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POTS AND POPULATIONS: ALTERNATE ANALYTICAL TECHNIQUES FOR USING CERAMICS AS INDICATORS OF SOCIAL UNITS

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MARGARET GAIL HANNA

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Pots and Populations: Alternate Analytical Techniques for using Ceramics as Indicators of Social Units", submitted by Margaret G. Hanna, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

David H. Kelley
Supervisor, Dr. D.H. Kelley
Department of Archaeology

Jane H. Kelley
Dr. J.H. Kelley
Department of Archaeology

Dr. P. Schledermann
AINA/Department of Archaeology

J. Edward Boyd
Dr. J.E. Boyd
Department of Psychology

E. Leigh Syms
External Examiner
Dr. E.L. Syms
Manitoba Museum of Man and Nature, Winnipeg

27 April 1982

ABSTRACT

A tentative explanation for the distribution of Duck Bay Ware, which predominates only at FbMb-1 in west-central Manitoba, is proposed. Six alternate analogue models are developed. Four deal with variations in social organization (settlement, marriage, and post-marital residence pattterns), one with trade, and one with function.

X-ray fluorescence and thin-section analyses were used to determine chemical and mineralogical composition of Duck Bay Ware and other wares occurring at FbMb-1 and other sites in Saskatchewan and Manitoba. The pottery at FbMb-1 (regardless of type) was unique in having a high P_2O_5 and a low feldspar content compared to all wares found at other sites. The high P_2O_5 content was interpreted as the use of crushed bone as a tempering agent in combination with plagioclase feldspar.

Two analogue models (endogamous non-sedentary and endogamous semi-sedentary) accounted more fully for the distribution of archaeological data and analysis results. Trade and function were eliminated as possible explanations. However, there is an apparent variation in feldspar content within the FbMb-1 ceramic assemblage which may be related to a functional aspect. Finally, the analysis indicates that paste characteristics, in this instance at least, vary geographically and not typologically as previously assumed.

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CHAPTER 1

INTRODUCTION

Recognition and Description of Duck Bay Ware:

Until 1975, the ceramic wares characteristic of the Late Woodland Period of the boreal forest and parkland of northwestern Ontario, Manitoba, and Saskatchewan included Winnipeg Fabric Impressed Ware (with three types) of the Selkirk Phase (present in northwestern Ontario and southeastern Manitoba), Clearwater Lake Punctate Ware of the Selkirk-related Clearwater Lake Phase (present in northern Manitoba and Saskatchewan), and Blackduck Ware (with many types) of the Blackduck Complex (present to greater or lesser degrees in all three provinces). In 1975, another ceramic ware, now called Duck Bay Ware, was isolated and identified in west-central Manitoba. This was not, however, the first time that ceramics of this ware had been recovered; they had merely not been recognized as distinct from either Blackduck or Selkirk ceramics.

The stylistic attributes of what is now called Duck Bay Ware were previously used by MacNeish to define the Sturgeon Punctate type of Winnipeg Fabric Impressed (Selkirk) Ware (1958: 170). MacNeish's description of

Sturgeon Punctate appears to have been based on a rather mixed bag of sherds. Decoration consisted of one of four kinds of punctates (ovoid, crescentic, rectangular, and round, in that order of frequency) appearing in one, two, or three rows around the rim. Ceramics with more than one row of punctates predominated in this type; ceramics with a single row of punctates he classed as aberrant. MacNeish further noted that Sturgeon Punctate was rare in southeastern Manitoba but dominant in northern Manitoba and Saskatchewan.

As archaeological investigations proceeded in southeastern Manitoba and northern Manitoba during the 1960s and 1970s, it became apparent that the Sturgeon Punctate type was in need of reassessment. Hlady's (1971) analysis of ceramics from The Pas region indicated that, contrary to MacNeish's original statement, vessels with more than one row of punctates were rare in northern Manitoba (see also Meyer 1978; Hanna 1975). The supposedly 'aberrant' single-row punctated ceramics were, in fact, the major ceramic type in northern Manitoba, and these Hlady renamed Clearwater Lake Punctate. The Clearwater Lake Phase, of which the ceramics were the most diagnostic artifact class, was identified as a northern variant of Selkirk Phase.

Sturgeon Punctate ceramics, therefore, encompassed ceramics with two or more rows of punctates. Infrequently, sherds of this type were found not only in southeastern Manitoba but also in Saskatchewan (Meyer and Smailes 1975), west-central Manitoba (Gibson 1975; Mayer-Oakes 1970), and northern Minnesota (Lugenbeal 1976), where they constituted a very small proportion of the ceramic assemblage (usually less than 5%). Consequently, these sherds were classed as Sturgeon Punctate or, if found in association with Blackduck ceramics, as aberrant Blackduck.

These multi-row punctated sherds were recognized as a separate ceramic ware as a result of salvage work and excavations at the site of Aschkibokahn, FbMb-1, where portions of 299 multi-row punctated vessels (73% of the total ceramic sample of 410 vessels) were recovered. FbMb-1 is presently the only known site where Duck Bay Ware predominates. Furthermore, Duck Bay Ware is stylistically distinct from both Selkirk and Blackduck wares and can in no way be considered an aberrant form of either. Analysis of the ceramics by Syms (1976, personal communication), Snortland-Coles (1979), and Badertscher (1980) indicated that, in spite of decorative variability, they had an overall stylistic coherency which separated them from both Selkirk and Blackduck wares.

The presence of so many vessels at FbMb-1 permitted adequate assessment of sample variability. Vessel shape appears to be limited to jars; no bowls, cups, or plates were apparent. Differences in projected rim diameters indicate some variation in vessel size, but this variation, though it cannot be adequately measured, appears to be limited. Decorative variability was used to segregate three types--Duck Bay Punctate, Duck Bay Notched Lip, and Duck Bay Undecorated (Syms 1976, personal communication). Snortland-Coles (1979: 28) collapsed the latter two types into one called Duck Bay Decorated Lip. However, since the sherds contained within Duck Bay Undecorated have no decorative elements on the lip or elsewhere, I have decided to retain Syms' original typology.

The ceramics known collectively as Duck Bay Ware are described as follows:

> These vessels display rims that are straight to slightly S-shaped descending to a sharply angled neck. Shoulders of these vessels tend to be also sharply angled, unlike those of Blackduck vessels. Surfaces are fabric impressed and have been smoothed prior to decoration partially obliterating surface treatment. Decoration is found on lips, rims, and, occasionally on shoulders (Snortland-Coles 1979: 27-28).

Duck Bay Punctate accounts for about 47% of the ware and is the most distinctive type. It has

> minimally three rows of punctates on the rim exterior. When additional rows are present these continue onto the shoulder and in some instances onto the body of the vessel. Punctates are generally rectangular in shape, but can be circular, crescentic, or irregular. Occasionally, they occur on the interior

> of the rim. Punctates or similar decorative elements occur with high frequency on the lip, and may or may not be the same as the punctates on the rim exterior (Hanna 1978: 3).

Duck Bay Notched Lip constitutes 26% of the ware. It is characterized by shallow closely spaced punctates on the rim interior, extending onto the lip. They are most frequently formed with the end of an object. Less frequent elements are cord-wrapped object, pseudo-cord-wrapped object, pie-shell crimping, fluting, and incising (Hanna 1978: 3,4).

Duck Bay Undecorated maintains the overall vessel shape characteristic of the ware but lacks decoration. This type constitutes about 27% of the sample (Hanna 1978: 3).

Four radiocarbon dates, A.D. 680 ± 275 (DIC 845) and A.D. 690 ± 285 (DIC 846) from the 1976 excavations and A.D. 1255 ± 175 (GX-5516) and A.D. 1180 ± 110 (GX-5517) from the 1977 excavations, were obtained at FbMb-1. The 1976 dates have been tentatively rejected because of small sample size and problems encountered in the lab during analysis (Snortland-Coles 1979: 49). The 1977 dates correspond well with the date of A.D. 1165 ± 67 obtained from a late Blackduck component containing a few Duck Bay Ware sherds in the Smith site (Lugenbeal 1976: 411).

Definition of the Problem:

The focus of this thesis is Duck Bay Ware, specifically an attempt to explain its limited geographical distribution. The area in which Duck Bay Ware is the predominant ceramic ware is restricted as compared with contemporary Blackduck, Selkirk, and Clearwater Lake Wares. Figure 1 and Table 1 summarize information about the distribution of sites containing Duck Bay Ware.

Superficially, there appears to be a wide-spread occurrence of the ware. However, examination of the frequency of occurrence at each of the sites indicated on the map shows that there is a considerable difference between the distribution of Duck Bay Ware and other contemporary wares, in that there is a sudden decrease in the frequency of Duck Bay Ware in sites outside the Aschkibokahn region. Whereas Blackduck, Selkirk, and Selkirk-related wares occur with a consistently high frequency throughout the extent of their distribution, Duck Bay Ware predominates at one site only (FbMb-1). Excluding 'sites' of single finds, the remaining sites containing Duck Bay Ware contain either between 10% and 20% or less than 5% of this ware in the total ceramic assemblage. The former class of sites is located within 100 km, either west or south, of FbMb-1.

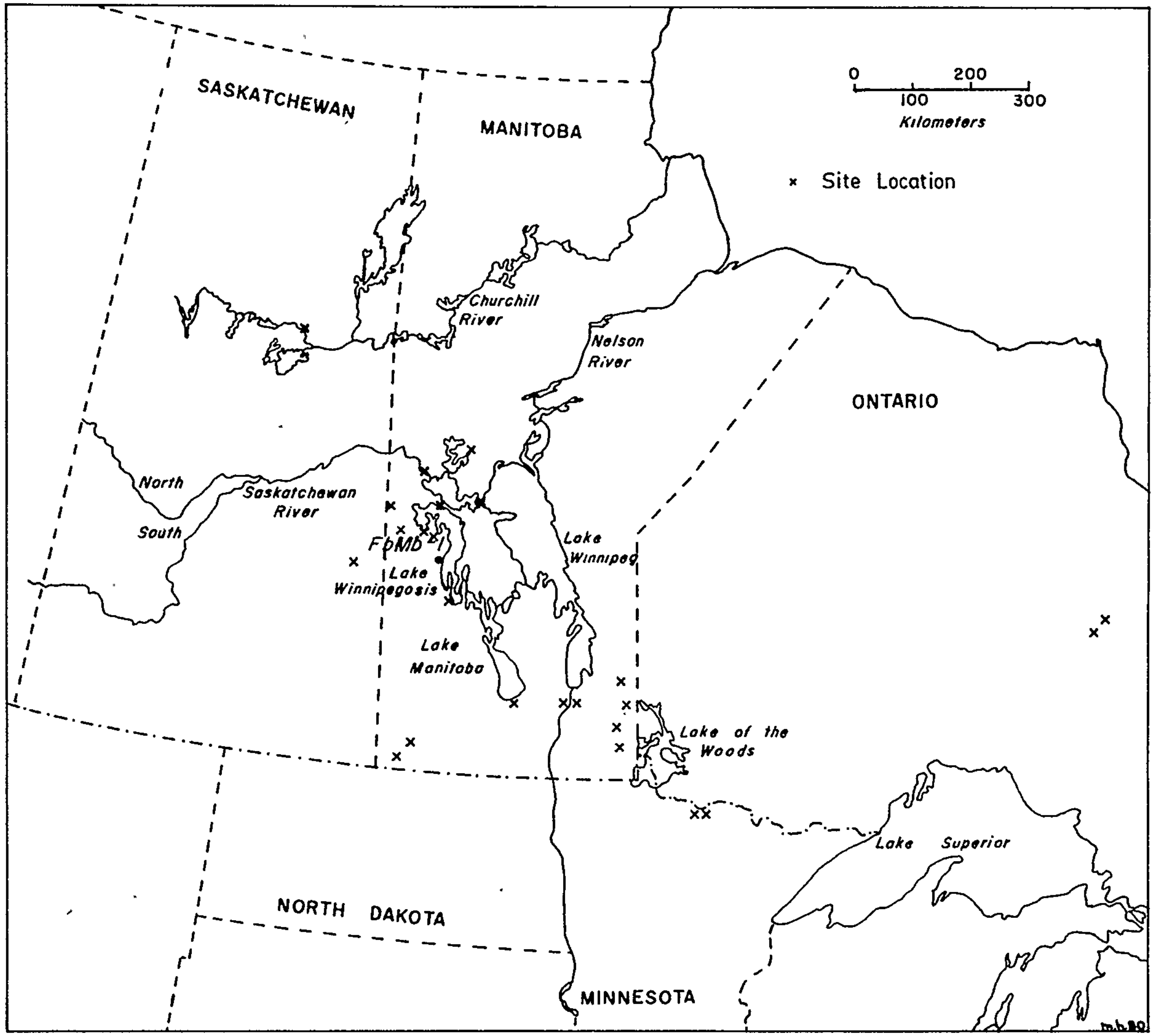

Figure I: Distribution of Sites Containing Duck Bay Ware

TABLE 1

DISTRIBUTION OF DUCK BAY WARE

SITE	LOCATION	TOTAL TYPES[1]	VESSELS/SHERDS DUCK BAY WARE	REFERENCE/REPOSITORY[2]
Drinking Falls GiNb-1	Saskatchewan 55°24'N 104°7'W	1 vessel	1 vessel	Brace and Dyck 1978 Meyer 1978 SMNH
Goldsworthy	Saskatchewan 52°33'N 103°42'W	many	1 sherd	Meyer, 1979 pers.comm. Archie Campbell collection
Oscar Point PAH-5	Manitoba 53°6'N 100°25'W	7? vessels	1 vessel	Gibson 1975 Kelley and Connell 1978 MMMN
GRS-1	Manitoba 53°8'N 99°15'W	580 sherds	6 vessels	Mayer-Oakes 1970 UM
GRS-8	Manitoba 53°55'N 100°15'W	14 sherds	1 sherd	Mayer-Oakes 1970 UM
GRS-16	Manitoba 53°8'N 99°55'W	1 sherd	1 sherd	Mayer-Oakes 1970 UM
GRS-27	Manitoba 53°48'N 101°15'N	5 vessels	2 vessels	Mayer-Oakes 1970 UM
GRS-34	Manitoba 53°11'N 99°37'W	4 vessels	2 vessels	Mayer-Oakes 1970 UM
GRS-37	Manitoba 53°10'N 99°37'W	2 vessels	1 vessel	Mayer-Oakes 1970 UM
GRS-38	Manitoba 53°8'N 99°35'W	4 vessels	2 vessels	Mayer-Oakes 1970 UM
Aschkibokahn FbMb-1	Manitoba 52°12'N 100°11'W	410 vessels	315 vessels	Snortland-Coles 1979 Badertscher 1980 Hanna 1978 HRB; Dauphin Museum

SITE	LOCATION	TOTAL TYPES	VESSELS/SHERDS DUCK BAY WARE	REFERENCE/REPOSITORY
Winnipegosis	Manitoba 51°39'N 99°57'W	17 vessels	3 vessels	Gibson 1976 Winnipegosis Museum
LAS43 FbMi-2	Manitoba 52°10'N 101°28'W	44 vessels	5 vessels	Gryba 1977 Eugene Gryba collection
LAS127 FbMf-1	Manitoba 52°14'N 100°59'W	5 vessels	4 vessels	Hill 1965 UM
LAS203	Manitoba	? (few)	1 sherd	LAS files Watson Crossley collection Grandview, Manitoba
LAS136	Manitoba 52°15'N 101°5'W	? (few)	1 sherd	LAS files deGroot collection Bowsman, Manitoba
MD-7	Manitoba 53°7'N 101°4'W	8 vessels	1 vessel	MAS files Dauphin Museum
LAS280	Manitoba 52°21'N 100°44'W	6 vessels	1 vessel	LAS files UM
LAS348	Manitoba 50°14'N 98°5'W	58 vessels	4 vessels	Shay 1971 UM
Horner	Manitoba 49°40'N 100°45'W	hundreds	3 sherds	Syms, 1980 pers.comm.
St. Andrew's	Manitoba 50°3'N 96°59'W	?	1 vessel	NMM files NMM
Lockport EaLf-1	Manitoba 50°4'N 96°57'W	hundreds	39 vessels	MacNeish 1958 MMMN
Melita	Manitoba 49°15'N 101° W	?	1 sherd	MMMN files MMMN
Great Falls	Manitoba	?	1 sherd	MMMN files MMMN

SITE	LOCATION	TOTAL TYPES	VESSELS/SHERDS DUCK BAY WARE	REFERENCE/REPOSITORY
Lac du Bois	Manitoba 50°19'N 95°42'W	?	1 sherd	MMMN files MMMN
'Whiteshell' site unspecified	Manitoba	?	1 sherd	MMMN files MMMN
MD-147	Manitoba 50°12'N 96°3'W	2	"1"3	MAS files Dauphin Museum
Bjorkland	Manitoba 50°7'N 96°2'W	500 vessels	"1" vessel	UW files UW
Margaret Lake	Manitoba 50°7'N 95°50'W	32 vessels	"1" vessel	UW files UW
LM-8, M-1	Manitoba 50°53'N 95°34'W	18 vessels	"2" vessels	Buchner 1979 UW
Cemetary Point EaKv-1	Manitoba 50°9'N 95°39'W	many	"1" vessel	UW files UW
Sturgeon Falls EaKv-2	Manitoba 50°10'N 95°39'W	many	"1" vessel	UW files UM
Valentine DkHx-1	Ontario 49°49'N 83°56'W	?	"3" sherds	Pollock 1975 Cochrane, Ont.
Duck Bay DiId-12	Ontario 49°27'N 84°30'W	?	"2" sherds	Pollock 1975 Cochrane, Ont.
McKinstry Md.2	Minnesota 48°31'N 84°34'W	33 vessels	"20" vessels	Stoltman 1973 UMINN
Smith 21KC3	Minnesota 48°30'N 94°41'W	147 vessels	6 vessels	Lugenbeal 1976 UMINN
Smith Md.3	Minnesota 48°30'N 94°41'W	15 vessels	"1" vessels	Stoltman 1973 UMINN

Notes

1. includes only contemporary vessel types, i.e., Blackduck and Selkirk
2. SMNH Saskatchewan Museum of Natural History, Regina
   MMMN Manitoba Museum of Man and Nature, Winnipeg
   UM Department of Anthropology, University of Manitoba, Winnipeg
   HRB Historic Resources Branch, Dept. of Cultural Affairs and Historical Resources, Winnipeg
   MAS Manitoba Archaeological Society, Dauphin Chapter, Dauphin
   NMM National Museum of Man, Ottawa
   UW Department of Anthropology, University of Winnipeg, Winnipeg
   UMINN Department of Anthropology, University of Minnesota, Minneapolis
   LAS Lake Agassiz Survey
3. " " indicates that the sherds appear to have some stylistic similarity to Duck Bay Ware, but for a variety of reasons (eg., small sherd size, examination of photographs or drawings rather than actual specimens) cannot be definitely assigned to Duck Bay Ware.

The apparent lack of Duck Bay Ware in the vicinity of FbMb-1 (i.e., approximately 75 to 100 km) can indeed be attributed to lack of archaeological investigation. However, this is not true for the region beyond the 100 km radius. The archaeology of the Swan River Valley to the west and the Dauphin region to the south is well known because of the activities of members of the Dauphin Chapter of the Manitoba Archaeological Society, who have been collecting and recording sites for decades, and of professionals involved in projects such as the Glacial Lake Agassiz Survey. Collections in the Swan River Valley are notable for the relative lack of any type of ceramic materials. This is not due to a corresponding lack of Late Prehistoric sites; the entire prehistoric sequence is well represented in the Swan River Valley. If there were sites in either the Swan River or Dauphin regions containing large proportions of Duck Bay ware, they would be known.

On the other hand, sporadic finds of Duck Bay Ware appear at a considerable distance from FbMb-1 at, for example, the Drinking Falls site (GiNb-1) about 425 km northwest of FbMb-1, the Smith site about 650 km southeast, and the Valentine site about 1200 km east. The Drinking Falls vessel can be considered 'classic' Duck Bay Punctate: three rows of rectangular punctates on the rim, a sharp angled neck, five bands each with three rows of rectangular punctates extending down the shoulder, a sharply angled shoulder, and a single row of punctates on the body immediately below the shoulder. Only photographs of the ceramics from the Smith site have been seen; however, both the descriptions and photographs bear striking similarity to Duck Bay Punctate vessels from FbMb-1 and little resemblance to anything else. Whether or not the pottery at the Valentine site is truly Duck Bay Ware is debatable, but the description matches that of Duck Bay Ware more closely than any other contemporary ceramic type (Pollock 1975).

In terms of bio-topographical zones, most of the sites are located within the southern limits of the boreal forest. FbMb-1, LAS 43, the sites in the Swan River Valley, the Winnipegosis site, LAS 348, the Goldsworthy site, and the St. Andrew's vessel are located within the parkland. Isolated sherds occur in sites in the Plains region of southwestern Manitoba (Syms 1980, personal communication) and North Dakota (Snortland-Coles 1981, personal communication).

This distribution stimulated three questions. Why is there only one site (FbMb-1) containing significant quantities of Duck Bay Ware. Why should minimal quantities of this ware be found in sites scattered from central Saskatchewan to northwestern Ontario? Why is Duck Bay Ware always found in association with either Blackduck or Selkirk Wares and never in an isolated component?

Methodology:

The method of analogy will be used to construct six models based on ethnographic data and general anthropological theories of social organization. Each model could potentially account for the distribution of Duck Bay Ware.

The method of analogy, as explored by Fewkes (1893) and elaborated upon by Strong (1936), Steward (1942), and Ascher (1961), has a respectable antiquity in archaeology. The use of ethnographic analogy involves abstracting descriptions of data or relationships between behavioural and material data and using these to derive inferences about the behavioural context of archaeological data. Analogy has been used, or has the potential to be used, to identify artifacts, to determine or infer the use of artifacts (eg., Semenov 1964), to infer the behavioural context of artifacts, artifact assemblages, features, or entire sites (eg., Binford 1967a, 1978b; Gould 1980; Longacre 1970), and to initiate, guide, and validate experimental archaeology (eg., Simon 1979; Binford 1978a).

Both Strong (1936) and Steward (1942) promoted the direct historical approach as a means of applying ethnographic data. In this context, continuity was demonstrated (or assumed) between the prehistoric and historic populations of an area, and, consequently, it was assumed that relations between material data and behaviour observed in the historic population had been present in the prehistoric culture. This approach is generally limited, however, to only recent prehistory.

The 'new analogy' was proposed by Ascher (1961) as a means of using ethnographic analogy when a prehistoric-historic continuum could not be demonstrated or assumed. He considered this type of analogy to be purely formal, in that no generic connection was implied. Instead, analogies were sought in cultures "which manipulate similar environments in similar ways" (1961: 319).

Ethnographic analogies have usually taken the format of argumentative analogies, that is,

> X has certain elements A, B, and C.
> Y also has elements A, B, and C.
> But X also has D.
> Therefore, Y has D (Carney and Scheer 1964: 146).

These analogies have usually assumed a one-for-one replacement of entities from the analogy to the archaeological context, that is, if two traits are found together in both the analogue and the archaeological data they are necessarily related. However, mere co-occurrence is not considered sufficient to demonstrate the validity of the analogue; rather, it is necessary to demonstrate that there are relationships among the entities which are common to both the analogue and the archaeological situation (Hesse 1966: 77, 84). Any one trait or cultural element may be the function of several factors. It is necessary to consider at least some of this complex set of interrelationships when deriving any analogue. The construction of analogues should include those causal or functional relationships between traits as well as the traits themselves.

While ethnographic analogy has potential to assist in interpretation, it has equally great potential to be misused. Analogy cannot be used indiscriminantly. The data from which the analogue is derived and the means of validating the analogy must be carefully considered.

Childe (1946: 250) suggested that analogues should be integrated complexes of traits, not agglomerations of unrelated traits. Analogues could be most profitably used to compare systadial cultures--"cultures occupying the same relative position in the sequence as defined by the common criterion of technology". Clark (1962) suggested two criteria to be met when constructing the analogue. First, both the source(s) of the analogy and the culture under examination should share a common level of subsistence. Second, the source(s) of the analogue and the culture under examination should exist under similar ecological conditions. He cautioned that archaeologists should be careful in applying the last criterion, because many different cultures can and do live in similar ecological conditions.

Validating the analogy is more problematic. Ascher (1961) and Chamberlain (1973) stated that there is usually more than one appropriate analogue for any one archaeological situation. It is dependent upon the archaeologist to explore all reasonable analogues and to present reasons for acceptance or rejection of each analogue. Tylor (1896, cited in Binford 1972: 81) suggested that archaeologists calculate the probability with which identical combinations of independent variables could appear independently in different cultures. Salmon (1976) suggested assessing the "prior probability" of an analogue. The prior probability is an implicit assessment of an analogue prior to its testing via its implications. In this way, many alternative hypotheses can be evaluated prior to testing. In such a procedure, it is necessary not only to assess the acceptability of the analogue but also to assess the variety, significance, and importance of the observational predictions. It is necessary to have supportive data in different domains. The significance and relevance of the data are factors which cannot be assessed logically; they must be examined on the basis of knowledge and experience with the data (Salmon 1975: 461).

Binford (1972, 1967a) has argued that the validation of the analogue depends as much on how the analogue is applied as it does on the content of the analogue. In his procedure, the analogue is no longer directly compared to the archaeological data, but instead becomes a basis from which to develop hypotheses about what will and will not be found in the archaeological record. These are then tested against the archaeological data. In this way, it is no longer the analogue which is being validated but rather the hypotheses derived therefrom. This avoids the thorny problem of whether or not analogues can be validated (Bunge 1973: 130; Carney and Scheer 1964: 149; Hesse 1966), since there are accepted and developed methods for the testing of hypotheses. If the configuration of traits predicted in the hypothesis does not correspond to the configuration observed in the archaeological record, then modifications may be made in the analogue, new hypotheses devised, and the new predicted configuration once again checked against the archaeological record.

As Morwood (1975) points out, an hypothesis cannot be proven or falsified on its own; rather, its validity can be determined only in relation to the validity of other alternate hypotheses. Confirmation of predictions derived from a theory (or model) does not confirm the theory--it merely adds to its empirical content. Conversely, the non-occurrence of predictions does not falsify the model UNLESS there is another theory which accounts more fully for the observed data. If several hypotheses are tested, the one(s) which account for (predict) the greatest amount of data is the most valid, but only until a new hypothesis is devised that accounts for more.

In spite of the weaknesses inherent in both the formulation and validation of analogues, they are at present the only link we have between observation of living systems and the analysis of extinct ones. The best role for analogy is that of hypothesis-generating, that is, arranging ethnographic data so that hypotheses about the behavioural context of archaeological data can be formulated and tested.

In this thesis, general or new analogy, and not the direct historical approach, will be used. General analogy must be used. Ethnic continuity between A.D. 1200 and the early historic period cannot be assumed since, during the protohistoric and early historic periods, there was considerable shifting of band territories in response to the fur trade. Similar territorial shifts may have occurred prior to the protohistoric period. Ethnographic data will be used to construct analogue models from which will be derived test implications to be compared against the configuration of archaeological data. Such models provide "neither theory nor proof" (Charlton 1981: 131), merely hypotheses. The relative validity of these hypotheses will be determined by their ability to account most completely for the observed distribution.

Use of this particular method requires evaluation of data sources. Generally, ethnographic and historical records of the boreal forest and parkland, while of variable quality and spotty in geographical coverage, provide sufficient descriptive data to build analogues for the prehistoric situation. The many general theories of social organization (eg., Levy 1952, 1966; Service 1962; Fried 1967; Radcliffe-Brown 1965; Levi-Strauss 1963) can provide both an analytical basis for understanding regularities and anomalies in the ethnographic material and a 'back-up' system to provide general hypotheses when ethnographic data are lacking.

Consequently, both data sources will be used. Specific ethnographic studies will be used to provide details of adaptation to a boreal forest/parkland environment. General studies will be used when specific details are few or lacking, to provide some understanding of the factors producing observed patterns of adaptation in the boreal forest/parkland, and as a means of justifying consideration of patterns of adaptation which have not been observed in the boreal forest/parkland.

Data concerning the context of ceramic production have had to come from ethnographic records of the northern Plains. Aside from Curtis' (1980) brief description of the use of ceramics by Cree, there are no descriptions of either production or use from the boreal forest. The northern Plains accounts were used for two reasons. First, their geographical proximity to the research area allows for the possibility of interaction between groups and thereby for the possibility of exchange of styles and technologies. Second, the social organization of northern Plains groups is likely to be more similar to that in the research area than would the social organization of other pottery-producing groups such as horticulturalists at the chiefdom/state level. This means there is a greater possibility that ceramics in these two regions were made in similar contexts, i.e., by women and for domestic use.

Social organization data, on the other hand, have been derived from ethnographies of boreal forest groups. There is, however, NO implication in the use of these data that the producers of Duck Bay Ware were Algonquians. Rather, they have been chosen as the data source because they "manipulate[d] similar environments in similar manners" (Ascher 1961: 319). The producers of Duck Bay Ware are assumed to have a band-level society; therefore, it is assumed that various aspects of their social organization will be similar to the range found in the ethnographic literature. Their subsistence base is considered to be similar, i.e., a dependence on a great variety of large and small game, fish, birds, and vegetable foods which varied seasonally. Likewise, their settlement pattern is assumed to be similar, since they traversed and occupied more or less similar terrain and hunted, fished, and gathered similar sets of resources. Furthermore, they were constrained to moving in similar manners from site to site: along rivers, streams, and lakes in summer and over frozen marshes, ice, and snow in the winter. They faced the same problems of moving and subsisting during spring breakup and fall freeze-up. Finally, the use of canoes and snowshoes is assumed.

Evidence and Reliability:

The relative validity of each of the models will be examined by comparing the test implications of each model against the configuration of three archaeological variables--type, technology, and location. Other ancillary data will also be considered.

Ceramic types will be used in this analysis as a means of identifying cultural units and delimiting the territory they inhabit. This traditional use of ceramic types entails the assumption that there is a significant correlation between the selected item and the cultural unit. There are problems in the universal application of this assumption, not the least of which is the ability to delineate boundaries of social units. Criteria such as language, trait distribution, territory, political organization, and settlement structure have been used (Naroll 1964; Barth 1969). Many of these are not appropriate for archaeology, either because they do not preserve in the archaeological record (i.e., language) or because they are common to many social units who have adapted to a common environment (i.e., settlement pattern). Archaeologists, consequently, depend predominantly on trait (i.e., artifact) distribution.

Type, or more specifically, style, is assumed to correlate with social boundaries because the people who use that particular style interact in common behavioural contexts. Style is perpetuated through common "communication contexts of enculturation and acculturation"; changes are due to "random errors" in communication either spatially (between social units) or temporally (between generations) (Wobst 1977: 318,319). However, there are instances where artifact styles and cultural units do not have corresponding boundaries (see discussion in Hodder

1978); furthermore, not all artifact classes exhibit similar amounts of stylistic variability (eg., ceramics versus end scrapers). Those who have presented cautionary tales about the non-correlation of style and boundary have not taken the next necessary steps and attempted to explain why the predicted correlation(s) did not occur, how that situation is similar to other instances of non-correlation (and, conversely, different from instances of correlations), what factors may be involved in situations of non-correlation and correlation, and ultimately how these individual instances can contribute to our understanding of social process both contemporary and prehistoric and to our ability to predict when artifact styles will (or will not) correlate with social unit boundaries. Isolated instances of non-correlation should not be taken as refutation of the assumption of correlation between style and social boundary, since, as Thomas (1980) has pointed out, argument by enumeration is neither proof nor disproof.

One possible way of examining the correlation of style and boundary is by viewing style as "a strategy of information exchange" (Wobst 1977: 317). If style contains the message (which may be a display of social or ethnic boundaries), then the selection of the medium in which to encode the message may be influenced by the ease with which the message can be embedded and the longevity of the artifact (hence, the longevity of the message). Ceramic decoration might be one very amenable means of carrying a message, since the style (decoration) can be applied in (potentially) great variety (thereby making it easy to differentiate 'us' and 'our' pots from 'them' and 'their' pots) without affecting the use aspect of the pots and without significantly increasing the amount of effort already expended in making the pot. Furthermore, a pot retains the 'message' embedded in it, even when broken, for long periods of time. In other words, pottery MAY have been chosen prehistorically to identify social units for much the same reasons that archaeologists today choose pottery to identify archaeological units--its malleability and durability make it an effective and efficient medium.

Technology, i.e., the behavioural patterns associated with resource selection and production, is the most important variable in this analysis. Technology is emphasized rather than stylistic analysis even though the latter has been the traditional choice when trying to determine prehistoric population movement and interaction. Style is an aspect of ceramics related to ideas rather than to geographical factors. The ideas about ceramic style which find their concrete expression in the finished product come from a multitude of sources, i.e., kin and non-kin from within the work group, household, local band, and society, and from extra-societal contacts. It can be difficult to trace the origin and dispersal route of these ideas when dealing with short time periods and small territories, as appears to be the case with Duck Bay Ware. Both our temporal control and data base are inadequate for these purposes.

People must, however, select raw materials to make their tools and utensils. Analysis of the patterns implicated in selection of raw materials has two advantages over style. First, most raw materials are geographically localized and have certain characteristics which permit identification of the source after the resource has been removed from the source. Clay deposits are discrete phenomena which can be 'fingerprinted' according to mineralogical and chemical composition. Ideally, each clay deposit has characteristic mineral and chemical constitutents, although the distinctiveness of one deposit from another may vary according to similarity or dissimilarity of parent material, formation processes, and possible diagenetic changes occurring during erosion and redeposition.

Second, people must travel to the raw material source; neither raw materials nor pots can move independently of people. If we can identify the source(s) from which raw materials were derived, we can determine the distribution of resource exploitation patterns characteristic of the social unit exploiting that particular raw material and, consequently, the movement of people using these patterns.

In order to analyze the technology, X-ray fluorescence and thin-section analysis of ceramics from FbMb-1 and other sites at which Duck Bay Ware appears will be used. These techniques have a much sounder methological basis than mere visual inspection and provide a much more accurate and detailed analysis of ceramic technology by being able to analyze attributes which cannot be assessed by visual means. In the cases where these analytical techniques have been applied to ceramic materials, the results have had significant implications not only for understanding prehistoric ceramic technology but also for the interpretation of these assemblages in terms of social processes (see discussion in Chapter 2).

There are a number of factors affecting the reliability of X-ray fluorescence analysis of clays and pottery and ultimately the accuracy of results and their usefulness for testing models. The first deals with the ability to differentiate chemically and mineralogically among clay deposits. The major clay elements (silicon, aluminum, and iron) may be present in consistent amounts between different deposits, but the minor and trace elements, which represent either substitutions into the clay mineral lattice or residual minerals highly resistant to weathering processes, are present as impurities in the clay deposit. The proportions of these minor and trace elements in each deposit will depend upon the parent material(s) from which the clay developed and subsequent weathering processes. These proportions are, therefore, likely to vary among different deposits. There is chemical and mineralogical variability within a deposit, but this internal variability has been shown to be less than variability between deposits (Rice 1978b: 514-515).

A second factor is the present availability of sources used prehistorically, if we are to correlate ceramics with the clay deposit from which they were made. Depletion or destruction of prehistorically used deposits may prevent us from making such a correlation. However, even if it is neither possible nor feasible to pinpoint the exact deposit, analysis of both clays and ceramics will identify the range of variation of minor and trace elements in both data sets, thereby permitting us to make at least preliminary statements about resource utilization patterns and the distribution of these patterns.

A critical factor involves possible chemical changes in the clay resulting from the various steps in ceramic production. Clay preparation may involve levigating and mixing either to remove unwanted impurities or to improve ceramic properties. Freeth (1967) tested for the possible effects of levigation on the chemical composition of clays and found them to be negligible when compared to the variation within the clay deposit. He concluded "it is very unlikely that the refining of a clay would give rise to changes which would be large enough to affect the correlation between pottery sherds and clays" (1967: 107). Rice (1978b: 535) came to a similar conclusion. Although some of the elements in her analysis showed a substantial decrease or increase in clay fine fraction, the overall difference in chemical composition was insignificant, and none of the fine fractions clustered apart from the clays from which they were derived.

Unfortunately, the effects of mixing different clays cannot be so easily discounted. Brooks et al (1973, cited in Rice 1978b: 529) reported that trace element concentration in a 50:50 mixture of two different clays paralleled the original concentration in each of the two clays. We cannot assume, however, that clays were always mixed in equal proportions. Experimentation with various mixtures of clays to compare their chemical compositions with that of the pottery would be a feasible, if lengthy, solution.

The addition of tempering material to the clay introduces another 'contaminant' in the chemical composition. Rice (1978b: 528-529) found statistically significant increases in some elements when untempered clay was compared with 15% and 29% ash-tempered clay. The elements that increased most were those already in high concentration in clays and/or tempers. However, the proportional change in element concentration did not reflect the proportion of ash added to the clay. Thin-section and X-ray diffraction analysis can provide a semi-quantitative analysis of tempering minerals used. Through mathematical manipulation, the proportion of total chemical composition accounted for by the tempering minerals can be subtracted. If one is merely analyzing for internal variability within a sample and if thin-section and/or X-ray diffraction analyses indicate that type and quantity of tempering minerals are relatively constant, variability within the sample can then be attributed to variability in clay deposits rather than variability introduced by the addition of tempering minerals.

It has been suggested that firing can alter the relative proportions of elements either through loss of the more volatile oxides or through loss of water leading to changes in relative concentrations (Catling, Richards, and Blin-Stoyle 1963). Freeth (1967), through experimentation, discounted both sources of error as being inconsequential as compared with natural variation occurring within clay deposits. Rice (1978b: 535) found no clear pattern of variation when unfired and fired clay and clay-ash samples were compared. Any apparent regular variation was not statistically significant and fell within the range of natural variation of the clay. These alterations should not prevent correlation of ceramics with clay deposits.

Once pottery is buried in an archaeological deposit, cation exchange between ceramics (especially low-fired, highly porous sherds) and groundwater can approach that of raw clays (Hedges and McLellan 1976). The potential exists for the relative proportion of minor and trace elements in sherds to be modified through exchange with elements, particularly Na^{+}, K^{+}, Ca^{++}, and Mg^{++}, contained in groundwater. These elements are often excluded when making comparisons (eg., Arnold et al 1978: 554). However, in order for the proportion of these minor elements to be significantly altered by cation exchange, their concentration in groundwater would have to be very high. Proportions of trace elements are more easily altered, but again "unless quite unusual situations occur . . . there is unlikely to be greater than a few percent change in trace element level" (Hedges and McLellan 1976: 207). Since the elements (oxides) analyzed in this study are classed as major and minor in concentration, contamination due to cation exchange is minimal.

In conclusion, there are several factors or production stages which potentially could alter the chemical composition of clay sufficiently to prevent correlation of clays and ceramics. Where these factors have been tested, they have usually been found to be statistically insignificant. Furthermore, the fact that previous attempts to correlate ceramics with clay sources have been generally successful indicates that these factors are usually of minor concern.

The third variable--location--is an obvious and essential variable in this attempt to explain the distribution of Duck Bay Ware. Only by knowing where items are found and in what proportion they occur can we make any estimate of the territory habitually used by a social unit and of the degree of interaction among social units, be they contiguous or more removed.

Locational analysis of sites containing Duck Bay Ware was contemplated as a major source of test data; however, there were inadequacies in our knowledge of site distribution which would have produced a false precision in the results. The distribution of sites in the region surrounding FbMb-1, in the Duck and Porcupine Mountains, and in the Interlake region is largely unknown. As is usually the case elsewhere, the portions of Manitoba which are best known archaeologically are those regions which have been extensively cultivated. These relatively unknown regions are forested, have little or no agriculture, and have been little investigated archaeologically. Any attempt to use a precise methodology such as locational analysis to describe and measure the distribution of sites containing Duck Bay Ware would have to incorporate these blank regions. The results would describe the distribution on the basis of presently known sites, not on the basis of all sites containing Duck Bay Ware. Since these blank regions are extensive, the results of locational analysis would be misleading rather than revealing of prehistoric patterns of ceramic distribution. Non-quantitative and subjective descriptions of site distribution will be used instead when assessing the models. While these methods do not provide precise or statistically based descriptions of distribution, neither do they, under these circumstances, present a false sense of precision.

Two other sets of variables will be considered--settlement pattern and the presence of 'exotic' goods at FbMb-1. These variables are not common factors to all models. However, because they appear to be important factors in evaluating some of the models, they will be briefly discussed here.

The settlement pattern variable requires that, ideally, we be able to identify the season(s) during which different sites in the local band's territory were occupied, the regularity with which different sites were occupied, and the proportion of the local band occupying the site. This requires a vast amount of information: locational data (what sites of what size are located in what biomes), seasonal data (based on faunal and floral remains), and some means of estimating the size of the population inhabiting the site. Even in well-investigated regions, there are large gaps in the data. In the Aschkibokahn region, only one site (FbMb-1) is known, so that it is impossible to determine the seasonal use of the Aschkibokahn hinterland.

On the other hand, it is possible to make reasonably accurate statements about the season(s) during which Aschkibokahn was occupied. Faunal remains constituted a very high proportion of the total recovery at FbMb-1. Some provided a general indication of season of site occupation, eg., fetal-immature-mature development stages of small mammals. Others, such as the presence of medullary tissue in bird bones, tooth eruption sequences, and fish scale annuli, provided a more precise indication of seasonality (Snortland-Coles 1979; Hanna 1981a; Fraser 1979).

Trade is proposed as one mechanism by which Duck Bay Ware is located in sites other than FbMb-1. Trade, however, is not a one-way affair, but involves a reciprocal movement of goods. Consequently, the types and relative amounts of lithic materials in FbMb-1 will be used to check the extent of interaction with surrounding or more distant local bands. Although goods other than lithic materials may have been traded and indeed may have been more desirable or more frequent trade goods (Wright 1967, 1968), the presence of 'exotic' lithic materials may be taken as minimal evidence of interaction with other local bands. The source of the raw materials and the frequency at FbMb-1 can be compared with the distribution and frequency of Duck Bay Ware in sites other than FbMb-1 to see if the movement of people in response to trading or other purposes was similar or different to the movement of Duck Bay Ware. The direction and frequency of interaction by both men and women with other local bands will give some indication of the territorial extent of the Aschkibokahn local band and the exclusiveness of territorial boundaries. However, since lithic trade items can be considereed at best as only minimal evidence of trade frequency with any other region, any inferences about territoriality must likewise be considered to be minimal statements.

CHAPTER 2

CHEMICAL AND MINERALOGICAL CERAMIC ANALYSIS:

CASE STUDIES

X-ray fluorescence, X-ray diffraction, neutron activation, optical spectroscopy, and thin-section analysis have been used singly or together in some combination in the analysis of ceramics for some time now. Given the range of information which these methods provide, it is suprising that more studies of this nature have not been carried out.

The review that follows is limited to New World, particularly North American and Mesoamerican, studies. There have been many similar and extensive investigations undertaken in the Old World, but none demonstrate problems, results, or interpretations which are not covered by New World investigations. Furthermore, the Old World studies are less relevant to the problem at hand, since they usually deal with large scale societies and mass-produced ceramics destined for trade. Some of the New World studies are also of this variety, but most deal with smaller-scale societies and ceramics produced predominantly or totally for local consumption.

Mineralogical and chemical studies have taken one of two approaches. The approach first used, and still most common, is an examination of archaeological materials, the results of which are used to infer behavioural patterns of raw material selection, production, and trade. The second approach, only recently being pursued, is essentially ethnoarchaeological. The effects of behavioural patterns (i.e., selection and production) as observed in contemporary pottery-producing communities on the mineralogical and chemical constitutents of clay, temper, and ceramics are examined. The results are used to construct models which can be used to interpret archaeological data.

The classic study is the analysis of Pecos pottery by Shepard (1936). She compared the results of thin-section analysis with the standard typology to see if types which were stylistically coherent were also technologically coherent, to examine the origin and distribution of pottery based on differences and similarities in paste and temper, and to ascertain if the technological data upheld the proposed development sequence of certain stylistic types. In some instances, the technological data correlated with stylistic data; in other instances, technological data contradicted inferences based on stylistic analysis. For example, the analysis of Black-on-white ware from Forked Lightning Ruin and Pecos showed that

> the pastes of the types recognized by [Mr. Amsden] are even more distinctive than the surface characteristics upon which his classification was primarily based. With one exception, the nomenclature originally applied has, therefore, been retained. It is clear, however, that emphasis upon exterior finish has tended to confuse the relationship of types and increased the difficulty of classification (1936: 470).

Most types of Black-on-white ware were found to be technologically valid. The exception was a type called Late Crackle, thought to be a development from the Crackle type of Black-on-white ware. Thin-section analysis showed first, Late Crackle was sand- or siltstone-tempered while Crackle was sherd-tempered; second, different clays were used; third, the colour, hardness, and porosity of Late Crackle had greater technological affinities to the Blue-gray type; and fourth, the geographical distribution of Late Crackle did not correspond with the distribution of the supposedly ancestral Crackle (1936: 474).

Another example is the development and distribution of Biscuit Ware. This ware is highly standardized as to both form and design, and is unique and distinctive for its porosity, light weight, and colour range. These latter features appear to result from the use of montmorillonite clays. Although the cultural factors which motivated the switch to montmorillonite clays are not understood, the resulting Biscuit ware had the advantage of taking organic paints very well. Technological data contradicted the proposed development of Biscuit ware from an earlier Black-on-white type called Biscuitoid. Biscuitoid paste and its ability to bind with organic paints were indeed 'intermediate' between Black-on-white and Biscuit wares, but there was no similar transition in the clays used in making the respective types nor did the geographical distribution of the two types correspond (1936: 492, 497).

The study contains numerous examples of such discrepancies between stylistic and technological analysis, although none were so great as to call into question the entire typology. The major difference in interpretation involved the contribution of Pecos to the ceramic development of the Upper Rio Grande region. Technological evidence indicated a large volume of trade between Pecos and the Galisteo Basin and the Rio Grande valley. Furthermore, Pecos potters rarely seemed to innovate new styles or methods; rather, they seemed to copy freely from their neighbours. The volume of trade between Pecos and other centres indicated that these centres may not have been as independent and that a higher degree of specialization may have been present than was originally thought (1936: 581).

Although Shepard demonstrated that mineralogical analysis could make significant contributions to archaeological interpretation, there was no rush to incorporate such analyses into archaeological investigations. While the reasons for this may be many and varied, Gladwin et al (1965) and Fontana et al (1962) are an adequate reflection of the attitude prevalent among archaeologists. The very brief discussion of the mineralogy of Snaketown pottery provided some information about the movement of pottery, but the researchers' attitudes towards the method, namely, that "further work would undoubtedly add many details but would be an end in itself, rather than an aid to archaeology" (N. Gladwin 1965: 230), put limitations upon the extent to which it was used. Fontana et al assumed that it would be impossible to demonstrate, first, whether or not Hohokam and Papago used different clays and tempers, and second, if these differences indicated cultural patterns or individual idiosyncracies (1962: 93,94). The elimination of this approach from their analysis demonstrated not only their inadequacies in the required technical skills (which they acknowledged) but also their apparent ignorance of the results and implications of Shepard's work for understanding some of the behavioural aspects of ceramic production at a cultural, as opposed to individual, level. Aside from a brief contribution by Drier

(1939), Shepard was the only person to continue technological ceramic analyses until the 1960s. The extent and significance of her contributions to this field are reviewed by Morris (1974, 1976), Arnold (1977), and Kolb (1975) and need not be repeated here.

Drier (1939) used X-ray diffraction and spectrographic analysis to analyze Middle and Upper Mississippian utilitarian and fine ware and Woodland ware from Wisconsin and Michigan. Spectrographic analysis indicated generally similar clay chemical composition with a few exceptions. X-ray diffraction analysis indicated first, Isle Royal and Aztalan Woodland sherds were physically and chemically similar; second, that Aztalan Fine and Utilitarian Mississippian wares used different clays but similar firing techniques; and third, Upper Mississippian ceramics contained silver and calcium in addition to shell tempering, whereas Woodland ceramics had no silver and only minimal amounts of calcium. He could not explain the occasional exception within each group, but proposed that trading, inheritance, or intermarriage were possible means by which 'exotic' materials could be introduced.

Beginning in 1962, Porter wrote a series of mimeographed articles outlining the procedures and results of thin-section analysis of sherds from several sites in the American Bottom (1962, 1963a, 1963b, 1963c, 1963d, 1964a, 1964b). He questioned many long-standing notions of ceramic and cultural development and provided many questions of his own. He eschewed visual inspection of paste and temper as being misleading at best.

> Although we may see a quantity of rock particles showing in the paste, we are more interested in knowing what the potter intended as the temper and not in what we think we see (1962: 1).

He usually found little correspondence between visual descriptions and petrographic descriptions of pastes and tempers. He suggested visual descriptions be reserved for stylistic analysis. Porter also bemoaned the fact that by ignoring the potential results of mineralogical analysis of ceramics and clays, archaeologists were missing data pertaining to movement of people and goods, supposedly one of the problems they were trying to explain.

In order to offset the criticism of sampling error as affecting his results, he examined all sherds found in one trash pit to assess variability (1963b). Visual inspection of paste indicated that variation existed. The mineralogical analysis confirmed the existence of variation, but indicated that there were limits to the variation. Although variation existed between sherds of different vessels, there was extremely little variation in sherds from one vessel.

His extensive sampling of sherds from a variety of sites led him to identify 12 different paste types. These were fairly consistent associations of certain paste characteristics with certain temper types and proportions (1963d). An examination of paste characteristics and clay deposits implied a fair amount of trade and consistent exploitation of specific clay sources for specific pastes. For example, non-local fireclay was consistently used for thin-walled cooking vessels whereas local alluvial clays were used for thick-walled storage vessels. He suggested that "<u>many of the sites listed as "Late Woodland" are nothing more than sites high in vessels with functional implications rather than differences due to differences in time (cultural evolution)</u>" (1963c: 10, emphasis in original).

Porter also discussed and proposed a tentative solution to the problem associated with shell-tempered pottery (1964b). Shell, which is $CaCO_3$, decomposes in the 650^o to 900^o C. range to produce CO_2 and CaO. This CaO combines with water to produce $Ca(OH)_2$ with a consequent increase in volume. This can have disastrous results for pottery, causing spalling and splitting. CaO also reduces the temperature at which vitrification occurs causing bloated and mishapen vessels at low temperatures. However, shell-tempered prehistoric pottery was consistently fired in the 850° to 950° C. range with no spalling or bloating. Porter examined the procedures of Portland cement manufacturers who potentially have a similar problem but who overcome it by adding pozzolanic materials. This is a "siliceous material which reacts with limestone in the presence of moisture to give a relatively stable strength producing calcium silicate" (Troxell and Davis 1956, quoted in Porter 1964b: 6). He suggested that local clays used in ceramic production may have had sufficient siliceous content to counteract the effects of $CaCO_3$. The problem remained at this state for another 15 years when a better solution was proposed (see review of Stimmell 1978, below).

Weaver (1963), who did a mineralogical analysis of Tchula pottery from the lower Mississippi Valley, and Payne (1970), who examined ceramics from Lambityeco, Oaxaca, from a potter's perspective, both suggested first, that prehistoric potters were not unduly concerned with the purity or quality of clays and second, that it took "centuries, or even millennia" to acquire knowledge about the qualities and properties of clays and tempers (Weaver 1963: 53-54; Payne 1970: 5).

Weaver (1963) is a good example of a poor mineralogical analysis, and Porter (1963a) challenged many of her statements and conclusions. Her regard for the respective responsibilities of archaeologist and geologist in sample selection, thin-section preparation, and mineralogical analysis and the interchange of information between them is less than desirable. She claimed to examine "materials which normally accompany clay-mineral deposits" to test the hypothesis about whether or not Tchula pottery was tempered, but her following discussion does not make it clear if she tested clay or merely deposits consisting of clay-sized particles. The results of examining these two classes would have different implications for the validity of her hypothesis. She also failed to distinguish between aplastics indigenous to the clay and those added to the clay by the potter. Pottery made from a particular clay deposit will not necessarily contain only the aplastics indigenous to the clay. Morphological appearance of the aplastics as well as mineral types must be used to differentiate between the two categories of aplastics. Her suggestion that

> tempering is a relatively sophisticated concept that could have been derived only from a great deal of experience or from potters who had a long tradition of pottery-making behind them (pg. 54)

under-estimates the ingenuity of prehistoric potters and ignores the many archaeological ceramic wares which do indeed have added aplastics.

A series of Fine Orange, Fine Grey, and utilitarian sherds from Yucatan and Guatemalan Late Classic and Post-Classic Mayan sites was analyzed using gamma ray spectroscopy in an attempt to answer questions about numbers, locations, and duration of manufacturing sites, and similarities or differences in clay among Fine Orange, Fine Grey, and utilitarian wares (Sayre and Chan 1968). Archaeological evidence had suggested a few, but not many, sources at which Fine Orange had been manufactured and from which the ware had been distributed to the rest of the Mayan region. Questions had been raised as to whether the colour difference between Fine Orange and Fine Grey ware was one of clay or one of firing conditions. Utilitarian ware was examined to see if the same clay was used for it as for the Fine Orange and Fine Grey wares and to see if there were any chemical evidence to suggest trade in utilitarian ware.

The results indicated that, chemically, Fine Orange and Fine Grey were very similar. Furthermore, almost all the Fine Orange sherds were chemically similar regardless of temporal or spatial location. Only a few sherds from the extreme edges of the distribution were chemically distinct. Utilitarian ware, on the other hand, was extremely variable both within and between sites. Sayre and Chan concluded that the chemically similar Fine Orange and Fine Grey wares were made from the same clay source (location unknown) and subsequently distributed throughout the Mayan region. The continuity of chemical similarity through time indicated that Fine Orange continued to be manufactured at one site for at least several centuries. Utilitarian ware, on the other hand, was locally made. This investigation answered some questions about source and distribution of wares, but, like any good research, it also raised many other questions, as Sabloff pointed out (1968). For one thing, chemical similarity cross-cut stylistic differences which have been associated with either resident Mayans (eg., as at Piedras Negras and Uaxactun) or invaders (eg., as at Seibal and Altar de Sacrificios). This disparity needed to be explained. A second question is the source of the few Fine Orange sherds which were chemically dissimilar. The location(s) at which these sherds were made and the relationships among all producing sites need to be specified.

Until the late 1960s, technological ceramic analysis had been concerned only with archaeological data. No attempt had been made to examine the ethnographic correlates of ceramic production in terms of how patterns of selection and production would influence the final mineralogical and chemical composition. Arnold (1971) provided the first comparison of ethnographic and mineralogical data. The Ticul potters distinguished between pottery clay (one kind) and 'ordinary' clay (at least two kinds) and among various additives: sah kab (with two sub-categories) and hi' (with three sub-categories).

Pottery clay was distinguished from ordinary clay on the basis of source (pottery clay came from only one source), taste (it tasted salty), and physical reaction to drying (it did not crack and fall apart). X-ray diffraction results showed that pottery clay consisted of partly hydrated halloysite which accounted for the fact that it would not break up when subjected to the drying test. The pottery clay source also contained a higher concentration of chloride ions than did the ordinary clays which either had low concentrations or no chloride ions at all. Of the additives, only the hi' could be considered 'temper' in the archaeological sense. It was used as temper only in cooking pottery to increase hardness and resistance to heat. X-ray diffraction analysis indicated that hi' was macro-crystalline calcite. Sak lŭ'um, the desirable sub-category of sah kab, looked like a hard white rock with a chalky texture. It was very light, however, and when wetted became sticky. It was added to clay to prevent sagging during construction and cracking during drying. If, when sak lŭ'um was added to moist clay, the sak lŭ'um remained dry, the temper was judged to be of good quality. Sak lŭ'um was identified as attapulgite, a clay which has a higher plastic and liquid limit than either halloysite or montmorillonite. Attapulgite can absorb more water than either of these two clay minerals without losing strength, which explains its ability to strengthen a vessel.

Arnold concluded that

> there is a definite relationship between the cognitive ethnomineralogical system . . . and the verbal, non- verbal and material aspects of the process of selection and using raw materials . . . [and] between the emic ethnomineralogical categories of pottery materials . . . and the mineral composition of the materials within these categories (1971: 37).

Even though the Ticul potters had no knowledge of the mineralogical or chemical composition of the clays and tempers, they could perceive and categorize the resultant physical properties. In spite of their lack of 'scientific' knowledge about clays and tempers, the potter had "developed a great deal of sophistication in dealing with his raw materials" (1971: 38). Furthermore, the potters appeared to be very concerned about the quality of both clays and tempers, submitting both to tests before they were used.

Arnold was also involved in a mineralogical analysis of modern ceramics from Quinua, Department of Ayacucho, Peru (1972, 1975). The village is located near Huari, and consequently the modern potters should have access to the clay and temper resources used by Huari potters. From the variety of clay, temper, and paint mineral sources available near the village, Quinua potters make a wide variety of decorated and undecorated pottery. They used both tempered and untempered paste, the former for decorated ware, the latter for undecorated ware. The present diversity of resources indicates that the valley could have easily supported the ceramic styles produced by Huari potters. X-ray diffraction analysis of clays, tempers, and paints had some interesting results. The difference between 'clay' and 'temper' was more one of degree rather than kind. Both contained plastic and non-plastic materials. Potters judged 'temper' versus 'clay' on the basis of plasticity. 'Clay' was found to contain an average of 5.3% non-plastics whereas 'temper' contained an average of 58.5% non-plastics. The 'tempered' paste was made from clay containing very few natural inclusions; consequently, potters added substantial amounts of volcanic glass (tuff) to the clay. The 'untempered' paste was made from clay containing substantial quantities of mica; consequently, it was not necessary for the potter to add 'temper'. 'Temper', on the other hand, contained plastic materials in addition to the non-plastic minerals, which consisted primarily of quartz, feldspar, and tuff. Arnold suggested, on the basis of this, that archaeologists should redefine their concept of 'temper' from "non-plastics added by the potter" to "anything the potter adds to the paste to improve its working properties" (1972: 100).

Petrographic analysis was introduced to the northern Plains by Bower (1973) who analyzed sherds from several sites in Alberta, Saskatchewan, and Montana. The observed morphological and mineralogical features were used to answer two questions:

> 1. What is the probability that the majority of the pottery found in nomadic sites in the area under consideration was made by the nomadic occupants? 2. Did any criteria for the choice of materials exist in the minds of potters in the nomadic groups considered; that is, was cultural selection operative? (1973: 8,9).

The results were compared with temporal, spatial, and typological data. She found first, that resources to make pottery were locally available and second, that, although granitic temper was widely used throughout the research area, there appeared to be "a correlation of types of granitic temper and types of surface finish . . . at the Morkin Site. This correlation may be present at other sites" (1973: 61). The temporal comparison was insufficient to demonstrate conclusively, although it did suggest, that this cultural preference persisted through time (1973: 57).

Mineralogical analysis can create problems when the results disagree with the results and interpretations of visual inspection and typological analysis. This difficulty arises usually because the mineralogical analysis is done long after the original typological analysis as an after-thought or as an independent study rather than as an integral part of the study. This problem is clearly demonstrated by a series of articles by Shepard (1952), Isphording and Wilson (1974), and Simmons and Brem (1979). Shepard described several types of temper used in Mayan pottery from northern Yucatan, one of which was volcanic ash (tuff). This presented a problem in that there were no known or unequivocal deposits of tuff in the area. The frequency with which tuff-tempered pottery occurred suggested, since local deposits did not exist, that considerable trade for either tuff or tuff-tempered pottery must have existed. Brainerd (1958: 70, quoted in Isphording and Wilson 1974: 484) could not accept that tuff in that amount could be traded over distances of some 500 km. He thought, instead, that tuff might be included in sedimentary deposits in Yucatan. However, the geology of the area does not support such a proposition.

Isphording and Wilson used X-ray diffraction to analyze sherds from the Maya site of Edzna and re-examined local clay and temper deposits. No tuff temper was found in the Edzna sherds. Microscopic examination of sections of fired clay from palygorskite-sepiolite and mixed-layer kaolinite-montmorillonite deposits showed that, even though these clays contain NO tuff, the physical appearance of the fired palygorskite clays could approximate the appearance of tuff. They thus concluded that Shepard had been in error in identifying the temper as tuff or that the samples she had examined were non-indigenous ceramics containing tuff.

Simmons and Brem challenged this conclusion for a number of reasons. They claimed that Isphording and Wilson had analyzed sherds from an area notable for its lack of ash-tempered pottery. Petrographic analysis of sherds from Dzibilchaltun and Chichen Itza confirmed the presence of tuff temper in quantities up to and sometimes exceeding 30% of the paste. They estimated that approximately 45,000 ash-tempered sherds have been recovered from four northern Yucatan sites. Simmons and Brem agreed with Isphording and Wilson's conclusion that no tuff deposits exist in Yucatan; furthermore, ash deposits in the Maya Mountains of Belize contained little or no sanidine and pumice, minerals common in the northern Yucatan sherds. They concluded that Mayan potters had to import their tuff from elsewhere.

The question then arose: was it tuff alone or tuff-tempered pottery that was traded? Simmons and Brem thought that tuff was imported.

> The presence of ash temper at some sites and its absence in the same wares at others, as well as the strong tendency for some shapes . . . within a ware to be associated with only one type of temper can mean only that local northern potters utilized different ingredients in manufacturing vessels within ware

> traditions shared throughout the region. It seems likely to us if finished vessels were imported from some foreign source, specific wares and vessel shapes would be consistently associated no matter where found (1979: 85).

Furthermore, variation in the quality (size) of the tuff suggested to Simmons and Brem that there were two or three distribution networks in operation during the several Mayan periods. During the Late Classic, Dzibilchaltun alone appeared to have access to the fine grades of tuff. Since the area around Dzibilchaltun contains salt fields, this may have been the commodity for which tuff was traded. During the Post-Classic, Chichen Itza obtained most of the fine tuff. Unlike Brainerd, Simmons and Brem did not seem to find inconceivable the quantity of ash which would have had to have been traded during these periods.

Technological analysis can work the other way--to indicate trade did not exist where stylistic similarities suggest it might. Of the pottery recovered from two complexes (Colima and Openo) in Western Mexico, some was stylistically so similar that the excavators considered the possibility of trade between the complexes or between them and a third unidentified complex (Harbottle 1975). Neutron activation analysis of sherds from each complex indicated that there was no chemical similarity in clay between the two complexes, thereby ruling out trade. Local manufacture was the obvious, though unproven, alternate explanation. One must bear in mind, though, that the results still did not explain the processes by which the stylistic similarity arose. It merely eliminated one possible explanation.

Technical analysis can help to sort out seemingly complex situations where several types are involved. Neutron activation analysis of pottery from Lubaantun, Belize, was undertaken in an attempt to differentiate between local and imported types (Hammond, Harbottle, and Gazard 1976). Four types accounted for 13,250 of the 13,600 sherds (considered to be 'major' types at the site) and five types made up the remaining 350 sherds ('minor' types). Because of the large number of samples involved, the results of neutron activation were subjected to cluster analysis and multi-dimensional scaling. The results indicated that the major types were locally manufactured, but there appeared to be differential selection of clays and possibly different local manufacturing centres for production of utilitarian and elaborately decorated pottery. Imported ceramics were also identified, but their sources were not always unambiguous. Trade with the nearby site of Pusilha and with the Belize Valley was suggested as was trade for Fine Orange ware from the Seibal sector of the Pasión Valley. An interesting, and unexpected, implication of this study was that elaborately decorated, fine pottery continued to be manufactured in Pushila after stelae were no longer erected, implying that "cessation of stela cult is not [necessarily] evidence for social collapse or abandonment" (1976: 167).

Brizinski and Buchanan (1977) used X-ray diffraction and X-ray fluorescence analysis to answer questions about ceramic technology, clay and temper selection, and duration of production patterns as reflected in the Laurel and Terminal Woodland ceramics from four sites near the Michipicoten River in northwestern Ontario. X-ray diffraction showed that the microcline-quartz and plagioclase-quartz ratios were consistent in pottery from all four sites and in both phases. The morphology of the tempering inclusions indicated that sand was added to the clay as temper. However, the ratio of the minerals in the ceramics was not the same as the ratio in the sands. The potters apparently selected for microcline feldspar and against plagioclase feldspar, mica (biotite), and magnetite. The reason for selecting against plagioclase is unknown, but the mica was apparently sorted out because of its tendency to expand upon heating, thereby causing spalling. Mica could be easily sorted out of the sand because of its black colour. Magnetite was included in this discrimination because it, too, is black. This temper formula continued throughout Laurel and Terminal Woodland ceramics in the Michipcoten River area.

X-ray fluorescence analysis indicated variation in Zn, Mn, and P, and showed that three different clay sources were exploited prehistorically. When local clays were analyzed, it became apparent that potters at the two Laurel sites were using local clays, specifically the same deposit, whereas the potters at the two Terminal Woodland sites were each using a different, non-local clay. Because the temper selection patterns continued unchanged, the authors suggested that the Terminal Woodland potters were bringing in clay from outside (and as yet unidentified) sources, mixing it with local sand (after biotite and magnetite had been removed), and making pottery at the sites.

The report on the ceramics from Kaminaljuyu (Wetherington 1978) contains several articles. Those of relevance are two by Rice and one by Arnold et al. The first article by Rice combines ceramic technology and ceramic ecology to assess continuity and change in ceramic assemblages:

> a 'technological' approach to pottery provides an objective means of studying the potter's behavior in coping with the peculiarities of the ceramic resources available to him (1978a: 406).

She also used the techniques to explore the utility of technological analysis to make ethnological and archaeological data more comparable and to explore the origin and growth of ceramic specialization, resource availability and utilization, and spatial and temporal patterns of redistribution. The study was limited to 'white', 'brown', and 'cream' wares (historic types). The clays for white and brown wares were known to be locally available; in addition, white ware production has a history extending back to the Formative period. Eleven clay samples, three volcanic ash samples, and 85 sherds were analyzed using mineralogical (X-ray diffraction and thin-section analysis) and neutron activation analyses.

The mineralogical analysis of clays, tempers, and prehistoric and historic pottery indicated that most wares and types cross-cut mineralogical groupings. Only the Post-Classic sherds and composite silhouette vessels were mineralogically separate. In addition, labial flange bowls seemed to be mineralogically consistent but they were not exclusive to that particular mineralogical combination (1978a: 465).

Neutron activation was employed first, to see if local clays could be differentiated and second, to see if any prehistoric pottery was made from these local clays. Most clays (except for two) and ash deposits (except for one) were similar. The clays exhibited chemical similarity probably because of common parent material and lacustrine depositional processes (1978a: 473).

Two main clusters of pottery based on chemical and mineralogical aspects were identified. Cluster 1 contained pottery made from local valley clays. This cluster was subdivided into three groups on the basis of physical properties of clay (eg., colour). Two of these groups were further subdivided on mineralogical features. Cluster 2 contained pottery made from an unknown and probably non-local clay source (1978a: Table 13).

There were three non-random associations of physical, chemical, and mineralogical properties of clays with pottery classes, namely, composite silhouette bowls, labial flange bowls, and cuspidor vessels. The other bowls and jars were highly variable; there were also mineralogical 'oddities' present, i.e., non-local clays and tempers (1978a: 485-486).

Based on these results, Rice developed a model of Formative craft specialization pertaining particularly to white ware. The four steps in this process went from domestic production, through a low-level form of informal exchange (with white ware becoming a desirable item), through white ware coming more under control of an elite (possibly a lineage?), to finally white ware being moved not through exchange but as tribute (1978a: 491-496). This theme is further developed in a subsequent publication (Rice 1981). In this model, an important assumption "is whether control of clay sources(s) and production of white wares were actually in the hands of a political elite" (1978a: 496). Other information (Michels 1976, cited in Rice) shows that ranked lineages existed in Kaminaljuyu and that they controlled various resources. Clay could have been one of those controlled resources.

Rice's second article in this publication examines some of the assumptions underlying provenience studies and attempts to test their validity. These assumptions are of two kinds:

> (1) methodological/statistical assumptions, which deal with the appropriateness of a given technique to a problem, the method of data collection, and parameters of mathematical models employed; and (2) anthropological/ behavioral assumptions, which center on the validity of any set of variables as accurate measures of certain aspects of human behavior (1978b: 513).

> These 'assumptions' . . . form an implicit, generally vague background to the interpretation of such studies, and need to be more explicitly stated as testable hypotheses (1978b: 514).

She compared the element concentration in several clays and tempers with 15% and 29% ash-tempered clay (using same ashes and clays) and with these mixtures in unfired and fired (to 750° and 850° C. in an oxidized atmosphere) states. She concluded that, although archaeologists can obtain very precise chemical and mineralogical ceramic data, the behavioural questions these data are supposed to answer are vaguely formulated and have not been widely explored (1978b: 538).

The article by Arnold et al (1978) went a step beyond Rice's article by attempting to find some of these behavioural-chemical/mineralogical correlations. They analyzed raw materials and pottery from two contemporary ceramic-producing villages in Guatemala. This study had the advantage of observing actual behavioural patterns and their effects on physico-chemical features rather than trying to infer behavioural complexes from physico-chemical aspects.

The several aspects they investigated were phrased as hypotheses. They first compared the trace element composition of clay and pottery. They found that, if elements were present in clay but not in temper, the ratio in clay and pottery was generally similar, i.e., was not significantly different in a statistical sense. If, however, trace elements were in both clay and temper, there was a significant difference in composition between clay and pottery (1978: 565).

They then compared the trace element composition of clays and tempers used in the pottery. They found that for the two communities investigated, there was a quantitative, but not a qualitative, difference, i.e., the clays and tempers had the same elements but in different proportions (1978: 566-567).

A comparison of trace elements in temper and pottery showed that there were significant quantitative differences between the two (1978: 569); consequently, trace element analysis of pottery was interpreted in this case as not directly reflecting the composition of clays and tempers. Rather, trace element analysis indicated the manner in which different communities mixed these to produce their pottery (1978: 569). A comparison of trace element ratios in the clays and tempers used by the two study communities and in the pottery they made showed no significant difference between either the clays and tempers or the final ceramic product. This was to be expected, since the potters exploited the same resources and mixed them together in similar manners (1978: 570).

The problem of shell-temper was again addressed as a result of some experimental archaeology (Stimmell 1978). Attempts to fire shell-tempered pottery resulted in vessels which spalled, exploded, or bloated when 'normal' open firing conditions and temperatures were followed. Since shell-tempered pottery was successfully produced prehistorically and continues to be successfully produced today, Stimmell began examining the ethnographic literature to see what procedures she was omitting. She discovered that either salt or sea water was added to pottery which was shell-tempered, and when she added salt to her pottery she found it, too, successfully fired. She then examined thin-sections of Mississippian shell-tempered pottery in a search for evidence of salt. Salt, when vapourized, leaves behind a characteristically square pore. Stimmell was able to locate these pores in Mississippian shell-tempered pottery. The results of this study had implications not only for ceramic technology but also for prehistoric trade networks.

Two studies which are not technical studies of the sort described above but which nevertheless deal with ceramic technology are by Corenblum and Syms (1977) and Simon (1979). Corenblum and Syms experimented by adding grit temper, in varying amounts, to 10 native Manitoba clays to observe the effects on plasticity, texture, shrinkage (during both air drying and firing), colour, and oxidation of core. The results indicated that, overall, the use of temper depended upon "a series of integrated variables which include initial clay composition, plasticity, shrinkage during drying, shrinkage during firing, and colour transformation" (1977: 36). The effects of temper, and the amount of temper which could be added to the clay, varied with the clay itself. Some clays retained plasticity only if low (less than 2%) quantities of temper were added; other clays could easily absorb up to 20%. Addition of temper did not increase strength, since the clays (with one exception) could be easily made into vessels in both the tempered and untempered states. Temper did have some effect on shrinkage, although the degree to which shrinkage was reduced varied with the clay. If "the advantages of temper remain dubious", there may be other reasons for its continued use such as cultural conservatism among potters. Another reason may be that grit was added not to improve the quality of clay but to produce certain properties in the finished product. The addition of grit may have been only partly to do with decreasing shrinkage during drying and firing. The advantages of porous fired vessels for keeping water cool and for heat dissipation should not be overlooked. Nevertheless, considering the variable qualities of different clays and the varying effects of temper on these clays, Corenblum and Syms concluded that

> it is necessary to carefully combine the variables of clay, percentage of tempering, and firing temperature. Such knowledge indicates a technological refinement that is beyond discovery by way of much of the cursory archaeological research in which clays are rarely analyzed, temper is not quantified, and firing temperatures are not determined (1977: 37).

Simon (1979) tested the viability of several manufacturing procedures as described in various ethnographic and historical accounts from the northwestern Plains, in particular the rawhide mould and ground mould methods. Using local clays and tempers, Simon attempted various approaches and variations in both making and firing pottery following as closely as possible the somewhat sketchy ethnographic and historical descriptions. The results were by and large successful. Pottery could be successfully formed, dried, and fired using these procedures. The end product was, admittedly, 'cruder' than pottery from the eastern Plains or Woodlands, but nevertheless was quite serviceable. Furthermore, the results of her experiments were very similar in shape and 'quality' to the Intermountain and Saskatchewan Basin ceramic traditions of the northwestern Plains.

These studies have demonstrated several things. First, these methods employ objective, replicable techniques to measure unquestionably quantifiable data. For those archaeologists intent on expanding the 'scientific' basis of archaeology, this is definitely an asset. Second, technological, mineralogical, and stylistic analyses must be used in conjunction with other data (be they cultural or environmental) to attempt to answer questions about ongoing processes in prehistoric social systems. They must be used in the context of known or developing models and theories of human behaviour. Third, technological and mineralogical analyses can be used to investigate problems for which stylistic analysis is inadequate or inappropriate. Fourth, technological and mineralogical analyses provide information that is complementary to stylistic analysis, i.e., it provides information that is not available by stylistic analysis. The two methods should be used as different approaches to answering problems. If the answers support each other, the research is relatively easy. If they contradict each other, it does not mean that one method or the other is 'wrong'. It probably means that our interpretations or models are wrong and that our research must be continued. It is at this point that archaeology becomes exciting.

CHAPTER 3

THE MODELS

Introduction:

In this chapter, six models will be developed as alternate explanations for the distribution of Duck Bay Ware. The test implications of each model for the configuration of style, technology, and location, as well as for settlement pattern and non-local lithic materials where relevant, will be predicted. The six models are 1) the movement of people (social organization), of which four alternate models are presented, 2) the movement of pots (trade), and 3) function.

Clay and the Fine Art of Pottery-Making:

Since we are trying to relate a cultural phenomenon (ceramic technology) to a geological phenomenon (clay deposits) in order to explain the distribution of Duck Bay Ware, we have to make certain assumptions about the utilization of clay deposits and the development of ceramic technologies. The validity of these assumptions is crucial because, if they are invalid, analytical methods, no matter how accurate or reliable, will provide only irrelevant results.

Assumption 1: Prehistoric potters were selective in their use of clay deposits because of 1) variation in clay source mineralogy which affects clay quality and 2) minimal clay qualities which must be met to produce ceramics.

Ethnographic and historical data from the northern Plains suggest that potters were familiar with clay properties, that selection of certain clays was practised, and that standard procedures for forming, drying, and firing the vessels were followed (see Simon 1979 and Syms 1977 for extensive discussion and bibliography). Assumptions about patterned selection and preparation of both clay and temper materials in prehistory appear to have been substantiated in previous studies as discussed in Chapter 2. There have been so few comparable analyses done in the parkland, plains, or boreal forest (Bower 1973; Brizinski and Buchanan 1977; Trigger et al 1980) that the validity of these assumptions for prehistoric hunting-gathering societies in the southern boreal forest and parkland has yet to be substantiated. Nevertheless, since at least minimal ceramic qualities must be present in a clay in order to produce pottery and since these minimal requirements are not present in all clay deposits (Bannatyne 1970), some selection procedures and standards must have been followed prehistorically.

Assumption 2: The ceramic technology of any region is developed in response to the variety and qualities of raw materials present in the region rather than being dependent upon the import of non-local raw materials.

We must be judicious in the use of this assumption for there are several instances, both historic and prehistoric, where extensive trade in raw materials was undertaken, eg., obsidian in Hopewell cultures (Streuver and Houart 1972: 66) and the exchange of salt, obsidian, and basalt among Yucatan, Guatemala, and Mexico (Rathje 1972). Nor is trade exclusive to chiefdom and state levels of sociocultural integration. There are, again, numerous examples of band and tribal level societies engaging in trade: Algonkians exchanged deer hides for corn (Gramly 1977), Assiniboine and Mandan exchanged meat and corn (Burpee 1927), obsidian and pipestone are found in Plains sites (Syms 1979: 293), chalcedony is found in boreal forest sites (Hanna 1973), Lake Superior copper is found in southeastern Manitoba (Steinbring 1980: 178-243), shells from the Gulf of Mexico are found in burial mounds in the northern Plains (Capes 1963; Syms 1979: 292).

This assumption focuses specifically on the origin of raw materials used in ceramic production rather than on the presence or absence of trade in general. Previously, the situation wherein the majority of ceramics at a site or in a region (however the region is defined) follows a particular technology has been interpreted as indicating local production (eg., Hammond, Harbottle, and Gazard 1976) whereas the presence of minimal quantities of non-local clays and tempers in a site/region has been interpreted as the result of importing ceramic vessels rather than raw materials (eg., Shepard 1965: 54). The Shepard-Isphording and Wilson-Simmons and Brem debate over tuff-tempered pottery in northern Yucatan revolves in part around the question as to whether or not a non-local raw material (tuff) could be traded in quantities sufficiently large to account for the high proportion of tuff-tempered pottery in that region (see discussion in Chapter 2). This is the only instance I have found in the New World where large scale trade of ceramic-related raw materials has been proposed.

The situation in the northern Plains, parkland, and boreal forest is unclear. Some of the historical and ethnographic documents IMPLY use of local materials (eg., the accounts told by Mahidiwi' [an Hidatsa woman] and Not-a-Woman and Wounded Face [both Mandans] [Wilson 1977: 99,104]). The use of non-local resources implies either no local resources are available or the non-local resources are superior to local resources. Clay deposits in Manitoba are frequent, many would have been accessible to prehistoric potters, and many meet at least minimal ceramic standards (Bannatyne 1970). Consequently, there is no apparent geological reason for attempting to acquire non-local ceramic raw materials in large quantities, even though there MAY have been cultural reasons for at least small scale trade for non-local raw materials. If, however, these non-local raw materials were used infrequently, rather than regularly, in ceramic production, they should have a minimal impact on the local technologies regardless of whether or not their ceramic properties differed from local resources.

Assumption 3: Women made most, if not all, pottery in parkland and boreal forest societies.

Most reports of indigenous pottery manufacturing on the northern Plains indicate that women were the potters (see Syms 1977: 59-60; Simon 1979: 71-74). Lowie (1920: 75) and Linne (1965: 20-21) noted on a more general level that pottery manufacture was the exclusive occupation of women wherever pottery was made by hand or in band/tribal levels of sociocultural integration. The only known exception is reported by Ewers (1945: 294), wherein Blackfoot men made flat unfired vessels; these vessels were also used only by men for ceremonial feasts.

Neophytes learned from older women, quite possibly a close relative (Flannery 1953: 65-66; Wilson 1977: 99). Among the Mandan and Hidatsa, pottery making was a craft specialization. Only a few women practised it; neophytes became, in effect, apprentices who paid a fee not only to learn the craft but also to copy particular design elements used by the practising potter (Bowers 1965).

Models 1 to 4--Movement of People:

The four models presented here are actually variations on a basic theme. These propose that the movement of people in response to some aspect(s) of social organization was responsible for the distribution of Duck Bay Ware. Four models, rather than only one, are presented to take into consideration variation which may have existed in these particular aspects of social organization.

A very important factor is the definition of the boundaries of the social unit under consideration. Minimum and maximum estimates of group size may be made. The minimum group is the one containing the fewest number of people required to be both economically and maritally viable. For reasons discussed below, the local band, consisting of at least 150 people, has been selected as this minimum group size. The maximum group size is limited by both environmental and social factors: the carrying capacity of the region exploited by the group and the ability of face-to-face interaction to maintain group solidarity and identity. The environmental limits to maximum group size will be discussed first. Then will follow a detailed examination of the social limits to maximum and minimum group size, the implications of variations in social organization for the movement of people within and without this group, and finally the models and their implications.

The environment--characteristics and carrying capacity:

Aschkibokahn is situated in the Westlake Plain of the Manitoba Lowlands, which is essentially the basin of Glacial Lake Agassiz. This Plain is bounded on the west by Riding, Duck, and Porcupine mountains and to the east by lakes Manitoba and Winnipegosis (Rowe 1972: 157; Klassen 1979: Figure 1). It is flat to gently irregular with a gentle eastward slope that is cross-cut by linear arrangements of drumlins and abandoned beach ridges. Drainage is consequently interrupted, resulting in extensive tracts of marsh and bog, particularly in the northern part (Klassen 1979: 29; Manitoba Dept. of Mines and Natural Resources 1956: 10, 11).

Aschkibokahn is an island at the joint mouths of the Duck and Drake rivers, where they empty into Lake Winnipegosis after draining an extensive marsh bordering the west shore of the lake. Minor variations in elevation appear to be the chief factor in determining the distribution of marsh, meadow, forest, and open water biomes in the vicinity of Aschkibokahn. These biomes interdigitate in a complex fashion because of the gentle eastward slope of the land and the cross-cutting extinct beach ridges. Consequently, the overall distribution of biomes and associated resources is more like a patchwork quilt than a layer cake. Aschkibokahn, therefore, is strategically located to permit easy and immediate access to five micro-environmental zones--marsh, forest, meadow, stream, and lake--and their resources. Any one of these biomes would be sufficient to support temporarily a human population. Combined, they suppport, augment, and complement their individual floral and faunal associations. The result is an incredibly bountiful area with resources ideally available year-round.

The radiocarbon dates obtained from the 1977 excavations indicate that Aschkibokahn was occupied during the latter part of the Neo-Atlantic and the beginning of the Pacific climatic episodes. The Neo-Atlantic episode is generally characterized by a significant warming trend, a southward extension of summer rains, weaker westerlies, and more meridional circulation beginning about A.D. 900 (Bryson and Wendland 1966). The effects on Manitoba climate are indicated by pollen data from Clearwater Bog suggesting warmer drier summers beginning as early as A.D. 750

(Nichols 1969: 155). Environmental data indicate a major discontinuity occurring about A.D. 1100 marking the transition to the Pacific climatic episode characterized by stronger westerlies and an eastward extension of dry weather (Bryson, Baerreis, and Wendland 1970: 64; Wendland and Bryson 1974: 20; Nichols 1969). Variations in climatic conditions would affect the location of major vegetation zones and presumably to a certain degree the associated faunal and floral resources available for human use.

There are no palaeoenvironmental data pertaining specifically to the Lake Winnipegosis region for the time A.D. 900 to 1400. Existing studies emphasize earlier, longer climatic episodes. Palaeoenvironmental data have been obtained from areas which do not replicate the peculiar geographical setting of Lake Winnipegosis, situated east of Duck and Porcupine mountains. These features tend to channel weather systems and create distinctively local weather patterns. However, if the warm dry climatic conditions of the Neo-Atlantic and Pacific episodes were sufficient to cause prolongued dessication of the Aschkibokahn region, this should be reflected in the faunal record since animal species move in response to changes in plant communities. The presence of the most important subsistence species inthe marsh--fish, furbearers (particularly muskrat and beaver), and waterfowl--is dependent on the maintenance of specific minimum water levels (Wolf 1955; Walker 1965; Manitoba, Dept. of Agriculture and Conservation 1965a, 1965b). Because Lake Winnipegosis is such a shallow lake, and because water levels in the marsh are intimately linked with lake levels, changes in rainfall and/or evaporation rates have the potential to alter the size and location of the marsh and the variety and distribution of resources in the marsh around Aschkibokahn. The faunal remains of FbMb-1 do not suggest any substantial difference between the time of site occupation and the present. Those animals which are rare in the region, either currently or historically, constitute only a very small percentage of the prehistoric fauna, whereas the animals which predominate today also dominate the archaeological assemblage (Snortland-Coles 1979: Table 19). This apparent stability is tentatively supported by pollen extracted from site soils which did not indicate any major change in vegetation since at least the time of major occupation (Slater 1977). Lacking concrete evidence to the contrary, the modern resource distribution will be used as the basis for postulating the prehistoric resource distribution around Aschkibokahn.

Wildlife survey data of west-central Manitoba indicate that the Aschkibokahn region is characterized by a wide variety and a high density of numerous species. Moose populations in the Swan-Pelican area have a density of at least one individual per square kilometer, and may be as high as two or three individuals per square kilometer (Larche 1977: 9). In addition, since the 1961 forest fire, the herd has shown increased numbers of twin calves, a trend which is only now declining as the forest approaches maturity (Bigelow 1979a). The lake and streams in the immediate vicinity of Aschkibokahn are major staging areas for waterfowl in spring and fall (Bigelow 1979a, 1979b; Canada, Dept. of Regional Economic Expansion 1971). The heavy annual spring spawning of pickerel and sucker in the mouths of the Duck and Drake rivers motivated the Fisheries Branch, Department of Renewable Resources and Transportation Services, to build a hatchery on the island. Residents of Duck Bay reported that suckers, pickerel, and jackfish winter under the ice just upstream from the mouths of the Duck and Drake rivers. The number of pelts taken on registered trap lines was 15,936 in 1976-77, with 12.1% being beaver and 11.0% being muskrat. This accounted for 42% of the total fur production in the region (Grower and McCloy 1978); however, there were no data on what proportion of the total furbearer population these figures represent.

Merely enumerating the number or density of species does not indicate the potential carrying capacity of a region. This should be assessed in two ways. First, does the region contain sufficient variation in species such that a decline in one (in terms of either quantity or 'prime' condition) can be offset by improvements in another? Second, does this complementary fluctuation provide sufficient food (i.e., calories) particularly during winter when greatest demands are placed upon metabolic functions?

The first problem will be assessed using Jochim's (1976) subsistence model, albeit in revised format. Jochim defined subsistence and settlement patterns as "the patterning of behaviour as a result of solutions to problems" (1976: 11). Subsistence problems relate to what resources should be used when and in what quantities, where they should be procured, and how many people are required to procure them. Solutions to these problems are based on considerations of several attributes, including weight, density, herd size, species mobility, fat content, and non-food yields.

Jochim constructed a predictive model of resource use by devising measures of performance--the critical ones being 'cost' and 'security'--for each resource. On the basis of these measures, he claimed to be able to calculate and predict the relative importance and proportion of each species in the diet at different seasons. His model allows one to see how different factors and seasonal shifts in these factors influence the ultimate decision of which animal is 'theoretically' the best one to hunt at any one time of the year.

The first modification to the model concerns the level at which both raw data and measures of performance are treated. Jochim combined both ratio level data (weight, density, and aggregation) with ordinal level data (mobility and non-food yields) in deriving his measures of performance, which were then treated as ratio level measurements. This interpretation gives a 'real' but misleading mathematical quantification. One may validly reduce ratio or interval level data to ordinal level data; one may NOT reverse the procedure by elevating ordinal data to interval or ratio level data. Since ranked data were combined with ordinal data in the calculation of the measures of performance, there would be less violence done to the assumptions underlying the way in which they were manipulated if the values were to be treated as ordinal data. The values given to the ratio level variables are really only approximations (i.e., mean values) and vary among both individuals and regions. Moreover, with regard to weight, for example, it was not the actual numbers of pounds of meat so much as it was the overall size of a particular species relative to others that motivated hunters to pursue that species.

The downgrading of ratio data to ordinal level data means measures of performance should be interpreted as ordinal measures rather than as ratio measures. By interpreting his measures as ratio level data, the correspondence between Jochim's predicted values and the ethnographic data may be more apparent than real. The assessments of resource exploitation as contained in ethnographic analyses are very subjective, and the passages that Jochim quotes (pp. 16-24) clearly indicate a ranking of efficiency, productivity, and desirability in terms of 'greater than-lesser than' rather than in absolute amounts. To substantiate the quantitative predictions of the model, comparisons with energy input-output analyses comparable to the !Kung Bushmen studies would have to be made. This quantitative analysis of subsistence scheduling does not exist; consequently, the attempt to demonstrate the validity of quantitative predictions is specious. Consequently, in assessing the Aschkibokahn region resource potential, the measures of performance will be given only ordinal level status.

The second modification concerns the values given to the variables of weight, non-food items, mobility, and fat. Meat weight will be used rather than total animal weight since the assumption of the model is that meat was the prime motive for hunting an animal. This shift to meat weight from total weight is important because of the relationship with non-food items and fat. These variables, which are components of total weight, are considered together in the measures of performance. If one uses total weight, then redundancy is introduced in the calculations. Non-food yields and fat are enhancing the value of meat weight not the total weight of the species. The values given to non-food yield and fat reflect the percentage of that variable relative to meat weight, with 1 being the value for no non-food yield or fat in that it neither increases nor decreases the intrinsic value of the meat. Concerning mobility, as long as the values given to mobility indicate relative degree of mobility for any species, the actual figures used for each level of mobility are irrelevant, since one cannot assume that the intervals between each value represent the same 'amount' of mobility.

The third modification is the addition of another measure to indicate the selection of species according to their fat content. This has nothing to do with Jochim's 'measure of prestige', but rather with a basic metabolic requirement. According to Mitchell and Edman (1951), one requires either a high fat or a high carbohydrate diet in order to maintain a high resistance to cold. A diet heavily weighted towards meat contains only minimal quantities of carbohydrates (Church and Church 1975); therefore, the population living on Aschkibokahn would require a high fat diet during the winter. There is no need to take recourse to an argument of some intuitive nutritional knowledge on the part of the population to include fat in their diet. Fat deprivation induces an acute physiological response, colloguially known as 'rabbit starvation', which initially begins as an intense craving for anything sweet, starchy, or fatty. It can end with sickness and death (Mitchell and Edman 1951).

Since fat content in the diet is crucial for survival, 'security' of a fat source is a more important consideration than is 'cost'. The basic format for calculating this measure will follow that of 'security', i.e.,

$$\text{fat security} \propto (fwd)/m$$

The amount of fat on an animal is dependent upon the relative proportion of fat as well as the size of the animal; consequently, both weight (w) and fat (f) proportion are pertinent variables. Security is proportional to density (d) and inversely proportional to the mobility (m) of the animal (Jochim 1976: 25).

This measure of fat security is especially relevant for fall and winter seasons. Fat content in the diet is not particularly crucial in the fall; however, fall is the last season in which extra supplies may be gathered for winter. Fat content also changes during fall and winter, affecting the desirability of species. Techniques used to preserve meat for winter use apparently affect the fat content of the stored meat. It appears that drying reduces fat content considerably whereas smoking meat does not to any appreciable extent (Church and Church 1975: 38, 62).

The measures of performance for each month are presented in Table 2 and summarized graphically in Figure 2. An examination of Figure 2 indicates several features. First, three species--beaver, moose, and muskrat--form the basis of subsistence. Second, the diet expands and collapses periodically, corresponding to certain significant shifts in the ranking of some species. This facilitates the identification of 'seasons': winter, existing from November to March; spring, from March to June; summer, from June to mid-August; early fall, from mid-August to mid-September; and late fall, from mid-September to early November. Spring is characterized by a dramatic increase in the variety of species available, with migratory game birds playing a moderately important role in the latter part. During summer there is a slight collapse indicating only that several minor species have the same rank of importance in the diet. Large game birds and fish (all species) form the mid-range

TABLE 2

MEASURES OF PERFORMANCE AND RANK

FOR VARIOUS FOOD ANIMALS[1]

ANIMAL	WEIGHT (kg)	NON-FOOD YIELDS	DENSITY (ind/km)	MOBILITY	AGGREGATION (ind/group)	FAT CONTENT	COST	RANK	SECURITY	RANK	FAT	RANK	OVERALL RANK
MONTH: APRIL													
FISH	.72	1.0	64.4	2	2000	1.013	720	1	23.18	6	23.49	7	5
WHITEFISH	.57	1.0	64.4	4	20	1.082	2.85	9	9.18	8	9.93	8	8.5
MOOSE	172.71	1.21	1.5	4	1	1.057	52.24	4	78.37	3	68.46	3	2
RABBITS	.70	1.0	12.1	3	20	1.036	4.67	8	2.82	9	2.92	10	10
BIRDS LG	6.27	1.01	16	4	100	1.120	158.32	2	25.33	5	28.09	6	3.5
MED	1.74	1.01	47	4	100	1.120	43.94	5	20.65	7	29.90	5	7
SM	.71	1.01	156	4	100	1.120	17.93	7	27.97	4	31.01	4	6
BEAR	90.73	1.01	.1	4	1	1.358	22.91	6	2.29	10	3.08	9	8.5
BEAVER	16.62	1.01	102	3	10	1.358	55.95	3	570.95	2	767.38	1	1
MUSKRAT	.93	1.00	2012	3	5	1.040	1.55	10	623.72	1	648.67	2	3.5
MONTH: MAY													
FISH	.65	1.0	64.4	4	20	1.011	3.25	7	10.47	8	10.58	8	7.5
WHITEFISH	.57	1.0	64.4	4	20	1.082	2.85	8	9.18	9	9.93	9	10
MOOSE	175.74	1.21	1.5	4	1.5	1.058	79.74	1	79.74	3	69.72	3	2
RABBITS	.72	1.0	12.1	3	20	1.036	4.8	5.5	2.90	10	3.01	11	11
BIRDS LG	6.36	1.01	16	4	6	1.140	9.64	4	25.69	6	29.00	6	5
MED	1.77	1.01	47	4	6	1.140	2.68	9	21.01	7	23.71	7	7.5
SM	.73	1.01	156	4	6	1.140	1.11	11	28.75	5	32.46	5	6
BEAR	92.32	1.01	.1	4	1	1.364	23.31	3	2.33	11	3.15	10	9
BEAVER	16.91	1.01	102	3	10	1.364	56.93	2	580.69	2	784.22	1	1
MUSKRAT	.95	1.00	2012	3	5	1.040	1.58	10	637.13	1	662.62	2	3
EGGS	.60	1.00	64	1	8	1.015	4.8	5.5	38.4	4	38.98	4	4
MONTH: JUNE													
FISH	.65	1.00	64.4	4	20	1.011	3.25	8	10.47	7	10.58	7	7
WHITEFISH	.57	1.00	64.4	4	20	1.082	2.85	9	9.18	8	9.93	8	9.5
MOOSE	178.77	1.21	1.5	4	1.5	1.059	81.12	1	81.12	4	70.99	4	2.5
RABBITS	.74	1.01	12.1	3	20	1.036	4.98	6	3.01	9	3.09	10	9.5
BIRDS LG	6.45	1.01	20	1	6	1.160	39.09	3	130.29	3	149.64	3	2.5
MED	1.80	1.01	13	1	6	1.160	10.91	5	23.63	6	27.14	6	5.5
SM	.74	1.01	40	1	6	1.160	4.48	7	29.90	5	34.34	5	5.5
BEAR	93.91	1.01	.1	4	1	1.370	23.71	4	2.37	10	3.22	9	8
BEAVER	17.20	1.01	102	3	10	1.370	57.91	2	590.65	2	801.18	1	1
MUSKRAT	.97	1.01	2012	3	5	1.041	1.63	10	657.05	1	677.22	2	4

ANIMAL	WEIGHT (kg)	NON-FOOD YIELDS	DENSITY (ind/km)	MOBILITY	AGGREGATION (ind/group)	FAT CONTENT	COST	RANK	SECURITY	RANK	FAT	RANK	OVERALL RANK
MONTH: JULY													
FISH	.65	1.00	64.4	4	20	1.011	3.25	6	10.47	5	10.58	5	5
WHITEFISH	.57	1.00	64.4	4	20	1.082	2.85	7	9.18	6	9.93	6	6
MOOSE	181.8	1.48	1.5	4	1.5	1.060	100.90	1	100.90	3	72.27	3	2
RABBITS	.73	1.01	12.1	3	20	1.036	4.92	5	2.97	9	3.05	10	9
BIRDS LG	6.54	1.01	20	4	6	1.180	9.91	4	33.03	4	38.59	4	3.5
MED	1.83	1.01	13	4	6	1.180	2.77	8	6.01	8	7.02	8	9
SM	.75	1.01	40	4	6	1.180	1.14	10	7.58	7	8.85	7	9
BEAR	95.50	1.01	.1	4	1	1.376	24.11	3	2.41	10	3.29	9	7
BEAVER	17.49	1.01	102	3	10	1.376	58.88	2	600.61	2	818.25	1	1
MUSKRAT	.99	1.01	2012	3	5	1.041	1.67	9	670.60	1	691.18	2	3.5
MONTH: AUGUST													
FISH	.65	1.00	64.4	4	20	1.011	3.25	6	10.47	5	10.58	5	5
WHITEFISH	.57	1.00	64.4	4	20	1.082	2.85	7	9.18	6	9.93	6	6
MOOSE	184.83	1.48	1.5	4	1.5	1.061	102.58	1	102.58	3	73.54	3	2
RABBITS	.70	1.00	12.1	3	20	1.036	4.67	5	2.82	10	2.92	10	10
BIRDS LG	6.63	1.01	20	4	6	1.200	10.04	4	33.48	4	39.78	4	3.5
MED	1.86	1.01	13	4	6	1.200	2.82	8	6.11	8	7.25	8	8.5
SM	.77	1.01	40	4	6	1.200	1.17	10	7.78	7	9.24	7	8.5
BEAR	97.09	1.01	.1	3	1	1.382	32.69	3	3.27	9	4.47	9	7
BEAVER	17.78	1.01	102	3	10	1.382	59.86	2	610.57	2	835.45	1	1
MUSKRAT	1.01	1.01	2012	3	5	1.041	1.70	9	684.15	1	705.15	2	3.5
MONTH: SEPTEMBER													
FISH	.65	1.00	64.4	4	20	1.011	3.25	8	10.47	7	10.58	8	7.5
WHITEFISH	.63	1.00	64.4	4	20	1.090	3.15	9	10.14	8	11.06	7	9
MOOSE	187.86	1.66	1.5	4	1.5	1.062	116.94	2	116.94	3	74.82	3	2
RABBITS	.68	1.02	12.1	3	20	1.036	4.58	7	2.77	10	2.84	10	10
BIRDS LG	6.72	1.01	31	4	100	1.220	169.68	1	52.60	5	63.54	5	3
MED	1.89	1.01	94	4	100	1.220	47.72	4	44.86	6	54.19	6	6
SM	.78	1.01	312	4	100	1.220	19.70	6	61.45	4	74.22	4	5
BEAR	98.68	1.10	.1	3	1	1.388	36.18	5	3.62	9	4.57	9	7.5
BEAVER	18.07	1.01	102	3	10	1.388	60.84	3	620.52	2	852.76	1	1
MUSKRAT	1.03	1.01	2012	3	5	1.042	1.73	10	697.69	1	719.80	2	4

ANIMAL	WEIGHT (kg)	NON-FOOD YIELDS	DENSITY (ind/km)	MOBILITY	AGGREGATION (ind/group)	FAT CONTENT	COST	RANK	SECURITY	RANK	FAT	RANK	OVERALL RANK
MONTH: OCTOBER													
FISH	.65	1.00	64.4	4	20	1.011	3.25	6	10.47	5	10.58	5	5.5
WHITEFISH	.63	1.00	64.4	2	2000	1.090	630	1	20.27	4	22.11	4	3
MOOSE	190.89	1.66	1.5	4	1.5	1.063	118.83	2	118.83	3	76.09	3	2
RABBITS	.70	1.12	12.1	3	20	1.036	5.23	5	3.16	7	2.92	7	7
BEAR	100.28	1.10	.1	3	1	1.396	36.77	4	3.68	6	4.67	6	5.5
BEAVER	18.38	1.03	102	3	10	1.396	63.10	3	687.41	2	872.39	1	1
MUSKRAT	1.03	1.15	2012	3	5	1.044	1.97	7	794.40	1	721.18	2	4
MONTH: NOVEMBER													
FISH	.65	1.00	64.4	2	20	1.011	6.5	4	20.93	4	21.16	4	4.5
WHITEFISH	.57	1.00	64.4	4	20	1.082	2.85	7	9.18	6	9.93	6	6.5
MOOSE	187.86	1.66	1.5	3	1.5	1.062	155.92	1	155.92	3	99.75	3	2
RABBITS	.72	1.12	12.1	3	20	1.036	5.38	5	3.25	7	3.01	7	6.5
BEAR	98.68	1.10	.1	1	1	1.388	108.55	2	10.85	5	13.70	5	4.5
BEAVER	18.07	1.03	102	2	10	1.388	94.06	3	954.47	2	1297.14	1	1
MUSKRAT	1.03	1.15	2012	2	5	1.042	2.96	6	1191.61	1	1079.70	2	3
MONTH: DECEMBER													
FISH	.65	1.00	64.4	2	20	1.011	6.5	4	20.93	4	21.16	4	4
WHITEFISH	.57	1.00	64.4	4	20	1.082	2.85	7	9.17	6	9.93	6	6
MOOSE	184.83	1.66	1.5	3	1.5	1.061	153.41	2	153.41	3	98.05	3	2.5
RABBITS	.74	1.12	12.1	3	20	1.036	5.53	6	3.39	7	3.09	7	7
BEAR	97.09	1.10	.1	1	1	1.382	106.70	3	10.70	5	13.42	5	5
BEAVER	17.78	1.03	102	1	10	1.382	183.13	1	1867.97	2	2506.34	1	1
MUSKRAT	1.01	1.15	2012	1	5	1.041	5.81	5	2336.94	1	2115.44	2	2.5
MONTH: JANUARY													
FISH	.65	1.00	64.4	2	20	1.011	6.5	4	20.93	4	21.16	4	4
WHITEFISH	.57	1.00	64.4	4	20	1.082	2.85	7	9.18	6	9.93	6	6.5
MOOSE	181.80	1.21	1.5	3	1.5	1.060	109.57	2	109.57	3	96.35	3	2
RABBITS	.72	1.12	12.1	3	20	1.036	5.38	5	3.25	7	3.01	7	6.5
BEAR	95.50	1.10	.1	1	1	1.376	105.05	3	10.51	5	13.14	5	5
BEAVER	17.49	1.01	102	1	10	1.376	176.65	1	1801.82	2	2454.76	1	1
MUSKRAT	.99	1.01	2012	1	5	1.041	5.00	6	2011.80	1	2073.55	2	3

ANIMAL	WEIGHT (kg)	NON-FOOD YIELDS	DENSITY (ind/km)	MOBILITY	AGGREGATION (ind/group)	FAT CONTENT	COST	RANK	SECURITY	RANK	FAT	RANK	OVERALL RANK
MONTH: FEBRUARY													
FISH	.65	1.00	64.4	3	20	1.011	4.33	6	13.95	4	14.09	4	4
WHITEFISH	.57	1.00	64.4	3	20	1.082	3.8	7	12.24	5	13.24	5	6
MOOSE	178.77	1.21	1.5	3	1.5	1.059	107.69	2	107.69	3	94.66	3	2.5
RABBITS	.70	1.12	12.1	3	20	1.036	5.23	4	3.16	7	2.92	7	7
BEAR	93.91	1.01	.1	1	1	1.370	94.85	3	9.48	6	12.87	6	5
BEAVER	17.20	1.01	102	1	10	1.370	173.72	1	1771.94	2	2403.53	1	1
MUSKRAT	.97	1.01	2012	1	5	1.041	4.90	5	1971.16	1	2031.66	2	2.5
MONTH: MARCH													
FISH	.65	1.00	64.4	4	20	1.011	3.25	5	10.47	4	10.58	4	4
WHITEFISH	.57	1.00	64.4	4	20	1.082	2.85	6	9.18	5	9.93	5	6
MOOSE	175.74	1.21	1.5	3	1.5	1.058	106.32	1	106.32	3	92.97	3	2
RABBITS	.68	1.12	12.1	3	20	1.036	5.08	4	3.07	7	2.84	7	7
BEAR	92.32	1.01	.1	2	1	1.364	46.64	3	4.66	6	6.30	6	5
BEAVER	16.91	1.01	102	2	10	1.364	85.40	2	871.03	2	1176.33	1	1
MUSKRAT	.95	1.00	2012	2	5	1.040	2.38	7	955.70	1	993.93	2	3

Notes:
1. Data on weight, non-food yields, density, mobility, aggregation, and fat content were obtained from the following sources:

Weight: fish, Scott and Crossman 1973
- birds, Godfrey 1966
- mammals, Banfield 1974

Non-food yields: moose, Peterson 1955
- birds, estimated from data in Godfrey 1966
- other mammals, estimated from data in Banfield 1974; hide weights obtained from Simpson and Lea Hides, Calgary

Density: fish, Rostlund 1952
- mammals, Banfield 1974; Bigelow 1979a; Shoesmith 1977
- furbearers, Grower and McCloy 1978
- birds, Bigelow 1979b

Mobility: an arbitrary scale
1 completely immobile (eg., hibernating bears)
2 mobile within a specific and highly restricted territory (eg., spawning fish)
3 mobile within a specific but moderately broad territory (eg., yarding moose)
4 mobile within unspecified or very broad territory (eg., fish during the summer

Aggregation: fish, Rostlund 1952
- mammals, Banfield 1974
- birds, Bigelow 1979b

Fat content: Church and Church 1975

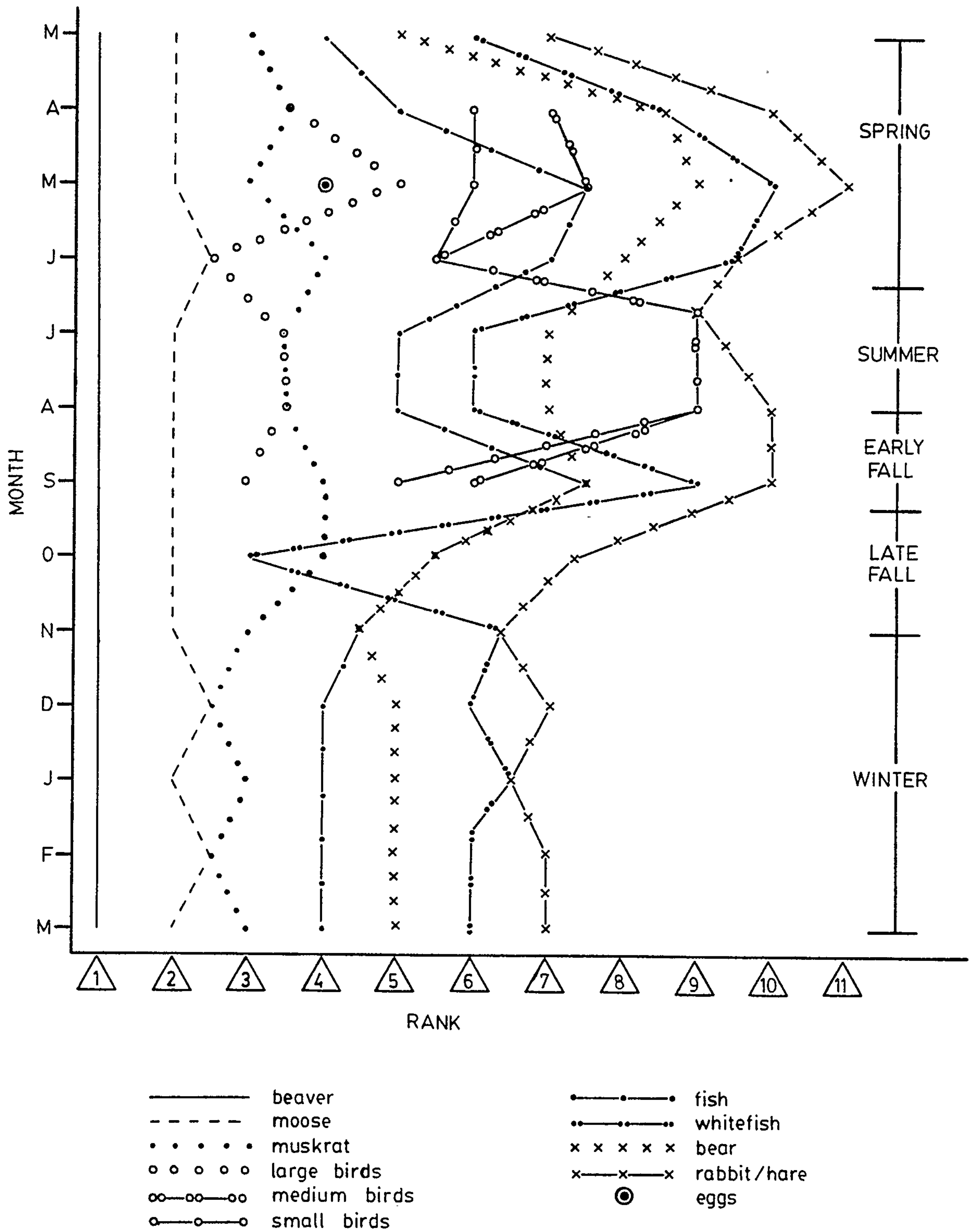

Figure 2: Predicted Rank of Major Food Animals

of subsistence. Fall again witnesses a minor expansion of the ranking distribution. Birds increase in importance in the early part of the fall, and, after their departure, whitefish make a dramatic increase. Winter is apparently a period of incredible monotony, in terms of both the species available and the almost static nature of their ranking.

Comparison of Figure 2 with the 1976 faunal recovery from FbMb-1 (Snortland-Coles 1979: Table 20) shows both correspondences and discrepancies. Of the former, both moose and beaver are the predominant animals, although their rank is reversed in the faunal assemblage. Both bear and birds are ranked low. The ranking of fish and muskrat are the two major discrepancies. According to Snortland-Coles, fish rank above beaver (27% or second as compared with 12% or third, respectively). It appears she used maximum weights for each species rather than mean population weights. Using population means calculated from data in Scott and Crossman (1973) and age-weight data collected by the Manitoba Department of Renewable Resources and Transportation Services (Hanna 1981a), fish drop to 10.37% (using the former figures) and to 5.83% (using the latter data) or is ranked third behind beaver. One should also consider that the calculated value of fish has been averaged out over the entire month in which spawning occurs, whereas the actual spawning period can be as short as a couple of days depending upon changes (either upward or downward) in water temperature (Scott and Crossman 1973). If these values were calculated on a daily or weekly basis, the ranking of fish might be considerably higher.

Muskrat accounts for a minimal proportion of the faunal assemblage as compared to its predicted third place rank. This may be due to two factors. First, it is possible the muskrat population (i.e., density) was over-estimated in the model, even though the data obtained in Banfield (1974: 198) apply specifically to Manitoba marshes. Second, muskrat may have been a seasonal food item, used only in the fall and winter when the musk glands are reduced and avoided at other times when the meat is very strong (Banfield 1974: 199). As presently constructed, the model does not account for seasonal variation in cultural preferences. Consequently, even if muskrat were a high ranked food species in fall and winter, its minimal use or avoidance during the rest of the year would decrease its overall rank as seen in the faunal assemblage.

The predicted distribution of species importance compares reasonably well with Jochim's (1976: Table 9, Figure 5) in that both indicate seasonal shifts in resource importance. Certain differences in species ranking, eg., beaver and muskrat play a much more important role at Aschkibokahn, reflect the very different environmental conditions of Aschkibokahn and Round Lake. Ranking the species importance may not seem as precise as 'calculating' usage proportions; however, it has a much sounder statistical basis while providing in a semi-quantitative manner essentially the same information.

Ranking species according to importance in diet does not indicate whether or not the territory was capable of supporting a population on a year-round basis and the size of the population it could support. This can be examined in one of two ways, either through analysis of carrying capacity of the species and harvesting efficiency of sustainable yields or through examination of historical records to see how many people were living in the region at a given time. Both approaches will be attempted here.

In order to calculate the carrying capacity, I will examine only the three top ranked species, moose, beaver, and muskrat. According to Feit (1980), the hunting effeciency of Mistassini hunters is 71 to 100% for moose and 50% for beaver. Data in Banfield (1974: 198) imply a possible hunting efficiency for muskrat of 25%.

Two assumptions underlie these calculations. First, there is a constant harvestable yield, and second, the harvestable yield maintains a maximum value. In fact, there would be variation due to bad winters, disease, over-hunting of areas, and gradual changes in vegetation, but the decrease in harvestable yields in the three top species would be offset by other species in the diet, eg., fish, birds, and vegetable foods. Table 3 presents the data and results of the calculations for these three species. The carrying capacity would probably be appreciably increased if I were able to include data for fish; however, the particulars for harvestable yield and hunting efficiency, especially during the crucial winter season, are not available or reliable.

Table 3 indicates that the maximum carrying capacity of the Aschkibokahn vicinity is 143 people. Hunting-gathering bands usually are restricted to between 30 and 40% of the carrying capacity of a region (Hassan 1975: 32); consequently, there could be between 43 and 58 people occupying the Aschkibokahn region.

Historical data were obtained from journals in the Hudson's Bay Archives, Winnipeg. The journals were those of Charles Isham at Swan River (1790-91, 1791-92, 1792-93), John Best, Ft. Dauphin (1795-96), Peter Fidler, Ft. Dauphin (1819-20, 1820-21), and Alexander Kennedy, Red Deer River (1812-13) (H.B.C.A.). The location of these posts relative to the Aschkibokahn region is illustrated in Figure 3. Hunters from all these posts exploited portions of the Aschkibokahn region. Data on food brought into the posts were recorded either as number of individuals (or portions

TABLE 3

CALCULATION OF CARRYING CAPACITY

ASCHKIBOKAHN REGION

SPECIES	HARVESTABLE YIELD ($/KM^2$)	HUNTING EFFICIENCY	NUMBERS HARVESTED (KM^2)	$\bar{X}$ WT (KG)	CAL/ 100 GR	CAL/ DAY
Moose	58 [1]	85%	50	181.8	201 [3]	50057.26
Beaver	80 [2]	50%	40	17.5	154 [3]	407572.61
Muskrat	1006 [2]	25%	251.5	.98	154 [3]	143506.31
TOTAL						601136.17
Total persons/day @4135.9625 cal/day [4]						145.34

Notes:
1 calculated from Bigelow 1979a
2 calculated from Banfield 1974
3 from Church and Church 1975
4 calculated from Rodahl 1960: 14

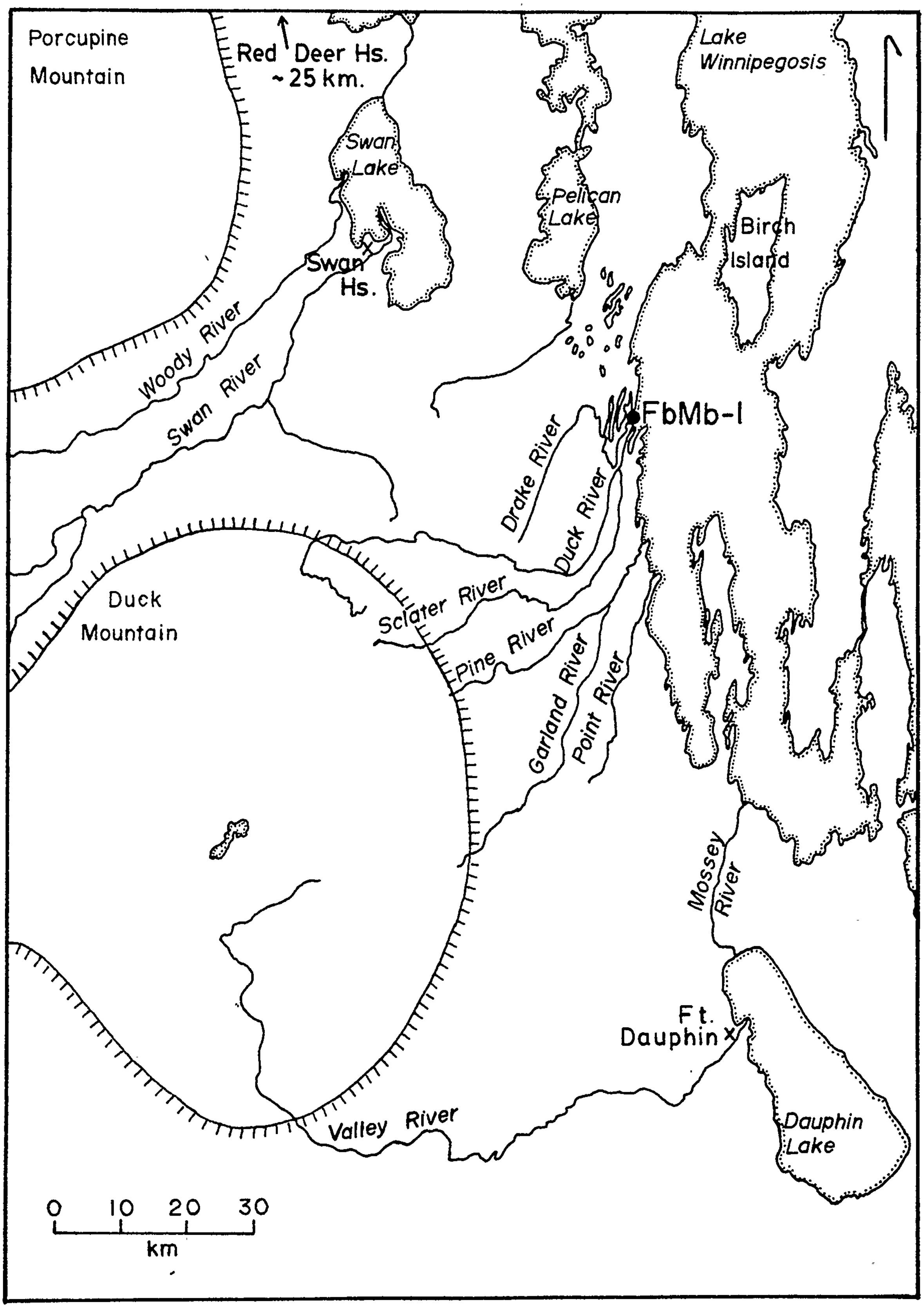

Figure 3: Location of Posts in or near Aschkibokahn Region

thereof) or as pounds of meat; almost always, the species was identified in the journals. Detail and accuracy of recording were variable both within and between journals; consequently, the figures derived can be considered only minimal. Peter Fidler specified that the usual ration for men was five pounds of meat per day, exclusive of bone (H.B.C.A. B51/a/2). If this were moose, the total number of calories consumed per man per day was 4568 calories. The amount of food brought into the post (as calculated from the journals) amounted to an average of at least 41672.106 calories per day, i.e., it could support at least nine men. There were at least four posts operating in the district: two at Ft. Dauphin (one HBC and one NWC), one at Swan River, and one on the Red Deer River. There were at least two Indian co-residential units in the region, and if we accept the average number of 25 as the size of each unit, the region was supporting a population of approximately 86 people in the late eighteenth and early nineteenth centuries.

The applicability of the historic data to the prehistoric situation is modified by two factors. First, these journals were written in the eighteenth and early nineteenth centuries at the end of the Neo-Boreal climatic episode. This episode of cooler moister conditions pushed the southern limit of the boreal forest considerably to the south (Bryson and Wendland 1966: 296; Baerreis and Bryson 1965: 217), entrenching Aschkibokahn firmly within the boundaries of the boreal forest instead of being only marginal to it as the region is now and was during the Neo-Atlantic and Pacific climatic episodes. This would reduce the carrying capacity of the region during the historic period relative to the potential carrying capacity of the Neo-Atlantic and Pacific climatic episodes. Second, the emphasis on furbearers, particularly beaver, during the historic period would put greater pressure on the beaver population decreasing the entire population as well as the harvestable yield. Since beaver are (or were) a significant species in subsistence, a drastic beaver population decrease would produce a simultaneous decrease in the overall carrying capacity of the region. Consequently, the figure of 86 people derived from the historic data can be considered to be only a minimum estimate of the prehistoric population.

In conclusion, the data suggest that both the variety and density of species in the Aschkibokahn region are sufficient to support a human population. The minimum and maximum populations and territory size can be estimated from these figures. The estimated carrying capacity of the area in proximity to Aschkibokahn indicates a density of 2.76 km^2/person, which falls well within the range of variation for hunting-gathering bands generally (Hassan 1975). It is somewhat higher than figures given for the boreal forest, but continues the general east to west-trending increase in density noted by Rogers (1969). A minimal band population of 150 people would then require 414 km^2. If the maximum territory exploited by the Duck Bay Ware producing band was encompassed within the 75 km radius of FbMb-1 (the distance outside of which Duck Bay Ware is known to be infrequent), and if this territory was able to sustain the population density of 2.76 km^2/person, the region could potentially support a population of 3185 people. (It should be noted that this figure is based on a half-circle of 75 km radius. Since Aschkibokahn is located on the lake margin, half of this 75 km circle would cover Lake Winnipegosis, which can be exploited but not inhabited.) This figure hardly represents reality. First, it assumes an even distribution of resources throughout this 75 km region; this does not occur because the relative proportions of lake, marsh, meadow, and forest biomes changes significantly as one proceeds inland from Lake Winnipegosis. Second, band level societies do not have mechanisms of social organization complex or extensive enough to integrate such a large number of people; most upper limits to band population appear to be in the 600 to 800 person range (Hassan 1975; discussion in Damas 1969).

However, it appears possible that the Aschkibokahn region could have supported a population larger than 150 people.

The structure of society and the movement of people:

Mineralogical and chemical analyses have identified the existence of patterned behaviour in resource selection (both clays and tempers) and have been used to differentiate between local and imported wares (see discussion in Chapter 2). With the exception of the studies by Bower (1973) and Brizinski and Buchanan (1977) (both reviewed in Chapter 2), archaeological studies have also concentrated on sedentary horticultural societies. It is significant that the two exceptions were done in Canada where ceramic producing hunting-gathering societies existed prehistorically. The fact that none of the ethnographic studies of contemporary ceramic-producing societies and only two of the archaeological studies have concentated on hunting-gathering societies severely limits our knowledge of the factors influencing the development and maintenance of patterns of resource selection and ceramic production in these societies. However, by combining general principles of social organization (eg., Levy 1952, 1966; Service 1962; Sahlins 1965, 1972) with ethnographic and historical data (eg., Rogers 1969, 1965; Damas 1969; Helm 1965; Honigmann 1956), it is possible to formulate some premises outlining social parameters influencing patterns of production and distribution.

Premise 1: The pottery which we call Duck Bay Ware was made and used by people who, collectively, formed a non-modernized society.

The degree to which a society is modernized or non-modernized affects features of the society such as the relationship with the human and non-human environment, complexity (number of structures), specialization and self-sufficiency of the structures, degree of centralization, and scale (Levy 1966: 93-107). Because of this inter-relationship, if we have tangible evidence for the degree of modernization and some aspects of the society, we can predict the nature of the remaining aspects.

The degree to which a society is modernized or non-modernized may be measured by the degree to which members of the society rely on animate (human and animal) as opposed to inanimate (wind, water, petrochemical, electrical, atomic) sources of energy. A non-modernized society is defined as one whose members rely primarily on animate sources of energy and who use relatively simple tools. Tool 'simplicity' or 'complexity' is not related to the number of parts from which a tool is made (as Oswalt [1976] proposes) but rather the degree to which tools increase the efficiency of human effort (Levy 1966: 13).

Members of non-modernized societies use tools which provide a minimal increase in the output of human energy.

The people making and using Duck Bay Ware were members of a non-modernized society. The lithic and bone artifacts recovered from FbMb-1 are relatively simple (Snortland-Coles 1979; Badertscher 1980; Walker 1978) and there is no evidence for primary reliance on non-animate energy sources. Given the non-modernized nature of the society, there are certain statements we can make about the organization of the society.

Premise 2: The number of concrete structures in a non-modernized society is few. Because they are so few, they are relatively non-specialized in terms of any of the aspects of society (role differentiation, solidarity, economic allocation, political allocation, integration, and expression).

A concrete structure is a social unit characterized by specific types of relationships and certain patterns of behaviour (Levy 1952: 88). The size, number, and function(s) of these structures vary widely among societies. The activities of members of these structures are oriented to satisfying the functional requisites of adaptation to the environment, sexual recruitment, role differentiation, communication, shared cognitive orientation, shared articulated sets of goals, regulation of the choice of means, regulation of affective expression, adequate socialization of new members, control of disruptive forms of behaviour, and adequate institutionalization of behavioural patterns (Levy 1952: 149-193). When there are few structures, all structures or, at a minimum, those structures which incorporate the overwhelming majority of the members of the society must generalize their activities in order to ensure that the functional requisites are met.

The nuclear family unit and the extended kinship system are two structures in hunting-gathering societies within which occur activities meeting functional requisites. A family structure is necessary in order 1) to recruit new members through sexual reproduction and 2) to socialize and enculturate these new members. This results, either ideally or actually, in two types of families: the family of orientation, a structure in which "a given individual is reared from infancy to some state of maturity", and a family of procreation, a structure in which an individual "ordinarily becomes a parent and has to do with the rearing of children considered to be his (or her) own or representatives of a younger generation than the one to which he (or she) belongs" (Levy 1952: 404). The family unit is the basic unit within which occur production and consumption (Schneider 1974: 186; Sahlins 1972: 74;

Service 1962: 108, 109), role differentiation based minimally on age and sex, and socialization and regulation of members (Dunning 1959: 123).

A structure of solidarity uniting family units is necessary to maintain the integrity of the society. The main structure of solidarity operating in hunting-gathering societies at the supra-family level is the kinship system. This is the structure within which occur recruitment of new members (Dunning 1959: Chapter 6) and distribution of goods and services (Sahlins 1965: 141). Other structures may be present, for example, work groups, trading partnerships, and special sodalities, but they serve to integrate more restricted portions of the society than does kinship and may operate only temporarily or sporadically (Service 1962: 21-23; Fisher 1969: 15).

Premise 3: Since these social units are relatively non-specialized, they are relatively self-sufficient.

Family units in hunting-gathering societies are relatively self-sufficient in two ways. First, under favourable conditions, they are capable of producing most of what they need and consuming most of what they produce (Fisher 1969: 15) Second, they are capable of satisfying most of the functional requisites necessary for the continued existence of the society. The functional requisite which they are least capable, or incapable, of meeting is that of sexual recruitment because of incest rules and imbalanced sex ratios within any given generation (Rogers 1969: 28; Fisher 1969: 14). It is because they are not completely self-sufficient in this respect that interaction with other structures must occur (Sahlins 1972: 95; 1965: 143). Hunting-gathering societies are generally recognized to have three levels of social organization above the family: the co-residential group (three to four families), the local band (two or more co-residential groups), and the macro-band (two or more local bands) (Rogers 1958: 19, 184; Leacock 1969: 9-11; Dunning 1959: 54-55), although some Great Basin and Inuit bands are exceptions (Steward 1955; Service 1962). The local band appears to be the minimal unit which is both economically and maritally viable. The family and co-residential groups may be economically viable, at least on a seasonal basis, but are not maritally viable (i.e., self-sufficient). Evidence from contemporary band societies indicates that the population size at which a local band, the basic unit of identification (Dunning 1959: 54; Rogers 1969: 25), can best operate as a unit is around 150 individuals (Lee and Devore 1968; Damas 1969).

Premise 4: Because of the relatively non-specialized and self-sufficient nature of the social units, the society is relatively non-centralized and small scale.

Centralization is concerned with co-ordination and control of both individuals and structures. Where the basic structures are relatively self-sufficient and non-specialized it is difficult to obtain and maintain any effective control at a level higher than that of the co-residential group (Rogers 1958: 199). When co-ordination and control of larger units is attempted, it is usually only temporary and for a specific purpose. Where control of political and economic allocation is placed in the hands of one or a few people, they are usually 'elders' and male, and their position is reinforced by appeal to their wisdom and experience rather than by any recourse to force (Rogers 1958: 21, 39).

The shaman was the only individual with any coercive power. Nevertheless, the shaman was still a peripheral member of the society (Steward 1955: 111) because his access to supernatural forces made him a dangerous member of society. His connection with the supernatural, which allowed him to cure illnesses and overcome enemies, also allowed him to achieve his own ends, to make demands that would be outrageous for any other individual to make, and to bring disease and destruction in retribution for real or imagined insults, slights, or snubs. Men who had demonstrated their abilities as warriors and hunters, who were generous with their possessions, and whose actions generally maintained the stability of the co-residential group were the ones in whom the power to co-ordinate, such as it was, was invested (Mandelbaum 1979; Rogers 1958: 200). Even then, consensus was the means whereby decisions were made. If members of the co-residential group disagreed with the decision, they could ignore it or relocate with impunity (Honigmann 1956; VanStone 1974).

This relatively non-centralized nature of hunting-gathering societies means that face-to-face interaction, supported and strengthened by reciprocal exchange of goods and services, is an important means of maintaining solidarity among the social units. This can happen on a regular basis only if the society is small scale, that is, comprises a small population and inhabits a limited area.

Premise 5: The level at which stable behavioural patterns appear is influenced by the level at which group membership is stable, i.e., the level at which most members interact within a group boundary rather than with other individuals/groups outside this group boundary.

Membership stability can be considered at each of the three levels of co-residential group, local band, and macro-band. The degree of membership mobility at each level has ramifications for the development of distinctive behavioural patterns at these levels. In a hunting-gathering society, the lowest level at which it is possible for membership and, therefore, behavioural patterns to be relatively constant is that of the local band. As stated in Premise 3, the co-residential group is too small to be a viable, self-sufficient unit. Several of these groups, which constitute the local band, must interact to be both economically and maritally viable. As members of the various co-residential groups interact, they have the opportunity to observe, learn, and ultimately share behavioural patterns.

The members of different local bands, which are largely though not necessarily completely self-sufficient, will interact to a lesser degree than do the members of co-residential groups within any one local band. As the frequency of interaction decreases, so does the opportunity for sharing behavioural patterns. Consequently, members of adjacent local bands will share some behavioural patterns, though not to the degree that behavioural patterns are shared within the local band.

Premise 6: The movement of women in response to environmental and social factors will determine the distribution of ceramic styles and technologies.

The movement of women (and by implication, the stability and distribution of technological patterns) within and between local bands is related to two major factors: 1) movement of the co-residential group in the course of the yearly subsistence cycle and 2) the initiation of new families of procreation. Both factors will influence the distances over which women travel and the frequency with which particular sites or regions are visited.

The distribution of sites over the landscape, the settlement pattern, is dependent upon the seasonal subsistence activities of the co-residential group (Beardsley 1956; Jochim 1976). Settlements, both large and small, of brief or extended duration, are formed at the loci where game is hunted, plants are gathered, trade is conducted, and lithic and clay sources are mined. Unusual factors can cause settlement shifts of greater or lesser permanence--for example, excessive drought or floods causing resource depletion, epidemics in both animal and human populations, and prolongued warfare or feuding--but neither the causes nor the results necessarily preserve in the archaeological record. Archaeologists are more likely to recover the results of routine patterned behaviour.

The types and frequencies of artifacts found in a site are dependent upon whether both men and women or only one sex is occupying the site. This in turn is dependent upon the duration of site occupation and the types of activities occurring there.

The settlement pattern may be characterized as either non-sedentary or semi-sedentary. Both are characterized by a hierarchy of sites in terms of importance (i.e., access to critical resources) and size. They are differentiated by the relative proportion of large and small sites and the existence of permanent base camps.

A non-sedentary settlement pattern is one in which several large sites are located at the sources of key resources (eg., fish spawning grounds, summer fishing camps, caribou crossings) with smaller sites scattered throughout both primary and secondary territories where less important or less frequently exploited resources are located. Co-residential groups move among these camps and occupy them so as to harvest seasonally available resources. The co-residential groups move frequently, though irregularly, more or less as a single entity among the more important camps whereas single families or single-sex task groups move between larger and smaller sites. This is considered to be the pattern typical of hunting-gathering societies (eg., Lee 1979; Damas 1969; Service 1962; Beardsley 1956).

A semi-sedentary settlement pattern is one in which a relatively permanent base camp, occupied at all seasons by at least a portion of the population, is surrounded by secondary camps temporarily occupied in the pursuit and possibly the processing of certain seasonally available resources. Whether both men and women or one sex only were at these satellite camps would depend upon the activities occuring there. In the late 1700s and early 1800s, relatively large and sedentary southwestern Ojibwa villages existed along the lake shores and on islands (Hickerson 1962; Bishop 1976). These villages had a fluctuating though year-round population ranging in size from 26 to over 800 individuals. They were probably at least partly supported by European food supplies; however, this historic settlement pattern appears to have been an elaboration of a previous indigenous pattern.

The total complex of behavioural patterns of any one local band should be distributed over an area which corresponds minimally with the extent of the primary territory encompassed by the yearly settlement pattern. Not all behavioural patterns will occur at all sites, since many activities are seasonally and spatially limited. The territory over which this behavioural complex is distributed will be much larger if the local band is non-sedentary than if the local band is semi-sedentary.

The initiation of new families of procreation requires that two people must unite to form a family of procreation. There are bounds, both ideally and actually, to the number of potential spouses and the social unit(s) from which an acceptable spouse may be selected. Minimally, an individual must conform to the rules of incest avoidance, which means that he or she must, under normal circumstances, seek a spouse from a different family of orientation. These different families of orientation may or may not correspond to different co-residential groups. In order to establish a new family of procreation, one of the couple must move at least temporarily from his/her family of orientation or co-residential group.

The movement of individuals, in establishing new families of procreation, may occur between co-residential groups either within a local band or between local bands. An important consideration, therefore, is the geographical dispersion of co-residential groups and local bands. If co-residential groups or local bands are widely dispersed, then individuals will have to travel farther to form families of procreation than if co-residential groups or local bands are close together. In all instances, the movement will influence the type of artifacts (i.e., male-related, female-related, or both) which move and the extent to which these artifacts move.

The movement of individuals initiating new families of procreation also follows patterns. Two approaches to analysis of these marriage behaviour patterns will be briefly examined here: exogamy-endogamy at the local band level and post-marital residence patterns.

Endogamy and exogamy specify, respectively, the group within which one must marry (by implication the group in which one is already a member) and the group outside of which one must marry. The local band is selected as the marital group boundary to be considered since it is the smallest unit of identification which has the potential to be endogamous (see Premise 3). A co-residential group must be exogamous because it contains too few members to be a maritally viable endogamous unit under normal circumstances. Furthermore, as Dunning points out (1959: 119), members of a co-residential unit consider themselves as consanguineal kin, with marriage among them prohibited. Members of other co-residential units are classed as either consanguineal or affinal relatives; marriage is permitted with the latter and also with the former if the kin relationship is not close.

There appears to be a difference of opinion among northern Algonquian ethnographers about whether or not the local band is, or can be, endogamous. For example, Leacock (1969: 12) and participants in the discussion in Damas (1969: 52) think that at least four local bands, or between 400 to 600 people, are necessary to form an endogamous unit. They appear, however, to be considering population size alone without considering other environmental or social factors. Population concentration and isolation, either geographical or social, may be as important as population size. For example, Dunning reports an increase in endogamous marriages among the Pekangekum band since the previously dispersed co-residential units settled in the vicinity of the post (1959: 164-169). Honigmann (1953: 814; 1956: 49), Rogers (1965: 70), and Rogers and Rogers (1980) report the existence of endogamous local bands with populations varying between 50 to 150 people. It seems that the extent to which the ideal marriage pattern is actualized is dependent on environmental, social, and demographic factors, and not demographic factors alone.

Anthropological studies have usually emphasized relatedness through descent as the basis for determining the group into (or out of) which one must marry (Fox 1967: 23; Service 1962: 31-33). Turner and Wertman (1977: v-vii) encountered difficulties when attempting to analyze northern Algonquian marriage patterns using descent principles, and suggested the use of alliance theory instead. With alliance theory, kinship becomes a means of expressing and stipulating rights and obligations between and among individuals and social units as a result of alliances established through exchange of women as spouses (Wertman 1976: 3). With hunting-gathering bands, alliances are initiated and maintained largely in response to environmental conditions, particularly whether the territory they inhabit is a resource dependent or resource independent territory.

The temporal and spatial distribution of resources can be used to categorize a territory in one of two ways. A territory may be considered to be resource dependent if resources exhibit a non-uniform spatial and temporal distribution (Wertman 1976: 9). As a result, there is uncertainty about the availability of resources either in any one locality in the territory or at any one time of the year. A territory may be considered to be a resource independent territory if resources exhibit a uniform spatial and temporal distribution. There is relatively little uncertainty about the availability of resources. The criteria of a resource independent territory can be met in one of two ways. The distribution of resources may be uniform and constant or the resources, though not uniformly distributed, may be stratified into micro-environments which are all in proximity to a base camp. Even if seasonal fluctuations are still a consideration, spatial variability is minimized since the proximity of interspersed biomes means that access to any and all biomes and their resources can be easily achieved from any one site. This spatial distribution may even offset seasonal variability to a greater or lesser degree in that resource aggregation, density, and mobility in one or more biomes may be enhanced by the very seasonal factors that are decreasing the resource potential in other biomes.

Local bands inhabiting a resource dependent territory may initiate alliances to facilitate access to resources and labour in time of need because of uncertainty about the temporal and spatial availability of resources in their own territories (Wertman 1976; Service 1962: 71; Yellen and Harpending 1972: 251). Each local band could enhance its ability to obtain refuge in times of famine or feud by arranging alliances with as many other local bands as possible. These rights and obligations were reciprocal between the parties to the alliance.

Although alliances could be initiated and maintained in many ways, an important mechanism was the exchange of women as spouses. This solidified the alliance in two ways. First, it enlarged the kinship group, thereby increasing the number of people with mutual obligations and privileges. Second, women produced children who further enhanced the alliances by reinforcing reciprocal rights and obligations across generational boundaries as well as across local band boundaries. These alliances would be further reinforced by both informal and formal means such as visiting, periodic relocation of families, and reciprocal exchange of goods and services.

Local bands inhabiting resource independent territories are less concerned about obtaining access to ouside resources since resource variation is minimized both spatially and seasonally (Wertman 1976). Under these conditions, the prime concern of local bands is not the availability of resources in the event of adverse conditons but rather the defense of their territory from outsiders (Yellen and Harpending 1972:248). However, relatively peaceful relations must be maintained with adjacent local bands, otherwise one would spend more time defending one's territory than feeding one's family. The defense of one's territory by force would be very difficult, given the non-centralized nature of the society of the 'invader' and the 'defender'. The integrity of the local band territory would be better maintained by the establishment of alliances between adjacent local bands. This would reduce potential conflict between them by stipulating rights and obligations that each party to the alliance could expect from the other.

The stability of the alliances is fragile because interaction between local bands is minimal. In a situation where alliances cannot be, or are not, maintained through regular informal means (eg., visiting), more formal means such as marriage are required. Where marriage is the means by which alliances are actualized, well-defined and regularly renewed patterns of marriage will develop. The renewal and affirmation of the alliance can occur not only over successive generations but also concurrently by means of sororal marriages. Other formal relationship such as trading partnerships or fictive kin relationships could be used to reinforce the alliances (Burch 1970; Bruner 1961: 201).

Exogamous and endogamous local bands would develop as a result of these circumstances. For local bands inhabiting a resource dependent territory, exogamy would serve not only to create alliances and, thereby, offset environmental liabilities but also to offset cultural factors such as imbalanced sex ratios (Dunning 1959: 67-70). Local bands inhabiting resource independent territories could become largely, though not exclusively, endogamous (Yellen and Harpending 1972: 248). They would not need access to other territories to obtain most subsistence resources since these would already be available in their own territory. Some alliances with other bands would be necessary to maintain peaceful relationships and to acquire access to desired resources not found in their own territory. These resources might be subsistence items, lithic materials, or ceremonial objects. It is possible for a population inhabiting a resource independent territory to live a semi-sedentary life style with most of the population being clustered at one site for most of the year (Aikens

1978: 81, 82). In these circumstances, alliances between co-residential units of the same local band might be even more necessary than alliances between adjacent local bands, since the co-residential units are spatially closer thereby increasing the possibility of territorial impingement. The local band could never be exclusively endogamous because of its proximity to other local groups with which it must maintain some, at least 'formal', peaceful relations.

The implications of endogamous and exogamous marital patterns for the distribution of ceramic production patterns follow from Premise 5. In an exogamous model, women are moving among several local bands; consequently, the behavioural patterns would be shared and homogenized in proportion to the frequency of interaction. The greater the number of local bands with which any one local band maintains exogamous relations, the greater the territory over which behavioural patterns have the potential to be shared. Conversely, in an endogamous model, there is a tendency for women to remain in their own local band and, consequently, there is less opportunity for behavioural patterns to be shared with other local bands. Ceramic production behavioural patterns will be largely restricted to the territory of the local group.

Post-marital residence patterns are relevant to this discussion because not only the source of spouses but also the residence of the couple after marriage affects the movement and distribution of women and ultimately of pottery within and between local bands. The residence patterns to be considered here are uxorilocality, bilocality, and virilocality.

A number of anthropologists view virilocal residence as the basic form in band societies because of the desirability, if not the necessity, of keeping together the males born into a family so that the economic viability of the family unit will not be threatened (Service 1962; Sahlins 1959; Steward 1955; Murdock 1949; Williams 1974). Men defend territory and hunt game animals, which account for between 10% to 99% of the diet; therefore, "agreement and co-operation between males is of economic consequence to the group" (Williams 1974: 19). This "agreement and co-operation" is best achieved by retaining sons born into the family. It follows, then, that a woman upon marriage goes to live with the family of her husband and loses to a greater or lesser degree her membership in her original family of orientation and/or co-residential group. The net effect is, ideally, a one-way transfer of women to other local bands if the local band is exogamous or, if the local band is endogamous, to other co-residential groups within the local band. The area over which women are exchanged depends upon whether the local band is endogamous or exogamous.

The argument for bilocal post-marital residence revolves around its proposed advantage in adaptation to variation in environmental and social factors such as resource concentration or depletion, the labour needs of the spouses' families, imbalanced sex ratios, and disparities in family size (Speck 1923; Murdock 1949; Sahlins 1959; Helm 1965; Lee 1974; Fisher 1969). In small populations, the latter two factors can seriously disrupt ideal marriage and post-marital residence patterns. Spouses can be as critical and scarce a resource under these circumstances as are key subsistence resources.

One of the implications of bilocal residence is that women do not necessarily leave their families of orientation upon marriage (Honigmann 1956: 62). This period of bride service is beneficial for both parties. On the one hand, the wife's parents have an extra son to provide for them while they continue to benefit from the daughter's work. On the other hand, the man, already familiar with the basic principles of where to find what animals, has an opportunity to become acquainted with the geographical details and productivity of his wife's family's territory. This benefits him and his family by giving them an option on additional territory if, in the future, his father's and/or brothers' territories are depleted. This option is best maintained if kinship ties with the wife's father and/or brother(s) are periodically renewed by visiting or living with them. The latter would serve to appraise the man of current conditions in his wife's father's territory.

The families of procreation constituting the co-residential group would relocate their residence as necessary and convenient among the primary territories of kinsmen. If a co-residential group had to move out of its primary territory, the members would not necessarily move as a single unit since each family would have slightly different sets of alliance relationships. Each family could move independently of the others to settle temporarily with their respective sets of kin. Thus, while the periodic movement of a family between the territories of their respective father/brother(s) might not approach some anthropologically ideal post-marital residential pattern, it certainly approaches the ideal for maximizing subsistence options. The overall result is a two-way movement of both men and women between co-residential groups and, if the local band is exogamous, between local bands.

Uxorilocality has been little discussed in the context of hunting-gathering societies because it appears so infrequently (Service 1962). Where it occurs in the eastern and central boreal forest, it appears to be a variation of bilocality, usually in the form of a period of bride service (Leacock 1955; Honigmann 1953). While the adaptive advantages of virilocality and bilocality among hunter-gatherers are obvious, those of uxorilocality are not.

Two explanations have been proposed. Martin (1969) suggested that matrilocality may promote a greater degree of social cohesion among groups. Matrilocal groups in South America exhibited a much lower incidence of inter-group fighting than did patrilocal groups. In the former situation, males, who did the fighting and who were dispersed among the social units, were less likely to fight if they would be fighting against kin.

Inglis (1970) has proposed an ecologically-based argument to explain the presence of matrilineal institutions among several societies in northwestern North America. Men were involved in subsistence activities--sea mammal hunting and deep sea fishing--which required intimate knowledge not of territory but rather of seamanship and sea mammal behaviour. Women, on the other hand, gathered plant foods and shellfish, items geographically localized, seasonally available, and, in the case of shellfish, located at places whose accessibility was affected by weather conditions and tides. Thus, women needed intimate knowledge of territory and local conditions, and, because they invested labour in maintenance of these territories and passed this knowledge on to subsequent generations, it was advantageous to keep women together. However, post-marital residence was avunculocal, not matrilocal, since men were also involved in salmon and oolachan fishing, activities which are highly localized and require labour investment in building and maintaining weirs and traps. These were seasonal, short-term activities as compared with sea mammal hunting which occurred most of the time. Overall, men were less involved in territorially delimited subsistence activities than were women.

The ability to differentiate archaeologically among virilocal, bilocal, and uxorilocal residence requires an examination and comparison of the distribution of both men's and women's tools. Under virilocality, women would be moving between co-residential groups or local bands whereas men would be relatively stable; consequently, men's tools would be restricted to the territory of the local band whereas women's tools would be distributed among the territory of adjacent local bands. Under bilocality, both men and women would be moving with approximately equal frequency; consequently, their respective sets of tools would be approximately equally distributed. Under uxorilocality, men would be moving between co-residential groups or local bands and the women would be relatively stable; consequently, women's tools would be restricted to the territory of the local band whereas men's tools would be distributed among the territory of adjacent local bands. Unfortunately, the distinction cannot be made for this particular situation at this time. Male artifacts from FbMb-1 and surrounding sites have not been subjected to a detailed enough analysis of stylistic and technological attributes or to a distributional analysis.

The models:

If we accept the above discussion that the Aschkibokahn region was capable of supporting a population of at least 150 people and that settlement and marriage patterns are two factors affecting the distribution of behavioural patterns relating to ceramic production, we can devise four alternate hypotheses to explain the distribution of Duck Bay Ware. In brief, the models predict that technology will correlate with location but not with style. The test implications are summarized in Table 4 and are presented in detail below.

Model 1: Duck Bay Ware was made, used, and deposited by women who were members of a non-sedentary, exogamous local group (Figure 4).

Aschkibokahn was one camp in the primary territory

TABLE 4

DISTRIBUTION AND VARIABILITY OF SITES AND TECHNOLOGIES FOR DIFFERENT SETTLEMENT AND MARRIAGE PATTERNS

	EXOGAMY	ENDOGAMY
NON-SEDENTARY	-large primary territory -gradual decrease in Duck Bay frequency outside territorial boundaries -faunal remains imply seasonal occupation -many large and small sites in territory -both men's and women's tools at most sites -minimal ceramic variability within and between local band territories linked by marriage	-large primary territory -sharp decrease in Duck Bay frequency outside territorial boundaries -faunal remains imply seasonal occupation -many large and small sites in territory -both men's and women's tools at most sites -minimal ceramic variability within local band territory -maximum ceramic variability between local band and adjacent local bands
SEMI-SEDENTARY	-small primary territory -gradual decrease in Duck Bay frequency outside territorial boundaries -faunal remains imply year-round occupation -one or two large sites, many small sites -both men's and women's tools at large site(s); both may or may not be present at small sites -minimal ceramic variability within and between local band territories linked by marriage	-small primary territory -sharp decrease in Duck Bay frequency outside territorial boundaries -faunal remains imply year-round occupation -one or two large sites, many small sites -both men's and women's tools at large site(s); both may or may not be present at small sites -minimal ceramic variability within local band territory -maximum ceramic variability between local band and adjacent local bands

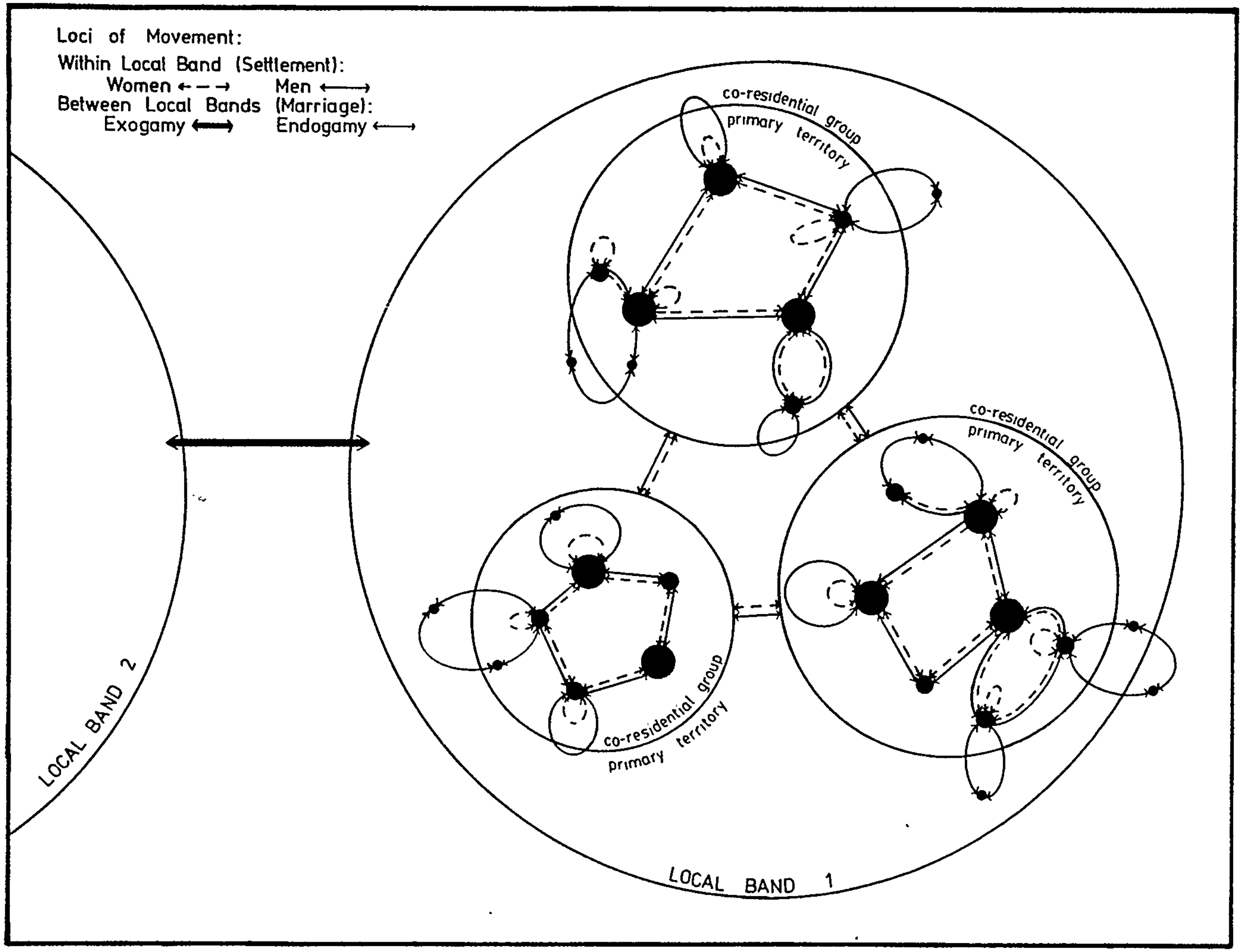

Figure 4: Model I — Non-sedentary Exogamous Local Band

of a local band. It was occupied seasonally by co-residential groups of the local band and by some co-residential groups of other local groups allied to the former by marriage. Aschkibokahn would most likely be occupied during the spring and fall. The large spawning runs of pickerel, northern pike, and sucker occur in the spring and in both spring and fall game birds use the region as a staging area on their migrations. After the spring spawning was completed, the people might stay on at the site but would eventually move to other camps to exploit other resources.

Because of local group exogamy, marriages would be contracted at least as frequently with contiguous local bands as within the local band. A large proportion of women would leave the territory of the local band and an approximately equal number of women from other local bands would enter the territory. This movement of women between and within local bands would expose them to variations in selection, production, decoration, and perhaps even use of ceramics. This would result in an homogenization of technologies and styles (i.e., women would come to share a common technology and style) or a relatively uniform mixing of different technologies and styles throughout the local bands associated by marriage. It is possible that a small proportion of marriages would be arranged with more distant local bands. This should result in the intrusion of some 'foreign' ceramic traits into the local band's territory and the appearance of a small proportion of Duck Bay Ware in more distant sites.

The test implications of this model are as follows:

1. The territory of the local band will contain many large and small sites;
2. Both men's and women's tools should be found at most sites both large and small;
3. There will be minimal stylistic, technological, and frequency variability in ceramics among sites in the local band territory and minimal variability among sites in territories of local bands linked by marriage. This will be manifested in the following ways:

3a. locational analysis should delimit a large primary territory containing sites with a high proportion of Duck Bay Ware, with a gradual decrease in Duck Bay Ware frequency proportional to the distance from the primary territory;

3b. chemical and mineralogical analysis of the ceramics should indicate uniform selection of clays and temper materials throughout both the local band territory and the territories linked by marriage. This uniform selection may occur as a result of either similar selection of different clays/tempers by all women in all associated local bands or use of only one clay or temper by all women in all associated local bands;

4. Faunal remains at FbMb-1 should indicate predominantly spring and fall occupation of Aschkibokahn.

Model 2: Duck Bay Ware was made, used, and deposited by women who were members of a non-sedentary endogamous local band (Figure 5).

As in the previous model, Aschkibokahn was one camp in the primary territory of the local band, occupied as a spring and fall focal point because of the aggregation of spawning fish (spring) and migratory waterfowl (spring and fall). Co-residential groups of this local band only would occupy Aschkibokahn, since alliances contracted outside the endogamous local band were to defend territory and prevent intrusion rather than to permit access to resources by outside local bands.

Because of local band endogamy, marriages would be contracted more often within the local band than with

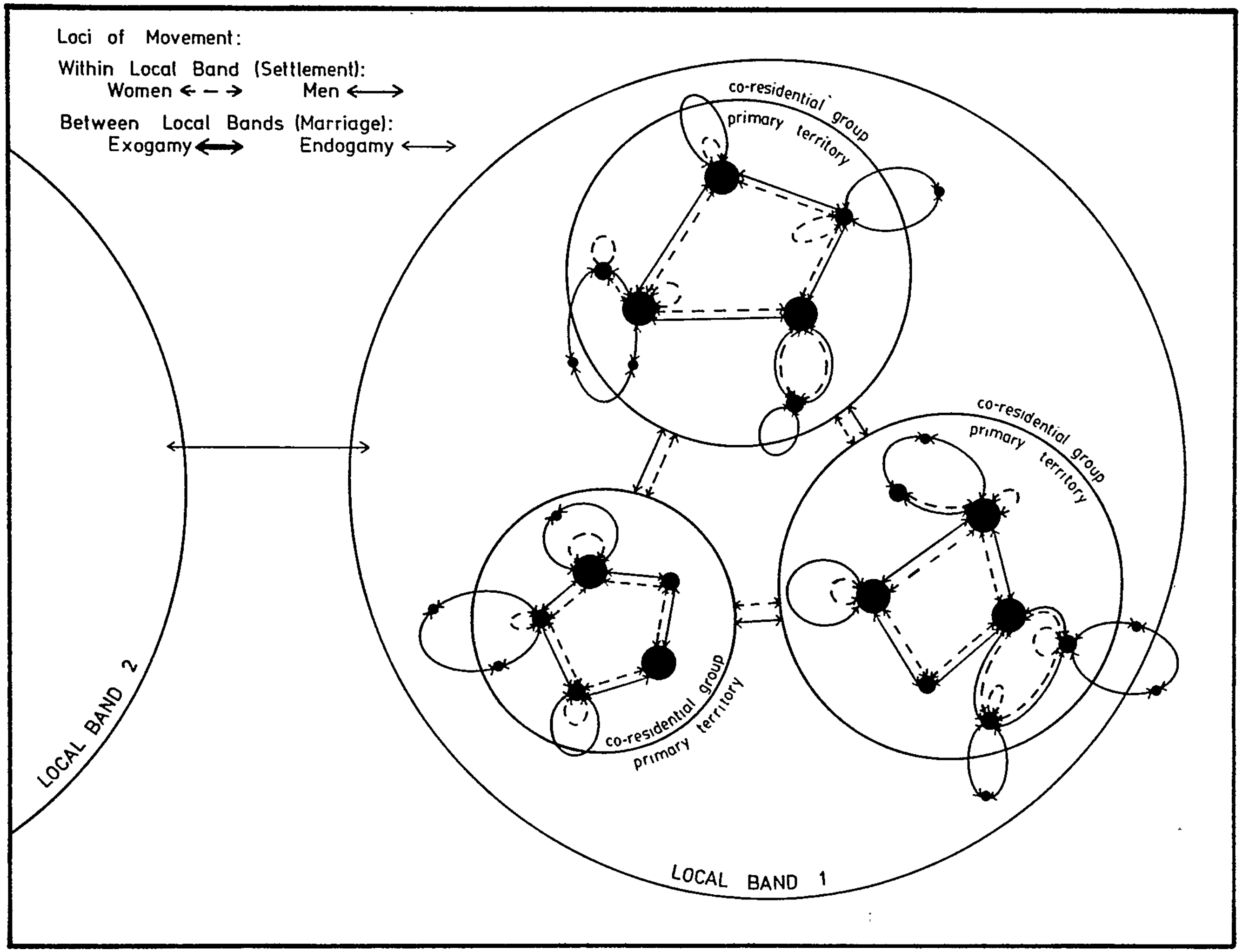

Figure 5: Model 2 — Non-sedentary Endogamous Local Band

contiguous local bands. The majority of women would remain within the territory of the local band, and only a small percentage would leave it. Conversely, only a small percentage of women from neighbouring local groups would enter the membership of the local band. Women moving within the local band would be exposed to variations in ceramic production among the co-residential groups, resulting in an homogenization of ceramic technologies and styles throughout the local band. The relative isolation from ceramic styles and technologies used by women in other local bands would result ultimately in the development of patterns distinctive from those of other local bands. There would be a minor amount of infiltration of 'foreign' styles and technologies into the local band as a result of alliances contracted with neighbouring local bands.

The test implications of this model are as follows:

1. The primary territory of the local band will contain many large and small sites;
2. Both men's and women's tools should be found at most sites both large and small;
3. There will be minimal stylistic, technological, and frequency variability in ceramics among sites in the local band territory. There will be significant

stylistic, technological, and frequency variability between the local band territory and surrounding local bands' territories. This will be manifested in the following ways:

3a. locational analysis should delimit a primary territory containing sites with a high proportion of Duck Bay Ware, with a very sharp decrease in Duck Bay Ware outside the territorial boundaries;

3b. chemical and mineralogical analysis of the ceramics should indicate uniform selection of clays and temper materials throughout the local band territory. This uniform selection may occur as a result of either similar selection of different clays and/or tempers by all women in all co-residential groups or use of only one clay and/or temper by all women in all co-residential groups.

3c. chemical and mineralogical analysis of the ceramics should indicate distinctive selection patterns of clays and temper materials corresponding to local band territories.

4. Faunal remains at FbMb-1 should indicate predominantly spring and fall occupation of Aschkibokahn.

Model 3: Duck Bay Ware was made, used, and disposed of by women who were members of a semi-sedentary, exogamous local band (Figure 6).

In this model, Aschkibokahn would be the logical choice for a base camp because of 1) its proximity to fish spawning grounds, waterfowl staging areas, plant resources, and game and 2) its situation at the mouths of two streams provides easy access to 'interior' biomes and resources. These latter resources would be exploited from temporary secondary camps. Co-residential groups of both the resident local band and adjacent allied local bands would inhabit Aschkibokahn. The affiliation of people occupying the secondary camps would probably be similar, the numbers would be fewer.

With local band exogamy, marriages would be contracted at least as frequently with contiguous local bands as within the local band. A large proportion of women would leave the local group territory and an approximately equal number of women from neighbouring local bands would enter the territory. Consequently, women would be exposed to a variety of technological, manufacturing, and decorative patterns in the ceramic production process. The result would be either a homogenization or a mixing of ceramic styles and technologies among the local bands associated by marriage. It is possible that a smaller number of marriages

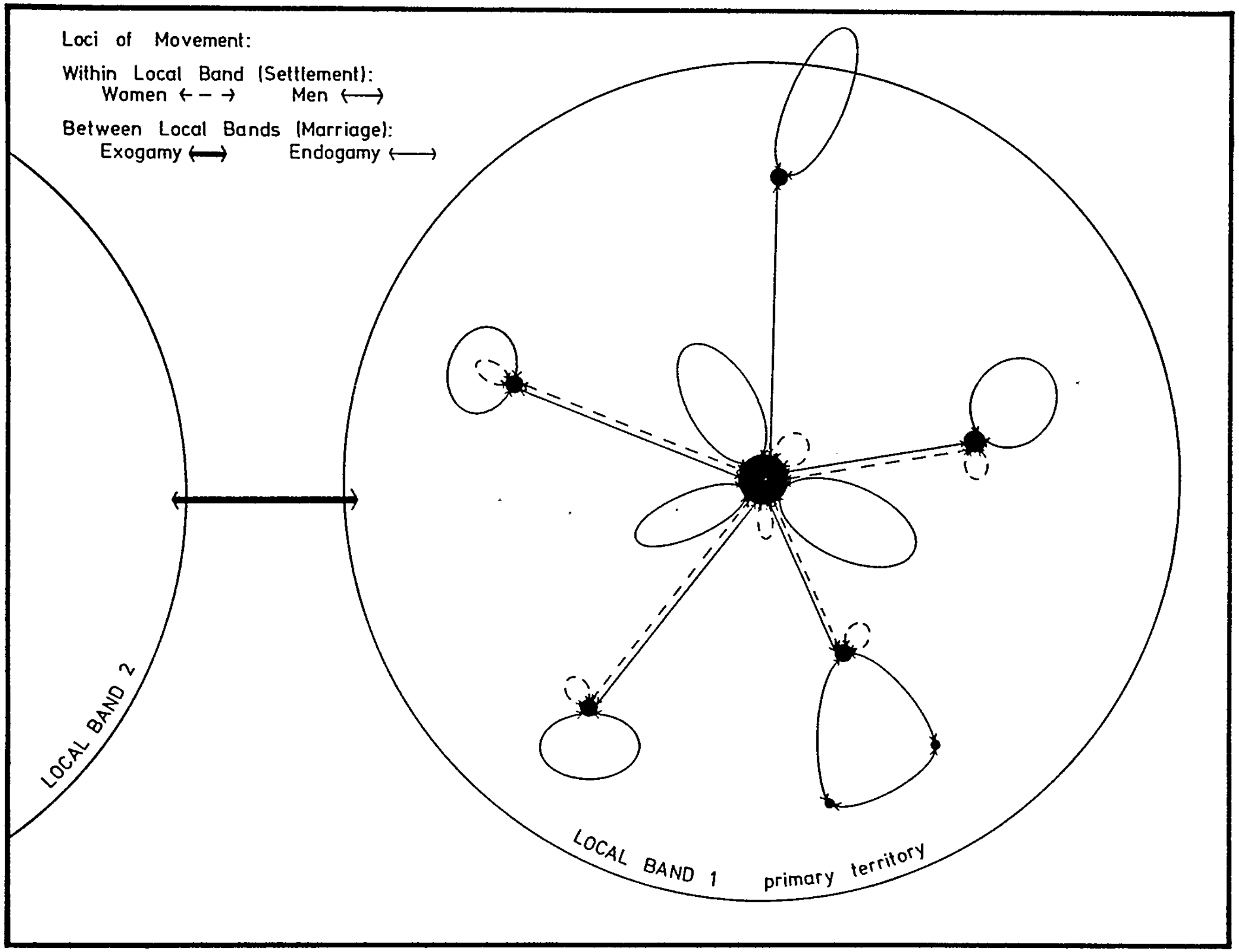

Figure 6: Model 3 — Semi-sedentary Exogamous Local Band

might be arranged with more distant local groups; in this case, 'foreign' techniques and styles would occasionally intrude into the Aschkibokahn local band territory while Duck Bay Ware would appear sporadically in sites distant from Aschkibokahn.

The test implications of this model are as follows:

1. There will be a large base camp in the primary territory with numerous secondary sites located throughout the territory;
2. Both men's and women's tools will be present at the base camp; both may or may not be present at all secondary camps;
3. There will be minimal stylistic and technological variability in ceramics among sites in territories linked by marriage. This will be manifested in the following ways:

3a. locational analysis should delimit a small primary territory containing sites with a high proportion of Duck Bay Ware, with a gradual decrease in Duck Bay Ware frequency proportional to distance from the primary territory;

3b. chemical and mineralogical analysis of the ceramics should indicate uniform selection of clays and temper materials throughout both the local band territory and the territories linked by marriage. This uniform selection may occur as a result of either similar selection of different clays and/or tempers by all women in all associated local bands or use of only one clay and/or temper by all women in all associated local bands;

4. Faunal remains at FbMb-1 should indicate year-round occupation of the site.

Model 4: Duck Bay Ware was made, used, and disposed of by women who were members of a semi-sedentary, endogamous local band (Figure 7).

As in the previous model, Aschkibokahn was the base camp from which adjacent biomes were exploited. Secondary camps would be set up around the base camp since the configuration of biomes would require periodic temporary movement among biomes by at least some portion of the local band. Both the base camp and the secondary camps would be occupied by co-residential groups of this local band.

With local band endogamy and with all co-residential groups living more or less permanently at Aschkibokahn, the exchange of women between co-residential groups means they would remain in relatively close and continual contact with their kinswomen, even if they became

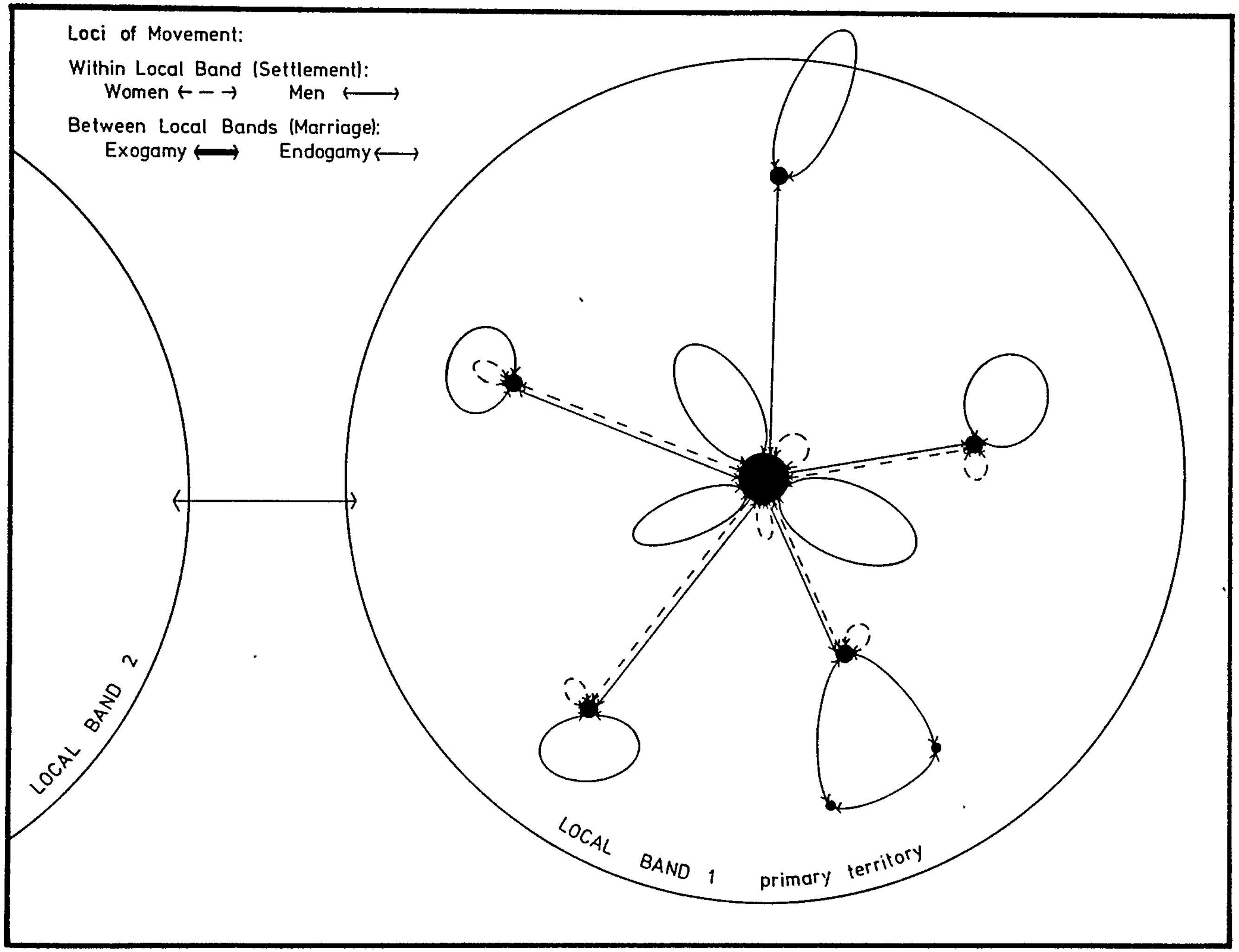

Figure 7: Model 4 — Semi-sedentary Endogamous Local Band

'officially' members of different co-residential groups. Behavioural patterns would be common to all women, and the ceramics would show a high degree of uniformity.

Some marriages outside the local band, i.e., with adjacent local bands, would be necessary to maintain formal and peaceful relations and to protect against territorial intrusion. Consequently, a few women from neighbouring local bands would enter the Aschkibokahn local band and, conversely, a few women from Aschkibokahn would move to other local bands. There would be a minor amount of infiltration of 'foreign' styles and technologies into the local band as a result of these marriages contracted with contiguous local bands.

The test implications of this model are as follows:

1. There will be a large base camp in the primary territory with numerous secondary sites located throughout the territory;
2. Both men's and women's tools will be present at the base camp; both may or may not be present at all secondary camps;
3. There will be minimal stylistic, technological, and frequency variability in ceramics among sites in the local band territory. There will be significant

stylistic, technological, and frequency variability between the local band territory and surrounding local bands' territories. This will be manifested in the following ways:

3a. there will be a primary territory containing sites with a high proportion of Duck Bay Ware and a very sharp decrease in Duck Bay Ware frequency outside the territorial boundaries;

3b. chemical and mineralogical analysis of the ceramics should indicate uniform selection of clays and temper materials throughout the local band territory. This uniform selection may occur as a result of either similar selection of different clays and/or tempers by all women in all co-residential groups or use of only one clay and/or temper by all women in all co-residential groups;

3c. chemical and mineralogical analysis of the ceramics should indicate distinctive patterns of selection of clays and temper materials corresponding to local band territories.

4. Faunal remains should indicate year-round occupation of the site.

Model 5--Trade:

Model 5: The distribution of Duck Bay Ware is a result of its being traded to other local bands subsequent to its production at Aschkibokahn.

Trade is a mechanism of exchange used ethnographically, and presumably prehistorically, for several reasons. At the most basic level, trade was used to offset deficiencies in the resource base. The Huron, for example, traded with the Algonquians to the north for deer hides which they used to make clothing (Gramly 1977). Cree and Assiniboine visited Mandan villages to obtain corn and other items (Burpee 1927). Such trade occurred between groups who inhabited different resource zones, who utilized different subsistence strategies (i.e., hunter-gatherers and horticulturalists), or who produced different manufactured goods (Wilmsen 1972: 2).

Trade amongst band and tribal level societies had a more important function, however. Trade was used to reinforce systems of social interaction. In such a context, what was important to the participants was not so much what was being traded as what social relationships between groups were being established, reinforced, and promised for future interaction (Wilmsen 1972; Wright 1967). The items being traded could be foodstuff (corn, meat, fat), manufactured goods (nets, mats, ceramics), or ceremonial items (bison heads, tobacco, feathers). The net results from a purely economic viewpoint would be the acquisition of needed or desired goods not obtainable in one's home territory. From a social viewpoint, what was being obtained was a geographical extension of social relationships, through trading partnerships or fictive kin relationships, and an affirmation that these relationships would continue into the future (Wright 1967; Wilmsen 1972; Ford 1972).

Information about ceramic trade is woefully lacking. The Mandan apparently made ceramics to trade (Flannery 1953), and the Huron traded ceramics to the Ottawa and Mascoutens (Adams 1961: 90). Both instances are cases where the ceramics were made by sedentary horticulturalists and were traded to non-sedentary hunter-gatherers.

The case for trade of Duck Bay Ware is less clear. The people occupying the region were not horticulturalists; whether or not they were semi- or totally sedentary has yet to be established. Certainly, there is no apparent difference in paste quality, size, or shape between Duck Bay Ware and other surrounding wares that would make it a desirable trade item. The souvenir value of Duck Bay Ware is unknown and probably unknowable. It may be, however, that Duck Bay Ware was obtained in trade not for the vessel itself but for what was contained in the vessel.

If, however, Aschkibokahn was the source as which Duck Bay Ware was made and the appearance of Duck Bay Ware at other sites is due to trade, then technology should correlate with style but not with location. In other words, the test implications of the trade model are as follows:

1. Duck Bay Ware should have a consistant chemical and mineralogical composition, no matter where it appears;
2. The chemical and mineralogical composition of Duck Bay Ware should be different from that of other wares both at FbMb-1 and at other sites where it appears.

Model 6--Function:

Model 6: The distribution of Duck Bay Ware is a result of its use for a particular function or in a particular activity.

Function is a badly underdeveloped avenue of investigation in ceramic studies. There are many assumptions and questions which are unexamined. Is there a correlation between the way an item is made and the way it is to be used? This assumes that there is something about the function that requires the pot to be made in a certain way through selection and/or processing of raw materials, the proportions of each in mixing the paste, vessel shape and size, firing procedures (either temperature, time, or fuel), or post-firing treatment (eg., greasing, smudging). Is that particular vessel class used only for that purpose, and conversely is only that vessel class used for that purpose? When it ceases to be functional for that purpose, is it discarded or is it recycled for other purposes? What factors influence whether it is to be discarded or recycled? What factors influence how it is to be recycled?

In addition, analytical procedures whereby we might determine function from vessel shape and size, carbonized remains on vessel interior and/or exterior, and technical aspects are practically non-existant and unexplored. There is so little relevant ethnographic information that we have no comprehension of the variation in function that may have existed. Consequently, function is proposed here more as a residual explanation; if the test implications of neither trade nor social organization predict the configuration of style, technology, and location as evidenced in the archaeological data, then some functional aspect(s) of Duck Bay Ware may be considered a reasonable (but as yet unprovable) alternate explanation.

There are at least two purposes for which Duck Bay Ware might have been made: processing of fish and salt production. In this case, the distinctive decoration would advertise not the ethnic identity of the person who made and/or used the vessel but rather the purpose, i.e., fish pot or salt pot. Although there may be other purposes (including the ever popular 'ceremonial object'), these two purposes are selected for initial examination because of the proximity of FbMb-1 to these resources. Salt springs and flats are common throughout the area on the west side of Lake Winnipegosis (Warkentin and Ruggles 1970: 532-533; personal observation 1976, 1977), although there are none known in the immediate vicinity of Aschkibokahn. Fish, of course, are one of the main reasons for occupation of Aschkibokahn in the spring, when the fish spawned in the mouths of the Duck and Drake rivers, and during the rest of the year, when fish seem to congregate there in smaller quantities than during spring spawning but more densely than in the lake.

The test implications of this model are:

1. Residues on pot interiors should have a high salt content (for salt pots) or a high fish-derived residue (for fish pots);
2. None of the previous models should adequately explain the distribution of Duck Bay Ware.

CHAPTER 4

DATA ANALYSIS

Introduction:

This chapter is concerned primarily with the procedures and results of x-ray fluorescence and thin-section analysis of Duck Bay Ware and other ceramic types from FbMb-1 and other sites, the X-ray fluorescence analysis of clays, and the thin-section analysis of selected fired clays and rocks from Aschkibokahn and the Swan River Valley. This will be followed by a presentation and discussion of the ancillary data.

X-Ray Fluorescence Analysis:

General principles:

When an element is bombarded with either a monochromatic or polychromatic beam of X-rays, electrons in the shells surrounding the nucleus are excited. When the X-ray beam exceeds a certain critical excitation voltage, an electron is removed from one of the shells and is replaced by one from an adjacent outer shell. At this point, the element emits a characteristic line spectrum of fixed wavelength. Greater energy (i.e., a higher critical voltage) is needed to remove electrons from the inner (K) shell than from the outer (L, M, etc.) shells (Hall 1959, 1960; Cullity 1956). Jenkins and de Vries (1969) provide a technical survey of the theory and method, while Cullity (1956) and Tite (1972) provide detailed summaries.

In primary X-ray spectrometry, the sample is placed inside the X-ray tube. Problems associated with this procedure include limits to size of the sample, and the time and possible damage involved in disassembling and reassembling the tube to insert each sample (Hall 1959: 83). These are now overcome by the use of secondary X-ray spectrometry. The sample, located outside the tube, is bombarded with 'white' (i.e., polychromatic) radiation. There is a higher proportion of radiation backscattering and the resulting peaks are reduced (Hall 1959: 84). Nevertheless, this procedure is relatively efficient and accurate. Either procedure may provide a qualitative analysis, whereby only the presence of elements is determined, or a quantitative analysis, in which the intensity of the spectrum is calibrated against a standard to give a relative proportion of the element present.

X-ray fluorescence should be considered as complementary to X-ray diffraction, optical spectroscopy, and atomic absorption spectroscopy. X-ray fluorescence is used to identify major and minor elements, i.e., elements present in proportions greater than 0.1%. Under certain conditions, trace elements as low as 0.0001% can be identified (Tite 1972: 271); however, the main element of the sample may mask the emitted spectrum of a trace element, seriously affecting sensitivity (Hall 1959: 85). Optical spectroscopy and atomic absorption deal better with trace elements of 0.0005% to 5% concentration (Hall 1959: 85).

X-ray methods are faster than optical spectroscopy, and the spectral line structure is both simpler and, ideally, more accurate (Hall 1959: 85). Originally, X-ray fluorescence could be used to identify only those elements with atomic numbers greater than 22 (titanium). With special controlled conditions (eg., the use of a vacuum, special filters, and certain analyzing crystals), this limit is now reduced to elements with atomic numbers greater than 4 (Cullity 1956: 407; Jenkins and de Vries 1969: Table 5).

X-ray fluorescence identifies the chemical constituents of clay and not the clay minerals as does X-ray diffraction, because X-ray fluorescence detects atoms, not molecules (Hall 1959: 85). The use of X-ray diffraction relys on the crystal structure of the clay molecule to produce the charateristic radiation (Tite 1972: 285-286). This crystal structure is either partly or totally destroyed during firing, depending on the maximum temperature reached.

X-ray fluorescence analysis may be either destructive or non-destructive. The latter procedure permits analysis of rare or valuable objects; however, it has certain limitations. X-rays are strongly absorbed by matter; consequently, only the surface of the object can be analyzed (Cullity 1956: 407; Hall 1960: 32). If a ceramic vessel has a slipped, glazed, or painted surface, this will be analyzed and not the clay. Furthermore, variations throughout the thickness of the sherd will not be detected. The sample surface is a critical factor. It should be flat and smooth to minimize the noise produced by back-scattering of X-rays (Tite 1972: 271; Cox and Pollard 1977). Most archaeological specimens, including pottery, have a corroded, eroded, or otherwise unsatisfactory surface. In some cases, the area to be analyzed can be polished, but then the procedure can no longer be considered strictly non-destructive. Recent developments with the electron microprobe (which analyzes an area of 1 mm or smaller) can avoid this problem (Hall 1959: 87; Tite 1972: 278).

The destructive procedure requires a maximum of 2 gr of the specimen to be crushed and pressed into a small biscuit of uniform and homogenized chemical composition. The size of the sample depends primarily on the concentration of the elements to be detected. Prepared samples can be more efficiently analyzed than actual specimens.

Error may be introduced during analysis. Contamination of samples during preparation may occur, but this can be avoided or minimized through rigorous preparation procedures. Minimal contamination at this stage does not significantly decrease accuracy of measurement when using major and minor elements as it does when analyzing for trace elements.

During the actual analysis, it possible that certain oxides will either enhance or mask the detection and recording of the proportion of other oxides. This error can be compensated for by a matrix correction procedure which is a statistical correction derived from the analysis of standards with known proportions of oxides.

Sample selection:

Potsherds:

Each rim sherd of the 1976 and 1977 excavations and the earlier Manitoba Archaeological Society, Dauphin Chapter, recovery was weighed to select those greater than 5 gr. Five grams was chosen as the minimum sherd weight to ensure that there was sufficient material to grind for the sample without destroying the decorated portion of the sherd. One hundred ninety-one sherds were greater than 5 gr. A series of 10% random samples (19 sherds per series) was drawn until patterning in chemical composition became apparent. A total of 61 sherds was selected: 57 by random selection and 4 chosen at the beginning of the project as test samples. These 61 sherds represent a 15% sample of all vessels recovered from FbMb-1. Thirty-eight sherds of various wares were selected, on the same basis of size, from sites in Saskatchewan and Manitoba.

Clays:

A brief 10-day survey of the Swan River Valley region in July, 1980, was undertaken to relocate and resample clay deposits recorded by Bannatyne (1970). Attempts were also made to locate other deposits in the valley as well as on Aschkibokahn. These were less than successful. At each deposit, samples were taken along the length and depth, except at Aschkibokahn where only one sample was taken. When testing the subsurface of the island, it was necessary to dig through a thick limestone cobble bed before reaching a deposit containing minimal quantities of clay and silt. A second test at the other end of the island revealed identical conditions. Unfortunately, neither time nor logistic support was available to survey for clay deposits in the vicinity of Aschkibokahn. A total of 34 samples was selected.

Sample preparation:

It was decided not to remove the temper from the potsherds prior to final grinding and preparation for several reasons. First, we do not know what, if any, proportion of the aplastics is indigenous to the clay and what proportion was added. Second, because of the size variation in aplastics, it is impossible to remove all aplastics by either chemical floatation or mechanical screening. Third, any attempt to remove aplastics would result in differing proportions being removed from each sample. The net effect would be to increase, rather than decrease, error in measurement and interpretation. The addition of the aplastic chemical composition to the total composition could be adequately controlled, if necessary, by thin-section analysis and X-ray diffraction. These techniques can identify the type of aplastic and, therefore, chemical composition as well as estimate quantity. This could subsequently be subtracted from the total chemical composition as determined by X-ray fluorescence.

The undecorated interior of each sherd was cleaned of dirt, catalogue number (ink and nail polish), carbonized materials, and any other non-ceramic materials and then ground using a small hand-held diamond grinding wheel. The preparation of the four test samples indicated that 1.5 gr of powdered sherd was sufficient for analysis. The powder was stored in individually labelled vials, with site designation, catalogue number, ceramic type, and donor institution marked on each vial. This procedure of selection, cleaning, grinding, and labelling was followed with sherds from other sites which were used for comparative purposes.

The clays were dried in an oven to remove moisture. Aside from this step, subsequent preparation of clay and ceramic samples was identical.

Each sample was pulverized in a swing mill for two minutes to produce a very fine powder of homogeneous composition. About 1 gr of the sample was placed in a press along with two large spoonsful of medium powdered cellulose. This was pressed at 20,000 psi for five seconds to produce a small biscuit about 3 cm in diameter and .5 cm in thickness. The back (cellulose side) of the biscuit was labelled with an identification number, pressure data, and date, and each was placed in a plastic container to prevent contamination. Care was taken not to touch the front (sample side) of the biscuit.

Results:

The initial analysis was to identify major and minor oxides in each sample. These oxides are SiO_2, Al_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, and MnO. A Phillips PW 1410 X-ray spectrometer with three analyzing crystals (Pe, LiF200, and TLAP) and a scintillation counter (for short wavelengths) and a gas flow counter (for long wavelengths) was used for analysis. The movement of the samples inside the spectrometer and selection of analyzing crystal, counter, and angle were controlled by a computer programme. The samples, in sets of three, were compared against a standard (a shale) with known composition. This permitted us to transform raw data (counts per second) to percentage of each oxide in each sample. These data, in uncorrected form, are presented in Tables 5 to 7.

Dunnett's test for multiple comparisons with a control (Dunnett 1964) and Q-mode factor analysis (Klovan 1975; Imbrie and van Andel 1964; Kim and Mueller 1978a, 1978b) were used to compare the chemical composition of FbMb-1 vessels to those from the comparison sites. Dunnett's test was used to test the probability that the percentage of each oxide in the two samples is similar. FbMb-1 vessels were compared against, first, vessels from all comparison sites, and subsequently, vessels from each of three of these comparison sites. These three sites (EaLf-1, LAS 348, and LAS 43) were represented by enough vessels (N = 10, 6, and 5 respectively) to permit a statistical comparison of oxide concentration. These comparisons were made for two reasons. First, lumping all the comparison

TABLE 5

CHEMICAL COMPOSITION (%), CLAY DEPOSITS

SAMPLE NUMBER	LOCATION	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	TOTAL
CL1	Pine R.	19.67	3.69	.79	.96	40.11	--	1.86	.14	.14	.07	67.43
CL2	"	50.56	14.16	3.19	1.91	9.58	.14	1.65	.44	.11	.05	81.79
CL3	"	63.41	18.35	2.17	1.41	1.95	.26	4.27	.92	.08	.03	92.85
CL4	"	19.88	4.08	.89	1.26	39.73	--	2.01	.14	.13	.05	68.17
CL5	"	16.75	4.16	.61	.64	42.12	--	2.17	.13	.12	.05	66.75
CL6	"	19.48	4.13	.59	1.44	40.72	--	2.05	.14	.14	.04	68.73
CL7	"	36.09	5.91	1.99	8.66	18.10	.57	1.45	.31	.15	.07	73.30
CL8	Pine-	30.89	6.42	1.89	8.80	20.27	.51	1.72	.28	.14	.05	70.97
CL9	Garland	28.42	5.90	1.76	9.38	20.74	.64	1.73	.25	.12	.04	68.98
CL10	"	27.79	5.07	1.52	9.94	22.32	.62	1.55	.21	.11	.04	69.17
CL11	"	38.56	6.86	2.14	7.04	16.85	.47	1.67	.35	.17	.08	74.19
CL12	"	45.35	8.64	2.75	6.34	12.46	.93	1.88	.45	.16	.08	78.98
CL13	"	41.04	7.70	2.30	6.43	15.37	.70	1.68	.38	.17	.08	75.85
CL14	"	35.33	6.27	2.02	7.80	18.75	.56	1.55	.33	.17	.07	72.85
CL15	"	32.69	4.93	1.67	9.23	19.57	.55	1.39	.29	.16	.07	70.55
CL16	"	37.69	8.41	2.47	7.46	15.63	.83	2.02	.36	.14	.06	75.05
CL17	"	33.71	3.84	1.45	8.91	19.80	.53	1.16	.25	.20	.08	69.93
CL18	"	24.54	4.00	1.30	10.43	23.70	.49	1.41	.17	.11	.04	66.19
CL19	"	21.88	4.04	1.19	10.27	26.09	.31	1.36	.17	.11	.04	65.46
CL20	FbMb-1	20.94	2.95	1.00	10.94	26.77	.37	1.02	.13	.35	.03	64.50
CL21	Swan R.	69.02	19.83	1.33	.69	.09	.70	1.73	1.21	.04	.01	94.65
CL22	"	91.13	10.97	.70	.26	.08	.27	.50	1.50	.04	.01	105.46
CL23	"	86.40	10.13	1.55	.44	.14	.35	1.31	1.12	.06	.01	101.51
CL24	"	84.80	4.83	.43	.18	.09	.13	.78	.70	.02	.01	91.97
CL25	"	78.86	7.03	2.46	1.80	2.69	.21	1.02	.78	.09	.15	95.09
CL26	"	69.17	15.03	3.18	.77	.31	.19	1.85	1.51	.12	.24	92.37
CL27	"	55.79	12.29	4.14	3.74	5.59	.77	2.38	.68	.20	.10	85.68
CL28	"	68.25	21.05	1.05	.54	.13	.23	1.58	1.30	.12	.07	94.32
CL29	"	69.30	19.63	1.90	.52	.12	.23	1.54	1.27	.09	.12	94.80
CL30	Swan R.	64.50	18.68	3.96	.67	.31	.50	2.08	1.70	.11	.29	92.80
CL31	(Fraser)	58.49	21.21	4.71	.80	.31	.47	2.27	1.72	.11	.39	90.48
CL32	"	53.90	24.99	2.88	.87	.27	.53	2.32	1.69	.10	.07	87.62
CL33	"	99.65	6.39	.42	.21	.11	.13	.67	1.21	.02	.01	108.82
CL34	Duck R.	57.99	22.99	3.39	1.61	.18	.21	5.26	1.05	.07	.03	92.78

TABLE 6

CHEMICAL COMPOSITION (%), FbMb-1 VESSELS

SAMPLE NUMBER	CATALOGUE NUMBER	TYPE	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	TOTAL
DB-1	M12h	DBNL	68.99	13.00	5.01	1.72	1.75	1.60	2.56	.62	1.12	.07	96.44
DB-2	MD1-3D1	b.s.	61.04	12.46	7.40	1.75	2.65	2.15	2.58	.54	1.39	.08	92.04
DB-3	M-12c	DBP	67.60	13.68	5.31	1.58	1.55	1.53	2.60	.67	1.26	.06	95.84
DB-5	BD-1	BD	61.88	12.86	5.55	1.92	2.71	2.26	2.62	.56	0.83	.05	91.24
DB-6	DBP-32a	DBP	65.56	13.41	5.57	1.59	1.66	1.55	2.42	.70	1.21	.13	93.80
DB-7	DBP-22	DBP	62.44	14.11	5.65	1.65	1.87	1.87	2.90	.66	1.44	.08	92.67
DB-8	MD1-9322	DBNL	73.60	11.12	4.20	.96	2.05	1.67	1.77	.58	2.21	.12	98.28
DB-9	A560	other	64.80	13.04	5.30	1.41	2.04	1.70	2.41	.66	.99	.07	92.41
DB-10	DBP-49	DBP	60.92	13.23	4.82	1.87	2.71	1.78	2.74	.65	2.13	.06	90.91
DB-11	MD1-9179	DBP	64.60	13.30	4.34	1.31	2.06	2.39	3.06	.46	1.72	.05	93.29
DB-12	G210	DBP	64.13	13.44	4.39	1.55	2.22	1.35	2.65	.71	2.69	.04	93.17
DB-13	DBU-8	U	67.16	12.83	5.04	1.51	1.59	1.49	2.49	.66	1.23	.06	94.07
DB-14	DBP-39b	DBP	66.77	13.14	4.97	1.50	1.84	2.13	2.25	.64	1.00	.07	94.31
DB-15	MD1-4464	BD	62.62	13.26	5.32	1.41	2.32	1.48	2.68	.71	2.32	.09	92.21
DB-16	MD1-4463	DBP	65.60	13.40	4.92	1.52	1.77	1.45	2.86	.73	1.04	.06	93.35
DB-17	MD1-707	BD	60.87	12.68	5.23	2.11	3.00	1.73	2.79	.67	1.70	.06	90.84
DB-18	MD1-10828	DBNL	62.30	12.79	6.77	1.48	1.55	1.34	2.46	.70	.83	.09	90.31
DB-19	MD1-6336	DBP	62.41	13.01	4.91	1.59	2.88	1.50	2.47	.69	2.67	.06	92.19
DB-20	A802	DBP	63.76	13.38	4.38	1.44	2.40	1.75	2.31	.70	2.31	.05	92.48
DB-21	MD1-9753	BD	63.00	13.52	4.78	1.35	2.00	1.70	2.73	.68	2.70	.08	92.54
DB-22	DBU-7	U	69.42	12.09	5.25	1.38	1.73	1.55	2.13	.71	1.12	.07	95.45
DB-23	DBP-32b	DBP	62.11	12.74	5.14	2.02	2.24	1.85	2.46	.68	1.52	.07	90.83
DB-24	J177	DBP	65.08	12.77	4.87	1.44	1.89	1.51	2.50	.68	1.54	.05	92.33
DB-25	DBNL-40	other	69.55	12.51	5.10	1.25	1.81	2.00	2.48	.57	.54	.07	95.88
DB-26	MD1-9989	BD	60.55	12.95	5.37	1.58	3.05	1.71	2.54	.62	4.15	.06	92.58
DB-27	MD1-10686	DBNL	66.62	13.30	4.97	1.71	1.73	1.79	2.19	.66	.93	.04	93.94
DB-28	E185	DBP	63.92	13.66	4.83	1.69	1.80	1.27	2.66	.70	2.59	.05	93.17
DB-29	DBU-26	U	64.16	13.57	4.91	2.12	1.86	1.52	2.69	.70	.76	.09	92.38
DB-30	MD1-7871	DBP	63.59	13.68	4.71	1.74	2.49	1.37	2.43	.71	1.93	.06	92.71
DB-31	MD1-5348	DBNL	60.17	13.35	5.33	1.71	2.39	1.09	2.41	.70	3.17	.05	90.37
DB-32	K192	DBNL	61.33	13.86	5.29	2.12	1.96	1.35	2.20	.69	1.48	.07	90.35
DB-33	G360	DBP	54.71	12.29	4.77	3.91	4.90	1.18	2.44	.67	1.45	.07	86.39
DB-34	MD1-11	BD	68.59	12.71	4.52	1.46	2.02	2.03	2.34	.62	.95	.05	95.29
DB-35	K228	DBNL	63.88	13.25	5.25	1.84	1.89	1.36	2.31	.69	1.43	.08	91.98
DB-36	DBP-54	DBP	69.50	13.05	4.89	1.52	1.78	1.95	2.17	.63	.85	.05	96.39
DB-37	MD1-816	BD	61.15	14.13	6.02	1.35	1.35	1.58	2.82	.76	2.62	.06	91.84
DB-38	DBNL-14	DBNL	67.36	13.44	5.11	1.60	1.56	1.64	2.46	.68	.54	.07	94.46
DB-39	M12h	DBP	74.15	11.70	4.00	1.28	1.41	1.64	2.49	.52	.74	.06	97.99
DB-40	DBP-43	DBP	61.10	13.64	5.38	2.06	2.01	1.81	2.32	.66	1.24	.06	90.28
DB-41	DBP-34	DBP	63.21	12.98	4.73	1.70	2.78	1.60	2.56	.66	2.24	.07	92.53
DB-42	DBNL-38	DBNL	65.78	12.79	4.76	1.45	2.22	1.84	2.32	.62	2.44	.11	94.33
DB-43	F876	U	63.20	13.40	5.30	1.82	2.00	1.36	2.37	.69	1.36	.07	91.57
DB-44	DBP-11	DBP	67.79	12.43	4.41	1.33	2.19	1.65	2.45	.61	1.34	.05	94.15
DB-45	DBNL-18	DBNL	70.23	12.46	4.32	1.55	1.44	1.85	2.31	.63	.46	.04	95.29
DB-46	MD1-8582	DBP	60.87	12.79	5.10	1.96	2.43	1.23	2.55	.69	2.07	.19	89.88
DB-47	A950	DBP	62.98	12.85	5.16	1.54	2.24	1.52	2.32	.65	1.87	.06	91.19
DB-48	H422	other	58.32	11.96	4.63	1.52	4.03	1.12	2.01	.63	5.37	.07	89.66
DB-49	G719	DBP	62.49	13.32	5.20	1.73	1.99	1.42	2.32	.68	1.87	.07	91.09
DB-50	J1118	BD	62.92	13.11	4.64	1.68	1.84	1.52	2.94	.62	1.88	.07	91.22
DB-51	J99	other	65.21	13.31	5.38	1.65	1.39	1.38	2.47	.68	.51	.08	92.06
DB-52	J613	DBP	66.36	12.44	5.15	1.48	1.78	1.31	2.33	.60	1.62	.05	93.12
DB-53	MD1-9181	DBP	62.37	13.03	4.33	.99	2.69	1.57	2.72	.58	4.70	.05	93.03
DB-54	DBNL-1	DBNL	63.22	14.01	5.13	1.89	1.76	1.66	2.53	.75	1.19	.08	92.22
DB-55	DBNL-34	DBNL	65.92	13.12	4.79	1.41	1.73	1.42	2.36	.70	1.28	.04	92.77
DB-56	DBP-39a	DBP	66.26	12.65	4.61	1.51	2.00	1.95	2.49	.62	1.48	.06	93.63
DB-57	K719	DBNL	62.58	13.90	5.30	2.12	2.14	1.63	2.09	.67	1.94	.07	92.44
DB-58	B518	DBP	68.51	12.78	5.09	1.42	1.52	1.76	2.15	.67	.95	.05	94.90
DB-59	DBU-9	U	58.07	11.94	3.19	3.73	6.30	2.16	2.75	.48	.58	.08	89.28
DB-60	DBP-24	DBP	64.57	12.99	5.17	1.99	2.02	1.65	2.25	.70	.96	.08	92.38
DB-61	MD1-8976	DBP	62.88	14.26	5.29	1.81	2.00	1.40	2.89	.74	1.30	.12	92.69
DB-62	D5-24	DBP	68.34	12.70	4.55	1.83	2.06	1.70	2.46	.64	.64	.08	95.00
	$\bar{X}$		64.41	13.04	5.00	1.69	2.18	1.63	2.48	.65	1.65	.07	
	s		3.53	.60	.60	.47	.80	.27	.24	.06	.96	.02	

TABLE 7

CHEMICAL COMPOSITION (%), COMPARISON SITE VESSELS

SAMPLE NUMBER	SITE	TYPE	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	TOTAL
CS-1	GiNb-1	DBP	57.25	15.93	6.07	1.81	.97	2.05	4.02	.88	1.39	.06	90.43
CS-2	EaLf-1	DBP	67.60	13.33	4.01	1.79	1.99	1.51	3.06	.50	.91	.08	94.78
CS-3	EaLf-1	DBP	74.81	12.01	5.05	1.01	1.23	1.83	2.21	.52	.37	.10	99.14
CS-4	EaLf-1	DBP	62.31	13.92	5.60	1.65	1.66	1.40	3.04	.69	.75	.10	91.12
CS-5	EaLf-1	other	68.53	14.86	4.76	1.51	1.54	1.64	2.63	.60	.33	.10	96.50
CS-6	EaLf-1	DBNL	63.38	14.26	4.92	1.67	1.52	2.52	3.01	.64	.28	.04	92.24
CS-7	EaLf-1	DBP	62.26	16.55	5.83	1.56	1.58	1.70	2.85	.79	.49	.07	93.68
CS-8	AO.87	DBNL	64.54	15.75	4.90	1.33	1.30	1.70	2.51	.64	.22	.07	92.96
CS-9	PAH5/618	DBP	58.95	15.64	6.56	2.23	1.45	1.86	3.08	.75	.54	.01	91.07
CS-10	PAH5/620	DBP	59.07	15.13	5.86	2.04	1.45	1.91	2.96	.71	.34	.11	89.58
CS-11	LAS127	DBNL	72.00	12.56	5.01	1.33	1.22	1.08	2.57	.75	.33	.21	97.06
CS-12	LAS127	DBP	61.94	14.92	5.50	1.63	1.47	1.37	3.17	.75	.76	.11	91.63
CS-13	AO.279	DBP	60.58	16.29	5.47	1.56	.95	1.49	2.96	.69	.79	.15	90.93
CS-14	HI.3-63	other	60.44	16.09	5.23	1.32	1.39	1.59	2.79	.66	1.88	.09	91.48
CS-15	AO.287	DBNL	71.96	12.52	4.95	.92	1.17	1.66	3.27	.60	.20	.11	97.36
CS-16	EaLf-1	other	71.67	13.96	4.55	1.30	1.41	1.64	2.49	.52	.42	.09	98.05
CS-17	EaLf-1	other	67.61	14.21	4.72	1.51	1.27	1.40	2.67	.63	.33	.14	94.49
CS-18	EaLf-1	DBNL	65.79	14.30	4.56	1.58	1.55	1.58	2.77	.59	.63	.10	93.45
CS-19	EaLf-1	DBNL	67.75	13.47	4.40	1.32	1.56	2.20	2.65	.53	.34	.08	94.30
CS-20	LAS348	DBP	74.23	11.10	4.06	.96	1.50	1.49	2.26	.49	1.01	.10	97.20
CS-21	LAS348	BD	63.79	13.26	5.10	1.22	1.74	1.91	2.37	.53	1.33	.06	91.31
CS-22	LAS67	other	72.05	12.67	3.65	1.01	1.12	1.71	3.01	.53	.18	.11	96.04
CS-23	LAS81	DBNL	63.06	14.50	4.82	1.64	1.92	1.78	2.62	.66	.72	.17	91.89
CS-24	GRS-1	DBNL	57.55	15.25	6.04	2.02	1.62	1.74	3.34	.71	.81	.15	89.23
CS-25	GRS-1	BD	56.25	14.66	6.60	1.87	1.80	2.05	3.13	.73	.56	.31	87.96
CS-26	GRS-1	DBP	56.83	15.27	6.12	2.15	1.71	2.13	3.18	.74	.66	.17	88.96
CS-27	GRS-37	DBP	51.01	14.60	5.89	3.45	3.04	1.85	3.37	.68	1.06	.11	85.06
CS-28	LAS127	DBNL	68.76	12.86	4.81	1.50	1.17	1.14	2.90	.72	.24	.21	94.31
CS-29	LAS43	BD	65.16	14.11	4.40	1.15	1.01	1.51	3.57	.56	.17	.08	91.72
CS-30	LAS43	DBP	64.75	14.11	4.59	1.48	1.26	1.17	3.43	.62	.51	.14	92.06
CS-31	LAS43	BD	64.95	13.73	4.42	1.40	1.81	2.41	2.22	.58	.32	.06	91.90
CS-32	LAS43	DBP	65.44	14.40	4.58	2.14	2.08	1.13	2.61	.65	.16	.09	93.28
CS-33	Goldsworthy	DBP	63.40	14.18	5.17	1.63	1.16	1.17	3.28	.66	.55	.11	91.31
CS-34	LAS348	other	60.48	15.09	5.29	1.85	2.63	1.49	2.19	.68	.69	.09	90.48
CS-35	LAS348	BD	66.32	14.51	4.73	1.28	1.37	1.47	2.58	.54	.59	.08	93.47
CS-36	LAS348	other	66.79	14.09	4.34	1.49	1.43	1.71	2.74	.56	.42	.13	93.70
CS-37	LAS43	other	73.79	12.39	3.98	.79	1.27	1.90	2.39	.50	.42	.08	97.51
CS-38	LAS348	other	65.04	14.91	4.82	1.37	1.33	1.60	2.35	.64	.64	.12	92.82
	$\bar{X}$		64.69	14.25	5.04	1.57	1.52	1.67	2.85	.64	.59	.11	
	s		5.43	1.22	.71	.46	.41	.33	.42	.09	.37	.05	

sites together (sites which range from central Saskatchewan to southeastern Manitoba) produces homogenized sample statistics (X, standard deviation, and variance) in which regional variability (if it exists) is subsumed. The chemical composition of vessels at each site may be at one end or another of the entire sample and, consequently, may be either more or less similar to the FbMb-1 sample than are the statistics representing the entire comparison site sample. Second, these three sites vary in distance from FbMb-1 and can give us an indication of the geographical dispersion of clay and temper selection patterns. LAS 43 is approximately 100 km west, LAS 348 approximately 300 km south, and EaLf-1 approximately 400 km southeast of FbMb-1. In addition, LAS 43 is closer to the known clay deposits in the Swan River Valley than is FbMb-1; consequently, if vessels from any site were to be made from any of these clay deposits, the logical choice would appear to be LAS 43. Unfortunately, sample size from other nearby sites (eg., LAS 127, PAH5) was not large enough to permit similar comparisons.

The null hypothesis, if translated into behavioural terms, states that the makers of pottery at FbMb-1 and at other sites selected the same clays and tempers, and prepared them in similar manners. The alternate hypothesis states that the makers of pottery at

FbMb-1 selected different clays and/or tempers than did people at other sites. If there is no difference in percentage concentration of any of the oxides, the null hypothesis cannot be rejected. If any of the oxides have a statistically different percentage concentration, then the null hypothesis must be rejected.

The results of Dunnett's test are presented in Tables 8 to 11. The percentage concentration is statistically different for a minimum of three and a maximum of five oxides. The difference in P_2O_5 concentration, consistently higher in FbMb-1 vessels, is statistically significant for all comparisons. CaO and MnO are significantly different in three of the comparisons; Al_2O_3, K_2O, and TiO_2 in two of the four comparisons. FeO is different in only one of four comparisons. The overall conclusion is that there are significant differences in chemical composition between FbMb-1 vessels and those vessels from all comparison sites and from the three individual sites of EaLf-1, LAS 348, and LAS 43, although the differences vary depending on what site is being compared to FbMb-1.

Dunnett's test permits a comparison of samples on the basis of only one variable at a time. To compare the samples on the basis of all variables simultaneously, Q-mode factor analysis, which "inspect[s] relationships between

TABLE 8

DUNNETT'S TEST

FbMb-1 VERSUS COMPARISON SITES

	FbMb-1		COMPARISON SITES				HYPOTHESIS ACCEPTED
	$\overline{X}$	s^2	$\overline{Y}$	s^2	$t_{\overline{XY}}$	$t_{.05}$	
SiO_2	64.41	12.46	64.69	29.48	.2828	2.5416	H_o
Al_2O_3	13.04	.36	14.25	1.49	5.6969	2.5638	H_1
FeO	5.00	.36	5.04	.50	.2897	2.5108	H_o
MgO	1.69	.22	1.57	.21	1.2557	2.4893	H_o
CaO	2.18	.64	1.52	.17	5.3951	2.6687	H_1
Na_2O	1.63	.07	1.67	.11	.6291	2.5183	H_o
K_2O	2.48	.06	2.85	.18	4.8920	2.5508	H_1
TiO_2	.65	.004	.64	.01	.5515	2.5451	H_o
P_2O_5	1.65	.92	.59	.14	7.7378	2.8607	H_1
MnO	.07	.001	.11	.003	4.0966	2.5508	H_1

H_o FbMb-1 = comparison site vessels

H_1 FbMb-1 $\neq$ comparison site vessels

TABLE 9

DUNNETT'S TEST

FbMb-1 VERSUS EaLf-1

	FbMb-1		EaLf-1				HYPOTHESIS ACCEPTED
	$\overline{X}$	s^2	$\overline{Y}$	s^2	$t_{\overline{XY}}$	$t_{.05}$	
SiO_2	64.41	12.46	60.40	54.91	1.6803	2.8103	H_o
Al_2O_3	13.04	.36	14.09	1.21	2.9475	2.7351	H_1
FeO	5.00	.36	4.84	.27	.8821	2.7628	H_o
MgO	1.69	.22	1.49	.04	2.2932	2.7955	H_o
CaO	2.18	.64	1.53	.04	5.3995	3.4829	H_1
Na_2O	1.63	.07	1.74	.12	.9593	2.6311	H_o
K_2O	2.48	.06	2.74	.06	3.1112	2.5585	H_1
TiO_2	.65	.004	.60	.01	1.5317	2.7113	H_o
P_2O_5	1.65	.92	.49	.04	8.3974	3.9357	H_1
MnO	.07	.001	.09	.0004	2.6633	2.6066	H_1

H_o FbMb-1 = EaLf-1

H_1 FbMb-1 $\neq$ EaLf-1

TABLE 10

DUNNETT'S TEST

FbMb-1 VERSUS LAS348

	FbMb-1 $\bar{X}$	FbMb-1 s^2	LAS348 $\bar{Y}$	LAS348 s^2	$t_{\overline{XY}}$	$t_{.05}$	HYPOTHESIS ACCEPTED
SiO_2	64.41	12.46	66.11	17.47	.9631	2.7099	H_o
Al_2O_3	13.04	.36	13.83	1.85	1.4093	3.1188	H_o
FeO	5.00	.36	4.72	.18	1.4777	2.6064	H_o
MgO	1.69	.22	1.36	.07	2.6072	2.6588	H_o
CaO	2.18	.64	1.67	.20	2.4362	2.6607	H_o
Na_2O	1.63	.07	1.61	.03	.2551	2.6219	H_o
K_2O	2.48	.06	2.42	.04	.6860	2.6044	H_o
TiO_2	.65	.004	.57	.005	2.6683	2.5037	H_1
P_2O_5	1.65	.92	.78	.09	5.0161	3.1067	H_1
MnO	.07	.001	.10	.0004	3.2917	2.5812	H_1

H_o FbMb-1 = LAS348

H_1 FbMb-1 $\neq$ LAS348

TABLE 11

DUNNETT'S TEST

FbMb-1 VERSUS LAS43

	FbMb-1 $\bar{X}$	FbMb-1 s^2	LAS43 $\bar{Y}$	LAS43 s^2	$t_{\overline{XY}}$	$t_{.05}$	HYPOTHESIS ACCEPTED
SiO_2	64.41	12.46	66.82	12.18	1.4832	2.6486	H_o
Al_2O_3	13.04	.36	13.75	.50	2.1818	2.7566	H_o
FeO	5.00	.36	4.39	.05	4.8374	2.9087	H_1
MgO	1.69	.22	1.39	.19	1.4708	2.6358	H_o
CaO	2.18	.64	1.49	.16	3.3478	2.7109	H_1
Na_2O	1.63	.07	1.62	.23	.0461	3.0929	H_o
K_2O	2.48	.06	2.84	.30	1.4578	3.2825	H_o
TiO_2	.65	.004	.58	.003	2.7155	2.6267	H_1
P_2O_5	1.65	.92	.32	.02	9.6281	5.4432	H_1
MnO	.07	.001	.09	.001	1.3596	2.6512	H_o

H_o FbMb-1 = LAS43

H_1 FbMb-1 $\neq$ LAS43

samples on the basis of all variables" (Imbrie and van Andel 1964: 1135), was selected. Q-mode factor analysis classifies the samples into groups (factors) fewer in number than the original variables. Each of these factors can be treated as an axis in n-dimensional space, where n equals the number of factors. Although these factors may explain mathematically the observed variation, they may be difficult to relate to actual archaeological data, observations, or processes. Rotating the axes will bring the factors into closer correspondence with archaeological 'reality'. Orthogonal varimax rotation leaves the axes at right angles but rotates them to form a best-fit relationship with the data. The disadvantage of this rotation is that the best-fit relationship will change as new data are added. With oblique rotation, the axes no longer remain orthogonal, but pass through the most extreme real sample (end-member) of each factor. This relates the factor to a sample with a known context. The axis (factor) will change only if a more extreme sample is added. The values in the composition matrix represent the contribution of each end-member to the composition of each sample (Imbrie and van Andel 1964). The disadvantage of this rotation is that the axes (factors) are no longer independent but now contain a certain amount of relatedness (Kim and Mueller 1978b).

A very important decision in factor analysis, and one which cannot be made in an objective or statistical manner, is the number of factors necessary to explain the structure underlying the sample. The "postulate of parsimony" (Kim and Mueller 1978a: 44) directs one to choose factor models with only a few factors. In spite of the number of factors ultimately chosen

> it must be realized however, that the number of causes operating is not necessarily equal to the minimum required [to explain the variation]. To identify the causes enumerated by the model is a problem for human ingenuity and for enlightened further inquiry, subject to the test of geological meaningfulness (Imbrie and van Andel 1964: 1154).

As a general rule of thumb, if a certain number of factors makes or permits a meaningful distinction of archaeological data on a spatial, temporal, or other basis, then that result is a better solution than another set of factors which does not permit such a distinction.

In the first attempt, all clay and ceramic samples were analyzed. A four-factor result was chosen. The data presented in Table 12 give the chemical composition (in percent) of each factor end-member. All ceramics segregated into Factor 1. The clays assorted into factors on a fairly consistent geographical basis. Factor 2 contained all the samples from the Pine River-Garland River deposit, the

TABLE 12

Q-MODE FACTOR ANALYSIS:

CLAY DEPOSITS, FbMb-1 VESSELS, AND COMPARISON SITE VESSELS

VARIABLE	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
SiO_2	61.2647	21.7686	91.5393	7.3302
Al_2O_3	13.5868	2.5049	15.8548	6.4950
FeO	6.2808	1.0700	1.2481	1.0645
MgO	1.9626	10.9397	1.0714	1.4337
CaO	1.0850	26.5478	-6.7000	47.2334
Na_2O	2.2057	0.4069	-0.0227	-0.2928
K_2O	3.0044	1.1878	1.2415	2.8778
TiO_2	0.4734	0.0761	1.4896	0.1273
P_2O_5	1.8256	-0.1391	-0.7628	0.3279
MnO	0.0811	0.0474	0.1008	0.0829
Factor End-member	DB2	CL20	CL22	CL15

TABLE 13

Q-MODE FACTOR ANALYSIS:

FbMb-1 VESSELS AND COMPARISON SITE VESSELS

VARIABLE	FACTOR 1	FACTOR 2	FACTOR 3
SiO_2	61.2422	73.3953	57.0846
Al_2O_3	15.5374	11.6286	11.4184
FeO	5.6625	3.9806	5.1395
MgO	1.8150	0.9831	2.2858
CaO	1.1012	1.6574	4.4730
Na_2O	1.4601	1.9358	1.5014
K_2O	3.1720	2.2255	1.8959
TiO_2	0.7314	0.4963	0.7094
P_2O_5	0.0826	0.8480	5.1191
MnO	0.1257	0.0594	0.0128
Factor End-member	CS13	CS20	DB48

FbMb-1 sample (which formed the end-member) and one sample from near the Pine River deposit. Factor 3 contained all the samples (with one exception, to be discussed below) from the Swan River deposit, all samples from the Swan River (Fraser) deposit, and one each from the Pine River and Duck River deposit. Factor 4 comprised samples from the Pine River deposit. The chemical composition of these factors, as represented by each end member, was very different for almost all oxides.

The exceptional clay sample (CL27), from the Swan River deposit, had its highest composition loading (0.3979) on Factor 1; the next highest composition loading (0.3023) was on Factor 2. This sample was taken from the talus at the base of the deposit where it was eroding into the Swan River.

The lumping of all the ceramics into a single factor was unexpected. It suggested, however, that the ceramic production process might alter the chemical composition of the product significantly from the original clay chemical composition. The most apparent step in the process which would cause this alteration is the addition of tempering materials. Less obvious steps would include mixing of clays from various sources and removal of inclusions in the clays. The great difference between the chemical composition of clays and ceramics made it impossible to identify clay source(s) mined for the ceramics on the basis of chemical composition alone, unless one could 'subtract' the chemical composition of the added temper.

If variation between clay and ceramic chemical composition was greater than that among ceramics from different sites, the inclusion of the clay data in the factor analysis would mask this smaller internal ceramic variation. Consequently, in the second stage of the analysis, the clay data were removed from the sample, and only the ceramic data were analyzed. A three-factor solution was chosen. Table 13 presents the chemical composition (in percent) of each factor end-member. Factor 1 is represented by a high Al_2O_3-high K_2O end-member (CS13), Factor 2 by a high SiO_2 end-member (CS20), and Factor 3 by a high P_2O_5-high CaO end-member (DB48) (see Figure 8). The FbMb-1 ceramics all segregate towards the high P_2O_5-high CaO end of the distribution. The end-member has such a relatively high P_2O_5-CaO content that many of the comparison site sherds have a negative composition loading (i.e., some of the Factor 3 end-member must be subtracted from the composition of the individual vessels) and, consequently, they are off the graphed distribution.

There is, however, no apparent geographical or typological basis for the distribution of the comparison site sherds on the graph. There are two possible

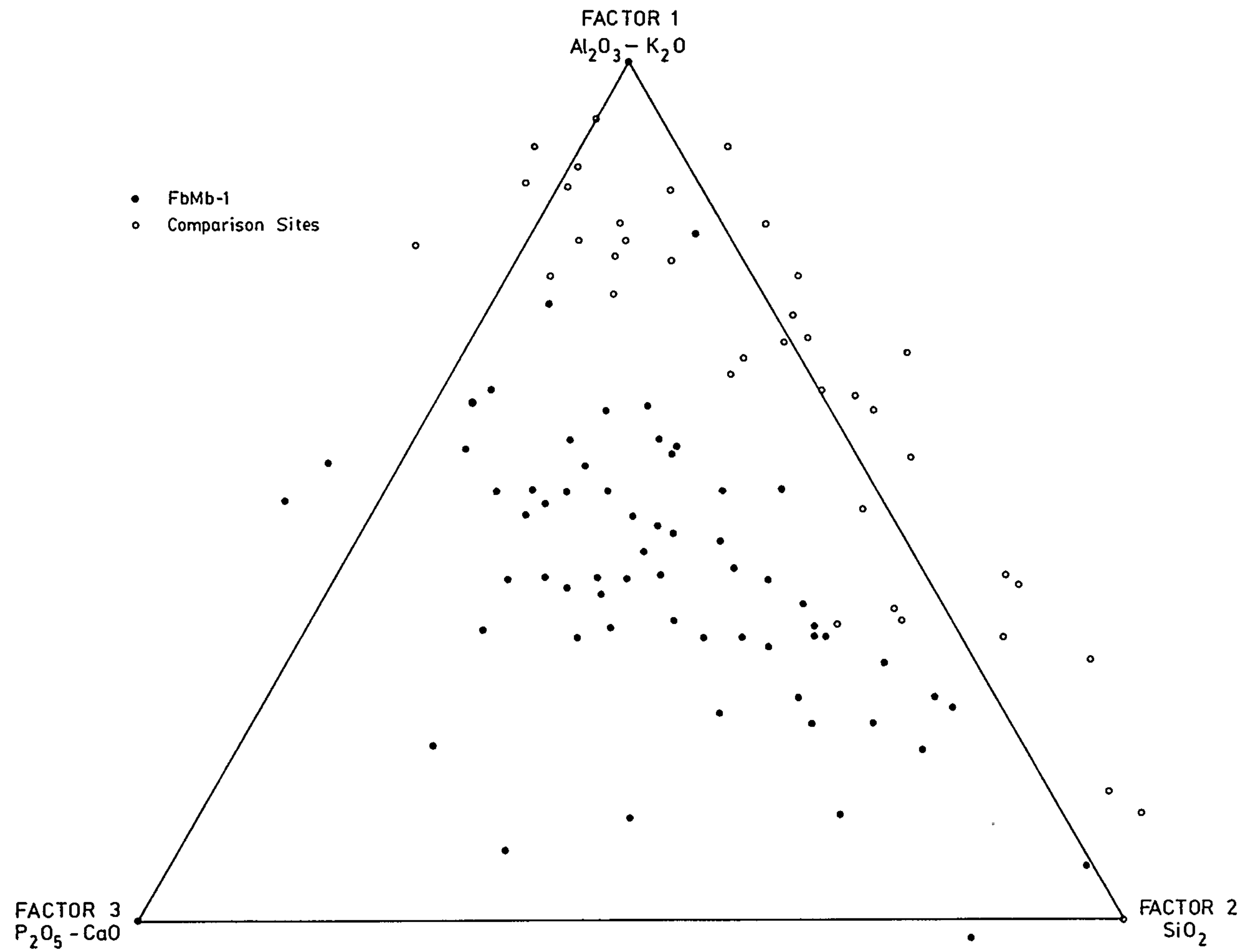

Figure 8: Q-Mode Factor Distribution, Showing Contribution of Each End-member to Each Vessel

explanations for this. First, the comparison site ceramics may have been made from glacially deposited clay. Analyses of glacial clays deposited on the prairies indicated a uniformity of mineralogical and chemical composition, with some variation in relative proportion of certain clay minerals but not in the kinds of clay and non-clay minerals present (Last 1974; Kodama and Brydon 1966). The apparent lack of geographical basis in the graphed distribution may reflect the use of homogenized glacial clays. Second, the sample from each of the comparison sites may have been too small to discern the actual process(es) underlying the distribution.

The variables distinguishing the FbMb-1 ceramics from the comparison site ceramics raise some interesting questions. The high P_2O_5 content may not be related to either the clay or non-clay minerals in the pottery. Phosphorus is not one of the common exchangeable cations occupying inter-layer positions in clay minerals; neither is it present in feldspar, the most common tempering mineral observed in the ceramic thin-sections (Deer, Howie, and Zussman 1966: 266, 282). Consequently, it would appear that the variable which characterizes the end-member of Factor 3 may not be associated with a rock-forming mineral but rather with organic material. A comparison of the mean P_2O_5 content of the FbMb-1 ceramics with that of the various clay deposits (Table 6, Table 5) indicates that there is a great difference in P_2O_5 content between the original clay and the final ceramic product. The high P_2O_5 content may, therefore, be the result of the addition of a phosphorus-rich organic material (eg., bone) to the clay during some stage of production.

FbMb-1 contained a substantial amount of bone; therefore, the possibility existed that the high P_2O_5 content in the pottery may have been the result of redeposition of collophane rather than addition of bone at the production stage. Collophane is a high phosphorus mineraloid redeposited from circulating groundwater or from leaching of bones into soils, other bones, or other substances such as low-fired pottery (Rogers 1922, 1924). Soils from FbMb-1, EaLf-1, and LAS 348 were analyzed on the assumption that, if P_2O_5 content in ceramics was dependent upon soil P_2O_5 content, there should be a correspondence between both ceramic and soil P_2O_5 content. FbMb-1 soils contained 4.5 ppm, EaLf-1 soils contained 3.5 ppm, and LAS 348 soils contained between 3.0 and 5.0 ppm of phosphorus. Thus, while soil P_2O_5 may have contributed slightly to ceramic P_2O_5 content, it would not be sufficient to account for the very high P_2O_5 content in FbMb-1 pottery as compared to other pottery (Limbird 1981, personal communication).

The amount of bone added to the clay may be roughly estimated by using the Ca/P ratio of bone apatite ($Ca_{10}(PO_4)_6(OH)_2$) which is 1.5:1 (McLean and Urist 1973: 59). The Ca/P ratio in the pottery does not correspond to this ratio, but allowing for the presence of these elements in the clay and non-clay minerals (particularly feldspar), approximately 5% (by weight) of bone may have been added to the paste. In practice, this would amount to about a 'slack handful' of bone per vessel.

Factor 3 is also distinguished from Factor 1 by a low Al_2O_3-low K_2O content. Both are important constituents of both clay minerals and feldspars (Deer, Howie, and Zussman 1978: 250, 282). Consequently, the FbMb-1 vessels are differentiated from some of the comparison site vessels on the basis of clay and non-clay minerals. Both the graphed distribution and Dunnett's test indicate that there is no distributional or statistical difference in SiO_2 content between FbMb-1 vessels and the comparison site vessels even though Factor 2 is identified by a high SiO_2 end-member.

The addition of tempering materials to the clay changed the chemical composition of the pottery sufficiently that it could not be compared directly with the clay chemical composition to determine if any of the sampled deposits were the clay source mined originally to make the pottery. However, in the course of preparing the X-ray fluorescence samples, red to reddish-brown flecks were observed in the paste of the FbMb-1 sherds but not, as a rule, in the comparison site sherds. This speckled appearance has been noted by both Bannatyne (1980, personal communication) and Brady (1960) as being characteristic of the Swan River Group deposits. This is a grey kaolinic shale of Cretaceous age which has only a few known exposures along the Pine, Swan, and Roaring rivers (Bannatyne 1970: 27); other exposures, presently commercially exploited, are covered by considerable overburden. The exterior of temperature-gradient bars made from this shale have smooth white exteriors when fired in the 400° to 800° C. range, but when these bars are cut the reddish specks appear on the interior. If fired above 1000° C. the specks become apparent on the surface (Bannatyne 1980, personal communication). Pyrite is the probable cause of these specks (Brady 1960: 15).

Tentatively corroborating evidence in support of the Swan River Group shales as being the clay formation exploited by the residents of FbMb-1 comes from X-ray diffraction analysis of five FbMb-1 sherds, three Swan River Group samples, and two Swan River (Fraser) samples (Table 14). All samples had approximately similar proportions of illite, quartz, and other trace minerals. The quartz content of the clays and pottery is considerably higher than

TABLE 14

X-RAY DIFFRACTION RESULTS,

SELECTED FbMb-1 SHERDS AND CLAYS

SAMPLE NUMBER	MONTMOR-ILLONITE	CHLO-RITE	ILLITE	KAOL-INITE	MIXED LAYERS	QUARTZ	FELD-SPAR	CAL-CITE	DOLO-MITE	SIDER-ITE	PYRITE	TOTAL (%)
DB5	tr	tr	10	0	0	54	27	1	6	1	tr	100
DB8	tr	tr	3	tr	0	78	17	1	1	tr	tr	100
DB11	tr	1	7	0	0	57	30	2	2	tr	2	101
DB18	tr	tr	12	tr	tr	66	20	tr	tr	0	0	100
DB20	0	tr	4	0	tr	72	21	tr	1	tr	1	100
CL26	tr	tr	6	14	0	75	3	tr	tr	1	0	100
CL27	2	tr	5	5	0	47	11	1	26	tr	2	99
CL29	1	0	5	9	tr	82	2	0	0	1	tr	100
CL30	0	tr	9	20	20	61	4	0	tr	4	1	99
CL31	tr	tr	10	23	0	55	5	tr	0	6	tr	99

that recorded by Brady, ranging from 58% to 68%. Furthermore, the Swan River Group clays had their second highest compositional loading on Factor 1, the factor encompassing the ceramics.

The terraces in the vicinity of the large outcrop of the Swan River Group shale were tested for the presence of archaeological material which should be there if the deposit was used prehistorically. However, no archaeological material was found, indicating that this particular deposit was not used prehistorically (Hanna 1981b). Although the actual deposit(s) from which the FbMb-1 pottery was made was (were) not located, the mineralogical similarities between the Swan River Group clay and the FbMb-1 pottery strongly indicate that the deposit was part of this formation.

The Swan River Group shales have good plasticity and workability. A potter, to whom we gave some of this clay, used it without any preparation to make pottery and reported that it had excellent working qualities (Slobodian 1980, personal communication). However, the high quartz content presents a difficulty in the firing stage because it "will produce a considerable volume change during heating and cooling due to the quartz inversion" which occurs at 575° C. (Brady 1960: 15). This expansion and contraction during firing and cooling can crack pottery.

One way to offset this problem is to add an inert tempering material which will open up the clay enough to withstand a certain amount of volume change without cracking (Slobodian 1980, personal communication). An ideal inert tempering material is crushed bone. If the organic portion of the bone burned out at the temperature which causes quartz inversion, this would leave small spaces in the clay which would act as a buffer against thermal shock. The pot would be more likely to survive the firing and cooling processes. The addition of bone may, therefore, have been a modification in the production process developed in response to the peculiar qualities of the Swan River Group shales.

If this is the case, it is difficult to understand why most of the other analyzed ceramics also do not have a comparably high P_2O_5 (i.e., bone) content since, according to the factor analysis, they have a similar range of quartz content. It is possible (but as yet untested) that the total SiO_2 content in comparison sites vessels represents not only quartz but also clays with higher SiO_2-Al_2O_3 content (i.e., more kaolin) and feldspars. As will be discussed in the following section, there is a tentative indication that the comparison site ceramics may contain approximately twice as much added feldspar as the FbMb-1 ceramics. If this observation is valid, the similar SiO_2 content would not necessarily imply a similar quartz content. The differences in clay mineralogy, and their relative contribution to the SiO_2 content, are impossible to determine since much of the clay crystal structure has collapsed, a result of firing, and is, therefore, undetectable by X-ray diffraction analysis. The actual proportion of quartz constituting the total SiO_2 content is therefore unknown in the comparison site sherds.

Figure 8 suggests, however, that there is an overlap of technological patterns between Factors 1 and 3. Some of the Factor 1 ceramics have a P_2O_5 content comparable to the low to middle range of Factor 3 ceramics. The sites from which these ceramics originate are located in central Saskatchewan (GiNb-1), at Cedar Lake (approximately 115 km north of FbMb-1), at the north end of Lake Winnipegosis, at LAS 348 (300 km south), and at EaLf-1 (400 km southeast), although only some ceramics from each of these sites overlap the Factor 3 pattern. It appears that the use of bone as temper was transfered to these other sites where different clays were used.

Conversely, two FbMb-1 vessels fall into the Factor 1 (high Al_2O_3) cluster. One has a P_2O_5 content typical of FbMb-1 (Factor 3) ceramics; the other has a very low P_2O_5 content. These may very well be vessels brought into Aschkibokahn from other sites. The former (a Duck Bay Punctate vessel) represents the use of bone temper with non-Aschkibokahn clays, whereas the latter (an undecorated non-Duck Bay Ware vessel) represents the use of neither clays nor bone temper typical of the Aschkibokahn production pattern.

Thin-Section Analysis:

General principles:

Thin-sectioning is a means of providing a qualitative and quantitative analysis of the mineralogical constituents of an item. With ceramics, this is limited to the non-clay minerals. Clay minerals are too small to be identified using this method (Shelley 1975: 141).

Minerals are identified microscopically on the basis of physical and optical properties. Physical properties include cleavage planes, fracture patterns, twinning, mode of aggregation, and crystal form. These are largely determined by electro-chemical structure of the crystal and the environment in which the crystal developed. The characteristic optical properties are the result of the effects of the crystal structure on a beam of light passing through it. Colour (in both plane- and cross-polarized light), angle of extinction, and index of refraction are among these properties.

There are two optic classes of minerals. Isotropic minerals include those lacking regular internal structure, such as glass and opal, and those crystalizing in the isometric (cubic) system, such as diamond, garnet, and fluorite (Kerr 1959: 51). Anisotropic minerals include all others. Anistropic minerals display the property of birefringence, that is, a ray of light passing through the crystal breaks into two beams. Characteristic interference colours are produced when viewed under crossed nicol prisms. These colours depend on the wavelength of light, the way the mineral is cut relative to the crystal axes, and the thickness of the mineral. As the microscope stage is rotated, these colours will change and/or go to extinction (become dark). Isotropic minerals go to extinction when viewed under crossed nicols.

Sample preparation

Preparation of thin-sections entails a partial destruction of the sherd. In most cases, rim sherds were selected for sectioning since results were to be correlated with the stylistic typology; consequently, restraints were placed upon the extent of destruction. Sherds were not selected by a random sampling process; rather, a minimum size of 25 cm^2 was used as the selection criterion. Thirty-six sherds were selected: 32 from FbMb-1, two from EaLf-1, Manitoba; one from Great Falls, Manitoba; and one from GiNb-1, Saskatchewan. Eleven beach cobblés from FbMb-1 and three cobbles from the Swan River Group outcrop were sectioned to compare potentially available minerals with those observed in the thin-sections. Three clay samples (one from each of the Swan River Group deposit, the Swan River (Fraser) deposit, and the Duck River) were fired first to approximately 700° C. and then to about 850° C. A thin-section was made from each brick after each firing.

Experimentation with body sherds indicated that the pottery was very brittle and friable. All sherds and the fired clay bricks were impregnated with thin-section epoxy in the area from which the section was to be taken. The sherd was heated, coated with epoxy, and allowed to cure for 1 1/2 hours. The sherd was then cut at a 45° angle. The fresh cut was impregnated with epoxy. A second cut was made parallel to, and about .75 cm from, the first cut. The freshly cut surface of the slice was impregnated with epoxy.

The slice was made at a 45° angle for two reasons. First, it provided a wider surface for examination than would a perpendicular cut. It also allowed one to examine the cross-section of the vessel, which a section made parallel to the surface would not have permitted. Second, in most cases it minimized destruction of the external decorated portion of the sherd.

One face of each slice was selected for mounting and was prepared by hand-grinding and polishing with successively finer grades of 400, 600, and 1000 silicon carbide grit on glass sheets. This face was mounted on a frosted 1" x 3" microscope slide with Hillquist thin-section epoxy. The mount was allowed to cure overnight. A cut-off saw was used to cut the mounted sections to a thickness of approximately 1 mm. The cut-off portions were used to prepare a second set of slides. The final grinding began by using 120 grit on a lap wheel, and was finished by hand polishing with 400, 600, and 1000 grit on glass sheets. The final thickness of .03 mm was ascertained by observing the interference colour of quartz under crossed nicols until it was straw-yellow to white. The slide was completed by afixing a cover slip.

Results:

The ceramic thin-sections were examined to identify and quantify the minerals and other aplastic materials present in the paste and to observe qualitative properties of the paste, eg., density, colour, and presence/absence of firing rim. The fired clays were examined to observe the type, quantity, and size range of natural-occurring aplastics and the colour and texture of the clay. The rock thin-sections were examined to observe the variety of minerals contained therein. Mineral proportions in the rock and clay thin-sections were not quantified. They were examined to provide information about the qualities of the raw materials which might have been used prehistorically.

A 10X10 grid inserted in the microscope ocular facilitated estimation of size (in mm^2) of individual mineral grains, total area of each mineral, and the total area of the thin-section. Subsequently, the size range of minerals present in the thin-section, proportion of each mineral relative to total area of the thin-section, and total proportion of all minerals could be calculated (Table 15, Figure 9). Five sherds and five clay samples were analyzed by X-ray diffraction to provide an independent check on mineral types and proportions (Table 14). The results suggest four trends, the implications of which may be significant for ascertaining production patterns.

The first trend concerns the types and proportions of minerals present in the ceramic thin-sections. Feldspar formed the bulk of the visible minerals ($\bar{X}$ = 10.28%) while all other minerals may be considered trace minerals ($\bar{X}$ varying between .09% to .58%). The rocks contained all the minerals observed in the ceramic thin-sections, although there were higher proportions of the trace minerals (biotite, amphiboles, garnets, pyroxenes, olivine, and chlorite) in the rocks than in the ceramics. The fired clays contained feldspar and trace amounts of visible quartz, which together accounted for less than 1% of the Swan River (Fraser) deposit, about 1% to 5% of the Duck River deposit, and about 25% of the Swan River deposit. The trace minerals observed in the ceramic thin-sections either were not present or were present in extremely minute proportions in the clay thin-sections. It appears that feldspar was the desired mineral tempering material. The somewhat lower proportion of trace minerals in the ceramics as compared to the rocks suggests an exclusion of these minerals quite possibly through sorting on the basis of colour (these minerals tend to be darker than feldspars) as suggested by Brizinski and Buchanan (1977: 62).

The presence of bone in the pottery was not substantiated in the thin-sections, but imprints of fish scales were observed in two split sherds. Whether or not bone fragments (particulary fish bone, if that is what they were using) would survive the firing process has yet to be determined.

There is a considerable discrepancy between the mineral quantities as determined by thin-section and X-ray diffraction analyses. Ceramic thin-sections were estimated to contain between 4% and 20% feldspar and .01% to 3% quartz whereas the X-ray diffraction estimates were 2% to 11% (clays) and 17% to 30% (ceramics) feldspars and 55% to 82% (clays) and 54% to 78% (ceramics) quartz. The great disparity in quartz, particularly, is a result of the high proportion of minute (i.e., clay-sized) quartz particles. Their presence in the clay matrix could be detected; when the thin-section was rotated under crossed nicols, they would go in and out of extinction producing a 'sparkling' effect. Even under high power magnification, they were too small to be counted and measured. Consequently, the quartz particles included in the thin-section estimates are only those large enough to be observed, identified, and measured, i.e., anything equal to or larger than 1/64 mm^2. The disparity in feldspar estimates is not so great, but again it is explained by the presence of clay-sized particles of feldspar which were too small to be included in the estimates.

The second trend concerns the size range of measureable aplastics in the ceramics. There appears to be a bimodal distribution, with the majority of aplastics in each thin-section falling in one or both of the size classes, less than 1/16 mm^2 and greater than 1 mm^2 (Table 15). Mineral inclusions in the clays were always less than 1/4 mm^2 and usually were less than 1/16 mm^2; furthermore, they were rounded or had obtuse angles. Mineral grains of this size in the ceramic thin-sections also had these morphological characteristics whereas grains larger than 1/4 mm^2 almost always had sharp or acute angles and rough

TABLE 15

TYPES, PROPORTIONS, AND SIZE RANGE OF MINERALS IN THIN-SECTIONS OF CERAMICS FROM FbMb-1, EaLf-1, AND GREAT FALLS, MANITOBA AND GiNb-1, SASKATCHEWAN

SITE	FELDSPAR[1]	AMPHIBOLE/ PYROXENE	BIOTITE	CHLORITE	QUARTZ	GARNET	OTHER[2]	TOTAL	SIZE RANGE 1/16 mm^2	1/4 mm^2	1/2 mm^2	3/4 mm^2	1 mm^2	PERCENT ADDED
FbMb-1	4.37%	.03%	--%	.05%	.05%	--%	.15%	4.65%	50%	30%	8%	12%	--%	1
	4.49	.04	--	--	.26	--	.04	4.83	90	10	--	--	--	none?
	5.06	.14	.26	.01	.49	.02	--	5.98	85	5	10	--	--	.5
	5.43	.03	.01	.03	.12	--	.06	5.59	65	20	--	--	15	1
	6.12	.07	.03	.04	1.06	.11	--	7.43	40	17.5	12.5	--	30	2-3
	6.27	.07	--	--	1.89	.09	--	7.32	66	33	--	--	--	none?
	6.54	.06	.02	.01	.56	.01	--	7.20	60	30	10	--	--	1-3
	6.68	.09	.26	.42	.37	--	.11	7.93	75	15	--	--	10	1
	7.07	.25	.04	.01	.15	.03	.42	7.97	65	25	10	--	--	1
	7.36	.38	.01	.28	.29	--	.21	8.53	50	30	7	3	10	1-2
	7.55	.07	.06	.04	.45	--	.33	8.50	55	15	2.5	15	12.5	2-4
	7.74	.10	.08	.01	.86	--	--	8.72	70	10	10	10	--	1-2
	7.75	.18	.05	.07	1.05	--	.03	9.13	65	30	5	--	--	.5-3
	8.21	.06	.01	.07	.31	--	--	8.67	60	20	2	3	15	2-3
	8.87	1.07	.74	.08	.89	.03	--	11.68	65	20	2	3	10	1-2
	8.97	.06	.01	--	.39	--	.21	9.66	50	15	--	--	35	3-4
	9.04	.22	.19	.02	.24	--	--	9.71	45	20	--	25	10	1-3
	9.72	.05	--	.09	.49	.16	--	10.51	55	12.5	7.5	10	15	1-4
	10.51	.89	.28	.04	.28	.44	.47	12.91	35	20	15	10	20	3-5
	10.65	.12	.03	--	1.41	.08	--	12.29	60	15	5	--	20	2-3
	10.68	.04	.32	.10	--	.17	--	13.31	50	5	5	5	35	4-5
	11.03	.12	.06	.05	--	.05	1.06	12.56	70	15	5	--	5	1-3
	11.95	.01	.46	--	.78	--	.38	13.58	25	20	10	10	35	5-7
	13.32	.23	.16	.15	.33	--	.03	14.43	75	10	2.5	2.5	10	3-5
	13.53	.13	.09	.10	.08	.07	--	13.91	70	1	2	2	25	3-4
	14.73	.42	.47	.15	.52	.41	.14	17.45	20	15	7.5	7.5	50	8-10
	15.03	.14	.29	.01	.13	.09	--	15.69	50	10	3	2	35	5-6
	15.62	.12	.09	.09	1.83	--	.05	17.80	45	25	5	10	15	3-6
	16.61	.06	.18	.03	.56	.03	.97	18.42	30	24	10	20	16	3-5
	17.00	.02	.12	.12	--	.08	--	17.42	45	5	10	10	30	5-6
	20.08	.24	.14	.22	--	.04	--	20.52	70	2	3	5	20	4-6
	20.94	.04	.36	.07	2.76	.06	.01	24.47	40	10	5	5	40	10-12
$\bar{X}$	10.28%	.17%	.15%	.07%	.55%	.06%	.15%	11.52%						
s	4.40	.23	.17	.09	.58	.11	.26	4.78						
EaLf-1	14.10	.40	1.30	--	--	--	--	15.80	40	1	2	2	55	9-10
	14.62	.09	.64	.24	.12	--	--	15.71	30	10	10	10	40	6-10
Great Falls	14.09	.01	.70	--	--	.24	--	15.04	2	15	10	8	65	9-12
GiNb-1	6.02	.01	.12	--	--	.15	--	6.18	35	10	15	10	30	2-4

Notes:
1 includes albite, microcline, and unidentified feldspars
2 includes olivine and cryptocrystalline quartz

margins. The bimodal distribution of mineral size in the ceramics, the morphological differences between the larger and smaller mineral grains, and the size range of minerals present in the fired clays suggest that the bimodal size distribution may represent a cultural pattern, namely, the decision of how much mineral temper to add to the clay when making pottery. The proportion of aplastics greater than 1/4 mm^2 might represent the amount which is added to the clay whereas the remaining proportion represents aplastics indigenous to the clay. Personal experience has indicated that it is practically impossible to see aplastics smaller than 1/4 mm^2 without the use of a hand lens. Since this is the size range of aplastics naturally included in the clay, the decision as to how much temper to add to the clay could conceivably be made independently, or in ignorance, of how much aplastic material was already present. If this bimodal distribution does indeed represent a cultural factor, the amount added (1% to 7% by volume) is considerably less than the 20% to 30% figure previously estimated (eg., Corenblum and Syms 1977: 37). Whether this represents a behavioural pattern unique to the pottery made at Aschkibokahn or a general tendency to overestimate temper quantities when thin-sectioning is not used, is not known and cannot yet be determined since the number of thin-sections from comparative sites are so few.

The third trend concerns the relative proportion of the different size classes of mineral grains. When the proportion of aplastics equal to or greater than 1/2 mm^2 is compared to the total proportion of aplastics (Figure 9), there appears to be less variation in the former than in the latter. In other words, it does not appear that temper was added to compensate for deficiencies in aplastic quantities occurring in the clay. This variation in proportion of added materials appears to fall into three groups: 1% to 3%, 3% to 6%, and 8% to 12%. The first two groups are characteristic of the FbMb-1 pottery, and the latter group of the comparative sites pottery, although two FbMb-1 sherds fall within this latter group. Again, whether this is purely cultural or may have some functional aspect is unknown. It may be that, because bone was also used as a tempering agent (if the interpretation of the X-ray fluorescence results is correct) in the pottery made at Aschkibokahn, it was not necessary to add as much mineral temper as was the practice elsewhere. On the other hand, the apparent division of the FbMb-1 pottery into two groups and the existence of a third (non-Aschkibokahn?) group based on temper proportions suggest other factors may be implicated. This division does not appear to be a function of the part of the vessel that is analyzed since the six body sherds are divided evenly between the two FbMb-1

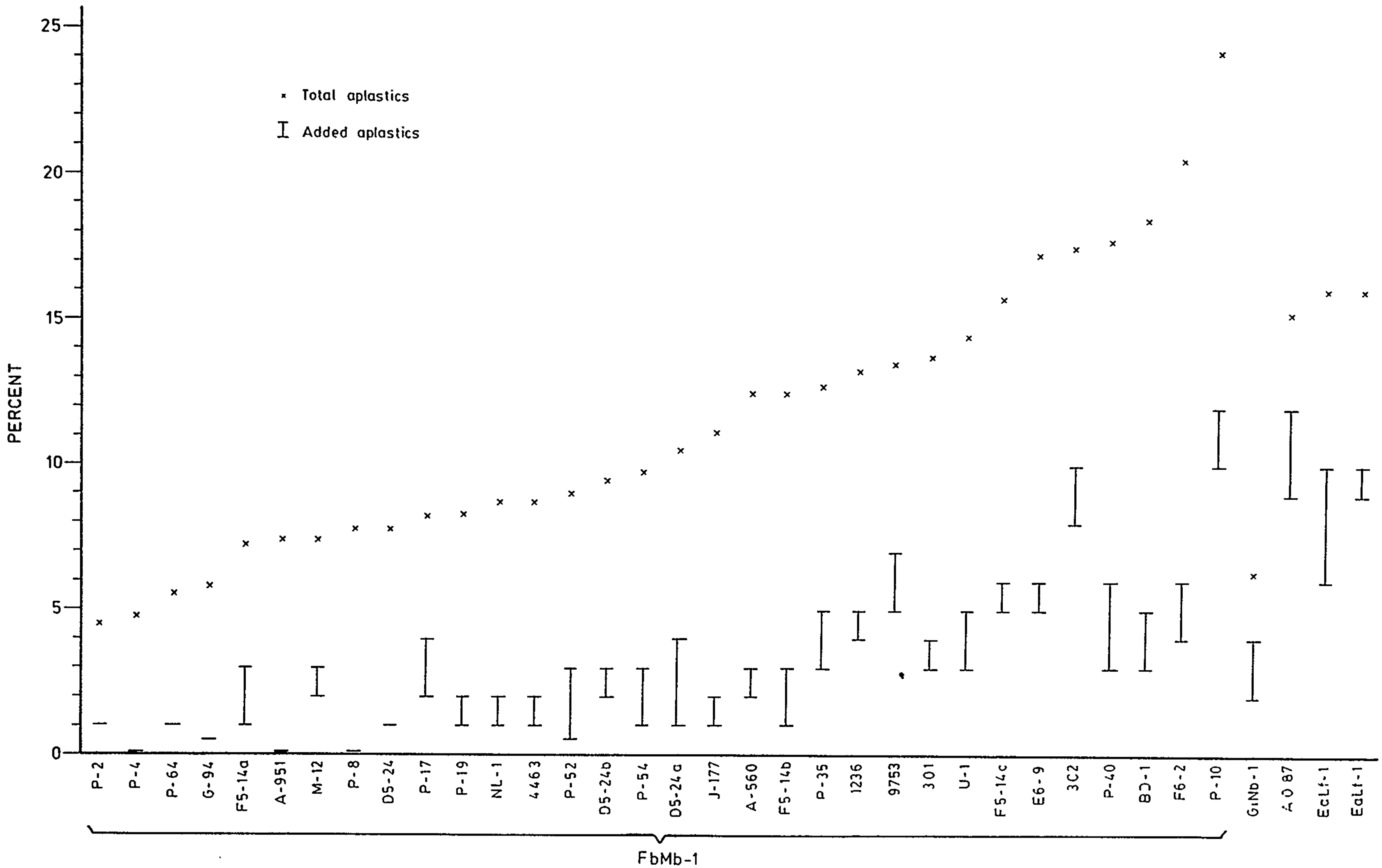

Figure 9: Total Mineral Aplastics and Estimated Added Mineral Aplastics (Temper)

groups. This implies that further consideration should be given to the suggestion that temper may have been added to produce specified or desired properties (eg., porosity) in the fired product in addition to, or rather than, modifying properties of the clay (Corenblum and Syms 1977: 37).

The fourth trend suggests that clays might have been mixed. The FbMb-1 ceramics contained considerable quantities of minute quartz/feldspar particles which could be seen only as 'flashes' as the thin-section was rotated and smaller quantities of 'larger' particles (i.e., up to 1/16 mm^2) whose morphology suggested they were minerals indigenous to the clay. This combination of 'large' and small indigenous aplastics was not seen in any of the clay thin-sections. The Swan River clay contained only minute particles (about 1/256 mm^2), the Duck River clay contained some minute particles but mainly 'larger' particles (1/16 mm^2 to 1/4 mm^2), and the Swan River (Fraser) clay contained very few visible minerals of any size. In order to produce a clay of the type seen in the ceramics, it would be necessary to mix two clays with the properities of the Swan River and Duck River clays. However, since the actual deposit(s) exploited by the Aschkibokahn potters has not been located, it is possible that the clay(s) from the deposit(s) may have had these properties. An additional indication that clays may have been mixed arises out of the factor analysis. CL27, the clay sample from the Swan River Group talus, has its highest compositional loading on Factor 1, the factor encompassing all the pottery.

The results discussed above cannot be presented as conclusive evidence of production patterns for three reasons. First, because the sherds were not randomly selected, we do not know how representative they are of the entire sample. Second, the validity of the scale of temper size classes for revealing cultural behaviour has yet to be demonstrated. Third, because so few comparison site sherds were analyzed, we cannot validly compare the apparent Aschkibokahn pattern to other sites. When considered together with the results of the X-ray fluorescence analysis, however, they suggest that the potters at Aschkibokahn were adding different proportions of mineral and other tempering agents to their clay (although the types and proportions of minerals they used were consistent) than were potters elsewhere.

Ancillary Evidence:

Type, frequency, and origin of 'exotic' ceramics and lithics:

As stated earlier, Duck Bay Ware constituted 73% of the ceramic assemblage at FbMb-1. The remainder was made up of Blackduck (about 20%), Selkirk (about 5%), 'undifferentiated Woodland' and 'other' (about 2%). The presence of Blackduck and Selkirk wares at FbMb-1 is not unexpected, since they are present elsewhere in the region. The 'other' category, however, included vessels with striking Plains ceramics attributes: intentionally smoothed surfaces, incipient S-rims, incising running the length of the lip, tabs, and possibly even appliques. These are not attributes included in either Blackduck or Selkirk wares, and their occurrence has not been noted elsewhere in the parkland or southern boreal forest.

Long-distance travel and trade is also indicated by the exotic lithic materials at FbMb-1. The locally available Swan River Chert accounted for 71% of the tools and 92% of the debitage (Walker 1978). Non-local lithics included chalcedony, pipestone, soapstone, Cathead and Selkirk chert, and rhyolite. Chalcedony might have been obtained from the Souris gravels of southwestern Manitoba but more probably came from North and South Dakota. Pipestone could have come from either South Dakota or Minnesota (Sigstad 1970: 378-379). Soapstone quarries are located in southeastern Manitoba (Wieser 1981, personal communication) and northwestern Ontario (Sabina 1963). Cathead and Selkirk chert are common in southcentral Manitoba and rhyolite in southeastern Manitoba.

Site occupation:

Evidence for seasonality must be derived from the faunal data. Fish, bird, and mammalian species predominate; molluscs, reptilian, and amphibian species are sparsely represented (Fraser 1979). The evidence on which seasonality estimates are based include fish scale annuli, medullary tissue in bird bone, apparent age at death of small mammals (eg., muskrat) individuals, and the presence of seasonally available migratory birds.

Spring, summer, and fall are the seasons for which there is best evidence. The majority of fish scales indicated spring death, and a small percentage indicated summer death (Hanna 1981a). Medullary bone was also present in some of the bird bones (Fraser 1979). Of the migratory bird species, most arrived in the spring, stayed the summer, and returned in the fall; only two species used the region as a staging area for further migration north in the spring or on their way south in the fall. Immature small mammals indicated summer or fall (Snortland-Coles 1979: 125).

Winter use of the island is the most difficult to determine. Migratory birds absent themselves from the region during winter and it is impossible to determine the archaeological 'absence' of a species when it is present at other times of the year. Also, by winter most small mammals will have reached maturity; consequently, age at death can no longer be used to indicate seasonality. Dental cementum annuli could provide evidence for winter occupation, but this analysis has not yet been used on the FbMb-1 data.

Three aspects must be considered if winter occupation is to be considered feasible: food, shelter, and firewood. Fish and denned furbearers would provide a relatively stable food source. Driftwood is plentiful along the shore of the island; it is easily collected, comes in all sizes from short branches to large trunks, and burns well (once dried). Shelter from prevailing winds is the critical factor for, as the excavation crews learned, the winds sweeping off Lake Winnipegosis can be very cold and very strong. If bush and trees were growing on Aschkibokahn during its occupation, they would provide sufficient shelter. If not, the occupants would have had to relocate. Even if relocation were necessary, they would have to move only a couple of kilometers up the Drake River to find shelter and still to be in proximity to the under-ice winter locations of sucker, walleye, and northern pike.

CHAPTER 5

SUMMARY, CONCLUSIONS, QUESTIONS

Summation:

This thesis has attempted to ascertain at least some of the underlying causes of the distribution of Duck Bay Ware. This was done not by using stylistic analysis, the approach most commonly used, but by using chemical and mineralogical analyses in conjunction with other artifactual and distributional data. The premise underlying this approach is that people living together tend to develop similar patterns of behaviour. In ceramics, this results not only in similar formal and stylistic attributes (known as types) but also in selection of similar raw materials (according to geographical availability) and in similar 'recipes' for preparing and mixing the raw materials to produce the final product. The dispersal of these patterns of selection and preparation can be established, with implications for the movement of people in response to subsistence and settlement requirements, trade, and marriage.

Six models were proposed as alternate explanations for the distribution of Duck Bay Ware. The test implications of each model predicted a particular correlation of style, technology, and location, in particular the size(s) and distribution of sites, the distribution of Duck Bay Ware, the relative proportions of Duck Bay Ware and other wares at FbMb-1, the type and distribution of raw material selection and preparation, the season of occupation of Aschkibokahn, and the presence of other artifactual and faunal material in FbMb-1. The evidence and analysis results now permit us to evaluate these implications.

Conclusions:

Stylistic, technological, and frequency variability:

The mineralogical and chemical analyses indicate a patterning of selection and/or production behaviours that corresponds with location rather than style. There is a uniform selection of clays and tempers by Aschkibokahn potters which is distinct from the behaviour(s) at other sites, be they nearby or far away. Unfortunately, the existence of selection and production patterns at other sites is not quite as apparent, probably because so few ceramics from each of these sites were analyzed.

The analysis suggests that the Aschkibokahn residents may have been selecting clays from the Swan River Group deposits whereas other potters were selecting clays from other deposits. The actual deposits used by residents of either Aschkibokahn or other sites are unknown; whether or not these deposits still exist to be tested is also unknown. The FbMb-1 pottery is also unique for the type and proportions of tempering agents used in ceramic production. The chemical analysis indicated a high P_2O_5 content, which has been interpreted as the result of adding bone to the clay. The mineralogical analysis suggested a low feldspar content relative to ceramics from other sites. Furthermore, the feldspar content in FbMb-1 ceramics seems to fall into two groups.

There is, however, a slight overlap of technological patterns, i.e., the use at other sites of bone temper with some other clays. This is best demonstrated by the Drinking Falls vessel from GiNb-1, Saskatchewan. Both the P_2O_5 and mineral temper proportions fall well within the range of variation of FbMb-1 pottery. Furthermore, the decoration is unequivocal Duck Bay Punctate (unlike sherds at other sites distant from FbMb-1, eg., those in southeastern Manitoba). However, the clay is entirely different in terms of colour, weight, 'feel', and non-clay mineral inclusions. In other words, at GiNb-1, non-local tempering and decorative patterns were integrated with local clays. This suggests that women from Aschkibokahn, who were accustomed to this technology, were moving to other bands and attempting to continue their tempering patterns while using different clays, rather than women from other bands attempting to copy the Duck Bay Ware style using their own technological patterns. Women from outside Aschkibokahn would have to familiarize themselves with the total technology rather than just observe completed vessels if they were to replicate Duck Bay Ware elsewhere. Furthermore, and even more importantly, they would have to overcome the technological conservatism of their own band, a factor which is very prominent in the maintenance of tradition among potters. It would be much easier for a woman, enculturated in the bone-tempered ceramic technological tradition, to continue making her vessels elsewhere, since she would be regarded as 'from outside' and, therefore, would be expected to do things differently (i.e., improperly, see Dunning 1959: 123) than it would be for a local woman to introduce a new technology into her own local band. The 'outsider' might, however, eventually succumb to the pressure of ridicule and begin to adopt the ceramic technology of her new local band.

Non-Duck Bay Ware ceramics at Aschkibokahn were not acquired by trade. First, both the chemical and mineralogical analyses indicate that Duck Bay and non-Duck Bay wares at FbMb-1 were made from similar clays and had similar types and quantities of tempering agents added, whereas ceramics at other sites (be they Duck Bay Ware or not) had different chemical and mineralogical qualities. Second, the Plains-like ceramics at FbMb-1 have very different paste attributes (hardness, density, and porosity) than do Plains ceramics from North and South Dakota. Non-Duck Bay Ware vessels may have been made at Aschkibokahn either by 'Blackduck', 'Selkirk', or 'Plains' women living at Aschkibokahn or by 'Duck Bay' women attempting to copy Blackduck, Selkirk, or Plains styles they had seen elsewhere. Differentiating between these is difficult, even impossible, at this stage. Both, however, entail long-distance travel by women who, when they arrived at Aschkibokahn, attempted either to copy ceramic styles they had seen elsewhere or to continue making and decorating ceramics in the style they had learned in their 'home' band. However, following from the premises outlined in Chapter 3, at least a certain proportion of these non-Duck Bay wares would be made by women who had married into the 'Duck Bay' band from outside.

The sources of non-local lithics and the locations of Duck Bay Ware outside FbMb-1 correspond reasonably well. At a minimum this suggests trade: lithics moving in one direction and ceramics, or something contained in the ceramics, moving in the opposite direction. However, the chemical analysis has eliminated trade in ceramics as an explanation. The alternative explanation is that people were travelling from Aschkibokahn to other bands (or vice versa) to obtain desired items. One or both of two consequences followed: women accompanied the men on these travels and either obseved new decorative styles which they then attempted to copy when they returned home or remained behind as spouses of men resident in the band and continued to make and decorate pottery as they had learned in their home band.

If we compare these results with the implications of each of the models, the results most closely correspond with the implications of Models 2 and 4, namely, there is minimal within-site technological variability and maximum between-site technological variability. Trade is eliminated as an explanation because the chemical and mineralogical pattern which characterizes the FbMb-1 pottery is not shared with any other sites. It appears that the boundary demarcating high Duck Bay Ware frequency corresponds to that delimiting the high P_2O_5-low feldspar pattern, at least in so far as all sites with low Duck Bay Ware frequency do not follow this technological pattern. The evidence weighs heavily in favour of the models proposing the movement of women in response to endogamous marriage patterns.

Function does not appear to be a likely explanation for the distribution of Duck Bay Ware; however, there may be some functional variability within the ceramic assemblage at FbMb-1. The mineralogical analysis suggests that within the FbMb-1 ceramics there may be two classes of paste depending upon how much feldspar was added. These two classes cross-cut all wares. So far, the significance of these differing feldspar proportions is unknown, but vessel function should not be eliminated as an important factor under consideration when pottery was being made. A comparison of vessel class (based on feldspar content) and the presence/absence of carbonized remains might be helpful in answering this question. The situation at other sites is unclear. Whether or not potters at other sites also produced pastes with differing feldspar proportions is unknown.

Territorial size and settlement pattern:

The region surrounding Aschkibokahn is archaeologically unknown. There is no evidence concerning the size of the territory exploited by the local band; the number, location, and size of sites; the season(s) sites were occupied; and at which sites one or both sexes were present. Even if we cannot observe the totality of the settlement pattern, we should be able to make tentative predictions about the type of settlement pattern by ascertaining what proportion of the year Aschkibokahn was occupied. The alternatives of non-sedentary and semi-sedentary settlement patterns have different implications for the length of time, and the seasons during which, Aschkibokahn was occupied.

Here there is both definite and equivocal evidence. The faunal assemblage from FbMb-1 contains definite evidence of spring, summer, and fall occupation (fish scale annuli, medullary tissue, juvenile small mammals, migratory birds). Winter is the only season for which there is no conclusive evidence either for or against occupation, even though winter resource distribution and concentration in the vicinity make it possible for bands to have wintered near the island, if not on it. The faunal evidence confirms some variation or combination of the site occupation as proposed in models 1, 2, and 3; the implication of model 4 has yet to be proved or disproved.

The distribution of ceramic production patterns eliminates models 1, 3, 5, and 6 which anticipated a more wide-spread distribution and a more gradual decline in the frequency of both ceramic types and characteristic production patterns in the case of models 1 and 3, or a correlation of technology with style as in the case of Model 5. Because we lack data on territorial size and settlement pattern, and because the seasonal implication of model 4 has yet to be disproved, it is impossible to choose between model 2 and model 4. At best, we can only conclude that there is more evidence supporting model 2 than there is evidence disproving model 4.

If we are to chose conclusively between these two models we need more data on settlement pattern and tighter temporal control. In order to ascertain the settlement pattern, extensive surveys of the Lake Winnipegosis shore north and south of Aschkibokahn, the upriver sections of the Duck, Sclater, and Drake rivers, and the Swan and Pelican lakes regions would have to undertaken. This is an extensive area, most of which is accessible only by canoe or float plane. Better temporal control is needed not so much at FbMb-1 as at other sites where Duck Bay Ware occurs. This study has assumed contemporaneity of sites, but only the Smith site in Minnesota has a date to confirm this assumption. If components elsewhere containing Duck Bay Ware are significantly older or younger than FbMb-1, the models as presently devised would not be valid, and other reasons for the distribution of Duck Bay Ware would have to be considered.

The scenario about A.D. 1100 to 1300 at Aschkibokahn is somewhat as follows. The women who produced Duck Bay Ware were members of a relatively endogamous band who inhabited the island of Aschkibokahn for a major part of the year and perhaps all year. The band was not, and could not be, completely endogamous due to the exigencies of unequal sex ratios among people of marriageable age (of particular concern to those seeking a spouse) which occur so frequently among small populations. Consequently, some women left the Aschkibokahn local band to reside in other local bands; conversely, some women from outside local bands came to reside at Aschkibokahn. Marriage was not the only means by which contacts were maintained between bands. The desire to obtain exotic materials such as chalcedony and pipestone also initiated and maintained inter-band movement, some of which apparently covered great distances.

At this point, there is neither need nor basis for speculating as to why women began and ceased to decorate pottery now known as Duck Bay Ware. If, however, we can correlate the origin and demise of Duck Bay Ware with the band in which it was made, there are some interesting speculations we can make about the duration and ultimate fate of the band. Duck Bay Ware appears toward the end of the Neo-Atlantic and during the Pacific climatic episodes, which are generally conceded to be warm dry periods (Bryson and Wendland 1966). The marsh region on the west shore of Lake Winnipegosis may have been an oasis for animals and, therefore, for humans. A band may have moved into the region, taken up residence there, and then through the years developed social mechanisms (particularly endogamy) to restrict entry by outsiders into their territory. Two factors may have led to the demise of the band. Band membership may have increased to the point where it could no longer operate efficiently as a single unit, with a portion of the band fissioning and relocating elsewhere. The change from climatic conditions similar to the present to the more severe conditions of the Neo-Boreal climatic episode may have depressed the resource potential of the region sufficiently so that it was no longer efficient or advantageous for the resident band to maintain endogamous marriages. The change to exogamous marriages (and perhaps bilocal residence?) would enhance the survival of band members under deteriorating climatic conditions.

The social aspects of such a scenario are not entirely unlikely. Rogers and Rogers (1980) found a comparable situation among the Cranes of Weagamow Lake in northern Ontario. The band which began as an endogamous unit eventually became too large to operate effectively as a unit and subsequently split. The climatic component is also likely, but there are no palaeoenvironmental data from the Lake Winnipegosis region which could be used to support or disprove the scenario. Palaeoenvironmental data from the Lake Winnipegosis region are sorely needed. Studies have been done to the north and south but they have emphasized the earlier, longer climatic episodes. In addition, the location of Duck and Porcupine mountains immediately west of

Lake Winnipegosis has a moderating effect on local climatic conditions which is not necessarily replicated at other locations where palaeoclimatic data have been obtained.

Questions:

This study has shed some light on the prehistory of one particular region of Manitoba. However, there are more general and more important implications, arising out of the chemical and mineralogical analyses, concerning what we know of prehistoric ceramic technology.

The analysis of FbMb-1 and other site ceramics suggests that prehistoric Woodland ceramic technology may be more complex than originally presumed. Aschkibokahn potters used not one but two temper agents--bone and feldspar--in the production of their ceramics. Whether or not a bone-feldspar temper combination has any advantage over straight feldspar temper in the forming or firing process or produces different qualities in the finished product is unknown. These questions would be best answered by experimental replication of vessels using similar types and proportions of raw materials.

By identifying vessels according to production patterns, it has been possible to decide whether a vessel was made locally or was imported from elsewhere. When using style, decisions of this sort are based on how closely any vessel corresponds to the majority of vessels at a site. This does not allow for idiosyncratic behaviour or for the immigration of women from other bands who either continue to make pottery in the style of their original band or try to reconcile styles of their previous band and their new band. Stylistically, such vessels would be classified as 'non-local' when actually they were locally produced. Even if women within a band were producing different styles, they would be constrained to using the same raw materials simply because of the nature of the distribution of clays with appropriate ceramic properties. Chemical and mineralogical analyses are capable of detecting the difference between the use of local and non-local materials. This is a much more reliable test of trade versus local production than is stylistic analysis.

The chemical and mineralogical analyses in this study indicate quite strongly that paste characteristics, which encompass temper, texture, colour, and hardness (Mayer-Oakes 1970: 185; Rice 1976) are related to geographical factors rather than correlated with decorative types. All but two analyzed FbMb-1 ceramics fell into a group characterized by high P_2O_5-low Al_2O_3 regardless of ware designation; conversely, the comparison sites ceramics fell outside this group regardless of ware designation. This result calls into question our definition of 'ware' which is basic to our entire typological scheme: "ware . . . includes a number of pottery types having similar paste, surface finish, and sometimes vessel form" (MacNeish 1958: 139; emphasis added). Here we have a situation in which vessels at different sites, which have been grouped into a single ware, have very different pastes. Furthermore, at FbMb-1 vessels, which stylistically are dissimilar and traditionally have been categorized as different wares, have identical pastes.

It should not be suprising that paste characteristics vary geographically. Potters were required to use materials at hand. The properties of the finished product are dependent as much on the properties of the raw materials (which vary geographically) as on the production process. That geographical variation in paste attributes has not been perceived is due primarily to the use of subjective, non-rigorous methods of analysis. Prehistoric ceramic technology in the southern boreal forest, parkland, and northeastern Plains has been assessed by what might be called the eyeball technique, i.e., through visual inspection of a sherd. Statements and conclusions as to types and proportions of various components of the paste and the method(s) by which the vessels were formed were based on this visual inspection, with no recourse to mineralogical and chemical analyses or experiments in making and firing vessels. This is in spite of statements by Shepard and Porter (see Chapter 2) about the validity and reliability, or rather the lack thereof, of visual inspection as an analytical technique. What is readily apparent to the eye is emphasized to the detriment of that which is not so apparent, and that which is not visible cannot be known to exist. The result is that conclusions are based on skewed or even erroneous observations. This disparity between visual assessment and mineralogical analysis is demonstrated by the difference between temper proportions estimated by the eyeball technique (20% to 30%) and those estimated by thin-section analysis (3% to 10%). Also, no visual analysis would ever have reported the addition of bone to paste.

This lack of mineralogical and chemical analysis has left us ignorant about the roles of clay properties and production processes in determining the properties of the finished vessel. Hardness and colour, for example, are the function of clay and non-clay minerals, firing temperatures and conditions, and subsequent use. Texture, which is a composite of porosity, density, and appearance, is a function of the workability of the clay (which in turn is a function of clay and non-clay minerals), the manner in which the clay is prepared (grinding, sorting, tempering, wedging, ageing), and the care taken in compacting the clay during vessel construction. Consequently, a statement such as

'Hardness varies between 3.0 and 3.5' tells us only the final state of the vessel. It does not inform us of the relative contributions of geological and cultural aspects to that final state. By using these and other analytical techniques, we can begin to put limits on the contribution of measureable geological and cultural factors (eg., firing temperature). This, in turn, should permit us to specify the range of complementary cultural (production) factors through experimentation with comparable clays and tempers.

The main disadvantages to these more sophisticated analyses are time, money, and training. They are time-consuming for both preparation and analysis of samples, they are expensive because trained personnel and special equipment are necessary, and they require at least minimal knowledge of geology and statistics to be able to interpret the results of the analysis. However, when the alternative is erroneous or incomplete data, data which are used to support hypotheses of culture change, development, and interaction, the disadvantages are minor in comparison. Archaeologists must learn to incorporate these analyses, much as they now automatically incorporate radiocarbon dating, if they continue to use ceramics as one of the main data sources for understanding and elucidating prehistoric cultural processes.

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