u>cultural component</u> consists of three subsystems; the techno-economic, the socio-cultural and the ideological (Gumerman 1988). The <u>natural component</u> has four subsystems; climate, natural vegetation, pedological and hydrological. These subsystems represent the key Icelandic environmental processes interacting with Norse cultural activities. For example, climate and vegetation affected the techno-economic aspect of Norse culture while cultural activities, such as clear-cutting woodlands and overgrazing by livestock in turn affected the Icelandic environment.

The arrows indicate four major intervals of environmental and cultural interactions: 1) The initial adaptation by the Norse to the Icelandic environment. 2) The environmental impact of the Norse during the Commonwealth (ie. clear-cutting forests, overgrazing by domesticates). 3A



1. SETTLEMENT PERIOD (9th C.)
2. COMMONWEALTH PERIOD (10th-13th C.)
3A. LITTLE ICE AGE (16th-19th C.)
3B. LITTLE ICE AGE (16th-19th C.)

Figure 2. Model of Norse Culture and Icelandic Environment. Adapted from Gumerman 1988

& 3B) The inter-relationship of the Little Ice Age (L.I.A.) on cultural activities and the natural system of Iceland. As a result, this model illustrates and emphasizes the mutual interactions that existed between the Icelandic environment and the Norse culture.

The multidisciplinary I.P.P. focuses on reconstructing the Norse subsistence economy and the changes it underwent throughout Icelandic history (McGovern & Amorosi 1988). This is an integral part of the Norse cultural component in the Icelandic systems model. Archaeological and archaeobotanical material obtained from the Svalbard midden provides information to aid in the understanding of the complex interactions between the environmental changes and subsistence activities (McGovern & Amorosi 1988). Consequently, Svalbard archaeobotanical material can potentially assist in the construction of the Norse cultural component of the Icelandic ecosystemic model.

Development of the Norse cultural component along with future paleoecological analysis of the Svalbard environment will provide information relevant to construction of a holistic model of the NE region of Iceland. Regional differences in Norse subsistence activities can potentially be elucidated by establishing comparisons between this regional model and other multidisciplinary studies of Iceland (e.g. Buckland et al in press; Sveinbjarnardottir et al 1980) Most importantly, the construction of a NE Icelandic systemic model creates a better understanding of the interdependence between the Norse cultural activities within the dynamic Icelandic environment. This information can then be utilized as a historic guideline for land-use planning in dynamic and marginal Northern environments.

CHAPTER II

Norse History of Iceland

In this chapter, Norse settlement and subsistence activities will be outlined using historical sources (i.e. the Sagas) against a background of general paleoenvironmental conditions for Iceland over the past one thousand years (Buckland et al in press; Ogilvie 1981, 1984a; Sveinbjarnardottir et al 1980). Combined, this data facilitates the development of models outlining Norse cultural activities during the climatic periods of the Little Climatic Optimum [L.C.O.](7-11th Century AD) and the Little Ice Age [L.I.A.](16-19th Century AD). In turn, these models will be utilized to interpret the botanical material from the Svalbard midden.

The Viking Age of the Scandinavian culture encompassed the 8-11th centuries AD. Seeking adventure and wealth from areas throughout Europe, the Vikings set out from their homelands (Norway, Denmark and Sweden). As a result of these sea-faring and land-faring expeditions, Norsemen began to establish permanent agricultural colonies throughout Western and Eastern Europe including the North Atlantic region (Crosby 1986). Remnants of this Norse expansion can be found from the Shetlands and Faroes to the sub-arctic environments of Iceland and Greenland (McGovern et al 1988). Norse colonization of these North Atlantic islands in the

9th and 10th centuries can be attributed to two major factors. Population pressure forced Norwegian farmers to seek new land, while the Norwegian King, Harladr Finehair, consolidated Norway under his rule, forcing petty chieftains to leave the country (Johannesson 1974; Jones 1984). As a result, both chieftains and common Norsemen set forth to colonize new lands, such as Iceland.

These first colonizers shared a hierarchical political organization and a well-developed sea-faring tradition. They had a subsistence economy based primarily on domestic animals with limited cereal agriculture and fishing. Most importantly, the Norsemen possessed an opportunistic readiness to exploit available resources, within limits, from the land and sea (McGovern 1988; McGovern et al 1988).

Iceland was a unique colony as the landscape and ecosystem had been only minimally altered by human activities. Initially settled by Ingolfr Arnarson and his followers in 874 AD, Iceland's remaining arable land had been claimed by 930 AD (Johannesson 1974). This sixty year interval is referred to as the 'landnam' or Settlement Period of Iceland. While Norsemen from western Norway dominated the colonists, others who had previously settled in the British Isles also moved to Iceland, bringing with them Celtic influences. By 1100 AD, the total population of Iceland was approximately 80,000, with a settlement pattern of widely scattered isolated farms along the coastal plain and inhabitable valleys (Gelsinger 1981; Jackson 1970).

Norse farmers brought along domesticated European plants and animals, iron age technology and north-temperate farming expertise to Iceland (McGovern 1988).

Even though Iceland was essentially virgin land, its climate and environment made it marginal for human settlement and agriculture (Ogilvie 1981; 1984b). Commonly known as the land of ice and fire, large glaciers co-exist with volcanic mountains on this northern island, leaving at the present time only about 25% of the total land mass available for agrarian purposes (Gelsinger 1981; Thorarinsson 1958). The Icelandic climate is highly variable, with alternating influxes of Polar air and ocean currents from the north and the milder Atlantic air and the Gulf Stream ocean current from the south (Ogilvie 1981). The first settlers of Iceland quickly realized the limitations of the Icelandic environment for agricultural and animal husbandry practices essential for the survival of their livestock (Johannesson 1974).

Reconstructed Subsistence Practices

The Norse settled Iceland during the Little Climatic Optimum when the Northern hemisphere experienced an average warming of $1^{o}C$ above modern mean temperatures (Dansgaard et al 1975). During the Settlement (870-930 AD) and Commonwealth Periods (930-1260 AD) Norse farmers enjoyed a successful and productive economy based on animal husbandry. They adapted so successfully to the sub-arctic agrarian lifestyle during these first 400 years of Icelandic settlement, that exportable surpluses enabled them to obtain not only essential imports, like grain and timber, but also non-essential luxury items like fine linens, wax and tar (Gelsinger 1981; Johannesson 1974).

The Saga of Hord, the Saga of Viga Glum (Boucher 1983; 1986), the Saga of Grettir the Strong (Hight 1913), the North Atlantic Saga (Jones 1984) and Banamanna Saga (Mageroy 1961) are examples of Icelandic Sagas that were utilized as the basis for reconstructing the Norse subsistence patterns for the L.C.O. and L.I.A. Although not representative of pure historical fact, the Sagas recount a variety of the agricultural practices in medieval Iceland filtered through the perceptions of their 12th and 13th Century authors. Written by well-informed historians and politicians, the Sagas elucidate the technological capabilities, social organization and daily life of the Norse during those first years of settlement (McGovern 1981).

Little Climatic Optimum Subsistence Practices

Agricultural crops were limited to barley which could only be grown successfully in the south/southwestern part of Iceland (Johannesson 1974). Animal husbandry, therefore, became the primary means of subsistence, with sheep, cattle and horses being the three most important animals. Cattle provided dairy and meat products, while horses were the major means of transportation. Sheep wool woven into woolen cloth **(vathmal)** became the first form of Icelandic currency **(ell)** and an essential export item [Bandamanna Saga] (Johannesson 1974; Mageroy 1961). Fresh and saltwater fishing were also used as a means of subsistence along with the occasionally beached whale and/or seal (Bachman 1985; Johannesson 1974; Preusser 1976). Hunting birds, collecting their eggs and gathering of wild berries, herbs and grasses supplemented the other subsistence practices [King Heidrek the Wise Saga] (Fridriksson 1972; Tolkien 1972).

The seasonal round of Norse subsistence practices focused primarily on the maintenance of the hayfields and grazing of the domesticate animals with fishing as an auxiliary activity (Figure 3). Four types of agrarian land-use areas (fields) were recognized: 1) The homefield **(tun)**, fertilized with manure and utilized for growing hay to supply winter feed; 2) The pasture meadows **(engi)** also used for haymaking but more often to supply grazing areas in the spring and fall; 3) The rangelands **(hagi)** that were the principal graze for the sheep and horses during the summer; and 4) The highland meadows **(seter)** utilized in the summer for grazing cattle (Preusser 1976). The maintenance of the hayfields consisted of manuring the **tun** in spring and cutting the hay in July and in a good year possibly again in September. Hay from the **engi** was also cut in summer [The

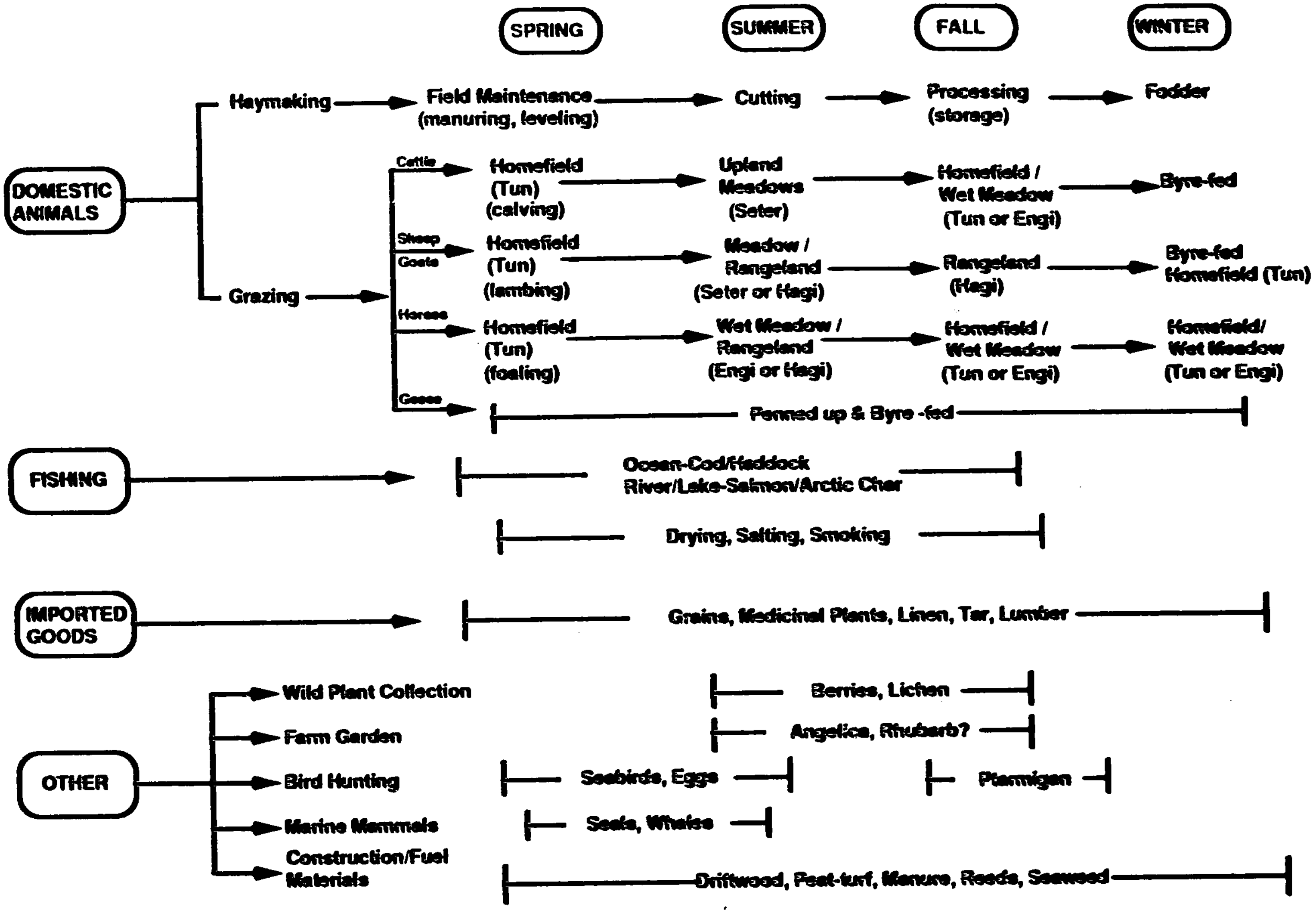


Figure 3. Norse Subsistence Practices from the Little Climatic Optimum (7-11th C.)
Adapted from Icelandic Sagas, Johansson 1974 and Preusser 1976.

Saga of Hord; The Saga of Viga Glum; The Saga of Grettir the Strong] (Boucher 1983 & 1986; Hight 1913).

Cattle were kept and fed in a barn (**byre**) through the winter, carried out to the **tun** in the spring and herded to the **seter** for the duration of the summer. The sheep grazed in the **engi** for the winter and spring, moving to the **hagi** and **seter** in the summer. The seashore was also an area grazed by the sheep. Horses utilized the **hagi** and **engi** for year-round graze. Sheep and cattle were rounded up in the fall with the milking cows and wethers being moved into the barn for winter. Calving and lambing was done in the spring while the fall was slaughter time. Thus, each domesticate animal had its own seasonal grazing pattern.

Fishing was done spring, summer and fall, while sea mammal exploitation (whales and seals) occurred during the winter and spring. In the summer and fall, wild plants were collected and farm gardens were harvested. Imported goods, such as grain and timber, were available year-round (Johannesson 1974).

Little Ice Age Subsistence Practices

During the Little Ice Age [L.I.A.], Icelandic temperatures dropped 2-3°C below modern averages (Dansgaard et al 1975; Lamb 1977). The arctic influence on the Icelandic climate was intensified, creating severe winters and increasing the frequency of coastal sea ice. The presence of land-fast coastal sea ice created lower summer temperatures and shorter growing seasons (Fridriksson 1970; Ogilvie 1981). The cooling and increased climatic variability of Iceland significantly influenced the subsistence economy of Iceland.

These climatic conditions directly affected the growth of grass and hay thereby reducing yields (Bergthorsson 1985; Ogilvie 1984b). Lower hay yield led to insufficient amounts of winter fodder, especially since horses, sheep and cattle were **byre**-fed. It became necessary to kill more livestock in the fall, while many more probably did not live through the winter months due to insufficient fodder. Highland **seters** were abandoned as summer pastures and mires (**engi**) were mowed, becoming an important source of fodder due to decreasing grass productivity. Goats and geese were not common livestock due to decreasing fodder supplies (Johannesson 1974). Sea ice resulted in lower ocean temperatures and the disappearance of fish, particularly cod, in the coastal waters (Cushing 1976; Ogilvie 1981). Imported goods were also extremely limited. As a result, other means of subsistence, such as utilizing sea mammals, hunting birds and collecting wild plants would have had a greater importance in the Icelandic subsistence economy (Figure 4).

The Icelandic subsistence economy during the L.I.A. experienced greatly reduced productivity leading to conditions of famine. Food shortages and the spread of

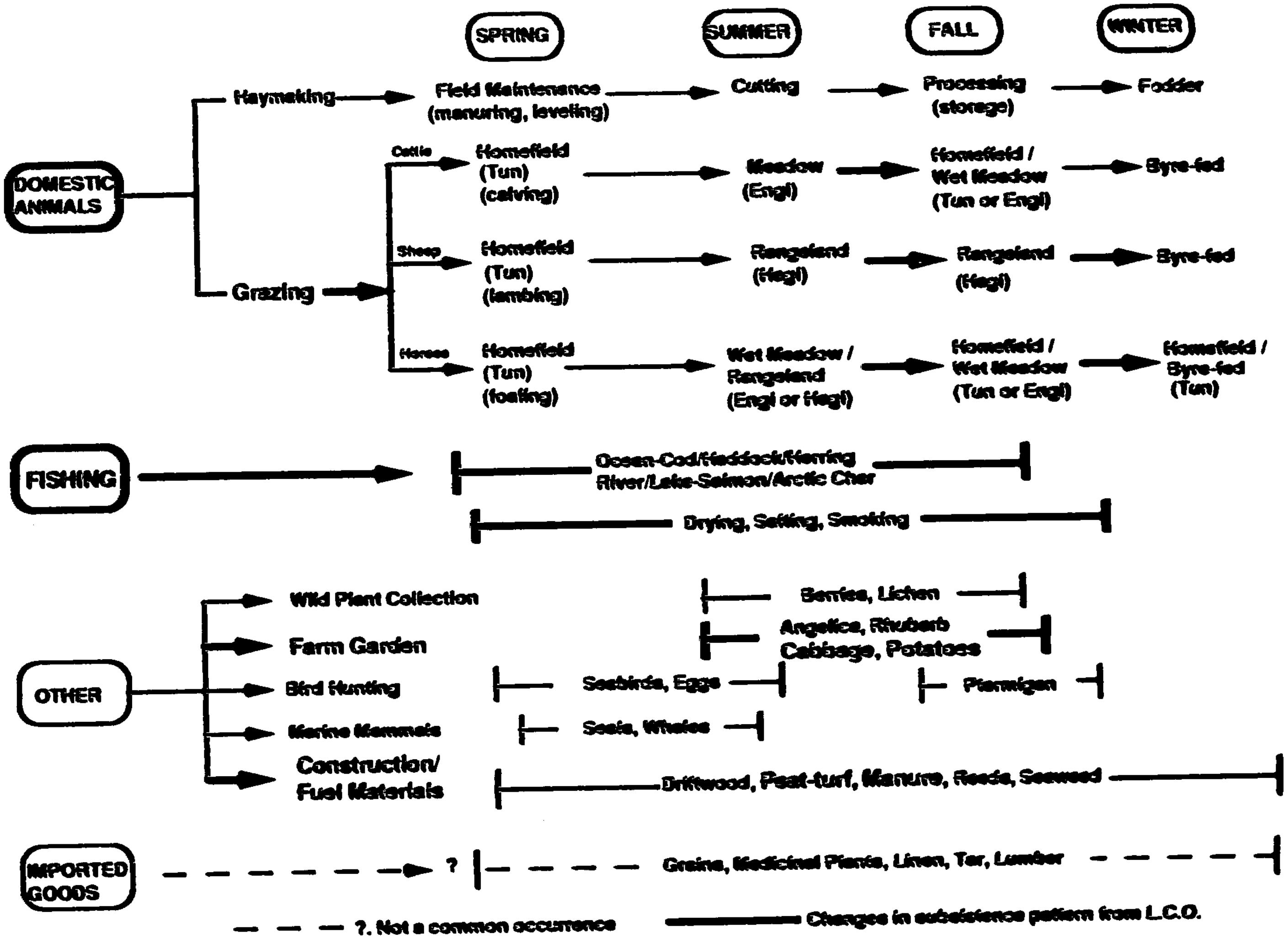


Figure 4. Norse Subsistence Practices from the Little Ice Age (16-19th C.)
Adapted from Johansson 1974 and Preusser 1976

diseases (i.e. the Plague) drastically increased the mortality rate. Consequently, the Icelandic population at the beginning of the 20th century was only 1/3 of the population during the Commonwealth period (Fridriksson 1972; McGovern 1988; Thorarinsson 1961).

It is believed that anthropogenic impacts of the Norse settlers on the sensitive Icelandic environment, combined with the cooling climate of the L.I.A., intensified the loss of productivity of the Icelandic hayfield communities. The effects of the the clear-cutting of the birch woodlands "that covered the land from the sea to mountains"[Ari the Learned: Islendingabok] (Johannesson 1974) and the introduction of domestic herbivores created irreversible damage to the Icelandic landscape. Overgrazing by these domestic animals, especially in upland areas, stripped the landscape of vegetation cover, increased the rate of erosion of the thin loessal soils and prevented restabilization of the landscape (Hallsdottir 1987; Sveinbjarnardottir et al 1982). Also, the inorganic content of lowlying areas was increased thereby altering the productivity of these lowland vegetation communities (Buckland et al 1986 & in press).

In summary, from the time of settlement, the Icelandic enivironment has been impacted by both climatic changes and anthropogenic influences. These processes exemplify the feedback system that exists between Norse subsistence practices and the Icelandic ecosystem.

CHAPTER III

Site Formation Processes

Assumptions of Norse Midden Formation

Archaeobotanical material from the Svalbard midden represents vegetation that was part of the 'waste stream' of Norse cultural activities (Schiffer 1987). Discussion of the botanical data recovered from paleoecological midden studies on Norse Greenlandic and Icelandic sites (Buckland et al in press; McGovern et al 1983; Sadler n.d.; Sveinbjarnardottir et al 1980) leads to the following assumptions regarding site formation processes at the Svalbard midden:

1) Middens only accumulate when the waste material was not being reclaimed as fertilizer for hayfields.

2) A farmsite midden contains the presence of plant macrofossils representing both human subsistence activities.

3) Animal refuse includes seeds from dung, hay, peat bedding and other material associated with agricultural practices.

4) Human refuse includes the seeds from edible plants, both wild and imported (e.g. grains and medicinal plants). Also, peat turf, wood and reeds used for the construction of structures would result from human subsitence activities.

5) Charred seeds would represent human subsitence activity from food processing or fuel burning (e.g. peat, dung, wood).

The combination of these assumptions and the Norse subsistence activity models derived from historical sources (Figures 3 & 4), was the basis for constructing a flowchart model of the input and taphonomic processes operative on macrofloral remains of the Svalbard midden (Figure 5).

This model of midden formation processes for Norse sites recognizes four dominant sources of botanical refuse reflecting direct resource use, indirect resource use and prehistoric seed rain (Minnis 1981). These are; 1) <u>midden vegetation</u>, 2) <u>household refuse</u> from farm houses, 3) <u>byre refuse</u> from the sheep and cattle barns and 4) <u>other</u> types of refuse. The natural vegetation source contributes seeds from weedy species growing on the midden (historic seed rain). The household refuse represents botanical remains from direct and indirect resource use (Minnis 1981). These are from floor coverings (e.g. reeds seeds), bedding (e.g. peat seeds), fuel (i.e. burnt vegetation from peat and dung) and food/medicine (i.e. seeds from edible berries, wild grasses and imported medicinal plants). There are three types of byre refuse: dung from hay consumption, fodder remnants (e.g. grasses, weeds and sedges) and peat bedding. The final source of refuse in the midden includes vegetation remains found in dung collected from rangelands, botanical construction material of Norse structures (e.g. peat turf)

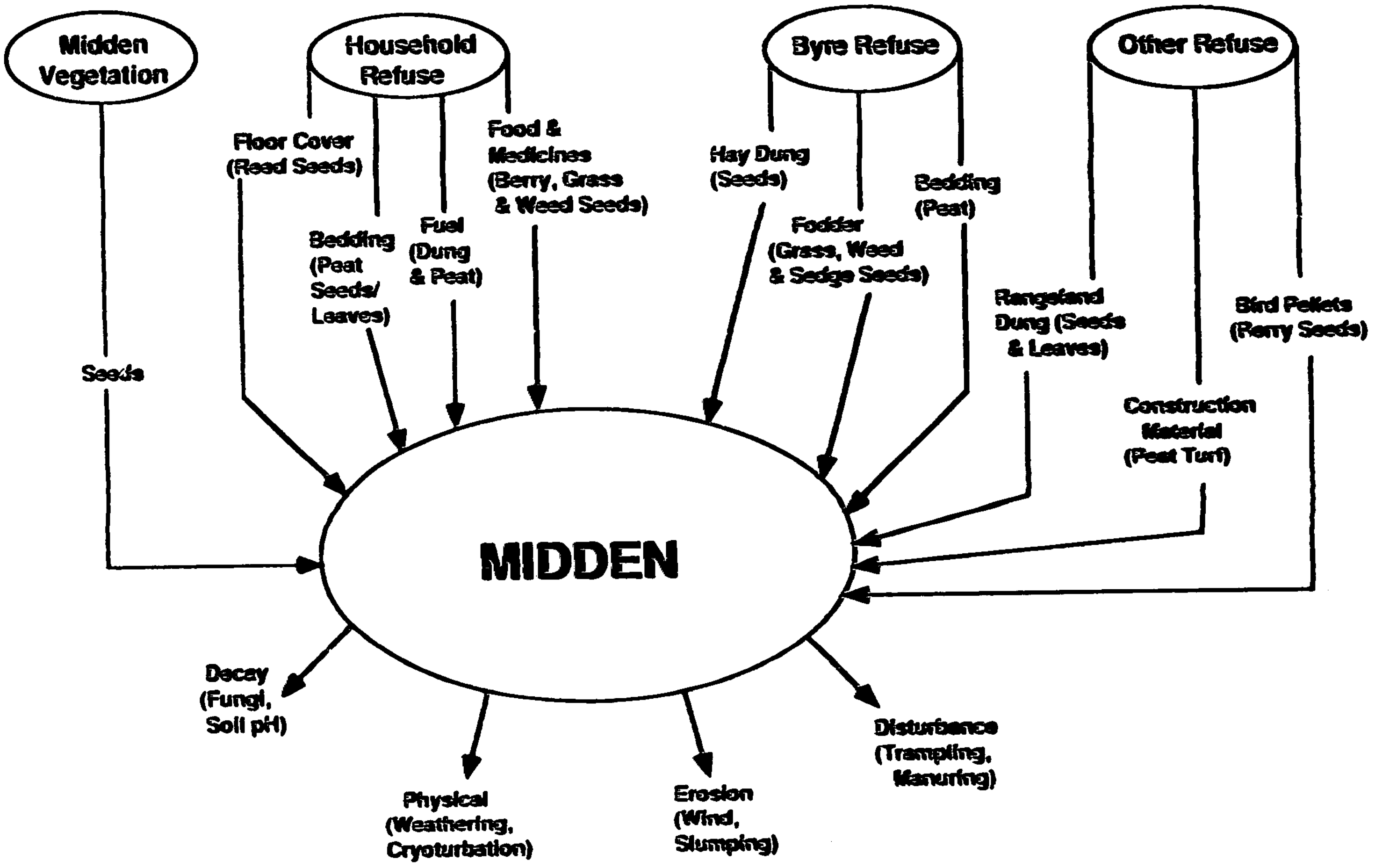


Figure 5. Midden Formation Processes of Norse Macrofossil Remains
Adapted from McGovern <u>et al</u> 1985; Schiffer 1987; Sveinbjarnardottir <u>et al</u> 1990.

and berry seeds from the pellets of wild birds (e.g. ptarmigin).

Natural environmental processes have a continuous impact on archaeological deposits, especially in open sites such as the Svalbard midden (Ford 1979; Miksicek 1987; Wasylikowa 1986). Consequently, midden taphonomic processes are included as an integral part of the midden formation model effecting botanical remains through alteration of the material (i.e. oxidation), destruction of material (i.e. chemical breakdown) or removal of material (i.e. erosion) following deposition (Schiffer 1987). Decay by fungi or soil chemistry destroys and alters botanical remains. Physical environmental processes, such as physical weathering and cryoturbation (freeze/thaw cycles) destroy and deplete midden botanical material. Wind erosion and downslope movement (gravity) of the midden removes botanical remains deposited in the midden. Lastly, disturbance of midden material lessens the amount of botanical refuse due to trampling by livestock or removal of midden material for field fertilizer.

This model of Norse midden formation processes will aid in the interpretation of the Svalbard midden archaeobotanical samples. In turn, this interpretation should elucidate Norse subsistence activities within the Icelandic environment for the past millenum. However, interpretation of the archaeobotanical remains from the

Svalbard midden must be tempered by biases introduced into the data.

Interpretation Biases of the Svalbard Midden

Differential or biased representation of macrofloral remains in the Svalbard midden is due to differences in botanical refuse durability, the seed production of prehistoric plants and various patterns of plant utilization by the Norse (i.e. as food, as fodder, as construction material or as fuel sources) (Belger and Keatinge 1979).

Preservation biases of macrofloral remains are the result of variations in plant biology and plant utilization patterns, thereby creating differences in the type and quantity of plant species recovered from archaeological contexts. Variation in seed quantities is linked to the biology of each plant type (i.e. growth patterns, productivity of seeds and seed characteristics) (Sveinbjarnardottir et al 1980). For example, seeds with oily outer coverings (berry seeds) are more likely to be preserved than fragile seeds (dandelion) (Wilson 1984).

Likewise, plants associated with activities involving fire (i.e. for food preperation or fuel sources) have high probabilities of being charred are therefore less susceptible to decay and are likely to be preserved in a midden (Pearsall 1989). Uncharred floral remains and fleshy plant parts (e.g. roots) have low probabilities of being found in midden deposits as they are more susceptible to decay (Miksicek 1987; Minnis 1981). In fact, only charred seeds should be considered archaeological remains, since uncharred seeds may be modern contaminates due to collection errors or aerial deposition (Minnis 1981). However, this also creates a bias in the seed remains, where only seeds that are resistant to carbonization will be recovered and are likely to be over-represented in the fossil record (Wilson 1984).

Taphonomic processes operative at the site will also affect the presence/absence of certain species within midden samples. Fungal decay, wind and water erosion, freeze-thaw cycles and trampling of the midden deposits by animals are all examples of taphonomic processes at Svalbard (Figure 5). These post-depositional processes can affect botanical remains by destroying or removing the plants that were deposited on the midden.

Midden deposits are subject to too many unknown variables of accumulation, preservation and distribution to make simple quantitative assessment of botanical data meaningful (Begler & Keatinge 1979). On the other hand, qualitative botanical data document the plants that were present at the site for a given time period. Interpretations of plant utilization patterns based on the presence/absence of certain species can best be accomplished through the use of analogies (Pearsall 1989). Modern land-use vegetation analysis provides analogous plant data while

Icelandic sagas and previous archaeobotanical studies of Norse sites contribute additional information to aid in the interpretation of the archaeobotanical samples from the Svalbard midden and the reconstructions of Norse subsistence practices.

CHAPTER IV

Site Description

Thistilfjordur District

The coastline of northeastern Iceland is an undulating plateau region crossed by many streams and rivers including the **Svalbardsa**. The Vopnafjordur-Thistilfjordur plateau rises inland to 300 m above sea level, with the 100 m contour line located within 3 km of the coastline (Preusser 1976). Farms are concentrated along the low-lying coastal areas (below ~200 m a.s.l.), where the maritime influences keep vegetation productivity reasonably high and 'frost-kill' processes to a minimum. The Svalbard farmsite is located approximately 40 m a.s.l., at 66°12'N latitude and 15°43'W longtitude (Figure 6). The highlands rising above the plateau are uninhabited, with barren rock or moss-lichen vegetation. The soils of the low-lying areas are slightly acidic, consisting of two basic types, either high in organic content or loessal mineral matter (Thorarinsson 1968). Although permanently frozen ground is non-existent in Iceland, frost-action creates a hummocky landscape of **thufur** in the better drained localities (Schunke & Zoltai 1988) while the poorly drained areas are predominantly bogs or fens.

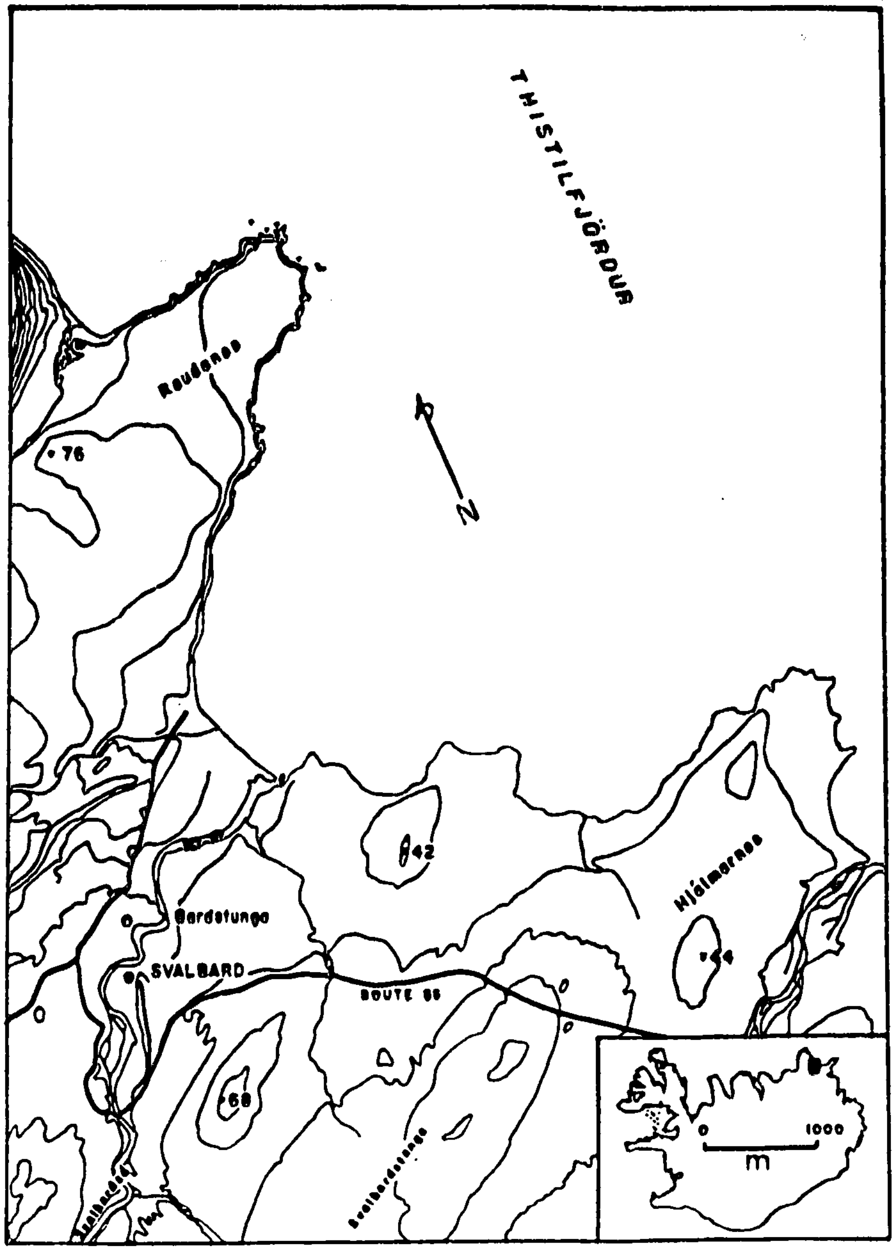


Figure 6. Map of Thistilfjördur District

Modifed from Amorosi & McGovern (1989)

Northeastern Icelandic Climate

The climate of N E Iceland is cold temperate oceanic, characterized by cool summers and relatively mild winters. The marginal location of the country between the Tropical Maritime and Polar air masses along with the warm Irminger and the cold East Greenlandic ocean currents creates highly variable weather patterns (Preusser 1976). The mean annual July temperature is 9-11° C and the mean annual January temperature is -2° C. The mean annual precipitation is 474 mm. for the NE region of Iceland (Einarsson 1963, Thorarinsson 1968). These are the lowest averages for Iceland. NE Iceland also has a high frequency of arctic drift ice. These climatic factors directly influence the types of vegetation communities that exist in the Thistilfjordur region and their productivity (Ogilvie 1984a).

Svalbard Vegetation Communities

The Icelandic flora consists of 500-550 vascular plant species, with many similarities to European and Scandinavian flora (Preusser 1976; Thorarinsson 1968). Vegetation prior to settlement is considered to have been birch woodlands up to 300 m a.s.l. and mires or fens in lowlying poorly drained areas (Hallsdottir 1987; Thorsteinsson 1981). The consequence of human land-use activities for the past millenium has denuded the Svalbard region of any woodland vegetation. Present day plant communities of N.E. Iceland consist of mires, heathlands, grasslands and hayfields. Additionally, the settlement of Iceland by the Norse agrarian culture introduced new species (anthropochors) and increased grasses and weedy species (apophytes) to the vegetation (Einarsson 1963; Vorren 1986).

Farm meadows, pastures and hayfields form more or less concentric land-use zones surrounding the center of Svalbard, the exception being modern fertilized hayfields that are separate fields. Norse farmers identify three agricultural land-use areas; the homefield (**tun**), the meadow pasture (**engi**) and the rangeland pasture (**hagi**). These areas are at the same time anthropogenic plant communities, created and maintained for specific purposes supporting communities of relatively specific composition. The homefield represents the area utilized for haymaking, while the meadow and rangelands are areas utilized for grazing domesticate animals. This Norse land-use pattern affects not only the type of species found within each plant community but also their productivity. **Tuns** tend to be the most productive while the intensively grazed **hagis** are the least productive (Fridiksson 1986; Thorsteinsson 1981) (Plate 1).

A botanical survey of the Svalbard region yielded approximately 200 plants, identified using Hordur Kristinsson's (1987) A Guide to the Flowering Plants and Ferns of Iceland and Pat Wosley's (1979) A Field Guide to

ICELANDIC LAND-USE AREAS

Photo A. Heathland (Hagi) & Grassland (Tun)

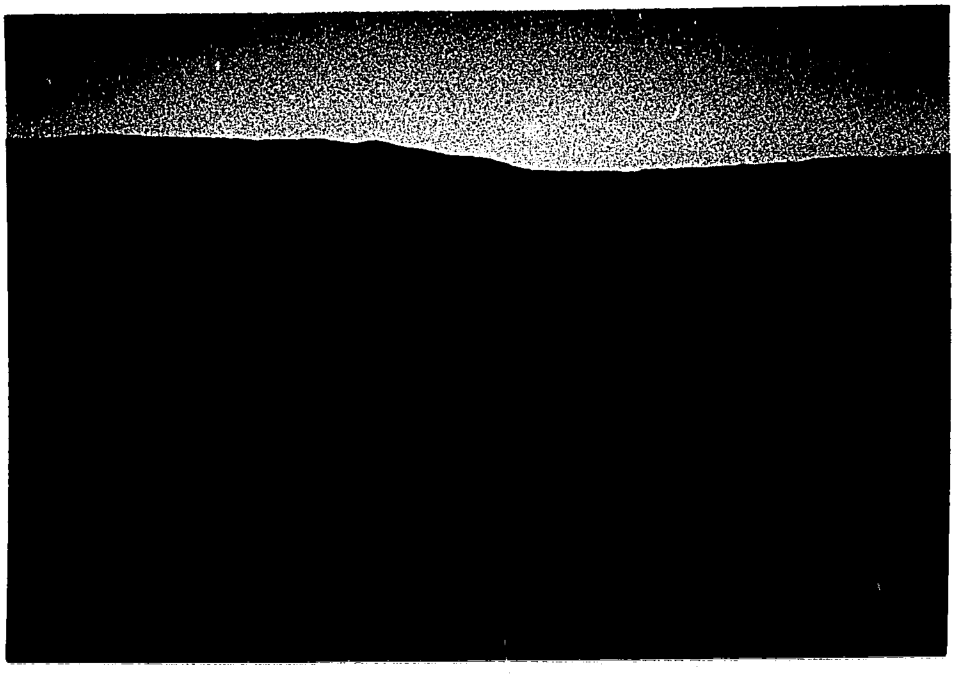


Photo B. Wetland (Engi)
Plate 1.

the Flowering Plants of Iceland. Additionally, species composition of eight Svalbard agricultural plant communities was observed: two **tuns**, two **engis**, three varieties of **hagis**, and the vegetation growing on the modern midden.

Both **tun's** were well drained with fertile soils. One surrounded the farm house while the other, a 'modernized' **tun**, was a chemically fertilzed hayfield quite a distance from the farm. The **engi's** were located in various poorly drained low-lying areas, close to the the Svalbard river. **Hagi's** included hummocky heathland, oceanside and river bank localities. The heathland **hagi** covered the largest area and had the greatest variety of plants. Lastly, the modern barn midden community consisted mostly of weedy species (Table I).

The composition of these Svalbard plant communities is comparable to those of other Icelandic farms (Boniface 1981) and even types of natural vegetation communities (Steindorsson 1981).

These eight land-use vegetation types (Table I) represent most of the vegetated area in the Svalbard region and typify the modern Icelandic agricultural land-use pattern. These will serve as modern analogs for reconstructing the past vegetation represented in the midden deposits.

I. *TUN* Vegetation

a) Farmyard *Tun*: Ranunculus spp., Stellaria spp., Rumex spp., Cerastium spp., Potentillia spp., Alchemillia spp., Viola sp., Carex spp., and POACEAE

b) Modern *Tun*: POACEAE, Ranunculus spp., Carex spp. & Rumex spp.

II. *ENGI* Vegetation

a) Wetland *Engi*: Carex spp., Potentillia spp., Alchemillia spp., Juncus spp., Equisetum spp., Eriophorum spp., Caltha palustris, Bistorta vivipara & Koengia islandica

b) Riverside *Engi*: Ranunculus spp., Rumex spp., Potentillia spp. Stellaria spp., Carex spp., Equisetum spp., Caltha palustris & Montia fontana

III. *HAGI* Vegetation

a) Heathland *Hagi*: Empetrum spp., Vaccinium spp., Salix spp., Betula spp., Festuca spp., Galium spp., Dryas spp., Parnassia spp., Luzula spp., Thymus spp., Polygonum spp., Thalictrum spp.

b) Riverslope *Hagi*: Equisetum spp., Carex spp., Stellaria spp. Taraxacum spp., Thalictrum alpinum, Bistorta vivpara & Polygonum aviculare

c) Oceanside *Hagi*: Thymus spp., Ranunculus spp., Plantago maritima, Achilea millefolium & POACEAE

IV. MODERN MIDDEN Vegetation

a) Farmyard: Stellaria sp., Cerastium sp., Rumex sp., Capsella sp., Ranunculus sp., Taraxacum sp., Heiracium sp., Achillea sp., Polygonum aviculare, Rhinanthus minor & POACEAE

Table I. Taxa from Present-day Icelandic Land-use Areas Following Steinddorson 1981 & Boniface 1981.

Archaeological Site Description

Svalbard (a large 'central place' farm in the Thistilfjord district, N.E. Iceland), was chosen by the I.P.P. as the site to carry out archaeological fieldwork in July and August, 1988 on the basis of successful testpit excavations in 1987. The excavations (Icelandic Site #6706-60) exhibited deeply stratified sequences that extend back into the Commonwealth time (11th C.). This deep midden consists of a collection of animal bones, botanical and artifactual evidence that document Norse subsistence practices and offers the first opportunity to establish a cultural sequence for the climatically marginal area of NE Iceland (McGovern & Amorosi 1988).

Svalbard was established as a community center in the 11th Century, controlling a large number of tenant farms in the area (McGovern & Amorosi 1988). Temporal continuity exists from the early modern to medieval times in the stratified deposits. Artifactual evidence dates from 1050 AD to the early 20th century, while three datable volcanic tephras found within the midden strata (Hekla 3000 BP, Hekla 1636 AD, Vatnajokull 1717 AD) correlate with the dated artifacts establishing reliable time lines. These timelines were then used to formulate nine analytical units (AU), AU1 being the oldest level. These AU were established to correlate the artifactual, faunal and floral remains from all excavation units (T. Amorosi, C.U.N.Y. pers. comm. 1989).

The midden is located on a river eroded two-mounded bluff that rises 11 meters above the **Svalbardsa** river on the modern Svalbard farmsite. A wide band of slumping midden deposit lies adjacent to the bluff edge, illustrative of the gravitational and erosive forces acting on the midden (Plate 2; Figure 7). The midden was apparently associated with a series of older farm structures situated in the homefield (**tun**), the most recent of which had been flattened.

The midden deposits extended horizontally over 22 m^2 to a depth of 2-2.5 m. The evident stratigraphy was formed of regular sediment bands lying at predictable bedding angles suggestive of gradual accumulation. The stratigraphic units were not continuous over the entire midden (e.g. Whale Bone layer), leading to differences in the archaeobotanical sample columns (McGovern & Amorosi 1988) (Figure 9: Note haituses). The sediments were largely organic eolian silt (loess) interbedded with volcanic ash/burnt lenses. Excavations into the midden were carried out in 1x1 m^2 units at three locations (Figure 7. Note: Old, Extension and Main areas). Conforming to the midden stratigraphy as much as possible, a 5 cm excavation increment was employed (Figure 8). A history of frost action is apparent in the stratigraphy of the Main and Old units. Organic preservation was generally good, facilitating the recovery of animal and macrofloral remains.

SVALBARD MIDDEN; Southern Exposure

Plate 2.

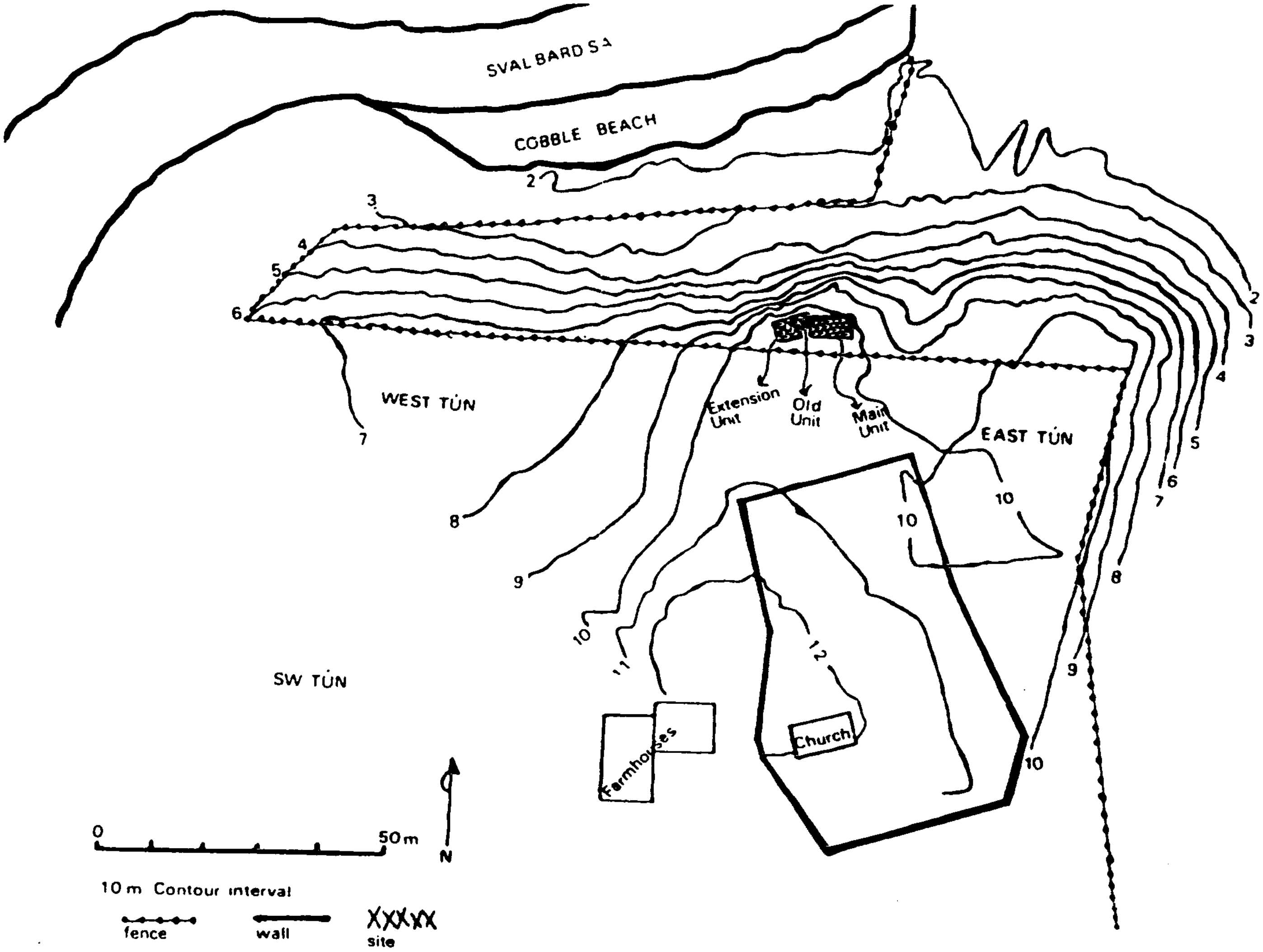


Figure 7. SVALBARD FARMSITE CONTOUR MAP Adapted from Amorosi & McGovern (1989)

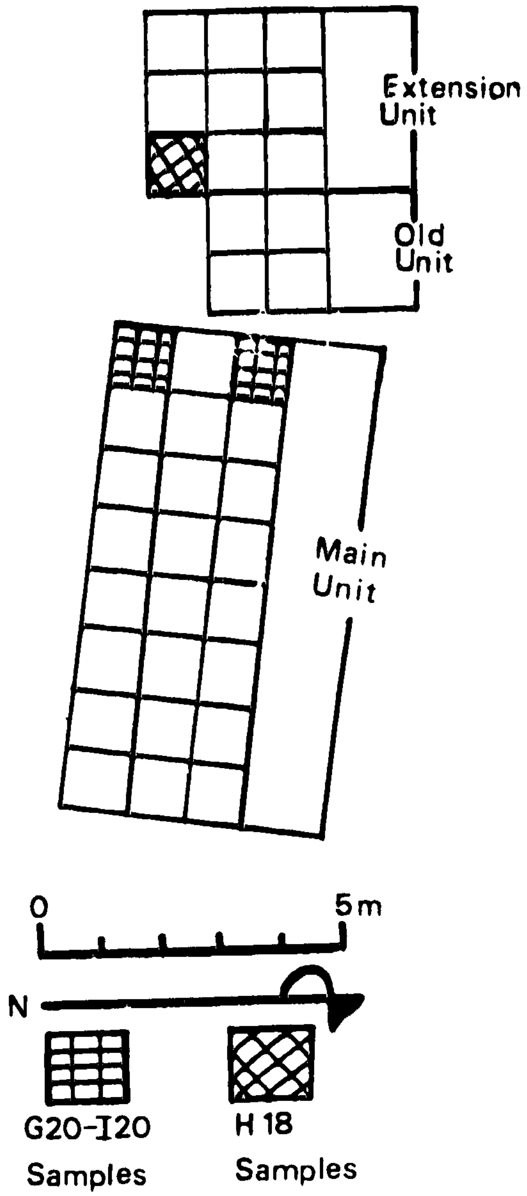


Figure 8. Svalbard Midden Excavation Units
Adapted from Amorosi & McGovern (1989)

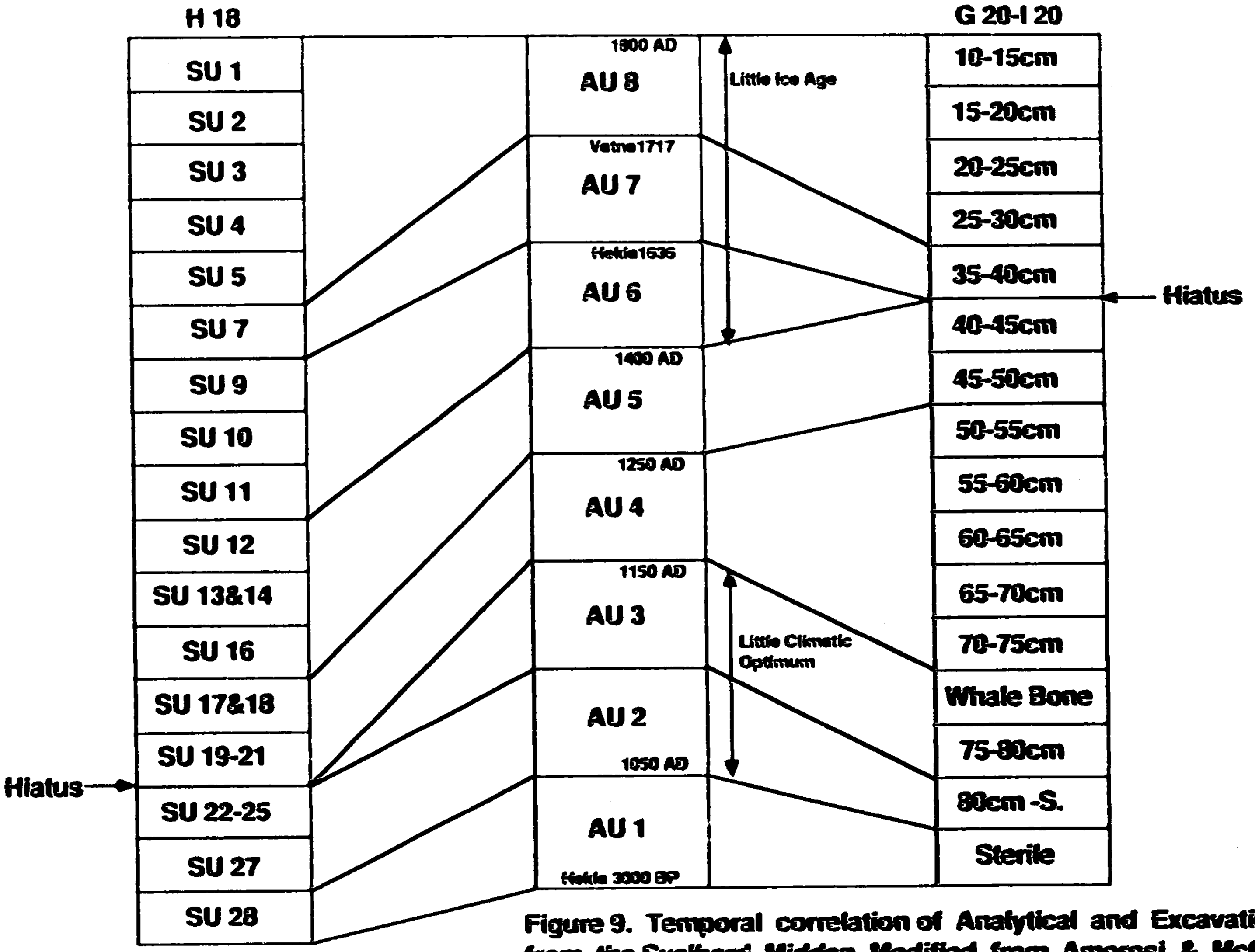


Figure 9. Temporal correlation of Analytical and Excavation Units from the Svalbard Midden. Modified from Amorosi & McGovern 1989

Archaeobotanical Field Methods

Collection of archaeobotanical samples from the Svalbard midden followed methods similar to those outlined by Pearsall (1989), Miksicek (1987), Wasylikowa (1986), Ford (1979) and Bohrer and Adams (1977).

Investigations of agricultural practices ideally require the collection of several series of samples from various points within the site (Wasylikowa 1986). Two sequences of archaeobotanical samples were therefore collected from areas within the midden which contained high concentrations of cultural remains. A total of 34 one-liter samples were excavated from the east profile of H18 in the Extension unit and G20-I20 in the the Main unit (Figure 8; Plate 3). The H18 series was collected as a column sample where the natural, distinct levels (stratigraphic units, SU) of the midden could be precisely sampled (Pearsall 1989). The G20-I20 series was collected using the 'composite' sampling technique where one liter volumes of sediment were collected from each 5 cm excavation level from the 1 m^2 excavated units. Collecting a standardized volume facilitates comparison between samples, stratigraphic layers and sample columns (Ford 1979).

All onsite samples were wet sieved in the Svalbard river through #40 mesh screen (>0.05mm), utilizing a wooden flotation bucket similar to the IDOT bucket of Wagner

ARCHAEOBOTANICAL SAMPLE COLLECTION AREAS

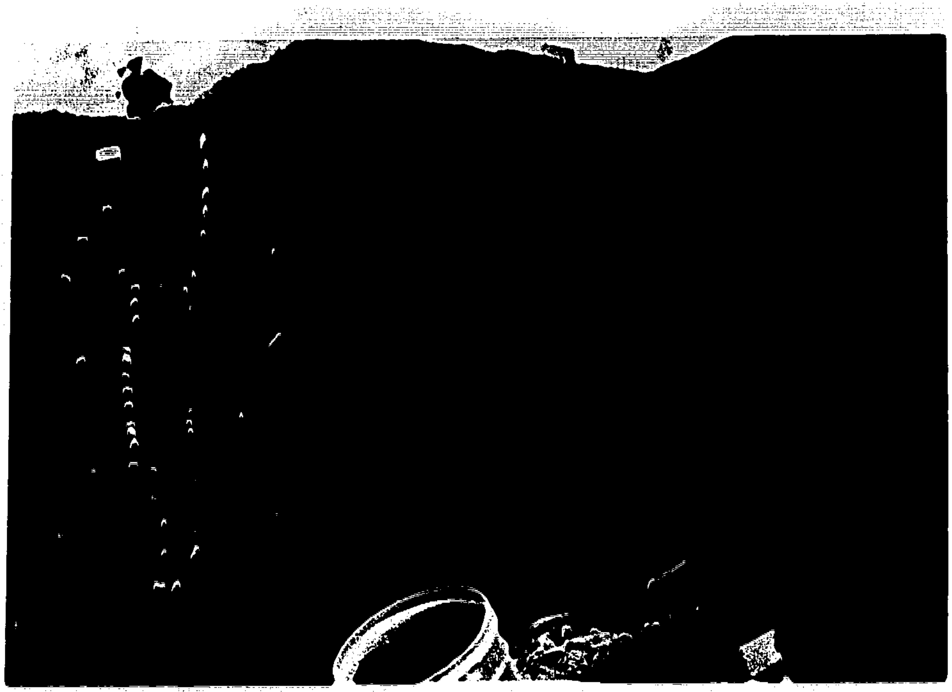


Photo A. H18 Profile; East Wall

Photo B. G20-I20 Profile; West Wall
Plate 3.

(1977). This greatly enhanced the quantity of botanical remains that could be recovered by separating the organic remains from the soil matrix and reduced the sample size to facilitate transportation (Pearsall 1989). Caution was taken to prevent sample contamination during screening.

The two sample columns (H18 and G20-I20) were correlated to the eight analytical units (AU) of the midden deposits. The AU's represent the successive timelines of Svalbard midden stratigraphy (Amorosi & McGovern 1989). This correlation facilitated the comparison and interpretation of the archaeobotanical samples for different time periods (Figure 9).

Archaeobotanical Laboratory Methods

Samples prepared for subsequent laboratory analysis required dispersion of sediment and the sorting of identifiable floral remains from indeterminable residue. The Svalbard macrofossil samples were split into two groups; high organic content and low organic content. The sediments from above the youngest tephra timeline (Vatnajokull 1717) in both the H18 sample series and the G20-I20 sample series were highly organic. Following methods outlined by Wasylikowa (1986), these samples were soaked and gently boiled in 5% KOH for 24 hours, to facilitate wet sieving through #40 mesh screen (>0.05 mm). The samples below the youngest tephra had lower organic contents and were wet sieved through #20 (>0.1) and #40 (>0.05) mesh nested screens.

Twenty-five percent of the sediment caught on the #20 screen was identified while 100% of the sediments from the finer, #40 screen, were separated into identifiable botanical remains and excess material. Using a low power binocular microscope, the identifiable plant remains from all samples were picked out of the sediments with a fine, 'sable hair' brush and stored in petri-dishes with alcohol for later identification.

Initial determination of the floral remains (i.e. seeds, leaves, spores) was based on comparisons with modern plants (Wasylikowa 1986) and Icelandic seed photos (Dr. P. Buckland, University of Sheffield) representing the majority of Icelandic plants. The final seed identifications were made utilizing the seed collections from the U. of A. herbarium and paleoenvironmental laboratory and seed identification manuals such as G. Berggren's (1969) Atlas of Seeds, Pt 2 & 3, Martin & Barkley's (1961) Seed Identification Manual, Montgomery's (1977) Seeds and Fruits of Plants in Eastern Canada and Northeastern U.S. and Delorit's (1970) Illustrated Taxonomy Manual of Weed Seeds. Ideally, carbonized as well as fresh material should be used as a reference collection for archaeobotanical material (Pearsall 1989); unfortunately, such a collection was not available. Charcoal wood fragments were identified after sectioning by Sergio Cervallos, Dept. of Botany, U. of A.

Dr. J.V. Matthews, Jr. (Geological Survey of Canada, Ottawa) assisted in macrofloral identifications.

Data Results

Macrofloral identifications were recorded in a tabular form using the Icelandic plant taxonomy of Love (1983) for terminology. The identified seed and leaf taxa along with other remains were arranged alphabetically and in stratigraphic order for samples from both of the H18 and G20-I20 series. These are presented as raw data tables (Appendix 1). These results were then utilized to construct macrofloral diagrams for both sample series (Figure 10 & 11). To organize the figures, taxa were grouped into four broad habitat groupings (i.e. **tun**, **apophytes** (weedy species), **engi** and **hagi**) based on the modern vegetation communities (Table I). All macrofloral remains were presented as individuals per liter. The two series of samples were then compared using analytical units to reveal trends in the presence of individual species or groups of species and their quantities.

CHAPTER V

Results

Seeds and other botanical remains were recovered from 33 of the 34 samples collected. The G20-I20 30-35cm sample was lost in laboratory processing; results of two (1 liter) samples collected from the Whale Bone, (WB level) in the G20-I20 series were combined in the macrofloral figures and Appendix 1.

The majority of the seeds and leaves were charred. Uncharred seeds that were fresh in appearance were recorded separately in Appendix 1 as it is believed they represent contamination. Only charred seeds were included in the macrofloral diagrams (Figures 10 & 11), while both uncharred and charred leaves were recorded as part of the macrofloral results, the rationale being that all uncharred leaves were partially decomposed.

Preservation of the seeds varied from being identifiable to the species level, to the genus or merely to the family. The carbonized seeds lacked surface detail limiting the identification process to the shape, size and structure of the seed. Determinations were made following the conventions used by Birks (1973) for pollen identification.

A taxonomic list of the macrofloral remains is presented (Table II). Probable habitats (wetland, grassland, heathland, apophyte) were chosen from modern botanical analysis and the quantities based on the total number of individuals recovered from all samples.

Raw Data Tables

A total of 62 taxa representing 31 families were identified (Table 2). The H18 sample series contained 53 taxa, while the G20-I20 series had 45. The lowest stratigraphic level (SU27) of the H18 series had the greatest variety of taxa, 20, while the second lowest level, 80cm-S., of the G20-I20 series had 18.

Fungal sclerotia (thick-walled, reproductive bodies of fungi, (Webster 1980)), megaspores, leaves and seeds were recovered in descending abundance. A total of 621 seeds were recovered from the 33 liters of midden matrix sampled, screened and picked. Twenty seven were considered modern contaminates. Highest seed concentrations were found in the basal units, 115/liter from SU27 in the H18 series and 70/liter from the 80cm-S. of the G20-I20 series.

Taxa	Number	Habitat
SELAGINELLACEAE		
Selaginella selaginoides(L.)	◆◆◆	Wetland
EQUISETACEAE		
Equisetum spp. L. carbonized	◆	Wetland
POTAMOGETONACEAE (=*JUNCAGINACEAE*)		
Potamogeton type L. carbonized	◆	Wetland
POACEAE		
P. undiff. carbonized and damaged	◆◆◆	Grassland
Poa type L. carbonized	◆◆◆	Grassland
CYPERACEAE		
Baeothyron Ehrh.[*Scirpus* L.] carbonized	◆	Wetland
Eleocharis R.Br. carbonized	◆	Wetland
Eriophorum type L. carbonized and damaged	◆	Wetland
Kobresia cf. Willd. carbonized	◆	Heathland
Carex type L. carbonized and damaged	◆◆◆	Heathland
C. cf. norvegica Retz. carbonized	◆	Heathland
C. cf.holostoma Drejer carbonized	◆	Heathland
C. cf. atrata L. carbonized	◆	Heathland
C. cf. nigra (L.) Reichard carbonized	◆◆	Wetland
C. cf. Lyngbyei Hornem. carbonized	◆	Wetland
C. cf. saxatilis L. carbonized	◆	Wetland
C. cf. rostrata Stokes carbonized	◆	Wetland
C. cf. diandra Schrank. carbonized	◆	Wetland
C. cf. canescens L.[*C. cf.curta* Good] carbonized	◆	Wetland
C. cf. echinata Murr. carbonized	◆	Wetland
C. cf. dioica L. carbonized	◆	Wetland
JUNCACEAE		
Juncus type L. carbonized and damaged	◆◆	Wetland
Luzula type DC. carbonized and damaged	◆◆◆	Heathland
POLYGONACEAE		
Acetosa pratensis Mill.[*Rumex acetosa* L.] carbonized	◆	Apophyte
Rumex type L. carbonized and fresh	◆	Apophyte
Polygonum type L. carbonized	◆	Grassland
Bistorta vivipara (L.) S.F. Gray [*Polygonum viviparum* L.] carbonized	◆	Heathland
CHENOPODIACEAE		
Chenopodium album L. carbonized	◆	Grassland
Atriplex cf. longipipes (Hulphers, Turesson) carbonized	◆	Grassland
EMPETRACEAE		
Empetrum nigrum L./ E. Eamesii Fern & Wieg. fresh and carbonized seeds and leaves	◆◆◆	Heathland
LIMONIACEAE		
Armeria cf. maritima (Mill.)Willd. fresh	◆	Heathland
GENTIANACEAE		
Gentianella type Moench. carbonized	◆	Grassland
MENYANTHACEAE		
Menyanthyes cf. L. carbonized	◆	Wetland
BORGINACEAE		
Myosotis type L.	◆	Grassland
PORTULACEAE		
Montia fontana L. [*M. lamprosperma* Cham.] carbonized	◆◆	Wetland
ALSINACEAE (=*CARYPHYLLACEAE*)		
CARYOPHYLLACEAE undiff. carbonized and damaged	◆	Apophyte
Alsine cf. media L. [*Stellaria media* (L.) Vill.] carbonized and damaged	◆◆	Apophyte
Stellaria undiff. L. carbonized	◆◆	Apophyte
S. cf. graminea L. carbonized	◆◆	Apophyte
Cerastium undiff. L. carbonized	◆◆	Apophyte
C. cf. fontanum Baumg. carbonized	◆◆	Apophyte
RANUNCULACEAE		
Ranunculus type L. carbonized and fresh	◆	Apophyte
R. acris L. fresh	◆	Apophyte
THALICTRACEAE		
Thalictrum type L. carbonized	◆	Heathland
FABACEAE		
F. undiff. L. carbonized	◆	Grassland
F. cf. Vicia L. carbonized	◆	Grassland
F. cf. Trifolium L. carbonized	◆	Grassland
GERANIACEAE		
Geranium cf. L.	◆	Wetland
VIOLACEAE		
Viola ssp. L. fresh and carbonized	◆	Wetland
ONANGRACEAE		
Chamerion cf. latifolium (L.) Holub [*Chamaenerion latifolium* (L.) Th. Fr.& Lge., *Epilobium latifolium* L.] fresh and carbonized	◆	Wetland
Epilobium type L. carbonized	◆	Wetland
HIPPURIDACEAE		
Hippuris vulgaris L.	◆	Wetland
CORNACEAE		
C. type L. carbonized	◆	Heathland
ERICACEAE		
E. type L. carbonized	◆	Heathland
Calluna vulgaris (L.) Hull fresh and carbonized	◆◆◆	Heathland
VACCINIACEAE		
Vaccinium L. carbonized seeds and leaves	◆	Heathland
LAMIACEAE (=*LABIATAE*)		
Thymus cf. L. fresh and carbonized seeds and leaves	◆	Heathland
PLANTAGINACEAE		
Plantago lanceolata L. carbonized	◆	Grassland
RUBIACEAE		
R. type L. carbonized and damaged	◆	Wetland
Galium cf. boreale L. carbonized	◆	Heathland
Galium cf. trifidum L. carbonized	◆	Wetland
CAMPANULACEAE		
C. type L. carbonized	◆	Grassland
CICHORICEAE (=*COMPOSITAE*)		
Aracium paludosum (L.) Monnier [*Crepis paludosa* (L.) Moench] carbonized	◆	Wetland

Number; ◆ = 0-10, ◆◆ = 10-20, ◆◆◆ = < 20

Table II. Macrofloral Taxonomic List
Taxonomy from Love 1983

H18 Series

The H18 series (Figure 10) had the largest number of seeds, 337, (24 of these being modern and not included in the results). Luzula undiff. had the greatest number of seeds in the entire series (41), followed by Poa type (39) and Carex type (37). Samples SU27 and SU22-25 had the greatest seed quantities and largest variety of taxa; 115 seeds representing 20 taxa and 82 seeds representing 15 taxa, respectively. The four seed taxa with the largest quantities per strata were in SU27, **POACEAE** and Luzula undiff. with 20, Poa type with 19 and Carex type with 14.

Other macrofloral remains from the H18 series included Selaginella selaginoides megaspores, fungal sclerotia, leaves, wood charcoal and Equisetum stems. Selanginella megaspores and fungal sclerotia had the highest numbers in the middle of the series (SU12); 77 and 121, respectively. There were 343 charred and uncharred leaves that were concentrated in the SU12-SU17&18 samples with 78,the greatest number, found in SU17&18. Empetrum nigrum/E.Eamesii and Calluna vulgaris leaves were the dominant leaf taxa recovered with small amounts of Thymus and unknown types. The wood charcoal was identified as Picea/Abies, however, only 5% of the total wood charcoal was identified and so **ANGIOSPERMAE** charcoal may yet be recovered. Equisetum stems were found throughout the series.

G20-I20 Series

The G20-I20 sample series had smaller quantities of seeds, taxa and other macrofloral remains than the H18 series (Figure 11). There were 284 total seeds (3 fresh contaminates) representing 45 taxa. Empetrum nigrum\E. Eamesii (35), then Carex type (29) and Alsine cf.media [Stellaria cf.media] (26) had the greatest number of seeds per taxa. Seventy seeds from 18 taxa were concentrated in the basal sample, 80cm-S., while the 75-80cm had 61 seeds from 13 taxa. In the 80cm-S. sample, Carex type and Stellaria cf.graminea had the largest number of seeds, 20 each, along with 11 Luzula undiff. and 10 Alsine cf.media seeds.

Additional macrofloral remains from the G20-I20 series consisted of Selaginella selaginoides megaspores, fungal sclerotia, leaves, wood charcoal and Equisetum stems. Selaginella megaspores had the greatest number (61) in the 20-25cm level. Fungal sclerotia quantities were greatest in the WB sample, 180. Leaves were concentrated in the 70cm-S. and 45-55cm samples of this series. Two hundred and fifty seven leaves were recovered with the greatest number, 43, from the WB sample. Once again, Empetrum nigrum/E. Eamesii and Calluna vulagaris were the dominate leaf taxa along with Vaccinium and unknown leaf types. **ANGIOSPERMAE** and Picea/Abies wood charcoal were identified from this series, where again only 5% of the total charcoal was analyzed. Equisetum stems (14) were found throughout the series.

Macrofloral Diagrams

Macrofloral diagrams facilitated the comparison of the two sample series. Both diagrams were organized on the basis of the midden stratigraphy, correlating the individual samples to the analytical units (AU) and dated volcanic tephras found in the midden.

The taxa are presented in four ecological groups and their placement in any one group is somewhat arbitrary as some of the plant taxa can occur in more than one of the habitats. Even so, analysis of the seed totals in each group revealed various trends. The greatest number of seeds in the H18 series (107) and G20-I20 series (106) were recovered from heathland (**hagi**) taxa. This represented 35% of the total seeds for the H18 series and 38% for the G20-I20 series. Concentrations of Empetrum nigrum\E. Eamesii and Calluna vulgaris leaves also represent **hagi** plants. In the H18 series, seeds from **tun** flora formed the second highest percent, 29% (88 seeds), with the **engi** and apophytic (weed) taxa each representing 18% of the total seeds. Apophytic taxa represented the second largest number of seeds in the G20-I20 series, 24% (65 seeds), while the **engi** had the third highest, 22% (57 seeds) and the **tun** had the least, 16% (42 seeds).

As previously mentioned, macrofloral samples from the midden base which correlate to AU2, had the greatest concentration of seeds. AU2 in the G20-I20 series also had the greatest number of leaf, megaspore and sclerotia remains. The greatest leaf, megaspore and sclerotia totals from the H18 series were in AU5. Minimal amounts of seeds were recovered from AU4-AU7 in both series. Seeds, sclerotia and megaspores increased towards the upper level (AU8) of the G20-I20 series. AU6, present only in the H18 series, had minimal amounts of all macrofloral remains. The AU3 (Whale Bone) level, found only in the G20-I20 series, had high amounts of seeds leaves and sclerotia.

The basic trends for both sample series are seed concentrations in AU2 & AU3, a paucity of seeds in AU4-AU7 and a concentration of leaves in AU2-AU6. Seeds increase in the upper levels of the G20-I20 series but not in the H18 series. The sclerotia and megaspores form no trends within the H18 series but decline drastically in AU4 & AU5 levels of the G20-I20 series. These results supply the fundamental basis for the following interpretation of the macrofloral remains from the Svalbard midden.

CHAPTER VI

Interpretation and Discussion

Differential preservation of macrofloral remains, culturally determined plant utilization patterns and taphonomic processes create biases within midden macrofloral remains making clear-cut interpretations of the botanical data problematic. The effect of macrofloral biases on interpretations can be lessened, however, through the use of analogy in the interpretation process (Pearsall 1989). Following on this, interpretation of the Svalbard macrofloral remains was based on; 1) plant compositions of present-day land-use areas in Northeastern Iceland (Table 1), 2) historical plant utilization patterns taken from the Sagas (Norse subsistence practices; Figures 3 & 4), and 3) previous Norse archaeological investigations (Norse midden formation processes; Figure 5). In this way, it is hoped that the archaeobotanical data of the Svalbard midden can be a useful source of information in the reconstruction of Norse land-use practices and the interpretation of any changes due to climatic and/or anthropogenic influences. Multiple hypotheses were generated from the Svalbard botanical material in order to explain the numerous factors which could have modified the Norse culture and NE Iceland environment during the last millenium.

Climatic Changes in NE Iceland

The Little Climatic Optimum and the Little Ice Age represent climatic changes, warming and cooling, respectively, which occurred during the thousand year history of the Svalbard farm. Analysis of the effects that these climatic changes had on the Norse farmers and NE Iceland environment was one of the potential goals of the archaeobotanical analysis of the Svalbard midden remains. However, these climatic changes were not clearly evident in the plant taxa recovered from the midden remains due to the absence of plants that could be used as climatic indicators (Birks 1981). Instead, the midden botanical remains represent plants with broad habitat and climatic niches.

Macrofloral remains are concentrated in AU2-AU4 (1050-1250 AD) and drastically decrease in AU6-AU8 (1400-1800 AD). These quantitative variations could possibly indicate fluctuating plant productivity due to the influence of climatic changes. The AU2-AU4 period correlates to the L.C.O., a warmer and presumably more productive period, while AU6-AU8 corresponds to the L.I.A., a cooler less-productive era (Fridriksson 1986; Ogilvie 1981). Caution must be taken, though, when using only quantitative data to identify climatic changes from culturally-influenced midden deposits since the abundance of macrofloral remains can also be influenced by the biases mentioned previously. Consequently, the complex depositional history of the Svalbard midden may contain too many cultural influences for the clear interpretation of a climatic signal.

Human Impacts on the Landscape

Documenting the Norse influences on the Northeastern Icelandic environment was yet another goal of the archaeobotanical analysis of the Svalbard midden. In order to thoroughly analyze the relationship between the Norse and the NE Icelandic environment, a sample sequence from a non-cultural setting that spans the pre-settlement and settlement time period is required for comparison. Environmental changes that were the result of Norse subsistence practices can still be interpreted from the Svalbard midden botanical data, although it is a culturally-influenced deposit representing the settlement time period.

The presence of anthropophilous plants and Selaginella selaginoides in the Svalbard midden remains are two possible indicators of human impact in NE Iceland. Anthropophilous plants [apophytes], (e.g. Rumex spp., Stellaria spp., and Cerastium spp.) represent taxa that often result from human disturbance activites such as agricultural practices, trampling and midden formation (Einarsson 1963). These taxa are relatively abundant throughout the midden deposits

(1050-1800 AD.) possibly as a result of Norse subsistence practices.

The megaspores from *Selaginella selaginoides* are highly resistant to decomposition and were found in substantial quantities from both sample series. This plant species thrives in the wet, peatland environments of Icelandic mires where it is often associated with **Cyperaceae** and *Hippurus vulgaris* (Peteet 1986; Steindorsson 1951; Warner 1984). During the Settlement of Iceland, *S. selaginoides* quantities increased due to the openness of the landscape due to the clearance of birch forests by humans (Einarsson 1963; Hallsdottir 1987). The substantial quantities of megaspores recovered from the Svalbard midden are therefore probably indicative of the human effects (woodland clearing) on the NE Icelandic environment during and following human settlement of the area.

The reduction of grassland species, **Poaceae** and **Cyperaceae** followed by increased amounts of heathland species, *Calluna vulgaris* and *Empetrum nigrum/E. Eamesii* found in the macrofloral diagrams (Figures 10 & 11) probably represent significant environmental changes. These changes are interpreted as the result of Norse subsistence activities where grasslands appeared to be replaced by heathlands in the Thistilfjordur district from 1150-1400 AD. Following the removal of the birch woodlands, grasses would have been the first colonizers of the open ground and are well represented from 1050-1150 AD. However, heathlands would become the dominant vegetation as other factors altered these grasslands. Factors such as; overgrazing by livestock, decreased fertility of soil, higher water tables, and loss of insolation from tree cover creating **thufur** would facilitate the inception of heathlands. This transition from woodland-grassland-heathland also occurred in Norway due to the impact of agriculture (Kaland 1986). To entirely understand the environmental processes involved in this transition from grassland-heathland, though, further paleoecological analysis is required.

Norse Subsistence Practices

Reconstruction of subsistence patterns at the community level of full-fledged agricultural societies are subject to the three biases previously discussed (Begler & Keatinge 1979). Taxa recovered from the midden can, however, supply information about household refuse, **byre** waste material and/or natural vegetation (Buckland _et al_ in press; McGovern _et al_ 1983; Sadler n.d.; Sveinbjarnardottir _et al_ 1980) (Figure 5). Some plant taxa are common throughout all of these divisions (household, byre and natural vegetation), especially those that are associated with both Norse household and agricultural practices (e.g. peat and animal dung).

Most likely, twenty-five of the taxa recovered from the midden represent both household and **byre** refuse. Usher's (1974) A Dictionary of Plants used by Man, Dimbleby's (1978) Plants and Archaeology and previous Norse midden floral analysis (McGovern et al 1983; Sadler n.d.; Sveinbjarnardottir et al 1980) provide the background information for compiling a list of these taxa and their possible uses by the Norse (Table III).

Human Uses of Plants from 1050-1150 AD

The majority of seed taxa were found in the AU2 & AU3 levels, deposited in a relatively short time period (1050-1150 AD). Plants were present from all four land-use areas (**tun**, **engi**, **hagi** and **apophytes**), especially from the **apophytic** (e.g. Cerastium spp., Stellaria spp.) and **hagi** categories (e.g. Calluna vulgaris, Empetrum nigrum/E. Eamesii). The following is a list of the plant taxa from AU2 & AU3 and their common uses in Norse agricultural practices.

Carex spp. [sedges], Juncus spp. and Luzula spp. were the main source of fodder from **engi** mowing and were also used as floor covering (Buckland et al 1983; Hallsdottir 1987; Jon Hauker Ingimundarson U. of Arizona, pers. comm. 1987; Sadler n.d.). Poa spp. [grasses] were the most common plant species collected as fodder from the **tun** (Buckland et al i.p.). Winter fodder for horses consisted of large quantities of Equisetum spp. (Jon Hauker Ingimundarson U of

Species	Plant Use	Reference
Atriplex cf. longpipes	Fodder	Usher 1974
Calluna vulgaris	Medicinal flowers & leaves; Beer flavour	Usher 1974
Carex spp. [Sedges]	Fodder & Floor cover	Buckland *et al* 1983
Chenopodium cf. album	Edible seed (gruel)	Dimbleby 1978
Empetrum nigrum/ E. Esmesii [Crowberry]	Edible berries for humans and animals	McGovern *et al* 1983 Buckland *et al* in press
Eriophorum spp. [Cottongrass]	Cotton-like perianth used as wicks	Dimbleby 1978
Equisetum spp.	Medicine and Fodder	Usher 1974
Geranium	Blue dye from flowers	Usher 1974
Hippurus vulgaris	Edible young leaves	Usher 1974
Juncus spp.	Stems as Floor Cover	Sadler n.d.
Luzula spp.	Stems as Floor Cover	Sadler n.d.
Menyanthes cf. trifolium [Bogbean]	Edible seed (gruel)	Sveinbjarnardottir *et al* 1980
Montia fontana [Blinks]	Edible leaves	Usher 1974
Poa spp.	Fodder & Floor cover	Sadler n.d.
Polygonum cf. aviculare [Knotweed]	Edible roots & seeds, Medicinal uses	McGovern *et al* 1983
Ranunculus spp.	Fodder	Greig 1984
Rumex spp. (*Acetosa* spp.) [Sorrel]	Edible leaves and red dye from roots	Sveinbjarnardottir *et al* 1980; Usher 1974
Stellaria cf. media (*Alsine* cf. *media*) [Chickweed]	Edible leaves and Fodder/hay	Sveinbjarnardottir *et al* 1980
Thalictrum spp.	Milk production stimulated by plant	Usher 1974
Thymus spp.	Flavouring herb	Usher 1974
Trifolium spp.	Fodder and Medicine	Dimbleby 1978
Vaccinium spp. [Bilberry]	Edible berries and blue dye	Sadler n.d. Dimbleby 1978
Vicia spp.	Edible seeds & Fodder	Usher 1974

Table III. Norse Plant Utilization Patterns

Arizona pers. comm. 1987; Usher 1974). Empetrum nigrum/E. eamesii [crowberry] have edible berries used for human consumption or as a source of wine. However, ptarmigin also consumed these berries and their pallets could be a source of seeds in the midden (Buckland et al in press; McGovern et al 1983; Sveinbjarnardottir 1980). Vaccinium [bilberry] provided a second source of edible berries from the natural vegetation, besides which, they could be used as blue dye (Dimbleby 1978; Sadler n.d.; Usher 1974).

Some of the weedy species (apophytes) recovered from AU2 and AU3 commonly grow on Norse middens and also have edible seeds and/or leaves. Montia fontana [blinks] has edible leaves and is a common weed that thrives in wet, manured areas (Fredskild 1988; Usher 1974). Edible leaves could also have been taken from two common apophytic plants; Rumex acetosa (Acetosa pratensis in Love(1983)) [sorrel] and Stellaria media (Alsine media in Love(1983)) [chickweed] (McGovern et al 1983; Sadler n.d.; Sveinbjarnardottir et al 1980; Vorren 1986). Lastly, the roots of S. media could have been used for a red dye (Dimbleby 1978). Must of these weedy species were also probably found in livestock fodder (e.g. S. media & R. acetosa).

Due to the scarcity of fuel in Iceland, animal dung was an important fuel source. The burning of dung is probably one source of the charred seeds from the midden (Bottema 1984). Dung collected from the byre would have seeds that represent fodder plants (e.g. Poa type, Fabaceae undiff., Carex spp., and Equisetum spp.). Heathland (**hagi**) dung would have seeds and leaves from Empetrum nigrum/E. eamesii, Thymus cf., Thalictrum spp. and Luzula spp.

Peat was considered an important resource to the Norse. It was used for fuel, bedding and construction purposes (Davidson et al 1986; McGovern et al 1983; Sadler n.d.; Sveinbjarnardottir et al 1980). The charred macrofloral remains from the Svalbard midden may have also been derived from the use of peat as fuel. According to Davidson (1986) peat cut and dried for fuel consists primarily of **Ericaceae** (Calluna spp.), **Cyperaceae** and **Poaceae**, all of which are present in AU2 and AU3. Peat used as bedding in the **byre** would become blended with animal dung. The use of this material as a fuel source would combine taxa found in both animal dung and peat.

Quantitative archaeobotanical data aids in the interpretation of the Svalbard macrofloral remains to a limited degree, even though there are many unknown variables affecting accumulation and distribution of midden remains (Belger & Keatinge 1979). Seed numbers were concentrated in AU2 & AU3 (1050-1150 AD). Luzula spp., Poa spp. and Carex spp. had the greatest number of seeds per taxa in the H18 series, representing plants utilized for fodder or as floor covering (Sadler n.d.). In the G20-I20 series, the greatest number of seeds per taxa were Carex spp., Stellaria cf. graminea, Luzula spp. and Alsine cf. media. Alsine & Stellaria are weedy species that grow naturally on the midden while the others are either from fodder or floor cover refuse (McGovern et al 1983).

Leaves recovered from the midden are concentrated throughout AU2-AU5 (1050-1400 AD) representing plants that are common in the heathlands. Empetrum nigrum/E. Eamesii and Calluna vulgaris leaves were the most abundant, while Vaccinium and Thymus leaves were found in smaller quantities. The presence of these leaves probably represent the use of these plants by livestock for grazing or by humans as flavouring herbs, edible berries or peat for fuel and bedding (Hallsdottir 1987; Usher 1974).

Human Uses of Plants for 1150-1800 AD

From AU4 to AU7 (1150-1717 AD), the abundance of seed taxa and numbers found in the macrofloral remains decreases. Seeds from plants in all land-use areas (e.g. Carex spp., Rumex spp. and Empetrum nigrum/E. Eamesii) are once again present, although in much reduced numbers. Of those present, many have common uses in the Norse subsistence practices.

Eriophorum [cottongrass] are wetland species that have cotton-like perianths that were used as wicks in oil lamps (Dimbleby 1978). Menyanthes trifolium [bogbean] has seeds that could have been cooked in a type of gruel. Gruel or a form of bread could have been made from the seeds and dried roots of Polygonum aviculare [knotweed] (McGovern et al 1983; Sadler n.d.; Sveinbjarnardottir et al 1980). In the

AU8 level (1717-1800 AD), more taxa and seed quantities were present than in the AU4-AU7 section with increases in **apophytes** representing plants that commonly grow on midden surfaces (ie. Stellaria spp., Rumex spp.).

In summary, the majority of information on Norse subsistence practices at Svalbard is from the early phase (1050-1150 AD) due to the concentration of seeds, leaves and taxa in AU2 and AU3. The most prevelant subsistence practices are; 1) burning of dung (from fodder and heathland sources) and peat for fuel, 2) human consumption of berries and herbs, and 3) reeds used for floor coverings.

Seeds decline in number and type over the AU4-AU7 interval (1150-1717 AD). This decrease may represent possible changes in Norse subsistence practices. There are two possibilities; 1) a decline in the amount of botanical refuse from subsistence activities and/or 2) the use of refuse material removed directly from the house/**byre** to be used as field fertilizer (manuring), a common agricultural practice, even today (Fenton 1981). Decreasing amounts of botanical refuse could possibly indicate fewer individuals (humans and livestock) residing at Svalbard, while field fertilization activities would probably increase productivity of the **tun**, which may have been necessary due to the lower plant productivity of L.I.A.

Reconstruction of Norse subsistence practices was one of the aims of this research project. A variety of Norse plant uses for 1050-1150 AD were able to be reconstructed (i.e. burning of dung and peat for fuel, human consumption of berries and the remnants of sedges used as floor covering). Furthermore, possible changes in Norse subsistence practices are indicated by the reduction of the botanical midden refuse from approximately 1150-1717 AD. This may have been due to fewer residents at the Svalbard farm or use of botanical refuse for field fertilizer or perhaps, environmental changes.

The Svalbard midden taxa correlate with taxa found in other Norse middens of the North Atlantic region. At Holt and Storaborg sites in southern Iceland, there are approximately twenty taxa in common with the Svalbard midden remains, including *Poa* spp., *Luzula* spp., *Carex* spp. and *Empetrum* spp. (Buckland *et al* in press; Sveinbjarnardottir *et al* 1980). From three Greenlandic Norse middens (Sandnes, Niaqussat and Nipaitsoq) there are approximately seventeen taxa in common with those from Svalbard (McGovern *et al* 1983; Sadler n.d.). Taxa similarities found in all of these Norse middens implies that the Norse were probably utilizing plants for comparible agricultural practices throughout the North Atlantic region or the North Atlantic ecology is relatively uniform at the genus level.

Midden Formation Processes

Information concerning the site formation processes operating at the Svalbard midden was yet another aim of archaeobotanical analysis of this site. The midden represents a cultural pattern whereby household and/or **byre** material that was placed in a specialized location as secondary refuse. This material has accumulated over time forming successive layers with no evidence of disturbance processes (e.g. burrowing animals). Taphonomic processes, such as the removal of material by downslope movement and freeze-thaw cycles are both evident in the stratigraphy of the midden. Preservation of prehistoric seeds was limited to charred seeds; decay processes are evidneced by the abundance of fungal sclerotia.

Decomposers are ubiquitous in most environments and the moist, acidic environment of the Svalbard midden represents a perfect location for an abundance of fungi (Schiffer 1987; Warner <u>et al</u> 1984). Fungal sclerotia, which are highly resistant to destruction even by fire, were recovered in substantial quantities from all levels of the Svalbard midden samples. Although not positively identified, they probably represent the Ascomycetes and Basidiomycetes fungal groups common as coprophilous [coprolite/dung] fungi (Richardson & Watling 1968). Their presence indicates that dung must have been deposited on the midden, either before or after burning the dung as fuel.

Remnants of freeze/thaw cycles (cryoturbation) are found in AU7 and AU8 of the Main unit. The non-linear, wavy stratigraphy apparent on the southern wall are probably remnants of frost mounds (i.e. hummocks or **thufur**) often associated with freeze-thaw activity. These features correlate in time with the L.I.A. perhaps indicating cooler temperatures.

CHAPTER VII

Conclusions

Utilizing information from historical sources (the Sagas) and previous Norse midden analyses, a number of interpretations can be derived from the Svalbard midden remains which relate to Norse agricultural practices, various midden formation processes and human influenced environmental changes. Possible effects on the NE Icelandic environment caused by climatic changes (L.C.O. & L.I.A) are not clearly evident.

The majority of archaeobotanical information represents the 1050-1150 AD time period. Reconstruction of Norse subsistence activities (e.g. dung and peat used for fuel; berries used for food) were based on the presence of specific plant taxa. Possible modifications to the Norse subsistence practices were evident in the limited quantity of seeds recovered from 1150-1717 AD (and leaves from 1400-1717 AD). This pattern could possibly indicate declining refuse production from fewer Svalbard residents and/or use of manure as a field fertilizer to enhance production.

Even though interpretation of the Norse subsistence practices from the Svalbard midden botanical remains was completed, problems were still apparent. Unfortunately as only charred seeds were recovered, any interpretation is limited to those taxa used as fuel or prepared over fire. The lack of a reference collection of both charred and uncharred seeds made the identification process fairly difficult. Lastly, interpretation of archaeological middens would be greatly aided if site formation processes operative on a present- day Icelandic farm midden were to be investigated. Botanical analysis of such a midden on an 'unmodernized' farm (i.e. no chemical fertilizer) would allow for monitoring the refuse input and decay output which then could be utilized for analogous purposes.

In addition to the reconstruction of Norse subsistence practices, environmental changes of the Thistilfjordur district (i.e. the transition from grassland to heathland) are apparent in the archaeobotanical data. This conclusion is based on the lack of grassland species and concentration of heathland species following 1150 AD. In order to fully understand the relationship between Norse activities, environmental processes and this vegetation change, paleoecological analysis of the Thistilfjordur district is necessary.

Reliable climatic reconstructions for the L.C.O. and L.I.A. and further analysis of anthropogenic impacts of the Thistilfjordur landscape require comprehensive paleoecolgical research of the Northeastern Iceland environment. Such a study should assemble environmental information from sources of proxy data (e.g. peat bogs, lakes, drainage ditches) free of any cultural biases and include analysis of palynological, hydrological and pedological data.

Palynological data should provide information on local vegetation prior to and including human settlement times. The presence of climatic indicator species and changes in influx rates associated with biological productivity could be interpreted as a climatic signal. Hydrological and pedological analysis should document natural processes influenced by human activities. Alterations to the inorganic sediment load in peat bogs and lakes along with increases in the mineral content of soils in low-lying areas are probable indicators of amplified soil erosion influenced by the over-grazing of Norse livestock.

In order to reconstruct the past vegetation of NE Iceland, a section of botanical samples (both pollen and macrofloral) were collected from a the walls of a drainage ditch approximately one km from the Svalbard midden deposit. These deposits seem to extend into the pre-settlement period and time-line correlations can be established between the Svalbard midden and ditch deposits through the use of the volcanic tephras apparent in the ditch stratigraphy. Future analysis of these samples will supply the initial environmental data for the interpretation of the interactions between the Norse culture and the NE Icelandic environment. Additional environmental data, such as inorganic sediment content, collected from other sources (e.g. peat bogs) would facilitate the interpretation of human impacts on the Thistilfjordur environment.

The combination of data from both the cultural deposits of the Svalbard midden and the environmental deposits from the drainage ditch would supply information for reconstruction of the hypothetical Norse culture-Northeastern Iceland Environmental Model (Figure 2). The inter-relationships that existed between Norse and their environment and climatic changes will then be elucidated. Then, this model can be used to represent a historical example of humans as part of global change.

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APPENDIX 1.

Raw Macrofossil Counts Presented as Macrofossils / Liter Organized according to Stratigraphic Levels

			Fresh		Fresh							
		vulgaris	vulgaris	/E. eamesii	/E. eamesii	type		**Total**	**Wood**	**Picea/Abies**		ssp.
Macrofossils	**Leaves**	Calluna	Calluna	Empetrum nigrum	Empetrum nigrum	Thymus	Unknown	**Leaves**	**Charcoal**	*Gymnospermae*	**Stems**	**Equisetum**
H 18									+=Present			
SU 1				1				1				
SU 2								0				1
SU 3				3				3				
SU 4				2				2		+		
SU 5								0		+		
SU 7				1				1				1
SU 9				2			1	3		+		
SU 10				3				3		+		1
SU 11		11		11	1	1		24				
SU 12		15	11	40	7			73		+		
SU 13 &14		15		26			2	43		+		
SU 16		13	1	23		1		38				
SU17 & 18		12	17	31	18			78		+		2
SU 19-21		7		11				18		+		2
SU 22-25		23		13	2			38		+		1
SU 27		7		17				24		+		

VOLCANIC									Fresh	
			selaginoides	sclerotia		pratensis	cf. media	paludosum	cf. maritima	
TEPHRA	**H18**	**DEPTHS**	Selaginella	Fungal	**Seeds**	Acetosa	Alsine	Aracium	Armeria	Baethyron
	SU 1	0-15 cm	59	87			1			
	SU 2	15-20 cm	47	55						
	SU 3	20-25 cm	41	49						
	SU 4	25-30 cm	53	69						
V atna 1717	SU 5	30-35 cm	44	84						
	SU 7	35-40 cm	19	105						
Hekla 1636	SU 9	40-45 cm	36	40						
	SU 10	45-52 cm	52	63						
	SU 11	53-59 cm	9	59			1			1
	SU 12	60-65 cm	77	121					2	
	SU 13-14	65-75 cm	52	79						
	SU 16	75-85 cm	38	104						
	SU 17-18	85-95 cm	20	84						2
	SU 19-21	95-105 cm	30	112				2		
	SU 22-25	105-110 cm	40	100			5			
	SU 27	110-120 cm	31	93		4	5			
Hekla 3000 BP										

	vivipara	type	cf. atrata	cf. diandra	cf. diocia	cf. nigra	type	undiff.	cf. fontanum	undiff.
H 1 8	Bistorta	**Campanulaceae**	Carex	Carex	Carex	Carex	Carex	**Caryophyllaceae**	Cerastium	Cerastium
SU 1							1		1	
SU 2						1	2			
SU 3						1	1			
SU 4							1			
SU 5							1			
SU 7								1		
SU 9			1							
SU 10							1	1	2	
SU 11							4			
SU 12		1		1		1	5		1	1
SU13-14							1			
SU 16							1			1
SU 17-18									1	2
SU 19-21					1		2			
SU 22-25							3		3	3
SU 27	1				1		14		3	4

	Fresh				Fresh			
	cf. latifolium	album		/E. Eamesii	/E. Eamesii	type	type	type
H 1 8	Chamerion	Chenopodium	Eleocharis	Empetrum nigrum	Empetrum nigrum	Epilobium	**Ericaceae**	Eriophorum
SU 1								
SU 2							1	
SU 3								
SU 4								
SU 5					1			
SU 7								
SU 9								
SU 10					1			
SU 11						4		
SU 12					1	4		
SU 13-14								
SU 16								
SU 17-18								
SU 19-21	1							
SU 22-25					6			2
SU 27		2						3

	cf. Trifolium	cf. Vicia	undiff.	cf. boreale	cf. trifidum	cf.	vulgaris	type	cf.	type	cf.
H18	**Fabaceae**	**Fabaceae**	**Fabaceae**	Galium	Galium	Geranium	**Hippuris**	**Juncus**	**Kobresia**	**Luzula**	**Menyanthes**
SU 1						2					
SU 2			1		1						
SU 3			1								
SU 4											
SU 5					1						
SU 7	1										
SU 9	1										
SU 10		1								2	2
SU 11		1									
SU 12						1					
SU13-14											
SU 16										1	
SU 17-18										2	
SU 19-21							3		1	1	
SU 22-25			1	1			2	7		15	
SU 27							2	5		20	

							Fresh		Fresh		
	fontana	lancelota	type	undiff.	type	type	acris	type	type	type	type
H 1 8	Montia	Plantago	Poa	**Poaceae**	Polygonum	Potamogeton	Ranunculus	Ranunculus	Ranunculus	**Rubiaceae**	Rumex
SU 1						1				1	
SU 2	1										
SU 3	1							1	2		
SU 4											
SU 5											
SU 7											
SU 9					1						
SU 10							1				
SU 11											
SU 12		2									
SU 13-14											1
SU 16									1		1
SU 17-18	1										1
SU 19-21				6							
SU 22-25			20	5							3
SU 27	1		19	20	2						

							Fresh		Fresh		
	cf. graminea	undiff.	type	cf.						Seed	Number
H18	Stellaria	Stellaria	Thalictrum	Thymus	Vaccinium	Viola	Viola	Unknown	Unknown	Total	of Taxa
SU 1		2		1						10	10
SU 2								1		8	6
SU 3								1		8	6
SU 4					1					2	2
SU 5										3	3
SU 7										2	2
SU 9								1		4	4
SU 10							2		2	15	9
SU 11										11	6
SU 12									2	22	11
SU 13-14							2	2		6	6
SU 16						1				6	7
SU 17-18		1								10	8
SU 19-21	1			1			3			22	11
SU 22-25			2					1		79	15
SU 27		2	2							110	20

				Fresh		Fresh								
			vulgaris	vulgaris	/E. Eamesii	/E. Eamesii	type		Total	Wood		Picea/Abies		ssp.
	Macrofossils	Leaves	Calluna	Calluna	Empetrum nigrum	Empetrum nigrum	Vaccinium	Unknown	Leaves	Charcoal	*Angiospermas*	*Gymnosperma*	Stems	Equisetum
G20	10-15 cm									+=Present				1
	15-20 cm				1				1					1
	20-25 cm							1	1					
	25-30 cm				4				4					2
	35-40 cm				4				4					
I20	40-45 cm		3		14				17			+		2
	45-50 cm		5		22		5	2	34			+		2
	50-55 cm		3		30			3	36					2
	55-60 cm		4		11	1	2	1	19			+		1
	60-65 cm				4				4			+		
	65-70 cm							1	1			+		
	70-75 cm		3	11	15		2		31			+		
	Whale Bone		6		35			2	43		+	+		
	75-80 cm		8		19			1	28			+		
	80-Sterile		4		27		2		33			+		3
	Sterile Soil													

VOLCANIC			selaginoides	sclerotia		cf. media	cf. longpipes		vivipara	cf. canescens
TEPHRA			Selaginella	Fungal	Seeds	Alsine	Atriplex	Baethyron	Bistorta	Carex
	G20	10-15 cm	37	38		1				1
		15-20 cm	38	34		3			1	
		20-25 cm	61	55		1				
Vatna 1717		25-30 cm	34	158		1				
		35-40 cm	9	89						
Hekla 1636	I20	40-45 cm	23	138					1	
		45-50 cm	8	67		2				
		50-55 cm	14	58				1	1	
		55-60 cm	9	85					1	
		60-65 cm	12	68		1				
		65-70 cm	3	53		1				
		70-75 cm	6	62						
		Whale Bone	32	180						
		75-80 cm	15	109		6	1			
		80-Sterile	44	155		10	1	2		
Hekla 3000 BP		Sterile Soil		90						

	cf. echinata	cf. holostoma	cf. Lyngbyei	cf. nigra	cf. norvegica	cf. rostrata	cf. saxatillis	type	cf. fontanum	undiff.
	Carex	Carex	Carex	Carex	Carex	Carex	Carex	Carex	Cerastium	Cerastium
G20 10-15cm	1			5		1		1		1
15-20 cm				1				1	1	2
20-25 cm								1		
25-30 cm								1		
35-40 cm			1					2		
I20 40-45cm							1	1		
45-50 cm				1						1
50-55 cm		2			1			2		1
55-60 cm								1		
60-65 cm								1		
65-70 cm				1				1		1
70-75 cm		1		2				1		
Whale Bone			1					1		3
75-80 cm				2				3		1
80-Sterile				1				12		2
Sterile										

					Fresh			
	cf. latifolium	type		/E. Eamesii	/E. Eamesii	type	cf. Trifolium	undiff.
	Chamerion	**Cornaceae**	Eleocharis	Empetrum nigrum	Empetrum nigrum	Epilobium	**Fabaceae**	**Fabaceae**
G20 10-15cm				3				
15-20cm	1			1				
20-25cm				1				
25-30cm				1				
35-40cm								
I20 40-45cm								
45-50cm				1		1		
50-55cm				1				
55-60cm							3	
60-65cm							1	
65-70cm			1	10		1		2
70-75cm		1		6				
Whale Bone				7	1			
75-80 cm			1			1		9
80-Sterile			8	4		1		
Sterile								

												Fresh
	type	vulgaris	type	cf.	type	type	fontana	type	undiff.	type	type	acris
	Gentianella	Hippuris	Juncus	Kobresia	Luzula	Myosotis	Montia	Poa	Poaceae	Polygonum	Potamogeton	Ranunculus
G20 10-15cm		1						1				
15-20cm								1				1
20-25cm	1					1				1		
25-30cm		1										
35-40cm											1	
I20 40-45cm					2			2		1		
45-50cm			1		2							
50-55cm												
55-60cm												
60-65cm												
65-70cm					1							
70-75cm				1	2		2					
Whale Bone					1		1					
75-80cm					11		5		9			
80-Sterile			1		3		4		8			
Sterile							1					

			Fresh									
	type	type	type	cf. graminea	undiff.	type	cf.				Seed	Number
	Ranunculus	Rumex	Rumex	Stellaria	Stellaria	Thalictrum	Thymus	Vaccinium	Viola	Unknown	Total	of Taxa
G20 10-15cm							1			3	20	11
15-20cm			1	1			1		1	1	18	14
20-25cm					1					1	8	7
25-30cm	1									1	6	5
35-40cm											4	3
I20 40-45cm									1		9	8
45-50cm					1						10	8
50-55cm		1				1	1	1		1	14	11
55-60cm							1			1	7	5
60-65cm										1	4	3
65-70cm					1			2		1	23	11
70-75cm		1									17	9
Whale Bone				2	2	1					20	9
75-80cm				12	2				1		63	13
80-Sterile	2	1		5	4		1			1	70	18
Sterile											1	1

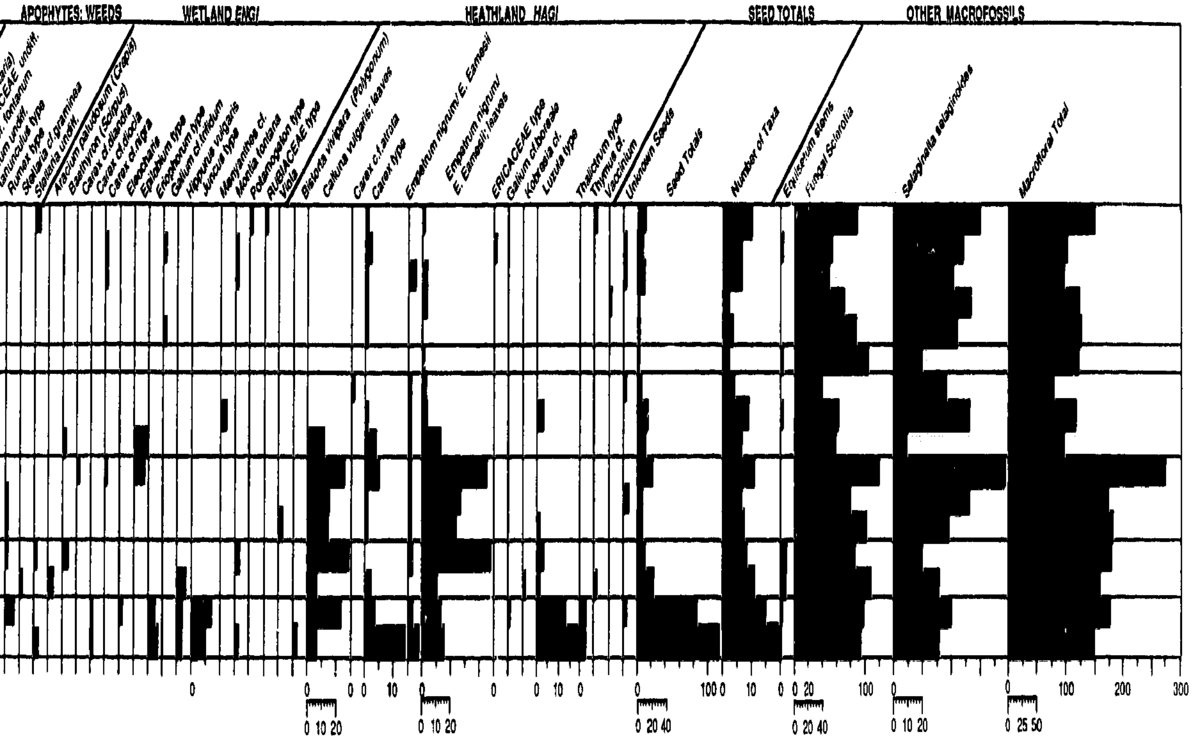

Figure 10. H18 Macrofloral Diagram

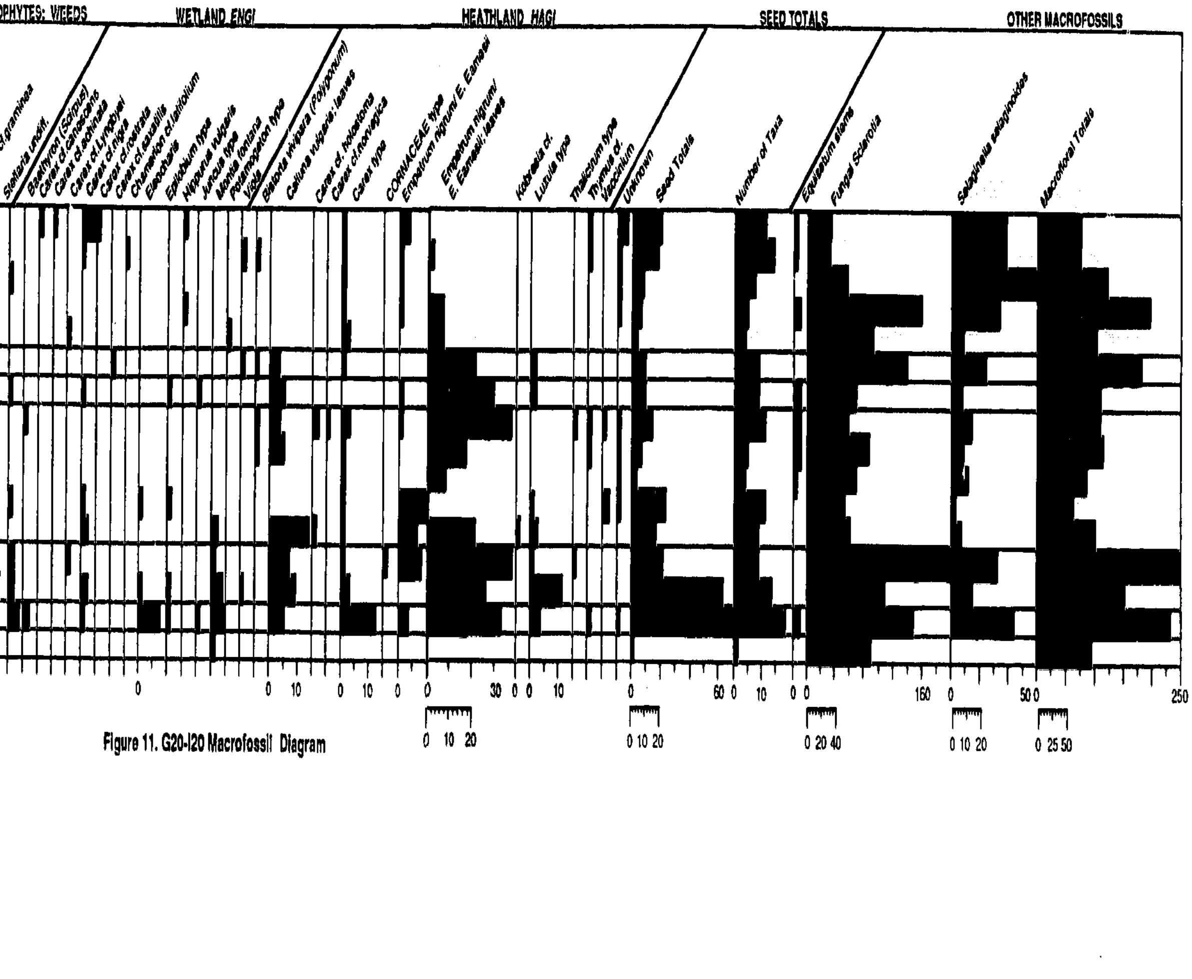

Figure 11. G20-I20 Macrofossil Diagram