ARCHITECTURAL VARIABILITY IN PALEOESKIMO TENT RINGS FROM JONES SOUND, NWT.

by

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ABSTRACT

This thesis documents and examines the scope of architectural variability in a sample of Paleoeskimo tent rings from the Jones Sound region of the eastern Canadian High Arctic.

A total of forty-four excavated and unexcavated tent rings were examined and analyzed using the predominantly metric methods of quantitative shape analysis. Tent rings were recorded using a simple radial mapping technique. A standardized system of centre-point determination and radial partitioning permitted subsequent analysis of perimeter rock distributions using multivariate statistical procedures. These analyses demonstrate that significant variability exists in the distribution of stones about the perimeter of these features. Principal components analysis indicates the existence of high level of internal structure in the relative distribution of stones about the tent ring perimeter. Cluster analysis indicates that clear groupings exist in the volume and distribution of these perimeter rocks. These patterns are explained in terms of past environmental and cultural-historical phenomena. In particular, these clusters are used to infer seasonal affiliations and to assess the possibility of contemporaneity between individual features.

Existing constructs regarding the temporal and/or cultural distribution of specific tent ring forms or attributes are critically assessed. It is suggested that current interpretations regarding the temporal-cultural diagnosticity of specific architectural elements within Paleoeskimo features are only partially supported by a rigid examination of the Jones Sound data.

Although preliminary in nature, this study demonstrates that meaningful insights into past conditions may be gained through the detailed metric analysis of simple architectural remains.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

One of the most fundamental tasks of archaeology is the documentation and explanation of variability in the material culture of prehistoric peoples. Before any of the more complex and profound theoretical goals of archaeology can be successfully addressed, the mundane but necessary job of classification must be carried out. Consequently, the development of analytical techniques that aid in the recognition, documentation and explanation of variability are a critically important part of contemporary archaeology.

1.1 Study Goals

This study explores the degree of architectural variability in a sample of Pre-Dorset and Dorset age tent rings from the Jones Sound region of the Canadian High Arctic. The study is a largely quantitative analysis which records and compares stone circles at a level of detail not normally undertaken in Arctic archaeology. It focuses upon the development of a predominantly metric methodology for implementing the detailed description and analysis of various architectural elements of excavated and unexcavated tent rings. Of principal concern is the documentation of patterns of variation in the construction of the perimeter rings of these features and the explanation of this patterning in terms of their environmental and culture-historical context.

Although this study should be viewed as principally contributing to Arctic archaeology, the procedures and techniques employed have much further reaching implications. Tent rings, as a common archaeological phenomenon across the globe, have presented a common analytical problem for archaeologists. By developing rigorous and verifiable methods for recording and detecting variability in these features, this analysis has made the task of other researchers easier.

1.2 Study Limits

For the sake of expedience and clarity, the following somewhat arbitrary limitations have been placed upon this study.

This thesis has been restricted intentionally to the almost exclusive examination of the perimeter portion of the tent rings under study. The exclusion of the interior portions of the tent rings from detailed analysis should in no way be taken to imply that significant structured variability does not exist in these interior elements. In fact, it is almost certain that the interior elements of Paleoeskimo tent rings exhibit a high degree of structured variation. However, in order for this study to have a broader applicability than for Arctic studies alone, the decision was made to focus upon the universal construction elements common to all tent rings.

This study has also been arbitrarily limited in geographical scope. While the Jones Sound area does form a definable geographical unit, it does not form a closed cultural or environmental sphere. This limitation was imposed for the purposes of analytical convenience.

It was not the intention of this study to provide a means for distinguishing between the physical remains of habitation features and other petroformic features like caches or cairns, although such a technique would certainly be of value to Arctic archaeologists. It is also not the intention of this study to analyze the distribution of cultural materials within or between individual features. Such a form of analysis would certainly be of potential interest to contemporary Arctic researchers. Instead, this study focuses exclusively upon the analysis of architectural and/or constructional elements and what these attributes can reveal about environmental and social conditions during the period of occupation.

Dekin (1976), Collins (1984), Bielawski (1988) and Robertson (1988) have all extensively commented upon the lack of a strong empirical basis in Arctic archaeological research. Cultural-temporal units are frequently defined upon the basis of intuitive and subjective criteria, often derived from unpublished sources. The variability which exists in most aspects of the material culture of prehistoric peoples has not yet been satisfactorily documented. If Arctic archaeology hopes to contribute to the development of a greater body of archaeological method and theory, then the documentation and quantitative analysis of the full realm of variation existing in the physical remains of past peoples must be undertaken. This study tries, in a modest way, to begin to address this problem.

Put simply, the principle goals of this study are: 1) to document the nature and extent of variability in Paleoeskimo stone circles; 2) to use this variability to test the possibility that specific tent rings found at the same site represent either contemporaneous or cyclically (seasonally) contemporaneous occupations and; 3) to determine if variability in stone circle morphology is a diagnostic indicator of cultural historical affiliations.

1.3 Outline

Chapter 2 fulfills the necessary task of introducing the broader context within which this research was carried out. The study is first placed in geographic context through a brief description of the Jones Sound area. Next, the Devon Island Archaeological Project is introduced. The study is then placed in cultural-historical context through a general discussion of High Arctic prehistory, with particular emphasis upon the Jones Sound geographic area and the Paleoeskimo-Eskimo cultural period. Terms and definitions unique to this study are then defined. A brief discussion and critique of important tent ring studies, both Arctic and otherwise, follows. Finally, the general problem of quantitative shape analysis is introduced and briefly discussed.

Chapter 3 provides brief physical descriptions of all sites and all cultural complexes employed in the course of this analysis. These descriptions provide necessary background understanding of the raw data analyzed in subsequent chapters.

The specific methodology employed in gathering and processing the study data is outlined in Chapter 4. Methodological considerations are divided into two components: field methodology, and post-field methodology. Criteria for the selection of individual features for inclusion in the study are outlined, and techniques for the collection of data are described. The standardization of data through the determination of a replicable analytical centre-point is extensively discussed. In particular, previous techniques are critiqued. Data smoothing techniques are described, and the rationale for the application of such techniques explained. As well, the criteria and rationale for feature rotation are discussed.

Chapter 5 provides a detailed discussion of the statistical procedures used to analyze the data. In particular, the rationale for the selection of specific procedures is outlined and the application of these procedures to the study data is explained.

Chapter 6 summarizes the results of the previously described analyses and discusses the possible implications of these results in terms of the stated research goals.

Chapter 7 presents the final conclusions of this thesis.

Appendix A contains tabular summaries of all data sets used in this research. Appendix B presents individual feature maps for all features included in this study. Appendix C contains rose charts which graphically present the data sets used in the analyses. Appendix D provides brief written descriptions of each individual feature.

CHAPTER 2

BACKGROUND

This chapter is intended to introduce the broader context within which this research was carried out. The purposes of this chapter are: 1) to familiarize the reader with the location of the Jones Sound area and specific study locales within that area; 2) to provide a brief introduction to the Devon Island Archaeological Project; 3) to briefly describe weather patterns in the study area; 4) to provide a brief contextual summary of Arctic prehistory with special emphasis upon the Jones Sound region and the Devon Island Archaeology Project; 5) to discuss the generalized problem of quantitative shape analysis, and; 6) to provide a short discussion of important existing tent ring studies.

2.1 The Study Area

The study area lies on the eastern periphery of the Queen Elizabeth Islands of the Canadian High Arctic, bounded by **Ellesmere Island** to the north and **Devon Island** to the south (see Figures 1 and 2). The body of water separating these islands is called **Jones Sound**. There are no permanent human habitations in this region except for the small community of **Grise Fiord** located on the southern shore of Ellesmere Island. Four locales in the Jones Sound area are of specific concern to this study and are described in detail below. They are: **Lee Point** (76°23'38" West and 82°23'26" North), on the south shore of Ellesmere Island some twenty kilometers east of Grise Fiord; **Sparbo/Hardy**

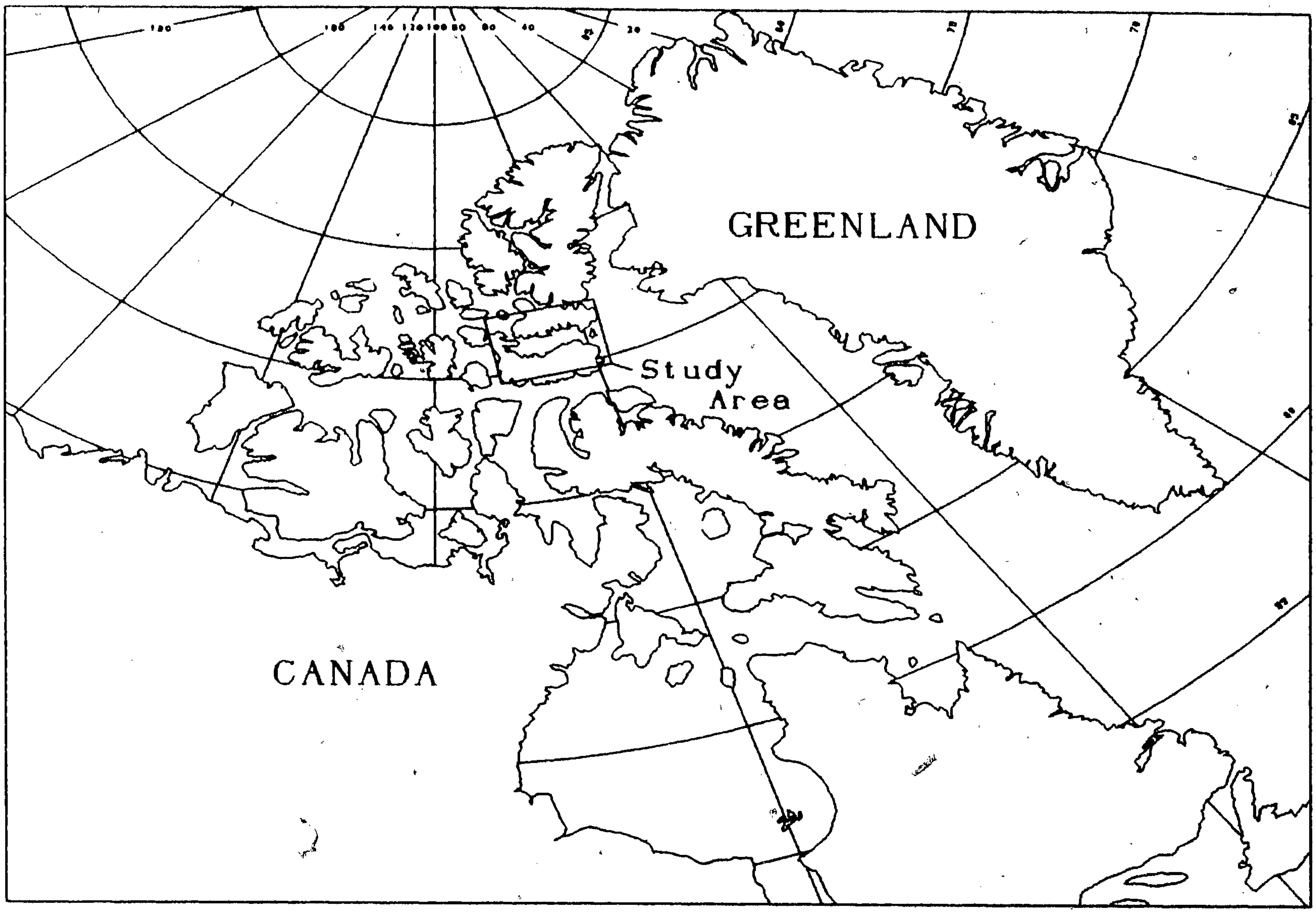


Figure 1: The Study Area

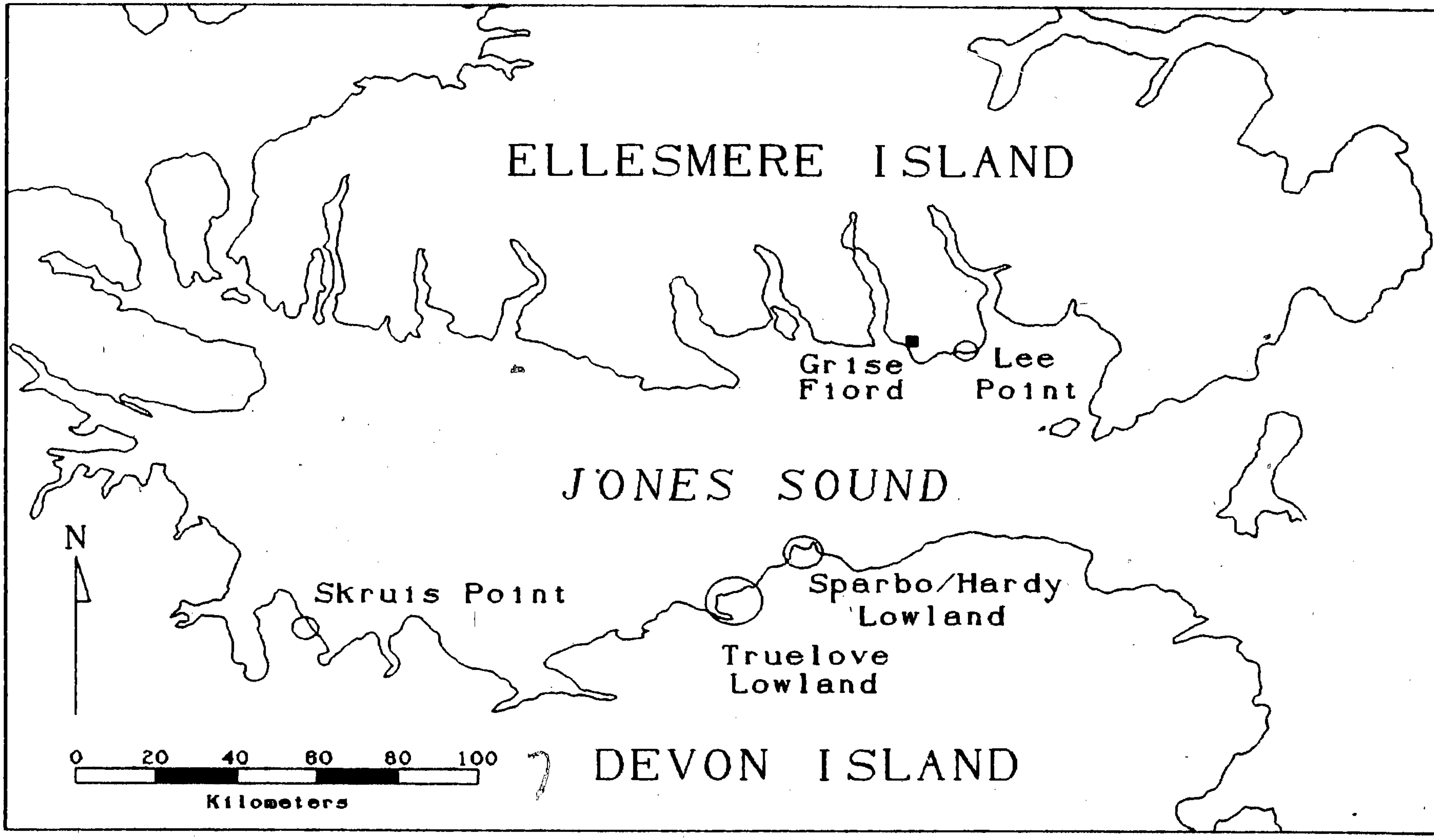


Figure 2: Jones Sound

Lowland (75°49'20" West and 83°47'15" North), on the northern shore of Devon Island some sixty-five kilometers southwest of Grise Fiord; **Truelove Lowland** (75°41'00" West and 84°30'00" North), on the north shore of Devon Island some ninety kilometers southwest of Grise Fiord; and **Skruis Point** (88°29'30" West and 75°34'00" North), on the northern shore of Devon Island some 100 kilometers west of Truelove Lowland and 180 kilometers southwest of Grise Fiord.

Jones Sound

Running east to west between the south shore of Ellesmere Island and the north shore of Devon Island, Jones Sound forms a passage between the North Water of Baffin Bay and the Grinnell Peninsula of Devon Island. Constricted at both ends, Jones Sound forms a broad basin teeming with marine resources. During the summer, narwhal (*Monodon monocerus*), beluga (*Delphinapterus leucas*) and walrus (*Odobenus rosmarus*) are regular visitors to the Sound. In the past, Bowfin whales (*Balaena mysticetus*), also added to the tally of significant seasonally available marine resources. Maritime species available throughout the year include: ringed seal (*Phoca hispida*), harp seal (*Phoca groenlandicus*), bearded seal (*Erignathus barbatus*) and polar bear (*Ursus maritimus*) (Helmer 1987b).

Ellesmere Island

Ellesmere Island is the most northerly major landmass in the Queen Elizabeth Islands. The south coast is particularly complex with many deeply incised inlets and fiords. The only permanent human habitation in the Jones Sound area is the small Inuit community of Grise Fiord, established by the Canadian government in the mid-1950s.

Lee Point

Lee Point is a small, lowlying promontory on the southern shore of Ellesmere Island, approximately twenty kilometers east of Grise Fiord. The point juts south-southeast into the waters of Jones Sound and is overlooked on the north by massive rock cliffs. A remnant portion of the South Ellesmere Ice Cap is only three kilometers away to the north. Lee Point is at the western limit of a lengthy series of narrow, low-lying, poorly drained flats which form the northwestern edge of the mouth of Starnes Fiord.

Devon Island

Lying directly south of Ellesmere Island across the waters of Jones Sound is Devon Island. Devon Island is roughly rectangular in shape, with the exception of the northwesterly jutting Grinnell Peninsula. The northeastern coast of Devon Island is characterized by steep near-shore cliffs, occasional fiords, and the scattered presence of small coastal lowlands.

Truelove Lowland

Truelove Lowland lies on the north shore of Devon Island, approximately ninety kilometers southwest of Grise Fiord (see Figure 3). The lowland is a broad, relatively flat, poorly drained area of about forty square kilometers. It is bounded on the east and south by the cliffs of the

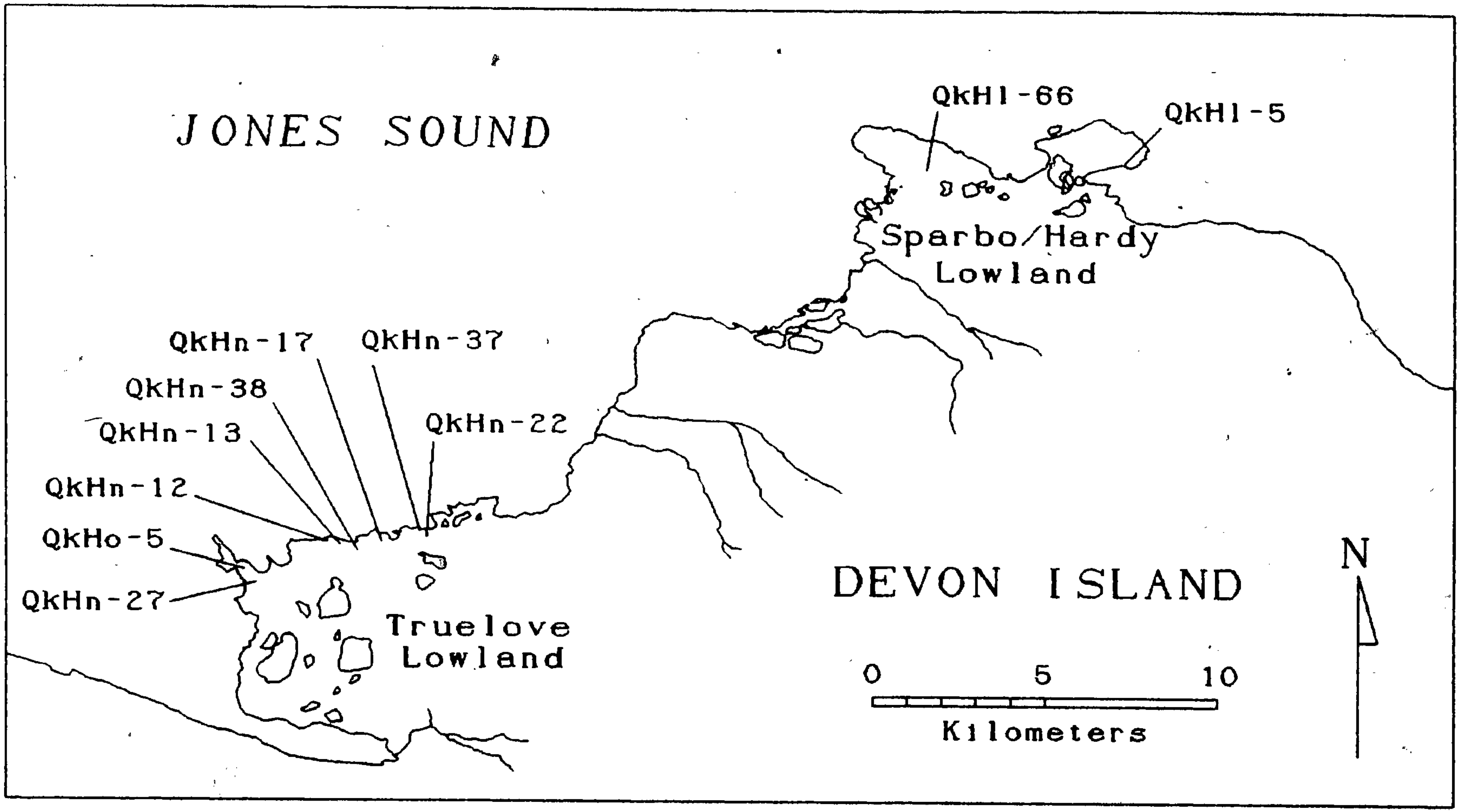


Figure 3 Truelove and Sparbo/Hardy Lowlands

Devon Island Plateau and on the south by the waters of the Truelove River and Truelove Inlet. To the north and west lie the waters of Jones Sound.

Truelove Lowland is an area of unusually rich floral and faunal diversity when compared to the surrounding polar desert. Ninety-six species of vascular plants, 182 species of lichen, 132 varieties of mosses and ninety-two types of fungus attract significant concentrations of muskox (*Ovibos moschatus*), caribou (*Rangifer tarandus pearyi*), arctic fox (*Alopex lagopus*), arctic hare (*Lepus arcticus*), short-tailed weasel (*Mustela erminea*) and lemming (*Dicrostonyx* sp.). Several lakes teem with arctic char (*Salvelinus alpinus*) while shorebirds (*Charadriiformes*) and migratory waterfowl (*Anseriformes*) are present in summertime (Bliss 1977).

Sparbo/Hardy Lowland

The Sparbo/Hardy Lowland lies on the north shore of Devon Island, some fifteen kilometers northeast of Truelove Lowland (see Figure 3). Capes Sparbo and Hardy are massive headlands jutting north into the waters of Jones Sound. Lying behind and to some degree sheltered by these two Capes is the Sparbo/Hardy Lowland. The Sparbo/Hardy lowland, like the larger Truelove lowland, is an oasis of biological productivity in an otherwise barren polar desert.

Skruis Point

Skruis Point lies on the north shore of Devon Island, about 100 kilometers west of Truelove Lowland. Skruis Point is a large (twenty-five kilometer wide) promontory stretching north into the waters of Jones Sound. It is bounded on the northeast by Bear Bay and on the west by Thomas Lee Inlet. The Skruis Point site lies on the eastern shore of the promontory, some twenty kilometers southeast of the northern extremity of the point. The site area is bounded by high cliffs to the northwest and southeast. It is situated within the mouth of a broad river valley which extends inland across the base of Skruis Point.

2.2 DIAP Project Background

The Devon Island Archaeological Project (DIAP) is an ongoing archaeological investigation under the direction of Dr. James Helmer of the University of Calgary (Helmer 1982, 1984a, 1984b, 1985, 1986, 1987a, 1987b, 1987c, 1987d, 1988). Initiated in 1982, this project has been committed to gaining a better understanding of prehistoric cultural dynamics within the Jones Sound area. The DIAP project has exclusively focussed upon the Paleoeskimo period and the resolution of cultural-historical and subsistence-settlement problems within this period (Helmer 1987b). Field studies were initiated in 1982 and continued through the summer of 1987. All tent ring data employed in this analysis were collected under the auspices of the DIAP project during this period.

Acting independently of, but in close association with the goals and activities of the DIAP project have been the investigations carried out by the Prince of Wales Northern Heritage Society (NHS) at the Field School Site on Truelove

Lowland (see section 3.1). Data gathered by the NHS Field School excavations in 1984 and 1985 (Bertulli and Strahlendorf 1984; Bertulli 1987) have been fully incorporated into all DIAP project investigations including this study.

In geographical terms, the in-field researches of the DIAP project have largely been concentrated upon the North Devon Lowlands region of northeastern Devon Island. In particular, investigations have centered upon the region between and including the two coastal lowlands of Truelove Lowland and Sparbo/Hardy Lowland. Additional smaller scale investigations have also taken place in the Grise Fiord region of south Ellesmere Island and at scattered locales upon the northern shore of Devon Island.

The geography of these islands is quite striking and has, of course, had a profound impact in structuring prehistoric human use. The bulk of Devon Island is characterized by a high upland plateau which is essentially sterile and uninhabitable. It is barren, inhospitable and depressing. The only significant geographical feature of the Plateau is the massive central icecap which plays a role in structuring local climate. The majority of the island's north shore, where DIAP project research has been centered, is dominated by very high and imposing near shore cliffs and capes, an extremely limited or non-existent fore-shore, and occasional fiords. These coastal environments, although more attractive than the upland plateau, are still not highly productive in a biological sense.

Scattered along the northeastern shore of Devon Island, there are a number of highly productive biological enclaves called lowlands. These lowlands, created by a combination of local topographical and microclimatological phenomena which combine to make them warmer and moister than the adjacent upland plateau and coast, are small (the largest is approximately forty square kilometers) but significant oases of floral, avian and terrestrial mammalian resources. Truelove and Sparbo/Hardy are two examples of such lowlands.

Extensive survey by DIAP personnel during the course of in-field studies in the Truelove-Sparbo/Hardy coastal area has resulted in the identification of more than of 200 archaeological sites, ranging in size from small lithic scatters to large and complex multi-component habitation sites. Excavations of varying extent have been conducted at a dozen of these sites. Analysis and interpretation of the materials recovered in these excavations is ongoing.

2.3 Climate

At a macroclimatological level, the surface weather systems of the Jones Sound area are governed by the interaction between the large-scale, cold-cored circumpolar vortex and the south Greenland low pressure area. The westerly flow of the vortex towards and around the south Greenland low dominates throughout the year, but considerable differences in the direction and rate of flow may be noted between summer and winter patterns (Hare and Hay 1974). Cyclonic disturbances are infrequent throughout the year, but are definitely associated with periods of high wind common during summertime (Bliss *et al.* 1973).

During the summer months (from June to the end of September), with the weakening and westerly displacement of the south Greenland low pressure area, the frequency of northerly and northeasterly winds increases while the general intensity of westerly flow declines. With the general weakening of the vortex, moving cyclones of the arctic frontal belt often traverse the area (Hare and Hay 1974), resulting in more generally chaotic wind distributions than are common in the winter.

During the winter months (October to June), the south Greenland low pressure area strengthens and moves east, causing a general increase in the rate and frequency of westerly flow. Also during this period, cyclonic disturbances become exceedingly rare (Hare and Hay 1974). Consequently, the predominance of strong westerly winds is almost complete during the winter months.

At the microclimatological level, no detailed long-term climatological records are known to exist anywhere in the study area. The closest long-term records are from Resolute Bay, on Cornwallis Island, some 400 kilometers southwest of Grise Fiord (Courtin and Labine 1977:73).

Although no long-term weather records exist within the study area, short-term climatological studies have been carried out at Truelove Lowland. Courtin (1973), Labine (1974) and Courtin and Labine (1977) collected detailed climatological data for the years 1972 and 1973 from a number of weather stations located in and around Truelove Lowland. Moreover, twelve years of intermittently recorded aeronautical weather from the Truelove Research Station was incorporated in their analyses. These data were used to construct a detailed microclimatological model for Truelove Lowland. In spite of the short term nature of these studies, considerable accuracy was attained in the predictive component of this simulation (Labine 1974:61). Consequently, the model may be regarded as an accurate reflection of contemporary weather patterns at Truelove Lowland.

Westerly winds form the dominant flow pattern throughout the year at Truelove Lowland. The intensity and frequency of this flow decreases in summer and increases in winter. Although the intensity of western winds during the winter months is higher than the speed of summer westerlies (Hare and Hay 1974), the mean monthly wind speeds in the summer (2.23 meters per second) exceeds the monthly means for winter (1.42 meters per second) (Courtin and Labine 1977:98). This is due to the influence of the high speed winds which normally accompany cyclonic disturbances during the summer months.

Easterly winds should not occur in the study area, except as a result of cyclones moving along the Arctic frontal belt. Such disturbances are virtually unknown during the winter months, but they are responsible for the light precipitation typical of summer (Hare and Hay 1974).

Winds from the south are sporadic and short in duration, but are frequently violent in nature (documented at up to 85 kilometers per hour). These intense southerly winds "appear to be associated with cyclonic storms" (Courtin and Labine 1977:99). The occurrence of these *föhn* winds appears to be very seasonal in nature, with highest frequencies expected in late summer (*ibid*:104).

Interestingly enough, Courtin and Labine's research indicates that the local micro-topography of Truelove lowland has little effect upon near surface wind directions. The intensity of certain winds is reduced in specific areas, and a general decrease in wind speed from east to west across the lowland has been noted, but predominant wind directions remain generally constant across the lowland (*ibid* 1975:100).

In summary then, winds from the west and northwest may be expected at any time of the year, although the frequency and intensity of these winds is highest during the winter months. Winds from the north, northeast or east should be rare during winter and more frequent during the summer months. These winds will also typically be stronger than average, although the common summer westerlies will be weaker than winter west winds. Winds from the south should be exceedingly rare during the winter, but much more frequent during the late summer. These southerlies will also be the most powerful winds encountered during the yearly cycle.

How applicable the microclimatological studies of Courtin (1973), Labine (1974) and Courtin and Labine (1977) are to the entire Jones Sound area is uncertain. The Truelove Lowland weather model is almost certainly directly applicable to the Sparbo/Hardy Lowland due to geographical similarity and physical propinquity. However, the application of the model to the Skruis Point and Lee Point samples is less certain.

The applicability of this contemporary weather model in inferring past conditions is also uncertain. Major climatic changes are known to have occurred at various times throughout the High Arctic during the 3,000 years of interest to this study (McGhee 1976). It is certainly possible that these climatic changes were accompanied by shifts in wind patterns. However, for the Truelove and Sparbo/Hardy Lowlands at least, the major physiographic elements which create and maintain wind patterns, the juxtapositioning of land, sea and icecap, remain much the same today as they did in the past. Consequently the pattern of wind distributions described above is assumed to hold throughout the past.

2.4 High Arctic Prehistory

Human occupation of the Canadian High Arctic began approximately 4,200 years ago and continued, on a regionally intermittent basis, until the present day (McGhee and Tuck 1986). This occupation can be divided into two discrete temporal and cultural periods. The more recent episode, called the Thule culture, first appeared throughout the eastern Queen Elizabeth Islands at about 1,100 RCYBP (Maxwell 1988). This widely distributed, technologically sophisticated culture was characterized by a broadly based maritime economy and a highly organized social life.

Thule

There is little doubt that the Thule culture is the biological and cultural ancestor of historic Inuit groups (McGhee 1978:103). However, the historical antecedents of the Thule culture appear to lie further afield. It seems likely that the source of Thule culture, and probably the Thule people themselves, stems not from the earlier Paleoeskimo cultures of the Canadian High Arctic, but from the Punuk and Birnirk cultures of the Bering Sea region of Alaska and Siberia (Maxwell 1988:250-252). It appears that at about 1,100 years ago the rapidly expanding Thule culture supplanted or absorbed the indigenous Paleoeskimo cultures then occupying the Canadian High Arctic (McGhee and Tuck 1976; Maxwell 1988). It is with the remains of these earlier Paleoeskimo cultures that this study is concerned.

Paleoeskimo and Arctic Small Tool Tradition

Possibly as early as 4,200 RCYBP, the Paleoeskimo occupation of the Canadian High Arctic commenced with the development and spread of the Arctic Small Tool Tradition

(ASTt) out of western Alaska and eastern Siberia (Dumond 1977; McGhee 1978). The ASTt migration appears to have occurred very rapidly and within a short time Paleoeskimo hunters had spread throughout the interior barrenlands of Canada, across most of the Arctic Archipelago and into Labrador and Greenland. There are no indications of any earlier human occupations in the High Arctic region.

ASTt assemblages are characterized by microblades, triangular chipped stone projectile points, flaked stone burins and a well developed bone, antler and ivory industry. The economic foundation for Paleoeskimo life seems to have been very broadly based and the remains of a variety of marine and terrestrial animals are common aspects of ASTt collections (Dumond 1984; Maxwell 1988).

Although geographically widespread, it is likely that the early period of Paleoeskimo occupation was characterized by a very small population of highly mobile and widely dispersed groups. These groups would also have been small and membership may have been quite fluid (McGhee 1979). By the end of the ASTt occupation of the High Arctic some 1,000 years ago, this settlement pattern had changed and large, complex communities had appeared (Maxwell 1988). This change in settlement patterns, first occurring about 2,800 years ago, is quite dramatic and is accompanied by major technological developments.

Early Pre-Dorset and Independence I

The earliest component of the Paleoeskimo occupation of the Arctic islands is Independence I. First identified in northern Greenland (Knuth 1967), Independence I was originally thought to be a regional variant of the more widespread Pre-Dorset culture. However, McGhee (1976, 1979) has argued that Independence I represents a distinctly different and somewhat earlier occupation than Pre-Dorset. Recently, Helmer (1988) has argued convincingly that Independence I is really no more than the earliest evidence of Pre-Dorset occupations. This disagreement, partially semantic and partially due to controversy regarding the adjustment or dismissal of radiocarbon dates based upon the type of materials dated (see McGhee and Tuck 1976; Arundale 1981) is as yet unresolved. Whatever the case, Independence I is indisputably an early manifestation of Early Paleoeskimo culture in the Eastern High Arctic. Best estimates would probably place the commencement of Independence I at about 4,000 RCYBP with an estimated duration of 300 years.

Independence I assemblages are usually characterized by large burins, bi-pointed or tapered stemmed projectile points and a generally high level of skill in the execution of all flaked stone tools. Serrated edges are commonly seen. Unusual tanged non-toggling harpoon heads are typical (Maxwell 1988).

Sites are often characterized by poorly defined tent rings with carefully made box hearths and axial features. Perimeter rings are sometimes absent or defined only upon the basis of widely scattered stones. These tent rings are often arranged in a dispersed linear pattern along fossil beach ridges (McGhee 1979). Other researchers have noted well defined, round or oval tent rings with round central hearths, fire-boxes or axial features (Schledermann and McCullough 1988).

Pre-Dorset

The beginnings of the Pre-Dorset culture almost certainly lie in Alaska and the Western Arctic. Due to the problematic nature of the radiocarbon dating of marine materials in the arctic, commencement dates as late as 3,700 RCYBP (McGhee and Tuck 1976) or as early as 4,200 RCYBP (Arundale 1981), have been suggested for Pre-Dorset. If the first alternative is true, then Pre-Dorset may represent a second migration into areas largely abandoned by Independence I hunters. If the latter case is true, Pre-Dorset and Independence I may represent contemporary cultures, competing for the same resources using very similar technologies. Whatever the truth of the matter, the Pre-Dorset culture had certainly come to dominate most of the High Arctic by about 3,700 RCYBP and this dominance persisted until about 2,800 RCYBP in most areas (McGhee and Tuck 1976).

Highest densities of Pre-Dorset materials are known from the game-rich Foxe Basin and Hudson Strait region. This so-called "core area", now thought to be a product of an unintentional archaeological sampling bias, shows a slow but continuous evolution of cultural traits throughout the Pre-Dorset sequence. Elsewhere in the arctic, particularly in the far northern islands, it appears that the Pre-Dorset occupation was much more sporadic in character (Maxwell 1988).

Pre-Dorset assemblages, although similar to Independence I, are differentiated on the basis of somewhat smaller microblades and other tool classes, the presence of occasional unifacially polished burins, symmetric and asymmetric stemmed or side-notched knives, distinctive projectile points with either parallel or somewhat incurvate lateral edges, and specialized sideblades and endscrapers (McGhee 1978; Maxwell 1984). Another diagnostic characteristic of Pre-Dorset assemblages is a wide and varied antler, bone and ivory industry which includes the presence of toggling harpoon heads, large open socketed lance heads and small, cylindrical, round-eyed needles (Maxwell 1988).

The remains of Pre-Dorset habitation structures are highly variable in appearance, ranging from small, very poorly defined ovoid or circular boulder rings to very well defined rings with complex axial features and occasional fireboxes defined by upright slabs (Maxwell 1984). It has been suggested that these more complex features represent winter period habitations (Maxwell 1988) or late summer occupations (Schledermann and McCullough 1988) but others ascribe these differences to a temporal cause (McGhee 1976). Other features may be no more than "a small oval area within which there is a greater concentration of artifacts and small rocks" (Maxwell 1984:362). These ambiguous features are often interpreted as the remains of short-term summer tents.

Sarqaq

Sarqaq remains a problematic entity for most Arctic researchers. First reported by Meldgaard (1952) from western Greenland, Sarqaq sites have now been reported from eastern Greenland (Maxwell 1988) and western Ellesmere Island (Schledermann 1987). Dates ranging from about 4,200 RCYBP to 2,900 RCYBP have been reported (Gullov 1986) but not all dates are accepted by most researchers (Maxwell 1988).

Schledermann (1987) argues that Sarqaq and Independence I were contemporaneous regional offshoots of Early ASTt. Under this scheme, Independence I would have disappeared relatively quickly while Sarqaq persisted in Greenland for a millenium or more. Maxwell (1985) has suggested that Sarqaq represents an isolated northern enclave descended from Independence I. Taylor (1968) and Schledermann and McCullough (1988) contend that very strong Sarqaq influences may be detected in the development of Dorset out of Pre-

Dorset. This confusion in the chronological placement of Sarqaq is due to the dearth of published information (particularly in English) on Sarqaq sites as well as the confusion regarding the acceptability of various radiocarbon dates (Schledermann 1987).

Organic artifacts are reputedly very rare on Sarqaq sites, either due to age, preservation or some other agency, so little is known of this important aspect of the technological assemblage. The few harpoon heads known show definite similarities with non-toggling Independence I forms.

Lithic collections are characterized by a relatively high proportion of ground and polished tools and a low frequency of microblades. Most burins are spalled, but are also bifacially and distally ground. Partially ground adzes, concave side-scrapers, finely serrated triangular, stemmed and bipointed projectile points with unifacial or bifacial grinding have all been noted. Of particular importance is an apparent preference for *angmaq*, a "grainy silicified slate" (Maxwell 1988:103) for the production of both chipped and ground stone tools. However, this preferential selection may be more imaginary than real given the limited geographical range of excavated Sarqaq sites.

Dwelling type forms from Sarqaq sites are not well documented, however Maxwell (1985:103) and Gullov (1986) describe axial tent rings with associated box hearths as typical. Schledermann and McCullough (1988:6) describe round, gravel walled, shallow depressions without hearths as well as axial dwellings.

Independence II and Transitional Dorset

The Independence II culture, also sometimes referred to as Transitional Dorset, is generally thought to date between 3,000 and 2,500 years ago. First identified by Knuth (1967) in Pearyland, and now recognized throughout northern Greenland, Cornwallis, Bathurst, Devon and Ellesmere Islands, the origins and fate of this cultural entity are obscure (McGhee 1978).

Independence II assemblages are characterized by the presence of microblades, ground burins, broadly side-notched bifaces, ovate side-blades, ground adzes, bone needles with gouged eyes, eared endscrapers and small oval or rectangular soapstone lamps. Harpoon head and projectile point styles seem to be identical to earlier Pre-Dorset forms.

Independence II or Transitional Dorset habitation remains are usually described as both distinctive and diagnostic. They are most commonly described as oval to rectangular tent rings with a vertical slab outlined axial passage and central box hearth (Knuth 1967; McGhee 1976). Schledermann and McCullough (1988) have noted somewhat more diversity in the style of Transitional Dorset tent rings. In particular, tent rings with "simple" axial features and an external rather than internal box hearth have been noted.

Artifact assemblages are, for the most part, substantially different from both Independence I and Pre-

Dorset collections. Upon the basis of similarities in tent ring styles and settlement patterns, McGhee (1979) has argued that Independence II developed out of the much earlier Independence I culture. However, there is little evidence for a transitional Independence I/II occupation of 600 years duration anywhere in the High Arctic. Others have argued, largely upon the basis of similarities between Pre-Dorset and Independence II harpoon heads, that Independence II forms a transitional phase between the Pre-Dorset and Dorset cultures (Maxwell 1984).

The extent to which the Independence II culture contributed to the later Dorset culture is equally confused, due largely to the "lack of reliable dates" (Maxwell 1984:363). Many of the distinctive Dorset traits were developing in the core region at the same time that other traits began to appear in more northerly Independence II assemblages. Some authors suggest that Transitional Dorset is really no more than a regional transitional phase between the Pre-Dorset and Dorset cultures (Schledermann and McCullough 1988, Maxwell 1984, Helmer and Plumet nd). Others suggest that Independence II is a distinct cultural entity which nevertheless participated in some form of bi-directional cultural exchange with the contemporaneous Dorset culture of the core area (McGhee 1979).

Whatever the truth of the various cultural-historical scenarios discussed above, the unique Transitional Dorset occupation of the High Arctic persisted until about 2,500

RCYBP, when all human occupation in the region appears to have temporarily ceased (Maxwell 1988).

Dorset

The Dorset stage of Paleoeskimo prehistory began approximately 2,800 RCYBP and continued until about 1,000 RCYBP (McGhee and Tuck 1976). This terminal date is roughly the same time as people of the Thule culture first migrated into the High Arctic. Although there has been much speculation about the nature of this cultural contact, the fact of total cultural replacement remains incontrovertible (Maxwell 1988).

In the core area of northern Hudson Bay, Foxe Basin, northern Ungava and southern Baffin Island where the Dorset culture likely developed, there is a continuous record of occupation and cultural development from 2,800 RCYBP to about 1,000 RCYBP. In this region the Dorset culture has been divided into Early, Middle and Late phases upon the basis of changes in house types, settlement patterns and technological elements (Maxwell 1988).

In contrast to this pattern of stability and prosperity within the Dorset core area, evidence for Dorset occupation of the High Arctic outside the core area is sporadic at best. Across much of the High Arctic, including the Jones Sound area, the Dorset period follows a cultural hiatus of close to 1,000 years duration. Between 2,500 and 1,500 RCYBP the Canadian High Arctic appears to have been largely uninhabited (Helmer 1987; Maxwell 1988; Schledermann 1987).

Dorset assemblages are radically different from most earlier Pre-Dorset collections and are characterized by the presence of side-notched projectile points and knives, numerous microblades, many ground and polished burins and adzes, occasional ground slate projectile points and small oval or rectangular soapstone pots or lamps. Organic technologies are equally in evidence with snow knives, sled shoes, flat needles with elongated gouged eyes and closed socketed harpoon heads commonly found (Maxwell 1988). One striking and exotic diagnostic attribute of the Dorset culture is the presence of distinctive art work in quantities not seen in earlier cultural settings (Taylor and Swinton 1967).

Dorset structural remains are highly variable in form, ranging from the massive, rectilinear, multi-household "longhouses" occasionally found at Late Dorset sites, to more common and modest stone circles with little internal structure (Maxwell 1988). One typical form is oval to rectangular in outline, and is often found with a well defined axial dividing feature with upright slab hearths or meat boxes. Other, more simple axial features are sometimes noted, but these may be in association with external box features (Schledermann and McCullough 1988).

Summary

The earliest human occupation of the High Arctic commences with the Independence I culture at about 4,000 years ago. Some researchers interpret Independence I as no more than the earliest manifestation of Pre-Dorset, while others maintain that the two are separate and distinct entities. Independence I occupations seem to disappear by about 3,700 years ago although some of the culture's distinctive characteristics do appear in the much later Independence II culture.

At some time before the disappearance of Independence I from the High Arctic scene, the Sarqaq culture appears in northeastern Greenland. Some suggest that Sarqaq is a very long-lived local variant of Pre-Dorset, while others suggest it springs from Independence I roots. The chronological position of the Sarqaq culture remains confused due to a lack of published information and confusion regarding the acceptability of various radiocarbon dates. If the full span of reported dates is accepted, then the Sarqaq culture dates to between 4,200 and 2,900 RCYBP.

Contemporaneous with both Independence I and Sarqaq, the Pre-Dorset occupation of the High Arctic commenced some 4,000 RCYBP and persisted, albeit with some local interruptions, until about 2,800 RCYBP. The Pre-Dorset culture is divided into three temporal phases upon the basis of compositional changes in assemblages. Early Pre-Dorset, which may include Independence I, may commence as early as 4,200 RCYBP. Middle Pre-Dorset began at about 3,600 RCYBP ago and persisted for between 400 and 600 years. At about 3,000 RCYBP the Late Pre-Dorset culture came to dominate the High Arctic.

The Independence II or Transitional Dorset culture first appears in the High Arctic about 2,800 RCYBP and lasts for about 300 years. The origins of Transitional Dorset are obscure, with Independence I, Sarqaq, Pre-Dorset and Dorset all implicated. At about the same time as the establishment of Independence II in the High Arctic, the distinctive Dorset culture developed in the core area to the south. Interaction between the existing Pre-Dorset culture and this developing Dorset culture is suggested as another possible source for the origins of Independence II. With the end of the Independence II occupation of the High Arctic at about 2,500 RCYBP, human occupation in the area temporarily ceased. Re-occupation did not take place until about 1,500 years ago when the Dorset culture established a tenuous presence in the area. This Late Dorset culture remained the sole cultural presence in the High Arctic until about 1,000 RCYBP, when the rapidly expanding Thule Culture replaced it. With the end of Dorset, the 3,200 year long Paleoeskimo occupation of the High Arctic drew to a close.

The relative distinctness of the previously discussed cultures remains an open question. Some traits once regarded as diagnostic of a particular culture are now known to occur in other contexts and times. For example, traits normally associated with Sarqaq assemblages are now frequently recognized in Pre-Dorset collections (Helmer 1988). However, other attributes still remain useful as separation criteria (Maxwell 1988).

Particularly important to this study was the changing perception of the diagnostic nature of architectural features. The axial passage tent ring, once the chief diagnostic of the Independence I culture, has now been widely reported in connection with both Pre-Dorset and Sarqaq assemblages (Mary-Rousseliere 1976, Helmer 1988, Maxwell 1988). Conversely, typical Independence I collections have now been identified in association with the simple round or ovoid tent rings once identified as diagnostic of Pre-Dorset (Schledermann and McCullough 1988). In a similar vein, Independence II assemblages have now been reported in conjunction with relatively simple ovoid tent rings rather than rectangular mid-passage structures (Helmer 1988).

It is now recognized that many of the perceived differences between previously postulated temporal-cultural units may have been no more than seasonal and/or functional differences magnified by archaeological sampling procedures (Helmer 1988; Schledermann 1987; Schledermann and McCullough 1988).

Helmer (1987d, 1988) and Helmer and Plumet (nd) have suggested a restructuring of the High Arctic cultural sequence to accommodate these changing views. In their view, the Arctic Small Tool Tradition may be divided into three distinct temporal entities upon the basis of broadly defined assemblage characteristics. These Sub-Traditions, called the Early, Middle and Late Paleoeskimo, are themselves composed of discrete cultural entities which correspond broadly with the named cultures already discussed. Terms like Independence I, Sarqaq and Independence II are subsumed under the broader headings of Early Pre-Dorset, Middle Pre-Dorset, Late Pre-Dorset and Transitional Dorset. This provisional cultural framework, presented in Table 1, provides the necessary culture-historical setting within which this study can be assessed. This framework is highly tentative and is to be used for ordering purposes only. In particular, the postulated bracketing dates are for general interpretive purposes only.

Table 1: Regional Paleoeskimo Cultural Chronology

RCYBP	CULTURE	SUB-TRADITION	
	THULE	*Neo-Eskimo*	
1,000	Late Dorset	Late Paleo-Eskimo	ASTt Tradition
1,500			
2,500	(Independence II) Transitional Dorset		
2,800	- - (Sarqaq ??) - - - Late Pre-Dorset	Middle	
3,200	- - - - - - - - - - - - Middle Pre-Dorset	Early Paleo-Eskimo	
3,600	- - (Sarqaq ??) - - -		
3,850	- Early Pre-Dorset- - (Independence I)		
4,200	*No Prior Human Occupation*		

2.5 Tent Ring Studies

Tents are a ubiquitous part of the material culture of nomadic hunter-gatherers. From Tierra del Feugo to

Greenland, from Mongolia to Morocco, the wandering peoples of much of the world have relied upon permanent but portable structures to protect them from the vagaries of climate and environment. The principal attributes which make a tent a tent are its portability and the comprehensive nature of the shelter it provides. The tent must be portable in order to complement the nomadic lifestyle of its occupants. It must also provide a more or less completely enclosed internal micro-environment which is decidedly different from the external macro-environment. The tents internal environment can be cooler or warmer, drier or moister and lighter or darker than the surrounding external environment but most importantly it is a more stable environment than that of the outdoors. These attributes are of critical importance to peripatetic groups because of technological limitations upon materials and transportation. In many parts of North America, most notably the Arctic and the Great Plains, the use of these structures has resulted in the creation of a special class of material remains: the tent ring.

Boulder Features

Tent rings are part of a broader class of cultural constructions commonly referred to as boulder features. Included in this category are caches, cairns, foxtraps, beartraps, kayak rests, hearths, windbreaks, graves and many others (Plumet 1981). Despite their widely differing functions, these features all share in common certain details of construction. All are relatively simple drystone structures assembled from unmodified cobbles, slabs and/or blocks of locally available rock.

Boulder features constitute an easily identifiable prehistoric cultural manifestation in most regions of the High Arctic. Unlike much of the rest of the world, vegetational and depositional environments in the Arctic islands do not significantly affect the visibility of most archaeological remains. Cultural materials deposited on the surface remain near the surface and are seldom obscured by vegetation or deeply buried by sediments.

Paleoeskimo sites in the High Arctic in general and in the Jones Sound area in particular are normally restricted to near-shore locations and are typically found on fossil beach terraces. These ridges are ancient beaches, formed in parallel succession as relative sea-level dropped due to isostatic rebound. Most sites include at least one or more boulder features and the bulk of these features are found in one of two depositional settings. The first and most common of these depositional settings is on poorly consolidated gravel beach sediments comprised of small, angular, mechanically fractured rock. These beaches usually have relatively level surfaces which are punctuated at irregular intervals by large, post-formational frost cracks. Because of the high energy of the beach environment during deposition, very little large rock (greater than cobble size) is incorporated in these beach sediments, and such stones rarely if ever project above the flat beach surface.

Consequently, most concentrations of large rocks lying on or projecting above the beach surface may be treated as a clear indication of past human activities.

Boulder features are also occasionally found in a somewhat different setting. In flat areas on fossil beaches where fresh-water pools or flows nearby, or on fossil beach segments near rocky headlands, sediment traps sometimes form. These locations are characterized by the deposition of fine-grained sediments on top of beach deposits and by the development of flourishing moss, lichen and sedge-grass communities. As a result, boulder features located in these areas may be more deeply buried and overgrown than is common. However, sedimentation rates in such locations are rarely rapid enough to completely obscure cultural materials. Consequently, given the complete absence of any naturally occurring rock in these sediment traps, recognition of boulder features in such locales is easily accomplished. Because of the bare gravel surfaces typical of most beaches, concentrations of vegetation are seldom encountered. Areas of past human activity, because of the use and loss or discard of organic materials, are often marked by a low "mat" of mosses, lichens and willows. These plants, surviving on the organic residues deposited within the feature, are another clear indication of past human activity.

Tent Rings

Tent rings, also occasionally referred to as stone circles, constitute both a functional and a descriptive category of boulder features. Functionally, they are inferred to represent the physical remains of primary portable habitations (tents). Descriptively, the term can be applied to a widely varying class of architectural remains. In fact, given the diversity in the appearance, shape and complexity of the features often incorporated under this category, the term "tent ring" may be a deceptive misnomer. In the narrowest sense this designation is often taken to imply the existence of a clear and recognizable perimeter 'ring' of stones. However, this interpretation ignores the vast majority of the physical remains of individual tent habitations. Consequently, in this study, the term "tent ring" is used in the broadest possible sense. The functional coherence of the category is stressed over the descriptive. In practical terms this means that any surface boulder feature interpreted as the remains of a primary habitation structure was a potential subject for this study.

The use of such a broad and inclusive non-descriptive definition entailed the risk that features which were not tent remains might be unintentionally included in this study. Fortunately, most other categories of boulder features are distinctive enough in their own fashion that the potential for misinterpretation is low. However, to minimize the possibility of confusion, no features were included in this study unless they met the following criteria. These habitation remains may, or may not, have a recognizable perimeter outline of stones. In the absence of a clearly defined or continuous perimeter of rocks, the presence of a surface concentration of occupational lithic and faunal debris roughly corresponding to the boulder scatter was taken to indicate the existence of a disarranged tent ring. Similarly, the presence of a cleared, compacted area of sediments delimiting a probable tent floor and roughly corresponding to the boulder scatter was also taken to indicate the presence of such a structure. Internal stones were examined for evidence of burning, grease staining or evidence of intentional arrangement as an axial passage or hearth. The presence of these attributes was taken to indicate the existence of a multi-purpose tent ring rather than a single function feature like a cairn, cache or trap.

The closest analogue to the Paleoeskimo structure responsible for the creation of stone circles may be the historic Inuit summer skin tent, or *tupik* (Spalding 1979) (see Figures 4, 5 and 6). The *tupik* was a highly variable structure, with distinctly different forms widely distributed across the Arctic (Boas 1888; Birket-Smith 1936; Leechman 1945; Balicki 1970; Dumond 1977; Reinhardt 1986).

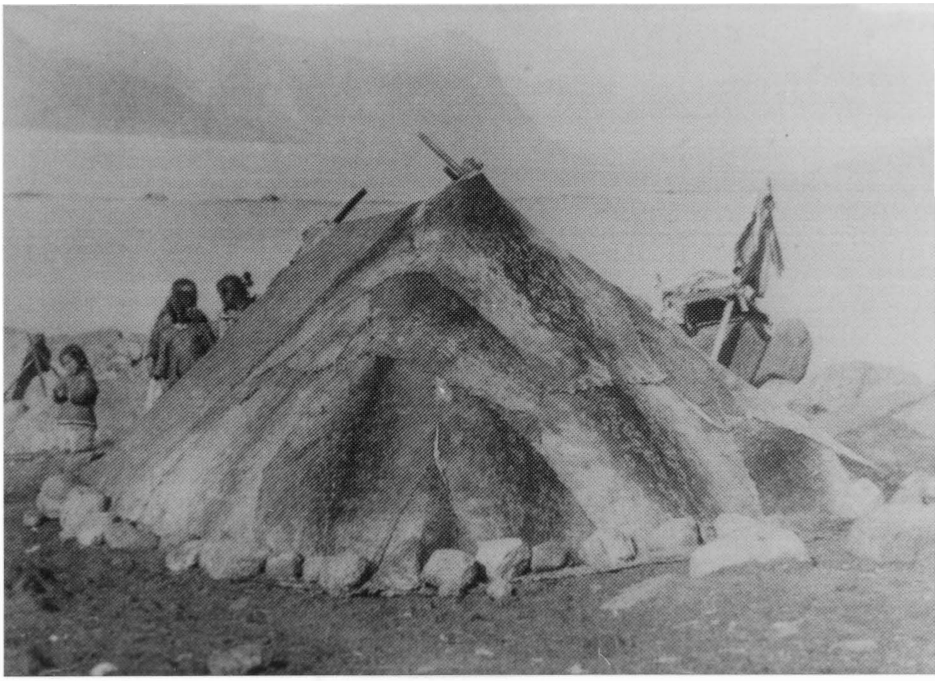


Figure 4: Historic Inuit *Tupik* (National Museums of Canada / 68941).

Figure 5: Typical Tent Ring (QkHn-13, Feature 4).

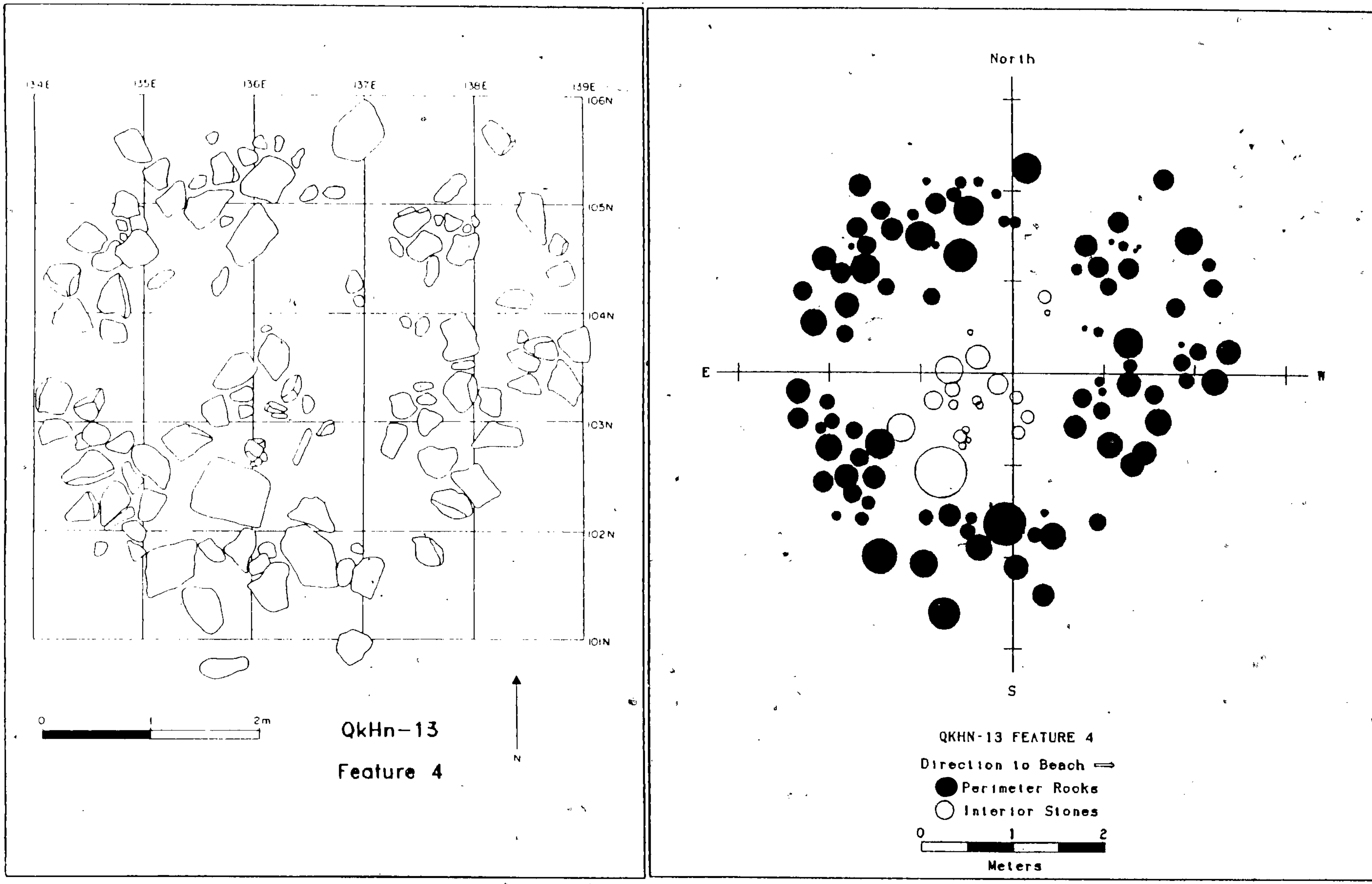


Figure 6: Comparison of conventional and computer generated plan-views.

Conical to rectangular tent frames with and without ridgepoles are known from most regions (Nabakov and Easton 1989; Faegre 1979; Leechman 1945).

Although the Inuit *tupik* presents a possible analogue for the tents of Paleoeskimo peoples, generalizations should be made with caution. The differences between Paleoeskimo and Inuit lifeways are so vast that analogies between these groups are tenuous at best.

In particular, there are no known analogues in Inuit structures for the linear axial feature (sometimes referred to as a mid-passage) which bisects many Paleoeskimo tent rings. Usually interpreted as a combination hearth box, storage cupboard and countertop, the axial feature usually consists of two parallel rows of upright rock slabs with flat-lying slabs laid between. Although no direct cultural contacts are postulated, striking similarities have been noted between the internal arrangement of Paleoeskimo axial features and the conical, curved pole *kata* of the Lapps of Finnmarken (Faegre 1979; Schledermann and McCullough 1988).

It is unlikely that pegs or stakes were commonly used to secure the perimeter of Paleoeskimo tents. No such stakes are known from any Paleoeskimo archaeological collections in the Eastern Arctic (Maxwell 1988). Furthermore, the physical location of most Paleoeskimo sites on poorly consolidated beach sediments overlying permafrost is not conducive to the effective use of stakes. It is much more reasonable to suppose that Paleoeskimo peoples habitually made use of local beach rock to anchor their hide tent covers. This supposition is strongly supported by the habits of the later Inuit occupants of the Arctic. Photographs and descriptions of *tupiks* with rocked perimeters are commonplace (see Figure 4). Ethnographers (Boas 1888:552-553; Birket-Smith 1936; Leechman 1945; Balicki 1970:26) have recorded the use of boulders, inside, outside, and both together to anchor leather tent covers.

It is clear that taphonomic issues affect the problem of variability in tent rings. The very act of abandonment should physically disturb structural stones, particularly those of the perimeter. Post-abandonment natural and cultural processes can disturb the feature even further. The net effect of these disturbances is an increase in random variation and a subsequent decrease in the scope of detectable patterned variability. Unfortunately, the chance nature of natural disturbance factors like muskox and frost heaves is impossible to quantify. Hence the contribution of these processes to variability in these features cannot be adequately judged at this time. Equally difficult to measure is the effect of cultural disturbance factors.

The universal taphonomic influence, abandonment, is also likely to be the most systematically destructive to patterned information. The perimeter of the ring must be disturbed in order to remove the tent. The direction and extent of that disturbance will depend upon a number of factors acting in concert. Things like the size and shape of the rocks, whether the stones were placed inside the tent on a tucked under flap or outside the tent on a pulled out flap, the number and exuberance of the people dismantling the feature will all contribute to the ultimate effect of abandonment. In this study, no attempt is made to measure, or account for the disturbance occasioned by abandonment. It is simply assumed that dismantlement disturbance was random in character and minimal in influence. Although this assumption is unsupported empirically, the successful analyses of other tent ring researchers operating under the same constraints suggests that the assumption may be valid (Finnigan 1981, 1982).

It is beyond the scope of the present study to undertake a comprehensive and exhaustive review and critique of all previous tent ring research; nevertheless, a brief summary of important works is in order. Some of these studies have been of importance in the shaping of current interpretations of Arctic prehistory. Others have been important in providing the methodological and analytical framework within which this study has been conducted.

Informal typologies of tent ring morphology have been used by Arctic archaeologists for decades. These typologies, although explicitly unstated, have nevertheless been powerful tools in the interpretation of High Arctic prehistory. In particular, McGhee's (1976, 1978, 1979) interpretations of Paleoeskimo prehistory have relied extensively upon perceived changes in the form of habitation structures. A leading trait in McGhee's lists of "Distinctive Characteristics" (1976:25) for each cultural entity discussed was the perimeter shape and internal rock arrangement of tent rings. Similarly, Dumond (1977) stresses the culturally diagnostic nature of feature forms without rigorously defining structure types.

More recently, some researchers have begun to question the diagnostic nature of tent ring forms (Schledermann 1988, Helmer 1988). Functional rather than cultural-temporal factors have been invoked to explain differences, and there is a general acceptance of high levels of variability in tent ring form.

Attempts have been made to create more formalized typological frameworks and procedures for the description and analysis of High Arctic tent rings. In Ungava, Plumet (1981) developed a formal classificatory typology for all boulder structures based upon morphological, functional and technical criteria. The principal goal of Plumet's study was the discrimination of functional classes of features using a combination of architectural and associational attributes. Similarly, Allison (1987) has devised a typological approach to Thule summer tent rings based largely upon the subjective classification of non-metric criteria.

Dekin (1976) proposed a somewhat different technique called "elliptical analysis" for the analysis of a single Paleoeskimo tent ring from the Closure Site on Baffin

Island. This method, although principally involved with the patterning of artifact distributions within a feature, was also concerned with feature shape and rock distributions about the ring perimeter. Although Dekin's analysis was not directed towards comparisons between individual features, it did attempt to record and use somewhat more detailed architectural information about an individual feature than is customary in Arctic research. Also significant was Dekin's attempt to formalize the subjective elements of the research methods in such a way that subjective bias would be minimized.

Reinhardt (1986) used ethnographic and historic records to develop an approach to the comparative analysis of Eskimo dwelling forms with particular emphasis upon archaeological implications. In this study he made the important point that architectural remains should be treated as artifacts for analytical purposes. However, Reinhardt's stress upon the ordering of internal space in these recent cultural manifestations makes it unlikely that meaningful insights can be developed for Paleoeskimo tent rings.

No other attempts to develop formal classificatory schemes for the analysis of High Arctic tent rings are known. While typological studies of the sort discussed above are unquestionably valid research avenues, they constitute, for the most part, an intuitive rather than quantitative approach.

Tipi Ring Studies

A very different analytical direction has been taken by tent ring researchers on the northern Great Plains. Explicitly quantitative approaches to the recording and analysis of "tipi rings" have been the rule, rather than the exception over the last two decades (see Finnigan 1982, Davis 1983b, Quigg and Brumley 1984). This interest has been partially due to the incredibly large numbers of tent rings found on the northern plains, partly due to the increasing importance of consulting archaeology, and partly due to the striking lack of other interesting artifactual material at many excavated tipi ring sites.

The investigation of tipi rings on the northern plains has a lengthy history. Early, largely descriptive, studies include Renaud (1942) and Wedel (1948). However, interest in tent rings remained sporadic until 1960, when Kehoe (1960), Malouf (1960), Moomaw (1960) and Mulloy (1960) revived discussion. The volume of descriptive studies steadily increased following these publications until the mid 1970s, when the first quantitative data regarding tipi ring size and rock distributions were reported by Schneider and Treat (1974). Despite the increased interest in stone circle studies through the 60s and early 70s, advances in knowledge and technique were limited. The period from 1975 onward was marked by a substantial increase in the volume of publications concerning tipi rings. Aaberg (1975), McIntyre (1978), and Quigg (1979) are only a few such examples. This interval is marked by a steady increase in the depth of analysis and the level of mensural data reported (Finnigan 1982).

Between the years 1979 and 1983, marked by the publication of the "Megaliths to Medicine Wheels" (Wilson, Road and Hardy 1981) and "From Microcosm to Macrocosm" (Davis 1983a) volumes, a major change in orientation can be perceived in tipi ring analysis. The presentation of mensural data, now commonplace, was accompanied by higher order statistical manipulation and analysis and a general increase in goal directed procedures (eg: Finnigan 1982, 1983; Mobley 1983; Wilson 1983; Quigg 1983). Recurrent themes in studies published during this period included an intensified interest in architectural details and an increased emphasis upon techniques for quantitative data collection (Quigg and Brumley 1984:69).

During the late 70s and early 80s, several methodological and analytical innovations important to the execution of this study occurred. The introduction and refinement of the Tipi-Quik mapping method (Smith 1974; Dau 1981) was of importance to the in-field component of this research. The establishment of standardized measurements and octal indices (Brumley and Kooyman 1978; Quigg 1979) was another important development. Davis (1983) represents the earliest use of multivariate statistics to analyze architectural variability in stone circles.

In the period since 1983, several studies have demonstrated the efficacy of architectural analysis in addressing specific research questions. The Forty Mile Coulee study (Brumley and Dau 1988), the single largest comparative tipi ring analysis to date, has achieved some success in the correlation of rock distributional data with seasonal wind patterns. Quigg (1983; 1986) has used differential rock distribution data to argue for the contemporaneity of specific features at the Ross Glen Site. Also at Ross Glen, distinctions in the size of rings, coupled with depth of burial of feature stones, have been used to suggest cultural-temporal and social differences. The success of these forms of analyses in satisfying fundamental archaeological goals suggested that similar procedures, applied to Arctic tent rings, might enjoy similar success.

2.6 Quantitative Shape Analysis

The analysis of shape is a constantly recurring problem for scientists of many disciplines. Wherever items must be sorted and categorized by form, be they boulders, brachiopods or burins, the problem remains the same: How can the subjective element be eliminated? How can these classificatory decisions be rendered consistent, replicable and verifiable?

In the past, researchers have tried to address the problem of subjectivity through recourse to systematically collected measurements. Items were measured, using a variety of methods, and these measurements became the basis for subsequent typological classifications. Examples of such classifications abound in archaeology (eg: Forbis 1960; Greaves 1982). Unfortunately, unless definitions for measurement points are precise and unambiguous, the derived metric indices may be just as subjective as non-metric descriptors.

In the fields of sediment geology, invertebrate palaeontology, computerized image processing and pattern recognition, a family of new approaches to shape analysis has been developed. These techniques, sometimes called "quantitative shape analysis", have succeeded in "almost completely removing the subjective element" (Clark 1981:303) from classificatory studies. Recent reviews of quantitative shape analysis can be found in Barber (1988) and Clark (1981).

Since the subjective element in measurement has been eliminated by using intensive mathematical procedures, it is no coincidence that the development of quantitative shape analysis has coincided with the general rise in use of computers and computing. The exact form of the calculations employed varies from technique to technique, but most share two common threads (Clark 1981). First, only two-dimensional shapes are normally considered. Second, the outline shape itself is used to mathematically define the reference point from which measurements to the perimeter are taken. The shape of an individual entity is characterized, not with reference to any externally defined criteria, but through reference to all other perimeter points.

Normally, the use of quantitative shape analysis presupposes a technique for deriving a digital approximation of the perimeter or outline of individual entities. This recording technique may entail the direct digitization of photo-approximated images or it may involve the use of sophisticated scanning or line following techniques and specialized hardware (Clark 1981; Davis 1986).

Once the discrete digital outline is obtained, the calculation of the reference point becomes a relatively straightforward proposition. The calculations centre around the definition of a common reference point. The digitized perimeter is analyzed, using a specified algorithm with characteristics appropriate to the nature and complexity of the objects of interest. This algorithm derives a unique reference point, usually a centroid, in physical space. The original digitized perimeter is then re-referenced in terms of this derived point. Each perimeter is thereby characterized as a set of truncated vectors radiating outward from an internally defined centroid. Using these methods, metric characterization of individual specimens can be quickly and systematically achieved. These characterizations have the following desirable qualities: they are unique, replicable and interpretable using multivariate statistical techniques (eg: Principal Components or Cluster analysis).

Although many archaeological classificatory studies have been dedicated to the differentiation of shapes, archaeologists have not been quick to embrace the concept or techniques of quantitative shape analysis. In the field of archaeology, Montet-White's (1973) analysis of lithic artifacts from the Paleolithic Malpas Rockshelter may be the earliest attempt at a form of quantitative shape analysis. The outline profiles of Caddoan ceramic vessels have also been described and analyzed using many of the principles of quantitative shape analysis (Turpin and Neeley 1977; Turpin *et al.* 1976). More recently, Helmer and Robertson (1988) and Robertson (1988) have used a form of shape analysis to examine certain classes of lithic artifacts from the DIAP project itself.

The application of quantitative shape analysis to the consideration of tent rings is a natural extrapolation of the technique. Measurements of the length of major axes of tent rings bear a striking resemblance to the style of measurements once used to characterize sand grain shapes (see Clark 1981). These indices have rapidly been supplanted by the development of the techniques of quantitative analysis. The need to develop a replicable, systematic, descriptive grammar for tent ring forms can be admirably addressed by many of the techniques of quantitative shape analysis.

CHAPTER 3

DESCRIPTIONS

Forty-four tent rings from twelve different sites located in the Devon Island Archaeological Project study area were mapped for the purposes of this study. Of this number five were from the Lee Point locale on Ellesmere Island, five were from the Skruis Point area of Devon Island, four from the Sparbo/Hardy area of Devon Island and thirty from the Truelove area of Devon Island (see Figures 2 and 3).

3.1 Site Descriptions

Skruis Point Site

The Skruis Point Site (see Figure 2) is located on the northern shore of Devon Island (88°29'30"W,75°34'00"N). The site lies near the base of the northeastern shore of Skruis Point, overlooking the waters of Bear Bay to the northeast. It consists of five tent rings and several dense lithic scatters located on broad, straight relict gravel beaches at the mouth of an unnamed river valley. High cliffs to the northwest and southeast provide some measure of shelter but the location is largely exposed to the elements. The tent rings at the site are found in two separate clusters at an estimated twenty to twenty-five meters above current sea level. No excavations or collections were conducted. The probable cultural affiliations, based upon examination of recorded surface finds, are Late Pre-Dorset or possibly Dorset in age (MacWilliams 1987; Helmer personal communication). The site was first recorded and mapped in the summer of 1987. Features 1 through 5 at this site were mapped for this study.

QkHl-5 (Icy Bay Site)

QkHl-5, the Icy Bay Site (see Figure 3), is located upon the southeastern shore of Cape Hardy in the Sparbo/Hardy Lowlands of northern Devon Island (75°49'20"W 83°47'15"N). The site consists of twenty cultural features scattered amongst the boulders and outcrops of a rocky headland which juts south into Icy Bay. Of these twenty features, the majority are low elevation Late Thule or Historic Inuit in age. Nine oval tent rings, located from four to nine meters above present sea level, comprise the Paleoeskimo-Eskimo occupation at this site. The site was first recorded by DIAP in 1984 and three features were completely excavated in 1986 (Helmer 1982, 1986). Features 1 through 3 were mapped for this study.

QkHl-66

QkHl-66 (see Figure 3) is located on northern Devon Island near the southwest edge of Cape Sparbo (75°48'17"W 83°53'28"N). The site lies on a broad, raised beach remnant overlooking a large shallow fossil bay to the east and north. The site is well sheltered on the northwest by the flanks of Cape Sparbo. An isolated tent ring with linear axial feature and associated cultural debris was noted. The site was located in the summer of 1986 by DIAP and mapped during that same time. No excavations or collections were undertaken at this site (Helmer 1986). The site is assumed to be wholly Pre-Dorset in origin.

QkHn-12 (Field School Site)

QkHn-12, the Field School Site (see Figure 3), is located on Devon Island on the northern shore of Truelove Lowland (75°41'40"W 84°32'00"N). The site consists of ten identified cultural features of both Pre-Dorset and Thule affiliation. It lies on a rocky headland on a series of poorly defined relict beach terraces located between two rock outcrops and facing northwest. The Icebreaker Beach Site lies immediately to the east. The site is sheltered by lowlying rock outcrops to the northeast and southwest while the ocean lies to the northwest. The Pre-Dorset features are located at between seven and nine meters above present sea level while the Thule materials are found at a considerably lower elevation. The site was first recorded in 1983 by DIAP. Test excavations by DIAP in 1984 were followed in 1985 by large scale excavations on the part of the Northern Heritage Field School. Mapping of features was carried out at this time (Helmer 1985; Bertulli 1987).

QkHn-13 (Icebreaker Beach Site)

QkHn-13, the Icebreaker Beach Site (see Figure 3), is located on the northern edge of Truelove Lowland on the north shore of Devon Island (75°41'20"W 84°30'00"N). It is found on a stacked series of relict beaches which rise from the southwestern shore of a small embayment in the convoluted local coastline. The site area is characterized by scattered bedrock outcrops with interspersed patches of remnant beach terraces. The site is somewhat sheltered from the north by two large outcrops but is otherwise exposed. Eleven tent rings, two scattered caches, an isolated firebox and a possible midden area make up this site. Features are found at between five and nine meters above present sea level. Originally identified in 1983, the site has seen excavation in 1984, 1985 and 1986 (Helmer 1985; 1986). Mapping of features was undertaken in 1986.

QkHn-17 (Twin Pond Site)

QkHn-17, the Twin Pond Site (see Figure 3), is located on the northern shore of Truelove Lowland, Devon Island (75°41'40"W 84°29'30"N). The site consists of seven tent rings distributed about the periphery of two small meltwater ponds. During the period of site occupancy, the ponds area may have formed a shallow embayment about which the features were situated. The features at the site are located at approximately nine meters above present sea level. High rock outcrops to the south, west and to the northeast provide considerable shelter to several of the mapped features. This site was originally identified in 1983 and excavations were undertaken in 1984 and 1985 by DIAP (Helmer 1985). Mapping was done in 1986.

QkHn-22 (Far Site)

QkHn-22, the Far Site (see Figure 3), is located on the extreme northwestern edge of Truelove Lowland, Devon Island (75°41'50"W 84°26'00"N). The site lies on a high relict beach directly overlooking the Tote Road Site to the northwest. It is constrained on the south by a high rock outcrop which gives the site area some shelter. The site consists of six tent rings, two disturbed caches and three circular semi-subterranean houses at approximately fourteen meters above present sea level. First located in 1983, excavations were carried out in 1984 and 1986 (Helmer 1985; 1986). Mapping was carried out in 1986.

QkHn-27 (Rocky Point Site)

QkHn-27, the Rocky Point Site (see Figure 3), is located on Truelove Lowland, northern Devon Island (75°41'00"W 84°38'30"N). It lies at the base of Rocky Point, a prominent northwest pointing peninsula at the northwestern extremity of Truelove Lowland. The site consists of twenty-three features arranged in a linear pattern paralleling the general southeast to northwest orientation of the landform. The features lie between six and seven meters above sea level on the highest preserved beach ridge on Rocky Point. Thirteen tent rings, seven boulder caches, two dense lithic scatters and one cultural depression were identified. The Rocky Point area is very barren and is not significantly sheltered in any direction. QkHn-27 was first located in 1983 and excavations were carried out here in 1984 and 1985 (Helmer 1985). Mapping was carried out in 1986.

QkHn-37 (Tote Road Site)

QkHn-37, the Tote Road Site (see Figure 3), is located on Truelove Lowland, northern Devon Island (75°42'10"W 84°26'00"N). The site lies on a series of poorly drained, raised beach terraces between two rock outcrops in a small cove near the head of a larger bay at the northeastern periphery of Truelove Lowland. The features at this site are well sheltered to the northeast, south and southwest by high rock outcrops. The Far Site lies immediately to the southeast. The site has been significantly disturbed in the past by tracked vehicles unloading icebreakers at the nearby beach. Three tent rings and one boulder cache are found at an elevation of four to six meters above the present sea level. The site was first recorded in 1984 and excavations were carried out in 1985 and 1986 (Helmer 1985; 1986). Mapping was carried out in 1986.

QkHn-38 (Hind Site)

QkHn-38, the Hind Site (see Figure 3), is located on the north edge of Truelove Lowland, northern Devon Island (75°41'40"W 84°31'00"N). The site lies on a poorly drained, heavily overgrown fossil beach terrace six to seven meters above present sea level on the south shore of a small embayment in the convoluted local coastline. Three tent rings and a possible midden or activity area have been noted at this site. The Icebreaker Beach Site lies directly northwest across a poorly drained sward. A rock outcrop immediately to the south provides some local shelter. The site was originally recorded in 1984 and excavations were carried out in 1985 by DIAP (Helmer 1985). Mapping was carried out in 1986.

QkHo-5

QkHo-5 (see Figure 3) is located on Truelove Lowland, northern Devon Island (75°41'10"W 84°38'30"N). The site is found on Rocky Point, just to the north of the Rocky Point Site. It consists of two closely contiguous axial passage features located upon the highest remnant beach ridge in the vicinity. The site area is quite barren and there is no local shelter. No artifacts or cultural refuse were observed in the immediate vicinity. The site was first recorded in 1984 by DIAP (Helmer 1985). No excavations have been undertaken. Mapping was carried out in 1986.

RcHh-1 (Lee Point Site)

RcHh-1, the Lee Point Site (see Figure 2), is located on the south shore of Ellesmere Island (76°23'38"W 82°23'26"N), approximately twenty-five air kilometers from the small community of Grise Fiord. The site lies on a prominent flat near the western end of the broad lowland that comprises Lee Point. High cliffs shelter the site location from the north. The site consists of more than 170 definable features spanning from Pre-Dorset to Thule/Inuit. The strongest cultural presence at the site is likely Dorset. Features are found from one to six meters above present sea level. The site was originally recorded in 1986 and test excavations conducted in the summer of 1987 (Helmer 1987b). Mapping was carried out in 1987.

3.2 Cultural Complexes

The following descriptions of cultural complexes are derived directly from the work of Helmer (1984a, 1984b, 1985, 1986, 1987a, 1987b, 1988) and his interpretations of data from the DIAP project.

The Far Site Complex

The Far Site Complex, attributed by Helmer to the Early Pre-Dorset culture, is represented in this study by Feature 8 at the Far Site (QkHn-22). Two other sites investigated by the DIAP project have been attributed to this complex: the Gneiss Site (QkHn-8) and the Over Site (QkHn-15). Radiocarbon dates associated with these features suggest an occupation on the order of 4,000 RCYBP (Helmer 1987b:19).

The most distinctive feature of the assemblages collected at these sites is the presence of fine edge serration on bifacially worked artifacts, particularly projectile points. Other distinctive traits include relatively wide microblades and the large size of formed tools in general. The presence of these traits, in conjunction with the suggested age of the complex, strongly suggest affinities with Independence I (Helmer 1987b:23). However, there are marked differences between the Far Site Complex and Independence I as well. In particular, bipointed serrated projectile points are not found in the Far Site Complex. Additionally, the habitation features at these sites do not reflect the rock-slab axial passage arrangement expected in Independence I sites. These differences are attributed by Helmer to seasonal and functional causes (1987b:23).

Icebreaker Beach Complex

The Icebreaker Beach Complex, represented in this study by Features 1, 2, 4 and 14 at the Icebreaker Beach Site (QkHn-13); Feature 4 at the Twin Ponds Site (QkHn-17); Feature 2 at Qkhn-38 and Features 2 and 3 at the Icy Bay Site (QkHl-5), is assigned by Helmer to the Early Pre-Dorset culture. Two other features investigated by the DIAP project have also been assigned to this Complex: Features 1 and 2 at the Inavik Site (QkHl-1). On the basis of relative beach elevation and observed surface artifacts, Feature 1 at QkHl-66 and Features 5, 8, 9, 11 and 16 at QkHn-13 may also be associated with this complex. Helmer suggests that the Icebreaker Beach Complex dates to between 3,850 and 3,600 RCYBP (1987b:25).

The assemblages from these features are quite variable, but are generally characterized by the presence of small triangular and bipointed projectile points, stemmed bifaces, ovate side-blades, thumbnail end-scrapers, concave side-scrapers, non-toggling, tanged unilaterally barbed harpoon heads, toggling, self-bladed, open socketed harpoon heads. Edge-serration is not seen.

Due to the occurrence of both Independence I and Central Arctic Early Pre-Dorset diagnostic elements in

Icebreaker Beach assemblages, Helmer has suggested that this Complex represents a technologically transitional stage between the two (1984b). Helmer has also tentatively suggested an association with Sarqaq materials upon the basis of tanged harpoon heads and the presence of partially ground burin spalls and adze fragments (1987b:19).

Twin Ponds Complex

The Twin Ponds Complex, represented in this study by Feature 1 at the Icy Bay Site (QkHl-5); Features 1 and 3 at the Twin Ponds Site (QkHn-17) and Feature 6 at the Field School Site (QkHn-12), is assigned by Helmer to the Middle Pre-Dorset Culture. Features 4, 6, 7 and 10 at QkHn-12 may also be associated with this complex. Estimates for the age of this complex are between 3,650 and 3,200 RCYBP (Helmer 1987b:20).

The single most distinguishing characteristic of Twin Ponds Complex artifact assemblages is the regular occurrence of small, finely flaked, concave based, triangular projectile points (Helmer 1987b:20).

Helmer hypothesizes a direct developmental sequence between the Icebreaker Beach and the Twin Ponds Complexes. Consequently, the distinction between these two complexes may be more arbitrary than real (1987b:28).

Rocky Point Complex

The Rocky Point Complex, represented in this study by Features 15 and 17 at the Rocky Point Site (QkHn-27), is assigned by Helmer to the Late Pre-Dorset culture. Features

1 through 5 at the Skruis Point site may also be tentatively associated with this Late Pre-Dorset period upon the basis of an examination of surface artifacts found in association with these features (Helmer, personal communication). Although highly tentative, Features 3, 6, 7, 8, 12, 20 and 21 at QkHn-27 may also relate to this complex. This complex is estimated by Helmer to date between 3,200 and 2,800 RCYBP although associated radiocarbon dates suggest a much earlier age of between 4,000 and 3,800 RCYBP (1987:20).

Assemblages from features attributed to this complex are somewhat variable but common elements include: broadly side-notched bifaces and/or projectile points; small side-notched burins and small polished burins. These assemblages, in spite of their variability, exhibit a great deal of similarity with other dated Terminal Pre-Dorset collections from east-central Ellesmere Island, northern Labrador and southwestern Hudson Bay (Helmer 1988:21).

Cape Hardy Complex

The Cape Hardy Complex, represented in this study by Feature 1 at the Tote Road Site (QkHn-37) and Feature 2 at QkHn-38, is assigned by Helmer to the Transitional Dorset Culture. The Cape Hardy Site (QkHl-4) is also assigned to this Complex. Features 1 and 2 at QkHo-5 may also relate to this cultural complex. Helmer dates this period to between 2,800 and 2,500 RCYBP (1987b:28).

Diagnostic characteristics of Cape Hardy Complex assemblages include: tip-fluted bifaces; wide, straight-based triangular projectile points; broadly side-notched bifaces; large, ovate side-blades; large, side-notched, flaked and ground burins and very narrow microblades (Helmer 1987b, 1987d).

The Cape Hardy Complex of north Devon Island bears strong relationships with Independence II materials from northeastern Greenland (Knuth 1967) and northwestern Devon Island (McGhee 1979) and with Transitional Dorset assemblages from west-central Ellesmere Island (Schledermann 1987). Traits normally associated with Independence II occupations but lacking in the Cape Hardy Complex are the presence of eared endscrapers and well defined axial passage tent rings.

Lethbridge Complex

The Late Dorset Lethbridge Complex has been tentatively associated with Features 46, 47, 48, 53 and 58 at the Lee Point Site (RcHh-1) upon the basis of observed surface artifacts and analysis of excavated materials from associated features (Helmer personal communication). The only other indications of a Dorset occupation in the study area are found at the Cook Site (QkHl-2) (Lethbridge 1939) and in the wall fill of an excavated Thule house at the Field School Site (QkHn-12) (Park 1987). Estimates for the age of this complex are between 1,500 and 1,000 RCYBP (Helmer, personal communication).

Summary

The cultural complexes described above were developed by Helmer as first order analytical units for the interpretation of the data collected by DIAP. The primary goal has been to associate individual features with one of the culture-historical units already discussed. These associations are recorded in Table 2. Feature numbers in italics indicate tent rings which can only tentatively be associated with a specific cultural complex. All of these assignments are provisional in nature and may be subject to change as the analysis of cultural materials continues.

Table 2: Summary of Complex Affiliations by Feature.

DIAP Complex Name	SITE	FEATURE #
LETHBRIDGE Late Dorset	RcHh-1	46,47,48,53,58
CAPE HARDY Transitional Dorset	QkHn-37	1
	QkHn-38	2
	QkHo-5	*1,2*
ROCKY POINT Late Pre-Dorset	QkHn-27	15,17
	QkHn-27	3,6,7,8,12,20,21
	Skruis Point	1,2,3,4,5
TWIN PONDS Middle Pre-Dorset	QkHl-5	1
	QkHn-17	1,3
	QkHn-12	6
	QkHn-12	4,*7*,*10*
ICEBREAKER BEACH Early Pre-Dorset	QkHn-13	1,2,4,14
	QkHn-13	*5,8,9,11,16*
	QkHn-17	4
	QkHl-5	2,3
	QkHl-66	*1*
FAR SITE Early Pre-Dorset	QkHn-22	8

Italics indicate tentative associations

CHAPTER 4

METHODS

The goal of this chapter is to provide the reader with the necessary understanding of the in-field and post-field data recording and preliminary data processing techniques employed during the course of this study. Concepts, terms and definitions unique to this study are discussed and defined and the rationale for the adoption of specific procedures is discussed.

Informal typologies of High Arctic tent rings already exist. These typologies have been successful in contributing to the deeper understanding of Paleoeskimo prehistory. Some attempts to formalize these classifications have been made but these studies have relied upon largely subjective criteria. In contrast, the study of tipi rings on the northern Great Plains has taken a largely quantitative direction. The collection and analysis of metric data, rather than nominal observations has been the objective. This study adopts some of these metric procedures and techniques for the analysis of variability in Paleoeskimo tent rings.

Although this research is exclusively devoted to the analysis of metric variability, it in no way espouses the opinion that continuous observations and quantitative analyses are the only possible approach to the collection of data and the exploration of variability in Paleoeskimo tent rings. An in-depth study of nominal observations would almost certainly yield revealing and significant results. A melding of both ratio and nominal level observations would likely be even more informative. Such an integrated approach was the one of the original goals of this study. Nominal observations were recorded during field studies and used during the initial analysis. However, these observations were not incorporated in the later stages of analysis. In order to ensure that this study was applicable outside the narrow geographical confines of arctic archaeology, the decision was made to focus the analysis upon an architectural element common to all tent rings: the perimeter. The exclusion of interior features from in-depth analysis effectively eliminated from detailed consideration the nominal observations recorded during field studies.

4.1 Field Methods

The following section outlines the procedures employed in this study in the selection of individual features for incorporation in this analysis as well as a detailed description and discussion of the techniques used to record data during the field portion of this study.

Feature Selection

Several criteria were employed in the selection of features for this mapping project. The overriding concern was to capture a sample of tent rings which were representative of the temporal, cultural and architectural diversity found in the study area. How successfully this goal was achieved cannot be objectively assessed at this time. Features representing every Paleoeskimo cultural entity known to exist in the Jones Sound area are represented in this sample (see Table 2). Most of the distinctive tent ring forms described by McGhee (1976) are also represented.

Boulder features of cultural origin are unmistakable in appearance and are easily identifiable in the field. Only those features which were felt to represent the remains of single portable habitations (tents) were selected. The criteria employed in differentiating between tent rings and other boulder features included the following. Tent rings often consist of roughly circular, ovoid or rectangular arrangements of rocks with a recognizable perimeter separating internal and external space. The interior area may contain structural stones and these stones may be arranged in distinctive non-random patterns. In the absence of a clearly defined or continuous perimeter of stones, the ground surface within the boulder feature was examined for occupational debris, including debitage, artifacts and faunal remains; the presence of these materials in association indicates the existence of a tent ring rather than a collapsed or dismantled cache or cairn. The ground surface within the feature was also examined for the presence of compressed or packed sediments; this appearance, indicating a floor or living area, was taken to represent the remains of a tent structure rather than a cache, cairn or trap. Stones within the postulated interior of the feature were also examined for the presence of burning or grease staining; such evidence, indicative of an internal hearth feature, was taken to indicate the remains of a tent ring.

It is possible that two closely contiguous or overlapping features might appear as a single boulder feature and be interpreted in this study as a single tent ring. Fortunately, the likelihood of "overlapping" features is low, given the natural desire for a flat and comfortable tent floor. However, the possibility of merging more than one feature does exist. Evidence of more than one hearth or axial passage area within a single perceived boulder feature was treated as a strong indication that more than one feature was involved. Similarly, the presence of separate compacted floor areas, or multiple vegetation patches were taken to indicate the possibility of more than one feature. Wherever it was suspected that two or more features might be merged, all such features were excluded from consideration.

A major goal of this study is to explore the full extent of variability existing in Paleoeskimo stone circles. Consequently, the selection of features was intentionally directed towards the mapping of as broad a range of features as possible. This is distinct from common archaeological excavation practices in the High Arctic, where well defined or well preserved features tend to be most commonly selected for excavation.

Wherever possible, features contiguous or nearly contiguous to excavated features were selected for mapping. Features close to excavated and/or dated features were selected for mapping for two major reasons. First, close proximity, especially in terms of beach elevation, has been used to suggest that features may represent contemporaneous occupation of the site area by multiple households. The examination of differential rock loading patterns may provide a test for such speculation. Second, even if features were not strictly contemporaneous, comparable beach elevations suggest comparable ages for individual tent rings.

The final characteristic influencing selection of features for mapping was opportunity. Field seasons in the Arctic are typically short, transportation is difficult and both are expensive. Consequently this study exploited opportunities to map features wherever possible. Although this opportunistic strategy has undoubtedly partially influenced the structure of the data collecte, it is a natural concomitant of field work in the Arctic environment.

Data Collection

The technique used to record data in the field was a variation of the radial Tipi-Quik mapping board system developed by Smith (1974) and later refined by Brumley (Dau 1981). For a more detailed summary of the use of this mapping system see Dau (1981).

This mapping system uses a square, flat board marked with an accurately depicted circle divided into 360°. A five meter tape is tethered to the centre of the board and the assembly is anchored in the approximate centre of the tent ring to be mapped with the zero degree mark of the board oriented to true north.

Normally orientation to north is accomplished by using a magnetic compass, but such devices are not particularly useful in many areas of the High Arctic. Instead aerial photographs and 1:50,000 Natioanl Topographic System maps were used to infer north. Bearings from site locations to distant visible landmarks were measured and compared to approximate true north.

Once the mapping board is anchored inside the feature, measurements of angle and distance are used to locate each rock precisely. The Tipi-Quik mapping technique was originally developed to speed up and simplify in-field mapping of stone circles by producing a detailed plan-view map while in the field.

For the purposes of this study, it was decided not to produce detailed maps while in the field. Instead, numeric data and nominal observations were recorded for each feature stone on a special data form. Data recorded in this fashion has two significant benefits. First, it was a faster and consequently less expensive field technique. Second, and more important, the recording of numeric information yielded a data set which could be manipulated and analyzed at a much higher level of resolution than was possible with a simple plan view drawing.

The individual stone was the basic unit of recorded data in this study. The stone (also referred to as a boulder or rock) was assumed to be the most simple element or component of architectural construction. For the purposes of this study, all rocks fist-sized and larger were recorded as part of the feature. Although unlikely, it is possible that smaller than fist-sized stones may have been employed in the construction of tent rings. However, due to the distinctive and obvious nature of these features, there can be little doubt that all mapped stones are indeed part of the feature.

The specific attributes which were recorded for each stone fall into three broad categories: locational data, proportional data, and non-metric observations. The locational data consisted of measurements of angle and distance from the measuring point. The proportional data consisted of measurements of the length, width and thickness of the individual rock. The non-metric data consisted of observations regarding rock form, orientation and association.

The locational data for each stone were recorded as an angle and distance measured in degrees and centimeters from the arbitrarily established 'field centre' to the perceived centre of mass of each stone. The recognition of a centre of mass for a particular rock was, of course, a highly subjective observation. Although a simple concept in physics, the precise definition of the centre of mass for a specific object is often difficult. It proved difficult to develop a reasonable, verifiable field technique which would permit the rapid determination of an accurate centre of mass for an individual rock. Consequently, no attempt was made to employ such a technique. Instead, the determination of the location of the centre of mass was left entirely to intuitive interpretation. Although the problem of estimating a centre of mass for each stone is an acknowledged potential source of error in this study, it is not expected that this error will significantly affect study results. Uncertainties in centre of mass placement are expected to be randomly assorted and should seldom exceed plus or minus 5 cms. A random uncertainty of this magnitude is comparable to the possible error factors inherent in the measuring apparatus itself.

As this study was originally conceived, the only proportional measurement collected was intended to be the weight of each individual stone. However, it was quickly realized that the removal and weighing of each feature rock would have a devastating effect upon the archaeological and architectural integrity of the tent ring being mapped. The destructive nature of this proposition was acknowledged, and a less destructive proxy measure for the weight of individual stones was derived from measurements of the length, width and thickness of each rock.

The measurement of length and width posed no threat to feature integrity as both measurements were visible in plan view. The impact of measurements of thickness were minimized by using a steel probe to ascertain shape and size below surface. The product of these three measures was taken to approximate the volume of the individual rock.

Prior to the commencement of in-field studies, a test of the efficacy of the proportional data in the prediction of the desired variable, weight, was made using non-archaeological data. A sample of 50 stones were recorded. These stones were intentionally selected to represent, as near as possible, the full range of shapes, sizes and lithologies that would be encountered in the archaeological sites of Jones Sound. The sample encompassed both porous sandstones and denser metamorphic rock. The most common forms were slabs and blocks but many rounded cobbles and irregular shapes were also included. The weight of each stone was recorded to the nearest half kilo using a common bathroom scale. Length, width and thickness were recorded to the nearest centimeter using a 3 meter hand tape in the manner described above. The product of the three variables (volume) was calculated. A linear regression analysis was conducted to determine the relative power of prediction of volume against weight. The result (r=0.95) clearly indicates a very high positive correlation between these variables (Hinkle *et al.* 1979:85). As a result of this high correlation the calculated volume can be considered a good predictor of weight.

Encouraged by the positive results of this analysis, a second linear regression was performed. This regression tested the hypothesis that only two measurements, length and width, are necessary to adequately measure weight. The product of length and width for any given stone is equal to the surface area of that stone when viewed from above. This variable was called size in this study. Regression of the size versus the weight of the fifty stone sample described above yielded a correlation coefficient of $r=0.74$, a high positive correlation (Hinkle *et al.* 1979:85). Although not as strong as the relationship between volume and weight, the relationship between size and weight was considered adequate enough to warrant its use as a proxy measure.

The non-metric observations recorded for each stone were association, orientation and shape. Association was a binary variable indicating whether the individual stone was associated with the perimeter or with possible interior features in the tent ring. Since the major focus of this study was upon perimeters, interior stones were excluded from subsequent metric analyses. Consequently the determination of association was very important to this study.

Interior stones were discriminated from perimeter rocks using several criteria. The primary assessment of association was based on an largely subjective examination of location and context. If an individual stone was clearly part of an internal hearth or mid-passage, it was excluded from perimeter analysis. Similarly, if a stone was clearly associated with a discernible perimeter ring, it was identified as a perimeter rock. In several features the presence of an area of compacted beach sediments or a small organic "mat" of moss and lichens was used as a visual clue to guide in the identification of the tent's floor area and to assist in the separation of interior from perimeter rocks. The presence of grease staining or burning on any rock was taken to indicate association with an internal function and such stones were excluded from consideration in perimeter analysis. Similarly upright sandstone slabs, normally a constituent of axial features or hearths, were usually interpreted as part of the interior, rather than perimeter elements of the feature. Although seldom difficult to decide in the field, the determination of this variable is recognizably subjective and intuitive, and as such it may have influenced the results of this study.

Orienation refers to the aspect of the stone with respect to the ground surface. It was recorded as one of three discrete subjective classes: upright, tilted or flat. Shape was recorded as one of a set of four discrete subjective classes: slab, block, cobble or irregular.

Orientation and shape were recorded with the intention of developing a characterization of interior elements with diagnostic power. This aim may still be addressable but, for the reasons outlined previously, this was not done.

4.2 Post-Field Methods

Feature Selection

Features which had been excavated by either DIAP or NHS archaeologists were not mapped in the field using the radial mapping system. Instead they were mapped during the course of excavation using a conventional grid and drawing system. In order to include these features in this analysis, a post-field radial mapping technique was applied. Only features which had been identified as single tent rings were mapped using this procedure. Excavated boulder features like QkHl-4, Feature 1, interpreted as two contiguous and disturbed tent rings, were excluded from analysis.

Data Collection

This post-excavation radial mapping technique used hand-drafted maps produced by more conventional means to create a digital record of rock attributes much the same as that described for in-field mapping. A copy of the map of the feature to be digitized was made. Each stone on the feature map was numbered. A mylar overlay (actually a transparent photocopy of radial graph paper in a suitable scale), was superimposed upon these maps. The mylar was placed with the axis of the graph in roughly the centre of the feature and care was taken to ensure that the zero degree radian was oriented to true north. Angle and distance measurements to an estimated rock centre were recorded on the same custom data form employed in the in-field component of this study. When all constituent stones had been recorded, the overlay was removed. This procedure is an analogue for in-field locational stone mapping.

A second smaller mylar (consisting of a regular rectangular grid at a suitable scale) was employed to derive proportional measures. This mylar was used to estimate the size of each rock. The mylar grid was situated over the subject stone and oriented in a convenient manner. A count of the number of grid squares enclosed within the outline of the rock of interest provided a close approximation of the relative visible surface area of that stone. These data were also entered upon the same data form. This measurement of visible surface area should closely approximate the size variable discussed earlier.

The non-metric binary attribute of association was recorded using many of the same subjective criteria as outlined previously in the description of field methods. The extrapolation of interior versus perimeter associations when examining plan-view maps proved somewhat more difficult than the same procedure would have been in the field. However, excavation notes, particularly descriptions of hearths or burned grease areas within the feature, proved particularly useful in deciding the probable association of any problematic stones.

Due to the two-dimensional nature of plan-view maps, there was no acceptable way to extrapolate a third dimensional measurement for the represented feature stones. Consequently there is no legitimate way to calculate a measurement of volume for each rock. Similarly, there was no way to reasonably infer the non-metric traits of orientation and shape. It therefore follows that these attributes could not be recorded for these post-field maps. This unattainable level of information in the data sample was the final reason that analysis of non-metric traits was suspended.

Data Entry

All collected data were entered directly on an IBM PC-XT compatible computer operating in the MS-DOS environment. Data entry and subsequent manipulations, analyses and presentation made use of a combination of commercially available programs and custom written software. All customized programs were written by the author in compiled Turbo-Basic (Borland 1987).

Centre-Point Determination

A major recognized difficulty of most stone circle studies has been the researcher's inability to determine a standardized, replicable centre-point for the feature (Finnigan 1982). Since the centre-point defines all subsequent investigative endeavours in most quantitative ring studies, it is obvious that such an inability could cause severe discontinuities within and between given data sets.

The fundamental concern in defining a centre-point for a stone circle is the need to ensure comparability. When archaeologists measure something (be it the length of a projectile point, the weight of potsherds or the diameter of a stone circle) they must ensure that measurements have been made in such a way that they can subsequently be compared with other measurements. The only way to do this is to make these measurements replicable. Replicability guarantees that regardless of chance factors like who took the measurement or where and when the analysis occurred, the results will be the same.

There is no claim that the derived centre-point would have had any meaning to the prehistoric human occupants of the structure. No analyst bothers to suggest that any technique locates a centre which would have had practical or symbolic meaning to past peoples, since such an interpretation is probably impossible and certainly unnecessary. As Wauchope points out: "one can manipulate the artifacts without much concern whether one understands precisely what they originally were, exactly how they were used, and just what they meant to the ancients" (1966:19). The importance of the derived centre-point lies in the ability to generate comparable data sets for statistical analysis, nothing more.

Several different styles or techniques have been proposed for locating the centre or mid-point of a stone circle. They may be grouped into three broadly similar categories: 1) In-field centering techniques; 2) Post-field subjective techniques and; 3) Post-field mathematical techniques.

The chief argument in favour of in-field centering techniques is standardization at low-cost. Brumley and Dau recognize that "relatively precise definition of the centre point is essential as it serves as the reference point for all subsequent measurements and observations" (1987:337). To address this concern they suggest a field technique consisting of the following steps:

> "1. A chain is held at any point on the interior ring wall margin and stretched across the ring to essentially the opposite side, where it is swung back and forth until the greatest inside diameter is found. With the chain held in that position, a pin or stake is placed at the midpoint of the defined axis.
> 2. This process is repeated at two other locations along the inner ring wall roughly equidistant from one another.
> 3. The three stakes or pins thus placed in the central portion of the ring define a triangle, the centre point of which is visually defined, marked and used as the centre point." (Brumley and Dau 1988:337).

In order to test the power of this centering procedure, eleven copies of eight different tent ring feature maps were produced on 8.5 by 11 inch paper (at an approximate scale of 1:40). EdOm-13, a small tent ring site near Empress, Alberta provided the source maps for this test (McCullough and Hanna 1988, Hanna 1989). Only feature stones were represented on these maps, all visible clues regarding the shape and orientation of the tipi rings were eliminated. Eleven archaeologists were contacted and each given one set of eight different ring maps. They were instructed to define a centre-point for each feature using the methods of Brumley and Dau as described above. Instead of a 5 meter chain and stakes, the subjects used a ruler and pencil. Although this procedure does not precisely replicate the form of Brumley and Dau's field technique, it does capture the major points. If anything, smaller discrepancies in centre-point determination may be expected from the use of small scale plan view maps since a complete overhead view of the entire feature is possible.

In effect, eleven different 'versions' of each of the eight features at EdOm-13 were produced by the eleven different subjects. The physical location of each projected centre-point was determined relative to a standard point and differences between 'versions' of each feature centre-point were calculated in real world scale.

Differences of opinion regarding centre placement were as high as 87 centimeters and all features had at least one disagreement of greater than 50 centimeters. The mean difference of opinion was 31 centimeters. Given an average feature diameter in this sample of 4.92 meters, the relative magnitude of disagreement was six percent. For a subjective field technique, an average error of six percent is neither excessive nor uncommon. However, the magnitude of disagreement concerning centre placement is not the important issue. What is important is the effect of these disagreements upon subsequently recorded information.

Each of the eighty-eight feature maps were partitioned into octants using the projected centre-point, and the number of rocks in each octant was counted and tabulated. The most frequently occurring recorded number of stones in each octant of the eleven 'versions' of each feature (the mode) was recorded. A cross-tabulation of feature number by subject was constructed (Table 3). The number of times that an individual subject disagreed by one or more concerning the number of rocks *per* octant when compared to the mode for that feature is recorded in this table. If an individual disagreed with the modal number of stones in all eight octants of a particular feature, an eight appears in the appropriate cell of the table. If no disagreements were noted, a zero was recorded. Note that agreement between two subjects about the number of stones in a particular octant does not guarantee that they are the same rocks in both cases. Also note that this table does not measure the magnitude of disagreement, it only shows the frequency of disagreement.

Examination of Table 3 shows that a high frequency of disagreement about the number of stones *per* octant is possible given identical features when an analogue for Brumley and Dau's centering method is used. Disagreements

Table 3: Disagreements in Number of Rocks *per* Quadrant *per* Feature by Eleven Analysts.

DISAGREEMENTS: NUMBER OF ROCKS PER OCTANT PER FEATURE										
		Feature								
		1	2	3	4	5	6	7	8	Tot
	A	0	0	7	1	3	0	2	1	14
	B	6	4	3	6	3	2	0	6	30
S	C	0	6	5	4	6	0	0	1	22
u	D	0	4	3	6	5	0	4	4	26
b	E	0	0	3	2	2	0	4	4	15
j	F	4	6	3	2	4	2	4	1	24
e	G	0	4	3	6	6	5	2	4	30
c	H	5	2	5	3	2	4	2	1	24
t	I	6	4	3	1	3	5	2	4	28
	J	0	4	3	1	3	4	2	4	21
	K	0	4	4	1	2	0	4	6	21
Tot		21	38	42	33	39	22	24	36	255
(%)		24%	43%	48%	38%	44%	25%	27%	41%	36%

were encountered an average of thirty-six percent of the time. With such a high possibility for differences of opinion between individual analysts, the field-centering technique was clearly unable to produce replicable measurements for identical features. Without replicability, comparability is also lost.

While it is acknowledged that conversion from small-scale maps to a real world scale may have exaggerated the apparent magnitude of disagreement concerning centre-point placement, any such exaggeration is expected to be minor. Real case disagreements are expected to be on same order of magnitude as these test results.

Post-field subjective centering techniques usually rely upon the abilities of the individual analyst to judgementally 'fit' preconstructed shapes to a map of the individual stone circle. Finnigan (1982, 1983) has suggested that a mylar overlay of concentric circles be fitted by eye to a map of the feature under consideration.

Dekin employed a similar subjective technique in his structural analysis of a Pre-Dorset tent ring from the Closure Site on Baffin Island. "An ellipse was constructed which enclosed the majority of rocks in this cluster. Attempts to fit other shapes to this cluster support the hypothesis that the shape of the tent was elliptical." (Dekin 1976:82). These techniques should be commended because they correctly recognize that the centering procedure is best performed in the lab under controlled conditions. However, they have little else to recommend them. They lack rigour, are largely impressionistic, and almost certainly generate non-replicable data.

Post-field mathematical centering methods share a great deal in common with the previously discussed techniques of quantitative shape analysis. As mathematical techniques, both are verifiable and consequently yield fully comparable results. A partial review and critique of some of the mathematical centering techniques proposed for tipi rings may be found in Poole (1984).

After review Poole developed a technique he called the "weighted mean" (Poole 1984:516-520). This name is, in fact, a misnomer as the calculations would be better described as a mean of interval means. This procedure uses the mean of interval data to calculate a feature mean in cartesian coordinates.

> "1. The coordinates of each point are read from the site plan and tabulated.
> 2. A suitable interval on both the *x* and *y* axes is chosen in order to establish a frequency distribution for the coordinates.
> 3. The coordinates in each interval are summed.
> 4. The means of coordinates in each interval are found by dividing these sums by the number of coordinates in the interval.
> 5. These means are summed.
> 6. The mean of the means is determined by dividing this sum by the number of intervals." (Poole 1984:516).

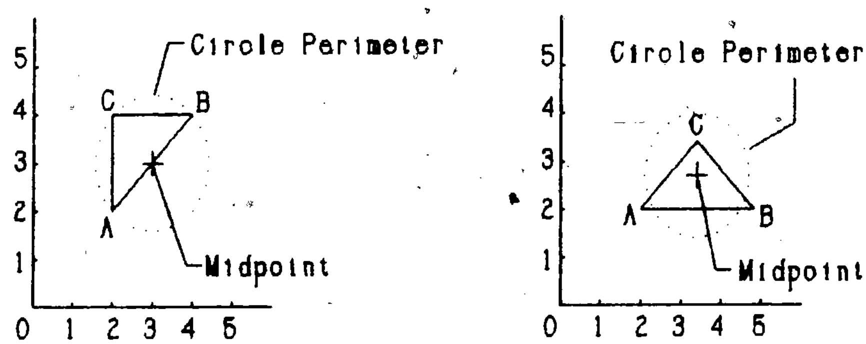
Poole selected his weighted mean technique from the several he tried because it: "was discovered easiest to calculate while not losing in accuracy" (1984:516). In either case, he was mistaken. The weighted mean technique is certainly not as computationally simple as the centre of gravity measurement which Poole discussed and discarded (1984:524) nor is the weighted mean technique any more 'accurate'. Futhermore, the weighted mean technique fails in the recognized principal goal of such techniques; it is not replicable. An optimal technique would be one which produces an identical result for two identical shapes regardless of orientation or positioning. Poole's technique failed to do this. The following example should make this clear.

In order to test Poole's proposed mid-circle calculation scheme, two physically identical triangles were compared (see Figure 7). It was felt that comparing the results of the analysis for two identically shaped but differently oriented simple forms would be a reasonable test of the efficacy of the procedure. The two triangles have identical dimensions; all sides are equivalent and all angles are the same. The only difference is that Triangle #2 has been rotated 45° clockwise about point A. The mid-circle of each triangle was calculated using Poole's "weighted mean" approach at a 1.0 interval spacing. That the two defined mid-circle points have different physical coordinates is not significant because the two triangles are located in somewhat different physical space. What is significant is the relationship of the defined mid-point to the previously defined points from which it was derived. The distance from each vertex to the defined centre-point is listed in Figure 7. The derived values for the centre-points of the two triangles are very different. Visual examination of the two triangles confirms the fact that the derived centres are not at all similar. It is apparent that Poole's technique is unable to generate similar solutions for identical simple shapes. Since Poole's weighted mean technique does not work for such relatively simple shapes as right-angle triangles, it seems unlikely that consistent results would be obtained using field data.

Another possible mathematical centering technique discussed and eventually dismissed by Poole was the mean centre of gravity measure (1984:524). A centre of gravity

Weighted Mean Midpoints and Radii for Two Identical Shapes

Triangle #1 | Triangle #2



Triangle #1

	X	Y	Distance (from Midpoint)
A	2	2	1.41
B	4	4	1.41
C	2	4	1.41
Midpoint	3	3	
Radius			1.41

Triangle #2

	X	Y	Distance (from Midpoint)
A	2	2	1.58
B	4.83	2	1.58
C	3.41	3.41	0.71
Midpoint	3.41	2.71	
Radius			1.29

Figure 7: Weighted Mean Mid-Circle: Test Case.

can be calculated using a number of algorithms, the simplest possible version is discussed.

The calculation of a mean centre can be accomplished by simple means if the location of individual rocks are known in cartesian coordinates. The mean of all *x* coordinates and the mean of all *y* coordinates provides the *x* and *y* coordinates of the mean centre. These calculations are simple and straightforward. Unfortunately, the derived value is easily influenced by clusters or gaps in the frequency of data points. A cluster of stones in one area of the tent ring wall, although not significantly altering the shape of the ring, will significantly alter the calculated mean centre. This instability in the location of the mean centre given a relatively stable tent ring form is reasonable grounds for not using this technique.

A tent ring represents a disturbed, discontinuous record of a perimeter which was once continuous. Due to the irregular nature of this perimeter, the types of centre-point determination developed for quantitative shape analysis cannot be directly used to isolate a centre-point for a tent ring. For example, a typical computing algorithm for centre of gravity calculation is the centering technique described by Tough and Miles (1984) and modified by Zakros and Rogers (1987). This technique requires a data set which is traversed in sequence (either clockwise or counter-clockwise). Such a constraint is impossible to satisfy with a scattered tent ring perimeter since there is no inherent ordering to the data.

Mean of Furthest Neighbours Analysis

Since none of the centering techniques so far discussed have been deemed adequate for the purposes of this study, an alternate technique had to be developed. The technique eventually adopted is called a "mean of furthest neighbours".

It is a characteristic of circles that a line from any given point on the perimeter of the circle to the most distant point still on the perimeter will pass through the center of the circle. The mean of the cartesian coordinates of these two points will furnish the centre of the circle in cartesian coordinates. This 'mean of two furthest neighbours' is adequate to describe a perfectly constructed, continuous circle. It therefore follows that a mean of the means of all possible furthest pairs will equally precisely locate the circle centre. Unfortunately, tent rings have anything but continuous perimeters. As a rule the perimeter of a stone circle consists of a scatter of points (individual stones) which roughly approximate the original form. Consequently, the furthest point from any known point on the perimeter of a tent ring may or may not correspond to another known point. However, by taking the mean of all possible furthest pair means for known points, an estimation of the centre can be made.

The mean of furthest neighbours calculation has a number of attractive properties for this analysis. First and foremost, because it is a mathematical technique, it is wholly replicable. Given the same data, the same centre-point will always be derived. Second, the mean of furthest neighbours minimizes the effect of clusters of perimeter data points on the location of the centre-point. The number of stones in a cluster will not unduly influence the location of the centre-point because the furthest point from each cluster stone will be incorporated into centre calculation as many times as there are stones in a cluster. Similarly, the effect of gaps in the perimeter ring is reduced by the mean of furthest neighbours technique. The stones located on either side of the gap in the perimeter wall will contribute more extensively to the derived centre-point. The increased importance in the calculation of points close to the perimeter gap has the effect of 'averaging across' the missing data points.

The principal advantage of the mean of furthest neighbours technique over other, more arithmatically simple procedures like a centre of gravity calculation, is the stability of the solution. The location of the centre-point will not be unduly influenced by clusters of stones or gaps in the perimeter wall. Consequently, similarly shaped entities will have similarly placed centres.

The principal disadvantage of the mean of furthest neighbours calculation is the computational complexity of the technique. Manual calculation of a furthest neighbour centre-point is possible but impractical. Computer processing is the only sensible solution.

Another disadvantage to the furthest neighbours centre-point calculation is the emphasis given to extreme values. A stone located more than one ring diameter outside the perimeter will have a very profound effect upon centre placement. Fortunately, the likelihood of inclusion of such an extreme outlier as a perimeter stone in any feature map is low.

In summary, the mean of furthest neighbours technique for centre-point determination developed for this study is considered the most appropriate technique for tent ring standardization. It generates a unique solution for each data set which is replicable, comparable and stable. Disadvantages are acknowledged, but these disadvantages are deemed less serious in scale than the problems of other techniques.

Data Processing: Recentering

As described earlier all collected field and post-field data was entered on computer. The first stage in the processing of this data was the determination of a centre-point for each mapped ring. The algorithm used was the 'mean of furthest neighbours', described above. The execution of this calculation was automated in a custom written computer program.

The first step in this program was conversion of rock locations. The position of each stone, recorded in radial coordinates relative to an arbitrary field centre, was converted into cartesian coordinates. Following conversion of coordinate systems, all perimeter rocks were identified through reference to the variable called association. Each perimeter rock was then automatically compared to all other perimeter rocks of that feature. The distance separating each stone from all other perimeter stones was calculated and the most distant stone identified. The mean of the coordinates of each 'furthest pair' was derived and a mean of all mean coordinates calculated. This mean of mean coordinates defined the new centre-point relative to the old field centre. All rock locations, both interior and perimeter, were then recalculated with reference to the new centre-point as the origin. Each stone location was then converted from cartesian to radial coordinates, and placed in a new data file. These re-centered data files became the source files for all subsequent data manipulations.

Feature Maps

Following the standardization of the data file using the mean of furthest neighbours technique, plan-view feature maps were prepared. Although not a primary goal of this study, the production of detailed plan-view feature maps is one way of documenting variability in these features. To aid in this procedure a special computer program was written to translate feature data files into a form which could be incorporated into a CADD (Computer Assisted Drafting and Design) program. CADDs are powerful mapping programs designed to enhance precision and speed in mundane and repetitive mapping tasks. They are especially useful for mapping digital data derived from external sources. The CADD program used in this study was Generic CADD 3.0 (Generic 1985). Individual feature maps for all tent rings included in this study can be found in Appendix B.

These maps represent reasonably close approximations of the surface appearance of the mapped feature. Each stone is represented by a simple circular shape and the size of each circle is directly proportional to the actual surface dimensions of the particular stone it represents. Although the map is not a 'photo-image' of the feature (rock shape and orientation are not depicted), it is nevertheless an accurate portrayal of the physical location and relative size of the constituent stones. For many purposes these maps may be a more useful portrayal than conventional plan-views as they are accurate depictions of relative rock size and location. Included on each feature map is a large 'cross-hair' oriented to the cardinal directions and located directly over the mathematically determined centre-point and an arrow indicating the direction to the fossil beach associated with the feature. A side by side comparison of a computer generated plan-view map and a more conventionally produced map is presented in Figure 6.

The creation of individual feature maps had several unforeseen benefits. By projecting a representation of the feature on the screen, any obvious typographical errors in the original data file could be detected and corrected. In addition, by automatically 'coloring' rocks according to individual non-metric attributes, a clear picture of the distribution of these attributes within the feature could be assembled. Although not reproduced here, such multi-dimensional maps may be useful interpretive tools in future tent ring analyses.

At the same time as the production of plan-view maps, summary tables were produced for each feature. Although not reproduced here, these tables contained summary information on every attribute recorded for each feature. These tables constituted the primary source of information for subsequent analyses.

Data Manipulation

Prior to analysis and subsequent data presentation, the re-centered tent ring data files were restructured in two fashions. These two forms of manipulation resulted in the production of specific data sets with widely different characteristics suitable for specific intended analyses. The two forms of manipulation were rotation and partitioning.

Data Manipulation: Rotation

One of the most difficult problems in quantitative shape analysis is the orientation of shapes for comparative purposes. In the case of a natural shape like sand grains, the orientation of individual grains is effectively random. Before analysis of the variation in their perimeter shapes can proceed, the perimeters must be rotated relative to one another so that their orientation is standardized (Clark 1981). On the other hand, the orientation of some shapes, like sand dunes, is decidedly not a random phenomenon. An external factor, wind, directly influences dune morphology. Consequently, orienting dune shapes according to a common factor with the external phenomenon is a sensible procedure. In the case of wind direction and dune shape, a common factor would be the cardinal directions.

Similar methodological problems can exist for the different forms of tent ring analysis. It is unrealistic to expect that all the disparate goals of tent ring analysis can be accommodated by a single rotation strategy. Four strategies for dealing with the problem of feature orientation were identified in this study: 1) orientation to cardinal directions (no rotation); 2) rotation according to internal orientation; 3) rotation according to beach location, and; 4) rotation according to maximum correlation.

The first orientation strategy, that of orientation to cardinal compass points, requires no rotation. Using this strategy is appropriate for certain types of analysis. For the correlation of patterns of wind direction with patterns of rock distribution, data for each feature should be oriented with reference to cardinal compass points.

Consequently, the information as recorded in the feature data file was appropriate for this analysis. However, if the analyst is seeking patterns in perimeter shape, a different form of standardization in orientation is necessary.

The second orientation strategy, rotation according to internal feature, is a tempting one for the analyst concerned with correlations in perimeter shape. Several of the features in this study have linear axial interior features. These internal features give a possible common reference point for rotation and subsequent analysis. Unfortunately, there are two characteristics of these internal features which make this form of rotation impossible. First, the rotation solution would not be unique as the linear axial feature 'points' in two opposite directions. Second, not all tent rings have axial features, and these would be consequently be excluded from analysis. Consequently, the rotation of features according to internal feature orientation was not attempted in this study.

The third orientation strategy, rotation relative to beach, does not suffer from these problems. The direction to the associated fossil beach was usually unique, relatively easy to ascertain and was common to all features. Furthermore, the shoreline location at the time the feature was occupied was almost certainly very important to the occupants. All features are located near beaches and many are in areas where the beach is the only proximate salient geographical feature. As well, those features which do have linear internal features show a strong tendency to orient perpendicular to the fossil beach with which the feature is associated. Previous researchers have noted this tendency, some ascribing it "universal" distribution (McGhee 1976; Maxwell 1988). In the Jones Sound sample, of the sixteen tent rings with recognizable linear internal features, ten of these features (62.5%) align directly perpendicular to the beach while four more (25%) fall within 45° on either side. For these reasons, rotation of each feature to align with the local beach was chosen as the optimal procedure for this analysis.

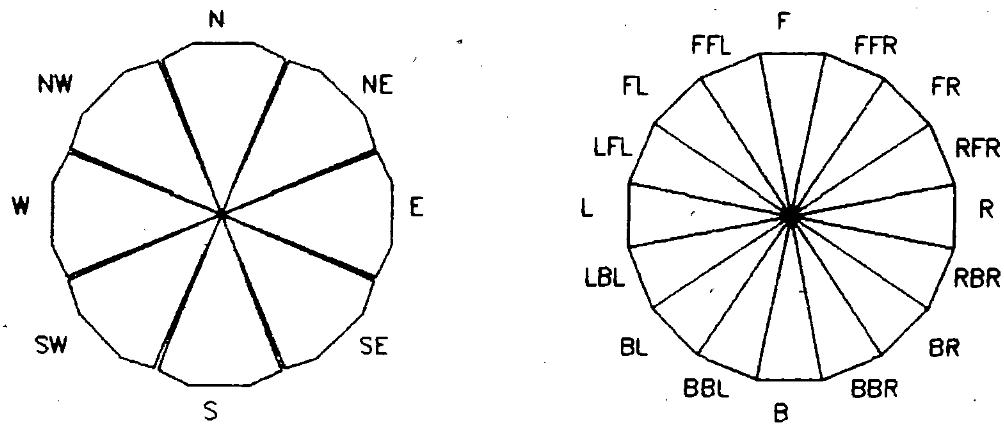
The final, and most intriguing possible orientation strategy involves the individual rotation of each feature against every other feature to determine the highest correlation between individual features. This form of rotation has been used in many quantitative shape analyses where there is no arbitrary external ordering phenomena (eg: sand grains). This form of rotation, in the absence of external interpretive phenomena, may have a very high potential for deriving order in seemingly randomly assorted shape assemblages (Clark 1981).

Data Manipulation: Partitioning

As mentioned earlier, only perimeter data were subjected to intensive quantitative analysis. This analysis required the grouping of perimeter rock information into definable zones for the purposes of data compression and simplification. Three partitioning strategies, each based upon a differently sized partition, were defined.

The term **quadrant** is used in this study to refer to a portion of a circle encompassing 90°, or one quarter of a circle. In this study, eight named quadrants are considered. Consequently, contiguous quadrants overlap each other by 45°. The eight named quadrants, and their spans, are illustrated in Figure 8. The names for the eight quadrant partitions were derived from combinations of the first letters of the four cardinal reference points ('N' for north, 'NE' for northeast and so forth). This use of the term quadrant is contrary to common usage, where four mutually exclusive partitions are envisaged.

The term **sedecant**, as used in this study, refers to a portion of a circle encompassing 22.5°, or one sixteenth of a circle. The sixteen possible divisions, and their spans are illustrated in Figure 8. Each of the sixteen non-overlapping sedecant partitions were named using two different systems of nomenclature. In the first system, each sedecant was named in reference to the cardinal compass points ('N' for north, 'NNE' for north-northeast, 'NE' for northeast, and so on). In the second naming system, a similar style of reference was adopted. However, in this system, sedecants were identified relative to the associated fossil beach rather than relative to north. The direction to the nearest point on the seaward edge of the fossil beach upon which the feature is located is arbitrarily referred to



Quadrant Span
(90°)

N	North	>315°-45°
NE	Northeast	>360°-90°
E	East	>45°-135°
SE	Southeast	>90°-180°
S	South	>135°-225°
SW	Southwest	>180°-270°
W	West	>225°-315°
NW	Northwest	>270°-360°

(Eight overlapping Quadrants oriented to North.)

Sedecant Span
(22.5°)

F	Front	>348.75°-11.25°
FFR	Front-Front-Right	>11.25°-33.75°
FR	Front-Right	>33.75°-56.25°
RFR	Right-Front-Right	>56.25°-78.75°
R	Right	>78.75°-101.25°
RBR	Right-Back-Right	>101.25°-123.75°
BR	Back-Right	>123.75°-146.25°
BBR	Back-Back-Right	>146.25°-168.75°
B	Back	>168.75°-191.25°
BBL	Back-Back-Left	>191.25°-213.75°
BL	Back-Left	>213.75°-236.25°
LBL	Left-Back-Left	>236.25°-258.75°
L	Left	>258.75°-281.25°
LFL	Left-Front-Left	>281.25°-303.75°
FL	Front-Left	>303.75°-326.25°
FFL	Front-Front-Left	>326.25°-348.75°

(Sixteen non-overlapping Sedecants oriented to the local Beach.)

Figure 8: Quadrant and Sedecant Angular Divisions

as the front of the tent ring. When standing within the feature and facing towards the front, the left, right and back portions of the tent ring are located in their respective positions. Sedecant names are assigned by combining the first letter of these four relative terms ('F' for front, 'FFR' for front-front-right, 'FR' for front-right, and so on) in the same fashion as used in describing cardinal directions.

The term octant, not directly used in this analysis, refers to a division of a circle which encompasses 45° or one eighth of a circle. There are normally eight non-overlapping octants. The eight named octants conform to the same names and arrangement as the eight named quadrants mentioned earlier although they do not overlap.

Most tipi ring researchers currently employ an octant partitioning system as the standard for data analysis (see Quigg 1986; Brumley and Dau 1988 for examples). These octants consist of mutually exclusive, equally sized partitions of the perimeter as described above. The reasoning behind selection of octal segments can be traced to early attempts to correlate rock distributions with prevailing wind patterns (Finnigan 1982; Brumley 1983). Since wind directions are normally presented in eight compass bearings, the use of octants was a logical step. However, Finnigan (1982:43-44) clearly demonstrated that the force of a wind from a specified direction acting on the side of a tent will exert maximum pressure over a much broader area than an octant. Consequently, although eight partitions are essential for correlation with wind patterns, the size of the octant 'slice' is too small to adequately measure the response by the tent occupants to wind effects. The solution to this seeming paradox is to retain eight partitions, and to expand each partition to encompass a more comprehensive portion of the ring perimeter. In this study, for simplicity's sake, the selected scale of overlapping measurement was the quadrant. Instead of eight mutually exclusive octants, eight overlapping quadrants were employed. By using overlapping units rather than mutually exclusive partitions, the analysis of correlations with wind direction is still possible and at the same time the use of quadrants more strongly reflects the prehistoric occupant's motivation in differential rock loadings.

The partitioning of rock distributional data into quadrants was deemed necessary to extract differential patterns of weight loading, but this was not the only goal of this study. Also of concern was the analysis of perimeter shape. As far as could be determined, there have been no quantitative analyses of tent ring size or shape in the High Arctic. Consequently, there are no guides to the level of information necessary to adequately encapsulate the variability inherent in these features. However, some size and shape analyses are known from tipi ring studies on the plains.

The analysis of form and size in tipi rings has enjoyed some success in discerning patterns relating to cultural-temporal settings (Finnigan 1982; Mobley 1983; Quigg and Brumley 1984; Quigg 1986; Brumley and Dau 1988). In most of these studies a relatively 'standard' group of methods has been adopted. All make use of measurements of the length of major axes as the variables of interest. Some contention exists between these researchers over the procedures appropriate for the collection of these measurements (eg: internal diameters versus external diameters), but most agree upon the use of relatively similar indices. The measurement of four major axes: north-south, northeast-southwest, east-west and southeast-northwest as suggested by Brumley and Dau (1988:337) would seem to be the most intensive and most commonly collected data pertaining to size and shape.

Unaccountably, no use has been made of the radial partitioning system to generate data which reflect the size and shape of the individual tent ring. Given the success of quantitative shape analysis in capturing variability derived from very similarly structured data, it became apparent that considerable potential existed for an application of such an approach. Consequently the decision was made to investigate the variability in perimeter form at a fairly detailed level using radially partitioned data.

Given the decision to use radially partitioned data to measure size, the next decision involved how to measure that size. Tipi ring researchers have made use of measurements of external diameters and average diameters for their analyses, but the most common, and most vociferously defended metrics indices have been internal diameters. Many researchers have argued upon the basis of ethnographic evidence that these interior measurements are a more meaningful measure of cultural variability than other measures of size (Brumley and Dau 1988, Finnigan 1982, Quigg 1986, Quigg and Brumley 1984). This argument has been based on the assumption that rocks were used to weight down the cover on the outside of the tipi. While this may be true of tipis, there is no *a priori* reason to suppose that stones were used only as exterior cover weights throughout all of prehistory in the Jones Sound area. The ethnographic evidence (Boas 1888; Balicki 1970) suggests that several different stone placement strategies were in use amongst historic Inuit groups. Although there are no compelling cultural/interpretive reasons to use internal or external ring measurements, there are good statistical reasons for not using these metrics. Internal ring diameters are effectively a measurement of minima while external diameters are a measure of maxima. Potentially the least informative way to characterize any sample is in terms of the maxima and/or minima. In any normally distributed population, the maximum and minimum values are likely to be subject to large-scale, random variability. Consequently, the decision was made to use the mean distance to perimeter rock midpoints for each radial partition as the unit of measure for all subsequent shape and size analyses.

Since there are no directly comparable studies or analyses which indicate an appropriate scale or procedure for investigating the variability in form and size of the tent ring perimeter, it was deemed prudent to prepare a very detailed data set for analysis. Consequently, the average distance to perimeter rock midpoints *per* sedecant was compiled for each feature. Minimally, the eight measurements in an octal data set would probably approximate the four major axes measured by Brumley and Dau (1988). However, since a higher degree of variability was anticipated in the tent rings from Jones Sound than has been observed in prairie tipi rings, it was hoped that sedecant data would reveal more detailed structural information and capture the shape of the feature in a better fashion.

In summary, the tent ring data were partitioned using two methods to prepare for subsequent presentation and analysis. All rock distributional data was divided into overlapping quadrants, oriented to north, to facilitate the analysis of differential rock loading patterns. All distance measures were partitioned into sedecants, oriented towards the local beach, to facilitate the analysis of feature size and shape.

Data Standardization and Presentation

In order to render the partitioned data in a more intuitively interpretable form, certain standardizing procedures were employed. The volume, size and number of rocks *per* quadrant were expressed both as raw numbers and as percentages of the feature total (Tables A1a to A5c).

Sedecant data were handled somewhat differently. Due to the small scale of sedecant partitioning, occasional sedecants were encountered with no stones. Since the presence of a continuous perimeter is an assumption of subsequent analysis, these 'missing values' were replaced by a linear approximation of the perimeter based upon contiguous values. In practical terms, the mean of the two sedecants on either side of a missing value was used to calculate the missing score. In order to assist in intuitive interpretation, each variable score was standardized by dividing by the mean distance to perimeter rocks *per* feature. This form of standardization eliminated the problem of scale.

With the availability of recentered, standardized data, the production of summarized data suitable for presentation and analysis could begin. A table summarizing interior and perimeter characteristics for each feature was produced. Although not reproduced here, these tables provided the preliminary source documents for all subsequent analyses.

To make the data presented in tabular form even more intuitively understandable, proportional directional piecharts were produced. Three sets of these 'rose charts' were produced to graphically depict the number of stones, size of stones, volume of stones and physical distribution of stones about the perimeter of each feature (see Figures C1a to C4f).

Similarly, in the case of size of rock *per* quadrant (Figures C2a to C2f), the length of each 'slice' of the rose chart is proportional to the total size of rock in that particular quadrant as a percentage of the total weight of stones in that specific feature. These rose charts are all oriented to north.

In the case of volume of rock *per* quadrant (Figures C3a to C3d), the length of each 'slice' of the rose chart is proportional to the total volume of stone in that particular quadrant as a percentage of the total number of rocks in that specific feature. These rose charts are all oriented to north.

In the case of average distance (Figure C4a to C4f), the length of each 'slice' of the piechart is proportional to the averaged distance from the derived centre-point to the centre of gravity of perimeter rocks in each sedecant of the feature. These rose charts are all oriented perpendicular to the local fossil beach strike rather than to north.

CHAPTER 5

ANALYSIS

The purpose of this chapter is to provide a brief discussion of the characteristics of the multivariate statistical analyses employed in this study and to outline the specific reasons for procedural decisions made in their implementation. A subjective discussion of tent ring conformation with reference to existing typologies is also provided.

5.1 Principal Components Analysis

Introduction

It is not within the scope of this study to fully examine all aspects of the theory and use of principal components analysis. For more detailed information concerning these procedures, excellent reviews can be found in Davis (1986), Kim and Mueller (1978), Levine (1977), Clifford and Stephenson (1975), Harris (1975), and Sneath and Sokal (1973). Specific discussions and critiques of archaeological applications exist in Doran and Hodson (1975), Orton (1980) and Vierra and Carlson (1981).

Principal components analysis (PCA) is a multivariate statistical procedure which seeks to explain variation in metric observations in terms of a smaller number of hypothetical variables (Kim and Mueller 1978:9). Often confused with a related procedure called factor analysis, PCA is a model free technique (Davis 1986:546) which creates components upon the basis of correlation between observations. Components are not directly measured, they are 'discovered' by examining correlation between measured variables (Kim and Mueller 1978:9). If considerable structure exists in the measurements being examined, or if there is a high level of redundancy inherent in the data, PCA will derive a small number of components which account for a high percentage of the observed variance in the original sample (Davis 1986:546-547). These 'principal components', representing a parsimonious description of existing variability, can be used to replace measured variables in subsequent analyses of the same data. By capturing a large percentage of variability in a small number of components, PCA reduces dimensionality and may thereby increase comprehensibility and interpretability. PCA can also be used to develop strategies for restructuring subsequent data collection for related samples.

Normally the first step in a PCA is an examination of the interrelationships among the variables under study. This examination is usually expressed in the form of a correlation matrix (Hodson 1969). Inspection of this matrix may reveal relationships among sets of variables which suggest 'hidden' relationships within these groups of variables.

These hidden relationships, or principal components, are extracted by isolating linear combinations of variables which are orthogonal to existing components and which maximize the explanation of variance in the original data.

Each successively extracted component seeks to maximize the explanation of the remaining variance. Consequently, each of these extracted components is, of course, uncorrelated with all other components (Davis 1986). Extraction of components will continue until all variance is accounted for. Normally, as many components are extracted as there are variables, although dependency between two or more variables will result in a reduction in the number of extracted components. If a high level of structure exists in the original data, then most of the variance will be accounted for by relatively few components.

An eigenvalue, or inverse measure of variance, is calculated for each extracted component. The larger the eigenvalue, the more variance is explained by the individual component and the less variance remains to be explained by subsequent components (Nie *et al.* 1978:470).

Although principal components with eigenvalues of less than 1.0 are generally not retained for further analysis, the number of components incorporated in any given analysis is largely left up to the individual researchers discretion (Nie et al 1975). A trade off exists between the loss of information inherent in the abandonment of components with low eigenvalues and the enhanced simplicity gained through adoption of the principal component model with fewer components. The more components retained, the more accurate the model; the fewer components retained, the simpler the model.

A summary of the relationships between variables and components in the form of a coefficient matrix is produced. These component loadings reflect the simplicity of the model. If a simple solution has been achieved, most variables will be strongly correlated with only one component. This simple solution is seldom the case following initial component extraction.

In order to reduce the apparent complexity of the patterns of correlation between variables and components, the initial component loadings matrix can be rotated. Rotation shifts component axes to find positions where formerly ambiguous coefficients are replaced by either strong or weak loadings. Hence each variable becomes more clearly aligned with a single specific component. Rotation does not affect the relationship between the original variables and the component model, but it does affect the amount of variance captured by each component (Davies 1971).

A rotated component loadings matrix is produced which summarizes the relationship of each variable to the retained and rotated components. This matrix, unlike the previously derived component loadings matrix, should have a relatively simple and unambiguous structure. Groups of variables should emerge which have high correlations with a single component and low correlations with all other retained components. The amount of variance explained by each rotated component can be calculated, as can the percent of total variance explained (Wilkinson 1987).

If a relatively simple solution is achieved, each variable will correlate highly with only one component. Some variables may have ambiguous component loadings (eg: no high loading, or more than one high loading), these variables may be legitimately excluded from subsequent analyses (Nie et al. 1975).

The final stage in a PCA can be the assignment of factor scores to specific cases. Each case will receive a score on each of the targeted number of components. These scores are calculated from the rotated component matrix using simple correlation. The component scores are normalized to zero mean and unity variance (Wilkinson 1987). In effect, these component scores contain a complete summary of the original data reduced to a number of dimensions equal to the number of components extracted. Reduced dimensionality is an important factor enhancing the interpretability of results. The production of component scores for each case is normally only undertaken if a subsequent form of Q-mode analysis, like cluster analysis, is intended.

Application

In this analysis, the extraction of principal components was conducted using the FACTOR module of SYSTAT, Version 3 (Wilkinson 1987). The data set consisted of the average distance to perimeter rocks *per* sedecant oriented to the local beach strike for all features (Tables A5a to A5c).

In cases where variables have widely different variances, or where observations have been measured using different scales, it is customary to apply some form of standardization procedure before conducting a PCA. In this study, neither of these conditions apply. The data consisted of continuous metric measurements of distance and the variances of individual variables did not differ excessively. Consequently there was no need to standardize the data before calculation of the correlation matrix.

Missing scores on particular variables can have a profound effect upon the results of a PCA. Hence, in the normal conduct of an analysis, the researcher must decide upon the form of deletion which will take place. Listwise deletion removes from calculation any observation with a missing value. Pairwise deletion only deletes those comparisons involving observations where one or the other element of the comparison is missing. Normally, pairwise deletion should be avoided since it can create tangibly skewed results due to sampling drift (Davis 1986). Due to the data smoothing technique employed for extrapolating absent perimeter scores explained in Chapter 4, there were no missing values registered in this data. Consequently, the selection of a deletion method had no effect upon the outcome of this analysis.

Vierra and Carlson (1981) have demonstrated that PCA can produce patterned results with a completely random data set. However, the random nature of the data will be exposed by the predominance of unusually low coefficient values in the correlation matrix (Vierra and Carlson 1981:277-278). Visual inspection of the correlation matrix generated in this study revealed that strong correlations existed between a high proportion of the variables. The large proportion of high correlations identified in this matrix clearly demonstratesd a significant degree of structure in this data and that a considerable reduction in data complexity could be expected from component extraction. Consequently, the average distance *per* sedecant data was deemed suitable for PCA.

The suitability of this sample for PCA is further borne out by an examination of the derived eigenvalues (see Table 4). A relatively simple data structure was suggested by the rapid decrease in magnitude of eigenvalues associated with increasing component numbers.

As mentioned previously, it is customary, but by no means obligatory, to proceed to rotation with only those components whose eigenvalues exceed 1.00. In this analysis, the eigenvalues of the first three components exceed 1.0 and these three components may be rotated without concern. The eigenvalue of the fourth component extracted was 0.82 (see Table 4). Although an eigenvalue of less than 1.00 indicates that the fourth extracted component does not

Table 4: Eigenvalues and Percent of Variance, Principal Components Analysis

PRINCIPAL COMPONENTS ANALYSIS: DISTANCE PER SEDECANT			
COMPONENT #	EIGENVALUES	PERCENT OF TOTAL VARIANCE EXPLAINED	CUMULATIVE PERCENT
1	9.680	60.5%	60.5%
2	1.267	7.9%	68.4%
3	1.200	7.5%	75.9%
4	0.818	5.1%	81.0%
5	0.577	3.6%	84.6%
6	0.476	3.0%	87.6%
7	0.392	2.5%	90.1%
8	0.363	2.3%	92.3%
9	0.267	1.7%	94.0%
10	0.258	1.6%	95.6%
11	0.215	1.3%	97.0%
12	0.144	0.9%	97.9%
13	0.136	0.9%	98.7%
14	0.077	0.5%	99.2%
15	0.071	0.5%	99.6%
16	0.057	0.4%	100.0%

account for any more of the variance than would be accounted for by a single variable, the fourth component was nevertheless retained in this analysis.

The four component solution was decided upon for several reasons. Although the fourth component had an eigenvalue of less than 1.0 and consequently accounted for less of the variance than could be accounted for by a single variable, inclusion of the fourth component increased the cumulative percent of variance accounted for to more than 80 percent. It was decided that the additional complexity of a four component model was more than justified by achieving such a high proportion of variance explained. As well, some tent ring researchers have suggested that measurement of four longitudinal axes are useful indices in the analysis of tent rings (Quigg 1986; Brumley and Dau 1988). The use of a four component model would explore the strength of this suggestion.

Communalities are the sum of the squares of all rotated component loadings for a specific variable. The communality of a given variable is a reflection of the degree to which that variable is accommodated by the principal component model. The higher the communality, the more that variable is accommodated by the constructed model.

The communalities for each variable in this analysis are presented in Table 5. It is clear that the proposed four component model incorporated a high percentage of the variance of almost all variables. No variables have communalities of less than 0.65 and most are greater than 0.80. Consequently, it is clear that a four component model accommodates most variables quite well. However, these communalities do indicate variables which, in a relative sense, are less compatible with the four component model.

Allocation of variables to the rotated components with which they have the strongest correlation shows a relatively simple structural pattern. In Table 5, the grouping of variables shows that component one loads highly on the variables clustered at the back-right of the feature, component two loads highly on the variables clustered at the front of the feature, component three loads highly on the variables on the left of the feature and component four loads highest on variables at the front-right of the feature. The high loadings on contiguous perimeter measures indicates that underlying structure does exist in this sample and that the PCA has been successful in identifying this pattern.

Table 5: Rotated Component Loadings, Distance *per* Sedecant Oriented to Beach.

VARIABLE	COMPONENTS 1	2	3	4	COMMUNALITIES
BR	0.87	0.21	0.25	0.20	0.90
BBR	0.81	0.21	0.31	0.18	0.83
RBR	0.79	0.23	0.27	0.37	0.89
R	*0.55*	*0.26*	*0.43*	*0.49*	*0.80*
F	0.15	0.77	0.24	0.37	0.81
FFL	0.42	0.75	0.24	-0.04	0.80
FFR	*0.15*	*0.71*	*0.10*	*0.54*	*0.83*
BBL	*0.18*	*0.62*	*0.52*	*0.36*	*0.82*
BL	*0.13*	*0.54*	*0.73*	*0.18*	*0.87*
B	*0.45*	*0.53*	*0.45*	*0.29*	*0.77*
L	0.22	0.17	0.83	0.29	0.85
LBL	0.26	0.26	0.79	0.20	0.80
LFL	*0.35*	*0.03*	*0.75*	*0.21*	*0.73*
FL	*0.33*	*0.36*	*0.64*	*0.02*	*0.65*
RFR	0.29	0.17	0.26	0.81	0.84
FR	0.31	0.37	0.26	0.72	0.82

Italics indicate eliminated variables.

Examination of the component loadings and communalities of each variable allows the elimination from further analysis of those variables least compatible with the component model. The elimination of specific variables was justified since it would be empiricism of the most naive sort to suppose that the measurement of sixteen arbitrarily defined units represents a 'real' subdivision of variability. Since the majority of communalities were greater than or equal to 0.80, this value was selected as an arbitrary cut-off point. Variables with communalities of less than 0.80 were eliminated from subsequent consideration. Although the remaining variables were incorporated well by the constructed four component model, there are some which, in spite of rotation, had high correlations with more than one component. Such ambiguity in component definition is contrary to the primary goal of data simplification. Those variables with more than one component loading higher than 0.50, or those variables with no loading higher than 0.70 were eliminated from further consideration. Those variables eliminated from further analysis by these methods are indicated in Table 5 by italics. The variables retained for subsequent analysis are back-right (BR), back-back-right (BBR), right-back-right (RBR), front, front-front-left (FFL), left (L), left-back-left (LBL), right-front-right (RFR) and front-right (FR).

Following the removal of variables with ambiguous component loadings and/or lower communalities as outlined above, nine of sixteen variables were retained (see Table 5) for final PCA. This principal component extraction was identical to the previously described analysis in all respects except for the reduced number of variables employed. The object of this analysis was to produce and record component scores for each tent ring for subsequent Cluster Analysis.

Summary

Principal components analysis was used to analyze the shape of the perimeter of the Jones Sound tent rings for 'hidden structure'. The data analyzed through PCA were the average distance to perimeter ring rocks *per* sedecant oriented to the local fossil beach.

PCA indicated a high level of internal structure in the data. The first four components isolated in the analysis were retained for further study. This four component model accounted for 81 percent of the total data variance. Rotation of the four extracted components yielded a simple underlying grouping of contiguous variables which captured most of the variance in the sample. Ambiguous variables were eliminated and a second PCA conducted using only retained measurements. Component scores for each case were calculated based upon this second PCA for subsequent cluster analysis.

5.2 Cluster Analysis

Introduction

"Cluster Analysis" is a generic name for a large body of somewhat related statistical procedures that are used to classify data. Although cluster analysis was originally developed for the biological sciences and has had considerable success in that field, there has also been a significant degree of interest in, and use by social scientists. Helpful descriptions of clustering techniques and discussions of their use exist in Aldenderfer and

Blashfield (1984), Clifford and Stephenson (1975), Davis (1986), Lorr (1983) and Sneath and Sokal (1973). Summaries of specific uses of these procedures in archaeology may be found in Doran and Hodson (1975) and Orton (1980).

Cluster Analysis can be described as a multivariate statistical procedure for placing entities or cases into groups or "clusters" that reflect a high degree of shared similarity. Put another way, clustering techniques take data consisting of information about a sample of entities and reorganizes these entities into relatively homogeneous groups. Normally, the degree of homogeneity within any cluster should exceed any similarities between clusters (Aldenderfer and Blashfield 1984:7). Two distinct forms of cluster analysis exist: hierarchical agglomerative techniques, and iterative partitioning methods (ibid:45). Hierarchical agglomerative techniques are the most commonly employed and best understood forms of cluster analysis and they are discussed exclusively in the following.

When speaking in terms of Cluster Analysis, variable scores for individual entities are usually described as a profile. Each case can be represented as a simple graph, with the variables ordered along the x axis and the variable scores reflected upon the y axis. The distinctive size and shape of this profile characterizes the individual entity.

As mentioned previously, the term "Cluster Analysis" subsumes a wide variety of disparate statistical procedures. However, all these procedures share a common two-stage structure. First is the calculation of a distance or similarity measure. This similarity measure can be described as a numeric representation of the relative similarity between individual entities when all considered variables are weighted equally. Hence, the first stage of a cluster analysis is the comparison of each case with every other case. The result of this comparison is the creation of a rectangular matrix of *n* by *n* cases where *n* equals the total number of cases. The diagonal of this similarity matrix will either be 0 or the highest possible score depending upon the nature of the calculation routine employed (Similarity or dis-similarity).

The calculation of similarity measures can be accomplished through one of four major routes (Sokal and Sneath 1973). Each of these routes has advantages and disadvantages which can only be assessed when considering the goal of the analysis and the nature of the particular data set under consideration.

Individual profiles are used to calculate similarity measures between entities. Depending upon the type of similarity measure being sought, the size or the shape of the profiles under consideration may have more or less influence upon the outcome of the calculation. Certain similarity algorithms are most sensitive to changes in the magnitude of differences in the profiles under comparison while others are more sensitive to changes in shape.

For instance, two entities may have identically shaped profiles even though one is elevated to a much higher position on the *y* axis. It is decided by the individual researcher if similarities in the shape of profiles or relative size differences are more important to the outcome of the analysis.

The second stage in a cluster analysis is the assignment of entities to different groups based upon the measured similarity and through the mechanism of a specified joining algorithm. Effectively, the joining algorithm is little more than a rule governing the way in which an entity's similarity measure is evaluated before it can be included in a given cluster. Joining rules can be very simple or very complex. For example: single linkage joins a case to a cluster if that case is most similar to any member of the cluster while complete linkage joins a case to a cluster only if the case is most similar to the most distant member of a cluster.

The selection of a clustering method is as important to the outcome of the analysis as is the selection of a similarity measure. Different joining algorithms maximize different attributes of the cluster shape in multivariate space. For instance: complete linkage joining tends to produce compact, hyper-spherical clusters while single linkage tends to produce long, "chained" or "ropy" clusters (Aldenderfer and Blashfield 1984:39-40). The choice of a joining algorithm is the decision of the individual researcher. Careful assessment of the characteristics of the data, and of the desired groupings is required before selection of a clustering method.

The assignment of cluster membership is the final, interpretive stage of the analysis. Hierarchical agglomerative methods produce dendrograms or shaded matrices which convey a graphical display of relatedness, but which do not indicate break points. Consequently, the number of 'natural' clusters in a sample may not be at all apparent. The hierarchical dendrogram produced by agglomerative techniques suggests that many possible groupings exist in the data. Which groupings are the most optimal is a problem as yet unresolved in cluster analysis (Everitt 1979). Many techniques, usually heuristic, have been developed to aid in the determination of the number of clusters. However, the selection of a specific method, and the ultimate decision as to the number of clusters remains entirely up to the analyst.

Application

The statistical analyses discussed in the following section were all performed using the CLUSTER Module of SYSTAT, Version 3 (Wilkinson 1987).

Two essentially different bodies of data, differing in structure, content and research intent were analyzed in this study using cluster analysis. The first of these bodies of data consisted of raw data scores for individual rings on the distribution of the volume, size and number of rocks *per* quadrant about the perimeter. These three separate data sub-sets were analyzed using cluster analysis to discern relative patterns in the loading of perimeter elements. The second body of data consisted of a single data set of component loadings derived from a principal components analysis of the average distance to perimeter rocks *per* sedecant as outlined previously. These data were analyzed twice using two different forms of cluster analysis in order to derive relative patterns in the size and shape of the perimeter of tent rings. In all, five different cluster analyses were conducted.

Since the intent of the analyses of the volume of rock *per* quadrant, the size of rock *per* quadrant and the number of rocks *per* quadrant was to isolate differential loading patterns, all three data sub-sets were analyzed using the same procedures. The similarity measure selected for these analyses was 1-Pearson's Product Moment Correlation Coefficient. This distance metric is most sensitive to changes in the form of a profile and least sensitive to changes in scale (Lorr 1983:35-36). The intention of these analyses was to identify similar patterns in the differential loading of perimeter elements. Consequently it was most suitable to examine these relationships using an algorithm sensitive to pattern and insensitive to scale.

The clustering method employed in these analyses was complete linkage. Complete linkage as a joining algorithm tends to produce clusters which are globular and compact and consist of cases which are very similar in character to all other members of the cluster (Aldenderfer and Blashfield 1984:40). As a clustering technique, complete linkage may be regarded as generally more rigorous than single linkage (ibid:40) while at the same time being more "admissable" than average linkage (Wikinson 1987:4).

It is possible for cluster analysis to create ranked, hierarchical arrangements in data where little real structure actually exists (Vierra and Carlson 1981). To ensure that structure was not being imposed, a visual examination of a correlation matrix of all cases against all other cases for a high proportion of low correlations is usually sufficient. Examination of the three correlation matrices associated with these analyses (not reproduced here) indicated a high proportion of moderate to high correlations. Consequently it was safe to assume that there was a reasonable degree of internal structure in all three of these data sub-sets and that cluster analysis had a reasonable and realistic chance of grouping that variability.

The first examined product of the three cluster analyses were the fusion coefficients. Fusion coefficients are relative measures of relationship between joined entities. Since a fusion coefficient is associated with each merger of clusters or entities (a fusion), the number of fusion coefficients for any analysis consisting of *n* entities will equal n-1. The fusion coefficients for these three analyses are presented in Table 6.

Since data structure pertaining to preferential weight loading in specific quadrants was anticipated, a maximum number of nine or fewer possible clusters was expected. These nine hypothetically conceivable clusters, consisting of heaviest loadings in each of the eight octants and a ninth possible distribution with no heavy quadrant, formed a guide to the maximum number of clusters likely in these samples. Nine clusters were regarded as a hypothetical maximum, the actual number encountered in each analysis was expected to be substantially less.

A commonly used heuristic technique for the extrapolation of the number of naturally occurring clusters in data is to graph the number of clusters on the y axis of a graph against the fusion coefficients associated with each merger on the x axis. Called a "scree plot" (Aldenderfer and Blashfield 1984:54), the objective of this graph is to identify marked flattenings in the slope of the line. Such a flattening indicates that two relatively dis-similar entities have been fused. The merging of dis-similar entities is a strong indication that natural cluster boundaries have been exceeded. Due to the previously mentioned anticipated number of clusters in these analyses, flattening was expected to occur at some point after nine.

Table 6: Fusion Coefficients.

NUMBER OF CLUSTERS	FUSION COEFFICIENTS				
	PER QUADRANT			DISTANCE PER SEDECANT	
	NUMBER	SIZE	VOLUME	PEARSON	EUCLID
1	1.957	1.929	1.905	1.995	2.837
2	1.936	1.916	1.837	1.990	2.598
3	1.656	1.846	1.714	1.849	2.397
4	1.483	1.632	1.427	1.287*	2.281
5	1.347	1.469	1.147	1.213	2.013
6	1.135*	0.999*	1.031	1.187	1.853
7	1.088	1.964	0.693*	0.844	1.840
8	0.979	0.799	0.677	0.773	1.547*
9	0.917	0.775	0.642	0.771	1.448
10	0.753	0.734	0.601	0.490	1.434
11	0.637	0.660	0.526	0.465	1.350
12	0.619	0.623	0.457	0.404	1.200
13	0.583	0.614	0.437	0.355	1.192
14	0.549	0.584	0.344	0.308	1.165
15	0.546	0.565	0.313	0.282	1.104
16	0.479	0.522	0.301	0.227	0.946
17	0.449	0.519	0.260	0.172	0.858
18	0.437	0.400	0.251	0.146	0.852
19	0.414	0.396	0.213	0.136	0.839
20	0.380	0.390	0.206	0.118	0.835
21	0.367	0.379	0.178	0.108	0.822
22	0.315	0.375	0.177	0.098	0.816
23	0.310	0.295	0.168	0.089	0.800
24	0.266	0.249	0.121	0.086	0.774
25	0.257	0.243	0.117	0.084	0.737
26	0.240	0.243		0.073	0.735
27	0.227	0.242		0.066	0.716
28	0.219	0.241		0.056	0.661
29	0.187	0.238		0.043	0.623
30	0.181	0.219		0.041	0.602
31	0.181	0.210		0.034	0.543
32	0.166	0.181		0.032	0.519
33	0.152	0.179		0.030	0.480
34	0.150	0.150		0.030	0.464
35	0.126	0.131		0.028	0.417
36	0.102	0.118		0.023	0.406
37	0.092	0.118		0.023	0.390
38	0.085	0.101		0.010	0.279
39	0.078	0.101		0.017	0.268
40	0.060	0.096		0.014	0.263
41	0.056	0.072		0.007	0.214
42	0.054	0.047		0.006	0.177
43	0.024	0.040		0.003	0.140

* *Denotes the number of clusters selected.*

Examination of scree plots produced from the volume *per* quadrant data in Table 6 indicated a distinct flattening at the seven cluster point in the analysis. Similarly, a definite point of inflection can be recognized at the six cluster level in the analysis of size of rock *per* quadrant. In the analysis of number of rocks *per* quadrant, the scree plot did not exhibit a definite break in slope. Flattening can be observed at the eleven cluster solution and the curve became essentially flat at the six cluster point. Either point would be a defensible break. Since a solution of less than nine clusters was logically anticipated, the six cluster solution was selected.

The clear inflectionary points in the scree plots for volume and size of rock *per* quadrant indicate that relatively distinct clusters have been identified at these points. Any additional merging would therefore be inappropriate. The relatively featureless curving of the scree plot for the fusion scores of the number of rocks *per* quadrant analysis indicated that strong 'natural' clusters may not exist in these data. The lack of these inflection points in this particular analysis was not particularly surprising. The number of rocks *per* quadrant was found to be the poorest predictor of weight distribution of the three variables examined in these analyses. Consequently, the number of rocks *per* quadrant likely encompasses a higher level of randomness in its distribution than do volume and size. A low level of structure in the data will result in scree plots with relatively constant slopes.

In light of the relatively successful analyses of the volume and size of rock *per* quadrant, the failure of the cluster analysis of the number of rocks *per* quadrant to isolate clearly defined data groupings indicated that the number of rocks *per* quadrant is a poor proxy measure of the weight of rock *per* quadrant. Consequently, an independent comparison of the volume of rock and number of rocks *per* quadrant was made. A linear regression of the volume of rock against the number of rocks *per* quadrant was carried out using the available data. With n=208, a very low correlation coefficient of r=0.167 was determined. Such a low correlation indicated the number of rocks *per* quadrant was a very poor proxy measure. Consequently, the clusters constructed by the number of rocks *per* quadrant analysis were not used in subsequent discussions.

The cluster analyses of the size and shape of tent ring perimeters were conducted in a somewhat different fashion. Instead of analyzing the original variables, these analyses were conducted using component scores derived from the previously described PCA. This analysis, conducted upon the average distance to perimeter rocks *per* sedecant, yielded four components which accounted for in excess of 80 percent of the variability in the sample. Use of these component scores instead of the raw variables themselves should reduce the effect of random, uncorrelated or stochastic variation upon the outcome of the cluster analyses.

Since the intention in this study was to identify patterns in both the size and shape of tent rings, two separate cluster analyses were conducted using the component scores data. Two different similarity coefficients were chosen for these analyses upon the basis of their unique properties. In order to isolate patterns in the shape of the perimeter of tent rings, 1-Pearson's Product Moment correlation coefficient was selected. As discussed previously, this distance measure is most sensitive to similarities in the shape of profiles and least sensitive to fluctuations in size. In order to isolate patterns in the size of the perimeter of tent rings, Euclidean Distance was selected as the similarity measure. This distance measure is most sensitive to changes in the shape of case profiles and is least sensitive to changes in form.

Both the size and shape analyses were conducted using the same linkage method. Since compact clusters with very similar membership characteristics were desired in each of these analyses, complete linkage was the joining algorithm employed.

Fusion coefficients from these analyses are presented in Table 6. Examination of a scree plot produced from the fusion scores of the shape analysis (Pearson's) indicates a marked flattening at the four cluster solution. Other minor flattenings occur at the seven and ten cluster solutions.

Since the four cluster point was the most strongly inflected, a four cluster solution was selected.

Examination of a scree plot produced from the fusion scores of the size analysis (Euclidean Distance) indicated a more poorly inflected slope with a small flattening visible at the eight cluster mark. Although not a distinctive change in slope, the eight cluster solution was chosen as the only likely break.

The relatively smooth curving of the scree plot associated with the size analysis may indicate that the relative size of tent ring perimeters is not 'naturally' assorted into groups. Instead, the size of rings may represent a clinal distribution which the cluster analysis has arbitrarily partitioned. In other words, it is possible that tent ring size forms a continuous distribution, from small to large, with no apparent breaks in between classes.

Once the decision regarding the target number of clusters had been made for each of the five analyses, each cluster analysis was re-run using the same algorithms, with the desired number of clusters selected. Cluster memberships for each tent ring were recorded and coupled to the original data from which the cluster had been derived.

Postulated cluster memberships for each feature for each of the five cluster analyses are summarized in Table 7.

Table 7: Cluster Memberships for Five Clusters.

CLUSTER MEMBERSHIPS						
FEATURE		VOLUME	SIZE	NUMBER	DISTANCE SHAPE	DISTANCE SIZE
QKHL 5	1		SE	SE-E	4	6
QKHL 5	2		SE	SE-E	3	6
QKHL 5	3		SE	SE-E	3	5
QKHL 66	1		NW-N	N	3	2
QKHN 12	4		SE	N	1	8
QKHN 12	6		W-SW	NW-W	1	5
QKHN 12	7		S-SW	SE-E	1	8
QKHN 12	10		NONE	N	2	8
QKHN 13	1	N-NE	NONE	NE-N	3	6
QKHN 13	2	E	NONE	NE-N	3	5
QKHN 13	4		W-SW	NE-N	4	6
QKHN 13	5	N-NE	NW-N	N	4	7
QKHN 13	8	SE	S	SW-S	4	6
QKHN 13	9	SE	SE	W	3	3
QKHN 13	11	E	NONE	W	1	1
QKHN 13	14		W-SW	SW-S	4	6
QKHN 13	16	W-SW	NONE	NE-N	3	6
QKHN 17	1		NONE	SW-S	4	6
QKHN 17	3		S-SW	N	4	7
QKHN 17	4		S-SW	N	3	6
QKHN 22	8		S-SW	N	2	4
QKHN 27	3	E	NONE	N	1	2
QKHN 27	6	N-NE	SE	SE-E	4	6
QKHN 27	7	S-SW	S-SW	NW-W	2	4
QKHN 27	8	SE	W-SW	SW-S	1	1
QKHN 27	12	N-NE	NONE	NE-N	4	6
QKHN 27	15		NONE	NE-N	2	4
QKHN 27	17		S	NW-W	4	1
QKHN 27	20	S-SW	S	SW-S	3	6
QKHN 27	21	E	SE	SE-E	1	2
QKHN 37	1		SE	SE-E	4	6
QKHN 38	2		W-SW	NW-W	3	3
QKHO 5	1	S-SW	S	SW-S	4	6
QKHO 5	2	W-SW	W-SW	SW-S	2	4
RCHH 1	46	W-SW	NONE	NE-N	1	2
RCHH 1	47	NONE	NW-N	NE-N	3	5
RCHH 1	48	E	NONE	NE-N	2	2
RCHH 1	53	S-SW	W-SW	SW-S	3	6
RCHH 1	58	S-SW	S-SW	SW-S	3	5
SKRUIS POINT	1	S	S	SW-S	4	2
SKRUIS POINT	2	S	S	SE-E	2	4
SKRUIS POINT	3	E	SE	SE-E	1	2
SKRUIS POINT	4	NONE	NW-N	N	2	2
SKRUIS POINT	5	W-SW	W-SW	SW-S	1	1

Tables summarizing the relevant mean variable scores for each analysis were produced (Tables 8 to 12) as were rose charts for the same data (Figures 9 to 13).

Table 8: Percentage Mean Volume of Perimeter Rocks *per* Quadrant for Seven Clusters.

PERCENTAGE MEAN VOLUME PER QUADRANT FOR SEVEN CLUSTERS										
	CLUSTER		QUADRANT							
#	NAME	CASES	N	NE	E	SE	S	SW	W	NW
1	N-NE	4	38%	33%	26%	26%	15%	22%	22%	23%
2	E	6	17%	37%	43%	34%	19%	20%	21%	14%
3	W-SW	4	26%	27%	20%	15%	15%	37%	39%	21%
4	SE	3	12%	16%	35%	39%	23%	22%	30%	23%
5	S-SW	5	24%	16%	15%	25%	33%	33%	28%	26%
6	NONE	2	32%	20%	25%	24%	21%	26%	22%	30%
7	S	2	21%	32%	23%	25%	38%	30%	18%	13%

Table 9: Percentage Mean Size of Perimeter Rocks *per* Quadrant for Six Clusters.

PERCENTAGE MEAN SIZE PER QUADRANT FOR SIX CLUSTERS										
	CLUSTER		QUADRANT							
#	NAME	CASES	N	NE	E	SE	S	SW	W	NW
1	SE	9	25%	27%	30%	34%	30%	18%	15%	20%
2	NW-N	4	40%	26%	17%	17%	18%	22%	25%	40%
3	NONE	11	27%	32%	28%	22%	15%	26%	29%	21%
4	W-SW	8	21%	19%	22%	21%	24%	31%	33%	29%
5	S-SW	6	28%	28%	15%	21%	33%	27%	24%	24%
6	S	6	21%	21%	21%	28%	35%	31%	23%	20%

Table 10: Percentage Mean Number of Perimeter Rocks *per* Quadrant for Six Clusters.

PERCENTAGE MEAN NUMBER PER QUADRANT FOR SIX CLUSTERS										
	CLUSTER		QUADRANT							
#	NAME	CASES	N	NE	E	SE	S	SW	W	NW
1	SE-E	9	22%	27%	34%	36%	30%	19%	14%	18%
2	N	9	38%	31%	19%	19%	22%	21%	21%	28%
3	NW-N	4	25%	20%	17%	21%	26%	24%	32%	36%
4	NE-N	9	29%	32%	28%	20%	16%	26%	27%	21%
5	W	2	12%	20%	31%	29%	21%	29%	37%	23%
6	SW-S	11	20%	19%	17%	25%	33%	35%	30%	20%

Table 11: Mean Distance to Perimeter Rocks *per* Sedecant for Four Clusters Based on Pearson's Distance.

MEAN DISTANCE TO PERIMETER ROCKS PER SEDECANT FOR FOUR CLUSTERS BASED UPON COMPONENT SCORES (PEARSON'S DISTANCE) (Distances measured in meters)				
SEDECANT	CLUSTER			
	1	2	3	4
F	1.56	1.82	1.82	1.48
FFR	1.75	1.69	1.81	1.60
FR	1.94	1.75	1.78	1.64
RFR	2.06	1.76	1.65	1.67
R	1.78	1.83	1.75	1.87
RBR	1.73	1.40	1.79	2.00
BR	1.55	1.42	1.82	2.05
BBR	1.53	1.59	1.72	2.09
B	1.66	1.68	1.83	1.85
BBL	1.74	1.79	1.80	1.74
BL	1.54	1.83	1.71	1.78
LBL	1.50	1.97	1.48	1.97
L	1.61	2.02	1.48	1.83
LFL	1.48	1.58	1.62	1.90
FL	1.26	1.64	1.69	1.72
FFL	1.34	1.58	2.02	1.58
MEAN	1.63	1.71	1.74	1.80
# OF CASES	10	8	13	13

Table 12: Mean Distance to Perimeter Rocks *per* Sedecant for Eight Clusters Based on Pearson's Distance.

MEAN DISTANCE TO PERIMETER ROCKS PER SEDECANT FOR EIGHT CLUSTERS BASED UPON COMPONENT SCORES (EUCLIDEAN DISTANCE) (Distances measured in meters)

SEDECANT	CLUSTER							
	1	2	3	4	5	6	7	8
F	0.86	1.62	1.81	1.82	1.80	1.64	1.62	2.44
FFR	1.35	1.70	1.88	1.64	1.91	1.59	1.81	2.54
FR	1.32	1.87	1.58	1.64	1.85	1.58	2.28	2.91
RFR	1.34	1.91	1.70	1.66	1.89	1.46	2.73	2.83
R	1.05	1.83	1.62	1.67	1.83	1.73	2.93	2.71
RBR	1.16	1.78	1.41	1.23	1.89	1.85	2.82	2.39
BR	1.04	1.59	1.27	1.25	1.99	1.96	2.85	2.31
BBR	1.11	1.54	1.15	1.47	2.03	1.90	2.73	2.42
B	1.21	1.44	1.97	1.64	1.85	1.81	2.59	2.76
BBL	0.95	1.59	1.75	1.79	1.84	1.78	2.31	2.83
BL	1.10	1.34	1.66	1.91	1.36	1.84	2.29	2.81
LBL	1.00	1.52	1.45	1.92	1.07	1.88	2.52	2.65
L	1.17	1.49	1.36	1.92	1.19	1.75	2.57	2.88
LFL	1.38	1.39	1.57	1.95	1.38	1.67	3.41	2.12
FL	1.04	1.37	1.92	1.65	1.49	1.62	2.39	2.14
FFL	0.72	1.42	2.39	1.54	1.99	1.74	1.82	2.36
MEAN	1.11	1.59	1.66	1.67	1.71	1.74	2.48	2.57
NUMBER	4	9	2	5	4	15	2	3

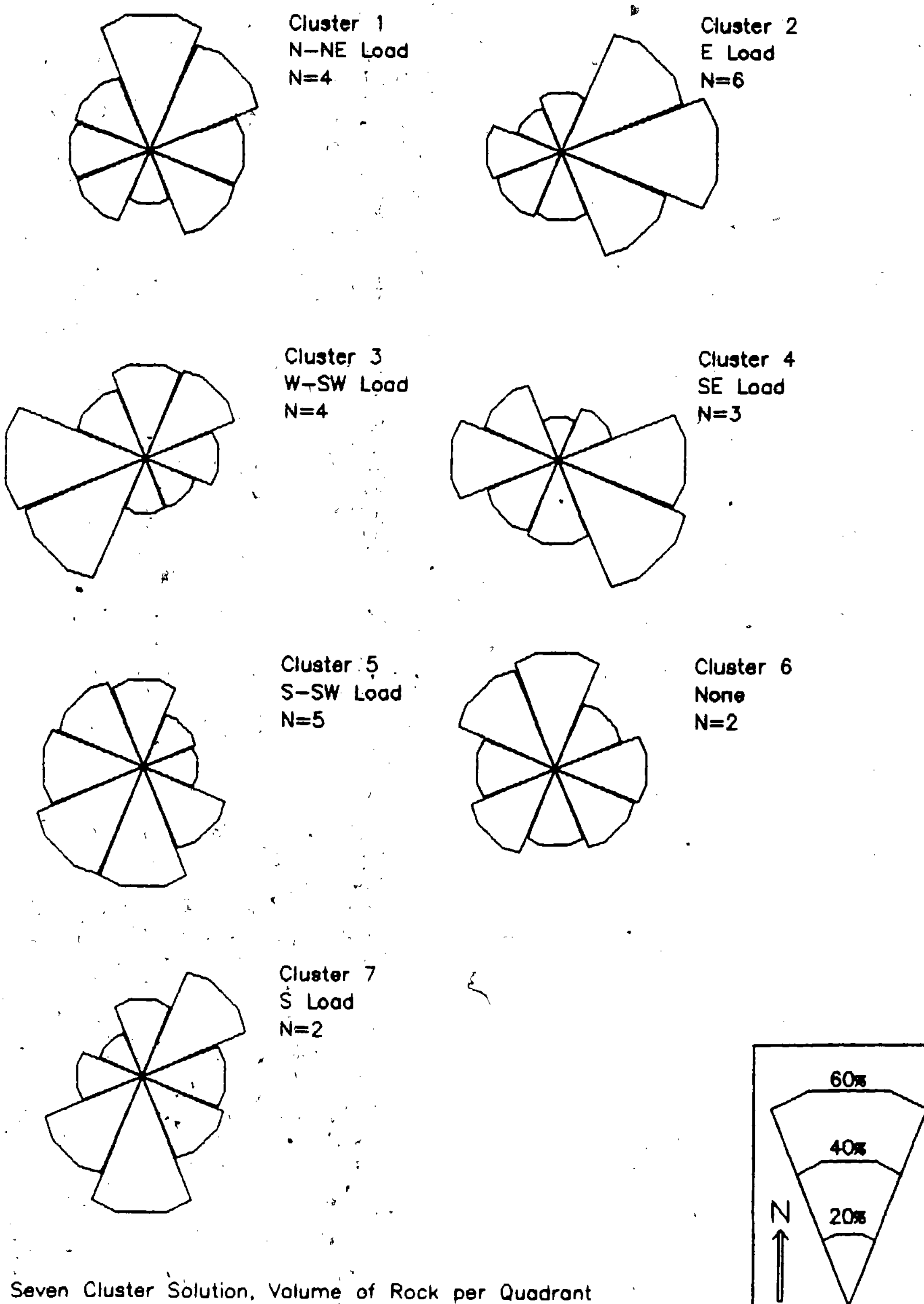


Figure 9: Seven Cluster Solution, Volume of Rock per Quadrant

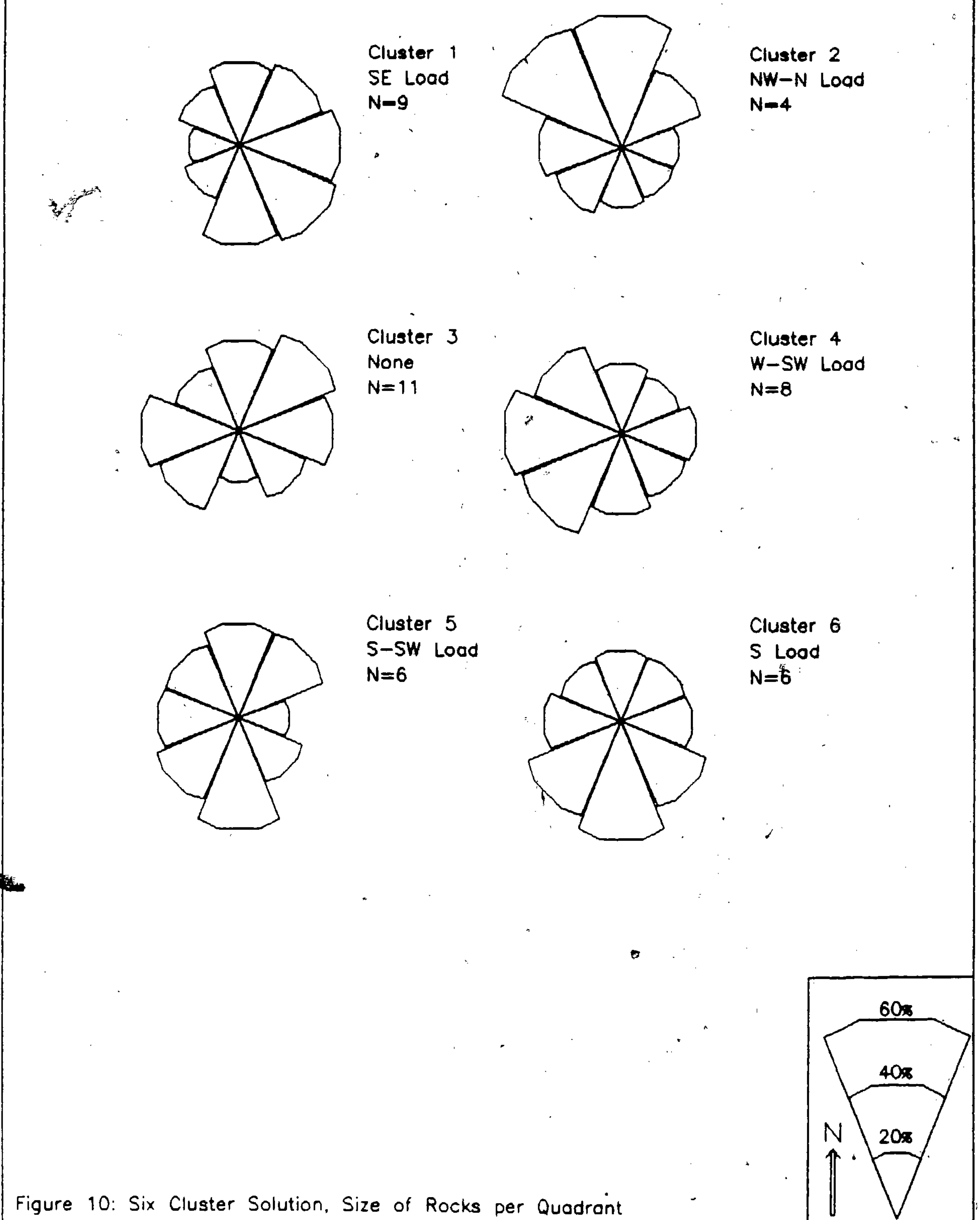


Figure 10: Six Cluster Solution, Size of Rocks per Quadrant

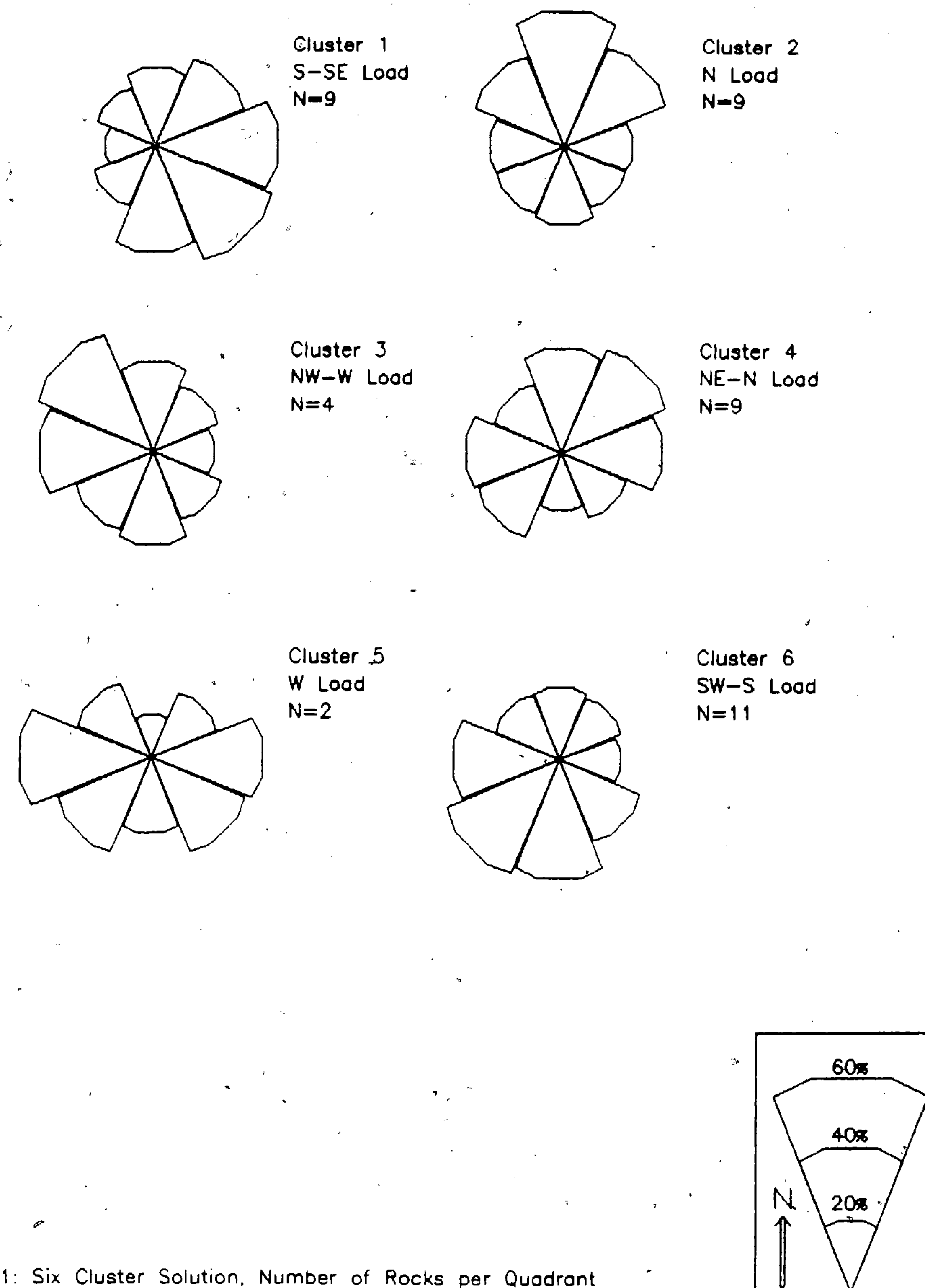


Figure 11: Six Cluster Solution, Number of Rocks per Quadrant

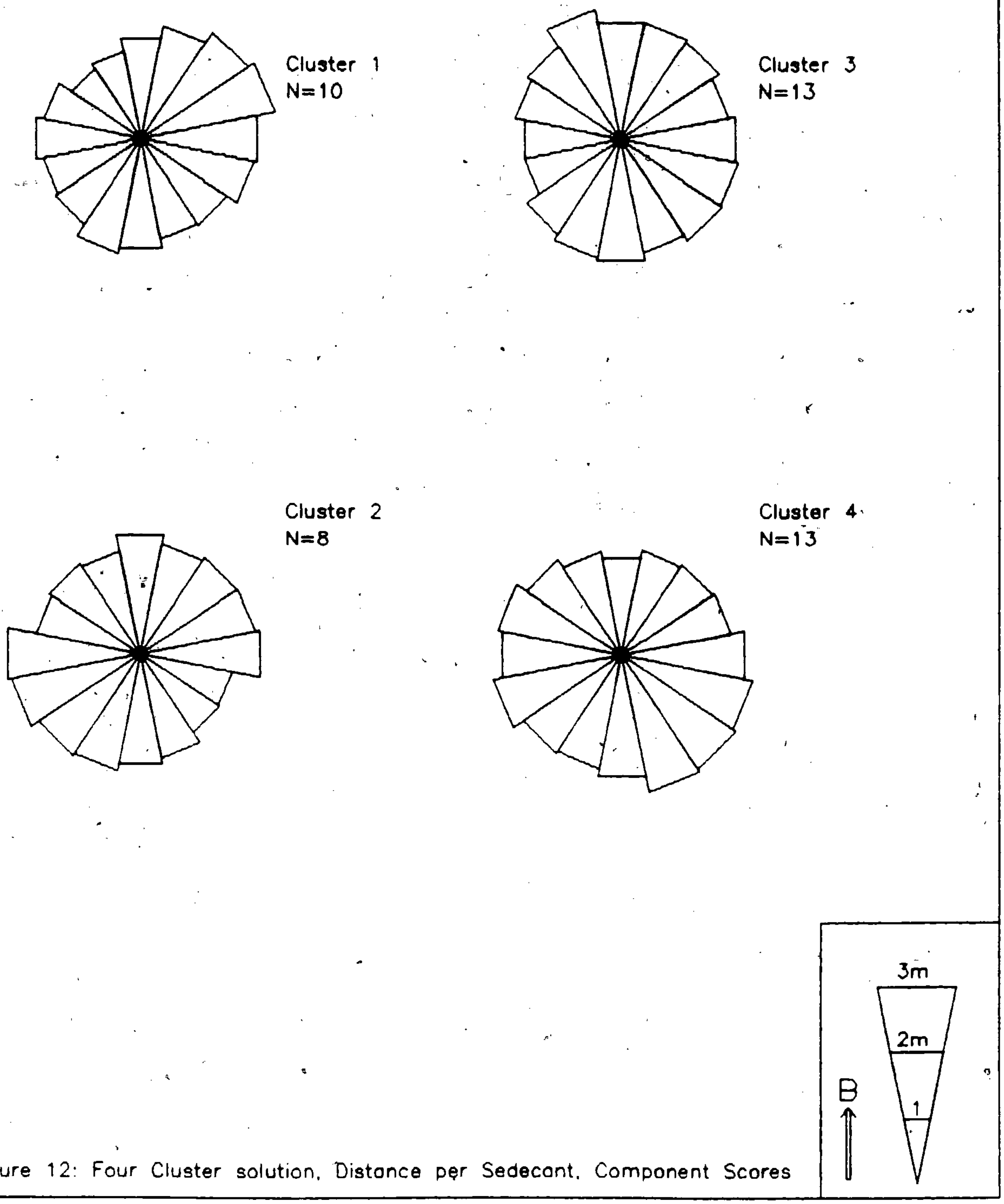


Figure 12: Four Cluster solution, Distance per Sedecant, Component Scores

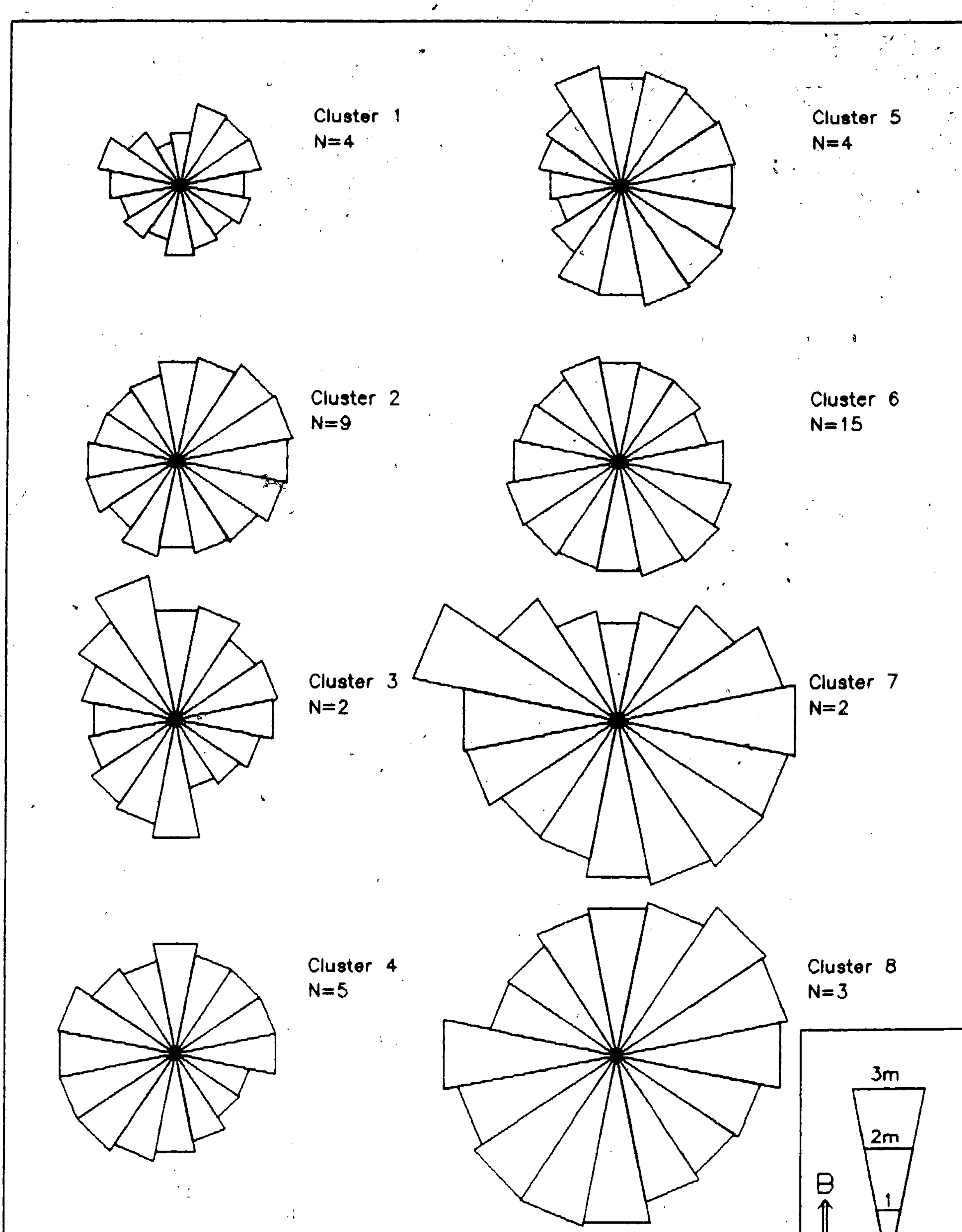


Figure 13: Eight Cluster solution, Distance per Sedecant, Component Scores

In Tables 7 to 10, clusters were assigned a name to reflect the inferred loading strategy. The concentration of one third of the perimeter rock in a single quadrant of the perimeter was deemed of sufficient magnitude to reflect a preferred loading strategy. Any quadrants with a mean value of greater than or equal to thirty-three percent of the total load for that cluster were designated as the name of that cluster. If two quadrants exceeded thirty-three percent and the lesser value was within five percent of the greater value, then both quadrants were incorporated in the cluster name. Any cluster with no recorded quadrant values exceeding thirty-three percent was named "None" to reflect the lack of any perceived preferential loading pattern. The use of cluster names, rather than cluster numbers, permitted easier comparison of results between cluster analyses.

Summary

Five separate cluster analyses, conducted on four different data sets were described in the preceding section. Three of these analyses were directed towards the recognition of patterns in the relative rock loadings about the perimeter of the tent ring. These analyses used the volume, size and number of rocks about the perimeter data sets. Each analysis was conducted using 1-Pearson's Product Moment correlation coefficient as the distance metric and complete linkage as the joining algorithm.

Two cluster analyses were conducted on the four component scores derived from the principal components analaysis of distance to perimeter rocks *per* sedecant oriented to beach discussed earlier in this chapter. The first cluster analysis of these data, directed towards the isolation of patterns of shape in perimeter form, used 1-Pearson's product moment correlation coefficient and complete linkage. The second cluster analysis of these data, directed towards the isolation of patterns of size in perimeter form, used euclidean distance and complete linkage to derive clusters.

The fusion scores from these analyses are presented in Table 6. Examination of these fusion scores led to the identification of an optimal number of clusters for each variable set (indicated on Table 6 by an asterisk). Cluster memberships for each analysis and for each tent ring are reported in Table 7 while relevant mean variable scores for each analysis are reported in Tables 8 to 12.

CHAPTER 6

SUMMARY AND DISCUSSION

The goal of this chapter is to provide a brief and general summary of the extent of variability existing in this sample of tent rings and a more detailed discussion of the meaning of that variability. The findings of the previous analyses are briefly recapitulated and discussed in terms of the associated environmental and culture-historical context. Individual features are tentatively attributed to specific seasonal periods and arguments for the possible contemporaneity of certain pairs of features are made. Additionally, the relationship between the size and shape of the analyzed tent rings and their cultural-historical setting is explored.

6.1 Summary

Descriptive typologies of tent ring morphology have been in existence for at least two decades. These largely subjective classificatory schemes have been employed with varying degrees of success by different High Arctic researchers throughout this period (see McGhee 1976; Plumet 1981; Maxwell 1988; Schledermann and McCullough 1988). In general terms, older classificatory systems focussed upon the feature as a temporal and cultural diagnostic. More recent interpretations have attempted to account for observed variability in terms of seasonal patterns of use.

As an example of the former, McGhee (1976, 1978, 1979) outlined the following broad scheme of chronological classification for High Arctic tent rings. Independence I features are described as "mid-passage" structures, often with poorly defined or non-existant perimeter rings (1976:25). Pre-Dorset tent rings are described as round or circular tent remains without evident mid-passages (1976:26). Independence II features are described as rectangular mid-passage structures with box-shaped hearths and well-defined perimeter rings (1976:27-28). Late Dorset tent rings are described as well-formed rectangular mid-passage structures with hearths (1976:28). Possible seasonal differences in feature construction were acknowledged by McGhee (1979:125) but these differences were not pursued.

Schledermann and McCullough (1988) and Maxwell (1988) presented a somewhat different interpretation of variability in Paleoeskimo tent rings. They recognize much higher levels of architectural diversity within cultural complexes, and describe this variability as a function of seasonal differences. In particular, Schledermann and McCullough have linked the existence of large and substantial tent rings and slab-lined axial features with fall habitations (1988:22). Smaller, more poorly defined features were presumably the result of shorter term spring and summer occupations. As corroborative evidence for this view, Schledermann and McCullough cite the preferential location of these more massive features in sheltered locales with south facing exposures (1988:18), the relatively small quantities of deposited lithic materials (1988:19), and the few associated meat caches (1988:19-20).

Recent research has shed considerable doubt on the linear axial feature as a cultural diagnostic. Plumet (1981), Maxwell (1988) and Helmer (1987d, 1988) have all disputed the diagnostic nature of the "mid-passage". No longer associated only with Independence I, Independence II and Dorset, the linear axial feature is now associated with Pre-Dorset assemblages as well (Helmer 1988:8). Schledermann and McCullough attribute such features to Sarqaq as well (1988:21).

Cultural-Temporal Groupings

Subjective visual examination of the tent ring plots provided in Appendix B (Figures B1 to B11), coupled with summary information provided in Chapter 4 and Appendix A demonstrated that certain similarities exist in the form of these tent rings and that these similarities could be correlated with the associated cultural complexes.

The single feature assigned to the Early Pre-Dorset Far Site Complex is relatively large and is constructed from a high number of larger than average sized stones. The tent ring perimeter is fairly well defined and continuous. The interior area of this feature is somewhat confused and there is little evidence of linearity in the arrangement of these internal stones.

The eight tent rings assigned to the Early Pre-Dorset Icebreaker Beach Complex tend to be relatively large and are constructed from a large number of reasonably large stones. Perimeters are generally well formed, roughly circular, and both linear and more confused interior features are noted.

The thirteen tent rings associated with the Middle Pre-Dorset Twin Ponds Complex are generally large, and are constructed of relatively fewer and smaller stones than are noted in earlier tent rings. Perimeters tend to be ovate and are usually well defined. Linear, circular and more confused internal features are noted.

The fourteen tent rings associated with the Late Pre-Dorset Rocky Point Complex are generally small and poorly defined. These features are characterized by confused perimeters constructed of relatively large numbers of relatively small stones. Interiors are equally confused with no definite indications of intentionally constructed internal features. Overall, Rocky Point Complex tent rings are best characterized as circular boulder scatters.

The three tent rings assigned to the Transitional Dorset Cape Hardy Complex are particularily distinctive in appearance. Feature perimeters are very poorly defined, intermittent and extremely lightly rocked. Strongly developed linear internal features are present in all examples.

The five tent rings associated with the Late Dorset Lethbridge Complex are also very distinctive in appearance. These features have well developed, relatively large, sub-rectangular perimeters composed of fewer and relatively smaller stones than are common in older features. No internal features were recognized in these tent rings.

These informal groupings, which seem to conform to the established cultural chronology for the region, also agree to a certain extent with the postulated tent ring forms included in the list of "Distinctive Characteristics" enumerated by McGhee (1976:25). However, there are distinct differences as well. In particular, linear axial features are clearly associated, not just with the Independence I and II related Far Site and Cape Hardy Complexes, but with the Pre-Dorset related Icebreaker Beach, Twin Pond and Rocky Point Complexes as well. In fact, the only cultural complex not associated in this study with linear axial features is the Late Dorset Lethbridge Complex.

Although these groupings suggest that general trends in the development of tent ring morphology can be observed through time, an alternative explanation for this variability is also possible.

Seasonal Settlement Groupings

Particularily exposed site locations, like the Skruis and Rocky Point areas, show very strong similarities in tent ring morphology. Features tend to be small, roughly circular boulder scatters with poorly defined perimeters constructed of small rocks. Interiors tend to contain large quantities of rock which are usually not arranged in any recognizable fashion.

Somewhat more sheltered site areas, like the Field School, Far, Hind, Lee Point and Icebreaker Beach locales, are characterized by features with larger and better defined perimeters which are composed of somewhat larger stones. Internal features within these tent rings are much better defined, and may consist of linear axial features, small circular hearths or confused jumbles of rock.

Extremely well sheltered site locations, like the Twin Ponds, Tote Road and Icy Bay areas, are characterized by large features constructed from particularly large numbers of large rocks. Perimeters are generally massive, and there is usually a considerable quantity of internal rock. Well defined interior linear axial features, as well as more confused masses of internal stone are noted.

Following Maxwell (1988) and Schledermann and McCullough (1988), the tent rings with massive perimeters and well developed linear internal features are suggested to represent the remains of late summer or fall habitations. Smaller, less well formed features may represent short-term spring or summer occupations. Although such interpretations are subjective and currently unverifiable, they do provide the beginnings of an hypothesized seasonal interpretive framework against which the results of the previously described statistical analyses can be compared.

6.2 Rock Distributional Patterns

The differential distribution of three variables; volume of rock *per* quadrant, size of rock *per* quadrant and number of rocks *per* quadrant, were analyzed using cluster analysis to define groupings of similar patterns of preferential rock loadings. These patterns of rock loading were expected to shed light on questions of seasonality and contemporaneity specific to the Jones Sound tent ring data and DIAP research goals.

The analyses of the volume and the size of rock *per* quadrant were successful in identifying well defined natural data clusters. Unaccountably, examination of Table 7 indicated a relatively poor correspondence between the cluster memberships assigned by these two analyses. In fifteen of twenty-six possible comparisons, the assigned cluster names significantly disagree regarding the preferential rock loading pattern of individual features. While some disagreement in cluster groupings was expected, the magnitude of disagreement was surprising in light of the results of the linear regression analyses discussed earlier. These linear regression analyses suggested that the two subject variables were strongly correlated. Closer examination of Table 7 indicated that the bulk of the disagreements pertained to the assignment of clusters with no preferential directional loadings (those labelled as "None" in Tables 7, 8 and 9). This indicated that the size of rock *per* quadrant loses predictive accuracy in cases where weak or ambiguous loading patterns were encountered.

As discussed earlier, cluster analysis using the number of rocks *per* octant yielded ambiguous results and was consequently not utilized in the following discussions.

Seasonality

The determination of the seasonality of occupation of individual tent rings in the High Arctic has often been a difficult problem. Although faunal samples from excavated Paleoeskimo sites are often large and well preserved, and many utilized species exhibit seasonal patterns of birth, growth or abundance, the frequent long-term storage of foodstuffs and the common recycling of osteological materials for tool production makes the assignment of seasonal affiliations difficult and only marginally reliable (Maxwell 1988). Nevertheless, there appears to be a general lack of evidence for winter period Paleoeskimo habitations in the eastern Canadian High Arctic. This lack has been interpreted by archaeologists in two different ways.

Due to the poor evidence for dogs and specialized sea-ice hunting equipment in early and middle ASTt sites, both necessary requisites for successful breathing hole sealing, Knuth (1963), Maxwell (1988) and McGhee (1976, 1978) have argued that Paleoeskimo peoples subsisted through the winter months upon stored foodstuffs gathered during the summer. In particular, Maxwell (1988:64) has used the phrase "virtual somnolent state" to describe the hibernation-like existence these have researchers suggested. The weak existing evidence for seal-oil lamps and snow-knives in earlier Paleoeskimo contexts is used to negate the possible use of snowhouses and, without snowhouses to live in and the technology to hunt with, it would have been impossible for Paleoeskimo people to survive on the sea ice for any length of time.

Other researchers (Gulov 1986; Schledermann and McCullough 1988; Mary-Rousseliere 1976) have suggested that the general lack of definitely identified Paleoeskimo winter sites is due simply to the fact that such sites were located on the sea-ice. Schledermann and McCullough point out that the quantity of cultural detritus found at suggested Paleoeskimo winter sites is relatively minor and that a long-term occupation would almost certainly create much more material residue. The extreme scarcity of meat caches in association with Paleoeskimo campsites can be used as a corroborating argument for this view. Recent documentation of finds of soapstone lamp fragments in Pre-Dorset context (Mary-Rousseliere 1976; Maxwell 1988) and in Sarqaq assemblages (Gullov 1986) have led Schledermann and McCullough to suggest that "temporary snow house camps on the sea-ice likely provided the primary winter shelters for peoples of the early ASTt complexes" (1988:22).

It seems entirely unlikely that Paleoeskimo people could have survived an entire winter living in a small tent, burning stored fuel and eating stored food as Knuth (1963), Maxwell (1988) and McGhee (1976, 1978) have suggested. There is very little fuel of any kind available in the high arctic and what little exists was likely used for the fabrication of various necessary tools. The inhabitants may have burned blubber or seal oil, but burning this potential food material would have made the acquisition and storage problems of summer even more acute. Consequently, it seems likely that Paleoeskimo people were living on the sea-ice throughout much if not all of the winter.

Faunal Evidence

Ongoing examination of faunal assemblages collected by the DIAP project in the Jones Sound area provides some support for this interpretation. No definite evidence for any peak winter period occupations has been identified (McCartney, personal communication). At the same time, some definite indications of early summer, mid-summer and late summer occupations have been noted.

Small seals (*Phoca hispida* and *Phoca groenlandicus*) are the dominant species represented in all excavated features, accounting for more than ninety-five percent of the total number of identifiable elements in all assemblages. These faunal collections are all characterized by high levels of similarity between sites regardless of location or cultural-temporal affiliations. In spite of this remarkable level of homogeneity, the following tentative suggestions of seasonal affiliation can be made (McCartney, personal communication).

Although derived from a somewhat limited sample, the presence of immature seal remains in the faunal assemblages from Feature 15 at QkHn-27 (Rocky Point) may indicate a spring to early summer affiliation. The much larger faunal collection from Feature 17 at this same site also contains quantities of juvenile small seal bone indicating an early summer occupation. The existence of small quantities of immature arctic hare (*Lepus arcticus*) found in association with Feature 6 at QkHn-12 suggests a mid-summer occupation for this feature (Bertulli and Strahlendorf 1984). Examination of excavated faunal material from randomly located units in the immediate site area show evidence of a large but seasonally mixed faunal assemblage. The presence of fish (*Salvelinus*) and migratory bird bones (*Anseriformes*), and relatively large quantities of terrestrial ungulate bone, in association with Features 1, 2, 4 and 14 at QkHn-13 (Icebreaker Beach), suggests that these features may constitute a peak summer habitation (Helmer 1987b). Although highly fragmentary in nature, large faunal samples were recovered from Features 1, 3 and 4 at QkHn-17 (Twin Ponds). Although analysis is still underway on this material, examination of seal teeth and other elements indicate a likely late summer occupation for all three of these features. Recovered faunal samples from Features 1 and 2 at QkHl-5 (Icy Bay), although scanty, have seal population characteristics which are consistent with a late summer seal harvest.

Volume of Rock *per* Quadrant

Cluster 1, representing a strong north to northeastern loading, may possibly indicate summer habitations although winter occupation can certainly not be ruled out. The frequency of north to northeastern winds is somewhat higher in summer but such winds will occur throughout the year. Cluster 1 is therefore treated as a seasonally ambiguous loading pattern and no suggestion of seasonality is made.

Cluster 2, representing very strong eastern loading is likely composed of summer to late summer occupations. Winds from the east are rare during the winter months but become increasingly more common as summer progresses.

Cluster 3, representing a strong west to southwestern rock loading pattern, is impossible to ascribe to a particular seasonal wind pattern. Western winds are most common during the winter months but are also very frequent during the summer months.

Cluster 4, representing a strong southeastern preferential rock loading pattern, almost certainly represents summer to late summer occupations. Southeastern winds are relatively rare in the study area and are normally associated with the cyclonic disturbances characteristic of late summer.

Cluster 5, a weak south to southwestern rock loading pattern, and Cluster 7, displaying a moderate southern rock loading pattern, most likely both represent late summer occupations. Southern winds are not expected to occur in the study area except in late summer when cyclonic disturbances are at their peak.

Cluster 6 does not display particularly heavy weight loading in any specific direction. Consequently no seasonal ascription is made for the members of this cluster.

In summary: it would appear that Features 1, 5 and 16 at QkHn-13, Features 6 and 12 at QkHn-27, Feature 2 at QkHo-5, Features 46 and 47 at RcHh-1 and Features 4 and 5 at the Skruis Point Site show patterns of rock loading which cannot provide effective insights into the season of occupation. Features 2 and 11 at QkHn-13, Features 3 and 21 at QkHn-27, Feature 48 at RcHh-1 and Feature 3 at the Skruis Point Site show patterns of preferential rock loading which are most consistent with the summer months. Features 8 and 9 at QkHn-13, Features 7, 8 and 20 at QkHn-27, Feature 1 at QkHo-5, Features 53 and 58 at RcHh-1 and Features 1 and 2 at the Skruis Point Site show patterns of preferential rock loading which are most consistent with occupation during the late summer. These results are tabulated in Table 13.

Size of Rock *per* Quadrant

Cluster 1, displaying a moderate southeastern rock loading pattern, likely represents late summer habitations. Southeastern winds are relatively rare in the study area and are normally only associated with the cyclonic disturbances characteristic of late summer.

Cluster 2, representing a strong northwest to northern loading pattern, can not be associated with any particular seasonal wind model. The frequency of northwestern and northern winds is somewhat higher in summer but such winds are known through out the seasonal cycle.

Cluster 3, displaying no indisputable preferential loading pattern, cannot be attributed to any particular seasonal period.

Cluster 4, displaying a moderate west to southwestern rock loading, cannot be attributed to any particular seasonal period. Western winds are the most common surface air-flows during the entire year and therefore no seasonal affiliation is preferred over any other for this cluster.

Cluster 5, displaying a moderate southern loading, and Cluster 6, displaying a moderate south to southwestern loading, likely both represent late summer habitations. The prevalence of strong southern *föhn* winds during late summer and their relative scarcity during other periods of the year makes this attribution very probable.

To summarize the seasonal affiliations suggested by the analysis of the size of rock *per* quadrant: Feature 1 at QkHl-66, Features 6 and 10 at QkHn-12, Features 1, 2, 4, 5, 11, 14, and 16 at QkHn-13, Features 3, 12, and 15 at QkHn-27, Feature 2 at QkHn-38, Feature 2 at QkHo-5, Features 46, 47, 48 and 53 at RcHh-1 and Features 4 and 5 at the Skruis Point Site show a pattern of rock loading which is not inconsistent with the wind distributions for any period of the year.

Table 13: Seasonal Affiliations Based on Volume and Size of Rock *per* Quadrant.

SEASONAL AFFILIATIONS			
FEATURE		SEASONALITY VOLUME	SIZE
QKHL 5	1		Late Summer
QKHL 5	2		Late Summer
QKHL 5	3		Late Summer
QKHL 66	1		Unknown
QKHN 12	4		Late Summer
QKHN 12	6		Unknown
QKHN 12	7		Late Summer
QKHN 12	10		Unknown
QKHN 13	1	Summer	Unknown
QKHN 13	2	Late Summer	Unknown
QKHN 13	4		Unknown
QKHN 13	5	Summer	Unknown
QKHN 13	8	Late Summer	Late Summer
QKHN 13	9	Late Summer	Late Summer
QKHN 13	11	Late Summer	Unknown
QKHN 13	14		Unknown
QKHN 13	16	Unknown	Unknown
QKHN 17	1		Unknown
QKHN 17	3		Late Summer
QKHN 17	4		Late Summer
QKHN 22	8		Late Summer
QKHN 27	3	Late Summer	Unknown
QKHN 27	6	Summer	Late Summer
QKHN 27	7	Late Summer	Late Summer
QKHN 27	8	Late Summer	Unknown
QKHN 27	12	Summer	Unknown
QKHN 27	15		Unknown
QKHN 27	17		Late Summer
QKHN 27	20	Late Summer	Late Summer
QKHN 27	21	Late Summer	Late Summer
QKHN 37	1		Late Summer
QKHN 38	2		Unknown
QKHO 5	1	Late Summer	Late Summer
QKHO 5	2	Unknown	Unknown
RCHH 1	46	Unknown	Unknown
RCHH 1	47	Unknown	Unknown
RCHH 1	48	Late Summer	Unknown
RCHH 1	53	Late Summer	Unknown
RCHH 1	58	Late Summer	Late Summer
SKRUIS POINT	1	Late Summer	Late Summer
SKRUIS POINT	2	Late Summer	Late Summer
SKRUIS POINT	3	Late Summer	Late Summer
SKRUIS POINT	4	Unknown	Unknown
SKRUIS POINT	5	Unknown	Unknown

Features 1, 2 and 3 at QkHl-5, Features 4 and 7 at QkHn-12, Features 8 and 9 at QkHn-13, Features 3 and 4 at QkHn-17, Feature 8 at QkHn-22, Features 6, 7, 8, 17, 20 and 21 at QkHn-27, Feature 1 at QkHn-37, Feature 1 at QkHo-5, Feature 58 at RcHh-1 and Features 1, 2 and 3 at the Skruis Point Site all exhibit a pattern of preferential rock loadings which are most consistent with wind directions encountered during the later summer months. These results are tabulated in Table 13.

Contradictions between the cluster assignments attributed to specific features by the two different cluster analyses do exist (see Table 7). Wherever such conflicts exist, the affiliation based upon the clusters created through the analysis of volume has been the preferred interpretation. Seasonal affiliations as derived from the volume of rock *per* quadrant and size of rock *per* quadrant are tabulated and presented in Table 13. Also presented in Table 3 are Seasonal affiliations for these features based upon other lines of evidence.

Contemporaneity and Seasonal Preferential Site Use

The prior discussion of weather patterns in the Jones Sound area indicates that there are certain patterns of directional wind flow which are most likely to occur at certain times of the year and which are unlikely to occur at other times. No particular wind direction may be eliminated as wholly impossible for any period of the year, however, certain wind patterns may be probabilistically associated with specific seasons.

The following section compares the rock loading patterns of specific features from individual sites. There are two goals in this comparison. Firstly, the possibility that specific features are contemporaneous. Secondly, the liklihood that specific sites represent examples of preferential seasonal site use.

The determination of the possible contemporaneity of individual features on a given site can be one of the most difficult problems for an archaeologist to resolve. Yet without such a determination, many complex questions concerning prehistoric social organization can be difficult to address. By comparing rock loading patterns between specific features which are, for one reason or another, suspected to represent contemporary occupations, this technique provides a simple negative test.

The suggestion that specific site locales represent areas which were preferentially used during specific parts of the annual cycle is currently of considerable interest to high arctic archaeologists. By looking for corroborative patterns in perimeter stone distributions, this technique provides a fast and inexpensive alternative to excavation and analysis.

At QkHl-5, the Icy Bay Site, there are three mapped features in the data sample. No distinct geographical groupings of features were observed at this site. Features 2 and 3 are located at the same beach elevation and approximately forty meters apart. Both tent rings have been assigned by Helmer (1987b) to the Early Pre-Dorset Icebreaker Beach complex. Consequently it is possible, although certainly not probable that these two features represent contemporaneous site use by more than one household. However, no such relationship has been postulated by Helmer. Feature 1, found on a beach surface almost four meters lower, relates to the later Middle Pre-Dorset Twin Ponds complex and almost certainly does not represent a contemporaneous occupation with either Feature 2 or 3. The well sheltered location of the site, with a good southern exposure, conforms to the pattern predicted by Schledermann and McCullough (1988) for late summer occupations. Comparison of rock loading patterns indicates that all three features at this site conform to a preferential southeast loading pattern. This loading pattern is almost certainly indicative of late summer. The strong similarities in rock loadings for all mapped tent rings at QkHl-5, in spite of the weak indications for contemporaneity of occupation, suggests that this site represents a pattern of preferential seasonal site use. Furthermore, the suggestion, however weak, that Features 2 and 3 were contemporaneous habitations cannot be refuted.

Table 13: QkHl-5: Feature Comparisons

QKHL-5: FEATURE COMPARISONS			
FEATURE	1	2	3
1	\	+	+
2	+	\	+
3	+	+	\
+ Similar Loading Pattern - Differing Loading Pattern			

At QkHn-12, the Field School Site, there are four mapped features in the sample data. These four features are somewhat scattered about the site area, but all are at roughly the same beach level and all have been tentatively attributed to the Middle Pre-Dorset Twin Ponds Complex. Consequently it is possible that two or more of these features may represent contemporaneous use of the site by multiple households. However, since no spatial groupings of features were apparent, no particular feature pairings were expected to be contemporaneous.

The Field School Site, upon the basis of location, aspect, shelter and recovered faunal materials, is suspected to represent a preferentially used late summer occupation. Comparison of rock loading patterns indicates that of these four tent rings, only Features 6 and 7 show slightly similar rock loading patterns. The possibility that Features 6 and 7 are contemporaneous remains an open question, but the contemporaneity of Features 4 and 10 with any other features at the site seems unlikely. The wide diversity of rock loading patterns at QkHn-13 would further suggest that use of this locale may not have been seasonally patterned.

Table 14:QkHn-12: Feature Comparisons

QKHN-12: FEATURE COMPARISONS				
FEATURE	4	6	7	10
4	\	-	-	-
6	-	\	+	-
7	-	+	\	-
10	-	-	-	\
+ Similar Loading Pattern - Differing Loading Pattern				

At QkHn-13, the Icebreaker Beach Site, there are nine mapped features in the tent ring sample data. The Icebreaker Beach Site is a complex series of beach ridges between two bedrock outcrops. These outcrops limit and constrain the usable site area. Whether because of these outcrops, or due to other factors, the features at this site form somewhat discrete geographical groupings. Features 1 and 2 are on the same beach surface, approximately ten meters apart, and thirty meters from the next nearest feature. At a somewhat lower beach level, and within twenty meters of one another, Features 4 and 14 form a second group. Features 5 and 8, within fifteen meters of one another, are located on a yet lower beach level. Features 11 and 16, some twenty meters apart, are located on the same beach level and forty meters from the nearest other feature. Features 4 and 14 are interpreted as likely contemporaries upon the basis of conjoining fragments of a single lithic artifact recovered during excavation of these two features (Helmer personal communication). The possible contemporaneity of Features 4 and 14 is not refuted by examination of rock loading relationships. No other instances of possible contemporaneity are confirmed at QkHn-13.

Upon the basis of location, shelter and faunal data, the Icebreaker Beach site was expected to represent a preferentially used mid- to late summer site. No pattern of preferential rock loadings were discerned in this comparison.

Table 15:QkHn-13: Feature Comparisons

QKHN-13: FEATURE COMPARISONS									
FEATURE	1	2	4	5	8	9	11	14	16
1	\	-	-	+	-	-	-	-	-
2	-	\	-	-	-	-	+	-	-
4	-	-	\	-	-	-	-	+	+
5	+	-	-	\	-	-	-	-	-
8	-	-	-	-	\	+	-	-	-
9	-	-	-	-	+	\	-	-	-
11	-	+	-	-	-	-	\	-	-
14	-	-	+	-	-	-	-	\	+
16	-	-	+	-	-	-	-	+	\
+ Similar Loading Pattern - Differing Loading Pattern									

At QkHn-17, the Twin Ponds Site, there are three mapped tent rings in the data sample. Features 1 and 3 at the site are located within twenty-five meters of one another and both date to the Middle Pre-Dorset Twin Ponds complex (Helmer 1987b). There is a strong possibility that these two features are the remains of contemporaneous habitations. Feature 4 is located approximately 120 meters away and is affiliated with the earlier Icebreaker Beach complex. Consequently, contemporaneity between Feature 4 and Features 1 and 3 is not suggested. The possible contemporaneity of

Features 1 and 3 is not confirmed by examination of cluster memberships.

Upon the basis of site location and recovered faunal material, the Twin Ponds Site locale was suspected to represent a preferentially used, late summer occupation. This suggestion was only partially supported by tent ring comparisons.

Table 17: QkHn-17: Feature Comparisons

QKHN-17: FEATURE COMPARISONS			
FEATURE	1	3	4
1	\	-	-
3	-	\	+
4	-	+	\
+ Similar Loading Pattern - Differing Loading Pattern			

At QkHn-27, the Rocky Point Site, there are nine features in the mapped sample. Although all of the tent rings at QkHn-27 likely represent Late Pre-Dorset habitations, it is highly unlikely that all represent contemporaneous occupations. Despite this linearity, four relatively distinct physical groupings of features were observed. Features 6, 7 and 8, within twenty-five meters of one another and all at the same beach level, constitute one such grouping. A second cluster, consisting of Features 12, 15 and 17 (all within twenty-five meters of one another) is located on the same beach surface approximately sixty meters to the northwest. Features 20 and 21, within thirty meters of one another and fifty meters further to the northeast comprise a third. Feature 3, forty-five meters southeast of Feature 6, is the lone mapped representative of the fourth cluster. The clustered nature of these features suggests that the members of the these three groupings may reflect four different episodes of contemporaneous site use. In particular, Features 15 and 17 are strongly suspected to be contemporaneous based upon the presence of two conjoinable lithic artifacts (Helmer personal communication). Strong similarities in excavated artifact assemblages, particularly microblade conformation and size, provide additional support for this hypothesis (Helmer 1987b:29). The possible contemporaneity of Features 12, 15 and 17 was not refuted by comparison of similarities in rock loading patterns.

Table 18: QkHn-27: Feature Comparisons

QKHN-27: FEATURE COMPARISONS									
FEATURE	3	6	7	8	12	15	17	20	21
3	\	-	-	-	-	-	-	-	+
6	-	\	-	-	+	-	-	-	-
7	-	-	\	-	-	-	-	+	-
8	-	-	-	\	-	-	-	-	+
12	-	+	-	-	\	-	-	-	-
15	-	-	-	-	-	\	+	-	-
17	-	-	-	-	-	+	\	-	-
20	-	-	+	-	-	-	-	\	-
21	+	-	-	+	-	-	-	-	\
+ Similar Loading Pattern - Differing Loading Pattern									

Upon the basis of location and recovered faunal materials, the Rocky Point Site is thought to reflect a preferred spring to early summer settlement pattern. No confirmation for this suggestion was found.

Two features were mapped at QkHo-5 on Rocky Point. These features are both located on the same beach surface and within five meters of one another. Rocky Point is a long, linear, relatively uniform geographic feature. The physical proximity of these two tent rings, given the uniformity of the local geographical setting, and the strong physical similarities in their appearance, strongly suggests that these two features represent a contemporaneous occupation by two households. The possibility of contemporaneity was not supported by examination of relative rock loading patterns.

Table 19:QkHo-5: Feature Comparisons

QKHO-5: FEATURE COMPARISONS		
FEATURE	1	2
1	\	-
2	-	\
+ Similar Loading Pattern - Differing Loading Pattern		

At RcHh-1, the Lee Point Site, there are five mapped features in the data sample. All are very similar in construction and are located at nearly the same beach level. Features 46, 47 and 48 form one grouping while Feature 53 and 58 form another. All are located within approximately forty meters of one another. Current reconstructions of Paleoeskimo lifeways suggest that Dorset represents a substantially more complex social setting than that of previous Paleoeskimo cultures. Consequently there is a possibility that all features represent contemporaneous site use by five households. There is an even stronger possibility that Features 46, 47 and 48 form one contemporaneous unit while Features 53 and 58 form another. Examination of cluster relationships indicates strong similarities in rock loading patterns between Features 53 and 58. No confirmation exists for any other suggestions of contemporaneity.

Table 20: RcHh-1: Feature Comparisons

RCHH-1: FEATURE COMPARISONS					
FEATURE	46	47	48	53	58
46	\	-	-	-	-
47	-	\	-	-	-
48	-	-	\	-	-
53	-	-	-	\	+
58	-	-	-	+	\

+ Similar Loading Pattern
- Differing Loading Pattern

At the Skruis Point Site, a sample of five tent rings were mapped. The site is located on a long stretch of parallel linear beach ridges. These tent rings form two very distinct and separate geographic clusters. Features 1 and 2, very similar in outward appearance, are located within a few meters of one another and at the same beach level. There is a very strong probability that these two features form a contemporaneous unit. Features 3, 4 and 5, also very similar to one another in outward appearances, are located approximately 150 meters to the southeast, and at a somewhat lower beach elevation. These features, all within twenty meters of one another and located on the same beach surface, may represent an episode of contemporaneous site use as well.

The relatively "tight" clustering of these features in geographical space, given the broad expanse of available but unused site area, argues strongly that these feature clusters are examples of concurrent site use. Examination of rock distributional cluster memberships indicates that Features 1 and 2 may very well represent contemporaneous habitations. The possible contemporaneity of Features 3, 4 and 5 is not confirmed.

Table 21: Skruis Point: Feature Comparisons

SKRUIS POINT: FEATURE COMPARISONS					
FEATURE	1	2	3	4	5
1	\	+	-	-	-
2	+	\	-	-	-
3	-	-	\	-	-
4	-	-	-	\	-
5	-	-	-	-	\

\+ Similar Loading Pattern
\- Differing Loading Pattern

Size and Shape Analysis

The analyses of tent ring form and size were undertaken to explore the possiblity that tent ring shape or size changed with time. Two cluster analyses, one sensitive to the detection of patterns in shape and the other sensitive to the detection of patterns in size, were conducted. These analyses used the individual features component scores produced by a PCA conducted on the average distance *per* sedecant oriented to north. The results of this PCA clearly indicated an underlying structure in the relationships between variables.

Shape

The cluster analysis focussed upon the detection of patterns of variability in the shape of tent rings revealed four relatively distinct and homogeneous clusters. The mean variable scores for each of these clusters are presented in Table 11 and are represented in Figure 12. Care should be taken in the interpretation of these data. The mean shapes presented in Figure 12 are not "types" *per se*. They do not illustrate an actual, or even a "typical" tent ring. Instead they illustrate the mean of all variable scores for that feature, which is something somewhat different.

As should be obvious from a visual examination of the four mean cluster representations in Figure 12, this cluster analysis did not isolate obviously distinct shapes in the data. Although minor differences can be noted, the four mean cluster shapes appear relatively similar in outline form. All four clusters may be described as roughly ovate to sub-rectangular in appearance. A more striking distinction between these clusters than shape is the orientation of the longest aspect of each cluster. The longest aspect of Cluster 1 appears to be oriented along the FFR-BBL diagonal. The longest aspect of Cluster 2 appears to be oriented along the R-L diagonal. The longest aspect of Cluster 3 appears to be oriented along the FFL-BBR diagonal. The longest aspect of Cluster 4 appears to be oriented along the BR-FL diagonal.

Comparison of these four clusters against the cultural-temporal complexes associated with each feature (Table 22) indicated no apparent relationship between cluster and complex.

Table 22:Perimeter Shape Clusters by Culture Complex

PERIMETER SHAPE CLUSTERS BY COMPLEX				
COMPLEX NAME	CLUSTER 1	2	3	4
Lethbridge	1	1	3	
Cape Hardy		1	1	2
Rocky Point	5	4	1	4
Twin Ponds	3	1		3
Icebreaker Beach	1		8	4
Far Site		1		

The detection of four distinct clusters with relatively similar shapes but different orientations was an unanticipated analytical result. The four different orientational clusters almost certainly represent "real" groupings in the data. The meaning of these groupings was not clear. No correlations exist between these four clusters and the associated cultural-historical units. It may be that these clusters represent associations of features with some common but as yet undetermined functional or social element.

Size

The cluster analysis that focussed upon the detection of patterns of variability in the size of features resulted in the creation or recognition of eight relatively poorly separated clusters. The mean variable scores for each of these clusters are presented in Table 12 and Figure 13. These groupings, although admittedly somewhat arbitrary, were nevertheless a useful way of partitioning a clinal distribution which would otherwise be fairly monolithic and difficult to analyze. Examination of the mean of mean variable scores for each cluster (Table 12) revealed a clear partitioning according to size. By ordering the clusters from smallest to largest according to the mean of mean variable scores for each cluster, a relative partitioning according to feature size was achieved. Comparison of these reordered clusters to culture complexes indicated the presence of a weak trend in feature size through time (see Table 23).

Table 23 : Perimeter Size Clusters by Culture Complex.

PERIMETER SIZE CLUSTERS BY CULTURAL COMPLEX								
COMPLEX NAME	CLUSTER 1 (smallest	2	3	4	5	6	7	8 largest)
Lethbridge					2	1		
Cape Hardy	1			1		2		
Rocky Point		1		3		3		
Twin Ponds	3	5				2	1	3
Icebreaker Beach		1	2		2	7	1	
Far Site		2		1				
Mean Radius (m)	1.11	1.59	1.66	1.67	1.71	1.74	2.48	2.57

Larger features appear most commonly in association with the Icebreaker Beach and Twin Ponds complexes while smaller features appear more frequently in the later Rocky Point, Cape Hardy and Lethbridge complexes. However, the weakness of this trend, coupled with the relatively small samples involved, makes it unlikely that this observation is statistically significant.

CHAPTER 7

CONCLUSIONS

Current understanding of Paleoeskimo prehistory is largely based upon intuitive perceptions and undocumented characterizations of sites and assemblages (Robertson 1988:176). Bielawski (1988:69-70) has convincingly argued that there is an increasing need for more detailed descriptive and classificatory studies of the full range of Paleoeskimo material culture before headway can be made in addressing broader research questions. By documenting some of the variability existing in a sample of Paleoeskimo tent rings, this thesis has contributed directly to the solution of this problem.

Although the documentation of variation in Paleoeskimo tent rings was a major goal of this thesis, it was not the only objective. The recognition of distinct patterns in this variability has been presented to suggest specific interpretations for individual features and groups of features which would otherwise not have been possible.

Of major importance to this study has been the development of a technique for standardizing the orientation and measurement of an inherently problematical entity. Tent rings have long posed serious problems for the analyst; the development and use in this study of a specifically designed computer program has permitted their analyses in new ways and at new depths. Data refined through the use of these standardizing procedures was examined using two multivariate statistical procedures to explore patterns and relationships. PCA helped simplify and refine the understanding of variability in the data while cluster analysis helped group the individual tent rings in potentially meaningful patterns.

Three practical uses have been made of the results of these cluster analyses. First, the clustering of differential rock distribution about the perimeter, when interpreted in terms of seasonal patterns of wind direction, has been used to postulate seasonal affiliations for specific tent rings. Second, the patterned distribution of perimeter rocks has also been used to test suggested instances of feature contemporaneity at specific sites in the Jones Sound area. Third, the patterned concentration of stones in the perimeter ring has been used to search for patterns of preferential seasonal site use. The success of these applications can not be independently assessed at this time but the results will hopefully contribute to the broader interpretation of Paleoeskimo prehistory emerging from DIAP.

Additionally, the analyses of the variation through time of the size and shape of tent ring perimeters have revealed interesting and somewhat enigmatic results. While it is clear that there are distinctly high levels of patterned variability in the shape of tent ring perimeters, this variability can not be well correlated with cultural-temporal units. The existence of informal tent ring typologies (Dumond 1977; McGhee 1976) which incorporated perimeter elements had implied that there would be significant changes through time in tent ring shape. However, the range of variability in Paleoeskimo tent ring form would appear to be great enough to effectively mask any temporally patterned variability. This is in keeping with more recent interpretations of Paleoeskimo adaptations which recognize much higher levels of variability and overlap in diagnostic cultural traits (Helmer 1988; Schledermann and McCullough 1988). The season, function, or duration of occupation, or some other, as yet undetermined factor, may account for this variation.

These analyses are best viewed as preliminary and exploratory. Many areas of possible refinement exist, particularly in methods. Future studies of tent ring morphology would do well to incorporate well considered non-metric attributes pertaining to interior features. The patterns recognized in such a mixed-mode analysis would doubtless be more informative and more useful than the isolated analysis of perimeter shape has been.

As well, future tent ring studies may benefit from the use of other forms of data standardization. The technique of tent ring rotation to orient all data sets towards the associated fossil beach was an important innovation of this study. The objectivity and replicability of this technique is not in doubt, but there are other, perhaps better ways. One possible approach which might prove useful is cross-correlation analysis (Robertson 1988:179). In such an analysis, the profile characterizing each tent ring shape would be rotated against all other tent ring profiles until a position of maximum correspondence could be identified. This maximum correspondence position could form the basis for subsequent cluster analyses. This form of analysis would doubtless prove particularly powerful in the identification of common shape patterns regardless of orientation.

Empirically and methodologically this thesis may be viewed as a qualified success. Empirical contributions to the interpretation of Paleoeskimo prehistory have been achieved while methodological contributions in the realm of tent ring analysis are recognized.

Specific empirical contributions of this study to the interpretation of Paleoeskimo prehistory include the metric documentation of the extent of variability in a sample of forty-four tent rings. These features are reported here at a level of description far beyond that normally conveyed in research monographs. Specific assignments are made of possible seasonal affiliations to individual tent rings upon the basis of patterns of preferential weight loadings. These seasonal affiliations will contribute to the ongoing interpretations of arctic prehistory of DIAP.

Additionally, the patterns of preferential rock loadings about the perimeter have been used to provide corroborative arguments for the contemporaneity of specific features and/or the preferential seasonal use of specific site locales. These arguments will also contribute to the continuing analysis and interpretation of the Paleoeskimo occupation of the Jones Sound region.

Specific methodological contributions of this study include the introduction of field recording procedures which permitted rapid and objective manipulation of architectural data using multivariate statistical techniques.

The development of a technique for mathematically standardizing tent ring data has important future implications for tent ring analyses. The introduction of the mean of furthest neighbours centering technique, which permits the identification of a fully replicable and stable centre reference point, allowed between feature comparisons at a level of consistency which otherwise may have been impossible.

The introduction of the use of overlapping partitioning for perimeter analytic units was another significant methodological innovation of this study. Although it was widely recognized that the influence of wind acting upon a tent surface was distributed over a broad portion of the tent circumference, previous analyses have used relatively small, non-overlapping partitions to examine rock loading patterns.

This thesis also represents the first attempt to study the shape of tent rings using radially partitioned data. Despite the long-term use of radial partitioning systems by tent ring analysts, and the gaining momentum of quantitative shape analysis in other disciplines, no previous attempts to use detailed radial information as the foundation for morphological analyses of tent rings exist. Several innovations in this shape analysis constitute significant contributions to the analysis of tent rings throughout the world. The rotation of tent rings about their central reference point to orient them to a shared external characteristic or feature is an analytical innovation with considerable future potential. Equally important, this study represents the first use of principal components analysis to approach the problem of variability in the size and shape of the perimeters of a sample of tent rings.

In a broader sense, it is hoped that this study may contribute to the analysis of all items of material culture by drawing attention to the considerable but largely unexplored potential of quantitative shape analysis. The detailed examination of many tool and structure forms are now feasible using these techniques.

In the final analysis, an important contribution of this thesis may lie in what was not done. The ability to determine a common point of reference for measurements within the feature, coupled with the recognition that external characteristics may be used to determine a common orientation, may have important ramifications for the analysis of artifact distributions within the tent ring. Valuable insights regarding the social organization of Paleoeskimo society at the level of the household may emerge.

As a last observation, this study has been an attempt to improve upon the intuitive biases common in the interpretation of Arctic archaeology and place the study of material culture in a quantitative realm. The metric analysis of tent ring morphology has considerable future potential which this research has scarcely touched upon. The extensive variability existing in these features, and the complexity of that variability, can only be understood and adequately explained through increased and more detailed study. This thesis, far from closing the book on variability in Paleoeskimo tent rings, has only just opened it.

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APPENDIX A

DATA TABLES

This appendix contains tabular presentations of all source data used in the multivariate statistical analyses conducted in this study. Five data sets are presented. They are: the number of rocks *per* quadrant for each feature (Tables A1a to A1b), the size of rocks *per* quadrant for each feature (Tables A2a to A2b), the volume of rocks *per* quadrant for each feature (Table A3a), the average distance to perimeter rocks *per* sedecant oriented to north (Tables A4a to A4c) and the average distance to perimeter rocks *per* sedecant oriented to the local beach strike (Tables A5a to A5c). Each of the data tables presents both raw scores and standardized scores. The tables presenting number, size and volume data are all standardized as percentages. The tables presenting distance data are standardized by division by the feature mean. Numbers in italics in these two tables indicate extrapolated scores. Extrapolated scores are missing perimeter values which have been approximated by determining the mean of contiguous scores.

Table A1a: Number of Perimeter Rocks per Quadrant.

NUMBER OF PERIMETER ROCKS PER QUADRANT										
SITE	FEATURE	QUADRANT								TOTAL
		N	NE	E	SE	S	SW	W	NW	
QKHL 5	1	16 13%	32 26%	44 36%	45 37%	40 33%	28 23%	21 17%	16 13%	121
QKHL 5	2	30 25%	32 27%	37 31%	50 42%	42 35%	22 18%	11 9%	16 13%	120
QKHL 5	3	18 22%	18 22%	29 35%	28 34%	23 28%	18 22%	12 15%	18 22%	82
QKHL 66	1	8 44%	6 33%	1 6%	1 6%	4 22%	5 28%	5 28%	6 33%	18
QKHN 12	4	20 44%	11 24%	9 20%	11 24%	9 20%	8 18%	7 16%	15 33%	45
QKHN 12	6	5 23%	0 0%	1 5%	2 9%	1 5%	6 27%	15 68%	14 64%	22
QKHN 12	7	14 28%	13 26%	20 40%	22 44%	9 18%	6 12%	7 14%	9 18%	50
QKHN 12	10	7 30%	6 26%	6 26%	4 17%	5 22%	6 26%	5 22%	7 30%	23
QKHN 13	1	25 37%	21 31%	14 21%	13 19%	10 15%	18 27%	18 27%	15 22%	67
QKHN 13	2	1 8%	7 54%	7 54%	1 8%	0 0%	3 23%	5 39%	2 15%	13
QKHN 13	4	26 27%	25 26%	26 27%	18 19%	15 16%	25 26%	29 30%	28 29%	96
QKHN 13	5	24 56%	15 35%	7 16%	7 16%	7 16%	5 12%	5 12%	16 37%	43
QKHN 13	8	8 17%	9 19%	8 17%	11 23%	18 38%	21 44%	14 29%	7 15%	48
QKHN 13	9	3 14%	2 9%	6 27%	7 32%	4 18%	6 27%	9 41%	7 32%	22
QKHN 13	11	3 10%	8 27%	10 33%	8 27%	7 23%	9 30%	10 33%	5 17%	30
QKHN 13	14	22 26%	19 22%	10 12%	26 30%	30 35%	24 28%	24 28%	17 20%	86
QKHN 13	16	9 21%	17 39%	14 32%	7 16%	8 18%	13 30%	13 30%	7 16%	44
QKHN 17	1	10 13%	9 12%	14 18%	21 28%	28 37%	29 38%	24 32%	17 22%	76
QKHN 17	3	17 36%	19 40%	13 28%	5 11%	6 13%	5 11%	11 23%	18 38%	47
QKHN 17	4	34 41%	36 43%	13 16%	21 25%	21 25%	17 21%	15 18%	9 11%	83
QKHN 22	8	31 34%	28 31%	12 13%	16 18%	29 32%	28 31%	18 20%	18 20%	90

Table A1b: Number of Perimeter Rocks per Quadrant.

NUMBER OF PERIMETER ROCKS PER QUADRANT										
SITE	FEATURE	QUADRANT								TOTAL
		N	NE	E	SE	S	SW	W	NW	
QKHN 27	3	16 32%	14 28%	10 20%	8 16%	9 18%	13 26%	15 30%	15 30%	50
QKHN 27	6	8 40%	7 35%	8 40%	6 30%	3 15%	2 10%	1 5%	5 25%	20
QKHN 27	7	11 26%	8 19%	6 14%	10 23%	12 28%	10 23%	14 33%	15 35%	43
QKHN 27	8	6 15%	7 17%	11 27%	9 22%	12 29%	15 37%	12 29%	10 24%	41
QKHN 27	12	10 26%	14 37%	12 32%	9 24%	7 18%	8 21%	9 24%	7 18%	38
QKHN 27	15	30 33%	35 39%	28 31%	22 24%	14 15%	22 24%	19 21%	12 13%	91
QKHN 27	17	22 25%	24 27%	17 19%	18 20%	24 27%	20 23%	26 29%	27 30%	89
QKHN 27	20	6 17%	6 17%	9 25%	8 22%	11 31%	15 42%	10 28%	7 19%	36
QKHN 27	21	9 19%	13 28%	15 32%	14 30%	15 32%	11 23%	8 17%	9 19%	47
QKHN 37	1	5 15%	8 24%	12 36%	13 39%	8 24%	2 6%	8 24%	10 30%	33
QKHN 38	2	14 28%	8 16%	10 20%	13 26%	16 32%	12 24%	10 20%	17 34%	50
QKHO 5	1	5 15%	4 12%	6 18%	10 29%	12 35%	14 41%	11 32%	6 18%	34
QKHO 5	2	6 24%	7 28%	5 20%	8 32%	8 32%	6 24%	6 24%	4 16%	25
RCHH 1	46	10 24%	12 29%	11 27%	8 20%	8 20%	12 29%	12 29%	9 22%	41
RCHH 1	47	17 33%	11 21%	11 21%	12 23%	8 15%	14 27%	16 31%	15 29%	52
RCHH 1	48	11 29%	12 32%	10 26%	8 21%	7 18%	10 26%	10 26%	8 21%	38
RCHH 1	53	9 27%	7 21%	7 21%	7 21%	10 29%	11 32%	8 24%	9 27%	34
RCHH 1	58	8 29%	7 25%	4 14%	7 25%	9 32%	8 29%	7 25%	6 21%	28
SKRUIS POINT	1	21 23%	24 26%	16 17%	21 23%	29 31%	33 36%	27 29%	15 16%	93
SKRUIS POINT	2	15 25%	16 27%	15 25%	16 27%	21 36%	14 24%	8 14%	13 22%	59
SKRUIS POINT	3	23 26%	31 35%	30 34%	28 32%	25 28%	14 16%	11 12%	16 18%	89
SKRUIS POINT	4	37 34%	24 22%	24 22%	25 23%	22 20%	21 19%	25 23%	38 35%	108
SKRUIS POINT	5	13 20%	10 15%	9 14%	14 21%	19 29%	24 36%	25 38%	18 27%	66

Table A2a: Size of Perimeter Rocks per Quadrant.

SIZE OF PERIMETER ROCKS PER QUADRANT (cm^2)

SITE	FEATURE	QUADRANT N	NE	E	SE	S	SW	W	NW	TOTAL
QKHL 5	1	8025	12300	18625	21025	16450	9525	11800	12050	54900
		14.6%	22.4%	33.9%	38.3%	30.0%	17.4%	21.5%	21.9%	
QKHL 5	2	16950	17275	13150	20250	19750	10375	4700	6650	54550
		31.1%	31.7%	24.1%	37.1%	36.2%	19.0%	8.6%	12.2%	
QKHL 5	3	9425	8900	10625	9625	8650	7200	3575	6550	32275
		29.2%	27.6%	32.9%	29.8%	26.8%	22.3%	11.1%	20.3%	
QKHL 66	1	6448	4920	512	528	2104	3208	4660	8068	13724
		47.0%	35.9%	3.7%	3.8%	15.3%	23.4%	34.0%	58.8%	
QKHN 12	4	13750	11500	11350	14800	13050	9200	7700	10350	45850
		30.0%	25.1%	24.8%	32.3%	28.5%	20.1%	16.8%	22.6%	
QKHN 12	6	850	0	300	600	300	1550	4275	3575	5725
		14.8%	0.0%	5.2%	10.5%	5.2%	27.1%	74.7%	62.4%	
QKHN 12	7	9225	8950	7075	7850	12400	10650	9650	10900	38350
		24.1%	23.3%	18.4%	20.5%	32.3%	27.8%	25.2%	28.4%	
QKHN 12	10	8400	8700	9900	7800	2900	5800	8000	6900	29200
		28.8%	29.8%	33.9%	26.7%	9.9%	19.9%	27.4%	23.6%	
QKHN 13	1	14341	12284	8617	8163	5537	9461	9241	7828	37736
		38.0%	32.6%	22.8%	21.6%	14.7%	25.1%	24.5%	20.7%	
QKHN 13	2	266	1893	2749	1122	0	919	1787	868	4802
		5.5%	39.4%	57.2%	23.4%	0.0%	19.1%	37.2%	18.1%	
QKHN 13	4	9387	8046	10368	8145	9366	13218	11925	11637	41046
		22.9%	19.6%	25.3%	19.8%	22.8%	32.2%	29.1%	28.4%	
QKHN 13	5	4972	3519	1880	1498	1821	1253	1030	3433	9703
		51.2%	36.3%	19.4%	15.4%	18.8%	12.9%	10.6%	35.4%	
QKHN 13	8	951	1390	2340	3029	2640	2662	2340	1190	8271
		11.5%	16.8%	28.3%	36.6%	31.9%	32.2%	28.3%	14.4%	
QKHN 13	9	1276	564	3420	4132	1301	1190	1738	1849	7735
		16.5%	7.3%	44.2%	53.4%	16.8%	15.4%	22.5%	23.9%	
QKHN 13	11	1768	3933	3325	1857	1905	2573	3441	2076	10439
		16.9%	37.7%	31.9%	17.8%	18.2%	24.6%	33.0%	19.9%	
QKHN 13	14	6707	7199	8253	9109	9893	12383	12271	8433	37124
		18.1%	19.4%	22.2%	24.5%	26.6%	33.4%	33.1%	22.7%	
QKHN 13	16	2971	3756	3206	1448	1519	3518	4521	3495	12217
		24.3%	30.7%	26.2%	11.9%	12.4%	28.8%	37.0%	28.6%	
QKHN 17	1	5013	6021	5139	3843	3609	5679	6669	4887	20430
		24.5%	29.5%	25.2%	18.8%	17.7%	27.8%	32.6%	23.9%	
QKHN 17	3	11250	10800	7100	6350	12325	10125	7100	10500	37775
		29.8%	28.6%	18.8%	16.8%	32.6%	26.8%	18.8%	27.8%	
QKHN 17	4	9198	10071	3753	8154	9423	6723	8226	5652	30600
		30.1%	32.9%	12.3%	26.6%	30.8%	22.0%	26.9%	18.5%	
QKHN 22	8	10700	11825	4325	5200	11475	11100	7375	5750	33875
		31.6%	34.9%	12.8%	15.4%	33.9%	32.8%	21.8%	17.0%	

Table A2b: Size of Perimeter Rocks per Quadrant.

SIZE OF PERIMETER ROCKS PER QUADRANT (cm^2)										
SITE	FEATURE	QUADRANT N	NE	E	SE	S	SW	W	NW	TOTAL
QKHN 27	3	3214	5072	4676	3635	3673	5070	4814	2600	16377
		19.6%	31.0%	28.6%	22.2%	22.4%	31.0%	29.4%	15.9%	
QKHN 27	6	3005	3179	2966	2007	1704	1200	368	1657	8043
		37.4%	39.5%	36.9%	25.0%	21.2%	14.9%	4.6%	20.6%	
QKHN 27	7	5215	4616	3178	5079	6146	5437	5878	5285	20417
		25.5%	22.6%	15.6%	24.9%	30.1%	26.6%	28.8%	25.9%	
QKHN 27	8	1732	2272	3656	3225	3113	4467	5186	3723	13687
		12.7%	16.6%	26.7%	23.6%	22.7%	32.6%	37.9%	27.2%	
QKHN 27	12	4436	5478	4496	4012	2800	4204	5012	3050	16744
		26.5%	32.7%	26.9%	24.0%	16.7%	25.1%	29.9%	18.2%	
QKHN 27	15	6642	6873	5433	5454	4068	5085	6003	4734	22146
		30.0%	31.0%	24.5%	24.6%	18.4%	23.0%	27.1%	21.4%	
QKHN 27	17	4059	4194	4032	5292	6804	5085	3906	4230	18801
		21.6%	22.3%	21.4%	28.1%	36.2%	27.0%	20.8%	22.5%	
QKHN 27	20	2144	1270	1893	2812	3578	3574	2610	2569	10225
		21.0%	12.4%	18.5%	27.5%	35.0%	35.0%	25.5%	25.1%	
QKHN 27	21	3506	4745	5487	5912	6104	3297	2802	3945	17899
		19.6%	26.5%	30.7%	33.0%	34.1%	18.4%	15.7%	22.0%	
QKHN 37	1	2250	2421	2133	3609	2997	144	2412	3618	9792
		23.0%	24.7%	21.8%	36.9%	30.6%	1.5%	24.6%	36.9%	
QKHN 38	2	5823	5148	5913	5526	5823	5958	8028	8955	25587
		22.8%	20.1%	23.1%	21.6%	22.8%	23.3%	31.4%	35.0%	
QKHO 5	1	1049	796	1222	1368	1877	1890	1211	1305	5359
		19.6%	14.9%	22.8%	25.5%	35.0%	35.3%	22.6%	24.4%	
QKHO 5	2	592	697	533	855	696	1183	1510	596	3331
		17.8%	20.9%	16.0%	25.7%	20.9%	35.5%	45.3%	17.9%	
RCHH 1	46	4769	5178	4165	2964	2495	6312	5958	2933	17387
		27.4%	29.8%	24.0%	17.0%	14.4%	36.3%	34.3%	16.9%	
RCHH 1	47	4747	3345	3783	3358	2641	3831	3494	4131	14665
		32.4%	22.8%	25.8%	22.9%	18.0%	26.1%	23.8%	28.2%	
RCHH 1	48	2943	3951	4437	3818	1931	2497	2707	1752	12018
		24.5%	32.9%	36.9%	31.8%	16.1%	20.8%	22.5%	14.6%	
RCHH 1	53	5852	3900	4220	3530	5507	7448	5272	5973	20851
		28.1%	18.7%	20.2%	16.9%	26.4%	35.7%	25.3%	28.6%	
RCHH 1	58	3855	2988	2014	5079	5827	4451	4463	3641	16159
		23.9%	18.5%	12.5%	31.4%	36.1%	27.5%	27.6%	22.5%	
SKRUIS POINT	1	3613	4204	2881	3894	5373	4926	3513	2356	15380
		23.5%	27.3%	18.7%	25.3%	34.9%	32.0%	22.8%	15.3%	
SKRUIS POINT	2	1786	2273	1711	2208	3098	2061	1498	1551	8093
		22.1%	28.1%	21.1%	27.3%	38.3%	25.5%	18.5%	19.2%	
SKRUIS POINT	3	3321	5105	4349	3495	3614	1820	1298	2162	12582
		26.4%	40.6%	34.6%	27.8%	28.7%	14.5%	10.3%	17.2%	
SKRUIS POINT	4	5913	2879	3180	4023	3703	3905	4636	6625	17432
		33.9%	16.5%	18.2%	23.1%	21.2%	22.4%	26.6%	38.0%	
SKRUIS POINT	5	2590	2109	1623	2626	2928	3046	4212	3572	11353
		22.8%	18.6%	14.3%	23.1%	25.8%	26.8%	37.1%	31.5%	

Table A3: Volume of Perimeter Rocks per Quadrant.

VOLUME OF PERIMETER ROCKS PER QUADRANT (cc)

SITE	FEATURE	QUADRANT N	NE	E	SE	S	SW	W	NW	TOTAL
QKHN 13	1	172741	140609	119081	128527	63034	102424	115498	98794	470354
		36.7%	29.9%	25.3%	27.3%	13.4%	21.8%	24.6%	21.0%	
QKHN 13	2	2128	24629	40453	17952	0	8479	16683	8204	59264
		3.6%	41.6%	68.3%	30.3%	0.0%	14.3%	28.2%	13.8%	
QKHN 13	5	43236	35417	18724	12638	17834	12432	7482	26789	87276
		49.5%	40.6%	21.5%	14.5%	20.4%	14.2%	8.6%	30.7%	
QKHN 13	8	6092	12484	23406	32069	24745	17629	16526	8587	70769
		8.6%	17.6%	33.1%	45.3%	35.0%	24.9%	23.4%	12.1%	
QKHN 13	9	11990	5184	34015	41127	13129	9815	15639	18647	74773
		16.0%	6.9%	45.5%	55.0%	17.6%	13.1%	20.9%	24.9%	
QKHN 13	11	24022	55525	42228	48717	19804	23939	31145	19018	117199
		20.5%	47.4%	36.0%	41.6%	16.9%	20.4%	26.6%	16.2%	
QKHN 13	16	32673	40634	33682	14072	18792	36785	46203	39859	131350
		24.9%	30.9%	25.6%	10.7%	14.3%	28.0%	35.2%	30.3%	
QKHN 27	3	21923	49689	49058	35971	37129	42380	40195	20265	148305
		14.8%	33.5%	33.1%	24.3%	25.0%	28.6%	27.1%	13.7%	
QKHN 27	6	24560	24060	22028	15620	16848	12816	5152	16092	68588
		35.8%	35.1%	32.1%	22.8%	24.6%	18.7%	7.5%	23.5%	
QKHN 27	7	55628	55766	34700	64850	78172	78867	76982	45939	245422
		22.7%	22.7%	14.1%	26.4%	31.9%	32.1%	31.3%	18.7%	
QKHN 27	8	16138	25684	39330	36261	27601	34740	50355	36739	133424
		12.1%	19.3%	29.5%	27.2%	20.7%	26.0%	37.7%	27.5%	
QKHN 27	12	58902	65248	46221	48055	18268	47856	48500	40732	171891
		34.3%	38.0%	26.9%	28.0%	10.6%	27.8%	28.2%	23.7%	
QKHN 27	20	14079	8874	14195	29364	38308	30384	23876	21836	90458
		15.6%	9.8%	15.7%	32.5%	42.3%	33.6%	26.4%	24.1%	
QKHN 27	21	18196	39508	48099	31813	20565	12155	10105	13489	96965
		18.8%	40.7%	49.6%	32.8%	21.2%	12.5%	10.4%	13.9%	
QKHO 5	1	7761	6044	8420	7601	13530	14855	8182	9393	37893
		20.5%	16.0%	22.2%	20.1%	35.7%	39.2%	21.6%	24.8%	
QKHO 5	2	3536	4376	3434	5812	4413	12791	16191	4595	27574
		12.8%	15.9%	12.5%	21.1%	16.0%	46.4%	58.7%	16.7%	
RCHH 1	46	63871	61092	42947	36658	33444	99774	87965	30703	228227
		28.0%	26.8%	18.8%	16.1%	14.7%	43.7%	38.5%	13.5%	
RCHH 1	47	48306	32734	40221	32623	31052	39928	32082	46376	151661
		31.9%	21.6%	26.5%	21.5%	20.5%	26.3%	21.2%	30.6%	
RCHH 1	48	25135	37716	61700	57904	21502	25134	24685	12268	133022
		18.9%	28.4%	46.4%	43.5%	16.2%	18.9%	18.6%	9.2%	
RCHH 1	53	78149	38484	48282	45622	75107	100506	68243	85169	269781
		29.0%	14.3%	17.9%	16.9%	27.8%	37.3%	25.3%	31.6%	
RCHH 1	58	58217	34238	26714	72629	79751	59783	64957	62989	229639
		25.4%	14.9%	11.6%	31.6%	34.7%	26.0%	28.3%	27.4%	
SKRUIS POINT	1	14994	22136	15360	15160	24301	20651	11661	8369	66316
		22.6%	33.4%	23.2%	22.9%	36.6%	31.1%	17.6%	12.6%	
SKRUIS POINT	2	5755	9713	7616	10443	14262	9111	6822	5188	34455
		16.7%	28.2%	22.1%	30.3%	41.4%	26.4%	19.8%	15.1%	
SKRUIS POINT	3	9510	18187	16200	13337	14801	6202	5833	8618	46344
		20.5%	39.2%	35.0%	28.8%	31.9%	13.4%	12.6%	18.6%	
SKRUIS POINT	4	21112	12230	15650	19399	15420	17184	16032	19401	68214
		31.0%	17.9%	22.9%	28.4%	22.6%	25.2%	23.5%	28.4%	
SKRUIS POINT	5	10475	9795	4197	7365	9145	8801	15189	13045	39006
		26.9%	25.1%	10.8%	18.9%	23.4%	22.6%	38.9%	33.4%	

Table A4a: Average Distance to Perimeter Rocks *per* Sedecant Oriented to North.

AVERAGE DISTANCE TO PERIMETER ROCKS PER SEDECANT (m)

SITE	FEATURE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	FEATURE MEAN
QKHL 5	1	2.14	1.69	1.70	2.18	1.78	2.09	2.38	2.16	1.64	1.85	1.80	1.42	2.03	2.26	2.75	2.48	2.04
		1.05*	0.83*	0.83*	1.07*	0.87*	1.02*	1.17*	1.06*	0.80*	0.91*	0.88*	0.70*	1.00*	1.11*	1.35*	1.22*	
QKHL 5	2	1.50	1.79	2.06	1.70	1.15	1.46	1.62	1.55	1.91	1.76	2.03	1.05	1.84	1.81	1.78	1.63	1.70
		0.88*	1.05*	1.21*	1.00*	0.68*	0.86*	0.95*	0.91*	1.12*	1.04*	1.19*	0.62*	1.08*	1.06*	1.05*	0.96*	
QKHL 5	3	1.00	2.01	1.43	1.25	1.02	1.45	1.82	1.98	1.68	1.81	1.68	2.02	2.07	1.59	1.39	1.52	1.58
		0.63*	1.27*	0.91*	0.79*	0.65*	0.92*	1.15*	1.25*	1.06*	1.15*	1.06*	1.28*	1.31*	1.01*	0.88*	0.96*	
QKHL 66	1	_2.17_	2.24	1.94	1.43	_1.48_	1.53	1.76	1.53	1.82	2.27	_2.20_	2.13	_2.12_	_2.11_	_2.10_	2.09	1.97
		1.10*	1.14*	0.98*	0.73*	0.75*	0.78*	0.89*	0.78*	0.92*	1.15*	1.12*	1.08*	1.02*	1.03*	1.05*	1.06*	
QKHN 12	4	2.10	2.11	2.08	2.77	3.17	3.04	2.38	2.48	2.10	2.24	2.74	3.16	3.18	2.84	2.62	2.31	2.65
		0.79*	0.80*	0.78*	1.05*	1.20*	1.15*	0.90*	0.94*	0.79*	0.85*	1.03*	1.19*	1.20*	1.07*	0.99*	0.87*	
QKHN 12	6	0.99	1.31	_1.79_	2.27	2.28	_2.23_	_2.17_	_2.12_	_2.06_	_2.01_	1.95	_1.70_	1.44	_1.37_	_1.30_	1.23	1.47
		0.67*	0.89*	1.27*	1.54*	1.55*	1.52*	1.48*	1.44*	1.40*	1.37*	1.33*	1.16*	0.98*	0.93*	0.88*	0.84*	
QKHN 12	7	2.05	2.53	3.03	2.75	3.07	3.14	2.77	2.43	2.42	2.55	2.91	3.03	3.28	2.60	3.01	2.40	2.77
		0.74*	0.91*	1.09*	0.99*	1.11*	1.13*	1.00*	0.88*	0.87*	0.92*	1.05*	1.09*	1.18*	0.94*	1.09*	0.87*	
QKHN 12	10	2.26	2.43	2.20	2.10	2.49	2.31	2.98	2.26	2.40	2.47	2.62	_2.30_	1.98	_2.50_	3.01	1.64	2.48
		0.91*	0.98*	0.89*	0.85*	1.00*	0.93*	1.20*	0.91*	0.97*	1.00*	1.06*	0.93*	0.80*	1.01*	1.21*	0.66*	
QKHN 13	1	1.60	1.69	1.71	1.86	2.16	2.18	1.89	1.86	1.81	1.95	0.97	1.86	1.75	1.74	2.13	1.07	1.80
		0.89*	0.94*	0.95*	1.03*	1.20*	1.21*	1.05*	1.03*	1.01*	1.08*	0.54*	1.03*	0.97*	0.97*	1.18*	0.59*	
QKHN 13	2	_2.00_	_2.11_	_2.21_	2.31	2.11	_1.48_	0.84	_0.82_	_0.80_	_0.79_	0.77	2.18	1.58	_1.69_	_1.79_	_1.90_	1.69
		1.18*	1.25*	1.31*	1.37*	1.25*	0.88*	0.50*	0.49*	0.47*	0.47*	0.46*	1.29*	0.93*	1.00*	1.06*	1.12*	
QKHN 13	4	1.98	1.99	2.24	2.08	2.20	2.18	2.03	1.93	1.93	1.47	1.93	1.68	1.67	1.18	1.60	1.74	1.91
		1.04*	1.04*	1.17*	1.09*	1.15*	1.14*	1.06*	1.01*	1.01*	0.77*	1.01*	0.88*	0.87*	0.62*	0.84*	0.91*	
QKHN 13	5	2.81	2.57	_2.63_	2.69	_2.20_	1.70	1.75	2.45	2.57	3.58	2.61	1.53	_1.34_	1.14	2.10	_2.46_	2.51
		1.12*	1.02*	1.05*	1.07*	0.88*	0.68*	0.70*	0.98*	1.02*	1.43*	1.04*	0.61*	0.73*	0.45*	0.84*	0.98*	
QKHN 13	8	1.68	1.71	1.60	1.59	1.30	1.57	0.89	1.26	1.63	1.43	0.53	_1.16_	1.79	1.49	1.30	1.28	1.48
		1.14*	1.16*	1.08*	1.07*	0.88*	1.06*	0.60*	0.85*	1.10*	0.97*	0.36*	0.68*	1.21*	1.01*	0.88*	0.86*	
QKHN 13	9	1.48	_1.20_	0.92	1.12	1.92	1.75	1.54	1.24	0.94	_1.51_	_2.08_	2.65	1.62	2.41	1.52	1.86	1.65
		0.90*	0.73*	0.56*	0.68*	1.16*	1.06*	0.93*	0.75*	0.57*	0.92*	1.26*	1.61*	0.98*	1.46*	0.92*	1.13*	
QKHN 13	11	_0.92_	1.21	1.13	1.31	_1.25_	1.18	1.24	1.07	1.41	0.78	0.89	0.58	1.05	1.17	0.36	_0.64_	1.05
		1.08*	1.15*	1.08*	1.25*	1.19*	1.12*	1.18*	1.02*	1.34*	0.74*	0.85*	0.55*	1.00*	1.11*	0.34*	0.68*	
QKHN 13	14	1.34	1.15	1.99	2.40	2.08	2.17	2.40	2.39	2.59	2.44	2.22	2.18	1.69	2.29	1.30	1.56	2.15
		0.62*	0.53*	0.93*	1.12*	0.97*	1.01*	1.12*	1.11*	1.20*	1.13*	1.03*	1.01*	0.79*	1.07*	0.60*	0.73*	
QKHN 13	16	1.65	1.58	1.80	1.49	1.49	1.39	1.86	1.43	1.29	1.36	1.54	1.74	1.46	_1.38_	1.29	_1.47_	1.57
		1.05*	1.01*	1.15*	0.95*	0.95*	0.89*	1.18*	0.91*	0.82*	0.87*	0.98*	1.11*	0.93*	0.88*	0.82*	0.94*	

* Denotes standardized scores (Sedecant mean divided by Feature mean). Numbers in italics denote extrapolated values.

Table A4b: Average Distance to Perimeter Rocks per Sedecant Oriented to North.

AVERAGE DISTANCE TO PERIMETER ROCKS PER SEDECANT (m)

SITE	FEATURE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	FEATURE MEAN
QKHN 17	1	1.72	1.93	1.53	1.56	1.18	1.82	1.90	2.11	1.95	1.50	1.66	1.71	1.51	1.25	1.16	1.04	1.66
		1.04*	1.16*	0.92*	0.94*	0.71*	1.10*	1.14*	1.27*	1.17*	0.90*	1.00*	1.03*	0.91*	0.75*	0.70*	0.63*	
QKHN 17	3	1.90	2.48	2.45	2.99	3.04	_3.06_	3.07	2.77	2.98	_2.91_	2.83	2.58	2.57	3.23	2.16	2.11	2.58
		0.74*	0.96*	0.95*	1.16*	1.18*	1.19*	1.19*	1.07*	1.16*	1.13*	1.10*	1.00*	1.00*	1.25*	0.84*	0.82*	
QKHN 17	4	_1.77_	1.55	2.30	2.56	2.01	2.10	2.39	2.22	2.43	2.17	2.29	1.78	2.01	2.19	2.26	1.98	2.18
		0.81*	0.71*	1.06*	1.17*	0.92*	0.96*	1.10*	1.02*	1.11*	1.00*	1.05*	0.82*	0.92*	1.00*	1.04*	0.91*	
QKHN 22	8	2.48	1.61	2.30	2.10	1.46	1.80	2.18	1.50	1.04	1.42	2.78	2.98	2.66	2.01	2.10	2.11	2.11
		1.18*	0.76*	1.09*	1.00*	0.69*	0.85*	1.03*	0.71*	0.49*	0.67*	1.32*	1.41*	1.26*	0.95*	1.00*	1.00*	
QKHN 27	3	2.05	1.62	_1.66_	1.69	0.95	0.93	1.47	1.74	0.72	1.24	1.18	1.26	0.91	1.32	1.39	1.18	1.38
		1.49*	1.17*	1.20*	1.22*	0.69*	0.67*	1.07*	1.26*	0.52*	0.90*	0.86*	0.91*	0.66*	0.96*	1.01*	0.86*	
QKHN 27	6	_1.07_	1.30	_1.34_	1.38	1.60	_1.51_	1.41	_1.59_	1.77	_1.66_	_1.56_	1.45	1.26	0.91	0.83	0.84	1.26
		0.85*	1.03*	1.06*	1.10*	1.27*	1.20*	1.12*	1.26*	1.40*	1.32*	1.24*	1.15*	1.00*	0.72*	0.66*	0.67*	
QKHN 27	7	1.86	1.12	1.53	0.86	1.09	1.35	1.16	_1.30_	1.44	1.68	2.45	1.57	1.59	1.34	1.63	1.15	1.43
		1.30*	0.78*	1.07*	0.60*	0.76*	0.94*	0.81*	0.91*	1.01*	1.17*	1.71*	1.10*	1.11*	0.94*	1.14*	0.80*	
QKHN 27	8	1.88	1.99	1.25	1.42	1.23	1.24	1.73	1.52	1.17	1.34	1.64	1.53	1.79	0.48	_1.00_	1.51	1.45
		1.30*	1.37*	0.86*	0.98*	0.85*	0.86*	1.19*	1.05*	0.81*	0.92*	1.13*	1.06*	1.23*	0.33*	1.02*	1.04*	
QKHN 27	12	0.92	1.11	1.37	_1.27_	1.16	1.94	0.89	1.28	1.38	1.51	1.69	_1.56_	1.42	1.62	1.12	0.88	1.26
		0.73*	0.88*	1.09*	1.01*	0.92*	1.54*	0.71*	1.02*	1.10*	1.20*	1.34*	1.24*	1.13*	1.29*	0.89*	0.70*	
QKHN 27	15	1.83	2.08	1.67	1.31	1.35	2.24	1.34	1.23	1.73	2.39	_1.90_	1.41	1.46	2.02	1.64	1.45	1.68
		1.09*	1.24*	0.99*	0.78*	0.80*	1.33*	0.80*	0.73*	1.03*	1.42*	1.13*	0.84*	0.87*	1.20*	0.98*	0.86*	
QKHN 27	17	1.25	1.00	0.76	1.10	0.93	1.31	0.94	0.81	1.29	1.10	1.24	1.79	0.98	0.86	0.87	1.69	1.11
		1.13*	0.90*	0.68*	0.99*	0.84*	1.18*	0.85*	0.73*	1.16*	0.99*	1.12*	1.61*	0.88*	0.77*	0.78*	1.52*	
QKHN 27	20	1.35	1.53	1.29	1.62	2.11	1.31	1.25	1.17	1.19	1.49	1.58	1.62	1.85	1.78	1.62	1.45	1.41
		0.96*	1.09*	0.91*	1.15*	1.50*	0.93*	0.89*	0.83*	0.84*	1.06*	1.12*	1.15*	1.31*	1.26*	1.15*	1.03*	
QKHN 27	21	1.38	2.07	1.68	1.59	1.51	1.46	0.79	1.05	0.79	0.53	1.35	1.36	1.08	0.87	1.11	0.97	1.27
		1.09*	1.63*	1.32*	1.25*	1.19*	1.15*	0.62*	0.83*	0.62*	0.42*	1.06*	1.07*	0.85*	0.69*	0.87*	0.76*	
QKHN 37	1	1.88	_1.81_	_1.74_	_1.66_	1.59	2.09	2.05	_2.15_	2.24	_2.18_	_2.13_	2.07	1.95	1.53	1.88	2.77	2.08
		0.90*	0.93*	0.95*	0.98*	0.76*	1.00*	0.99*	1.03*	1.08*	1.05*	1.02*	1.00*	0.94*	0.74*	0.90*	1.33*	
QKHN 38	2	1.75	1.62	1.61	1.17	2.01	1.74	1.77	1.66	1.77	1.62	1.76	2.12	1.99	1.34	1.64	1.53	1.71
		1.02*	0.95*	0.94*	0.68*	1.18*	1.02*	1.04*	0.97*	1.04*	0.95*	1.03*	1.24*	1.16*	0.78*	0.96*	0.89*	
QKHO 5	1	1.62	_1.86_	2.10	2.11	2.64	2.05	1.89	1.92	1.94	2.21	_1.98_	1.75	2.26	2.11	2.18	1.92	1.98
		0.82*	0.94*	1.06*	1.07*	1.33*	1.04*	0.95*	0.97*	0.98*	1.12*	1.00*	0.88*	1.14*	1.07*	1.10*	0.97*	
QKHO 5	2	1.92	1.73	_1.57_	1.40	1.85	1.55	1.77	1.97	2.15	2.00	_1.87_	_1.74_	1.61	1.58	1.94	_1.93_	1.75
		1.10*	0.99*	0.90*	0.80*	1.06*	0.89*	1.01*	1.13*	1.23*	1.14*	1.07*	0.99*	0.92*	0.90*	1.11*	1.10*	

* Denotes standardized scores (Sedecant mean divided by Feature mean). Numbers in italics denote extrapolated values.

Table A4c: Average Distance to Perimeter Rocks *per* Sedecant Oriented to North.

SITE	FEATURE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	FEATURE MEAN
		AVERAGE DISTANCE PER SEDECANT (m.)																
RCHH 1	46	1.59	2.19	1.82	2.00	1.77	1.54	1.47	1.70	2.40	2.61	2.07	2.05	1.98	1.91	1.88	1.74	1.95
		0.82*	1.12*	0.93*	1.03*	0.91*	0.79*	0.75*	0.87*	1.23*	1.34*	1.06*	1.05*	1.02*	0.98*	0.96*	0.89*	
RCHH 1	47	2.26	1.99	1.76	1.33	1.49	1.32	1.67	1.90	1.78	1.80	1.93	1.83	1.61	1.71	2.08	2.16	1.83
		1.24*	1.09*	0.96*	0.73*	0.81*	0.72*	0.91*	1.04*	0.97*	0.98*	1.05*	1.00*	0.88*	0.93*	1.14*	1.18*	
RCHH 1	48	1.53	1.70	1.50	1.66	1.73	1.35	1.38	1.32	1.60	1.77	*1.71*	1.64	1.63	1.22	1.23	1.50	1.56
		0.98*	1.09*	0.96*	1.06*	1.11*	0.87*	0.88*	0.85*	1.03*	1.13*	1.10*	1.05*	1.04*	0.78*	0.79*	0.96*	
RCHH 1	53	2.15	*2.25*	2.35	1.89	*1.90*	1.91	1.99	2.27	1.76	1.75	1.88	1.70	1.32	1.43	1.83	2.06	1.91
		1.13*	1.18*	1.23*	0.99*	0.99*	1.00*	1.04*	1.19*	0.92*	0.92*	0.98*	0.89*	0.69*	0.75*	0.96*	1.08*	
RCHH 1	58	2.02	1.88	*1.39*	0.89	*1.43*	1.96	1.68	1.91	2.14	2.33	1.99	1.80	1.62	2.14	2.26	*2.14*	1.97
		1.03*	0.95*	0.71*	0.45*	0.73*	0.99*	0.85*	0.97*	1.09*	1.18*	1.01*	0.91*	0.82*	1.09*	1.15*	1.09*	
SKRUIS POINT 1		2.32	1.69	1.74	2.15	1.88	2.41	1.75	1.52	1.38	1.76	1.24	1.12	2.20	1.42	1.31	1.69	1.73
		1.34*	0.98*	1.01*	1.24*	1.09*	1.39*	1.01*	0.88*	0.80*	1.02*	0.72*	0.65*	1.27*	0.82*	0.76*	0.98*	
SKRUIS POINT 2		1.15	1.55	1.39	1.07	0.91	0.78	1.14	*1.47*	1.58	1.52	1.45	1.40	1.10	1.13	1.60	1.55	1.23
		0.93*	1.26*	1.13*	0.87*	0.74*	0.63*	0.93*	1.20*	1.28*	1.24*	1.18*	1.14*	0.89*	0.92*	1.30*	1.26*	
SKRUIS POINT 3		1.33	2.02	1.71	1.53	1.39	1.27	1.27	1.55	1.10	1.55	1.43	0.98	0.86	1.48	1.22	1.20	1.41
		0.94*	1.43*	1.21*	1.09*	0.99*	0.90*	0.90*	1.10*	0.78*	1.10*	1.01*	0.70*	0.61*	1.05*	0.87*	0.85*	
SKRUIS POINT 4		1.70	1.55	1.50	1.07	1.09	1.34	1.58	2.00	1.61	1.40	1.25	1.21	1.67	1.50	1.60	1.82	1.50
		1.13*	1.03*	1.00*	0.71*	0.73*	0.89*	1.05*	1.33*	1.07*	0.93*	0.83*	0.81*	1.11*	1.00*	1.07*	1.21*	
SKRUIS POINT 5		0.95	0.95	0.75	0.81	0.77	0.70	1.04	0.96	0.74	1.02	1.01	0.91	0.65	0.98	1.01	1.06	0.87
		1.09*	1.09*	0.86*	0.93*	0.89*	0.80*	1.20*	1.10*	0.85*	1.17*	1.16*	1.05*	0.75*	1.13*	1.16*	1.22*	

* Denotes standardized scores (Sedecant mean divided by Feature mean). Numbers in italics denote extrapolated values.

Table A5a: Average Distance to Perimeter Rocks *per* Sedecant Oriented to Beach.

AVERAGE DISTANCE TO PERIMETER ROCKS PER SEDECANT (m)

SITE	FEATURE	SEDECANT F	FFR	FR	FRF	R	RBR	BR	BBR	B	BBL	BL	LBL	L	LFL	FL	FFL	FEATURE MEAN
QKHL 5	1	1.64	1.85	1.80	1.42	2.03	2.26	2.75	2.48	2.14	1.69	1.70	2.18	1.78	2.09	2.38	2.16	2.04
		0.80*	0.91*	0.88*	0.70*	1.00*	1.11*	1.35*	1.22*	1.05*	0.83*	0.83*	1.07*	0.87*	1.02*	1.17*	1.06*	
QKHL 5	2	1.91	1.76	2.03	1.05	1.84	1.81	1.78	1.63	1.50	1.79	2.06	1.70	1.15	1.46	1.62	1.55	1.70
		1.12*	1.04*	1.19*	0.62*	1.08*	1.06*	1.05*	0.96*	0.88*	1.05*	1.21*	1.00*	0.68*	0.86*	0.95*	0.91*	
QKHL 5	3	1.68	1.81	1.68	2.02	2.07	1.59	1.39	1.52	1.00	2.01	1.43	1.25	1.02	1.45	1.82	1.98	1.58
		1.06*	1.15*	1.06*	1.28*	1.31*	1.01*	0.88*	0.96*	0.63*	1.27*	0.91*	0.79*	0.65*	0.92*	1.15*	1.25*	
QKHL 66	1	*2.12*	*2.11*	*2.10*	2.09	*2.17*	2.24	1.94	1.43	*1.48*	1.53	1.76	1.53	1.82	2.27	*2.20*	2.13	1.97
		1.02*	1.03*	1.05*	1.06*	1.10*	1.14*	0.98*	0.73*	0.75*	0.78*	0.89*	0.78*	0.92*	1.15*	1.12*	1.08*	
QKHN 12	4	2.08	2.77	3.17	3.04	2.38	2.48	2.10	2.24	2.74	3.16	3.18	2.84	2.62	2.31	2.10	2.11	2.65
		0.78*	1.05*	1.20*	1.15*	0.90*	0.94*	0.79*	0.85*	1.03*	1.19*	1.20*	1.07*	0.99*	0.87*	0.79*	0.80*	
QKHN 12	6	*1.79*	2.27	2.28	*2.23*	*2.17*	*2.12*	*2.06*	*2.01*	1.95	*1.70*	1.44	*1.37*	*1.30*	1.23	0.99	1.31	1.47
		1.27*	1.54*	1.55*	1.52*	1.48*	1.44*	1.40*	1.37*	1.33*	1.16*	0.98*	0.93*	0.88*	0.84*	0.67*	0.89*	
QKHN 12	7	3.03	2.75	3.07	3.14	2.77	2.43	2.42	2.55	2.91	3.03	3.28	2.60	3.01	2.40	2.05	2.53	2.77
		1.09*	0.99*	1.11*	1.13*	1.00*	0.88*	0.87*	0.92*	1.05*	1.09*	1.18*	0.94*	1.09*	0.87*	0.74*	0.91*	
QKHN 12	10	2.20	2.10	2.49	2.31	2.98	2.26	2.40	2.47	2.62	*2.30*	1.98	*2.50*	3.01	1.64	2.26	2.43	2.48
		0.89*	0.85*	1.00*	0.93*	1.20*	0.91*	0.97*	1.00*	1.06*	0.93*	0.80*	1.01*	1.21*	0.66*	0.91*	0.98*	
QKHN 13	1	1.75	1.74	2.13	1.07	1.60	1.69	1.71	1.86	2.16	2.18	1.89	1.86	1.81	1.95	0.97	1.86	1.80
		0.97*	0.97*	1.18*	0.59*	0.89*	0.94*	0.95*	1.03*	1.20*	1.21*	1.05*	1.03*	1.01*	1.08*	0.54*	1.03*	
QKHN 13	2	1.58	*1.69*	*1.79*	*1.90*	*2.00*	*2.11*	*2.21*	2.31	2.11	*1.48*	0.84	*0.82*	*0.80*	*0.79*	0.77	2.18	1.69
		0.93*	1.00*	1.06*	1.12*	1.18*	1.25*	1.31*	1.37*	1.25*	0.88*	0.50*	0.49*	0.47*	0.47*	0.46*	1.29*	
QKHN 13	4	1.67	1.18	1.60	1.74	1.98	1.99	2.24	2.08	2.20	2.18	2.03	1.93	1.93	1.47	1.93	1.68	1.91
		0.87*	0.62*	0.84*	0.91*	1.04*	1.04*	1.17*	1.09*	1.15*	1.14*	1.06*	1.01*	1.01*	0.77*	1.01*	0.88*	
QKHN 13	5	*1.34*	1.14	2.10	*2.46*	2.81	2.57	*2.63*	2.69	*2.20*	1.70	1.75	2.45	2.57	3.58	2.61	1.53	2.51
		0.73*	0.45*	0.84*	0.98*	1.12*	1.02*	1.05*	1.07*	0.88*	0.68*	0.70*	0.98*	1.02*	1.43*	1.04*	0.61*	
QKHN 13	8	1.79	1.49	1.30	1.28	1.68	1.71	1.60	1.59	1.30	1.57	0.89	1.26	1.63	1.43	0.53	*1.16*	1.48
		1.21*	1.01*	0.88*	0.86*	1.14*	1.16*	1.08*	1.07*	0.88*	1.06*	0.60*	0.85*	1.10*	0.97*	0.36*	0.68*	
QKHN 13	9	1.62	2.41	1.52	1.86	1.48	*1.20*	0.92	1.12	1.92	1.75	1.54	1.24	0.94	*1.51*	*2.08*	2.65	1.65
		0.98*	1.46*	0.92*	1.13*	0.90*	0.73*	0.56*	0.68*	1.16*	1.06*	0.93*	0.75*	0.57*	0.92*	1.26*	1.61*	
QKHN 13	11	*0.92*	1.21	1.13	1.31	*1.25*	1.18	1.24	1.07	1.41	0.78	0.89	0.58	1.05	1.17	0.36	*0.64*	1.05
		1.08*	1.15*	1.08*	1.25*	1.19*	1.12*	1.18*	1.02*	1.34*	0.74*	0.85*	0.55*	1.00*	1.11*	0.34*	0.68*	
QKHN 13	14	1.30	1.56	1.34	1.15	1.99	2.40	2.08	2.17	2.40	2.39	2.59	2.44	2.22	2.18	1.69	2.29	2.15
		0.60*	0.73*	0.62*	0.53*	0.93*	1.12*	0.97*	1.01*	1.12*	1.11*	1.20*	1.13*	1.03*	1.01*	0.79*	1.07*	
QKHN 13	16	1.46	*1.38*	1.29	*1.47*	1.65	1.58	1.80	1.49	1.49	1.39	1.86	1.43	1.29	1.36	1.54	1.74	1.57
		0.93*	0.88*	0.82*	0.94*	1.05*	1.01*	1.15*	0.95*	0.95*	0.89*	1.18*	0.91*	0.82*	0.87*	0.98*	1.11*	

* Denotes standardized scores (Sedecant mean divided by Feature mean). Numbers in italics denote extrapolated values.

Table A5b: Average Distance to Perimeter Rocks *per* Sedecant Oriented to Beach.

AVERAGE DISTANCE TO PERIMETER ROCKS PER SEDECANT (m)

SITE	FEATURE	F	FFR	FR	FRF	R	RBR	BR	BBR	B	BBL	BL	LBL	L	LFL	FL	FFL	FEATURE MEAN
QKHN 17	1	1.72	1.93	1.53	1.56	1.18	1.82	1.90	2.11	1.95	1.50	1.66	1.71	1.51	1.25	1.16	1.04	1.66
		1.04*	1.16*	0.92*	0.94*	0.71*	1.10*	1.14*	1.27*	1.17*	0.90*	1.00*	1.03*	0.91*	0.75*	0.70*	0.63*	
QKHN 17	3	1.90	2.48	2.45	2.99	3.04	*3.06*	3.07	2.77	2.98	*2.91*	2.83	2.58	2.57	3.23	2.16	2.11	2.58
		0.74*	0.96*	0.95*	1.16*	1.18*	1.19*	1.19*	1.07*	1.16*	1.13*	1.10*	1.00*	1.00*	1.25*	0.84*	0.82*	
QKHN 17	4	2.26	1.98	*1.77*	1.55	2.30	2.56	2.01	2.10	2.39	2.22	2.43	2.17	2.29	1.78	2.01	2.19	2.18
		1.04*	0.91*	0.81*	0.71*	1.06*	1.17*	0.92*	0.96*	1.10*	1.02*	1.11*	1.00*	1.05*	0.82*	0.92*	1.00*	
QKHN 22	8	2.30	2.10	1.46	1.80	2.18	1.50	1.04	1.42	2.78	2.98	2.66	2.01	2.10	2.11	2.48	1.61	2.11
		1.09*	1.00*	0.69*	0.85*	1.03*	0.71*	0.49*	0.67*	1.32*	1.41*	1.26*	0.95*	1.00*	1.00*	1.18*	0.76*	
QKHN 27	3	1.39	1.18	2.05	1.62	*1.66*	1.69	0.95	0.93	1.47	1.74	0.72	1.24	1.18	1.26	0.91	1.32	1.38
		1.01*	0.86*	1.49*	1.17*	1.20*	1.22*	0.69*	0.67*	1.07*	1.26*	0.52*	0.90*	0.86*	0.91*	0.66*	0.96*	
QKHN 27	6	0.83	0.84	*1.07*	1.30	*1.34*	1.38	1.60	*1.51*	1.41	*1.59*	1.77	*1.66*	*1.56*	1.45	1.26	0.91	1.26
		0.66*	0.67*	0.85*	1.03*	1.06*	1.10*	1.27*	1.20*	1.12*	1.26*	1.40*	1.32*	1.24*	1.15*	1.00*	0.72*	
QKHN 27	7	1.63	1.15	1.86	1.12	1.53	0.86	1.09	1.35	1.16	*1.30*	1.44	1.68	2.45	1.57	1.59	1.34	1.43
		1.14*	0.80*	1.30*	0.78*	1.07*	0.60*	0.76*	0.94*	0.81*	0.91*	1.01*	1.17*	1.71*	1.10*	1.11*	0.94*	
QKHN 27	8	*1.00*	1.51	1.88	1.99	1.25	1.42	1.23	1.24	1.73	1.52	1.17	1.34	1.64	1.53	1.79	0.48	1.45
		1.02*	1.04*	1.30*	1.37*	0.86*	0.98*	0.85*	0.86*	1.19*	1.05*	0.81*	0.92*	1.13*	1.06*	1.23*	0.33*	
QKHN 27	12	1.12	0.88	0.92	1.11	1.37	*1.27*	1.16	1.94	0.89	1.28	1.38	1.51	1.69	*1.56*	1.42	1.62	1.26
		0.89*	0.70*	0.73*	0.88*	1.09*	1.01*	0.92*	1.54*	0.71*	1.02*	1.10*	1.20*	1.34*	1.24*	1.13*	1.29*	
QKHN 27	15	1.64	1.45	1.83	2.08	1.67	1.31	1.35	2.24	1.34	1.23	1.73	2.39	*1.90*	1.41	1.46	2.02	1.68
		0.98*	0.86*	1.09*	1.24*	0.99*	0.78*	0.80*	1.33*	0.80*	0.73*	1.03*	1.42*	1.13*	0.84*	0.87*	1.20*	
QKHN 27	17	0.87	1.69	1.25	1.00	0.76	1.10	0.93	1.31	0.94	0.81	1.29	1.10	1.24	1.79	0.98	0.86	1.11
		0.78*	1.52*	1.13*	0.90*	0.68*	0.99*	0.84*	1.18*	0.85*	0.73*	1.16*	0.99*	1.12*	1.61*	0.88*	0.77*	
QKHN 27	20	1.62	1.45	1.35	1.53	1.29	1.62	2.11	1.31	1.25	1.17	1.19	1.49	1.58	1.62	1.85	1.78	1.41
		1.15*	1.03*	0.96*	1.09*	0.91*	1.15*	1.50*	0.93*	0.89*	0.83*	0.84*	1.06*	1.12*	1.15*	1.31*	1.26*	
QKHN 27	21	1.11	0.97	1.38	2.07	1.68	1.59	1.51	1.46	0.79	1.05	0.79	0.53	1.35	1.36	1.08	0.87	1.27
		0.87*	0.76*	1.09*	1.63*	1.32*	1.25*	1.19*	1.15*	0.62*	0.83*	0.62*	0.42*	1.06*	1.07*	0.85*	0.69*	
QKHN 37	1	1.59	2.09	2.05	*2.15*	2.24	*2.18*	*2.13*	2.07	1.95	1.53	1.88	2.77	1.88	*1.81*	*1.74*	*1.66*	2.08
		0.76*	1.00*	0.99*	1.03*	1.08*	1.05*	1.02*	1.00*	0.94*	0.74*	0.90*	1.33*	0.90*	0.93*	0.95*	0.98*	
QKHN 38	2	1.99	1.34	1.64	1.53	1.75	1.62	1.61	1.17	2.01	1.74	1.77	1.66	1.77	1.62	1.76	2.12	1.71
		1.16*	0.78*	0.96*	0.89*	1.02*	0.95*	0.94*	0.68*	1.18*	1.02*	1.04*	0.97*	1.04*	0.95*	1.03*	1.24*	
QKHO 5	1	2.18	1.92	1.62	*1.86*	2.10	2.11	2.64	2.05	1.89	1.92	1.94	2.21	*1.98*	1.75	2.26	2.11	1.98
		1.10*	0.97*	0.82*	0.94*	1.06*	1.07*	1.33*	1.04*	0.95*	0.97*	0.98*	1.12*	1.00*	0.88*	1.14*	1.07*	
QKHO 5	2	1.94	*1.93*	1.92	1.73	*1.57*	1.40	1.85	1.55	1.77	1.97	2.15	2.00	*1.87*	*1.74*	1.61	1.58	1.75
		1.11*	1.10*	1.10*	0.99*	0.90*	0.80*	1.06*	0.89*	1.01*	1.13*	1.23*	1.14*	1.07*	0.99*	0.92*	0.90*	

* Denotes standardized scores (Sedecant mean divided by Feature mean). Numbers in italics denote extrapolated values.

Table A5c: Average Distance to Perimeter Rocks *per* Sedecant Oriented to Beach.

SITE	FEATURE	F	FFR	FR	FRF	R	RBR	BR	BBR	B	BBL	BL	LBL	L	LFL	FL	FFL	FEATURE MEAN
		AVERAGE DISTANCE PER SEDECANT (m.)																
RCHH 1	46	2.40	2.61	2.07	2.05	1.98	1.91	1.88	1.74	1.59	2.19	1.82	2.00	1.77	1.54	1.47	1.70	1.95
		1.23*	1.34*	1.06*	1.05*	1.02*	0.98*	0.96*	0.89*	0.82*	1.12*	0.93*	1.03*	0.91*	0.79*	0.75*	0.87*	
RCHH 1	47	1.78	1.80	1.93	1.83	1.61	1.71	2.08	2.16	2.26	1.99	1.76	1.33	1.49	1.32	1.67	1.90	1.83
		0.97*	0.98*	1.05*	1.00*	0.88*	0.93*	1.14*	1.18*	1.24*	1.09*	0.96*	0.73*	0.81*	0.72*	0.91*	1.04*	
RCHH 1	48	1.60	1.77	*1.71*	1.64	1.63	1.22	1.23	1.50	1.53	1.70	1.50	1.66	1.73	1.35	1.38	1.32	1.56
		1.03*	1.13*	1.10*	1.05*	1.04*	0.78*	0.79*	0.96*	0.98*	1.09*	0.96*	1.06*	1.11*	0.87*	0.88*	0.85*	
RCHH 1	53	1.76	1.75	1.88	1.70	1.32	1.43	1.83	2.06	2.15	*2.25*	2.35	1.89	*1.90*	1.91	1.99	2.27	1.91
		0.92*	0.92*	0.98*	0.89*	0.69*	0.75*	0.96*	1.08*	1.13*	1.18*	1.23*	0.99*	0.99*	1.00*	1.04*	1.19*	
RCHH 1	58	2.14	2.33	1.99	1.80	1.62	2.14	2.26	*2.14*	2.02	1.88	*1.39*	0.89	*1.43*	1.96	1.68	1.91	1.97
		1.09*	1.18*	1.01*	0.91*	0.82*	1.09*	1.15*	1.09*	1.03*	0.95*	0.71*	0.45*	0.73*	0.99*	0.85*	0.97*	
SKRUIS POINT 1		1.31	1.69	2.32	1.69	1.74	2.15	1.88	2.41	1.75	1.52	1.38	1.76	1.24	1.12	2.20	1.42	1.73
		0.76*	0.98*	1.34*	0.98*	1.01*	1.24*	1.09*	1.39*	1.01*	0.88*	0.80*	1.02*	0.72*	0.65*	1.27*	0.82*	
SKRUIS POINT 2		1.60	1.55	1.15	1.55	1.39	1.07	0.91	0.78	1.14	*1.47*	1.58	1.52	1.45	1.40	1.10	1.13	1.23
		1.30*	1.26*	0.93*	1.26*	1.13*	0.87*	0.74*	0.63*	0.93*	1.20*	1.28*	1.24*	1.18*	1.14*	0.89*	0.92*	
SKRUIS POINT 3		1.22	1.20	1.33	2.02	1.71	1.53	1.39	1.27	1.27	1.55	1.10	1.55	1.43	0.98	0.86	1.48	1.41
		0.87*	0.85*	0.94*	1.43*	1.21*	1.09*	0.99*	0.90*	0.90*	1.10*	0.78*	1.10*	1.01*	0.70*	0.61*	1.05*	
SKRUIS POINT 4		1.67	1.50	1.60	1.82	1.70	1.55	1.50	1.07	1.09	1.34	1.58	2.00	1.61	1.40	1.25	1.21	1.50
		1.11*	1.00*	1.07*	1.21*	1.13*	1.03*	1.00*	0.71*	0.73*	0.89*	1.05*	1.33*	1.07*	0.93*	0.83*	0.81*	
SKRUIS POINT 5		0.65	0.98	1.01	1.06	0.95	0.95	0.75	0.81	0.77	0.70	1.04	0.96	0.74	1.02	1.01	0.91	0.87
		0.75*	1.13*	1.16*	1.22*	1.09*	1.09*	0.86*	0.93*	0.89*	0.80*	1.20*	1.10*	0.85*	1.17*	1.16*	1.05*	

* Denotes standardized scores (Sedecant mean divided by Feature mean). Numbers in italics denote extrapolated values.

APPENDIX B

FEATURE MAPS

This appendix presents plan-view "maps" of each feature analyzed in this study. These drawings were produced directly from the feature data files using a custom-written data transferral program and a commercial CADD program. These maps are not "photo-images" of the actual appearance of the feature. Instead, they are a physical approximation of the appearance of the tent ring.

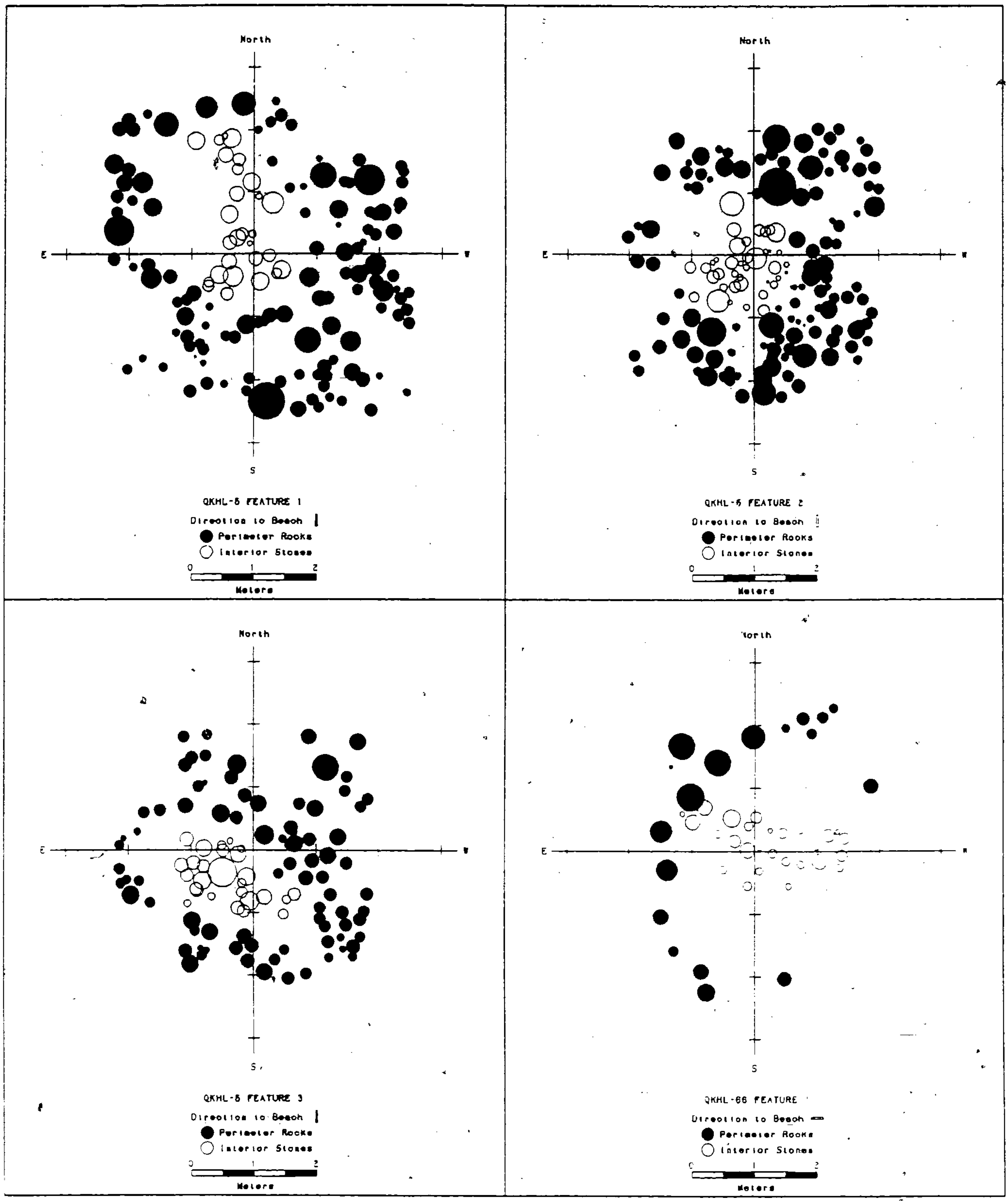


Figure B1 Feature Maps

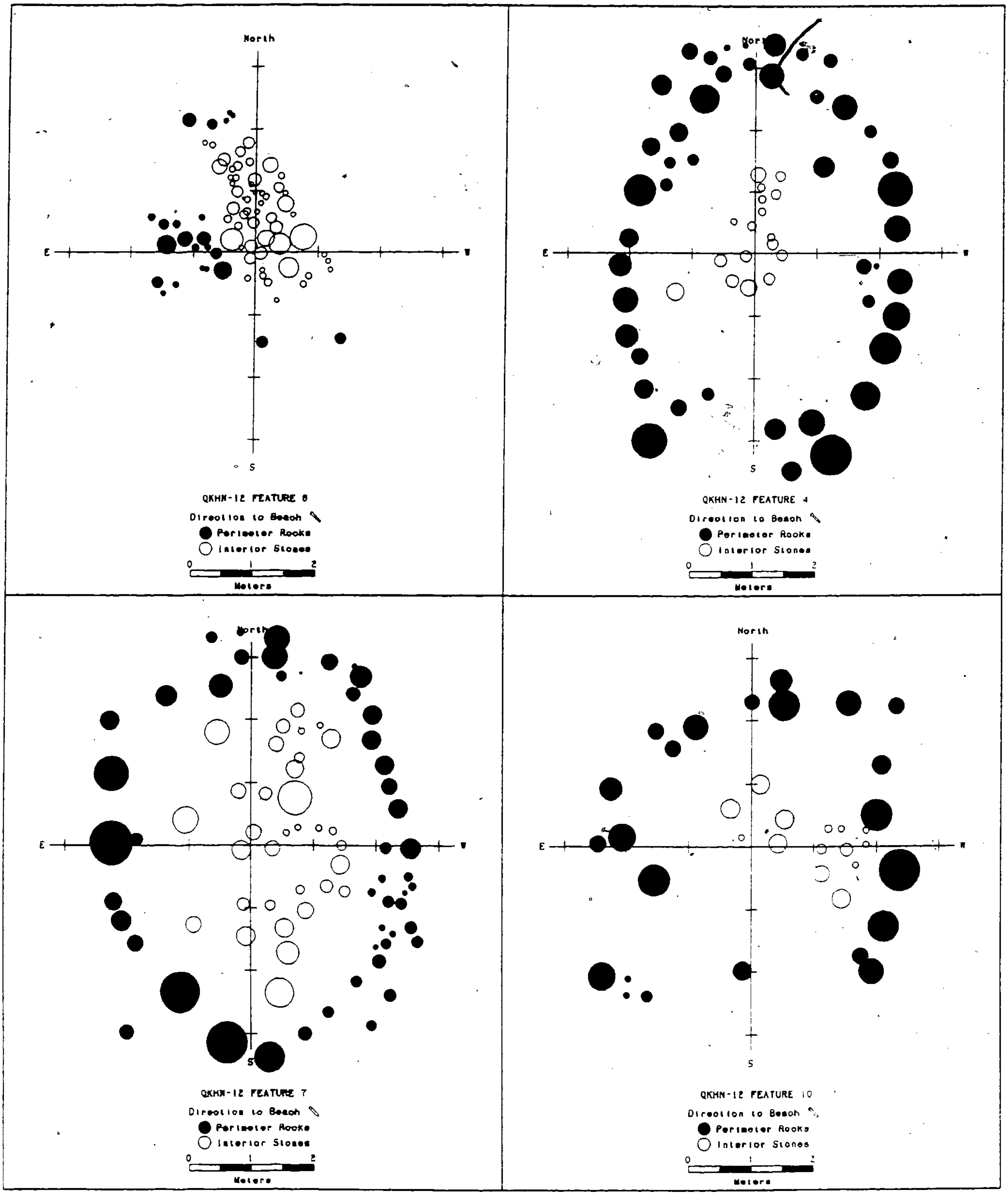


Figure B2. Feature Maps

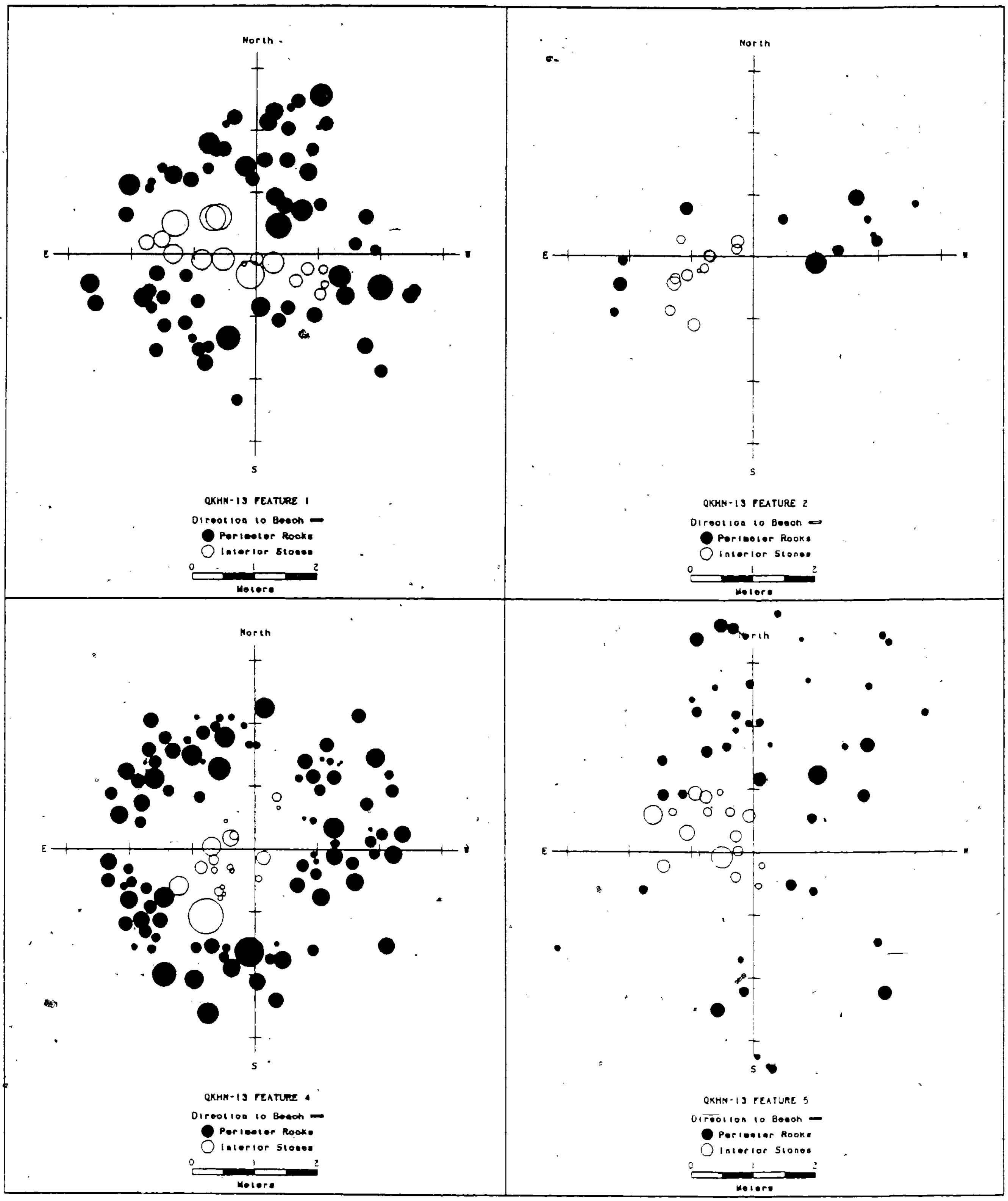


Figure B3. Feature Maps

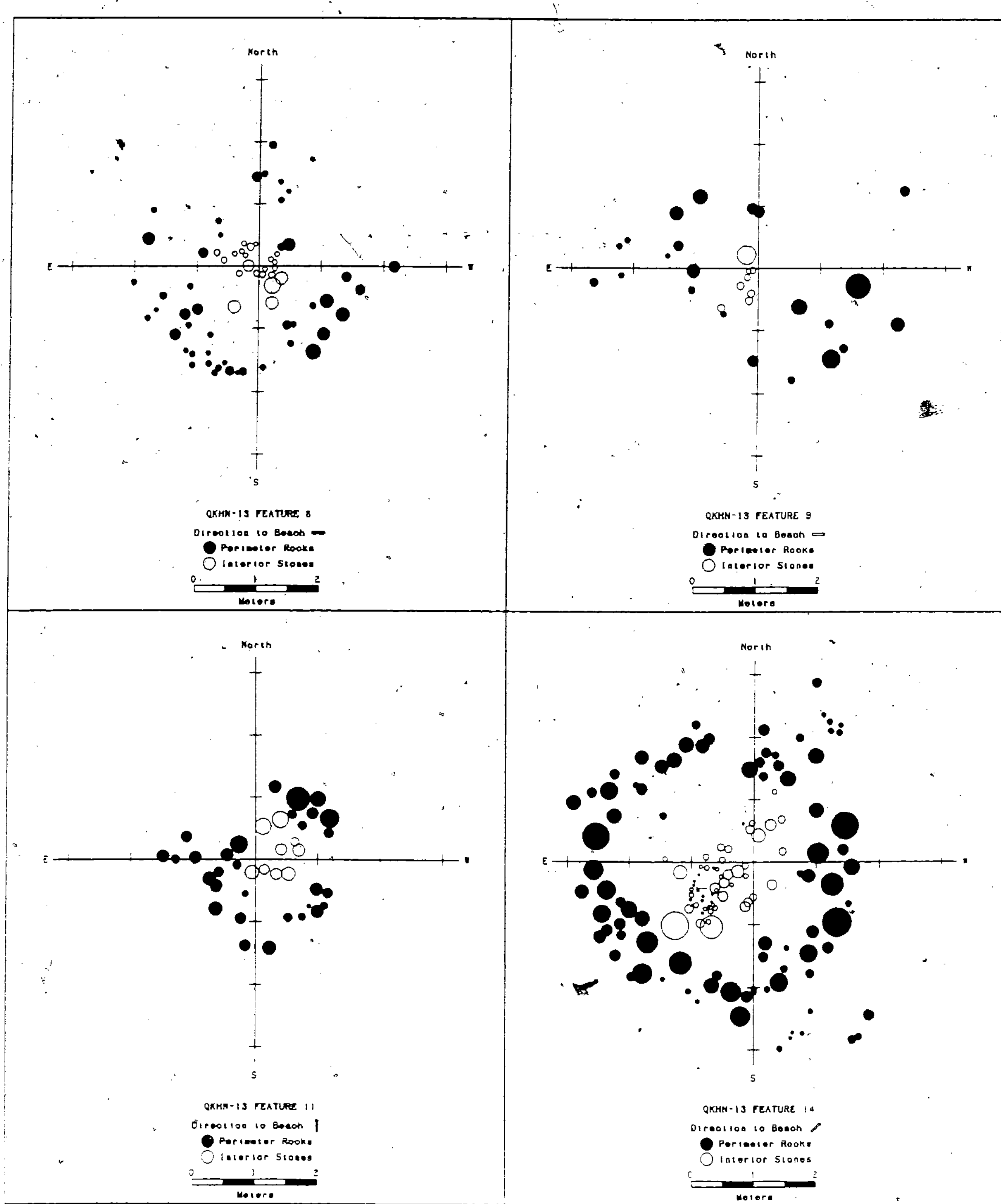


Figure B4 Feature Maps

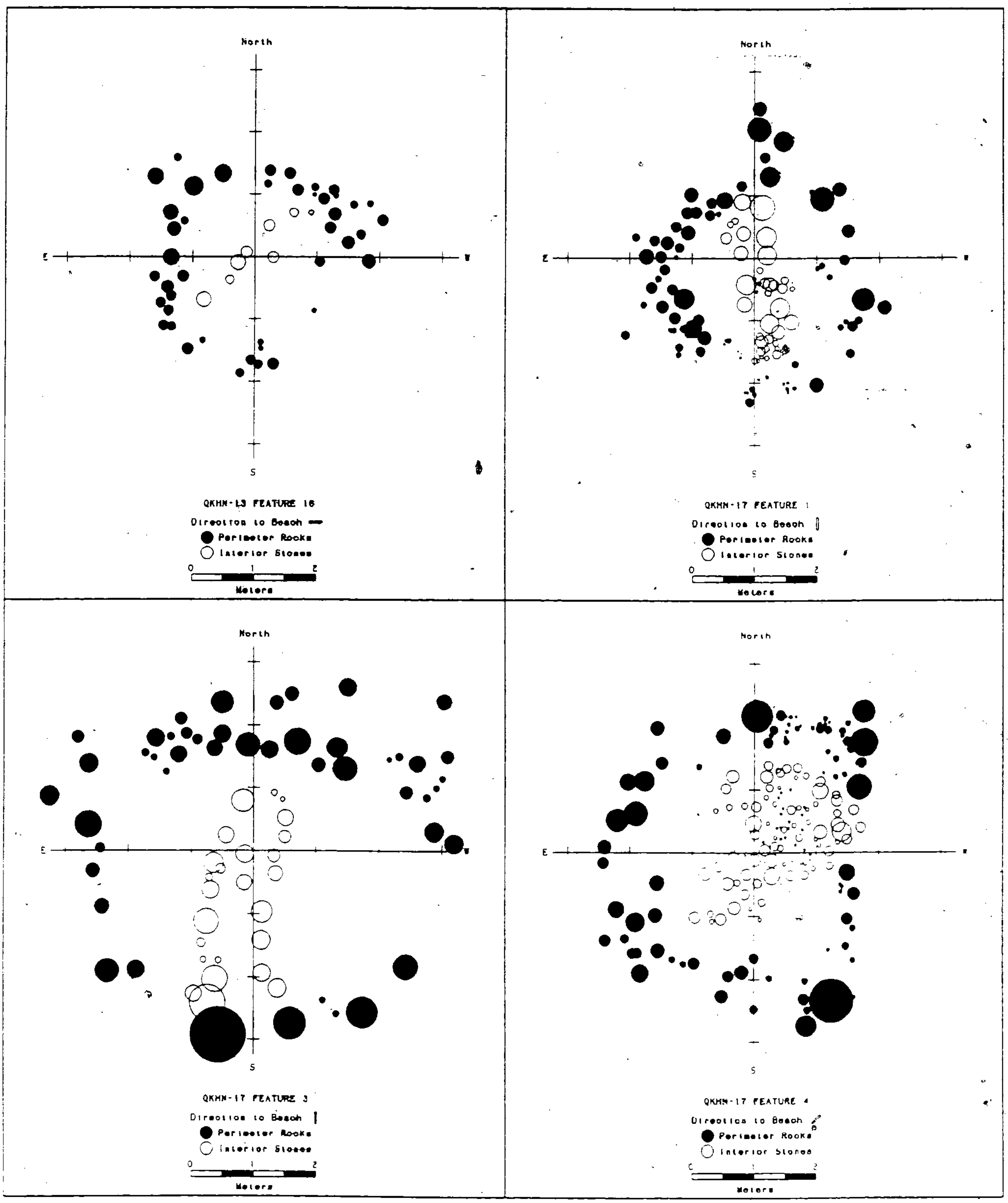


Figure B5 Feature Maps

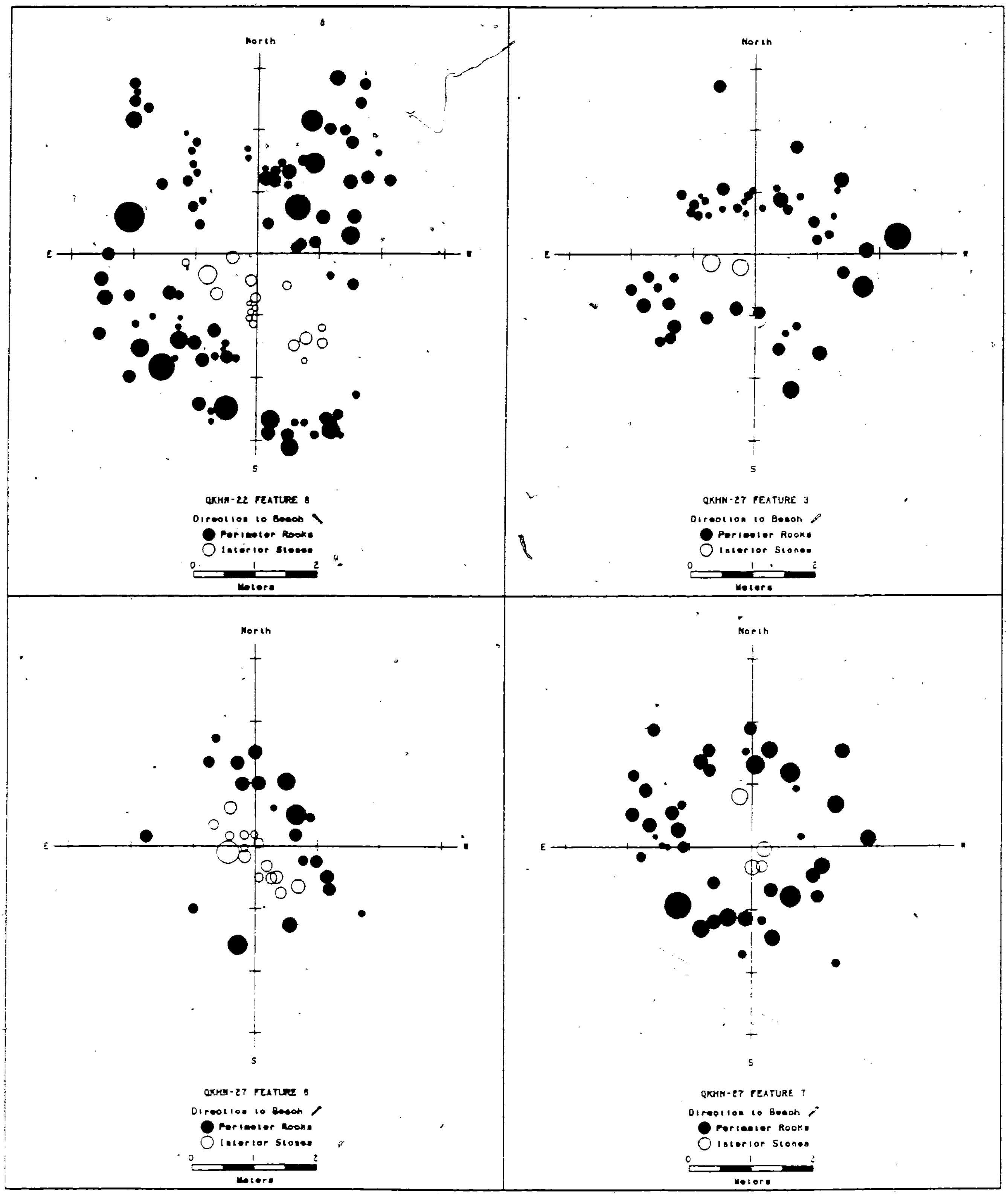


Figure B6 Feature Maps

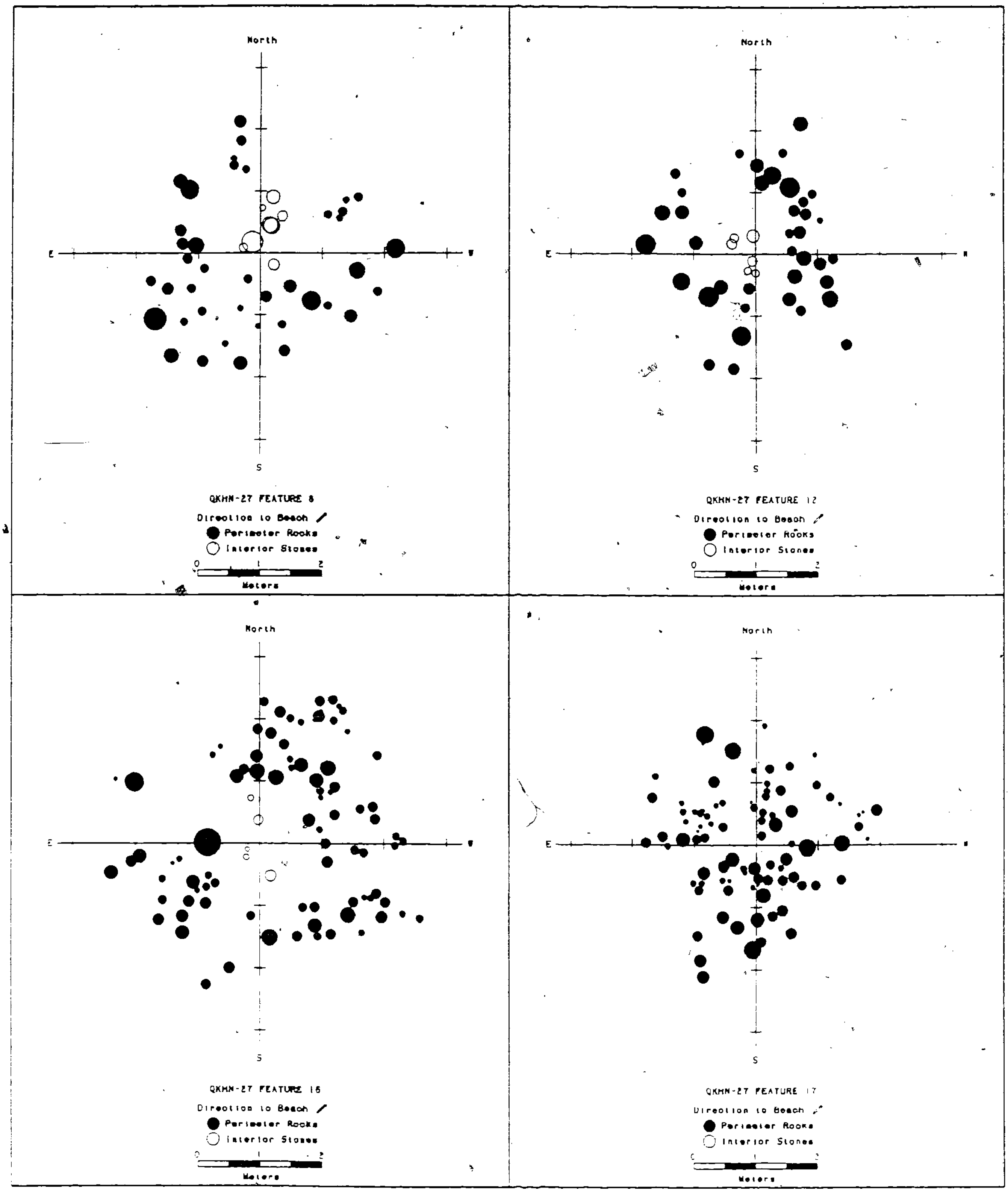


Figure B7 Feature Maps

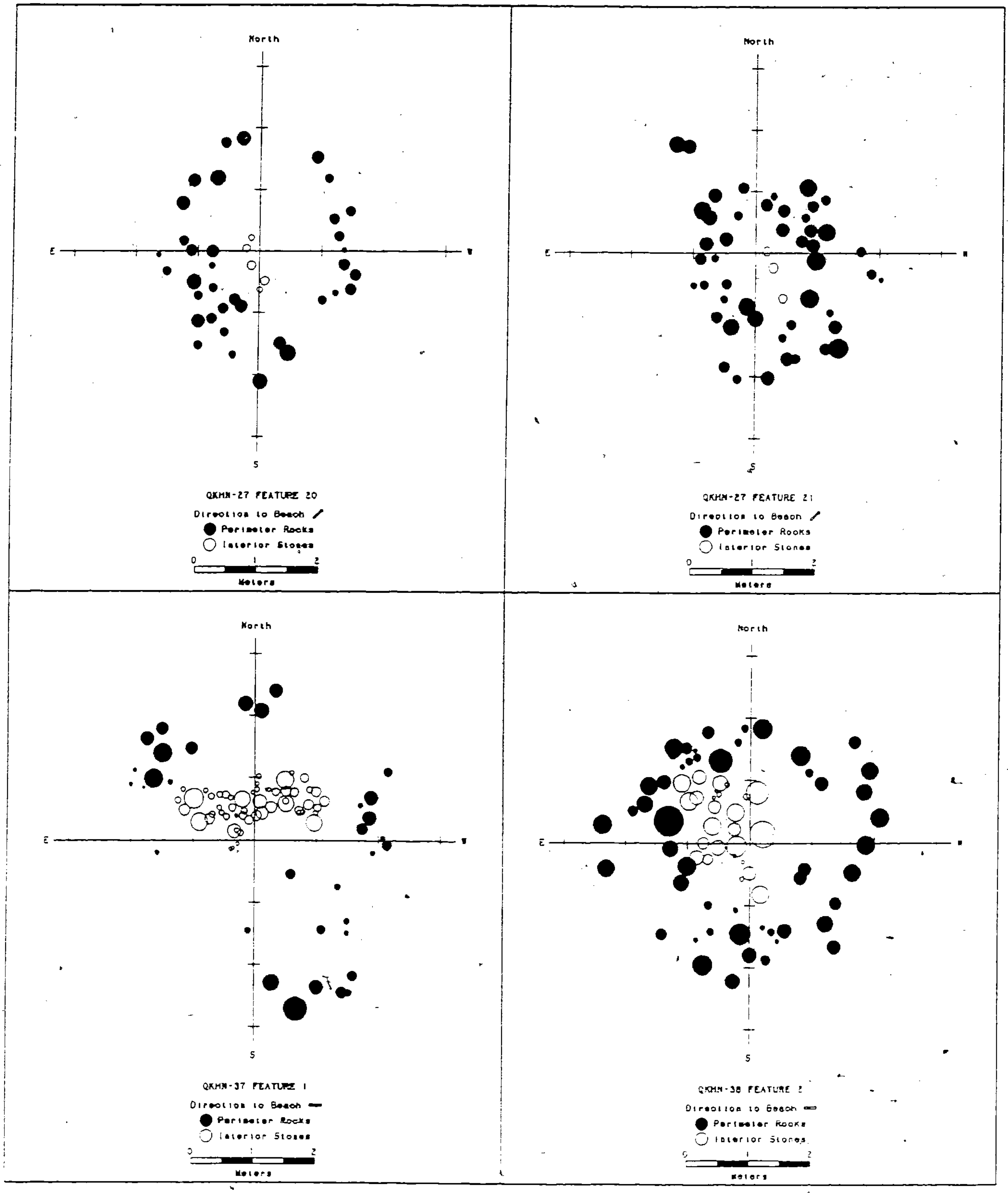


Figure B8 Feature Maps

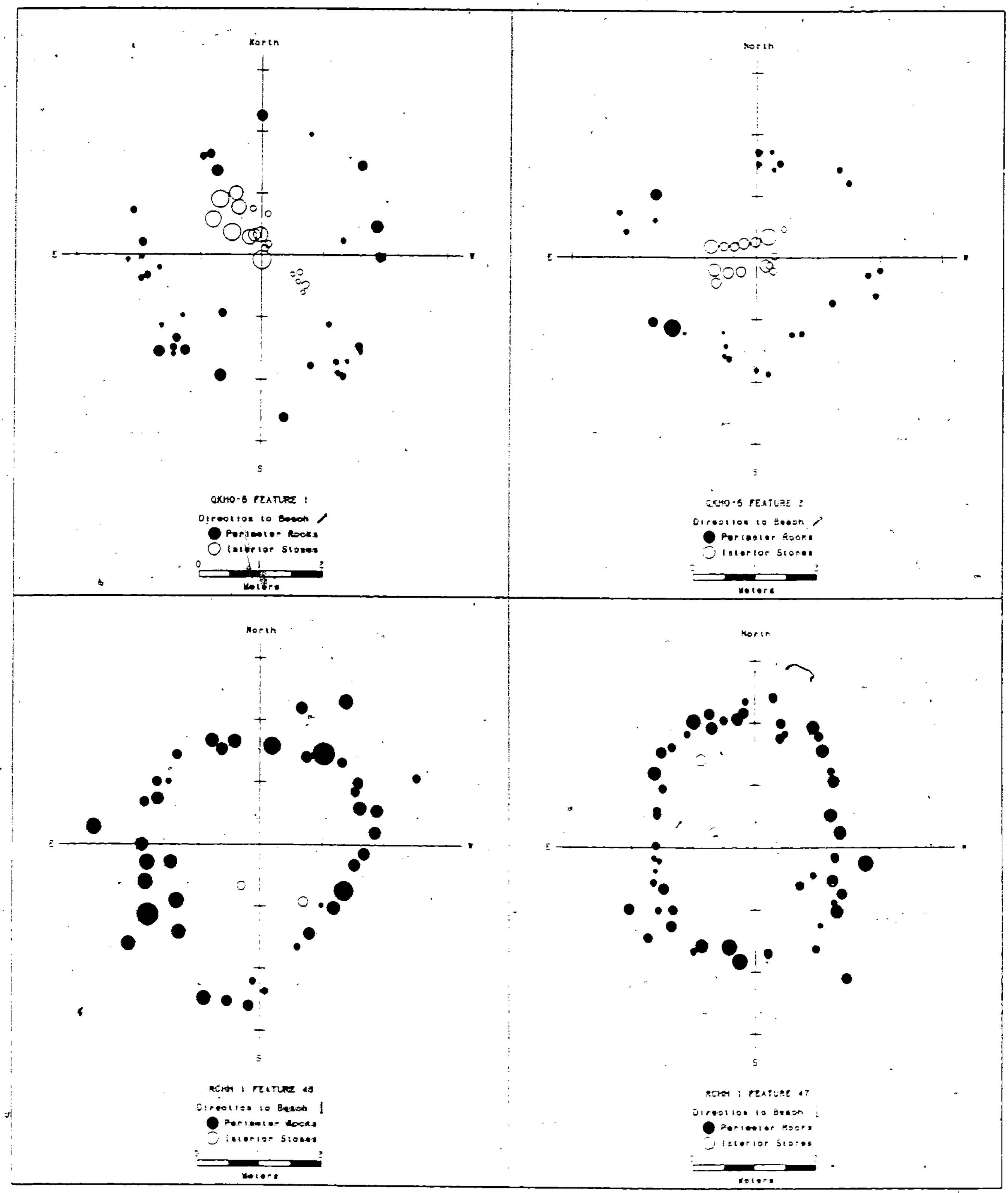


Figure B9 Feature Maps

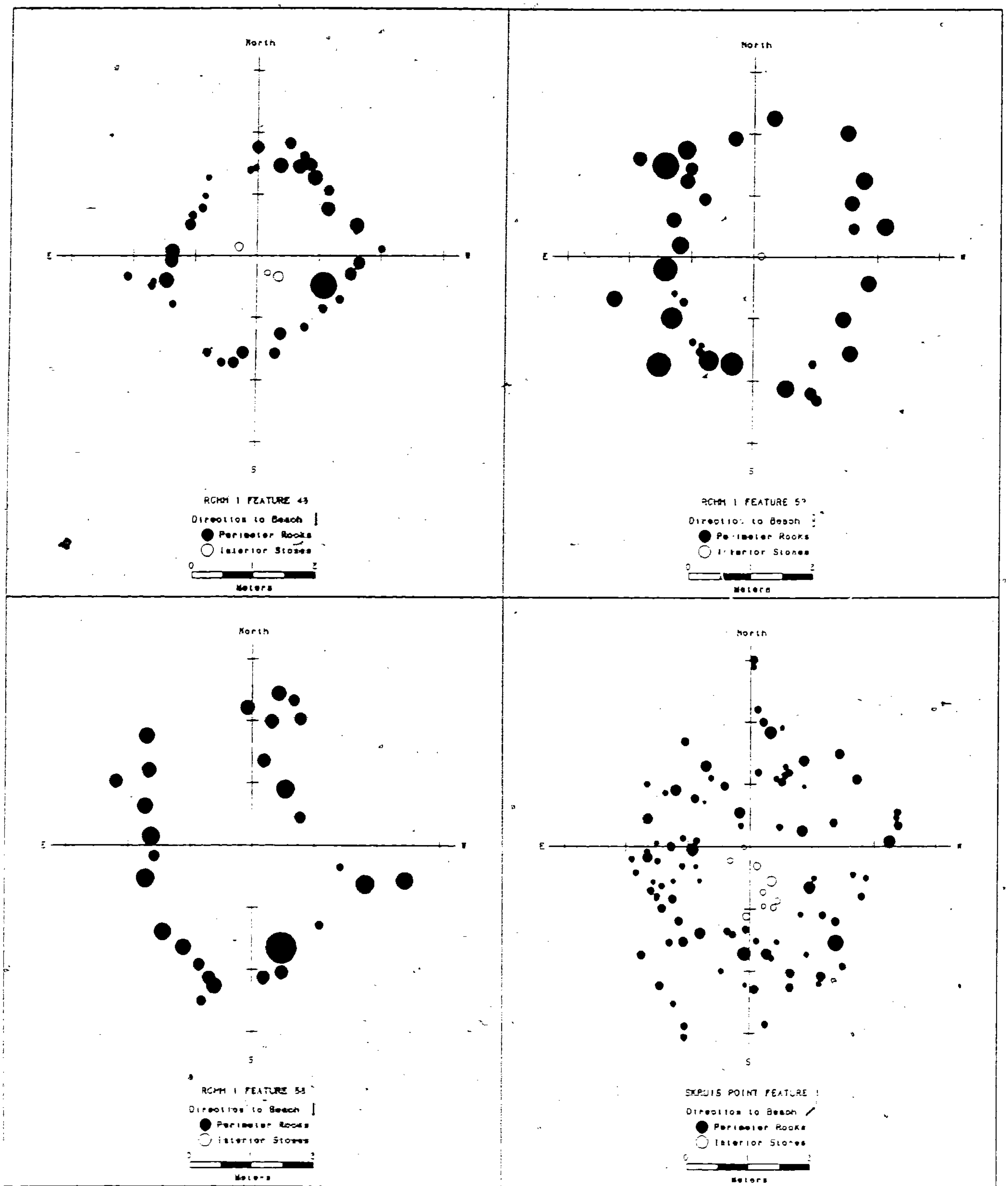


Figure B10 Feature Maps

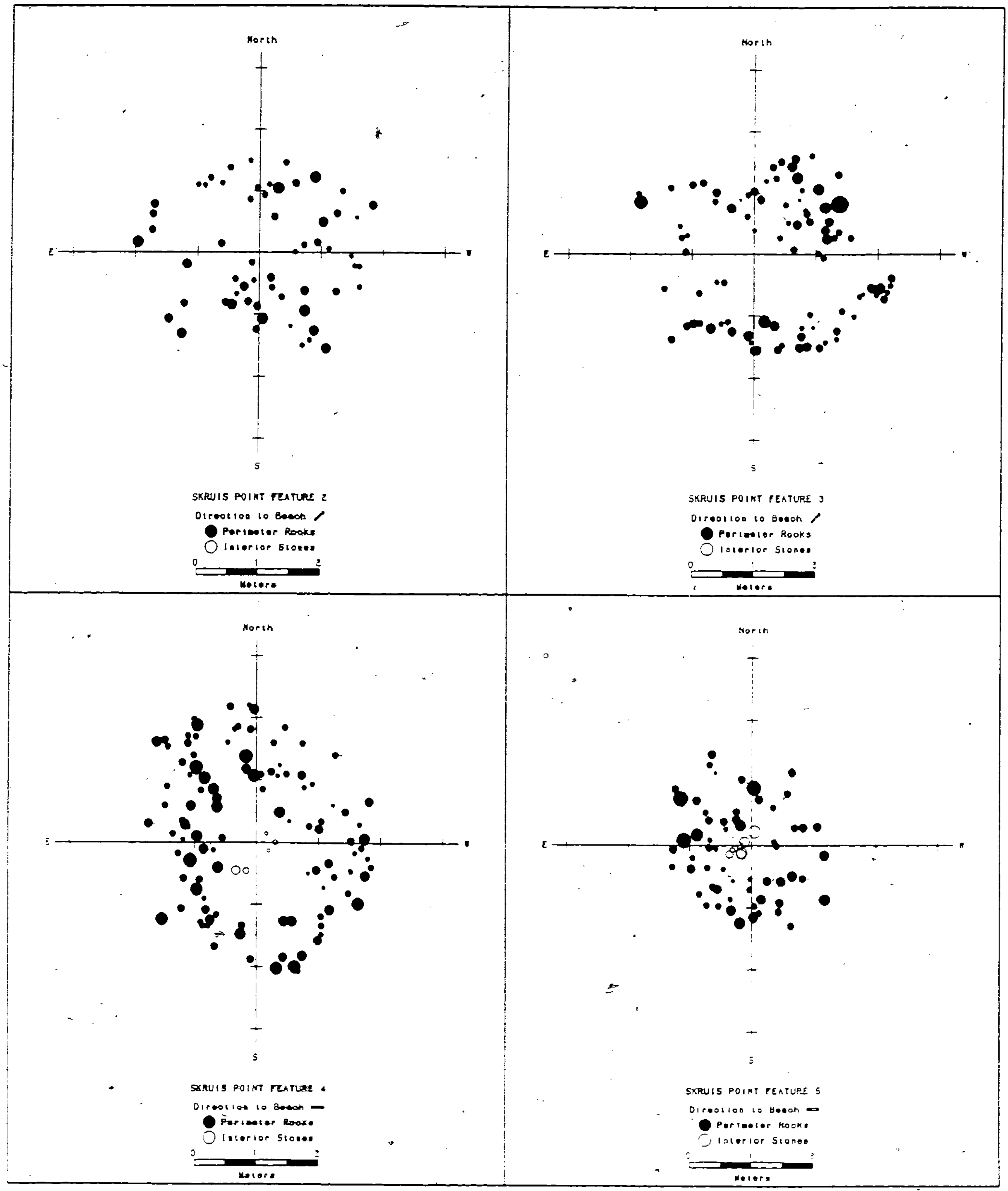


Figure B11 Feature Maps

APPENDIX C

ROSECHARTS

This appendix presents proportional directional piecharts, sometimes called "rose charts", which graphically depict the distribution of rocks about the perimeter of each tent ring involved in this analysis. Four sets of rose charts are presented. They are: the number of rocks *per* quadrant, the size of rock *per* quadrant, the volume of rock *per* quadrant and the average distance to perimeter quadrants oriented to the associated fossil beach.

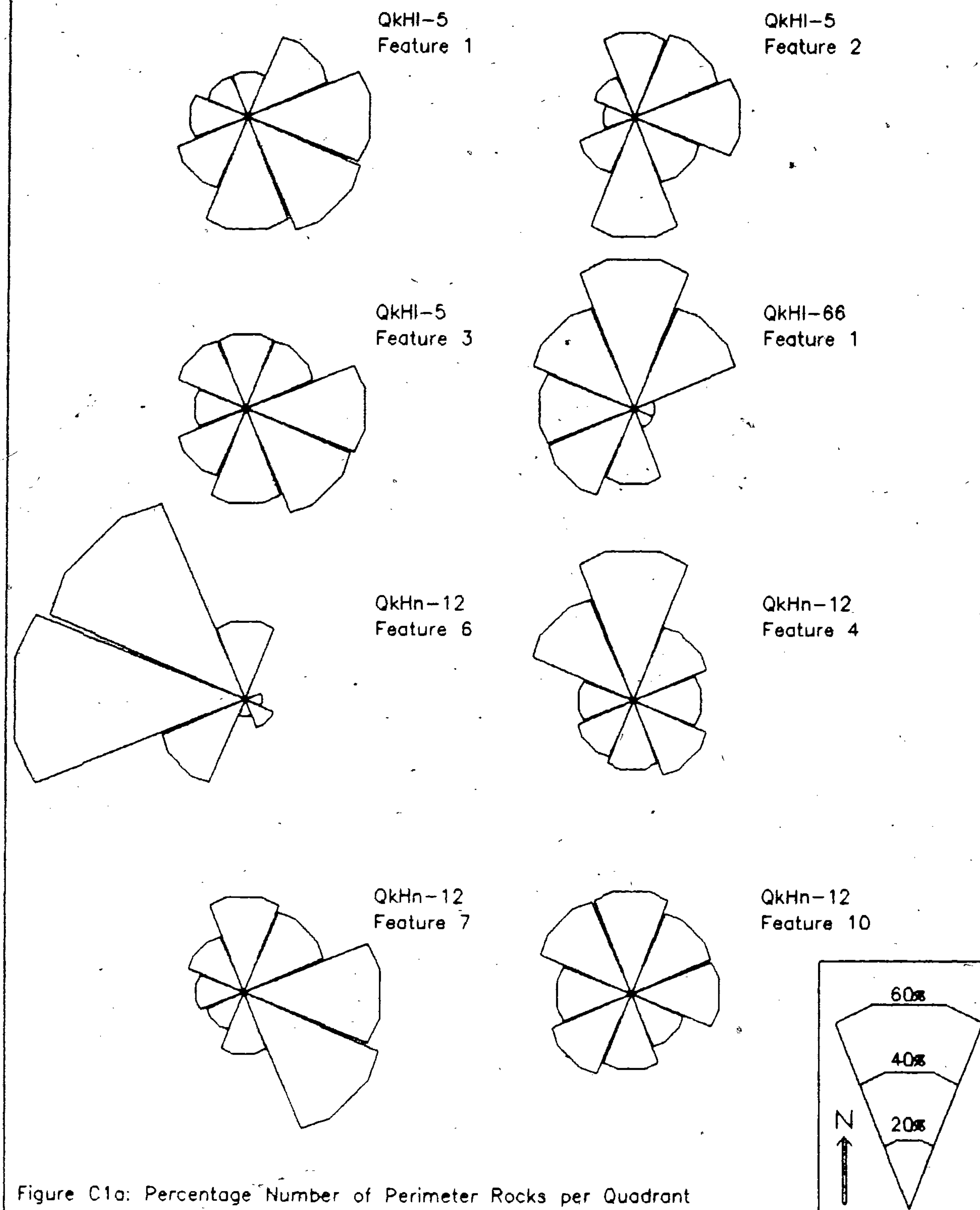


Figure C1a: Percentage Number of Perimeter Rocks per Quadrant

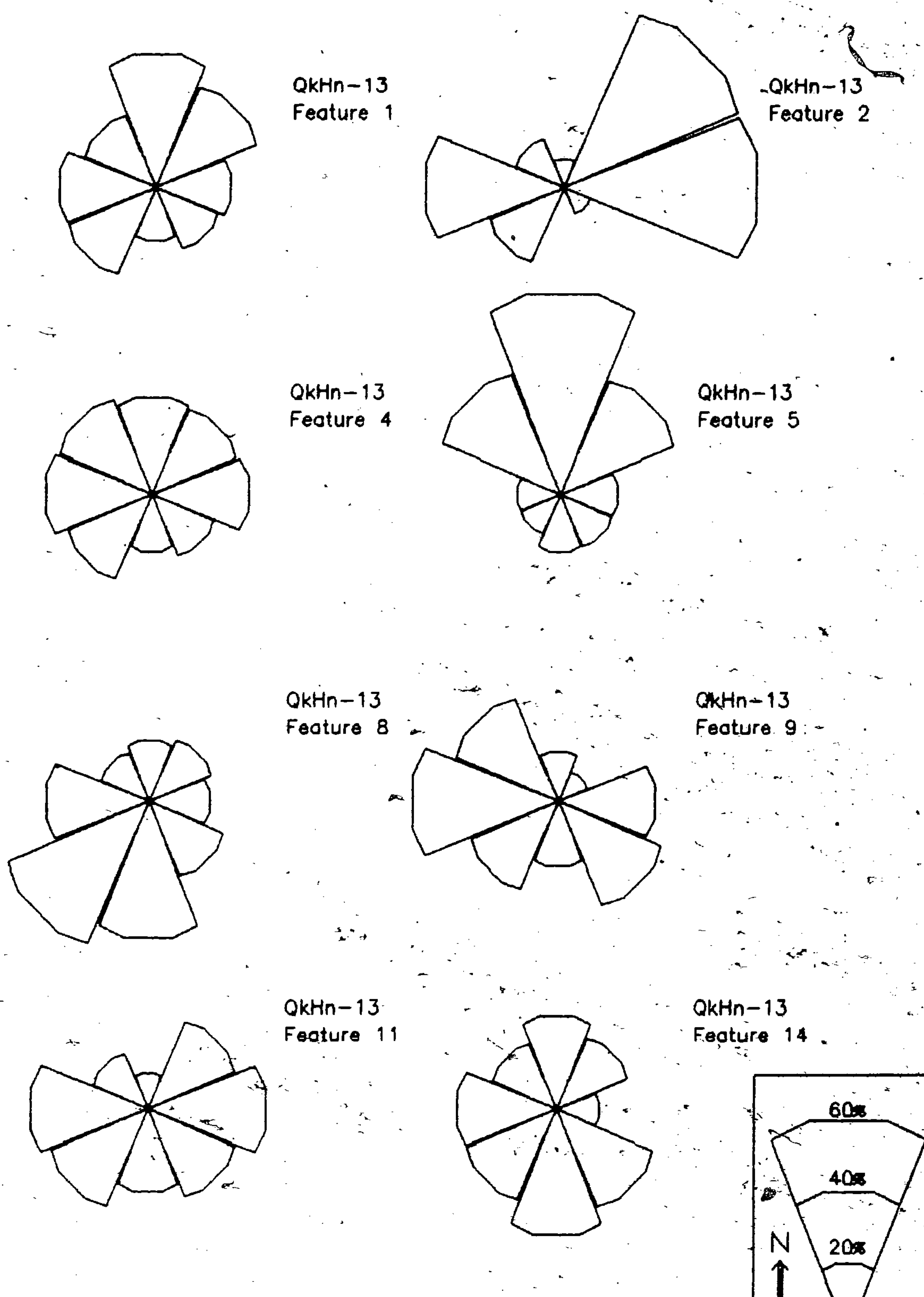


Figure C1b: Percentage Number of Perimeter Rocks per Quadrant

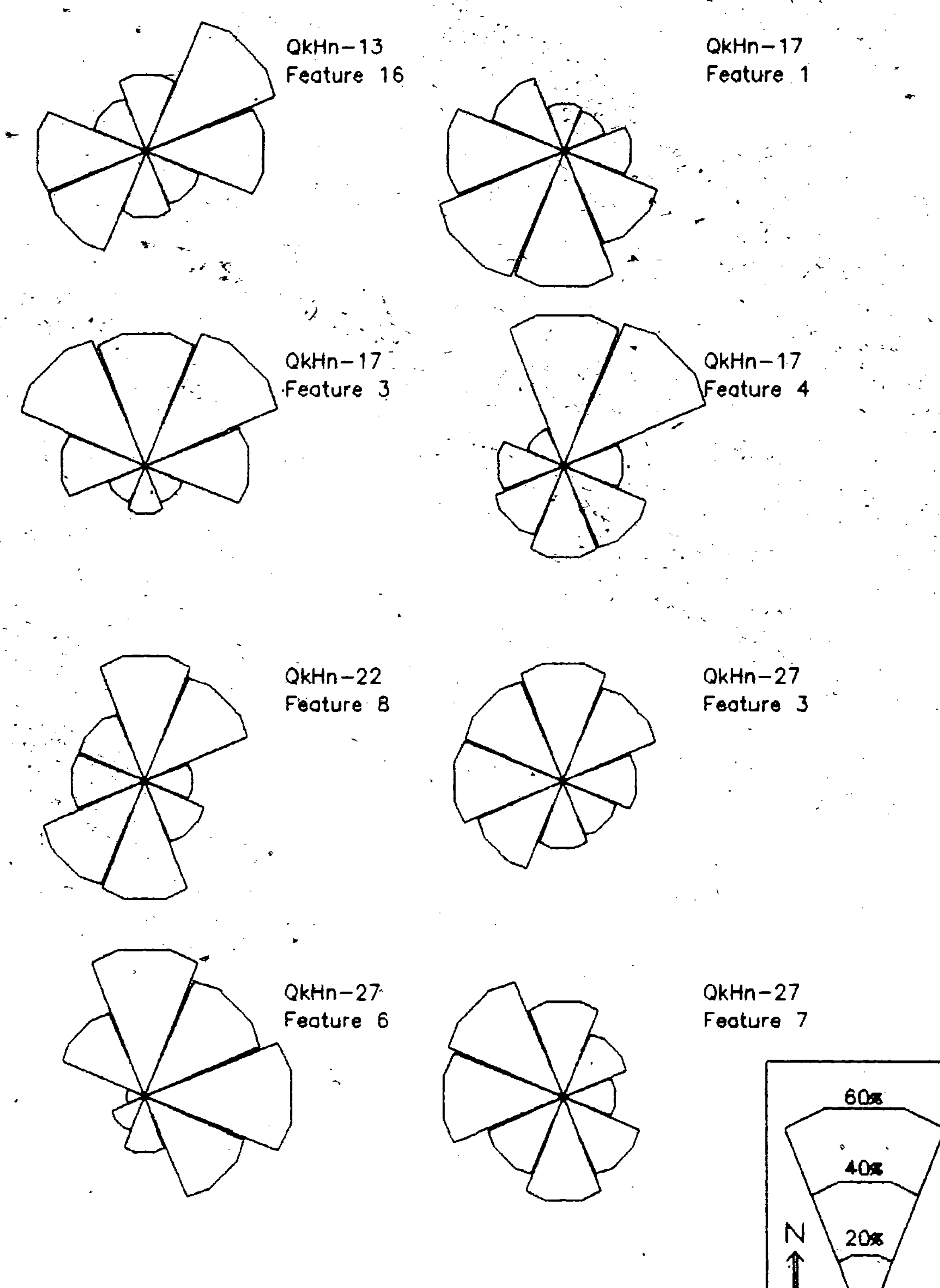


Figure C1c: Percentage Number of Perimeter Rocks per Quadrant

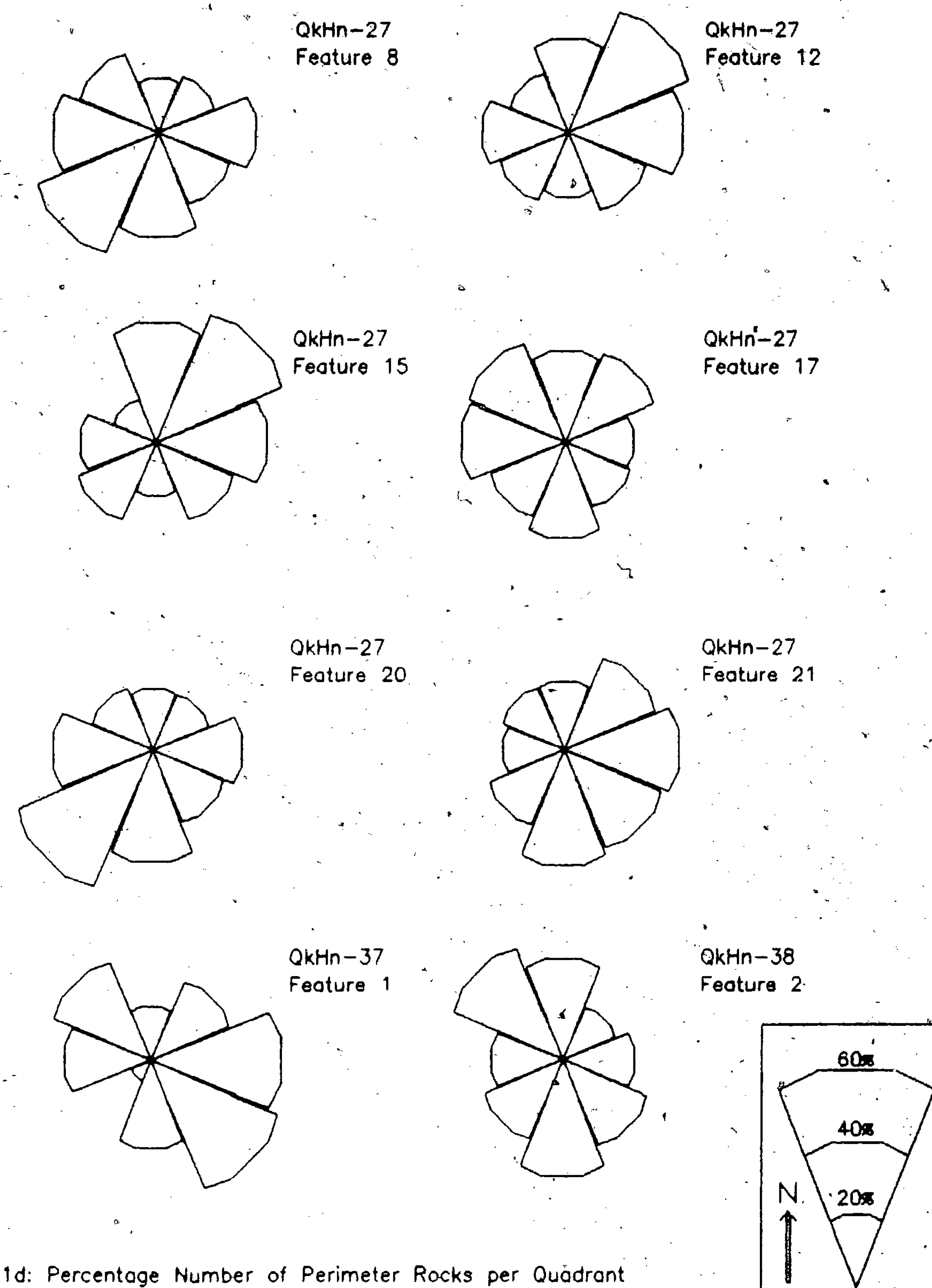


Figure C1d: Percentage Number of Perimeter Rocks per Quadrant

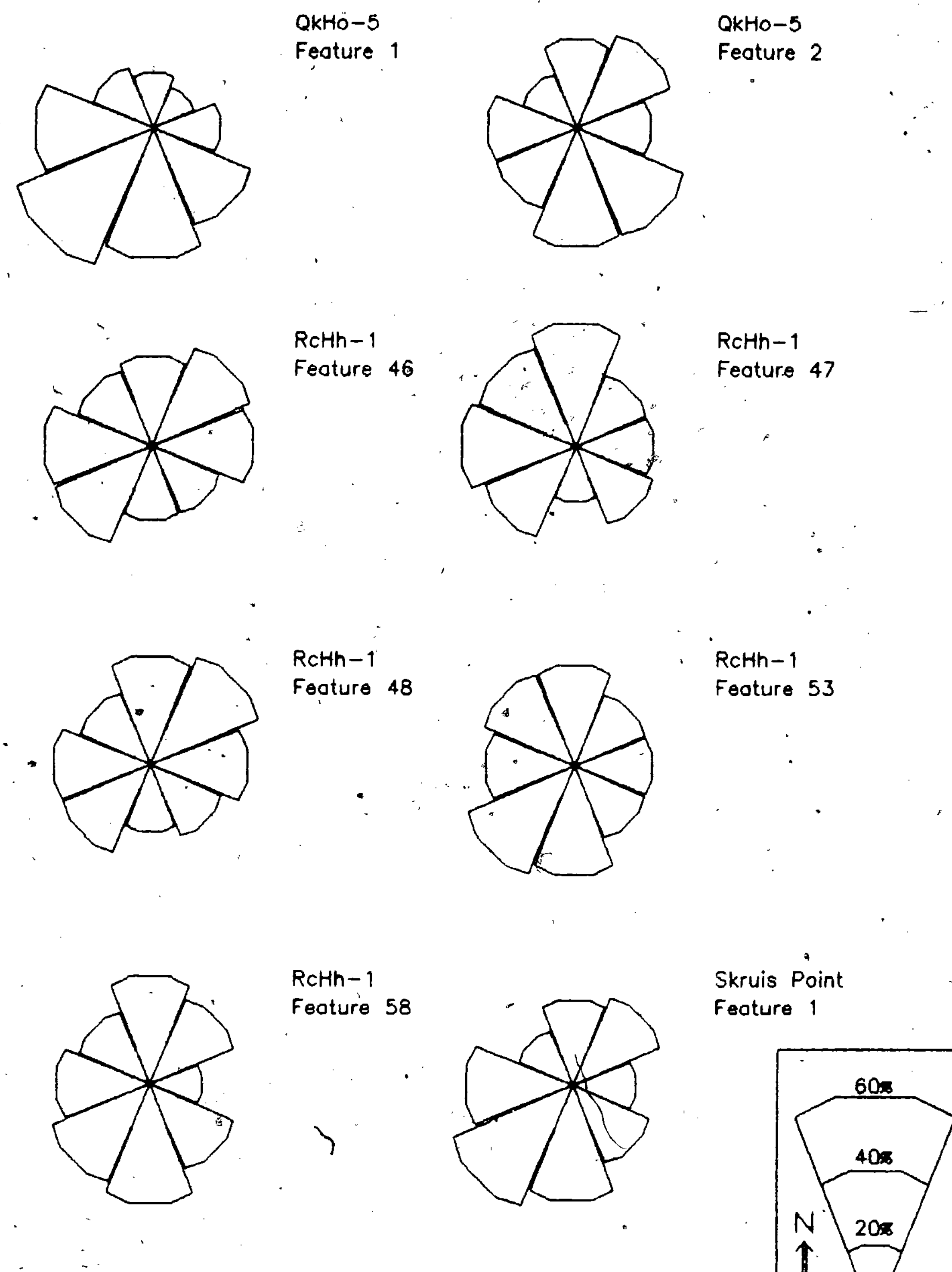
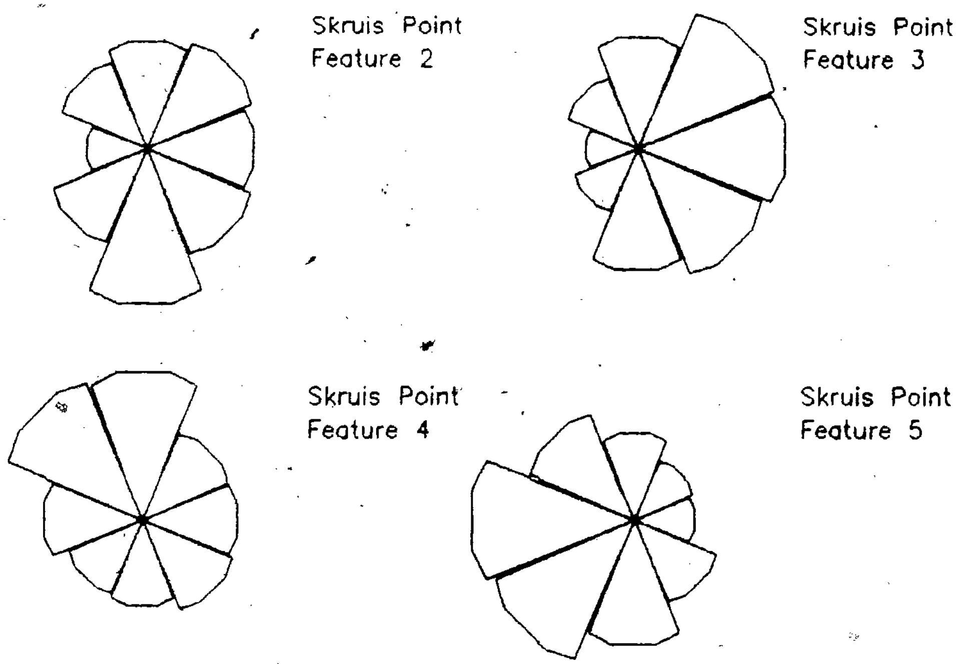


Figure C1e: Percentage Number of Perimeter Rocks per Quadrant



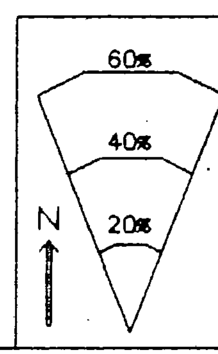


Figure C1f: Percentage Number of Perimeter Rocks per Quadrant

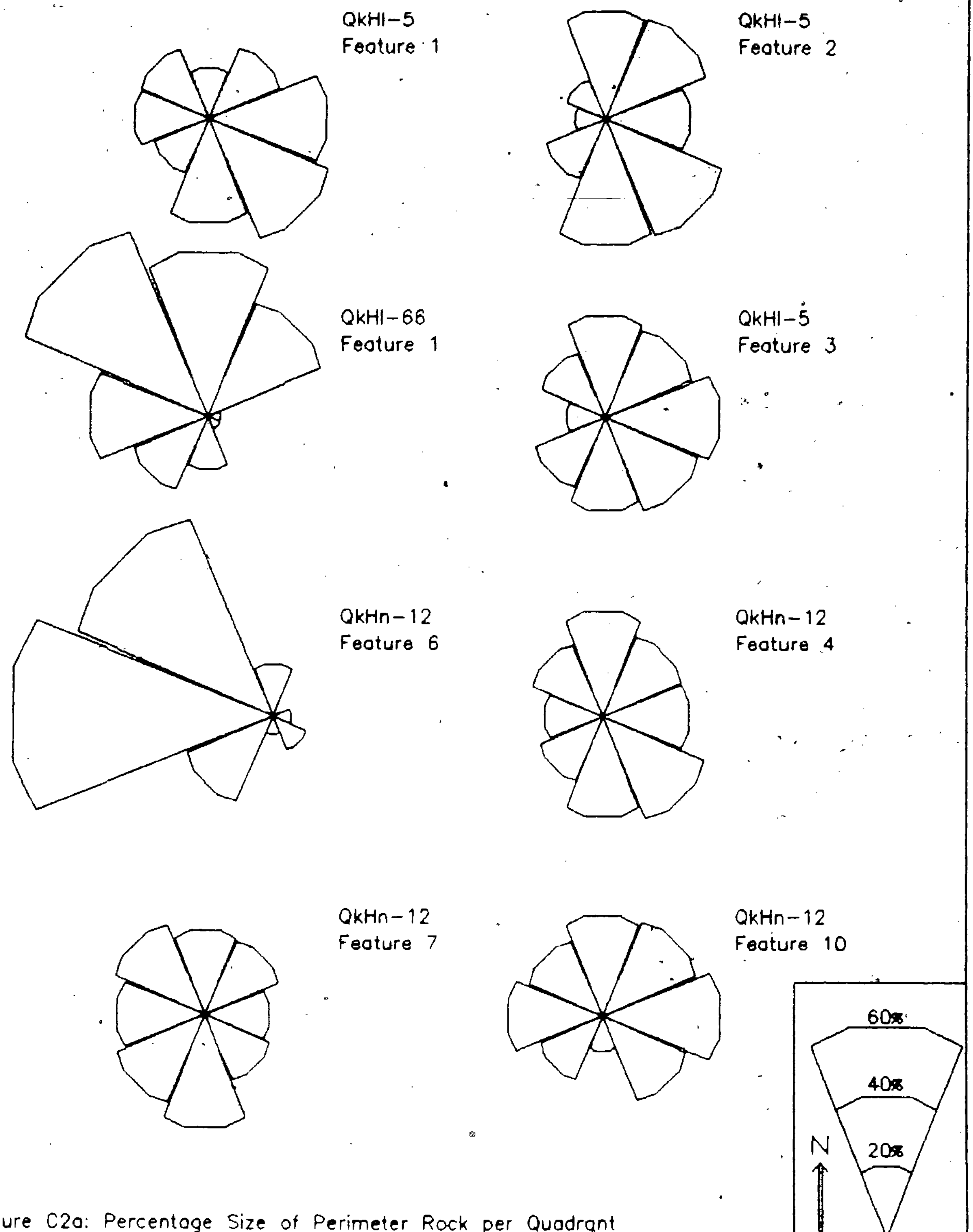


Figure C2a: Percentage Size of Perimeter Rock per Quadrant

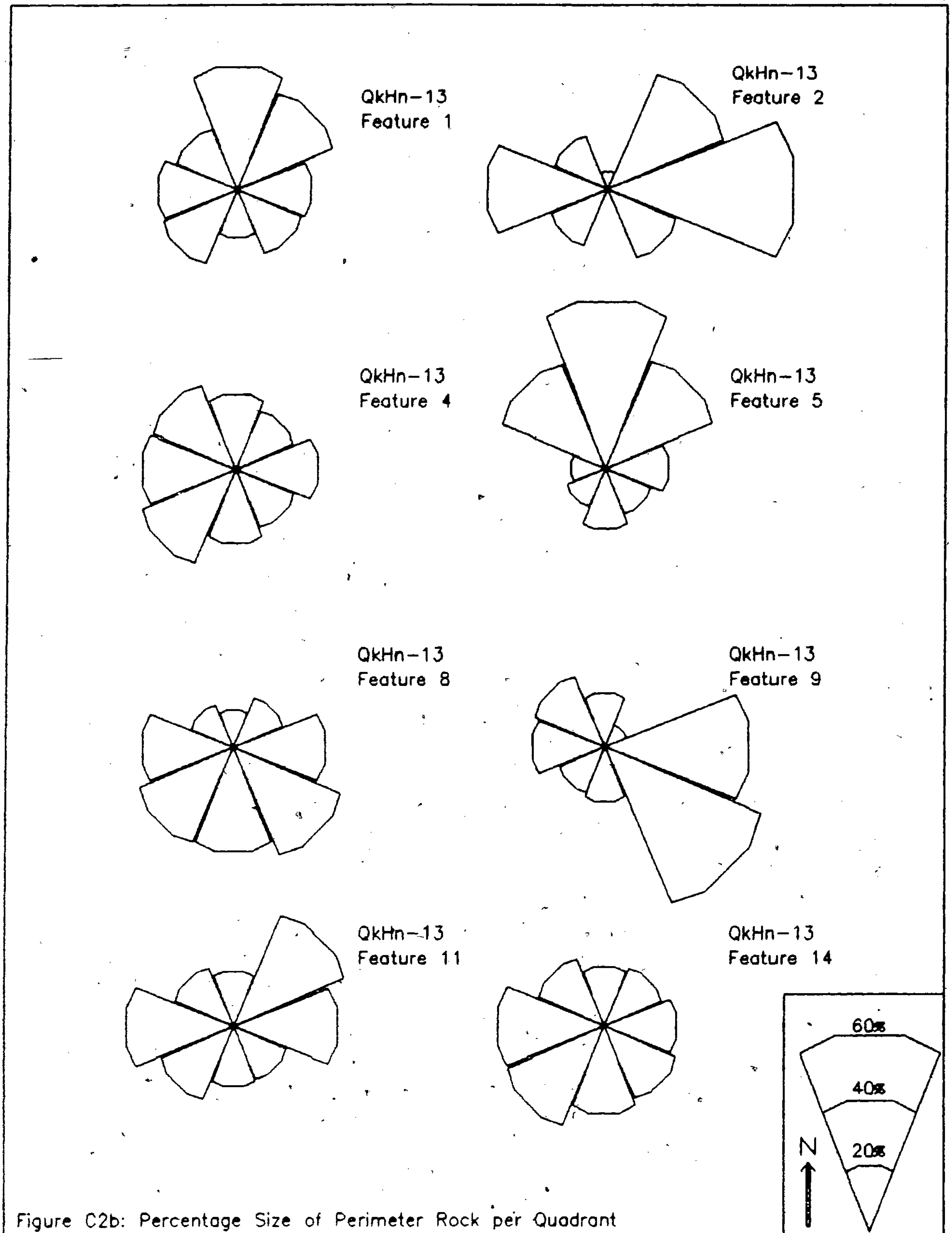


Figure C2b: Percentage Size of Perimeter Rock per Quadrant

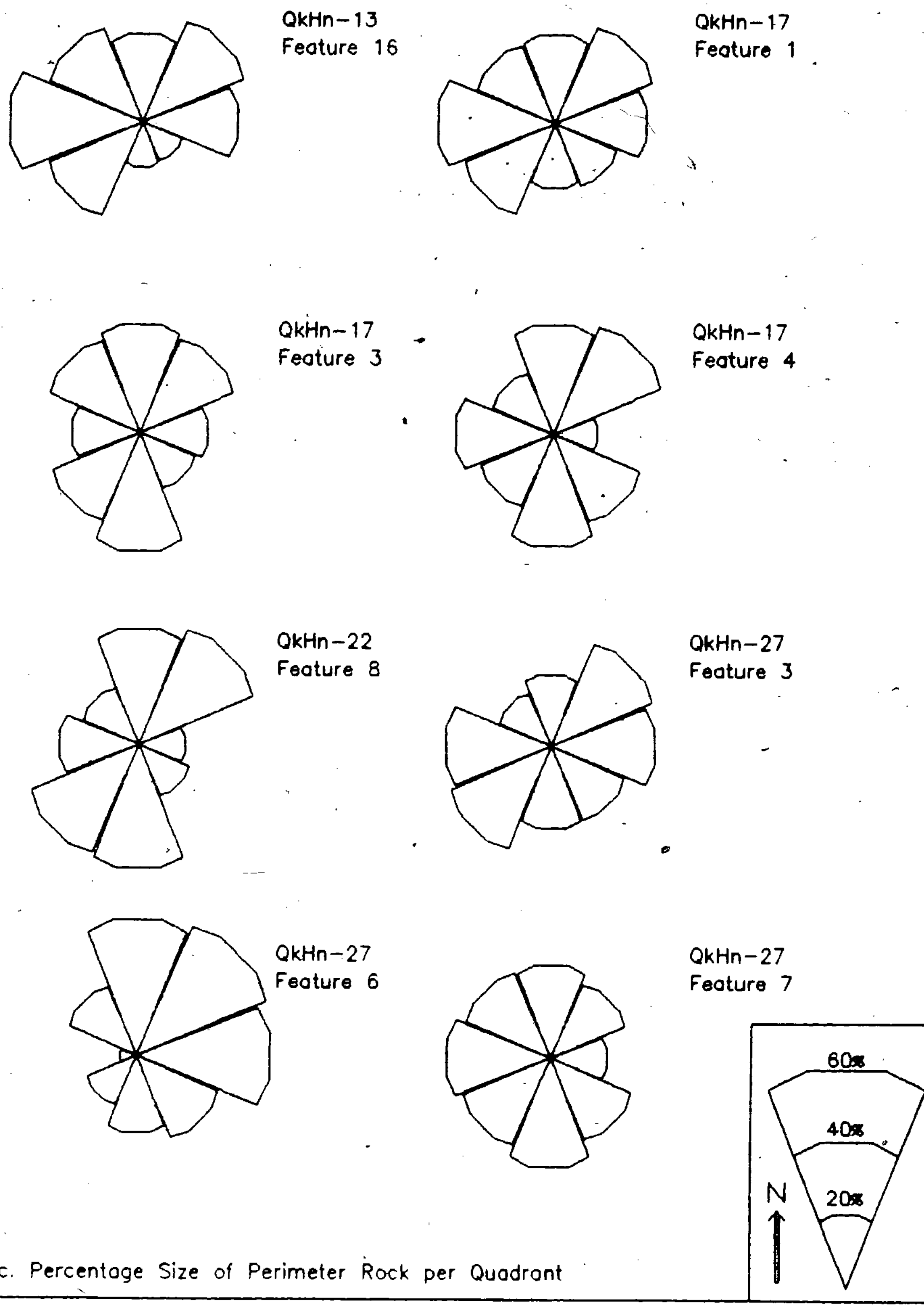


Figure C2c. Percentage Size of Perimeter Rock per Quadrant

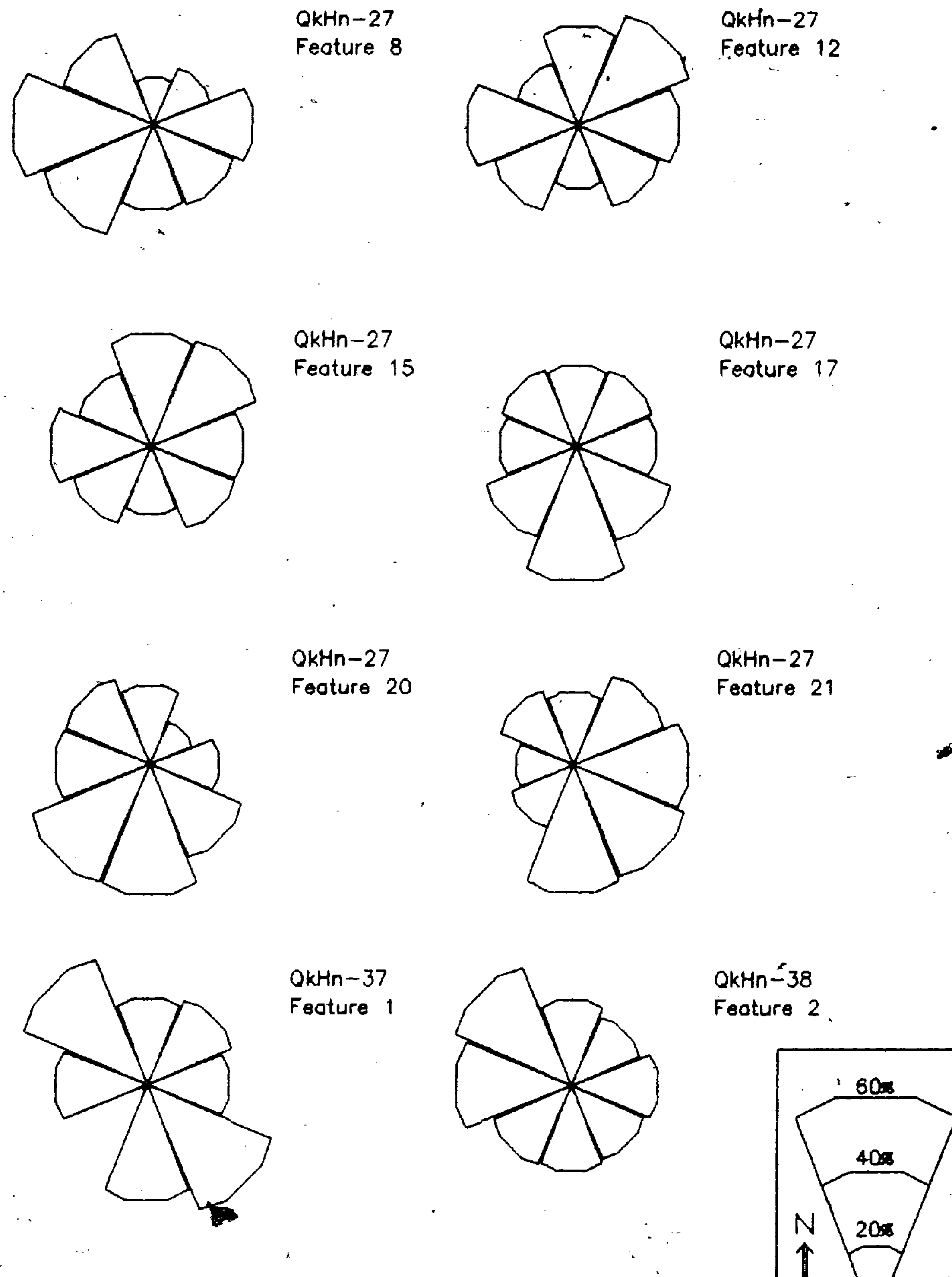


Figure C2d: Percentage Size of Perimeter Rocks per Quadrant

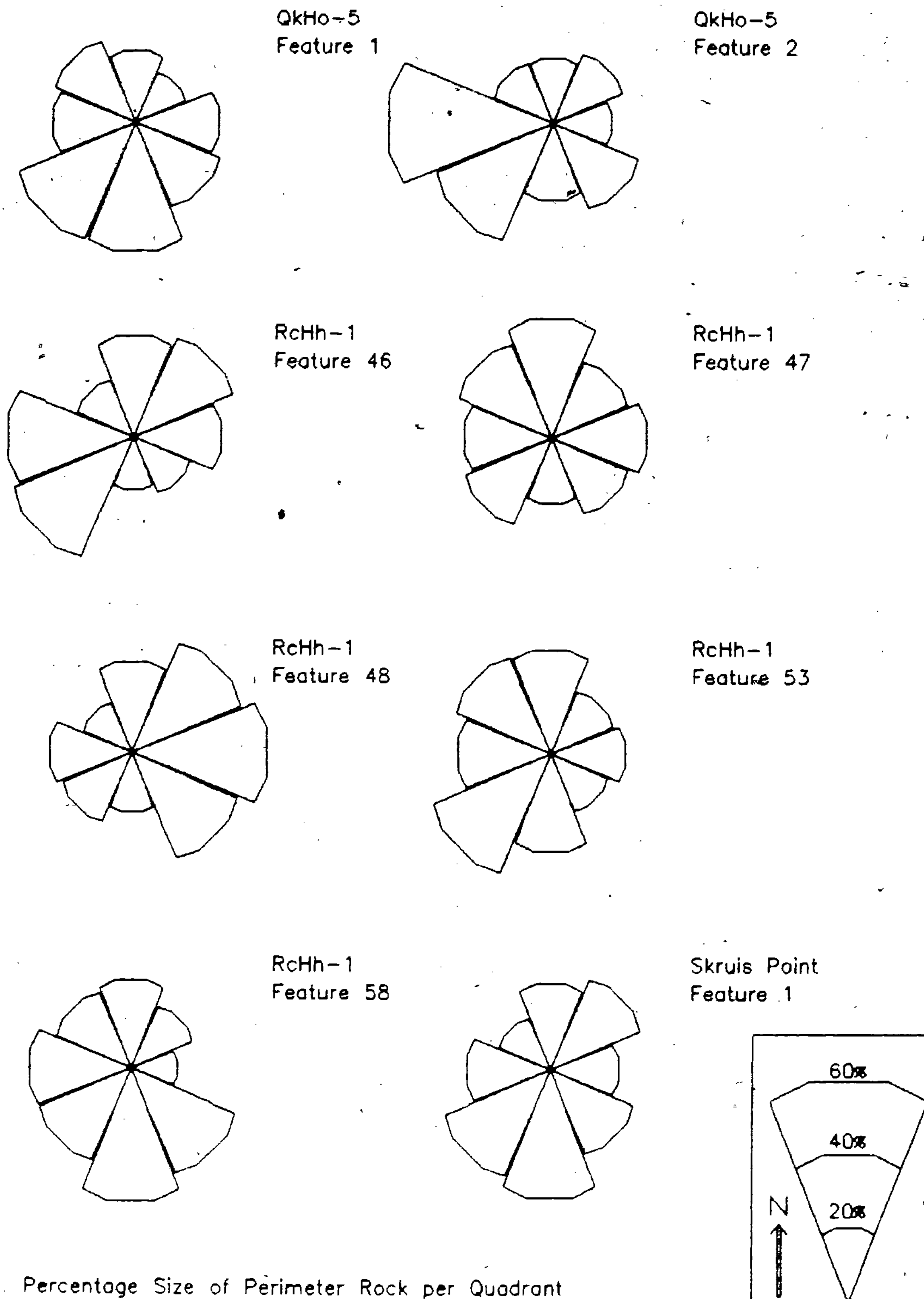


Figure C2e. Percentage Size of Perimeter Rock per Quadrant

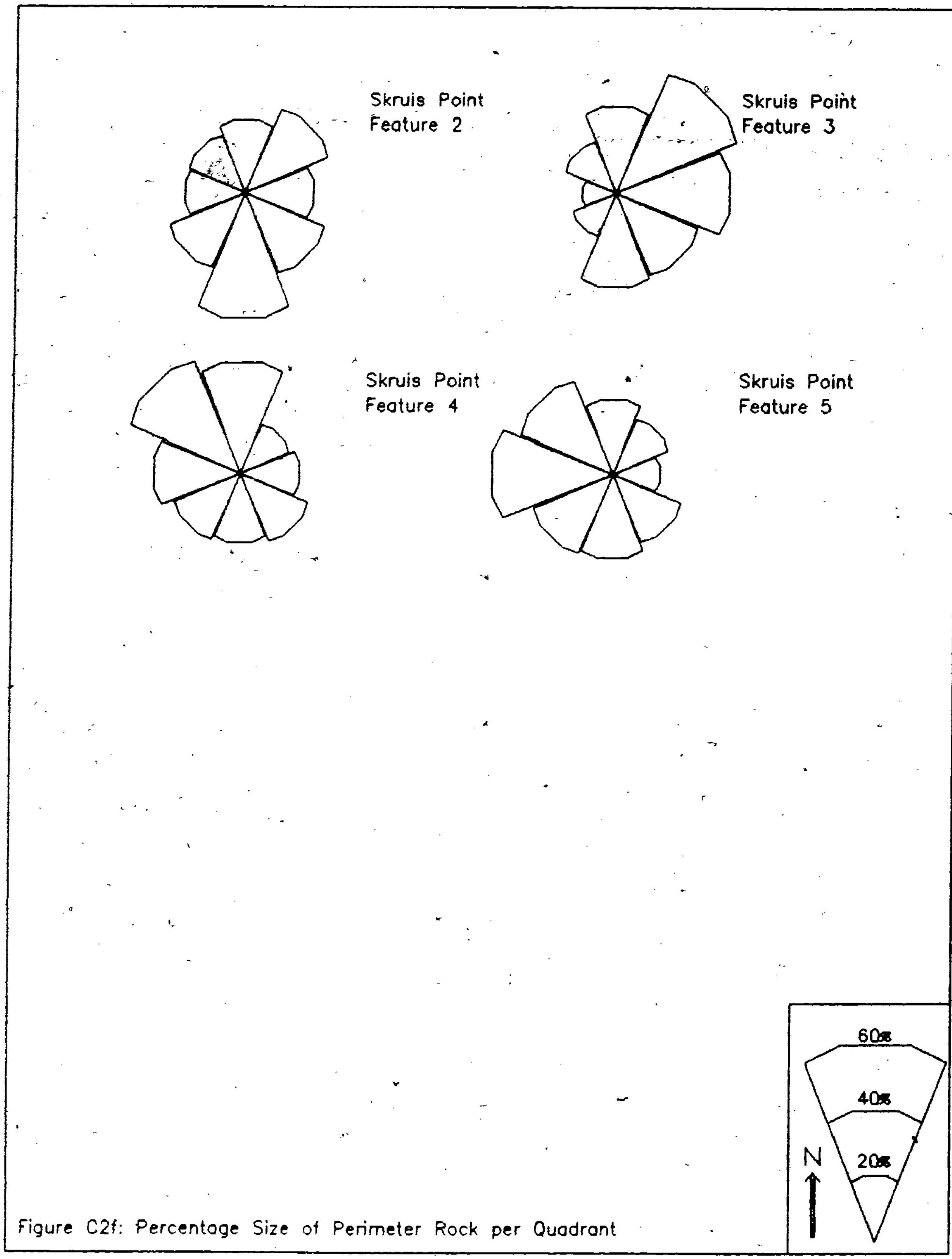


Figure C2f: Percentage Size of Perimeter Rock per Quadrant

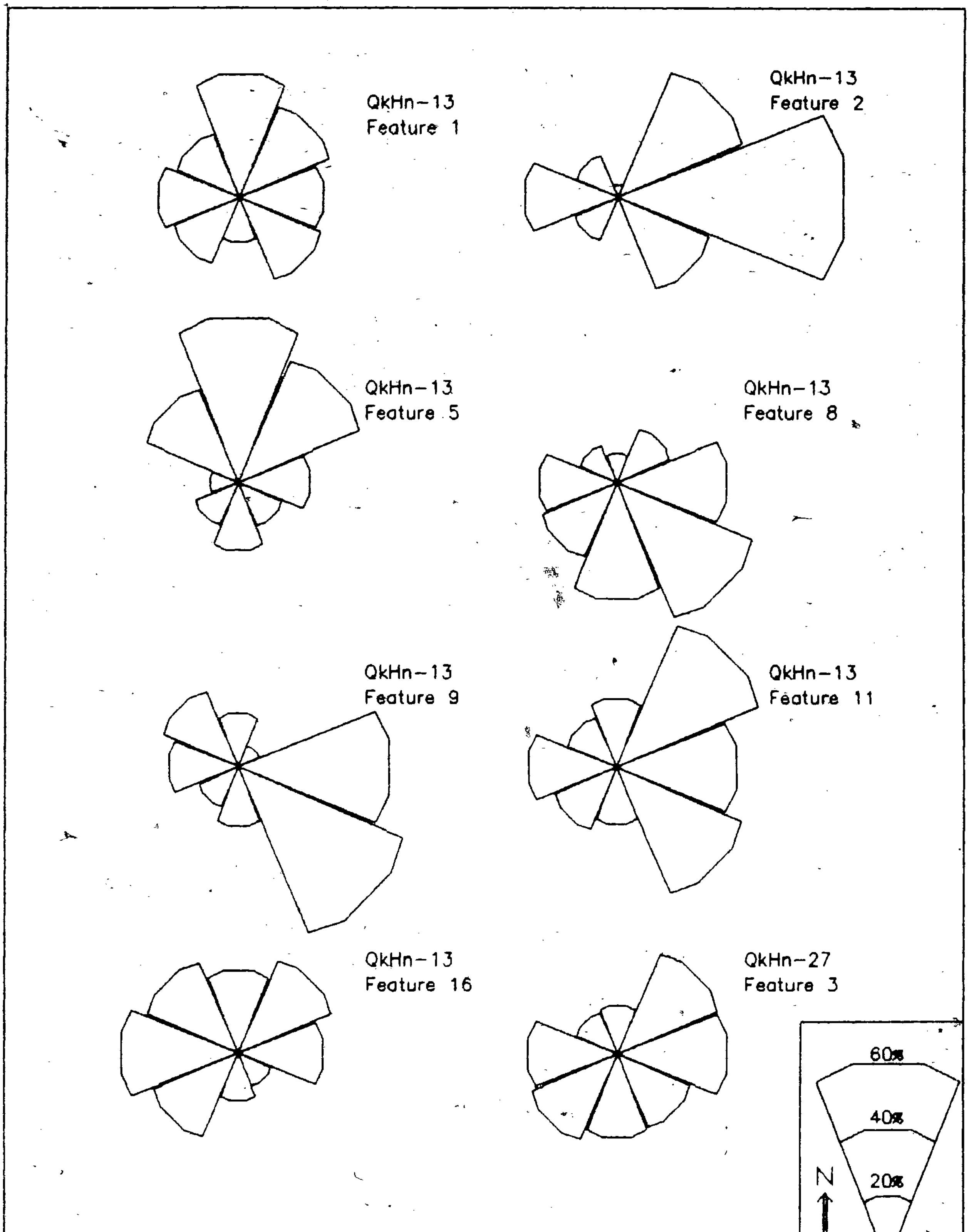


Figure C3a: Percentage Volume of Perimeter Rock per Quadrant

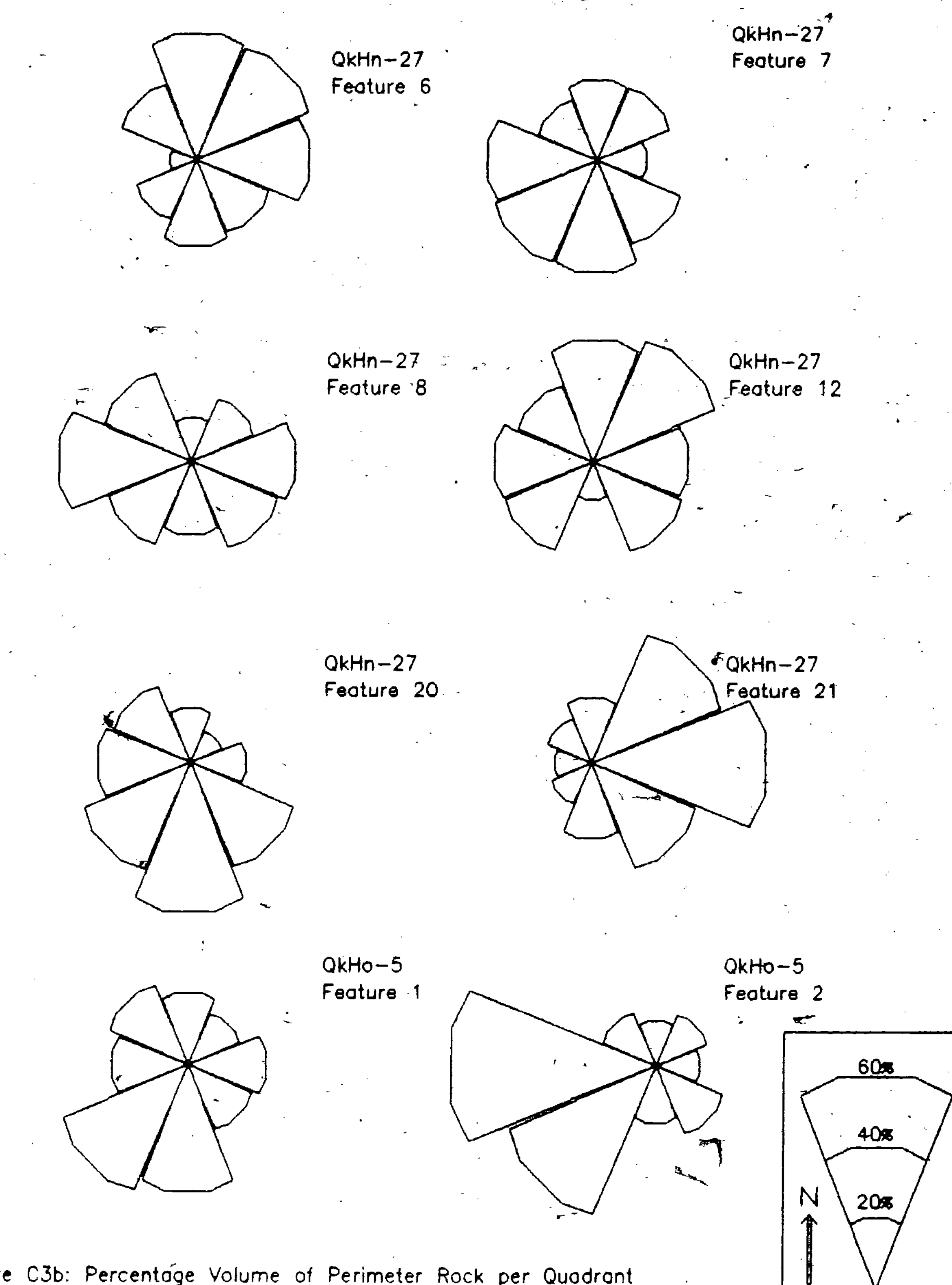


Figure C3b: Percentage Volume of Perimeter Rock per Quadrant

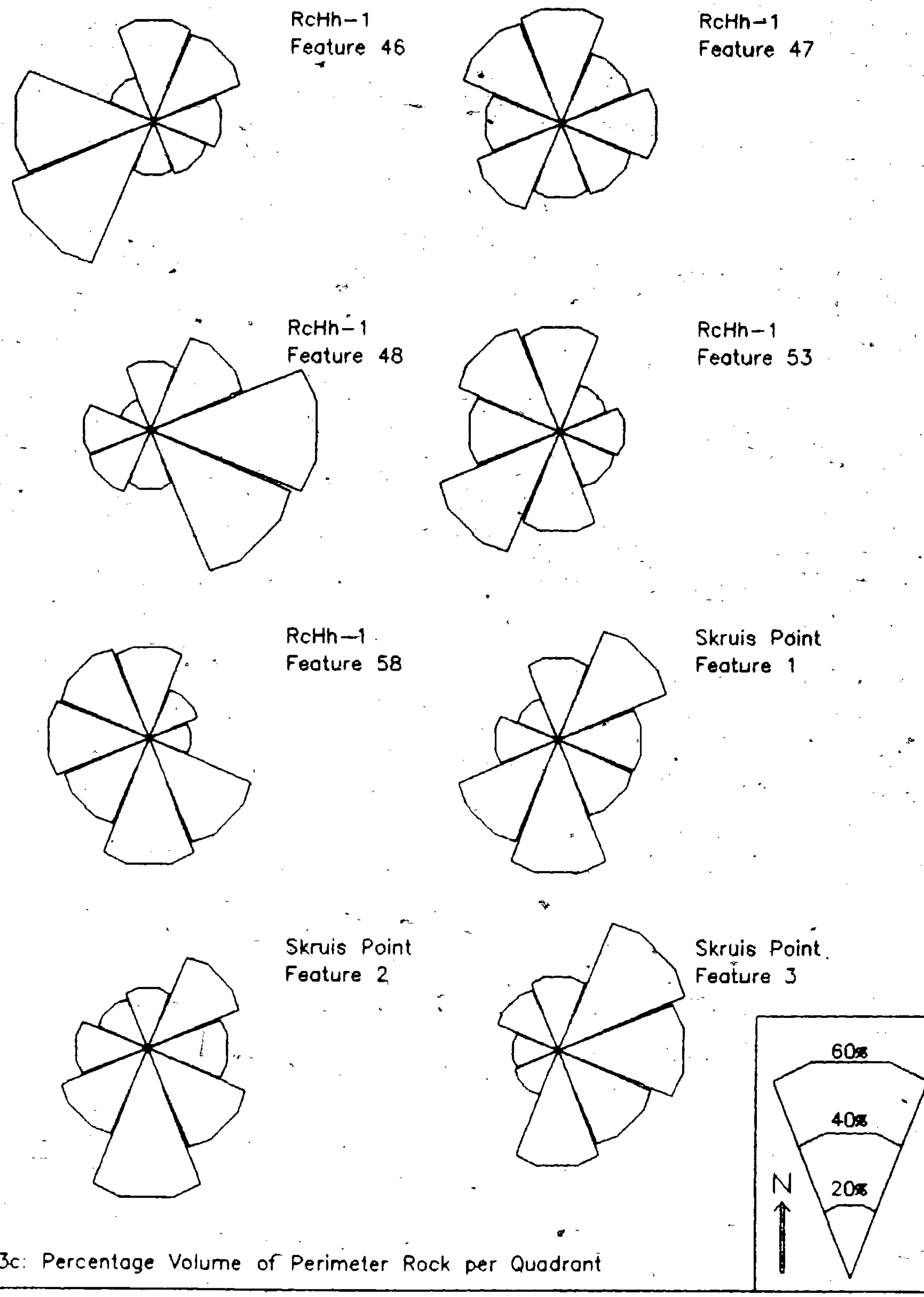


Figure C3c: Percentage Volume of Perimeter Rock per Quadrant

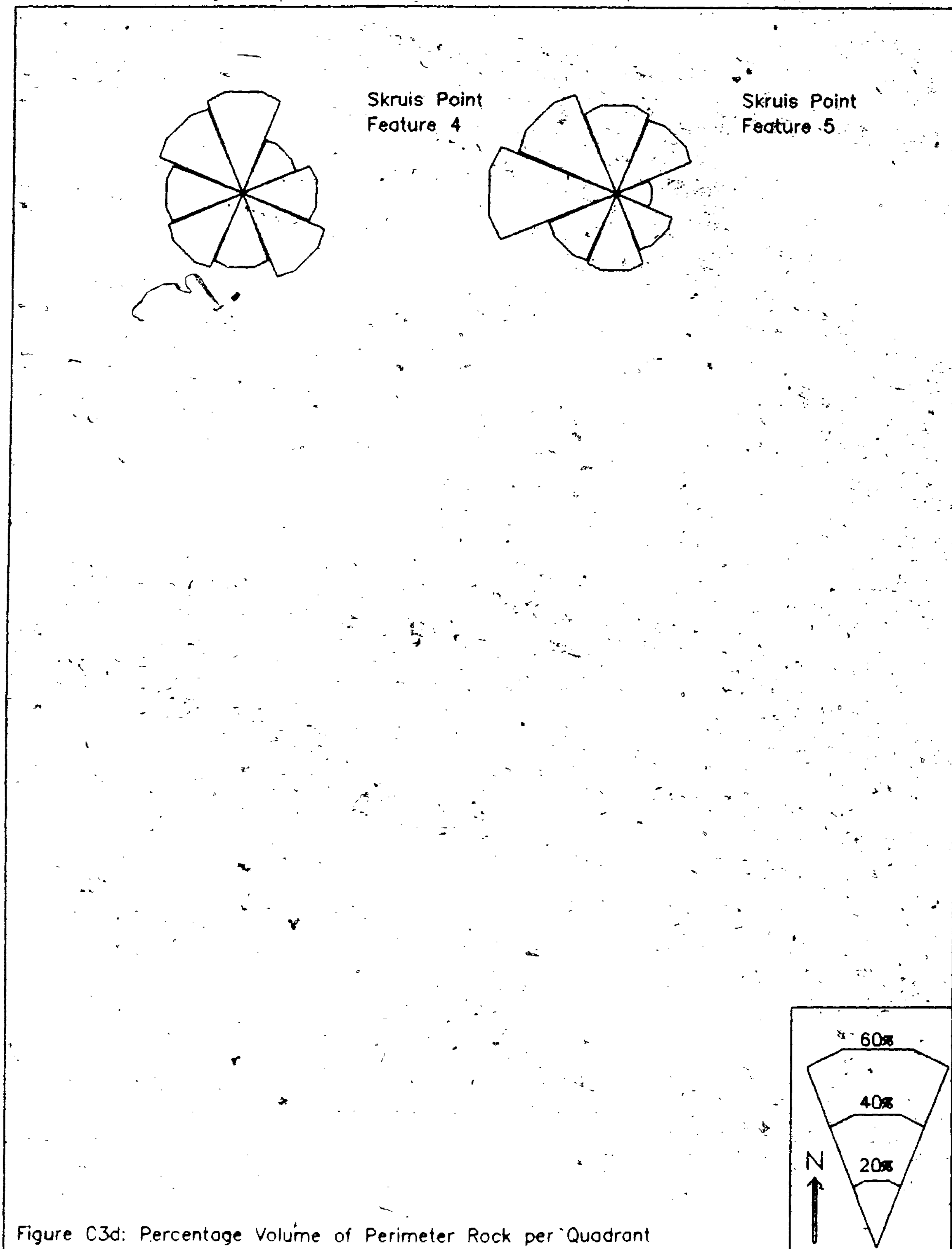


Figure C3d: Percentage Volume of Perimeter Rock per Quadrant

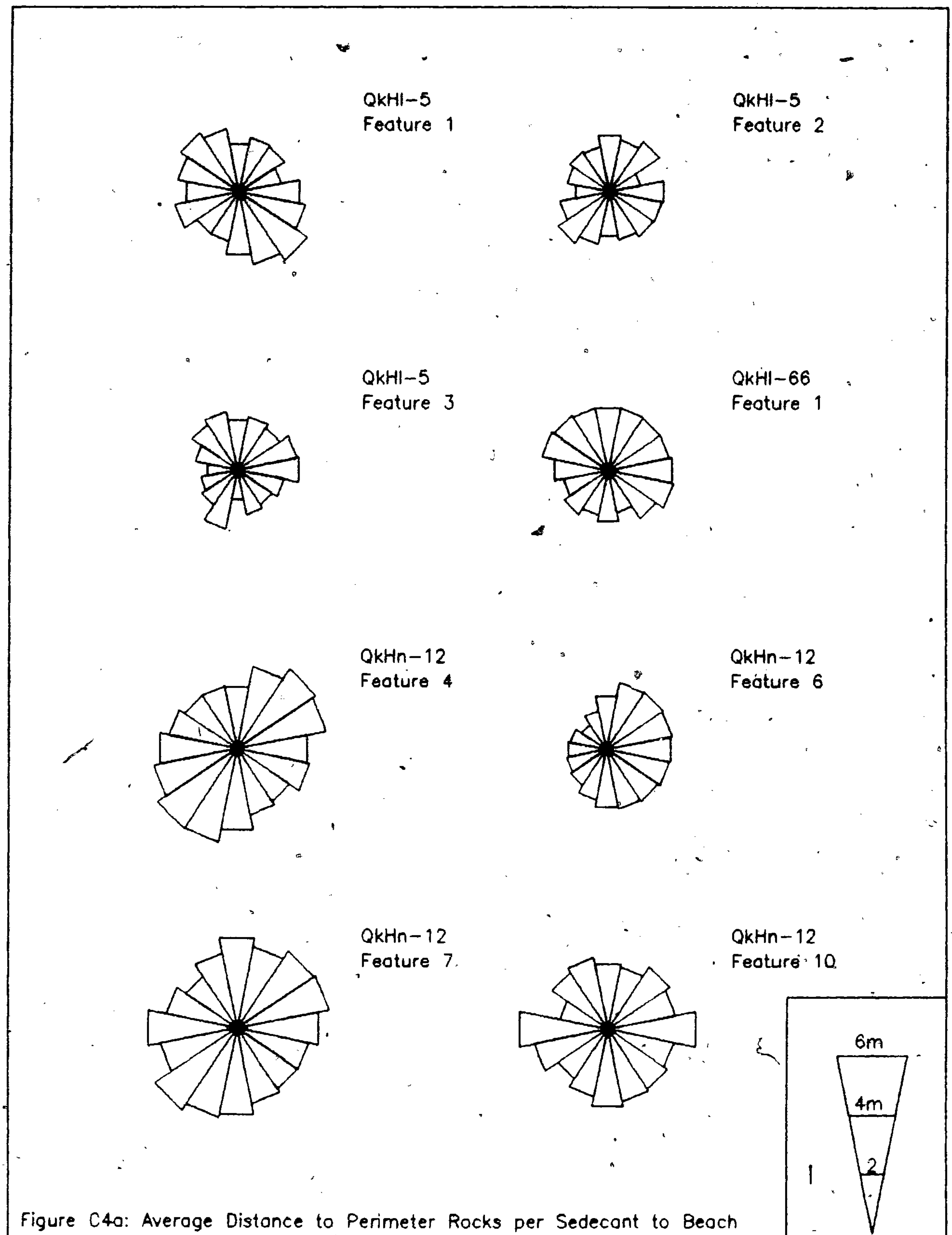


Figure C4a: Average Distance to Perimeter Rocks per Sedecant to Beach

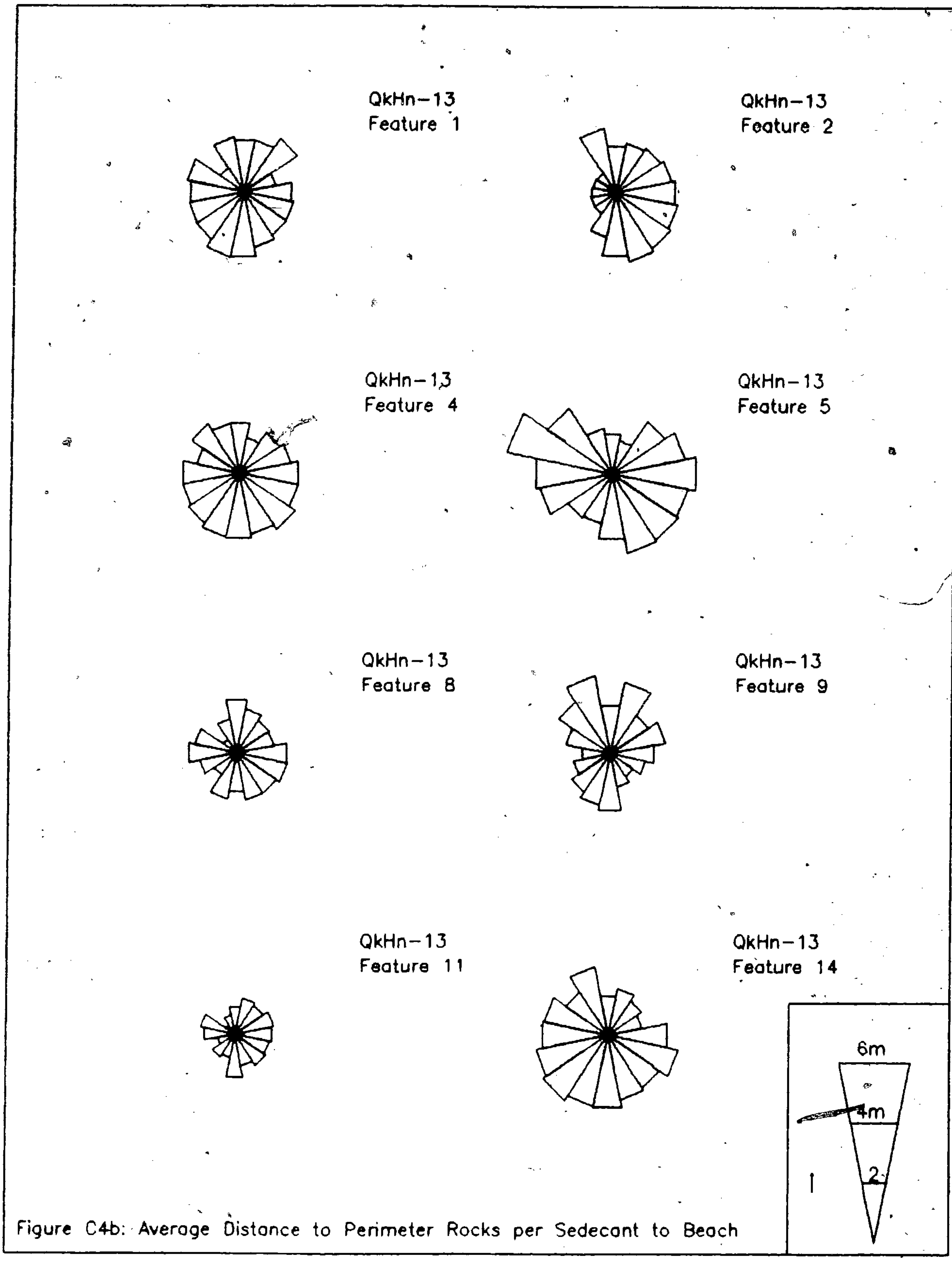


Figure C4b: Average Distance to Perimeter Rocks per Sedecant to Beach

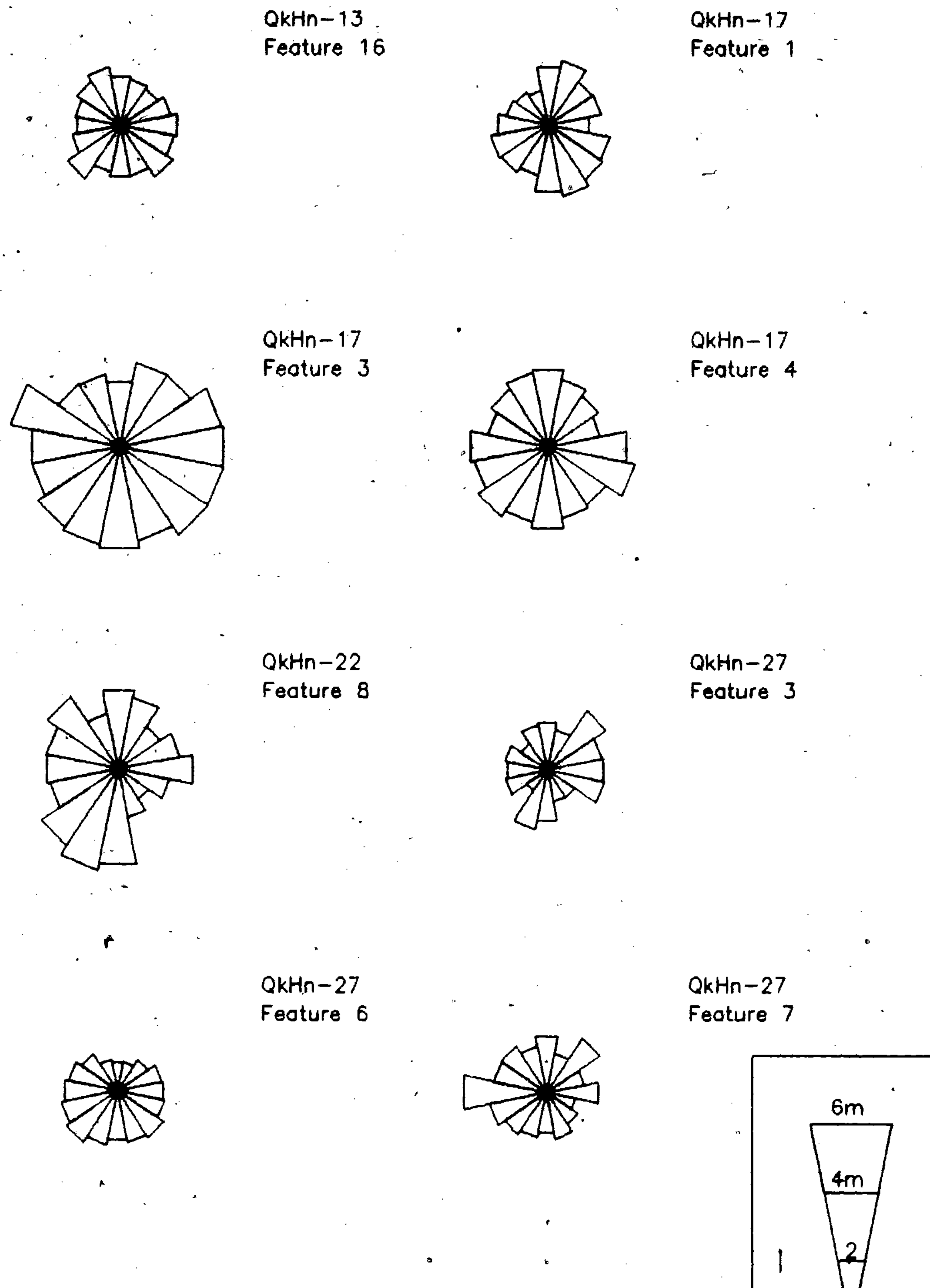


Figure C4e: Average Distance to Perimeter Rocks per Sedecant to Beach

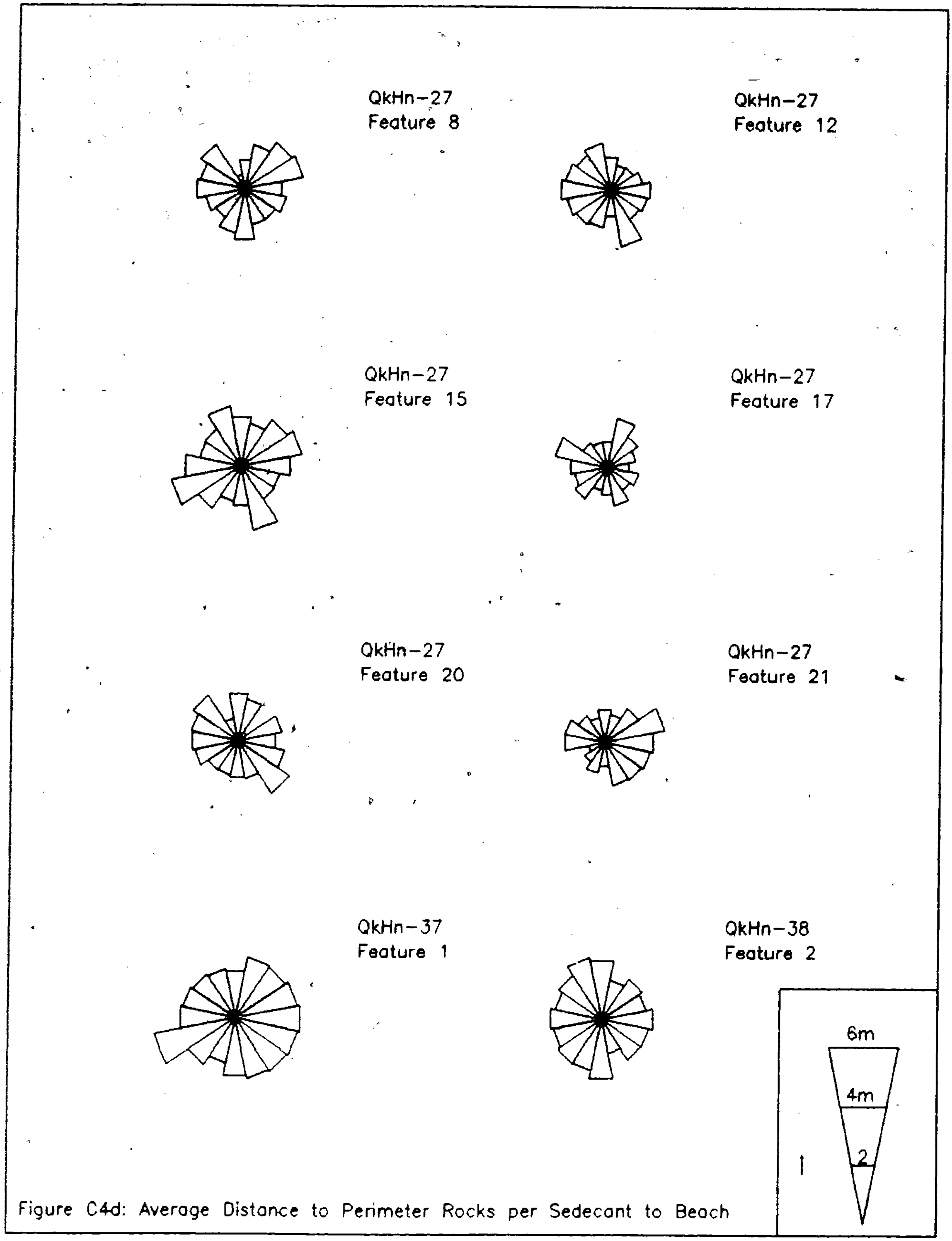


Figure C4d: Average Distance to Perimeter Rocks per Sedecant to Beach

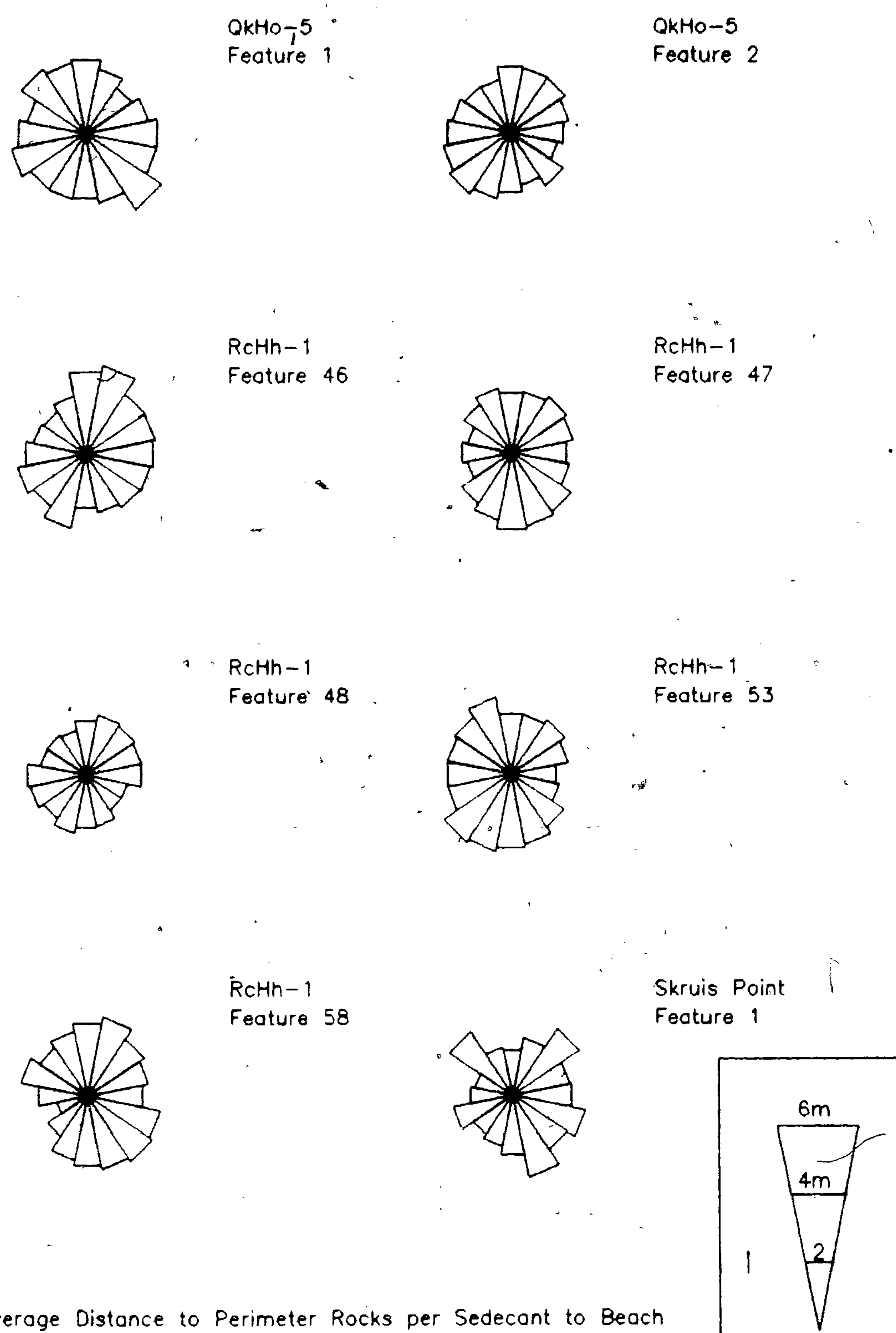


Figure C4e: Average Distance to Perimeter Rocks per Sedecant to Beach

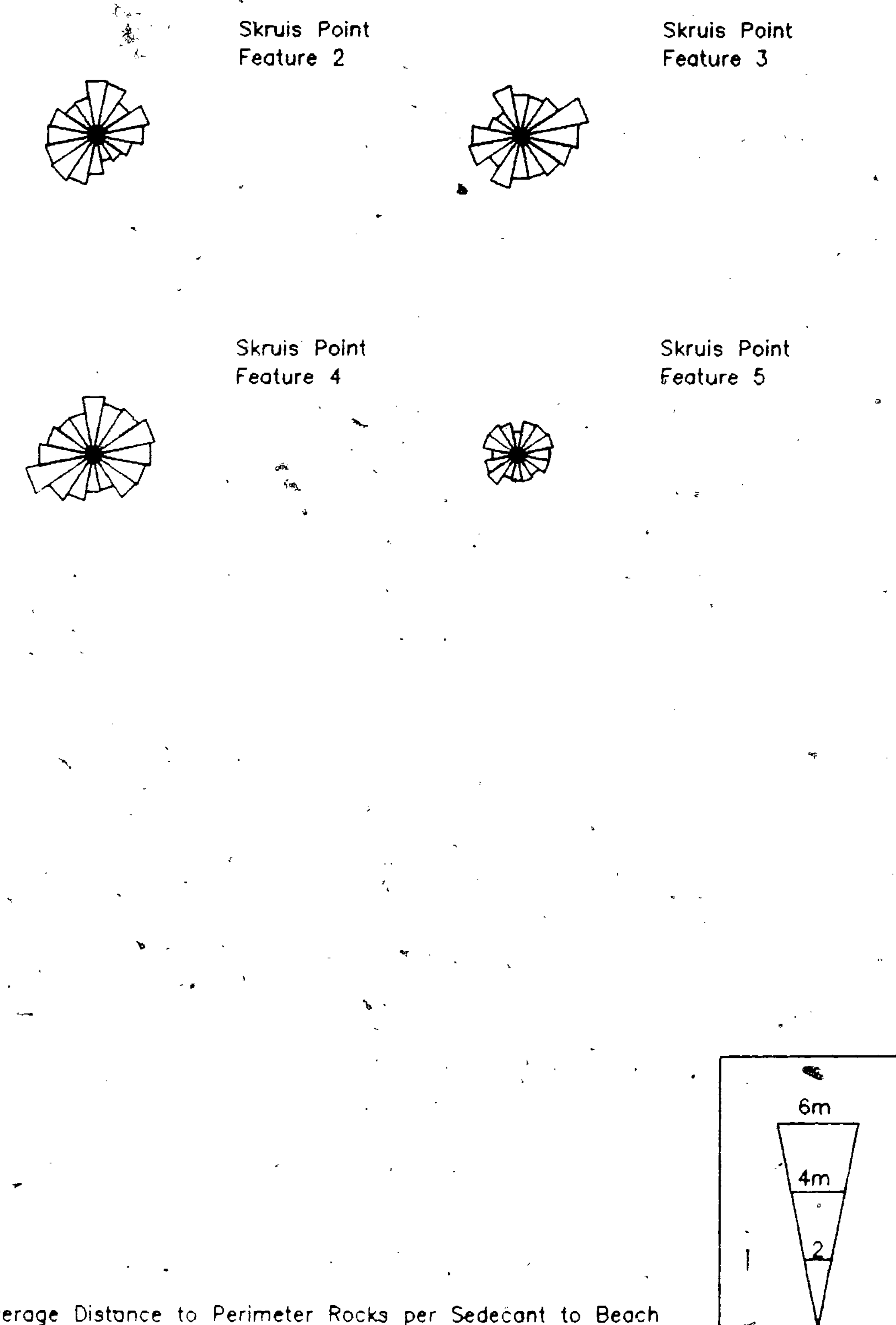


Figure C4f: Average Distance to Perimeter Rocks per Sedecant to Beach

APPENDIX D

FEATURE DESCRIPTIONS

This appendix contains brief descriptions of each of the individual features included in this study.

QkHl-5 Feature 1 (Figure B1)

This feature is a medium sized (mean radius of 2.04 meters, estimated floor area of 13.07 m^2) reasonably well defined ovoid tent ring with disturbed axial feature. One hundred and twenty-one rocks comprise the perimeter while a further twenty-nine stones constitute the interior feature. The greatest number of perimeter rocks (n=45) are found in the southeastern quadrant while the fewest perimeter rocks (n=7) are found in the western octant. The maximum areal load (21025 cm^2) is found in the southeastern quadrant. The longest axis is the NW-SE (5.13 meters), while the shortest axis is the NE-SW (3.50 meters). The orientation of the interior feature is impossible to determine. The direction to the local beach is south.

This feature was tested in 1985 and completely excavated during the summer of 1986. Based upon recovered artifacts, Helmer has attributed this feature to his Twin Ponds Complex of Middle Pre-Dorset affiliations (1986). A corrected (for isotopic fractionation) radiocarbon age of 4070±80 BP (Beta 20780) for charcoal collected in the hearth area of this feature is rejected by Helmer as somewhat early for this feature.

QkHl-5 Feature 2 (Figure B1)

This feature is a small (mean radius of 1.70 meters, estimated floor area of 9.08 m^2), reasonably well defined circular tent ring with a disturbed interior feature. One hundred and twenty rocks comprise the perimeter while a further thirty-eight stones constitute the interior feature. The greatest number of perimeter rocks (n=50) are found in the southeastern quadrant while the fewest perimeter rocks (n=5) are found in the western octant. The maximum area load (20250 cm^2) is found in the southeastern quadrant. The longest axis is the NE-SW (4.09 meters), while the shortest axis is the ENE-WSW (2.75 meters). The orientation of the interior feature is impossible to determine. The direction to the local beach is south.

The feature was completely excavated during the summer of 1986. Based upon recovered artifacts, Helmer has attributed this feature to his Icebreaker Beach Complex of Middle Pre-Dorset affiliations (1986). No radiocarbon age is available for this feature.

QkHl-5 Feature 3 (Figure B1)

This feature is a small (mean radius of 1.58 meters, estimated floor area of 7.84 m^2), reasonably well defined circular tent ring with a disturbed interior feature. Eighty-two rocks comprise the perimeter while a further twenty-eight stones constitute the interior feature. The greatest number of rocks (n=29) are found in the eastern quadrant while the fewest rocks (n=5) are found in the northern octant. The maximum area load (10625 cm^2) is found in the eastern quadrant. The longest axis is the NNE-SSW (3.82 meters), while the shortest axis is the N-S (2.68 meters). The orientation of the interior feature is impossible to determine. The direction to the associated fossil beach is south.

The feature was completely excavated during the summer of 1986. Based upon recovered artifacts, Helmer has attributed this feature to his Icebreaker Beach Complex of Middle Pre-Dorset affiliations (Helmer 1986). A corrected radiocarbon age of 3770±180 BP (Beta 20781) from charcoal collected in the central area of this feature is accepted by Helmer as consistent with the probable age of this feature.

QkHl-66 Feature 1 (Figure B1)

This feature is a medium sized (mean radius of 1.97 meters, estimated floor area of 12.19 m^2), partial tent ring with a well defined axial feature. Eighteen rocks comprise the perimeter while twenty-seven stones constitute the interior feature. The greatest number of perimeter rocks (n=8) are found in the northern quadrant while the fewest rocks (n=0) are found in the eastern and southeastern octants. The greatest areal load (8068 cm^2) is found in the northwest quadrant. The longest axis is the NNE-SSW (4.51 meters), while the shortest axis is the ENE-WSW (3.56 meters). The direction to the associated fossil beach is east.

No distinctly diagnostic artifacts were observed in the near vicinity of this feature and no excavations were conducted. However, the presence of a chipped stone biface fragment and scattered flakes indicates a probable Pre-Dorset age. Based upon relative beach elevation and other characteristics, this site is tentatively affiliated with the Early Pre-Dorset Icebreaker Beach Complex. The feature was discovered and radially mapped in 1986. No radiocarbon dates exist for this tent ring.

<u>QkHn-12 Feature 4</u> (Figure B2)

This feature is a large (mean radius of 2.65 meters, estimated floor area of 22.06 m^2), well defined ovoid tent ring with central feature. Forty-five rocks comprise the perimeter while seventeen stones constitute the interior feature. The greatest number of perimeter rocks (n=20) are found in the northern quadrant while the fewest rocks (n=3) are found in the western octant. The greatest areal load (13750 cm^2) is found in the north quadrant. The longest axis is the E-W (6.35 meters), while the shortest axis is the N-S (4.20 meters). The direction to the associated fossil beach is northwest.

The feature was completely mapped by the Northern Heritage Trust Field School Project in 1985. Examination of surface artifacts and the results of test excavations in the near vicinity indicate a Middle Pre-Dorset cultural affiliation for this feature (Bertulli 1987). No radiocarbon dates exist for this tent ring.

<u>QkHn-12 Feature 6</u> (Figure B2)

This feature is a small (mean radius of 1.47 meters, estimated floor area of 6.79 m^2), very poorly defined tent ring with a well developed axial feature. Twenty-two rocks comprise the perimeter while fifty-seven stones constitute the interior feature. The greatest number of perimeter rocks (n=15) are found in the western quadrant while the fewest rocks (n=0) are found in the eastern and southeastern octants. The greatest areal load (4275 cm^2) is found in the west quadrant. The longest axis is the ENE-WSW (3.97 meters), while the shortest axis is the N-S (3.05 meters). The direction to the associated fossil beach is northwest.

This feature was mapped and partially excavated during the summer of 1985 by the Northern Heritage Field School Project. Based upon examination of recovered artifacts Helmer assigns this feature to his Twin Ponds Complex of Middle Pre-Dorset affiliation. Charcoal recovered from the excavated central feature yielded a corrected age of 3535±90 BP (Beta-15389) which is accepted by Helmer.

QkHn-12 Feature 7 (Figure B2)

This feature is a large (mean radius of 2.77 meters, estimated floor area of 24.11 m^2), well defined ovoid tent ring with a disturbed inner feature. Fifty rocks comprise the perimeter while thirty-three stones constitute the interior feature. The greatest number of perimeter rocks (n=22) are found in the southeastern quadrant while the fewest rocks (n=3) are found in the southern, western and northwestern octants. The greatest areal load (12400 cm^2)

is found in the south quadrant. The longest axis is the E-W (6.35 meters), while the shortest axis is the N-S (4.47 meters). The direction to the associated fossil beach is northwest.

This feature was completely mapped in 1985 by the Northern Heritage Field School Project. Examination of associated surface artifacts and the results of test excavations in the near vicinity indicate Middle Pre-Dorset affiliations. No radiocarbon date is available for this feature.

<u>QkHn-12 Feature 10</u> (Figure B2)

This feature is a medium sized (mean radius of 2.48 meters, estimated floor area of 19.32 m^2), reasonably well defined circular tent ring with a disturbed interior feature. Twenty-three rocks comprise the perimeter while fourteen stones constitute the interior feature. The greatest number of perimeter rocks (n=7) are found in the north and northwestern quadrants while the fewest rocks (n=1) are found in the southern octants. The greatest areal load (9900 cm^2) is found in the east quadrant. The longest axis is the SE-NW (5.99 meters), while the shortest axis is the SSE-NNW (3.90 meters). The direction to the associated fossil beach is northwest.

This feature was completely mapped in 1985 by the Northern Heritage Field School Project. Examination of associated surface artifacts and the results of test excavations in the near vicinity indicate Middle Pre-Dorset affiliations. No radiocarbon date is available for this feature.

QkHn-13 Feature 1 (Figure B3)

This feature is a small (mean radius of 1.80 meters, estimated floor area of 10.18 m^2), poorly defined tent ring with a confused axial feature. Sixty-seven rocks comprise the perimeter while fifteen stones constitute the interior feature. The greatest number of perimeter rocks (n=25) are found in the northern quadrant while the fewest rocks (n=4) are found in the southern octants. The greatest areal load (14341 cm^2) is found in the north quadrant. The greatest volumetric load (172741 cc) is found in the north quadrant. The longest axis is the SE-NW (4.02 meters), while the shortest axis is the NE-SW (2.68 meters). The direction to the associated fossil beach is east.

This feature was originally mapped using the radial method in 1985 and subsequently completely excavated. Examination by Helmer of artifacts recovered during excavation indicate affiliations with the Early Pre-Dorset Icebreaker Beach Complex. No radiocarbon date is available for this feature.

QkHn-13 Feature 2 (Figure B3)

This feature is a small (mean radius of 1.69 meters, estimated floor area of 8.97 m^2), very poorly defined tent ring with disturbed interior. Thirteen rocks comprise the perimeter while eleven stones constitute the interior feature. The greatest number of perimeter rocks (n=7) are found in the northeastern and eastern quadrants while the fewest rocks (n=0) are found in the northern, southeastern, southern and southwestern octants. The greatest areal load (2749 cm²) is found in the east quadrant. The greatest volumetric load (40453 cc) is found in the east quadrant. The longest axis is the ENE-WSW (4.49 meters), while the shortest axis is the SE-NW (2.63 meters). The direction to the associated fossil beach is east.

This feature, closely associated with Feature 1 at the same site, was radially mapped during the summer of 1986. Surface artifacts observed in the near vicinity indicate an Early Pre-Dorset cultural affiliation.

<u>QkHn-13 Feature 4</u> (Figures 5, 6 and B3)

This feature is a medium sized (mean radius of 1.91 meters, estimated floor area of 11.46 m²), well defined circular tent ring with a disturbed axial passage. Ninety-six rocks comprise the perimeter while twenty stones constitute the interior feature. The greatest number of perimeter rocks (n=29) are found in the western quadrant while the fewest rocks (n=4) are found in the southeastern octant. The greatest areal load (13218 cm²) is found in the southwest quadrant. The longest axis is the NE-SW (4.17 meters), while the shortest axis is the ESE-WNW (3.36 meters). The direction to the associated fossil beach is east.

This feature was completely excavated and mapped during the summer of 1983 by DIAP. Helmer's analysis of recovered artifacts indicates a Middle Pre-Dorset cultural affiliation for this feature. Unburned terrestrial mammal bone yielded an uncorrected age of 3850±95 BP (NMC-1313).

QkHn-13 Feature 5 (Figure B3)

This feature is a large (mean radius of 2.51 meters, estimated floor area of 19.79 m^2), very poorly defined tent ring with a disturbed interior. Forty-three rocks comprise the perimeter while sixteen stones constitute the interior feature. The greatest number of perimeter rocks (n=24) are found in the northern quadrant while the fewest rocks (n=0) are found in the eastern octant. The greatest areal load (4972 cm^2) is found in the north quadrant. The greatest volumetric load (43236 cc) is found in the north quadrant. The longest axis is the NNE-SSW (6.19 meters), while the shortest axis is the ESE-WNW (2.84 meters). The direction to the associated fossil beach is east.

This feature was radially mapped in the summer of 1986. Artifacts observed on the surface in the vicinity, as well as this features proximity to the dated Feature 4, suggest a Early Pre-Dorset cultural affiliation.

QkHn-13 Feature 8 (Figure B4)

This feature is a small (mean radius of 1.48 meters, estimated floor area of 6.88 m^2), reasonably well defined circular tent ring with a somewhat disturbed central feature. Forty-eight rocks comprise the perimeter while twenty-one stones constitute the interior feature. The greatest number of perimeter rocks (n=21) are found in the south western quadrant while the fewest rocks (n=3) are found in the northeastern, eastern and northwestern octants. The greatest areal load (3029 cm²) is found in the southeast quadrant. The greatest volumetric load (32069 cc) is found in the southeast quadrant. The longest axis is the N-S (3.31 meters), while the shortest axis is the NE-SW (2.13 meters). The direction to the associated fossil beach is east.

This feature was radially mapped in the summer of 1986. Artifacts observed on the surface in the vicinity suggest an Early Pre-Dorset affiliation.

<u>QkHn-13 Feature 9</u>

This feature is a small (mean radius of 1.65 meters, estimated floor area of 8.55 m²), very poorly defined axial passage tent ring. Twenty-two rocks comprise the perimeter while eight stones constitute the interior feature. The greatest number of perimeter rocks (n=9) are found in the western quadrant while the fewest rocks (n=1) are found in the northeastern and southwestern octants. The greatest areal load (4132 cm²) is found in the southeast quadrant. The greatest volumetric load (41127 cc) is found in the southeast quadrant. The longest axis is the ESE-WNW (4.16 meters), while the shortest axis is the N-S (2.42 meters). The direction to the associated fossil beach is east.

This feature was radially mapped in the summer of 1986. Artifacts observed on the surface in the vicinity suggest Early Pre-Dorset cultural affiliations.

<u>QkHn-13 Feature 11</u> (Figure B4)

This feature is a small (mean radius of 1.05 meters, estimated floor area of 3.46 m^2), poorly defined tent ring with confused interior. Thirty rocks comprise the perimeter while nine stones constitute the interior feature. The greatest number of perimeter rocks (n=10) are found in the eastern and western quadrants while the fewest rocks (n=1) are found in the northern, eastern and northwestern octants. The greatest areal load (3933 cm^2) is found in the northeast quadrant. The greatest volumetric load (55525 cc) is found in the northeast quadrant. The longest axis is the ESE-WNW (2.35 meters), while the shortest axis is the SE-NW (1.60 meters). The direction to the associated fossil beach is north.

This feature was radially mapped in the summer of 1986. Artifacts observed on the surface in the vicinity suggest an Early Pre-Dorset cultural affiliation.

<u>QkHn-13 Feature 14</u> (Figure B4)

This feature is a medium sized (mean radius of 2.15 meters, estimated floor area of 14.52 m^2), well defined ovoid tent ring with axial feature. Eighty-six rocks comprise the perimeter while fifty-five stones constitute the interior feature. The greatest number of perimeter rocks (n=26) are found in the southeastern quadrant while the fewest rocks (n=7) are found in the northeastern octant. The greatest areal load (12383 cm^2) is found in the southwest quadrant. The longest axis is the ENE-WSW (4.58

meters), while the shortest axis is the NNE-SSW (3.59 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in the summer of 1986. Artifacts observed on the surface in the vicinity suggest an Early Pre-Dorset affiliation.

QkHn-13 Feature 16 (Figure B5)

This feature is a small (mean radius of 1.57 meters, estimated floor area of 7.74 m²), well defined circular tent ring with interior feature. Forty-four rocks comprise the perimeter while eight stones constitute the interior feature. The greatest number of perimeter rocks (n=17) are found in the northeastern quadrant while the fewest rocks (n=1) are found in the eastern and southeastern octants. The greatest areal load (4521 cm²) is found in the west quadrant. The greatest volumetric load (46203 cc) is found in the west quadrant. The longest axis is the NE-SW (3.34 meters), while the shortest axis is the ESE-WNW (2.77 meters). The direction to the associated fossil beach is east.

This feature was radially mapped in the summer of 1986. Artifacts observed on the surface in the vicinity suggest Early Pre-Dorset affiliations.

QkHn-17 Feature 1 (Figure B5)

This feature is a small (mean radius of 1.66 meters, estimated floor area of 8.66 m²), well defined circular tent ring with well defined axial feature. Seventy-six rocks comprise the perimeter while thirty-eight stones constitute the interior feature. The greatest number of perimeter rocks (n=29) are found in the southwestern quadrant while the fewest rocks (n=3) are found in the northeastern octant. The greatest areal load (6669 cm^2) is found in the west quadrant. The longest axis is the N-S (3.67 meters), while the shortest axis is the E-W (2.69 meters). The direction to the associated fossil beach is north.

This feature was completely excavated by DIAP in 1985 and radially mapped in 1986. Comparative lithic analysis by Helmer attributes this feature to his Twin Ponds Complex of Middle Pre-Dorset affiliations. A corrected radiocarbon age of 3680±90 BP (Beta 15389) on charcoal from this feature is rejected as too old by Helmer.

<u>QkHn-17 Feature 3</u> (Figure B5)

This feature is a large (mean radius of 2.58 meters, estimated floor area of 20.91 m^2), very well defined ovoid tent ring with a well developed axial feature. Forty-seven rocks comprise the perimeter while twenty-five stones constitute the interior feature. The greatest number of perimeter rocks (n=19) are found in the northeastern quadrant while the fewest rocks (n=2) are found in the southern and southwestern octants. The greatest areal load (12325 cm^2) is found in the south quadrant. The longest axis is the ESE-WNW (6.29 meters), while the shortest axis is the N-S (4.88 meters). The direction to the associated fossil beach is north.

This feature was completely excavated by DIAP in 1985 and radially mapped in 1986. Comparative lithic analysis by Helmer attributes this feature to his Twin Ponds Complex of Middle Pre-Dorset affiliations. No radiocarbon date is available for this feature.

QkHn-17 Feature 4 (Figure B5)

This feature is a medium sized (mean radius of 2.18 meters, estimated floor area of 14.93 m^2), reasonably well defined circular tent ring with well formed axial feature. Eighty-three rocks comprise the perimeter while one hundred and two stones constitute the interior feature. The greatest number of perimeter rocks (n=36) are found in the northeastern quadrant while the fewest rocks (n=4) are found in the eastern octant. The greatest areal load (10071 cm^2) is found in the northeast quadrant. The longest axis is the SE-NW (4.65 meters), while the shortest axis is the NNE-SSW (3.72 meters). The direction to the associated fossil beach is northeast.

This feature was completely excavated by DIAP in 1984 and radially mapped in 1986. Comparative lithic analysis by Helmer attributes this feature to his Icebreaker Beach Complex of Middle Pre-Dorset origins. No radiocarbon age is available for this feature.

QkHn-22 Feature 8 (Figure B6)

This feature is a medium sized (mean radius of 2.11 meters, estimated floor area of 12.99 m^2), reasonably well defined tent ring with a very confused interior. Ninety rocks comprise the perimeter while eighteen stones constitute the interior feature. The greatest number of perimeter rocks (n=31) are found in the northern quadrant while the fewest rocks (n=5) are found in the western octant. The greatest areal load (11825 cm²) is found in the northeast quadrant. The longest axes are the NE-SW and the ENE-WSW (5.08 meters), while the shortest axis is the NNE-SSW (3.03 meters). The direction to the associated fossil beach is northwest.

This feature was completely excavated during the summer of 1986 by DIAP. Analysis of the recovered assemblage by Helmer indicates connections with his Early Pre-Dorset Far Site Complex.

QkHn-27 Feature 3 (Figure B6)

This feature is a small (mean radius of 1.38 meters, estimated floor area of 5.98 m²), poorly defined tent ring. Fifty rocks comprise the perimeter and there is no interior feature. The greatest number of perimeter rocks (n=16) are found in the northern quadrant while the fewest rocks (n=2) are found in the eastern and southeastern octants. The greatest areal load (5072 cm²) is found in the northeast quadrant. The greatest volumetric load (49689 cc) is found in the northeast quadrant. The longest axis is the ENE-WSW (2.95 meters), while the shortest axis is the E-W (1.86 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in 1986 by DIAP. No excavations were conducted and no radiocarbon date is available for this feature. Examination of surface artifacts in the vicinity indicate a likely Pre-Dorset affiliation. This feature is tentatively associated with the Late Pre-Dorset Rocky Point Complex.

QkHn-27 Feature 6 (Figure B6)

This feature is a small (mean radius of 1.26 meters, estimated floor area of 4.99 m^2),very poorly defined tent ring with confused interior. Twenty rocks comprise the perimeter while fifteen stones constitute the interior feature. The greatest number of perimeter rocks (n=8) are found in the northern and eastern quadrants while the fewest rocks (n=1) are found in the south, southwestern, western and northwestern octants. The greatest areal load (3179 cm^2) is found in the northeast quadrant. The greatest volumetric load (24560 cc) is found in the north quadrant. The longest axis is the NNE-SSW (2.96 meters), while the shortest axis is the ENE-WSW (2.24 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in 1986 by DIAP. No excavations were conducted and no radiocarbon date is available for this feature. Examination of surface artifacts in the vicinity indicate a likely Pre-Dorset affiliation. This feature is tentatively associated with the Late Pre-Dorset Rocky Point Complex.

<u>QkHn-27 Feature 7</u> (Figure B6)

This feature is a small (mean radius of 1.43 meters, estimated floor area of 6.42 m^2), reasonably well defined tent ring with a somewhat confused interior. Forty-three rocks comprise the perimeter while two stones constitute the interior feature. The greatest number of perimeter rocks (n=15) are found in the northwestern quadrant while the fewest rocks (n=3) are found in the eastern octant. The greatest areal load (6146 cm^2) is found in the south quadrant. The greatest volumetric load (78867 cc) is found in the southwest quadrant. The longest axis is the NE-SW (3.98 meters), while the shortest axis is the ENE-WSW (2.43 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in 1986 by DIAP. No excavations were conducted and no radiocarbon date is available for this feature. Examination of surface artifacts in the vicinity indicate a likely Pre-Dorset affiliation. This feature is tentatively associated with the Late Pre-Dorset Rocky Point Complex.

<u>QkHn-27 Feature 8</u> (Figure B7)

This feature is a small (mean radius of 1.45 meters, estimated floor area of 6.60 m^2), very poorly defined tent ring with confused interior. Forty-one rocks comprise the perimeter while seven stones constitute the interior feature. The greatest number of perimeter rocks (n=15) are found in the southwestern quadrant while the fewest rocks (n=2) are found in the northwestern octant. The greatest areal load (5186 cm^2) is found in the west quadrant. The greatest volumetric load (50335 cc) is found in the west quadrant. The longest axis is the NNE-SSW (3.33 meters), while the shortest axis is the ESE-WNW (1.72 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in 1986 by DIAP. No excavations were conducted and no radiocarbon date is available for this feature. Examination of surface artifacts in the vicinity indicate a likely Pre-Dorset affiliation. This feature is tentatively associated with the Late Pre-Dorset Rocky Point Complex.

QkHn-27 Feature 12 (Figure B7)

This feature is a small (mean radius of 1.26 meters, estimated floor area of 4.99 m^2), poorly defined tent ring with confused interior. Thirty-eight rocks comprise the perimeter while six stones constitute the interior feature. The greatest number of perimeter rocks (n=14) are found in the northeastern quadrant while the fewest rocks (n=3) are found in the western and southwestern octants. The greatest areal load (65248 cm^2) is found in the northeast quadrant. The longest axis is the ESE-WNW (3.56 meters), while the shortest axis is the SE-NW (2.01 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in 1986 by DIAP. No excavations were conducted and no radiocarbon date is available for this feature. Examination of surface artifacts in the vicinity indicate a likely Pre-Dorset affiliation. This feature is tentatively associated with the Late Pre-Dorset Rocky Point Complex.

<u>QkHn-27 Feature 15</u> (Figure B7)

This feature is a small (mean radius of 1.68 meters, estimated floor area of 8.87 m^2), poorly defined tent ring. Ninety-one rocks comprise the perimeter and there is no interior feature. The greatest number of perimeter rocks (n=35) are found in the northeastern quadrant while the fewest rocks (n=3) are found in the northwestern octant. The greatest areal load (6873 cm^2) is found in the northeast quadrant. The longest axis is the NNE-SSW (4.47 meters), while the shortest axis is the SSE-NNW (2.68 meters). The direction to the associated fossil beach is northeast.

This feature was completely excavated by DIAP in 1985 and radially mapped in 1986. Analysis of assemblage composition by Helmer indicates association with his Late Pre-Dorset Rocky Point Complex. An Accelerator Mass Spectrometer (AMS) corrected radiocarbon age of 4060±80 BP (Beta 16554) on charcoal is rejected as too old by Helmer.

<u>QkHn-27 Feature 17</u> (Figure B7)

This feature is a small (mean radius of 1.11 meters, estimated floor area of 3.87 m^2), poorly defined tent ring. Eighty-nine rocks comprise the perimeter and there is no discernible interior feature. The greatest number of perimeter rocks (n=27) are found in the northwestern quadrant while the fewest rocks (n=7) are found in the southeastern octant. The greatest areal load (6804 cm^2) is found in the south quadrant. The longest axis is the ENE-WSW (2.89 meters), while the shortest axis is the SE-NW (1.81 meters). The direction to the associated fossil beach is northeast.

This feature was completely excavated by DIAP in 1985 and radially mapped in 1986. Analysis of assemblage composition by Helmer indicates association with his Late Pre-Dorset Rocky Point Complex. An AMS corrected radiocarbon age of 3800±90 BP (Beta 15391) on charcoal is rejected as too old by Helmer.

QkHn-27 Feature 20 (Figure B8)

This feature is a small (mean radius of 1.41 meters, estimated floor area of 6.25 m^2), reasonably defined tent ring. Thirty-six rocks comprise the perimeter while five stones constitute the interior feature. The greatest number of perimeter rocks (n=15) are found in the southwestern quadrant while the fewest rocks (n=3) are found in the southeastern and northwestern octants. The greatest areal load (3578 cm^2) is found in the south quadrant. The greatest volumetric load (38308 cc) is found in the south quadrant. The longest axis is the E-W (3.96 meters), while the shortest axis is the N-S (2.54 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in 1986 by DIAP. No excavations were conducted and no radiocarbon date is available for this feature. Examination of surface artifacts in the vicinity indicate a likely Pre-Dorset affiliation. This feature is tentatively associated with the Late Pre-Dorset Rocky Point Complex.

<u>QkHn-27 Feature 21</u> (Figure B8)

This feature is a small (mean radius of 1.27 meters, estimated floor area of 9.08 m^2), poorly defined tent ring with confused interior. Forty-seven rocks comprise the perimeter while three stones constitute the interior feature. The greatest number of perimeter rocks (n=15) are found in the eastern quadrant while the fewest rocks (n=3) are found in the northern and western octants. The greatest areal load (6104 cm^2) is found in the south quadrant. The greatest volumetric load (48099 cc) is found in the east quadrant. The longest axis is the NE-SW (3.03 meters), while the shortest axis is the SE-NW (1.90 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped in 1986 by DIAP. No excavations were conducted and no radiocarbon date is available for this feature. Examination of surface artifacts in the vicinity indicate a likely Pre-Dorset affiliation. This feature is tentatively associated with the Late Pre-Dorset Rocky Point Complex.

<u>QkHn-37 Feature 1</u> (Figure B8)

This feature is a medium sized (mean radius of 2.08 meters, estimated floor area of 13.59 m^2), very poorly defined tent ring with a well developed axial feature. Thirty-three rocks comprise the perimeter while fifty-six stones constitute the interior feature. The greatest number of perimeter rocks (n=13) are found in the western quadrant while the fewest rocks (n=0) are found in the southwestern octant. The greatest areal load (3618 cm^2) is found in the northwest quadrant. The longest axis is the SSE-NNW (4.92 meters), while the shortest axis is the E-W (3.54 meters). The direction to the associated fossil beach is west.

This feature was mapped and test excavated during the summer of 1986 by DIAP. Analysis of recovered artifacts by Helmer indicates connections with his Cape Hardy Complex of Transitional Dorset affinities. A corrected radiocarbon age of 2710±60 BP (Beta 15393) is consistent with this assignment.

QkHn-38 Feature 2 (Figure B8)

This feature is a small (mean radius of 1.71 meters, estimated floor area of 9.19 m^2), reasonably well defined circular tent ring with interior feature. Fifty rocks comprise the perimeter while twenty-six stones constitute the interior feature. The greatest number of perimeter rocks (n=17) are found in the northwestern quadrant while the fewest rocks (n=3) are found in the eastern octant. The greatest areal load (8955 cm^2) is found in the northwest quadrant. The longest axis is the E-W (4.00 meters), while the shortest axis is the ESE-WNW (3.08 meters). The direction to the associated fossil beach is east.

This feature was tested in 1985 and excavations were completed in 1986 by DIAP. The feature has been attributed by Helmer to his Cape Hardy Complex of Transitional Dorset affiliations., A corrected radiocarbon age of 2880±190 BP (Beta 15394) is consistent with this assignment.

QkHo-5 Feature 1 (Figure B9)

This feature is a medium sized (mean radius of 1.98 meters, estimated floor area of 12.32 m^2), reasonably well defined circular tent ring with a well developed axial feature. Thirty-four rocks comprise the perimeter while eighteen stones constitute the interior feature. The greatest number of perimeter rocks (n=14) are found in the southwestern quadrant while the fewest rocks (n=1) are found in the northeastern octant. The greatest areal load (1890 cm^2) is found in the southwest quadrant. The greatest volumetric load (14855 cc) is found in the southwest quadrant. The longest axis is the E-W (4.90 meters), while the shortest axis is the N-S (3.56 meters). The direction to the associated fossil beach is northwest.

This feature was radially mapped by DIAP in 1986. There were no surface artifacts observed with this feature but, based upon beach elevation and architectural style, it may be associated with either Late Pre-Dorset or Transiticnal Dorset.

QkHo-5 Feature 2 (Figure B9)

This feature is a small (mean radius of 1.75 meters, estimated floor area of 9.62 m^2), reasonably well defined circular tent ring with a well developed axial feature. Twenty-five rocks comprise the perimeter while fifteen stones constitute the interior feature. The greatest number of perimeter rocks (n=8) are found in the southeastern and southern quadrants while the fewest rocks (n=1) are found in the northwestern octant. The greatest areal load (1510 cm^2) is found in the west quadrant. The greatest volumetric load (16191 cc) is found in the west quadrant. The longest axis is the N-S (4.07 meters), while the shortest axis is the ESE-WNW (3.13 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped by DIAP in 1986. There were no surface artifacts observed with this feature but, based upon beach elevation and architectural style, it may be associated with either Late Pre-Dorset or Transitional Dorset.

<u>RcHh-1 Feature 46</u> (Figure B9)

This feature is a medium sized (mean radius of 1.95 meters, estimated floor area of 11.95 m^2), very well defined defined sub-rectangular tent ring. Forty-one rocks comprise the perimeter while two stones constitute the interior feature. The greatest number of perimeter rocks (n=12) are found in the northeastern, southwestern and western quadrants while the fewest rocks (n=4) are found in the northern and southeastern octants. The greatest areal load (6312 cm^2) is found in the southwest quadrant. The greatest volumetric load (99774 cc) is found in the southwest quadrant. The longest axis is the NNE-SSW (4.80 meters), while the shortest axis is the SE-NW (3.35 meters). The direction to the associated fossil beach is south.

This feature was radially mapped by DIAP in 1987. Surface artifacts in direct association indicate Dorset affiliation for this feature. However, the extreme complexity of occupation at this site make a Thule attribution possible as well. No radiocarbon date exists for this feature.

<u>RcHh-1 Feature 47</u> (Figure B9)

This feature is a medium sized (mean radius of 1.83 meters, estimated floor area of 10.52 m^2), reasonably well defined sub-rectangular tent ring. Fifty-two rocks comprise the perimeter while four stones constitute the interior feature. The greatest number of perimeter rocks (n=17) are found in the northern quadrant while the fewest rocks (n=3) are found in the southwestern, eastern and southern octants. The greatest areal load (4747 cm^2) is found in the north quadrant. The greatest volumetric load (48306 cc) is found in the north quadrant. The longest axis is the SSE-NNW (4.06 meters), while the shortest axis is the ESE-WNW (3.03 meters). The direction to the associated fossil beach is south.

This feature was radially mapped by DIAP in 1987. Surface artifacts in direct association indicate Dorset affiliation for this feature. However, the extreme complexity of occupation at this site make a Thule attribution possible as well. No radiocarbon date exists for this feature.

RcHh-1 Feature 48 (Figure B10)

This feature is a small (mean radius of 1.56 meters, estimated floor area of 7.65 m^2), well defined sub-rectangular tent ring. Thirty-eight rocks comprise the perimeter while three stones constitute the interior feature. The greatest number of perimeter rocks (n=12) are found in the northeastern quadrant while the fewest rocks (n=2) are found in the southwestern octants. The greatest areal load (4437 cm^2) is found in the east quadrant. The greatest volumetric load (61700 cc) is found in the east quadrant. The longest axis is the NNE-SSW (3.47 meters), while the shortest axis is the ESE-WNW (2.57 meters). The direction to the associated fossil beach is south.

This feature was radially mapped by DIAP in 1987. Surface artifacts in direct association indicate Dorset affiliation for this feature. However, the extreme complexity of occupation at this site make a Thule attribution possible as well. No radiocarbon date exists for this feature.

RcHh-1 Feature 53 (Figure B10)

This feature is a medium sized (mean radius of 1.91 meters, estimated floor area of 11.46 m^2), well defined sub-rectangular tent ring. Thirty-four rocks comprise the perimeter while one stones constitute the interior feature. The greatest number of perimeter rocks (n=11) are found in the southwestern quadrant while the fewest rocks (n=2) are found in the southern octant. The greatest areal load (7448 cm^2) is found in the southwest quadrant. The greatest volumetric load (100506 cc) is found in the southwest quadrant. The longest axis is the SSE-NNW (4.33 meters), while the shortest axis is the E-W (3.22 meters). The direction to the associated fossil beach is south.

This feature was radially mapped by DIAP in 1987. Surface artifacts in direct association indicate Dorset affiliation for this feature. However, the extreme complexity of occupation at this site make a Thule attribution possible as well. No radiocarbon date exists for this feature.

RcHh-1 Feature 58 (Figure B10)

This feature is a medium sized (mean radius of 1.97 meters, estimated floor area of 12.19 m^2), well defined sub-rectangular tent ring. Twenty-eight rocks comprise the perimeter and no internal feature is present. The greatest number of perimeter rocks (n=9) are found in the southern quadrant while the fewest rocks (n=1) are found in the southeastern octant. The greatest areal load (5827 cm^2) is found in the south quadrant. The greatest volumetric load (79751 cc) is found in the south quadrant. The longest axis is the NNE-SSW (4.21 meters), while the shortest axis is the ENE-WSW (2.69 meters). The direction to the associated fossil beach is south.

This feature was radially mapped by DIAP in 1987. Surface artifacts in direct association indicate Dorset affiliation for this feature. However, the extreme complexity of occupation at this site make a Thule attribution possible as well. No radiocarbon date exists for this feature.

Skruis Point Feature 1 (Figure B10)

This feature is a small (mean radius of 1.73 meters, estimated floor area of 9.40 m^2), reasonably well defined ovoid tent ring with confused interior. Ninety-three rocks comprise the perimeter while nine stones constitute the interior feature. The greatest number of perimeter rocks (n=29) are found in the southern quadrant while the fewest rocks (n=9) are found in the northern, northeastern and eastern octants. The greatest areal load (5373 cm^2) is found in the south quadrant. The greatest volumetric load (24301 cc) is found in the south quadrant. The longest axis is the E-W (4.08 meters), while the shortest axis is the NE-SW (2.98 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped by DIAP in 1987. No excavations were conducted and no radiocarbon dates are available. Examination of directly associated artifacts indicate definite Late Pre-Dorset affiliations.

Skruis Point Feature 2 (Figure B11)

This feature is a small (mean radius of 1.23 meters, estimated floor area of 4.75 m^2), reasonably well defined circular tent ring with a somewhat confused interior. Fifty-nine rocks comprise the perimeter and no interior feature is present. The greatest number of perimeter rocks (n=21) are found in the southern quadrant while the fewest rocks (n=5) are found in the northwestern and western octants. The greatest areal load (3098 cm^2) is found in the south quadrant. The greatest volumetric load (14262 cc) is found in the south quadrant. The longest axis is the NNE-SSW (3.07 meters), while the shortest axis is the ESE-WNW (1.91 meters). The direction to the associated fossil beach is northeast.

This feature was radially mapped by DIAP in 1987. No excavations were conducted and no radiocarbon dates are available. Examination of directly associated artifacts indicate definite Late Pre-Dorset affiliations.

Skruis Point Feature 3 (Figure B11)

This feature is a small (mean radius of 1.41 meters, estimated floor area of 6.25 m^2), reasonably well defined circular tent ring. Eighty-nine rocks comprise the perimeter and no interior feature was identified. The greatest number of perimeter rocks (n=31) are found in the northeastern quadrant while the fewest rocks (n=5) are found in the western octant. The greatest areal load (5105 cm^2) is found in the northeast quadrant. The greatest volumetric load (18187 cc) is found in the northeast quadrant. The longest axis is the NNE-SSW (3.57 meters), while the shortest axis is the E-W (2.25 meters). The direction to the associated fossil beach is east.

This feature was radially mapped by DIAP in 1987. No excavations were conducted and no radiocarbon dates are available. Examination of directly associated artifacts indicate definite Late Pre-Dorset affiliations.

<u>Skruis Point Feature 4</u> (Figure B11)

This feature is a small (mean radius of 1.50 meters, estimated floor area of 7.07 m^2), reasonably well defined circular tent ring with a somewhat confused interior. One hundred and eight rocks comprise the perimeter while five stones constitute the interior feature. The greatest number of perimeter rocks (n=38) are found in the northwestern quadrant while the fewest rocks (n=9) are found in the northeastern octant. The greatest areal load (6625 cm^2) is found in the northwest quadrant. The greatest volumetric load (21112 cc) is found in the north quadrant. The longest axis is the SSE-NNW (3.82 meters), while the shortest axis is the ENE-WSW (2.28 meters). The direction to the associated fossil beach is east.

This feature was radially mapped by DIAP in 1987. No excavations were conducted and no radiocarbon dates are available. Examination of directly associated artifacts indicate definite Late Pre-Dorset affiliations.

<u>Skruis Point Feature 5</u> (Figure B11)

This feature is a small (mean radius of 0.87 meters, estimated floor area of 2.38 m^2), poorly defined circular tent ring. Sixty-two rocks comprise the perimeter while no interior feature was noted. The greatest number of perimeter rocks (n=25) are found in the western quadrant while the fewest rocks (n=3) are found in the northern octant. The greatest areal load (4212 cm^2) is found in the west quadrant. The greatest volumetric load (15187 cc) is found in the west quadrant. The longest axis is the SE-NW (2.05 meters), while the shortest axis is the E-W (1.42 meters). The direction to the associated fossil beach is east.

This feature was radially mapped by DIAP in 1987. No excavations were conducted and no radiocarbon dates are available. Examination of directly associated artifacts indicate definite Late Pre-Dorset affiliations.