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REGIONS AND RESOURCES



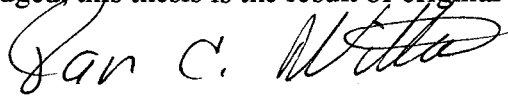
by Dan C Witter

A thesis submitted for the
degree of Doctor of Philosophy of the
Australian National University

the first day of April

~~1990~~ 1990

Except where otherwise acknowledged, this thesis is the result of original work on the part of the candidate.

A handwritten signature in black ink, appearing to read "Dan C. Witter". The signature is written in a cursive style with a large, sweeping initial 'D'.

Dan C. Witter

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ABSTRACT

The goal of this thesis is to bring together several topics for the purpose of site prediction and significance assessment in management archaeology.

This was approached as a survey project along a great transect with three sample areas at Boorowa, Cobar and Tibooburra. The field operation was concerned with the methodology of sampling by transect and quadrat, land systems analysis, sample unit coverage and site recording. A technological system for classifying, recording and analysing stone artefacts was developed in order to compare the artefact assemblages within and among the sample areas.

The results of the survey showed that the main determinants of artefact morphology were the material type, logistics of access and transport, and the reduction strategy. Few assemblages provided indications of functional differences. Sites with a substantial portion of microblade manufacture were found to be distinctive in terms of the rest of the stone assemblage and site structure. These also were mostly in fine-grained mosaic environments, and were interpreted as "microblade base camps", with differences in land use strategies from other sites which are presumed to be later in time. Broader patterns of regional variation show a "core tool oriented" pattern east of the Bogan River, and a "flake tool oriented" pattern to the west. Other details concerning hearths, grinding stones and specialised flake tool manufacturing processes were found to vary along the great transect. Methods for measuring this regional variation are proposed in the form of Stone Technological Regions, Land Systems Divisions, Cultural Adaptive Areas and Archaeological Formations.

The thesis project and its results are presented as a methodological and theoretical model for developing a research framework in management archaeology.

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CHAPTER 1

INTRODUCTION

The Problem

This thesis is a study of stone artefact variation among three different environmental types in New South Wales. The aim is to try to discover processes of land use that allow predictive modeling of site locations and contents. The broader objective of this work is to provide a methodological and theoretical basis for the conservation of archaeological sites, even though most of the project is concerned with the archaeology of Southeastern Australia.

In some respects this is actually three theses. Firstly, it was necessary for me to develop a technological and logistical approach towards stone artefacts for the purposes of comparison among regions. This had to be used in the context of three separate surveys and related to the environmental context of sites and assemblages. Finally, I had to develop a methodology which was applicable for heritage conservation, and could address the concepts of site prediction and significance in the context of management archaeology.

I intend to show that there is considerable archaeological variation from one region to another in Southeastern Australia. I will try to illustrate how this can be explained using models about Aboriginal cultural processes and a knowledge of how the archaeological record is formed. In management such an understanding is essential to assess the meaning and significance of known sites. Also needed is the capacity to make predictive statements about where other sites can be expected. Inherent in this is the issue of how a research dimension can be related to applied archaeology. I do not expect to disentangle the complex relationship between academic and public archaeology here, but it is a theme which is fundamental to the project. It also should be understood that this thesis is not concerned with other types of site significance such as from an Aboriginal point of view, or in terms of Aboriginal heritage. This would be yet another project.

To summarise: the problem is concerned with regional variation in the archaeological record: how do we find out what it is, how do we explain it, and how can we then manage it as a cultural resource?

The remainder of this introduction is addressed towards explaining how certain terms and concepts are used in the thesis, and then to give some historical background as to why I undertook this project.

DEFINITIONS AND CONCEPTS

My approach towards this thesis was derived from cultural ecology (Steward 1955) and the relationship between environmental determinants and cultural adaptation (see Harris 1969:643-87). In order to clarify how I perceive cultural adaptive processes, and how I think they can be discovered, it is necessary to discuss some of the key concepts.

The Concept of Regional Variation

Geographical patterning is a common archaeological interest (e.g. Hodder and Orton 1976), and has received some attention in Australia. Tindale, for example, put forth a regional successional scheme for the Southeast of South Australia (Tindale 1957), and McCarthy has nominated certain cultural regions on the basis of artefact types (McCarthy 1976:94-8). Recently, more sophisticated studies of regional variation have been carried out such as the study of gene flow throughout Australia using Aboriginal skeletal remains by Pardoe (1984).

Part of the idea of regional variation is one of scale: how large should a region be and how does one define it? There seems to be little emphasis on relative scales of investigation in the Australian literature (Head 1984:10). For example, when does a "local level" become a "regional level"? This distinction depends on the subject of the study. In the case of hunter-gatherers it might be defined in terms of the size of group territory, land use patterns, or language. In this thesis, regions are defined in terms of environment and stone artefacts.

The approach towards the environment here is by land systems. This provides a means of defining environmental types at a local land use level as well as at a larger scale. Later, in Chapter 9, I will propose a broad regional scheme of Land Systems Divisions which is intended to reflect the degree of environmental difference which would have affected Aboriginal behaviour.

The stone artefacts were mainly approached in technological terms. Due to differences in material availability and methods of manufacture, there should be distinctive stone artefact areas. This has led to the proposed Technological Regions scheme, which also is presented later in Chapter 9.

Cultural Adaptation

By cultural adaptation, I mean the way in which a culture comes to terms with its environment. If a culture is to survive at all, it must permit its members to adapt to their natural surroundings. Regardless of the extent to which individuals may be preoccupied with their social or spiritual life, they still must cope with a variety of environmental factors such as drinking water, food and materials.

Most archaeological remains are associated with this aspect of life, such as stone tools, manufacturing waste, food debris, and settlement locations in an environmental context. It should be possible to develop a cultural adaptive frame work to explain the behaviour which creates the major part of the archaeological record. Ultimately it would be desirable to be able to integrate this with other aspects of culture (i.e. social or religious). For example, there are a variety of features which suggest various ceremonial, social or cognitive facets of past Aboriginal culture, such as stone arrangements, bora rings, rock art, exchange items, and so on. These now are studied in isolation since the cultural adaptive background is not known.

Regional differences in cultural adaptations can be expected, and it would be desirable to identify such areas of behaviour. This would be a way of integrating the land systems and stone technological patterns mentioned above with other aspects of the archaeological record and such ethnographic material as is available. An attempt to do this is given later in Chapter 9 as a Cultural Adaptive Area scheme.

Cultural Strategies

The concept of a strategy as a heuristic device is regularly used in population ecology and related fields (e.g. MacArthur and Connell 1966, Emlen 1973). This type of concept has been used in a cultural context for optimum foraging strategy analyses (e.g. Winterhalder and Smith 1981, Crumly 1979, Bettinger 1980). For the purposes of this thesis I use strategies to refer to particular cultural adaptive processes. At a very broad level, cultural strategies can be seen as adaptations to both the social and the biophysical environment, and there probably is no real boundary. In archaeology however, what we have are materials representing mainly the biophysical aspects which relate to technology, economy and land use. It is in this later context that I am concerned with cultural strategies.

A cultural strategy itself is a product of cultural evolutionary processes. The appearance of what I define later as the Microblade Industry was not because there suddenly was an abundance of high quality stone to flake, and its termination was not

because the stone was used up. If, as I have suggested elsewhere, (Witter 1988:39-40) the industry depended upon the extensive transport of cores for blade production, then this would have conflicted with an essential principle of nomadism, which is to travel light. The manufacture of backed blades may be assumed to be due to the specifications for a particular type of implement which was required at the time. To say that the production of backed blades was a matter of "style" does not explain their presence. I consider that the industry arose as an adaptive response, and its abandonment implies that its adaptive value was no longer important. The suggestion of "diffusion" from outside of Australia is not helpful (Dorch 1981). For the design of a particular implement to be adopted, regardless of the source of knowledge, it is necessary to have an appropriate set of cultural conditions. It is an understanding of these which provides an explanation.

Strategies are sets of rules. Individuals make decisions according to these rules. For example, a least-cost rule of stone transport or access to food resources is likely to have a major effect on where a camp site is located and what the artefacts in it will be like. The collective patterning of this should indicate something of the broader strategies of settlement and stone technology. This should be indicated by the logistical processes of the flaked stone, and the way in which the distribution of artefacts maps out the pattern of activities over the landscape.

A knowledge of these strategies leads to a predictive capacity. It should be possible to predict where archaeological sites are, and what will be in them. A failure in these predictions serves to indicate that either the model is inadequate, or there are situations where different sets of rules are operating.

The issues of identifying adaptive strategies and site prediction by explanation are an important theme in this thesis. In some projects extrapolation from empirical patterning is taken as "site prediction" (e.g. Huges and Sullivan 1984:37, Ross 1986:66). It will be argued later that the expectations derived from this method should be more properly referred to as "forecasting". In Chapter 7, I evaluate the preceding three Chapters on the study areas as to how adaptive strategies can be inferred. The issue of prediction by explanation is finally discussed in Chapter 10.

The Concept of Comparability

Any study of regional variation needs to address the issue of comparability of the data. For example, what biases are there in different studies? What concepts were being measured by the observations? How systematically were these observations carried out?

The meaning of data is not self evident. What, for example, is an "archaeological site"? (see a discussion of this in Chapter 4). This is a basic unit of survey data, yet there is no consistency of how many artefacts are needed to identify a site, nor whether the criteria to be used are the exposures, the land form or the extent (not normally visible) of the cultural deposit. The results of sites recorded over a landscape are also ambiguous. Within a given survey, parts where the ground surface was well exposed and bare can be expected to give different results from areas where there was an aggrading surface and heavy grass cover.

It is unavoidable that sites are defined on an arbitrary basis, and that there will be parts of the area surveyed where they cannot be detected. In spite of this, site frequency is a type of survey analysis carried out regularly, and inferences about human behaviour are based on it. If the factors which go into detecting and identifying sites differ from one region to another, then it undermines the comparisons to be made and makes an evaluation of regional variation difficult.

In practice, most of my project was oriented towards methodological problems such as site recording and documenting the survey process. This has included problems of sampling, and the need to control the survey method by what I will define later as coverage analysis.

I also had to develop a system of artefact classification and analysis which can be used consistently, regardless as to the region, stone material or manufacturing process. This approach differs from the conventional typological approach as is normally used in Australia (i.e. McCarthy 1976). Therefore, in the absence of other sources to cite, it is necessary to present the basis for this approach in detail in Chapter 3.

As the following discussion on the history and background to the project shows, these methodological issues have been a major preoccupation which led to the thesis.

HISTORY AND BACKGROUND OF THE PROJECT

It should be evident by now that I hope to weave together a variety of themes in this thesis such as regional variation, cultural adaptive strategies, survey methodology and cultural resource management. Any one of these offers abundant scope for research. I think that the most simple explanation of why these issues need to be linked together would be to describe my personal involvement over the last 20 years.

The importance of the methodological problems mentioned above became apparent to me in 1970 at the first conference of the Southwest Archaeological Research Group (SARG) conference in Prescott, Arizona (Gumerman 1971, SARG 1974). By this time a number of large scale survey projects had taken place in the Southwestern United States, both as grant-funded research and as salvage surveys. Moreover, attempts had been made to compare the data obtained in one survey with that of another. The SARG conference was motivated by the discovery of the lack in comparability in attempts to compare one survey report with another.

The approach adopted by SARG was for all of the participants to agree upon a problem orientation and "core" data set as a research design. This was to be shared by all of the members, and was: "why do people settle where they do, and why do larger communities develop?" In order to pursue these issues a minimum set of field observations was required in standardised form. These categories were designed to record environmental factors which might be relevant. This research design was to be applied to all projects in addition to various other interests or information requirements. A large number of organisations and institutions participated in this programme, and an enormous amount of data was processed, but in the long term, it cannot be said to have been successful.

The methodological problems have not gone away. Perhaps excavated sites can be treated as self-contained, but sites recorded on survey are necessarily related to a general pattern and have to be put into a regional context. Even allowing for differences in problem orientation or sample strategy, it is probably thought by most archaeologists that the data obtained on most surveys should have some level of analytical compatibility. This view is contradicted by Daniels (1978:32) who claims that this can come only when there is a single research design and rigid controls of bias.

Since I was present at the initial SARG conference and participated in the program, I have had the opportunity to consider the weaknesses of this massive endeavour. I believe that SARG did not meet its expectations because it did not resolve the necessary methodological and theoretical requirements. These were, in fact, addressed at the outset, but abandoned as being too difficult to solve in the short term. It was felt that early results were particularly desirable, and due to the commitment to the existing scheme, proposals made later to re-examine methodological shortcomings were discouraged.

One example of this was the case of environmental observations. Recording environmental characteristics from a radius of 0.5km to 20km has different implications, such as in food procurement, access to water or the availability of fire

wood. The scale of environmental observations in the SARG research design were arbitrary and not based on any body of theory as to how people range over the landscape.

Thus one crucial issue was the quality of the data and the lack of developed analytical concepts in survey. By an analytical concept I mean a theoretical basis for making observations in the field. In ecology, for example, there is a body of theory about dominance. This may be measured in various ways such as by biomass or canopy cover. The results may be used to consider a variety of theoretical problems such as the processes of vegetational succession in a region. In archaeology it is difficult to find an equivalent approach. There is, for example, a body of theory about settlement strategy, and some assumptions that site frequency should reflect this, but the methodology for the acquisition of data are not at the same systematic level.

Another issue not pursued by SARG was one I have already referred to, which is taking the distribution of sites within a region and their contents at face value. Formation processes (e.g. Schiffer 1972, 1973), and other site detection conditions greatly affect where and how many sites are found. Dots on a map are not enough, and the effects of alluviation, deflation or pasture cover must be quantified in order to evaluate the extent and nature of the missing data.

These problems have an especial relevance to management. If an archaeological impact survey is carried out, how valid is it as a statement of the cultural resource? Can the data be used in a broader analysis to predict where other sites will be?

In Australia, most archaeological fieldwork takes place on management surveys. It is a common experience, however, that the data obtained is difficult to use even for simple research projects. In management there is a special interest in being able to use such data for predictive analysis or to define the archaeology of particular regions since actions and recommendations are proposed in this context.

At the 49th ANZAAS conference in Auckland in 1979, in a session on cultural resource management, I presented a paper (Witter 1979) on predictive theory in public archaeology. I outlined two approaches. The first was called empirical generalizations. This is what is generally used as "predictive theory" and consists of statements about where sites are usually found. I suggested that this could be made more effective if the cultural patterning and site formation processes were separated and defined for different regions which I called Cultural Adaptive Areas and Archaeological Formations.

The second approach was by explanatory models. For this, detailed site recording was needed for environmental, site contents and formational data. A research framework for analyses then would be needed to develop explanatory models as to why the sites were located where they were. If these were understood as adaptive strategies, then unknown areas could be evaluated more realistically.

It was these methodological issues in the context of regional variation and predictive modelling which became the basis for the research design of this thesis. The work was further intended to be management oriented, since research in this area by those government organisations responsible for prehistoric site conservation is normally very limited. Part of the problem was one of feasibility - not only as to how an explanatory predictive approach might work, or how regional variation can be evaluated, but how this might be implemented at the management level and applied for conservation purposes. This then, is the crux of the thesis, and what was referred to in the first two paragraphs of this Introduction.

The field work component needed to cover a sufficiently broad range of environmental, cultural and formational diversity. This was conceived as a "great transect" along the Moomba Pipeline in New South Wales (Figure 1.1), where a previous archaeological impact survey had been conducted (see Chapter 2). This transect went from an upland temperate environment across the Darling River and out to the central desert.

The original idea was that my survey could be compared with the earlier work as a way of demonstrating the consequences of different methodologies. As it turned out, the difficulties in establishing comparability were greater than anticipated and this exercise was abandoned. Instead, the project proceeded to investigate three sample areas along the great transect: Boorowa, Cobar and Tibooburra. These areas were chosen as representative of three environmental types. The sites in these areas are dominantly exposures of flaked stone debris, with little material that would date earlier than about 5000 years ago. Thus the type of cultural remains was to be held as constant as possible and the environment varied. This approach developed into the research design which is the subject of the next Chapter.

The Unifying Theme

The regional studies are not the main goals of this project, nor is the technological classification of stone artefacts. The unifying theme is derived from a fundamental principle in management archaeology, which is:- the need to know what the cultural resource is, and what the archaeological values are which require conservation. The

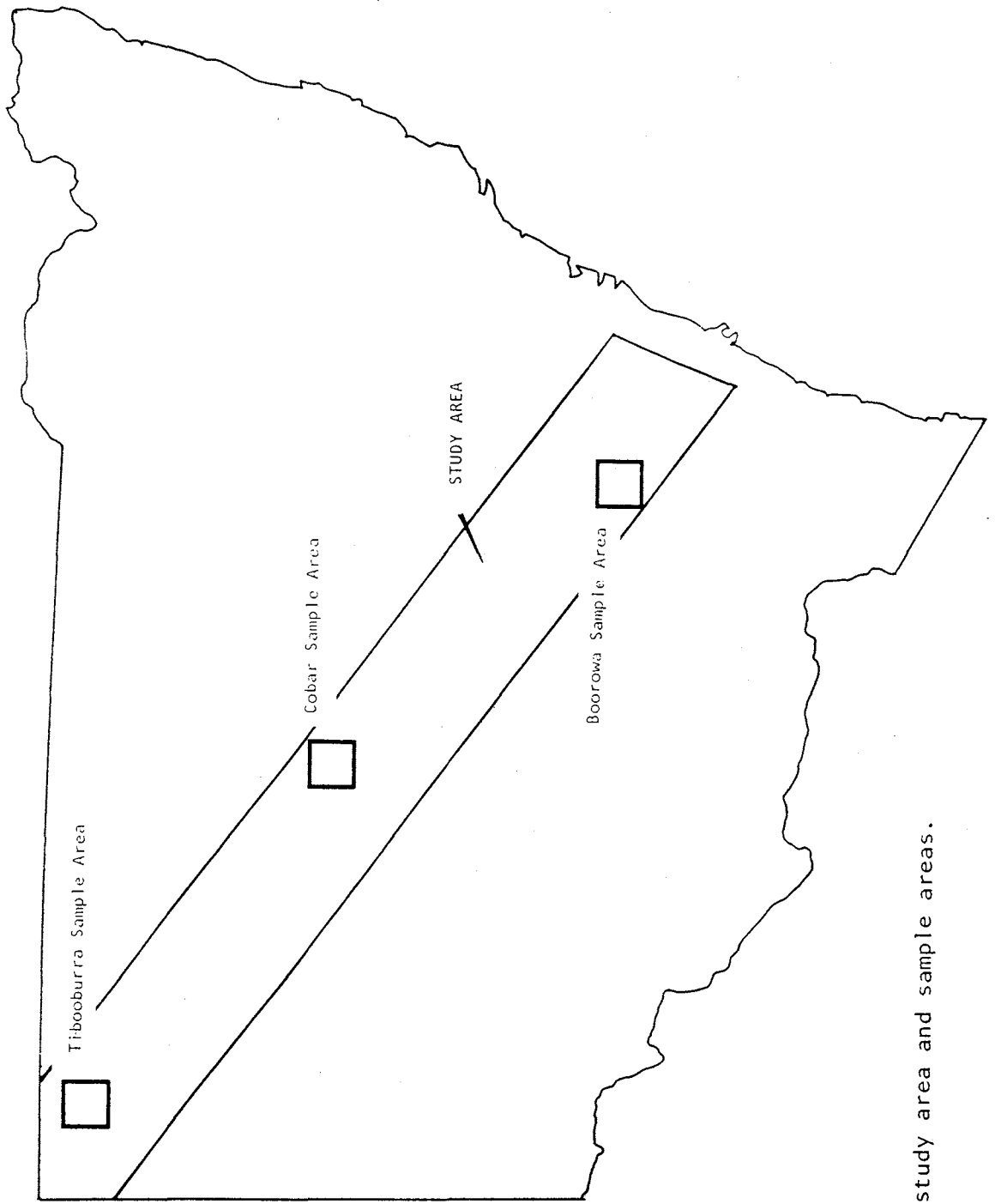


Figure 1.1. Location of the study area and sample areas.

essential questions are: how does the archaeological resource vary, how do we find out, and what does it mean?

From past experience, it cannot be said that the archaeological resource in NSW is well known for the purposes of cultural resource management. The main source of existing archaeological knowledge is from university research, but this work has not provided managers with:

1. A scheme of regional variation for archaeological sites and their contents across NSW (the division by McCarthy, 1976, is hardly adequate).
2. Patterns of occupation over landscapes throughout NSW (although there are a variety of studies for particular areas).
3. A coherent set of models about land use strategies or other cultural processes which affect site variability.

This knowledge is needed for management planning and assessment. It would be unrealistic and perhaps unfair however to expect management priorities to be major issues in university research. It is the government organisations with the statutory responsibility for cultural heritage conservation who must ensure that they are informed managers.

Government archival sources in the form of a sites register, the accumulation of archaeological impact statements, and other types of reports also has been found to be of little practical help (as opposed to Flood 1984:58). Without specific requirements for data quality and a framework for comparability, this material is piecemeal, idiosyncratic and particularistic.

The current archaeological heritage literature also seems to be little oriented towards systematics, or seriously address the problem understanding of the cultural resource. The chief exception is a concern with the mechanics of a sites register (e.g. Flood et al. 1989), but this is not the same as an integrative and holistic approach (as will be discussed at the end of this thesis).

What, in fact, is this cultural resource? Rock engravings or shell mounds may readily come to mind. Sites of this sort are rare, and however interesting they may be, only make up a small part of the archaeological record. There can be no doubt that most prehistoric archaeological sites are open occupations, mainly consisting of flaked stone artefacts, and which apparently belong to the Late Holocene. This comprises the major

part of the visible archaeological resource. In spite of this, the basic questions remain unclear: Are all open sites the same? How are the differences identified? Do they form a pattern over the landscape? Can this be extrapolated elsewhere? How much error is there in field observations? What would explanatory models for the distribution of this variability be like? The purpose of the main body of the thesis is to explore these questions.

The final chapter is intended to show where the systematics and organisation of information about the archaeological resource fits into the broader field of cultural resource management.

STRUCTURE OF THE THESIS

I will briefly summarise the chapters below and explain how they fit into the overall thesis.

Chapter 2 presents the research design. I discuss some of the procedural problems and how they were applied to the great transect. This is preparation for the Methods chapter and the chapters on the three sample areas. I also give a brief account of the field work.

In Chapter 3 it is necessary to undertake a digression into stone artefacts. Without this chapter it would be difficult to understand the techniques used for site recording, the analysis by the Reduction Chart and the debitage histograms. One of the main aims of the stone artefacts chapter is for its use in management. This requires a method for recording stone artefacts in the field, and in which the analysis is simple. It requires a basic grasp of the principles of stone technology and a knowledge of particular stone tool manufacturing processes which I call "industries". The description of the stone technological industries is comprehensive as it applies throughout the great transect, but is not an attempt to write a definitive work on Australian stone tools.

Following this is Chapter 4, on methodology. I cover various aspects of sampling and site recording and explain the general principles involved. I then discuss how these were addressed in the field. Although in some respects this Chapter is slightly like a manual for doing survey work, the real goal is to clarify the way in which the field work and analysis was conducted.

Next are the descriptions of the surveys in the three sample areas. The Tibooburra (Chapter 5), Cobar (Chapter 6) and Boorowa (Chapter 7) areas are treated in the same way. These chapters follow a format of setting the stage with the environment,

ethnography and previous archaeological work. Then I give an account of the land systems which were the basis for the sample units. The coverage of the sample units is then evaluated in terms of the sites found. Following this is the stone tool analysis using the Reduction Charts and this is followed by the debitage histograms. At this stage I then discuss the archaeology in terms of the main trends, the sites which are unusual, and finally, suggest some aspects of land use strategies. The objective of these chapters is to try to identify some adaptive behavioural processes within the Late Holocene for the sample areas. This is different from trying to produce three separate regional prehistoric sequences for each.

In Chapter 7 the three sample areas are put together along the great transect and compared in terms of their environmental and artefactual variability. This is with a view to assess the regional differences and the potential for predictive modeling. The objective of this Chapter is to examine the Australian archaeological record for potential patterning which can be used in the context of cultural resource management.

The pattern of regional variation is expanded according the concepts of Stone Technological Regions, Archaeological Land Systems Divisions, Cultural Adaptive Areas and Archaeological Formations. The point of this is not just to invent new terms. These are concepts which I developed to measure particular kinds of processes which operate on the landscape. Since these are the main factors which make up the archaeological record in different regions, it is important to isolate them if the regions are to be compared. Except for the Stone Technological Regions which applies to Southeastern Australia, the other schemes are confined to the great transect.

Finally, in Chapter 10 comes the management implications. My approach to this is at the practical level, and is consistent with the previous chapters. For this reason I have avoided branching out into a review of the literature or a comparison of management philosophies. My strategy has been to use the thesis itself as a model, rather than take a didactic approach. The objective is to demonstrate empirically aspects of method and theory which can be used, given the kind of archaeology normally encountered during management surveys. For example, Chapter 2 is concerned with some of the aspects of project research design relevant in management. The methodology Chapter was oriented towards techniques which can be used in management surveys. The surveys of the three sample areas are examples of the methodology for sampling, coverage, Archaeological Land Systems Units and techniques for stone artefact analysis. These are all feasible at the level of archaeological impact surveys. Chapters 8 and 9 are background for the discussion of problems in site significance assessment and predictive theory in management. The main issue in the chapter on management however is the implementation of these aspects into a practical research framework with

a feed back process which can be used in heritage conservation. My final comments are on the potential of research in management which relate to academic research.

In some respects this final chapter on management will seem like an anomaly, since it does not directly follow on from the three study areas. At a more abstract level however, this thesis addresses the concepts and methods needed in management archaeology. Fundamental to the principles of management is knowing the resource to be conserved. A research framework is needed for this which will generate usable data and models and provide a structure for regional variation. The ultimate intention is not merely a polemic about how managers need to know their resource better, but to show in practical terms how this can be achieved.

CHAPTER 2

THE GREAT TRANSECT

RESEARCH DESIGN

Before proceeding to the survey areas, I need to indicate the overall structure of the research in order to show how the three areas are related.

The research strategy was to compare the prehistoric cultural ecology of three different types of environments. This was most simply done by beginning with the relatively humid temperate environment of the Dividing Range, and continuing into the arid zone. As already mentioned, it was originally thought that the Moomba Pipeline Survey would be of assistance. The results of this survey however did not produce sites in the Dividing Range country, and the data were not recorded in a way to provide comparability (the issue of comparability will be discussed more in the Methods Chapter). Other work in the area of the Moomba Pipeline zone is listed below (see Figure 2.1).

1. Allen, H. 1968: Most of northern NSW and part of southwest Queensland, ethnography and literature review.
2. Sullivan, S. 1970: Northwestern NSW, ethnography and literature review.
3. Allen, H. 1972: Most of western NSW, survey and excavation.
4. Flood, J. 1973: The Southern Highlands of NSW and Victoria, survey and excavation.
5. National Parks and Wildlife Service 1972 to 1974, various impact reports by Haglund and Buchan: The Moomba Pipeline from Sydney to the Northwest corner of NSW.
6. McCarthy F. 1976: The Cobar region, various art sites.
7. Clark, P. 1977: The Boorowa area, survey.
8. Johnson, I. 1979: The Blue Mountains area, excavation and literature review.

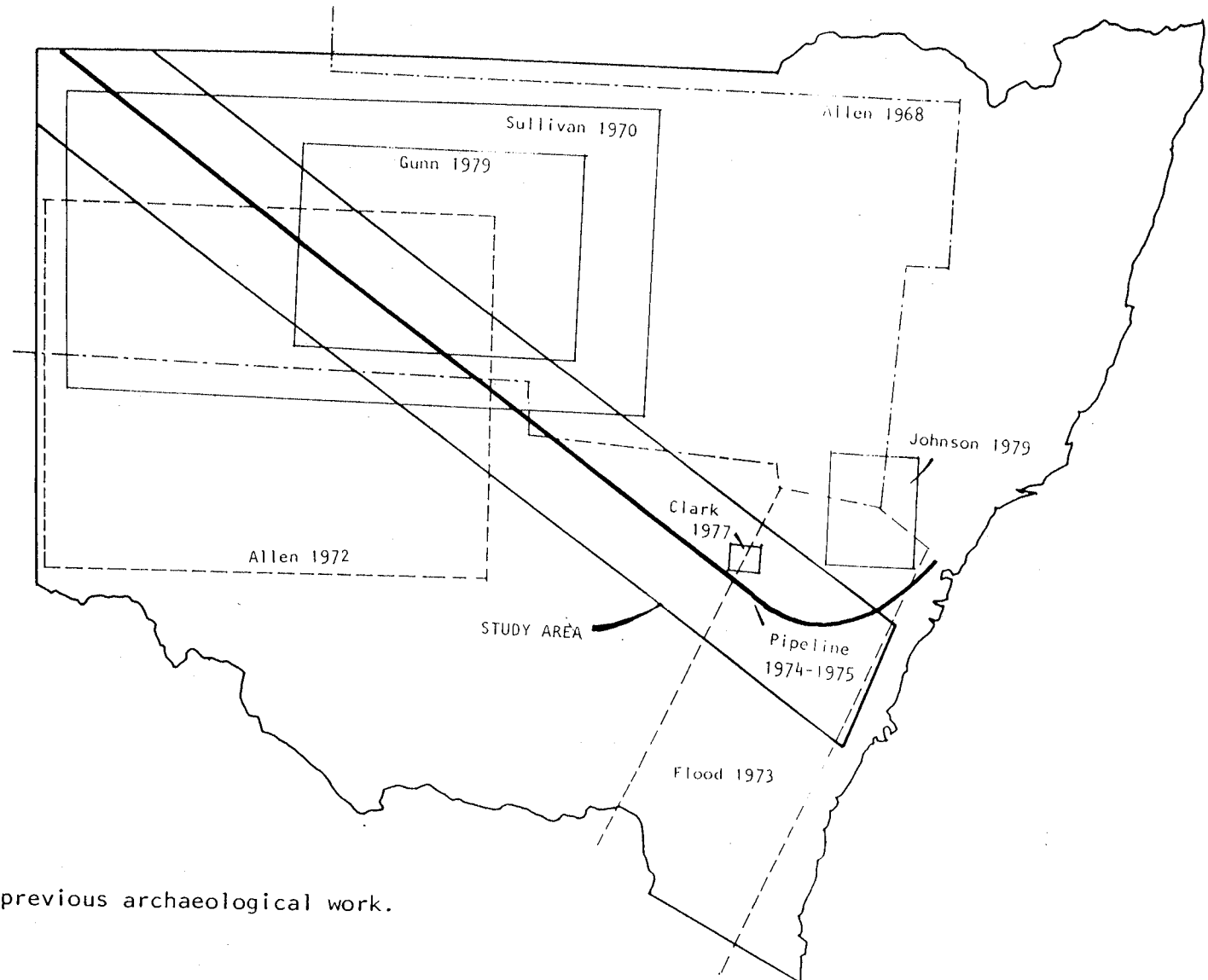


Figure 2.1. Locations of previous archaeological work.

9. Gunn, R. 1979: The Cobar region, various art sites.

This work generated a variety of questions, many of which relate to specific regional adaptive problems, and ranging through demographic, economic, sociological and chronological issues. This work also provided an exhaustive review of the ethno-historical documentation, previous archaeological investigations and major environmental features.

Before proceeding, I should note that the Aboriginal tribal/linguistic name spellings used here are from Tindale (1974). This is for the purposes of consistency, although I am aware that more recent orthographies maybe more accurate.

The work cited above provided a few regional models, such as that by Allen (1972) on the relationship of Barkindji people of the Darling River and the Ngemba of the Cobar area, or by Flood (1976, 1980) on the use of Bogong moths. Not surprisingly however, these various projects did not generate any overall models or theories, except to fit into the generally accepted chronological framework of a change in artefact types after 5000 years ago. It also should be noted that these few projects cover an extremely large area, and the details of the archaeology remain mostly unknown. Any survey work I carried out would still be part of the on-going exploration.

My assumption at the outset was that site location was firstly due to environmental determinants. These determinants required an optimal solution to factors such as water and food within the context of a subsistence strategy (e.g. Winterhalder and Smith 1981). The subsistence strategy could be specialist or generalist, opportunistic or intensive, and at various levels of complexity. As the interaction between the environmental determinants and the cultural strategy is better understood, predictability becomes increasingly reliable (Gumerman 1971, Williams et al. 1973, Jochim 1976). This is not to say that there are not a variety of other factors which affect settlement patterns and site contents, but this approach seemed to be the one most likely to account for the greatest variability.

The implications for my thesis survey were: How are the resources distributed over the landscape (food, water, stone etc.)? What kinds of cultural strategies are implied by site environmental location and site contents? What are the observational biases (sampling and site detection) and formational factors (preservation, sedimentation, and erosion) which will affect the field work and analysis? Finally: how can I compare regions in terms of adaptive strategies? This last point should reflect broad evolutionary cultural processes in common at a continental level, or other processes which were developed in response to regional environmental factors.

Another criterion was that this approach needed to be applicable to management archaeology. An explanatory approach towards site prediction reveals something of the dynamics of the culture. This knowledge of cultural processes provides a basis for a more insightful evaluation of site significance.

To fully realise such objectives would be extremely ambitious. At a more realistic level I had two goals. Firstly, I hoped to assess the feasibility of developing land use models as a specific form of cultural adaptation. Secondly, I intended to describe some general patterns in artefact distribution, environment and formation among the regions, as background for further model building.

My approach was to sample the study area and assess (a) the range of variation among site types and within a site type, (b) the common and rare forms of this variation, (c) the degree of complexity among the sites in terms of artefacts, environment, internal site structure and landscape distribution, and (d) the biases due to sample coverage, site recording, and formational processes.

The above four points formed the basis for my survey methodology, and are expanded in the section on sampling below. The survey needed to be able to define the ordinary pattern as a basis for recognition of outstanding or unusual sites. The issue was that of whether or not all sites are similar, and if some are different, how different is "different"? In this case I was not concerned with typological similarities, but differences in artefact manufacturing processes, as indicated by the assemblages. The recognition of this was further dependent upon field conditions and observational biases. In this project I particularly wanted to develop an approach which would quantify the survey coverage, assess the artefact variability and provide an environmental context. These methods are described below as coverage analysis, Reduction Charts and land systems units.

I considered that this empirical background was essential for the development of models about land use within a region. None of the previous work had attempted modeling at this level, nor provided sufficiently controlled data.

The strategy for a deductive approach for a relatively poorly known study area was to divide the research into two stages. In the first stage, expectations would be formulated about site distribution and artefact variability in conjunction with field work. This would be re-evaluated and a second field exercise would take place. The variability of stone artefact assemblages and site locations would be summarised and land use models

proposed. The broader aspects of regional patterning then could be considered, and the relevance of the research to cultural resource management would be evaluated.

THE GREAT TRANSECT

The transect approach has been used in a variety of archaeological surveys (Schiffer et al. 1978:11-2). It is a technique which provides a description in the form of a cross-section or a profile. This is particularly useful where boundary effects are relevant and change (or the lack of change) can be illustrated along a line from point A to point B. Profiles for the great transect are given in Figure 2.2A for the physiography, and in Figure 2.2B for the annual rainfall and evapo-transpiration (Plumb 1973).

Since limits on time and funds prohibited coverage of the entire 1100km transect, three large sample areas were chosen. An alternative would have been to select several much smaller areas for sampling. The use of many small areas would help to indicate boundaries or gradients, but a few large areas would describe better the variability within a discrete region (see Krebbs 1978:92-3, Kershaw 1973:229, Whittaker 1975:112-3, Odum 1971:146, Daubenmire 1968:258 for different versions on this distinction). The second alternative also was chosen because a small area might leave out important environmental types or kinds of sites within a settlement pattern.

This study has avoided boundary areas in order to investigate the systemic properties of major regions. Between the Cobar and Boorowa areas for example, the Dividing Range slopes meet the Western plains and there appears to be a major boundary between arid and temperate ecosystems. This is also the eastern extent of the Tula Industry and where the quartz technology of the Dividing Range country begins. An investigation of this zone would have made it difficult to compare with other less complex areas. The Darling River area was similarly avoided since the aquatic environment and associated sites presents a considerably more complex and dynamic situation.

General Context of the Great Transect

The great transect line begins at Tibooburra. This area is a system of low ranges and plains lying between the Strzelecki Dune Field to the west, and the Bulloo and other arid lakes to the east. Ethnographically, the Aborigines of the area seem to have been mainly associated with the Dieric language group (Oates and Oates 1970) of the eastern Lake Frome basin, Coopers Creek, Grey Ranges and Bulloo basin. Within this system, they belong to a cultural association known as the "Lakes Group" Beckett 1958:96, Elkin 193:44). Archaeologically, there are many elements in common with Central Australia (see Gould 1968), such as pirri points and tulas. These are made from

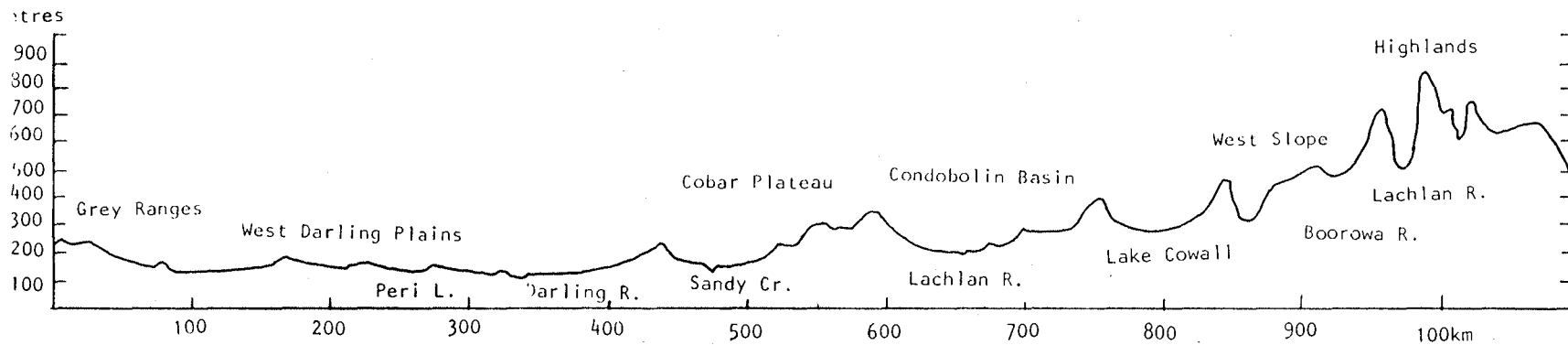


Figure 2.2A. Physiographic profile through the study area.

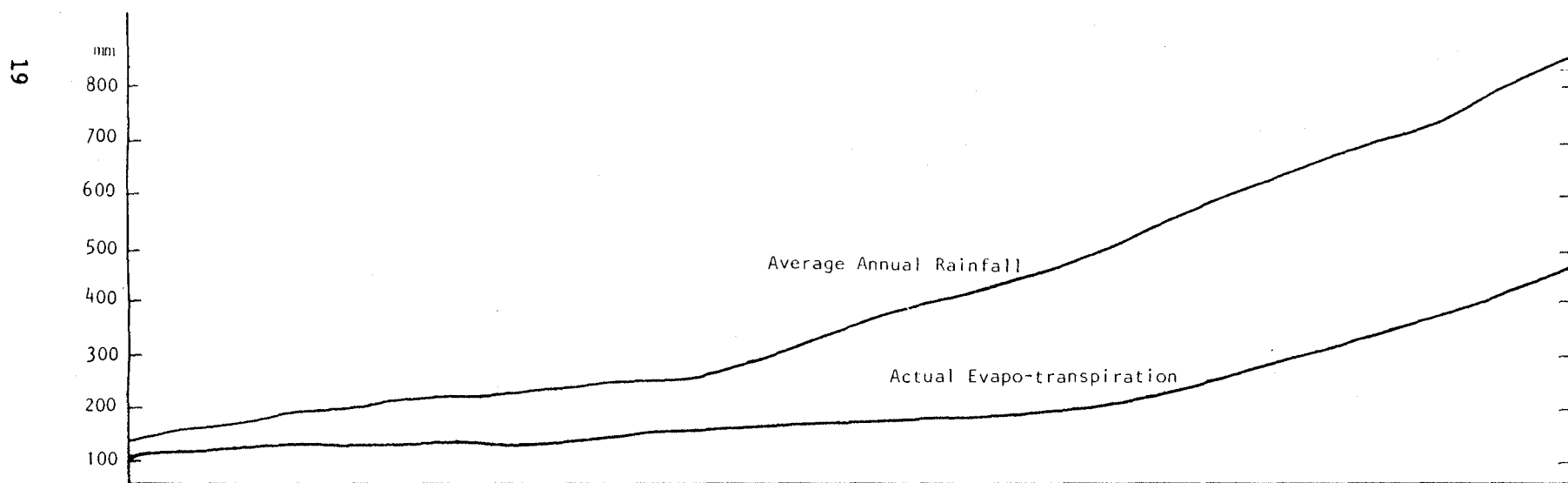


Figure 2.2B. Climatic profile through the study area.

duricrust silcrete which is the chief tool material. Quartz from Proterozoic rocks also is locally common.

Proceeding southeast are the arid plains and the Paroo channel country west of the Darling. The ethnographic and archaeological cultures are continuous with those in the Tibooburra area.

Reaching the Darling River, there is a system of flood channels and lakes which periodically contain large quantities of water. The addition of these aquatic ecosystems and access to permanent water introduces a new economic dimension. The Barkindji and other people of the Darling Valley, unlike their neighbours to the west, did not practice circumcision, were perhaps less mobile and lived in greater population densities. It is presumed that they had considerable interaction with their more upland neighbours and, in times of widespread drought, had to accommodate an influx of refugees (Allen 1972, 1974). Except for the addition of fresh water shell middens, the archaeology of the Darling is much like that further west. It is the core area of items such as "widows caps" and cylcons (Allen 1972:116-9).

Continuing south-east from the Darling River is the Cobar plateau. This is a semi-arid zone of plains and small sandstone ranges drained by Sandy Creek. The region contains extensive woodlands, especially cypress pine, and a variety of shrublands. Ethnographically, the people were affiliated with the Wiradjuric language group as Ngemba speakers. These people show some cultural elements from the west, such as matrilineal moiety systems and the archaeology includes tulas and grinding equipment. Pirri points are rare, but bondis are common. Silcrete is the main tool material, but in the eastern portion quartz and fine-grained volcanics from the Lachlan geosyncline become prominent.

To the south-east of the Cobar Area is a series of low ranges containing woodlands and shrublands which form a small basin. The Lachlan River issues from the Dividing Range near Forbes and passes through this basin, and west of Lake Cargelligo it enters the Riverine Plain. Most of this area has been cleared for irrigation or pastoral use, although there seems to be a slight rain shadow effect. The Lachlan was probably a focus for the Wiradjuri in a way similar to the Darling River for the Barkindji.

The archaeology of the Western Slopes is poorly known. Tulas and large flake tools are rare and artefactual assemblages are often dominated by quartz (Witter 1980a). This change in material reflects the absence of duricrust silcretes and the presence of a "quartz belt" with few other kinds of workable stone. Even the Microblade Industry is largely in quartz (Witter 1980a).

At the town of Young, the gradient to the Dividing Range steepens and undergoes a transition at about 500 metres elevation to the Southern Tablelands of the Boorowa area. The Southern Tablelands are mostly uplifted rolling plains and hills with a few ranges and some deeply incised valleys. There are eucalypt woodlands remaining on the ranges, but most of the land has been cleared. Although quartz is an important element in the archaeology, other materials such as silcrete, and a fine-grained volcanic material are common, especially for use in the Microblade Industry which is well represented. No tulas are known for this area and the heat-retainer hearths, common on the western plains, are rare.

This is the eastern limit of the Wiradjuri and people with affinities with coastal populations border on this zone. To the east the matrilineal moiety system gives way to one where residential groups are apparently the main device used to define social relations (Berndt and Berndt 1977:55).

Finally, east of the transect, are the high forested ranges which drop in a 100 metre scarp to the coastal plain. The population densities here are presumed to be much greater due to the abundance of fresh water, high productivity of the land and the availability of coastal resources. This is probably the best-known region in terms of an archaeological sequence (Lampert 1971 a,b, McCarthy 1948, 1964, Flood 1980, Johnson 1979).

Sample Area Selection and Preliminary Expectations

Using the background outlined above, including the review of the previous archaeological work, an inspection of the National Parks and Wildlife Service Sites Register, and a preliminary field trip along the great transect route, it was possible to define my sample areas according to the following criteria:

1. They must consist of a large area (at least 50km x 50km) with a mixture of drainage valleys, ranges and intervening terrain which would ensure vegetational differences.
2. They cannot be on a major environmental boundary.
3. They cannot include a major aquatic habitat.
4. Nearly all sites would be defined mainly on the presence of stone artefacts.

5. The areas should be equally separated and belong to different environmental zones (arid, semi-arid and temperate).
6. The sites would almost entirely be Late Holocene in age.

Following these criteria I identified my three sample areas, the Tibooburra, Cobar and Boorowa areas (Figure 1.1).

From my preliminary research I also formulated some expectations of what I would find from an examination of the topographic maps. These were mainly based on factors such as where water seemed to be present, where different kinds of foods which could be anticipated, and the implications for a generalised plant-oriented subsistence strategy.

1. Tibooburra area. Sites were expected to cluster along the main drainage (12 Mile Creek). They also should occasionally occur in the blow out/claypan exposures among the dunes, especially when associated with temporary lakes and swamps. A series of sites should be associated with the rock outcrops and ridges. The open plains of gibber and desert loam should have very few sites.
2. Cobar area. Sites were anticipated along the major drainage (Sandy Creek), and in the drainage valleys in the uplands and ranges. At lower elevations they should be scattered along the flats associated with claypans and playa lakes. Sites otherwise should be rare in the rolling hills and ranges.
3. Boorowa area. Sites should be associated with the Boorowa, Yass and Lachlan River flood plains and along some of the tributaries. They also should be on high ground overlooking small drainage valleys. Small sites should occur along the upland ridges and spurs.

The approach towards these areas was to be mainly ecological (i.e. Bettinger 1980). Problems in stone artefact analysis and interpretation were not anticipated at this stage. The methods for assessing stone artefact technology and logistics had to be developed in the middle of the project. The results of this work are given separately in Chapter 3.

It was important that the analysis avoid sites earlier than the Late Holocene. The comparability of sites from one region to another within the same time period was difficult enough. It would be an enormous addition to introduce Pleistocene sites with potentially different technologies and subsistence strategies to reconstruct environmental conditions, and include the effects of different formational processes..

The criteria I used to determine Late Holocene sites were as follows:

1. Typological indicators. It is conventional to use particular tool types as a chronological index (e.g. Johnson 1979). Also the relative size of artefacts in the assemblages is thought to indicate chronology (e.g. Lampert 1981). There is some justification for certain tool types such as tulas or backed blades to be used in this way, since they are products of particular manufacturing processes. The use of size is much more uncertain since this can be greatly influenced by proximity to the stone source.
2. Geomorphology. Another approach is the use of geological processes to distinguish between the Holocene and Pleistocene periods. For example, features such as lunettes or source bordering dunes indicate Pleistocene deposits, or the degree of consolidation oxidation of sediments may have chronological implications.

During the project, an attempt was made to combine, where possible, the tool type indicator and geomorphological approaches. The success of this is difficult to assess, but no sites suspected of an age greater than Early Holocene were included in analysis.

THE FIELD OPERATION

The scheduling of the field work was intended to make use of those seasons with the best weather for the region in a multi-stage approach (Redman 1973, Schiffer et al. 1978:16). In general, this worked well, except for being caught in the Tibooburra area when the drought broke. The calendar of field work was as follows:

Phase I

Tibooburra Area: 25 August 1980 to 21 September 1980

Boorowa Area: 17 October 1980 to 14 December 1980

Cobar Area: 24 February 1981 to 18 March 1981

Phase II

Tibooburra Area: 25 April 1981 to 11 June 1981

Cobar Area: 27 June 1981 to 10 July 1981

Boorowa Area: Trips based from Canberra, 17 October 1980 to 8 August 1981

In Phase I the first step was to spend 2 or 3 days driving over the region to get a general idea of the landscape. In this process the conditions of exposure and visibility were

noted and a general impression was obtained of the ground relative to topographic and air photo maps. From this a preliminary physiographic stratification for sampling was made. The Phase I portion was conducted mostly alone which allowed considerable flexibility in the daily programme. Generally, it took about 2 or 3 weeks to obtain an appreciation of the contents and distribution of sites.

Phase II was intended to help fill up gaps in the sample and investigate problems defined by preliminary analysis. Some sites were returned to for detailed recording.

In the course of travelling to the study areas along the great transect, it also was possible to spot check for sites along the way. This was usually at roadside exposures or other locations with easy access. The purpose of the spot checks was to test for broad regional patterns.

CHAPTER 3

AUSTRALIAN STONE INDUSTRIES

STONE ARTEFACTS

Recording stone artefacts to be used in analysis and for comparison among the three sample areas was a special problem which was encountered during the project. In this section I summarise my approach towards stone artefacts and explain the way in which I use the term "industry". I then describe specific stone artefact industries of Southeastern Australia and explain their significance.

General Principles

The conventional approach towards stone artefacts is typological (e.g. McCarthy 1976, Jones 1971, O'Connell 1977, Ferguson 1980). Some of these approaches also emphasize particular characteristics, such as implement edges or tool shapes.

This system in is in fact a mixture of different concepts. It includes functional types (scrapers), technological types (cores), ethnotaxons (tulas) and descriptive types (geometric backed blades). Such a system does not measure any particular process, but incorporates a wide range of meanings (Witter 1986). The short comings of the typological approach also have been noted by Hiscock (1982:79) who advocates a system based on technology.

In this thesis the orientation towards stone artefacts is not to try to identify ethnic (i.e. "cognitive") types or functional categories, which in any case, seem difficult to verify. Technological features, would appear to be easier to recognise, and it is possible to use refitting, replication, assemblage analysis and other techniques to understand the reduction processes. Stone tool technology also is a fundamental element in stone tool manufacturing and maintenance, regardless of what else was in the mind of the maker. In addition, the process of tool making is responsible for the great abundance debitage which lends itself to technological analysis.

This approach avoids assumptions about stone artefact morphology as a product of mental templates or ideal cognitive types (e.g. Deetz 1967:7. Clarke 1968:135). It also does not presuppose that the morphology is due to the type of tool use or functional variability (e.g. Binford and Binford 1966).

A technological approach begins with getting the stone. This starts the process of transporting stone from its source to other sites, which may be called stone logistics. Thus the distribution of stone sources introduces certain environmental determinants into stone tool manufacture at the outset. These logistical constraints have a major influence on artefact manufacture and morphology (see Hiscock 1979:114-6, Rolland and Dibble 1990).

The manufacture of stone artefacts depends on the flaking properties of the piece of stone and its initial size. This determines the potential tools which can be made. For example, quartz behaves differently to chert, and it is not possible to make a large flake tool form a small core.

Also fundamental is the mechanics of stone fracturing (Speth 1972), Cotterell and Kamminga 1987). Although the fracturing properties of stone varies with the material types, the principles remain constant. The rules concerning platform angle, core overhang, or contours of the flaked surface of a core must be recognised and employed by any stone tool maker.

Finally, there is the reduction strategy used. The characteristics of the stone and the technological knowledge must be put together as a series of steps in which various techniques are used at the appropriate stage to achieve the final product.

The outcome of this approach should be a classification which measures only technological and manufacturing processes. This would differ from the conventional typological system which uses a mixture of concepts, some of which include technological aspects, and specific manufacturing products.

The Stone Technological Industry Concept

In the course of the field work I had made a few representative collections for laboratory analysis. I began work on this material in order to identify the stages of manufacture and the options for production of various tool types. The objective was to define sets of closely related manufacturing processes. These basic strategies of tool production I will call here an industry. In this sense the term industry is not used as a chronological marker (Coles and Higgs 1969:67, Roe 1970:27), nor as a presumptive ethnic pattern, nor set of mental ideals (e.g. kartan, gambierian, bondian etc). It also is not interchangeable with the term assemblage. Assemblage refers to any group of items from a particular provenance, whereas the term industry is applied here to the manufacturing strategies which may be present in the assemblage. Each industry

operates within a distinctive set of rules. It was necessary therefore to identify and separate the different industries otherwise found mixed together in site assemblages.

Thus if a certain sequence of rules are followed, the result will be a particular morphological class regardless of ideal type or functional requirement. My aim was to evaluate the complexity of the technology rather than totally reconstruct all manufacturing procedures. I needed to know if the stages required were several or few, and if the options at a particular stage were many or limited. It was also necessary to appreciate some of the techniques used such as those related to stone material type or core size.

I began the analysis by looking at the least ambiguous sources of evidence. From the survey there were a number of workshops where pieces could be refitted. Often this was only a few conjoins, but in five cases enough could be refitted to demonstrate a reduction process. These workshops were all for microblade production and provided a means to define the most complex of the industries.

The next best data were the workshops which could be demonstrated to be of the same core due to the material type or a few conjoins. These workshops were usually found within an area of one or two metres diameter, and sometimes the debris were so dense that one flake lay on another. The survey produced about 20 such microblade workshops. The items from these workshops could be seriated to show various stages of manufacture. Two workshops were particularly useful for demonstrating the various stages in backing blades. Other cases were valuable for indicating blade core types other than those previously described in the literature.

Workshops served to isolate and define the quartz lamellate industry. This industry occurred only in the Boorowa area. Quartz is extremely difficult to re-fit because of its irregular surfaces and the large amounts of shatter. However, the morphology and size characteristics of the contents of three workshops was highly distinctive and provided a descriptive basis for this new industry.

Other quartz workshops were found which belonged to the Core and Flake Tool Industry, and indicated a special technique which was used to work quartz. This is described later as the fracture line (or flaw) propagation technique.

Information revealing essential details on the Tula and Pirri Industries was found at a quarry in the Tibooburra area and at a stone source/domestic site in the Cobar area. The remaining inferences on these industries was derived from the range of artefacts from these areas.

The Tibooburra area produced the greatest morphological range within the Core and Flake Tool Industry. It was in the course of this analysis that the "Reduction Chart" was developed. This analytical method is described in Chapter 4, and is used extensively for the implement assemblages from the three sample areas.

Additional understanding was gained through various replication trials. This includes those I carried out at a workshop session in January 1983 held at "Themida". This was hosted by Wilfred Shawcross, led by Jeff Flenniken and organised by Peter White. There also were various other informal occasions used to help clarify reduction processes. The replication work was especially relevant for the Microblade Industry and the quartz technology.

Some of my findings required terms which are not part of the conventional nomenclature. This led to the quandary of whether to use long descriptive terms, invent new ones, redefine the old, use locality names, apply "oid" or "-like" and so on. The direction I took was to mainly adapt terms used elsewhere in the world for a special use in the Australian context. This was because I was mainly concerned with the concept of the term, rather forms or typological shapes. Thus terms such as *tranchet*, *lamellate*, *nuclear*, etc. are given a specific meaning for assemblages in Australia, based on technological concepts elsewhere. Other new terms were invented only where confusion in concepts seemed to be a particular problem, such as *cusplate* for *denticulate retouch*. I have also tried to include terms from familiar typologies, such as "tula" and "pirri" as much as possible. In this however, I am not concerned with the forms of the artefacts, but the manufacturing strategies which produced their technological attributes.

CORE AND FLAKE TOOL INDUSTRY

The Core and Flake Tool Industry comprises the most simple and unspecialised form of stone working technology. The chief function of this industry is to provide edged tools for a variety of cutting and chopping tasks. Although multi-functional, it has a major role in the manufacture and maintenance of wooden implements.

Before proceeding with the description of this industry, it is important to stress that it is not the same thing as the "Core Tool and Scraper Tradition" (such as defined in Mulvaney 1975 or White and O'Connell 1982). The Core Tool and Scraper Tradition was described as having typological and other characteristics which were of chronological significance. In archaeology, the "tradition" concept normally applies to shared diagnostics (usually with ethnic implications) which are not confined to a particular time period (Rouse, 1972:207). The Australian use of this term is confusing,

and the assumptions behind it are not the same as those for the Core and Flake Tool Industry.

The definition of the term Core and Flake Tool Industry here is based on an underlying concept about a particular kind of manufacturing strategy (with no chronological or ethnic implications). This strategy is present throughout the Australian prehistoric sequence. It is important that the processes represented are not confused with issues of chronology.

The attempt to use elements of this industry for chronological purposes, in my view, has not been very successful. For example, at the Keniff Cave Site it was observed that the older artifacts belonging to this industry tended to be larger than younger ones (Mulvaney and Joyce 1965:179-81). Since size at the point of discard can mean a variety of things, such as distance from source or duration of use of implement, the size criterion is a dubious identifier of Late Pleistocene-Early Holocene sites. There have been various other attempts to differentiate this industry morphologically (Lampert 1971, McCarthy 1948, Jones 1971). However, the different morphological types tend to grade into each other as well as with Late Holocene assemblages. Thus far, all efforts to identify types or assemblages exclusive to a particular time period (e.g. fossil indicators, Johnson 1979) have been unsuccessful.

The industry has also been studied from a functional point of view both in respect to morphology (Ferguson 1980, O'Connell 1977, Jones 1971) and use wear (Kamminga 1978, 1982, Fullagar 1982). Comments as to manufacturing processes have as yet been scant (Hiscock 1979, Flenniken and White 1985:148-9).

The descriptions below include the reduction of cores, flake tool reduction by marginal contraction and edge shaping flake tools. Quartz reduction techniques also are described. The background for this was derived from using the Reduction Chart which is explained in the next chapter and then applied to the recorded assemblages in Chapters 5, 6, and 7. I have replicated all of manufacturing sequences I present here many times using different stone materials (Witter 1989).

Core Reduction

The characteristics of the cores of this industry will be considered first. Cores have an ambiguous role in that they can be used either as an implement or as a producer (Hiscock 1979) to supply flakes. Another difficulty is that platform preparation and other effects of flake production look similar to the results of edge resharpening or edge damage from use.

The difference between a producer core and a flake tool also is not always clear cut. In some regions a large flake is commonly used to produce further flakes for tools, normally with the bulbar surface as the platform. The discarded form often is difficult to distinguish from a large flake tool. In other cases, a large flake used as an implement may be resharpened until it has a very thick cross section and looks like a core.

The most difficult distinction perhaps is that between a large piece of stone, such as a cobble or a weathered fragment, which has been sharpened for use as a tool, and the same item which has been used as a producer core for flake tools. Even though both may apply to the same piece of stone, it is of concern in the reduction process to know what its role was at the time of discard. The concept of a natural piece of stone which was used as a tool has special logistical and technological implications. This process is incorporated with other kinds of uses and origins in the term "core tool. Below artefacts which appear to have been natural pieces dedicated as tools or at least for their last resharpening event before discard will be referred to as a "nuclear tool".

Materials such as quartz or some types of coarse-grained stone do not readily flake with a conchoidal cleavage. These are block fractured fragments and often it is impossible to identify the cores from the flakes. The term block fracturing here refers to the various types of non-conchoidal or non-Hertzian fracturing. Some assemblages are dominated by quartz, and the tendency is to arbitrarily record the large pieces as "cores".

Rules for identifying cores as producers or implements in the field were difficult to apply consistently during the survey. In the analysis these were all lumped as cores, unless they seemed to be made on a flake, in which case they were grouped with the flake tools.

On the Reduction Charts, (examples are given in Chapters 5, 6 and 7) cores were observed to undergo two important processes: a change in size and a change in cross section. The first to be considered is the reduction in size and this is described below in the following steps:

1. Large cores. Pieces in excess of 100gm are in this category. Because large flakes may readily be detached by striking well behind the edge of the platform, overhang trim may not be needed, and considerable force may be used depending on the toughness or brittleness of the stone material. The flakes produced from large cores tend to be relatively large in size, have thick platforms and pronounced percussion bulbs.

2. **Small Cores.** Small cores may result from the reduction of large cores or may be due to the selection of a small piece of stone at the outset. A small core may require overhang removal so that it may be successfully struck near the edge of the platform. The resulting flake usually has a relatively small and thin platform, a less pronounced bulb of percussion, and a flatter cross section.
3. **Bipolars.** As a small core is reduced further, or if the piece of stone is very small to start with, it will be too light to hold when striking with the hammerstone. It then becomes necessary to place the core on an anvil in order to produce flakes. When an anvil is being used in this manner the flaking properties change again, and the flakes tend to shear flat rather than produce percussion bulbs due to the wedging and compression-controlled effect (Cotterell and Kamminga 1987:698). The procedure is to set the core on the anvil so as to obtain direct contact when struck by the hammerstone. If the material is tough it may take numerous blows to develop a stress line for fracture. In the course of this, small retouch flakes are produced at both ends until the core splits in two. The objects usually called bipolar pieces or "fabricators" are cores which failed to split or were otherwise discarded.

The change in core cross section is the next factor to be considered. This is the longitudinal section through the centre of the core, and the process takes place as follows:

1. **Lenticular cross section.** A core with a lenticular cross section has acute platform angles which may be struck uniaxially or bifacially. As the platform edge is worked back, the angle increases towards 90 degrees if most flakes are thicker at the proximal rather than distal ends (due to the percussion bulb). The cross section therefore changes from relatively thin to one which is proportionately thicker.
2. **Square cross section.** The lenticular core ultimately takes on a rectangular blocky cross section where the platform angle is 90 degrees or greater. At this point further reduction will give an obtuse platform angle which is ineffective as a tool working edge or as a platform for producing flakes. A bifacial technique may be used on relatively thick cross sectioned cores as a way of using the bulb scar to give a lower platform angle for a flake struck across the previous platform surface (Flenniken and White 1985:136).
3. **Conical cross section.** If the core is being used to produce a series of the largest possible flakes, it tends to take on a conical cross section. This is because the

flakes are terminating out through the bottom of the core (the side opposite to the platform, rather than adjacent to the platform). As a result, the distal end of the flake is likely to be thicker than at the bulb (a plunging termination, Cotterell and Kamminga 1987:701), and the end of the core opposite to the platform contracts more rapidly. This effect helps to maintain an acute platform angle. The core finally fails to produce large flakes when it becomes too light to maintain its striking inertia (Hiscock 1982a). When this happens, not enough force enters the core from the blow to detach an entire flake, and step termination takes place. The platform also assumes a round shape because any "corners" were used as vertical ridges to assist in detaching a large flake. The use of these ridges automatically results in a circular shaped platform. At the discard stage, these large producer cores have platforms which are circular in shape and step terminated. These belong to the category often referred to as a "horsehoof" (Kamminga 1982:85-90, Flenniken and White 1985:136).

4. Core rotation. Once a platform angle becomes too high, or there are too many step terminated flake scars, the reduction may continue by finding a new platform where there is an acute angle. Eventually all possible platforms may be exhausted. The result is a multi-platform core.
5. Reforming a lenticular cross section. Sometimes a core may be reshaped into a lenticular form. This results in a considerable loss of mass and much debitage. Once the core is reformed it is unable to produce flakes as large as the previous core.

The processes of size diminution and cross section change occur simultaneously in core reduction. The discard may be a transition stage from a large to a small core, or where the lenticular cross section has become blocky and more large flakes cannot be produced, or the weight is insufficient for certain types of tool use. Differences in raw material, flaking techniques and implement use are additional factors which contribute to variation in core morphology.

The effects of core reduction on cross section are shown in Figure 3.1 on two cores from the Tibooburra area. The core in 3.1A has a low cross section and has been mostly unifacially flaked, although there are a few bifacial scars. The core in 3.1B is a more advanced stage. In this case it has been bifacially reduced and the core is much thicker in cross section, and step terminated flake scars can be seen.

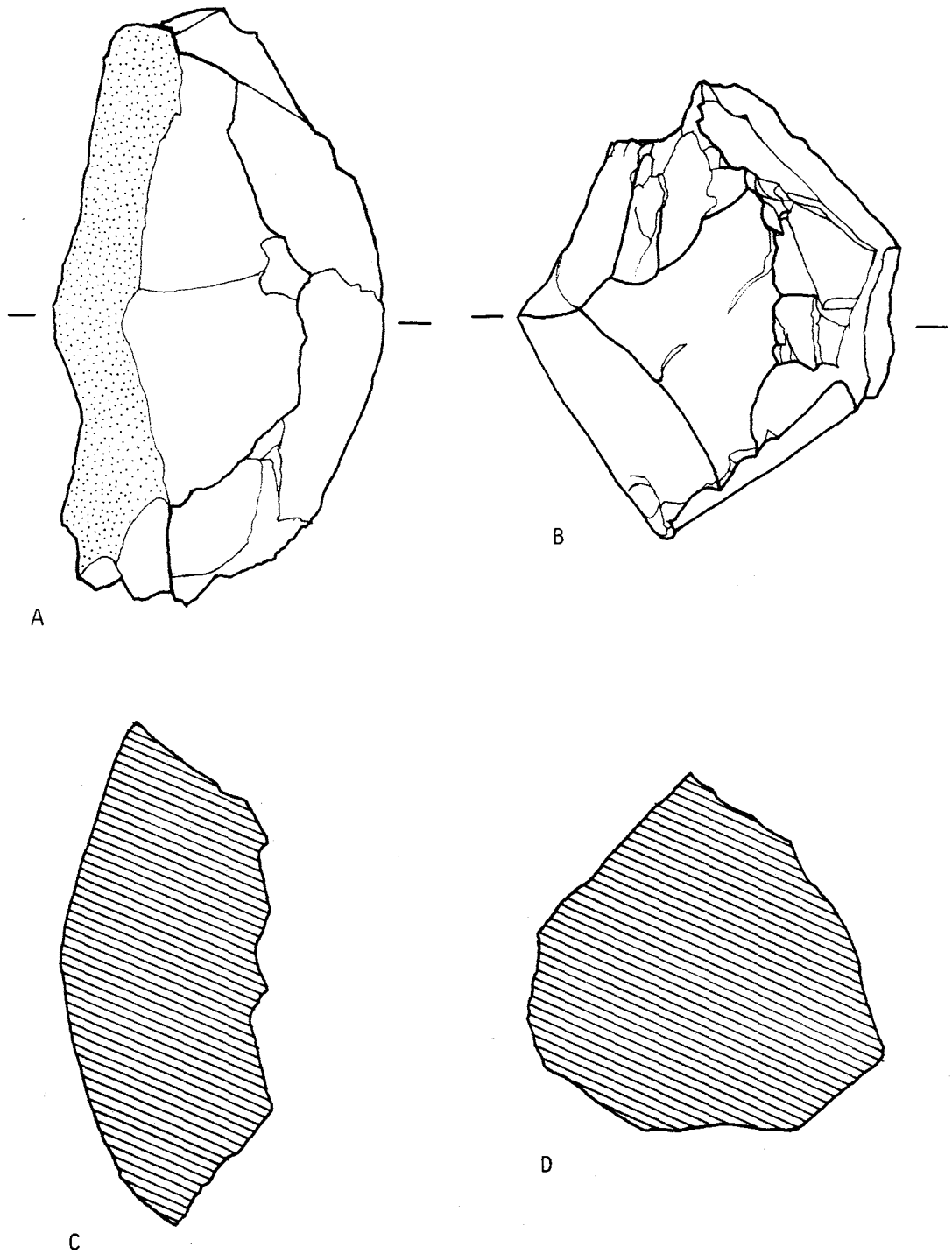


Figure 3.1. Core and Flake Tool Industry: cores.
A. Core in an early stage of reduction. Unifacial, with a lenticular cross section.
B. Core in a late stage of reduction. Bifacial, with a thick cross section.

Flake Production

Flake production strategies within the Core and Flake Tool Industry range from attempting to extract the largest possible flake from a core to trying to make a resharpening flake as small as possible. For example, on well developed producer cores the flake scars show that the process was to remove maximum sized flakes down the entire side of the flaked surface to the bottom end of the core. Retouch, on the other hand, is a technique which removes the minimum of stone. The conservation of the mass of a stone tool is important for a heavy duty tool and the resharpening retouch must be kept as small as possible. Flakes of intermediate size are produced as unsuccessful large flakes or major edge renewal because of the edge/platform angle becoming too high.

The type of stone also affects how flakes can be produced. For example, it is difficult to do fine retouch on coarse-grained stone. Some types of materials such as quartz tend to break up into smaller pieces when struck, rather than detach as a single large flake.

Another major factor is the core size. It is obvious that if the core is small to start with, or if a large core has been considerably reduced, that the flakes have to be mostly small. The inertia threshold effect (Hiscock 1982a) also is very important in flaking large or small cores. A large core can withstand considerable force on impact to produce a large flake. This is most easily done if the point of force application is well in back of the edge of the platform. In some cases a pronounced bulb is developed, and overhang trim may be helpful to determine where the next blow should go. In the case of a core with a mass below the inertia threshold of flakeability for the material, flakes need to be detached by lighter blows which are closer to the platform edge. Because of working close to the edge, it often is necessary to remove the overhang to prevent the platform from collapsing.

The elongation of flakes is due to the use of a vertical ridge and a low platform angle. These are important in large flake production to ensure that the flake terminates at the opposite end of the core from the platform (Flenniken and White 1985:136-40).

The result of these processes are a variety of flake sizes, shapes, platform features and patterns of dorsal flake scars. At the most simple level it is possible to discuss flakes in terms of whether they are large or small, and whether the platforms are broad (large area) or focal (small area). These distinctions are discussed in more detail in Chapter 4 on artefact recording and classification.

Figure 3.2 illustrates some of the variability found in debitage. The flake in 3.2A is a focal platform flake where the platform surface was made small by considerable platform retouch. The example in 3.2B shows an elongated flake. The dorsal flake scars indicate that it does not belong to the Core and Flake Tool Industry, but is from a blade core, and should be with the Microblade Industry. In the case of this item there is no platform retouch or overhang trim indicated. If the material is fine-grained enough, this often is not needed since very little force can be used, making the percussion bulb small and shallow (as shown in the cross section), and the overhang is negligible. In some cases this effect also may be due to bending fractures, (Cotterell and Kamminga 1987).

An example of a broad platform flake is shown by 3.1C. Note the vertical ridge, the bottom of the core on the distal end of the dorsal surface, and how the cross section shows a low platform angle. These are all characteristic of a process designed to produce a maximum sized flake. Another broad platform flake is shown as 3.2D. This is the type of small flake which can be used to remove overhang or resharpen and renew a working edge.

Another broad platform flake is shown in figure 3.2E. This is a biface flake made on a bifacial core. The top of the platform has the facets from the previous flake scars.

Flake Tool Reduction: Marginal Contraction

Flakes may be divided into tools or waste. If distinct resharpening retouch is present, recognition is easy. The identification of flakes as tools when only use wear is present can be uncertain. Microscopic use wear, unfortunately, cannot be detected in the field. If, however, clear macroscopic edge damage is present, then the flake can be classed as an implement. However if the material is coarsely textured, or the use damage is ambiguous, or lighting conditions are poor, then field identifications are difficult to make. During the field work the use-wear/retouch flake tools were recorded only for undoubted cases, and no "possible" items were recorded.

The term "flake tool" here applies to implements originating as flakes which do not appear to be producer cores. They range from having macroscopic edge damage or fine retouch to having heavily flaked margins. This encompasses conventional terms such as scraper, or utilized flake.

Among the flake tools there are two main reduction strategies: marginal contraction and edge shaping. I will describe marginal contraction first. In marginal contraction the edge is removed while resharpening, making the flake tool smaller, but with the

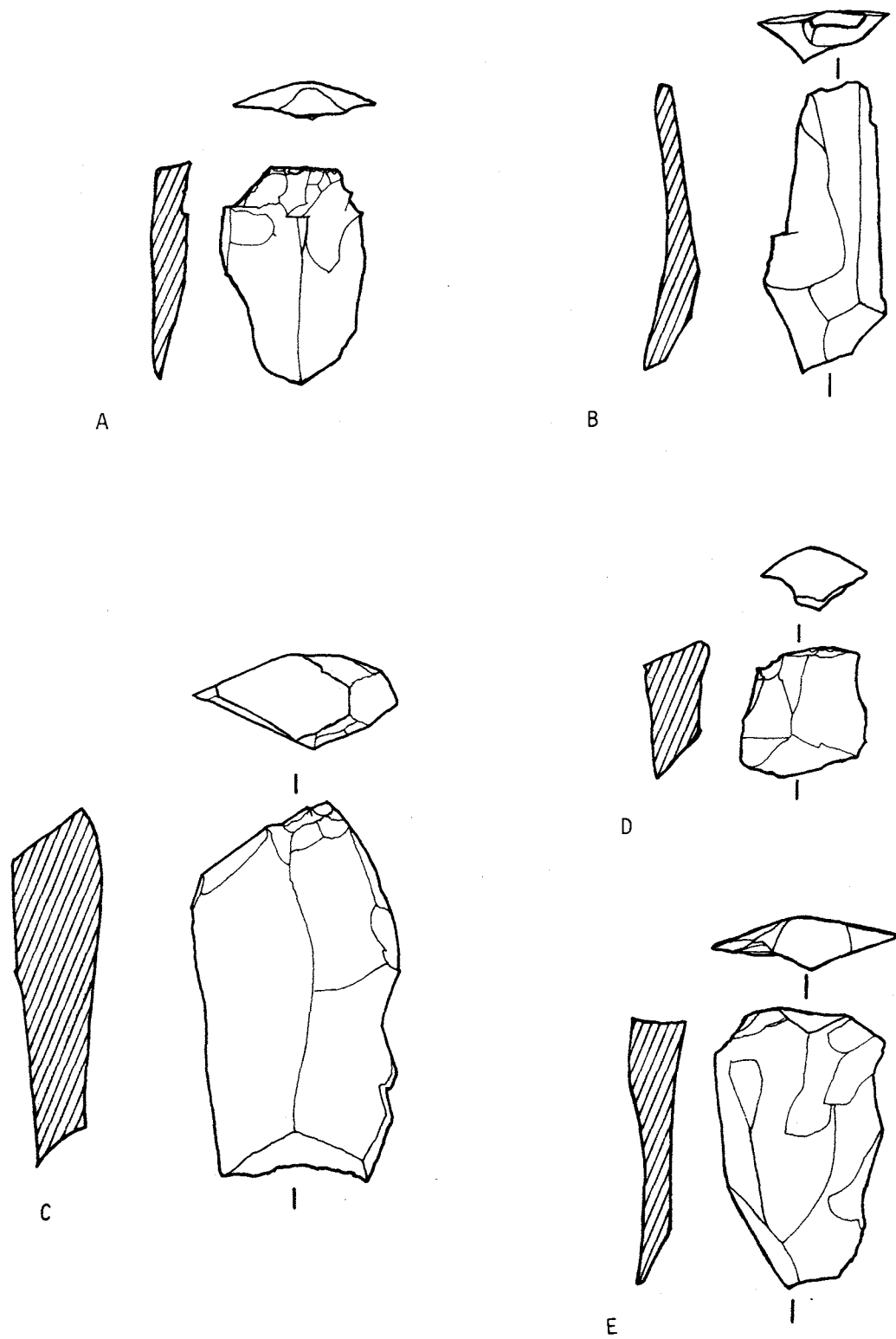


Figure 3.2. Core and Flake Tool Industry: debitage.
 A. Focal platform flake.
 B. Focal platform flake (blade).
 C. Broad platform flake.
 D. Broad platform flake.
 E. Broad platform flake (bifacial platform).

thickness measurement usually remaining constant. During this process the cross section, edge angle, retouch type and edge shape all change simultaneously. These are described below in the following steps:

1. Low edge angle and thin cross section. A flake which is relatively broad and thin may be expected to have low edge angles and a thin cross section. As the edge is resharpened, it tends to become bevelled with scalar retouch. With further resharpening the edge retreats back towards the centre of the flake (marginal contraction). The result is a steeper edge angle with every resharpening event. The form of retouch on low angle cross section flakes (under about 70 degrees) is usually of a scalar form. As retouch continues, the projecting parts of the flake are prone to be removed and the shape becomes more rounded and convex. If a flake is retouched on the distal end it automatically takes on a convex shape if it has a dorsal ridge. If the edge being used is localised, then a combination of use-wear and retouch causes a broadly concave edge to develop.
2. High edge angle and thick cross section. Flake tools with thick cross sections may be formed on a thick flake or a low angle cross section flake which has been retouched sufficiently to take on a high edge/platform angle form (greater than about 70 degrees). In either case, the angle continues to increase with resharpening. Depending on the thickness of the flake and the force applied, step terminated retouch flakes will occur. In this process the bevel deteriorates as the edge is worked back. The result is the eventual loss of a platform angle and working edge. Flake tools of this sort are particularly likely to have broadly convex shaped edges from advanced marginal contraction. They also can take on a "horsehoof"-like appearance, even though in an earlier stage they would have been readily recognisable as a flake tool or a "steep-edged scraper".
3. Very high edge angle and very thick cross sections. Very thick cross sections may be the result of the process described above or may be thick flakes freshly removed from the core. However, it is possible to obtain effective working edges by what will be called here "cusped retouch". These are large retouch flakes struck hard and well back from the edge. Since the flake is thick, it will not snap and the result is a fresh edge with a denticulated margin. A single such flake will simply leave a large notch. (See Hayden 1979:86 for an illustration of a cusped retouched flake in use). This type of denticulated or notched implement is the result of the furthest stage of flake tool reduction and not a functional category. It also is common for these denticulated implements to take on a rounded shape as a "discoidal" since the retouch is likely to be all around the

edge, even the platform end. Large examples of this type of flake tool that have thick cross sections also resemble producer cores.

The type of retouch and edge angle on a flake tool therefore is mainly due to the edge resharpening process rather than functional requirements (Hiscock 1982a). This does not eliminate the possibility that a thin sharp edge may be preferred for some tasks, or for other work, a robust relatively high angle edge would be more durable. However, the dominant factors in edge angles and retouch types are due to the stage of discard in the above sequence.

Flake size is an important factor in marginal contraction. Large, broad platformed flakes which are relatively thick and usually come from a large core, have the greatest potential for edge modification. They are sufficiently robust to be resharpened several times and lend themselves to the full sequence described above. Smaller flakes are harder to grip and more likely to snap, although relatively heavy retouch may be performed if they are rested on an anvil. Pressure retouch also is effective for small thin flake tools.

The stone material type further affects this process. Fine-grained stone enables more stages of retouch than a material which is coarse grained or difficult to flake. Quartz (except if very fine quality) tends to inhibit any retouch at all. This is because quartz is so brittle that the blow is likely to crush the edge rather than produce a clean fresh one.

The shape of the flake tool edge is also affected by the reduction process. Generally, resharpening follows the original outline or the contour of the flake, and often a broadly convex shape results. In some cases wear or resharpening along a limited part of the edge will result in a shallow concave edge. Without microscopic examination however, it is difficult to attribute special functional implications to the range of edges which vary from broadly concave to broadly convex. As mentioned above, notched and denticulate edges produced by cusped retouch can be accounted for as marginal contraction.

In Figure 3.3 are a series of flake tools from the Cobar area which illustrate the relationship between cross section and retouch type. A use-wear/retouch flake tool is shown in 3.3A. Although the cross section can be variable, these are very often small-sized implements. This may be because they usually were originally produced as debitage in the context of manufacturing some other implement. It may have been common for areas of waste to be picked over and pieces selected for immediate use and discard.

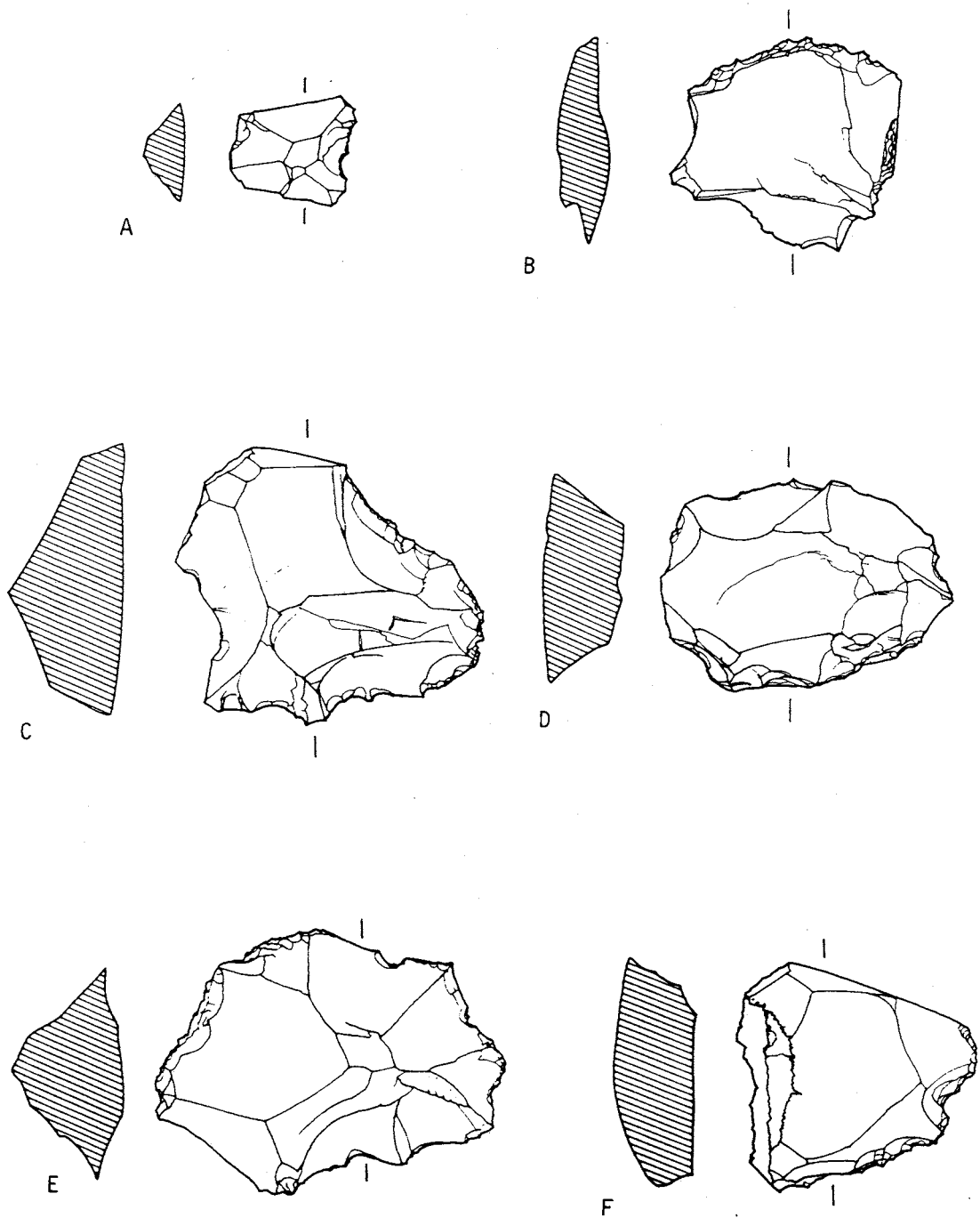


Figure 3.3. Core and Flake Tool Industry: flake tool marginal contraction.

- A. Usewear/retouch flake tool.
- B. Scalar retouch flake tool.
- C. Scalar/step retouch flake tool.
- D. Step retouch flake tool.
- E. Denticulate flake tool (with cusped retouch).
- F. Step retouch flake tool (over cusped retouch).

The flake tool shown as 3.3B has been retouched on one side and still has a thin cross section. The edge/platform angle is becoming higher, and the scalar retouch soon will change to step. The flake tool 3.2C is mostly scalar retouch, and a convex end is forming around one of the dorsal ridges.

In the case of 3.3D the size is similar to 3.3B, but it is much thicker and with step retouch. The example in 3.3E also is thick; has step retouch; and is beginning to develop a convex edge shape.

The flake tool in 3.3F has had six large cusped flakes removed to form a denticulate edge. Some of these rejuvenated edges also show subsequent scalar and step retouch. This example is unusual because of having some ventral retouch as shown in the cross section which otherwise is very thick.

There are also two specialised types of retouch which result in marginal contraction. One of these is when a flake tool is hafted on its lateral edge and used as an adze. The resharpening flakes are usually very fine and often removed by pressure retouch. The result is referred to as a burren. Although it functionally belongs with the tulas, the burren is not made on a specialised core and belongs with the Core and Flake Tool Industry.

The second type of specialised retouch is burins. Burins may show a single burin spall or be dihedral. These artefacts probably represent an alternative flaking technique (i.e. Hayden 1977:185). In Gippsland burins were systematically produced but these were part of the Microblade Industry (Clark and Pickering 1978:44, Hotchin and May 1983, Flenniken and White 1985:145-6). Burins here refer to the technological product and not snapped flakes which have been used as bone-cutters (Fullagar 1982:64-6).

Flake Tools: Edge Shaping

In spite of the effects of marginal contraction, there are some edges which appear to have been shaped, rather than the result of simple edge resharpening and marginal contraction. These are outlined below:

1. Serration. The edge of a serrated flake tool (or "saw") is formed by small retouch flakes which make distinct indentations along the edge and appear as a series of well formed teeth. This does not include the dentation caused by cusped retouch which is struck further back from the edge.

2. Concave. A concave is a deep semi-circular edge which is produced by small retouch flakes. It is distinguished here from a notch formed by a single hard blow in the manner of cusped retouch.
3. Convex. A convex is where the edge has been formed into an even, semi-circular shape regardless of the original shape of the margin. The flake tools with convex distal end retouch do not properly belong to this category, since the convex edge forms automatically. However, it is probably a significant part of the reduction strategy that the decision was made to retouch the distal end rather than a lateral edge. These forms sometimes overlap with the tulas in size, shape, and presumably function. The larger examples in an advanced stage of reduction also grade into forms which look like producer cores.
4. Micro-convex. The convexes above grade into a smaller micro-convex form. These have finely worked edges, and are almost always formed on the distal end of a flat thin flake. They are often called "thumbnail scrapers". In many cases this type of retouch is made on products from blade cores, and the implements therefore belong to the Microblade Industry.
5. Discoidals. It is difficult to determine if the discoidal forms have had their edge shaped in a controlled manner or are a simple consequence of marginal contraction. In some cases however, discoidals seem to be part of a specific strategy which includes flaking around the platform end and producing an even edge all around. The large sized examples sometimes are difficult to discern from producer cores.
6. Projections. Sometimes a fine point or projection will be formed along the flake margin or particularly towards the distal end. Provided it does not appear to be a manufacturing stage of a unifacial point or another industry, it may be assumed to be a flake tool. Such a projection is formed by fine retouch flakes and is not the result of two cusped flakes adjacent to each other.

Figure 3.4 shows some flake tools with shaped edges from the Tibooburra area. The example in 3.4A has a convex edge formed on the distal end. The edge is very precisely formed, and the convex shape is not entirely due to the influence of the dorsal ridge. A micro-convex is shown in 3.4B. This may be compared with 3.4C which is made on a blade-like flake. It is probable that the flake originally came from a blade core, and this implement more properly belongs with the Microblade Industry. The implement in 3.4D is a discoidal. Considering the terminated flake scars high up on the sides of this tool, it is likely that it began as a very large flake, and the resharpening

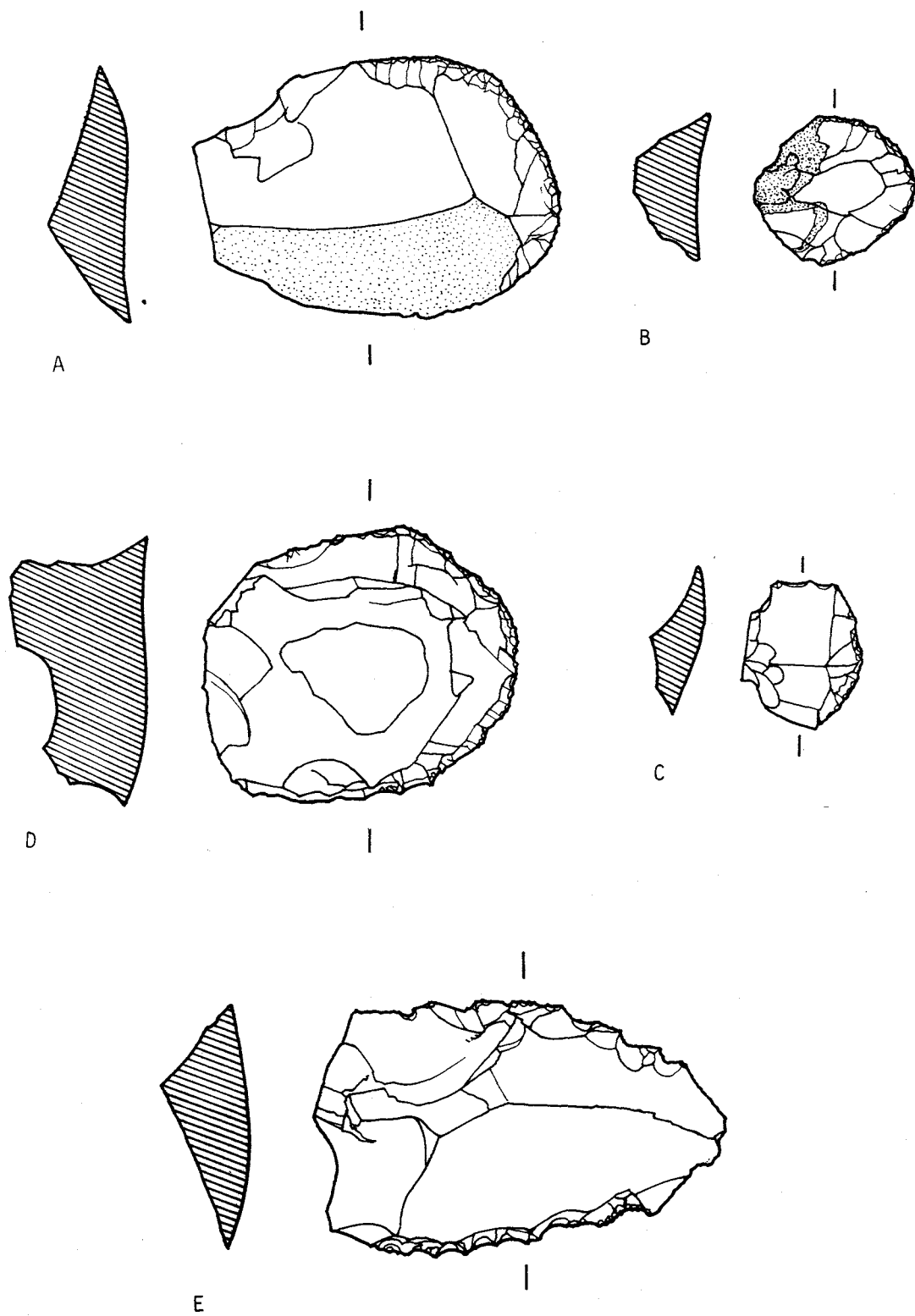


Figure 3.4. Core and Flake Tool Industry: specialised flake tools.
 A. Convex flake tool.
 B. Microconvex flake tool.
 C. Microconvex flake tool (on a blade).
 D. Discoidal flake tool.
 E. Serrate flake tool.

process has undergone repeated cycles of cusped retouch and then finer retouch. Whether its carefully rounded shape is a design feature of the tool, or whether it is the result of marginal contraction is difficult to determine. The serrate flake tool shown in 3.4F has serrate retouch on both lateral margins.

Quartz Technology

The discussion so far has been concerned with materials that usually fracture conchoidally. Quartz however, readily produces a block fracture and its technology is poorly known (Barber 1981). Large portions of Southeastern Australia have extensive quartz deposits, and although the stone artefact assemblages are dominated by this material it has received little study (Sullivan 1973 Hiscock 1982b). Most quartz working was carried out as an adaptation of the core and flake tool industry. The difference was in the use of controlled fracturing along existing crack lines in the stone, rather than the conventional conchoidal approach. I have referred to this process as the fracture line acceleration technique (Witter 1989), but perhaps it should more properly should be called the crack or flaw propagation technique (J. Kamminga, pers. com).

My assessment of this process was from examining the numerous quartz workshops found in the Boorowa area. These were dense concentrations of fragmented quartz, usually between one and two metres in diameter, and some were collected for more detailed examination. Blue water colour paint was used to make the artefacts more opaque and define the flake scars. It was clear that the pieces had been struck, but not in a way which would produce conchoidal flakes. Replication trials indicated that conchoidal flakes from quartz were not overly difficult to produce. The fracture line propagation technique however was found to provide assemblages identical to the Boorowa workshops. The reduction process is described below:

1. Initial block of quartz. Blocks of reef quartz normally show a network of fracture lines throughout the material. These are often stained red with iron oxides or show other discolouration. These fracture lines form a random pattern which allows a suitable crack to be selected. The technique is to tap along the fracture line. The result is controlled flaking due to the selection of the fracture line.
2. Reduced quartz cores. The core which is produced in this manner has edges which are remarkably sharp and durable, although usually with a high edge angle. The edges of the fragments produced also are usually very sharp as well. Conchoidal resharpening retouch is sometimes possible, but this usually only crushes and dulls the edge. A new edge is best provided by tapping along another fracture line.

3. Terminal cores. Cores flaked by the fracture line process usually permit reduction down to about 40gm to 10gm depending on how homogeneous the material is. If there are few fracture lines remaining, conchoidal flake scars are likely to develop, and the core may be flaked in a more conventional manner. Usually, however, it is too small, and further reduction must be bipolar.
4. Debitage. The debitage is a mass of block fractured debris with very few pieces showing percussion bulbs. This is typical of most quartz workshops where pieces with percussion bulbs are much fewer than might be expected even considering the nature of the material.
5. Flake tools. Frequently, as a quartz core is being reduced, an internal zone of homogeneous material with relatively few fracture lines is found. Such material can produce flakes with percussion bulbs, or be split as a bipolar. The result often is a piece which can be retouched and become a convex or microconvex flake tool. These implements usually have a plano-convex cross section and an oval form.

The recognition of worked quartz by flaw propagation is made particularly difficult since the reduction technology operates mainly to accelerate the natural process of quartz weathering. The debris however often shows hammerstone effects on the edges particularly if a water base paint is used.

Quartz is an extremely hard material and seems to be ready for anvil use at a larger size than most other materials (see Hiscock 1972a). Quartz bipolars therefore may be common where material occurs in pebble form or if the reef quartz is in limited supply. Bipolar manufacturing may not be conspicuous since the debris may not have a high proportion of pieces which show anvil crushing or discarded bipolar cores. Bipolar reduction is a two-stage process described below, beginning with a lump of quartz which is likely to weigh about 40gm.

1. Initial bipolar core. The quartz is held balanced so that one corner is on the anvil and the opposite is centred over it. The main requirement is to have the force pass directly through the centre of gravity of the core. If the core is not symmetrical in shape the hammering will produce a series of small fragments from the top and bottom ends until symmetry is achieved.
2. Bipolar halves. With continued hammering, the core usually splits into two or more pieces. It is this shearing in two which produces pieces with sharp edges.

One of the pieces may be put back on the anvil to be worked again the same way. The bipolar technique therefore produces flat pieces with sharp edges which are the largest possible flakes from such a small core.

Core and Flake Tool Industry: Discussion

As a result of the analyses to be discussed for the three sample areas, it is my contention is that the variability within the Core and Flake Tool Industry is mainly affected by availability of the stone resource. As an overall strategy it may be compared with a generalised optimum foraging strategy (e.g. Winterhalder and Smith 1981). The logistics of stone procurement is on a least cost basis similar to food gathering within an economic radius.

Another major feature is the high discard rate to minimise the transport of large masses of stone. The implements therefore are disposed of whenever possible. However, this must be done within a stone material conservation strategy. If the route to the next camp is not likely to cross any flakeable material, stone will have to be transported (unless shell or bone can be substituted). A balance must be maintained as to having an adequate supply of stone to hand, but without having to carry excessive amounts of it.

The technology used in this industry is not of a high order of complexity. The use of technological knowledge however is extremely flexible. It was a technology which was adapted to optimise a great variety of situations with different stone materials, types of sources, needs for transport and requirements for implements.

In this industry there are two main processes. Either a natural piece of stone is picked up to be used as a tool, or a flake is taken from it to serve as a tool. Producer cores are often easy to recognise because of the large, long flake scars down the side of the core, and the frequent conical shape. Large flake tools which have been reduced to an advanced stage with cusped and sometimes invasive flaking have a similar shape and cross section and may be confused with producer cores. Nuclear tools which have been extensively resharpened are sometimes difficult to distinguish from heavily reduced flake tools. They also merge into an "indeterminate core" which is a combination producer and tool. Completing the circle, there is no definite break between an indeterminate core and one which is distinctly a producer. The identification of the main technological products of this industry must therefore deal with a morphological continuum.

The functions of the tools seems to be particularly elusive. Because of this difficulty, functional interpretations were minimised in this project. For example, it is possible to

recognise a range of heavy - medium - light - fine duty tools for chopping, hacking, scraping, slicing, shaving, carving etc, but it is not clear how this continuum should be broken up. In addition, small hafted tools presumably can endure heavier use. Edge angles seem to be mostly the automatic result of resharpening and marginal contraction, although there probably are a few tasks where thin very low angle edges are needed, or robust high angle edges are preferred. The specialised edges such as serrations and projections would seem to relate to specific functions such as sawing or drilling, but these are usually rare on sites. Therefore, without high powered microscope usewear analysis, or residue analysis, the identification of tool function is very speculative. In some assemblages however, functional complexity may be indicated by the range of tool sizes, shaped edges and specialised forms.

The identification of function is further undermined by the resharpening process. For example, if the main use is nuclear tools for heavy and medium duty work (chopping and hacking), the discard stage is likely to be a tool only suited for light duty tasks. The main tools, in fact, have been destroyed during the process of use, and the platform damage on the debitage is usewear and resharpening retouch - not platform preparation. Since the resharpening results in much debitage, a flake tool production sequence may be replaced by re-cycling debitage as incidental light and fine duty tools. The resultant assemblage would be misleading, and it would appear that the main tools were small "cores" and flake tools with usewear or scalar retouch for relatively light work. As mentioned in the chapter on regional variation below, this is a major issue in the Dividing Range country.

MICROBLADE INDUSTRY

Backed blades have long been recognised in Australia (Campbell and Noone 1943, Mitchell 1949). They have been studied mainly as representing a "Bondian" culture period and having value as a chronological marker in regional sequences (McCarthy 1948, Pearce 1974, Johnson 1979).

Studies which are particularly concerned with the Microblade Industry have mainly been analyses of backed blade morphology (Glover 1967, Pearce 1974, 1977). A small amount of interest has been shown as to their geographical distribution (Mulvaney, 1975) and manufacturing techniques (Dickson 1973, Leubbers, 1978, Hiscock 1986a, Witter 1978, Flenniken and White 1985:135-41). Considerations of the function of backed blades are also relatively scarce (McBryde 1978, Kamminga 1980).

The Microblade Industry seems most conspicuous in the east and west temperate parts of continental Australia, and absent or scarce in the north tropical regions. Radiocarbon

dates for the beginning of the Industry vary locally between about 6000 and 3000 years BP and the termination is usually between 2000 and 1000 years BP (White and O'Connell 1982:117-20).

Backed blades are generally believed to be the elements of a compound spearhead, although speculation as to how they were attached varies widely (McCarthy 1976, McBryde 1974, Clark 1979, Kamminga 1980). Backed blades, blade-cores and bladelets are a common component in sites in Southeastern Australia and are mentioned to varying degrees in most of the literature of this region.

The Microblade Industry is defined here as a manufacturing process which produces flakes of a standardised flat, thin cross section, frequently (but not necessarily) in "blade" form (twice as long as wide). Some of the flakes produced in this way are subsequently modified by steep (backing) retouch techniques into a variety of forms.

This definition eliminates other backed types (eloueras and juans), and other forms which are also based on a blade technology (leiliras and pirri points). It is concerned only with the industry which results in forms commonly called bondi points, geometrics or microliths. Eight core reduction processes and two backing procedures are identified here for this industry.

The list below summarises the material collected during the survey which was used for technological analysis:

site	no. cores	no. flakes	no. conjoins
Tib-13B4c	1	42	32
Tib-13B4c	1	14	8
Cob-103-1	0	37	9
Boo-56A1c	1	71	23
B00-56A1c2	0	81	44

Prismatic Conical Blade Core Reduction

The most commonly recognized reduction process is that of the prismatic cores. This sequence is similar to that identified among European assemblages (e.g. Bordaz 1970:50-7, Flenniken and White 1985:135:41).

Prismatic cores are likely to begin as large cobbles, nodules or outcrop fragments. Large thick flakes may also be used as cores. Heat-treating may further take place at

this stage (See Flenniken and White 1983, Hankel 1985). This anneals the material and provides more control for blade production. The Australian prismatic blade reduction sequence proceeds as follows:

1. Platform angle. A platform angle of 90 degrees or less is required at the outset. Angles closer to 70 degrees seem to be preferable and may be produced in a variety of ways. One process is to reshape the platform by removing flakes from the top and sides. Another is to strike the core a hard blow well below the platform so that a flake with a very pronounced bulb is produced. The negative bulb scar provides a lower platform angle. Similar platform rejuvenation flakes may be used if the desired platform angle has been lost. These are driven across the top of the platform from the edge of the flaked surface to re-set the angle.
2. Core over-hang and platform preparation. If a pronounced over-hang is produced on the flaked surface, it may be removed as platform preparation. This usually is not necessary on material which shatters easily and the overhang is crushed off at the moment of flake detachment. The platform may be prepared by small retouch flakes down the flaked surface or in some cases by flakes across the top of the platform.
3. Vertical ridge. A series of vertical ridges is produced by detaching flakes at regular intervals. The overlapping flake scars form straight vertical ridges. This produces a flaked surface with a series of narrow "fluted" flake scars.
4. Blade production. Once the above requirements have been met (steep platform angle, no overhang, vertical ridges) then a series of blades may be detached from the core. These usually have a low triangular or trapezoidal cross section with straight parallel or tapering sides.
5. Preforming on the core. The sides of the core may be flaked so that an asymmetrical tapering blade is produced. This seems to be more than merely making the flaked surface even and is a preforming technique for bondi points (Luebbers 1978:223-5, Witter 1976:63). Such blades may resemble crested blades or redirecting flakes (Johnson 1979:101-4, Flenniken and White 1985:139). This preforming process is diagrammed in Figure 3.5A.
6. Core termination. A consecutive series of blades may be removed from the platform with the angle and overhang being dealt with as required. Usually once a series of blades are removed the vertical ridges continue to maintain themselves. As the process continues the core usually takes a tapering or conical

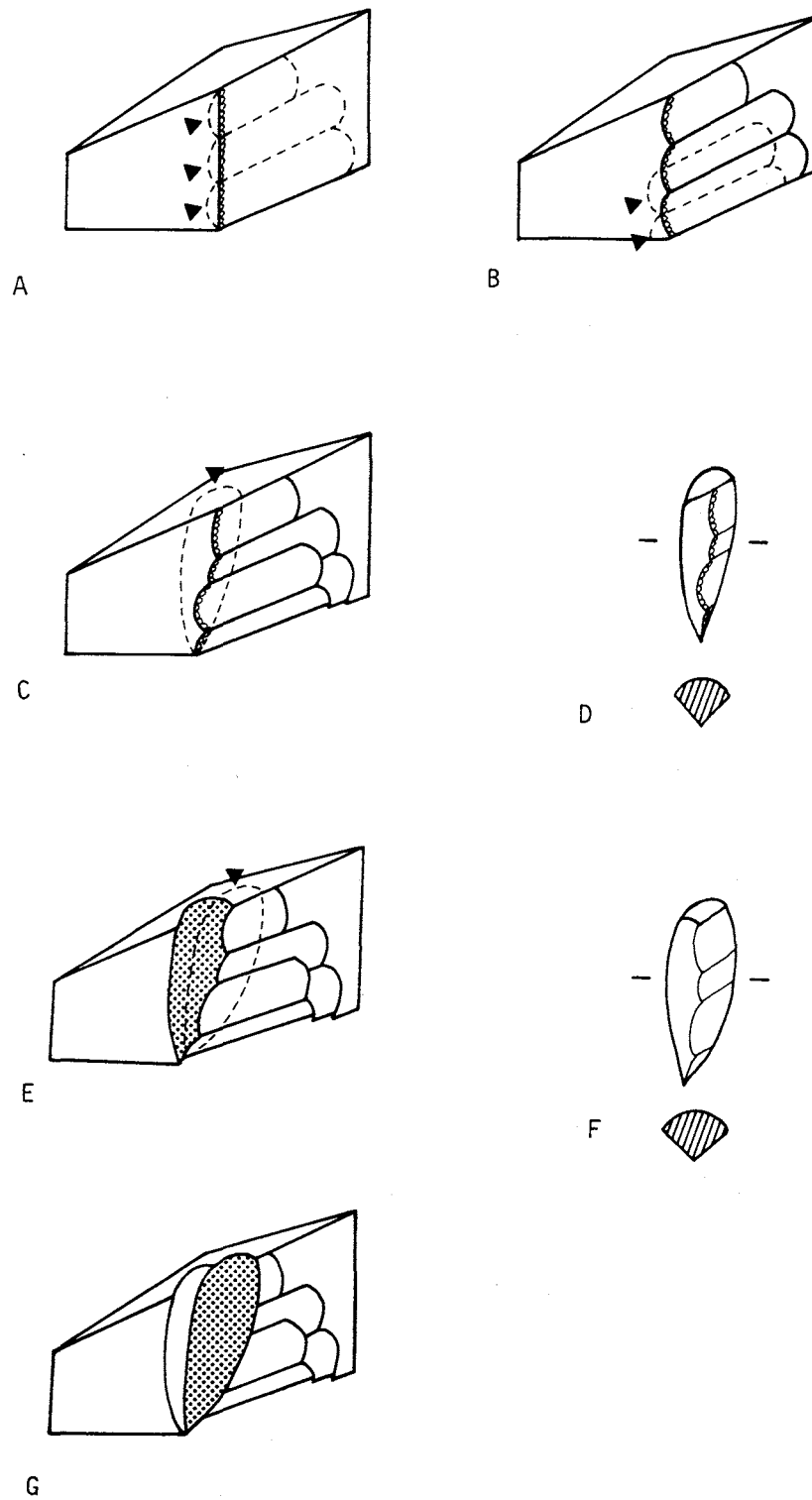


Figure 3.5. Preforming on a blade core.
 A. Flakes driven transversely across the blade core.
 B. Continued transverse flake scars.
 C. Blade detached down corner of blade core.
 D. Crested preformed blade.
 E. Blade core showing blade scar and the production of a second blade.
 F. Preformed blades from continued reduction.
 G. Blade core showing blade scars.

form because of occasional plunging blades. The core may be discarded at a very small size (22mm long, or 6gm).

Burin Blade Core Reduction

The next reduction process to be defined is that of the burin blade core (Witter 1977:62, Leubbers 1978:223).

1. Core. The burin blade core originates as a large, thick flake detached from a large core.
2. Platform angle. Sometimes the platform on the large flake can serve as the platform for the blade core, if it has an acute angle in respect to its lateral edges (Figure 3.6A). In some cases a notch faceted in the lateral side provides a platform for blade production (Figure 3.6B). A large flake with a split cone also provides a good platform.
3. Platform over-hang. This may be removed as in the case of the prismatic cores.
4. Vertical ridge. The starting ridge is provided by the lateral edge of the large flake.
5. Blade production. The blades are produced by working the relatively narrow core back, and producing blades which are technically burins. These tend to have triangular, relatively thick cross sections and tapering sides (Figure 3.6C). This also has been described as a twin ridge reduction process (Cundy 1977).
6. Core termination. The core is reduced much as a prismatic core. Preforming on the core may take place (Leubbers 1978:223) and the platform end may be reversed. In many cases the platform may receive a rejuvenation blow across the top in order to re-set the angle. In the early stages the bulbar surface of the original large flake may be seen on the core, but eventually this can be removed.

The burin blade core is therefore a modification of the prismatic core. When a large flake is to be used for a prismatic core, the bulbar surface is used for the platform. A burin blade core however is oriented at right angles to this and can start on a smaller initial flake.

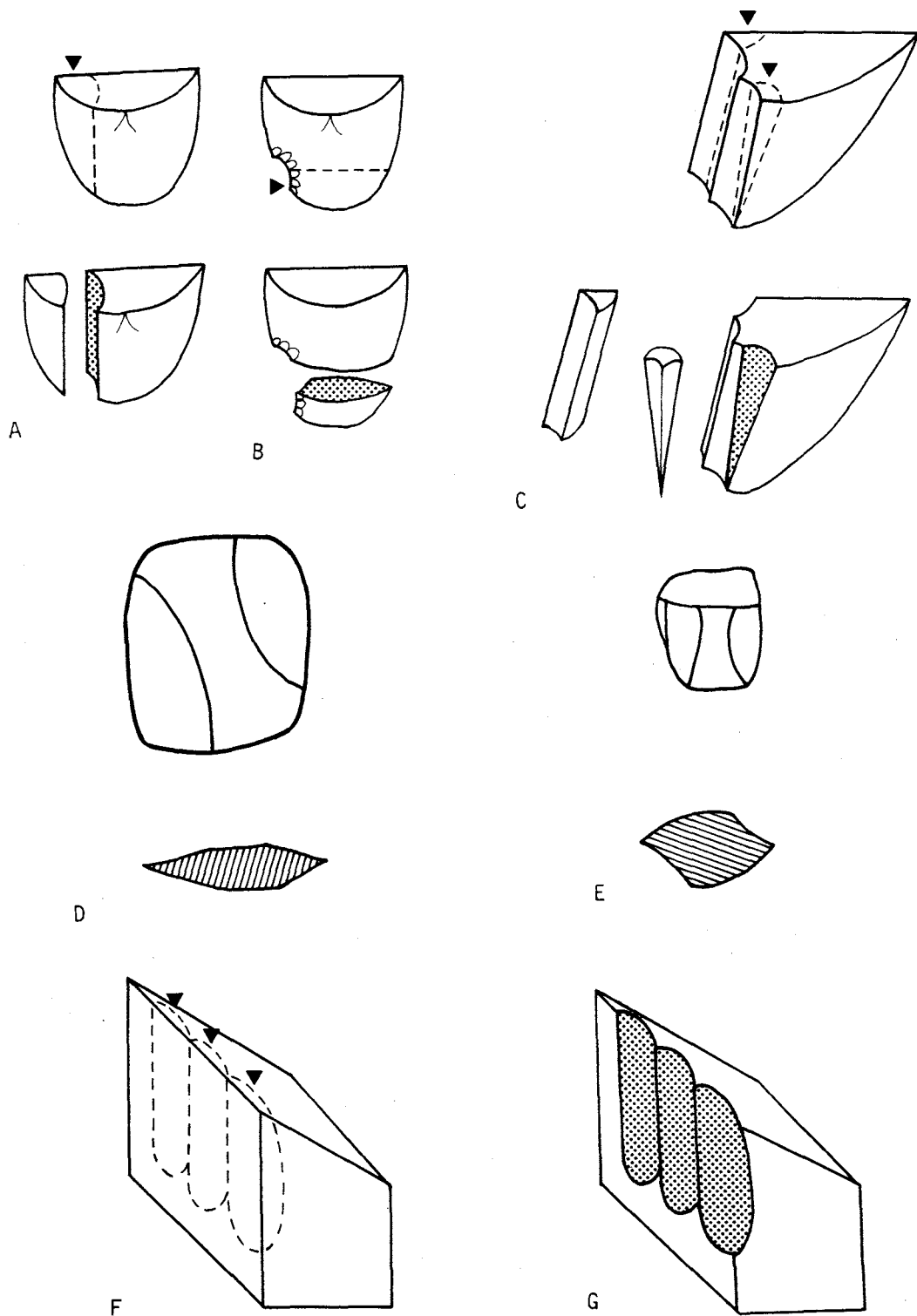


Figure 3.6. Microblade core techniques.

- A. Removal of a burin blade from the platform of a large flake.
- B. A faceted notch to remove a burin blade or set a new platform.
- C. Types of burin blades.
- D. Tranchet blade core showing 2 blade scars.
- E. Tranchet blade core showing 3 blade scars.
- F. Steep platform for a quartz blade core.
- G. Blade scars on a steep platform quartz blade core.

Bipolar Blade Core Reduction

Another form of blade core is the bipolar blade core. This type is probably rarely recognised as separate from a prismatic core. Indeed, there may be cases where the terminal stage of a prismatic or burin core is worked further on an anvil. Thus cores which cannot be worked free-hand due to size, high platform angles, or other reasons may become bipolar blade cores. The blades are produced by direct anvil percussion.

Bipolar blade cores often show anvil crushing opposite to the platform and need not have an acute angle platform. They presumably occur when the core has become very small and the platform angle may have been lost. However, this may also be the reduction process for a piece of stone which is already very small, and is started as a blade core.

Tranchet Blade Core Reduction

The blade reduction processes described above produce the types of cores which are conventionally recognised as belonging to the Australian Microblade Industry. There are in addition some core types and reduction processes not previously been described. The first to be defined is the tranchet blade core process (Dallas and Witter 1983:20, 26, Witter 1988).

The term "tranchet" (Bourdes 1968:248) was chosen because the resultant blade is intermediate between a burin and a conventional flake relative to the axis of the large flake which serves as the core. It has no implications here as a tool sharpening technique, but is applied in a technological sense. Since tranchet axes and projectile points do not appear to occur in Australia, it would seem to be safe to use this term without any danger of confusion in an Australian context.

1. Core. The core is formed by detaching a large flake much in the same way as for the burin blade core. In addition it may be necessary to trim off excess material to straighten the edge or preform on the core.
2. Platform angle. The platform angle is by a special faceting technique. A steep platform angle is produced by flaking the edge of the core in a way similar to resharpening the edge on a flake tool.
3. Vertical ridge. As in the case of the burin blade core the lateral edge of the large flake is the vertical ridge.

4. Blade production. The blades are produced as a tranchet flake. In terms of the original large flake used as a core, the lateral edge and part of the dorsal or ventral surface is removed with the bladelet. This bladelet often has an unusual form in which its dorsal ridge overhangs one of the lateral edges. The result is an "upside down" looking blade. The flakes are usually tapering and with thick triangular cross sections.
5. Core termination. Only a single bladelet seems to be produced from each faceted platform. However, the blades may be driven from opposite ends and opposite sides. This type of core may also be rested on an anvil, but without the direct bipolar technique described above. When discarded the core is usually a square lozenge shape and relatively small sized (4mm or 15gm). Two diagrams showing the position of the blade scars are given in Figure 3.6D.

Tranchet blade cores do not look like conventional blade cores, and do not have the columnar series of flake scars. They are relatively common in some regions. The platform faceting is probably usually mistaken for tool retouch and the cores are likely to be classed as "scrapers". In some cases, this type of blade core is, in fact, re-cycled and used as a flake tool with subsequent retouch as an implement.

The tranchet blade core may be recognised as a further modification to the burin blade core process. The tranchet blade cores described by Hiscock (1986) would belong mainly to what I define as burin blade cores. The distinction between the two different types is that the platform for the burin blade core is flat, whereas the tranchet blade core has a steeply faceted, angled platform.

Often blades from a tranchet blade core show a distinctive "inverse" type of cross section in that the dorsal side is flat and a ridge runs down the ventral face. Examples of this type of bladelet are probably included in the forms defined as redirecting spalls by Johnson (1979:101).

The use of tranchet blade core here also is different from the example described by Hiscock (1986), which here is a burin blade core. The key distinction between a burin blade core and a tranchet blade core is that platform on the burin blade core is flat, whereas on the tranchet blade core it is steeply faceted. The significance of this probably related to the potential productivity and flexibility to the two techniques. In replication trials the burin blade core is an easy technique, and lends itself to rotation and intensive reduction. The tranchet technique is much more difficult, and seems to be limited in the numbers of blades it can produce. The advantage may be that it can be readily change its function into a utilitarian cutting implement.

Alternating Platform Blade Core Reduction

All of the processes described so far are derivatives of unifacial techniques. The differences are due to various alterations such as the orientation of the core or platforming techniques.

Another process is bifacial. This has not been previously described and does not provide classic blade forms. It is diagrammed in detail in Figure 3.7, and described below as the alternating platform process:

1. Platform angle. The core is trimmed so that an edge with an acute angle is formed.
2. First series of flakes. A series of flakes is removed along this edge. The negative bulb scars produce an acute platform angle for the next series which will extend across the present platform.
3. Platform overhang. The overhang is usually removed by small retouch flakes after each series.
4. Second series. The core is rotated so that the second series of flakes is removed from the same worked edge but extend down the adjoining side, thus forming a biface.
5. Vertical ridge. A vertical ridge system is not much used and the flakes tend to have oblique dorsal ridges.
6. Flake production. The flakes are typically thin and wide and are removed as an overlapping series. Each series produces the platform angle by the negative bulb scars for the next, alternate series. The flakes have the typical wave-like platform of a bifacial flake formed by the flake scars of the preceding series.
7. Core termination. The bifacial reduction continues as described until it reaches a relatively small size (35mm or 17gm). The small sized cores are likely to receive considerable battering before a flake is detached and the core may be mistaken for a bifacial implement.

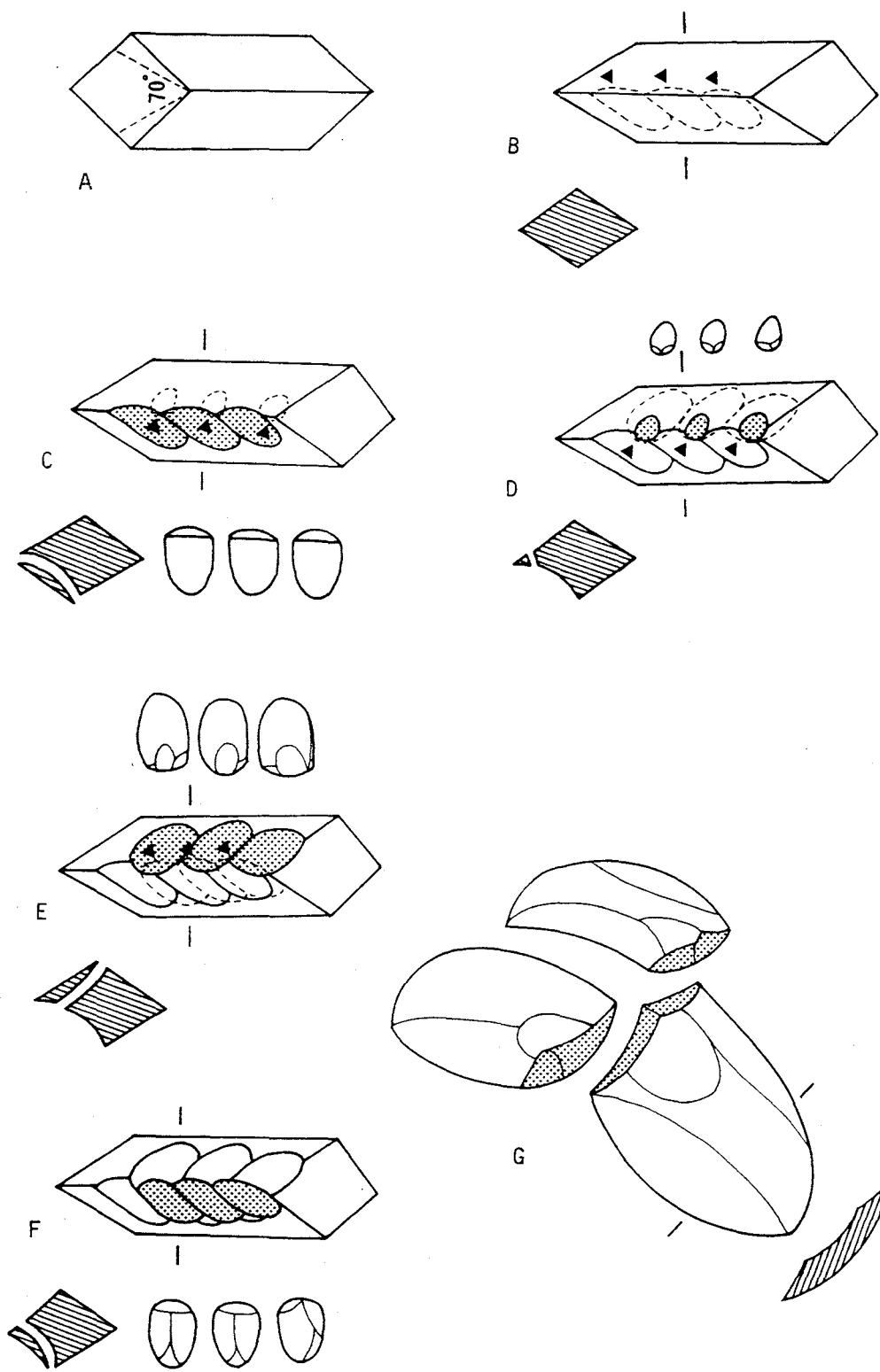


Figure 3.7. Alternating platform blade core reduction.
 A. Initial core with the platform angle at 70 degrees.
 B. Points of impact for the first row of flakes.
 C. First row of flakes and points of impact for platform preparation.
 D. Prepared platform and points of impact for second row of flakes.
 E. Second row of flakes on adjacent platform.
 F. Third row of flakes on alternate platform.
 G. Relationships of bifacial flakes showing platform surfaces.

At all stages in the above sequence the core has a distinctive sinuous edge. The workshop associated contains backed rejects and the debitage has the wave-like bifacial platforms.

The above reduction process belongs to the Microblade Industry even though it is not a blade technique. This is because it produces flat thin flakes with controlled cross sections and these flakes are given backing retouch in the same manner as conventional blades.

Cube (or Rotated) Blade Core Reduction

Another newly discovered technique is that of the cube blade core. This technique appears to be an anvil based procedure which is not bipolar.

1. Core. The core begins a piece which is already small. This may be a core which has lost its platform, or which is too small to reshape for an acute angle edge.
2. Platform angle. The main platforming technique appears to be by platform rejuvenation flakes struck across the top of the platform.
3. Flake production. The core is probably anchored on an anvil but with the bottom end free (unlike direct bipolar technique). Flat, thin, relatively short flakes are more commonly produced than blades.
4. Core rotation. After one flake has been produced, the core is rotated, another little step terminated platforming flake is struck off, and the next blade/flake is detached.
5. Core termination. The core has a blocky multifaceted form and is in no way similar to a conventional blade core. These cores are as small as 30mm and 15gm. The process is probably related to a quartz lamellate production process which will be described later.

This core was identified as a type of blade core because it occurred in undoubted microblade workshops in which backed blade rejects were made from the same material as the core. Replication trials indicate that this type of core may develop from rotating a burin blade core.

Quartz Steep Platform Blade Core Reduction

Quartz is usually regarded as a material which does not permit controlled conchoidal flaking. In some regions, however, quartz backed blades are inexplicably common. If the blades were the result of a chance fracture, then it implies that vast quantities of quartz would have to be smashed up until a suitable fragment was obtained. However, it will be shown here that quartz blades may be obtained in a systematic and controlled manner.

The first technique is the steep platform quartz blade core. This process was discovered by a salvage excavation in the Boorowa area near Dalton (Witter 1981). The excavation produced two cores, the debitage from those cores including blades and various backed blade rejects.

1. Platform angle. The platform angle is the most critical factor. This is usually trimmed to an angle less than 60 degrees.
2. Platform overhang. Since quartz is extremely brittle the platform tends to crush off and platform preparation is not needed.
3. Vertical ridge. This seems to be used, but may not be of special importance.
4. Flake production. The flakes or blades are detached with hard blows. The steep platform allows the force to shear across the internal checks and fracture lines in the quartz and results in blades or elongated flakes. The toughness of the material is probably what prevents the steep platform from collapsing. A diagram indicating this process is indicated in Figure 3.8.
5. Core termination. The cores from this process appear to be discarded when still relatively large (60 gm). It may be that the relatively great force required to detach blades necessitates a relatively high mass in a hand-held core.

Even though this process is designed for quartz, the lump used as the core must be of relatively high quality material which is fairly homogeneous.

Quartz Faceted Platform Bipolar Blade Core Reduction

Another form of quartz blade manufacture is an anvil technique (Witter 1984b). Although described here as a quartz technique, an example of this type of core has been seen made of basalt.

1. Core. The core is an elongated bipolar at least 50mm in length. The top end is bevelled by faceting retouch in the same way as the tranchet blade core described above. The result is a steep platform angle of 60 degrees or less.
2. Blade production. The bottom end of the core is flat, but only the edge is placed on the anvil. The platform is then struck and the distal end of the blade detaches at the point of anvil contact (as shown on the crushing of the core).

Microblade Cores: Comment

The reason I have discussed the microblade core reduction processes in detail is to demonstrate that there are a variety of ways in which the same end product (backed blades) may be made. Part of the importance of this is to illustrate some of the versatility of strategy and technological knowledge used by Aboriginal stone flakers. There is no one kind of "classic" blade core type. Even the ones shown in Figure 3.8 should not be thought of as fixed types. On a site there will be as many intermediate forms as those which show a particular type of described reduction.

The other reason to discuss the blade cores in detail is show that many of the cores in the Microblade Industry look like other kinds of implements. In Figure 3.8 there are some examples of the cores discussed above. The conical prismatic form is shown in 3.8A as an example which is widely recognised.

The tranchet blade core in 3.8B however was made on a large flake and looks like a flake tool. The faceting retouch used to set the platform also can be confused with resharpening retouch. In the case of this specimen, after it was used as a source of blades, it was in fact recycled as a "flake tool". It was retouched and made into an implement with a projection such as might be used for boring or graving. This type of re-use of tranchet blade cores however is relatively uncommon.

The burin blade core in 3.8C, and the bipolar blade core in 3.8D both have elongated flake scars which show them to be the producers of blades. The bifacially flaked alternating platform core shown in 3.8E is a typical discard stage. It looks like a heavily flaked implement from the Core and Flake Tool Industry. It was only from refitting such a core from the Tibooburra area, and finding such cores in the Boorowa area on microblade workshops and of the same material as the backed blades, that this form of blade core was discovered.

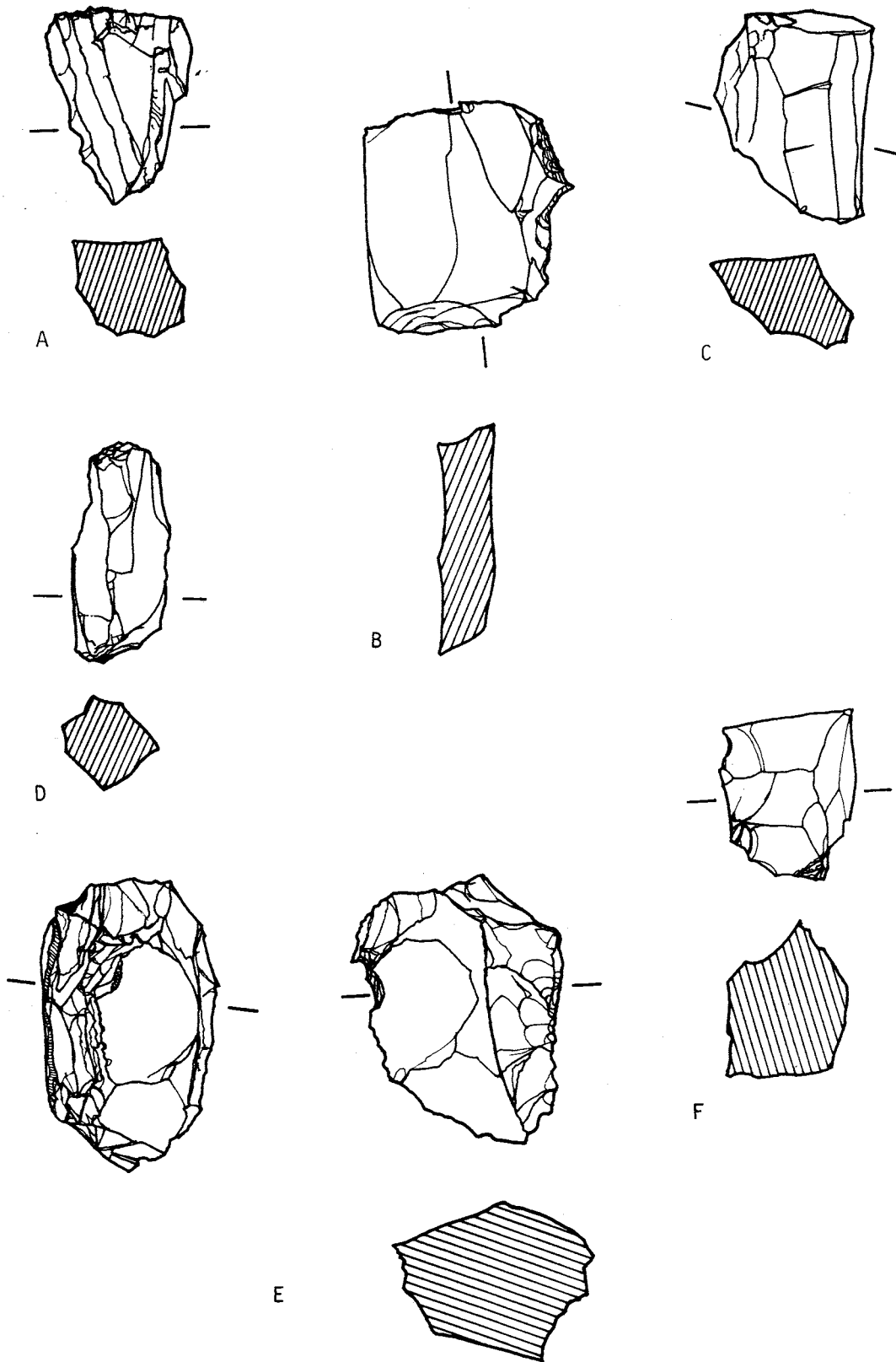


Figure 3.8. Microblade Industry: cores.
 A. Conical prismatic blade core.
 B. Tranchet blade core.
 C. Burin blade core.
 D. Bipolar blade core.
 E. Alternating platform blade core, terminal stage.
 F. Cube blade core.

Another strange form is the cube blade core shown as 3.8F. As mentioned above, it was found on microblade workshops, and only after close examination was it understood to be a microblade producer.

Bondi Backed Blades

So far, the blade production processes have been discussed without reference to further shaping by backing retouch. Backing blades into various shapes is a relatively simple process (Dickson 1973:12-3) and is considerably less complex than the blade production techniques described above. There are two distinct backing processes which result in either bondi forms or geometric forms. The terminology I use differs from some conventions (i.e. McCarthy 1967: 40-3) in order to reflect the distinctions between the two separate manufacturing processes.

The bondi sequence will be described first. The three stages delineated are arbitrary divisions in a gradational sequence.

1. Preform stage. During the preform stage a point was formed on the distal tip of the blade by retouch along the lateral edge (Figure 3.9A). Discard or loss is common at this stage and rejected preforms are relatively frequent among workshop debris. This was a delicate stage since the pointed tip is very fragile (Figure 3.9B). Similar items include crested blades or "redirecting flakes" (3.5C&D). These are due to edge straightening or preforming on the core so that bondi-like forms will automatically result. The type called a woakwine point (McCarthy 1976:48) is commonly found as a rejected bondi preform in a workshop, rather than a separate kind of functional end-product.
2. Shaped stage. In this stage retouch had continued along all or most of the lateral edge, but not the platform end. The retouch is uneven and large and there may be heavy step fracturing caused by crushing the edge back with the hammerstone (chimbely as defined by Dickson 1973:12).
3. Finished stage. Here the bondi point is completely and evenly retouched on all edges (including on the platform) except for the remaining sharp lateral edge. Thus the artefact is complete a manufacturing sense, although at earlier stages it may have been functionally adequate.

The bondi points produced in this manner may be made from flat blades and consequently result in "flat bondis" which are relatively thin in respect to their width.

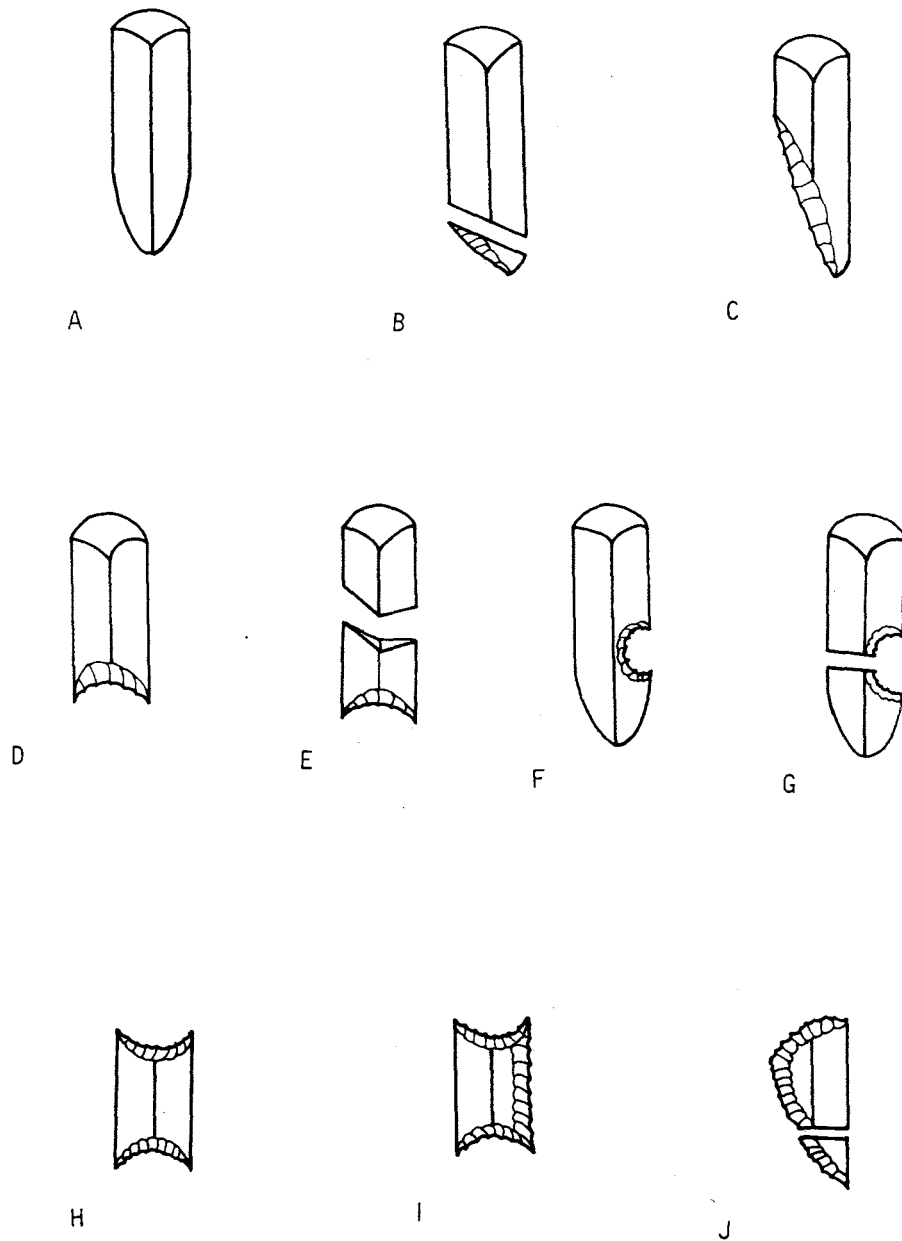


Figure 3.9. Microblade Industry: backed blade rejects.
 A. Initial blade blank.
 B. Snapped tip from bondi point reduction.
 C. Discarded partly backed bondi point (preform).
 D. Distal end reduction for a geometric.
 E. Blade snapping for a geometric.
 F. Micro-notch to snap a blade for a geometric.
 G. Snapped micro-notch.
 H. Discarded partly backed geometric.
 I. Discarded geometric preform.
 J. Broken geometric.

However, some of the blade production processes yield thicker blades and will result in "thick bondis". This difference in cross section as indicated by thickness/width ratios tends to provide two statistical groups of bondi points (Pearce 1974).

Geometric Backed Blades

The geometric forms result from initiating the backing process at the ends rather than along the lateral edges. Their production is described in a sequence similar to that for bondi forms.

1. Preform stage. In this stage the process of percussion backing on the anvil or crushing (chimbelling) with the hammerstone were the most common methods. This may begin at one end to truncate the blade (Figure 3.9C). It then may recommence on the opposite end (Figure 3.9D), and as a final option, on one lateral side (Figure 3.9E). Many of the pieces may be confused with small retouched flake tools and therefore may not be identified as preformed backed blades. Another reduction technique was to use a micro-notch in the lateral edge (Figure 3.9F&G) and snap the blade in a way analogous to the microburins of Europe (Clark and Pickering 1978). In some cases it seems clear that the blade was snapped transversely by a blow against an anvil without the micro-notch (Figure 3.9H).
2. Shaped stage. At this point a recognisable geometric form emerged. However, the retouch tends to be uneven and in some cases relatively serrate.
3. Finished stage. Whether the lateral edge was completely retouched or not, all of the backing was even and without "burrs". The backing is normally by anvil bipolar percussion, but pressure backing may be used which gives a steeply bevelled edge of narrow, even retouch flakes. Again, finished refers to the manufacturing sequence and need not have functional implications.

The geometric forms tend to be on flat blades and this seems to be the main purpose of the alternating platform core reduction technique. Bondi forms rarely exceed 12 mm in width, and geometrics within this range often provide the most finished and symmetrical examples. Those over 12 mm are frequently asymmetrical and somewhat irregular in form. This is probably more than just shaped stages which have not been reduced further to more finished forms, and may represent a larger type of geometric form. This category of the large geometrics is probably sometimes confused with the type of artifact called an elouera. The elouera however is not part of the Microblade

Industry since it is not formed on the products of microblade reduction but made on large, thick flakes.

Blade Reduction: Comment

The Australian backed blades form a morphological continuum in which strongly asymmetrical forms called bondi points are at one end and various geometric forms are at the other. Glover (1967) has proposed that the length-width ratio of 2:1 may be used to separate the bondi type. This has been re-examined by Pierce (1977) who included thickness in his calculations and obtained categories for thick and thin forms.

As described above, the bondi and geometric forms are manufactured in distinctly different ways and are easy to identify in the preformed and shaped stages. Probably the best general criterion for the more finished forms is a 40 degree rule. If the lateral edge is worked first then the angle at the point will be less than 40 degrees in plan view, and may be called a bondi. If the ends are worked back first then the angles formed by even the most asymmetrical examples will be greater than 40 degrees.

The thick and thin groups of backed blades observed by Pearce (1977) are the result of the type of blade core used. Prismatic and alternating types of cores will most often contribute towards the thin class. The burin and tranchet blade cores will cause a bias towards the thicker range. The assemblages from some regions are predominantly one or the other, whereas others have both. The reasons for the types of cores which produce this patterning are probably mainly due the distribution of raw material and the logistical strategies of transport.

The type of blade reduction process also has an effect upon backed blade morphology. For example, the alternating platform technique seems to apply to geometrics and the tranchet blade technique appears to result in bondis.

Some of the variation in backed blade production can be seen in Figure 3.10. The bondi shown in 3.10A was made on a flat blade such as is normally produced from the prismatic blade core. The bondi in 3.10B however was made on a corner blade which would have come from a tranchet blade core. The geometric in 3.10C was made on a flat blade which may have been relatively narrow. It was smoothly finished off into a small form of a geometric and has light use-wear on the edge. The geometric in 3.10D was made on a larger flake. A feature also found among the large geometrics is that although there is heavy use-wear, the backed edges may not be smoothly finished off.

Future work on the morphological and metrical variation of backed blades, as well as usewear studies, should take into consideration whether the items are at a finished, and presumably fully functional stage, or are likely to be manufacturing rejects. At sites which are well exposed, but not overly disturbed, most of the backed items belong to workshop debris of the same core and were never functional implements.

An overall scheme for how blade blanks are transformed into finished products is shown in Figure 3.11. This shows flat blades of various sorts (3.11A, B & C) which have the potential for a several different forms of bondi and geometric. The blade preformed on the core however is destined to become a bondi (3.11D), although the corner blade (3.11E) is shown as becoming either a bondi or a geometric. The blade shown as 3.11F is from a tranchet blade core, and is an "upside down" blade. The two blanks from the alternating platform core (3.11G & H) are shown as wide and an elongated forms, and result in geometrics which are not necessarily symmetrical.

Microblade Industry: Other Tool Forms

In addition to the backed blades there are other products of the Microblade Industry. Most of these have functional analogues with the Core and Flake Tool Industry. They are assigned to the Microblade Industry because they originated from microblade cores.

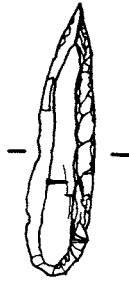
Probably the most common are a large part of the micro-convex flake tools usually called "thumbnail scrapers". These are made on flat blades where the dorsal ridge is very low and does not interfere with the resharpening of the bevel.

Another case seems to be restricted to Gippsland, Victoria. This is the regular production of burins on blades (Hotchin and May 1893). In this technique the platform is steeply faceted and then the burin is removed from the lateral edge. Dihedral forms may be made by the next burin blow which removes the platform end.

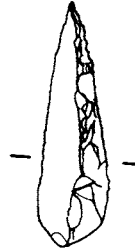
Blades also are commonly found as flake tools with usewear, and in various stages of retouch. These may have been waste products from a blade core which were picked up and recycled as implements.

Microblade Industry: Discussion

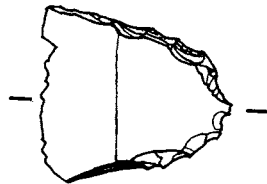
One of the most obvious features of the Microblade Industry is that it involves a high proportion of wastage. From a rough estimate from the workshop material and refitted cores, it is my impression that about one of twenty flakes backed are likely to be removed from the workshop floor.



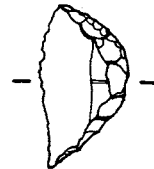
A



B



C



D

Figure 3.10. Microblade Industry: backed blades.
A. Bondi point made on a flat blade.
B. Bondi point made on a corner blade.
C. Geometric, large type with usewear.
D. Geometric, small type.

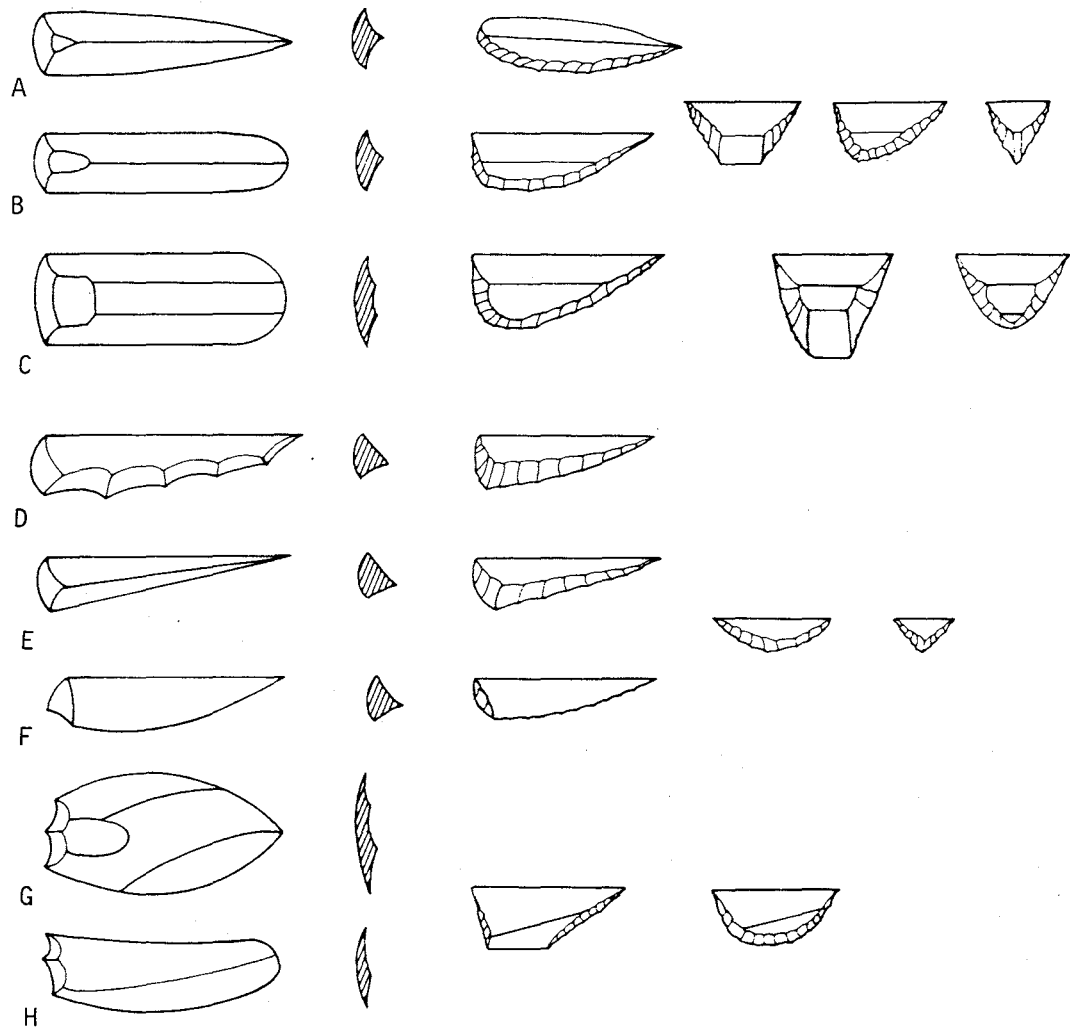


Figure 3.11. Microblade Industry. Blade reduction processes.

A. Tapering flat blade.

B. Straight sided parallel flat blade.

C. Broad flat blade.

D. Preformed (crested) blade.

E. Corner blade.

F. "Upside down" corner blade from a tranchet blade core.

G. Broad blade from a bifacial alternating platform core.

H. Narrow blade from a bifacial alternating platform core.

The success rate of blade production is improved as the stone becomes more flakeable, homogeneous and cryptocrystalline. If the flakeability and quality of stone are important to reduce wastage and expedite blade production, then the common presence of fine-grained stone (even if non-local) is a significant factor in this industry (Johnson 1979:95, White and O'Connell 1982:123-4).

Given such transport of stone, then techniques for core conservation may be expected. The bipolar and cube-core techniques permit the reduction of blade cores to a very small size.

The burin core and tranchet cores were probably stone conservation techniques developed so that a large flake detached from a utilitarian heavy-duty core tool could serve as a blade core. The advantage was that the core tool could be retained as an implement without extensive reduction to set up a blade core. The tranchet blade core could also be re-used as a utilitarian implement at any time.

The technology further made use of materials of poor flakeability such as quartz, although the failure rate was high.

The broad technological repertoire within the Microblade Industry as shown by the reduction sequences above implies a complex logistical process. This would seem to be explicable as an instant supply strategy (Witter 1988:40). The technology existed to instantly produce flakes with a standardised cross section for backing purposes.

TULA INDUSTRY

Ethnographic observations of a wood-working tool formed by a piece of flaked stone set in gum on the end of a stick or spear thrower were recorded relatively early (e.g. Spencer and Gillen 1899:594). The stone tool used is commonly known as a tula adze (McCarthy 1976:27:8). The tula adze has received some study regarding its hafting and function (Sheridan 1979, Hayden 1979), but there is little description of the complete stone industry.

There is some uncertainty as to when the tula adze first appears in the archaeological record. Gould reports "micro adzes" extending to about 8000 BP at Puntutjarpa (Gould 1977:104). These have been examined by Hiscock and Veth (1991) who point out that these artefacts do not have the distinctive features of tula flake production, and that no true tulas have a date greater than 6,000 BP.

The tula adze is known throughout the arid and semi-arid portion of Australia (McCarthy 1976:31-2, Mulvaney 1975:77) although little has been done to establish precise boundaries. The stone component of the adze is a large flake hafted on its platform end. It is used and resharpened until it is too small to be hafted. At this stage the tula is discarded and the artefact is termed a "slug" (Mulvaney 1975:77).

The definition of the tula industry used in this study refers to a specific manufacturing process and does not include the "burren adze", or other types of hafted flakes.

Tula Core Reduction

The core reduction process is a highly distinctive feature of the Tula Industry. Three types are described as follows:

1. Macro-flake core. This core begins as a very large flake (150mm diameter, 50mm thick and 1000gm), whose bulbar surface is used as the platform for the production of tula flakes. McCarthy (1976:17) probably alludes to this but a full description is not provided. The platform on the tula flakes show this curved surface and may even carry ripple marks from the original ventral surface of the macro-flake. Examples of this type of core were found at the Nocabrinna Quarry (Tib-110) in the Tibooburra area, and at the Elsinore Site (Cob-137) in the Cobar area..
2. Cobble core. A second core type is a desert pavement cobble (i.e. silcrete gibber) in which the curved cortex surface of the cobble was used as the platform to produce tula flakes. Tula flakes from this type of core may be recognised by cortex which covers the platform. A core of this type was refitted from the Box Creek Site (Tib-113) in the Tibooburra area.
3. Faceted core. The third type of core is a block which has been faceted to form a convex platform (Flenniken and White 1985:142-3) This faceting is by flakes driven from the edge of the core across the top of the platform to obtain the dome-like effect characteristic of the other two core types.

The reduction of these tula cores follows much the same series of steps in order to produce the tula flakes. These are as follows:

1. Platform preparation. Before the tula flake is removed the platform edge is trimmed back. This trimming results in a straight edge which is seen on the

platform end of the tula flake. On the "slug" forms this platform preparation can be mistaken for resharpening retouch of the tula implement.

2. Vertical ridge. Combined with the platform preparation is the removal of the vertical ridge which may run down the flaked surface. This gives the tula flake its characteristic trapezoidal cross section.
3. Flake production. The tula flake is struck hard and well back from the platform. This gives a relatively thick flake with a pronounced bulb of percussion and a reflected distal end (curving back ventrally). The platform of the flake is therefore thick and wide giving a maximum surface on the platform. This is presumably important for hafting purposes (Sheridan 1979).
4. Core Termination. The cores are worked back until they either become too light or other factors interfere. The terminal stage of the macro-flake type of core is recognisable because of the bulbar surface of the original flake. The other kinds of cores are probably less obvious but clearly identifiable. The discard stage of the tula core is likely to be classed as a form of "horsehoof" core or a core tool.

Tula Flake Reduction

The tula flakes produced are extremely distinctive, and when found discarded prior to hafting on camp sites, stand out from other debitage due to their convex platform, strongly reflected distal end and trimmed platform. These flakes next undergo the following sequence of reduction.

1. Wear/retouch of lateral edges. Prior to hafting the tula flake may be used as a hand-held flake tool while it is transported from one site to the next. Consequently a tula flake may be found with edge damage only on its lateral edges. Such flakes were found on surface sites in the Tibooburra and Cobar areas, but as very rare items.
2. Initial reduction of distal edge. Once the platform end is hafted the distal edge is bevelled by retouch and may be used as a scraping, hacking or chiselling tool. Through resharpening, the reflected end of the tula flake is removed and occasionally the flake was discarded when the bulbar part was reached. It has been suggested that it was the more proximal portion of the tula flake which was important for use (Sheridan 1979, Kamminga 1985, Flenniken and White 1985). This may have been true when dry hardwoods had to be carved. A cache of trimmed tula flakes has been found in Queensland in which only the bulbar

surface was present, the axial length was usually less than the axial width, and there was no extended distal end (Hiscock 1988). This was interpreted as a batch of prepared tulas ready for exchange. However, it was noted that Roth 1904:17) observed tula flakes being manufactured, and that they were relatively elongated. Considering the elongated flake scars on the tula cores, and the use of the low platform angles which would result in a long flake, I suggest that the truncated form of tula adze flake represents a particular stage of use. It may be that the elongated stage with the reflected distal end was used up rapidly, and the truncated bulbar stages tended to accumulate.

3. Continued reduction of the distal edge. The use of the hafted tula flake, however, is likely to continue and the distal margin is further resharpened, often with step flaking, and retreats back towards the platform end. The low trapezoidal cross section and lack of a high dorsal ridge is important at this stage. This removal of the dorsal ridge before the tula flake was struck off has been interpreted "thinning for hafting" (Hiscock and Veth 1991:339). This however would seem unlikely if a maximum surface area on the platform was an advantage for hafting. If the tula flake was thicker the resharpening would result in step flakes instead of a scalar flaked bevel. If the step flake retouch continued it would result in the loss of the working edge. Another feature is often noticeable at this stage. These are very thin flakes back from the edge on the ventral surface. This does not represent purposeful retouch but is due to the impact of the edge of the implement on hard wood during use (J. Kamminga, pers. com.). When the retouch reaches the bulbar swelling on the flake, discard is likely to take place, and tula adzes at this stage are occasionally found.
4. Final reduction of the distal end. The resharpening process may continue until the longitudinal cross section becomes triangular. Indeed, once the thick proximal portion has been reached and is undergoing retouch then either the distal or platform end is equally suitable for hafting. If the distal end is hafted, then the platform end will be removed by retouch. The original platform trimming, however, should not be confused with this resharpening. When the tula flake becomes too short for a firm haft in the adhesive then it is finally discarded as a "slug".
5. Reduction of lateral edge. When the tula flake has been reduced to the above stage it is very short and wide. The lateral sides become points where the proximal and distal ends meet. The tula flake may therefore occasionally be rehafted so that one lateral edge (now pointed) protrudes from the adhesive to provide a working edge for gouging and engraving (O'Connell 1977:276).

The size range of tula flakes vary considerably on a local basis and in some areas include very small forms which are called here "microtulas". These have all of the distinctive tula flake characteristics, and are resharpened down to a slug form. From the description provided by Hiscock and Veth (1988) these do not appear to be the same as the tula micro adzes in Gould (1977:84).

The microtulas do not appear to receive heavy use and may be hafted on the platform end, the lateral edge or on the corner of the two (oblique hafting). The thinner forms of microtulas grade morphologically into the category of small convex flake tool usually called a thumbnail scraper. These microtulas seem to be produced where massive forms of raw material are rare and a large enough tula core cannot be set up.

From replication trials I find tula flakes difficult to manufacture. A low platform angle is needed to produce the long flake in the absence of a dorsal ridge. However, it is not easy to keep this low platform angle by the time the convex part of platform is reached. It is no wonder that the tula flakes were made at the stone source due to the high failure rate.

In Figure 3.12 are illustrations of various aspects of the Tula Industry. A small sized tula core (or "microtula core") is shown in 3.12A. This is from a workshop in the Cobar area (Cob-137), but some from the Tibooburra quarry Tib-110 are two or three times as large. Shown in 3.12B is the first discard stage where the distal reflected end has been removed, and the flaked bevel has reached the percussion bulb. This example shows cortex on the surface of the platform because it was produced on a cobble tula core. Two examples of slugs which are not yet at their terminal stage and have been produced from macro-flake tula cores are shown in 3.12C&D. The slug in 3.12C shows a ripple mark on top of its platform, and 3.12D shows the convex platform derived from the bulbar surface of the core. Both also have been retouched only from the distal end and show ventral use-wear flakes. The terminal stage of a slug is shown in 3.12E. This example has been resharpened from both ends. The slug in 3.12F was produced from a tula core which was faceted in order to achieve a convex effect on the platform. A microtula slug is shown in 3.12. In this case the resharpening retouch has not been directly from the distal end, but obliquely to the longitudinal axis of the flake. Although not drawn, the platform and dorsal side show that this flake was produced on a tula core.

Tulas are normally grouped with another "adze" type known as a burren (McCarthy 1976:31). A burren flake is a relatively large thick flake removed from a conventional type of core. A burren flake is used in the same way as a tula except that it is hafted on

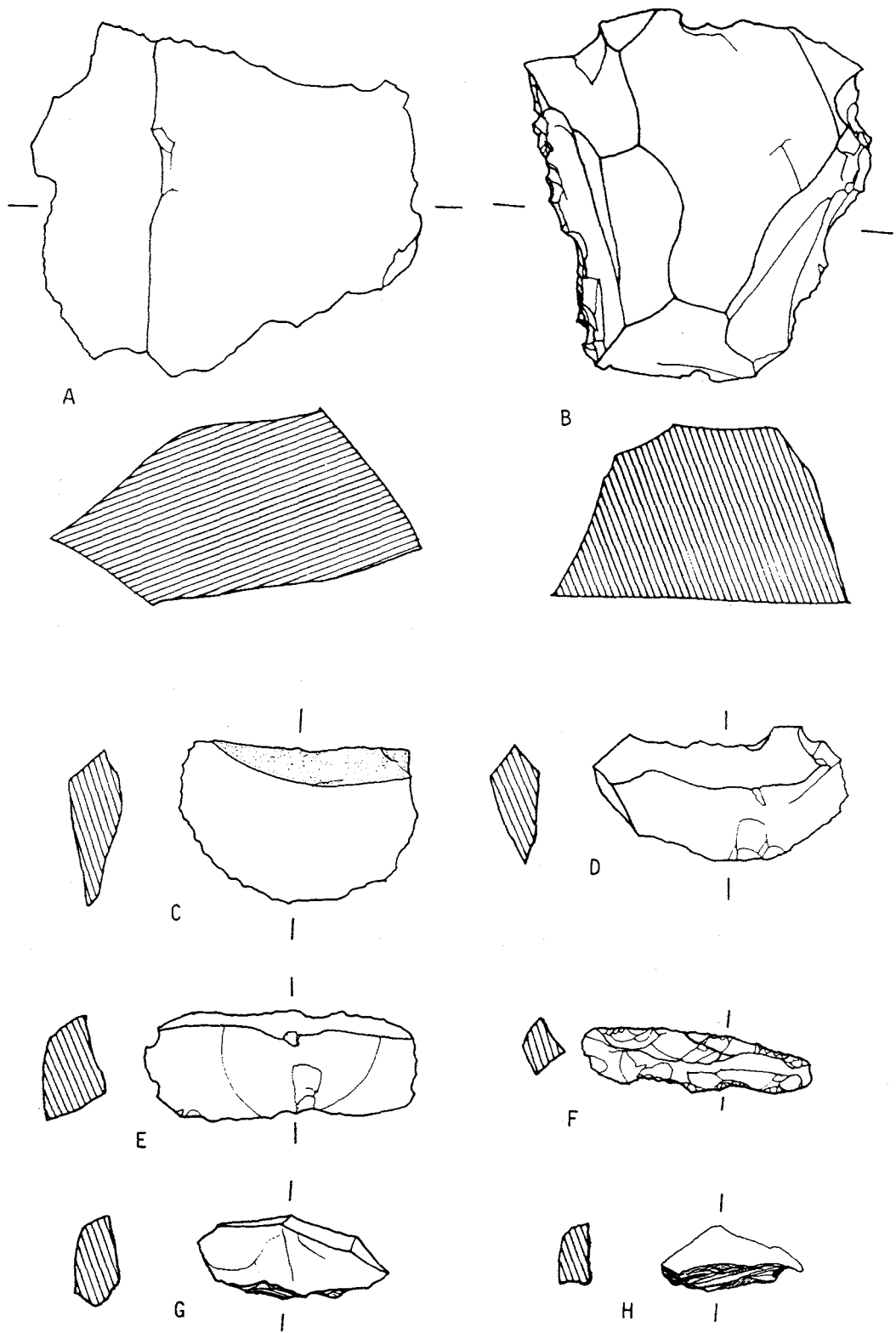


Figure 3.12. Tula Industry: core and slugs.
 A. Tula core, ventral view, longitudinal cross section.
 B. Tula core, dorsal view, transverse cross section.
 C. Tula slug, reflected distal end reduced, from cobble core.
 D. Tula slug, advanced reduction, from macroflake core.
 E. Tula slug, advanced reduction, from macroflake core.
 F. Tula slug, final stage of reduction.
 G. Tula slug, from a "gabled" faceted core.
 H. Microtula slug.

the lateral edge. The opposite lateral edge therefore becomes the working edge and is resharpened. With use it may be rehafted so that the old and blunt working edge is hafted in the adhesive. However, lacking the broad platform end of the tula flake the burren will tend to split out of its adhesive more readily (Sheridan 1979, Hayden 1979).

The burren form is clearly part of the same functional suite as the tula and in heavily retouched examples they may be hard to distinguish. The burren, however, is not produced from a tula core and has already been referred to under the Core and Flake Tool Industry.

Tula Industry: Discussion

During the thesis survey, tula cores and tula flake workshops were only found on quarries or at domestic camps near a source of raw material. The tula flakes therefore were produced on the outcrop and transported elsewhere for use.

The distribution of the Tula Industry is generally central Australian. This region is characterized by plains and dune country where there is no flakeable stone alternating with other areas where stone is available in vast quantities and often massive form. Such a pattern of distribution could be called "coarse grained" with a large "patch" size.

The solution to providing stone tools in the areas without stone was to use a weight reduction strategy. By producing a set of flakes which were of optimal form for hafting and resharpening the need to transport large cores into stone-poor regions is reduced. According to J. Kamminga (pers. com.) an X-ray photograph of a hafted tula had also a number of other tula flakes contained in the adhesive, rather like a magazine in a rifle.

When the Aborigines arrived at the next stone source, the last of the "slugs" would be discarded. This would result in heavily reduced tulas of non-local material to be common near quarry localities. Gould found a tendency for such tulas of exotic and poor grade material to be located near high quality stone sources. The explanation offered by Gould was that value was placed on these tulas was due to a sacred association and role in an exchange network (Gould 1980:154-9). The simplest explanation is not exchange but logistics, and that the tulas were discarded after re-tooling at the quarry.

Where the stone sources were marginal and less massive, a full sized tula core would be difficult to obtain. In these cases the core faceting technique described above could be used. Otherwise, smaller tula cores were made, and resulted in microtulas.

Another solution was to produce elongated burren flakes from other cores. Although less suited to hafting, the burren can be resharpened as an even bevel in the same way as a tula. When it was necessary to haft other flakes as "adzes" with the distal end as the working edge, difficulties in resharpening would arise due to the dorsal ridge.

It has been suggested that the localised distribution of burrens has a "cultural significance" (McCarthy 1976:32, Mulvaney 1975:82-3). The areas having burrens as defined by these authors, however, are along the southern and eastern margins of the tula industry and reflect the lack of availability of suitable raw material for tula cores rather than ethnic values or cognition.

Another suggestion is that the availability of spinifex adhesives facilitated the use of tula flakes (Sheridan 1979:121), since the distribution of the tool type and adhesive are both within the central arid area. An additional explanation of the eastern boundary is that the woods of the desert country are harder and require the special cutting qualities of the tula flake (Flood 1973:192, Sheridan 1979).

Whatever the merits of the above suggestions, the most powerful explanation is the distribution of stone. The eastern boundary of the Tula Industry is the great alluvial valleys west of the quartz belt. Once in the quartz region, there are large lumps of quartz abundant everywhere to serve as heavy duty wood working tools. Quartz flake tools which could have been hafted are present, but they are rare. The absence of tula forms is probably because a large quartz core is equally as effective as a hafted tula or other flake tool, but requires much less maintenance and is far easier to procure and manufacture.

PIRRI INDUSTRY

The term pirri point has been used for some time (Hale and Tindale 1930) and is generally applied to unifacial points in the central arid region (Campbell 1960, McCarthy 1976:42). The term was from Aboriginal people no longer using this artefact, who interpreted it as a "pirri" or graver (Kamminga 1985). The eastern bi-marginally trimmed points from the Snowy River (Geering 1981) however, are completely isolated from the central Australian ones. The Pirri Industry described here is based on the Tibooburra area which is on the eastern margin of its range, and may vary considerably from unifacial point production elsewhere.

The main interest in unifacial points seems to be as a chronological marker, and a culture period known as the "Pirrian" has been proposed (Tindale 1957). These points

are not well documented by excavations, but it they probably appear by about 5,000 years ago (White and O'Connell 1982:119), and disappear prior to European contact.

Examples where unifacial points have received specific investigation are few (Palter 1977, Kamminga 1978:328-33). Otherwise they usually receive only passing comments (Tindale 1957, Akerman 1978). The general consensus of previous studies is that unifacial points were used as spear heads.

Pirri Core Reduction

During the survey a quarry was encountered where it appeared that blade manufacture for unifacial points had taken place on a large scale (Tib-110). Pirri cores in the form of large conical prismatic cores were found at the quarry. The associated debitage was tapering blades between about six to eight centimetres in length. A single workshop was also found which had manufacturing stages of unifacial points (Tib-19). The process of core reduction indicated is as follows:

1. Core. The main feature of a pirri core is the steep platform angle needed for blade production. This seems to be mainly obtained by a single blow across the top of the platform to form a concave surface (P. Hiscock pers. com.).
2. Blade production. In the blade production the overhang is trimmed off and then the blade struck off but not close to the platform edge. Straight vertical ridges and hollows are set up and the blades removed are straight sided, parallel and tapering.
3. Core termination. The final stage of the core is a conical blade core (60 mm long, 120 gm) which may still show the concave platform due to the initial platforming flake.

Pirri Point Reduction

Retouch on these blades was not observed at the quarry and it is likely that further flaking was done elsewhere, perhaps after heat-treatment (K. Akerman, pers. com.). The following sequence of unifacial retouch is indicated by the items from a workshop in the Tibooburra area (Tib-19), and some other points found in isolation.

The Pirri Industry, like the Tula Industry, is a weight reduction strategy. The blade blanks were initially produced at the outcrop. The finishing of the pirri blades may

have been at a considerable distance from the quarry. This might account for the rare large blade-like flakes found on domestic sites. These may show light retouch on the edges and perhaps were discarded pirri blades used as flake tools.

The pirri core is most easily produced where there is a massive deposit of material. Localities where the stone is in smaller form, such as a gibber plain may be more difficult for core manufacture, unless a very large cobble was found.

QUARTZ LAMELLATE INDUSTRY

Flat thin pieces of quartz are a common feature on sites in Southeastern Australia. These are products of block fracturing and to distinguish them from conventional flakes I have called them lamellates (Witter and Simmons 1978:50).

The Boorowa area produced three workshops with lamellate debris (Boo-56E9, E10 and Boo-59C4, see Ch. 6). These pieces showed no indication of bipolar work and indicated that a different type of stone working had taken place. Another feature of the quartz artefacts in the area was a multi-faceted or polyhedral type of core. It seemed that the lamellates could be produced by detaching the facets from these cores. When workshop Boo-59C4 was found, two of the predicted heavily reduced forms of such multifaceted cores were present. On the basis of replication trials it was found that controlled square flat thin lamellates could be made readily from this type of core.

Among the ethnographic collections are items called "jag" or "death" spears and the "taap" knife (Mulvaney 1975:108). These implements have small pieces of stone set in a row on one or both sides of the wooden shaft like a series of teeth. Although a variety of materials, including glass, may be used, quartz is commonly found.

There has been some speculation as to how the quartz fragments were produced. One suggestion is that the bipolar process described above could be used to manufacture flat thin pieces of quartz (Hayden 1973, Lampert 1971:46-7, Vanderwall 1977:353). Split bipolars well may have been used for this purpose, but it also appears that there was a more specific technique for the systematic manufacture of lamellates.

Lamellate Core Reduction

The multifaceted lamellate cores require a relatively large piece of homogeneous quartz (some cores are up to 100gm). The main process of production is described below:

1. Core. The core should be a homogeneous piece of quartz with relatively few fracture lines. These lumps are commonly found within ordinary chunks of reef quartz once the main fracture lines have been split.
2. Faceting. The core is supported on an anvil, but not in the manner as the bipolar technique. The edge of the core opposite the platform should not be in direct contact with the anvil but slightly free.
3. Lamellate production. The procedure begins by striking a corner of the core. The detached corner piece will be pyramid or prism shaped. The next piece to be removed is therefore usually flat thin and square in shape (a lamellate). The piece following will also be a lamellate but usually larger. The size range of lamellates usually seems to be about 8 x 8mm to 12 x 12mm.
4. Terminal core. The final size of the multifaceted core is about as small as can be held down by the thumb and weighs about 7 gm.

Lamellate Industry: Discussion

Since the Lamellate Industry previously has not been recognised as a manufacturing process in its own right, its distribution is not clear from the literature. It probably occurs throughout the quartz belt of the western Dividing Range and extends to the coast in many places. The survey located a number of quartz workshops in the Tibooburra area (Tib-13, Tib-107), but none of them were like the distinctive lamellate workshops in the Dividing Range country. Moreover, there was no debitage resembling lamellates on other Tibooburra sites near quartz sources. All of the quartz seemed to be flaked in a way similar to silcrete.

The antiquity of the lamellate production is difficult to determine. The presence of bipolar cores as lamellate producers is ambiguous since this is also a final stage of core reduction. Its presence would be best indicated by an assemblage of lamellate flakes or a multi-faceted core. The earliest example of a definite lamellate industry seems to be at the Werrabee Site in Victoria dated at about 8000 years BP (S. Simmons, pers. com.).

The function of the lamellates seems to be primarily as compound elements in a type of spear. Ethnographically, this "death spear" is referred to as a greatly feared weapon used in combat (Smythe 1878:304, Mulvaney 1975:108). It was particularly lethal since the pieces of stone came loose and remained in the body (Tench 1793:205-6). The jag spear also was effective in kangaroo hunting, even though the stone elements detached once inside the animal and had to be replaced after each hunt (Bulmer, n.d.).

ABRADED STONE INDUSTRIES

The term abraded stone artefacts is used here in opposition to flaked stone artefacts. Abraded stone artefacts usually are not commonly found on surveys and will not be discussed here in detail. As with the flaked stone industries they are defined in terms of their manufacturing process. In many cases, wear during use is a fundamental part of reduction process, and it is not possible to discuss tool manufacture and function separately.

The items from these industries are usually heavy in weight and highly curated. They are rarely discarded and usually cached or extensively transported. In many cases therefore, it is necessary to visit a large number of sites in order to obtain a representation of different reduction stages.

Descriptions of the various artefact forms may be found in McCarthy (1976), and Smith (1986, 1988). I will not discuss these industries in detail here, but briefly mention their characteristics.

Percussion Industry

The tools in the Percussion Industry include large to small sized hammerstones which may be spherical to elongate in form. The hammerstones may additionally have an anvil pit. The pitted anvil stones also belong to this industry. These tools show wear by flaking, and are strictly speaking pecked stone artefacts rather than abraded.

Grind Stone Industry

The tools of this industry are produced in the course of grinding various materials. These include various types of milling slabs and mortars which are used primarily for plant food processing. The milling slabs are of basin or grooved types. The top grinding stone ("muller") is often a re-cycled fragment of a slab and shows different stages of wear. In some cases grinding slabs may be pecked as part of a "resharpening" technique. Other forms of grinding stones may be for crushing ochre, working bone tools or for sharpening hatchet heads. Not all of the components of this industry are portable artifacts because it includes bed-rock mortars, axe grinding grooves and similar archaeological features.

Ground Edge Industry

This industry is mainly represented by stone hatchet heads. The grinding process has been described in detail by Dickson (1972, 1980, 1981). The grinding may be relatively brief as when a suitably shaped stream cobble is sharpened or it may be lengthy and complex when the stone is derived from a quarry of exceptionally tough and durable material. Extraction from an outcrop results in the bifacial production of blanks (Binns and McBryde 1972:69), often using material which mostly block fractures. The grinding may occur on the edge only or extend across the entire hatchet head. Pecking or hammer dressing also may take place prior to grinding. Sometimes after considerable use, the edge is resharpened or re-formed by flaking. The hatchets vary considerably in shape, size and the presence of a hafting groove (Dickson 1976a, 1976b, 1981). The smallest may be hafted as a chisel. The products of the ground edge industry can be subject to long distance transport and exchange and may be found at great distances from their original source (McBryde 1978).

Sculpted Industry

Other abraded forms appear to have a strictly social function. In southeastern Australia these include the "cylcons" which seem to be restricted to an area west of the Dividing Range and into the Eyre Basin (Black 1942, Gresser 1964, McCarthy 1976, Hamm 1987).

CHAPTER 4

METHOD

Methodology of the Project

In this chapter I account for the overall methodology used in various aspects of the survey. The problem of sampling is fundamental to this project, thus the first topic is the concept of sampling - what sampling does and the importance of scale and method. For this I apply archaeological land systems units and survey methods for coverage in the field to find sites. The recording of sites is the next subject. This includes the techniques to be used to analyse stone artefacts, as well as the field methods.

SAMPLING

Sampling within regions has become an important approach in archaeological survey and has resulted the development of in what might be called a sampling point of view (see Mueller 1975, Read 1975, Schiffer and Rathje 1983, Schiffer et al. 1978:10-3). Early examples of sampling in Australia include Smith 1980, Egloff 1984, and Vinnicombe 1984. The sample perspective used in this project was derived mainly from the plant ecological literature (Daubenmire 1968, Kershaw 1973) and particular archaeological projects I have participated in where sampling was used (Judge et al. 1975, Reher 1977).

Principles of Sampling

Strictly speaking, an archaeological sample is any place where an archaeologist has looked for sites. The sample strategy for this project was defined in terms of three concepts. These are systematisation, formalization and representativeness.

A systematic sample can be obtained by the consistent application of specified sampling procedures. Intuitively looking for sites (however experienced one might be), or using local knowledge, cannot be said to be systematic, even though a great mass of information may be accumulated. A systematic sample must be in units of known size, shape and place, and conform to an explicit sample strategy. Sample units which do not contain sites are as important as those which do. The techniques used to assess the effectiveness the ground coverage and to record the sample unit data must also be consistent and deviations in procedures noted.

The degree to which a survey can be said to be formal depends on statistical criteria. Of special consideration are standards of plot size, shape and pattern since these affect the mathematical techniques which are appropriate to deal with survey data. A systematic sampling procedure may be carried out at an informal level in which these factors are allowed to vary, but the more constant and ordered they are, the more powerful their statistical potential. In addition, the formal character of the sample is affected by biases in the placement of the sample units. In some cases randomisation may be desired to avoid bias.

Representativeness is the extent to which a sample is able to account for the types and variation of sites in an area. It depends on the formal characteristics as well as the structure of the sample pattern (stratification), the percentage area covered and other factors. Depending on the objectives of the sample, the results of a 20% coverage may be little different from 100%. If certain types of rare site are essential for the study, an 80% coverage may be inadequate (Judge et al. 1975). In archaeology no survey is likely to be entirely representative since all of the relevant events in the past will not be evident on the surface. Representativeness is affected by the method of coverage, the size of the region to be sampled, the factors affecting site preservation and detection and the meaning assigned to the materials found.

Sample Strategy

In the development of the research design, and during the following questions were used as methodological guide-lines: a) what is the sample intended to measure? b) what are the practical and physical constraints? c) how is the sampling bias to be treated? and d) what analyses are to be used?

The aim of the survey is to measure past Aboriginal land use and determine cultural adaptive strategies by the use of archaeological remains. It was assumed that particular portions of the landscape may have been used in certain ways by Aboriginal people based on cultural strategies. The places where sites are found, and their contents, should reflect Aboriginal decision-making relative to cultural strategies and the local bio-physical environment. The features which are common among regions should reflect broad adaptive strategies whereas the differences between regions are more likely to be due to local environmental determinants.

Within the research design this was expressed as the following questions:

1. What is the range of variation that can be expected? (Types of sites, their contents, environmental associations, etc.)

2. What within this range is common and what is rare? (Also what are the biases against finding unusual cases.)
3. How much cultural complexity can be expected? (Limits of site deposits, internal patterning of sites, chronological components, etc.)
4. What are the biases in the data, and how difficult is it to obtain reliable data? (Includes formational and site detection factors, recording techniques and observer variation, and limitations in interpreting the evidence such as stone artefact identifications or environmental reconstruction.)

The practical constraints on the field work varied considerably for the regions sampled. Transects work well for open country with good ground surface visibility, but are inefficient in wooded or farmed regions where the patchy exposures of bare ground favour a quadrat approach. Access, finding land marks or locating the land owner are among other factors relevant in the time spent to organize and implement the field work.

The sampling was kept systematic in that the size, form and location of the sample units were documented. The objective was to define patterning on a gross scale over a large region which meant that the circumstances under which sites were found varied considerably. This resulted in differences in sample technique among different areas, but with certain minimum standards which will be discussed later under ground coverage.

The scale and scope of this survey was very broad, and few formal methods were used. This limited the possibility for testing for sample bias (e.g. Hodder and Orton 1976). A less formal option was to make the biases as explicit as possible. Thus the procedure used in the placement of the sample units was to formulate propositions from the research design whilst in the field about what sites should be associated with various physiographic features. The sample units were then placed to test these expectations. This approach consisted of the following steps:

1. Determine the size and location of the region to be sampled.
2. Define the main physiographic or land systems types and stratify the sample area.
3. Place sample units relative to expectations as to where sites should or should not be, and test both possibilities.

4. Try to test the full range of physiographic variability.
5. Adapt the sample size and shape to the conditions of exposure, visibility and land form.
6. Other things being equal, place the sample unit where access is easiest.
7. Consider the effect of formational factors, such as avoiding areas of very recent alluviation or dune development.
8. Continue sampling until there is apparent redundancy in the results.
9. As redundancy is dependent on the range of variation, check whether some physiographic or land system types need to be sampled more intensively.

Since the sample programme was in areas which were poorly known, I was confronted with the sampling paradox: if one knew what the distributions were in advance, then it would be easy to design the ideal sampling strategy. In archaeological survey the investigation begins at the opposite end, i.e. the distributions are not known and the sample strategy is intended to discover them. This process therefore is imperfect at the outset, and depending on the resolution and completeness of data needed, may require several steps and trials using different methods.

As stated by the research design, the primary objective was to record the most common sorts of sites in the most usual kinds of places. This was to assess what the most ordinary and regular forms of land use were. Since the survey was to be over three regions instead of one, an inventory of all types of sites and environments within a region was impossible.

The discovery of the most commonly occurring types of sites and artifacts presented little difficulty. It is a truism that whatever is the most common will be the most frequently found (other things being equal). The full range of variation, however, requires a much more intensive survey program. In order to find the rare types of sites, sites in unusual places, or to define the full range of variation of the common types, the sample methodology needs to become increasingly sophisticated. It has been my experience that in most regions, the common types of sites (scatters of flaked stone) usually turn out to be extremely abundant, whereas the rare kinds of sites (stone arrangements or art sites) are very rare indeed. Many of these rare site types are conspicuous and obtrusive (i.e. art sites and stone arrangements). These are site types

which are the most likely to be reported on the State Register, so that examples will be known for the region.

The analysis of the survey data would determine the site types and their contents which were most often associated with various types of environments. The environmental data was organised in a "land systems" approach (see also Hughes and Sullivan 1984), in which there were archaeological land systems units within a land systems type. The concept of site type was refined to include the differences in site contents within the broader "camp site" type.

Coverage Analysis

The concept of coverage analysis is to specify what part of the area covered within a sample unit would permit site detection. This includes the distinction between obtrusive and unobtrusive sites, and defining types of terrain which have different site formational factors. It should be possible to estimate these effects and calculate the amount of coverage which has taken place over a surface which has been exposed and is bare, as well as likely to preserve unobtrusive sites. This would comprise the effective coverage (Witter 1980a&b).

My system of effective coverage is to record particular values for calculation in a formula in the course of surveying a sample unit. I will provide a general discussion of the concept and field procedures before specifying how coverage was recorded during this survey.

The formula I have developed is mathematically very simple, although it can have numerous variables. An expanded version of the formula is as follows.

$$\begin{aligned} &\text{Sample Unit in metres} = (\text{SU}) \\ &x (\%t) x (\%c) x (\%s) x (\%d) x (\%e) x (\%v) x (\%b) \\ &= (\text{EC}), \text{ or Effective Coverage in metres} \end{aligned}$$

where:

SU = The initial Sample Unit, or the entire area/line designated as a sample unit, whether a transect or quadrat, and whether one or more terrain types (in metres or square metres).

EC = The Effective Coverage of the Sample Unit, or how much of the area/distance could have had sites detected per terrain type (in metres or square metres, or percentage of the SU).

and as percentage values for:

- t = Terrain type. This is the physiographic or topographic feature.
- c = The amount of the sample unit actually covered by foot (metres or square metres).
- s = Surface sediments which would contain archaeological deposits (%).
- d = Disturbance by modern land modification (%).
- e = Exposure by erosion which would reveal the deposit (%).
- v = Visibility within the exposure which provide bare ground to detect unobtrusive archaeological materials (%).
- b = background effects which may interfere with detection (%).

In the field, the variables above may be estimated as percentages. For example, a sample quadrat 500m x 500m (the SU) may be entirely located on an alluvial flat (t = 100%). If it were partly on a ridge slope, then the SU would have to be subdivided. It may have only been half covered on foot (c = 50%) because most of it is in pasture grasses. Of this, 10% may be on an actively aggrading creek flood plain, but the rest is on a relatively inactive surface (so that s = 90%) and another 10% of the area may be bulldozed into a stock tank (d = 90%). The main exposure type may have been in the form of scalds which provided a lag surface and were present in patches over the about half of the area covered (e = 50%). However, there may have been a recent rain, so that even these scalds supported a ground cover of ephemerals which only left 20% visible (v = 20%). It also may have been that there was abundant naturally fragmented quartz in the soil, and that in the region most of the artefacts were made of quartz. Thus it may have been judged that with such heavy interference that the chances of recognising a quartz artefact was reduced further by half (b = 50%). The variables recorded would be expressed as decimal values (i.e. 50% = 0.5). The above values may be solved in the equation as follows:

$$SU = 500m \times 500m = 250,000sqm$$

$$\times 1.0t \times 0.5c \times .9s \times .9d \times .5e \times .2v \times .5b =$$

5,062sqm EC, or about 2% effective.

From these calculations, a sample unit (SU) which was 250,000sqm in size and surveyed, would come to only 5,062.5sqm (2%) effective coverage (EC).

The order of the variables in the calculation is important. Firstly the terrain features within the sample unit need to be made explicit. A large ridge may be divided into an erosionally stable crest, a degrading main slope and an aggrading foot slope. If this is within the same sample unit it needs to be divided into three parts so as to be consistent with the subsequent values. A transitional or mixed zone also may be treated as a single terrain type on archaeological criteria, such as the boundary strip of a dune field meeting a flood plain, and the different site detection effects combined as averages. The main guides for defining the terrain types are land form, vegetation, soil and scale, as well as consistency with the rest of the survey. It is easiest if the sample unit consists of a single terrain type. The terrain types should be identified as part of the research design.

If the entire area within a sample unit and particular terrain type was not covered on foot, then the percentage exposure is relevant only for the part actually walked over. Alternatively, the sample unit may be defined only in terms of where walked per terrain type. In any case, this must be made clear before any of the other values are calculated.

The processes of active sedimentation (aggrading, degrading, stable) and the amount of land disturbance are somewhat optional. They are based on the assumption that the observer is able to identify these effects and the differences are applicable to the survey. If they are to enter into the calculations however, they need to be introduced at this stage.

Exposure may be as individual erosional features (scalds, blowouts, gullies), or as an entire surface (hill slope with skeletal soil, colluvial plain). In any case, visibility must always be expressed in terms of the exposed area (and therefore always follows exposure). For example, a sand plain may have 50% visibility overall among scattered vegetation. The small exposed patches, such as created by vehicle tracks or ant nests however may be the only areas with visibility below the loose sand flux (which, in fact may be 100%). If the erosional patches in the sand veneer equal 0%, then the visibility effectively also is 0%.

Background effects are mostly applicable within the area exposed and visible (such as a gravelly surface, or naturally fragmented quartz in the soil). If factors such as day light conditions are to be used (overcast day and late afternoon with weak light or intense midday overhead dazzle), these values could be entered at an earlier stage.

All values also must be averaged at the time of observation. For example, a colluvial slope with a natural weathered surface may have an exposure of 100%. However, it may have a patchy cover of pasture grasses which varied from 10% to 80 % visibility. If this range was recorded and then averaged for the purposes of calculation, the median value would be 45%. However, the patches with good visibility in fact may have been very small, and a more realistic overall mean value might have been about 20% visibility.

Effective coverage applies only to foot coverage (vehicle coverage must be dealt with separately). The visual swath for foot coverage depends upon conditions of exposure, visibility and background. The coverage "lane" or "swath" width needs to be adjusted for different terrain types. For example, on a relatively bare lag surface, a four metre wide field of view may be adequate to detect artefacts. However, a stony shrub covered may permit only a two metre field of view. Thus the foot coverage would have to be adjusted by zigzagging or walked over twice as much. A lack of confidence in the intensity of coverage also can be expressed such as by recording a lower value for coverage (c in the above equation if it seemed that the visual swathes were spaced too far apart).

In recording it also must be clear what the values represent. For example, if the visibility was recorded as 20% it may be interpreted that either 20% was bare ground ($v = .2$), or that the ground cover was 20% ($v = .8$).

An obvious problem with the effective coverage concept is the difficulty of interpretation of the variables and the differences among individual observers in assessment of percentages. Rigorous procedures (such as are used in plant ecology for the quantification of ground cover) have not yet been developed for this method. Therefore, the use of coverage analysis should not be expected to have great precision. Its main value is to indicate the conditions experienced by the observer during survey so that the size of the sample units and frequency of sites are not taken at face value. Statements about "poor visibility" or "good exposure" are nearly meaningless unless there is at least some approximate method to quantify them.

Sample Units

In all cases the coverage of transects or quadrats was by foot. The categories recorded during the survey were for the purposes of environmental description and for use in coverage analysis. They were as follows:

1. Physiography or terrain type. These were land forms such as a ridge, flood plain or hill slope. Normally there was only a single physiographic or terrain type for each sample unit.
2. Surface soil. These were in terms of colour and texture, such as black clay or brown loam. In some cases, this was assumed with the physiographic type, such as a dune being of red sand, or a rocky ridge of buff coloured sandstone.
3. Vegetation. The vegetation was recorded as structure and dominant species, such as yellow box woodland or Mitchell grass grassland. Unless there had been obvious land clearing, an effort was made to have only a single vegetational type per sample unit.
4. Types of sedimentation. The sedimentological processes were recorded as aggrading, degrading, stable, or a combination. For example, dunes were a dynamic combination: aggrading/degrading. Effects from disturbance, such as ploughing, also were noted. Usually there was only a single sedimentological type per sample unit.
5. Types and percentages of exposure. The types of exposure, such as scalding, gullyng or deflation were quantified for each sample unit for use in the coverage analysis.
6. Type of ground cover and percentage. This was the amount of visibility (bare ground) on the exposures, and was recorded for the coverage analysis.
7. Background effects, and if significant, percentage estimation. This was difficult to consistently record (such as effects from lighting, texture of the ground, etc.). If there was a significant level of background interference from natural quartz in the soil (20% or more), it was estimated.
8. Isolated finds. The isolated finds were recorded as to quantity and type. This included artefacts or uncertain identifications (e.g. 3 silcrete flakes, possible hearth or burnt stump, etc.).
9. Sites. Sites were identified by the criteria discussed later under the heading of site recording.
10. Sketch. A sketch was made showing the physiography and the route where walked. It also showed the position of isolated finds and sites. A percentage

estimate of partial coverage was included if the entire sample unit (such as a quadrat) was not completely walked.

The techniques of coverage varied depending on local conditions. Where the visibility was excellent (over 50%) the swath was usually narrow (10m). Even so this required zigzagging in order to look over the entire surface. This swath may be reduced further by poor background conditions, such as a gibber pavement, to a width of 4m (2m on either side). Where visibility was poor but in the form of small areas of bare ground, the swath may be 20m wide with an extreme zigzag. It was my impression that the ability to detect an unobtrusive site such as a scatter of stone flakes probably became unreliable when the overall visibility was 20% or less. Thus sample units with a visibility less than 20% were avoided.

In the course of walking the sample units an effort was made to be aware of the possibility of sites at different eye-levels such as scarred trees or rock art versus flaked stone scatters flat on the ground. There also was the need to try to scan for large sized items such as hatchet heads or grinding slabs as well as for small items such as backed blades.

SITE RECORDING

Definition of a Site

What is meant by an archaeological site is difficult to explain. One well known definition is that a site is "a locus of human behaviour" (Gumerman 1971, Butzer 1982:230). This is rather like saying a "site is a place", and hoping that what is meant by "human behaviour" is universally understood. Part of the problem is that a "site" can measure many different things, and it is difficult to provide an all-inclusive definition. For example, even within the behavioural concept there are a variety of processes, such as procurement, domestic life, artistic expression, or ceremonial activities which define an archaeological site in different terms.

Other definitions make a more specific reference to the presence of cultural materials or residues (Ragir 1967:81, Plog et al. 1978). This also is somewhat tautological, since it is hard to imagine an archaeological site without cultural materials (unless documentary or oral references are included).

Another approach, which would seem to side step these difficulties, is to use site types such as rock art sites, or camp sites in which each is defined by the materials present. However, even in this situation it is necessary to specify the criteria for each site type.

For example, what is the definition of a camp site? Is it a minimum of one artefact per 100sqm or 10,000sqm? What is the reason for choosing one or the other? Is an art site each single rock face with a painting on it, or is it an entire valley with numerous painted rock faces?

In my view, an archaeological site is a place arbitrarily designated as such by the observer (see also Hope 1984:130). It takes on meaning from its description and data. The validity of each site and its size needs to be determined on its own merits according to the observer. It is the details recorded and the criteria used to determine the boundaries which make a "site" comprehensible to someone else. This is to some degree included in the approach by Plog and others (1978) by referring to "cultural materials of sufficient quality and quantity to allow inferences about human behaviour at that location".

The main source of confusion seems to be the distinction between a site, which is the unit of observation, and what may be called an "archaeological occupation". I consider an occupation to be a unit of past behaviour on the landscape. This often is the main objective of a survey, and must be inferred from sites which are the units of observation. An occupation may be a 20km valley bottom where there was frequent camping, or an isolated 10m x 10m single event workshop area at a stone material outcrop. The way in which an occupation is documented by "sites" depends upon the circumstances of sampling, coverage conditions and analytical requirements. Unambiguous examples of a particular site representing a single and complete hunter-gatherer settlement appear to be rare.

If a "site" is the basic unit of observation then its arbitrary nature must be recognised. The best approach to this seems to be to make explicit the criteria used for recognising the site and in determining the boundaries (as discussed below under site dimensions).

Survey results often are in terms of site frequency. Depending on the criteria used, and manner of site definition, the same survey may produce a body of data with relatively few sites, many of them very large, or many separate small sites. Thus for the purposes of analysis it may be desirable to combine a series of sites found in exposures along a creek bank into a single larger site, so as to be comparable with other sites in the analysis. For some types of surveys this might require the concept of a site complex or precinct. In this project, I was mostly concerned to work out the type of artefact assemblages associated with physiographic types, rather than identify total occupations on the landscape.

Another option is the "non-site" approach. This has been used to define artefactual patterning when there is little distinct clustering or few places which seem to be domestic occupations, although isolated finds indicating other activities may be abundant (Thomas 1975, Doelle 1977:202-3). In this situation the sample unit may be used for analysis instead of the conventional site.

A non-site technique also was used by Foley (1977) to construct artefact density contours as an indication of home range. Unfortunately, this study failed to quantify the effective coverage. The areas of greatest artefact density therefore may have been largely the zones with the best exposure and visibility. Foley also did not account for the effect of proximity of stone sources. Artefact density would be expected to increase in the vicinity of a stone source, and diminish further away.

Non-site methodology merits further investigation. Its greatest potential probably is where formal sample strategies can be set up to address specific research questions. I did not use it in this project because of my more general aims and the need to quickly and easily identify structurally associated artefact assemblages in variable sized sample units.

During my survey of the sample units, sites were defined in terms of their boundaries, and as a surface deposit containing cultural materials with analytical potential. This does not satisfactorily cover Aboriginal rock paintings or scarred trees, but these forms of cultural remains were outside of the main interest of the thesis. The "deposit" concept made it easy in the field to specify the size of the site, the criteria for the boundaries, the effective coverage, the formational features, and the cultural contents.

Isolated finds were recorded when I could not conceptually reconcile them as a coherent deposit. Later, some areas of "isolated finds" were made into sites, and other sites were relegated as isolated finds for the sake of consistency in analysis. There also were cases of separately recorded sites being merged into a single site. Such data manipulation required the recording of site boundary criteria.

Site Recording Principles

Site recording is a sampling process at a detailed level (Binford 1964, Schiffer et al. 1978), and the rules applying to systemisation, formalisation and representativeness for sites are the same as those already described for regional sampling.

Part of the sampling process is to decide upon the data categories needed: what things should be recorded and in what way? Why are they meaningful?

An important way to discover meaning is through analysis. However, the potential of site data to be used in analysis depends upon how the analytical concepts are perceived by the site recorder. By analytical concepts I mean what is being measured by site data. These concepts may not always be explicitly identified, but have been addressed in various ways. In the following I will outline the main concepts used to record sites during the survey, and refer to some of the techniques used.

1. **Site dimensions:** The number of sites and their sizes are basic units for comparing survey results. This can be a questionable approach if sites and their boundaries are determined on the basis of different criteria. For example, is an area with multiple exposures of the same deposit a single large camp site or numerous small camp sites? The implications vary considerably.

The concept of site dimensions I have used is to make explicit the criteria for the length-width measurements of a site. There seem to be only four fundamentally different criteria which may be used to define a site boundary: exposure, physiography, cultural patterning and arbitrary decisions. Exposure may include erosional features such as the edge of a blow out or a scald. Physiographic characteristics may be used such as a ridge top or a flood plain. Cultural criteria may be found in the case of an appreciable concentration of flaked stone, or a midden deposit. Arbitrary boundaries such as a fence line or a gully can be used to define the edge of a site. The minimum number of flakes per square metre approach, which was not used in this project, is a combination of arbitrary and cultural criteria. During the survey the criteria for the boundaries of each site was noted, and a particular site could have multiple criteria.

2. **Site Structure:** Site structure is the subdivision of a site into smaller parts. This may be for the purpose of identifying specific activity areas, or other internal differences (Binford 1964). These subdivisions may correspond to features, activity areas, or undisturbed deposits. Formational factors also may be significant if some parts of a site are more severely eroded than others. In addition, a large site may be subdivided arbitrarily for detailed recording.

During the survey, site structure was designated by zones, each with its own dimensions and criteria. This was done by the use of wire rods with attached flagging. Such markers or flags were inserted in the ground at artifact locations or at features to indicate the patterning of the site (Reher 1977:14). Later in the analysis of the artefacts, particular zones could be chosen as being representative

of the site. For example, badly eroded zones were avoided, and workshop features were included selectively.

3. **Archaeological Features:** An archaeological feature is a non-portable artefact. It is a reference point for particular activities or represents a cultural facility (Binford 1964:165). For example, the rocks used as heat retainers in a hearth, or the debitage of a workshop floor, identify an activity which occurred at a specific place, and gives additional meaning to other associated artefacts.

The concept of a feature can be powerful for the interpretation of a particular site. Features also may be compared among sites. In the case of this survey, features such as heat retainer hearths and stone flaking workshops were recorded individually, and their contents noted.

4. **Cultural Attributes.** Cultural attributes are selected items which are either present or absent on a site. These may be to indicate chronology, ethnicity, or activities. The presence/absence approach is an easy way to determine site types, classify them, or make correlations with other aspects, such as environmental features.

During the survey the site recording was as quantitative as possible. Later however, at a general level of analysis, sometimes only certain attributes were used, such as the numbers of sites having backed blades, grinding stones or hearths in order to discuss general patterns.

5. **Archaeological Assemblages.** An assemblage is a population of items from a particular location that is adequate for statistical analysis and provides a quantified statement of site contents (See Clarke 1968: 245-6). Although there may be a special interest in scarce articles, such as ground edge hatchets, it is the more numerous if less attractive items which are the most available for analysis.

During the survey discontinuous variables (e.g. stone material types, artefact morphology) were recorded for all sites, and their quantity and proportions assessed. On selected sites continuous variables (e.g. artefact measurements) also were recorded. The measurement of debitage length was speeded up by using a gauge in 5mm or 10mm units and recording length classes. Implements were measured in three dimensions, and sketches were made to accompany the descriptions. A special problem was the taxonomy and classification of artefacts (Clarke 1968:162-5). This is discussed in detail later in this chapter.

6. **Site Coverage.** The conditions of site coverage greatly affect what can be recorded on a site. Although the biases due to coverage factors are widely recognised (Ammerman and Feldman 1974, Foard 1978:362, Shiffer et al. 1978:6, Butzer 1982:260), it remains a vexing problem.

Site coverage for sites was treated in the same way as for the sample units. Data on percentage area covered, exposure, visibility, sedimentation, disturbance, and background were noted. This was so that the site size derived from the site dimensions measurements could be translated into an effective area for the site. This was needed to assess the completeness of the site data and the density of the artefacts present.

7. **Physiographic Situation.** The physiographic situation of an archaeological site is the topographic unit or land form which is within the site boundaries. It is an important consideration in decision-making for Aboriginal settlements (Peterson 1973, Tindale 1972:244). It includes implications for microclimate, such as camp sites being placed to avoid cold air drainage or to catch the morning sun where early warm air masses develop (Vinnicombe 1984:111), as well as access to resources such as water.

Site situations were recorded during the survey using two systems. One was to use what seemed to be an appropriate physiographic term (e.g. ridge or flood plain), and the other was to describe the land surface generally, such as "flat", or "slope". The result should be regularities in what parts of a land system unit were used.

8. **Environmental Association:** An environmental association consists of the environmental types which are next to a site location. One of the most common assumptions about settlement location is that they are placed as close to important resources as possible (Silberbauer 1972:300, Gumerman 1971) This has led to studies of site environment as a means of inferring land use (Judge, et al. 1975).

The environmental features associated with the sites on the survey were recorded as the physiography and vegetation to be seen to the north, south, east and west of the site. This was later useful to check that the site belonged to the appropriate land system unit.

There were other analytical concepts that were considered in the course of this project. One of these is that of site formation. This includes the processes which cause the site to look the way it does. Formation processes begin with the human activities which

create the cultural deposit, and the various natural processes which protect or disturb it (Schiffer and Rathje 1973, Schiffer 1972). In this project, the formational processes were considered more in the context of the coverage analysis, than in detail for each site.

Another concept is that of the environmental setting, also called catchment analysis (Foley 1977, Vita-Finzi and Higgs 1970, Jarman 1972, Roper 1979). In this project the land systems were used to account for the environment of the potential foraging radius.

Analytical and Summary Site Recording

Analytical site recording is the process of obtaining data for the analysis of a particular site according to certain analytical concepts (Witter 1979:45-7). It means using theory-based analytical concepts to acquire detailed data about the site. Analytical site recording therefore is not merely detailed recording, but it needs to be guided by some body of theory about the meaning of stone artefact assemblages or environmental associations.

This process further assumes that the data recorded for one site is comparable with another (see Rouse 1973). For example, site data which fails to account for the artefact assemblages, site coverage or environment loses in comparability with sites which include all these aspects.

Summary recording is the reaction of the observer to various site characteristics. The recording forms for government registers are of this type (see Flood et al.1989). Even though some are relatively detailed and provide a degree of standardisation, the data categories cannot be said to be theory based.

Comparability and standardisation in site recording however, are not necessarily the same thing. A standardised system is likely to be misleading if the same data category is capable of more than one interpretation. According to Daniels (1978:32) comparability can only be achieved within a single research design.

A broader approach is the systematic use of defined analytical concepts as a form of "middle range theory". In this context, the function of analytical concepts is to control for bias both at the interpretive and observational levels.

Analytical site recording is much more demanding than the more conventional recording technique which mainly provides a summary of observations. This I refer to

as summary recording, and consists mainly of the reactions experienced by an archaeologist who has visited a site, and with a minimum of quantification.

If, however, a great deal of time is spent using various sampling techniques and detailed recording methods on a surface site, one of the advantages of survey is lost: being able to record many sites in a short period of time. During this survey most sites were recorded at a general summary level as well as a few at a more detailed analytical level.

Site Recording Procedures

Once a site was found, the first decision was whether to undertake a detailed analytical or a summary recording process. Not surprisingly, the preferred sites for analytical treatment were those with good exposure and abundant material. The site should have a broad range of variability and be a good example of its type. Sometimes a series of sites were recorded at a summary level first and then selected sites were returned to for analytical recording.

Summary recording usually took about a quarter of an hour to complete, or perhaps an hour for large sites. The first step was to determine the size of the site. In the process of walking over the site to determine the limits of its boundaries, it was usually possible to note most of the contents. Environmental and locational observations could then be made before continuing the survey.

The process of analytical site recording was somewhat more complex, and I will describe it below as a general series of steps:

1. Exploration. My initial questions were: how big is the site and what kinds of things are there? Thus the first task was to determine the site boundaries such as by tying surveyors flagging to vegetation or placing wire flags at the limits of the site. Major characteristics (in situ deposits, hearths, flake clusters) also would be flagged. At this stage, it was usually possible to fill out the part of the form on site type and general characteristics, and commence the site sketch.
2. Site zones. In the course of drawing the sketch the site structure in the form of various zones or features was initially mapped and designated. In this process it was usually convenient to fill in the data on the zones and features, and comment further on the internal patterning of the site or stratigraphic details.
3. Assemblages. My next stage was to decide on how much was to be recorded in detail. For example, if a site was arbitrarily divided into two zones (such as either

side of a creek), only one zone might be treated in detail. Recording concentrations of material could be in a 2 x 2 metre square as though it was a feature. The size of the area to have detailed assemblage recording depended on the quantity and variety of materials. Normally this meant recording in detail over 20 and under 200 items. Within a site all of the implements were recorded. The debitage however might be recorded in detail from only a limited area as representative, and a total quantity estimated for the entire site.

4. On-site environment. In the course of having walked over the site, I usually became aware of the environmental features and it was easy to make the mental shift towards sediments and land forms. This usually meant that the site was covered a third time and gave a chance to note any hearths or implements which had not been previously seen.
6. Off-site environment. When going to the more general observations, the change of scale to the surroundings of the site required another mental adjustment. I usually tried to find a handy vantage point to look at the site setting and associated vegetation. These observations were mainly used as ground-truth for subsequent interpretation from maps.
7. Location. This was usually the most convenient time to mark the location of the site on the map and note any other information which would be needed for the State Sites Register.

The forms for the analytical site recording were designed so that an A-4 page contained four boxes or compartments. Later the form was photocopied and the copies cut into four sections which will fit into a 100 x 150 mm card file box, allowing each of the sections to be filed under a category such as debitage or environment. Thus all of the compartments could be used as index cards and sorted.

The forms were filled out as though they were a "short-answer examination". Thus the headings were specific enough so that the information did not inadvertently get lost as in the "essay" approach to site recording. However, they were not so rigid or terse that they tended to exclude information or unanticipated details as in the "tick-the-box" type of form (Figure 4.1).

STONE ARTEFACT RECORDING

Although most sites were recorded at the summary level, representatives for each land system type were recorded at an analytical level. In the detailed recording of stone

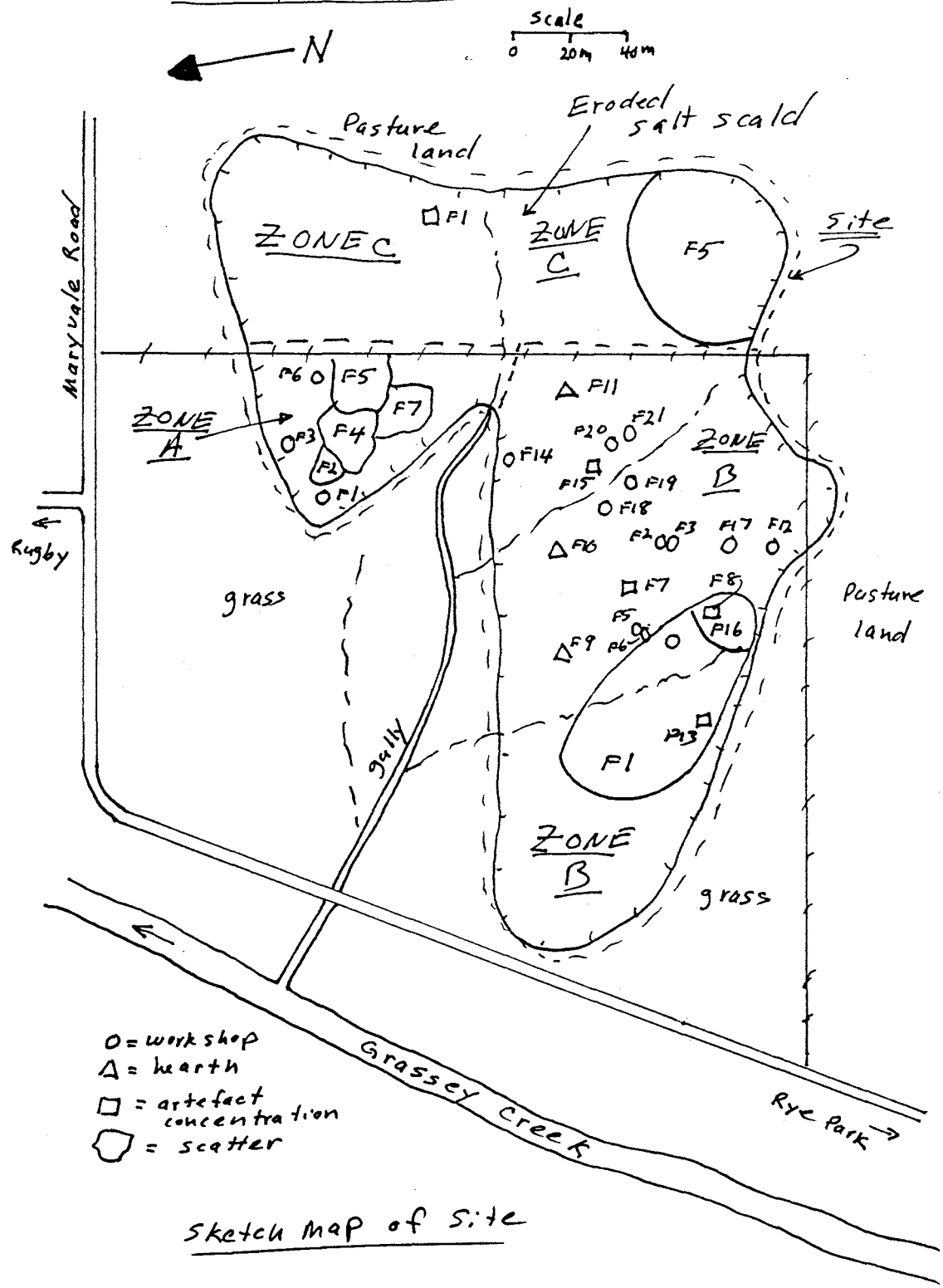
site type	Grassey Creek 3NOV80	B0059	association	Grassey creek	B0059
site type, age, function	Occupation/camp site, microblade technology, Quartz technology, hearths, grindstones and heavy duty tools.		dir.	landform	vegetation
site criteria and boundaries	dimensions 280 x 200 m		X	valley, lower slopes	eroded, mostly bare
Entire site area exposed as a scald, with the road to the north and west, and intact un eroded pasture grasses to the south and west.			O	small basin/valley	pasture.
			N	creek valley	pasture
			E	Ridge	pasture
			S	Ridge	pasture
			W ₁	creek	aquatic veg.
			W ₂	creek	pasture
			NW	Ridge	woodland
preservation	Fair/poor - Areas heavily eroded, but some parts still in situ?				
situation	Grassey creek	B0059	formation	Grassey creek	B0059
landscape type	small valley in steep hilly land with rolling hills and ridges.		exposure and disturbance Spring area - eroded saline scald. caused by clearing and farming according to owner. used to be a wheat field.		
landform type	gently sloping land in a stream valley with a small tributary to Grassey Creek.		visibility 50% of area is eroded scald with 100% vis. Rest is dense grass, 0% vis.		
hydrology	creek with permanent aquatic veg. near by. Site is on an old spring/soak		soil and strat. site has been stripped to the white clay horizon which rests on the partly exposed gravelly red and yellow clay deposits. Remnants of less eroded sediments of a brownish sandy clay to the south and east.		

Figure 4.1. Sample of site recording forms.

zone/feat.		Grassey Creek			B00-59	tool drawing	Grassey Creek			B00-59				
Z/F	size	type, description												
Z A	60x90m	edge of scald, fence to east, gully to south (Arbitrary area)												
Z A F1	2x2m	Felsite workshop (scattered)												
Z A F2	10x10m	Quartz scatter												
Z A F3	1x1m	Felsite workshop												
Z A F4	20x20m	Artefact scatter												
Z A F5	20x20m	Artefact scatter												
Z A F6	1x1m	Felsite workshop												
Z A F7	20x20m	Felsite scatter												
tools		Grassey Creek: Z B, F1			B00-59	debitage		Grassey Creek			B00-59			
type	material	L	W	T	description	no	Z	B	F	7	sample size 3x3m	material	Felsite	
BB Triang.	Felsite	28?	24	5	Prob. finished, break on corner	1	LC	FP col	FP prx	BP upl	BP prx	distal	laminar	amorph
BB Trap?	Felsite	(25)	23	7	Broken	2	m							
Flake Tool	Felsite	54	26	9	Patination: 2+ time periods of retouch?	3	d							
Flake Tool	Silcrete	24	19	7	light retouch on heavy use wear	4	1							
Convex FT	Quartz	38	32	12	convex scald retouch	5	2							
core	Quartzite?	91	56	39	step retouch and wear - core tool	6	3							
							4							
							5							
							6							

Figure 4.1 Sample of site recording forms, continued.

Grassey Creek site



- O = workshop
- Δ = hearth
- = artefact concentration
- = scatter

Sketch map of site

Figure 4.1 Sample of site recording forms, continued.

artefacts it was hoped to account for the factors due to manufacturing processes and the transport of stone in order that functional characteristics could be recognised.

Preliminary analyses of artefacts after each field trip was carried out so as to improve successive observations. Most of the detailed artefact recording was done in the field, but some collections were made as a back up.

There are a variety of attributes which may be recorded for stone artefacts (Hiscock 1989, Wright 1983). Since I needed to compare assemblages among the three sample areas, I wanted my data to reflect relatively universal characteristics, rather than details peculiar to the region.

The implements (i.e. worked pieces such as cores, flake tools, backed blades, etc.) were recorded as to form/type, types of retouch, and size (length, width and thickness). The debitage (flakes and block fractured fragments) was recorded according to platform type, length class and breakage. These features were intended to indicate the degree of flaking precision and curation of artefacts.

All sites in the survey have a sample area prescript such as Tib = Tibooburra, Cob = Cobar and Boo = Boorowa. The number following is the site number. In another letter comes next, it indicates a zone designated within the site. This may be followed by another number which represents a feature within the zone such as a workshop or hearth. If features are recorded in a site which is not divided into zones the feature number is separated from the site number by a dash.

Reduction Chart

In the course of the survey it became clear that there were considerable differences in artefacts along the great transect. Some of these differences could be accounted for typologically, such as the presence of tulas, pirris or bondi points. However, the conventional typological system for the Core and Flake Tool Industry seemed to be inadequate to describe the variation encountered.

For the analysis I needed a system which would evaluate the influence of raw material, stage of reduction and function of artefact assemblages which were mainly from core and flake tool production. I also needed to have a comprehensive system which applied to flake tools, cores and all of the different industries.

Several approaches were tried, such as making graphs of conventional tool types or sizes derived from multiplying the length, width and thickness. It was difficult to tell from these graphs what was being measured. It was not clear which details were due to

function, technology or regional ethnicity. This very much undermined any attempt to assess land use strategies.

As a result, I took a fresh tack, and began by assuming that technology is needed to produce every stone implement. If I could account for this dimension alone, I could better assess the functional or regional ethnic aspects. This meant asking the question: what are the main processes which occur in stone artefact reduction? The most basic seemed to be that as a piece of stone is worked, it becomes smaller, and that the cross section changes. These processes have been described in detail in Chapter 3 for the Core and Flake Tool Industry. Since the fundamental rule in working stone is that small thin pieces are struck away from large thick pieces, this could be measured by looking at the relative thickness of the pieces.

Going from these first principles, I developed what I call a Reduction Chart (Figure 4.2). The objective of the Reduction Chart is to indicate relative cross section and size, since these change simultaneously during the flaking process. Artefact morphology also can be represented (as shown in Chapters 5, 6, and 7), and a technological classification was developed to measure how one form changed into another.

The Reduction Chart in Figure 4.2 shows the vertical axis to be the thickness measure, and the horizontal axis is the length times width. The square root of this relationship is used to avoid curved exponential effects (Pardoe, pers. com.). The artefacts are plotted as a scattergram. The principle of this measure is similar to Pagan's "flake index" (Hiscock 1979).

A number of features of the Reduction Chart are explained in Figure 4.2. Firstly, the thickness measurement is never greater than the width, and the width is never greater than the length. If all are identical they would form a line 45 degrees at the origin between the two axes. Therefore the top sector of the graph is always empty.

The processes indicated by positions of artefacts on the Reduction Chart were determined by plotting artefacts at different stages of reduction. Replication trials also were measured and plotted for confirmation.

The Reduction Chart in Figure 4.2 is marked off by two dashed lines, one at about 5gm and the other at about 100gm. These lines were determined by trial and error and would vary depending on the specific gravity of the stone. The significance of the 100gm line is that it is roughly at the inertial threshold in core reduction and is effective in heavy duty tool use. Above this mass most pieces of stone may readily produce large flakes, and any stone artefact is a potential core. Items which are smaller than five grams

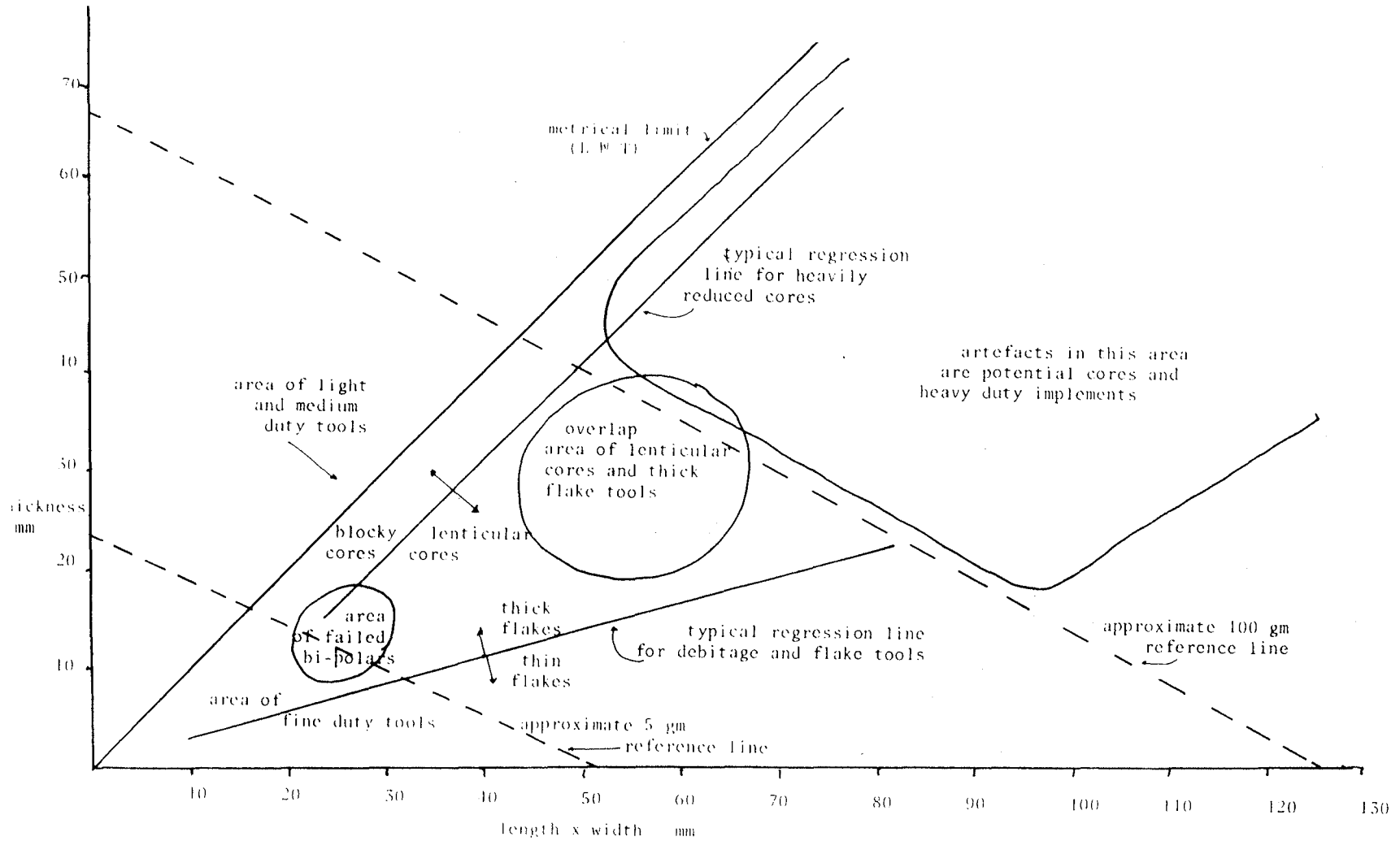


Figure 4.2. Layout of the Reduction Chart.

however, are not readily reducible except by bipolar techniques. This class includes the fine duty implements such as "thumbnails". The zone in between contains medium duty flake tools and the smaller class of cores.

In Figure 4.2 two regression lines are shown. Both were fitted by eye and show the trends taken by flake tools and cores. Cores form a steeper line due to their relative thickness, whereas flake tools have a more gradual line. Cores and flake tools converge with each other just before the 5gm line. At this size a core is usually too small to be a source of a flake large enough to use unless it is split by the bipolar technique.

There is also a gap between the two lines which increases towards the 100gm line. The artefacts which fall into this area include cores with lenticular cross sections have acute platform angles and are the easiest to flake. If discarded at an early stage of reduction, such cores can overlap on the Reduction Chart with large flake tools which have been heavily reduced and have a thick cross section. These often have cusped retouch ("denticulation" or "notches").

The general reduction process as represented by the Reduction Chart is shown in Figure 4.3. This shows the change in core cross section up to the line called the "metrical limit", and the regression line of approximately 45 degrees it then follows until it is split as a bipolar core. The flake tools are shown as having a constant thickness as they go through different stages of retouch. The larger, thicker flake tools can progress through to the cusped retouch stage, but the smallest and thinnest ones can only acquire scalar retouch in the marginal contraction process.

Apart from the overlapping described above, the Reduction Chart provides a consistent way to classify cores and flake tools. The degree of reduction is indicated by the types of retouch and position relative to the regression lines. The Reduction Chart was based on silcrete which is extremely widespread, and in many regions the most common flakeable stone. Allowances should be made therefore for assemblages of tougher material such as quartz or more brittle materials such as felsite. It should be noted that the Reduction Chart is only intended to serve as a visual representation of assemblages, and not as a statistical technique. Although it can be used to plot debitage, in this thesis it was used on implements only.

The Reduction Charts presented in this thesis were done with MacIntosh software, and the format is shown in Figure 4.4. The implement categories shown in the key will be explained later in this Chapter under the stone artefact classification section. In the Reduction Charts for assemblages from the three sample areas the scale on the vertical and horizontal axes was automatically varied by the soft wear. For this reason, the

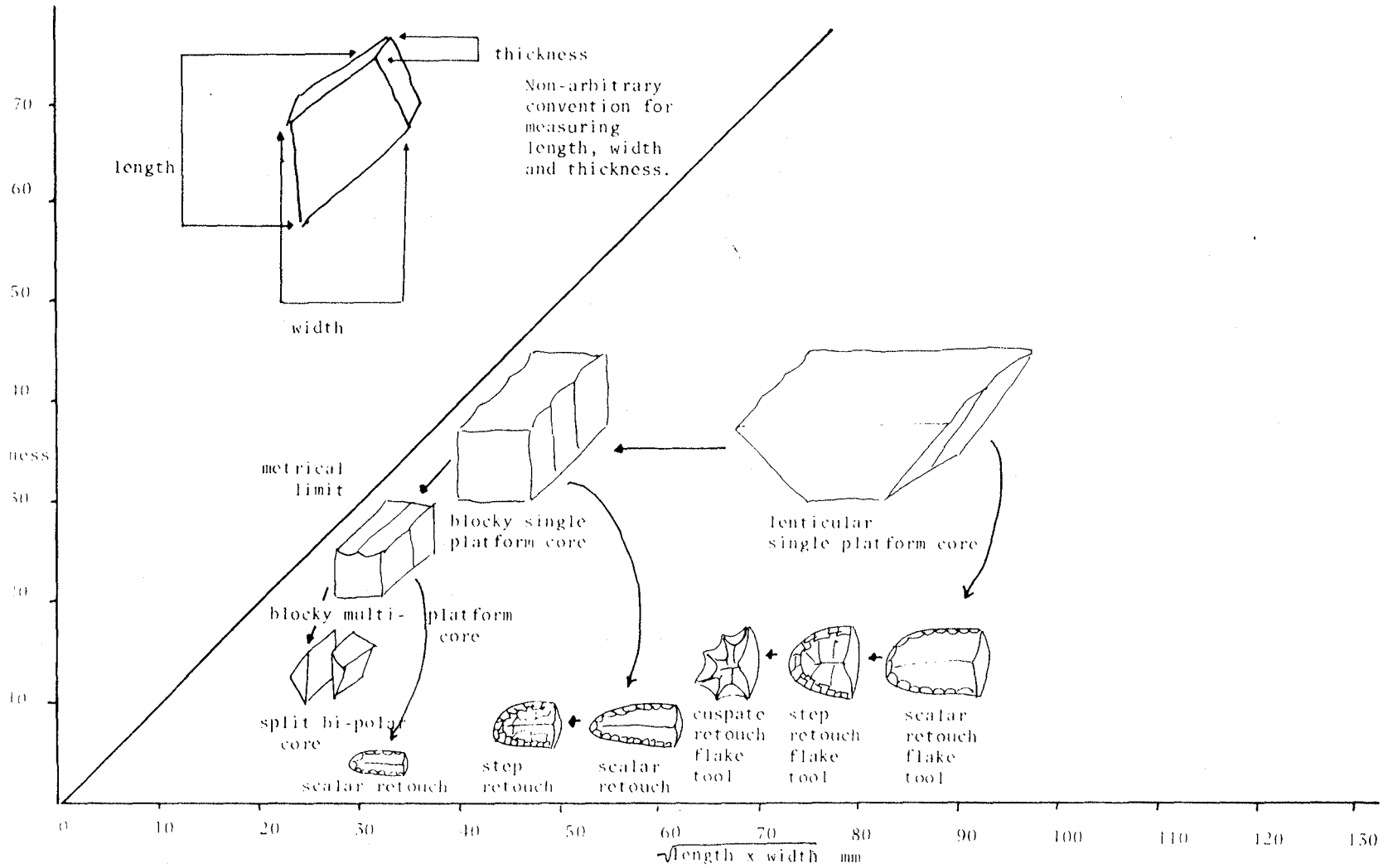


Figure 4.3. Schematic diagram of reduction processes on the Reduction Chart.

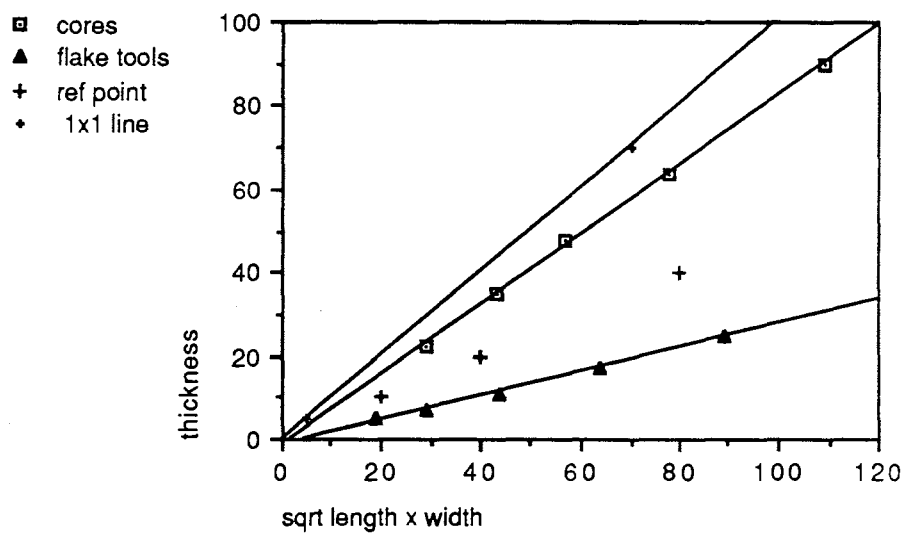


Figure 4.4 Reduction Chart format for the thesis.

"metrical limit" on Figures 4.2 and 4.3, and the "1x1 line" on Figure 4.4 will vary in slope. Therefore, when a regression line was plotted by the software, the slope is only meaningful in respect to the 1x1 line. As a further aid to interpret the Reduction Charts, reference points have been put in. These are crosses plotted at 20 by 10, 40 by 20, and 80 by 40 respectively on the horizontal and vertical axes. These help to compare artefact sizes, and assess the position of regression lines.

A more sophisticated approach with multivariate statistics could have been used to show differences in size, cross section and morphology with better precision and detail (J. Burton, pers. com.). My objective however was to understand different reduction processes and strategies using a quick and simple graphic representation with a minimum of data. I wanted to develop a technique which would be easy to understand and could be readily applied in management archaeology.

Debitage Analysis

Thedebitage recorded during the survey is presented in histogram form. As in the case of the Reduction Chart, a variety of types of analyses were tried to determine a technique which would show technological differences among the assemblages. It was found that a simple stacked histogram ofdebitage types per length class was effective for this. The length classes were recorded in the field as previously described in this chapter. The length classes provide an impression as to the relative sizes and where they peak. Since the size, such as volume or weight, increases geometrically as the length increases arithmetically, the longer flakes are proportionately much larger than the shorter ones. The length classes however are adequate to distinguish thedebitage size on a gross level, provided the distortion is remembered in interpreting thedebitage histograms.

Features ofdebitage morphology were mentioned in the section on flake production and shown in Figure 3.2. Three kinds ofdebitage were recorded in the field: focal platform flakes, broad platform flakes and block fractured fragments. Focal platform flakes were struck close to the edge of the core and tend to show platform preparation and a less pronounced percussion bulb. Broad platform flakes are struck further back from the edge and the platforms may have some over-hang. Percussion bulbs are often prominent. Block fractured fragments are debris which do not show platforms or other indications of a conchoidal fracture. The broad platform flakes are usually produced in a "heavy handed" manner on large cores, where as focal platform flakes are more of a "light touch technique" on small cores. Block fracturing is usually due to characteristics of the material which interfere with the formation of a cone of force. The accelerating

fracture line (flaw propagation) technique however may be used on quartz to avoid the development of a percussion bulb.

Another factor which was recorded was breakage. This was so that the size of whole conchoidal flake would not be confused with the broken ones. Therefore, broken proximal focal platform and broken proximal broad platform flakes were recorded separately. The pieces which were from conchoidal flakes but without a platform were recorded as distal fragments. The block fractured fragments were recorded as "amorphous". If made from quartz, a second type of block fractured category was recognised which was the lamellate. These are flat thin fragments which are the equivalent of precision flaking in quartz.

No effort has been made to distinguish the various industries among the debitage. Thus flakes from the Microblade and the Lamellate Industries are analysed together with those from the Core and Flake Tool Industry unless they came from discrete workshops.

The debitage histograms used in this thesis were generated by MacIntosh software as shown in Figure 4.5. The specimen debitage histogram shown in 4.5A is an example which was recorded in 5mm length classes. All start from 10mm long. Smaller items were considered microdebitage and their recording was too unreliable without using a sieve. Thus Class 1 is 10mm to 14mm, Class 2 is 15mm to 19mm and so on. Note that only the complete debitage give a true indication for length. In order to reduce the variables the distal fragments of conchoidal flakes were lumped with the amorphous as the "remainder". This also included any flat thin block fractured lamellate-like fragments of non-quartz materials.

In some cases the length classes were recorded as 10mm classes, also starting at 10mm. This type of debitage histogram is shown in 4.5A where gaps are left. In these histograms, Class 1 = 10mm to 19mm, Class 3 = 20 to 29mm and so on. This arrangement permits an accurate comparison for the size range. The reason for these differences was that later in the project it was found that 5mm intervals were more informative than those at 10mm.

One of the features of the software is that it adjusts the scale to the data, so that the scale of the vertical and horizontal axis can vary. Thus, in order to compare these graphs it is important to note what the different length classes are.

All of the data on debitage type per length class were calculated as to percent so as to make comparison easier. The number used for the assemblage is shown below the key of types.

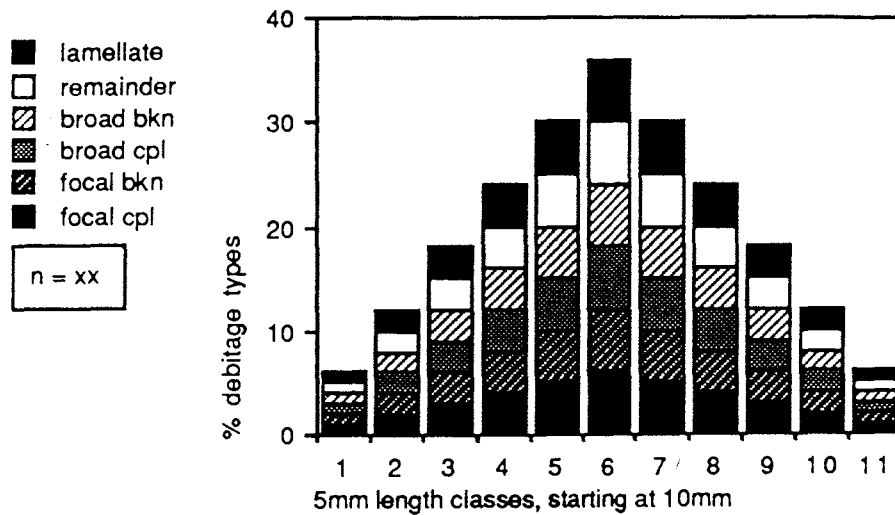


Figure 4.5A Debitage histogram format for 5mm length classes

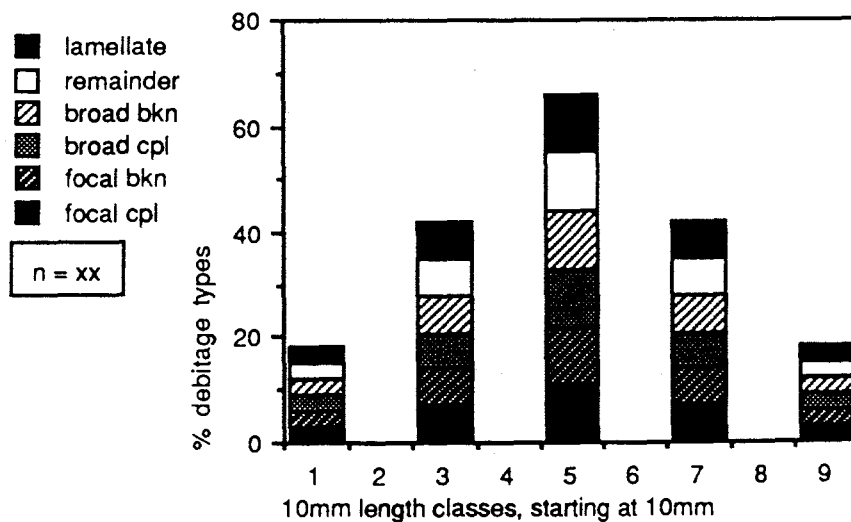


Figure 4.5B Debitage histogram format for 10mm length classes 117

Similarly to the Reduction Chart, I wanted a way to simply and graphically represent debitage from a body of data which required a minimum of time for field recording. Length classes can be carried out very quickly in the field and stacked histograms can be constructed readily.

Stone Artefact Classification

The stone artefact classification was developed for use in the Reduction Chart and was based on the manufacturing processes for the various Industries. It is not a complete classification of Australian artefacts, but designed to account for the technological variability present on the great transect.

This classification has been kept as close to the conventional nomenclature as possible. This saves trying to invent too many new names, and most of the terms should be familiar to Australian archaeologists. The classification differs from the conventional typological systems in that it is primarily concerned to measure technological processes.

Not all sites were fully recorded in respect to this system, since its development was an on-going process during the study. For convenience in plotting the Reduction Charts, some of the categories below were grouped.

The classification is as follows:

I. *DEBITAGE*

These are flaked debris presumed to be discarded at the instant of production, as indicated by the absence of edge modification or wear.

A. *Conchoidal Flakes*: flakes produced with a positive bulb.

1. **Broad Platform Flakes**: These are flakes with a large platform surface. Viewed from the platform end, the body and the rest of the flake is obscured. Usually produced by detaching the flake by striking well in back of the platform.
2. **Focal Platform Flakes**: These are flakes with a small platform surface. When viewed from the platform end, most of the rest of the body of the flake can be seen. Made by striking close to the edge of the platform. Often has had overhang trim.

3. Distal fragments. These are flakes with the platform broken off. They are pieces which may have parts of the bulb, ripple marks, step or hinge terminations or other indications which show that they were originally produced conchoidally.

B. *Block Fractured Fragments*: These are flakes produced without a positive bulb and did not fracture conchoidally. They do not have an identifiable platform and are not distal fragments.

1. Lamellates: These are flat thin block fractured fragments made of quartz. Although they may have been made from a lamellate core, there are other techniques which can produce lamellates (e.g. bipolar).

2. Amorphous: This is the other block fractured category for any type of material.

II. FLAKED IMPLEMENTS

These are flaked objects which have continued in the manufacturing process past the debitage stage. They are indicated by subsequent flake scars, retouch or edge damage.

A. *Core and Flake Tool Industry* (see Chapter 3)

1. Cores: The cores include "nuclear" tools (from cobbles and weathered blocks) which were resharpened with large flakes, as well as producers for flake tools (this includes large flakes which were used as producers). This is because of the difficulty in providing distinguishing criteria under field conditions. The cores were divided as follows:

- a. Unifacial platform core.
- b. Bifacial platform core.
- c. Multiplatform core.
- d. bipolar

2. Flake Tools: These are flakes which have edge damage from use, resharpening retouch and edge rejuvenation. It does not include producer cores made on a flake. In the process of detailed recording the following distinctions were made:

- a. Use-wear/retouch
- b. General flake tools (marginal contraction).
- c. Special flake tools.
* convex

- * microconvex
- * concave
- * projection
- * serrate
- * discoidal
- * burren
- * burin

B. *Lamellate Industry* (see Chapter 3)

Multifaceted Lamellate Core A quartz core which has been flaked by removing corners and facets using an anvil rest. It has a polyhedral shape, which is not due to fracture line acceleration (flaw propagation).

C. *Tula Industry* (see definition in Chapter 3)

1. **Tula Cores:** These are the cores with the convex or "domed" platforms used to produce tula flakes. They have already been described in Chapter 3, and are listed below.
 - a. Macro-flake tula core
 - b. Cobble tula core
 - c. Faceted tula core
2. **Tula Flakes/Slugs:** These are flakes produced from the tula cores. When hafted as an adze they undergo resharpening in various stages until they are discarded as slugs (see Chapter 3).

D. *Microblade Industry* (see Chapter 3)

1. **Blade Cores:** These are cores to produce flakes with standardized cross sections for backing. They have been described earlier in Chapter 3, and are listed below.
 - a. Prismatic conical blade core
 - b. Bipolar blade core
 - c. Burin blade core
 - d. Trenched blade core
 - e. Cube blade core
 - f. Alternating platform blade core

- g. Quartz steep platform blade core
 - h. Quartz faceted bipolar blade core
2. Backed Blades: These are the backed flakes from the blade cores, or some intermediate manufacturing stage. They have been described in detail in Chapter 3 and are listed below:
 - a. Bondi points
 - b. Geometrics
 - c. Backed piece (identification uncertain, broken)

F. *Pirri Industry* (see Chapter 3)

1. Pirri Cores: A large core used to produce a blade blank for a pirri point.
2. Pirri Points: A unifacial point with invasive flaking, or some manufacturing stage of point manufacture.

III. *ABRADED IMPLEMENTS*

These are items which show abrasion by battering, pecking or grinding. The initial stages may have been formed by flaking, such as roughing out a grinding slab, or flaking a hatchet preform.

A. *Percussion Industry* (see Chapter 3)

1. Hammerstone
2. Anvil
3. Hammer/anvil

B. *Grind Stone Industry* (see Chapter 3)

1. Milling Slab
2. Muller
3. Mortar
4. Pestle
5. Whetstone
6. Grind stone fragment

C. *Ground Edge Industry* (see Chapter 3)

Ground edge hatchet

CHAPTER 5

THE TIBOOBURRA AREA

BACKGROUND

The Tibooburra sample area includes the town of Tibooburra and is located in the extreme northwest corner of New South Wales. It is roughly 75km long and 25km broad. Figure 5.1 shows the general location of the Tibooburra Area, and Figures 5.1A and 5.1B give the details of land systems, sample units and sites.

Environment

The landscape is mostly flat open plains with ranges of low hills. The average elevation is about 150m and varies from about 80m at the Bulloo Overflow to about 330m in the Grey Ranges. To the east of the Tibooburra area are the low desert plains of the internally drained Bulloo basin, and to the west is the more arid Strzelecki dune field and Lake Frome basin. The environmental data below is taken from Plumb (1973).

The Tibooburra area is desert, with a mean rainfall of about 180mm, and an average annual temperature of about 20 C. Although overall the rainfall shows a seasonal tendency towards summer, it is highly irregular in the short term. Prolonged droughts are common. The temperature also ranges widely with an average summer maximum of about 36 C. and an average winter minimum of about 5 C., but the extremes can be considerably in excess of these averages. The area is subject to sudden changes in weather and high winds may cause severe dust storms. Heavy rains in hot weather may cause flooding and fill water holes. However, with little seepage and intense evaporation, there is little benefit for most of the vegetation. The less frequent cool light rains which may last for a few days have a proportionately greater effect on the plant and animal life.

The Tibooburra Area is located on an anticlinal uplift which runs on a roughly north-south axis. As a result, Cambrian, Silurian and Cretaceous rocks have been raised and exposed through erosion of the overlying Tertiary sediments. The effect is a landscape of gently undulating plains with ranges and mesas of low to moderate relief. The Paleozoic rocks produce ranges of granite or slate hills, whereas the

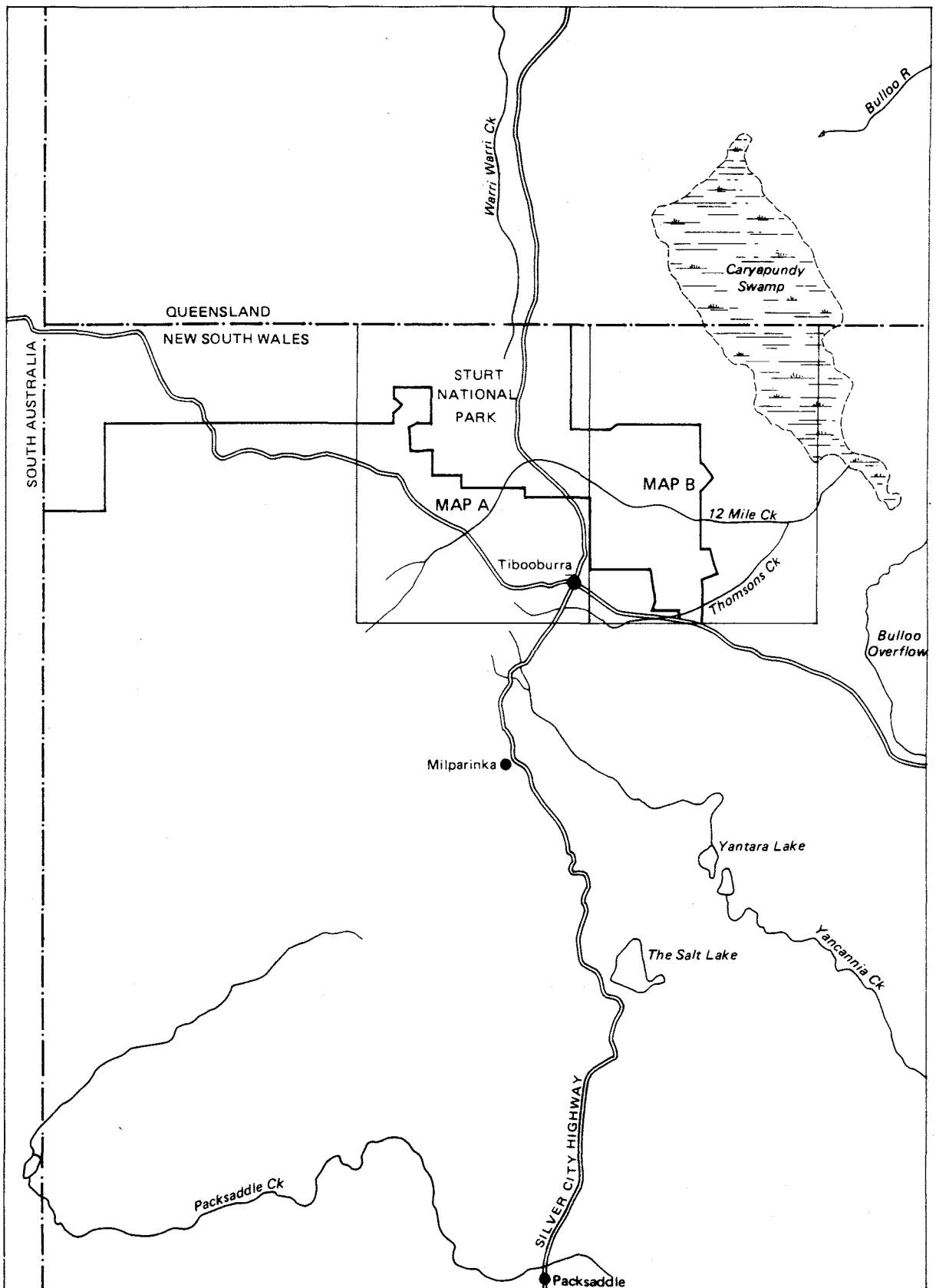


Figure 5.1 Map showing the location of the Tibooburra Area and the positions of Map A (Figure 5.1A) and Map B (Figure 5.1B)!

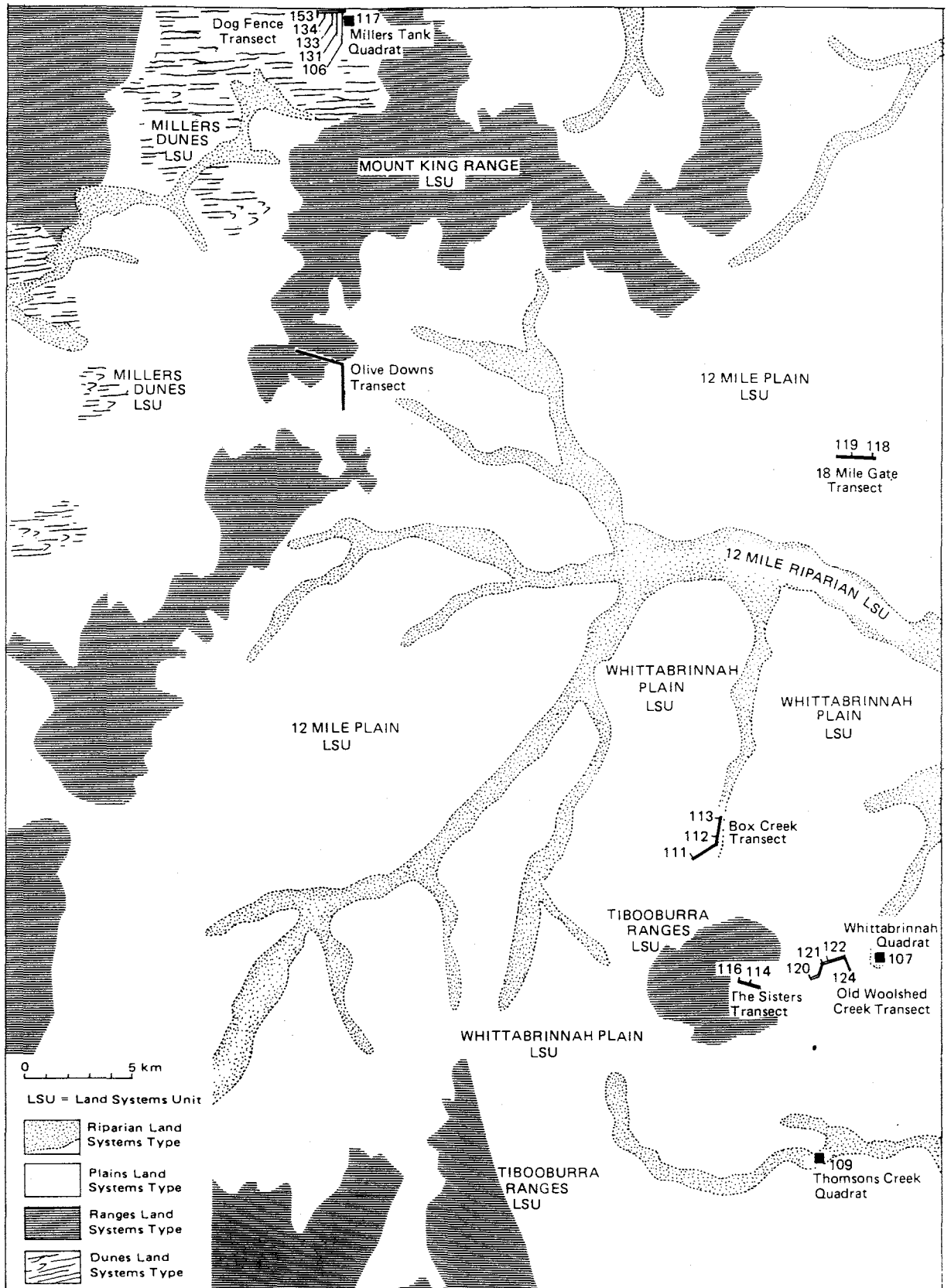


Figure 5.1A Map A of the Tibooburra Area, showing the land systems, units, sample units and sites.

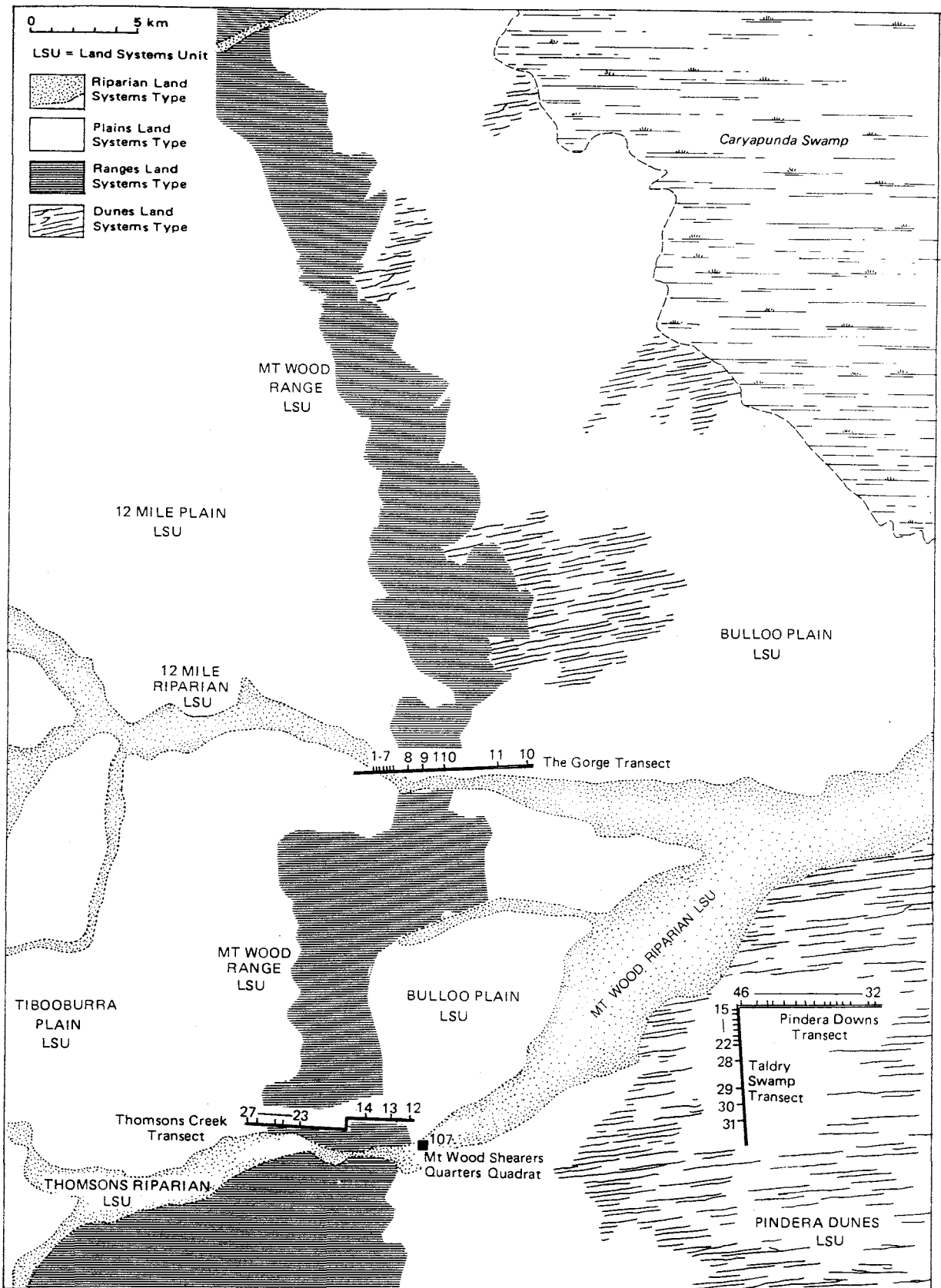


Figure 5.1B Map B of the Tiboorurra Area, showing the land systems units, sample units and sites.

weaker Cretaceous sediments are usually weathered and eroded into plains. The Tertiary deposits are either horizontally bedded and form plains, or where uplifted, produce cuestas and mesas due to the resistant duricrust rocks (silcrete).

The soils are of a few main types. Bare rock and skeletal soils are found associated with outcrops and grade into gibber desert pavement which covers a large part of the plain. This pavement usually overlays a red desert loam, although there are some areas where the pavement is not present. There are extensive areas of sand plains as well as sand hills and longitudinal dunes. The dunes are formed of red sand with a clay core (Wasson 1983).

The vegetation consists of arid shrublands and grasslands. Along the major water courses are riparian woodlands and the plains are mostly covered by a tussock grassland. Under drought conditions these plains appear barren. Tall acacia shrublands are usually found on the hilly and stony terrain with a more varied shrubland in the dune and sand hill country.

Even in such a remote area as this, European land use has altered the environment considerably. The early European settlement was mainly due to gold mining in the late 1800's, and a great deal of the land was heavily cut over in order to obtain fuel for steam-driven equipment and mine shoring. This cutting was continued by the pastoralists to provide fence posts (Gerritsen 1981). Other effects on the vegetation include post-European fire suppression, rabbits, and grazing by sheep and cattle. The present abundance of red kangaroos and emus appears to be due to the establishment of water bores and stock tanks, protection from dingos by the Dog Fence, as well as government control on shooting.

In the Tibooburra area the earliest recorded sightings of Aboriginal people were by Sturt in 1844 when he established base camps at Depot Glen ("Preservation Creek") and Lake Pinaroo (Fort Grey or "The Park"). His encounters with Aborigines were relatively few, and his most frequent remarks were regarding tooth evulsion, circumcision and the generally less fit appearance of the local people compared to those on the Darling River. He also came upon some abandoned camps in the area but does not provide much detailed description (Sturt 1849).

Aboriginal Culture

Various languages seem to have been in use in the Tibooburra area. The area to the east of Tibooburra (around the Buloo Overflow) has been mapped as the Karengapa (Tindale 1974) or as Wongkumara (Beckett 1958, Hercus 1982). The language to the west appears to have been Wadikali (Tindale 1974, Hercus 1982, Beckett 1958), and included what is now the NSW/SA State boundary. The information is somewhat confused depending on whether Mathews (1886-7) is used as a source, or the Aboriginal informant George Dutton (Beckett 1967, Hercus 1982).

There are no ethnographic accounts of the Aboriginal people in the Tibooburra area, but description of the Maljangapa speakers to the south (Beckett 1967, Tindale 1974) is perhaps generally applicable to the region. The social system was divided into matri-moieties made up of totemic matri-clans. Independent of this was a hot and cold wind pair of sodalities which were inherited from the mother. The kin system was of a classificatory type, and the ideal form of marriage was sister exchange. Circumcision was practised but not subincision. Other ceremonies include the Wiljaru. There also are mythological cycles about Gulimugu (a "sky hero"), Eaglehawk and Crow, and the Rainbow Serpent. Most of these details come from the recollections of a single informant, George Dutton (Beckett 1967, Hercus 1982:4).

The European occupation of the area began with a mining boom in 1880 but by 1891 sheep pastoralism became the major industry (Gerritsen 1981). Maintenance of the vermin-proof fence, constructed in 1887, became another economic factor. These processes greatly constrained the Aborigines who eventually had to settle in a permanent camp near the town of Tibooburra, most of whom were Wonkumara. In 1937 the remaining local Aboriginal people were forcibly loaded into trucks and abducted to Brewarrina (Goodall 1982:338). The Aboriginal people now in the region often come from further west and north, but there is no substantial permanent community.

Previous Work

The archaeology is mainly known from the sites recorded by J. Gerritsen and R. and J. Rowlands now in the National Parks and Wildlife Service Site Register, as well as those recorded by Buchan (1974, 1975) during the Moomba Pipeline survey. This last is in summarised report form. There is a brief chapter on Aborigines in a history of the Tibooburra area (Gerritsen 1981:1-5) and an article on some hearths on a

lunette at Lake Yantara which have been dated to 25,000 BP (Dury and Langford-Smith 1970). There is also a report on an Aboriginal dam on the Bulloo Overflow (Rowlands and Rowlands 1969). The only other published materials are comments in the Sturt National Park leaflets and an undated NPWS publication by Haigh and Goldstein. Although the region is within the study areas designated by Allen (1972) and Sullivan (1970), there are no references specific to the Tibooburra area in either of these theses.

Except for Lake Yantara, all of the archaeology known in the area is Late Holocene. It is possible that there may be earlier archaeological deposits in the valley fill of the major streams, but if so, they are not well exposed. The most remarkable site known in the area is the stone arrangement complex near the Bulloo Overflow. The largest single arrangement, which is on the Pindera Downs Nature Reserve, consists of a long stone bordered "path" and various stone rings and piles.

Other types of sites in the area include a rock well, rock engravings, and gidgee trees with a slab of wood removed. There are also numerous quarries. Some are intensively worked, but most are stone source sites of silcrete some of which run for kilometres along a rock outcrop. The most abundant type of sites are various occupation types which may have heat-retainer hearths or stone workshops in them. The most notable formal tool types are pirris, tulas, and various kinds of geometric backed blades. A broad assortment of large sized flake tools is common, and milling equipment is present. There is probably some bias against the more conspicuous formal artifacts, due to the private collecting which previously was common in the area.

ARCHAEOLOGICAL LAND SYSTEMS

For the purposes of sampling the environmental patterning which was briefly sketched above, the Tibooburra Area was divided into land systems types and units as shown in Figure 5.1A and 5.1B. These maps show the Tibooburra Riparian, Ranges, Plains and Dunes Land Systems Types, and indicate the Land Systems Units which are described below. Although the arrangement here was designed specifically for this project, the NSW Soil Conservation Service Land Systems Series Sheet, Milparinka SH54-7 and Urisino SH54-8 were of use.

Tibooburra Riparian Land System Type

The Tibooburra Riparian Land Systems Type consists of the major water courses with woodlands and other vegetation. The flood plain is covered with loose alluvial sand, and exposure is in the form of flood scouring and scalds, as well as braided channels and washouts. This type ranges from broad flood plains and numerous anastomosing channels to a single channel and narrow flood plain. The Archaeological Land System Units within the sample area are as follows:

1. **Mount Wood Valley Riparian Unit.** The Mount Wood Valley Unit is where the main drainage systems of the Tibooburra anticline leave their gorges in the Mt. Wood Range and encounter the Bulloo Plain. When they enter the flat land they branch out and become a broad anastomosing system. The dominant vegetation is a woodland, mainly of red gum (*Eucalyptus camaldulensis*), coolabah (*E. microtheca*) and cooba (*Acacia salicina*) along the channels. Grasses and low chenopods and other shrubs and forbs cover the remaining flood plain. The effect is one of numerous open flats among rows of trees bordering the channels. The water tends to remain in the deeper channels, as well as some of the small shallow channels which are cut into clay rather than sand.
2. **Twelve-Mile Creek Riparian Unit.** This is the main trunk of the drainage system of the Tibooburra anticlinal basin as it discharges into the Bulloo Overflow. It crosses a plain of relatively soft Cretaceous sediments. The flood plain is clayey, broad, and has numerous channels, some of which may be two metres deep. The channels are lined with a woodland of coolabah, red gum and gidgee (*Acacia cambagei*). The long narrow intervening patches of open flood plain carry chenopod shrubs, forbs, grasses and low shrubs. This valley is much like the Mt. Wood Valley, except that it is narrower and there is generally heavier tree cover and a tendency for water to be longer lasting in the channels (especially in the gap through the Mount Wood Range). Associated with these waterholes is a wider and more mesic range of vegetation.
3. **Thomsons Creek Riparian Unit.** The valley of Thomsons Creek is similar to that of Twelve Mile Creek. Even though the catchment area is not as large, it receives a great deal of rapid run-off from the ranges up-stream. The flood plain is sandier, and red gums tend to be the dominant tree, forming a mosaic pattern.

Tibooburra Plains Land System Type

In general the plains were paved with desert-varnished gibber cobbles with grassland as the main vegetation. These plains were often very extensive and are occasionally cut by small water courses with some wooded vegetation. Sand plains also were present. Visibility on the pavements is generally better than 50% and the surface is neither degrading nor aggrading, thus artifacts could have been lying on this surface for tens of thousands of years. The sand plains usually have a veneer of loose drifting sand. Thus, although visibility may be good, the exposure is poor. The units within this type are as follows:

1. Twelve Mile Plain Unit. This is the dominant physiographic feature in the area. It is a broad undulating gibber pavement of silcrete and other gravels to the north of Twelve Mile Creek. Occasionally there are outcrops of Cretaceous sandstone and there is a dendritic network of small stream channels throughout. The area is a vast grassland of Mitchell grass (*Astrebla sp.*). In time of drought it looks barren except for scattered low chenopod shrubs. When there is sufficient rainfall it can be a waving grassland of metre tall tussocks. The plain has a local relief of 20 metres, although due to its vastness and treelessness it looks entirely flat and undifferentiated. Because of the clayey Cretaceous soils, there is poor run-off and considerable surface water remains after a rain. The Mitchell grass responds best to an initial rain for growth followed by a second rain for fruiting. It easily withstands burning, and rain on a burned-over area produces optimal green pick for kangaroos (Ian Denney, pers. com.). Tall Mitchell grass also provides excellent shelter on windy days for kangaroos who use it for cover.
2. Whittabrinna Plain Unit. This is another pavement which slopes evenly from the Tibooburra Ranges towards Twelve Mile Creek. It is crossed by parallel drainage lines and is mostly a gibber pavement over Cretaceous deposits. However, the areas with deeper colluvial or aeolian soils tend to have a heavier cover of low shrubs such as blue brush, salt brush and mulga. The pavement cover is mainly quartz, quartzite and metamorphic cobbles rather than the silcrete gibber stones so common on the Twelve Mile Plains to the north.

3. Tibooburra Plain Unit. This plain is a continuation of the Whittabrinna Plain. It tends, however, to have more colluvial deposits and more shrublands with a greater abundance of quartz in the gibber gravels.
4. Bulloo Plain Unit. This is a combination of gibber and sand plains which gently slopes towards the Bulloo Basin. It is for the most part treeless Mitchell grassland with low chenopod shrubs. Bassias may be common, and some areas may have scattered mulga.

Tibooburra Ranges Land System Type

The ranges include mesas, cuetas and other ridges or groups of hills. Exposure and visibility were optimal throughout most of this landscape. The vegetation is mostly shrub savannah with small areas of open woodland. The ranges differed greatly depending on whether they were capped by Tertiary silcrete or were of granite or metamorphic rock. The Units are as follows:

1. Mount Wood Range Unit. The Mount Wood Range is an extensive system of cuetas capped by Tertiary silcrete and with a relief of about 40 metres. The dip slope is to the east and the surface is usually covered by a gibber pavement which merges with the Bulloo Plain. On the western scarp slope the softer Cretaceous sediments are often exposed. The crests, scarps and water courses frequently have a low woodland of mulga (*Acacia aneura*), gidgee and belah (*Casuarina cristata*) with an understory of grasses, blue bush (*Maireana sp.*), and other shrubs. On the steeper exposed slopes the scattered mulga gives a low savannah effect and the gentle slopes are covered with low shrubs and grasses.
2. Mt. King Range Unit. The Mount King range is also of silcrete, but it is higher and with more mesas. The dip slope is to the west and Cretaceous rocks are exposed on the scarps. There is little woody vegetation on the mesa tops and slopes except for blue bush and salt bush (*Atriplex sp.*). Mulga, gidgee and belah occur in the water courses and valleys along the scarps. The relief of this range is 60m, and higher than the Mount Wood Range. Although there is less tall shrub or small tree vegetation, the low shrub cover is generally thicker.
3. Tibooburra Range Unit. This is an entirely different type of range and is formed of Pre-Cambrian slates and Silurian granites. It is part of the resistant

core of the anticline which has undergone further block faulting. The range is mainly in the form of a cluster of steep but rounded ridges with sharply cut stream valleys. The vegetation is generally sparse on the steep hill slopes and the mulga and blue bush is mainly in the sheltered drainage valleys. The gentle slopes may be covered by the low spiny copperburr (*Bassia sp.*). Due to erosion by rapid run-off, and considerable seepage, this range is the most barren part of the area. However, some of the drainage valleys have mesic pockets with a variety of woody and herbaceous plants, dense vegetative cover and sheltered rock pools.

Tibooburra Dunes Land System Type

Apart from the Strzelecki dune field to the west, the sand dune country is more sand drifts and sand hills with clay pans and temporary ponds rather than well-formed longitudinal dunes alternating with swales. Most of the dune areas are covered with a shrub savanna and the relief is about three metres. The dunes are all composed of loose red sand covering a clayey core. Very few artifacts were found in the loose sand, and sites were mainly discovered where exposed as a lag scatter on the clay pan blow-outs.

1. Pindera Dunes Unit. The Pindera dunes are a region of low aligned dunes which have formed on an old gibber surface. This surface is occasionally visible between the dunes, although the interdunal swales frequently are characterized by small playas. A chain of small swamps and larger playas, presumably along a prior watercourse runs in a northeasterly direction towards Mt. Wood Creek. The dunes are stabilised with a shrubland having stands of mulga, other woody shrubs, occasional clumps of white wood (*Atalaya hemiglauca*), as well as chenopod shrubs and assorted grasses. The interdunal areas may be covered with blue bush, other chenopod shrubs and grasses. The temporary swamps tend to be dominated by cane grass (*Eragrostis australasica*) and lignum (*Muehlenbeckia cunninghamii*).
2. Millers Dunes Unit. This is a pocket of low stable sand hills. It is different from the high parallel dunes to the west which have actively mobile crests and a different flora. On the sandy areas is an open mulga shrubland with forbs, grasses and low shrubs. These are occasionally broken by extensive clay flats which may be covered with Mitchell grass. Some of the areas with thicker sand

deposits provide seepages where they rest on the original clay surface. Elsewhere the sand may thin out and merge with a pavement plain.

FIELD WORK

Work began in the Tibooburra Area from a base at the Mount Wood Shearer's quarters which was made available by the Sturt National Park staff. From the initial excursion it was known that sites would be found readily in the area, and that the chief problem would be access in a large area with few roads. The 1:100,000 topographic maps contained few land marks since the physiographic features were of low relief and not usually sharply defined. This made transects the easiest type of sample unit. Ideally, they would begin at one point, such as where a gully crossed a road and then be walked by the aid of compass to some other distinctive point. However, the most often used procedure was to walk paralleling a fence line. This was usually done keeping at a distance of about 200 metres off of the fence line to minimize the effects of artefact collections which might have been made during the construction of the fence.

Usually a transect which crossed over a particular physiographic type could be walked in a day. In some cases the visibility was so good and the sites so numerous that the transect had to be cut short. Where the sites were too extensive it was often necessary to arbitrarily limit site boundaries within 15 or 25 metres on either side of the transect line in order to reduce otherwise excessive recording time. Had quadrats been used, the number of sample units would have been considerably reduced because of the time taken up in redundant site recording.

In the course of the survey, time was taken to become familiar with the vegetation and landscape, including visits to areas further afield and not sampled such as the Bulloo Overflow and the Strzelecki Dune Field. A rough stratification of the area by physiography was prepared in the field as a basis for the land systems version described above.

During the first visit the sample units were mostly located in the dune country and riparian environments. The second visit (Phase II) included more of the ranges and plains. Two field assistants were present on this second trip and the base was at the Whittabrinna homestead which had recently been acquired by Sturt National Park. This location provided easier access to the western part of the sample area.

SAMPLE PATTERN, COVERAGE AND RESULTS

The results of the sample can be summarised in terms of how well the Land System Types are represented and the frequency of sites in each. The results of this are broadly indicated by the site frequencies and artefact abundance for the various Land System Types.

The Land System Units, sample units and the sites recorded shown in Figures 5.1A and 5.1B. This also is listed in Table 5.1 and the details of the sample sizes and the calculated effective coverage is given.

Effective Coverage

Most of the survey in this area was by transect, and this is summarised by Land Systems Type in Table 5.2A where the sample proportions are shown as metres. The distance for the Plains, Ranges and Dunes Land Systems Types are similar (between 29% to 33%), with the Riparian Type being represented by only 6%. This was because it seemed as though sites were so abundant in this Land System that it needed relatively little survey. This was checked by a few quadrats in riparian situations all of which produced sites and are shown in Table 5.2B.

The effectiveness of the survey as was affected by exposure and visibility also is shown in Tables 5.2A&B. The transect coverage was the most effective in the Ranges and Plains Types (62% and 64%) and least effective for the Riparian and Dunes Types (46% and 39%). This was because the Ranges and Plains Types were mostly degrading or stable surfaces and were little vegetated. The Riparian Type seemed to have considerable fresh alluvium spread over it with exposures mostly as scalds, small channels and washouts. In places there also was considerable vegetation. The Dunes Type was greatly influenced by the proportion of sand which was slightly mobile and would cover occupation sites which might be on the dunes themselves. The sites here were mostly found where there was the blowout and clay pan combination in the swales to leave a lag deposit on the exposed clay.

The overall result of the effectiveness of the transects as shown in Table 5.2A was that the Plains and Ranges Types were the best represented (37% and 34%), followed by the Dunes Type (24%) and finally the Riparian Type (5%).

TIBOOBURRA AREA

SAMPLE SURVEY

land systems by type and unit	sample units: quadrats, transects	dist/area surveyed by sample unit	effective distance/ area	sites recorded by site number
<u>RIPARIAN</u>				
Mt. Wood Valley	shearers Q	1400sqm	1260sqm	108
12 MiCreek	the gorge T box creek T whittabrinna. Q	1800m 920m 11200sqm	656m 582m 450sqm	1, 2, 3, 4, 5, 6, 7 112, 113 107
Thomsons Creek	thomsons cr Q	5000sqm	450sqm	109
total	transects quadrats	2720m 17600sqm	1238m 2160sqm	9 sites 3 sites
<u>PLAINS</u>				
12MilePlain	18 mi gate T olive downs T the gorge T	2000m 2500m 500m	1129m 1150 375m	118, 119
Whittabrina Plain	box creek T old wool shed T	1645m 2150m	1165m 1130m	111 120, 122, 123
Buloo Plain	the gorge T mt wood T	4150m 700m	3308m 525m	10, 11 12
Tibooburra Plain	mt wood T	200m	100m	27, 26
total	transects.	13863m	8882m	12 sites

land systems by type and unit	sample units: quadrats, transects	dist/area surveyed by sample unit	effective distance/area	sites recorded by site number
<u>RANGES</u>				
Mt. Wood Range	the gorge T	2200m	1800sqm	8, 9, 110
Mt. King Range	olive downs T	2500m	1150mm	
Tibooburra Range	the sisters T	1050m	905m	114, 116
total	transects	12950m	8050m	10 sites
<u>DUNES</u>				
Pindera Downs Dunes	pindera downs T	6800m	3035m	32,33,34,35,36, 37,38,39,40,41, 42,43,44,45,46
	taldry swamp T	5500m	1735m	15,16,17,18,19, 21,22 28-31
Millers Tank Dunes	dog fence T	2000m	824m	106,131,133, 154
	millers tank Q	2000sqm	200sqm	117
total	transects quadrats	14300m 2000sqm	5594m 200sqm	31 sites 1 site
<u>TOTAL SAMPLE</u>	transects quadrats	443155m 19600sq m	23764m 6390sqm	62 sites 4 sites

note: T = Transects, Q = Quadrats

Table 5.1 Table listing sample units within the land systems units and the recorded sites. Shown also is the total coverage and the calculated effective coverage (by % of sample unit covered, and effects from exposure and visibility). The sites per sample unit are shown by site number.

EFFECTIVE COVERAGE:		TRANSECTS		TIBOOBURRA AREA	
land system type	total distance l/s type (m)	% total dist. l/s type	effective coverage l/s type (m)	% effective coverage of l/s type	% effective coverage of transect
riparian	2720	6	1238	46	5
plains	13863	32	8882	64	37
ranges	12950	29	8050	62	34
dunes	14300	33	5594	39	24
totals	43833	100	23764	53	100

Table 5.2A. Table showing effective coverage of transects by land systems type.

EFFECTIVE COVERAGE:		QUADRATS		TIBOOBURRA AREA	
land systems type	total area land systems type (sqm)	% total area land systems type	effective coverage l/s (sqm)	% effective coverage of l/s type	% effective coverage of quads
riparian	17600	90	6190	35	97
dunes	2000	10	200	10	3
totals	19600	100	6390	33	100

Table 5.2B. Table showing effective coverage of quadrats by land system type.

Site Frequency

The frequency of sites in the Land Systems Types is shown in Tables 5.3A&B. For the purpose of this analysis some of the sites which were recorded separately during the survey were lumped together as the same site. This was because after considering the biases in exposure, the sites seemed to be part of the same deposit. Thus Table 5.2A&B presents the coverage data as well as the numbers of obtrusive and unobtrusive sites. In the Tibooburra Area survey, the camp sites were considered to be unobtrusive, whereas the quarries were classed as obtrusive. This is because the occupation sites could be readily covered by sediments or vegetation, but the quarries were on outcrops which would not be obscured in this way. The frequency of the two types of sites therefore had to be calculated separately before being merged as a value of metres per site in Table 5.3A. This table shows that sites are the least frequent in the Ranges and Plains Types (roughly 1km between sites), but considerably greater for the Dunes Type (about 200m per site), and finally, the greatest frequency for the Riparian Type (nearly one site per 100m). All of the quadrats were entirely covered by archaeological occupation, and each comprises a "site" (Table 5.3B).

The representation of sites in the Riparian Land Systems Type turned out to be as expected. Whenever the riparian environment was encountered, sites were found and it is likely that occupation within this Land System is effectively continuous along the entire section of most water courses.

The chief surprise was the Dunes Type. A large proportion of this Land System was surveyed, and even though the effective coverage was relatively low, it is clear that there is a high frequency of sites in the sand dune areas.

The Plains Type which look as though they would produce no sites at all, revealed a thinly scattered occupation. This is probably because the plains are not as flat and undifferentiated as they at first appeared. There are in fact various hills, water courses and hollows throughout this Land System, and these features have their associated sites.

The Ranges Type, which has extensive areas of dry rugged ridges and mesas that are punctuated by occasional drainage valleys, were roughly as expected. Sites were present, but at a relatively low frequency.

SITE FREQUENCY:		TRANSECTS		TIBOOBURRA AREA	
land system type	number of obtrusive sites	number of unobtrus sites	distance per obtrus site (m)	distance per unobtrus site (m)	total dist per site by l/s type (m)
riparian	-	9	-	138	138
plains	2	10	6931	888	880
ranges	3	7	4317	1150	1146
dunes	-	31	-	180	180
total	5	57	11248	417	390

Table 5.3A. Table showing the total transect distance per obtrusive and unobtrusive sites by land system type. Note: distance per obtrusive site / distance unobtrusive site - distance unobtrusive site = total distance per site by land system.

SITE FREQUENCY:		QUADRATS		TIBOOBURRA AREA	
land system type	number of obtrusive sites	number of unobtrusive sites	area of obtrusive sites (sqm)	area of unobtrus sites (sqm)	% area of sites in quads
riparian	-	3	-	17600	100
dunes	-	1	-	2000	100
total	-	4	-	19600	-

Table 5.3B. Table showing total quadrat area per obtrusive and unobtrusive sites by land system type.

Site Types

The site types (such as camp sites or quarry sites) are summarised according to Land System Types in Tables 5.4 in which the transect and quadrat data are combined. This includes the percentage of sites having hearths and ground stone present which would suggest economic activities such as seed grinding or food baking. Also given are the percentages of sites with the Microblade/Pirri Industry present to indicate a chronological factor, and workshops, which may imply specialised activities.

It is not surprising that quarry sites would occur in the ranges. Those recorded on the plains indicate that any outcrop is likely to be used. If the Tables on effective coverage are consulted also (Table 5.2A&B), then it may be noted that the dunes produced half of all of the sites, but for about a quarter of the coverage. The riparian land systems comprised 12 sites, also with relatively low effective coverage.

Table 5.4 also shows that the dunes also produced half of the sites with the Microblade or Pirri Industries present well as the ground stone. The ranges, however, had relatively more microblade/pirri artefacts present than might have been expected. The riparian sites also are represented by microblade/pirri artefacts and ground stone.

Artefact Abundance

In Table 5.5 the numbers of backed blades, pirri points and tula slugs are listed. This indicates the distribution of the specialised industries in conventional typological terms. Also shown are the minimum tools per square metre, as well as the means and extremes.

The abundance of implements found on sites was estimated as tools per square metre of effective coverage on the site (see Appendix). The numbers of implements were used as an indicator of artefact abundance rather than debitage, since those sites with great quantities of flakes were estimated rather than counted.

The ranges and dunes emerge as having most of the specialised implements, although the riparian sites show the highest value for all implements per square metre. There was however a single site in the dunes which produced as many backed blades as were found in the entire rest of the survey, as well as a large number of tula slugs (Tib-117, Appendix). The large number of tula slugs among the riparian quadrats also comes mostly from a single site (Tib-108, Appendix).

SITE TYPE:		TIBOOBURRA AREA				
landsystem type	quarry sites	camp sites	microblade /pirri sites	ground stone sites	sites with hearths	sites with workshops
riparian	-	12	5	7	9	1
plains	2	10	1	-	-	1
ranges	3	7	3	1	1	3
dunes	-	32	10	6	4	5
total	5	61	19	14	14	10

Table 5.4 Table showing site types by number and land systems type. Note: total number of sites = 66

STONE TOOL ABUNDANCE:		TIBOOBURRA AREA				
landsystem type	total no. back blades	total no. pirri points	total no. tula slugs	min. tools per sqm	mean tools per sqm	max tools per sqm
riparian	2	2	36	0.004	0.145	0.467
plains	2	-	9	0.005	0.066	0.125
ranges	9	2	14	0.004	0.124	0.686
dunes	47	16	76	0.005	0.114	0.500
total	60	20	135	-	-	-

Table 5.5. Table showing numbers of certain implement forms as well as densities of tools by effective area.

STONE ARTEFACT ANALYSIS

Having discussed the environment and how it was sampled above it is now necessary to examine the artefactual content of the sites. This is by analysis of the assemblages which were recorded in detail. The types of materials available for flaking are first described. Next I consider the Reduction Charts (See Chapter 4) to interpret the variability among the implements, and compare the implement assemblages among various sites. I then turn to the debitage and use the histograms to evaluate the implications of the Reduction Charts.

Materials

In the Tibooburra Area the availability of raw material for stone tool manufacture was from silcrete outcrops of Tertiary duricrust exposed as strike ridges from an anticline roughly centred over Tibooburra and Milparinka. There also are silcrete cobbles from gibber pavements which are colluvially derived from the weathered Tertiary. This silcrete is mostly of coarse grained sand and the silicious cementation is variable. In some areas the silicification has taken place in voids left by Miocene plant roots and other cavities in the soil.

The earlier rocks exposed in the core of the anticline also produce a metamorphosed quartzite which can be flaked. These earlier rocks also have numerous quartz reefs. The quartz and quartzite weathers into gravel and cobbles which form extensive gibber pavements. Sometimes these also are mixed with the silcrete gibber.

One of the features in the middle of the anticline is a massive intrusion of Ordovician granite. This appears to have baked some of the Cambrian sandstone into a black hornfels. Although this stone looks much like basalt, I assume that it is the result of contact metamorphism. Near Tibooburra there is a small quarry of this material where preforms for hatchets were produced.

Implement Assemblages

Two sites were selected for detailed artefact recording to represent typical camp sites based on a watercourse. These are Tib-1, the Gorge Site (Figure 5.1B, located in The Gorge transect) and the Whittabrinna Site, Tib-107 (Figure 5.1A, located in the Whittabrinna quadrat). The environment of these sites is much the same: both belong to the Riparian Land System Type and are exposed on flood scours of major flood

plains. Neither are much associated with the Microblade or Pirri Industries, possibly because the exposures into the deep alluvial fill of the valleys are relatively shallow. Both sites are located adjacent to a gibber plain where there is an abundance of raw material. The Gorge Site also is located within one kilometre of massive silcrete outcrops.

The Reduction Charts for The Gorge (Figure 5.2) and Whittabrinna (Figure 5.3) Sites show a wide range of cores and flake tools. Regression lines have been plotted for the cores for both sites. The Gorge Site has a higher proportion of large cores, but neither indicate cores with thick cross sections. This is because the cores are relatively little reduced. The regression lines for the flake tools on these sites shows that the flake tools are relatively larger and thinner for The Gorge Site. The reference point at 20mm on the vertical axis and 40mm on the horizontal axis can be used to compare the differences in flake tool size and cross section.

These differences seem to be explicable in terms of the stone source. The Gorge Site is near massive outcrops of silcrete and a silcrete quarry (Tib-9). Large cores were brought on to the site and the cores were discarded at an early stage of reduction. The flake tools on The Gorge Site also were disposed of with little resharpening since a supply of large flakes was readily available.

The Whittabrinna Site (Tib-107) is not as close to an outcrop, but near a gibber pavement containing silcrete and quartzite and quartz cobbles. In this case, the stone is not available in such large pieces, and good flaking stone is probably less common. The cores therefore are smaller, and the flake tools tend to be thicker and more resharpened. These two sites will be used as "typical" domestic camp assemblages to compare with the other reduction charts which follow.

The 12 Mile Creek Site (Tib-11) is in a tributary cut into a Plains Land System Type, but next to the boundary of a flood plain in a Riparian Land Systems Type (Figure 5.1B, The Gorge Transect). It also is adjacent to a silcrete outcrop which has been quarried. The Reduction Chart shows that although some flake tools are present, the site is dominated by cores (Figure 5.4). These include thin lenticular forms, especially among the larger examples, as well as heavily worked cores with thick cross sections. In addition to using this place as a camp, it would seem that the major activity was the production of large flakes from cores, presumably for transport as implements elsewhere. A lenticular core would be extracted from the outcrop and flaked until the platform angle became too high, as is indicated by the largest cores in

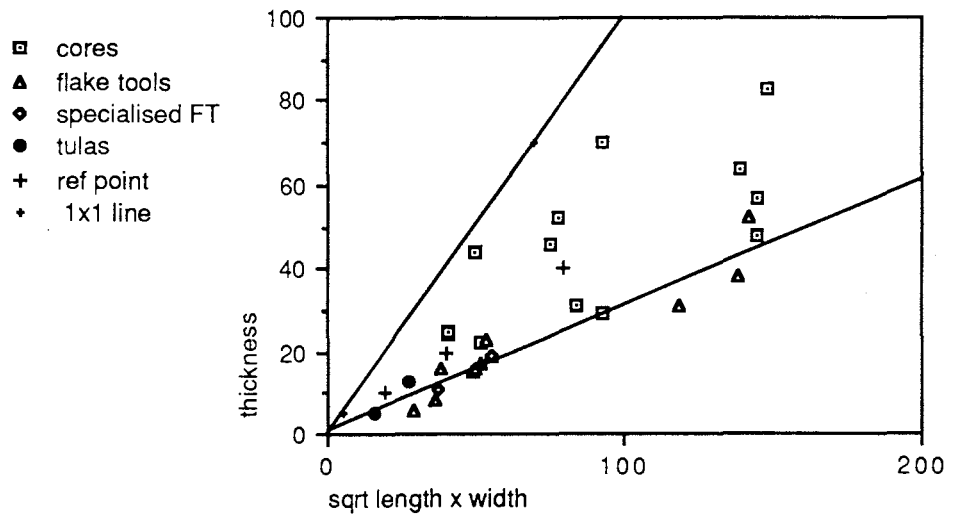


Figure 5.2 Reduction Chart for Tib-1.

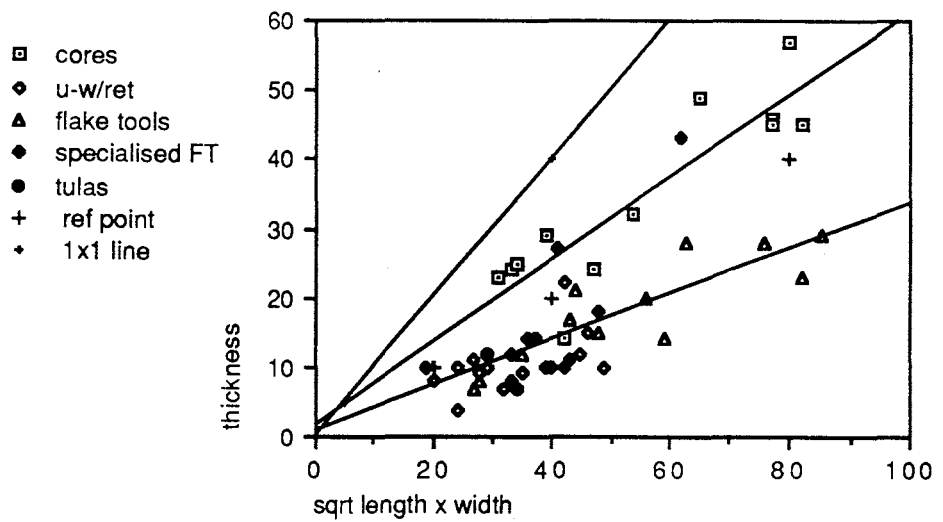


Figure 5.3 Reduction Chart for Tib-107.

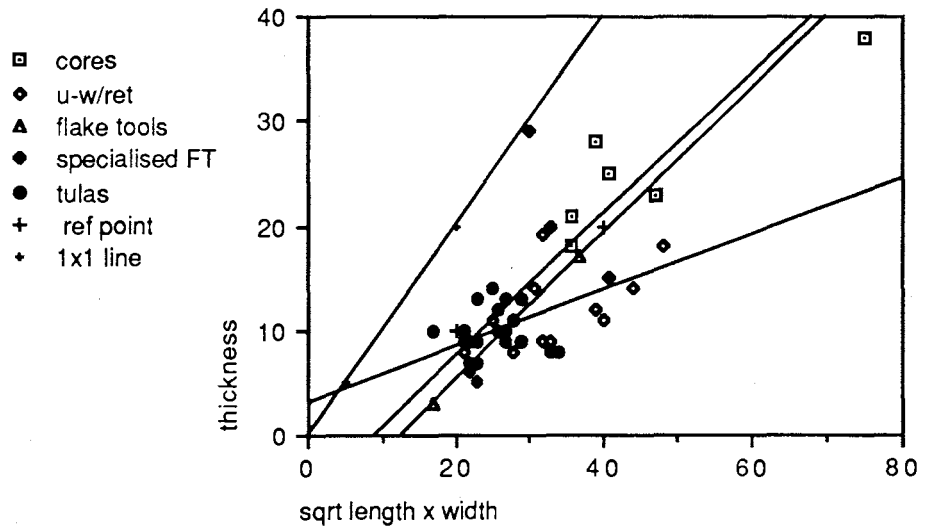


Figure 5.4 Reduction Chart for Tib-108

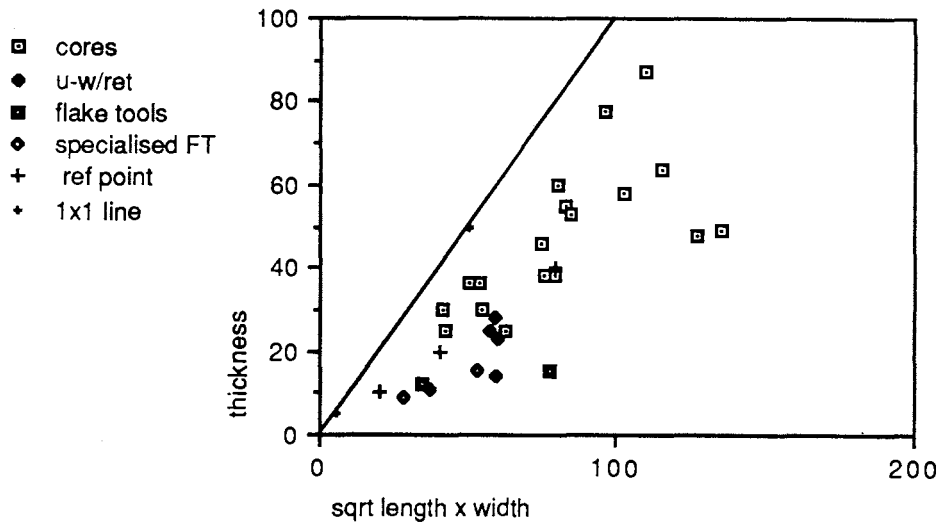


Figure 5.5 Reduction Chart for Tib-11

the Reduction Chart. Such a core might then be discarded, or a new platform found and reduced further. The smaller cores in the Reduction Chart could probably represent the second cycle of reduction. The differences between the Reduction Chart for this site (showing the dominance of cores), and the Gorge and Whittabrinna Sites are attributable to the intensive quarry workshop activities which took place in addition to camping.

Another site located in a Riparian Land System Type is the Tula Site, Tib-108 (Figure 5.1B, Mt Wood Shearers Quarters quadrat). This site was analysed (Figure 5.5) because of the surprising abundance of tula slugs. These are shown in the Reduction Chart as a large cluster which dominate the rest of the assemblage. It also may be seen that the usual range of cores and large implements present in the previous domestic sites is lacking.

It is not clear why such an abundance of tula adzes (which are difficult to make) should have been expended in such quantities when an adequate stone supply was available on the adjacent gibber plain. Regression lines for the flake tools and specialised flake tools have been plotted and both indicate considerable resharpening in addition to that for the tula slugs. The regression line for the flakes with use-wear however have a much lower slope, and indicate that they were selected as thin flakes, and were discarded after the fresh sharp primary edge became dull.

Presumably this site represents a specialised activity area perhaps in respect to tool use, or perhaps in a social context. For example, it might represent a "men's camp" located away from the domestic area in which men usually arrived with hafted tula flakes. Small cores could be obtained nearby as needed.

The Thompsons Creek Site, Tib-109 (Figure 5.1A, Thomsons Creek quadrat) was analysed as an ordinary camp site in the Riparian Land Systems Type, but located in the area of a gibber plain of quartz instead of silcrete. There are two Reduction Charts for this site. Figure 5.6 shows the non-quartz artefacts which are mostly silcrete, but include some quartzite and black hornfels. The pattern here differs considerably from The Gorge and Whittabrinna sites because of its scarcity of flake tools. The Reduction Chart shows a scatter of large lenticular cores and another group close to the 1x1 line between the 40/20 and 80/40 reference lines. This cluster of smaller cores presumably are heavily reduced core tools derived from the larger ones.

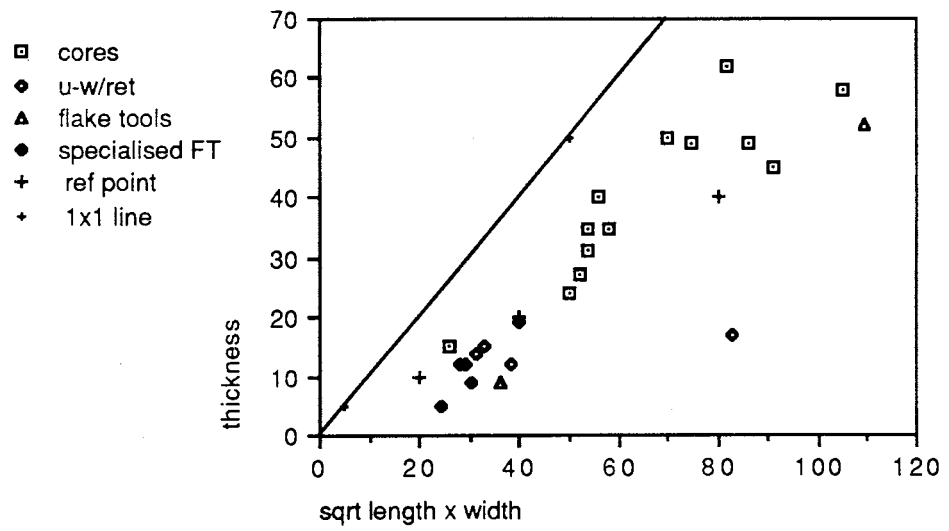


Figure 5.6 Reduction Chart for Tib-109, non-quartz.

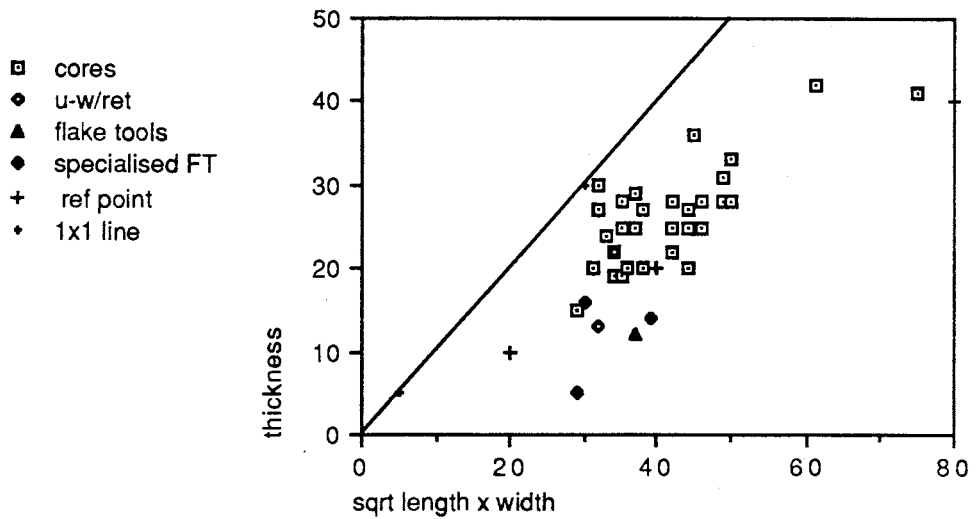


Figure 5.7 Reduction Chart for Tib-109, quartz.

The quartz tools are shown in Figure 5.7. These also are mostly cores, but they cluster at the 40/20 reference point. This is roughly where the flake tools group on The Gorge and Whittabrinna sites. Thus, although a range of large silcrete cores and small flake tools are present, most of the implements were made from quartz pebbles which were picked up near-by, and the notable lack of flake tools was substituted by an abundance of small quartz cores. These were flaked as pebble tools (often bifacially) and used in place of the medium duty flake tools of silcrete. Rather than carry in large amounts of silcrete from elsewhere, the more available quartz pebble tools became the functional equivalent of the more usual large flake tool.

The 18 Mile Gate Site, Tib-118 is located in the Plains Land System Type, and is at least 5 km away from a major stream valley (Figure 5.1A, 18 Mile Gate transect). The plains here are mostly sand and loam, and without the large gibber cobbles common elsewhere. There is no indication of the Microblade or Pirri Industries. Although a few large cores are present, the tool assemblage shown on the Reduction Chart (Figure 5.8) is mostly a variety of flake tools and small cores, similar to the The Gorge and Whittabrinna Sites. The specialised flake tools are prominent, and are plotted on a regression line. In consulting the raw data, these were mostly convex forms and probably represent flakes carried to the site to serve as implements (such as would have been prepared at the 12 Mile Creek Site), and heavily reduced.

The Taldry Dunes Site, Tib-19 is located in the Dunes Land System Type (Figure 5.1B, Taldry Swamp transect). This site is a considerable distance from either gibber cobbles or an outcrop. The Reduction Chart (Figure 5.9) shows that the implements in general are relatively small, the cores are few, and the specialised flake tools are conspicuous. Once again the raw data indicates that these are mostly convex ended forms. This similarity of the Taldry Dunes Site to the 18 Mile Gate Site may be attributed to their distance from main stone sources. A convex edge tends to be the automatic result of repeated resharpening on a flake tool, and would be particularly likely to occur on a hafted implement. Heavy pieces of stone are not prone to be transported long distances, and those which are carried away will become smaller due to regular use or flake production. These sites therefore would be functionally similar to the first sites to be analysed (The Gorge and Whittabrinna Sites), but without the large core component.

Not plotted on a Reduction Chart (because of too few artefacts) is Tib-22 which is located near the Taldry Dunes Site. This was the only site in the dunes with large

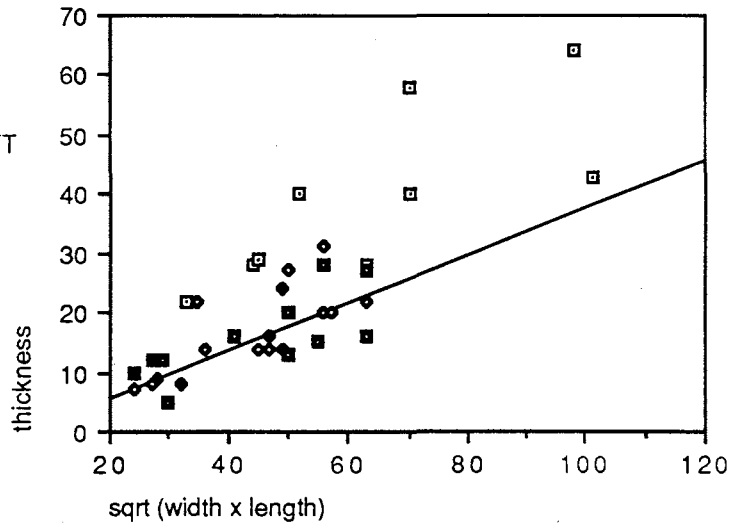


Figure 5.8 Reduction Chart for Tib-118

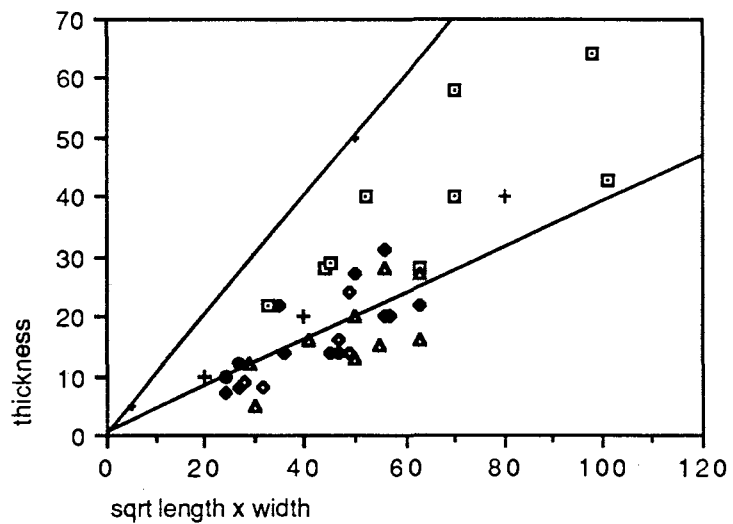


Figure 5.9 Reduction Chart for Tib-19

cores, and may be interpreted as a cache of 4 large cores. Thus in some cases, large cores may be transported away from the source and deposited in a strategic location.

The Mt. Wood Site, Tib-13 is on the edge of a Ranges Land System Type (Figure 5.1B, Mt. Wood transect). It is located at the base of a ridge in a tributary valley near a Plains Land System, and nearly two kilometres from a major drainage belonging to the Riparian Land System. It has been heavily eroded and all of the artefactual debris are resting on a hard clay surface. This site featured a number of microblade workshops, and these and other artefacts from specialised industries are presented together in Figure 5.10. The backed blades form a sloping regression line, showing that the larger ones are thicker, and two blade cores can be seen. The regression line for the tulas is flat because all were of the same thickness, but at different stages of resharpening. The two pirri points also were of the same thickness.

The rest of the Mt Wood Site assemblage is shown in another Reduction Chart (Figure 5.11). This assemblage might be expected to be similar to the residential type to site shown for The Gorge and Whittabrinna Sites. Although some of the cores and flake tools are large sized, the utilitarian tool kit of the Mt. Wood Site is comprised mostly of small implements. This may be seen by comparing the reference point at 40/20 from these sites with the Mt. Wood Site. A regression line has been plotted for the flake tools, and it may be seen that the most of the specialised forms have relatively thin cross sections, perhaps indicating that they are fine duty tools for precision work.

There are no cores with relatively thin cross sections (as indicated by the steep regression line), and therefore all seem to be well reduced. This feature, together with the small sized flake tools would imply considerable distance from a stone source. Consequently it is somewhat surprising that the site is within 500 metres of a massive source of silcrete and a quarry (Site Tib-14).

It would appear that a principal activity at this camp was the manufacture of backed blades, and that little heavy woodworking took place. The stone used for the microblade cores was of a fine grade, unlike the coarse-grained stone source nearby. The explanation for the unexpected characteristics of this site may be attributed to the specific requirements of the Microblade Industry.

The assemblages from the Mt. Wood Site and the Taldry Dunes Site show a similarity in having small sized implements. This in part may be due to a pattern of raw

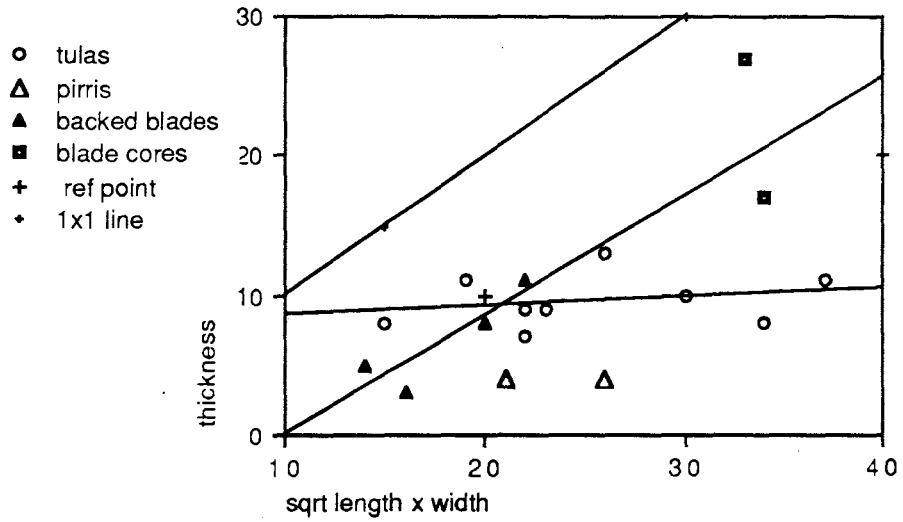


Figure 5.10 Reduction Chart for Tib-13, specialised industries

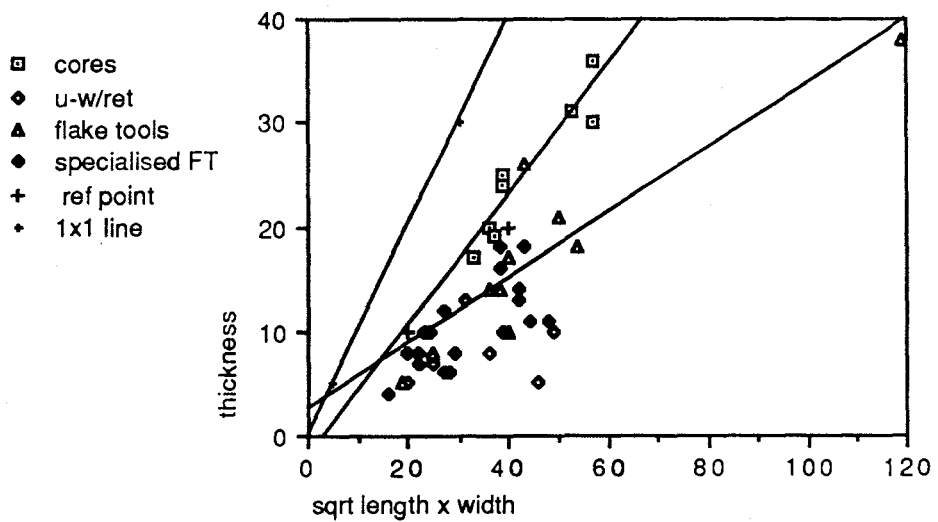


Figure 5.11 Reduction Chart for Tib-13, Core and Flake Tool Industry

material use characteristic of the microblade sites. For example, for these sites the stone material transport, particularly the finer grades, may have been more systematic and less dependent on local sources in order to maintain a supply for backed blade production.

The Sisters Site, Tib-114, was analysed because it was in the Ranges Land System (Figure 5.1A, The Sisters transect) and was dominated by quartz implements. The Reduction Chart (Figure 5.12) shows this site to be largely quartz flake tools with a few cores. The site is in the Tibooburra ranges with quartz reefs providing the most available material. The regression lines for the specialised flake tools (upper line), and the use-wear/retouch flake tools (lower line) both are at a relatively low slope. This site is located next to massive outcrops of relatively homogeneous quartz, and the material would be readily available as large splinters. Under these conditions, the assemblage is what might be expected for an ordinary domestic camp, even though the Reduction Chart is notably different from similar camp sites elsewhere in the Tibooburra area.

Most of the differences among stone tool assemblages in the Tibooburra Area can be attributed to the availability of stone material of different sorts. The variation in flaking properties and distance to a stone source are the main determinants in tool size and shape in most cases. Exceptions to this pattern can be recognised in which there seem to be special functional or chronological factors which result in an anomalous assemblage for the locality.

Debitage Assemblages

The Gorge and Whittabrinna Sites were previously described as having similar environments, stone material availability and tool assemblages. A histogram of the debitage from the Gorge Site (Tib-1 in Figure 5.13) also can be compared with that of the Whittabrinna Site (Tib-107 in Figure 5.14). These graphs do not exactly match because of differences in field recording. Trials were made to determine if 5mm length classes instead of 10mm length classes, and the inclusion of the debitage types of broken platformed flakes demanded an excess of time. However, the length classes are positioned at the same place and comparison is possible. On the debitage histograms the Gorge Site peaks at length class 5 (30mm to 39mm), as does the Whittabrinna Site (30mm to 34mm), But the Whittabrinna Site indicates a more abrupt fall-off after length class 5 than The Gorge Site. In both, the proportions of complete focal and broad platformed flakes to the remainder are roughly equal,

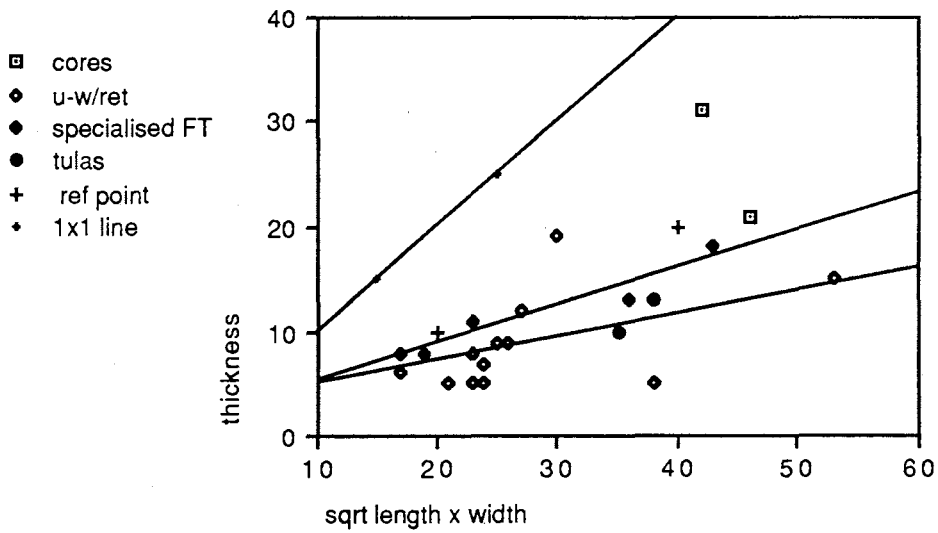


Figure 5.12 Reduction Chart for Tib-114

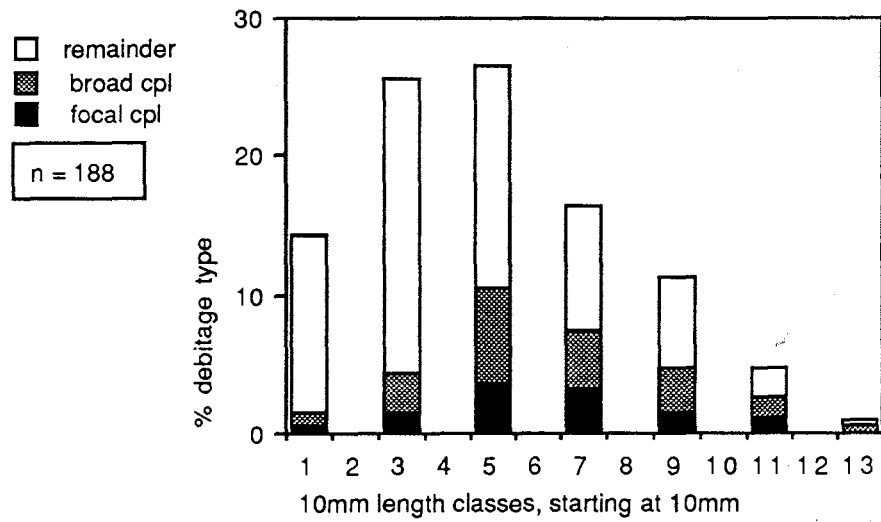


Figure 5.13 Debitage histogram for Tib-1

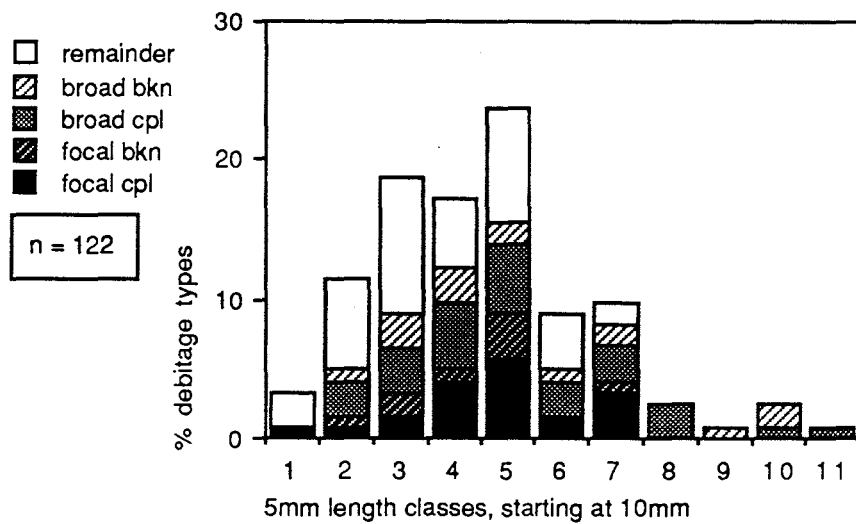


Figure 5.14 Debitage histogram for Tib-107

although there is a tendency for there to be more focal complete flakes in The Gorge Site.

The differences mentioned above are consistent with the differences in stone materials. The Whittabrinna site has no silcrete outcrops nearby which would minimise the presence of large cores on the site to produce large flakes. This larger range of debitage in the Gorge Site is consistent with the component of large cores shown in the Reduction Chart (Figure 5.2) due to the proximity of a massive silcrete source. Both sites are bordered by a gibber plain, but that at the Whittabrinna Site contains less silcrete and more quartzite than at The Gorge Site. This would be consistent with the fewer focal platform flakes at the Whittabrinna site since this type of flake is difficult to make on the quartzite.

The conclusions made from the debitage are consistent with the interpretations based on the Reduction Charts, which is that the reduction processes on these two sites are very similar. Little specialised stone flaking can be identified, and the presence of Industries other than the Core and Flake Tool Industry is negligible.

The 12 Mile Creek Site was described from the Reduction Chart as including quarry workshops. The debitage histogram (Tib-11 in Figure 5.15) from this site is extremely distinctive and shows a broad range of large flaked debris which peaks at length class 10 (55mm to 59mm), and does not begin until LC (length class) 3. The complete broad platformed flakes clearly dominate the assemblage. There can be no doubt that the main process taking place at this site is the production of large flakes for implements as was indicated by the Reduction Chart (Figure 5.5). The large flakes manufactured here would have been transported to sites elsewhere, such as The Gorge Site which is nearby, or to more distant sites with poorer stone availability.

The Tula Site is environmentally similar to The Gorge and Whittabrinna Sites, but the Reduction Chart (Figure 5.5) showed a very different stone tool assemblage which included many tulas. The debitage histogram for this site (Tib 108 in Figure 5.16) shows a limited size range of mainly small flakes which peak at LC 2 (15 to 19mm). The numerous broad platform flakes in the range of LC3 to 6 would have come from the small cores shown in the Reduction Chart. If they were for resharpening core tools, more focal platforms might be expected. However, mention was made of the numerous small flakes with macroscopic usewear.

It is likely that the small cores were used to produce the broad platformed flakes, which in turn were used for a task requiring a very fine, sharp edge. The highly

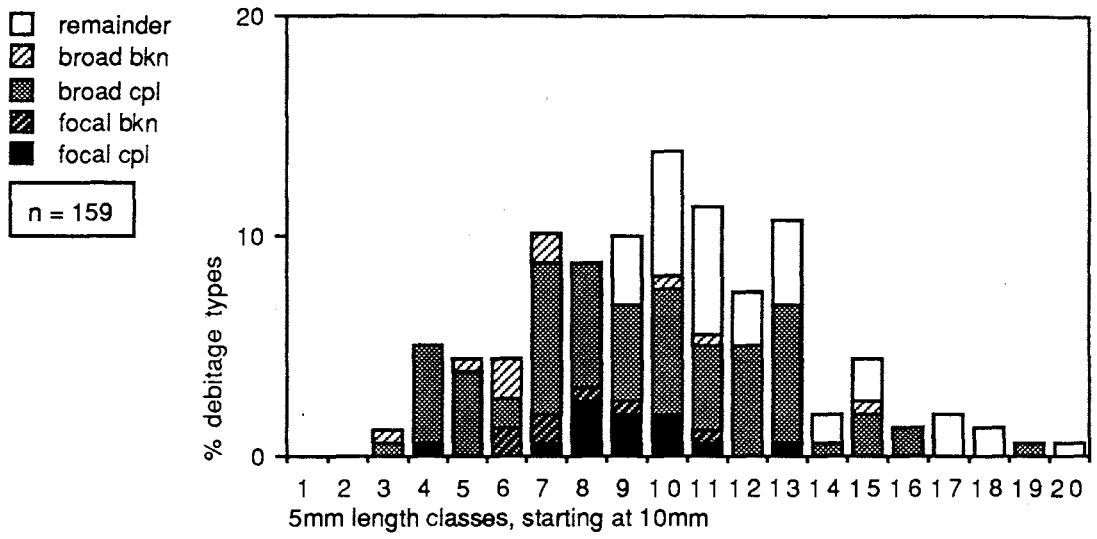


Figure 5.15 Debitage histogram for Tib-11.

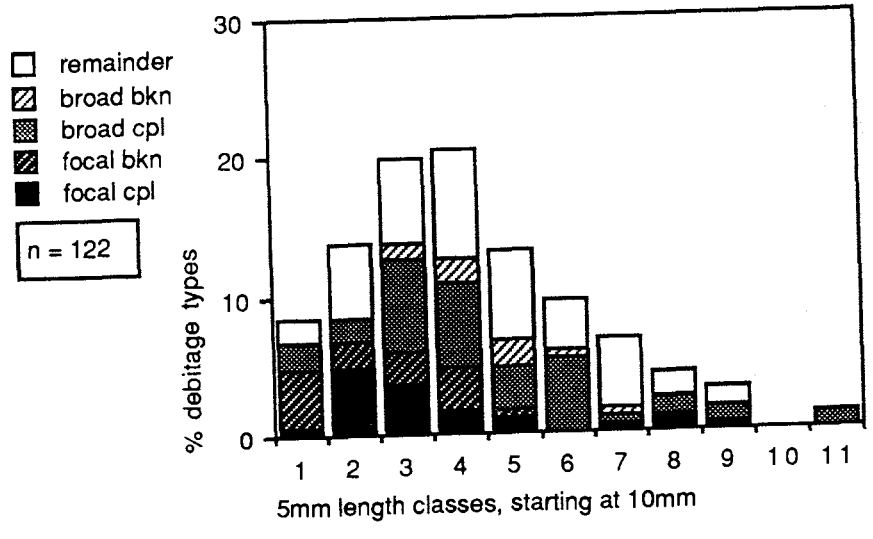


Figure 5.16 Debitage histogram for Tib-108.

specific use of the Core and Flake Tool Industry at this site supports the specialised function implied by the Tula Industry.

The Thompsons Creek Site was previously described as environmentally similar to the Gorge and Whittabrinna Sites, and the differences on the Reduction Chart were attributed to manufacturing pebble tools from the quartz gibber pavement near-by (see Figures 5.6 and 5.7). The graph for the silcrete debitage (Tib-109 in Figure 5.17) shows a peak at LC 4 (25mm to 29mm) which is dominated by focal platform flakes. These presumably were derived as resharpening debris from the cluster of heavily reduced cores noted for the implement assemblage. The few very large broad platform flakes at LC12 and 13 may have been carried on as potential large flake tools.

The quartz debitage (Tib-109 in Figure 5.18) is nearly all less than 39mm and block fractured. Most of this debitage is waste from the quartz pebble tool manufacture shown in the Reduction Chart (Tib-109 in Figure 5.7).

The interpretation from the Reduction Chart was that the quartz pebble tools were substitutes for the medium duty flake tools found on other sites. However, since these gibber pebbles are not large, the heavy duty work needs to be done by larger pieces of material which must be carried in. The non-quartz debitage is mainly due to resharpening these implements, and providing the few light duty tools required.

Another quartz assemblage is shown for The Sisters Site (Tib-114 in Figure 5.19). The quartz here is derived from reefs, and the debitage histogram shows few pieces having platforms. The Reduction Chart indicates a range of flakes for tools struck off the outcrops, and the debitage histogram is what would be expected from resharpening these flake tools.

The Mount Wood Site is shown in Figure 5.20 (Tib-13). This site was recorded in a manner similar to The Gorge Site and is in 10mm length classes and the broken platform flakes are included in with the "remainder" debitage type. The peak for this graph is at LC 3 (20mm to 29mm), and the complete flakes are dominantly focal platform. The Reduction Chart for the Flake and Core Tool portion of the assemblage (Figure 5.11) was anomalous as a camp site near a massive stone source which mostly had small implements. The debitage is consistent with small core reduction, some of which may be from the microblade core reduction as indicated from the Reduction Charts. Compared with other camp sites near a stone source such as The Gorge and

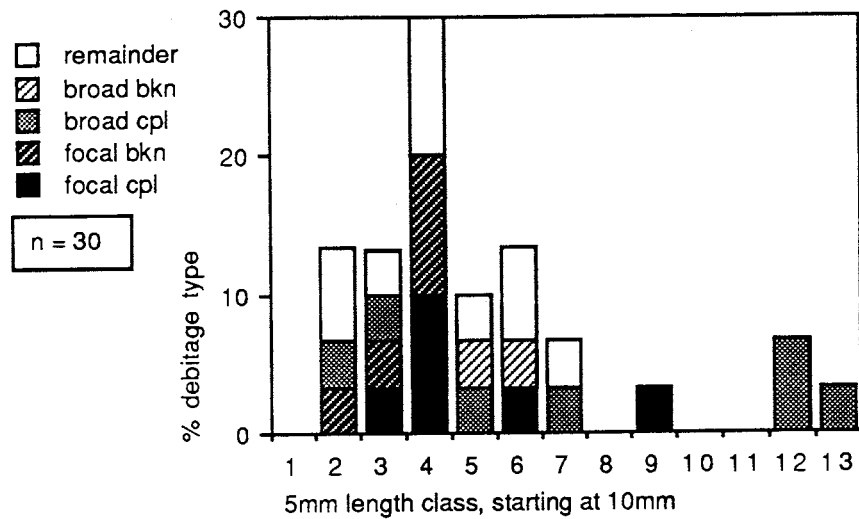


Figure 5.17 Debitage histogram for Tib-109, silcrete

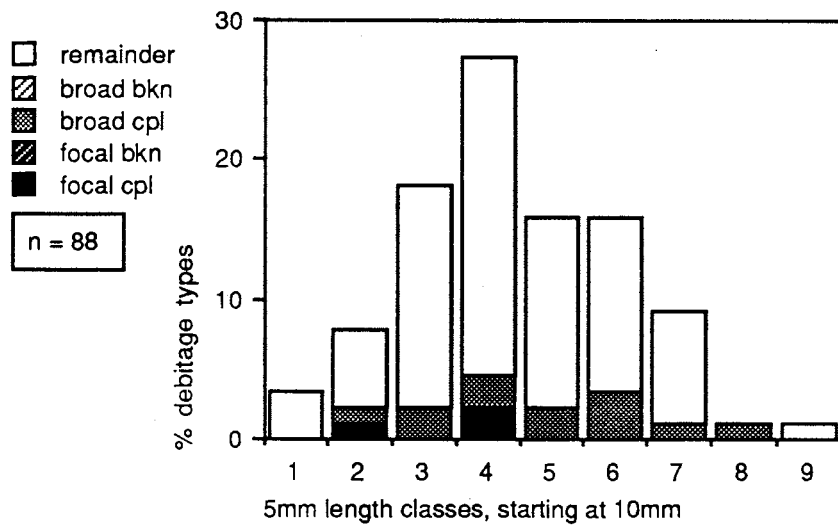


Figure 5.18 Debitage histogram for Tib-109, quartz

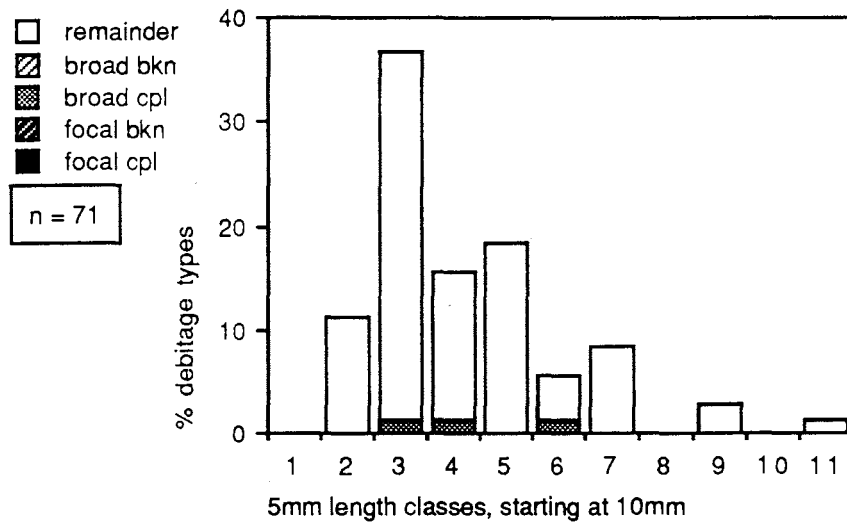


Figure 5.19 Debitage histogram for Tib-114, quartz

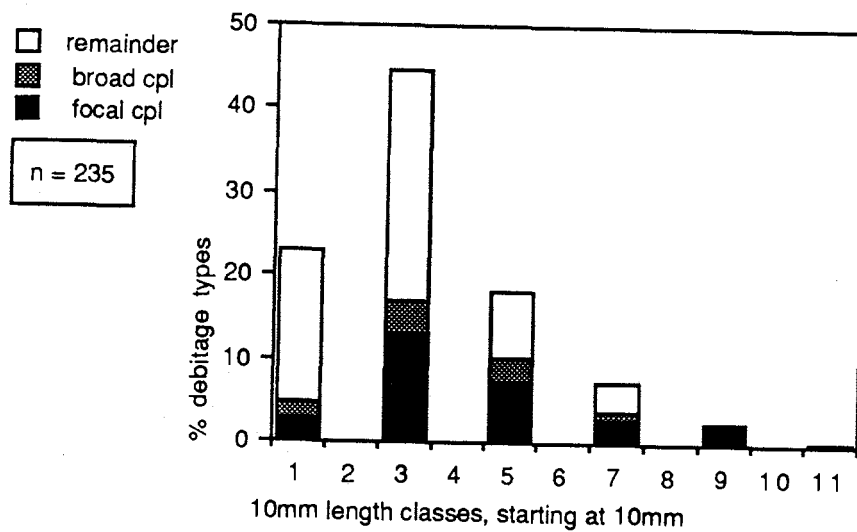


Figure 5.20 Debitage histogram for Tib-13

Whittabrinna Sites however, the debitage is smaller than would be expected. It later will be suggested that the Mount Wood Site is a "microblade base camp" with chronological or functional implications which would account for the incongruities in the stone assemblage.

Another site with a large microblade component, but in the more remote dunes country is the Taldry Dunes Site. The debitage histogram for this is shown in Figure 5.21 (Tib-19). This graph is similar to the Mount Wood site, except that it indicates more smaller flakes, especially in the remainder category. There also is a greater proportion of complete broad platform flakes to complete focal platform flakes. This site is relatively remote from a stone source and the Reduction Chart (Figure 5.9) shows small sized implements and few cores. The debitage for the Taldry dunes confirms the absence of large implements which might be reduced to a smaller size. Although this also may be a microblade base camp, the quantity of broad platformed complete flakes indicates less specialisation than that suggested for the Mount Wood Site.

The sites above indicate the range of variation among the debitage assemblages. The significance of this, as well as the results of the Reduction Charts are considered in the following section.

ARCHAEOLOGY OF THE TIBOOBURRA AREA

The basic findings of the survey have been discussed separately: land systems, coverage, site types and artefact assemblages. This section will try to bring these aspects together and provide some general statements about the archaeology of the Tibooburra area. This will use extensively the data listed in the Appendix. Each Land System Type is considered individually, and finally, the implications for prehistoric land use strategies are discussed.

Riparian Sites

The riparian sites were recorded according to a variety of criteria in which the cultural debris was visible due to local flood scouring and erosion, or extensive degraded areas on the flood plain. Elsewhere, the surface was covered with loose sand and grass cover. It is probably fair to say that this land system is a single archaeological deposit with intermittent concentrations of cultural materials. The density of artefacts was variable, but this may have been a function of the criteria used to determine the

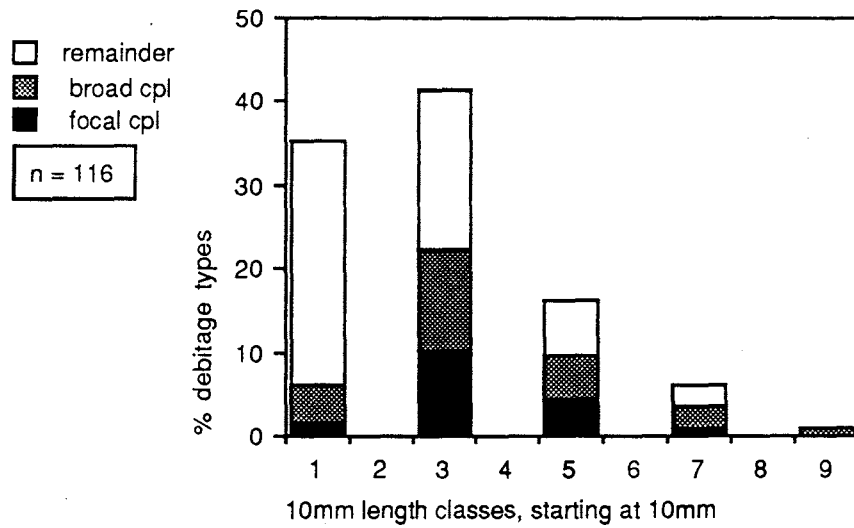


Figure 5.21 Debitage histogram for Tib-19

site boundaries. If only the dense part of an exposed deposit is identified as a site, then the frequency of artefacts will be high. The very large sites recorded by quadrats, such as Tib-107, Tib-108, and Tib-109 have relatively low overall effective tool densities because patches of low concentrations were included within the site boundaries.

In the Riparian Land System silcrete was the dominant material except for the Thompsons Creek Site (Tib-109) which was associated with a quartz gibber plain. Most of the stone debitage was broad platformed or without a platform, and most of the areas defined as sites had between 50 and 200 items. This is consistent with the pattern indicated by the sites already analysed in detail, and indicates the anomalous nature of the Tula Site (Tib-108).

The Riparian Land System pattern was what might be expected, since most of the long term water, and therefore overall occupation, would be along the major water courses. The flood plains of the major stream systems also comprise a high productivity environment with riparian woodlands, shrubs and seed grasses among the anastomosing channels and water holes.

At the domestic camps food processing would be a prominent activity, and there would be a complex range of wood working. Artefactual debris therefore was usually found whenever there was an exposure. The normal absence of the Microblade or Pirri Industries may have been a function of aggradation, since they were sometimes present where there was deep erosion. This erosion may be due to heavy runoff caused by the impact of grazing from introduced animals.

Plains Sites

As shown in Tables 5.4 and 5.5a, the Plains Land Systems sites had the lowest densities of tools as well as little diversity of stone industries. These sites seem to reflect genuinely small camps, since a large part of them have cultural criteria for the boundaries, low values for the dimensions and low quantities of debitage.

It is perhaps unexpected that there are sites at all out in the plains country. However, this type of environment is more differentiated than at first appears, and there are sites frequently located along small water courses, various flats and low ridges. These sites seem to be without hearths or grinding stones suggesting that there was little

elaborate food preparation. Although workshops were found at one site, most of the debitage was broad platformed and block fractured.

The plains environment is one which has little runoff after rains. Thus there is extensive standing water throughout and rapid ephemeral growth after a rainfall. Soon, however, the water is evaporated away, and the vegetation becomes brown. The sites in this Land System therefore seem to have been short-term occupations, and perhaps were mostly in use after the period with the microblade technology.

Ranges Sites

In the ranges, exposure was rarely a factor affecting site detection. Quarry sites were found as discontinuous debris along ridges, and camp sites showed regular concentrations of occupation along tributary bottoms. This meant that the site boundaries were usually a combination of landform, arbitrary and cultural criteria.

Hearths were rare, but several workshops were recorded. Silcrete was the main material except in the Tibooburra Ranges Land System Unit where quartz was the most abundant material. Broad platformed debitage or pieces without platforms were the main types, even though the Microblade and Pirri Industries seem to be relatively well represented. In most sites the debitage was under 50 pieces due to the generally low densities on sites in this land system. The spectacular exception is Tib-110 which is an entire small ridge which has become a quarry and has thousands upon thousands of flakes. In fact, this ridge has been so extensively quarried that at a distance it is gleaming white because all of the weathered grey silcrete has been removed. Due to the vast numbers of cores and other artefacts on this site no attempt was made to count tools or estimate their density on this site.

The ranges are an environment with rapid runoff and low productivity. The water courses carry water shortly after a rain, but dry up quickly except for some places where water holes and rock pools form. The best conditions for the use of the ranges may have been during the long slow rain which sometimes take place in winter. This is unlike the sudden heavy monsoon type of rainfall which may have favoured the use of the plains.

Dunes Sites

In the Dunes Land System, practically every exposure produced artefactual debris, and in some cases in abundance. More often, the numbers of artefacts were small and it was difficult to determine if the sites represented a discrete deposit of artefacts, or was part of a continuous scatter of isolated finds. The sites were mainly defined by the exposure. Since this was usually over a very large area, the sites were normally recorded by arbitrary 10 or 20 metre boundaries from the transect line.

The type of exposure was usually the blow-out/claypan combination found in the dune swales. In the centre of the claypan is a temporary pond and around the edge is a margin undergoing deflation and which is the blow-out portion. Deep blow-outs in the high dunes which went down to the clay core of dune were present but not common. There was only one case where a site was found in the loose sand of a dune, but it is probable that sites on dune crests which were covered by loose sand are more common than indicated by this survey.

In spite of such extensive occupation, hearths and grinding gear seemed not to be prominent. When hearths were present, either stone or fired clay was used, probably depending on availability. The workshops were mainly associated with the large microblade sites. In general the dune sites were not close to raw material except for a few cases where a gibber plain of silcrete cobbles was nearby. The stone material was mainly silcrete, and there were a few sites where focal platform debitage was common. Usually, however broad platformed flakes or those without a platform were the principal types.

Most of the sites contained under 50 pieces of debitage, but this quantity could have been increased in most cases by extending the arbitrary site boundaries in the exposures. Another factor which probably affected flake density is related to the evolutionary development of a clay pan system. The debris found in the blow-out zone is a lag deposit of the full range of artefacts, including all of the small flakes. As the sand continues to be blown back this material comes to rest on the surface of the clay. This surface is now subject to erosion by water which carries the clay sediments out in to the clay-pan. During heavy rains it is probable that the smaller debitage is transported as well. In the process of eroding the clay surface it covers up the flat objects such as flakes. Thus, away from the blowout zone in the clay pan the main artefacts which are visible are the cores embedded in the clay. This process was estimated in the calculations for effective density, and in general only 10% of the clay

pan was considered to be comprised of the blow out zone. In some sites the visibility was also patchy with small sand remnants or small blowouts.

The picture which emerges for the dunes is one of regular occupation throughout the swales. All of these swales hold water for short periods after rains, and some swampy hollows contain water for longer periods as well. The vegetational productivity of the dunes is probably relatively high as indicated by the substantial dune shrubland, perhaps because the sand can become saturated with water after a rain. If so, this also may produce long term soaks in some places.

Land Use Models

The survey has shown that there are differences in the sites to be found in the various land system types. It is possible to define the typical characteristics of such sites and account for the variation which is due to local factors such as stone material types. It is in this context that certain sites stand out as unusual and require explanation.

Perhaps the most dramatic site found during the survey was the Nockabrinna Quarry Site. This was more than an ordinary place to acquire utilitarian implements, but the highly silicified and massive white silcrete deposit appears to have been reserved for the production of specialised stone industries. It was the place where tula flakes had been removed from special tula cores, and where the blanks for pirri points had been detached from large conical prismatic cores right on the out-crop. Except for an isolated workshop on a gibber cobble on the Box Creek Transect, it was the only place found where tula flakes were being made. The only other example of pirri point manufacture was at the Taldry Dunes Site (Tib-19).

It seems clear that this was a major re-tooling place. Thus, before travelling out of the silcrete ranges in the Tibooburra area, especially the great expanses where stone is absent to the west and north, a place such as this would have to be visited to produce the tula flakes and pirri blanks for transport.

This site served another function. It also was used to produce the long leilira blades. These ranged in size from 150mm to 300mm in length and were made on immense prismatic cores. No leilira blades or a modification from a leilira blade was found on any of the camp sites during the survey. Since this artefact was not part of the tool kit used in the Tibooburra area, the production of the big blades must have been in another context. The nearest area where these blades are used appears to be in north

west Queensland, some 1500km away (Smith and Cundy 1985:36). There seems to be no doubt that these leilira blades were being produced as part of an exchange system. For example, if tula flakes were being made for a trip in a northerly direction where contact with other groups could be expected, the opportunity may have been taken to provide some big blades for trading purposes. There may have been several intermediaries before the blades reached their destination. It is possible that a stone source such as this, which permitted exceptionally long and thin blades, carried an element of prestige (see Jones and White 1988:68).

The Tula Site has already been mentioned as being functionally distinctive. Of the 65 occupation sites recorded in the Tibooburra area, this was one which especially stood out as having a marked functional difference. The variability found on the other sites seemed to be either due to the available stone material or the presence of a specialised industry in the context of ordinary camping activities. Occasionally flake tools having a concave or serrate edge would be found on a site, implying perhaps specialised use, but these were always a very small part of the assemblage.

Other conspicuous sites were the Mt. Wood (Tib-13), Millers Tank (117), and Taldry Dunes Complex (Tib-19,20) Sites. These sites are distinctive because of their large areas with abundant artefacts, microblade workshops, and numerous backed blades and pirri points. These sites would seem to belong to the period of the microblade-pirri technology. They also seem to be different from the other small sites which produce an occasional backed blade or pirri point. They also tend to feature hearths, workshops, grinding gear and high proportion of focal platform debitage. These sites give the impression of being central base camps where there was long term occupation, perhaps with satellite camps associated elsewhere.

This seems to be implied particularly by the Taldry Swamp and Pindera Downs Transects in the Dunes Land System Type. In this case, the Taldry Dunes Complex is located at a temporary swamp in an extensive zone of sand hills. Numerous small sites were located throughout this area and backed blades or pirri points were frequently present. These small sites (or at least lightly occupied areas) perhaps represented satellite camps during the microblade/pirri period.

Sites with backed blades and pirri points also tended to occur in the Ranges Land System. The Mt. Wood Site has been mentioned as a potential base camp. This site is located on a creek bed where numerous small tributaries come together. It also is about 200m from the boundary of the Ranges and Plains Land Systems and about

1.5km from where the Mt. Wood Range is cut by Thompsons Creek and a Riparian Land system. The effect of this environmental heterogeneity is to produce a mosaic of different types of environmental patches where the three land systems types come together, and like the dunes there are frequent changes of vegetational cover.

This type of mosaic, or patchy environment is similar to that of the dunes microblade sites already discussed. The vegetational pattern in the dunes consists of stands of shrubs on the dune ridges and low grassy cover and sometimes bluebush in the swales. Cane grass and lignum are associated with the swampy areas. The effect is a fine-grained mosaic in which there is a change of vegetational cover every 100m or 200m.

No "microblade base camps" were found in the context of the Riparian Land System, but this may be a factor of the depth of exposure on the flood plains. Also none were found on the Plains Land System which was well exposed. This land system type is highly homogeneous in its vegetative cover, and only a single site with a pirri point was found.

The implications therefore are that the microblade base camp type of site can be expected to occur in places where there is a fine-grained mosaic of vegetative cover (that is, small patches of tall and short vegetation) associated with a water source. Land Systems which tend to have a mosaic effect, such as ranges and sand hills also are likely to have the highest frequency of microblade sites in general.

The non-microblade-pirri sites however, are extensively distributed throughout the Tibooburra area, especially in the Riparian Land System where they form massive occupations such as the Gorge, Whittabrinna, and Thompsons Creek sites which have already been suggested to be long term camps.

In the Dunes Land Systems these sites also are common, but in the form of scattered activity areas rather than major camps. Site Tib-46 is the only case where there was a artefact high density in the dunes without backed blades or pirri points. This however borders the flood plain of Thompsons Creek, and the setting is as much riparian as dune country.

It would appear therefore that the post-microblade occupation was strongly oriented towards the highly productive riparian systems. After falls of rain however, it would be possible to disperse throughout the plains, dunes or ranges, using the available

water and resting the food resources associated with the riparian environment. In some cases long distance trips would be possible (giving opportunities for exchange for leilira blades, etc), and the small foraging groups would recombine at various places along the riparian systems.

The model of a dispersion and contraction type of settlement strategy based on environmental productivity differs from the base camp - satellite camp strategy in an environmental mosaic suggested for the microblade period.

There also seem to be some chronological implications. It is tempting to assume that the Microblade and Pirri Industries belong to the same time span, and those without this technology are later. Sites earlier than the onset of the specialised industries in the region may have been encountered by the survey, but my strong impression is that the effects of flood plain alluviation, sand dune movement and land degradation have made such sites hard to find. Occasional highly varnished artefacts were noted on the gibber plains as isolated finds, but no sites were recorded which appeared to be Late Pleistocene or Early Holocene. I also recognise that even if the Microblade and Pirri technology mark a particular chronological period, there is no guarantee that all of the occupations of such a time period would necessarily leave debris from these particular Industries. It also may be that a minor microblade period occupation which leaves behind a few backed blades or a pirri point could have later become a major camping area.

Bearing in mind the chronological hazards, there seems to be a process of change in the Late Holocene for the Tibooburra area. I have an impression of an earlier base camp/satellite system associated with the Microblade and Pirri Industries which is oriented towards fine-grained patchy environments, and where there is considerable transport of high grade flaking stone. Later in time there seems to be an intensive use of the high productivity environments, such as the riparian systems, and periodic dispersions throughout all other environmental types. With these sites assemblage variability of the Core and Flake Tool Industry can be explained in optimum foraging terms relative to stone material availability. The implications of these suggestions is discussed further and compared with the other two areas in Chapter 8.

CHAPTER 6

THE COBAR AREA

BACKGROUND

The Cobar area lies to the south and west of the town of Cobar in mid-New South Wales. The total area investigated was about 150 km by 75 km, but main area surveyed was within 50 km by 50 km. The location of the area surveyed is shown in Figure 6.1.

Environment

The average elevation of the sample area is about 220m. The main drainage system, Sandy Creek, terminates in sand hills to the west at about 100m. The area is an undulating plain with hills and rimmed with rocky ranges to the east and north. The peaks near Nymagee to the east are at about 500m, and Mt. Buckwaroon to the north is about 400 m. The following environmental data is taken from Plumb (1973).

The climate of the Cobar area is semi-arid with a mean rainfall of about 300mm. There is a weak seasonal tendency for the winters to be wetter, but the rainfall is highly variable throughout the year as well as from one year to the next. Parts of the region are poorly drained and may be subjected to temporary inundation. Again, as in the Tibooburra area, cool rains which continue over a few days have the greatest effect on the vegetation. The temperature averages roughly 19 C. with a summer average maximum of about 35 C. and a winter average of 4 C. As with the Tibooburra area, the range of the extremes is considerable and temperature can change rapidly. Prolonged hot weather is common as are extended droughts.

The Cobar area is a low plateau plain mainly on folded Devonian sandstones and shales, although some Silurian sediments are present. Paleozoic volcanics also occur in the eastern part of the area. The landscape is one of plains with occasional strike ridges of tilted resistant rocks. The high ranges to the north and east have undergone considerable block faulting. The region is internally drained, since Sandy Creek has probably not reached the Darling River since the Pleistocene. The plains have some sand dune development which increases towards the south and west. The most recent

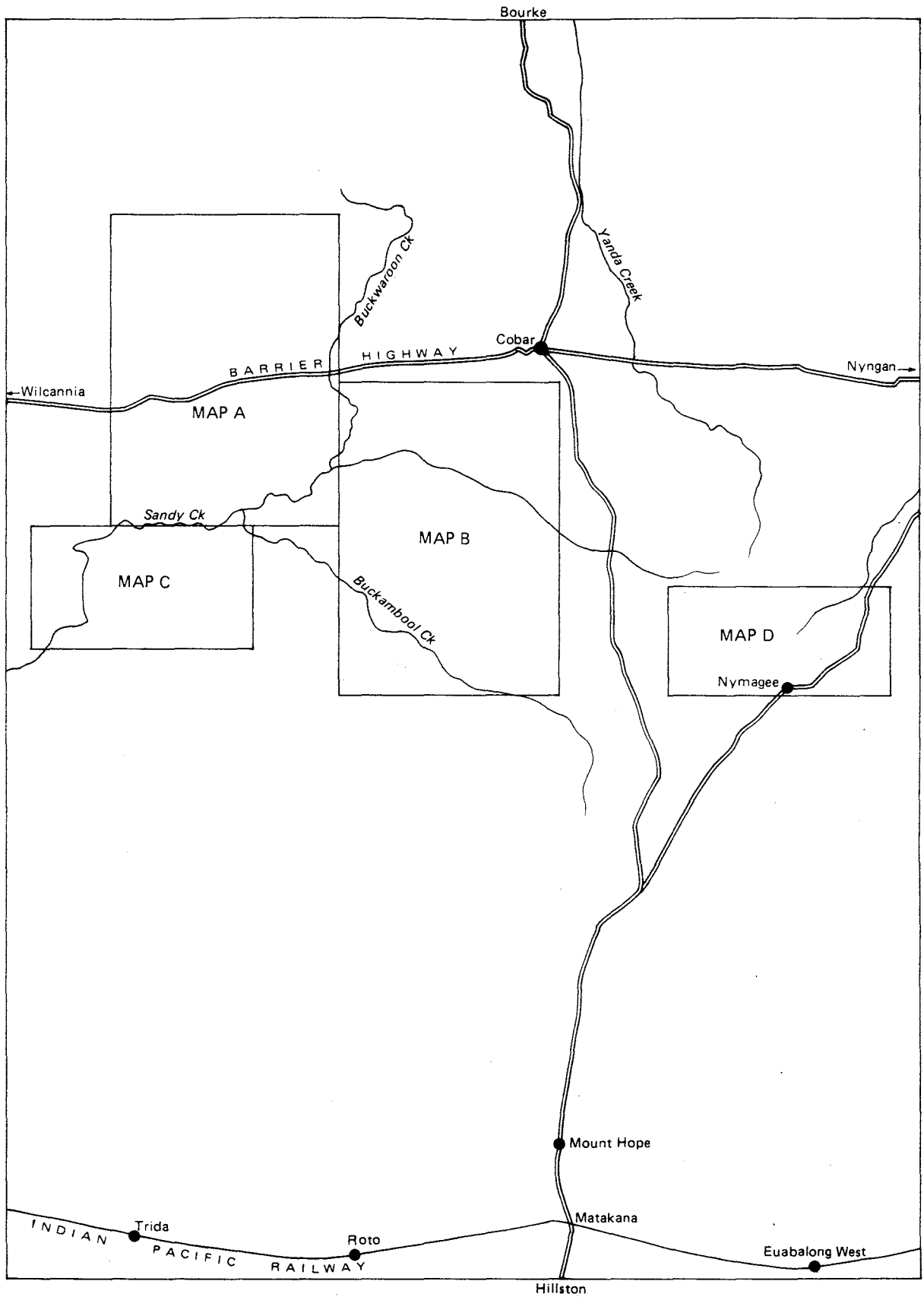


Figure 6.1 Maps showing the location of the Cobar Area and the positions of Map A (Figure 4.1A), Map B (Figure 4.1B), Map C (Figure 4.1C) and Map D (Figure 4.2D).

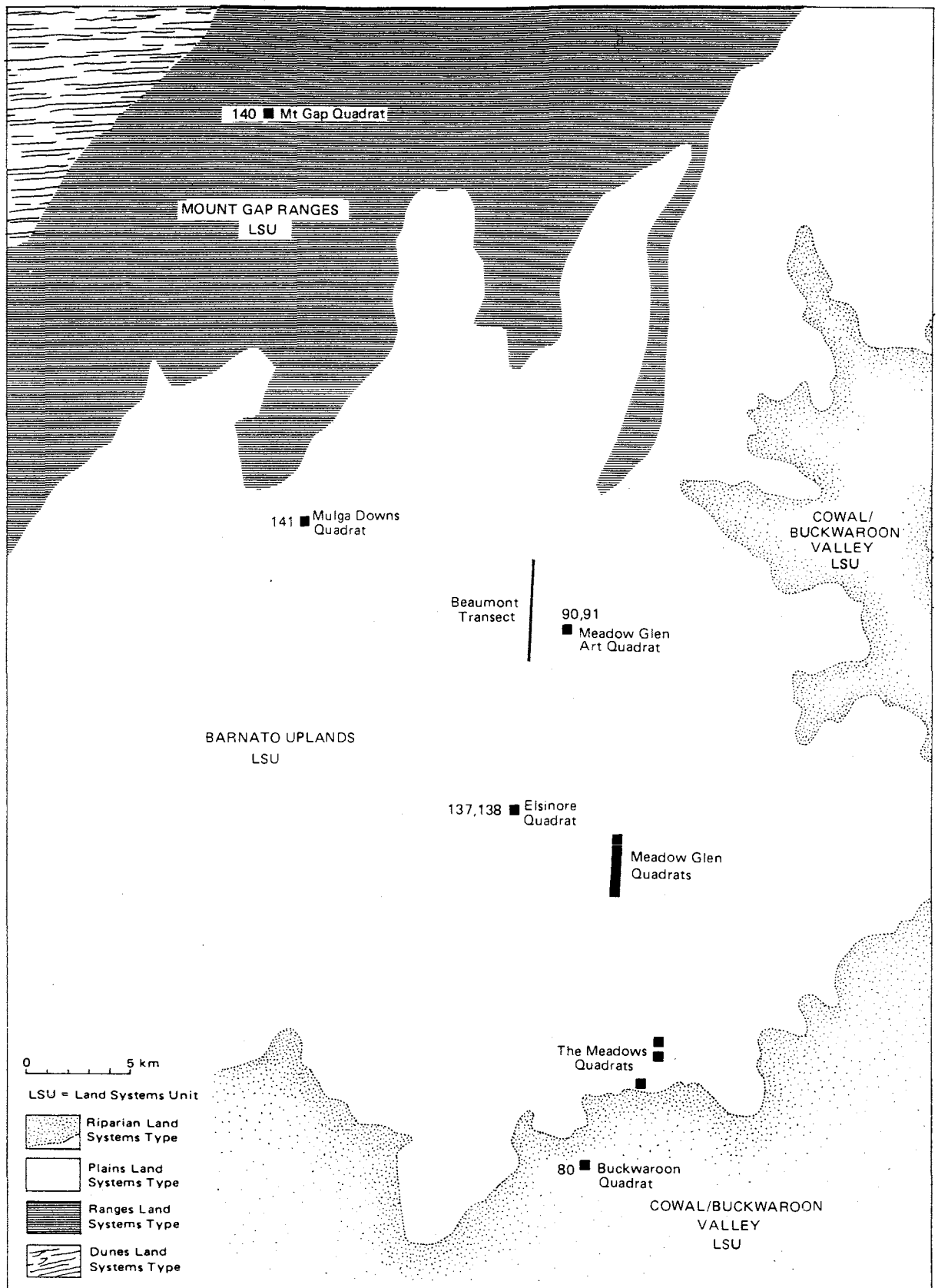


Figure 6.1A Map A of the Cobar Area, showing the land systems units, sample units and sites.

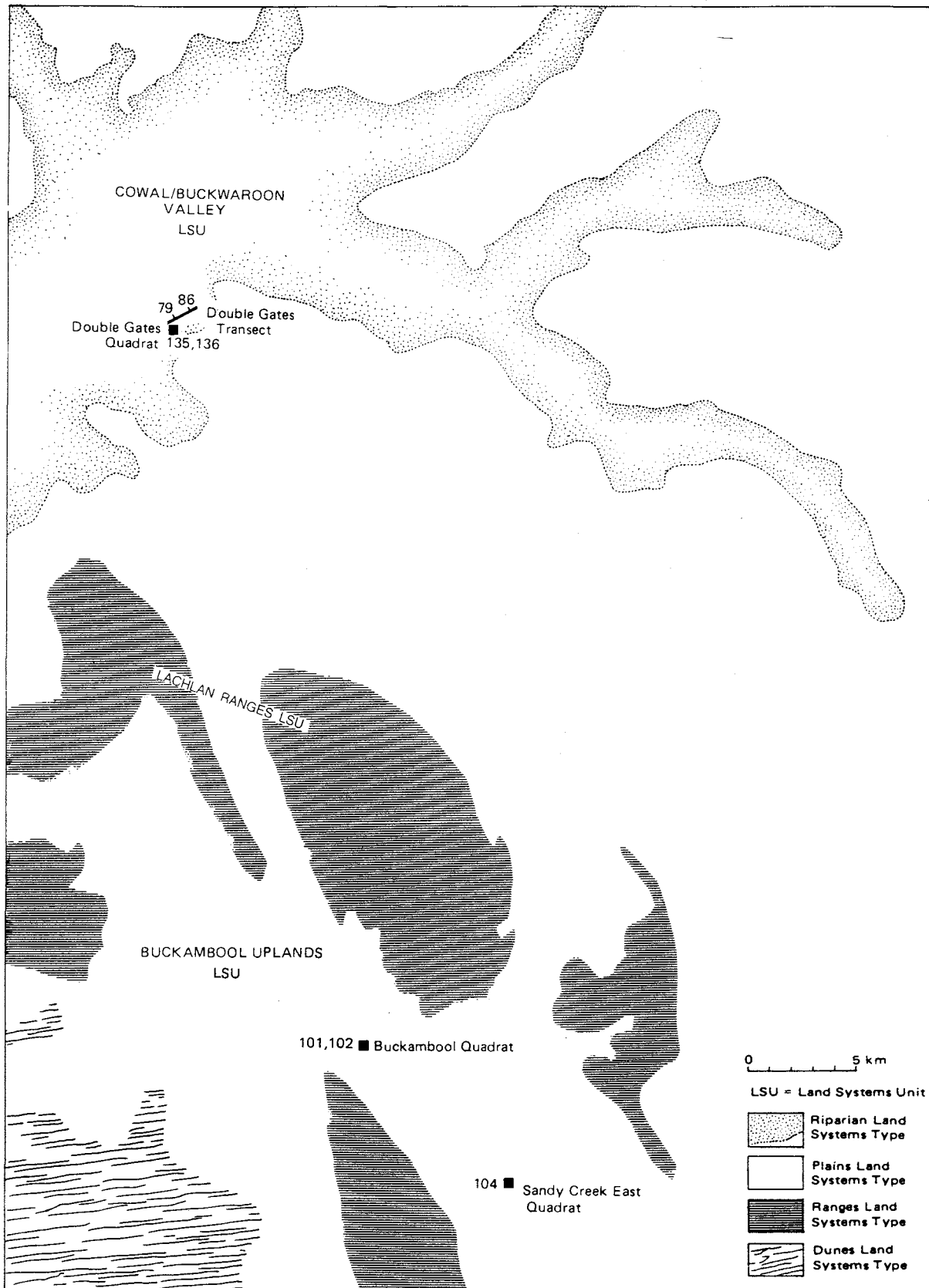


Figure 6.1B Map B of the Cobar Area, showing land systems units, sample units and sites.

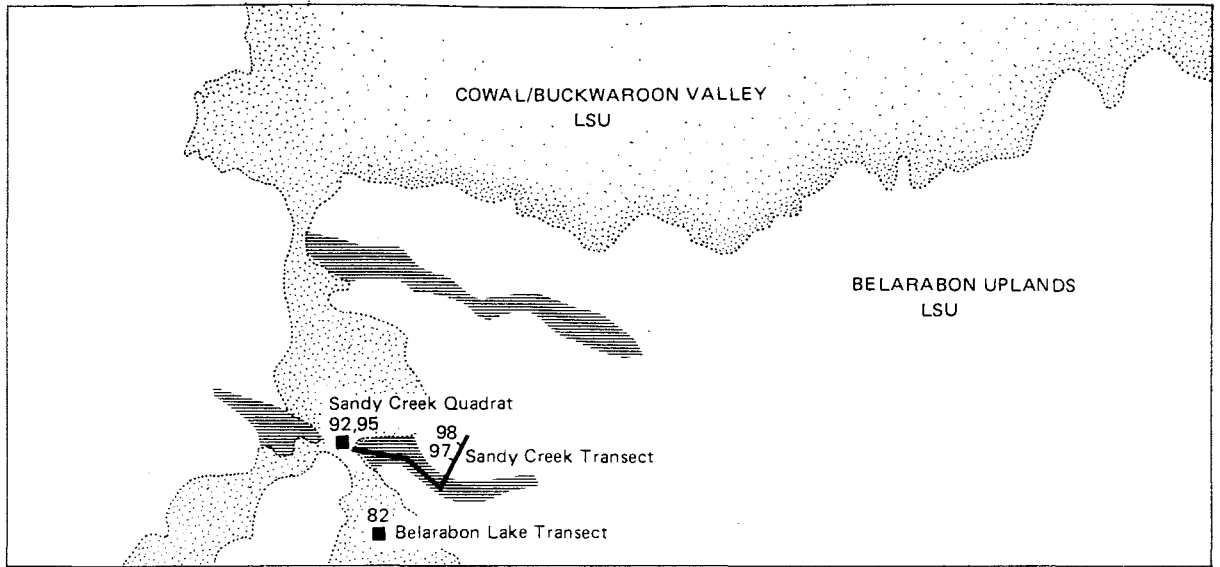


Figure 6.1C Map C of the Cobar Area showing land systems units, sample units and sites.

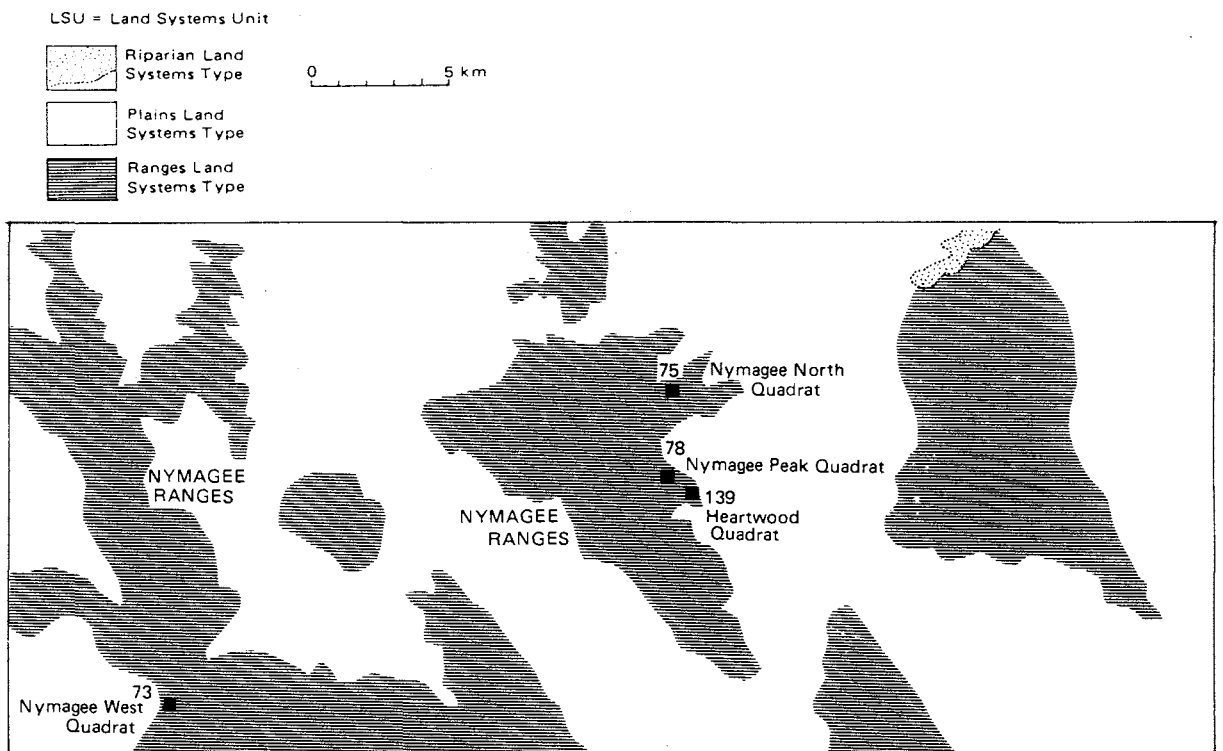


Figure 6.1D Map D of the Cobar Area, showing land systems units, sample units and sites.

phase of dune formation seems to have been about 2500 to 640 years ago (Wasson 1976).

The soils range from rocky skeletal and sandy types to heavy red clays. Over much of the area the clays are covered by a veneer of red sand which is of the same material as the dunes. There are some pavements of lag gravels but these are not extensive.

The vegetation has large areas of low to medium open woodlands of cypress pine with a grassy understorey. There also are other extensive open low shrubby woodlands of various species and some mallee. Riparian woodlands of gums are associated with the main watercourses.

As in the Tibooburra area, bores and stock tanks have contributed towards high numbers of emus and kangaroos. The grazing from sheep and rabbits has probably considerably altered the understorey vegetation and the large numbers of goats in the region intensifies this effect. Although clearing and logging appear to have been limited, the recent suppression of burning has most likely had the greatest effect on vegetation.

Aboriginal Culture

There appear to be no early historical accounts directly relevant to the Cobar area. The nearest example appears to have been that of Oxley in 1817 (Oxley 1820). In the area between Condobolin and Lake Cargeligo he sighted an Aboriginal family of six and later an elaborate six foot high burial mound. As he crossed from this area to the Macquarie River near Dubbo in the east he did not remark on Aborigines until he was near the river. Later, Sturt (1849) made a series of observations on the Aborigines of the Darling River west of the Cobar Area.

Among the few remarks concerning Aborigines in the Cobar area are those by Bennett (1883). These includes the use of eucalyptus, hakea and currajong roots for the extraction of water and the statement that people ranging 50 miles away would retreat to the Darling and Lachlan Rivers during droughts. He also mentions feuding between the river people and those of the back country.

The Aboriginal people for the area have been mapped as Wongaibon (Tindale 1974), but through the work of Donaldson (1980) it appears that the language in the area was Ngemba (or "Ngiyambaa" according to Donaldson).

In the absence of much specific ethnographic work, it is difficult to assess in detail the culture of the people in the region. The area is mapped as having matrilineal moieties with sections based on matri-lineal totemic clans (Berndt and Berndt 1977:55). The people possessed Eaglehawk and Crow moieties and myths. They also had a Rainbow Serpent mythological cycle (Hercus 1982), and the Biame (a "sky hero") myths.

In the late 1800's the Aborigines were quickly displaced or eliminated when their land was taken away by large pastoral holdings. There was some attempt by the Aborigines to occupy camps associated with the original homesteads, but these did not last long. The survivors now seem to have mostly relocated themselves in settlements along the Darling and Lachlan Rivers.

Previous Work

The first archaeological work published on the area was by McCarthy (1976) who was interested in the rock paintings in the area. The focus of this work was to record and compare the painted figures which could be found at five localities. Some additional descriptive information, such as on stone artefacts was provided and test excavations were carried out on six of the rock art sites. This work was followed up by a reassessment by Gunn (1979), who supplied additional data on artefactual debris. The area was also within the region investigated by Allen (1972), who tested one of the rock art sites at Meadow Glen. A series of reports and site records for the NPWS was recorded during the Moomba Pipeline Survey (Haglund 1974, Buchan 1974). More recently, there have been studies near Belarabon on Sandy Creek (Ross 1981, Bonhomme and Stanley 1985). There has also been an investigation of a stone source used by Aborigines which was endangered by mining development (McBryde 1981). One rock art locality, Mt Grenfel, has been reserved by the National Park and Wildlife Service as an Historic Site.

The rock art, which has attracted much attention, is either directly painted on the sandstone rock shelter walls or blown on as stencils. The paintings are most often of macropodids and emus, but there is a wide variety of other naturalistic animal paintings as well. The human representations are mainly stick figure types, which may be grouped and holding weapons as if in a ceremonial context. Painted tracks of kangaroos and emus are common and there are a few problematical and rather

abstract looking types of paintings. There are a great many stencils, mainly hands, of both adults and children. Other stencils include feet and boomerangs.

Apart from the art sites, the area contains scarred trees, stone material sources, and most abundantly, a variety of occupation sites. These latter are known from the Late Holocene only, and may be extensive, often associated with one or more of the other types of sites. The range of artefacts include milling equipment, tulas and burrens, backed blades (bondis and geometrics), elouera, rare pirris, bipolars, hammerstones and assorted flake and core tools. The animals bones from excavations include small macropodids, possums, bandicoots, native rat and a skink (Allen 1972).

LAND SYSTEMS

In order to sample the area described above, it was divided into archaeological land systems types and units as shown in Figure 6.1. The NSW Soil Conservation Service Land Systems Series Sheets Barnato SH55-13 and Cobar SH55-14 were consulted in the preparation of the Archaeological Land System Types and Units.

Cobar Valley Land Systems Type

These valleys belong to the major water courses which have broad flood plains and channels 2 or 3 metres deep. The bottom and sides of the channels are usually covered with woodland. Valley width differs as to whether it crosses the undulating uplands or is constricted by passing through low sandstone ranges.

1. Cowal-Buckwaroon Valley Unit. This is the major alluvial valley in the sample area. Buckwaroon Creek comes down from the north and forms a broad plain as it joins with Sandy Creek. Sandy Creek has the greater catchment area, but since it must pass through a gap in the ranges it does not form a broad plain until it meets Buckwaroon Creek. The plain has a low relief to up to 3 metres and is composed mainly of red earths on Quaternary deposits. The plains become increasingly sandy towards the southwest. They are cut by major channels that are filled with dense bimple box (*Eucalyptus populnea*) and occasional red gums (*E. camaldulensis*). This woodland is also scattered over the plain and associated with minor channels and sandy hollows. Other vegetation includes white cypress pine (*Callitris columellaris*), mulga (*Acacia anuera*), ironwood (*A. excelsa*), budda (*Eremophila mitchelli*), hop bush

(*Dodonaea sp.*) and bellah (*Casuarina cristata*). Perennial short grasses and forbs occur throughout the flood plain.

Cobar Uplands Land Systems Type

The central part of the area consists of low hills and hilly plains with numerous small intermittent water courses. Some portions have woodland vegetation with a thin cover of loose sand, and elsewhere there is a pavement of lag gravels where the vegetation is more open and mixed. Occasionally there are rocky outcrops and ridges with open shrublands.

1. Barnato Uplands Unit. These are low ridges with drainage flats or narrow valleys. The local relief is mainly to 20m, but increases to 50m to the north. The ridges consist of outcrops of Devonian sandstone and shale. This is overlain with Tertiary sandstone and silcrete in some places, but elsewhere is covered with Quaternary colluvium or sand sheets. The soils are mostly sandy or stony but some red earths and brown soils are included. There are extensive stands of white cypress pine, particularly associated with the water courses. Woodlands of red box (*Eucalyptus intertexta*) and belah or shrublands with rosewood (*Heterodendrum oleifolium*), and native orange (*Capparis mitchellii*) may also be found. The main grass cover is wire grass (*Aristida sp.*) and is associated with a variety of forbs. The vegetation tends to be heavier towards the northern part of the area.
2. Belarabon Uplands Unit. These are undulating hills with low (3m) to moderate local relief (20m) on predominantly Devonian sediments. A veneer of colluvium is found throughout with brown soils and red earths and patches of dunes. Most of this area is a shrubland with mulga, ironwood, rosewood, cassia and hop bushes. The ground cover is mainly wire grass, spear grass (*Stipa sp.*) as well as other grasses and forbes.

Cobar Ranges Land System Type

These ranges arise as hills in relative isolation or form extensive ranges bordering the sample area. The vegetation is mainly woodlands. This varies considerably depending on whether it is on the dry slopes or in the mesic valleys cut into the ranges.

1. Mt. Gap Ranges Unit. These ranges are a series of steep ridges and valleys mostly trending north-south with a local relief of up to 200m. The ranges are of tilted and block faulted Devonian sandstones and shales with patches of Tertiary sandstone. Quaternary fill is in the stream valleys. There is little soil development and most of the slopes are rocky and sandy. The vegetation is woodlands of red box with mulga, grey mallee (*Eucalyptus morrisii*), cassia and eremophilas. Pines are abundant on the lower slopes which are usually more sandy. The ground cover is wire grass, other short grasses and various forbs.
2. Lachlan Downs Ranges Unit. These are abrupt high ridges which loosely form a set of ranges of Devonian sandstones having a relief of about 100m. The soils are mostly shallow and stony with areas of red earths and sand on the low land between the ridges. The vegetation consists of woodlands of red box, mulga, grey mallee, cassia and eremophilas. On the foot slopes and low hills there is cypress pine, bimble box, and cassia.
3. Nymagee Ranges Unit. These high rounded ranges with a relief of 200m are mostly of Silurian granite. the soils are mostly coarse and rocky and the vegetation is dominated by white cypress pine. Also present is red box, bimble box, kurrajong, acacias and eremophilas. The result is a moderately dense woodland with a grassy ground cover. The lower slopes may have a mallee component and an understorey of small shrubs.

FIELD WORK

The first trip to the Cobar area was to inspect the area within the triangle formed by Nymagee, Meadow Glen and Belarabon. This included a large tract of physiographically diverse terrain, but was spread over a larger area than originally intended. The second trip concentrated more on the Meadow Glen area and was based at the Meadow Glen shearer's quarters. Two field assistants were present on this occasion and the survey was conducted mainly in the area between Buckwaroon Creek and Mt. Gap.

This region was well covered by a network of access tracks, and it was possible to identify the sample locations both by physiographic features on the 1:100,000 orthophoto and topographic maps as well as using the vehicle odometer to check locations. Because of the relatively dense vegetation in the region, any long transect required considerable compass navigation and it was difficult to reliably trace a

transect route on the map. The sizes of some of the sample units were measured by driving across country and using the odometer. The sampling approach used was mainly quadrats or short transects. This was because the exposure was usually in the form of deflated clay pan areas, patches of well-swept lag surfaces or washed-out rocky slopes.

Due to the tall wooded vegetation, line of sight was usually impossible beyond more than 100m, and quadrats were the best means of utilizing this patchy exposure. The visits were during a drought period and grass cover was extremely sparse, and in most areas organic litter was not excessive. The main problem in site detection was the presence of a thin veneer of loose sand which covered most of the region. This is probably of Late Holocene age and formed at a time of dune development elsewhere in the region (Wasson 1976).

The vegetation and land form differences in this area were rather more complex than in the other areas visited, and the descriptions made of the physiographic divisions were heavily based on the NSW Soil Conservation Service Land Systems Series Louth SH55-9, Barnato SH55-13, and Cobar SH55-14 at the 1:250,000 scale.

SAMPLE PATTERN, COVERAGE AND RESULTS

This section gives an overall picture of the survey. It indicates the distribution of the sample units, the effectiveness of the sample, and the general pattern of sites found.

The outcome of the survey is shown in Table 6.1 which lists the Land Systems Units and Types, the sample units within them and the sites recorded. Also shown are the distances or areas covered in each sample unit and the effective coverage calculated for them.

The distance covered by transect was relatively small in the Cobar area, only about 5km (Table 6.2A) as compared to the nearly 44km in the Tibooburra area. This was due to problems in navigation through woody vegetation and the tendency for large areas to have extensive loose sand cover. This made transects an inefficient procedure, and even so, the transect coverage was only 32% effective.

land systems by type and unit	sample units: quadrats, transects	dist/area surveyed by sample unit	effective distance/area	sites recorded by site number
<u>RANGES</u>				
MT. Gap Ranges	mount gap Q	318750sqm	18200sqm	140
Nymagee Ranges	nymagee north Q	120000 sqm	12000sqm	75
	nymagee west Q	5000sqm	900 sqm	78
	nymagee peak Q	20000sqm	2000sqm	
	nymagee south T	200m	100m	
	heartwood Q	45000sqm	9000sqm	130
total	transects	200m	100m	
	quadrats	508750sqm	42000sqm	5 sites
<u>TOTAL SAMPLE</u>				
	transects	5080	1625	4 sites
	quadrats	2321950	437544	19 sites

note: T = transects, Q = quadrats

Table 6.1 Table listing sample units within the land systems and the recorded sites. Shown also is the total coverage and the calculated effective coverage (by % of sample unit covered, and the effects from exposure and visibility), The sites per sample unit are shown by site number.

COBAR AREA

SAMPLE SURVEY

land systems by type and unit	sample units: quadrats, transects	dist/area surveyed by sample unit	effective distance/area	sites recorded by site number
<u>VALLEY</u>				
Cowal/Buckwaroon valley	buckwaroon Q double gates Q double gates T sandy creek Q belarabon Q	165000sqm 150000sqm 500m 630000sqm 10000sqm	3300sqm 7500sqm 125m 63000sqm 5000sqm	80 135, 136 79,86 92, 95 82
total	transects quadrats	500m 955000sqm	125 m 78800sqm	2 sites 6 sites
<u>UPLANDS</u>				
Barnato uplands	mulga downs Q beaumont T mead,glen art Q meadow glen Qs the meadows Qs elsinore Q	19800sqm 3980m 3100sqm 293600sqm 185000sqm 82800sqm	2322sqm 760m 1600sqm 65135 sqm 30150sqm 10240sqm	141 90 91 37, 138
buckambool uplands	buckambool cr. Q sandy creek Q	71000sqm 400sqm	7100sqm 200sqm	101, 102 104
Belarabon uplands	sandy ridge T sandy plain Q	800m 202500sqm	640m 20625sqm	97, 98, 99
total	transects quadrats	4380m 858200sqm	1400m 137372sqm	2 sites 9 sites

EFFECTIVE COVERAGE:			TRANSECTS		COBAR AREA
land system type	total dist. l/s type (m)	% total dist. l/s type	effective coverage l/s type (m)	% effective coverage of l/s type	% effective coverage of transect
valleys	500	9	125	7	24
uplands	4380	87	1400	91	32
ranges	200	4	100	2	50
total	5080	100	1625	100	32

Table 6.2A. Table showing effective coverage of transects by land systems type.

EFFECTIVE COVERAGE:			QUADRATS		COBAR AREA
land systems type	total area land systems type (sqm)	% total area land systems type	effective coverage l/s (sqm)	% effective coverage of l/s type	% effective coverage of quads
valleys	955000	41	258172	59	27
uplands	858200	37	137372	31	16
ranges	508750	22	42000	10	8
total	2321950	100	437544	100	19

Table 6.2B. Table showing effective coverage of quadrats by land system type.

Effective Coverage

As shown in Table 6.2B, the greatest quadrat coverage was on the alluvial flats of the valleys (41%). This was mainly due to the extensive scalds found in this situation which invited survey. This is partly why the coverage in this type of environment was the most effective (24%). The uplands received about a third of the survey but with a severe drop in effectiveness (16%) due to poor exposure. The ranges received the least coverage (22%), and only 8% of that turned out to be effective mainly because of heavy vegetative cover. As a result, the valleys were very well represented (59%), and the ranges poorly represented (10%).

These results came somewhat as a surprise, since at the time, the Cobar area seemed to be a place where there was relatively little ground cover. However, in recording the amount of exposure in the sample units it is clear that this was deceptive, and had more quadrats with less loose sand, litter and woody vegetation been chosen, the survey would have given better results.

Site Frequency

Since only 4 sites were recorded on transects, the results in Table 6.3A are not very informative. The quadrats however produced more (Table 6.3B), including one obtrusive site in the form of a rock shelter with art. Because of its small size in respect to the upland area covered, its percentage area is not calculated.

The unobtrusive sites recorded in the quadrats are shown as the percentage of the site size in square metres relative to the entire area covered in quadrats for the Land System Type. Considering the generally poor effective coverage, the site area is very high. Part of this is probably because some sites which were recorded separately during the survey were later lumped together as belonging to the same deposit and treated as a single large site. Another factor which was perhaps more important was the method used to account for sample bias. As discussed in Chapter 4, this was done by trying to make explicit the assumptions about where sites should be, or should not be. Sampling would take place until there was redundancy. This was more difficult in the Cobar area since it was more spread out than the other areas. In this case therefore, selection of sample units may have had a tendency to be biased for places where sites should be present. If however, this tendency was consistent, then the proportions per land system should be representative, and the high proportion of sites in valleys (Table 6.3B) is a reliable indication.

SITE FREQUENCY:		TRANSECTS		COBAR AREA
land systems type	number of obtrusive sites	number of unobtrusive sites	distance per obtrusive site (m)	distance per unobtrusive site (m)
valleys	-	2	-	62
uplands	-	2	-	700
ranges	-	-	-	-
total	-	4	-	381

Table 6.3A. Table showing total transect distance per obtrusive and unobtrusive sites by land systems type. Note: distance per obtrusive site / distance unobtrusive site - distance unobtrusive site = total distance per site by land system

SITE FREQUENCY		QUADRATS		COBAR AREA	
land systems type	number of obtrusive sites	number of unobtrusive sites	area of obtrusive sites (sqm)	area of unobtrusive sites (sqm)	% area of sites in quads
valleys		6	-	203250	21
uplands	1	8	300	118950	14
ranges		5	-	69000	14
total	1	21	300	391200	12

Table 6.3B. Total quadrat area per obtrusive and unobtrusive sites by land systems type.

Site Types

The site types are shown in Table 6.4 in which the small amount of transect data is combined with the quadrat data. The sites recorded indicate a high frequency of ground stone and hearths throughout the area (Table 4.4b). This differs from the Tibooburra area where such sites were much less common. This may reflect a difference in food resources or the intensity of food preparation. A single quarry was found (the Elsenore Site, Cob-137). This was not in the form of an outcrop, but was where a camp site was utilising a rubble deposit of silcrete. The only obtrusive site encountered was the Meadow Glen art site which had been previously test excavated (Allen 1972).

The microblade/pirri sites were more abundant in the ranges and the tulas were more common in the valley, and the mean tool density was the least in the uplands (Table 6.5).

Tool Abundance

The artefact densities are of a similar order of magnitude for all Land Systems Types and no marked trends are obvious in Table 6.5. Tula slugs were common, and were best represented on the valley sites. It can be seen that there was only a single pirri point found, but backed blades were abundant, especially in the ranges.

STONE ARTEFACT ANALYSIS

As in the case with the Tibooburra area, the implements are analysed according to the Reduction Chart and the debitage is presented in histogram form. First however, the stone materials of the region are briefly described.

Materials

In the western part of the Cobar area "silcrete" was the main type of flaked stone. Presumably, this was from Tertiary duricrust. However, some of the ridges of Devonian sandstone can be silicified (McBryde 1981) and produce a quartzite-like material which can be flaked, although usually of a poorer quality than the Tertiary silcrete. The silcrete and the quartzite look very similar (Wasson et al. 1979) and field identification is unreliable. It should be understood therefore that all of the silcrete or silcrete-like stone was recorded as "silcrete" during the survey. The only silcrete

SITE TYPE		COBAR AREA				
landsystem type	art sites	camp sites	microblade /pirri sites	griundstone sites	sites with hearths	sites with worksh0ps
valleys	-	8	7	8	5	2
uplands	1	10	1	8	6	4
ranges	-	5	5	4	4	4
total	1	23	13	20	15	10

Table 6.4 Table showing site types recorded by land systems types. Note: total number of sites = 23.

TOOL ABUNDANCE:				COBAR AREA		
landsystem type	total no. back.blade	total no. pirri points	total no. tula slugs	min tools per sqm	mean tools per sqm	max tools per sqm
valleys	16	1	23	0.004	0.071	0.036
uplands	27	-	15	0.003	0.015	0.250
ranges	67	-	12	0.003	0.042	0.147
total	110	1	50			

Table 6.5. Table showing numbers of certain implement forms and densities of tools by effective area.

source found (Elsinore Site, Cob-137), was in the form of re-deposited Tertiary silcrete boulders.

Towards the east is another major source of fine-grained igneous material. An outcrop of this was never found during the survey, but it appears to be an intrusive rhyolite from the Paleozoic volcanics. It was recorded as "fine-grained volcanic" during the survey. This material weathers readily, and on sites with an exceptional abundance of artefacts (e.g. Nymagee Site, Cob-78) flake tools of this material may be found with two stages of weathering. This resulted from implements being discarded on the site, and then at a later time, being picked up, resharpened, used, and discarded again.

Implement Assemblages

The Buckwaroon Site (Cob-80) is located on the flood plain of a major water course surrounded by sandy plains and rocky hills (Figure 6.1A). There are no pavements of gibber cobbles or outcrops of workable stone near-by. The Reduction Chart of this site (Figure 6.2) shows a mixture of cores and flake tools. A large number of implements near the 20/10 reference point are present (and would be mostly under 5gm in weight). Prominent in this group are the tula slugs. The specialised flake tools also are common and they cluster along the regression line plotted for the general flake tools. The slope for this line is relatively low, and well below the 20/10 and 40/20 reference points. This line also indicates that the specialised flake tools are of a similar thickness. An examination of the raw data reveals that the specialised flake tools are mainly convex shaped. It is likely that these were hafted as adzes in addition to the tulas. Because of the step terminated resharpening flakes caused by the dorsal ridge, they would be discarded at an earlier stage. The tula flakes were produced without the dorsal ridge so that it was possible to resharpen the bevel back much further.

The cores in Figure 6.2 produced a regression line which was parallel with the 1 x 1 line. All of these cores therefore were reduced to nearly square cross sections due to intensive reduction. These features of advanced reduction are consistent with the lack of nearby stone sources. It also is possible that there are some effects from long term camping. For example, if a supply of stone has not been recently brought in, it is necessary to reduce the cores until there are no more acute platform angles.

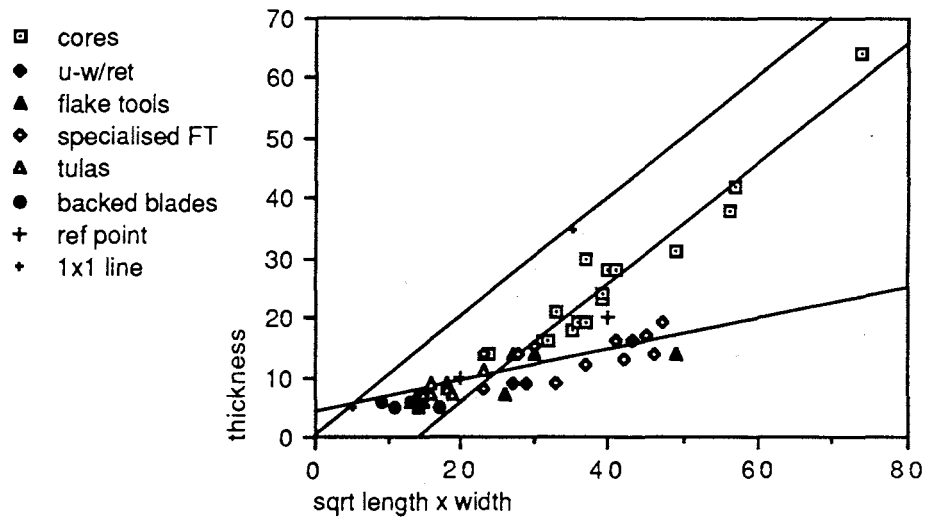


Figure 6.2 Reduction Chart for Cob-80

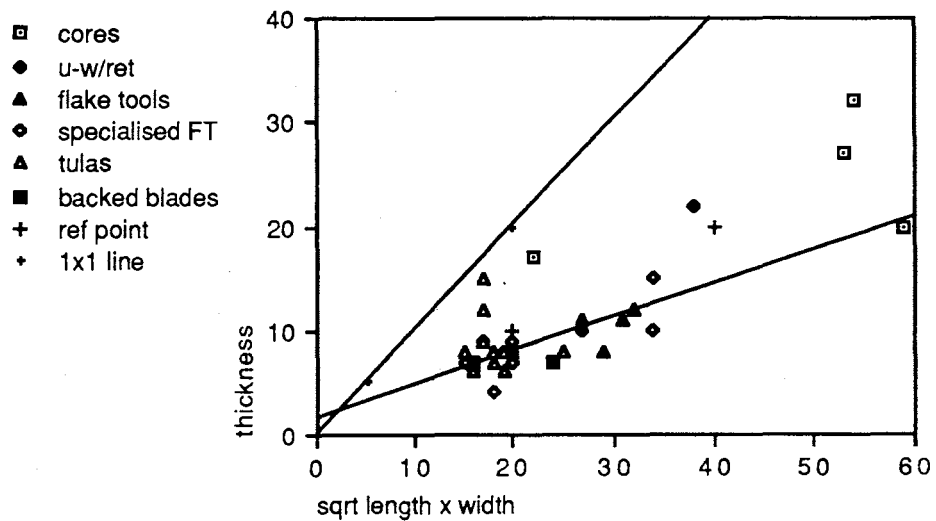


Figure 6.3 Reduction Chart for Cob-137

In comparison with the cores from the Elsinore Site to be described below (Figure 6.3), it can be seen that the Buckwaroon Site cores are relatively large, and must have come from a source which could produce larger quarry blanks. These were probably brought on the site as large flakes, and possibly used as heavy duty flake tools at the outset.

The Elsinore Site (Cob-137) is on a tributary north of the above site but located at an eroded deposit of silcrete cobbles (Figure 6.1A, Elsinore quadrat). The reduction chart (Figure 6.3) shows the cores to be of a similar size to those of the Buckwaroon site, but much thinner in cross section except for the smallest one.

The regression line for the flake tools is similar to that for the Buckwaroon Site, indicating a similar process of producing flakes as implements. There also is a cluster of discarded tulas. Since this site contained some tula flake production workshops, some of these may have been discarded due to replacements made on the spot. The tula core from this site and the workshops indicate that the manufacture here was of microtulas, probably because it was not possible to obtain larger cores from the boulders in the colluvial deposit.

Further to the east, in the ranges, an extensive occupation north of Nymagee was recorded as the Heartwood site (Cob-139 in Figure 6.1D). This seems to be a major camping locality near a permanent spring. This site and another recorded near-by (Nymagee Site, Cob-78 in Figure 6.1D) produced a number of whetstones, hammer stones, and ground edged hatchets which had been cached there. The main raw materials were quartz, silcrete and a fine-grained volcanic stone. The Reduction Chart for the fine-grained stone (silcrete and volcanic) is discussed first, followed by the quartz Reduction Chart.

The Reduction Chart of the fine-grained types of stone (Figure 6.4) shows a wide variety of tools. The regression line for the flake tools is in a similar position relative to the reference points as that for the previous two sites. The use-wear/retouched flake tools however tend to cluster below this line as a group of very small implements (note the position of the backed blades). It is possible that the use of the very fine edge from these tools may have implications for a specific activity present at this site and not found for the others.

The cores for this site have had a regression line plotted, and it can be seen that the cores are relatively low in cross section, especially the larger ones, some of which are

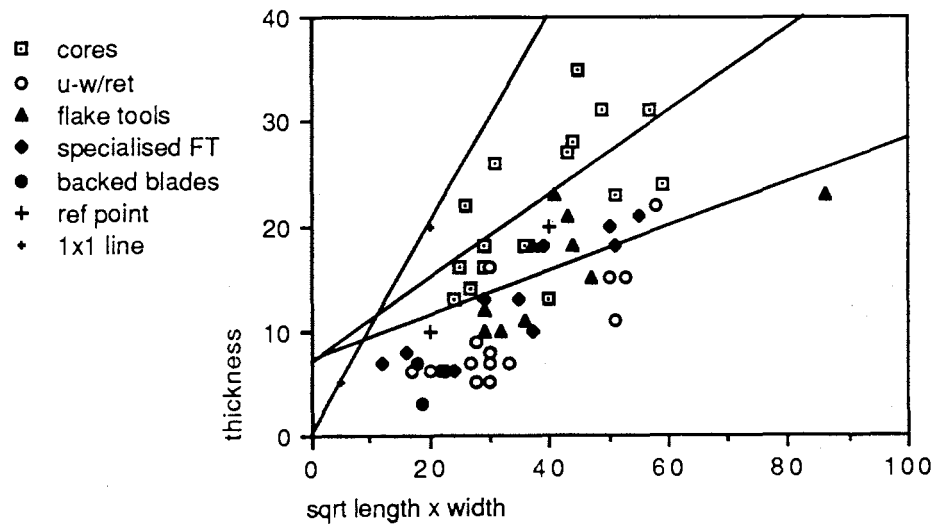


Figure 6.4 Reduction Chart for Cob-139, fine-grained stone

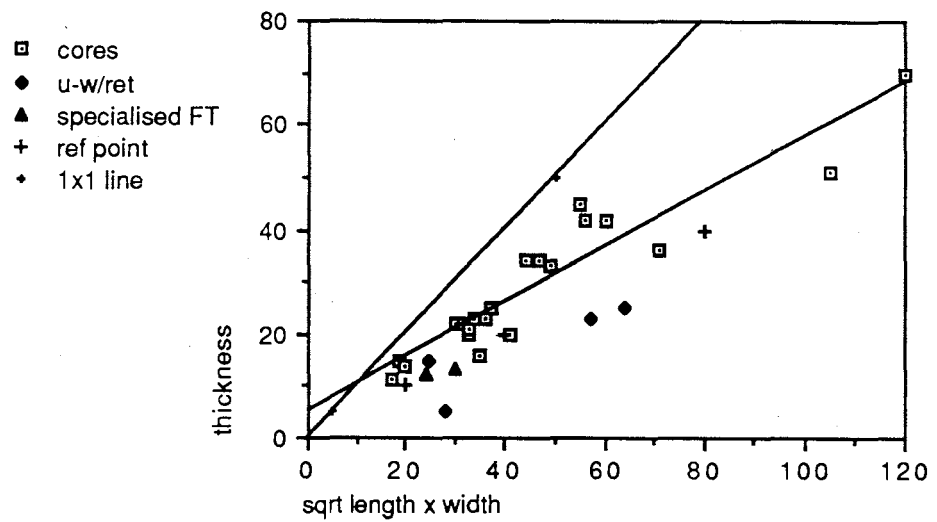


Figure 6.5 Reduction Chart for Cob-139, quartz

massive. The implication of a nearby stone source is consistent with the Elsinore Site example. The difference is that the material source for the Heartwood Site must be providing larger sized cores.

The quartz assemblage (Figure 6.5) for the Heartwood Site shows a series of cores for which a regression line has been plotted. Relatively few flake tools are present, and it is probable that these cores are implements rather than producer cores.

Immediately north of the above site is another which was much less intensively occupied. This is the Nymagee North Site (Cob-75, Figure 6.1D). On the Reduction Chart (Figure 6.6) a variety of core cross sections are indicated. This includes a group lined up near the 40/20 reference point. These seem to be a discard stage for a particular type of core which was used differently from the larger and thicker cores which are in a variety stages of reduction.

Tula slugs were present at this site, but did not occur in the zone recorded in detail and used as data for the Reduction Chart. Tula slugs (mainly "microtulas") also were found on the nearby Nymagee Site (Cob-78), but as indicated by the assemblage shown in Figure 6.4, they are not nearly as important a part of the tool kit as in the previous assemblages. It would seem that the need to manufacture tula flakes became less important in the high ranges where stone materials were relatively common. Once out in the rolling hills and flats however, it appears that the technological mode was changed into one designed for stone material conservation and the use of adzes.

The flake tools for the Nymagee North Site are mostly smaller than in the preceding site and the regression line for the flake tools is steeper in respect to the reference points. These tendencies may indicate that the flake tools are resharpened to a more advanced stage. Considering this, and that some of the cores are highly reduced, it is possible that the main difference between this site and the Heartwood Site is that it is a few kilometres more distant from the stone sources. The other difference is the cluster of very small use-wear/retouch flake tools.

The Microblade Industry is represented on all of the above sites. A very large part of the backed blade manufacture however may have taken place in the ranges, as indicated by the numerous blade cores shown for the Nymagee North Site. Considering the very small size and thin cross sections for some of the Heartwood Site cores, it is probable that some of these also were blade cores which were not recognised in the field.

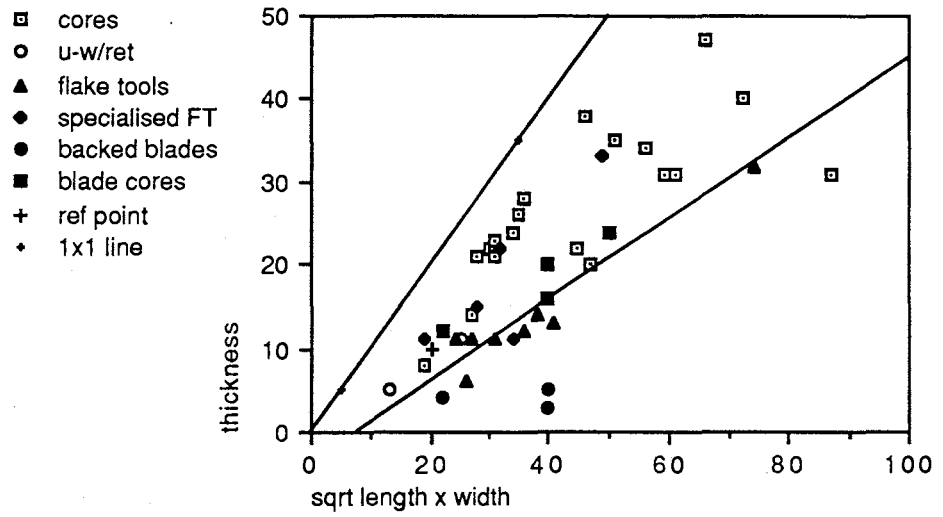


Figure 6.6 Reduction Chart for Cob-75

Debitage Assemblages

The implements for the Buckwaroon Site (Cob-80) were shown in the Reduction Chart in Figure 6.2 as representing a typical large camp site along side a major water source. Thedebitage from this site was divided into coarse-grained materials (mostly quartz) in Figure 6.7, and fine-grained materials (mostly silcrete) in Figure 6.8. The fine-grained stone is smaller sized and has more focal platform flakes than the coarse-grained stone. This is what would be expected from the two material types in which there are a wide range of cores and flake tools.

A site which is in the uplands, but seems to be dominated by microblade production, is the Buckambool Site (Cob-103) in Figure 6.9. The histogram of the debris generally scattered over the site shows a lack of large sized flakes, but the peak is at length class (LC) 3 which is 20mm to 24mm and within the main distribution of the Buckwaroon site. Thus it would seem that some of the same activities were taking place, but without large core reduction. An example of a microblade workshop from this site is shown in Figure 6.10. This workshop was partly refitted, and although the core was absent, it was concluded that the producer was a conical prismatic type. The peak is at LC 1 (10mm to 14mm), and the longest flakes are the blades which are complete focal platform flakes. Although there were not enough implements from this site to justify a Reduction Chart, thisdebitage assemblage seems to be what can be expected for most sites which are heavily represented by the Microblade Industry.

Moving into the ranges, threedebitage histograms are shown for the Nymagee North Site (Cob-75). Two graphs are shown, one of the fine-grained volcanic material common in the area (Cob-75 in Figure 6.11) and another of quartz (Cob-75 in Figure 6.12). These graphs reflect the results of the Reduction Chart for the site (Figure 6.4). The Reduction Chart showed a scatter of large cores as well as a smaller cluster close to the 1x1 line. There also were a range of flake tools. Figure 6.12 indicates extensive quartz flake production including flat thin pieces (lamellates). An examination of the raw data indicate that the cluster of small cores are mostly quartz, and the quartzdebitage would be mostly from the reduction of these as core tools. A few large broad platform quartz flakes also are present in Figure 6.12, peaking at LC 7 (40mm to 44mm) and these were probably for use as flake tools. The large cores of fine-grained material were producing the flakes in Figure 6.11 which has a very high proportion of focal platform flakes. Most of these are probably from resharpening heavy duty core tools, although some may have been utilised as the smaller flake tools which were present.

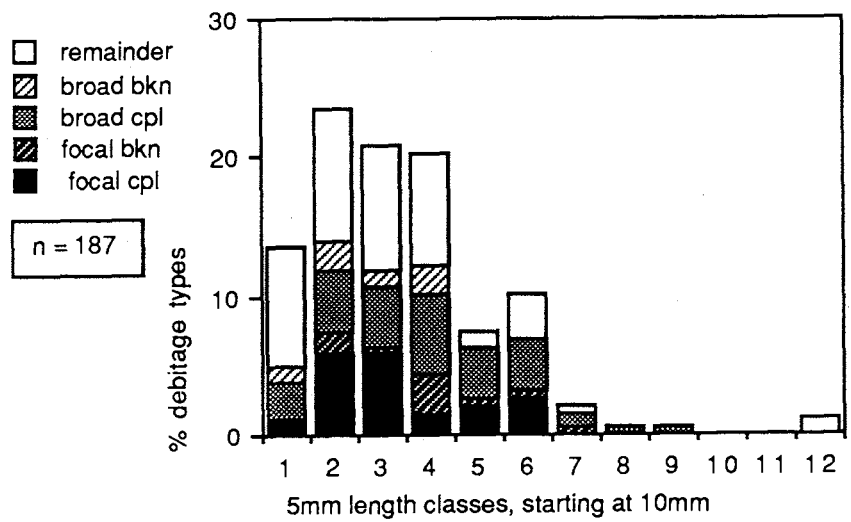


Figure 6.7 Debitage histogram for Cob-80, fine-grained

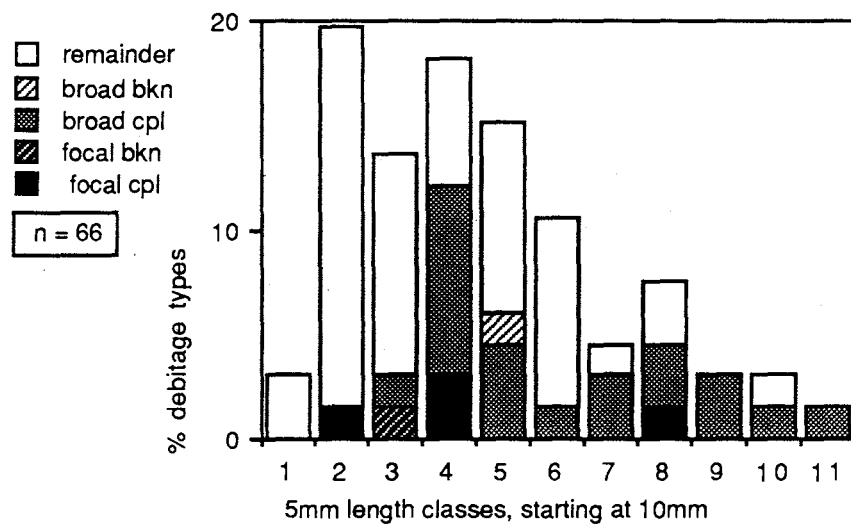


Figure 6.8 Debitage histogram for Cob-80, coarse-grained

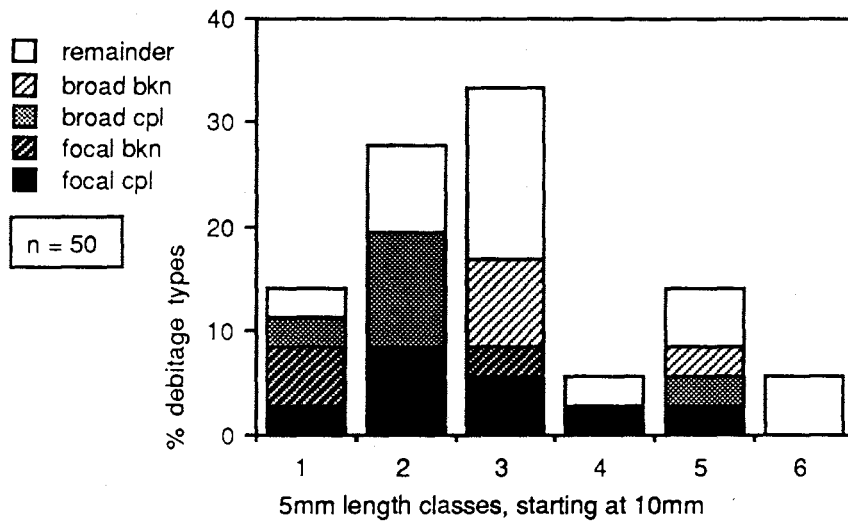


Figure 6.9 Debitage histogram for Cob-103

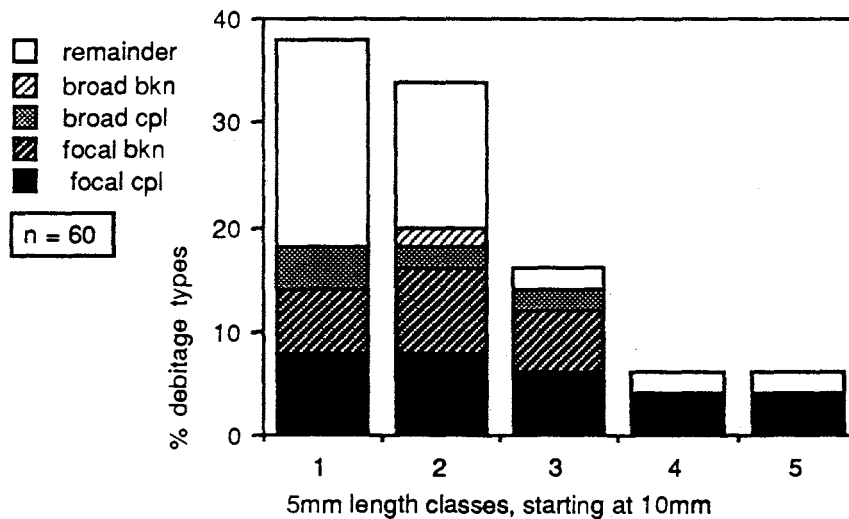


Figure 6.10 Debitage histogram for Cob-103, workshop

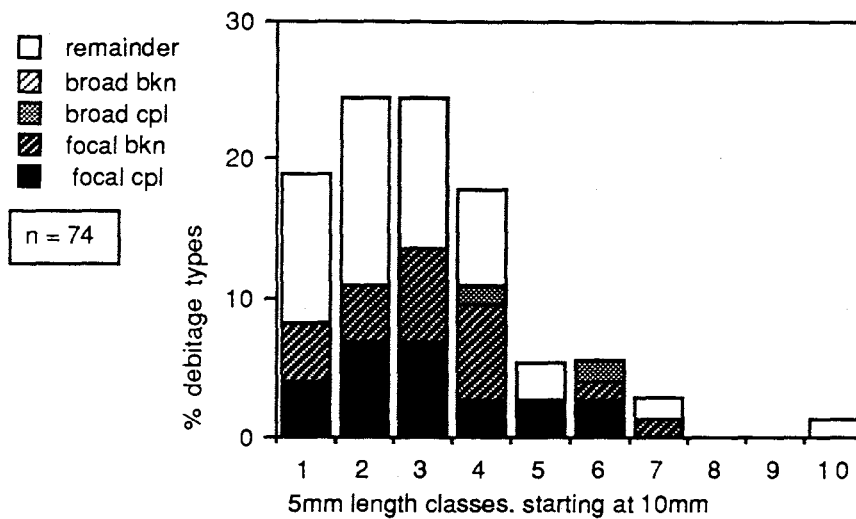


Figure 6.11 Debitage histogram for Cob-75, fine-grained volcanic

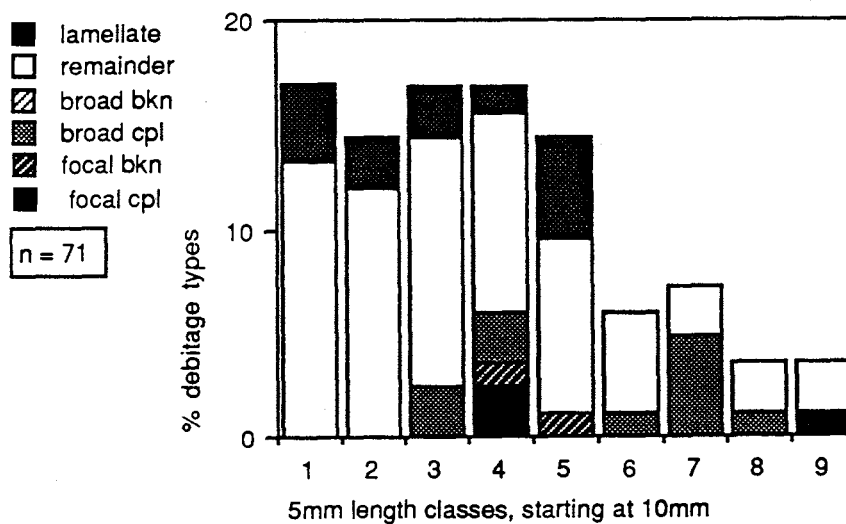


Figure 6.12 Debitage histogram for Cob-75, quartz

In the case of the Nymagee North site, the two separate manufacturing processes are clarified by the debitage which shows that there was a process of reduction for medium duty core tools, and another for the fine-grained materials which included heavy duty core tools and light duty flake tools.

The Microblade Industry also was represented at this site, and a porcelainite workshop for backed blade manufacture is shown in Figure 6.13 (Cob-75). This graph shows the dominance of focal platform production, but high level of breakage which is characteristic for porcelainite.

The Hartwood Site is close to the Nymagee North site, and the implement analysis indicated that it was probably closer to stone sources. This site produced a variety of workshops, including some belonging to the Core and Flake Tool Industry. The workshop shown in Figure 6.14 (Cob-139B20) shows a high proportion of large broad platform flakes at LC 5 and 6 (30mm to 39mm). Some complete flakes with platforms extend to length class 11 (60mm to 64mm). This would be the scene of production for a series of large flakes, possibly for transport away from the site.

In the same feature was a quartz workshop shown in Figure 6.15 (Cob-139B20). This workshop shows a significant proportion of broad platform flakes and lamellates. This probably reflects the high quality of quartz which readily permits platformed flakes and flake-like pieces to be produced. Most of the debitage is relatively small however, and probably not in the context of large flake production. Although it might be from resharpening a quartz implement while in use, an alternative interpretation is that it is a quartz core being trimmed and prepared for transport. If the latter was the case, then this would be consistent with the suggestion that the fine-grained volcanic core which was flaked at the same place also represented the production of implements for transport.

The Heartwood Site also had a number of microblade workshops, and one is shown in Figure 6.16 (Cob-139C29). This is a classic case in which LC 4 (25mm to 29mm) is nearly all complete focal platform flakes after a steady rise to this point. The large numbers of smaller debitage in the remainder category are mostly the breakage of the distal parts of blades.

A final debitage histogram (Figure 6.17) from the ranges is shown for The Gap Site (Cob-140, see map in Figure 6.1A). This was selected because it was in a different area of ranges. There were not enough implements for a Reduction Chart, and barely

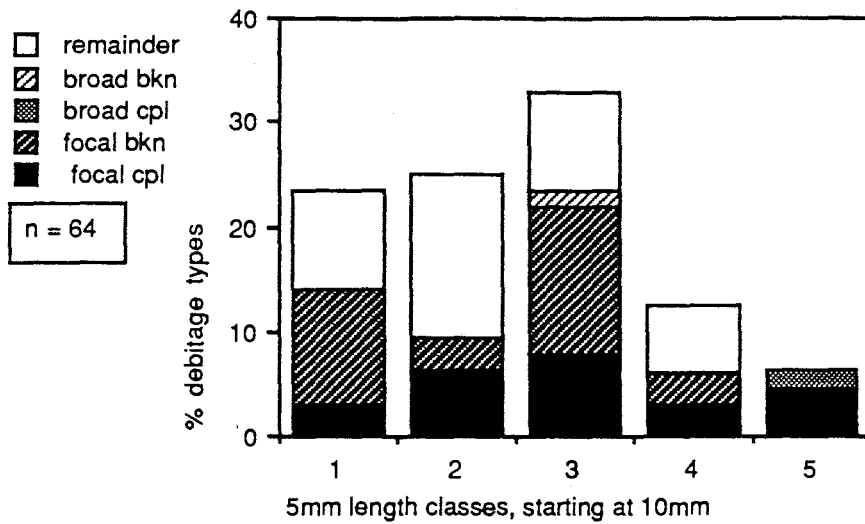


Figure 6.13 Debitage histogram for Cob-75, porcelainite workshop

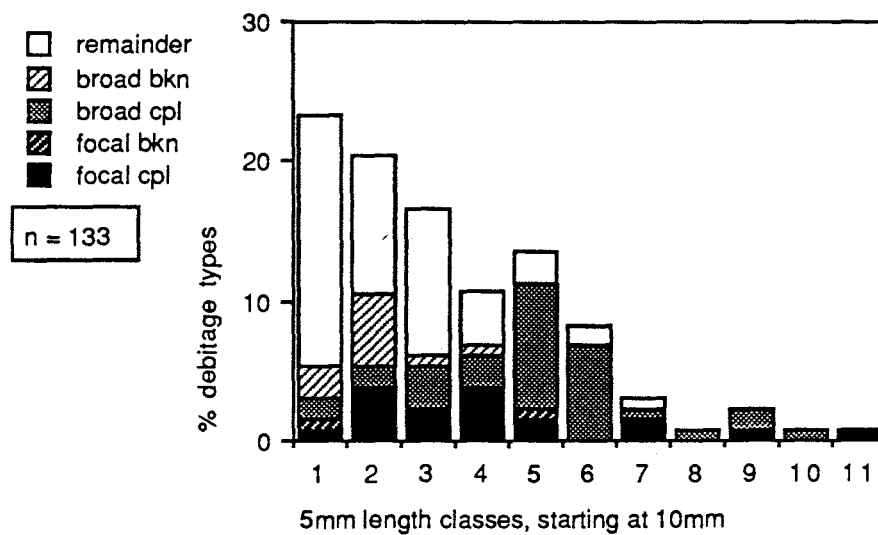


Figure 6.14 Debitage histogram for Cob-139 B20, fine-grained volcanic

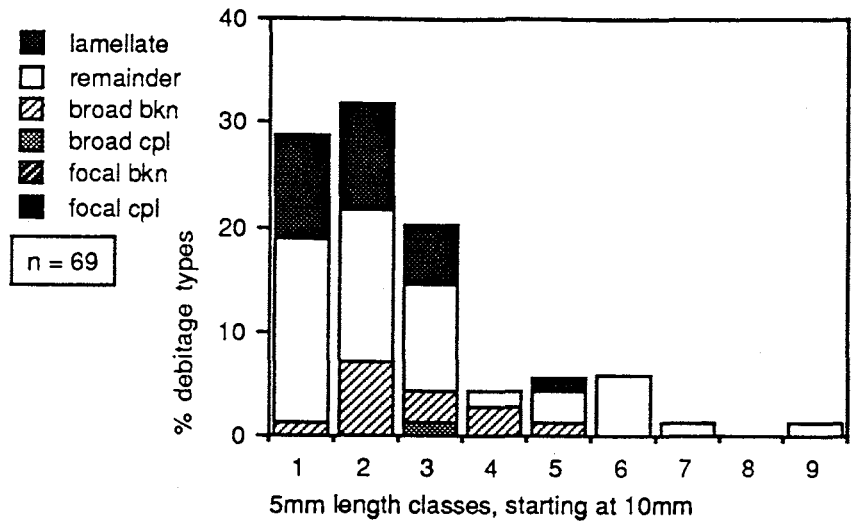


Figure 6.15 Debitage histogram for Cob-139 B20, quartz

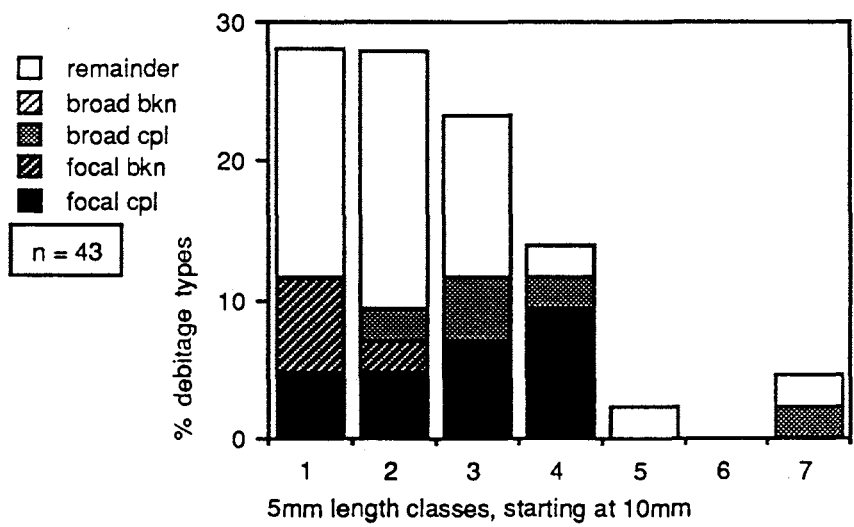


Figure 6.16 Debitage histogram for Cob-139 C29, microblade workshop

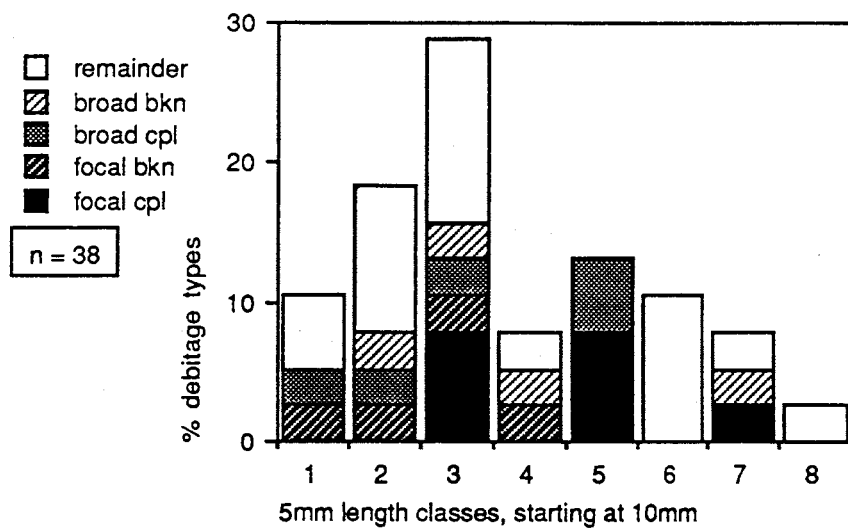


Figure 6.17 Debitage histogram for Cob-140

a sufficient quantity of debitage to graph. The pattern of complete and broken platformed flakes is not clear cut. The histogram shows a peak at LC 3 (20mm to 24mm) with the complete focal platform flakes being conspicuous, and another large number of complete platformed flakes at LC 5 (30mm to 34mm). This is probably best interpreted as a versatile use of cores as a source of flake tools as well as being resharpened as implements themselves, and is what might be expected at a short term camp site with good stone access.

The debitage assemblages above were mainly selected to show the extent of variation in the Cobar area. It includes some specific manufacturing processes as well as those which are highly generalised. The implications of this are included in the following section on the archaeology of the area.

ARCHAEOLOGY OF THE COBAR AREA

The sample pattern, environment and artefact variability have been described above. What now follows is a general discussion on the archaeology of the Cobar area, using this material and drawing heavily from the data collated in the Appendix as well.

The earlier discussion of Tables 6.2A&B and 6.3A&B noted that there seemed to be better effective coverage on the ranges, but that there may have been an overall bias to select quadrats which would produce sites. This needs to be considered in further interpretations of the data.

It also was noted that to obtain the three different Land Systems Types an extremely large area was required. For this reason the extensive dune areas (mainly to the south and west) were not incorporated in the sample. This type of environment may have been a significant element in the settlement strategy, but will have to be omitted from the following discussion.

Valley Sites

The valleys indicate that the main criteria for site boundaries was exposure, and this was chiefly as claypan/blowouts, blowouts and washouts, most of which could be collectively classed as scalds. The sites were largely found on degraded alluvial flats although some were present in dunes which were actually small sand drifts. Hearths of a variety of types were abundant, and a total of 211 were recorded for this land system type. The debitage also was relatively varied, and in addition to quartz and

silcrete, an important material was a fine-grained volcanic material, probably a rhyolite. In all cases however, silcrete was the most common material. Workshops were present (8 recorded), and debitage with focal platforms also was relatively common, and this may have been because there was considerable microblade reduction taking place.

In some cases very extensive sites were recorded, and even so, had to be arbitrarily bounded. It is probable that there are intermittent archaeological deposits throughout this land system type, but mostly with a low density of artefacts. Except for occasional floods, or heavy rainfall events, the valley streams do not often carry water, and this is probably why the red gums grow in the channel bottoms. There also is a great deal of sand cover in the uplands which would reduce the runoff. Good long term waterholes were probably rare in this Land System Type, but after being periodically charged with water it was no doubt very productive. This may be why about half of the hearths found were recorded for the valleys.

Uplands Sites

The uplands sites were mostly determined by exposure, and sometimes this exposure was sufficiently extensive that cultural boundaries could be found, but there were cases where arbitrary cut-offs were needed. The upland sites were along small watercourses, often against the slope of a ridge. Once again, hearths were common, but only 60 were recorded. The main material for stone flaking was silcrete, and 9 workshops were recorded. In many cases focal platform reduction was common and the quantities of flakes were rarely large.

The uplands are similar to the valleys in that the result of most rains is to produce short term water sources and ephemeral bursts of productivity. The uplands however are highly heterogeneous with varying amounts of rocky and sandy surfaces as well as flat and hilly land. Thus depending on rains during cool or warm times of the year, as well as the amount of rain fall, there were probably a wide range of options in this Land Systems type.

Even though the discussion regarding Tables 6.2A&B and 6.3A&B suggested some sample bias, there were a few extensive sample systems (Beaumont transect, Meadow Glen quadrats, and The Meadows quadrats - Table 4.1) which did not produce sufficient archaeological material to be judged a "site". Also in one instance (the Elsinore Site, Cob-137), there seems to have been a seep or a spring. It would be a

mistake therefore to assume that sites were abundant throughout this Land System Type. However, even though different kinds of environments were occupied, there seems to be considerable similarity in the sites throughout, including the Valley Land Systems Type.

The most distinctive site in the uplands country was the Meadow Glen Rock Art Site. It is located near a large waterhole and like most of the other Cobar art sites, it is associated with a large camp site (McCarthy 1976, Gunn 1989). The decorated overhang mostly seem to be in places where social gatherings could be expected by people seeking shade or protection from rain. Thus although some of the art sites may have had a sacred function, it would seem that most were mainly adjuncts to the main living areas. Part of the significance was probably the presence of a large waterhole in the uplands country which permitted a large sized camp. Evidence of belonging to such a place in the form of a hand stencil, or a drawing representing some event could have been meaningful in a variety of ways.

The dating of rock paintings is a notoriously difficult problem, and there is no direct evidence applicable to the Cobar case. However, considering the generally good preservation of the paintings, it seems probable that they do not represent a great antiquity. Only a single backed blade was found at the Meadow Glen site by the survey. McCarthy, who recorded the sites associated with the rock art and undertook some excavations as well, encountered relatively few backed blades (McCarthy 1976:89-96). Backed blades also were not conspicuous during the recording of site Cob-90. This site therefore cannot be considered as a microblade site in the same sense as other sites in the Cobar area, and it may be that it belongs mainly to a later period.

Ranges Sites

Sites in the ranges were mainly identified by places where there was enough erosion and gulying to strip away the vegetation and litter. This was mostly along watercourses at the base of hills, and largely seemed to be seepage or spring discharge points. The exposure was probably in large part due to grazing impact and there were usually stock dams nearby. Exposure and water availability therefore seem to be closely related.

These sites also produced hearths, but not necessarily in abundance (although 50 hearths were recorded at the Heartwood Site, Cob-139). In some cases quartz was

common, sometimes more common than silcrete, presumably due to local availability. This presence of quartz also probably affected the tendency towards block fractured debitage. Workshops were very numerous in the ranges sites (14) considering the few sites present.

Two very large and extensive sites were recorded in the ranges (the Heartwood Site Cob-139, and the Nymagee Site Cob-78), both of which are located on permanent springs. Thus unlike the Tibooburra area where the long term sites appear to be associated with waterholes on the main stream systems, it is the ranges in the Cobar area which take on this function. The most productive food source was probably in the valleys, but as drought began, they would have to retreat to the springs in the Ranges.

A chronological assessment of this pattern is difficult to make. No sites which seemed to be in Late Pleistocene or Early Holocene sediments or surfaces were found. There were none with technological features which did not seem to belong to a later time. Backed blades and workshops were very strongly associated with the ranges, but were not uncommon elsewhere.

Land Use Models

Although the Cobar area is drought prone like the Tibooburra area, it is not as arid. The survey did not include the sand dune area but kept to the ranges, rolling hills and major stream bottoms.

In the ranges there are a few locations where there are permanent springs such as the Nymagee Site or the Heartwood Site. At these sites the microblade debris are exceptionally abundant and extensive. I suggest that such sites represent base camps during drought times. Nearby there are other sites with less microblade material which may represent foraging expeditions from the base camps. At present the vegetation in the ranges associated with these sites in the Nymagee area is mostly wooded with open areas on dry aspects. The condition in Aboriginal times is difficult to conjecture, since burning patterns could have resulted in a more mosaic effect.

Another place where microblade sites were found was on the flood plains of the major streams. These flood plains were mostly covered by a thin sheet of wind-blown sand and areas with a good lag surface was limited. However, this was extensive in some places, and backed blades are consistently present, although not usually in exceptional

quantities. In some situations however, such as the sites in the Double Gates quadrats (Cob-79, Cob-86, Cob-135 and Cob-136) the microblade material was conspicuous. This area consisted of channels and flood hollows with wooded vegetation, and other patches which were open with saltbush or grasses. The effect was a mosaic pattern such as discussed for the Tibooburra area for sites with a large microblade component.

Sites with backed blades were found also in the uplands. At the quarry site Cob-135 they were present, but not in exceptional numbers and no microblade workshops were found. This area however was mostly open, and although there were stands of trees it did not have a strongly mosaic effect. The exposure for the Buckwaroon Site (Cob-102) was small and limited to the edge of the stream bank, but the stone assemblage was consistent with what has been suggested to be a "microblade base camp".

The microblade sites in the Cobar and Tibooburra areas both occur as extensive occupations at localities with long term water, and where there is, or probably was, a mosaic type of vegetative cover. In the case of the Cobar area this is more in the ranges rather than on the major streams. Throughout both areas, sites with small numbers of backed blades or pirris also are relatively frequent. There seemed to be a lack of such sites on the Tibooburra plains, and in the Cobar area such sites were uncommon in the uplands.

The period presumed to follow the Microblade Industry may also be compared between the Cobar and Tibooburra areas. The permanent spring localities have an extraordinary density of debitage, cores and flake tools, and these certainly would have been intensively used during times of drought, the same as in the previous period.

After rains, however, the rest of the region would have been readily accessible and productive. The nature of the occupations in these regions is difficult to assess because of the thin layer of sand which covers much of it, but it is clear that the riparian environment received a great deal of use, and there was considerable activity in the upland country.

This use is well represented by hearths and grinding slabs. Tabular sandstone is common in the region, and grinding slab fragments are common. In form they are of the basin type but are rarely worn to much depth. Since the sandstone is relatively hard, it must be pecked to produce an abrasive surface. This pecking may be a factor

in the breakage of the grinding slabs. The alluvial flats associated with the stream bottoms would have been highly productive for grasses, and these were clearly an important food resource.

The flaked stone associated with the valley sites varies in density. For example, parts of the Buckwaroon Site (Cob-80) are relatively dense, and the Belarabon Lake Site (Cob-82) has a high density. It would seem that small scattered camps and larger aggregations both occurred along the major watercourses. If the Microblade Industry can be used as a chronological indicator, this valley occupation seems to be greatest late in time.

Another conspicuous feature of the valley sites are the hearths. These are mainly constructed of fired clay heat retainers derived from termite nests. They vary from about half a metre to two metres in diameter and are a prominent feature. In some cases grinding slab fragments may also be included as heat retainers along with the termite clay. In one example, the Buckwaroon Site (Cob-80-F1), three grinding slabs were deliberately broken up for this use. The fragments were placed in the hearths in stacks. The breakage included both the rectilinear fracturing before use in the hearth, and the curvilinear heat spalling caused later.

These hearths would have been used for cooking a variety of foods (Clark and Barbetti 1982:148-9). In this region the main function may have been for baking root foods such as the ribbon lily (*Triglochin procera*) which might have been abundant in the box swamps and channels associated with the major streams.

I suggest that the most effective way to intensively use the valley type of environment would be as small groups distributed linearly along the major creeks rather than as a large base camp set up to use "hinterland" resources as well. In the valleys it would be possible to camp directly adjacent to the principle food resource and literally eat one's way along the stream.

The implications of the proposed differences between the microblade period land use and the later non-microblade period are discussed further in Chapter 8.

CHAPTER 7

THE BOOROWA AREA

BACKGROUND

The Boorowa sample area is in the Southern Tablelands and is about 75km by 25km in size. It extends from Boorowa nearly to Canberra. The location of the Boorowa area is shown in Figure 7.1.

Environment

The elevations are mostly between 700m and 600m. The Boorowa River at Boorowa in the northern part of the area is at about 480m and the Yass River at Yass to the west is 500m. The peak elevations are about 815m in the Mundoonan Range in the middle, and about 810m at Narrawa Peak near the Lachlan River to the east. Further to the east is the divide of the Great Dividing Range and on the opposite side to the west are the slopes which fall away to the plains. The following environmental data was mostly taken from Plumb (1973).

The Boorowa area has a temperate climate, generally with an average rainfall of between 630mm and 760mm, with the greater falls in the higher elevations. The seasonal rainfall is not marked, but there is a tendency for more rain in the winter. The region receives its rainfall with some regularity, although there are occasional droughts and floods. The average annual temperature varies according to elevation as well, ranging from 15 C. at the lower elevations to 12 C at the greater altitudes. The summer average maximum may be about 30 C. and the winter average minimum 0 C. Although there can be considerable daily variation, the climate is not as violently changeable as the other two areas. Although it is cooler and more moist, falls of snow are very light, rare, and of short duration even at the higher elevations. Fogs and nightly frosts are common in the winter months. The area is generally well-watered, and there are some permanent streams and many temporary water courses which carry water regularly, especially in winter.

The Southern Tablelands consist chiefly of uplifted and block faulted Silurian and Ordovician sedimentary and igneous rocks. These include siltstones, shales, granites

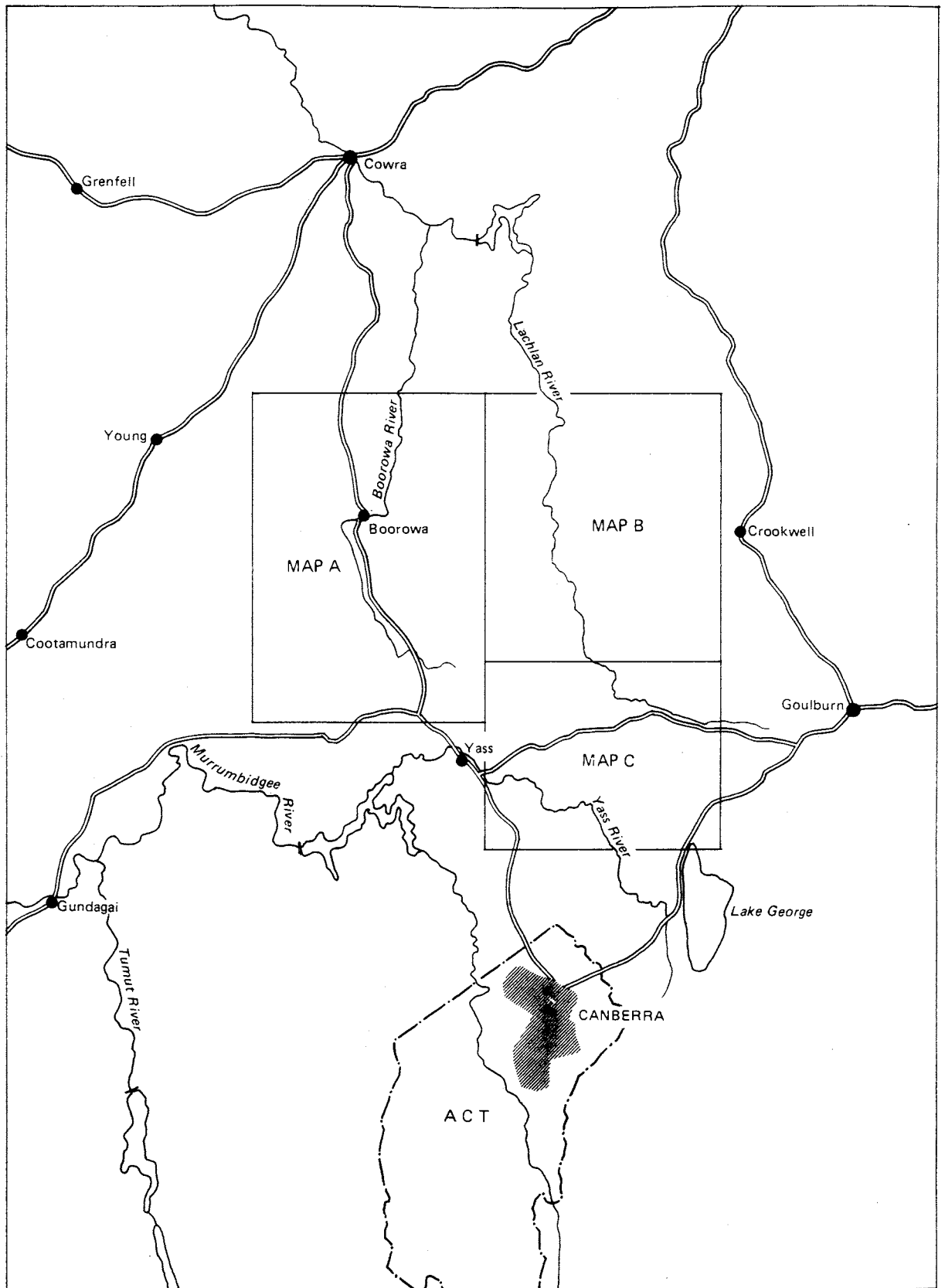


Figure 7.1 Map showing the location of the Boorowa Area and the positions of Map A (Figure 7.1A), Map B (Figure 7.1B) and Map C (Figure 7.1C).

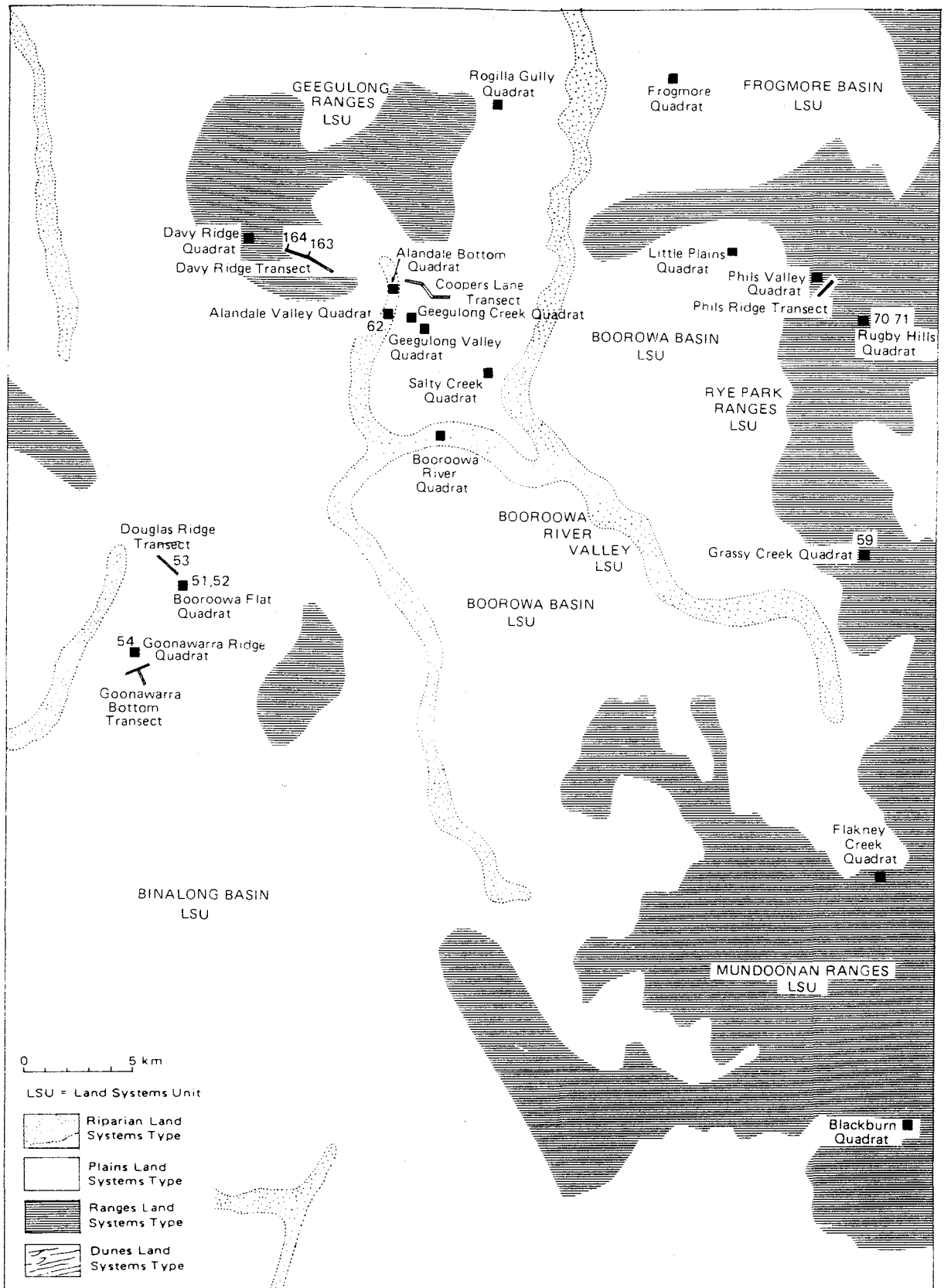


Figure 7.1A Map A of the Boorowa Area, showing the land systems units, sample units and sites.

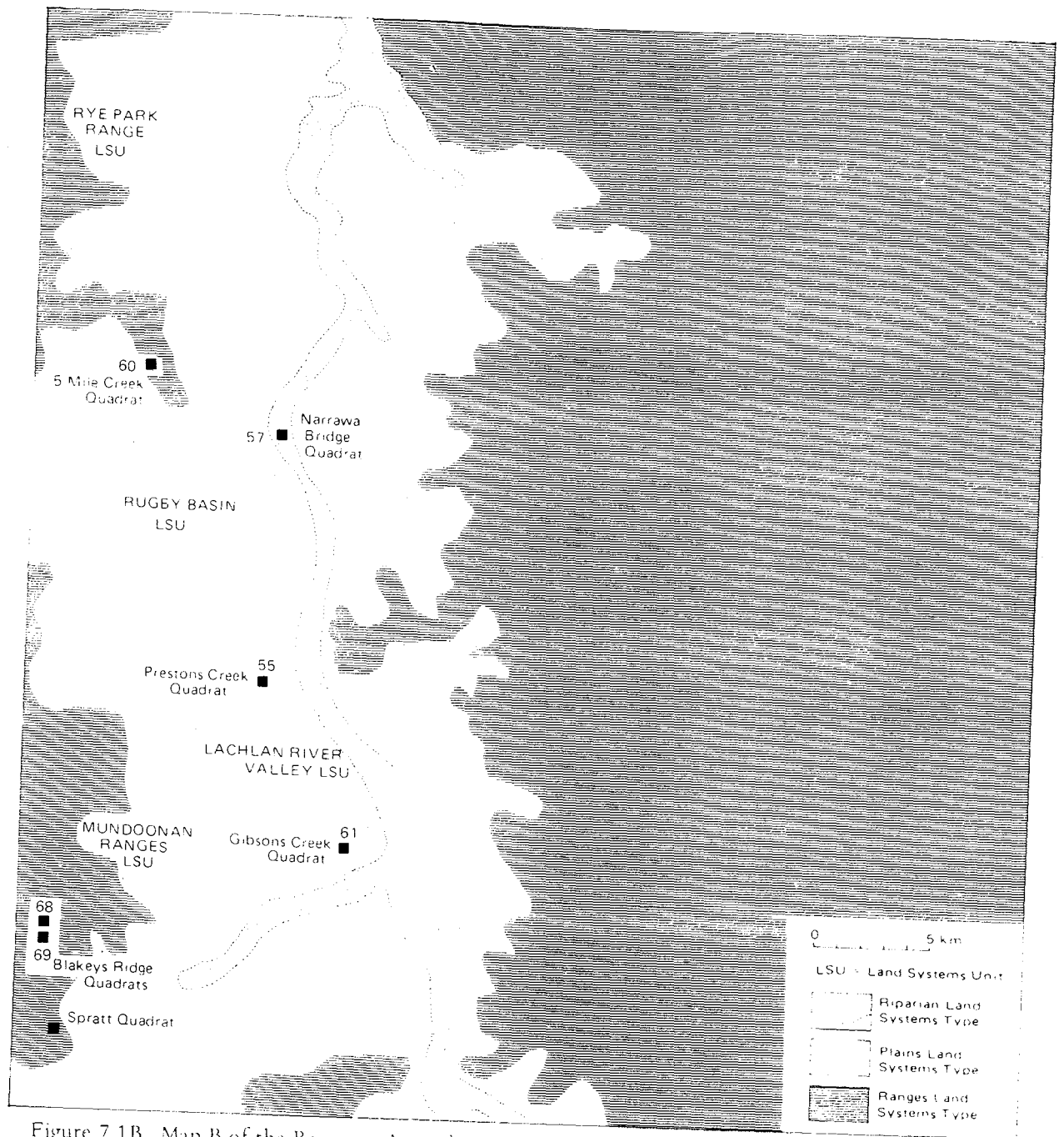


Figure 7.1B Map B of the Boorowa Area, showing the land systems units, sample units and sites.

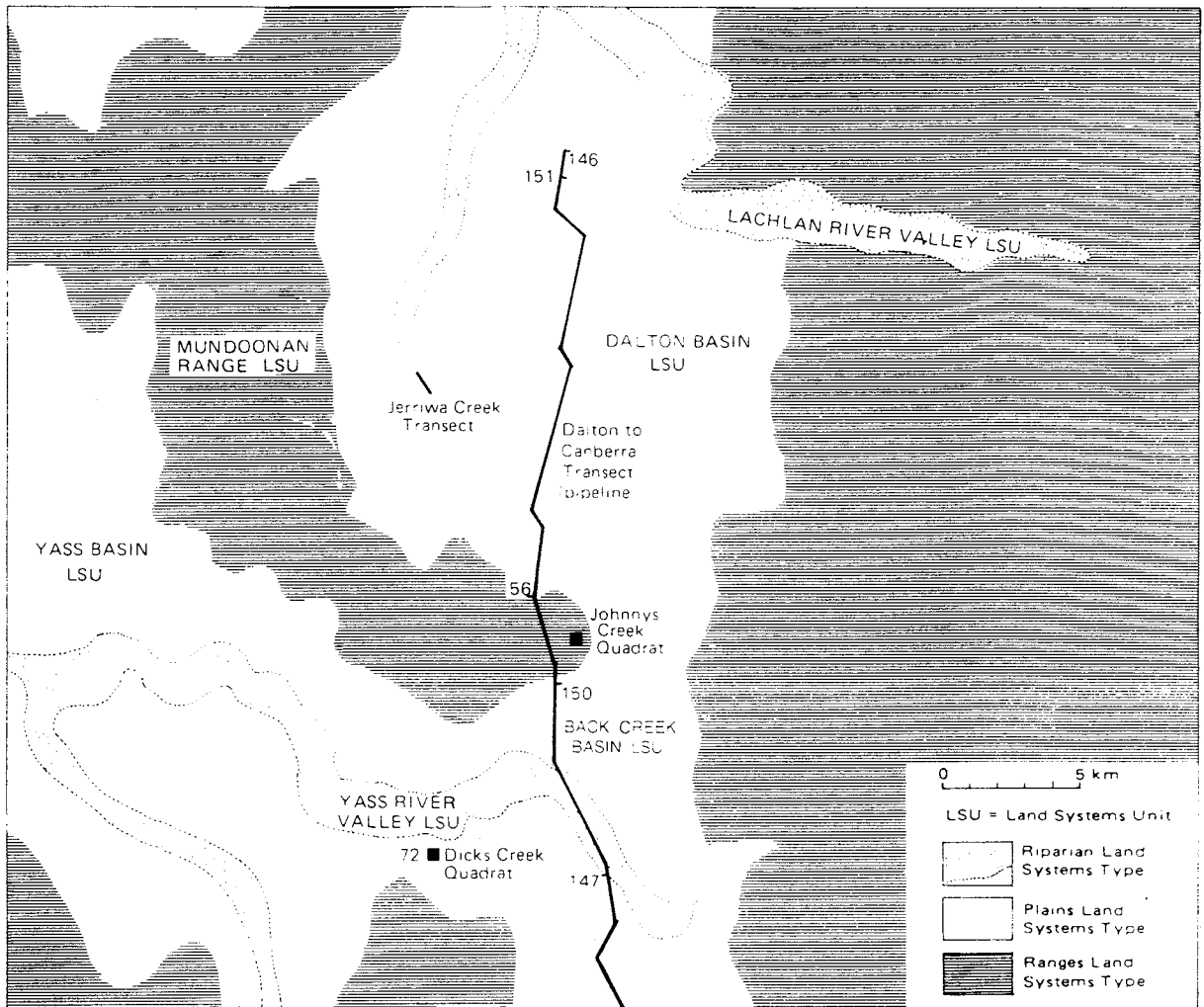


Figure 7.1C Map C of the Boorowa Area, showing the land systems units, sample units and sites.

and various extrusive volcanics. A few localities of Tertiary sedimentary and volcanic rocks are also known.

The landscape varies from undulating plains to high rugged ranges, but rolling plains and gentle hills predominate. The drainage of the region includes the catchments of both the Lachlan and Murrumbidgee Rivers. The soils mostly consist of grey and brown loams which rest on a clay hard-pan and are underlain by a clayey sub-soil. The soil on the steep hills is thin and stony and the granite soils are usually more coarse textured and leached.

Before clearing for pasture, the vegetation was mainly eucalypt woodland of medium height with a grassy understorey. This woodland probably was relatively open on the low alluvial plains. Natural grasslands also seem to have formed on the low plains, apparently due to cold air flow and frost. The higher elevations and ranges would have had dense woodlands and forests with a more shrubby understorey. Streams with flood plains were bordered by riparian woodlands and would have had swampy areas with permanent aquatic vegetation. All of this area has been cleared or logged, and the present stands of woodland are mostly secondary growth. Even the savannah-like areas have been selectively cut over, leaving trees for fire wood and shade. Some pastures with native grasses still exist, but introduced grasses generally predominate. The area has been heavily affected by European pastoralism with some areas under cultivation. Other effects are the innumerable dams on water courses, road systems and housing. Seeps and springs are rapidly becoming saline, causing considerable erosion. This may be a direct result of deforestation (Packard 1984).

Aboriginal Culture

All of the first-hand information on the Aborigines of the Boorowa area of the Southern Tablelands is in the form of passing comments or general statements by early travellers. Even by 1818 few Aborigines were noted in the area. However, over ten sources have been collected by Flood (1980) which have statements relevant to the Boorowa Area, and others have been found by Clark (1977). The people were pictured as using bark huts and skin cloaks in the colder months, as well as building bough huts. There are accounts of kangaroo drives and fish drives. Although the nature of the diet is difficult to infer, root foods and meat may have been of primary importance.

According to Tindale (1974) and Oates and Oates (1970), the Boorowa area was occupied by Ngunawal speakers belonging to the Yuin-Kuric group of the Dividing Range and coast. The Yuin sub-group is located from about the Victoria border to Sydney. Clark (1977:14), however, suggests that the Wiradjuri, which were allied with the Wongaibon/Ngemba speakers, would have extended from the west about midway into the Boorowa Area.

The Ngunawal seem to have disappeared with no recorded details on their social and political life. However, they were probably similar to the Ngarigo to the south (see Flood 1980:122), for which there is a little more information. Here the social organisation contained Eaglehawk and Crow classes which had nine totemic groups each, probably inherited patrilineally. Initiation ceremonies, possibly including the use of Bora Rings, were associated with the ritual evulsion of an incisor. There were no moieties or sections, and marriage was exogamous to the residential group (Berndt and Berndt 1977:55). This situation seems to have led to frequent raiding in retaliation for wife capture. The residential group seems to have been the political focus with a relatively well-defined leadership role for the head of the group. The Ngunawal, together with the people occupying the highlands, participated in the feasts and ceremonies associated with gathering and processing the bogong moths (Flood 1976).

European settlement began with sheep pastoralism and this continues to be the main industry. Boorowa was founded as a result of gold mining. At present it is mainly a pastoral area with some crop production. Although there are assorted small enterprises associated with the larger towns, it is little industrialised. There was a brief Aboriginal reserve at Yass and there are the remnants of one at Cowra (Read 1988). However, attempts by Aboriginal people to form settlements in the region have been opposed by municipal governments and the Aboriginal Protection Board.

Previous Work

The archaeology of the Southern Tablelands was first investigated in a doctoral thesis by Flood (1973). This work included the recording and analysis of sites in the Canberra lowlands. Another research project was carried out by Clark on Waterhole Flat near Boorowa (1977). In addition to his detailed survey work, he undertook a test excavation of an Aboriginal camp which was occupied within historic times. Work also was carried out in the Yass River valley by Packard (1984). The results

showed a strong correlation of seeps with archaeological sites, especially those containing the Microblade Industry.

No sites were recorded along the Moomba Pipeline where it crossed the area (Haglund 1974). However, a survey on a branch connection with Canberra produced numerous archaeological sites (Witter 1980b), one of which underwent salvage excavation (Witter 1981). Relevant to the region also is the work on the Lake George pollen sequence (Singh 1983).

Although rock art sites and stone arrangements are known in the highlands to the south and east, none has been located in the Boorowa Area. In the absence of rock overhangs and the general agricultural disturbance of the surface, this is not surprising. Scarred trees and even carved trees have been recorded to the west (Witter 1980a, Bell 1981), but none have been found in the Boorowa Area. A Pleistocene occupation has been reported to the east at Lake George (Flood 1980:345). Quarries are rare, but a rhyo-dacite dike near Boorowa shows some signs of extraction (Boorowa Flat Quarry, Boo-51). The archaeological material in the area is almost entirely Late Holocene camps or isolated finds such as hatchet heads and other items. Some of the camp sites are very extensive, with abundant flaked stone and occasional heat-retainer hearths. The formal artifacts include bondis and assorted geometrics, bipolars, eloura, hatchet heads and whetstones, thumbnails, hammer stones and anvils, as well as a variety of flake and core tools. A well-developed quartz industry for producing lamellates and other artifacts of quartz is common in this area.

ARCHAEOLOGICAL LAND SYSTEMS

For the purposes of sampling the environment described above a land system scheme similar to those of the previous two areas was devised (Figures 7.1A, B, and C). In this instance there were no NSW Soil Conservation Service 1:250,000 maps to consult, but some information was made available by the Yass District Office. There also were publications on land systems in the Yass Valley by the Joint Planning Committee for the Regional Research and Extension Study of the Southern Table lands (1961) and in the Queanbeyan area by Gunn (et al. 1969). The Boorowa area Archaeological Land Systems Types and Units are given below.

Boorowa River Valley Land System Type

Most of the major water courses, such as the Lachlan, Yass and Boorowa Rivers are associated with terraces and floodplains. In general the riparian valleys of the main rivers and their major tributaries were relatively narrow. In addition to these there is also a widely branching network of ephemeral creeks which are semi-riparian in nature. The cut-banks now associated with these streams probably formed in post-contact times and the stream bottoms were probably more boggy in the past. These wet soils together with the cold air drainage appear to have encouraged the development of grassland areas on the valley bottoms in pre-European times. Elsewhere in the valleys, the vegetation was dense woodland. Many of the streams had permanent water and they would have supported aquatic plants and animals including fish and fresh water mussels.

1. Boorowa River Valley Unit. The Boorowa River and its main tributaries do not usually have extensive flood plains and portions may have had weakly developed channels. The distinction between the overstorey vegetation lining the river and the rest of the basin plains was probably not great, but the principal trees would have been Blakelys red gum (*Eucalyptus blakelyi*) and river red gum (*E. camaldulensis*). The only swampy portion appears to have been just up-stream of the town of Boorowa. The understorey of the valley bottoms was probably lush with herbaceous vegetation.
2. Yass River Valley Unit. In some portions of the Yass River and a few of its tributaries, the flood plains and terraces are well developed and have deep alluvial soils. Stands of Blakelys and river red gums would have been present as well as yellow box (*E. melliodora*), and apple box (*E. bridesiana*). In some areas casuarina or leptospermum may have been common. Otherwise, it is likely that extensive areas were covered in grasslands (*Themeda sp.*, *Poa sp.*).
3. Lachlan River Valley Unit. In general the Lachlan River is steeply cut into hilly country. Although there are floodplains and terraces developed in some places, there probably was not a great distinction between the Blakelys red gum, river red gum and yellow box woodlands along the valley bottom and the valley sides, except that there may have been a more herbaceous understorey.

Boorowa Basin Land Systems Type

Most of the area is comprised of valley basins with undulating plains and rolling hills. Depending upon local physiographic conditions the region would have been covered by an open woodland or savanna with grasslands in the frost hollows. The soils range from red earths to podsols and other duplex types.

1. Boorowa Basin Unit. The Boorowa Basin consists of rolling plains and hills on Silurian volcanics which were dissected by numerous water courses. The tree vegetation would have been dominantly white box (*E. albens*) and Blakeleys red gum.
2. Binalong Basin Unit. This basin effectively is a continuation of the Boowowa Basin.
3. Dalton Basin Unit. The Dalton Basin consists of hills and flats formed on mainly Ordovician granite. In addition to the yellow box and Blakelys red gum the woodlands and savannas would have had Argyle apple (*E. cinerea*) and a variety of acacias and other shrubs.
4. Rugby Basin Unit. This basin essentially is an extension of the Dalton Basin Unit.
5. Back Creek Basin Unit. This is a small basin surrounded by hills and ridges. It has flats with extensive Quaternary alluvial deposits and this may have been covered with grasslands. The hills are on Ordovician sediments and would have been a woodland of Blakeleys red gum and yellow box with a mixture of apple box, scribbly gum (*E. rossii*) and spotted gums (*E. mannifera*).
6. Yass Basin Unit. The Yass Basin has formed on both Ordovician sedimentary and Silurian volcanic rocks, and although there are some relatively flat areas, most of it is hilly and steep. The vegetation would have been mostly a Blakeleys red gum and yellow box woodland. An extensive grassland to the south of the town of Yass may have been present due to cold air drainage.

Boorowa Ranges Land Systems Type

The high ranges occur between the basins and vary from rounded hills of high elevation to steep and prominent ridges. The vegetation is a relatively dense sclerophyll woodland. The soils are stony with some duplex types, especially podsols.

1. Rye Park Range Unit. This is a gentle ridge of Ordovician sedimentary rocks with a relief of about 100 m. It would have been covered by a woodland of stringy bark (*E. macrorhynca*), but with spotted gum and scribbly gum being important or dominant in some portions. Locally iron bark (*E. sideroxylon*) or apple box would have been present as well.
2. Geegulgong Ranges Unit. This is another low system of ranges and probably had vegetation similar to the Rye Park Ranges Unit.
3. Muntoonan Ranges Unit. These ranges are steep ridges and high hills of mostly Ordovician sedimentary rocks with a relief of about one hundred metres. The vegetation was dominantly red stringy bark sclerophyll woodlands but spotted gums and scribbly gums may have been numerous or locally dominant.

FIELD WORK

The initial excursion in this area was carried out by driving the roads over a region bounded by Boorowa, Crookwell, Yass and Canberra. The area finally chosen for sampling was largely determined by where there were the most ploughed fields and eroded patches. After a period of camping in various places in the area, the remainder of the field work (Phase II) was undertaken from Canberra. Some previous fieldwork had been done in this area in the form of a pipeline survey between Dalton and Canberra (Witter 1980b). The results of this contributed considerably towards the early stages of the sample operation. A salvage excavation resulting from that survey was of further assistance (Witter 1981). Since the area has for the most part been cleared for farming and portions have been ploughed or are improved pasture, one of the main problems was in finding places with adequate exposure within the different Land System Types. Even more difficult was estimating the impact on native vegetation from over 100 years of clearing and farming.

All of the area was covered by 1:50 000 topographic maps, and these helped to determine the placement of the sample units. Some air-photo mapping was available, but was at a scale of inch to the mile and considerably out of date. Another difficulty was the system of land ownership which involved many small properties occupied by different land owners. In some cases the owners lived in town rather than on the property. All of this meant that often more time was required to locate and talk to a land owner for access than would be used in covering a small exposure or walking a transect which would cross a number of properties.

The quadrat approach was favoured in this area because it could focus on the large exposures such as ploughed fields or salt scalds. Transects also would have been mostly over pasture land with a visibility of less than 10%, making the detection of sites unlikely. The valley bottoms were particularly difficult to sample due to infrequent exposures. The ranges were usually covered by secondary woodlands and also tended to have few exposures. The sloping and hilly basin land was the easiest to sample, and an effort was made to include the full range of land systems, although exposures in granite country seemed hard to find.

SAMPLE PATTERN, COVERAGE AND RESULTS

As in the previous two sample areas, the effective coverage, site frequency, site types and artefacts are summarised in this section.

A list showing the various Land Systems Units and Types sampled is given in Table 7.1. Included in this are the distances per transect or areas per quadrat covered, and the estimations of how effective the coverage was.

Effective Coverage

The sample by transects for the Land System Types is shown in Table 7.2A. The greatest distance covered was in the Basins Type, and this also was the most effectively surveyed. In this case, the effective coverage closely corresponded to the actual distance mainly because vehicle tracks were used for transects, and these had similar amounts of bare ground. The quadrats (Table 7.2B) also show that by far the greatest sample was in the basin areas. This was largely because the valleys were either under crop or heavily grassed over, and the ranges were mostly wooded. The main areas with erosion, gullies and scalding were out in the basin country.

BOOROWA AREA

SAMPLE SURVEY

land system by type and unit	sample unit: quadrats, transects	dist/area surveyed by sample unit	effective distance/area	sites recorded by site number
<u>VALLEYS</u>				
Boorowa Valley	boorowa riv. 1 Q boorowa riv. 2 Q alandale val. Q alandale bot. Q	20000sqm 15000 sqm 125000sqm 14000sqm	4000sqm 3000sqm 5000sqm 4500sqm	62
Lachlan Valley	narrawa brdg T	300m	300m	57
Yass Valley	dalt to canb T	4388m	525m	147
totak	transects quadrats	4688m 174000sqm	825m 12500sqm	2 sites 1 site
<u>BASINS</u>				
Boorowa Basin	geegulong val. Q geegulong cr. Q coopers lane T salty creek Q little plains T	52500 sqm 141000sqm 3000m 10000sqm 1050m	750sqm 28500sqm 300m 5000sqm 1050m	
Binalong Basin	boorowa flat Q douglas ridge T goonawara bot. T goonawara rdg Q	3520000sqm 520m 3300m 37500sqm	35200sqm 260m 3300m 37500sqm	51(quarry), 52 53 54
Frogmore Basin	frogmore Q rogilla gully T	200000sqm 600m	24000sqm 600m	
Rugby Basin	gibsons creek Q prestons creek Q	5500sqm 72000sqm	1100sqm 72000sqm	61 55
Yass Basin	dicks creek Q dalton to canb T	2600sqm 5740m	1872sqm 1155m	72 150
Dalton Basin	jerrawa crT dalton to canb. T	140m 14835m	140m 275m	146,151
total	transects quadrats	29185m 4041100sqm	9561m 205922sqm	4 sites 6 sites

land system by type and unit	sample unit: quadrats, transects	dist/area surveyed by sample unit	effective distance/area	sites recorded by site number	
RANGES					
Geegalalong Ranges	davys ridgeT davys ridgeQ	1100m 10000sqm	1100m 125sqm	63, 64	
Rye Park Ranges	phils valleyQ phils ridgeT rugby hillsQ 5mi creek Q grassey crQ	70000sqm 4000m 28000sqm 4000sqm 56000s	7500sqm 200m 12600sqm 2000sqm 8000sqm	70, 71 60 59,	
Mundoonan Ranges	flakney creek Q blaknys ridge Q blackburn Q spratt Q jonneys creek Q dalton to canb. T	11000sqm 1050sqm 800sqm 30000sqm 3750sqm 2500m	5500sqm 1050sqm 800sqm 300sqm 591 sqm 1085m	68, 69 565	
	total	transects quadrats	7600m 214600sqm	2385m 38466sqm	3 sites 6 sites
<u>TOTAL SAMPLE</u>		transects quadrats	41473m 792700sqm	12771m 256888sqm	9 sites 13 sites

note: T = transects, Q = quadrats

Table 7.1 Table listing the sample units within the land systems and the recorded sites. Shown also is the total coverage and the calculated effective coverage (by % of the sample unit covered, and effects from exposure and visibility). The sites per sample unit are shown by site number.

EFFECTIVE COVERAGE:			TRANSECTS		BOOROWA AREA
land system type	total distance l/s type (m)	% total dist. l/s type	effective coverage l/s type (m)	% effective coverage of l/s type	% effective coverage of transect
valleys	4688	11	825	18	7
basins	29185	71	9561	33	75
ranges	7600	18	2385	31	18
total	41473	100	12771	31	100

Table 7.2A. Table showing effective coverage of transects by land systems type.

EFFECTIVE COVERAGE:			QUADRATS		BOOROWA AREA
land systems type	total area land systems type (sqm)	% total area land systems type	effective coverage l/s (sqm)	% effective coverage of l/s type	% effective coverage of quads
valleys	174000	4	12500	7	5
basins	4041100	91	205922	5	80
ranges	214600	5	38466	18	15
total	4429700	100	256888	6	100

Table 7.2B. Effective coverage of quadrats by land systems type.

Site Frequency

The site frequency by transects (Table 7.3A) indicates that in the basin areas that the sites were over 2km apart and elsewhere this frequency would be under 1km. The picture suggested by the quadrats however is different (Table 7.3B. Sites cover 3% or less of the land in the valleys and basins, but represent nearly half of the area covered in the ranges. This discrepancy is caused by the presence of two exceedingly large sites associated with extensive spring areas in the ranges and which were undergoing widespread scalding from salinity.

Site Types

All of the sites in the Boorowa Area were camp sites (Table 7.4), except for one quarry site of a material tentatively identified as a dacite. Although this was a relatively coarse grained material, it seemed to have been used only for flaking stone implements and not for ground edged tools.

Table 7.4 indicates that microblade sites are common throughout the land systems, that hearths are rare, and sites with workshops are generally present. Nearly all of the sites have quartz lamellates present, although there is no indication if specialised cores were being used.

Artefact Abundance

The presence of backed blades is seen in more detail in Table 7.5. Although the ranges produced 9 of the 21 sites recorded, 94 of the 126 backed blades were recorded in this Land System Type. Except that the densities of implements seem to be very low in the valley sites, and the basins have the site with the highest tool density, there does not seem to be much difference in mean tool densities. The somewhat greater densities with the transect sites is probably due to the tendency to record the more concentrated part of the site if on transect. There is also an improved likelihood of recognising low density sites in quadrats, since there is less chance of walking through a portion where the artefacts are very scarce (Schiffer et al. 1978:11-2).

STONE ARTEFACT ANALYSIS

The approach towards stone artefacts from the Boorowa area is the same as for the two previous areas. The stone materials are described first. Then the implements are

SITE FREQUENCY:		TRANSECTS		BOOROWA AREA	
land system type	number of obtrusive sites	number of unobtrusive sites	distance per obtrusive site (m)	distance per unobtrusive site (m)	
valleys	-	2	-	423	
basins	-	4	-	2390	
ranges	-	3	-	795	
totals	-	9	-	1419	

Table 7.3A. Table showing total transect distance per obtrusive and unobtrusive sites by land system type. Note: distance per obtrusive site / distance unobtrusive site - distance unobtrusive site = total distance per site by land system

SITE FREQUENCY		QUADRATS		BOOROWA AREA	
land system type	number of obtrusive sites	number of unobtrusive sites	area of obtrusive sites (sqm)	area of unobtrusive sites (m)	% area of sites in quads
valleys		1		2000	1
basins	1	5	30000	111929	3
ranges		6		98400	46
totals	1	12	30000	212329	27

Table 7.3B. Total quadrat area per obtrusive and unobtrusive sites by land system type.

<u>SITE TYPE:</u>		<u>BOOROWA AREA</u>					
land systems type	quarry sites	camp sites	micro-blade sites	grind stone sites	sites with hearths	sites with workshop	lamellate sites
valleys	-	3	4	-	-	-	3
basins	1	9	6	1	-	2	9
ranges	-	9	5	2	2	4	7
totals	-	21	15	3	2	6	19

TABLE 7.4. Table showing site types recorded for transects by land systems type. Note: total number of sites = 21.

<u>TOOL ABUNDANCE:</u>		<u>BOOROWA AREA</u>		
land system type	total no. backed blades	min tools per sqm	mean tools per sqm	max tools per sqm
valleys	4	0.002	0.006	0.010
basins	28	0.002	0.016	0.615
ranges	94	0.002	0.014	0.179
totals	126	-	-	-

Table 7.5. Table showing numbers of certain implement forms and densities of tools by effective area.

analysed on the Reduction Chart. This is followed by an examination of the debitage histograms. In the case of the Boorowa Area the debitage histograms are emphasised over the Reduction Charts, since the sites in this area did not as readily provide large assemblages of implements. Debitage however was extremely abundant, and there were numerous well preserved workshops.

Materials

The Boorowa area contains an abundance of reef quartz throughout. There is almost no place where a piece of quartz cannot be found within 100 or 200 metres. Sources of silcrete also seem to be numerous, but not as massive outcrops. The only silcrete source found during the survey was associated with Berrambangalo Site (Boo-56). This was a very weathered low outcrop. It is possible that the silcrete sources normally occur as in this form or as degraded colluvium.

Another important type of stone was a very fine black material referred to here as "felsite". No source of this was found, but it may have been derived from the Paleozoic volcanics. Also frequent, but unsourced, was a fine-grained volcanic stone which is presumed to be a rhyolite. The only quarry which was discovered was a dacite dike (Boo-51). This material was coarse and had large phenocrysts.

Implement Assemblages

The Prestons Creek Site (Boo-55, Figure 7.1B, Prestons Creek quadrat) is on a heavily scalded and eroded foot slope in the Basins Land System Type. It contained a mixture of felsite and silcrete implements as well as a few of quartz (Figure 7.2). A regression line has been fitted to the cores and indicates relatively low cross sections for most of the cores. Most of the cores are small and tend to group around the 40/20 reference point, which in the Tibooburra Area was typical for flake tools. Thus these core-like artefacts probably were the functional equivalent of flake tools found elsewhere. Also unlike most of the previous cases, the thickest cores are highly reduced, and may be part of a different reduction process from the smaller cores.

A regression line also has been plotted for the flake tools. The use-wear/retouch and specialised flake tool categories group below this line are very small implements. This may have some functional significance for precision tool use. Some microblade reduction also is indicated by the backed blades.

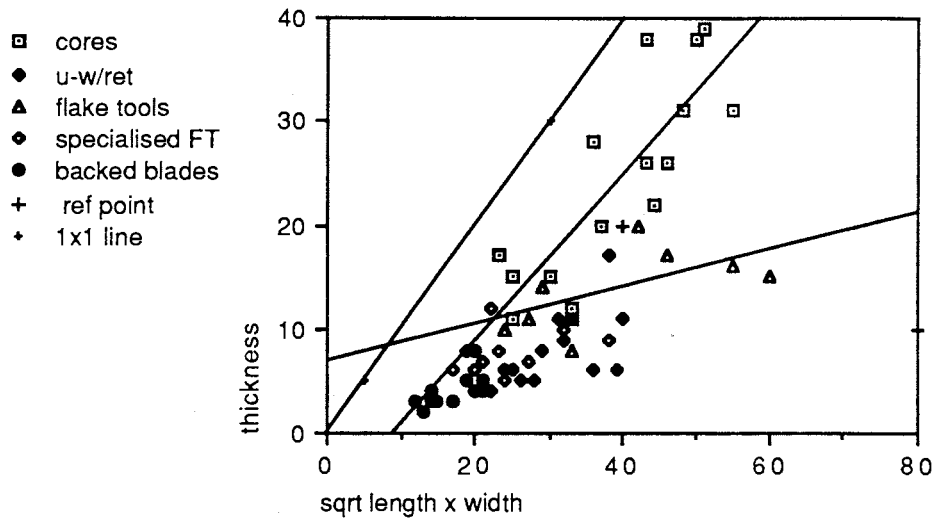


Figure 7.2 Reduction Chart for Boo-55

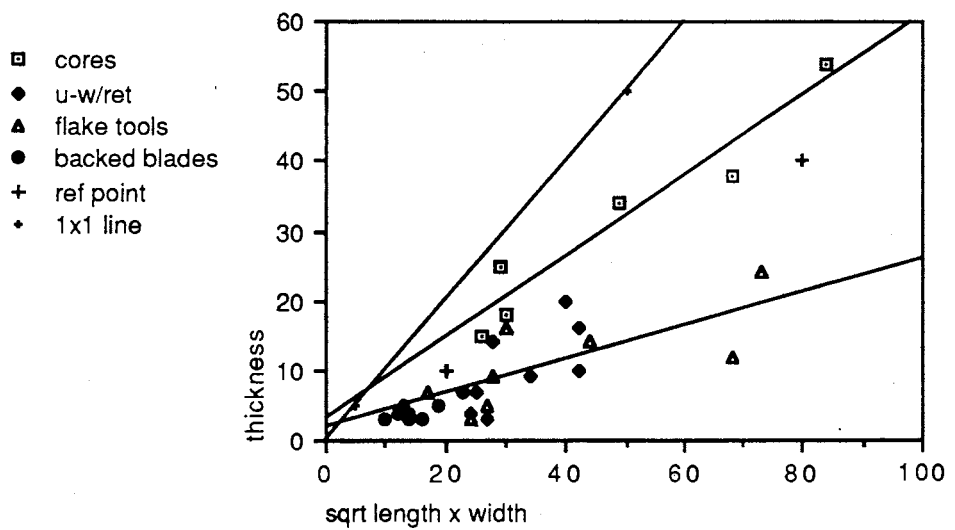


Figure 7.3 Reduction Chart for Boo-72

The Dicks Creek Site (Boo-72, Figure 7.1C, Dicks Creek quadrat) also is in a Basin Land Systems Type and is a scald on a lower foot slope. The Reduction Chart (Figure 7.3) shows a regression line for the cores which indicates a relatively low cross section for the larger examples. Some of the cores are larger than those at the Prestons Creek Site, but there also are small ones in the vicinity of the 40/20 reference point.

This site also shows a series of light to medium flake tools and a regression line has been plotted. Unlike the Prestons Creek Site above, there are no specialised flake tools and those with use-wear/retouch are scattered about in various sizes.

These two basin sites have differences which are difficult to explain in terms of stone material access. The presence of backed blades also suggests no important chronological differences. The Dicks Creek Site seems to be a simple case where cores were brought onto the site and reduced to become smaller and have more square cross sections. No specialised use of unretouched flakes or other flake tools seems to have been made. The Prestons Creek Site (which was exposed as a much larger area than the scald recorded for the Dicks Creek Site) seems to have some specific forms of use with heavy duty core tools and fine duty flake tools. This pattern might be consistent with wood working crafts, such as shield making, in which a large wooden blank is shaped, finished and ornamented.

One of the largest sites found was the Grassy Creek Site (Boo-59, Figure 7.1B). This site was located on the foot slope in a high tributary valley in a Ranges Land System Type. It was extensively exposed site and provided well defined workshops and clusters of debris.

Several microblade workshops were present, and all of the microblade implements are shown together in Figure 7.4. The chart contains mainly backed blades, and a regression line indicates that they are all of a similar thickness. This backed assemblage consists of rejects at various stages of manufacture. The finished items would have been removed for use elsewhere.

Other concentrations of implements debris or tools associated with hearths (but not from microblade workshops) are shown collectively in the Reduction Chart in Figure 7.5. This chart includes only the bipolars, cores and specialised flake tools of fine-grained stone (referred to as Boo-59 fine-grained - 1 in the Figure). The pattern here for the cores is similar to the Dicks Creek Site, and the regression line indicates that

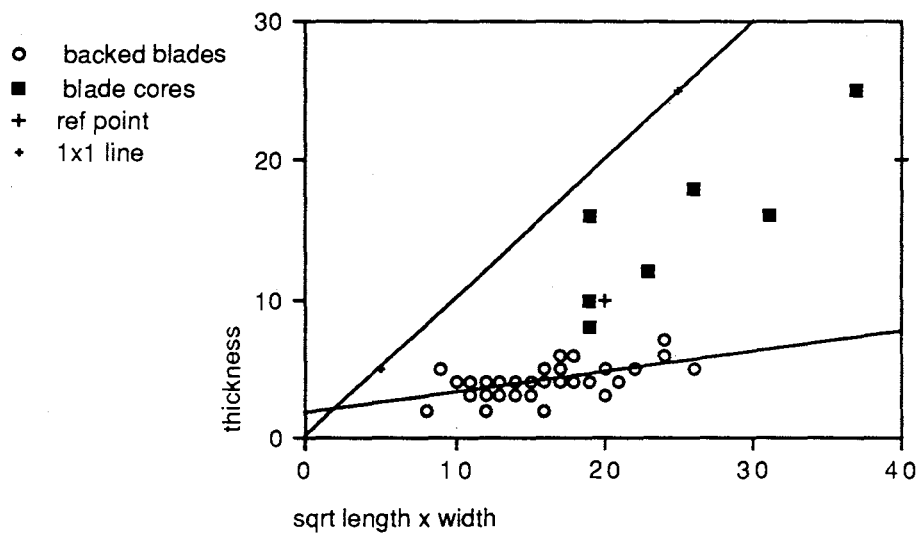


Figure 7.4 Reduction Chart for Boo-59, Microblade Industry

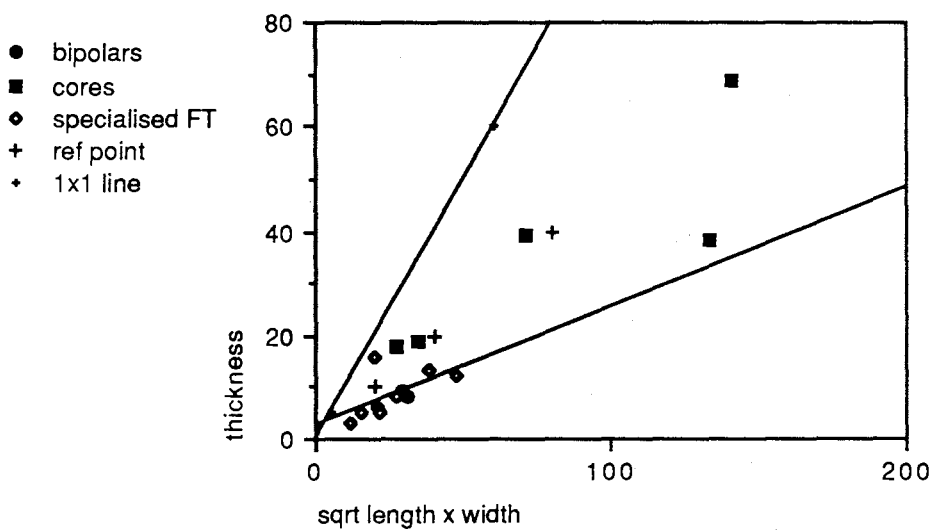


Figure 7.5 Reduction Chart for Boo-59, fine-grained stone - 1

the large cores have relatively low cross sections. The pattern shown by the cores from the Core and Flake Tool Industry is made clearer by recognising the blade cores and separating them out. This was helped by having identified some of the unexpected forms of blade cores by the time this site was found. For example, the bifacial alternating platform and the cube core types described in Chapter 3 had been discovered when this site was recorded.

A regression line also is shown for the specialised flake tools. Some of these are very small and thin, and an inspection of the raw data shows that these are micro-convex or "thumbnail" forms. They are similar to the convex flake tools found in the western sites already described, but thinner in cross section.

More flake tools for the Grassy Creek Site are shown in Figure 7.6. A regression line has been fitted for the flake tools. The use-wear/retouch tools mostly group with the fully retouched flake tools. Comparing the position of the specialised flake tools in respect to the reference points in the above graph, it can be seen that they also would group with the generalised flake tools. The reason the specialised flake tools were plotted with the cores was to prevent excessive crowding in Figure 7.6.

The quartz was plotted separately on Figure 7.7 and there is a regression line for the cores. These show a tight group of small highly reduced cores near the 1 x 1 line, and between the 40/20 and 20/10 reference points as well as a few larger ones with lower cross sections. These would seem to reflect the use of fragments of reef quartz as having an equivalent function to flake tools elsewhere. A single very large quartz core is present, and this may represent the original size of the others. If this was the normal size for a heavy duty implement, then the resharpening process would transform it into a smaller core-like implement. The fracture line acceleration (or flaw propagation) technique makes it possible to keep a relatively low cross section for leverage during use, since resharpening does not require an acute platform angle. Quartz flake tools also are present, but few, and mostly very small.

The Grassy Creek assemblages indicate a highly variable pattern of stone procurement and use. Cores of fine grained material, some of which are large, were brought onto the site. Some of this material was used for microblade cores, and backed blade production was a major activity. Flakes also were produced for flake tools, and might undergo varying degrees of retouch and shaping. Quartz was an important material and could be brought in as large pieces and finally reduced down to light duty implements which were a functional equivalent to the flake tools of finer

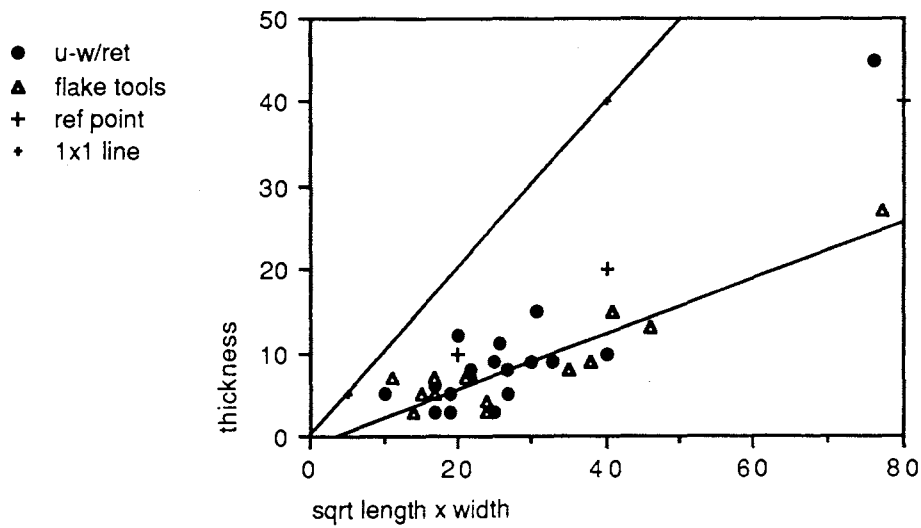


Figure 7.6 Reduction Chart for Boo-59, fine grained stone - 2

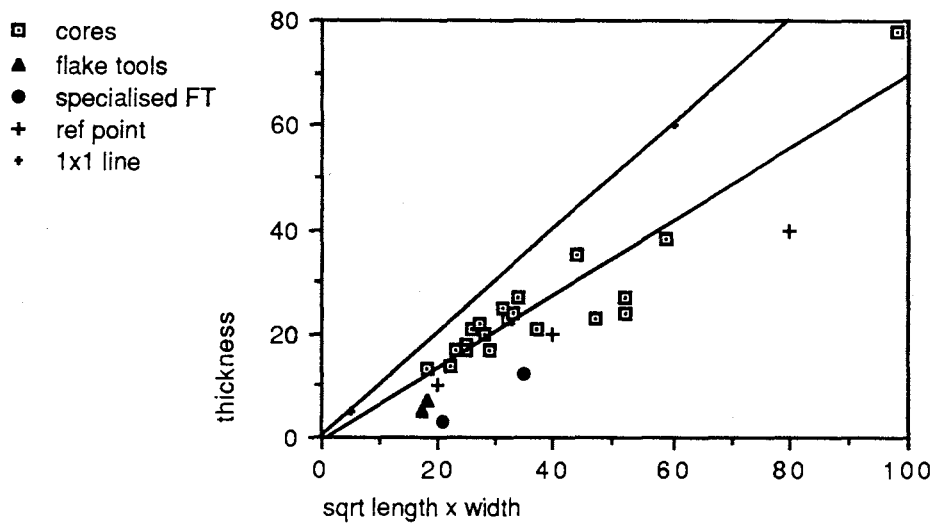


Figure 7.7 Reduction Chart for Boo-59, quartz

grained stone. This site is somewhat similar to the Prestons Creek and Dicks Creek Sites combined, and apparently represents a wide range of different types of activities due to long duration camps or frequently repeated visits. The site itself is in an ecotonal location near a basin of the Lachlan River, and situated at the mouth of a pass between two high ranges.

The Berrambangalo Site (Boo-56, Figure 7.1C, Canberra to Dalton transect) was another extensively exposed site on the foot slope of low hills and in the Ranges Land System Type.

The Microblade Industry was plotted as for the Grassy Creek Site in Figure 7.8. The backed blades are of a similar thickness, but mostly smaller in the Berrambangalo Site. More conspicuously, there are none of the larger blade cores.

The implements of fine-grained stone belonging to the Core and Flake Tool Industry are shown in Figure 7.9. The cores are mostly small sized, but not thick in cross section. The flake tool, use-wear/retouch, and specialised flake tool categories also were very small and mostly below the 20/10 reference point.

The quartz component of the Core and Flake Tool Industry is shown in Figure 7.10. A relatively high proportion of generalised flake tools were present and a regression line has been fitted. The specialised flake tools group with them, but the use-wear/retouch forms are generally smaller. The flake tools merge in size with the cores. The slope for the regression line of the cores is not as steep as for the flake tools, indicating a lower cross section for the larger cores (for which there are no large examples such as in the Grassy Creek Site). It is possible that the distinction between core and flake tool is artificial in the case of this assemblage. The fracture line acceleration (flaw propagation) technique can maintain a relatively low cross section, and the smaller examples may have been arbitrary recorded as "flake tools" in the field. Another possibility is that the quartz cores were little altered from the pieces picked up on the nearby hill slopes and discarded after relatively little use. The quartz core cluster for the Berrambangalo Site is in a similar position to the 40/20 reference point found with the quartz pebble tools from the Thomsons Creek Site in the Tiboburra area (Tib-109, Figure 5.7).

The Berrambangalo Site differs from the Grassy Creek Site by having smaller artefacts. Although there is a silcrete source nearby, it is extremely weathered and only small pieces are available. The quartz also is often reduced to a small size,

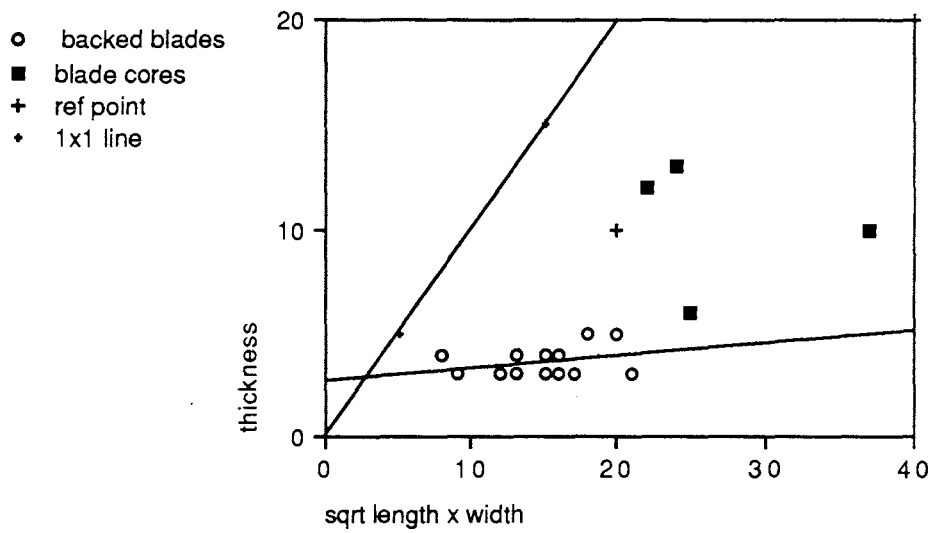


Figure 7.8 Reduction Chart for Boo-56, Microblade Industry

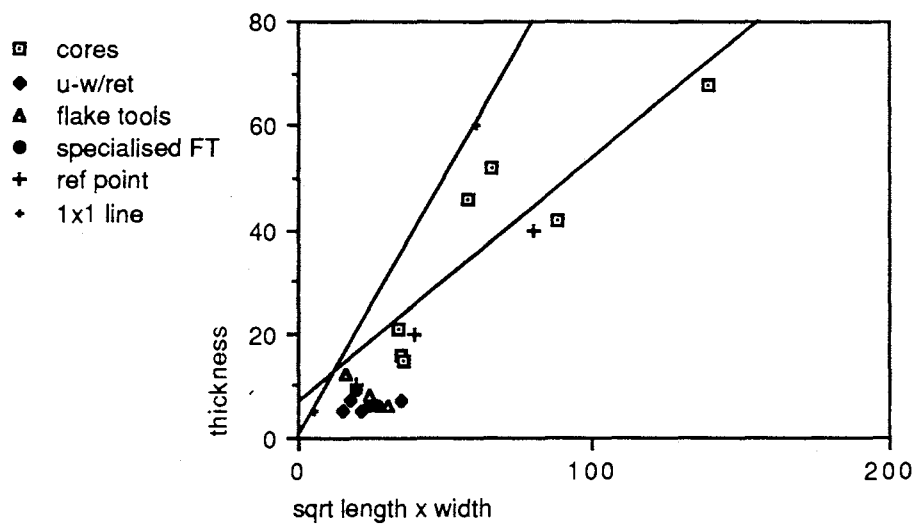


Figure 7.9 Reduction Chart for Boo-56, fine-grained stone

- bipolars
- cores
- u-w/ret
- ▲ flake tools
- specialised FT
- + ref point
- * 1x1 line

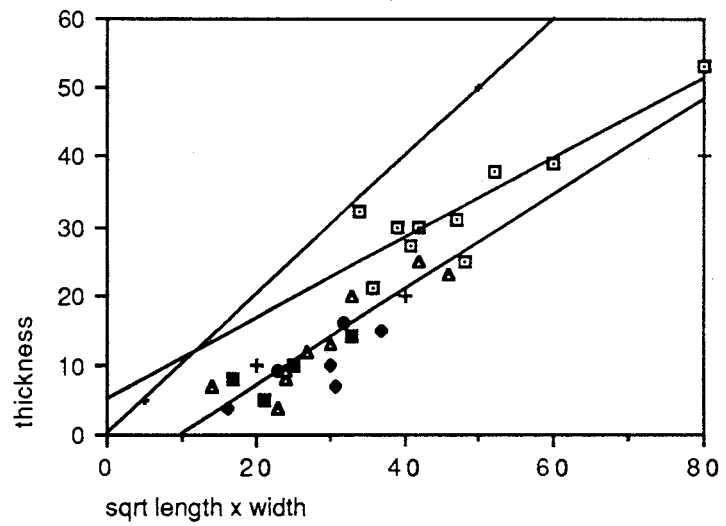


Figure 7.10 Reduction Chart for Boo-56, quartz

including some bifacial technique using an anvil. This again may reflect the piece size locally available. Taking into consideration these material differences, the Berrambangalo Site appears to be a relatively complex occupation similar to the Grassy Creek Site. Also similar is that it is in the Ranges Land System but near a Basin Land System type, and at the mouth of a pass (i.e. between the Mudoonan Range and the range along the Lake George fault scarp).

Debitage Assemblages

The firstdebitage assemblage to be examined is the Prestons Creek Site (Boo-55) which is located on a hill slope in the basin country. All of thedebitage at this site is mixed together as a lag on a clay surface. Quartzdebitage was not recorded on this site due to confusion with naturally fractured quartz in the soil. Figure 7.11 shows the felsite flakes. In this graph the focal complete flakes peak at LC3 (20mm to 29mm - note the 10mm length classes rather than 5mm length classes) and there is little broad platform debris present. The silcrete is shown in Figure 7.12 (Boo-55) and in this case the peak in complete focal platform flakes is at LC 5 (30mm to 39mm), and again, the broad platform is a minor component. The Reduction Chart (Figure 7.3) interpretation for this site was that cores were the main implement, but there also was a substantial component of light duty flake tools. This is indicated again by thedebitage which implies that the felsite cores are smaller than the silcrete cores at the outset.

Another site in the basin country is The Dicks Creek Site (Boo-72). The Reduction Chart (Figure 7.13) interpretation was that it was similar to the Prestons Creek Site, but with larger cores. This is consistent with the Reduction chart for the felsite in Figure 7.13 which shows a peak at LC 5 which quickly drops away for the larger flakes. The very high proportion of the remainder category indicates that although the felsite cores were large, they tended to block fracture. The flakes with platforms however are all focal, and are probably resharpening flakes. The fine-grained volcanic material is shown in Figure 7.14 (Boo-72). This indicates that smaller cores were being flaked. The complete broad platformed flakes are particularly prominent in this assemblage and indicates a different use from the felsite. This is consistent with the series of flake tools present, particularly the examples of those with usewear. It would appear therefore, that the fine-grained volcanic cores were mostly producers for implements with sharp thin cutting edges.

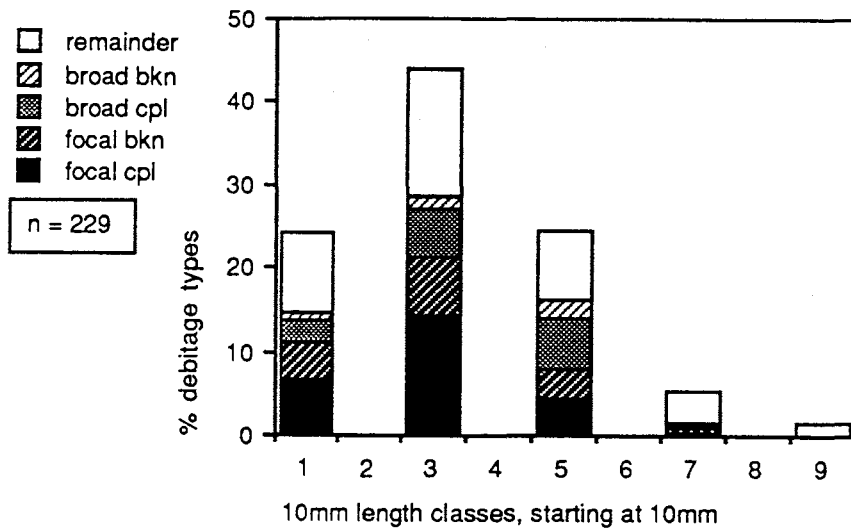


Figure 7.11 Debitage histogram for Boo-55 felsite

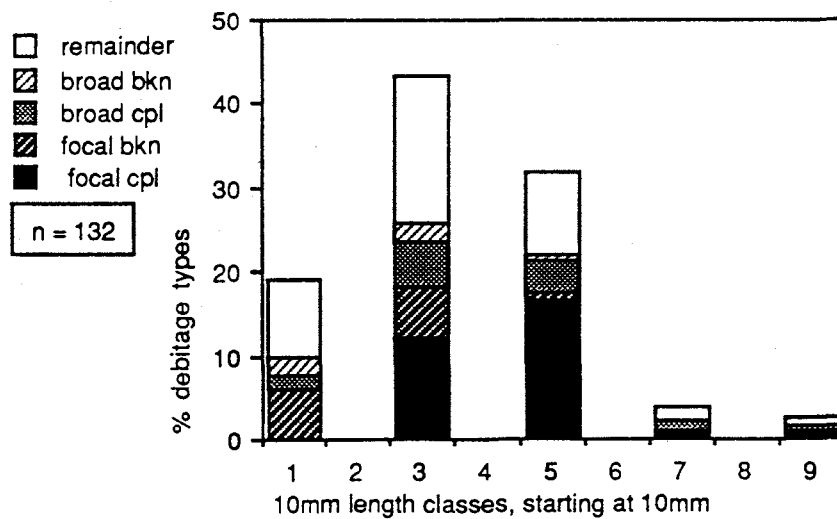


Figure 7.12 Debitage histogram for Boo-55, silcrete

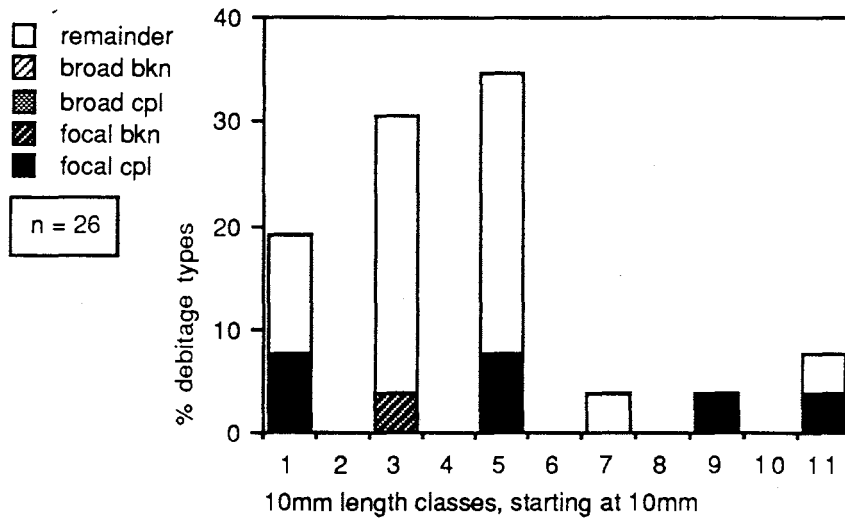


Figure 7.13 Debitage histogram for Boo-72, felsite

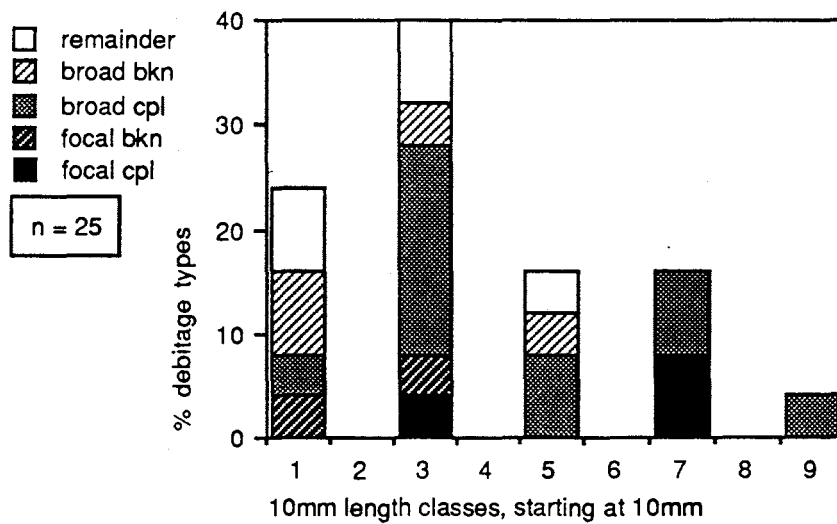


Figure 7.14 Debitage histogram for Boo-72, fine-grained volcanic

The Berrambangalo Site was a major site located low in the ranges near a gap (see Boo-56 in Figure 7.1C). Because of the numerous workshops from this site which represent a variety of flaking processes, there are 9 debitage histograms presented. The first two are those which show a scatter of silcrete (Figure 7.15, Boo-56) and quartz (Figure 7.16, Boo-56) which is distributed over the site. The silcrete shows a roughly even proportion of focal and broad platformed flakes, mostly in the range of LC 3 to LC 7 (20mm to 59mm). The interpretation for the Reduction Chart for fine-grained stone (Figure 7.8) was that although there was a range of forms, the implements were mostly relatively small. Even though a silcrete source was nearby, it appeared that the material was generally available in small pieces. The silcrete debitage histogram shows the range of flakes which would be expected from reducing medium duty core tools as well as manufacturing light duty flake tools.

The quartz debitage, which is shown in Figure 7.16 peaks at the smallest length class due to the large number of lamellates. Since lamellate workshops are present at this site, this would account for this high proportion. The quartz core workshop from the Cobar area (Figure 6.15) shows the effects of fewer small lamellates in a process which was not lamellate production. The block fractured debitage in the "remainder" type has a pattern similar to the silcrete, except with a higher proportion of smaller debris. This probably is from resharpening core tools (or "nuclear tools").

The microblade cores for the Berrambangalo Site were noted to be small, and a microblade workshop would be expected to produce mostly small flakes. The microblade workshop in Figure 7.17 (Boo-56A11) shows most of the debris in the LC1 (10mm to 19mm), and the complete focal platform flakes/blades in LC 3 (20mm to 30mm).

Two lamellate workshops were recorded and the results are shown in Figure 7.18 (Boo-56). The great dominance of lamellates in LC 1 (10mm to 19mm) is a clear signature of lamellate core reduction (note also the proportion of LC 1 lamellates in the general quartz scatter for this site shown in Figure 7.16 - also refer to Chapter 3 for a description of the multifaceted lamellate cores).

A bipolar workshop is shown in Figure 7.19 (Boo-56). Note that this is not as effective a means of manufacturing lamellates in length class 1, and that there is considerable amorphous waste. In the case of this workshop, the bipolar reduction was probably for the production of a flake tool.

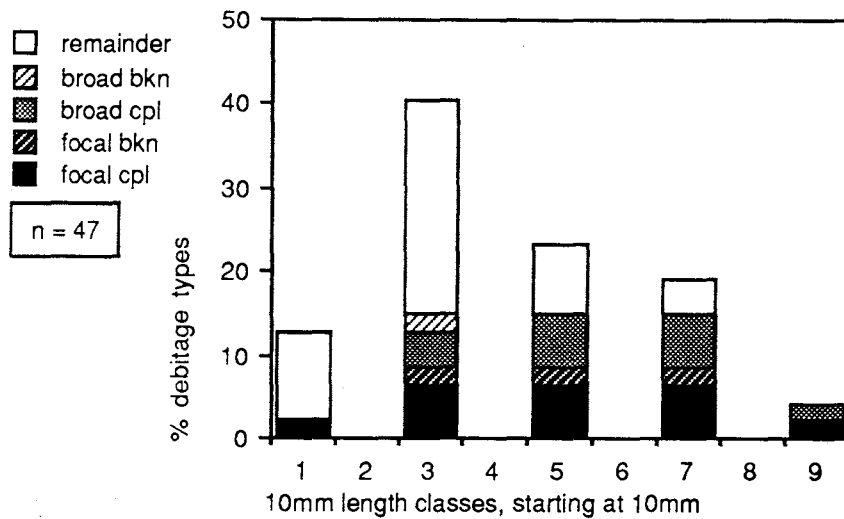


Figure 7.15 Debitage histogram for Boo-56, silcrete

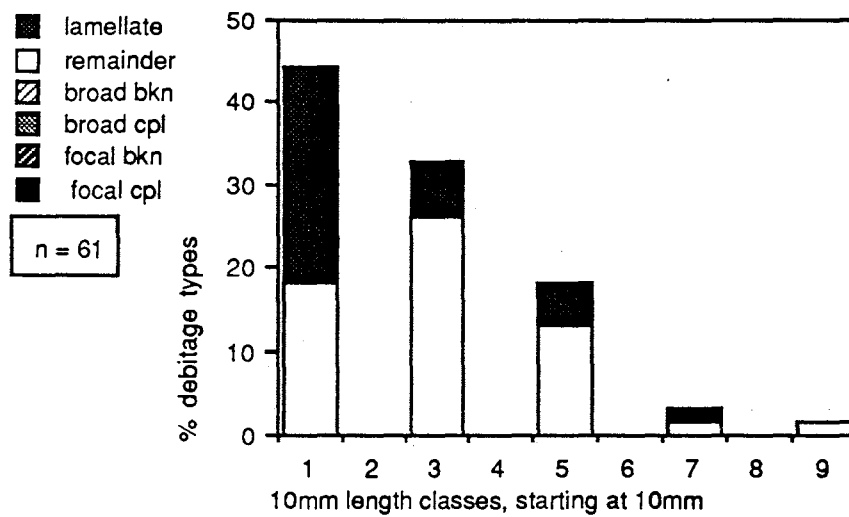


Figure 7.16 Debitage histogram for Boo-56, quartz

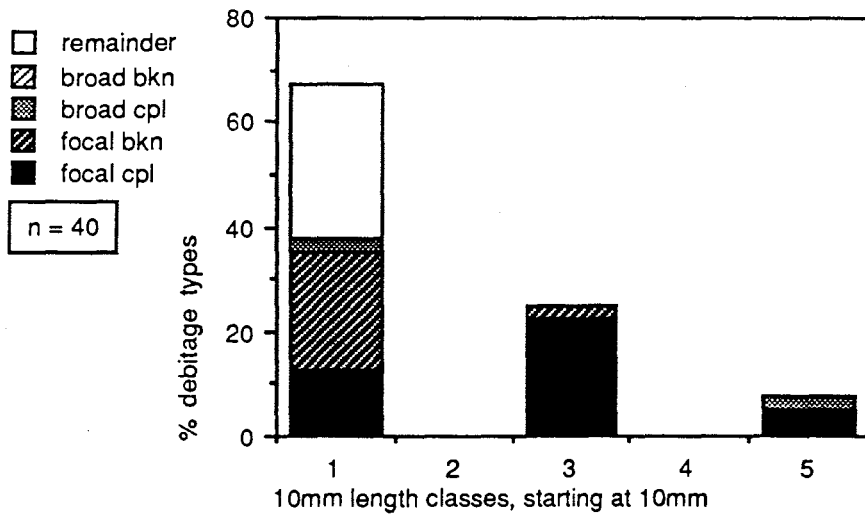


Figure 7.17 Debitage histogram for Boo-56 All, microblade workshop

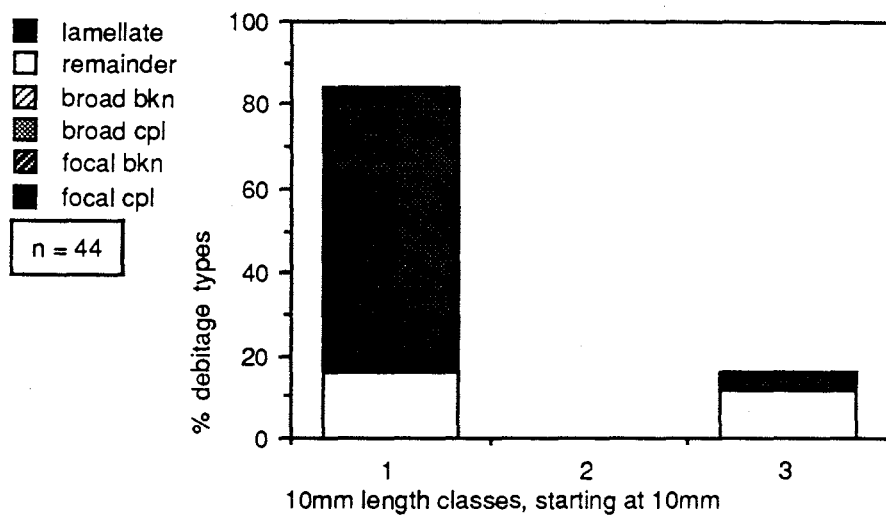


Figure 7.18 Debitage histogram for Boo-56, lamellate workshop

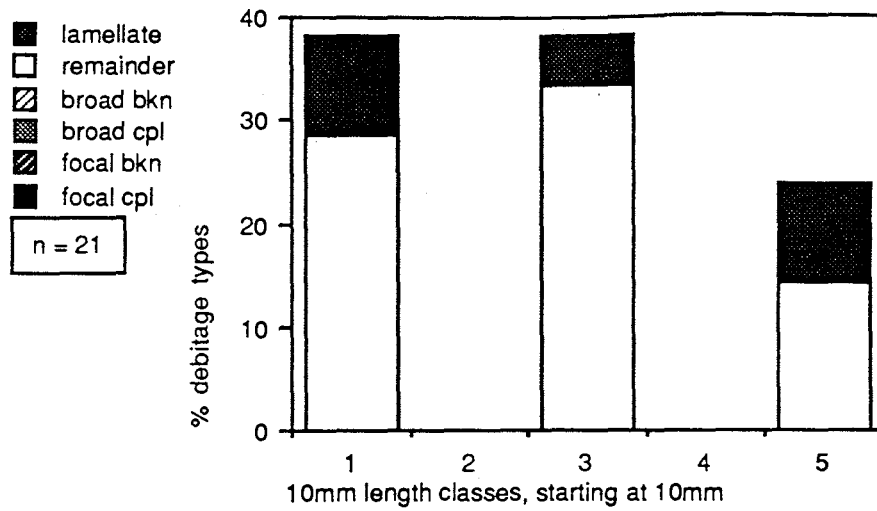


Figure 7.19 Debitage histogram for Boo-56, bipolar workshop

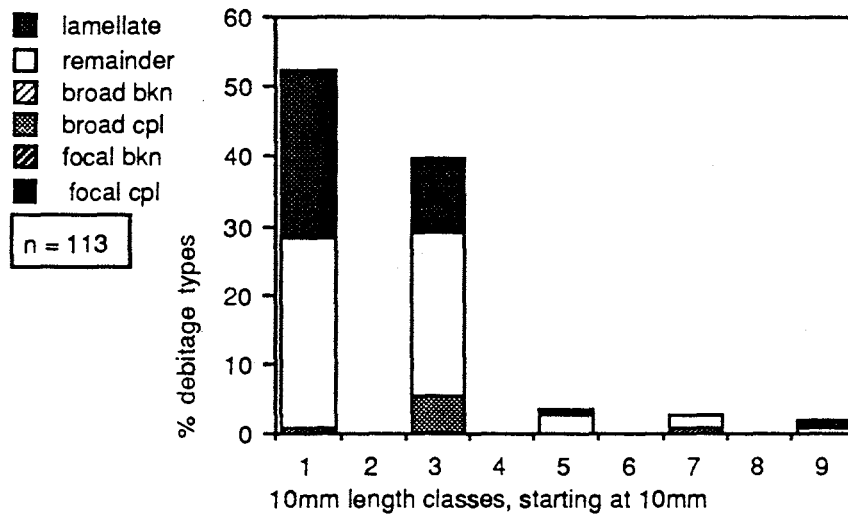


Figure 7.20 Debitage histogram for Boo-56 B7, quartz workshop

The next three debitage histograms are attributed to what may be called fracture line acceleration, or perhaps more properly, the flaw propagation technique. These are shown in Figures 7.20 (Boo-56B7), 7.21 (Boo-56A3), 7.22 (Boo-56G15) and 7.23 (Boo-56H17). All show much the same process. Flakes with platforms are rare or absent, but there is considerable control in the production of relatively thin fragments. This control is not nearly as good as the lamellate workshops, but much better than the bipolar workshop. It is a distinctive quartz working signature which I interpret as a technique to use the existing fracture lines by selectively propagating the flaws already present. This makes it possible to avoid the edge crushing effects from resharpening quartz nuclear ("core") tools by conchoidal flaking. These piles of quartz fragments which form the workshops would represent the waste from resharpening quartz core tools in the context of use, such as in a wood working task.

Another site which has a wide range of workshops and is in an environmental context similar to the above site is the Grassy Creek Site. A series of debitage histograms have been prepared for this site.

The first pair of graphs are similar to the Berrambangalo Site, in which Figure 7.24 (Boo-59) shows the quartz scatter and the main fine-grained material, felsite, is shown in Figure 7.25 (Boo-59). The quartz histogram for the Grassy Creek Site is remarkably similar to that for the Berrambangalo Site. There is however one notable difference which is the broad platformed quartz flakes at length class 7 (40mm to 49mm). This can be interpreted as representing an occasional large conchoidal quartz flake detached as a flake tool.

The felsite scatter for the Grassy Creek Site shown in Figure 7.25 (Boo-59) differs from its Berrambangalo Site counterpart by having considerably more smaller debitage. The focal platform category is especially prominent among the smaller debitage, and complete focal platform flakes dominate in LC 5 (30mm to 39mm). This effect is probably due to a mixture of processes in which microblade reduction debris is combined with core tool resharpening. The few large broad platform flakes may have been produced for flake tools.

An example of a workshop which is not for microblade production is shown in Figure 7.26 (Boo-59B12). The peak of the focal platformed flakes of silcrete is at LC 5 (30mm to 39mm). This workshop was partly refitted and was found to be from a systematically reduced biface core. Considering the size of the flakes, it probably indicates the manufacture of flake tools, rather than core tool resharpening.

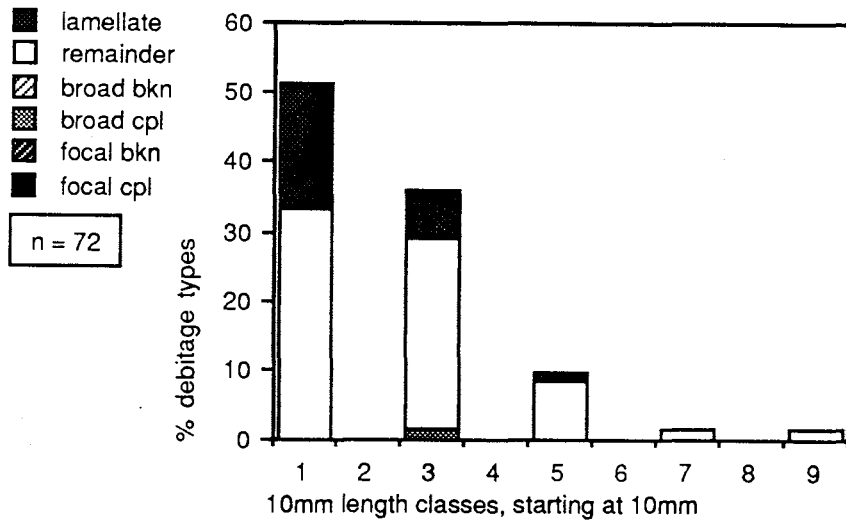


Figure 7.21 Debitage histogram for Boo-56 A3, quartz workshop

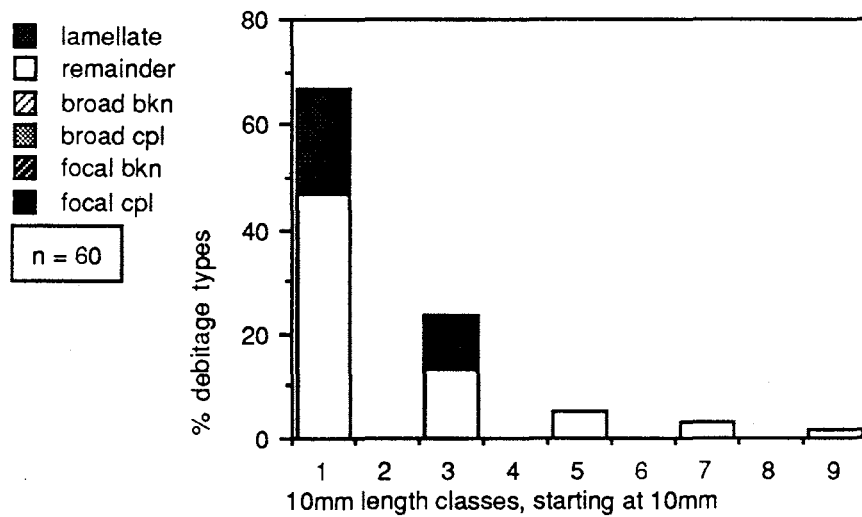


Figure 7.22 Debitage histogram for Boo-56 G15, quartz workshop

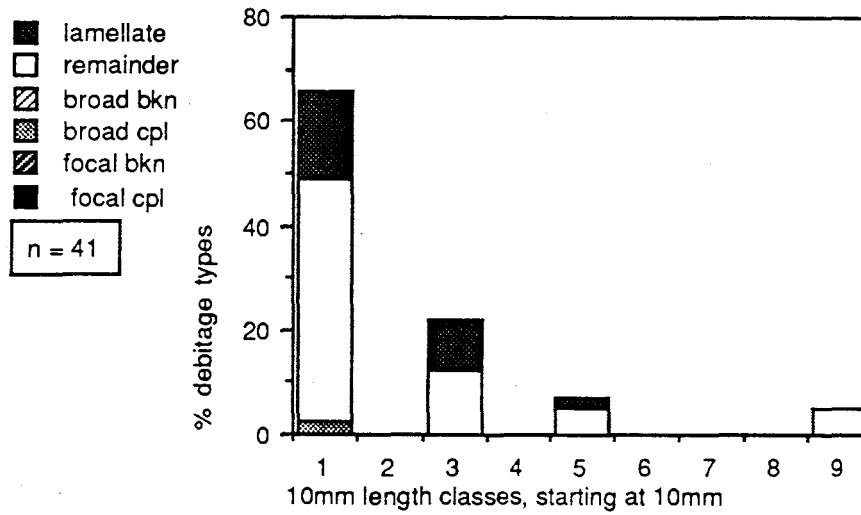


Figure 7.23 Debitage histogram for Boo-56H17, Quartz workshop

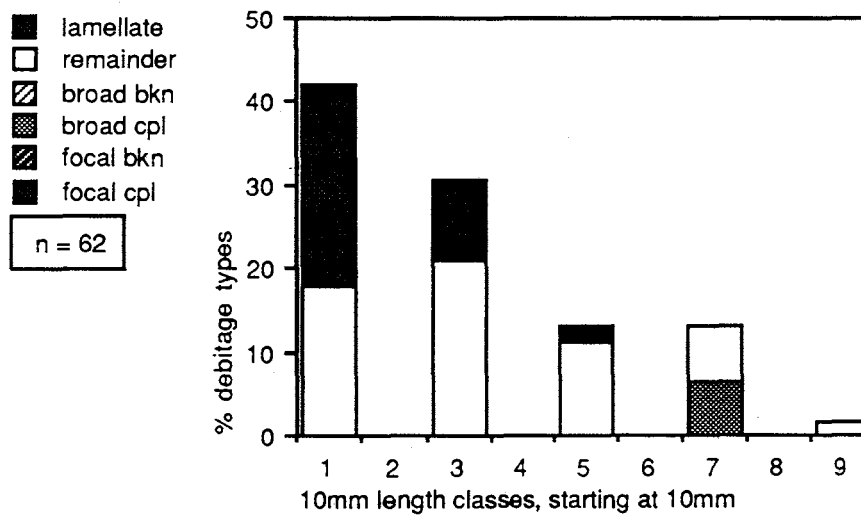


Figure 7.24 Debitage histogram for Boo-59, quartz

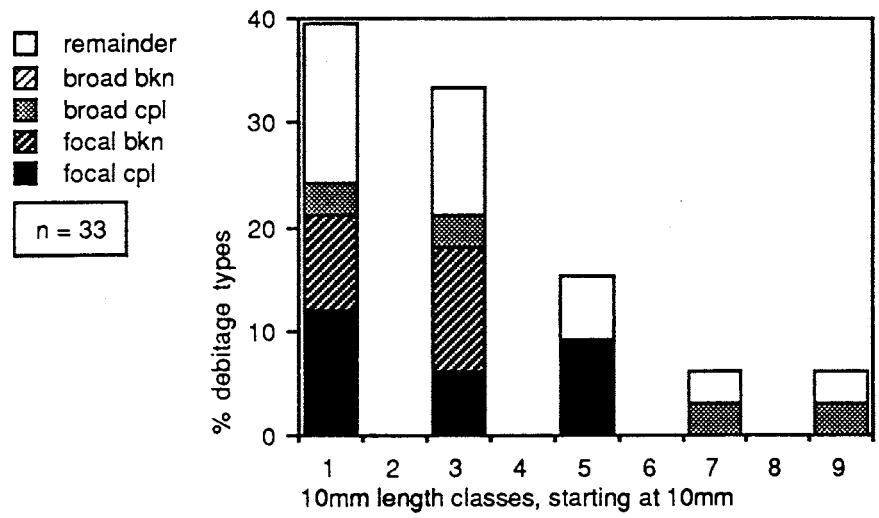


Figure 7.25 Debitage histogram for Boo-59, felsite

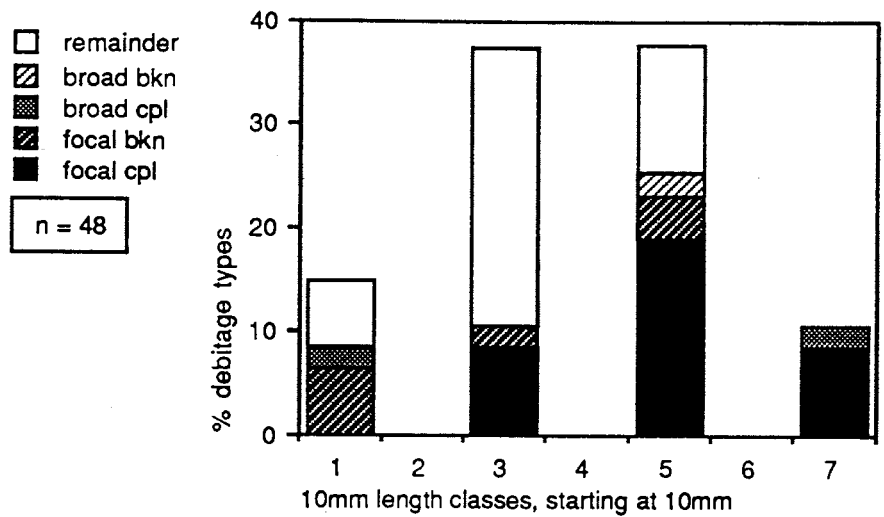


Figure 7.26 Debitage histogram for Boo-59 B12 silcrete workshop

The size range of the complete focal platform flakes from the microblade workshop of shown in Figure 7.27 (Boo-59C1) peaks at LC 3 (20mm to 29mm). This overlaps the above workshop somewhat, but was found to be from prismatic conical blade core reduction. The entire assemblage peaks at LC 1, and a large part of the remainder category would be broken flakes. This level of breakage is common in microblade workshops because of the production of very thin blades. A similar workshop but with smaller silcrete debitage is shown in Figure 7.28 (Boo-59B8) where a cube type blade core was found (see Chapter 3).

The silcrete microblade workshop shown in 7.29 (Boo-59B7) has a different pattern, in which there is less breakage and waste. This is probably typical for blade cores such as the burin blade core and the tranchet blade core which are made on large flakes (see chapter 3).

Single large occupation sites such as the Grassy Creek Site highlight the problem of heavily eroded sites such as the Prestons Creek Site discussed earlier in which waste from the Microblade Industry can be mixed together with the Core and Flake Tool Industry in an unknown proportion. If discrete workshops are present, then the different manufacturing processes are clearer. The two microblade base camp sites here (Berrambangalo and Grassy Creek) have a very large proportion which is from blade core reduction, making the interpretation of the Core and Flake Tool Industry component difficult. In spite of this, it appears that core-like implements are the main medium and light duty tools (quartz and fine-grained stone), and flake tools provide the light duty component. The fine-grained stone which is brought on to the site, and is the main material for microblade production, also is used as a core tool until a large flake is removed as a burin or tranchet blade core (e.g. Figure 7.29), or the entire piece is reduced as a blade core (e.g. Figure 7.27).

ARCHAEOLOGY OF THE BOOROWA AREA

As in the previous two chapters, the various aspects of the survey process and archaeology have been described and discussed. What follows is an attempt to integrate this with the rest of the site data (given in the Appendix) into an overall consideration of the archaeology of the Boorowa area.

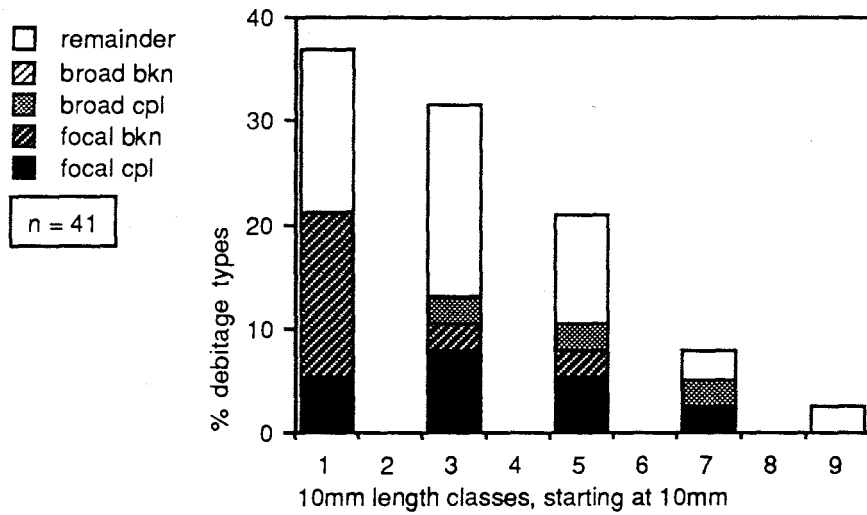


Figure 7.27 Debitage histogram for Boo-59 C1, microblade workshop

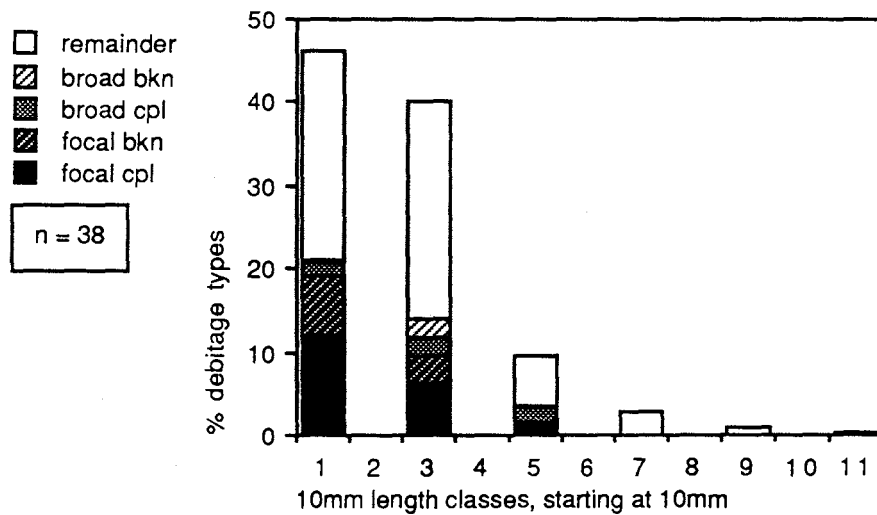


Figure 7.28 Debitage histogram for Boo-59 B8, microblade workshop



Figure 7.29 Debitage histogram for Boo-59, B 7 microblade workshop

Valley Sites

Only 3 sites were recorded in the Valley Land System Type because places with exposure such as by ploughing or scalding were difficult to find. No hearths or workshops were recorded, and the main stone materials were silcrete, quartz, a fine-grained volcanic material, and black felsite.

In one case an extensive site was found on a ploughed terrace of the Boorowa River (Brial Crossing). This terrace had formed at a choke in the river and was potentially Pleistocene in age. The artefactual assemblage was dominated by flaked quartz cobbles and other artefactual debris which were not as reduced to as small a size as the other sites in the Boorowa Area. It seemed that this site could have been dominated by artefacts from an early time period. It also was possible that the river was used as a source of cobbles for flaking material, and pieces which had been tested and were unsatisfactory were left discarded (i.e. a "quarry"). Due to the ambiguities of this site, and the likelihood of a substantial Late Pleistocene or Early Holocene component, it was dropped from the sample.

Another site was found in a sand pit on the Yass River at Sandy Vale. This produced a stratigraphic section of about 2m, in which artefacts appeared to be weathering out. Once again, because of the chronological uncertainties, this site was removed from the sample.

Basin Sites

The Basin Land System Type shows that exposures in the form of scalds and washouts were mainly used for site boundaries. Some of these were extensive and were arbitrarily bounded. Tracks, stock tanks and gully banks were other important means of exposure. Most of these sites were along streams in valley bottoms. No undoubted hearths were found, although some sites had workshops. Quartz was the main material in all of the sites, and silcrete was present in most. Felsite and other materials were sometimes common, and the fine-grained volcanic material occasionally was present. Among the debitage there was no clear dominance of any of the types, and none of the sites seemed to produce great amounts.

Within this Land System Unit there were two sites which produced a large number of tools over a large area (Dicks Creek Site Boo-72, and Prestons Creek Site Boo-55). These sites were located on large salt scalds which had created an extensive lag

surface. Thus the size and productivity of the site was in part a function of its conditions of exposure. The presence of a seep implies that there was a predictable water source away from the permanent streams, and possibly even relatively moist conditions which would have affected vegetational growth. The salt scald sites are located in a foot slope context where water is discharging from higher elevations. The process of clearing for pasture has meant that more of the water has come to the surface, and is more readily evaporated. The residue of salt from this is responsible for killing the ground cover, creating scalds. Since these sites are on slopes, gullying usually also takes place.

Both of the salt scald sites are conspicuous for the presence of the Microblade Industry and workshops features. It was observed that the eroding microblade workshops of fine-grained material were in a zone of compact white clay (A2 horizon) below the more friable brown top soil (A1 horizon). The depth of these workshops below the original surface appeared to be between 10cm to 30cm. Where the loose brown top soil was being eroded away, the artefact assemblages seemed to be dominated by quartz debris. Without carrying out excavation it appeared that there was a stratigraphic relationship in which a deposit featuring microblade production and non-local materials was below a later deposit mainly comprising the more readily available quartz. The deeper gullies (0.5m to 1m deep) gave no definite indication of artefacts in the red clays below the microblade horizon of white clay. The only possible exception was a very weathered flake tool which was resting on a deep gully slope in the Allandale Valley Quadrat (Figure 7.1).

Ranges Sites

The conditions for the exposure of sites in the Ranges Land System Type was similar to the basin country, and most were found on gullying salt scalds near a water course. There were however some found on ridges where there were other types of exposure such as dirt tracks. Interference of naturally fragmented quartz in the soil made the identification of artefacts difficult, particularly since quartz was the most abundant artefactual material. Silcrete and felsite also were sometimes common, and it would be these and other fine-grained materials which would have produced the high proportion of focal platform debitage present.

As in the case of the basins, the ranges produced two large salt scald sites with abundant tools (Berrebangalo Site Boo-56, and Grassy Creek Site, Boo-59). These two sites are very similar to those described for the basin country. These and the

smaller salt scald sites tend to be near the margins of their land system type. Others are likely to be on the edge of an outlier of hills, or on the side of a valley cut into the ranges. The major feature therefore seems to be the association with these seepage areas with the principal camping places. The more hilly the terrain, the more likely the frequency of seepage areas will increase.

From the sample it is difficult to assess the interaction between occupation on the permanent streams such as the Yass, Lachlan and Boorowa Rivers, and that associated with seeps in the hilly areas. It is possible, for example, that the places in the hills were more likely to have active springs in the winter and be out of the cold air flow. The rivers may have been mainly resorted to during the drier months or under drought conditions. There is some suggestion that the springs in the hills were particularly associated with the Microblade Industry, and an increased use of the rest of the basin country and perhaps the river flats was a later tendency.

Land Use Models

The survey of the Boorowa area was greatly restricted by conditions of exposure and visibility. Extensive sites were found, however in large salt scald areas. These sites produced remarkable quantities of microblade debris, and where erosional conditions were suitable, numerous microblade workshops.

In the case of the Berrebangalo Site (Boo-56) and the Grassy Creek Site (Boo-59), the processes of erosion to a lag surface were remarkably effective in revealing relatively intact activity areas such as workshops with little disturbance. All of these workshops were discrete areas, usually within one or two metres, and very rarely included more than one core or seem to overlap on to another workshop. If these sites had been occupied by large numbers of people for a long time, and particularly if there was a "men's area" where crafts and stone working would take place, I would expect more mixing of different workshops. The impression therefore is one of extensive occupation, but not so intensive as to result in the disturbance of features or the superimposition of activities. The structure of these sites seems to indicate a base camp associated with the Microblade Industry in a manner already discussed for the Tibooburra and Cobar areas.

Sites were found in all Land Systems Types, although the riparian environment seems to be the least used and without major sites. In this region there are other sources of long-term drinking water than the main rivers, and droughts are infrequent. Also this

is a hilly region, and it may be that conditions of cold air flow at night prevented a valley bottom from being an ideal place to camp.

Sites with backed blades were common, especially those situated on footslopes. These footslopes were broken up by spurs and small drainage valleys. Before land clearing and bush fire suppression, these areas probably had a mosaic type of environment. Grasslands would have occurred in the path of cold air drainage in the small valleys, and the spurs and slopes would have had tree cover. The density of the understorey would depend on burning patterns. The result would be a fine-grained patchy environment such as has been discussed for the Tibooburra and Cobar areas. These conditions also seem to apply to the Boorowa area.

The two most outstanding "microblade base camps" were located in a foot slope situation at the base of the ranges. The setting therefore was in an ecotonal context which would be particularly likely to support a mosaic type of vegetation. The significance of their being placed near low passes through the ranges is not clear. These may be strategic points on travel routes, or it may mean that the woodlands were not as dense as at higher elevations.

The land use strategy associated with the microblade sites therefore seems to have focused on these footslope areas near seeps, with satellite camps scattered higher in the ranges and out in the basins. If the sites with little or no microblade material implies a later time period, then these later sites seem to be more associated with the basin country and along the creeks and perhaps rivers.

People from the Boorowa area also might have joined the moth feasts in the highlands, (Flood 1976, 1980) though this area is quite distant. It is possible that large aggregations took place near the Lachlan, Yass or Boorowa Rivers as travel routes, especially if there were connections with the Wiadjuric speakers to the west. If so, such sites were not encountered in the sample. As mentioned previously, exposures on the river flood plains were difficult to find during the survey. Fish weirs also have been mentioned by Flood (1980). This might suggest that large riparian sites would occur along the rivers, but no indications of this were found during the survey.

CHAPTER 8

VARIATION AND CULTURAL STRATEGIES

VARIATION AMONG THE SAMPLE AREAS

The three sample areas have been described separately in Chapters 5, 6, and 7. Now it should be possible to compare the results. What is their relationship along the great transect? Does the Cobar area show intermediate features between the Tibooburra and Boorowa areas? Is it really part of one or the other, or is it in a separate region of its own? What kinds of predictive statements can be made about the sites in these areas? I will first look at the differences in the debitage and then consider the flaked stone tools. Next I will examine the ground stone artefacts and the hearths. The patterning in respect to land systems will follow this, and finally the issue of developing models of land use strategies will be discussed.

Flake Morphology

The overall pattern of debitage can be indicated on the basis of flake morphology. Table 8.1 shows the flake types recorded as described in Chapter 4: focal platform, broad platform, no platform, and quartz lamellates. These are listed in the Appendix as common or present, and the percentages per sample area are shown in Table 8.1.

The Tibooburra area is dominated by debitage which has broad platforms or no platforms at all. In the Cobar area, the no-platform category is the major group, while the focal and broad platformed flakes are represented about equally. Quartz lamellates are rarely present. In the Boorowa area the broad platform flakes become less common, and the proportion of focal platform flakes are similar to the Cobar area. There are fewer sites where flakes without platforms are common, but this is probably because of the increase in lamellates.

Table 8.2 lists the main debitage material categories: silcrete, quartz, fine-grained volcanic, felsite and "other". Silcrete is the dominant material in the Cobar and Tibooburra areas, and is much less important around Boorowa. Quartz dominates the Boorowa area, is important in the Cobar area, and becomes a minor material in the Tibooburra Area. The various other stone materials also become notably more significant in the Boorowa Area.

DEBITAGE MATERIALS

CAMP SITES

SAMPLE AREAS

stone material	Tibooburra Area		Cobar Area		Boorowa Area	
	n	%	n	%	n	%
silcrete						
common	50	88	21	91	4	19
present	7	12	2	9	14	67
quartz						
common	7	12	4	17	18	86
present	13	23	12	52	3	14
f-g volcanic						
common	-	-	-	-	1	5
present	-	-	11	48	10	48
felsite						
common	-	-	-	-	5	24
present	-	-	-	-	13	62
other						
common	1	2	-	-	3	14
present	16	28	10	43	7	33
total sites	57		22		21	

Table 8.2. Table showing the proportions of stone materials recorded as debitage for the three sample areas.

In the Boorowa area, quartz was consistently used to produce the flat thin lamellates. It is difficult to determine what proportion was in the context of producing lamellates as implements, and how many flat thin quartz fragments are due to resharpening quartz implements by the flaw propagation/fracture line acceleration technique (see Chapter 3).

Quartz in the Cobar Area was only common for the sites in the ranges near Nymagee, and accordingly, flat thin fragments were produced. No multifaceted Lamellate Industry cores were found, and it is not clear what the method of manufacture was.

Sites with quartz also were present in the Tibooburra area. A few with lamellate fragments were recorded, but it was noted that the quartz was treated much the same as silcrete, and there appeared to be no specific lamellate production.

Silcrete was available in massive supply around Tibooburra. The fact that the cores are likely to be large means that the flakes will tend to be struck relatively far back from the platform edge, resulting on broad platforms. Since much of this silcrete is coarse-grained, it often fractures without showing conchoidal features (i.e. bending fractures).

The silcrete in the Cobar area seems to be from heavily weathered sources, and the pieces for cores were usually small to start with. In the reduction process, this meant that a light blow which does not shift the position of the core needs to be closer to the edge, if the force is to be sufficient to detach a flake. This also makes overhang removal more important to prevent the platform from collapsing. The result was more focal platformed flakes. A range in core size therefore may be expected to produce a combination of focal and broad platformed flakes.

In the Boorowa Area, the role of silcrete seems to be similar to the fine-grained volcanic and felsite materials. On the less heavily eroded lag surfaces it could be seen that these materials were closely associated with backed blade production. Thus although the fine grained materials might be transported as heavy duty implements and resharpened occasionally, it appears that they were primarily destined to be reduced as microblade cores. This differs from the Cobar Area where silcrete and fine-grained volcanic materials were normally large implements in the Core and Flake Tool Industry. These trends are supported by the debitage histograms and Reduction Charts which have already been discussed in Chapters 5, 6 and 7. Both flakes and implements are largest in the Tibooburra area, and remain relatively large in the Cobar area, but become notably smaller in the Boorowa area.

It also has been shown that the Pirri Industry, which is present in the Tibooburra area, is very rare in the Cobar area, and absent in the Boorowa area. The Tula Industry which was found in the Tibooburra and Cobar areas also is missing from the Boorowa area. Although quartz lamellates are present in the Cobar area, they are abundant only in the Boorowa area where the specialised lamellate cores occur, and the flaw propagation/fracture line acceleration technique is widely used. The Microblade Industry which is present in the Tibooburra and Cobar areas, seems to be the most prominent in the Boorowa area.

Tool Morphology

The main explanation for the above patterning seems to lie in the relationship of flake tools to cores within the Core and Flake Tool Industry. The Reduction Charts show that large to medium flake tools are a major component in the Tibooburra and Cobar assemblages. In the Tibooburra area silcrete was abundant and in large sized pieces, and large flake tools were easy to make. These are a more portable form to carry across extensive dune areas than bulky cores which would produce relatively more waste for their mass. The Cobar area was similar, but the silcrete was less available as large pieces. Both the Tula and Pirri Industries operated on the principle of producing a specialised flake at the stone source for transport.

This process of flake transport was changed in the Boorowa area. Stone (usually quartz) was available almost everywhere. A large lump of quartz is the functional equivalent to a large flake tool of silcrete or a tula adze. The large lump of quartz has the added advantage that it is easy to pick up, requires no maintenance, nor preparation of adhesives, and need not be transported from camp to camp. During use, the resharpening inevitably resulted in its becoming smaller, and it was usually discarded as a small core. Thus the main implement, which was a large lump of quartz, was transformed to a smaller lump and a great deal of debitage.

Accordingly, the Tibooburra area was strongly oriented towards flake tools. The Cobar area was similar, but rather more opportunistic, and the Boorowa area was mainly oriented towards core tools.

Is there a boundary between the Boorowa and Cobar areas for these different strategies? In the course of the survey work and visiting the sample areas, an attempt was made to try to find a zone where there was a change-over from a flake to a core tool strategy. This was by stopping and looking at artefacts in roadside exposures (see Chapter 2). The transition appears to be on the Bogan River where the broad alluvial surfaces and extensive sand plains of the west begin. Here, most of the flakes are small, quartz is

prominent, but the fine-grained materials tend to be broad platformed and the Tula Industry is present.

A broader implication of the differences in artefactual assemblages along the great transect is that tool function is not the chief factor which determines the morphology. Throughout the analysis of stone artefacts, a special effort was made to identify functional assemblages. As a general rule, such sites were uncommon, and artefacts with functional implications (e.g. Cane 1988) were a very small part of the assemblage. Instead, it was the pattern of stone availability, the reduction strategies used to cope with the problem of distance to materials, the size of the pieces, and the flaking properties of the material which were the principal factors. Within the Core and Flake Tool Industry, most of the implements, regardless of shape or attributes, appear to be generalised wood working tools.

The Tula Industry is a specialised extension of the Core and Flake tool Industry to provide greater logistical range for similar functions. The Microblade, Pirri and Lamellate Industries probably have specialised functions, possibly in connection with hunting activities.

Hearths and Ground Stone

The presence of hearths and ground stone seem to be the main indicator of economic activities to be found on sites. The numbers of hearths and pieces of ground stone on the sites in the three sample areas are shown in Table 8.3. A ratio is also given as to the proportion of these items to the number of sites.

This table shows that heat-retainer hearths and fragments of ground stone were a minor component among the Tibooburra and Boorowa areas, but were very important in the Cobar area. It might have been expected that the Tibooburra area would have produced more ground stone, since seed milling is generally considered to be important in an arid land economy.

Part of the discrepancy between the Cobar and Tibooburra areas is due to the availability of the grinding slabs and the need to curate them. In the Cobar Area there are numerous Devonian strike ridges with tabular sandstone. It is easy to acquire a milling slab and transport it to a nearby camp where it can be discarded after use. The slabs are so numerous they can even be used as heat retainers in hearths. At the Buckwaroon Site (Cob-80) this was common, and small stacks of grindstone fragments could be seen protruding like cut sandwiches from some of the hearths. In one case a

GRIND STONE AND HEARTHS CAMP SITES SAMPLE AREAS

features	Tibooburra Area		Cobar Area		Boorowa Area	
	n	ratio	n	ratio	n	ratio
grinding stone	21	0.4	197+100	13.0+	4	0.2
hearths	41	0.7	330	15.0	5	0.2
total number of camp sites	57		22		21	

ratio = grinding stone fragments : camp site

Table 8.3. The ratios of hearth counts and pieces of grinding stone recorded per site in each sample area. Note that in the Cobar area the actual numbers of grinding stone fragments were not counted on every site because of their great abundance. An additional 100 pieces has been added as a conservative estimate.

hearth was weathered out with large numbers of grind stone fragments. After refitting, it could be seen that at least 3 grinding slabs had been used. The straight line fractures were where they had been deliberately broken for use as heat retainers. The curved fractures were due to the heat, probably from sudden chilling after the cooking pit was opened.

In the Tibooburra Area it was noted that most pieces of grind stone were mullers at a final stage of wear, and that some of the mullers showed the dished wear pattern from a milling slab, indicating that they were re-cycled. Otherwise, the grinding slab fragments found on sites were mostly very small. During field work no potential sources for the coarse sandstone used for the milling equipment were found. The implication is that they were carried in from a distance, highly curated and re-cycled.

The Boorowa area also had a number of grinding stones, but none belonged to the large seed grinding slab type. They were mostly mortars, or whetstones for sharpening hatchet heads.

The heat-retainer hearths presumably imply a particular type of cooking process. For example, they may have been for baking root or other plant parts to convert starches into a more digestible form. This type of activity separates the Cobar area from the other two areas. At Cobar, hearths were mostly associated with land where there was regular flooding (Table 6.4), and this habitat feature may have been mostly responsible for producing the foods processed in the hearths.

Environment

Patterning in site frequency for the various Land System Types has been discussed previously for each sample area. All of these discussions dealt with the distribution of water as a major limiting factor, even in the Boorowa Area which has the highest rainfall. Throughout all of these areas there are times when short term water is abundant everywhere. There are other times when it is restricted to a limited number of permanent sources.

The hydrology of these patterns is not always evident from topographic maps showing streams and lakes. For example, the riparian environment in the Tibooburra area produced extensive archaeological deposits as expected, but the dunes also turned out to be heavily occupied. This apparently was made possible by the numerous small cane grass swamps which must have provided relatively long term water. In the Cobar area extensive sites were found in the main valley system. More important however, were the sites associated with permanent springs in the ranges. Although the level of

occupation in the valleys for the Boorowa area was difficult to assess from the sample, and although there are permanent streams in the area, the major sites were found along the footslopes in seepage areas, especially in the lower ranges.

The strategy of water use in the arid and semi arid regions is strongly linked to the distribution of food resources and procurement strategies. Places with water grow the most plants, and are the most likely to produce vegetable foods, as well as provide feed and water for animals. Such high productivity areas (e.g. alluvial valleys or swamps) tend to be discontinuous. However, the long term occupation of these high productivity areas results in depletion, and there is pressure to forage elsewhere.

There has been some research into diet using ethnographic information relevant to the arid parts of the great transect (e.g. Allen 1968, 1972, 1974). However, this is mostly based on observations from historical sources and is too incomplete for detailed modeling. In addition, the ecology of these plants and animals, and the various Aboriginal procurement methods are inadequately known. Consequently, little basis exists to link specific food resources to particular Land Systems Units or other environmental types, except at a highly speculative level.

In the more temperate part of the great transect the relative subsistence value of various environmental types also is unclear. Once again, the ethnographic studies (e.g. Flood 1976, 1980) are unable to give a sufficiently detailed picture of the diet, or the subsistence procurement methods. Moreover, the ecology of the known resources is extremely difficult to reconstruct due to the extensive European modification of the environment.

LAND USE MODELS

In Chapter 2 I stated that one of my goals was to assess land use models from the distribution of sites and their contents. The analysis of these data depends upon how sites are exposed and recorded. Further bias occurs in the way particular land systems are sampled. The specific resource value of particular land systems units or environmental features remains difficult to assess. In some areas ground stone artefacts and heat-retainer hearths may be common, but their meaning ambiguous. The main regional differences in flaked implement morphology seem to be due more to technology and the proximity of stone sources than site function. Given this as the data base, how can cultural adaptation and land use strategies be used to formulate explanatory predictions about site location and contents?

The development of a land use model approach depends on being able to assess the biases in the data and to understand what the data can be used to measure. Ordinarily a particular model will be difficult to test directly with the data available, and models which can be conclusively and directly disproved are rare in many sciences (see Chalmers 1976), and this includes archaeology. One approach is to ask at the outset: how is the adaptive system organised (i.e. "organisational variability", Witter 1986, 1988)?

The first consideration was the organisational indications provided by stone technology, core reduction and stone logistics. It was suggested in Chapter 3 that the Microblade Industry represented an instant supply system for hunting. This was based on the evidence for a relatively complex pattern of microblade core transport and material conservation techniques. The concentrations of microblade workshops found on certain sites also indicate intensive maintenance activities, such as would be found at a base camp. I suggest that this implies a base camp - satellite camp system (Witter 1988). Thus on various foraging trips, stone would be collected and brought back to the main camp. If movement took place from one food resource location to another, then microblade cores might be expected to mainly reflect the most local stone. Since a technology existed to use relatively intractable materials, special trips to obtain stone which flaked easily would be unnecessary.

In Chapter 3 I show some of the reduction sequences used in the Microblade Industry. I suspect that we may have underestimated the significance of this industry, and it is a much more dynamic and complex process than occasionally backing a blade. This leads me to consider that sites with backed blades may imply greater differences in settlement and subsistence than are generally recognised. If there is such a difference then there should be other factors in addition to the presence of backed blades.

It was pointed out (Chapter 5) that in the Tibooburra area "microblade base camps" were found which were associated with fine-grained mosaics. One example was the dune country. This alternated as open and shrubby vegetational cover occurring on swales and dunes about every 100m to 200m. In parts of the ranges the confluence of tributaries cause another patchy environment of mulga, gidgee and grasses at a similar scale. The same is the case for the riparian environment where the cover alternates between woodland and flood plain grasses. The plains, on the other hand, have a generally low cover of Mitchell grass or low chenopod shrubs and are a much more coarse grained pattern of vegetative cover.

Around Cobar, certain places in the ranges produced extensive microblade sites. Apart from the presence of water, these were also fine grained patchy environments with

scattered stands of woodlands and open country. Sites Cob-102 and Cob-103 were located where a large ridge was next to a tributary and resulted in more variable cover. No major microblade sites were found in the extensive cypress pine regions or shrubland country in the uplands. The Double Gates quadrats on the map looked like a homogeneous flat, and was sampled as a place unlikely to have microblade sites. However, it was situated on an alluvial plain where the flood hollows, small sand dunes, gravel areas and scalded alluvial clays produced a fine-grained patchy environment with a change of cover of about every 100m or 200m. Accordingly, Site Cob-135 produced a pirri point and some backed blades.

The major microblade sites in the Boorowa area were located in a zone along the boundary of the steep ranges and the basins. Although the land has been cleared, these would have been places where the woodlands on the spurs would have come down to the grassy tributary bottoms and plains savannah country. This situation could be made even finer grained by Aboriginal burning practices. More coarse-grained environments such as continuous woodland cover on the ranges or extensive savannahs on the plains and low hills do not have as heavy microblade occupation.

To summarize, regardless of whether the environment is arid, semi-arid or temperate, microblade sites are associated with fine-grained patchy environments. This does not necessarily indicate high vegetational diversity, but merely that the vegetative cover changes at a frequent interval. The implication, therefore is not access to a particular plant resource, or necessarily a combination of such resources.

An explanation of this pattern might be related to cover. Cover is an essential feature in animal behaviour and a major factor in hunting tactics. The importance of a fine-grained patchy environment might be that it provides small feeding grounds and concealment so that hunters can more readily make a close approach. It also might have the effect of causing kangaroos to break up into small groups instead of collecting into large mobs. If so then search time would be reduced by going through a small patch of cover rather than trying to look for animals in a more extensive area.

The implication of this model is that it should be possible to analyse an area in terms of those places which produce a fine-grained mosaic as a way to identify places where microblade base camps should be present.

The "non-microblade" sites may be more closely associated with environmental productivity. In some cases this would simply mean that the most watered places are the most productive. In other situations this would not be so. The monsoonal showers on the plains of the Tibooburra Area result in a great burst of growth, even though it is

short term. This land system has numerous small sites throughout, but very few of the microblade/pirri artefacts are represented.

The most permanent waters around Cobar are springs which are extremely localised. The sites with the fewest microblade/pirri elements are located throughout the uplands and alluvial valleys where there is more seepage and less run-off from the rains.

In the Boorowa area it also would appear that the more productive low flat country and river valleys were more important after the "microblade period".

The differences between the proposed microblade and non-microblade settlement pattern models for each of the three sample areas as discussed above is diagrammed in Figure 8.1. This diagram is intended to illustrate the differences between a base camp/satellite system and an aggregation/dispersion system as it would operate in different landscape types.

As already mentioned, the presence or absence of the Microblade Industry may not be a reliable chronological indicator, even though I have used it in this way for this thesis. It may, for example, represent an alternate (but synchronous) subsistence mode, such as hunting seals with one tool kit and then caribou with another as among the Eskimo. Changes over time might be mainly in the frequency in which one mode or the other was used (Paul Packard, pers. com.). It is, in any case, an organisational indicator in regard to relatively complex logistical and technological demands. Organisational measures such as productivity, stability, diversity and patchiness can be used on environments. The organisation of cultural adaptive strategies can be measured in terms of generalised or specialised, opportunistic or intensive, centralised or extended, and so on (Bettinger 1980). It is these organisational measures which provide a basis to assess Aboriginal adaptive strategies from the archaeological record.

Models such as these also need to be seen in their regional context. In the next chapter, examples of regional variation are presented as Technological Regions, Land Systems Divisions, Cultural Adaptive Areas and Archaeological Formations. If a predictive and explanatory approach is to be taken for a particular region, it is important that the area is not seen in isolation.

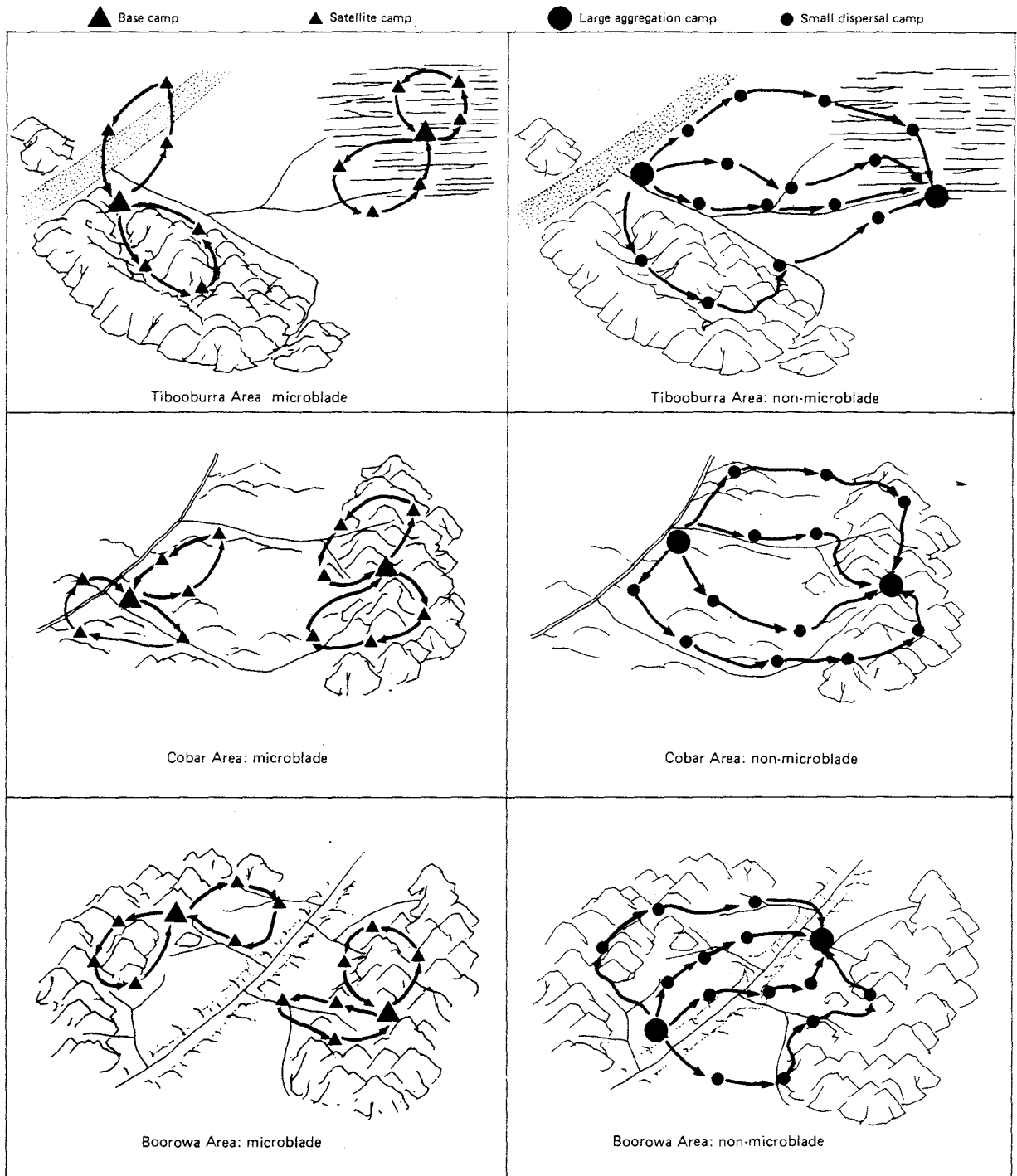


Figure 8.1 Schematic model of a possible difference in settlement pattern between the Late Holocene microblade mode/period and the non-microblade mode/period.

CHAPTER 9

REGIONAL PATTERNING

Types of Patterning

In this chapter I discuss four schemes for regional patterning. These are Stone Technological Regions, Archaeological Land Systems Divisions, Cultural Adaptive Areas and Archaeological Formations. These terms refer to specific concepts to measure certain kinds of variation from one region to another.

One of the objectives of the great transect was to assess the nature of archaeological variation over a large area. The analyses in Chapters 5, 6, and 7 showed differences in stone artefact technology among the sample areas. This was used as a starting point to develop a system of Stone Technological Regions for Southeastern Australia.

The great transect also showed that there were environmental differences among the sample areas. At the local level these were identified as Archaeological Land System Units and Types. More broadly however, there should be Land System Divisions which ought to have substantial effects on settlement in respect to the distribution of water, food, stone and other resources.

Cultural Adaptive Areas are at the scale of the Archaeological Land Systems Divisions. These incorporate Stone Technological Regions, the distribution and contents of economically related features such as midden deposits and hearths, as well as ethnographic information which indicate differences in Aboriginal adaptive strategies. The Cultural Adaptive Area scheme is a behavioural concept, and intended to synthesize various empirical forms of regional variation at a theoretical level.

The major biases which affect the development of this theoretical level are formational factors which determine preservation, sedimentation exposure and visibility. These affect more than camp sites with stone artefacts. For example ranges with rock overhangs protect paintings; a sand dune or an aggrading environment rich in carbonate preserves burials. These formational factors, together with the site types they affect, are dealt with in the Archaeological Formations scheme.

The concepts for the four kinds of regional patterning should not be confused with each other. The Stone Technological Regions are an empirical measure of the spatial distribution of stone artefacts from a technological perspective. The Archaeological

Land Systems Divisions are strictly concerned with the broad scale environmental variability (physiography, vegetation, soils or hydrology) relevant to human activities. The Cultural Adaptive Areas are a hypothetical framework about human behaviour in different regions. The Archaeological Formations are empirical generalisations of what is usually found, and what biasing factors are important.

STONE TECHNOLOGICAL REGIONS

One of the results of the survey work was to provide a basis for comparison among the three sample areas using the Reduction Charts and debitage histograms. Differences among the artefacts were noted. To summarise from the previous chapters, in the Tibooburra area the debitage was relatively large in size, with broad platforms. Unless near a stone source, cores were uncommon. The implements were also large, with flake tools being common. Forms such as tulas were numerous and there were occasional pirri points. The backed blades were all geometrics.

The Cobar area was similar to Tibooburra in that flake tools were still common and often large sized, although the debitage tended to be smaller and more often focal platformed. Normal tula slugs were present, but there also were many microtulas. Other hafted or potentially hafted flake implements were present such as convex flake tools and burrens. Pirri points were extremely rare, and backed blades included both bondis and geometrics.

In the Boorowa area the debitage was mostly small, and focal platforms were more frequent. Implements were small also, especially flake tools, which usually had little retouch. Cores were common, especially from quartz. There were no tula slugs or similar forms, and the distal convex flake tools (which might have been hafted) were rare. There were no pirri points, but among the backed blades bondis were very common. Quartz was used on a more systematic basis and the Lamellate Industry was clearly present.

The Cobar area was a variation of the pattern found at Tibooburra, but somewhere between the Boorowa and Cobar areas was a major transition in artefact technology.

As mentioned in the previous chapter, I attempted to determine boundaries in stone technology along the great transect. Artefact assemblages from the Southern Tablelands were similar down the western slopes of the Dividing Range as far as the Bogan River. West of the Bogan was an abrupt change to the Cobar type of assemblage. This continued across the Darling River to about White Cliffs where the assemblages began to be much more like the Tibooburra Area.

A provisional map for Technological Regions in Southeastern Australia is shown in Figure 9.1, and the distinctive features of each Region is set out in Table 9.1. This material is taken from results of research which has followed on from this thesis (Witter in press).

In the map on Figure 9.1 I define major boundaries which I call "Provinces" and minor boundaries for "Regions" (Figure 9.1). Provinces were mainly established on Core and Flake Tool Industry criteria. These show three major trends in stone technology for the Western Plains, the Dividing Range and the Murray Basin.

The Western Plains Province features large sized debitage and implements, in which flake tools are usually dominant. The cores also are large and often are clearly producer cores with circular platforms ("horsehoof"-like). The technology is oriented towards flake tools. In this area stone material occurs in massive outcrops, gibber or weathered rubble in localised areas. The rest of the landscape consists of extensive areas of sand plains and dunes, or black clay alluvial plains: areas where stone for flaking is not available.

My interpretation of this pattern is that the general strategy is to produce large flakes as implements which may be taken out into areas where stone is absent. The transport of cores is minimised since a few flakes would be lighter than the entire core. If heavy duty work is required, flakes are more versatile since they can be hafted. The Tula industry is a sophisticated and highly efficient development of this use of flake tools. Intermediate areas where the stone sources are less massive, (such as the Cobar area) show transitional forms such as burrens and microtulas, as well as the cores being rather more common. Since these cores undergo more transport, they commonly are resharpened into square cross section forms, and a bifacial approach may be used to maintain an acute platform/edge angle.

The Dividing Range is characterised by sites with an abundance of debitage, usually relatively few implements, and these most often are cores. These cores rarely take on the circular platforms or conical cross sections of producer cores. They mostly represent weathered blocks, nodules or pebbles which are directly converted into tools (referred to as a "nucleus tool" in Table 9.1).

The core-like implements are usually small, a feature which would be expected from an implement which had been repeatedly resharpened until most of the mass was lost. In this process the large core-like implement was destroyed in the context of use by resharpening and discarded. Thus the principal tools begin large sized, but are not

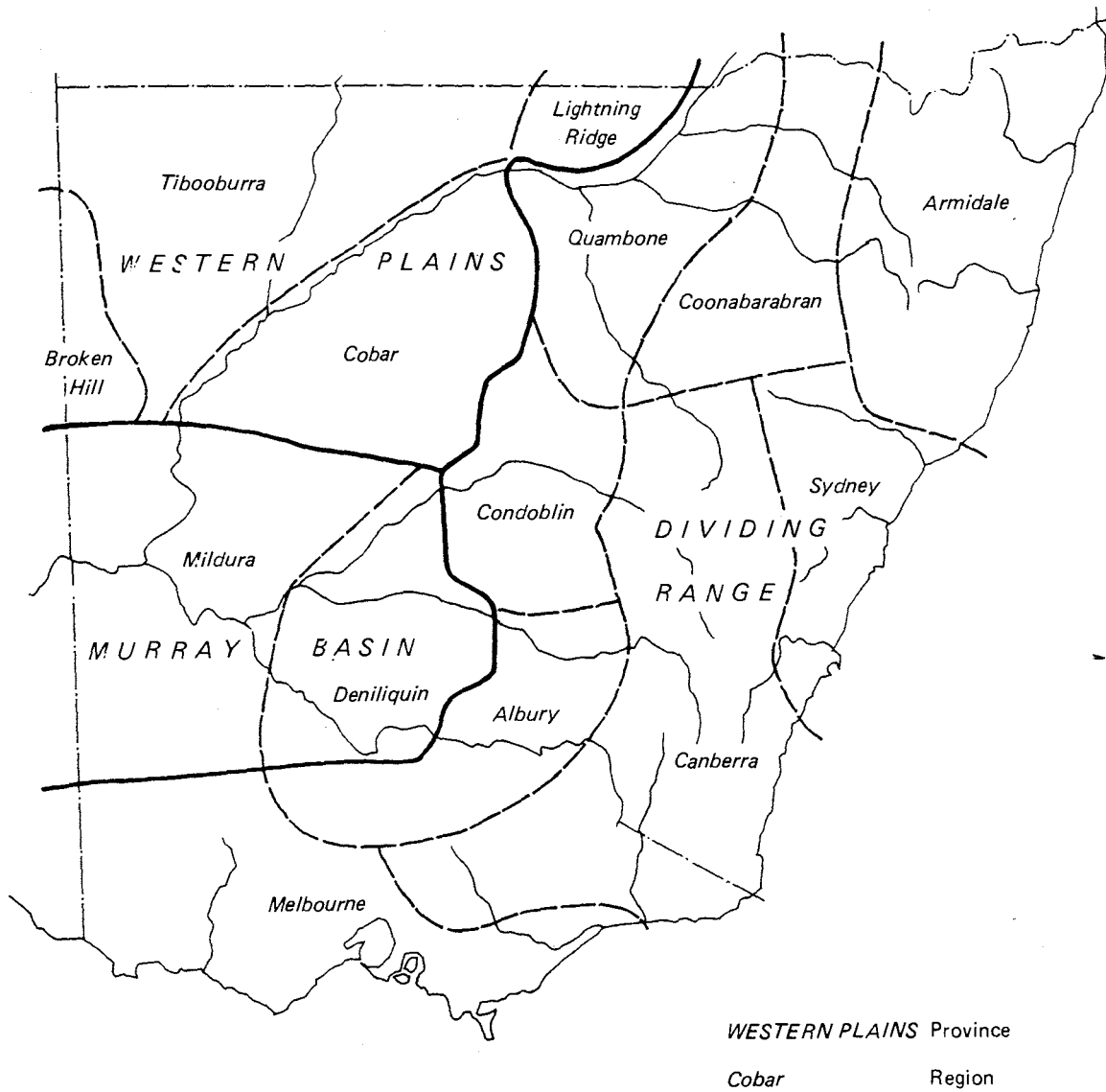


Figure 9.1 Map showing regions of variation in flaked stone technology

	CORE AND FLAKE INDUSTRY				TULA INDUSTRY	PIRRI INDUSTRY	LAMELLATE INDUSTRY	MICROBLADE INDUSTRY												
KEY:	core tool oriented	flake tool oriented	quartz blocks	pebble bi-polar	burrans	large convexes	discoidals	pebble 'adzes'	elouera	dihedral burins	tula 'adzes'	microtulas	unifacial point	lamellate cores	stage 1 blade core	stage 2 b.c.	stage 3 b.c.	bondi points	small geometrics	large geometrics
DIVIDING RANGE PROVINCE																				
Armidale Region	X	O	X	O	O	?	O	O	O	O	O	O	O	X	R	X	L	X	X	X
Sydney Region	X	O	O	X	O	O	O	O	X	O	O	O	O	R	R	X	L	X	R	O
Canberra Region	X	O	X	O	O	R	O	O	O	O	O	O	?	X	L	X	L	X	X	X
Melbourne Region	X	O	X	L	O	O	O	O	O	L	O	O	O	X	L	X	L	X	X	L
Coonabarabran Region	X	O	O	X	O	O	O	O	O	O	O	O	O	O	R	X	X	X	X	X
Albury Region	X	O	X	O	O	O	O	O	O	O	O	O	O	X	R	X	X	X	X	X
Quambone Region	L	O	O	X	O	O	O	O	O	O	O	O	O	O	O	R	X	X	X	?
Condobolin Region	X	O	X	X	X	O	O	O	O	O	O	O		?	L	X	R	X	X	X
MURRAY BASIN PROVINCE																				
Deniliquin Region	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O	O	R	?	?
Mildura Region	L	L	O	O	R	O	O	O	O	O	L	R	O	O	O	R	R	R	R	R
WESTERN PLAINS PROVINCE																				
Lightning Ridge Region	O	X	O	L	R	R	X	L	O	O	R	R	R	O	X	O	O	X	X	X
Cobar Region	L	X	O	O	X	R	R	O	O	O	R	X	R	O	X	X	O	X	X	X
Tibooburra Region	O	X	O	O	R	X	R	O	O	O	X	O	X	O	X	O	O	O	R	X
Broken Hill Region	L	X	X	O	R	O	O	O	O	O	R	O	R	O	X	R	R	O	X	X

NOTES: quartz blocks = fracture line acceleration technique; large convexes = larger than 'thumbnails'; pebble 'adzes' = small 'adzes' made on pebbles; microtulas = small sized tulas; unifacial point = pirri point; stage 1 blade cores = various nuclear cores for microblade production; stage 2 blade cores = 'large flake' microblade cores; stage 3 blade cores = small anvil microblade cores; small geometrics = geometrics less than 13 mm wide; large geometrics = greater than 13 mm wide.

Table 9.1 Table showing the distribution of technological industries in Stone Technological Regions

commonly found on the sites. The functional transformation goes from heavy duty tools at the out-set to medium and light duty core tools as use continued. These were the functional equivalents of the large flake tools and hafted flake tools further to the west. The resharpening process resulted in an abundance of debitage which is kept as small as possible to conserve the mass of the implement, and large flakes for tools are uncommon. For fine duty work however, these flakes are always available on the ground at camp sites. Their abundance also means that they can easily be discarded and replaced when dulled by usewear, rather than having to retouch a new edge which will be less sharp. This core tool orientation is possible because flakable stone is common throughout most of the Dividing Range country.

Over very large parts of the Dividing Range Province the stone is in the form of quartz. This includes a "quartz belt" which extends south from Dubbo, through Wagga Wagga to Albury/Wodonga and westerly towards Bendigo and Ballarat (the same reef quartz which attracted the gold miners). In this zone 100% quartz assemblages are common, and where there is weathered quartz in the soil, the recognition of archaeological sites as indicated by stone artefacts is very difficult. This is particularly so since "fracture line acceleration" (or flaw propagation) is the main flaking technique, and the waste looks the same as natural weathering.

The Murray Basin is an anomaly. In this area the stone material is flaked into extremely small debris, even more so than the Dividing Range. Flake tools are rare, as are cores which are likely to be in the form of bipolars. This is explicable since there are no stone sources out on the Riverine Plain. However, even when a stone source is nearby, such as along the boundary, the material on the Riverine Plain seems to be excessively reduced. Even near the northern border of the Riverine Plain the hafted adzes which are common in the Western Plains are remarkably rare.

It would appear that there was little stone transported onto the Riverine Plain, and there may have been considerable substitution of shell and bone as cutting implements. The strategy towards stone technology is a "small stone" orientation in which the available material is reduced systematically and intensively into the smallest possible fragments until all of the material is completely exhausted. The axe heads frequently were heavily flaked (probably to restore the edge angle) and the debitage is occasionally found on sites.

These technological orientations within the Core and Flake Tool Industry are the main basis for defining the three Provinces described above. This is further supported by the Tula and Pirri Industries in the Western Plains, and the Lamellate Industry in the Dividing Range.

There are further variations which help to define the Technological Regions. These are mostly due to specific patterns of stone material distribution. For example, there is a similarity between the Sydney Region (Sydney Basin and Hunter Valley) and the Coonabarabran Region. This is because both are dominated by the Mesozoic sandstones which carry quartz conglomerates and where other flakable materials are erratically distributed. This separates the Armidale Region to the north and the Canberra Region to the south which are similar due to the extensive use of reef quartz in both, and the Melbourne Region is a southwestern extension of this. In the Albury Region quartz dominates, sometimes to the exclusion of all else. The Macquarie River plains (Quambone Region) is similar to the Riverine Plains with highly reduced small fragments of stone being common on sites. The Condobolin Region on the Lachlan River has heavily reduced assemblages also, but elements from the west, such as the Tula Industry are present.

A transition zone for the Western Plains Province runs north from the Condobolin Region west along the Bogan River in the Cobar Region and the Lightning Ridge Region. In this zone stone is not as frequently available as it is in the Dividing Range. Where it does occur, it is rarely in the form of massive silcrete outcrops such as further west. The Cobar Region is characterised by quartz conglomerates and poorly cemented Paleozoic quartzite as well as remnants of Tertiary silcrete scattered throughout a large area. In the Lightning Ridge Region, west of the Barwon River, the silcrete outcrops are more massive, but often are weathered into rubble.

It is not until the northwest corner of New South Wales is reached that the silcrete outcrops are massive, and desert weathering processes make it highly accessible, either as scree from the outcrop or as a pavement of gibber cobbles. These sources are intermittent with extensive sand plains and dune fields, and the Tibooburra Region extends into South Australia and Queensland.

The other more specialised industries are consistent with this pattern. Although the Pirri Industry is represented in the transitional Western Plains Regions, it is prominent only in the Tibooburra Region. The full sized tulas also belong to this region. They are more infrequent, or occur as microtulas in the transitional regions. The Microblade Industry is present throughout, but only geometrics seem to be present in the Tibooburra Region, and these are usually relatively large sized. The western transition zone has a mixture of backed blades of different sizes and shapes. Once into the Dividing Range Province the bondis are abundant and the geometrics are mostly small sized.

There also are differences among regions for blade production, such as blade cores designed for reef quartz in the high quartz regions, or for pebble quartz in the Coonabarabran Region. Regions where good quality flaking stone is not common such as the Canberra Region tend to use large flakes for blade cores such as the burin blade technique or the tranchet technique.

Among the abraded industries, ground edge hatchets and hammer stones are too infrequent on sites to allow much comment. The Grinding Stone Industry however was represented throughout the Western Plains Province. Milling slabs were particularly conspicuous in the Cobar Region, probably because tabular sandstone is so common there. In the Murray Basin ground stone is present also, but usually as isolated small fragments on sites. These often have striations which do not seem to be from seed grinding. Such fragments may have been transported as wood working rasps. Once a milling slab was worn out, the pieces would be converted into a muller, hatchet whetstone, or other smaller grinding implements (Witter 1982). In the Dividing Range Province milling slabs are rare although they occur in the western fringe such as the Coonabarabran and Condobolin Regions. The main kind of grinding gear which is to be found in this province is the smaller, thicker mortars which may be for grinding food other than grass seeds.

ARCHAEOLOGICAL LAND SYSTEMS DIVISIONS

Land systems are the result of climate, physiography and geology which interact over time to develop soils and vegetation types. In Southeastern Australia there are two major physiographic effects; the high ranges in the east and south, and the plains to the west and north. Aridity increases along a roughly northwestern axis. The pattern is made more complex by rivers which mostly flow to the west or south across the western plains, as well as low ranges in various places. In the eastern and southern ranges there also are a variety of landscapes such as high plateaus, valleys, and localised plains, as well as the coast line (See the physiographic profile in Figure 2.2).

For the Tibooburra, Cobar and Boorowa Areas I identified various land systems units and grouped them roughly as (a) major drainages, (b) the main ranges and (c) the country in between. Although this provided a basis for comparison of sites within a sample area, and for interpretation, it was inappropriate for comparisons among the different sample areas. For example, a riparian environment along a temporary creek in the Tibooburra area is different from one on a permanent river in the Southern Tablelands. The greater vertical relief of the ranges in the Boorowa area affects the climate more than the low ranges in the Cobar or Tibooburra areas.

Thus it is not a matter of sites associated with certain physiographic features alone which are important for comparisons of one region to another. It is necessary to include the qualitative and systemic context of the physiographic features as they occur in different broad environmental types.

Using the great transect to illustrate this principal, some of these broader, division level features have been summarised in Table 9.2 for the three sample areas. The categories used were physiography, climate, hydrology and vegetational structure. These are environmental aspects that might be expected to influence land use in general and assist in interpreting more detailed land systems units or other environmental types.

CULTURAL ADAPTIVE AREAS

Efforts to distinguish regional differences in the archaeological record are mostly limited to comments on the distributions of certain tool types (Mulvaney 1979:224-5). Ethnographic differences by region have been proposed by Elkin (1938:40-1), Berndt and Berndt (1977:55), and a map of tribal boundaries was published by Tindale (1974). Ethnographic regional variation was the topic of a book edited by Peterson (1976:66) in which he also proposes a regional system on the basis of drainage systems. Linguistic mapping has been produced by Oates and Oates (1970).

There also have been attempts to integrate the archaeological with the ethnographic record over large regions in Southeastern Australia. Examples include Allen (1968, 1972) in western New South Wales, Ross (1981) in the Mallee, Balme (1984) in the North Central Rivers area of NSW, Williams (1988) and Lourandos (1980, in Western Victoria, McBryde (1974) in the New England area and Flood (1980) in the southern Dividing Range.

A forum to integrate various studies over the entire area was led by Isabel McBryde who formed a Southeast Group (McBryde 1984:4). Still lacking however, is a map for Southeastern Australia which indicates the basic regional variation of the archaeology.

Part of the difficulty is that the ethnographic record to go with the archaeology is extremely patchy, since it is mainly incidental scraps from explorers accounts or early settler's narratives. The absence of systematic ethnographical studies with first hand observations on economic activities, technology and camp structure makes our present interpretations on subsistence or settlement highly speculative.

The greatest part of the archaeology relates directly to technology (artefactual assemblages) and economy (food refuse), and reflects settlement locations of people in

ARCHAEOLOGICAL LAND SYSTEMS DIVISIONS

division	physiography	climate	hydrology	vegetational structure
Tibooburra	Low relief. Extensive plains of gibber and sand. Areas of dunes. Localised hills and rocky ridges. Alluvial flats on braided water courses. Large and small lake flats	Hot, and arid. Rainfall irregular with a tendency towards winter dominance. Drought prone.	No permanent streams or lakes. Long-term water holes mostly along major watercourses. Temporary playas, swamps and claypan depressions.	Mostly open vegetation. Extensive grasslands and low shrublands. Localised scattered small trees. Woodlands along water courses.
Cobar	Medium relief. Sand plains and rolling hills. Patches of dunes. Alluvial flats on major water courses. Isolated ridges and extensive ranges of steep hills. Occasional playa lakes.	Hot, semi-arid. Rainfall irregular with mostly winter dominance, Drought prone.	No permanent streams or lakes. Water holes mostly along major water courses. Also isolated springs. with rare permanent soaks in ranges. Temporary playas, box swamps and claypan depressions	Mostly semi-open vegetation. Largely cypress pine woodland or savanna of mixed small trees and tall shrubs. More open at lower elevations. Low shrubs and grassy ground cover. Woodland along water courses.
Boorowa	High relief. Extensive rolling plains and hills with isolated high hills. Occasional flat plain. Ranges high, forming various basins with rivers. Rivers and main streams with alluvial flats.	Medium cool, temperate with moderate rainfall. Mostly regular winter dominant rain. Occasional droughts.	Permanent rivers. Other water courses which commonly carry water. Springs numerous, especially along footslopes	Mainly dry woodland with an understory. More dense at higher elevations. May be open grasslands on flats and in areas of frost hollows.

Figure 9.2. Archaeological Land Systems Divisions as indicated by the three sample areas.

the past (site environments). More specialized sites such as rock art, quarries, burials or stone arrangements are relatively localised in distribution, and are usually rare. Most of the archaeological materials found are therefore part of the human adaptive response to the environment.

The most effective approach would be to define the environmental boundaries which have cultural implications and to test them against the archaeological and ethnographic record. In such a scheme the underlying assumption would be that of regional adaptive variation in the form of "Cultural Adaptive Areas" (Witter 1984a:48).

Using the sample areas I have compiled archaeological and ethnographic information (Table 9.3) under headings such as stone artefact technology, extraction and processing technology, foods, settlement, and subsistence strategy. Some of the data are provisional, and likely to change with further research. The Tibooburra and Cobar Areas could be grouped into a general Western Plains Area, although they are separated by the Darling River.

ARCHAEOLOGICAL FORMATIONS

Archaeological Formations are based on the concept of archaeological formation processes (Witter 1984:49). This includes the various natural processes which are responsible for preserving and destroying sites, the human activities which create or disturb sites, as well as the factors which affect site detection such as exposure and visibility.

In Table 9.4 the formational headings for the three sample areas are as sedimentation, exposure, visibility, obtrusive sites and unobtrusive sites. Stable surfaces which are not being covered over with sediment or redeposited by erosion favour the detection of sites. Such sites however are usually unstratified and liable to have repeated occupations superimposed on them.

A common form of exposure is the "scald" which may be formed by deflation, flood scouring, ponding or salinity. In some regions this is developed into a clay pan/blowout system and in others it is associated with gullying. The exposure, whether it is due to erosion or a weathered surface is greatly affected by visibility. In some regions this is mainly from herbaceous growth, in others it is due to woodlands leaf litter.

Archaeological sites may be divided into those which are obtrusive or unobtrusive (Schiffer et al 1978:6). Obtrusive sites include rock shelter deposits, rock art, and

CULTURAL ADAPTIVE AREAS

area	stone artefact technology	Food processing technology	foods and diet	settlement pattern and strategy	subsistence strategy
Tibooburra	Flake tool orientation Tula, Pirri and Microblade Industries common.	Occasional use of cooking pits. Use of seed grinding slabs probably frequent	Main staples are roots and fruits? Grass seeds important. also Lizards and large game probably significant.	Mostly as small camps distributed in all environments with occasional large camps at major water sources.	Arid land with high mobility depending on rain fall pattern. Generalised and plant oriented?
Cobar	Marginal flake tool orientation Tula and Microblade Industries common.	Extensive use of cooking pits and seed grinding slabs. Mortars frequently used.	Main staples are roots and grass seeds? Occasional fruits. Lizards, grubs and small mammals probably important.	Scattered small camps, but large camps when water abundant in favourable places, or at permanent soaks.	Semi-arid land, with high mobility depending on rain fall. Generalised, plant oriented. Perhaps occasionally intensive.
Boorowa	Core tool orientation with quartz technology, Lamellate and Microblade Industries common.	Occasional use of cooking pits and mortars.	Main staples are roots and large game? Fruits, seeds and fish also probably important.	Large camps at strategic ecotonal locations with water. Small camps scattered through all environments.	Medium mobility in a temperate environment. Hunting a major activity? Plant gathering intensive?

Table 9.3. Cultural Adaptive Areas as indicated by the three sample areas.

ARCHAEOLOGICAL FORMATIONS

formation	sedimentation	exposure	visibility	obtrusive sites	unobtrusive sites
Tibooburra	Mostly stable, localised dune activity. Aggrading on creek flats and degrading on ranges.	Extensive weathered surfaces and gibber plains. Clay pans and scalds common on alluvial flats and dune swales.	Mostly good - 50% to 80% bare ground. Ground cover as grasses, low shrubs and forbs.	Quarries numerous on outcrops. stone arrangements rare on gibber flats rock art rare in ranges.	Flaked stone scatters with occasional hearths are abundant and, nearly continuous along major watercourses, also common in dune swales.
Cobar	Mostly stable, but with extensive slightly active sand cover. Aggrading on creek flats and degrading on ranges.	Large areas with scalds and clay pans. Occasional gullies. Ranges mostly with weathered surfaces.	Mostly fair - 20% to 50% bare ground. Ground cover as grasses, shrubs, and forbs. Leaf litter extensive in some areas	Outcrop quarries rare in ranges. Rock art and shelters scattered through-out lower ranges but not common	Flaked stone scatters abundant. Major sites associated with springs in ranges. Hearths common especially along major water courses.
Boorowa	Degrading on the steeper slopes, but mostly stable on the rolling hills. Aggrading on the river flood plains.	Ploughed areas occasionally available. Salt scalds. gullying and dirt tracks some times to be found.	Mostly poor - 0% to 20% bare ground. Ground cover as crop, pasture grasses and woodland litter	Outcrop quarries rare.	Flaked stone sites abundant, particularly on scald exposures near springs and water courses. Hearths rare.

Table 9.4. Archaeological Formations as indicated by the three sample areas.

outcrop quarries. Unobtrusive sites usually are comprised of flaked stone scatters or hearths.

Variation in these characteristics can be seen for the sample areas. Other regions would contrast strongly with these, such as the aggrading Riverine Plain with its earth mounds, the extensive degrading areas of the Sydney Basin with its abundant rock shelters, or a coastal zone with middens and coastal geomorphological processes.

REGIONAL SCHEMES

As discussed at the beginning of this chapter, there have been various attempts to determine cultural patterning on a regional basis. This was an objective by Allen (1972) across western New South Wales. Balme tried to investigate this in the upper Darling River Basin (the North Central Rivers Project), using a land systems scheme (Balme 1984). Other kinds of regional patterning have been studied such as carved trees (Bell 1981), cylcons (Hamm 1987) or bora grounds (McBryde 1974). There are also potentials for mapping various other aspects of material culture, stone tool materials, ceremonies, plant foods and so on.

The schemes which I have outlined above are of a comprehensive type since they are applicable to all regions generally, but each is specific as to what it is intended to measure. It is not possible in the analytical phase to mix environment, formational factors and cultural areas in the one scheme. These need to be compiled and evaluated individually to determine comparability and reliability of the data. After this has been accomplished, more synthetic systems can be put together.

Geographical information systems (GIS) are recognised as a means to assess archaeological regional patterning (Kvamme 1989). At the most basic level it combines multiple layers of data such as soil types, topography and recorded sites. An uncritical "overlay" approach however is extremely risky (Kvamme 1989:190-1). Superimposing vegetational, soils, and geological maps merely gives a measure for the boundaries and scale thought to be useful for the maker of each type of map. They are meaningful in terms of vegetational structure, soil type or geological formation, but were those the boundaries recognised by Aboriginal land users?

Overlaying cultural variables also is questionable. Site density and site types in a State Register are a function of where archaeologists have been active, what they were looking for, and the methods they used. Even the distribution of tool types from site records would be extremely frustrating because of the variation in terminology among individual recorders.

The results of directly feeding environmental and cultural data into a computer (such as for cultural resource management purposes as mentioned in the next chapter) would be doubtful at best and misleading at worst. The meaning of the data in archaeological terms needs to be assessed, and the concept being measured must be made explicit.

CHAPTER 10

ARCHAEOLOGICAL RESOURCE MANAGEMENT

CULTURAL RESOURCE MANAGEMENT

Cultural resource management, (or CRM) is what was previously referred to as "public archaeology" (McGimsey 1972). The concept of cultural resources is that there is an extensive record of cultural remains ("sites", or archaeological occupations) on the landscape. This is a resource which tells us something about the past. It is non-renewable and extremely fragile. A variety of processes endanger this resource such as natural erosion, farming or development. It is not possible to protect all of this resource, but there should be procedures which minimise its destruction, and priorities to improve its conservation as well as the protection and preservation of certain examples.

The task of carrying out this conservation is the responsibility of particular governmental organisations. The justification of doing this at public expense is to ensure this heritage and relics of the past will persist for the benefit of future generations as national cultural assets. This includes the recognition of a special relationship between the indigenous people of Australia and the remains of their past and various other aspects of significance.

The preceding chapters are not concerned with the full scope of CRM and heritage. They are about survey methodology, stone artefact variability, land use models and regional variation. These are needed for an understanding of the prehistoric archaeological resource. Ideally, this should be known before taking steps towards its conservation. Management has been forced in large part to operate the other way around. The reason for taking on such a broad topic in this thesis, and covering three otherwise unrelated regions, was to provide managers with a systematic basis for the understanding and assessment of the archaeological resource. To illustrate this, I provide below a rough sketch of certain aspects of management, in order to show how a research component is needed for management decision making.

Research in Management

The crux in management is the decision making basis needed to reduce the loss of cultural values. This has to be cost effective, practical, and based on an understanding of the resource.

As indicated in the introductory chapter, it is the archaeological input into the decision making process which underlies the purpose of this thesis. I have been concerned with how information about the archaeological record can be acquired and what it may mean for use in a management context.

If the decision making process is to be other than arbitrary, there needs to be a systematic basis for comparison and a coherent and comprehensive research framework. This may be conceived as a standing research design, or an on-going approach with questions generally applicable to various management projects in different regions. The results of the projects must feed back into the standing research design in order to achieve a net gain in archaeological theory. This includes the capacity to integrate data, evaluate patterning and examine models at various levels.

Before proceeding further however, I need to set the scene in public archaeology. What is "cultural resource management"? What is its history? How does it work? The limitations and potential of a research framework in a Public Service context need to be understood if it is to be developed at all.

Historical Perspective

At present, there is no up-to-date or comprehensive published material on the history of cultural resource management in Southeastern Australia, although various articles have dealt with different aspects (Sullivan 1985, Bowdler 1983, Coutts 1982, 1984). What follows therefore is a summary of my impressions of the main features.

In Australia, management archaeology began as a minor duty of museums. A register was kept, and occasional salvage efforts were organised. By the late 1960s and early 1970s specific "relics" legislation was passed by a number of States, and management archaeology was recognised as a full-time job. The Site Recorder program of the Australian Institute of Aboriginal Studies made a contribution at the National level to the work carried out by these State offices.

The initial concern was with the site registers. It was necessary to establish how many sites were known and where they were (e.g. McKinlay and Jones 1979, Flood et al. 1989). It also was hoped that the register could be increased so that they would contain most of the sites in existence and serve as the basic management tool.

The Acts also attempted to include a local policing structure. This was usually in the form of additional duties for officers in a department which had regional offices already

established, such as Crown Lands Department Inspectors in Victoria or National Parks Rangers in New South Wales. Such arrangements however, were difficult to implement. A great deal of intensive instruction about archaeology and close supervision was needed to make these officers knowledgeable and useful. This need for the training of non-archaeologists put a considerable strain on the staff of the state archaeological offices and was difficult to maintain. Without frequent liaison, the archaeological duties of the regional officers dropped due to pressure from other requirements.

Another management practice which soon emerged was that of the contract survey. The registers were clearly incomplete for the various developmental projects, and the staffing of the state offices were inadequate for undertaking most management surveys as a government service. The objective of the contract surveys was to identify sites so that they could be avoided by the developer. If this was not possible, then legal mechanisms were in place to regulate the destruction of sites, and possibly require salvage.

In Victoria, a long term scheme was set up in the form of 1 : 100,000 map sheet surveys. The idea was to produce these map sheets showing the locations of the sites and a booklet summarising the prehistory of the map sheet. The model for this was the Geological Survey publications (Coutts et al. 1976). The surveys were to be carried out by the Victoria Archaeological Survey and assisted by a volunteer work force. This approach cannot be said to have been successful. One reason was the drastic underestimation of the quantities of sites and the problems in detecting them. The archaeology of Victoria was poorly known, which meant that a summary of the prehistory of a map sheet area had to begin from scratch. The efforts needed to conduct the surveys and to put together a publication therefore were much greater than anticipated, and this initial attempt to introduce a research approach to management archaeology lost its momentum.

In some cases other regional studies were made by State offices, especially if outside funding could be obtained (i.e. National Estate or the Australian Institute for Aboriginal Studies). These might include rock art or shell midden areas, inventory an area known to have sites of special interest, examine regions where extensive development was expected, or to investigate areas where information was particularly lacking.(e.g. Vinnicombe 1984, Gunn 1979, Hotchin and May 1983, Balme 1986). Some projects were specifically for planning, such as for National Parks (Godfry 1980), and shire studies (Hughes and Berryman 1985, Witter 1985). However, these projects could only occur on a sporadic basis since they depended on the priorities of the granting agency.

In some cases, archaeological resources have been sufficiently important to affect whether or not development takes place at all. One example was the contribution of archaeological considerations towards the Franklin River Dam dispute (Jones 1982, 1983, Mulvaney 1983, Stockton and Stevenson 1984:75). The State of Tasmania failed to undertake an adequate assessment for archaeological resources in the form of a management survey. The subsequent discovery of highly significant sites seems to have been a factor in preventing the construction of a hydroelectric dam.

Consulting work is now a minor industry, and a further development was that of the Australian Association of Consulting Archaeologists. This came about as an awareness of the need for professional status for free-lance archaeologists. One of the concerns of this organization was the standards of reporting (Haglund 1984).

Another recent development was the inclusion of management implications in academic studies such as doctoral theses where methodological issues were considered (Sullivan 1982, Stockton 1982).

Currently, there has been a concern to integrate Aboriginal heritage interests and European historical sites as part of a more inclusive concept of heritage conservation.

After fifteen or twenty years of management archaeology in Southeastern Australia it is possible to assess its development. The naive expectation that the State sites register could be the basis for management decision making, or that project-specific surveys were effective in the long term is changing. There is an awareness of the need for planning, an improved methodology, and broader concepts (Sullivan 1984).

Management Implementation

Administratively, the functions of a public archaeological office include maintaining itself, carrying out existing commitments and responding to new demands. In practice it has been my experience that State archaeological organizations usually operate as though they were in perpetual crisis, trying to catch up on an increasing backlog, while new and unexpected situations are continually arising. Under these conditions it is difficult to avoid ad hoc policies or develop a research program in an orderly way, even though the term "management" implies a controlled system of operation and planning.

Little can be done about the constraints imposed by political influences, departmental policy, or financial and staffing restrictions. Although certain functions are expected, there are rarely the resources to carry out all the work needed. Because of this, it is difficult to decide upon priorities for what projects to accept and which to leave alone.

Feasibility remains a major obstacle for both private consultants and government departments to carry out research. For example, additional time might be needed to obtain more detailed or specialised data on an impact survey. If so, the client would have to pay for a longer study. Developers are rarely happy about such requests.

If research requirements for contract work are being coordinated by a State office, it may be necessary to set new standards for technical and theoretical skills among consultants. Most consultants however have developed their own approach in conducting surveys in order to maintain commercial viability. New demands, or changes in routine may not be welcomed with enthusiasm by some (see also Sullivan 1983).

Such research by consultants also implies changes in government office structure and policy. More time must be spent to prepare specific terms of reference for various projects. If data are coming which need more organizing, then more staff are required to handle it. The integration of research results to-up-date policies and procedures for management would demand yet more time. The limitations of staff ceilings and funds may make it difficult for a government office to respond to a research programme, or perhaps demand it undergo radical restructuring.

Clearly, more is involved than simply developing new management initiatives or policies. On the other hand, the fundamental problem is one which will not go away: management decision-making cannot be better than the data and interpretive capacity. At present most of the available data base is poorly controlled, arbitrary, and with uncertain comparability. The interpretation of survey results mostly depends upon the experience and inclinations of the management archaeologists.

This strongly subjective predicament has had other effects. For example, for non-archaeologists the basis for archaeological management recommendations is normally shrouded in mystery. They are often made to believe that it is impossible for them to have any grasp of cultural resource management. This has not helped to inspire sympathy concerning cultural resources among the various types of land managers.

To summarise, the establishment of a research framework is not without obstacles for the management of archaeological values. This is without trying to address Aboriginal heritage values, site protection works, or other conservation needs. If it is to be implemented it must be workable and the advantages unambiguous.

SIGNIFICANCE IN MANAGEMENT

If it can be assumed that any archaeological site can uniquely say something about the past at a particular place, then all sites must be significant. But are all sites equally significant? Must all be protected, or should some sort of discrimination be used, and if so, what are the criteria? There are several issues regarding site significance, and the relevance of archaeology in them varies (see also Schaafsma 1989).

One common measure of site significance is whether the site can be said to be a good example of its type (a well preserved shell midden), is something rare (a stone arrangement), or has attributes outside of the normal range of distribution (rock art styles). This can be based on the materials and physical context of the site only, and not involve other archaeological considerations. Such significance is enhanced however, if additional dimensions (oral tradition, artefact analysis, regional studies, etc.) can be brought in through interpretation (ICCOMOS 1981).

It has been stressed that current research issues are a major source of significance (Schiffer and Gumerman 1977, Bowdler 1981, 1986). This is because current research on stone artefacts, animal bones or rock art styles can be related to theories about economy, change through time, or religion. Since this is an active learning process, the meanings given to sites are subject to change, and some are more interesting than others. Taking together the various topics, it may be considered that there is a sum total of archaeological research, knowledge and theory. Archaeological significance comes from this, and a trained archaeologist is expected to have a grasp of the full scope of concepts and principles.

Certain sites may be said to have public appeal as prehistoric "monuments" or "relics". They document the use of the landscape by previous occupants, and give a feeling of inheritance. Sites which readily capture the imagination in this way are rock art sites, burials, axe grinding grooves, large midden mounds, etc.. This monumental quality is sometimes referred to as "educational significance" because it would seem to lend itself to instruction about the past and create an awareness of heritage and antiquity. This kind of site is evocative and can stand alone in its own right. Such interest however can be greatly expanded with archaeological interpretive in-put.

The monumental sites contrast considerably with the mundane unobtrusive sites which are so abundant. Such sites may be large or small, well or poorly preserved, have a high or low diversity of contents, or be judged to be of some particular age. The value of such sites as a cultural resource is often ambiguous (see McKinley and Jones 1979, Sullivan and Bowdler 1984 and McBryde 1985 on this issue).

Another criterion is that of research potential. This is often thought of as excavation potential such as for in situ deposits, well-defined activity areas or materials in good condition. This tends to be difficult to determine because sites which are well preserved are likely to be poorly exposed, and what remains buried is obscure.

Perhaps founded on the idea of research potential is an implicit concept about the information value (in a cybernetic sense) represented by a site. This includes aspects such as the quantity, variety, complexity and quality of information. A large site with thousands of pieces of flaked stone, even if eroded, has a high information content. A small but well preserved shell midden representing a single event of a meal with little "noise" from other occupations has information of high quality. These sorts of "information" concepts can be applied to any site, regardless of preservation, type, size or particular characteristics.

A major consideration which has not yet been discussed is that of significance to Aboriginal people. Aborigines are probably the largest interest group with the deepest concerns regarding the prehistoric sites in Australia. In my experience, the basis for Aboriginal significance is highly varied. In some cases there is a spiritual identification due to specific oral traditions, and sometimes the interest is rather like that for monumental significance as defined above. Attitudes range from little concern by some individuals about particular types of sites (e.g. small camp sites) to the position held by others that no part of their heritage should be disturbed or lost. These attitudes are highly varied within a community and show considerable differences regionally. The issues regarding Aboriginal heritage and significance are highly complex, and it is not my purpose to explore this topic further here.

There obviously is great overlap in Aboriginal and archaeological concerns, but the philosophical basis appears to be very different. Management of the cultural heritage needs to be recognised as having an Aboriginal heritage dimension as well as that of archaeological values. To clarify areas of common interest it is necessary to explain to Aboriginal people what archaeology does, and ask them if they think it is relevant. Part of this process is the obligation to inform the Aboriginal community about what archaeologists are doing and involve their participation (Kelly 1979). In some cases certain archaeological interpretations are of interest to the Aboriginal community, such as life history details which can be from a study of burials. If so, it is essential to represent the archaeological aspects in a way which is intelligible and acceptable to the Aboriginal community (i.e. Pardoe 1987).

In practice, site significance is assessed by a variety of criteria. One set of criteria is in the form of a body of policy built up by the State authority. Thus rock art, stone arrangements, burials, or Pleistocene occupations receive much more attention for protection and preservation than the average shell midden or stone artefact scatter. These uncommon "policy" sites are usually considered to have particular importance for an interest group concerned with cultural identity, scientific research, or other heritage value. When these sites are encountered on a survey, they automatically rate a special status regardless of any other consideration. The vast bulk of the archaeological record however do not belong to this class, and it is the significance of these which this thesis is concerned about.

SITE PREDICTION

Site prediction is the other side of site significance. The more it is possible to explain what processes took place to create a site, the more this knowledge can be used to say where other sites will be. Testing predictions about why certain kinds of sites will be in particular places is a way of evaluating the capacity for the assessment of significance.

The concept of site prediction is usually discussed in two different ways. One is prediction by explanation (Zubrow 1973, Witter 1979) in which cultural processes are modelled. The other is as empirical generalisations or forecasts about site distribution patterns. This leads to the "sites are near water" approach (i.e. Judge, et al. 1975, Williams et al. 1973), which is not prediction in a scientific sense, but should be referred as "forecasting". For example, a geological map may rely heavily on areal photographs to indicate the various rock types and geological formations. Although it may "predict" that a particular outcrop is likely to be Tertiary duricrust, this is not considered to be a predictive theory. Meteorologists can only extrapolate from past patterns, and are careful to claim that they can only "forecast" the weather.

In management archaeology however, it is customary to refer to "predictive theory" in this way (Ross 1986:64-5), and to use it as an aid for planning. For example, it may be said that camp sites frequently occur within 200m of creek banks, or burials usually occur in dunes, or rock art is often found where there is the cavernous weathering of sandstone. There are, of course, regions where such sites do not occur in these kinds of places. Even for those regions where such rules apply, sites often fail to be found where they should be, or they turn up where they ought not.

A rigorous probabilistic approach might seem appropriate. This would provide site frequencies per area for site types within an environmental type at some level of statistical reliability. The difficulties with this were indicated in Chapter 4 (see also

Witter 1979). In practice it would be difficult for a labour intensive formal statistical approach to be practical. In addition, probabilistic statistical statements would be only valid for the areas already surveyed, and projections elsewhere are likely to be dubious.

Another way of discussing site patterning would be to refer to "archaeologically sensitive" areas. This implies a cruder system of anticipating sites and can be a rank-ordering approach, based on experience within a region.

A GIS scheme for archaeological sensitivity would be important as a way of providing a foundation for archaeologically sensitive land. This could measure values for physiographic types with different kinds of sites using regional schemes such as Archaeological Land Systems Divisions, Cultural Adaptive Areas and Archaeological Formations as discussed in the previous chapter.

Such a scheme would be useful for the various governmental departments (including local government) which have various conservation responsibilities. These administrators usually have no background in archaeology and rarely any special interest. A guide which would indicate the nature of the archaeological resources they might encounter should make it easier for them to bring this into their programmes. An intelligible system for archaeological sensitivity would allow them to make preliminary planning decisions, and understand the role of archaeologists in the planning process. The main risk is that some archaeologists or land managers may forget that it originated as a provisional arrangement, and use it as a definitive statement.

The basis for genuine predictive models (not just environmental correlations) remains poorly developed. It is difficult to provide models with a set of cultural rules or a "grammars" designed for various regions about Aboriginal behaviour. For example, I have suggested some aspects of how the organisation of cultural strategies might be modelled in Chapter 8. As settlement patterns for particular regions become known (also as indicated in Chapter 8), explanatory predictive approaches can be taken with increased confidence. In addition to behaviour, models about environmental reconstruction and site formation processes need to be integrated into an overall theoretical approach.

A RESEARCH FRAMEWORK

My experience has been that management projects need to be divided into an investigation phase and the following management actions. The steps in this follow these questions:

A. Investigation (based archaeological field data relevant to the case):

1. What is the resource? This includes the site contents, features and other material aspects about the site.
2. Where is it? This is the location on the landscape.
3. What does it mean? This is the results of analysis and interpretation.

B. Management (based on administrative policy and procedures):

1. What is the threat? This is the impact or other forms of endangerment.
2. What are the options? These are the methods for minimising the loss of the resource, reducing impact, or in some cases ensuring total protection.
3. What is feasible? The action to take place must be cost effective and based on existing funds.

In my experience, this usually is inadequate, partly because of the limited time and funds, but also because of the shortcomings of a framework to provide the research dimension. This then is unlikely to be carried over to guide the more strictly management aspects. These issues must be addressed if methods to deal with effective coverage or stone artefact analysis are to be used effectively by culture resource managers.

This thesis is concerned with the investigative phase, and its underlying purpose was to examine the prospects for a standing research design as a basis for investigation. Before examining this however, the issue of scale needs to be considered relative to management operations: the site, the locality, and the region (see Butzer 1982:230-4).

The Site

The site is the basic unit of management. It is specifically that which is protected, stabilised or studied. The issue is mainly that of the data needed to answer the question above of "what is the resource"? In Chapter 2, I stressed that site recording needs to be done in a context of analytical concepts relative to a body of theory about settlement strategies, economic processes, or optimising behaviour. In practice, this need not be high-powered. The use of analytical concepts such as site dimensions, assemblages or environmental association is not radical, but it does need systematic operationalisation.

One pay-off is a data base which permits comparisons among projects and regions. Although minimum standards may be set regarding analytical categories, this does not mean standardisation. In fact, there is some risk in uncritically loading data into a computer from standardised forms. It should be expected to be necessary to re-interpret a body of data to make it consistent for a particular analytical objective.

Another advantage is in site interpretation. A common concern in management is to try to reserve a representative sample of sites, or to put a priority on the protection of the full range of variation of a particular type of site. This involves the concept of a "representative type" or a "site profile" which would give land managers some idea of what the cultural resource was thought to be. The use of the Reduction Charts in this thesis shows that assemblages can be expected to vary considerably within a region, even though the results of summary recording look much the same.

Methodological research into site recording and analysis (e.g. Flood et al. 1989) needs more recognition as a management priority. This area of research is easily conducted, but it is curiously difficult to find in management reports or the published literature.

The Locality

The locality level is a discrete area containing sites. It may be surveyed, reserved or identified as having importance. It includes the environmental context of a site or a group of sites which land managers can deal with a site complex, precinct, or curtilage. The locality involves project research designs, coverage and archaeologically sensitive land. Project research designs are important because a structure is needed to integrate the various aspects of sampling, coverage conditions, environmental patterning, site data and cultural models. Since there is no fixed way to do this, each investigator needs to select a research orientation which is suitable for the project. Project research designs are a matter of individual or institutional initiative (Bowdler, 1981, 1986, Stockton and Stevenson 1984, Hughes and Sullivan 1979, Sullivan and Hughes 1984).

In practice this is easier said than done. Normally in a management survey, there is little time to give to a research perspective in advance, let alone prepare one which is appropriate for the data which will be found. Sometimes this can be developed in the field, but many projects are so brief that this is not possible. Even when data can be acquired within a research context, the time may not be available for a consultant or a government archaeologist to do the analysis and include the results in the report.

Regardless of the research dimension, it is common to assume that the surveys or investigations are at least "systematic". This may assume that every part of the pipeline or developmental area was covered on foot and all "sites" were recorded. Such work however does not necessarily provide a systematic survey. For example, if the coverage is not quantified, it may not be possible to appreciate that only 10% or less of the area or line could be effectively covered. Again, in the absence of a referenced or explicitly defined stone artefact classification, or method for estimating artefact quantities and site size, the value of the site recording process becomes dubious. Anyone who has tried to use the management survey reports for an analytical project is invariably frustrated. The data is inconsistent, ambiguous and comparability is uncertain. Even the government officer who must review impact survey reports often finds it difficult to understand what was done on a survey and what was found. In spite of this, such reports pass as being "systematic" studies.

As a point of clarification, I should say that what I mean as a research context is not the sections in the front of archaeological reports which summarise the environment, ethnography, and previous archaeological work. Admittedly, this is "research" in the sense that it involves library research, and gives some of the background needed for research, but it is not a research design which directs attention to the relevant questions about the project.

The Region

The regional level is a broader administrative area for the purposes of general policy. It deals with large scale GIS schemes, models or prehistoric sequences. Regions may be identified according to archaeological features, environmental types, processes of site endangerment, or research needs.

The level of the region is perhaps the most difficult to come to grips with. This is addressed in Chapter 9 where I suggested various GIS schemes such as Stone Technological Regions, Archaeological Land Systems Divisions, Cultural Adaptive Areas, and Archaeological Formations. Setting up any broad regional scheme however is not a simple undertaking. There are methodological difficulties such as the type of data needed and how they are to be used. The theoretical component also needs to be well understood so it is clear what the regional boundaries or their subdivisions are intended to measure.

In this thesis I have considered aspects of cultural strategies adapted to the Tibooburra, Cobar and Boorowa regions, and in the case of the Microblade Industry, how a strategy or mode could be effective across many regions.

A regional (or large scale locality) study which uses a "dots-on-the-map" approach results in a report which stays forever in the file cabinet (Sullivan and Hughes 1979). It provides little basis for understanding regional variation or regional cultural strategies. Management decision-making needs a processual approach. Conditions are always in a state of change. Patterns of modern land use, the money available, or the political climate can change to make recommendations or policy obsolete. A regional study which gives a basis for understanding the processes of site formation, settlement strategy, artefact production, or other aspects of the archaeological record means that a cultural resource manager has a better chance of coping with various unexpected situations when they come up, and can allocate rational priorities for the work which needs to be done.

A Framework

The concept of a framework, or standing research design, is the identification long term issues for study and their relationships. In a management context, it would be the theory and method needed for the investigation and assessment of sites, localities and regions, as well as to guide the appropriate management action. It needs to be coherent and comprehensive for the area of operation (e.g. a State), within budgetary constraints, and be intelligible to non-archaeologists (developers, shire planners, Aboriginal communities).

The chief elements are relatively few:

1. **Regional variation.** Control over regional variation and the identification of regional boundaries or gradients are necessary. In a GIS there are three basic information themes: culture (as it is recognisable archaeologically), environment (as it affects the distribution of sites) and formation (biasing effects). A management programme also might include administrative boundaries, the register of already known sites, or areas of various types of site endangerment or threat.
2. **Methodology.** The methodology would cover survey, site recording, excavation and analysis. A prescriptive programme is needed to ensure minimum standards and comparability.
3. **Interpretive Issues.** Standard interpretive issues include the meaning given to stone artefacts, settlement implications of site types and frequencies, and land use

modeling. Special issues may involve regional rock art styles, subsistence implications from a midden locality, or the reconstruction of a particular site.

Assuming that a standing research framework was established at the level of site, locality and region, how would it work? In the Boorowa Area for example, there have been two impact surveys for gas pipelines. One was the original Sydney to Moomba survey (Haglund 1974), and later was the Dalton to Canberra survey (Witter 1981a). The survey by Haglund was part of the first large scale management survey ever conducted in New South Wales. Everything was unknown, such as if sites are common on the Southern Tablelands or how to recognise quartz artefacts. Apart from the archaeology, even the logistical and procedural aspects of mounting regional level surveys was new. The survey itself located no sites in the Boorowa area and left an impression that sites on the Southern Tablelands were likely to be rare.

The Dalton to Canberra pipeline was approached using the research perspective developed in this thesis. Certain research exercises were conducted within the limits of the funding available for that survey. For example, it recorded data for a trial coverage analysis to determine effective coverage. It also was possible to carry out detailed recording on some sites in order to evaluate the quartz assemblages. On this survey several sites were found and a range of assemblage variability could be demonstrated.

As a consequence, there was a salvage excavation of one site near the main pipeline which could not be avoided and a mitigation survey. Since it could be shown quantitatively that most of the pipeline was obscured by poor visibility, and that a hypothetical site frequency could be proposed, construction of the pipeline would probably encounter and disturb other unrecorded sites. Thus a mitigation survey was proposed and carried out. The value of the mitigation survey was to re-survey select portions of the pipeline which were considered to be archaeologically sensitive after the construction was finished. The mitigation survey was to document the undetectable sites so that there would be a record of their existence.

The original survey by Haglund was conducted during a time of heavy rains, so that there was herbaceous growth even on the scalds and visibility was virtually nil (L. Haglund and J. Stockton, pers. com.). Also at that time there had been no investigation into quartz assemblages, and the policy was to not accept a piece of stone as flaked unless it had indications of a bulb of percussion (L. Haglund, pers. com.). Although this was a sensible policy in the absence of knowing about quartz technology, it undoubtedly reduced the chances of site recognition.

The data and research content from the Dalton to Canberra survey was relevant only for the immediate concerns of the pipeline construction. There was no feed-back mechanism in to apply these results into a wider context for future surveys in the region. What is needed is a structure where information can be abstracted into a more usable and accessible form than a file cabinet of survey reports. For example, in the Canberra to Dalton pipeline survey, there were recommendations to re-survey portions of the pipeline route in archaeologically sensitive areas. At the time, I thought this mainly meant the sections near stream crossings, and I was not fully aware of the importance of footslopes, particularly in the transition zone from the basins to the ranges. There were no state-wide GIS, nor regional models as a basis for recommendations or which could be tested by my survey.

How would a feed-back system work in which the results of management surveys could become part of a research framework? An example is shown in flow chart in Figure 10.1.

In this diagram, a project research design is important to identify the appropriate methodology and the research issues which might be investigated. If this can be incorporated, it provides guidelines for two important aspects of the field operation: sample strategy and site recording. The project should obtain data in which the biases and analytical concepts are made explicit. The result is a body of data which is systematic, controlled, and based on behavioural, ecological, or sedimentological theory to what ever degree is feasible for the project.

Even if the data is not fully analysed in the course of the project, it would be in a form which can be understood and employed for subsequent analytical needs. The analysis provides generalisations and models. In a direct management context the data provides a guide as to why statements about site significance or archaeologically sensitive areas are made. At a broader level it can be used for an examination of regional variation and the development of GIS schemes. It also provides a basis for identifying a range of "representative types" within a region, for site interpretations, and a broader concept of significance. Ideas from the field experience can contribute towards theory building, critiques of previous work and the development of new insights. The development of processual and predictive theory needs an environment of debate and challenge (Chalmers 1978) for stimulus.

How would the sort of research framework outlined above actually fit into cultural resource management at a State level? The flow chart for Figure 10.2 can be used to illustrate. Management projects begin with certain objectives because someone is paying money (often under duress) for a particular service, or to satisfy the terms of a

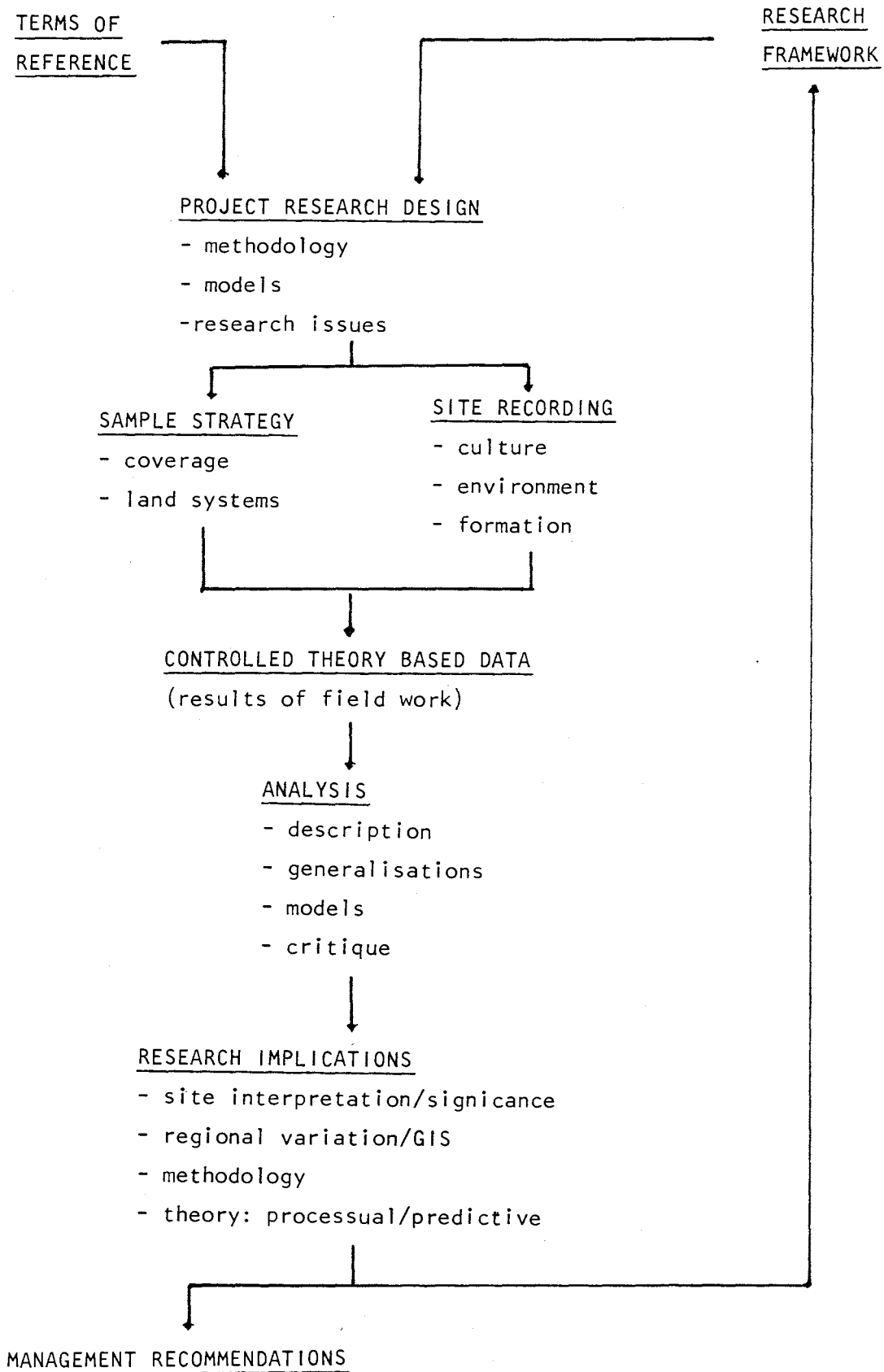


Figure 10.1 Flow chart showing the research process in management surveys.

PROJECT SPECIFICATIONS

- Aboriginal liaison, other public relations
- terms of reference (type of development, size of job, etc.)
- operational conditions (terrain, access, type of archaeology, etc.)

RESEARCH FRAMEWORK

- (as a standing research programme)
- methodology: techniques, bias, analytical concepts, standards
 - regional variation: data base, geographical information systems
 - interpretive issues: models, theoretical problems, etc.

PROJECT

CONSTRAINTS

- Aboriginal interests
- developmental limitations
- conservation policies

INDIVIDUAL

INTERESTS

- (stone tools, rock art, survey technique, exchange systems, etc.)

RE-EVALUATION

AND ANALYSIS

FOR RESEARCH

PROGRAMMES

PROJECT RESEARCH DESIGN

MANAGEMENT PROJECT

- field operation
- analysis
- report preparation

MANAGEMENT

RECOMMENDATIONS

PUBLICATION?

ARCHIVES,

REGISTER

REVIEW AND NEGOTIATION

FOR IMPLEMENTATION

MANAGEMENT ACTION

- avoidance
- salvage
- site protection works
- planning zones

Figure 10.2. Flow chart showing the role of a research framework in cultural resource management. The research framework provides a feed back process using data from various management projects.

grant. The archaeologist is confronted with a combination of tasks. This includes consultation with the Aboriginal community and other public relations matters such as dealing with land owners or shire engineers. The terms of reference can vary greatly, such as a powerline for hundreds of kilometres or the location of a small area for a telecommunications tower. The operational conditions also differ for each case, such as visibility, physiographic types, road access, archaeological assemblages (such as being dominated by quartz), and so on.

The flow chart shows the normal process from field operation to report as being influenced by the research framework at each step. The feed-back loop shown in the flow chart is the essential element needed to upgrade the field performance. The management action which follows from the report is a combination of applied archaeology and other factors.

Note that the sites register is considered to be an archive and not part of the research framework. The main role of the sites register is as a precaution in order to determine if anything already is known about the project area. Although this procedure should not be eliminated, it is not a feed-back process.

The research framework shown in Figure 10.2 is expanded from Figure 10.1 into functions which are within the capacity of a state archaeological office. One component is the methodological criteria and data standards. This includes methods of coverage, sampling and site recording which are appropriate for various regions and types of management objectives. Almost any impact survey, however small, can consider these aspects.

Information at a regional and local level is generally recognised as important, but this is mostly acquired by experience and stored in the minds of individuals. A GIS is a way of putting this knowledge into a more usable form which can be continually tested and updated (Witter 1986, Kvamme 1989). Any management field trip would be in a position to draw upon this and make comments accordingly.

Finally, interpretive issues may be developed at various levels. These include stone technology, art styles, and land use models. The approach may use environmental or cultural reconstructions, models about adaptive, social or cognitive change, or problem specific issues (such as the function of Murray Basin earth mounds, or the meaning of art sites in the Cobar area).

The vital part of the research framework is the feed-back process. A single effort to establish GIS schemes, or to determine methodological standards for survey, or identify

problem issues would have dubious value without continuity. The system also needs to be viewed holistically. Even if it can only be developed in parts or stages, interconnectedness among the various research elements needs to be part of the overall programme.

Ultimately, the key factor in the development of a research framework is the commitment which the government departments are prepared to make. Although individual contractors can carry out research in a commercial context, the scope and facilities are limited. The effectiveness and efficiency of the present situation needs to be reviewed. What does the existing levels of staffing and funding accomplish? Is it properly structured? I suggest that there is a threshold effect which would sharply reduce the crisis management conditions and come to terms with decision making for priorities and the management of archaeological values. The essential component for this is an on-going research framework with a feed back process.

THE ACADEMIC CONTEXT

In Chapter 1, I alluded to the relationship between academic and management archaeology. It is on this issue that I will close this thesis.

Academic research is usually problem oriented. A common type of problem is the regional cultural sequence (e.g. Jones 1971, Flood 1980, Schrire 1980). This has resulted in a variety of particularistic studies in relative isolation, and there is considerable difficulty in testing a model developed for one region elsewhere. Even processual studies about population increase and social dynamics or climate change are usually in an isolated regional context such as for the Basalt Plain of Victoria (Lourandos 1980, Williams 1988). Other more broadly applicable studies, such as use-wear (Kamminga 1978, 1982, Fullagar 1982) are specialised in their application. General issues such as Aboriginal colonisation, or megafaunal over-kill are limited to the particular topic. The result is that a large part of the research results comprise a variety of idiosyncratic methodologies and isolated studies.

Investigations in regional variation are rare. Examples of this deal with skeletal remains (Pardoe 1984) or rock art (Maynard 1979), but there is little movement to integrate a broader and more comprehensive perspective.

Management archaeology has a vested interest in integrating various aspects of regional variation. Both State and Federal departments keep sites registers and are concerned about site significance and heritage protection over large areas. In the case of on-the-ground managers, their assessment of sites, or archaeologically sensitive areas has to be

accurate, but it matters if their judgement results in the loss of cultural resources. Moreover, they have to make decisions now, not some time in the future. It is important that they have access to data which is of adequate quality and in a meaningful context.

It is not necessarily up to academic research to provide a comprehensive framework on regional variation or survey methodology for CRM. As outlined in Figure 10.1, there are areas of archaeological research in which management archaeology needs to take the lead. The advantages of being able to maintain long term programmes, acquire large data bases, and develop a theoretical basis for well informed conservation is within the capacity of the Public Service. Similar functions are carried out in other fields such as for a National Resource Atlas (Plumb 1973), land systems (Laut et al. 1977) or kangaroo management (Caughly et al. 1987). At this level government resource management in other disciplines becomes part of the broader research field. I think that there has been a past lack of direction as to the research needed in management archaeology and it is timely for this to be a major issue of debate.

Perhaps the most interesting research direction which can come from management archaeology is in respect to what I have called "organisational variability" (Witter 1981a, 1988). The concept of organisational measures of cultural behaviour has been used in various places in this thesis. For example, the logistics of stone material transport can be evaluated on a least cost basis (weight/distance) or in terms of the efficiency (amount of wastage) for various stone tool manufacturing processes. Environmental factors which affect land use have been considered in terms of patchiness, productivity and diversity. These types of measures are not restricted to a particular region and provide a systematic basis for comparison.

I suggest that site prediction by explanation will have to develop this organisational approach for the assessment of cultural strategies. If so, this will have an important applied role in conservation. The theoretical implications in archaeology however are far wider (e.g. Bettinger 1980) and are involved in understanding cultural processes in general.

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APPENDIX

SURVEY DATA

APPENDIX A

SITE DATA FOR THE TIBOOBURRA AREA

Listing of site numbers recorded in the Tibooburra area by sample unit, land system, and site type. Certain type artefacts also listed

Key:

Site no. = Site number with a Tib- prefix, samp unit = sample unit, land system = land system type, site type occ = occupation or "camp" sites, tula = tula slugs, b.b. = backed blades, pirri = pirri points, g.s. = ground stone.

Sample units: gorge = The Gorge transect, mt.w = Mt. Wood transect, taldry = Taldry Swamp transect, pind = Pindera Downs transect, dog = Dog Fence transect, whit = Whittabrinna quadrat, shear = Mt. Wood Shearers Quarters quadrat, thom = Thomsons Creek quadrat, box = Box Creek transect, syst = The Systers transect, mill = Millers Tank Quadrant, 18mi = 18 Mile Gate transect, wool = Old Woolshed Creek transect.

Site no.	samp unit	land syst	site type	tula	b.b.	pirri	g.s.	lam
1	gorge	ripar.	occ	2				
2	gorge	ripar	occ	1				
3	gorge	ripar	occ					
4	gorge	ripar	occ	2	1		1	
5	gorge	ripar	occ					
6	gorge	ripar	occ	2		1		
7	gorge	ripar	occ	1		1		
8	gorge	range	occ					
9	gorge	range	quarry					
10	gorge	plain	occ					
11	gorge	plain	quarry					
12	mt.w	plain	occ					
13	mt.w	range	occ	10	7	2	1	
14	mt.w	range	quarry					
15	taldry	dune	occ					
16	taldry	dune	occ					
17	taldry	dune	occ					
18	taldry	dune	occ					
19	taldry	dune	occ	4	8	4	5	
21	taldry	dune	occ					
22	taldry	dune	occ	1			1	
23	mt.w	range	occ					
24	mt.w	range	occ					
25	mt.w	range	occ		1			
26	mt.w	plain	quarry					
27	mt.w	plain	occ					
28	taldry	dune	occ	1	1	1		
29	taldry	dune	occ					
30	taldry	dune	occ					
31	taldry	dune	occ		1			
32	pind	dune	occ					

33	pind	dune	occ	1					
34	pind	dune	occ						
35	pind	dune	occ	1	1	1			
36	pind	dune	occ						
37	pind	dune	occ	1				2	
38	pind	dune	occ	2		1	1		
39	pind	dune	occ						
40	pind	dune	occ		2				
41	pind	dune	occ	1					
42	pind	dune	occ		1				
43	pind	dune	occ						
44	pind	dune	occ						
45	pind	dune	occ						
46	pind	dune	occ					2	
106	dog	dune	occ						
107	whit	ripar	occ	2			2		X
108	shear	ripar	occ	21			1		
109	thom	ripar	occ	2	1				X
110	mt.w	range	quarry	X		X			
111	box	plain	occ						
112	box	ripar	occ	1			1		
113	box	ripar	occ	2					
114	syst	range.	occ	3	1				X
116	syst	range	occ	1					
117	mill	dune	occ	42	30	9	2		
118	18mi	plain	occ	1					
119	18mi	plain	occ						
120	wool	plain	occ						
121	wool	plain	occ		2				
122	wool	plain	occ						
123	wool	plain	occ						
131	dog	dune	occ	10	3				
133	dog	dune	occ						
134	dog	dune	occ						
153	dog	dune	occ	2			2		

Site Data. Data from sites recorded at the summary level, and summary level artefact data from sites recorded in more detail.

Land system type: riparian

site: 1, 2,3,4,5,6,7,107,108,109,112,113 = 12

criteria: exposure 1,3,4,5,6,108, = 6

group expos. 2,109 = 2

land form 11,107,108,109,112,113 = 6

cultural 108,109,112,113 = 4

arbitrary 11,107,108,109 = 4

exposure: flood scour: 1,2,107,108,112,113 = 5

gully bank: 3,4 = 2

washout: 5,6,7, = 3

situation: w/c edge: 1,2,3,4,5,6,107,108,109, = 9

flat: 7 = 1

land form: flood plain: 1,2,107,108,109 = 5

creek bottom: 112,113 = 2

drainage channel: 3,4 = 2

FP margin: 5,6,11 = 3

features: Stone hearth 1,5,107,108(=3),109,112(=5),113(=2) = 6

workshop 107 = 1

debitage: (com = 30% +, pres = - 30%)
 silcrete com 1,2,3,4,5,6,7,107,108,112,113 = 11
 pres 109 = 1
 quartz com 109,113 = 2
 pres 1,2,3,4,5,107,108 = 7
 other com = 0
 pres 1,4,107,109 = 4
 focal plat com 108 = 1
 pres 1,2,4,6,7,107,109,113 = 8
 broad plat com 1,2,3,4,5,6,7,107,108,109,112,113 = 11
 pres 109 = 1
 no plat com 1,2,3,4,5,6,7,107,108,109,112,113 = 12
 lamellate pres 107,109 = 2

Debitage abundance classes. Quant = quantity of pieces of debitage recorded.

quant 0--50 3,5,112,113 = 4
 51--200 1,2,6,7,107,108,109 = 7
 201--1000 4 = 1
 1000 + = 0

Artefact density. Site = site number. Dimen. = site dimensions in metres length x width. Area in square metres with v = visibility, e = exposure, c = percentage of site covered, b = background effects. E.A. = effective coverage in square metres, o = occupation/camp, q = quarry. Tools = total implement count made on the site. Dens. = density of implements on site as corrected for effective coverage.

SITE	DIMEN.	AREA	E.A.	TOOLS	DENS.
1:	50 x 80	= 400 x .9v x .5e	= 180 o	30	0.167
2:	40 x 120	= 4800 x .9v x .5e	= 1770 o	7	0.004
3:	2 x 10	= 20 x .9v	= 18 o	4	0.222
4:	5 x 30	= 150 x .5v	= 75 o	36	0.467
5:	16 x 16	= 256 x .9v	= 230 o	4	0.017
6:	5 x 5	= 25 x 1v	= 25 o	10	0.400
7:	20 x 200	4000 x .2v	= 800 o	9	0.010
107:	80 x 140	= 11200 x .5ve x .8b	= 4480 o	63	0.014
108:	70 x 50	= 1400 x .9v	= 1260 o	62	0.050
109:	50 x 100	= 5000 x .9 x .1	= 450 o	71	0.120

Land systems type: dunes

site: 15,16,17,18,19,21,22,28,29,30,31,32,33,34,35,36,37,38,39,40,
 42,41,43,44,45,46,106,131,133,134,153 = 32

criteria: exposure 15,16,17,18,19,28,29,30,32,33,34,35,36,37,38,39,
 40,41,42,43,44,45,117,106,131,133,153 = 26

group expr 21,31,46,117 = 4

land form :153 = 1

cultural 134 = 1

arbitrary 15,16,17,18,19,21,28,29,32,34,36,37,43,44,45,
 117,153 = 18

exposure: blowout-claypan 15,16,17,18,19,21,22,28,29,30,31,32,33,34,
 35, 36,37,38,39,40,42,41,43,44,45,46,106,117 = 27

blowout 131,133,135,153 = 4

loose sand 38 = 1

lake flat 134,135,153 = 3

situation: hollow 15,16,17,18,19,21,22,28,29,30,31,32,33,34,35,36,
 37,39,40,41,44,45,131,133,134,153 = 26
 rise 38, 42,43,121,122 = 5
 flat 46,117,106,131,153 = 5
 land form: dune swale 15,16,17,18,19,20,21,22,28,29,30,31,32,33,34,35,
 36, 37,39,40,41,44,45,117,106,131,132,133,134,153 = 31
 dune crest 38 = 1
 dune slope 42,43,106,131, = 3
 pavement plain 46,117 = 2
 lake flat 133,134 = 2
 features: stone hearth 30,34,42,117(=5) = 4
 clay hearth 17,31(=2),44 = 3
 workshop 19 (=7),117(=5),134,153 = 4
 tool cluster 40 = 1

debitage: Abundance classes: com = 30% or more (i.e. common), pres.
 = less than 30% (i.e. present).

silcrete com 15,16,17,18,19,21,22,28,29,30,31,32,33,34,35,36,
 37,38,39,40,42,41,43,44,45,46,106,117,131,133,
 134,153 = 32
 quartz pres 17,21,28,41,46,117,131 = 7
 other com 30, = 1
 pres 16,28,32,35,40,41,117 = 7
 focal plat com 19,30,35,42 = 4
 pres 15,16,18,21,22,28,29,31,32,33,34,36,38,39,40,41,
 43,45,46,117,131,133,153 = 25
 broad plat. com 15,16,17,18,19,21,22,28,29,30,31,32,33,34,35,36,
 37,38,39,40,41,42,43,44,45,46,106,117,131,133,134,
 153 = 32
 no plat com 15,16,17,18,19,21,22,28,29,31,32,33,34,35,35,37,38,
 39,40,41,42,43,44,45,46,106,117,131,133,134,153 = 31
 pres 30 = 1

Debitage abundance classes. Quant = quantity of pieces
 of debitage recorded.

quant 0--50: 18,21,22,28,29,30,31,33,34,36,37,39,40,41,42,43,
 44,45,46,106,133,134 = 22
 51--20: = 15,16,17,32, = 4
 201--1000: 19,35,38,131,153 = 5
 1000 +: 117: 1

area (v = visibility, e = exposure, r = recorded)
 Artefact density. Site = site number. Dimen. = site dimensions in metres length x width. Area in square metres with v = visibility, e = exposure, c = percentage of site covered, b = background effects. E. A. = effective coverage in square metres, o = occupation/camp, q = quarry. Tools = total implement count made on the site. Dens. = density of implements on site as corrected for effective coverage.

SITE	DIMEN.	AREA	E.A.	TOOLS	DENS.
15:	10 x 40	400 x .1e	= 40	11	0.275
16:	20 x 100	2000 x .5v x .1e	= 100	9	0.060
17:	20 x 100	2000 x .5v x .1e	= 100	5	0.050
18:	20 x 30	600 x .1e	= 60	2	0.030
19:	200 x 200	40000 x .5v x .1e (= 2000)		56	0.028
	20 x 150	3000 x .5v x .1e (= 150)		25	0.160
		4300	=2150	81	0.038
21:	20 x 200	4000 x .5v x .1e	= 200	7	0.010
22:	20 x 20	400 x .1e	= 40	19	0.475
28:	20 x 50	1000 x .5v x .1e	= 50	6	0.120
29:	50 x 20	1000 x .5 x .1e	= 50	5	0.100
30:	5 x 10	50 x .1	= 5	2	0.400
31:	10 x 30	300 x .1 (=30)			
	10 x 30	300 x .1 (=30)			
	20 x 50	1000 x .1 (=100)	= 160	10	0.063
32:	20 x 200	4000 x .5v x .1e	= 200	8	0.040
33:	20 x 50	1000 x .1e	= 50	4	0.080
34:	20 x 40	800 x .1e	= 80	7	0.088
35:	20 x 50	1000 x .1e	= 100	10	0.100
36:	20 x 200	4000 x .5v x .1e	= 200	6	0.030
37:	10 x 100	1000 x .1e	= 100	12	0.120
38:	50 x 100	5000 x .1e	= 500	27	0.054
39:	40 x 20	800 x .5v x .1e	= 40	4	0.100
40:	50 x 200	10000 x .2e	= 2000	16	0.008
41:	100 x 200	20000 x .5v x .1e	= 1000	16	0.019
42:	20 x 30	600 x .5e	= 300	9	0.030
43:	10 x 50	500 x .1e	= 50	3	0.060
44:	20 x 30	600 x .1e	= 60	3	0.050
45:	20 x 40	800 x .2	= 80	4	0.050
46:	40 x 40	1600 x .5v x .1e	= 80	18	0.225
106:	100 x 30	3000 x .5v x .2e	= 150	4	0.027
117:	1000 x 10	10000 x .1e (=1000)			
	500 x 20	10000 x .1e (=1000)	= 2000	152	0.076
131:	30 x 30	900 x .8v x .7e (= 504)		8	0.016
	30 x 30	900 x .1e (= 90)		54	0.600
		1800	= 594	62	0.103
133:	10 x 20	300 x .1e	= 30	4	0.133
134:	10 x 5	50 x .4v	= 20	10	0.500
153:	20 x 25	500 x .5e	= 250	35	0.140

Land systems type: Range

site: 8,9,13,14,23,24,25,110,114,116 = 10

criteria: exposure : 131 = 1
 land form : 8,13,24,110,114,116 = 6
 cultural : 9,14,23,114 = 4
 arbitrary : 14,24,27,114,116 = 5
 exposure: rocky surface 8,9,14,114,116 = 5

flood scour 13,114, = 2
 pavement 23,24 = 2
 washout 25, = 2
 outcrop 14,110 = 2
 situation w/c edge 13,25,27,114, = 3
 bench 8 = 1
 crest 9,24,116 = 2
 slope 14,23, = 2
 land form tributary bottom 13,25,114 = 3
 ridge 8,9,14,23,24,110,114,116 = 10
 features stone hearth 13 = 1
 workshops 13(=4),110(=7+),116 = 3
 debitage: (com = 30% +, pres. = - 30%)
 silcrete com 8,9,13,14,23,24,25,110 = 8
 pres 114,116 = 2
 quartz com 114,116 = 2
 pres 13,25 = 2
 other pres 25 = 1
 focal plat com 13 = 1
 pres 9,14,24,25,110 = 5
 broad plat com 8,9,13,14,23,24,25 = 7
 pres 114,116 = 2
 no plat com 8,9,13,14,23,24,25,110,114,116 = 10
 lamellate pres 114 = 1
 quantity 0--50 8,9,23,24,25 = 5
 51--200 114,116 = 2
 201--1000 13,14 = 2
 1000 + 110 = 1

Artefact density. Site = site number. Dimen. = site dimensions in metres length x width. Area in square metres with v = visibility, e = exposure, c = percentage of site covered, b = background effects. E. A. = effective coverage in square metres, o = occupation/camp, q = quarry. Tools = total implement count made on the site. Dens. = density of implements on site as corrected for effective coverage.

SITE	DIMEN.	AREA	E.A.	TOOLS	DENS.
8:	10 x10	100 x.7v	70 o	3	0.043
9:	5 x 10	50 x .9v	45 q	3	0.067
13:	50 x 90	4500 x .5e	2250	71	0.032
14:	10 x 10	100 x .7v	70 q	48	0.686
23:	6 x 6	36 x .5	18 o	2	0.111
24:	10 x 50	500 x .9	450 o	9	0.111
25:	40 x 50	2000 x .9	1800 o	7	0.004
110:	60 x 200	12000	12000 q	X	?
114:	150 x 200	30000 x.8v x.5e (=12000)		22	0.002
	120 x 50	6000 x .8 (=4800)		21	0.004
			16800 o	43	0.026
116:	60 x 60	3600 x .8	2800 o	29	0.036
112:	100 x 20	2000 x .5v	=1000 o	12	0.013
113:	100 x 200	20000 x .7v x .1e	=1400 o	13	0.009

Land systems type: Plains

site: 10,11,12,26,27,111,118,119,120,121,122,123 = 12

criteria: exposure : 26,120,121,122,123 = 5
 land form : 11,118 = 2
 cultural : 10,12,27,111,118,119,123 = 7

arbitrary : 12,26,27,118,120 = 5
 exposure: washout 11,27 = 2
 pavement 10,12,26,111,118,119,123 = 7
 blowout 120, 121,122 = 3
 situation w/c edge 11,27,112,113 = 4
 flat 10,12,111,123 = 4
 rise 118,120,121,122 = 4
 hollow 119 = 1
 slope 26 = 1
 land form tributary bottom 27 = 1
 plain 10,12,111,118,119,120 = 6
 ridge 26 = 1
 flood plain margin 11 = 1
 pavement 123 = 1
 sandplain 121,122 = 2
 features workshops 118(=2) = 2
 debitage: (com = 30% +, pres. = - 30%)
 silcrete com 10,11,12,26,27,111,118,119 = 8
 pres 120,121,122,123 = 4
 quartz com 121,122,123 = 3
 pres 27,111,118,119 = 4
 other com 122 = 1
 pres 113,118,120,121,123 = 4
 focal plat com 10,118 = 2
 pres 11,26,27,121,122 = 5
 broad plat com 11,12,26,27,111,118,119,121,122,123 = 10
 pres 120 = 1
 no plat com 10,111,118,119,120,121,122,123 = 8
 pres 11,12,26,27 = 4
 quantity 0--50 10,12,27,111,121,123 = 6
 51--200 26,118,119,120,122 = 5
 201--1000
 1000 + 11 = 1

Artefact density. Site = site number. Dimen. = site dimensions in metres length x width. Area in square metres with v = visibility, e = exposure, c = percentage of site covered, b = background effects. E. A. = effective coverage in square metres, o = occupation/camp, q = quarry. Tools = total implement count made on the site. Dens. = density of implements on site as corrected for effective coverage.

SITE	DIMEN.	AREA	E.A.	TOOLS	DENS.
10:	7 x 10	70 x .7v x .8b	= 39 o	2	0.051
11:	120 x 13	= 15600 x .9v x .1r	= 1404 q	28	0.020
12:	10 x 10	100 x .5v x .8b	= 40 o	5	0.125
26:	5 x 10	50 x .5	= 25 q	5	0.200
27:	20 x 80	1600 x .9v	= 1440 o	7	0.006
111:	60 x 20	120 x .8v x .8b	= 77 o	9	0.117
118:	117 x 90	10530 x .8v x .8b	= 6739 o	46	0.007
119:	10 x 20	200 x .8 x .8	= 128 o	2	0.016
120:	15 x 45	675 x .5e	= 338	11	0.033
121:	15 x 30	450 x .2e	= 90	8	0.089
122:	60 x 60	1200 x .8v x .2e	= 192	23	0.120
123:	90 x 50	4500 x .5v	= 2250	12	0.005

APPENDIX B

SITE DATA FOR THE COBAR AREA

Site no	sample unit	land syst type	site type	tula	b.b.	pirri	g.s.	lam
73	nym-w	range	occ	1	2		2	X
75	nym-n	range	occ		3		1	X
78	nym pk	range	occ	8	40		X	X
79	doub g	valley	occ	2	1		1	
80	buckw	valley	occ	9	1		X	X
82	belara	valley	occ	5	1		56	X
86	doub g	valley	occ	2			6	
90	meadart	upland	art					
91	meadow	upland	occ		2		7	X
92	sandy	valley	occ		2		38	X
95	sandy	valley	occ		5		27	
97	sandy	valley	occ				5	
98	sandy	upland	occ		1		6	
99	sandy	upland						
101	b'bool	upland	occ		2			
102	b'bool	upland	oc		9		6	
104	sandy-e	upland	occ				4	
135	doub g	valley	occ	5	6	1	16	
136	d'gate	valley	occ		1		2	
137	elsen	upland	occ/q	15	7		10	
138	elsen	upland	occ		4		3	
139	heartw	ranges	occ	1	22		8	
140	mtgap	ranges	occ	2				
141	mulga	upland	occ					

Land system type: Valleys

site: 79,80,82,86,92,95,135,136 = 8

criteria: exposure : 80,82,86,136 = 4
 grp. exp : 79,92,95,135 = 4
 land form : 92,95,136 = 3
 cultural : 80,136 = 2
 arbitrary : 80,86,92,135 = 3

exposure: claypan/blowout 79,80,85,135 = 4
 blowout. 82,92,95 = 3
 washout 85,92,95 = 3
 lag pavement 136 = 1

situation watercourse edge: 80,92,95,136 = 4
 flat: 79,80,86,92,95,136 = 5
 hollow: 79 = 1
 slope base: 136 = 1

land form alluvial flats: 79,80,86,92,95,135,136 = 7
 dune: 82,92,94 = 3

features: hearth, termite clay 80(=70),82(=15),92(=10),135(=43) = 2
 ter-clay/grind stone 82(=32) = 1
 ter-clay/stone 82(=9),93,96(=6) = 3
 stone 82(=9),92(=7),95(=6) = 3

workshops: 80(=6),135 = 2

debitage: (com = 30% +, pres. = - 30%)

silcrete com 79,80,82,86,92,95,135,136 = 8

quartz pres 79,80,82,92,95,135,136 = 7

fine-grain volcanic pres 79,80,82,86,92,135 = 6
 other pres 79,82,86,135 = 4
 debitage platform:
 focal plat com 82,86,95,135,136 = 5
 pres 79,80,92 = 3
 broad plat com 80,82,92,95,135,136 = 6
 pres 79,86 = 2
 no plat com 79,80,82,86,92,95,135,136 = 8
 lamellate pres 80,82,95 = 3
 debitage quantity
 0--50 136 = 1
 51--200 79,95,135,136 = 4
 201--1000 82,92 = 2
 1000 + 80 = 1

area (v = visibility, e = exposure, c = percentage covered)

SITE	DIMEN.	AREA	E. A.	TOOLS	DENS.
79	120 x 60	7200 x 3v	2160	8	0.004
80	550 x 300	165000 x .2e	33000	202	0.006
82	50 x 60	300	300	108	0.036
86	25 x 5	125 x .8e	100	21	0.210
92	60 x 400	12000 x .2e (3500)			
	5 x 350	1750 x .2e (3000)			
	50 x 300	15000 x .2e (3000)			
		19150	9500	70	0.007
95	65 x 135	8775 x .6e (5265)			
	25 x 50	1250 x .5e (625)			
		10025	5890	48	0.008
135	80 x 40	32000 x .2e	6400	41	0.006
136	200 x 300	50000 x .1e	5000	552	0.004

Land system type: Uplands

site: 90,91,97,98,99,101,102,104,137,138,141 = 11

criteria: exposure : 91,101,102,104,137,138,141 = 7
 grp exp : 137 = 1
 land form : 97,09 = 2
 cultural : 91,97,98,99,101,104 = 6
 arbitrary : 91,97,98,137 = 4
 exposure: washout 91,97,98,99,101,102,104,137,138 = 9
 eroding slope 98 = 1
 vehicle track 101 = 1
 blowout = 97,97,138,141
 rock shelter 90 = 1
 situation: watercourse edge 91,97,98,99,101,102,104,137 = 8
 flat 91,97,98,137,138 = 5
 slope base 91,98,99,137,138,141 = 4
 cliff 90 = 1
 land form alluvial slope 91 = 1
 talus slope 91,98 = 1
 gully bank 101,102,104 = 3
 foot slope 141 = 1
 rock shelter 90 = 1
 features: hearth, stone 91(=14),97,99(=28),137(=19) = 4
 termite clay 104(=2) = 1
 ter-clay/stone 97,98(=6) = 2
 rock art 90 = 1

scarred trees 91(=7)
 workshops 98(=2),102,137(=4),138(=2) = 4
 debitage: (com = 30% +, pres. = - 30%)
 silcrete com 91,97,98,99,101,102,104,137,138,141 = 10
 quartz pres 91,98,104,137,138 = 5
 f-g vol pres 91 = 1
 other pres 101,137 = 2
 debitage platform:
 focal plat com 91,97,98,99,101,102 = 6
 pres 104,137,138, 141 = 4
 broad plat com 91,97,98,104,137,138,141 = 5
 pres 99,,101,102, = 3
 no plat com 91,97,98,99,101,102,137 = 7
 pres 104,138,141 = 3
 lamellate pres 91,98 = 2
 quantity 0--50: 90,99,101,104,141 = 5
 51--200: 91,97,98,102,138 = 5
 201--1000: 137 = 1
 1000 +

area (v = visibility, e = exposure)

SITE	DIMEN.	AREA	E. A.	TOOLS	DENS.
91	100 x 280	28000 x .1e x .5v	1400	35	0.025
97	100 x 200	20000 x .5e	625	13	0.002
98	100 x 400	40000 x .5e	20000	12	0.002
99	10 x 20	200 x .5e	100	5	0.050
101	5 x 70	350	350	8	0.023
102	50 x 100	5000 x .2e x .5v	500	20	0.040
104	20 x 50	1000	1000	9	0.009
137	200 x 400	80000 x .2e x .5c	8000	115	0.014
138	35 x 80	2800 x .8v	2240	21	0.009
141	80 x 80	1600 x .8v	1280	4	0.003

Land Systems Type: Ranges

site: 73,75,78,139,140 = 5

criteria: exposure : 73,140 = 2
 grp expos : 75,78,139 = 3
 arbitrary : 78,139 = 2
 exposure: washout 73,75,78,139,140 = 5
 gully 75,78,139,140 = 4
 situation: watercourse edge = 73,78,139,140 = 4
 slope base 73,75,78,139 = 4
 flat 140 = 1
 land form sloping land 73 = 1
 foot slopes 75,78,139,140 = 4
 plain 140 = 1
 features: stone hearth 73,75,78(=6),139(50),140 = 5
 workshop 73,75(=2),78(5),139(=6) = 4
 scarred trees 78 = 1
 debitage: (com = 30% +, pres. = - 30%)
 silcrete com 78,139,140 = 3
 pres 73,75 = 2
 quartz com 73,75,78,139
 f-g vol pres 73,75,78,139 = 4
 other pres 73,75,78,139
 debitage platform:
 focal plat com 78,140 = 2

pres 73,75,139 = 3
 broad plat com 78,140 = 2
 pres 73,75,139 = 3
 no plat com 73,75,78,139,140 = 5
 quantity 0--50 140 = 1
 51--200 73 = 1
 201--1000 75 = 1
 1000 + 78,139 = 2

area (v = visibility, e = exposure, c = percentage covere
 SITE DIMEN. AREA E. A. TOOLS DENS.

73	100 x 200	20000 x .5e	10000	30	0.003
75	60 x 130	7800 x .2e (=1560)			
	4 x 4	16 (=16)			
		7816	1576	58	0.037
78	50 x 200	10000 x .2e x .5c	1000	147	0.147
139	100 x 450	45000 x 2e	9000	193	0.021
140	50 x 100	5000 x 5e	2500	7	0.003

APPENDIX C

SITE DATA FOR THE BOOROWA AREA

site	sample	land syst	site	b.b.	g.s.	lam.
51	b'flat	basin	quarry			
52	b'flat	basin	occ			x
53	douglas	basin	occ	1		x
54	g'ridge	basin	occ	4		x
55	preston	basin	occ	16		
56	d to c	ranges	occ	28		x
57	narawa	valley	occ	1		x
59	grassy	ranges	occ	55	1	x
60	5mi.cr	ranges	occ			x
61	gibson	basin	occ	2		x
62	alan'v	valley	occ	1		x
63	davy	range	occ			x
64	davy	range	occ			x
68	blakly	range	occ	1		x
69	blakly	range	occ	4		
70	rugby	range	occ	6	1	
71	rugby	range	occ			x
72	dicks	basin	occ	6	2	x
146	d to c	basin	occ	2		
147	d to c	valley	occ	2		x
150	d to c	basin	occ			x
151	d to c	basin	occ			x

Physiographic type: Ranges

sites: 56,59,60,63,64,68,69 70,71 = 9
 criteria: exposure : 60,63 64,70,71 = 5
 grp expos : 56 = 1
 cultural : 60,63,64 = 3
 disturb. : 59,63 = 2
 arbitrary : 56 = 1
 exposure: salt scald : 56,59,68,70,71 = 5

washout : 56,59,68,69,70,71 = 6
track : 60,63,64 = 3
stock tank : 63 = 1
bank : 56,61,69,71 = 4
situation water course edge: 56,60,70,71 = 4
flat : 59 = 1
top : 63,64 = 2
slope : 68,69 = 2
land form footslope : 59 = 1
flat : 59 = 1
val. bottom: 56,60,61,69,71 = 5
ridge top : 63,64 = 2
high slope : 68 = 1
hill slope : 70 = 1
quartz interference
present: 59,60 = 1
severe : 68,69,71 = 3
features
workshop quartz : 56(=7),59 = 2
felsite : 56,70(=2),59(=6) = 3
fel & qz : 70 = 1
silcrete : 56(=4),59 = 2
sil & qz : 56 = 1
sil & fel: 69 = 1
s, f & q : 59 = 1
f. g. vol: 56,59(=2) = 2
hearth stone : 56(=3),59(=3) = 2
debitage material: (com = 30% +, pres. = - 30%)
silcrete com 56,68,69 = 3
pres 59,60,64,70,71 = 5
quartz com 56,59,60,63,64,70 = 6
pres 68,69,71 = 3
felsite com 59,70,71 = 3
pres 56,63,68,69 = 4
f g vol com 63 = 1
pres 56,59,68,69,70 = 5
other pres 56,63,71 = 2
debitage platform:
focal plat com 59,60,68,69,70,71 = 6
pres 56,63,64 = 3
broad plat com 59,68 = 2
pres 56,63,64,70,71 = 5
no plat com 56,59,60,63,64,68,69,70 = 8
pres 71 = 1
lamellate com 64 = 1
pres 56,59,60,63,68,71 = 6
debitage quantity:
0--50 60,63,64,68,69,71 = 6
51--200 70 = 1
201--1000 56 = 1
1000 + 59 = 1

area (v = visibility, e = exposure, r = recorded, q = quartz interference)

SITE	DIMEN.	AREA	E.	A.	TOOLS	DENS.
56:	250 x 600	150000 x .5e x 8q	6000	87		0.002
59:	280 x 200	56000 x .5e x .8q	= 22400	150		0.007
60:	20 x 200	4000 x .2v	= 800	2		0.003
63:	140 x 60	8400 x .2v x .1e	= 168	3		0.179
64:	10 x 50	500 x .5	= 250	3		0.120
68:	40 x 60	2400 x .8v x .5q	= 960	4		0.004
69:	300 x 100	30000 x .8v x .5q x .5e	= 6000	10		0.006
70:	100 x 50	5000 x .8v x .8 q	= 3200	19		0.006
71:	20 x 50	1000 x .8v x .5q	= 400	10		0.025

Land systems type: Basins

sites: 51,52 53,54,55,61,72,146,150,151 = 10
 criteria: exposure : 53,54 61,72 = 4
 grp. expos: 52,55, 56, 146 = 4
 land form : 54 = 1
 arbitrary : 51,52,55,72, = 4
 outcrop : 51 = 1
 exposure: salt scald : 55,61,72,146 = 4
 washout : 55,61,72,146,150 = 5
 track : 52,48,49,54,151 = 5
 stock tank : 50,52 = 2
 bank : 52,53,61,146,54 = 5
 obtrusive : 51 = 1
 situation water course edge : 51,52,53,61,72,146,150 = 7
 rise : 54 = 1
 slope : 55 = 1
 top : 151 = 1
 land form valley bottom: 52,53,54,61,72,146 = 6
 hill slope : 51,55 = 2
 foot slope : 53,72 = 2
 high slope : 150 = 1
 spur top : 151
 quartz interference present: 72 = 1
 severe : 55,61 = 2
 features workshop, : f g vol : 55 = 1
 silcrete 72
 felsite 72
 termite mound?/
 clay hearth? : 53,55 = 2
 debitage material: (com = 30% +, pres. = - 30%)
 silcrete pres 53,55,61,72,146,150,151 = 7
 quartz com 52,53,54,55,61,72,146,150,151 = 9
 felsite com 55,150 = 2
 pres 52,53,54,55,61,72,146 = 7
 f g vol pres 52,55,72 = 3
 other com 51,52,53,54 = 4
 pres 54,55,72 = 3
 debitage platform:
 focal plat com 50,55,61,150 = 4
 pres 51,52,54,72,151 = 5
 broad plat com 53,61 = 2
 pres 51,52,54,55,72,150 = 6

no plat com 53,61,151 = 3
 pres 51,52,53,54,55,56 = 6
 lamellate com 53,150,151 = 3
 pres 52,54,56,61,72 = 5
 debitage quantity:
 0--50 53,54,61,150 = 4
 51--200 52,72,146,151 = 4
 201--1000 55 = 1
 1000 + 51 = 1

area (v = visibility, e = exposure, r = recorded)

SITE	DIMEN.	AREA	E. A.	TOOLS	DENS.
51:	100 x 300	30000 x .1v	3000	10+	?
52:	20 x 30	600 x .9v x .2d	108	7	0.065
	10 x 60	600 x .5v x .5e	150	1	0.007
	10 x 10	100 x .5v	50	1	0.020
	1 x 4	4 x .5v	2	1	0.500
		1304	310	10	0.032
53:	5 x 80	400 x .5v	200	4	0.020
54:	60 x 100	6000 x .5v	3000	8	0.003
55:	300 x 240	72000 x .5e x .5q	18000	79	0.004
61:	5 x 5	25 x .5q	13	8	0.615
72:	130 x 20	2600 x .9e x .8q	1872	40	0.021
146:	40 x 115	4600 x .1e	460	8	0.173
150:	10 x 300	3000 x .1e	300	0	----
151:	20 x 115	2300 x .5e x .5v	575	2	0.001

Land system type: Valley

site frequency: 57,62,147 = 3
 criteria: exposure : 57,62 = 1
 grp. expos: 147
 exposure: salt scald 62,147 = 2
 track 57 = 1
 ploughing 147 = 1
 bank 147 = 1
 situation: watercourse 57,62, = 2
 slope 147 = 1
 land form floodplain 57,62 = 3
 valley bot 147 = 1
 footslope 147 = 1
 quartz interference present: 57 = 1
 severe: 147 = 1
 debitage material: (com = 30% +, pres. = - 30%)
 silcrete com 57 = 1
 pres 61,147 = 2
 quartz com 57,62,147 = 3
 felsite pres 62,147 = 1
 f-g vol pres 62,147 = 2
 other pres 62,147 = 2
 debitage platform:
 focal plat pres 57,62,147 = 3
 broad plat pres 57,62,147 = 3
 no plat com 57,62,147 = 3

lamellate pres 57,62,147 = 3
debitage quantity:
0--50 57,62 = 2
51--200 147 = 1
201--1000
1000 +

area (v = visibility, e = exposure, r = recorded)

SITE	DIMEN.	AREA	E.	A.	TOOLS	DENS.
57	50 x 400	20000 x .1e x.2v x.8q	320	1		0.003
62	20 x 200	2000 x .5v	1000	4		0.004
147	40 x 100	4000 x .1e	400	4		0.010