SOUTHWEST REGIONAL OFFICE
DIVISION OF ANTHROPOLOGY

ARCHEOLOGICAL INVESTIGATIONS ALONG THE PROPOSED ALIBATES TOUR ROAD

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WITH A CONTRIBUTION BY JAMES M. RANCIER

ALIBATES FLINT QUARRIES NATIONAL MONUMENT

POTTER COUNTY, TEXAS

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ARCHEOLOGICAL INVESTIGATIONS ALONG THE PROPOSED ALIBATES TOUR ROAD IMPROVEMENT CONSTRUCTION ROUTE ALIBATES FLINT QUARRIES NATIONAL MONUMENT POTTER COUNTY, TEXAS

by

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with contributions by

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submitted to

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Prepared Under the Supervision of

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ABSTRACT

In August and September, 1987, archeologists from the Southwest Cultural Resources Center (SWCRC), Division of Anthropology (PCA), Branch of Cultural Resources Management (PCRM), Southwest Regional Office (SWRO) of the National Park Service (NPS) conducted archeological investigations at five areas along the proposed construction route for tour road improvements at Alibates Flint Quarries National Monument, Texas. The investigations included detailed site mapping, controlled surface artifact collections and, at most sites, subsurface test excavations. The sites were located by surface indications during previous inventory surveys. Four sites were composed of surface lithic artifact scatters and one additional site contains potentially significant subsurface cultural horizons. This report summarizes the NPS archeological data recovery program and field methodologies employed to investigate the sites. A summary of the results of the fieldwork is provided. Analyses of the NPS field data and collections were carried out by Chambers Group, Inc. (CGI) during the winter of 1988-1989. A total of 5,052 lithic items were examined, classified, and analyzed. These analyses suggest that the four surface sites are dominated by lithic artifacts technologically unlike those produced during the Antelope Creek Phase exploitation of the Alibates quarries. Recommendations for further study of this newly-described technological manifestation are presented. NPS field assessments of significance of the subsurface deposits were confirmed by CGI analysis.

ACKNOWLEDGEMENTS

We at CGI cannot adequately acknowledge those NPS personnel and volunteers who participated in the field phase of this study; we were not present. James Rancier, James Bradford, Scott Travis, John Evaskovich, and Wesley Phillips were the NPS field team; Cherie Scheick and Tara Travis volunteered their time.

CGI personnel for the lab and cataloging phases of this project included Ken Lord (Principal Investigator), the author (Project Director and Lithic Analyst), Steve Hoagland (Lithic Analyst), Robin DeLapp (Graphics, Cataloging), Teri Van Huss (Managerial support, Production, Word Processing, Cataloging), and Wayne Oakes (Graphics, Cataloging). Roman Fojud of Datagraph, Inc. assisted with computer-aided drafting. Thank you all. Thanks also to all the staff of the Rehabilitation Center, Inc. who ensured that all artifacts were properly labeled.

NPS also provided assistance with the cataloging phase of this project. Thanks especially to Barbara Stanislowski.

Ken Lord was supportive, interested, and patient; his belief that CRM archaeology can be good archaeology made this project possible.

The approaches taken in this study developed partly out of five years' conversations with Jim Rancier, which continued during his service as NPS Contracting Officer's Representative for this project. Other lithic analysts were also helpful. Dick Chapman's thoughts were, as always, valuable. Phil Shelley discussed his work on debitage scatters produced by rockhounds. J.R. Gomolak shared his considerable pragmatism. Karl Laumbach offered useful suggestions. Discussions with these and other workers at the 1988 Ghost Ranch Lithic Concordance encouraged me to attempt the somewhat novel approaches presented here; the approaches themselves evolved out of a "minimalist research protocol" which I developed with Matt Schmader.

Chris Lintz, scholar and gentleman, made his library of manuscripts and his decades of experience available, in spite of an astonishingly busy schedule. Steve Hoagland bore patiently with an inappropriate research design and helped make it workable. I thank these good folks for their contributions; of course, all the errors are mine.

JBB

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

LIST OF TABLES (continued)

MANAGEMENT SUMMARY

The implementation of portions of the General Management Plan Amendment, Alibates National Monument and the Parkwide Development Concept Plan/Road System Evaluation, Lake Meredith Recreation Area, Texas, both approved on March 5, 1985, provided the requirement for archeological investigations included in this report. All field archeological work was conducted by National Park Service employees and volunteers. All laboratory analysis was carried out by CGI personnel. Computer-assisted drafting was done by Roman Fojud.

In 1986, two archeological surveys at Alibates Flint Quarries National Monument covered approximately six linear miles of existing and proposed tour road right-of-way and two areas where trailhead development was being considered. The majority of the proposed right-of-way follows the disturbed existing route. Six areas of archeological concern were identified as a result of these inventory surveys conducted by SWRO archeologists James E. Bradford in January, 1986, and James M. Rancier in May, 1986. Changes in construction plans necessitated the second survey in May. In total, approximately three person days were expended completing these surveys. Of the six areas of archeological concern present, only four will be directly impacted by road construction plans as it now stands and one site may be impacted if plans for future trailhead development are implemented in coming years. The site located at the proposed trailhead facility area will be avoided during this phase of the construction project. Further archeological investigation will be required at the trailhead location if future planning and development is to impact this archeologically sensitive area.

As a result of previous archeological surveys, the five areas that would potentially be impacted by construction were further investigated in August and September, 1987. These investigations included mapping, surface collections, and test excavations at some sites. The purpose of these investigations was to determine significance of each area, assess low density artifact scatters for possible site status at two areas, and to implement a data recovery and analyses program. These actions were intended to mitigate any potential adverse effects to the four areas that may be directly impacted by road construction and to test one site that may be impacted by future construction, as well as to gather data for management decisions. A formal Scope of Work was compiled for the archeological phase of the project and only minor deviations from this work plan were made as a result of field decisions.

Archeologists from the NPS, SWRO, participating in the project included field director James Rancier along with James Bradford and Scott Travis. John Evaskovich from the Wupatki National

Monument Survey Project worked on the project from September 3rd to 8th. Alibates Flint Quarries National Monument interpretive specialist Wesley Phillips worked with the crew on September 1st. From Santa Fe, New Mexico, archeologist Cherie Scheick volunteered her services September 29th and 30th, and volunteer Tara Travis helped out on September 30th. In all, 46.5 person days were required to complete this phase of the fieldwork. The site areas cleared for construction activities as a result of these investigations included field numbers ALFL-86-1 through ALFL-86-4. Site ALFL-86-6 is to be avoided. Site ALFL-86-5 will not be affected by construction activities.

Sites ALFL-86-1 through ALFL-86-4 were effectively mitigated by the actions of this project and archeological clearance was granted.

Site ALFL-86-6 will require further testing before any decision can be made regarding future construction at this area. That portion of the site which was labeled as Area 1 in the Scope of Work remains the most viable location for a trailhead parking facility, however, the archeological testing accomplished during this project was not sufficient to provide clearance. Evidence of stratified geological deposits were encountered and artifacts that were possibly associated with these sediments were recovered. In addition, carbonized material (flecks of charcoal and charcoal staining) was encountered in one of the 1 x 1 m test squares. Artifacts were recovered at depths up to the maximum depths of test excavations. Although no living surfaces were found within any of the test excavations, the number of such excavations was limited and the possibility that occupational levels or surfaces may exist still remains. Further test excavations consisting of backhoe trenches and 1 x 1 m test pits are recommended. These should concentrate on well controlled vertical proveniences at areas identified as containing artifacts and at the area where carbonized material was found associated with several artifacts.

Laboratory analysis of the resulting collections and preparation of this report were carried out by Chambers Group, Inc. under NPS contract No. PX 7029-8-0986. Analysis and report preparation began in October, 1987. CGI analysis staff included Dr. Kenneth J. Lord (Principal Investigator), Jack B. Bertram (Project Director/Computer Specialist/Analyst), and Steven R. Hoagland (Analyst). Hoagland carried out the entire debitage analysis and recorded those variables on cores and tools for which consistency of observation was a special concern. Bertram developed analysis protocols and procedures, analyzed all non-debitage items, carried out all computer-based studies, and prepared the report. Dr. Lord coordinated the project, provided managerial support, and served as photographer and editor. CGI report production and graphics support were provided by Teri Van Huss and Robin DeLapp, respectively. Original illustrative drawings were prepared by Wayne Oakes. Approximate CGI effort for the analysis and report production phases of this project was:

Lord	25 hrs,
Bertram	446 hrs,
Hoagland	327 hrs,
Van Huss	260 hrs,
DeLapp	104 hrs, and
Oakes	34 hrs.

Mr. Roman Fojud, an independent consulting specialist in computer-aided drafting, prepared AutoCad maps of the NPS sites from available NPS instrument survey data. Mr. Fojud expended approximately 40 hours on this project.

In the course of the CGI analyses, a total of 5,052 lithic items were examined, classified, and analyzed. These analyses suggest that the four surface sites are dominated by lithic artifacts technologically unlike those produced during the Antelope Creek Phase exploitation of the Alibates quarries. Recommendations for further study of this newly-described technological manifestation are presented. NPS field assessments of significance of the subsurface deposits at site ALFL-86-2 and ALFL-86-6 were confirmed by CGI analysis.

INTRODUCTION

by James Rancier and Jack Bertram

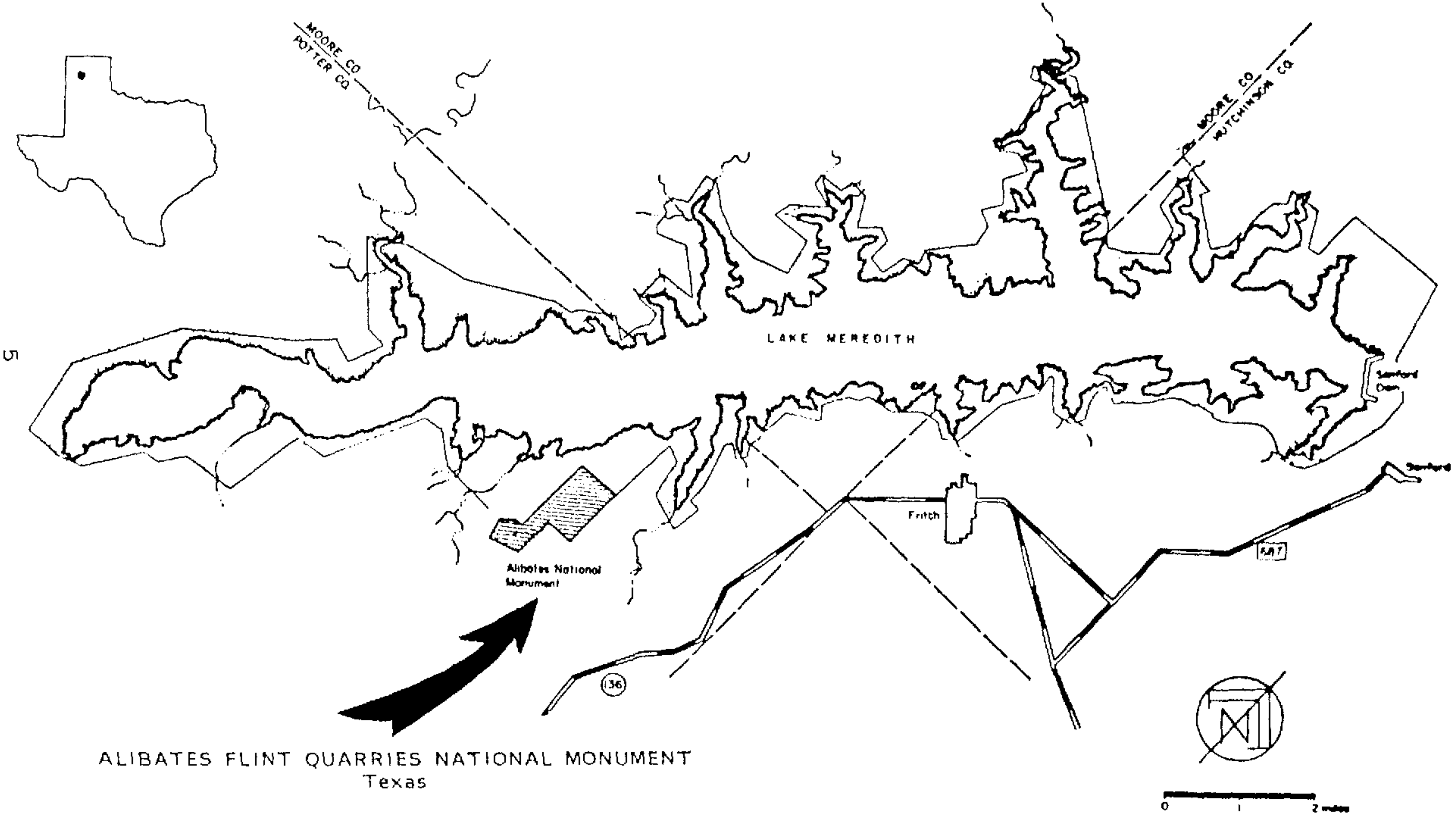
Alibates Flint Quarries National Monument was established by Congress on August 21, 1965. In contains a portion of the regionally important aboriginal Alibates "flint" quarries and various other site types that may date from 12,000 years ago to well into the historic period. The monument is located in Potter County, Texas, within the Canadian River basin of the Central Texas Panhandle area (Figure 1). The monument is located in the Canadian breaks south of the Canadian River. This location is part of the generalized High Plains geographic region and the Plains-Grassland vegetation region. This area, with its river and once numerous springs and the riverine to Plains-Grassland environment and vast high quality "flint" reserves, undoubtably provided prehistoric cultures with unusually rich resources necessary for living throughout most of prehistory. The geological occurrence of chert in isolated sections of the Alibates Formation, as exposed inside portions of the monument, is a major source of Alibates "flint". Several other major and minor outcrops of this colorful material are known to exist outside the monument.

The present phase of facility improvements scheduled for Alibates Flint Quarries National Monument will involve approximately three miles of existing road right-of-way and new alignments. The existing two-lane dirt road will be upgraded by widening and paving. Portions of the existing road will be realigned to improve traffic safety and prevent inundation during times of elevated reservoir water levels. Road improvement will help assure accessibility from the visitor contact station to the interpretive areas of the monument. Future facility improvement phases may include work on the visitor contact station and provisions for a new trail and trailhead facilities to serve the interpretive quarry location.

This report presents a summary of the post-survey fieldwork accomplished by NPS personnel and volunteers at four sites situated along the proposed construction route. It also includes data collected during initial testing and recording at one site that lies in an area being considered for future trailhead construction. This report outlines fieldwork methodology and site descriptions written originally by Jim Rancier and edited by Jack Bertram. NPS field recommendations for future investigations and management decisions are included.

This report also presents the results of lithic and other analyses carried out by CGI as the concluding phase of this project. These results include descriptive, tabular, and statistical analyses, interpretations, and recommendations for future directions, both scientific and managerial.

Figure 1
Project Location



RESEARCH CONTEXTS

ENVIRONMENTAL CONTEXT (Jack Bertram)

Environmental characteristics of the Alibates-Lake Meredith study area have been discussed in detail by Boyd (1987), Bowers (1975), Bousman (1974a,b), Schmidt-Couzzourt (1983), Redfield (1953), Wright and Meador (1979), Green (1986), Lintz (1986), and Etchieson and Couzzourt (1987). These sources will be very briefly summarized here, in order to provide an environmental context for this study.

Lake Meredith is a man-made impoundment of the south fork of the Canadian River. The Canadian, with its main tributaries (the North Canadian, the Conchas, and the Ute Rivers) is the only continuous drainage which crosses the southern High Plains. The Canadian Valley thus must have provided the major prehistoric access route between the tall grass prairie-woodlands of Texas and Oklahoma and the Pecos and Rio Grande drainage systems of New Mexico.

The southern High Plains (Figure 2) are structurally composed of eroded Triassic and Permian shallow sea anhydrites, sandstones, limestones, and dolomites unconformably overlain by the Ogallala gravels. This late Miocene and Pliocene piedmont alluvial fan complex was produced by erosion of the uplifting southern Rocky Mountains; it consists of sands, gravels, and occasional cobble bars. The Ogallala's extent essentially defines the short grass plains province from the Dakotas south into central Texas; it has been the predominant aquiferous water source for both prehistoric and historic high plains settlements away from the Canadian and other rivers. The Ogallala gravels also provided sources of workable metaquartzites, orthoquartzites, cherts, and igneous rocks used by prehistoric peoples. Near Lake Meredith, this source of stone material was greatly overshadowed by the remarkable Alibates silicified dolomites. Alibates, as the silicified dolomite is usually called, constitutes one of the best lithic materials for chipped stone tool-making available anywhere in the southern Plains. Adding to its appeal was its remarkable and sometimes beautiful banded or mottled coloration, with colors ranging from reds and purples, through browns, yellows, and tans, to nearly pure white. Alibates is still keenly sought by rockhounds due to its beauty.

The tall grass prairies to the east of the High Plains are relatively moist and generally rather rich for much of the year in exploitable plant and animal species. The High Plains, by contrast, are rather poor in generally available food resources, but their high, relatively cold, arid steppes are seasonally very productive. During the warm wet season and in good years, bison in large numbers migrated up onto the steppes to graze; dune

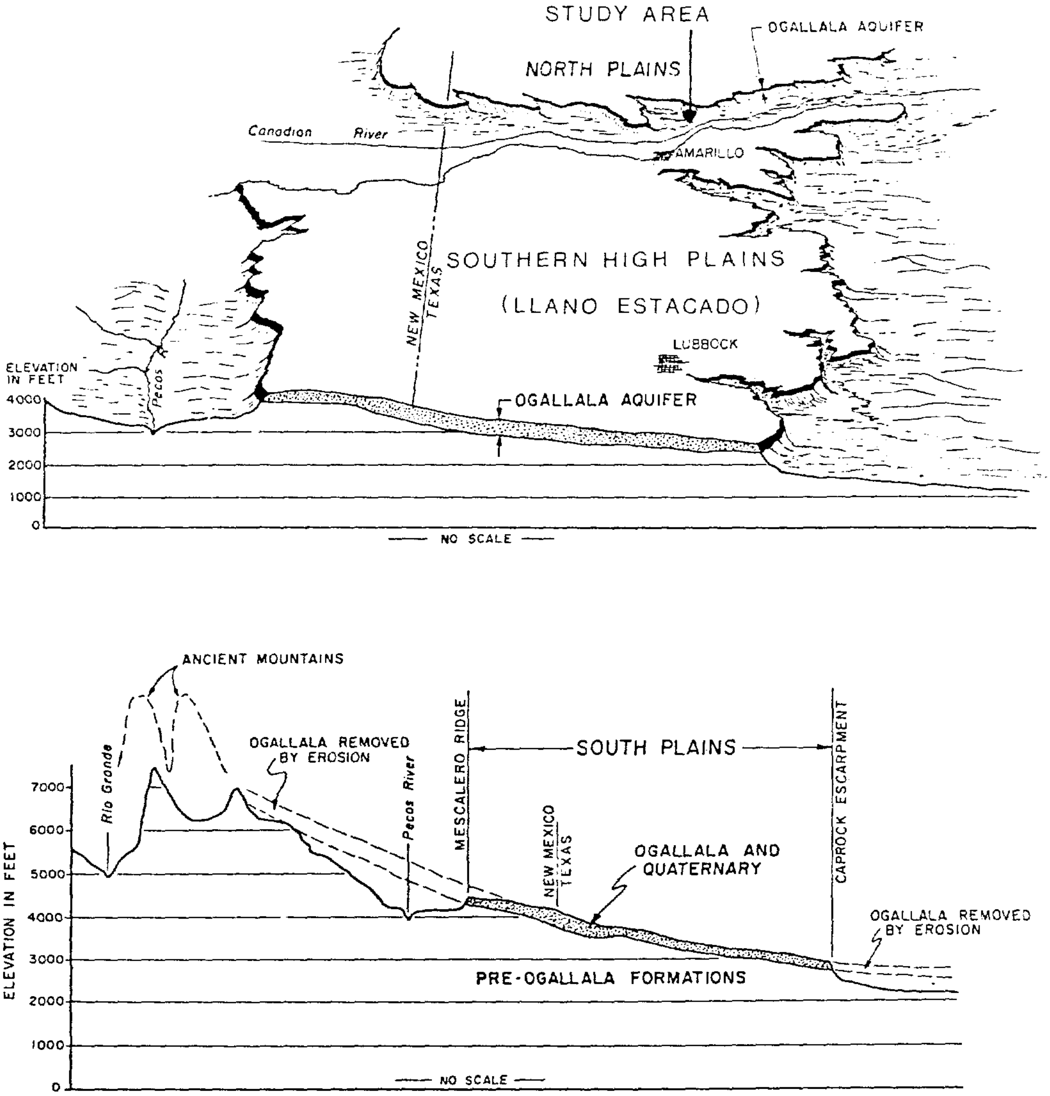


Figure 2
The Southern High Plains, the Canadian Valley
and the Ogallalah Aquifer
(modified from Boyd, Appendix 1, in
Etchieson and Couzzourt, 1987)

fields and playa associations were richly productive of grasses and annuals, attracting deer, antelope, and waterfowl, and producing many rabbits and smaller bird and mammal resources.

The Canadian breaks and valley lie on an ecotone between the riverine extension of the tall grass prairie biotic community, the riverine communities of the Kansan Mesquite Plains District, and the upland short grass plains communities. Previously abundant springs flowing from the Ogallala ensured that most larger creeks in the area flowed perennially. Balanced against these advantages are the climatic problems of the area. Rainfall is variable, unreliably, on average low (20 inches per year), and it falls mostly during intense summer thunderstorms. Summers are often hot and dry. Winters in this portion of the High Plains can be severe. The reliable growing season is probably 200 days or a little less.

RESEARCH LIMITATIONS (James Rancier)

The construction plan dictated the area of the archeological survey and correspondingly, the sites and site types represented in this project. This was not a research-based archeological project, therefore the sites that were located on survey and subsequently investigated further by a data recovery program do not represent sites selected exclusively for scientific inquiry. The range of site types recorded represent only a fraction of the types present in the monument and surrounding region. Because of these circumstances, the scope of questions that can be addressed or answered are limited. A research orientation rather than a research design was developed for the initial NPS Scope of Work under which the post-survey field and lab work was performed; continuation of this orientation was specified as a term of the contractual arrangement under which this report was prepared by CGI. A number of questions pertinent to the history and prehistory of the monument and regional area were developed for the Scope of Work; only some of these questions may be addressed to any detail using the limited data recovered during the fieldwork. Although the data are limited, they can be utilized to further our understanding of the types of sites investigated and may be applied to other sites of this type encountered in the future. The sites recorded were not bedrock quarries or Panhandle Aspect structural types, but appeared to represent areas where gravel sources of Alibates chert were exploited or where limited/special activities took place. Very little is known about these site types or their relationship to other sites in the monument area. Less spectacular sites such as those encountered in this project have commonly been overlooked in past investigations and their potential to provide useful scientific information neglected. The data recovery program associated with this construction project has provided the opportunity to examine a sample of some of the lesser known site types in the monument.

RESEARCH ORIENTATION (James Rancier)

The research orientation developed for this archeological investigation was limited in scope due to the nature and number of sites located during surveys within a restricted area defined by the construction project. However, the research orientation set forth in the Scope of Work for this investigation was written with consideration of the limitations imposed on such a project. The research orientation also considered the possibility that potentially more complex archeological resources could be encountered during subsurface excavations within site areas. In essence, the research orientation was designed to accommodate the data on what was known about the sites and for conceivable discovery situations. The research orientation was developed as a guide for fieldwork and subsequent analyses. Excerpts from the research orientation as found in the Scope of Work follow:

> One of the major interpretive themes established for Alibates Flint Quarries National Monument involves the question of how the availability of the local lithic material affected the cultures of the region and how this influence changed through time. Four distinct types of lithic material procurement strategies are known to have been utilized by past cultures at the monument. These procurement strategies include the bedrock quarrying of material, the selection of materials located on talus slopes below the bedrock sources, the selection of material from gravel sources, and the collection of material left on archeological sites by earlier cultures.
>
> Beyond this, very little is known about the cultural consequences or relationships of these strategies through time.
>
> The limited number of sites and range of site types handled during this project may not allow for addressing major regional research questions. However, the knowledge gained from the investigation can be used to address basic research questions that apply to Alibates Flint Quarries National Monument and the surrounding area. As such, the following questions will be used to guide the research conducted for this project:
>
> 1. Where are the archeological sites located and why?
>
> 2. What types of archeological sites are present?
>
> 3. What types of lithic procurement activities are present?
>
> 4. What methods were utilized to obtain or extract the lithic materials during the procurement activities?

5. Can specific tool assemblages required for lithic material procurement be identified?

6. Can basic tool assemblages and task specific tool assemblages be identified?

7. Were activities other than quarrying, material selection, and initial lithic reduction represented at the lithic procurement areas?

8. Where are sites other than lithic procurement sites located and why?

9. Can lithic reduction strategies other than initial core reduction be separated from site lithic assemblages to delineate site type or intrasite activity areas?

10. What effects have direct procurement, direct trade, and indirect trade had on the local and regional archeological record?

11. What effects have past environmental situations and fluctuations had on the local and regional archeological record?

12. How can answers to the previous questions be applied to answer questions relating to our knowledge of past cultures, cultural change, and cultural chronology at the local and regional level?

By applying these questions to the new data gained through this project, in combination with the existing data base, our understanding and interpretation of past cultures of the area can be advanced.

This research orientation was extended to specify directions for laboratory analysis in the Scope of Work provided to CGI by NPS. A responsive, specific, lithic analysis research design was prepared by CGI; it is presented below. As analysis continued, modifications to the original CGI lithic analysis program became necessary - these are also detailed below (see the Lithic Analysis section).

PREHISTORIC OVERVIEW (Jack Bertram)

Archeological work within the western Texas Panhandle has been synthesized recently by several regional specialists (Hughes and Willey 1978; Hughes 1979; Etchieson 1981; Couzzourt 1982; Lintz 1982, 1986; Couzzourt and Etchieson 1987) whose works will be only briefly summarized here.

Emphasis will be placed on chronology, lithic technology, and overall adaptation. The presentation of this precis will follow a chronological order. After the presentation of chronology, central technological issues will be examined.

PaleoIndian (12000[?] BC to 5000 BC)

PaleoIndian exploitation of the southern High Plains is, by PaleoIndian standards, relatively well documented. Several major sites and numerous less well-studied sites from this period are known from the region, including the type sites for cultural groups using styles of points named for those type sites: Clovis, Folsom, Midland, Plainview, Milnesand, San Jon, and Rex Rogers.

PaleoIndian groups on the High Plains are generally thought to have been relatively specialized big game hunters, concentrating earlier in the period (Clovis culture) on mammoth and bison, shifting to an emphasis on bison (Folsom-Midland culture) as mammoth became extinct, and continuing as bison hunters into the period of appearance of modern bison (Milnesand, Rex Rogers, San Jon). PaleoIndian sites are usually recognized on the basis of exceptionally well-made and distinctive lanceolate points and other formal tools in association with large and/or extinct fauna.

Within the southern High Plains, these tools are commonly made from distinctive materials, often quarried within the Lake Meredith-Alibates area (Bertram, personal observation; Dennis Stanford 1987, personal communication).

Within the Lake Meredith area, definite PaleoIndian artifacts are uncommon but certainly present; Couzzourt and Etchieson (1987:3-1 to 3-2) indicate that stratified sites are also known, but they provide no other details.

Archaic (before 5000 BC to AD 500 or later)

Archaic assemblages from the southern High Plains are poorly known. Only two reasonably well-reported excavated sites (Chalk Hollow site: Wedel 1975; Twilla site: Tunnell and Hughes 1955) are known from near the study area. Archaic peoples are thought to have been generalized hunter-gatherers who practiced little or no horticulture, who lacked pottery and the bow, and who commonly left evidence of the use of stone-boiling and other burned rock heating and cooking techniques on their sites.

On the southern High Plains, no definitely diagnostic Archaic tool forms are known. Although most dart points are probably Archaic in age, dart points are not uncommonly found in later sites (Couzzourt and Etchieson 1987:3-2). There seem to be no well-dated and fully published Archaic sites from the Lake Meredith area, although Couzzourt and Etchieson (1987:4-2) provide sketchy information on a possible Archaic component at the Short Creek site, currently undergoing analysis.

NeoIndian (AD 200 or earlier to European contact at AD 1541)

The NeoIndian stage was characterized by peoples who used the bow, who employed pottery, and who practiced agriculture. None of these three defining traits is absolute. Ceramics are usually rare on all but the largest and latest southern High Plains NeoIndian sites. Many NeoIndian sites were undoubtedly occupied for purposes which had nothing directly to do with agriculture. Darts, presumably propelled by a spearthrower rather than a bow, continued to be used by later groups (see esp. Willey and Hughes 1978). The NeoIndian stage is known well enough in the region to be broken down into subperiods, each of which apparently has at least two different cultural groups present in the area. Following the chronological systems suggested by Eighmy (1984) and Couzzourt and Etchieson (1987), these subperiods and groups are listed below.

The earliest NeoIndian subperiod is the Early Ceramic (ca. AD 200 to AD 1100). Two cultural groups are distinguished for this period. The Palo Duro Aspect, defined from the Deadman Shelter site (Willey and Hughes 1978; see also Wedel 1975, and Etchieson 1979) seems to be characterized by corner-notched arrow points, mostly of the basally corner-notched Deadman style, co-occurring with corner-notched dart points and plain brownware pottery having clear Pecos Mogollon, Jornada Mogollon, or Jornada Eastern Extension Mogollon (i.e., southern and southeastern New Mexican) cultural affiliations.

A second (probably different) cultural complex is found in the region and seems to co-occur occasionally with Palo Duro material. This complex is usually called Plains Woodland based on the thick, cord-marked, Woodland-style pottery which seems to have been the standard ceramic ware. These people also used corner-notched arrow points, but most commonly of the wider-based Scallorn style. Their assemblages are otherwise not different from Palo Duro assemblages. Several Woodland sites are well known; the best examples include Lake Creek (Hughes 1962) and Tascosa Creek (Couzzourt 1985).

It seems certain that both Palo Duro and Plains Woodland sites occur in the Lake Meredith area (Green 1986; Etchieson 1981; Schmidt-Couzzourt and Couzzourt, in prep, cited in Couzzourt and Etchieson 1987). It seems clear that both complexes are basically early Formative in technology and adaptation. Cultigens were occasionally grown by people of both complexes; both seem to have followed an otherwise Archaic life style, closely analogous to that of the better-known Late Woodland groups to the east and the early Mogollon and Basketmaker Anasazi to the west.

The Middle and Later Ceramic or Plains Village Period (ca. AD 1150-1450)

Work still in progress may eventually indicate that late Plains Woodland peoples developed directly into the succeeding Middle Ceramic Plains Village groups; Plains Woodland structural sites seem to underlie Antelope Creek-like but probably culturally distinctive Middle Ceramic period structures at the Courson Ranch (Wolf Creek/Buried City) sites northeast of Lake Meredith (Lintz, 1989 personal communication; Couzzourt and Etchieson 1987). Even if Palo Duro and Plains Woodland groups were culturally distinctive (a proposition not yet established), both may have been ancestral to Plains village groups. The Antelope Creek sites are most easily seen as developing from a Woodland base; the poorly-known Ochoan and post-Ochoan settlements (Collins 1966, 1968, 1971) farther south on the eastern Llano Estacado may be more clearly derived from Palo Duro. However, these latter generalizations are drawn almost entirely from ceramic technology and architecture and are built on sparse and poorly-understood archeological data bases (Lintz 1984, 1986; Bertram et al. 1987).

The Plains Village cultural complex usually identified as the Antelope Creek Phase or Antelope Creek component of the Canark complex (Lintz 1984, 1986) is a group of related settlements which seems to have extended at least from Landergin Mesa on the west and the Oklahoma Panhandle on the north to the Oklahoma border on the east; most intense occupation, however, was definitely centered on the Alibates quarries and Lake Meredith area.

These people made thin (Borger) cord-marked pottery, used side-notched arrow points, and manufactured a wide range of exceptionally well-made lithic tools, especially "guitar pick' preforms, beveled knives, large bifaces, and well-prepared blade cores. Their adaptation seems to have combined fairly intensive horticulture with systematic and successful bison hunting; in both regards they contrast with the preceding Early Ceramic peoples. Their architecture runs the gamut from large, formalized, possibly ceremonial, multi-room "pueblos" to casual, single-room "fieldhouse" structures (c.f., especially Lintz 1984, 1986). By contrast, non-structural Antelope Creek sites (camps, quarries) are virtually unknown (Couzzourt and Etchieson 1987:3-5) and are usually recognized on the basis of stone tool typology, the presence of bison-bone tools, and/or a lithic assemblage heavily dominated by Alibates silicified dolomite.

Even restricting the tally to sites considered to be of clear Antelope Creek affiliation, the overwhelming majority of sites reported from the Lake Meredith area are Antelope Creek sites. Architectural, ceramic, and subsistence/paleobiological data from these sites have been relatively well reported.

By contrast, the author was able to locate only one systematic analysis of an Antelope Creek lithic assemblage, a biface reduction/midden collection from site 41PT8, the Turkey Creek site (Bandy 1976; see also Davis 1985). Couzzourt and Etchieson (1987:6-45) revisited this site and collected two sherds; one Borger cord-marked and one possibly of Woodland age, suggesting that the assemblage Bandy analyzed may not even be Antelope Creek. This possibility, however, seems remote.

The Antelope Creek complex settlement system seems to have begun a slow process of decay by ca. AD 1400 (Lintz 1986). By the time of the Coronado Entrada (AD 1541), the Alibates villages were apparently abandoned.

Protohistoric and Early Historic (AD 1541 - ca. 1840)

Populations of mobile hunter-gatherers continued to camp in the Lake Meredith area and to exploit the Alibates quarries after the Antelope Creek abandonment. There can be little doubt that these groups included ethnic Apaches (Querechos) and Caddoans (Excanxaques, Teyas, etc.) and probably other groups as well. Within the historic period, Utes and especially Comanches came to dominate the region; over time, these peoples alternately competed with and collaborated with Texas-Oklahoma Caddoans, New Mexico Puebloans, and (increasingly through time) Hispanic New Mexicans, all of whom came to the Alibates area periodically to hunt bison and to trade. Recognition of these various groups in archeological sites is not easy; all (including the Hispanics) used some stone tools and all had some access to European trade goods. Probably, sites with Puebloan and micaceous pottery are mainly referable to New Mexicans (Pueblos, Apaches, Hispanics). Materials from this period are known from the study area (Etchieson 1986b) and from Tule Canyon (Hughes and Willey 1978). The Tule Canyon material, from the Sand Pit site, had a predominance of Alibates silicified dolomite not found in earlier Tule Canyon assemblages and a very high scraper/knife ratio, which may suggest that metal knives had displaced flake knives even while stone scrapers continued to be preferred (c.f., Bertram et al. 1987:18).

ECONOMIC AND EXCHANGE PATTERNS (Jack Bertram)

Alibates Flint Quarries National Monument was established partly out of a growing recognition that Alibates silicified dolomite had been widely circulated during much of the prehistoric and early historic period. This material has long been considered to be so visually distinctive that artifacts could be recognized as being made from Alibates material by anyone familiar with the range of variation of Alibates.

In recent years, the assumption of Alibates distinctiveness has been called into question by several authors, especially Shelley (1984), who would argue that the Salado Canyon source north of Yeso, New Mexico, may have provided much of the "Alibates" found in Llano Estacado sites. Certainly, there are other sources which seem to mimic a portion of the Alibates range of variation; Tecovas jasper from Oklahoma and the Texas Panhandle (Cameron 1980), the Tecovas equivalent from the Baldy Hill quarries in Union County, New Mexico, and Shelley's Salado Canyon source each closely resemble some true Alibates color and texture variants. Other more widespread Oklahoma sources may emulate the full range (Briscoe, 1986, personal communication).

Lithic assemblages made from material displaying nearly the full range of Alibates variation do occur, especially in the Canadian and upper-middle Pecos drainage systems. Both Bertram and Hoagland were carrying out preliminary cataloging analysis of NPS collections from Pecos Pueblo as this present report was in preparation. Our observations led us to concur with Kidder, who reported that:

> With only one or two exceptions, the two-edged knives (as well as the four-edged knives next to be considered) are made of a purplish-gray stone streaked with darker reddish-purple in much the same was that bacon is streaked with lean. The material is difficult to describe, but once seen is very easily recognizable. I have not observed it anywhere in the Southwest, save at Pecos and at sites to the east. The same stone is found abundantly along the Canadian River in Texas, near Amarillo, in which region are remarkably extensive quarries, now being investigated by Mr. Snodgrasse under direction of Dr. Wissler for the American Museum of Natural History. It may be called, according to Mr. Snodgrasse, silicified alibates dolomite. There can be little doubt that supplies of this handsome and admirably serviceable chipping material reached Pecos from the Amarillo quarries. The implements made from it are preponderatingly of eastern types, but that many of them were actually fashioned at Pecos seems evident from the large numbers of its flakes found in the upper rubbish (Kidder 1932:31).

In discussing unusual items, Kidder noted that:

> ...Two large and very beautifully made knives with bevelled edges were found. One of them...is of gray flint...The other knife is four-edged. It is excellently fashioned from light-veined purplish stone (the above-mentioned dolomite). It is much longer and broader than the other four-edged specimens from Pecos (Kidder 1932:34).

He also found Alibates to be common at Pecos in the form of scrapers:

> ...The stone used [for end scrapers] is almost invariably the banded red and gray Amarillo dolomite...The stone

> from which the [side] scrapers are made are the usual ones employed for other chipped implements, but as in the case of the "snub-nosed" end-scrapers the banded Amarillo dolomite occurs with great frequency (Kidder 1932:39).

In summarizing his lithic observations, Kidder reiterated:

> ...Beginning in late Glaze IV and reaching its height in Glaze V there was an influx of snub-nosed scrapers, two-edged knives, and side-scrapers made, for the most part, of the already mentioned pink-veined gray dolomite. Snub-nosed scrapers and two-edged knives are characteristic of the western Plains, side-scrapers may well also be a Plains type (they are as a rule so formless that their absence from museum collections is not surprising). The stone from which almost all these forms are made seems to be a product of the Amarillo country in the Panhandle of Texas. Hence it is evident that their appearance at Pecos indicates an intensification of contact with tribes to the east (Kidder 1932:44).

Kidder relegated to a footnote what may be his single most informative observation on Alibates:

> It should be noted, however, that the two **finest** dolomite knives found at Pecos...**both came** from graves of the Glaze I period [emphasis ours].

Kidder's footnote may indicate a shift in Pecos access to Alibates materials, from only rare and excellent pieces (i.e., typically well-made Antelope Creek manufactures) during the Antelope Creek period to much more common import of rather less well-made formal tools after the Antelope Creek abandonment.

In discussion of published or unpublished reports of Alibates materials in sites distant from Alibates, the author is inclined to credit strongly only observations made by individuals who are clearly familiar with the range of variation of this most variable of resources. As Lintz (1987:4) points out, "Macroscopic studies conducted by people not familiar with the range of Alibates can be misleading." Couzzourt, Hughes, Briscoe, Lintz, Etchieson, and Shelley unquestionably know the range of Alibates; as a result of this present study, perhaps the author and Hoagland may also now be counted among those somewhat familiar with the range of Alibates material. Other reports, by researchers not known by the author to be fully familiar with Alibates, have not been cited.

The longest-range cases of Alibates transport known to the author are formal tool examples from Lindenmeier, personally examined by Dennis Stanford (1987, personal communication) and from Pueblo Bonito in Chaco Canyon (Shelley, 1989, personal communication). Both sites lie approximately 600 linear kilometers from Alibates.

There can be no doubt that less-formalized tools of Alibates materials were widely disseminated in all time periods, especially during the PaleoIndian and Late Prehistoric. Bertram has seen indubitable, excellent Alibates PaleoIndian points from the middle Dry Cimarron Valley, partly confirming early guesses that many of the Folsom type site's points were of Alibates stone. In Bertram's opinion, a high proportion of the formal tools in private collections from near Melrose, New Mexico, are also of Alibates stone.

Bertram analyzed debitage collections from LA 46962 and LA 46964, near Ute Reservoir on the Canadian in eastern New Mexico. He found a high proportion of Alibates material, which occurred as small biface debitage (reported in Chapman 1985).

Analysis of survey sites' debitage and of private collections from Conchas Reservoir, on the Middle Canadian in New Mexico, were recently carried out by Lintz, by Earls, and by Kramer (all in Kramer et al. 1988). Kramer (1988:106,112,116) reports Alibates as a rather consistently small component (ca. 4%) of survey assemblages. Earls reports that amateur

> ...collections averaged a great deal of Alibates flint from the Texas Panhandle area; this type averaged perhaps 30 percent of the total in all collections. Large roughout bifaces and numerous flakes indicate that Alibates was carried both in blank form and as rather large cores. Most of the Alibates was used for making arrow points, although it was used in a few PaleoIndian pieces. Georgetown or Edwards Plateau chert...was much less common (Kramer et al. 1988:185).

Lintz (Kramer et al. 1988:333) found proportions of Alibates debitage at Conchas Reservoir to be variable in abundance from site to site, ranging from extreme rarity to being "relatively common at LA 60585 and LA 60589."

The previous discussion indicates that Alibates materials, which widely circulated, seems to have been traded or transported longer distances mainly as formal tools, formal cores, or other specialized items. Only in the area reasonably expected to be within the New Mexico hunting range of Antelope Creek peoples (i.e., the Canadian River drainage system) does Alibates appear to be at all common; even there, Alibates usage is neither uniform nor pervasive. Moreover, little evidence appears to exist that Alibates was regularly and heavily traded <u>by Antelope Creek folk</u> to the New Mexico pueblos; rather, their protohistoric Athabaskan and Caddoan successors may have brought in most of the Alibates found by Kidder and by the later NPS excavations at Pecos. It is also possible that the Glaze IV-V Alibates influx at Pecos was the product of forays onto the Plains by the Pecos Indians themselves, who were perhaps later accompanied by Hispanic and/or Athabaskan hunting and trading partners. The further assessment of these alternatives is outside the scope of this report.

In summary, Alibates material was distributed westward over the northern Llano Estacado, the Canadian Valley, and the Ute/North Canadian uplands over most of northeast New Mexico. Distribution to the east cannot be fully evaluated until Briscoe's observations on similarities between Day Creek Dolomite and Alibates are further explored.

The New Mexico examples are drawn only from those assemblages which seem to exhibit much of the known Alibates color and color pattern ranges. In this way, the author hopes to use available data responsibly, while paying proper heed to Shelley's caution concerning "Alibates" from other sources.

One may conclude that the mechanisms of Alibates circulation were variable through time; one may speculate that Alibates may have been most widely circulated during periods in which large game hunting was a central aspect of adaptations in the region, specifically during the PaleoIndian period, the Antelope Creek phase, and the Protohistoric-Early Historic period. As would be expected of mobile big game hunters, the Alibates objects most generally circulated (to the west, at least) were prepared formal tools and fully formalized, especially bifacial, cores in both the PaleoIndian and Antelope Creek-Late Puebloan periods.

Expectations which may be drawn from this brief summary might include:

1. Alibates quarrying for export during the Antelope Creek period probably took place mainly in formal bedrock quarries. The same may be true of the PaleoIndian and Protohistoric periods.

2. At other periods, casual and/or infrequent visits to Alibates may have been more characteristic. In that case, quarrying for export may have depended more on easily available, lower quality, colluvial materials.

3. Casual or expedient production during periods of more formal quarrying may also have relied on cobble sources immediately at hand. Reduction in these cases may have been less careful, inasmuch as immediate goals were probably limited to the production of edges, rather than of formal tools or of shaped cores.

4. Evidence of formal manufacture would therefore provide a weak but usable basis for temporal or cultural inference. Evidence of informal manufacture might be referable to any period.

FIELDWORK METHODS, SITE DESCRIPTIONS, AND EVALUATIONS

by James Rancier
Jack Bertram, editor

INTRODUCTION

The goal of the NPS field archeological project was to implement a data recovery program that would successfully gather information required to assess and evaluate sites, mitigate potential adverse construction impacts on sites, and provide recommendations for future planning and management decisions. To accomplish these goals, a comprehensive fieldwork strategy, including site mapping, controlled surface collections, and test excavations, was carried out by NPS personnel. Five sites were treated. A sixth site, ALFL-86-5, was found to lie outside the area of anticipated impact; it was not treated.

FIELD METHODOLOGY

Mapping

The sites were mapped using a combination of a metric stadia rod, metric tape measures, a theodolite, and an electronic distance meter (EDM). A true north orientation was utilized in all mapping; magnetic declination was adjusted for a deviation of 10.5° east of true north. A Brunton compass was used to orient the theodolite and EDM for mapping purposes. Two permanent steel stakes (1/4 x 3/4 x 24 inches) were implanted on or near to each site. Field datum points and/or subdatum points were tied with one another, with road construction survey points, and/or with benchmarks when available. The permanent datum points were stamped with the assigned temporary site number and datum number. Data on site boundaries, topographic contours, and collection grids were recovered in the mapping process. Site ALFL-86-2 was not mapped for contours due to its great length and elevational range.

Depending upon site composition, artifacts were mapped by individual point location, by point location of concentrations, by collection grid, or by a combination of these methods. All test square or trench excavation proveniences were located using the southwest corner of the units as subdatums. Road construction plan maps and the Alibates Ranch, Texas, USGS 7.5 minute topographic map (1970) served as field location reference maps (Figure 3).

Rough field maps, partial draftsman's manuscripts, theodolite and EDM notes, field notes on setup errors, and portions of the project civil engineering plan-and-profile maps were provided by

ALIBATES RANCH QUADRANGLE
TEXAS
7.5 MINUTE SERIES (TOPOGRAPHIC)

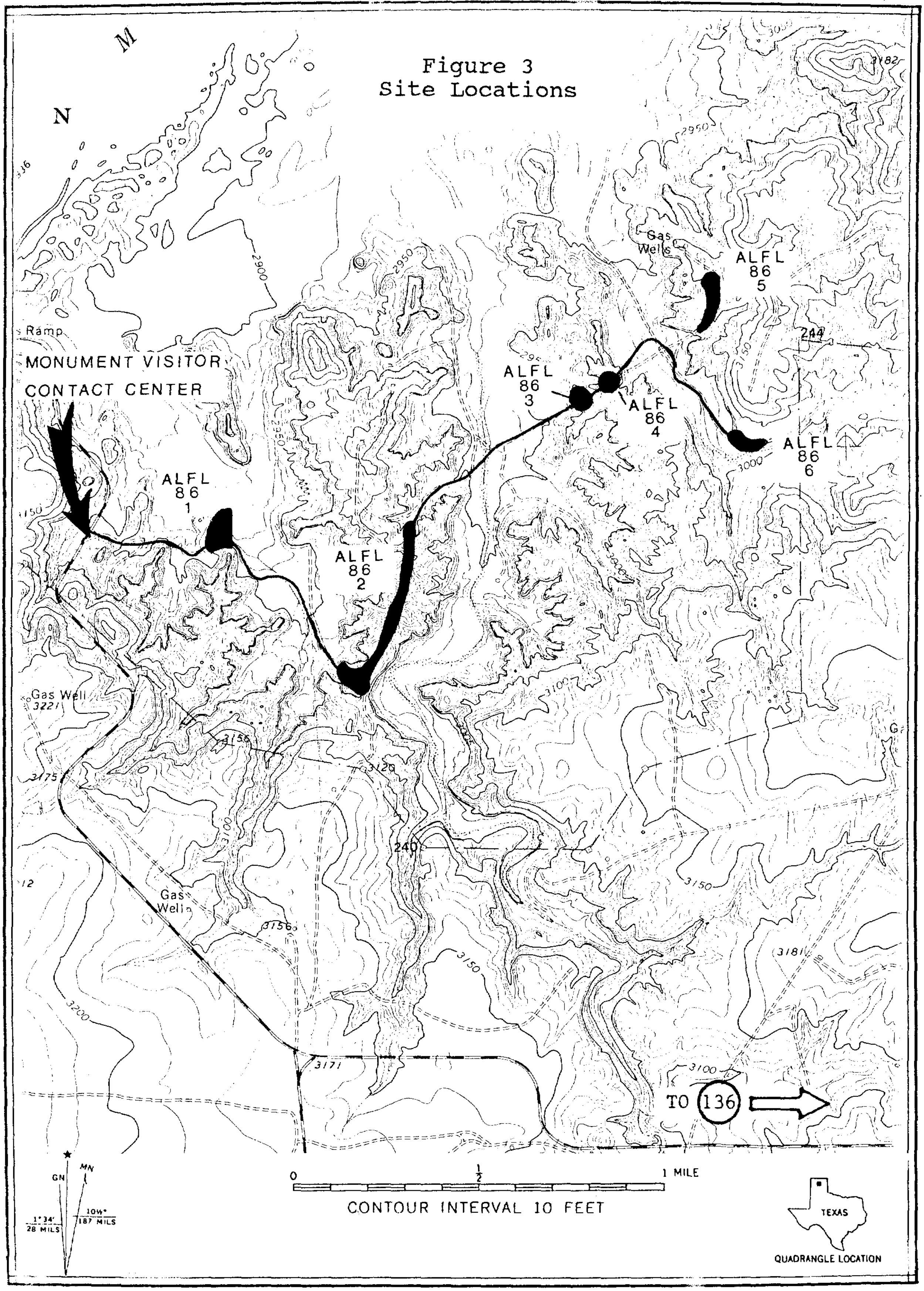


Figure 3
Site Locations

NPS to CGI for revision under the Scope of Work. Data were processed and coordinates transformed in IBM XT and AT computers, using programs written in VP-Info, Microsoft Basic, GW-Basic, and other languages. Data were loaded initially using Word Perfect 4.2. Cleaned data, with coordinates transformed into a Cartesian frame, rather than expressed in the survey data polar/radial frame format, were downloaded as dBASE III-compatible files and submitted to Roman Fojud for computer-aided drafting. Mr. Fojud, working in AutoCad (Release 10), produced Figures 6, 8, 11, 13a-g, 17, 20, and 24, all of which are cited below.

It is difficult for a draftsman, working either manually or with a computer, to produce maps which accurately portray the surveyor-archeologist's perceptions of the planimetry, topography, and cultural patterns found on a site, unless the draftsman can work closely with the surveyor-archeologist who originally recorded the data. Also, the inevitable field errors are often confusing and may be impossible to recognize and to correct.

For this reason, CGI has elected to reproduce the NPS maps (as presented in the Scope of Services) as well as the AutoCad maps produced by Mr. Fojud. It is strongly recommended that the reader consult both sets of maps. The AutoCad maps are completely reliable, but they lack many qualitative details which are present on the NPS maps...details which were never recorded on paper until the NPS surveyor-archeologist and draftsman prepared the NPS preliminary maps.

Photography

Black-and-white print and color slide photographs of pertinent site data, site overviews, permanent site datum locations, and archeological field methods used at the various sites were recorded using 35 mm cameras. A metric scale/north indicator was used in photographs as required. A total of 40 color slides and 37 black-and-white photographs were taken as a result of this project. Photographic logs were maintained to record information about each exposure.

Collections

NPS Accession Number ALFL-95 has been assigned to the project collections by the park curator. Approximately 4,500 artifacts and as many as 500 non-artifactual lithic samples were collected. No non-lithic artifacts were found during the project. Specific collection techniques employed at each site will be covered in the following text.

Surface collections were taken from all sites and all artifacts observed on the surface were collected, with one exception...no surface collection was made at site ALFL-86-6. The methods of surface collection varied depending upon site composition and included: a) point location of individual artifacts or related groups of artifacts; and b) grid system collection from individual collection units of maximum size not exceeding 5 x 5 square meters. When artifact concentrations were mapped and collected by the point location method, individual artifacts were normally the focus of the collection. However, when artifacts were clustered closely together, then the maximum collection diameter was one meter. Any deviation from this standard was noted in the field records.

Subsurface collections were obtained through one or more of the following methods: shovel tests, hand-held power auger tests (10-inch diameter), 100 x 30 cm test trenches, and 1 x 1 m test pit excavations. Vertical control was by arbitrary 10 cm control levels in all excavations except auger tests. All sediments from all excavations were sieved through 1/4-inch hardware cloth. Subsurface testing was not required at sites ALFL-86-3 and ALFL-86-4 because these sites were located on badly eroded terrace deposits.

All collections were placed in bags specifically labeled to identify the original provenience. Provenience information was also recorded separately on artifact record forms or on mapping data log forms. Field specimen (FS) numbers were assigned to each collection provenience.

The collections have been washed, repacked, analyzed, and cataloged by CGI. They will ultimately be curated at Lake Meredith Recreation Area headquarters.

FIELD DATA ON INDIVIDUAL SITES

ALFL-86-1

Site Description. Field interpretation of this site placed it in the "surface procurement quarry" site classification. Site activities included lithic raw material testing and initial core reduction. Alibates chert was the predominant artifact material type in the assemblage. The lithic raw materials present were composed of cobbles and small boulders (size based on the Wentworth Scale) that may be the remnants of an eroded Pleistocene terrace deposit that unconformably overlies the Permian age Whitehorse Formation. No diagnostic artifacts were recovered during the archeological data recovery project and no evidence of in-place cultural horizons was located. The majority of the site has been heavily disturbed by erosional processes. If the low raw material densities observed on the site during this project are indicative of past densities of Alibates chert, then the resource would have been limited.

The site is located on the lower portion of an eroding ridgespur that projects northeastward away from the higher tableland to the

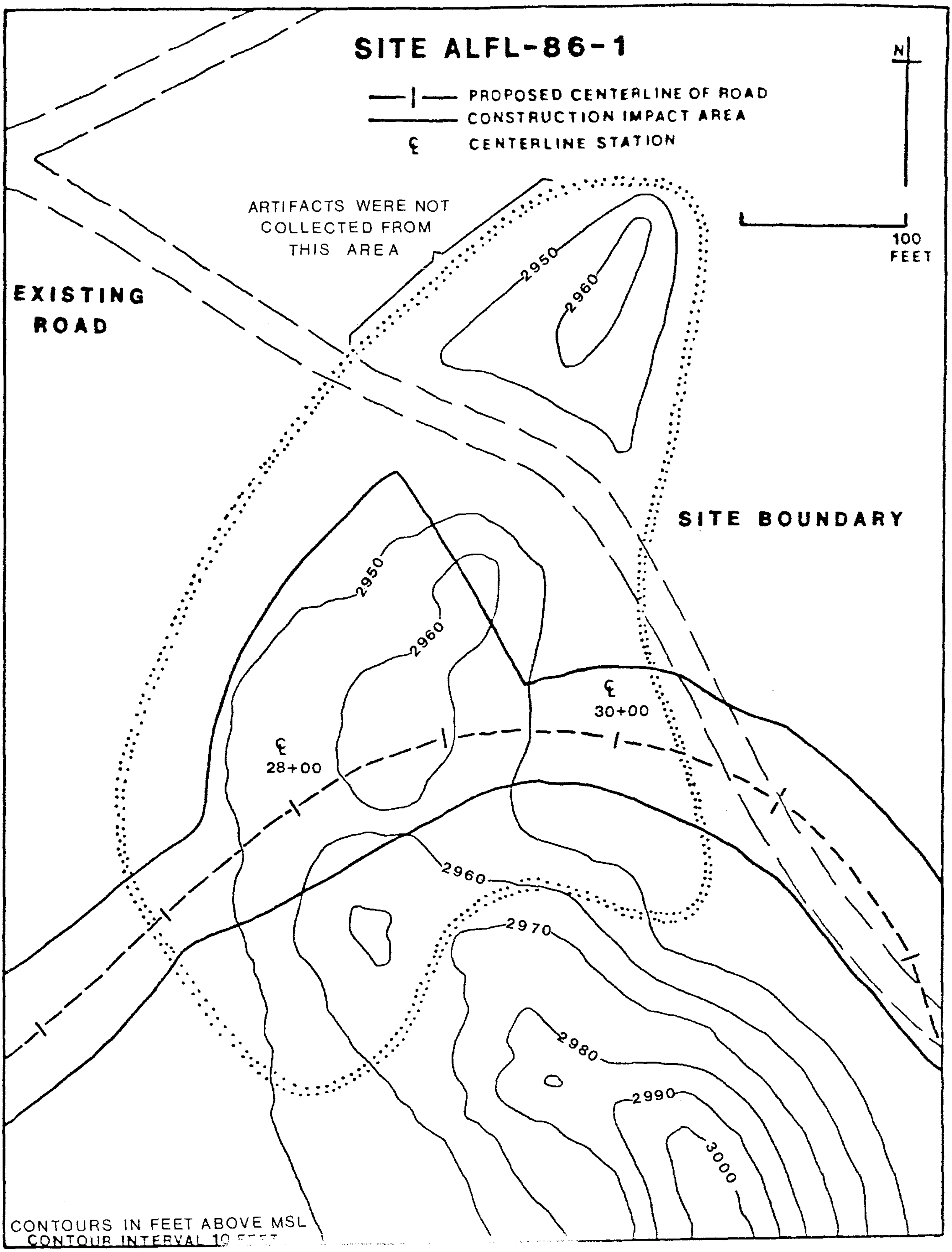


Figure 4

Site ALFL-86-1, Field Site Map

southwest (Figures 4 and 5). The tableland above the site is capped with residual dolomite from the lower section of the Permian-age Alibates Formation and what appears to be erosional remnants of the Tertiary period Ogallala Formation. The lower ridgespur is covered with a mantle of well rounded cobbles and boulders composed of various metamorphic and sedimentary material types as well as limited amount of subangular shaped Alibates chert. Large, blocky shaped Alibates dolomite is present at some locations, especially in the northern area of the site. This residual Alibates dolomite may be the source of some of the Alibates chert in the site area. The dolomite and Alibates chert are not well rounded like the other naturally occurring materials on the site, indicating the source of the Alibates material is not the same or is of shorter transport origin than the other material.

Figure 5
View across ALFL-86-1 to NNW. Canadian in background. ROW centerline in saddle in foreground. Rancier and Travis on ridgetop.

Temporal Affiliation. Prehistoric, date range unknown.

Site Location. The site is located between construction centerline stakes 27+00 and 31+50 (Figure 6). UTM: Zone 14; 255640 mE and 3940470 mN.

Maximum Site Dimensions. 93 m E-W x 130 m N-S; 12,090 sq m

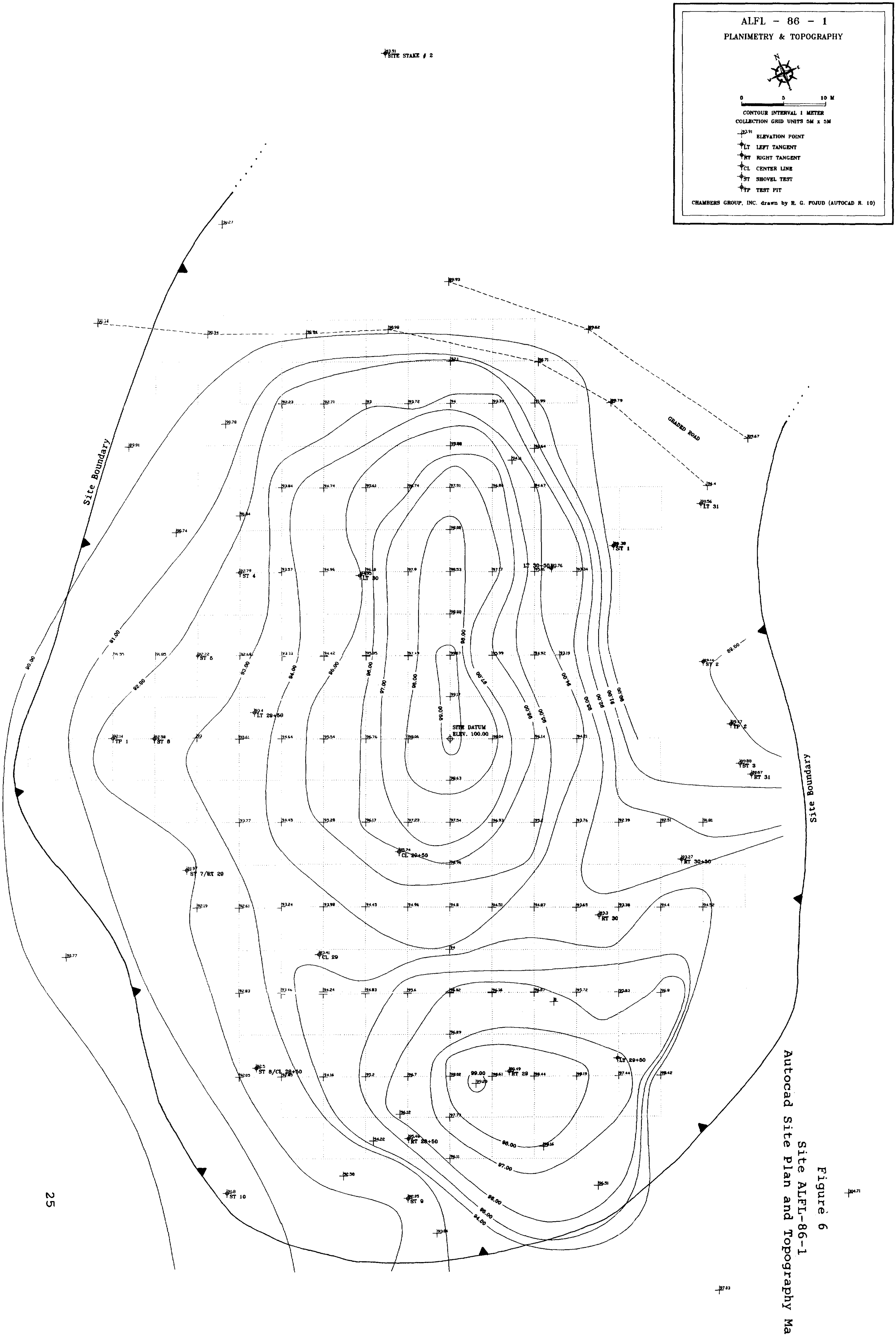


Figure 6
Site ALFL-86-1
Autocad Site Plan and Topography Map

Mapping. The site was mapped by theodolite and metric tape or stadia rod. The artifact collection grid system and location of test excavations were tied into one of several subdatums. Draft planimetric and topographic maps showing the location of the grid system, test excavation, and artifact grid counts have been completed.

Surface Collection. Artifact density was considered moderate at this site; ground visibility was good (Figure 7). A grid system composed of 5 x 5 m square units was laid out over the site. This grid was oriented in line with the long axis of the ridgespur (Figure 8).

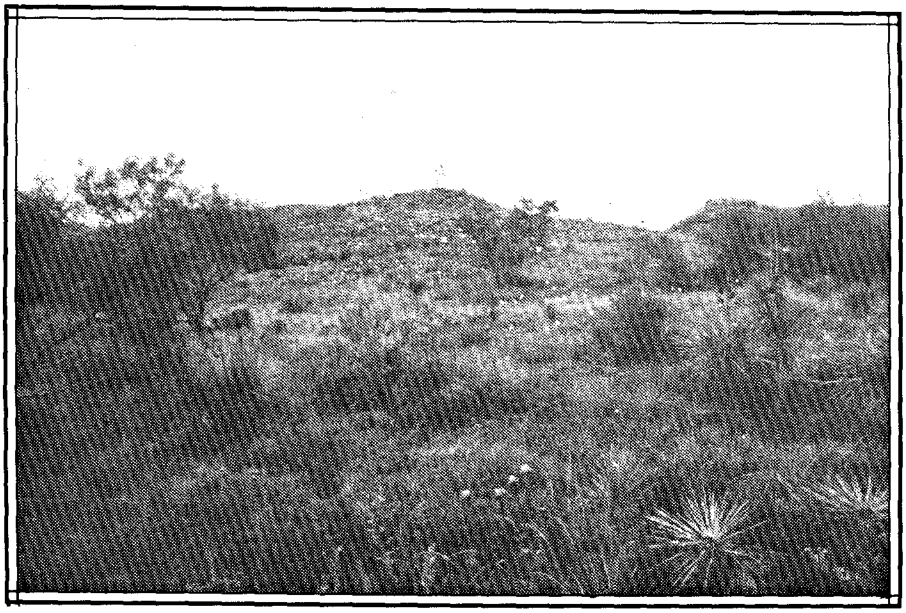


Figure 7
ALFL-86-1. View upslope toward site center. Pinflags on artifacts. View to east. Rancier on ridgetop.

All visible artifacts were collected from within the grid system. There were no artifact collections in the site area northeast of the existing road.

Test Excavations. Ten shovel tests and two 1 x 1 m test pits (Figure 9) were excavated in areas of the site that appeared to have the best potential of containing subsurface cultural deposits. The areas chosen for test excavation were located below the eroded ridgespur in colluvial areas where sedimentation has occurred. No occupation levels were located at the site.

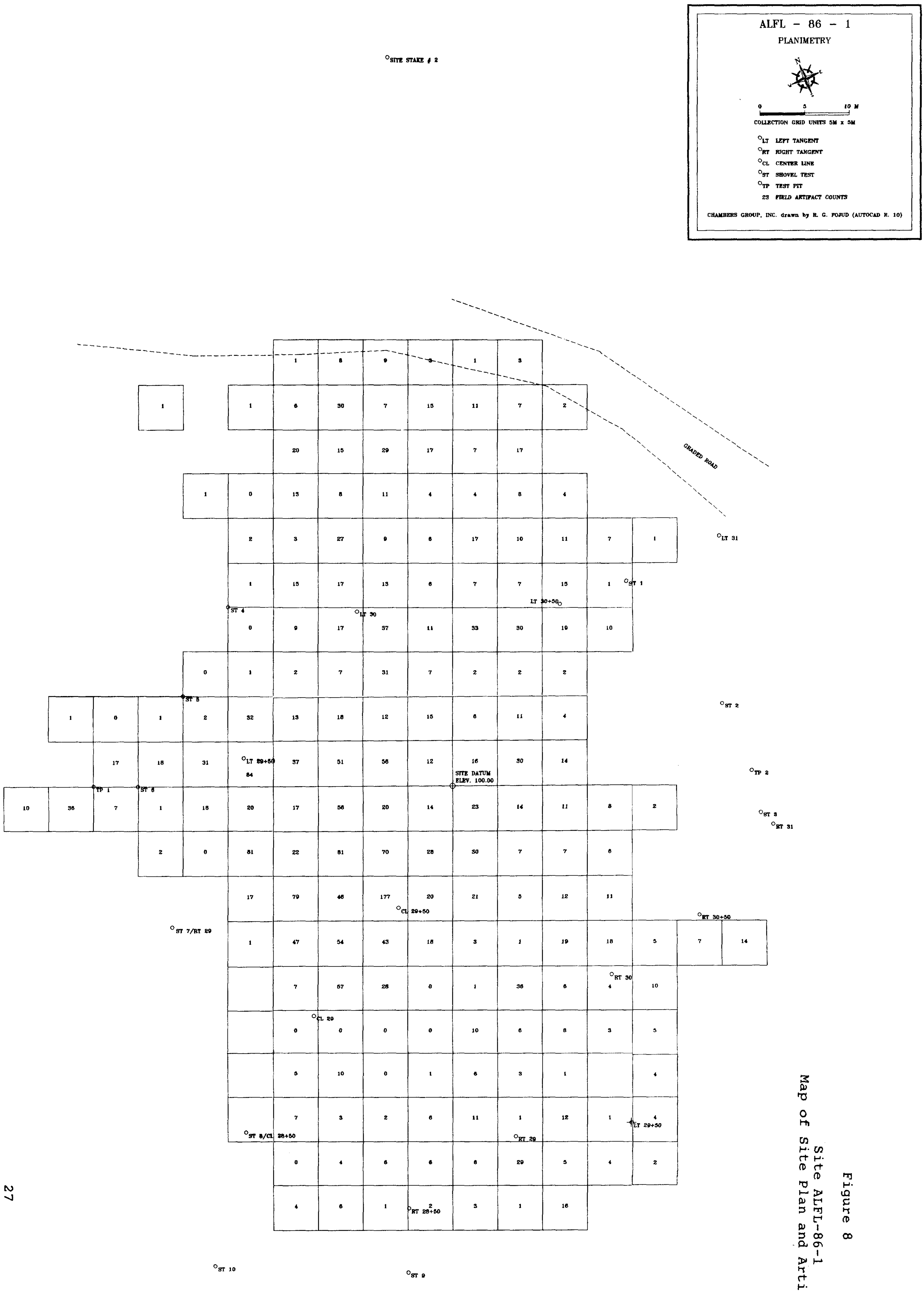


Figure 8
Site ALFL-86-1
Map of Site Plan and Artifacts

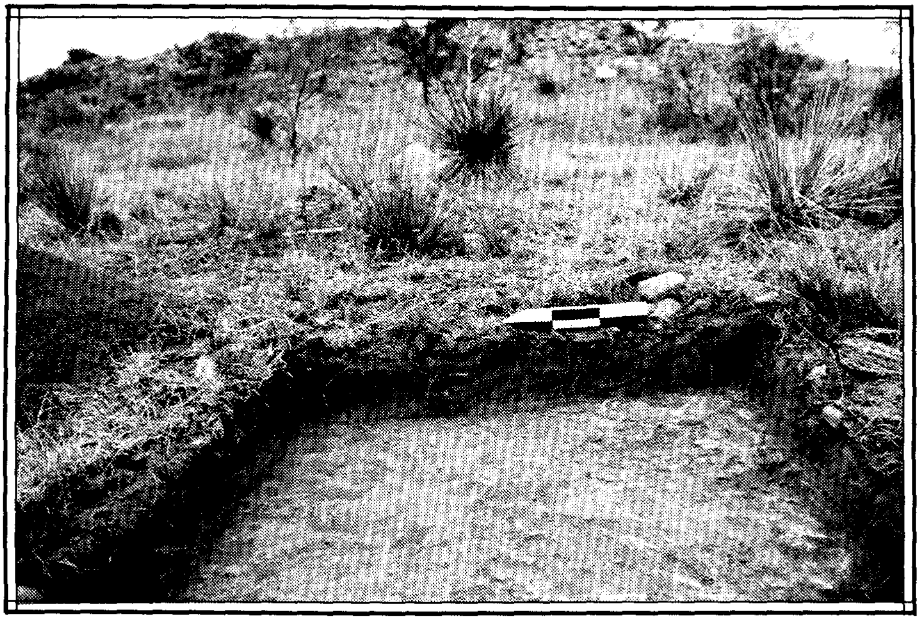


Figure 9
ALFL-86-1, east wall, TP1. 10 cm scale points north; shale in bottom of the pit.

Artifact Count. Approximately 2,763.

Impacts on the Site. Past impacts include construction of the existing dirt road that passes through the northern portion of the site, evidence of gravel and/or fill dirt removal in the southern portion of the site, probably surface collection of artifacts and Alibates chert, recent breakage of lithic material on the site by rockhounds or flintknappers, sheet and rill erosion, past livestock grazing, and the completed archeological data recovery program. The road realignment and construction project as planned will destroy most of the site area south of the existing dirt road.

ALFL-86-2

Site Description. Field interpretation of this site places it in the "surface procurement quarry" classification. It contains one intrasite concentration that may represent a temporary camp or special activity area. Based upon the types of debitage observed, the quarry activities included lithic raw material testing and initial core reduction. The area described as a temporary camp or special activity area contained one medium sized corner-notched projectile point (made from Tecovas jasper), a scraper, debitage, and what appears to be small amounts of fire-cracked rock (burned rock) derived from cooking or heating processes.

The raw lithic materials present on-site are cobbles and small boulders that may represent the remains of a Pleistocene terrace similar to the situation found at ALFL-86-1. In this case, the substratum of the terrace differs in that Tertiary sediments are believed to underlie the eroding Pleistocene gravel deposits in some areas of the site. It is notable that the form of the unmodified Alibates chert present on this site consists of subangular shapes in contrast to the other material types that are well rounded. This reflects a similar source or transport mechanism for the Alibates chert as found on site ALFL-86-1. The amount of Alibates chert available to past cultures may not have been very extensive at this location, if the amount observed during this project is any indication of prehistoric raw material densities.

The site occurs on a long linear ridgespur (Figures 10, 11 [in map pocket at back of report], and 12) and is composed of a light scatter of lithic artifacts interconnecting four distinct concentrations/activity areas (including a possible temporary camp/special activity area).

<u>Temporal Affiliation</u>. Prehistoric, date range largely unknown. Only one artifact concentration contained a medium sized corner-notched dart point that may date to the Late Archaic period (ca. 1500 B.C. to A.D. 500). The projectile point is reminiscent of the Ellis or Edgewood types; however, because the ears of the stem and part of the base are missing, type determination is difficult. Other artifact concentrations did not contain diagnostic artifacts and are not dated.

<u>Site Location</u>. The site is located between construction centerline stakes 60+00 and 87+00 (Figure 11 in map pocket). UTM designations are:

Zone 14:	256220 mE;	3939770 mN
	256180 mE;	3939810 mN
	256200 mE;	3939900 mN
	256320 mE;	3940120 mN
	256420 mE;	3940280 mN
	256430 mE;	3940510 mN
	256480 mE;	3940510 mN
	256480 mE;	3940420 mN
	256480 mE;	3940280 mN
	256410 mE;	3940140 mN
	256330 mE;	3939950 mN
	256280 mE;	3939880 mN

<u>Maximum Site Dimensions</u>. 710 m N-S x 52-109 m E-W; 38,915 sq m.

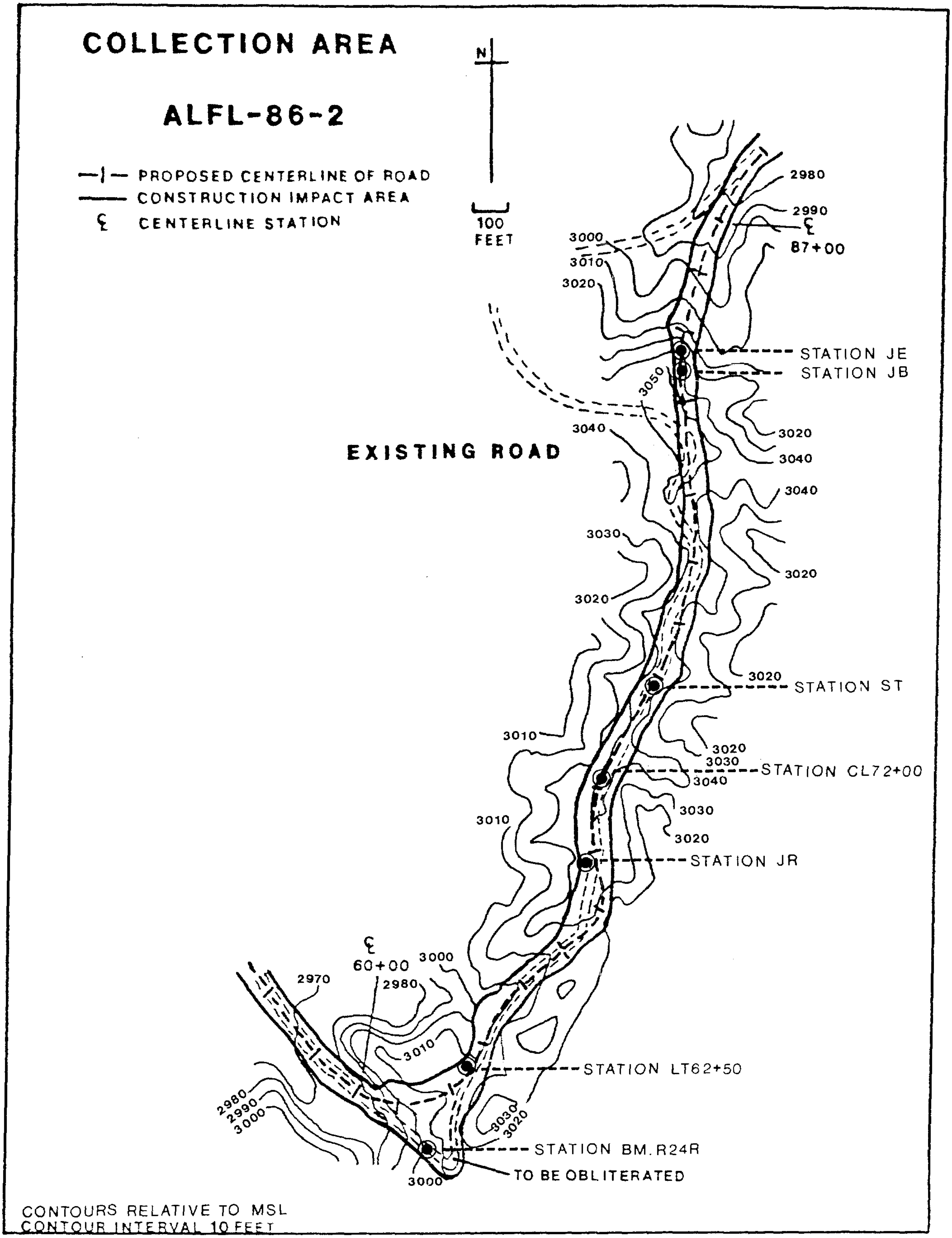


Figure 10

Site ALFL-86-2, Field Site Map

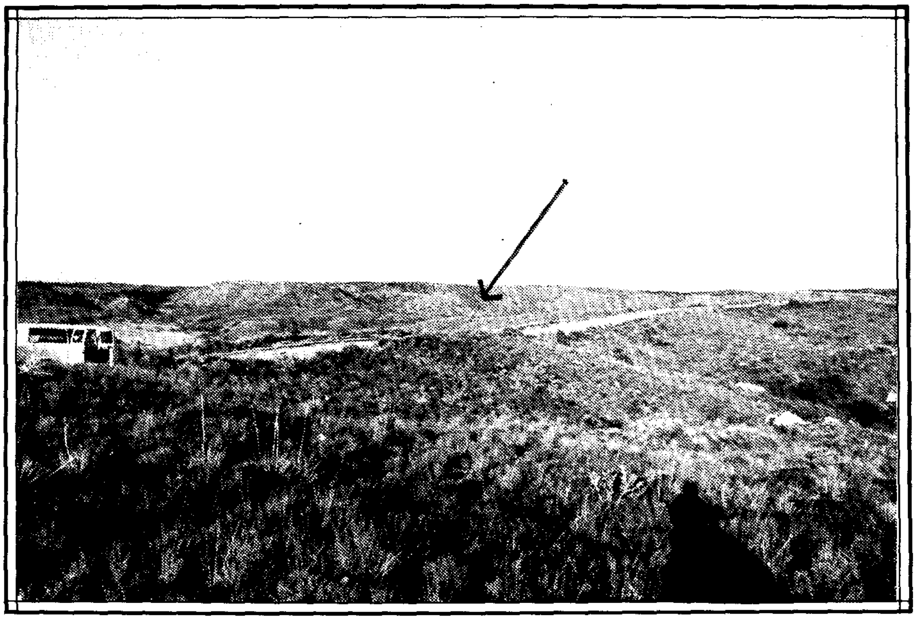


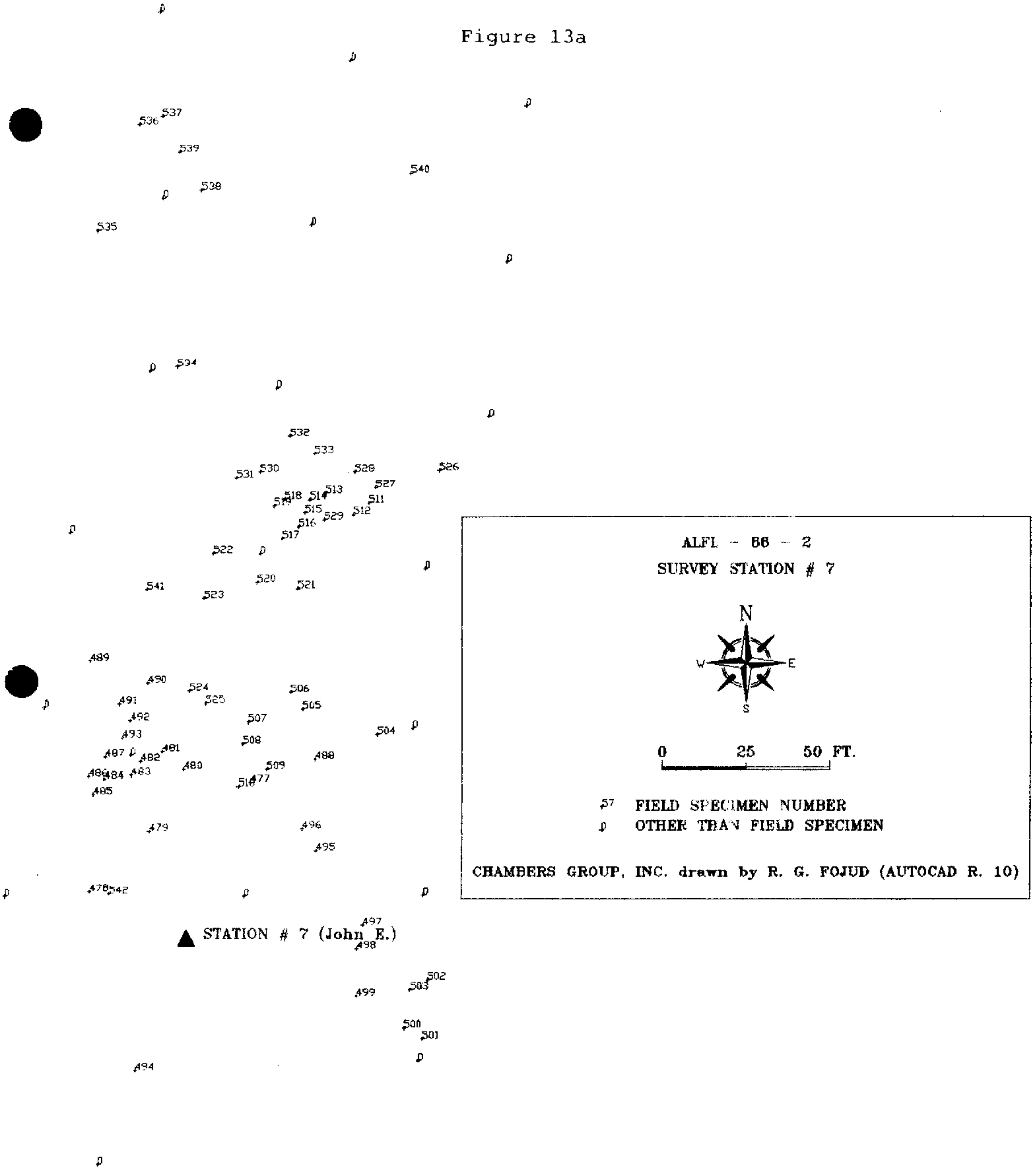
Figure 12
ALFL-86-2. Overview from datum JB toward permanent site datum #1 to west. Arrow points to J. Bradford on permanent datum.

Mapping. An EDM was used to map all surface artifacts, artifact concentrations, and excavation locations. Seven subdatums were required to map this very long and narrow site. In a few instances, errors were made during field mapping concerning horizontal readings. These were consistent reading errors that were realized before completion of fieldwork at the site and before preparation of a map was possible. These errors have been corrected.

Surface Collection. Artifact density was considered light at this site; ground visibility was good. Artifacts were collected by individual point location or by point location of artifact concentrations. The EDM point location "shot" number recorded on Mapping Data Log forms served as the FS number rather than the Artifact Record Form as used on ALFL-86-1 (see Figure 13a-g).

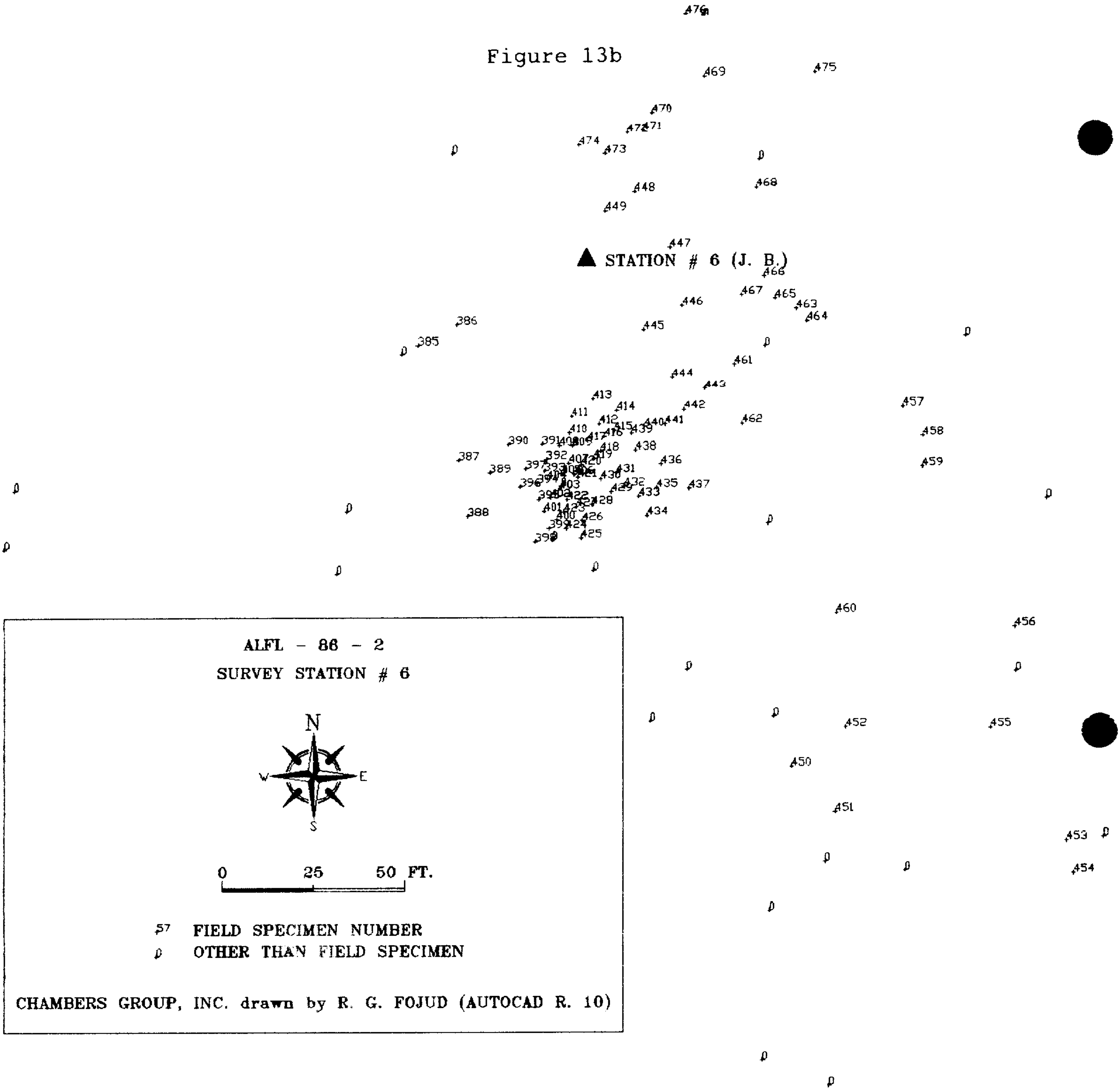
Test Excavations. Excavations included 10 shovel tests and a single 1 x 1 m test pit; two intersecting test trenches were placed radiating from the test pit.

Figure 13a



Site ALFL-86-2, Map of Datum JE Artifacts

Figure 13b



Site ALFL-86-2, Map of Datum JB Artifacts

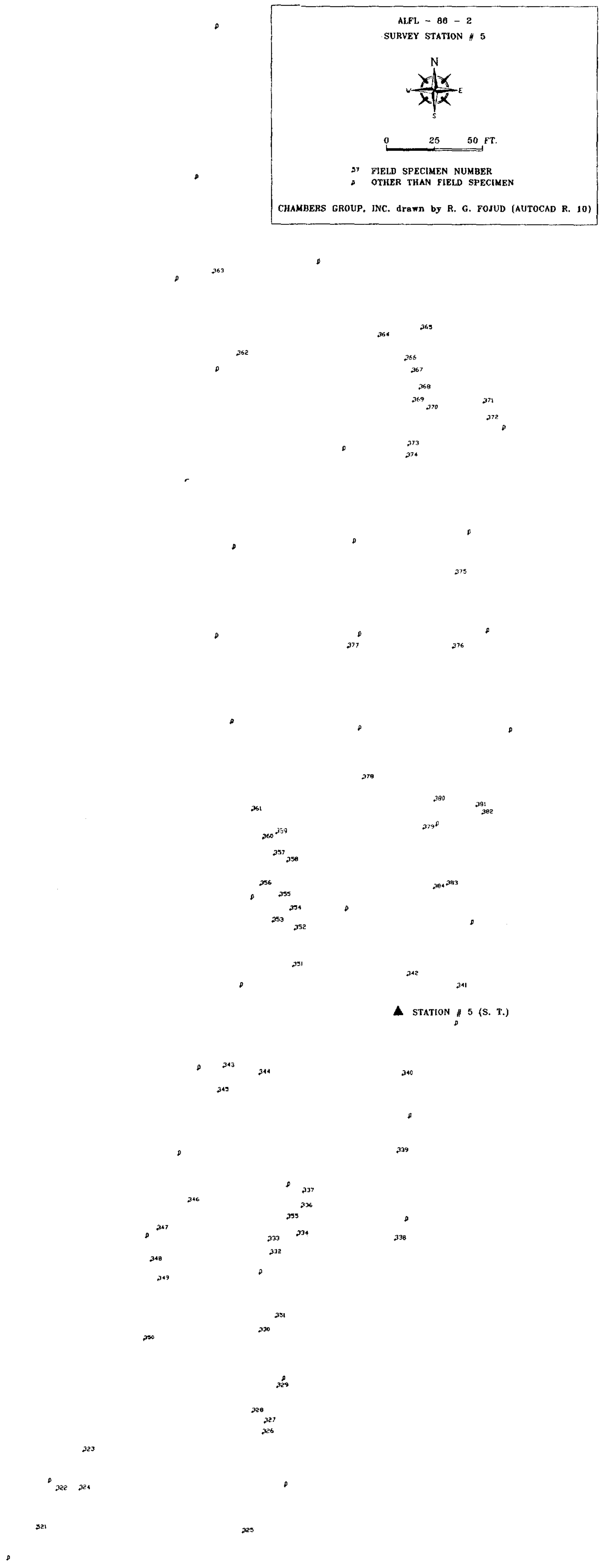


Figure 13c
Site ALFL-86-2, Map of Datum ST Artifacts

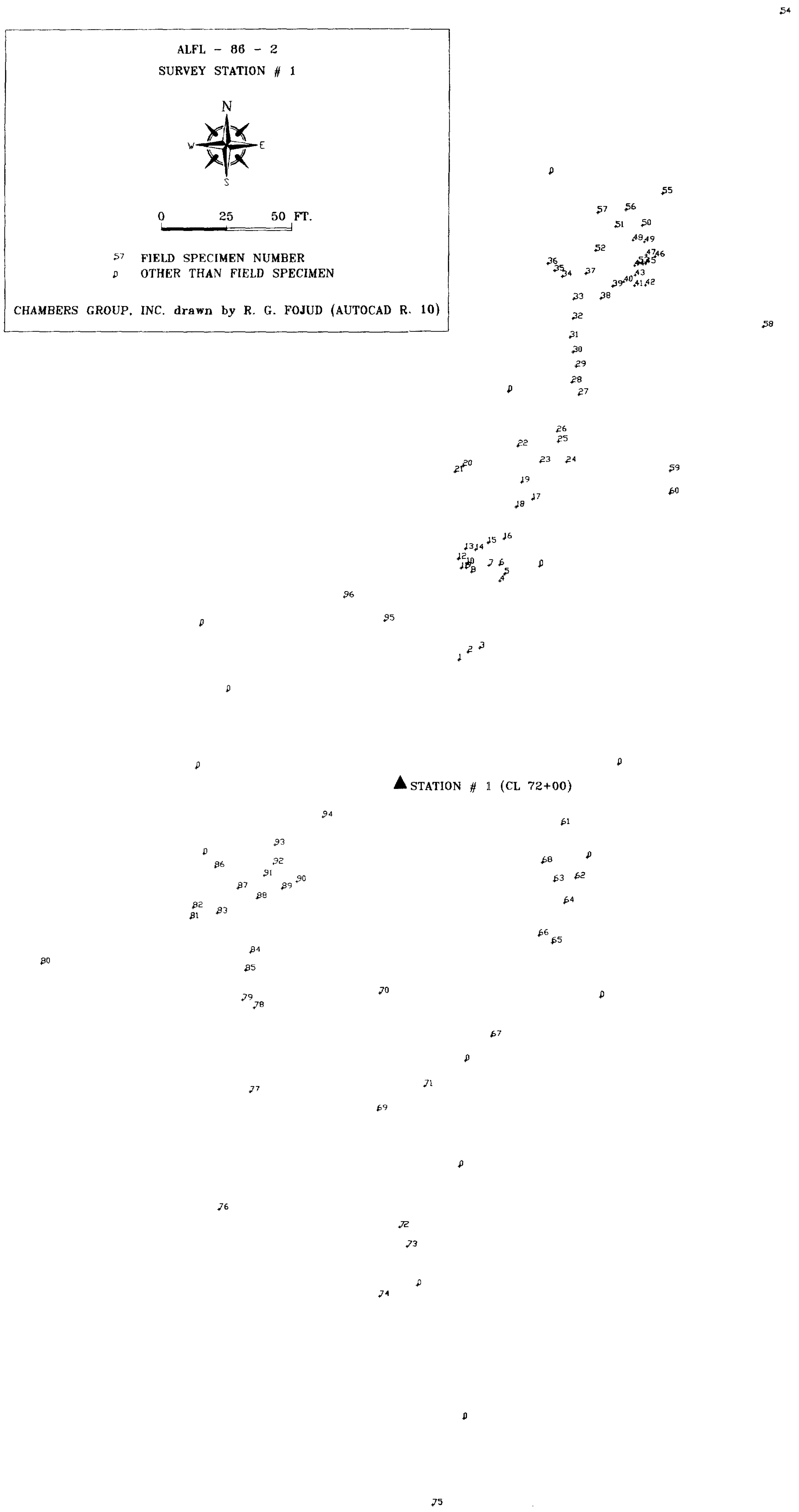


Figure 13d
Site ALFL-86-2, Map of Datum CL72+00 Artifacts

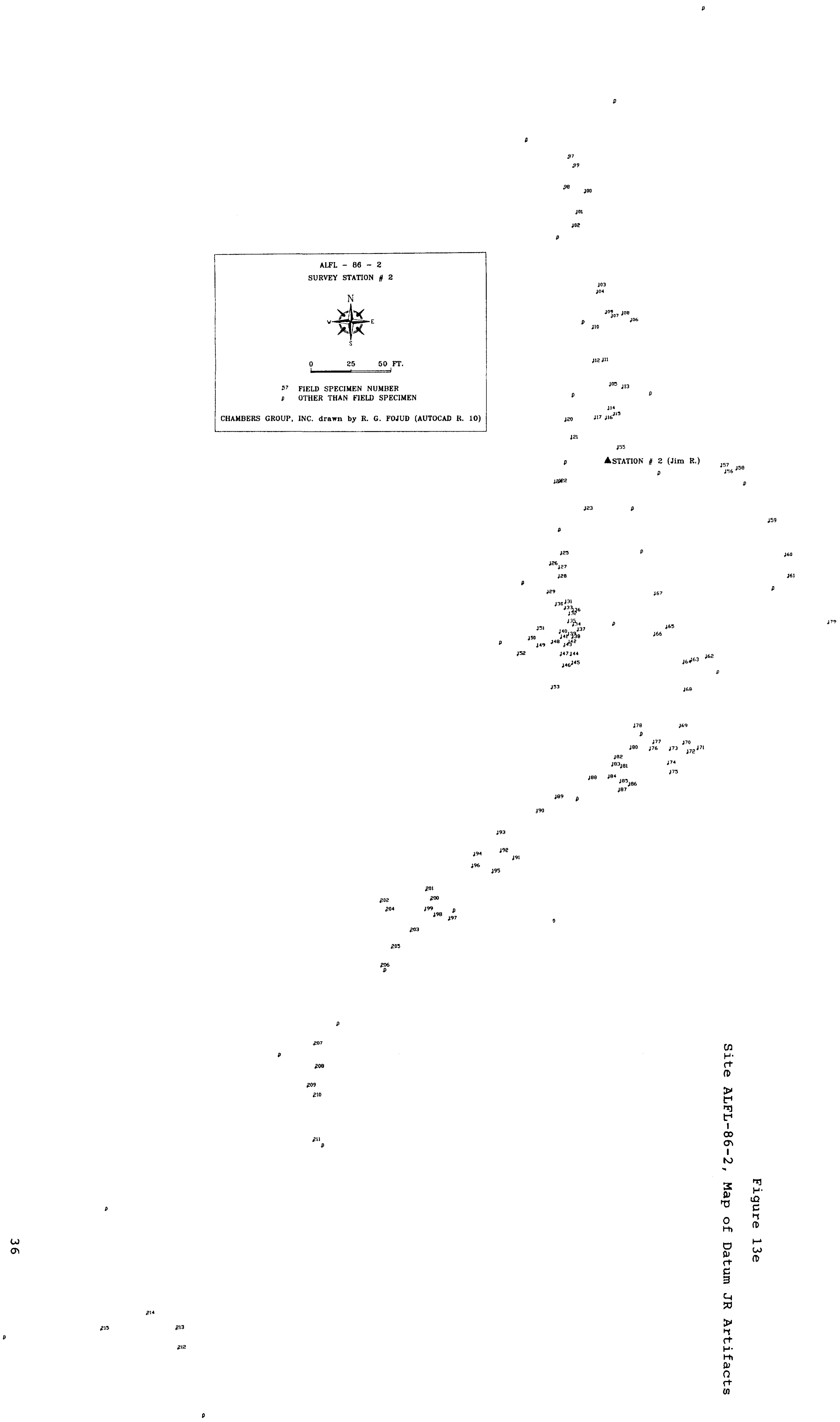


Figure 13e

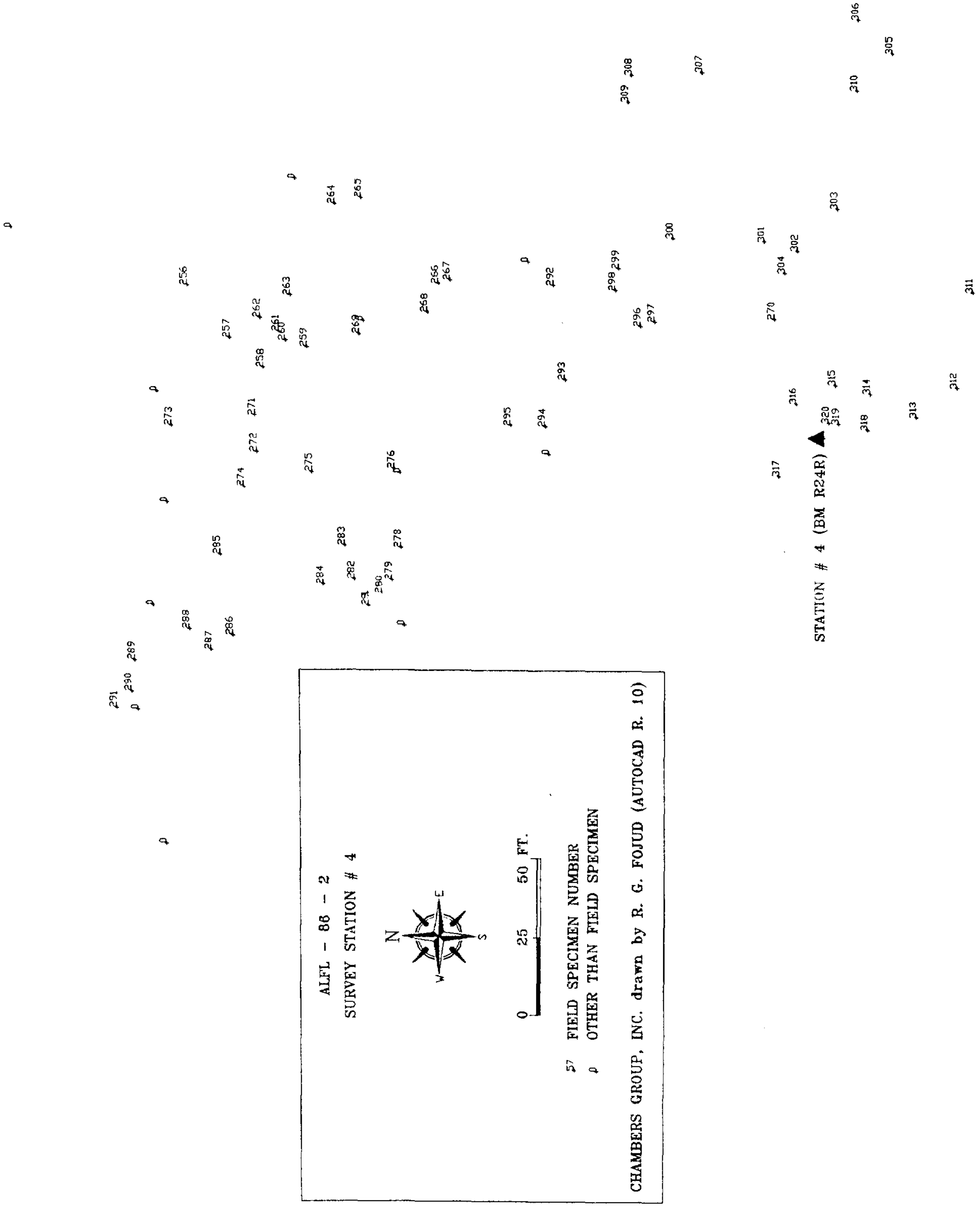
Site ALFL-86-2, Map of Datum JR Artifacts

Figure 13f

Site ALFL-86-2, Map of Datum LT62+50 Artifacts

Figure 13g

Site ALFL-86-2, Map of Datum BMR24R Artifacts



The test pit (Figure 14) and trenches (refer back to Figure 11) were additions to the Scope of Work and were intended to evaluate the temporary camp/special activity area that was identified during site mapping and collection procedures. Excavations revealed that the archeological materials present appear to be limited to the upper stratigraphic levels, that the area is very rocky and is probably deflated, and that the material located may be of scientific value. Fortunately, the area of Test Pit 1 and the test trenches is located outside the construction ROW.

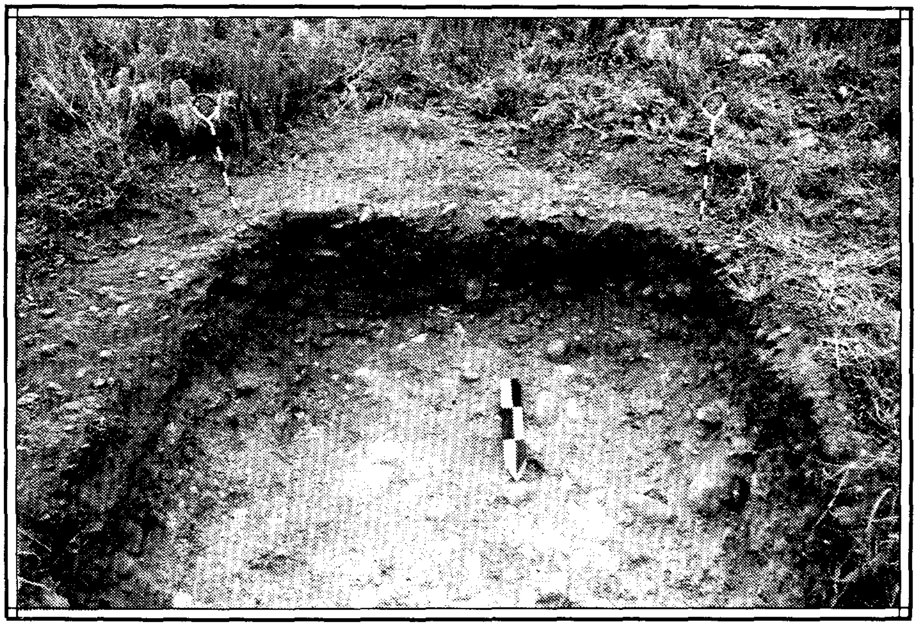


Figure 14
ALFL-86-2, south wall profile, Test Pit 1

Artifact Count. Approximately 1,598.

Impacts on the Site. Past impacts to the site include construction of the existing dirt road that passes through the middle of the site area, possible surface collection of artifacts and raw Alibates chert, wind and water erosion, past livestock grazing, soil test excavations that were associated with the proposed road construction project, and the effects of data collection by this archeological project.

ALFL-86-3

Field interpretation of this site places it within the "surface procurement quarry" classification. Site activities appear to have included core reduction. The possibility of generalized lithic workshop activities also exists. Alibates chert is the predominant artifact material type. The size and the quantity of the knappable material available at this site is limited in relation to that at ALFL-86-1 and 2, and the intensity of lithic reduction activity, site size, and density is correspondingly less by comparison. No diagnostic artifacts were recovered at this site.

The site sits on a low hilltop that is considerably below the elevation of the caprock mesas and margins of the plains that form the higher elevations of this Canadian breaks area (see Figure 15). The hill appears to be an eroded remnant of a Pleistocene, or perhaps a Holocene age terrace composed primarily of fluvially deposited sands with varying amounts of larger sediments up to the size of small boulders. The naturally occurring Alibates chert pieces were subangular in shape, inferring shorter transport than the rounded large sediments within which they occur. Alibates chert is not common in the natural sediments at the site. The larger sediments tend to occur as deposits capping the slopes and upper margins of the hill, eolian deposits are present in accumulations on the hilltop. Erosion has created a form of desert pavement at the site and the archeological material present appears confined to the surface.

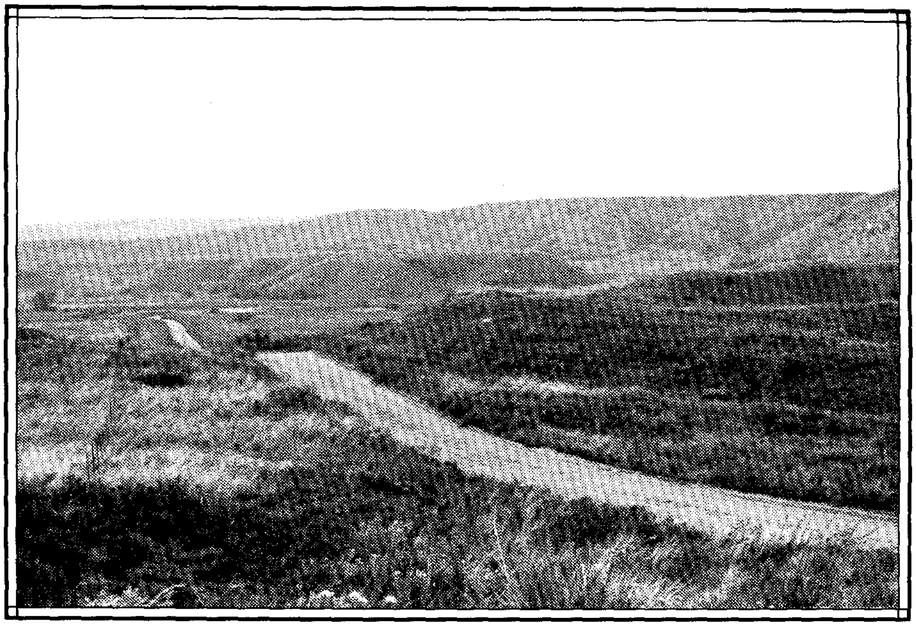


Figure 15
ALFL-86-3. From the Bureau of Reclamation benchmark along the site, showing entire site; view to west.

Of importance to the lithic analysis for this site is the fact that a range fire burned on the south side of the road in 1987. The fire did not burn on the north side of the road and the differential effect on the artifacts may be observable in the artifact assemblage. Photographs documented the effects of the fire on the vegetation in the burned area. The fire, and perhaps subsequent erosion, appears to have exposed additional artifacts that were not observed during survey of the area.

Site ALFL-86-4 is in a similar location, it lies approximately 400 feet northeast of site ALFL-86-3 and contains comparable artifacts, depositional history, and grass fire exposure.

Temporal Affiliation. Prehistoric, date range unknown.

Site Location. This site is located between construction centerline stakes 115+00 and 118+00 (Figure 16). UTM: Zone 14; 257240 mE 3941060 mN.

Maximum Site Dimensions. 84 m E-W x 64 m N-S; 5,376 sq m.

Mapping. This site was mapped by theodolite and metric stadia rod from one subdatum location.

Surface Collection. Artifact density at this site was considered low, ground visibility was good. Collection methodology consisted of point location of each artifact or artifacts if several were located within a one meter diameter area (Figure 17).

Test Excavations. There were no test excavations at this site. A majority of the site area appears to be eroded and a form of desert pavement is present on the surface. Road and erosional cuts did not contain evidence of any subsurface archeological remains.

Artifact Count. Approximately 151.

Impacts on the Site. Past impacts on the site include construction of the existing dirt road, erosion, past livestock grazing, a range fire, and this archeological data recovery program. New road construction will widen the swath of the road through the site.

ALFL-86-4

Site Description. Field interpretation of this site is essentially the same as site ALFL-86-3. The site is classified as a "surface procurement quarry" of light artifact density originating from initial core reduction and perhaps generalized lithic workshop debris. No diagnostic artifacts were found. Alibates chert was the predominate artifact material type. The size, quantity, and physical qualities of the terrace deposited

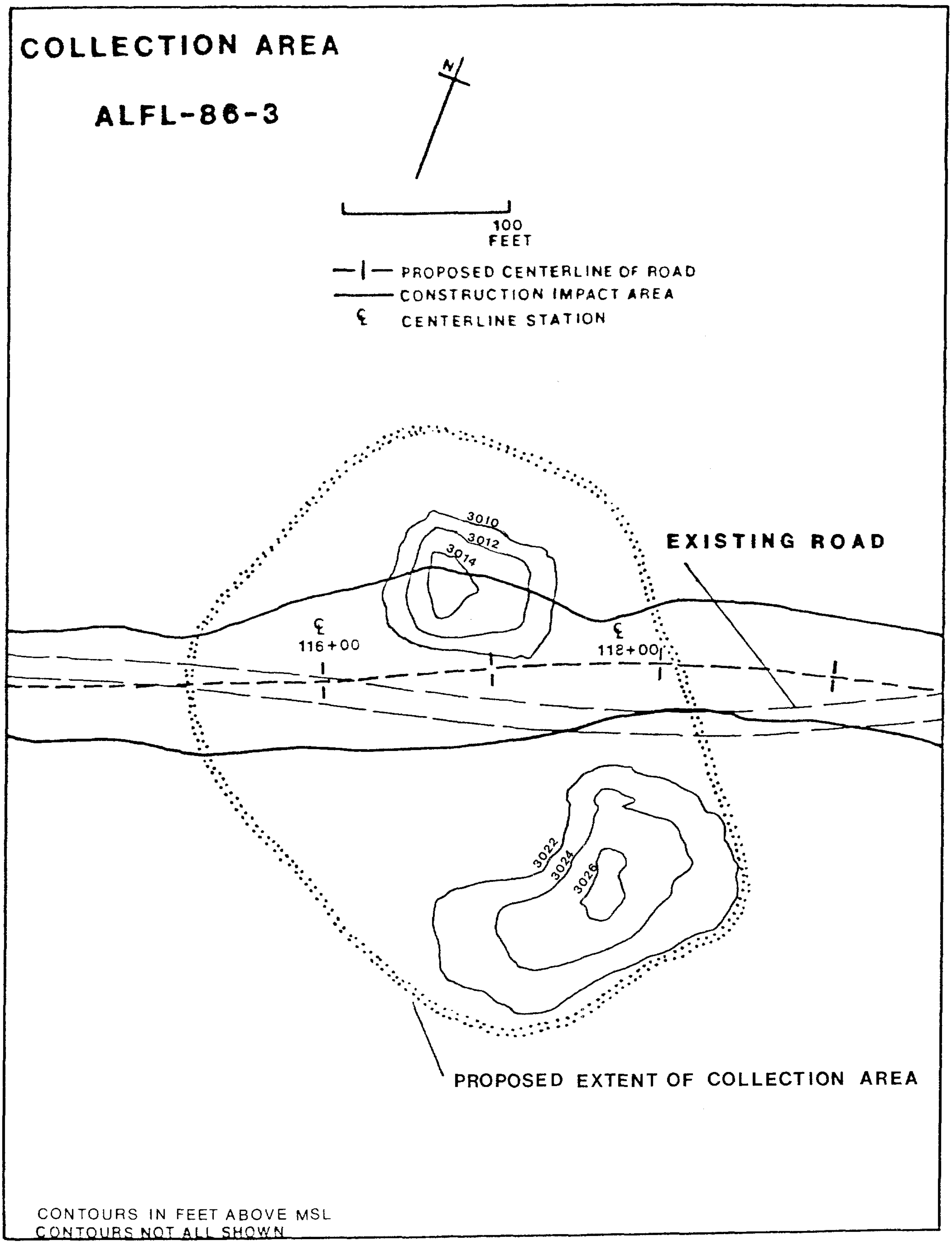
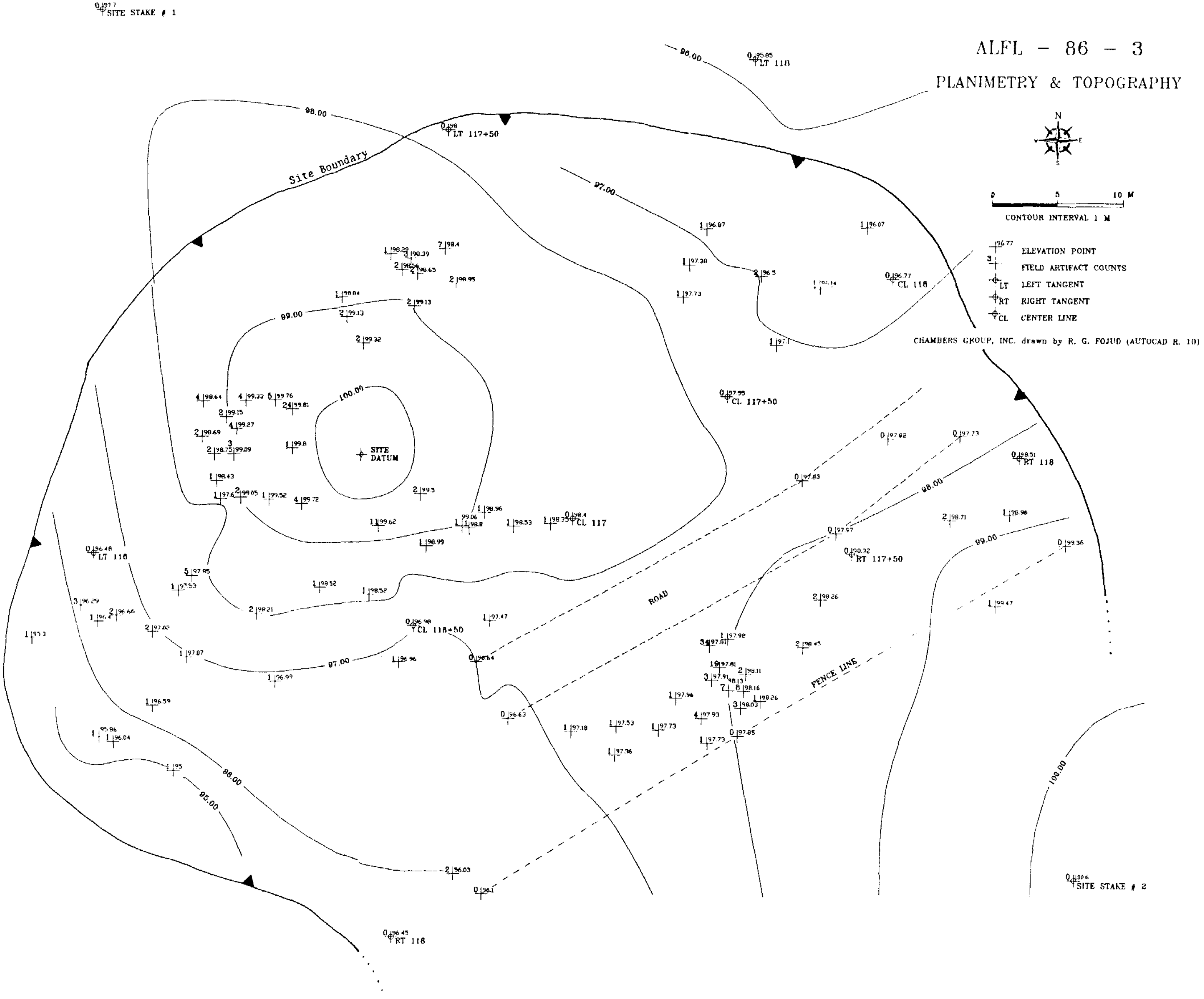


Figure 16

Site ALFL-86-3, Field Site Map

Figure 17

Site ALFL-86-3
Map of Site Plan, Topography, and Artifacts



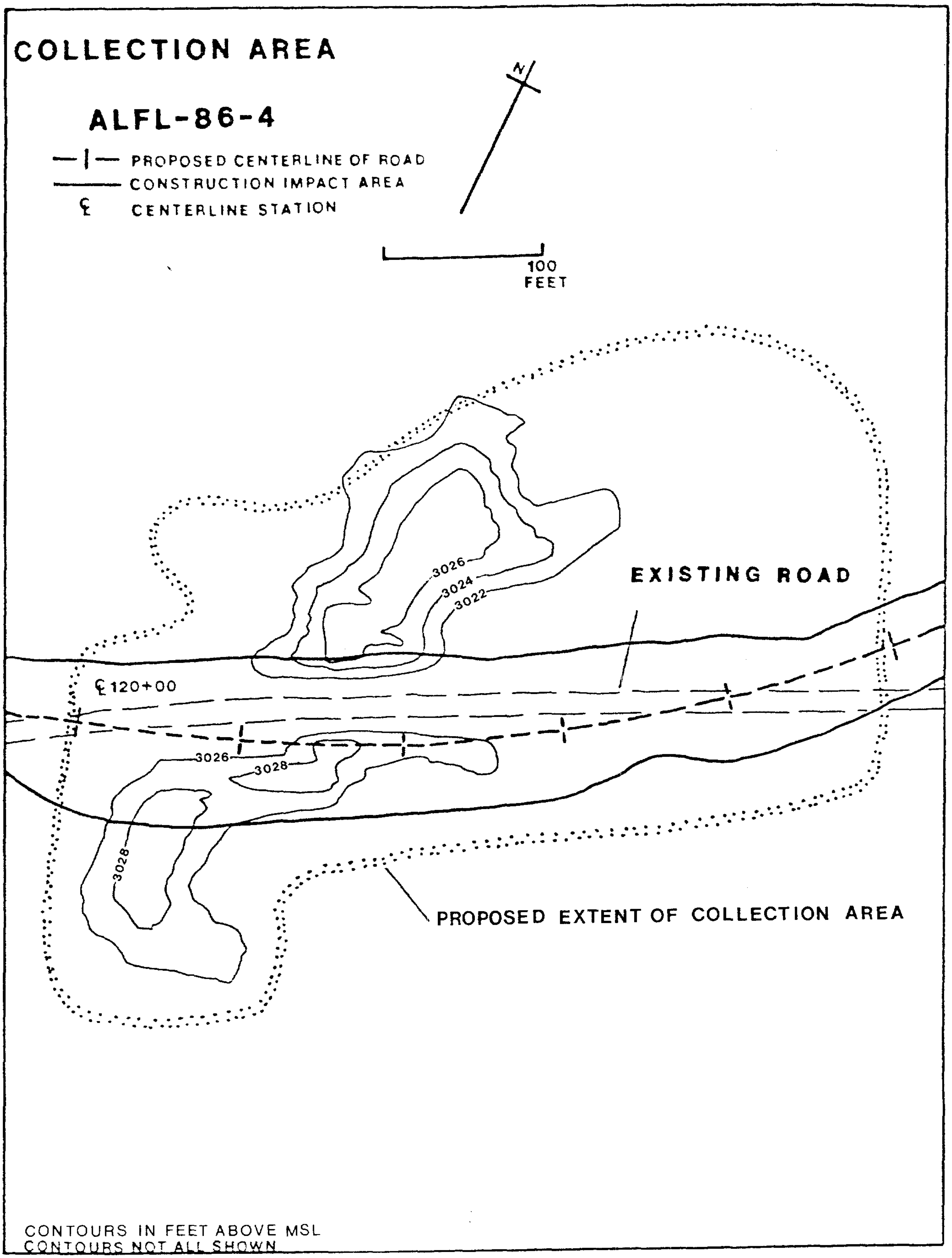


Figure 18

Site ALFL-86-4, Field Site Map

cobbles and small boulders present in the sediments are comparable to those found at site ALFL-86-3; they probably have a similar, if not identical, natural origin.

The site is located on a low hilltop situation similar to ALFL-86-3 (Figures 18 and 19). The sites are very similar, with one notable exception, ALFL-86-4 is closer to the Alibates chert bedrock. In fact, only the floodplain of one arroyo separates the site from the talus slope and caprock Alibates chert source. The caprock is a major source used by the National Park Service for its interpretive program.

Figure 19
ALFL-86-4, from Bureau of Reclamation benchmark 239F and permanent datum #1. Site overview to north. Bradford in photo.

The same range fire which impacted site ALFL-86-3 affected this site. The fire approached the site from the south and stopped at the dirt road.

Temporal Affiliation. Prehistoric, date range unknown.

Site Location. This site is located between construction centerline stakes 120+00 and 124+00. UTM: Zone 14; 25760 mE 3941140 mN.

Maximum Site Dimensions. 145 m NE-SW x 84 m E-W, 66 m NW-SE; 12,180 sq m.

Mapping. Method was identical to that at ALFL-86-3.

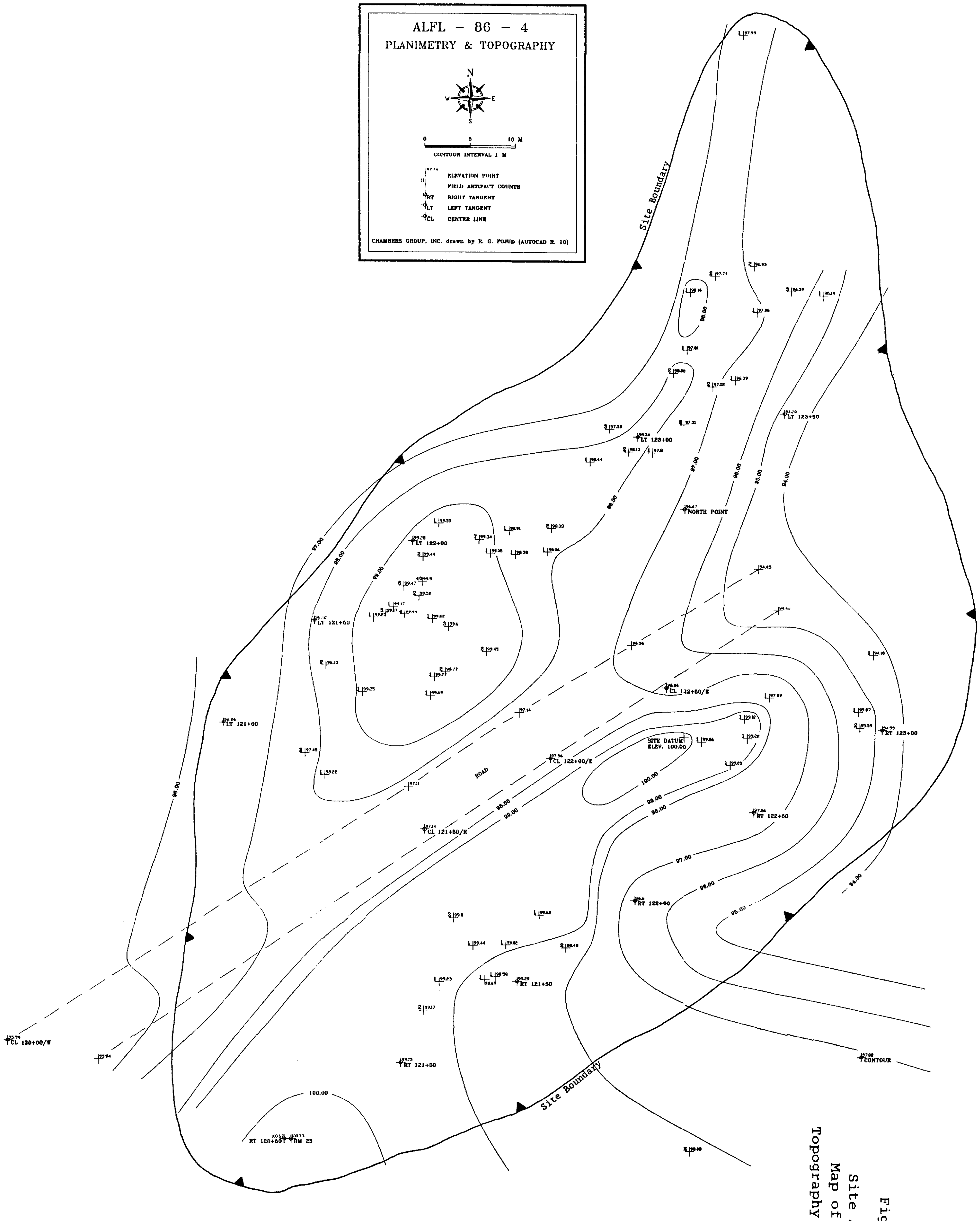


Figure 20
Site ALFL-86-4
Map of Site Plan,
Topography, and Artifacts

Surface Collection. Method of surface collection was identical to that at site ALFL-86-3 (Figure 20).

Test Excavations. There were no test excavations at this site. A majority of the site appears eroded, resulting in a form of desert pavement on the surface. Road and erosional cuts did not contain any evidence of archeological remains.

Artifact Count. Approximately 130.

Impacts on the Site. Past impacts on this site include construction of the existing dirt road, erosion, past livestock grazing, a range fire, and this archeological data recovery program.

ALFL-86-6

Site Description. The field interpretation of this site assigns it to the quarry/workshop classification. As suggested in the survey interpretation of the site, the possibility that a campsite component may be present here remains viable, as flecks of carbonized material were found in one test pit. A stratified area of the site is exposed in a road cut (Figure 21) and consists of a surface artifact scatter and two subsurface artifact bearing levels at depths of approximately 25 cm and 55 to 60 cm below the present ground surface (Figure 22). Quarry/workshop activities were indicated by artifacts on the surface, exposed in the road cut, and through limited test excavations. Evidence of various stages of core reduction and biface manufacture are represented in the artifact assemblage. No diagnostic artifacts were recovered. The predominate lithic material type present at the site is Alibates chert. The probable source of the majority of lithic material found on the site comes from the talus deposits derived from Alibates dolomite caprock originating at the bedrock deposits on the mesa immediately above and northeast of the site. The talus deposits contain some very large boulders of Alibates chert, most of these are weathering into angular fragments of various sizes. Several noncultural specimens were collected for comparative use by lithic analysts.

The site boundaries are actually research boundaries. Artifacts extend beyond the research boundaries and beyond any area of possible impact from the construction project. The areas defined on the northwest and by the arroyo along the southern edge of the site are archeological defined site limits; however, all other boundaries were defined based on the possibilities of future development in the area. The site is a portion of the massive artifact scatter that continues up the talus slope to the bedrock quarries and up the major arroyo to the east of the site. This site is actually a very small portion of a large site complex, the range of which is beyond the scope of this project.

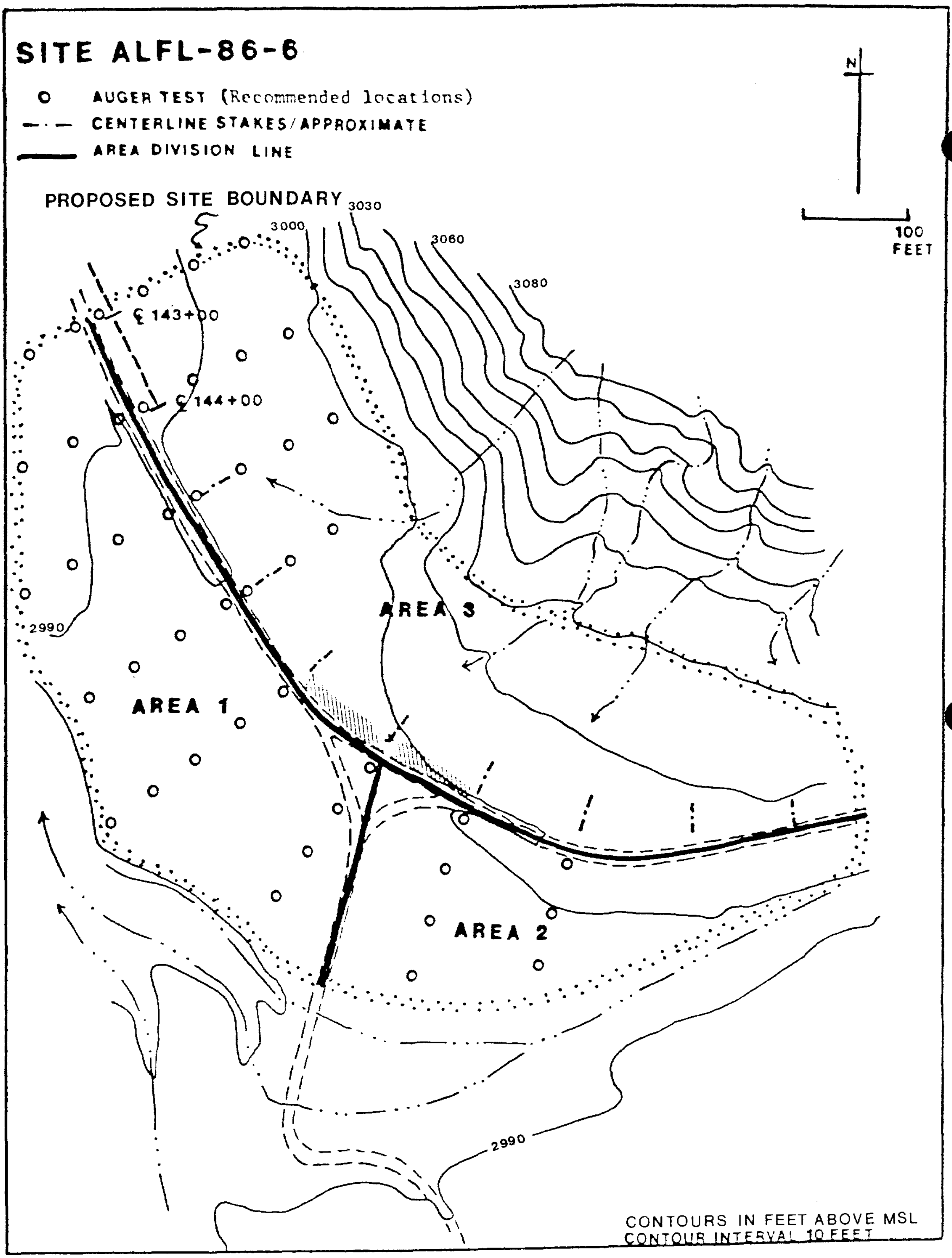


Figure 21

Site ALFL-86-6 Field Site Map

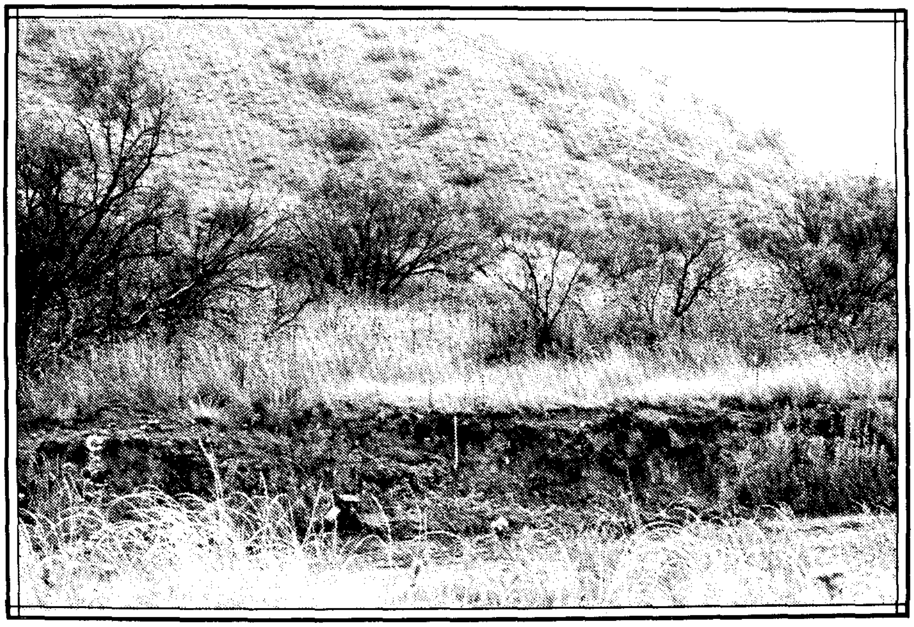


Figure 22
ALFL-86-6, interpretive mesa in background. View of exposed road cut, with two levels of artifacts exposed (tape flags). Tape measure for scale. View to NE from existing intersection at station centerline 147+00.

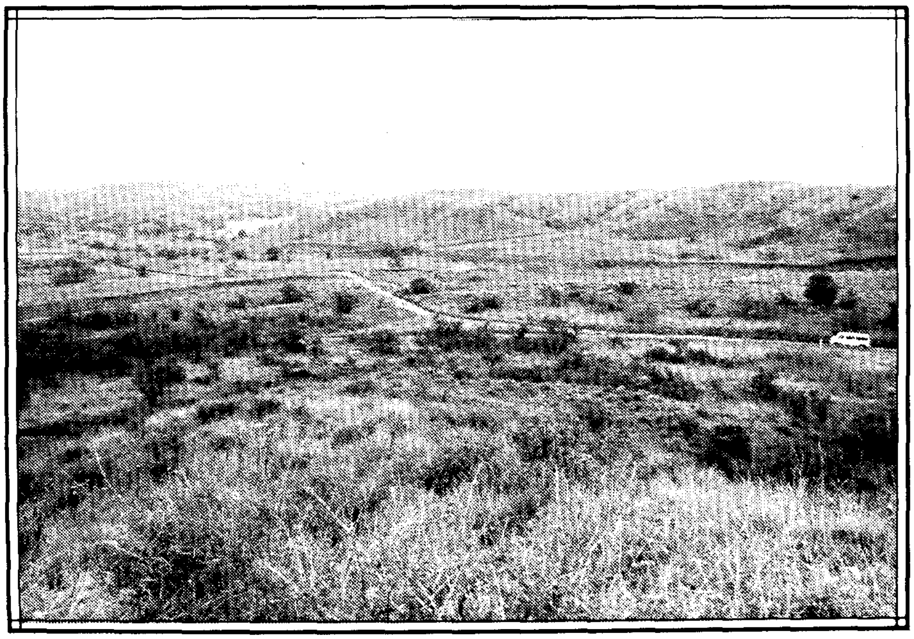


Figure 23
ALFL-86-6, overview; east one-half of site. Van near main datum. View to SW from interpretive mesa slope. Road intersection and auger test areas 1, 2, and 3 visible in photo.

The site sediments of the talus portion of the site are extremely rocky. The colluvial toe slope sediments appear to be a fine sandy loam containing relatively few rocks; this sedimentary unit contains the stratified cultural deposits that are exposed in a road cut near the center of the site. The alluvial deposits of the arroyo floodplain/terrace are composed of various sized, sometimes well sorted, sands that contain an occasional lens of pebbles or gravel. The varied sedimentary history of the site adds to its complexity (Figure 23).

Temporal Affiliations. Prehistoric, date range unknown.

Site Location. Site is located between construction centerline stakes 143+00 and 152+50. UTM: Zone 14; 257940 mE 3940860 mN.

Maximum Site Dimensions. 184 m E-W x 218 m N-S; 40,112 sq m.

Mapping. This site was mapped by theodolite, metric stadia and metric tape.

Surface Collection. Surface artifact density was considered low to heavy at this site. Vegetation was heavy during this phase of the project and, in general, fewer artifacts were observed in August and September of 1987 than in the previous survey in 1986. Because this site would not be impacted by construction as proposed at this time and because of the density of vegetation, no artifacts were collected from the surface of this site even though it was called for in the Scope of Work. If the site will be impacted in the future, then surface collection is recommended. Surface artifacts on the southerly portions of the site are often associated with recent animal burrows. Although these artifacts may be out of original context, they may be useful in isolating relatively undisturbed subsurface deposits or for interpretation of past site activities in a general manner. The surface artifacts in the northerly portion of the site (as divided by the road) are found in areas that exhibit less disturbance, such occurrences may be the result of soil variation and choice as characteristic of the burrowing animals present.

Test Excavations. Fifty auger tests and two 1 x 1 m test pits were excavated at this site (Figures 24 [in map pocket] and 25). All excavations were placed at points established in a grid system set up with theodolite and metric tape. The 1 x 1 m test squares were excavated in Area 1 at two locations where surface artifacts and auger tests suggested the possible presence of subsurface archeological deposits. Evidence of animal burrowing was minimal at the locations of the two test pits (Figures 26 and 27).

Figure 25
ALFL-86-6, detail of work. Auger testing. From left to right, Travis, Evaskovich, Bradford. View to NE.

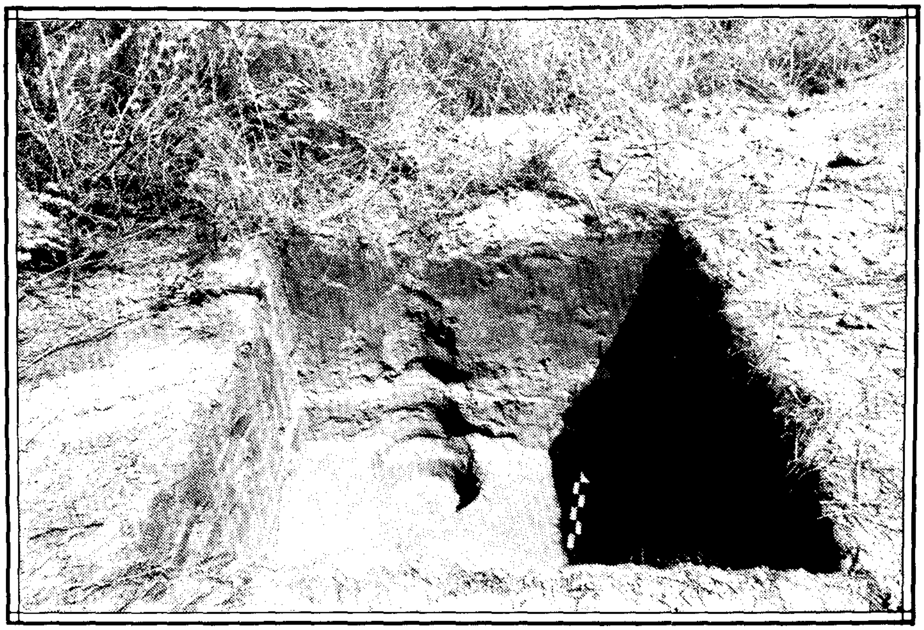


Figure 26
ALFL-86-6, Test Pit 1, north profile. View to north.

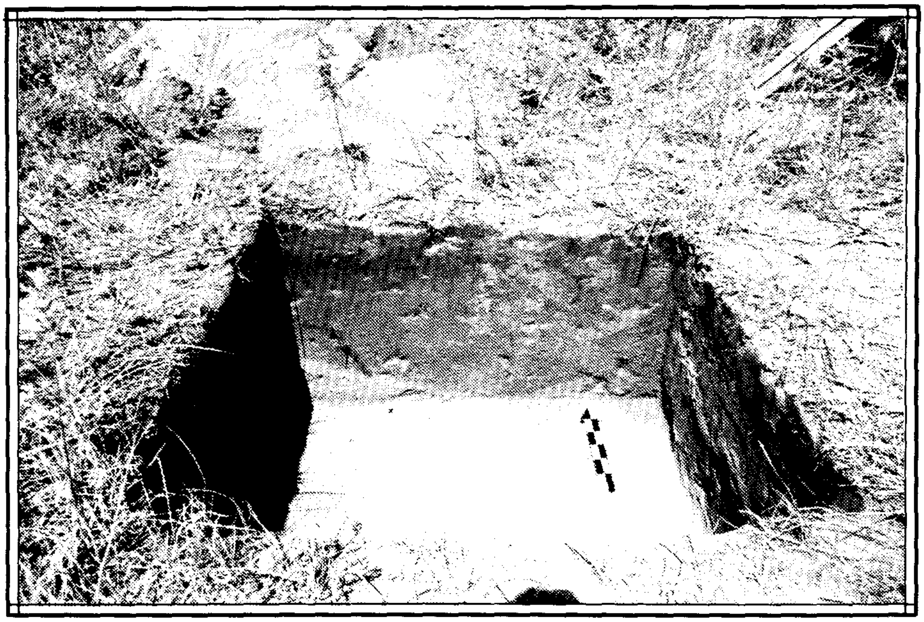


Figure 27
ALFL-86-6, Test Pit 2, north profile. View to north.

The presence of a dark, possibly humic layer, confined to the top 10 to 20 cm of sediment (as exposed in the majority of the test excavations across the site) suggests that the present surface may have been stable enough to allow soil development. If indeed this discoloration is the result of soil development, then it is probable that erosion has not been a serious factor at the site for a considerable period of time, perhaps not since prehistoric times.

Artifact Count. Approximately 292.

Impacts on the Site. Past impacts on the site include road construction and maintenance of the existing dirt road, arroyo bank, and road cut erosion, livestock grazing, construction of a subsurface natural gas pipeline, and, to a minimal extent, this archeological data recovery program. Portions of the site could be impacted by future trail and trailhead facility construction.

Recommendations. This site is considered to contain potentially significant archeological resources. Implementation of a more thorough archeological testing and evaluation program is recommended before any ground disturbing activity takes place within the site boundary or from centerline station 143+00 to the Monument boundary fence to the northeast. Controlled surface collection and subsequent subsurface test excavations should be part of any future archeological testing and evaluation program. Area 1, as delineated on Figures 21 and 24, remains the most logical location for placement of any future developments if the site cannot be avoided altogether.

LITHIC ANALYSIS

by Jack Bertram

INTRODUCTION

In accordance with Section 4 (Statement of Work) of the Scope of Services for this project as prepared by NPS, lithic analysis procedures and methods were developed. Specific minimum lithic analysis requirements of the scope of services are reproduced below:

> At minimum, an in-depth lithic analysis including types of cores, debitage, formal tools, material types and sources, color, presence or absence of heat alteration, the presence of reworked or utilized artifacts, and artifacts that display modification through patinated surfaces is required. The analysis will be geared to isolate reduction strategies and stages of manufacture present at sites and intrasite activity area.
>
> Debitage analysis will include the amount of cortex present based on percentages, size of the artifact, the type of platform used to detach flakes, and the separation of core reduction flakes from biface manufacturing flakes.
>
> The analysis shall attempt to isolate discrete lithic reduction strategies, stages of manufacture present, and technologies that may be indicators of cultural affiliation and chronology.
>
> Analysis of bifaces will be guided by the "stage" concept of manufacture.
>
> Type of cortex present will be monitored on all artifacts to establish the natural depositional origin of the material (such as fluvial deposits [cobbles] or bedrock quarry sources).
>
> All artifacts shall be inspected for traces of usage and associated functional inferences.

The approach to lithic analysis adopted by CGI for this project was geared to address the issues and monitor the domains of variation specified above. Particular emphasis was placed on definition of reduction trajectories and reduction stages as these concepts are generally understood; variables were selected and procedures defined so as to allow discrimination of biface reduction from core and blade reduction, as was required by the scope of services.

As the analysis proceeded, it became clear that the lithic items collected by NPS crews from sites ALFL-86-1, 2, 3, 4, and 6 were, for the most part, products of reduction events not readily classifiable within the prescribed core/flake and biface/flake model. Rather, many of the presumably artifactual items from these sites appeared to have been broken by thermal stress, by weathering processes, or by high-energy and/or high-force crushing agents, probably including heavy equipment disturbance, geological loading, colluvial movement, and deliberate human acts, both ancient and modern.

As a consequence, the CGI lithic analysis was called upon to address questions for which it was not designed, and for which almost no theory exists; the most central of these questions related to the agents and mechanisms of breakage.

This section will present the theoretical rationale and basis of the CGI lithic analysis approach as originally designed. Observational domains and variables will then be defined and justified, and the implied measurement procedures will be specified in detail. Following this presentation, the problems inherent in analysis of "non-core" lithic reduction sets will be discussed. Finally, a strategy allowing the CGI analysis approach to be applied to "non-core" reduction sets will be presented.

CONVENTIONAL LITHIC ANALYSIS THEORY AND METHOD

Archeological analysis of chipped stone technology was essentially begun by Evans' (1872) study of the Brandon gunflint technology. Cotterell and Kamminga (1987) have emphasized that debate over the cultural significance or lack of significance of "Eolithic" tools found in Britain, France, and Germany, led eventually to the universal acceptance of an operational definition of chipped stone technology in terms of the mechanics, characteristics, and products of conchoidal flake manufacture.

Other methods of chipped stone tool manufacture have been observed ethnographically, reconstructed archeologically, and/or replicated experimentally. These include especially the production of usable stone fragments by bipolar percussion as well as by thermal shock and other mechanisms (Purdy, 1982; Patterson 1979; Ellis 1940). In practice, however, almost all research effort in lithic analysis has been directed toward stone-breaking techniques which produce recognizable conchoidal flakes - that is, flakes having platforms, definable ventral surfaces, bulbs or pseudobulbs (lips) of percussion, and other "diagnostic" flake attributes.

Such flakes are produced in large scale by pressure-flaking, baton-flaking, or hard-hammer flaking along an edge, and in small scale (microwear) by the edge stresses created in tool use. In general, they have in common, at all scales, a set of diagnostic attributes valuable in their recognition (Speth 1972).

These means of flake detachment have in common also the technological characteristic that they can be applied with great control. It is this attribute of control which led most prehistoric artisans to emphasize direct and indirect hard-hammer, soft-hammer, and pressure flaking techniques as predominant aspects of their repertoire. This same controllability attribute has led modern lithic analysts to devote their analytical, methodological, and replicative experimental efforts almost exclusively to the study of hard-hammer, soft-hammer, and pressure flakes and flaking.

This emphasis has been reasonable. Insofar as lithic artifacts exhibit stylistic or formal attributes which are culturally or otherwise diagnostic, those attributes are present as the result of controlled flaking. Moreover, one suspects that acquiring skill in controlled flaking is generally more challenging than are less controlled techniques; controlled flaking has therefore captured the attention of the experimental lithic analyst as craftsman (Crabtree 1972, 1973; Bordes and Crabtree 1969; Bradley, 1975; Frison and Bradley 1980).

The Conventional Lithic Analysis Model

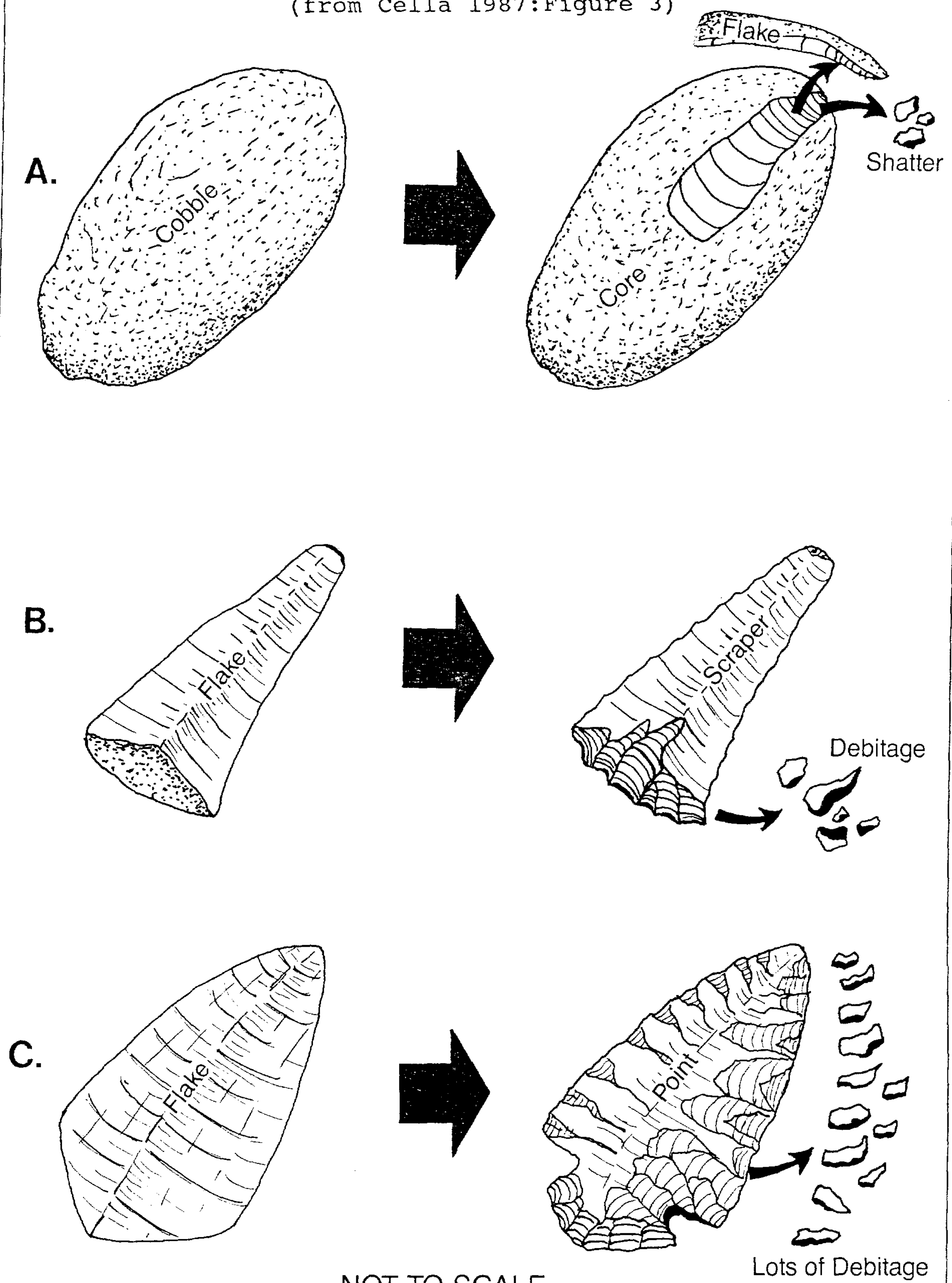
The development of lithic analysis has emphasized the recognition and interpretation of the products of controlled flaking; see especially the pioneering and seminal studies of Chapman (1977, 1982), Wilmsen and Roberts (1978), Speth (1972), Patterson (1983), Laumbach and Brockman (1983), and Moore (1982, 1983). These and similar studies all employ variants of the standard model for conventional lithic analysis in the Southwest and southern Great Plains regions. This model, as implemented by CGI, will now be presented.

Lithic reduction, as practiced in the prehistoric and protohistoric periods, proceeded through stages of work from raw material to use and/or discard of all the products of reduction. Initially, material would be acquired through collecting or quarrying of stone from bedrock or alluvial cobble deposits. As pieces of stone were acquired, they were broken to test their quality. If acceptable, materials were selected for further reduction.

Reduction is defined as the breaking apart of stone pieces to produce immediately or eventually usable items (Figure 28). It was typically carried out by striking a stone mass with a smaller stone (hard-hammer percussion) or with an antler, bone, or hardwood billet (soft-hammer percussion); alternatively, breakage was accomplished by using a stone, bone, or antler punch which was struck by a hard or soft hammer (indirect percussion). In exceptional cases, breakage was accomplished using steadily

Figure 28
Idealized Lithic Reduction Sequences

(from Cella 1987:Figure 3)



NOT TO SCALE

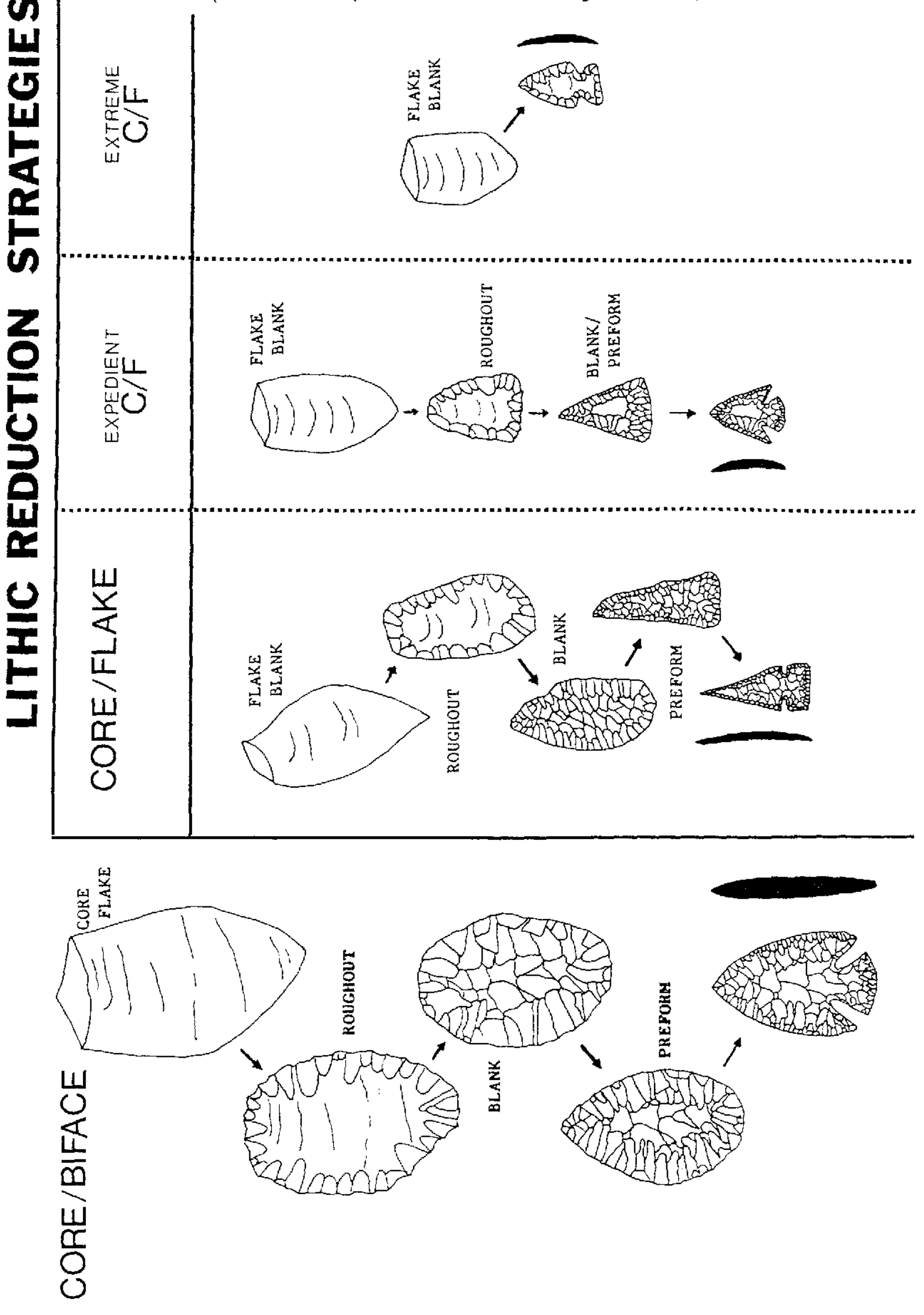
increasing pressure (pressure flaking), rather than a sudden blow.

In general, controlled breakage could be achieved only by percussion or pressure near an acute edge of the object to be broken (the core). The surface of the piece to which force was applied (the platform) was selected or modified so that it intersected acutely the surface along which the detached piece (the conchoidal flake) was to be removed. If a flake were successfully detached, it would retain on one side (the dorsal face) the original surface of the core. On the opposing, freshly broken surface (the ventral face), it would exhibit typical characteristics of conchoidal flakes (see below). On the end to which force was applied, it would retain a small, usually oval or crescentic, remnant of the platform surface. Flakes removed from a core might themselves then be treated as cores, as smaller flakes were removed from them. Flakes might also be removed with the intent of modifying the core, either for use of the core as a tool or as preparatory steps so that flakes of specific shapes might subsequently be struck from the core. In many circumstances, it is likely that both the core and the detached flakes were viewed as potentially useful tools.

The manner in which a core was reduced was influenced by its shape, material quality, and the form of the desired products (flakes and/or core). A potential core might be discarded after only one or two test flakes were removed (tested candidate core). If further flakes were removed mainly from a single platform surface, and if this platform surface were perpendicular to the long axis of the core, the flakes produced would tend to be long, narrow, and lamellar (flake blades). The core would, as a result, take on the shape of a multifaceted, cylindrical or conical prism (prismatic blade core). If flakes were struck opportunely from several platforms, as these were created by prior detachments, the core would take on a polyhedral or irregularly faceted form (irregular polyhedral core).

If the original core were a flat or discoidal cobble, a flat tabular piece, or a large flake obtained by percussion from a still more massive source (large core, outcrop, boulder), a more versatile style of core reduction could be followed. Flakes could be detached from either or both faces by striking along the edge of the disk of material. The resulting core could continue to produce serviceable flakes, while itself serving as a useful knife, axe, scraper, etc., until it has been reduced to a small size incapable of generating flakes large enough to be usable (see Figure 29). This flexible and efficient technology tended to produce distinctive flakes, generally known as biface flakes; the discoidal cores so produced are of typically flattened section and or oval, circular, rectangular, or triangular shape. Both main faces might experience substantial flake removal (bifacial discoidal core) or only one surface might be used to produce flakes (unifacial discoidal core).

Figure 29
Lithic Reduction Strategies
(from Lord, et al. 1987:Figure 7.5)



It is the consensus of lithic analysts and lithic experimenters that the form and type of the parent core can commonly but not consistently be inferred from the character of the flake produced. Similarly, flake characteristics are thought to be indicative but not consistently diagnostic of the detachment techniques used in their production. The basis for making inferences about parent core form and about detachment techniques will now be reviewed.

When a cobble or tabular piece is tested, the flakes detached bear on their dorsal surface the exterior (cortex) of the piece from which they were struck. If the tested piece was alluvial (i.e., a tumbled cobble or pebble) the cortical surface will characteristically exhibit old impact scars (hertzian cones and ring cracks) and rounding abrasion. If the tested piece was removed from bedrock or colluvial deposits (i.e., a nodule or tabular piece), the cortical surface will lack substantial abrasion rounding and will have few old impacts scars, unless it underwent extensive colluvial tumbling. In determining cortex characters, ambiguous cases commonly arise when one studies cortical flakes or cores from which most of the cortical surface had been removed. Pieces may have experienced in-place or colluvial weathering followed by initial alluvial rounding. Other items may have broken along old interior flaws or faults; these surfaces commonly appear weathered and might be mistaken for cortical surfaces. Chemical weathering might remove the original cortex of an alluvial cobble, leaving it with an appearance resembling that of a bedrock nodule.

In general, flakes detached for material testing purposes are thought to have been detached casually, using hard hammer percussion. They may not be assumed to have been simply discarded; where material sources are dominantly alluvial and where materials are dominantly of coarse grain, these cortical (primary) flakes may provide better cutting edges than do flakes having little (secondary) or no (tertiary) cortex.

Where material sources are rectihedral, ovoid, or spherical, core reduction commonly produced irregular polyhedral or prismatic blade cores and their respective flake classes. Removal of flakes from either type of core can be carried out by hard-hammer, soft-hammer, or indirect percussion, or by pressure; for the production of large flakes using pressure, a lever, crutch, or other tool is usually required to generate the high force necessary for flake removal. Hard-hammer or indirect percussion probably were the techniques most commonly used. Flakes detached from irregular polyhedral cores tend to have non-parallel edges; they frequently have rounded outlines. They are struck from platforms which have spine angles of about 70°-80° and which rarely exhibit much preparation (secondary chipping or grinding to control platform character and platform angle). Hence, flake platform remnants may have cortical platforms or platforms bearing the scars (facets) of one or several previous flake detachments; most common are single-facet platforms.

Flakes detached from prismatic blade cores have platforms similar to those or irregular polyhedral core flakes; however, cortical platforms are rare unless the parent material is blocky and weathered. Prismatic blade flakes are rarely primary, but are almost always secondary or tertiary. They have parallel or near-parallel edges and tend to be long relative to their width. Dorsal scars from previous flake detachments tend to be oriented along the long axis of blade flakes; as a result, prismatic blade flakes tend to have a flattened triangular or trapezoidal cross-section.

Flakes produced in the course of reduction of bifacial or unifacial discoidal cores (i.e., biface flakes) commonly display characteristics more or less clearly different from those of flakes removed from other core types. Because they are struck from the edge of a discoidal core, their platform-spine angle is typically low, on the order of 20-50°. Because of their low platform-spine angle, they were commonly detached by means of soft-hammer production, which was less frequently used in reduction on other core types. Soft-hammer flakes typically lack hertzian cones or bulbs of percussion; their mode of detachment is by "bending" torsional stresses exerted by the baton or other soft hammer, rather than by impact breakage of the hertzian sort produced by hard-hammer flaking. Soft-hammer flake platforms commonly are crescentic in shape; they bear several scars, since they represent a remnant of the discoid's edge.

Hard-hammer reduction was also used in discoidal core reduction, especially in early reduction stages. Hard-hammer biface flakes commonly have more diffuse bulbs of percussion and less clearly expressed hertzian cones than do hard-hammer flakes produced from other core types. These flakes are, in fact, often detached by a combination of hertzian and bending mechanisms, hence their intermediate morphology.

Discoidal core flakes, however detached, tend to be thinner relative to their surface area than are flakes produced by other techniques. Because they also typically lack large, thick percussion bulbs, discoidal core (biface) flakes also tend to be substantially lighter per unit surface area than are flakes produced from other core types.

Pressure flakes, detached by the non-abrupt application of force, are typically very small and thin, although very large prismatic blades may be produced by pressure flaking. Other than by their small size, pressure flakes are not reliably distinguishable from hard-hammer or soft-hammer flakes (Crabtree 1968; Faulkner 1972; Cotterell and Kamminga 1979, 1987).

Just as early-stage flakes are likely to bear some cortex on their dorsal surface and to have relatively few dorsal scars produced by previous detachments, later-stage flakes are likely to have more dorsal scars because more detachments have occurred previously. Because of the high area-mass ratio of pressure flakes and discoidal core (biface) flakes, especially soft-hammer biface flakes, these flakes tend to have more dorsal scars than do core flakes. Very high dorsal scar counts may be observed on extreme examples of discoidal core flakes, such as biface thinning flakes, Levallois flakes, and Folsom or Clovis channel flakes.

In generally accepted approaches to lithic analysis, the categories of flakes and core described above constitute the bulk of defined debitage types. Most lithic analyses recognize other methods of core reduction/flake production only as unusual cases. For example, bipolar reduction, done by smashing a "core" between a hammerstone and an anvil stone, is known ethnographically and archeologically, but is generally viewed by analysts as a technique suited to and mostly used for the extraction of usable edges from refractory materials or from small pebbles, "Apache tears", or tektites.

In summary, the conventional or standard lithic analysis approach emphasizes conchoidal reduction patterns directed at the controlled production of usable flakes or at the controlled removal of flakes to produce a usable core tool. Other modes of lithic reduction are commonly de-emphasized or ignored in normal lithic analysis.

Application of the Conventional Model - the Alibates Observational Design

Application of the generally accepted approach to the Alibates lithic collections by CGI emphasized the recognition and characterization of biface reduction vs. core reduction. Data from the five Alibates sites tested and collected by NPS crews were initially recorded using an analytical protocol designed for this purpose. This protocol will now be presented.

Overall Typology: All objects were initially classified for analysis as angular debris, flakes, cores, formal tools, SOFTs, or rocks. Definitions and procedures follow:

Angular Debris: any object bearing evidence of potentially deliberate human breakage, but not classifiable as a flake, SOFT, core or formal tool was classified as angular debris. Angular debris was analyzed, along with flakes, as debitage.

Exceptions: angular debris with use or retouch was classified as a SOFT, formal tool, or core as appropriate.

Cores: Any object bearing probable evidence of the deliberate removal of more than one flake, where the length or width of each flake scar was greater than 10 mm, was classified as a core. Occasional rocks from which a single flake had undoubtedly been struck were classified, within the core class, as tested cobbles.

Exceptions: Cores also bearing significant evidence of tool use were classified as SOFTs; late stage bifaces (see below) were classed as formal tools, rather than as biface-discoidal cores.

Flakes: Following Chapman's (1977) usage, any object having a surface which appeared to have a ventral surface was classified as a flake (Figure 30). It was anticipated that most flakes would be of the conchoidal varieties. Flake ventral surfaces would typically display concentric undulations (i.e., conchae, or ripples), hackles, lances, Wallner lines, a bulb of percussion, or a surface developed distally from a hertzian cone (see Cotterell and Kamminga 1979; 1987 for extensive discussion of these terms). Effectively, any object which could reasonably be viewed as a biface flake or core flake, or non-conchoidal "bipolar flake/bipolar core" was classified as a flake.

Exception: Flakes exhibiting deliberate retouch, utilization, or extensive flaked modification were classed, as appropriate, as cores, SOFTs, or formal tools.

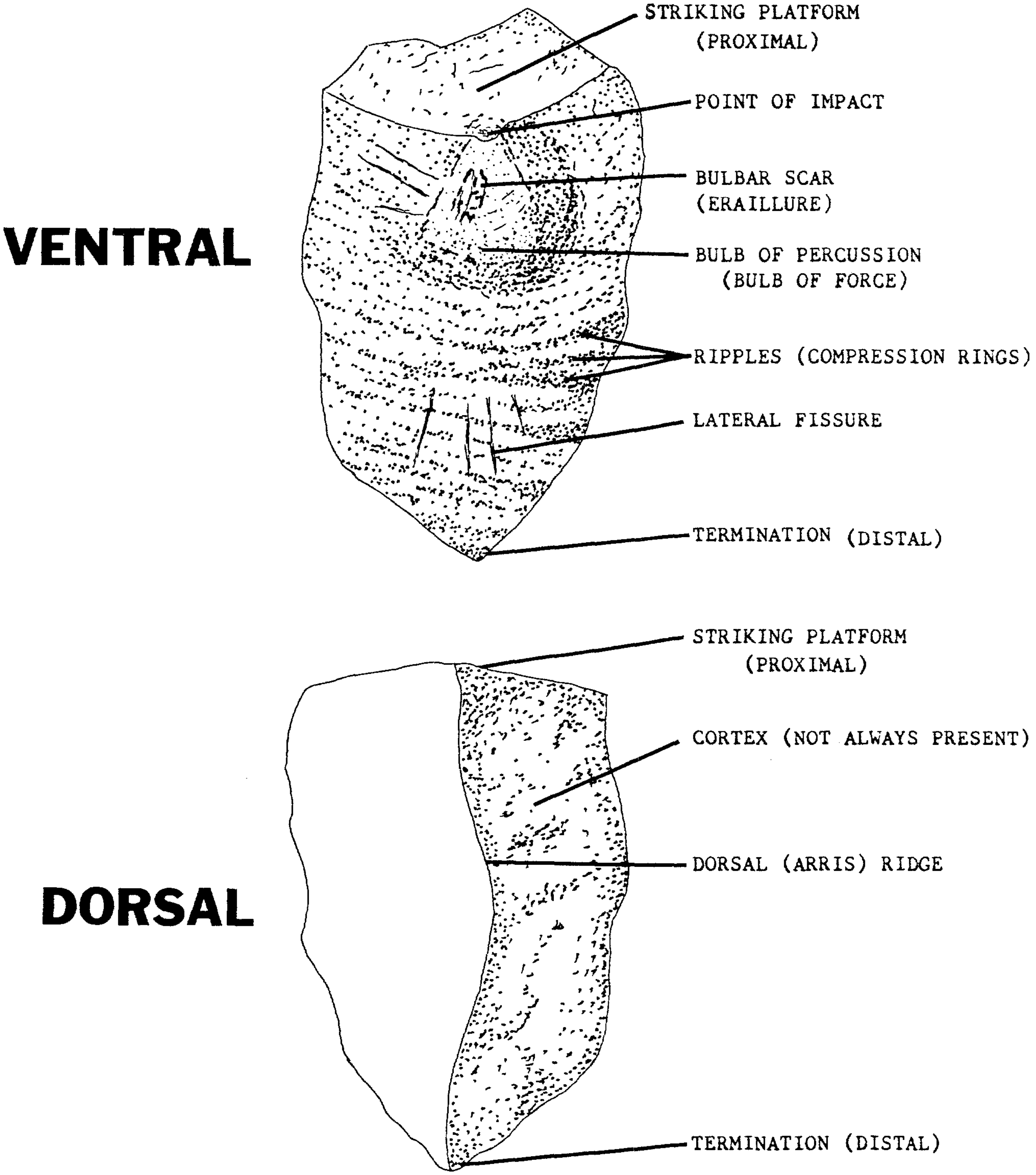
Formal Tools: Any stone object having artificially regular outlines or cross-sections, or a clearly specialized edge, point, or surface, was classed as a formal tool. Formal tools explicitly included: a) bifaces refined by regular shaping beyond the biface/discoidal core stage (i.e., Stage 2 to Stage 5 bifaces); b) unifaces bearing the sort of facial work diagnostic of a Stage 2 to Stage 5 biface, but of course on only one surface, e.g., "guitar picks" (Etchieson and Couzzourt 1987:7-3); c) uniface edge tools with extensively worked, formalized outlines suggesting repeated, specific use and/or hafting (e.g., end scrapers); and d) heavily utilized items such as very battered hammerstones, groundstone resharpening tools, peckers, etc.

Exception: Stage 2 bifaces and cobble cores with heavy edge utilization were classified as SOFTs; their alternative classification was noted.

In recognition of their common triple role as cores, tools, and blanks/preforms/tools, bifaces are often described according to the stage to which their reduction was carried (Muto 1971a, b). The definitions for biface stages employed in the CGI Alibates analysis followed Muto's treatment in thrust and intent. The CGI biface stages were defined as follows:

> Stage 1 bifaces are biface-discoidal cores. Edge modification was directed mostly toward maintaining usefulness as a core, and not primarily toward edge trimming, biface thinning, or regularization.
>
> Stage 2 bifaces are usable as bifacial cores, but have been regularized by secondary rework to allow for control of the item's overall shape, cross-section, and edge regularity. They were commonly used as tools.

Figure 30
Flake Attributes
(from Lord, et al. 1987:Figure 7.11)



Stage 3 bifaces are of limited use as cores for production of other than very specialized (e.g., Levallois) flakes. They typically have regular symmetry in at least two axes; they exhibit flaking effort directed at facial and edge regularization. Removal of usable flakes would generally disrupt the symmetry and regularity already achieved. They often display edge wear resulting from tool use.

Stage 4 bifaces are even more regular than Stage 3 bifaces. They would generally be classifiable as hoes, points, or knives except that they lack completed modification for hafting. They often were used as precision tools.

Stage 5 bifaces are fully haftable, completely usable finished tools with clear modification to facilitate hafting. They may exhibit repair of damage resulting from use (e.g., beveled resharpening in-haft, etc.).

Stage 6 bifaces are hafted bifaces which have been reworked to serve a new function (e.g., "T-drills", scrapers, or points).

SOFTS: An acronym coined for this analysis, SOFTs ("sort-of-formal-tools") include all those edge-damaged, edge-retouched, edge-utilized, or battered objects commonly classified in other analyses as utilized flakes, retouched flakes, or "other formal tools". They explicitly included non-formalized spokeshaves, expedient scrapers, minimally retouched flake knives, etc. as well as all debitage and cores which bore evidence of patterned edge damage judged as having a significant chance of having resulted from deliberate use as a tool.

Exception: Formal tools were not re-classified as SOFTs.

Rocks: Objects which bore no convincing evidence of deliberate human modification made in the course of pre-modern material testing, tool manufacture, or tool use were classified as rocks. This class included cracked pebbles, split cobbles, materials which appeared to have fractured along flaws due to thermal stresses, and crushed or smashed materials with no evidence or normal conchoidal or bipolar breakage, such as was observed on specimens collected in the NPS field sessions and labeled as "non-cultural breakage" or "let-down boulder". Also included were obviously modern efforts by rock hounds and others to reduce rocks, either "Indian-fashion" or for collection of geological specimens.

The original CGI observational design, as required by the NPS scope of work, was designed to observe the distinctive flake and core characteristics described above, to permit assessment of the significance of early versus late stage reduction activities and of core versus biface reduction strategies in contributing to the assemblages collected from Sites 1, 2, 3, 4, and 6.

Variables selected by CGI for observation on flakes were chosen as efficient and objective indicators of the reduction strategies and reduction stages represented. These observational variables and their significance are now discussed, as are other observational categories also required by the Scope of Work. Typical examples and definitional problem pieces are illustrated in Figures 31 and 34.

Size and Shape: Since different reduction trajectories produce different sizes and relatively thicker or thinner flakes, size and shape were monitored. This was done by recording length, width, and weight for all objects thought to represent cores, flakes, fragments of cores or flakes, or angular debris produced in the course of reduction episodes.

Length (striking axis of flakes; longest axis of other objects) and width, measured to the nearest millimeter with a dial caliper, were recorded to provide an index of flake area, estimated as length x width. Weight, rather than thickness, served as the third variable necessary to determine thickness/area proportions and overall size. Thickness was not measured, since it varies widely across the length and width of a typical flake. Weight is easier to measure systematically than is thickness, moreover, weight divided by area provides an index which is proportional to "average" thickness. Weight was measured to the nearest gram using a digital balance.

Of course, the "true projected area" of a flake is not determined with great accuracy by simply multiplying length by width. The projected area of flakes which are rectanguloid in shape can be estimated accurately in this way. Areas of oval, circular, and semi-circular flake are typically overestimated by 20%. Areas of perfectly triangular flakes area overestimated by 50%. On the average, however, few flakes are perfectly triangular or rectangular. Probably the great bulk of estimate errors produced by this method are systematic over-estimates of about 20%. Where a variable is used as an index, of course, truly systematic errors are of little importance.

Cortex: Cortex presence, an important indicator of reduction stage, was monitored as a percentage of overall object surface area. This procedure is a departure from usual practice, which is to monitor cortex as a percentage of dorsal surface area only. Usual practice makes recording observations of cortex presence on angular debris difficult. The overall cortex area observation, as used by CGI, permits cortex percentage recordation to be made in a comparable way both for objects having a definite ventral surface (i.e, flakes) and objects not having a definite ventral surface (i.e., cores, tested cobbles, and angular debris). The CGI cortex percentage as determined for flakes can readily be converted to a fairly accurate, conventionally defined dorsal cortex estimate by multiplying by 1.7. Objects having more than 60% overall cortex, or equivalently more than 100% dorsal cortex (by the multiplication conversion) are of course unlikely to be flakes.

Cortex Type: Cortex, where present, was also described as tabular, cobble, or unknown. If cortex was tumbled and subspherical, it was coded as cobble. If cortex was subangular but had ring-crack fields or other heavy tumbling evidence along edges, it was also recorded as cobble. If cortex was not heavily tumbled and was subangular, it was recorded as tabular. If cortex was absent, was neither clearly cobble nor tabular, or was suspected to represent a flaw surface rather than true cortex, it was coded as unknown.

Facial Scar Count: Total scar count was recorded as an index of effort intensity for all objects and for flakes as an index of reduction stage. An effort was made to eliminate small retouch or damage flake scars in this count by counting scar facets at arm's length. As with cortex observation, recording of scar or facet counts included the ventral surface; facet counts were made for angular debris on all of the Sites 3-6 assemblages, on a 70% sample of the Site 1 lithics, and on a 42% overall sample of the Site 2 lithics. Sampling intensity on angular debris for this variable within Site 2 loci ranged from no sample (Site 2, datum LT 62+50) to a 70% sample (Site 2, datums BMR24R and "Jim Rancier"). Samples were drawn sequentially.

Platform Data: Information on platform character was recorded for flakes. Platform scars were counted; to exclude small damage facets, the count was made at 30 cm distance from the observer's eye. Platform cortex was recorded as an estimated percentage of total platform area. These variables are indicators of reduction stage and trajectory.

Breakage: Data on completeness was also recorded for flakes. In assessing completeness, attention was paid to evidence of recent breakage (trampling snaps, etc.). Items were described as whole, proximal, distal, lateral (split longitudinally), or as segments (the residual category). For angular debris, evidence of much more recent fractures implied classification as a segment, while absence of such evidence resulted in classification as a whole piece.

The data were recorded to inform on reduction strategies; as used by CGI, they encoded information on platform presence, flake, termination, and production failures. Whole flakes have platforms, retain two lateral edges, and have a feather, hinge, outre passé, or cortical termination. Proximal flakes have platforms, retain two lateral edges, and have a step or snap termination. Distal flakes have no platform, but they do have an outrepassé, feather, hinge, or cortical termination. Lateral (split) flakes have a partial or complete platform and a single lateral edge opposed by an apparent compression fracture. Segments are those flakes which are not readily classified as whole, proximal, distal, or lateral.

In practice, of course, many "whole" flakes will be classified as "proximal"; some bending (soft hammer) "whole" flakes will be classified as distal because they lack obvious platforms.

Rework: Rework of artifacts is in practice detectable only where substantial textural differences unrelated to material character are present on adjacent flake scars. Old patinated or partially recorticated debitage which experienced much later breakage will exhibit these changes. Where such changes were evident, the number of contrasting texture levels were counted and recorded. Minor edge damage was ignored.

It should be noted that rework is easily confused with heat-treatment. If a flake is heat treated, thermal alterations will result in dulling of its surface. If flakes are then removed, they will, in general, appear much fresher than the surfaces subjected to thermal alteration. In this case, estimates of the number of rework episodes would often be inflated, since no objective criteria are known permitting distinction of exposure-weathered from thermally-weathered (heat-treated) surfaces.

Heat Treatment: As was pointed out above, the recognition of heat treatment on siliceous materials is difficult. However, heat treatment generally is thought to produce increased luster, brittleness, and workability. In general, siliceous materials having substantial iron mineral content are thought to become redder, more yellow, or darker overall as a result of heat treatment. Alibates materials, however, are known for their wide range of natural colors, luster, and brittleness; substantial variability may be observed across the surface of a single geological specimen or artifact (cf. Tunnell 1978; Shelley 1984; Holliday and Welty 1981). Heat treatment can sometimes be recognized through destructive testing; this entails breakage of the piece and comparison of freshly broken surfaces with older surfaces. This method, however, is not reliable, since older weathered surfaces may also be expected to be considerably duller than are fresh breaks.

Heat treatment was coded as present for objects displaying crazing, pot-lidding, unusual luster, fresher edge-damage scars, or unusually reddened flecks in areas having a background color other than red. As the analysis progressed, it became clear that most objects, including many which exhibited no work at all, were being judged as having been heat treated. At this point, the criteria for heat treatment were made more restrictive, so that only objects with exceptional luster and waxy texture were judged as having been heat treated.

The earlier criteria were applied to Site 1 FS 1 through 75, to Site 3 FS 1 through 12, and to all of Sites 4 and 6. The later criteria were applied to all of Site 2 and to higher FS numbers from Sites 1 and 3.

Color: Color was coded as a triple observation: dominant color, secondary color, and color pattern. Dominant color was defined as the one color judged to be represented over the greatest proportional area of an artifact. Secondary color was that color next most commonly represented over the area of an artifact. Color pattern was recorded to permit distinction of banded from graded color changes.

Colors coded were red, yellow, purple, white, and brown. Red was restrictively defined as having a Munsell hue of 6.3R to 9.5R and a value of 3 to 9, inclusive. "Typical Red" was chosen as Cadmium Medium Red PR108 [77202], according to the AATCC Color Index (1985). Yellow was restrictively defined as having a Munsell hue of 0.1Y to 9Y and a value of 7 to 9, inclusive. "Typical Yellow" was defined as Cadmium Yellow Medium PY37 [77199], according to the Color Index. White was defined as all values greater than 9.0 and also included BP (blue purple), B (blue), and RP (red purple) colors with values greater than 8.0. Purple was all hues of BP, P, and RP with chroma greater than 4 and values of 4 to 8, inclusive. Brown was defined as all other colors not yet listed, with the exclusion of those colors of hue YG (yellow green), G (green), and BG (blue green). Artifacts best described as YG were very rare and were coded as yellow. No Alibates items having hues G or BG were seen.

Color pattern proved difficult to define. It was intended that the Banded category be used for all objects with bands which appeared distinct and unblurred at arm's length. It was thought that this definition would result in classification of perhaps a quarter or more of the assemblage as banded. In fact, the banded definition was not very applicable, as most pieces with banding displayed some degree of color blurring at band edges. These objects were all classified as mottled (the intermediate category). Objects with no obvious color demarkation at all were classified as graded.

Plausibility: As analysis progressed, it became evident that many objects being classified as flakes or angular debris, and also perhaps a few being classified as cores, were in fact the product of breakage events unrelated or not clearly related to normal core reduction and conchoidal flake production. Rather than redefine categories to exclude these products of hammer-smashing by rockhounds, crushing by colluvial movement and road traffic, and fragmentation under thermal stress, a new variable, plausibility, was defined and observed for all but a small portion of the assemblage. Cases were to be coded as "high plausibility" if they appeared subjectively to be typical core or biface reduction products. "Low plausibility" was to be coded where massive hertzian initiation cones far from platform edges, very large apparent bipolar shatter, crushing, or inexplicable fracturing was present. The subjective rating system apparently failed to monitor atypical breakage, as a very low percentage of the total collection was ultimately coded as being of "low plausibility". This unfortunate result probably was due to the inherently subjective nature of normal lithic analysis definitions for "typically conchoidal" flakes.

Core Observations

Objects classified as cores were monitored in the same way as was debitage for size, shape, weight, cortex, overall scar count, breakage, rework, color, heat treatment, and plausibility. Figures 31 and 32 contain examples of cores.

Platform character variables were redefined to refer to the average platform cortex percentage and average platform scar count for all definite flake detachments from the core, as inferred from platform remnants having well-preserved flake initiations for flakes of maximum size in excess of 10 mm.

A special item number, unique within a site-field specimen set, was assigned to each core or SOFT to allow for re-identification of the coded cases. The number of definite flake-removal scars, having clear initiations and terminations, was counted for each core. This number, in general, was expected to be much smaller than the overall facet count. This variable was coded in order to allow estimation of the minimum flake productivity for each core and to assess the probable levels of work invested in each object to make it into a useful core.

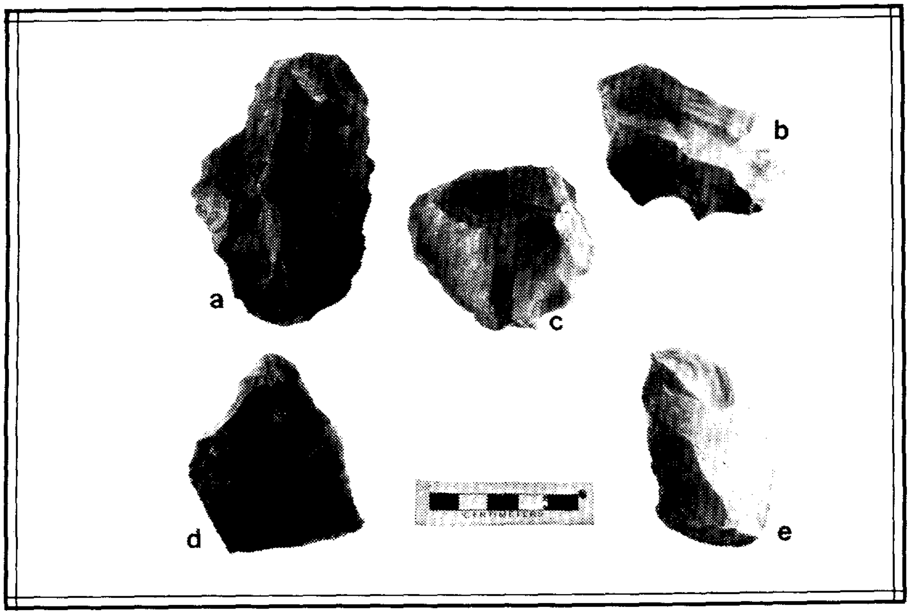
A judgement was made as to which flake scar represented the most recent non-modern detachment of a flake with maximum dimension greater than 10 mm; the maximum length and width of this scar were measured as was done for flakes.

The core was subtyped as a tested cobble/chunk, an irregular polyhedral (amorphous) core, a prismatic blade core, a biface-discoidal core, or a uniface-discoidal core. Formalized (Stage 2-5) bifaces and unifaces were not classified as cores.

SOFT Observations

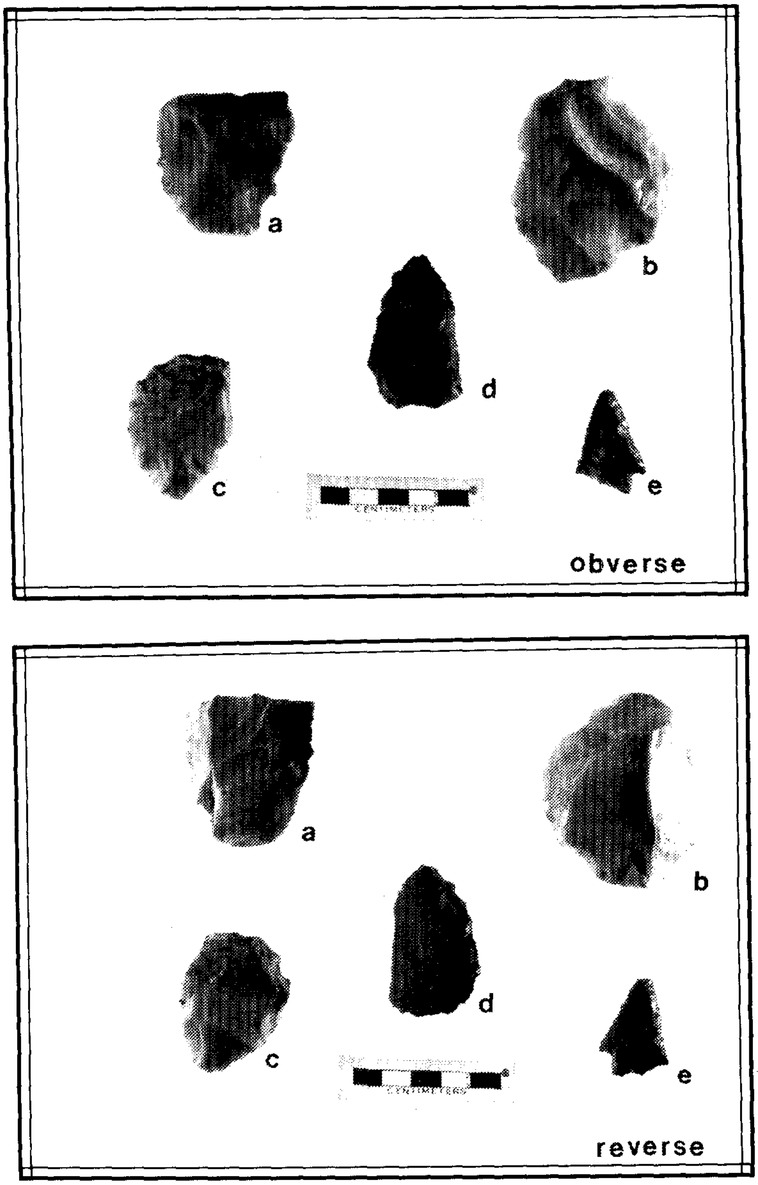
Objects were classified as SOFTs (sort-of-formal-tools) if macroscopic observation, followed by binocular microscopic examination at 20-40x indicated the presence of patterned edge damage indicating that the edge damage in question might reasonably be interpreted as having resulted from cutting, chopping, sawing, scraping, or planing activities. For defining use-damage, criteria used were those discussed in Hayden (1979). Recognized categories of microscopic edge damage included stepping, feathering, abrasion, grinding, and polish. These are discussed in detail below. Figures 31 and 33 illustrate examples of SOFTs.

Figure 31
Examples of Recycling and of Definitional Problems



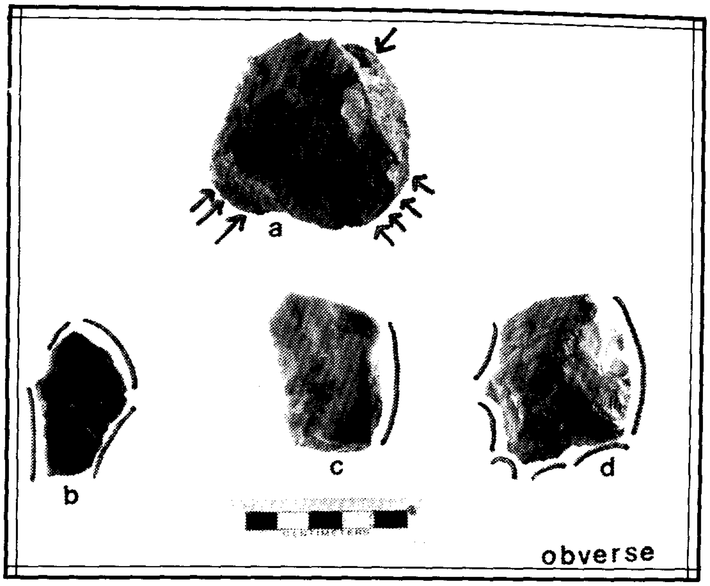
a) ALFL-86-4, FS 11, Item 1: Uniface discoidal core reused/reworked as SOFT with a utilized convex, abrupt, unifacial edge
b) ALFL-86-3, FS 18, Item 1: Irregular polyhedral core reused/reworked as SOFT with unifacial spokeshave (concave) wear.
c) ALFL-86-2, FS 37, Item 1: SOFT (convex unifacial) reused/reworked as a prismatic blade core.
d) ALFL-86-2, FS 470, Item 1: Tumbled rock with intermediate tabular/cobble cortex, worked into a core of irregular polyhedral or prismatic blade type. Numerous failed ring cracks are present on platforms.
e) ALFL-86-3, FS 33, Item 1: Flake or angular fragment retouched as convex multiple SOFT with abrupt and acute end and side, unifacial and bifacial work.

Figure 32
Biface Examples



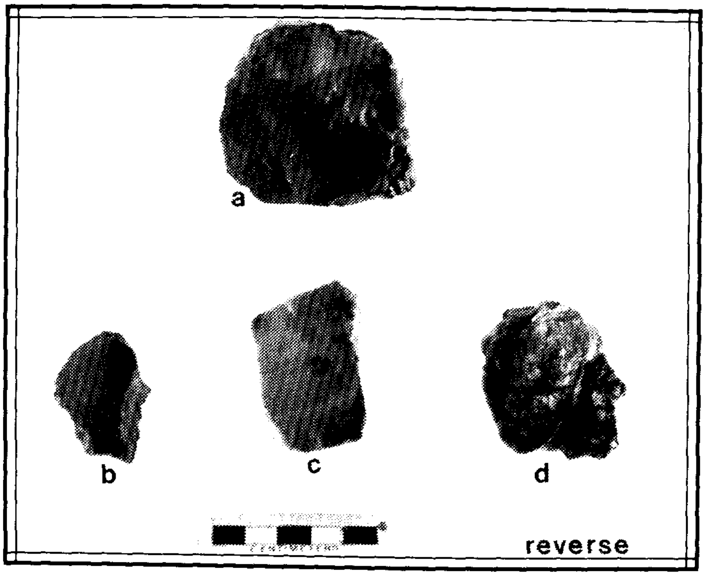
a) ALFL-86-2, FS 407, Item 2: Bifacial/discoidal core (i.e., stage 1 biface) snapped - almost regular enough to classify as a stage 2 biface (a formal tool).
b) ALFL-86-1, FS 114, Item 5: Stage 2 biface, slightly more developed than bifacial core above.
c) ALFL-86-2, FS 89, Item 2: Stage 2 biface, thinning well advanced on most of edge.
d) ALFL-86-2, FS 544, Item 1: Stage 3 biface preform (formal tool) or bifacially, acutely retouched flake (SOFT). Probably an example of flake-biface technological trajectory with utilization of intermediate product as a knife.
e) ALFL-86-2, FS 181, Item 3: Stage 4-5 biface, expended projectile point.

Figure 33
Definitional and Formal Examples



Key:) utilized edge

→ battered edge



a) ALFL-86-2, FS 0443, Item 3: Thermal shatter or naturally-shattered rock, reused as a toother/ pecker (for use on groundstone, etc.); probably also reused as a hammerstone. Minor scraper use is possible on one edge.

b) ALFL-86-4, FS 26, Item 4: Flake of intermediate bipolar/conchoidal type, massively retouched into a SOFT with at least five different use edges. If not for its irregular shape and expedient character, this would have been classified as a formal tool...a scraper.

c) ALFL-86-1, FS 177, Item 1: Bipolar or naturally fractured angular chunk, massively reused as side scraper -- a unifacial formal tool showing hard stepped wear.

d) ALFL-86-2, FS 543, Item 1: Rather like example b, except that use is regular enough to justify classification as a multiple scraper (a formal tool).

Variables coded for SOFTs included the full set of debitage variables, as was done for cores. In the case of SOFTs, all debitage variables were defined exactly as for debitage, with the exception of plausibility. For SOFTs, consideration of plausibility based only on the apparent character of the object before it experienced retouch and/or use as a tool.

A unique identification number was assigned to each item within a site-field specimen number collection, in order to allow its unique re-identification from coded data. As noted above, item numbers were assigned sequentially to all cores and SOFTs as a single set.

Retouch/Use Scar Density: Under microscopic (20-40x) examination, the average number of retouch/use micro-scars per centimeter of utilized edge was estimated. This procedure entailed examination of a visually "typical" segment of each edge, counting of all use scars along that segment, determination of the segment's length, and averaging of the results.

Retouch/Use Scar Density Variation: In measurement of the previous variable, attention was paid to the range of micro-scar sizes along an edge. If all or most scars along all examined edges were of about the same size, this variable was coded as "low". If edges were composed of many rather large scars and many very small scars, as in the case of a micro-feathered retouched edge overlain by stacked step microscars, the variation in scar size was coded as "high". In intermediate cases, variation was coded as "medium".

Major and Secondary Wear Evidence: In microscopic examination, a subjective judgement was formed as to what form of microwear was most prominent and was next most prominent. These were coded, respectively, as major wear and secondary wear. Wear was classified as follows:

1. stepped wear was composed mainly of microflake scars having stepped or deeply hinged terminations;

2. feather wear was composed mainly of microflake scars having feathered or shallowly hinged terminations;

3. abrasion wear was composed of generalized scratching and scuffing having no distinct grinding facets suggesting that it was produced by deliberate grinding of the edge, as is common for platform preparation. Abraded edges are rounded in cross-section;

4. grinding wear was defined as generalized, scratching, scuffing, grinding, and crushing with distinct faceting of abraded surfaces, suggesting deliberate edge dulling. Ground edges have a polyhedral cross-section;

5. <u>polish wear</u> was defined as glossy or finely striated rounding of edges and adjacent flake scar marginal ridges.

<u>Plausibility as Tool</u>: This subjective variable was coded to reflect the analyst's judgement as to the likelihood that the edge(s) in question actually resulted from tool use. Factors taken into account included freshness of breakage, consistency of edge character, and overall tool "heft" or grippability. Also considered was the apparent likelihood that the damage observed could have resulted from colluvial or trampling damage; this was judged by placing the object on a flat surface and noting whether the retouched edge readily contacted the surface when the flake was rocked from side to side suggesting "natural retouch". Frequent reference was made to Bertram's personal collection of broken stone and glass, acquired from cattle lounging areas, gravel quarries, and dirt roads. These "autofacts" and bovifacts" display a wide range of edge damage (Bertram, in prep; see also Knudson 1979). Alibates objects with edge damage seen often in the reference collection were judged to have low plausibility as tools. Objects with edge damage types not common in the reference collection were judged to have high plausibility as tools, intermediate cases were rated as having moderate plausibility as tools.

<u>Edge Type Category</u>: SOFTs with edges considered to have evidence of deliberate retouch or use damage were classified as <u>convex</u> (code=0), <u>straight</u> (code=1), <u>concave</u> (code=2), <u>denticulated</u> (code=3), <u>pointed</u> (code=4), or <u>compound</u> (code=5). Convex and straight tools need no definition. Concave tools were those with wear only in concavities. Denticulated tools were those where concave edges separated by a pointed or convex edge exhibited wear on both concave edges and on the intervening convex or pointed edge. Pointed tools were those where only the pointed projection of an edge exhibited wear. Compound tools were those having wear on more than one shape of edge (with the exception of denticulated wear, which was viewed as a fundamental edge class in itself). Thus, for example, a flake having a worn point and a worn convex end, would be classed as compound.

<u>Edge Count</u>: The number of classifiable edges found on a SOFT was defined as edge count and recorded.

<u>Secondary Class</u>: If an object otherwise classifiable as a bifacial core, etc. exhibited clear evidence of use, it was classified as a SOFT; its secondary classification was also recorded. Tested cobbles/chunks with use wear were coded as "X", bifacial cores as "B", unifacial and prismatic cores as "U", and irregular cores as "C".

<u>Formal Tools</u>: Formal tools were not encoded for computer analysis. Rather, they were set aside for detailed individual description and illustration; only seven formal tools were

recognized in the entire analysis. These are shown in Figures 32 and 33.

Rocks: Objects not classifiable as debitage, cores, SOFTs, or formal tools were classified as rocks. A non-computerized tally by FS number of these objects was prepared, but no description, coding, or numerical analysis of pieces was carried out.

PRELIMINARY OBSERVATIONS

Material Types

The Scope of Work as specified by NPS required that material type be recorded for all artifacts. As almost all materials were thought to be Alibates silicified dolomite ("Alibates Chert", "Alibates Flint", etc.), the decision was made to set aside "non-Alibates" pieces for separate description, very few artifactual objects which did not appear to be Alibates silicified dolomite were encountered. These included a few sub-rounded pebbles of massive crystalline quartz, an object identified in the field as "petrified wood", a Tecovas jasper projectile point, and perhaps fifty items (mostly well-struck, large, blade flakes) of a grainy purplish-tan to cream colored material with pale violet veining, thought to be a Dakota orthoquartzite (silicified sandstone).

These objects were reexamined after approximately 2,000 undoubtedly Alibates objects has been processed. The following conclusions were reached:

1. The "petrified wood" was finely-banded Alibates silicified dolomite.

2. The subrounded massive quartzite or "bull quartz" pebbles were tumbled or battered quartz vugs common in veins, seams, and voids within Alibates dolomite and silicified dolomite.

3. The "Dakota quartzite" materials seemed similar in color and texture to grainy materials sometimes present as portions of definite Alibates pieces. Both the "quartzite" and the "grainy Alibates" were found to contain faults, veins, and seams of pale violet to pink chert. Both types of materials were subjected to microscopic examination, bulk hand-specimen (cold hydrochloric) acid-drop assay, and crushed powder acid-drop assay. Both materials, under binocular examination at 40x, proved to be composed mainly, not of rounded, but of angular crystalline structures. Neither effervesced in bulk. Both effervesced slightly in powdered form.

Based on these observations, it was concluded that the "orthoquartzite" artifacts also were Alibates silicified dolomite; they differed from the much more common, glossy, microcrystalline Alibates only in that silicification of the precursor dolomite or sandy dolomite rock had not continued to completion. Bowers

(1975) recorded sandy variants of Alibates dolomite, examples of silicified or opalized later sands and breccias within faults in Alibates dolomite, and cases in which silicification of dolomite had not proceeded to completion. Any of these members could have produced the tan, veined, cherty dolomites or dolomitic silicified sandstones originally identified by CGI as "Dakota orthoquartzite".

Breakage and Reduction Patterns

The CGI lithic descriptive analysis, as described above, was designed and carried out under the fundamental assumption that the lithic study collections from the five Alibates Flint Quarries National Monument sites consisted of the kinds of reduction products described from other studies of lithic collections in the area: conchoidal "core" flakes, conchoidal "biface" flakes, flake fragments, angular debris from conchoidal flake production, and spent and unspent conchoidally-reduced tools discarded after use or broken in production.

Under this assumption, the variables monitored by the CGI analysis protocol should have permitted clear characterization of the assemblage in terms of relative proportions of early versus later stage reduction products of various subtrajectories of core reduction and of specialized biface and blade production. Certain variables were expected to be particularly valuable in this analysis. Foremost among important variables were to have been total scar facet count, total platform facet count, total cortex percentage, and platform cortex percentage.

As analysis proceeded, both the project director (Bertram) and the descriptive lithic analyst (Hoagland) became convinced that a substantial portion of the assemblage had not been produced by a conchoidal flake reduction technology. In the following paragraphs, evidence to support this proposition will be presented:

1. Conchoidal flakes almost always have a definable, single ventral surface.

2. If secondary breakage occurs in conchoidal flake removal, it generally splits flakes into two or three lateral segments (i.e., split parallel to the flake axis) or into two or three longitudinal segments (i.e., broken across the flake axis).

3. Where conchoidal hard-hammer flake platforms with bulbs of percussion are preserved, they generally consist of a poorly-expressed, partial hertzian cone, visible as a rule only on the proximal portion of the flake's ventral surface but almost never visible on the dorsal surface, and occupying only a small portion of the ventral surface area.

4. Conchoidal flakes and their platforms are almost always thinner dorso-ventrally than they are wide.

5. Unretouched conchoidal flakes with platforms almost always retain the edge at which their source core's platform intersected the lateral core surface, a portion of which was removed to form the flake. This surface makes up the flake's dorsal surface; it is easily recognized.

6. The angle at which the flake's platform intersects the flake's dorsal surface (the platform angle) only rarely approaches 90 degrees. For hard hammer reduction, platform angles of 60-80 degrees are common. For soft-hammer reduction, angles of 35-50 degrees are most common.

7. When items produced by conchoidal reduction can be refit, a clear sequence of breakage is determined and the flake versus core versus angular shatter identity of the components is self-evident.

In contrast, Bertram and Hoagland made the following non-coded observations in the course of analysis of the Alibates collections:

8. Many flakes having clear bulbs of percussion had no definable ventral surface. Rather, they appeared as cylindrical prisms capped at one end by massive hertzian cones, some of which extended smoothly into all the "flake faces", and some of which were 2-3 cm in diameter.

9. Many flakes possessed platforms much deeper than wide; i.e, these flakes were struck at a point far from the platform edge.

10. Many flakes possessed apparent platform angles at or in excess of 90 degrees.

11. When objects could be refit (a common occurrence), clear sequences of breakage and definite core-flake-angular identities for the objects could not be determined. Many appeared simply to be crushed cobbles or crushed tabular chunks, lacking striking platforms, flake characteristics, etc.

12. In several cases, apparent flakes proved to have been produced when a cobble was crushed or struck in its center. Only one blow could be defined, and the "flake" proved to be an interior piece, with other pieces having shattered away from it on all sides. Individual identifications of fragments as distal flakes, lateral flakes, or flake segments were proved incorrect; the entire refit cobble was shown to have been broken into bipolar angular debris, wedge-fractured angular debris, or material broken up mostly along natural flaws (see Figures 34, 35, and 36).

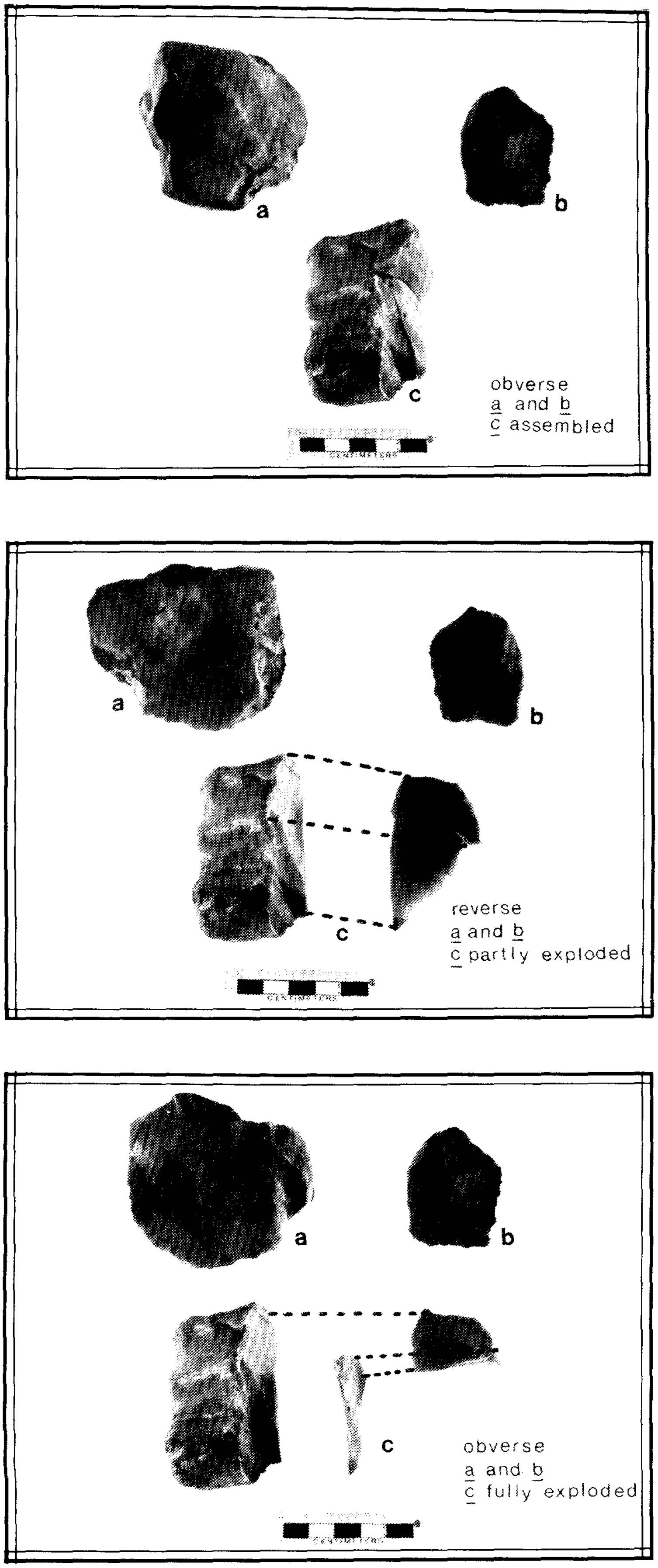


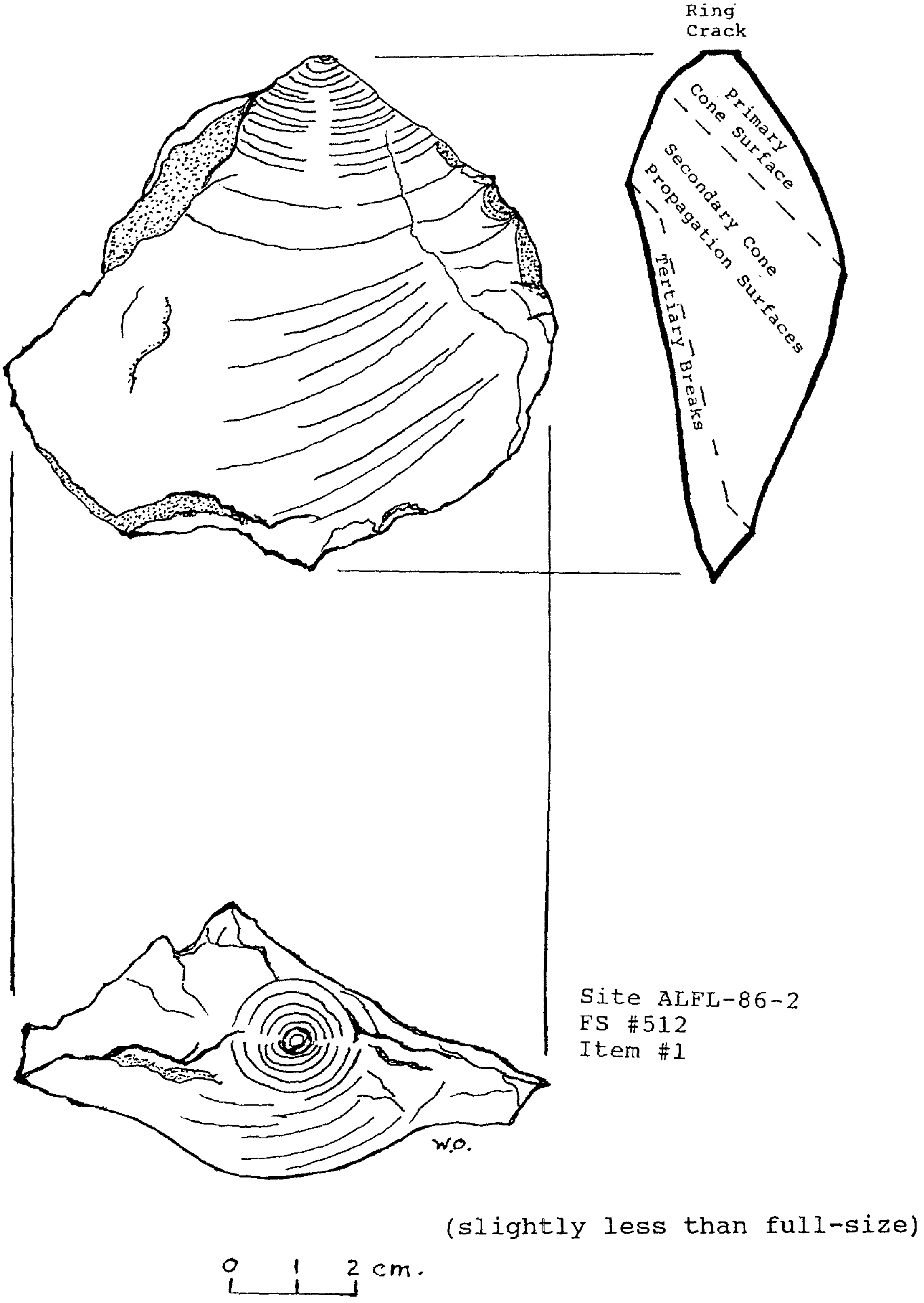
Figure 34
Debitage and Breakage

a) ALFL-86-2, FS 512, Item 1: Massive "bipolar core", angular fragment with minimal rework or use, hence a possible SOFT (unifacial straight and concave). Note the remarkable bifacial expression of a very large hertzian cone. See also Figure 35.

b) ALFL-86-2, FS 394: Angular debris fragment or bipolar core. This item appeared ventrally to be a typical retouched, heat-treated conchoidal flake. However, dorsal examination reveals:
   1) hertzian cone is also expressed dorsally.
   2) hertzian cone was struck on an obtuse "platform".
   3) "Retouch" is actually edge failure along dense field of incipient cones or ring cracks which make up the cortex surface.
   4) Old surfaces and flaw surfaces are more lustrous and glossy than are more recent fracture surfaces.

c) ALFL-86-2, FS 394: Refit on three flake/angular(?) fragments showing typical wedging/bipolar reduction and character of its products. Note exploded and refitted views in three panels. See also Figure 36.

Figure 35
Very Large Hertzian cone "pseudoflake" or "bipolar core"
See Figure 34, Item A for photograph



Site ALFL-86-2
FS #512
Item #1

(slightly less than full-size)

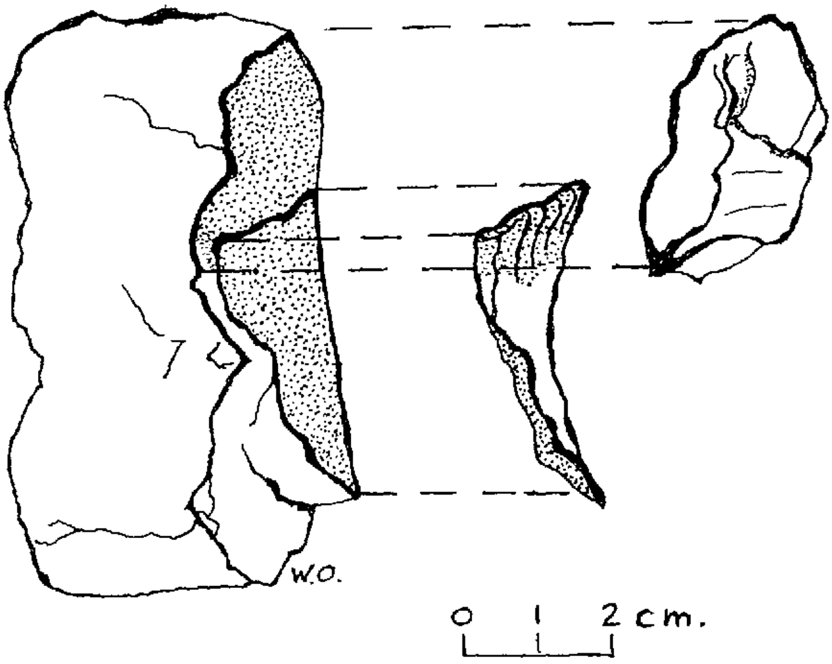


Figure 36
ALFL-86-1, FS 99. High impact wedging reduction, producing two "flakes" and one "core". Note: the interior flake originates well <u>below</u> the impact surface. See Figure 34, Item C for photograph.

These observations indicate that much of the study collection was not produced by conchoidal flaking techniques.

If this inference is correct, then the value of many of the CGI descriptive variables is questionable, to wit:

1. Many "flakes" are not flakes.

2. Many "platforms" are not platforms.

3. Scar counts for many pieces do not reflect effort investment at all; rather, they merely indicate the number of pieces into which an object was shattered.

4. Cortex percentages do not, in many cases, have any bearing on reduction stages. If only one blow shattered a cobble, then all the fragments produced are, logically, "primary debitage". If an object was shattered by thermal stress, its fragments are not debitage at all.

The qualitative conclusion reached by Bertram and Hoagland is that the CGI analysis, as conceived, was at least partly inappropriate.

ADJUSTMENTS IN ANALYSIS STRATEGY

In the previous section of this report, we advanced the hypothesis that an unspecified but significant portion of the Alibates NPS collections were not produced by conchoidal flake reduction techniques, as these are usually construed by lithic analysts. If this hypothesis is correct, then the CGI observed variables on debitage cannot be reliably used to infer stages and trajectories of reduction.

Options for a Revised Analysis

To correct the deficiencies in the analysis design, two options were considered:

Option 1: Define expectations and characteristics of non-conchoidal reduction products. Develop new variables. Redo the analysis, measuring appropriate variables to allow segregation of the non-conchoidal component of the assemblage.

Option 2: Find reliable means to classify (as conchoidal or non-conchoidal) the assemblages using data already collected. Based on this classification, characterize the non-conchoidal component of the NPS Alibates assemblages.

Theoretical Revision for Reanalysis

At first, Option 2 was viewed as unworkable. Effort was directed as amassing a substantial theoretical basis for redesign and reanalysis.

We were surprised to learn that almost no modern analysts had paid significant attention to non-conchoidal fracture mechanisms. With few exceptions, these mechanisms were studied closely only during the pioneer period in lithic analysis, a century ago. At that time, attention was focussed on the "Eolithic" problem; resolution of that problem was achieved mainly by demonstrating that human beings mostly reduce lithic materials conchoidally, while natural processes produced both conchoidal and non-conchoidal fractures (cf. Schnurrenberger and Bryan 1985). This conclusion was eventually systematized by Barnes (1939:111) who offered a rule of thumb: collections "may be considered to be of human origin if not more than 25% of the [platform angles] are obtuse." This rule of thumb has since been accepted almost universally and rather uncritically, as "Barnes' Law" (cf. Bleed 1977; Taylor and Payen 1979; Simpson et al. 1985).

Schnurrenberger and Bryan (1985) addressed the issue of natural versus cultural breakage with mixed success, using research techniques which require detailed knowledge of glacial, alluvial, and/or colluvial processes operating on sites. Their techniques are not directly applicable to the Alibates problem because insufficient data on the processes acting on these surface assemblages are available. Their methods entail the sort of detailed processual information obtainable only through geomorphological research and excavation. They (p. 138) offer a caution to students of this problem: "Archaeologists must recognize that the issue regarding problematic sites is not human versus natural, but human versus a particular natural process [emphasis ours]". They note, but do not develop, issues relating to non-conchoidal reduction by humans, citing as an example the "ridge-back core" problem (Childer 1977; Childer 1981 personal communication cited in Schnurrenberger and Bryan 1985:135). They concluded that no objective, statistical, quantitative means were as yet available for distinguishing between human conchoidal, human non-conchoidal and various natural reduction processes.

Approaches to the problem are suggested by a number of studies in brittle fracture mechanics. These studies are generally abstract requiring substantial training in physics to interpret them.

Cotterell and Kamminga (1979; 1987) have presented studies from fracture mechanics in a manner more accessible to archeologists. They discuss flake reduction in terms of three stages of flake detachment: initiation, propagation, and termination. They recognize three kinds of flake initiation: hertzian, bending, and wedging. Hertzian initiation is produced by impact or pressure, which forms a ring crack and hertzian cone. Bending initiation is produced by flexure of an acute edge, resulting in breakage due to tensile stresses. Wedging initiation is produced by impact or pressure, which forces detritus into flaws, causing a crack to form.

In general, hinge fractures and soft-hammer flakes appear to be initiated by bending. Hard hammer and pressure flakes are mostly initiated by the hertzian process, as are some bipolar flakes. Other bipolar flakes and a small proportion of hard-hammer flakes may be initiated by wedging.

Bending initiation produces flakes with no associated bulb of percussion, but with an associated "initiation hinge", commonly referred to as a "lip" or "soft hammer bulb". Hertzian initiation produces a partial hertzian cone, which forms the typical "hard hammer bulb". Wedging produces little or no evidence of its initiation point, except that radiating ripples or striations may sometimes diverge from the initiation site.

The distinction between conchoidal and non-conchoidal flakes appears to reside primarily in Cotterell and Kamminga's propagation phase. They recognize two modes of flake propagation: stiffness-controlled and compression-controlled.

> There are two modes of crack propagation in flaking. A fracture that has created a relatively thin flake will have propagated under a combination of bending and compressive forces. The crack path of such a flake has been controlled largely by the stiffness of the flake as it forms (Cotterell et al. 1985)... In the other mode, the crack propagates under secondary tensile stresses created by an essentially compressive stress field well away from the edge of a nucleus. Compression-controlled fractures are a characteristic of bipolar flaking [emphasis ours] (Cotterell and Kamminga 1987:692).

Cotterell and Kamminga's termination phase has little obvious relevance to the problem of recognition of conchoidal versus non-conchoidal flaking. It appears that a flake initiated in any way and propagated by either the stiffness or compression modes may plunge, hinge, produce reflex terminations, outre passé terminations, etc. This would lead us to expect that distal fragments would be much less diagnostic than other parts of flakes.

Further interpreting the Cotterell-Kamminga model, it appears that the thinness, relative to length and width, of stiffness-controlled flakes depends on their platform angle, their mode of detachment, and the field of other forces to which they are subjected. In general, it would appear from their computations that soft-hammer conchoidal (i.e., bending-stiffness) flakes are predicted to be generally much thinner, relative to their area, than are hard-hammer conchoidal (i.e., hertzian-stiffness) flakes.

Bipolar and other non-conchoidal (i.e., hertzian-compression and wedging-compression) flakes will in general be far thicker than hard-hammer flakes for equal flake length and width. This follows from the fact that compression flakes can only be initiated far from acute edges of a nucleus (core). If they were initiated near a core edge, they would become stiffness-controlled flakes.

Crushing of platforms is characteristic of over-application of force in all three flake initiation modes. However, the secondary flaking produced by platform crushing is readily apparent in conchoidal flaking. In wedging initiation, however, the shattering of platform surfaces will probably often produce "flakes" with "platforms" which appear carefully prepared by flaking and grinding.

The breakage characteristic of wedging, especially on subspherical, cubic, or ovate objects, is likely to result in much secondary breakage. The nucleus is literally blown apart, producing numerous "cortical cores" or "cortical flakes" and often several "tertiary flakes", some with hertzian bulbs and most with numerous apparent "dorsal flake scars", especially in flawed material.

In bipolar reduction, it appears that the character of flake initiation is largely a matter of the forces applied and the rate of change of those forces. For large nuclei, it seems apparent that true hertzian initiation, followed by compression-mode propagation, would require great momentum and probably high velocity in the impacting object, whereas wedging initiation could be produced with repeated low-momentum and/or low-velocity impacts, each of which forced more detritus into incipient crack flaws. Given extreme force, wedging can certainly be produced by pressure alone; Cotterell and Kamminga (1987:698) use standard engineering pressure-strength test results to exemplify wedging-initiated and compression-controlled fracture.

It would appear that the Cotterell-Kamminga model can provide certain expectations for assemblages, but that it offers less help in defining observational variables for immediate analytical partitioning of assemblages. Expectations from the model included the following:

1. Biface flakes will have a higher area/weight ratio than other flakes.

2. Bipolar debitage and natural fracture will have a much lower area/weight ratio than other flakes.

3. Core (i.e., hertzian-stiffness) flakes will have intermediate area/weight ratios.

4. Biface flakes will display a relatively low variation and high mean for flake scar counts and for platform scar counts.

5. Bipolar/crushing debris will show a high variation and wide range in platform and overall scar counts.

6. Core flakes will display a rather low mean value and low overall variation for both platform and overall flakes scar counts.

7. Biface flakes with dorsal cortex will be heavier per unit area than will tertiary biface flakes.

8. Core flakes with dorsal cortex will also be heavier per unit area than will tertiary core flakes.

9. Bipolar/crushing debris often will be <u>lighter</u> per unit area if cortex is present than if cortex is absent.

10. Hard hammer flakes struck well back from platform edges will exhibit characteristics intermediate between 1) core flakes struck near the edge and 2) bipolar/crushing "flakes".

11. Flakes struck on platforms at moderate edge angles (45-65 degrees) will exhibit characteristics intermediate between

biface (i.e., soft hammer) and core (i.e, hard impact flakes).

12. Very small, thin flakes will not be readily classifiable into any flake category, because their mechanics of production entail extreme stresses when compared to the area of flake detached. Similar tiny flakes could readily be produced by a wide range of human reduction techniques and also by most natural processes.

In summary, the Cotterell-Kamminga analytical model provides rich predictions for differences between types of reduction; these predications readily can be phrased in terms of variables observed in the original CGI analysis. Their model also indicates that distinction of human from non-human bipolar/crushing reduction is difficult, requiring complex assumptions to be made about the nature and magnitude of breaking stresses applied by humans versus those applied by a wide range of natural forces.

On this basis, Option 1 (redescription using new variables) was discarded in favor of Option 2 (reanalysis using data already recorded).

Use of Empirical Models, Theoretical Models, and Data Already Recorded

Direct evaluation and application of the utility of the Cotterell-Kamminga model and its implications was seen, in the previous section, to be dependent primarily on data about flake proportions. To effectively evaluate the model, it was advisable to assess its fit to well-controlled data sets.

As a result of the CGI Abiquiu Reservoir Project of 1984-1987, data of two sorts were available which were appropriate for testing or calibrating the model for flake types and flake proportions advanced above.

While serving as CGI Project Director for the Abiquiu Reservoir Project, James Rancier produced a comparative study collection of lithic reduction replication assemblages covering all the major trajectories and stages of lithic reduction encountered at Abiquiu. The reduction stages and trajectories employed at Alibates were not greatly different from those at Abiquiu, judging from available literature and from Bertram's experience with both areas. Consequently, it was decided that the Rancier CGI reference collection, which was classified by Rancier according to actual reduction stage, method, and trajectory, was a suitable model for the Alibates cobble reduction sites studied in this project, at least in terms of flake character variation across stages and trajectories.

Secondly, Rancier (who coincidentally later became the archeologist who directed and reported the testing/mitigation of the Alibates sites) had implemented a completely comparable, although more detailed, computerized description and analysis system for the debitage from the Abiquiu sites. Thus it was possible to access flake data from the computer files of the Rancier Abiquiu analyses which was totally comparable to the Rancier CGI reference collection.

Comparison of the Alibates Assemblages with the Abiquiu Data Base

The CGI Abiquiu data base was generated in the course of collection and excavation within the Abiquiu Reservoir area in 1984. Sites were collected and/or excavated and samples of lithics from over 50 sites were analyzed in detail by CGI personnel under the direction of James Rancier. From this sample, examples were taken for comparison with the Alibates assemblages from 39 sites, of which the great bulk of cases (87%) came from six sites: LA 25322, LA 25358, LA 25435, LA 25501, LA 27043, and LA 47940 (Lord et al. 1987).

These six sites are all set on wide terraces overlooking the Rio Chama Canyon in north-central New Mexico. All are located on or near extensive deposits of alluvial and colluvial Polvadera obsidian and Pedernal chalcedonic chert. Only a few kilometers south of the cobble material deposits, both Polvadera and Pedernal materials can be quarried directly from their source deposits as large, tabular pieces of high quality. The cobble materials, however, are of somewhat poorer quality.

LA 25322 (450 flakes included) is an extensive protohistoric Tewa, Apache, and Hispanic settlement with numerous small stone structures, overlying a late Archaic quarry-campsite complex. LA 25358 (over 1,000 flakes) is a later Archaic to Basketmaker habitation site with stratified pithouse occupations. It may be the earliest well-dated pithouse complex in northern New Mexico. LA 25435 (130 flakes) is a Puebloan surface quarry and lithic reduction site, set on a terrace composed almost entirely of obsidian and chert cobbles. It lies on the major route to the Pedernal and Polvadera quarries, which lie 6 and 8 km up the mountain front to the south and southwest. LA 25501 (140 flakes) is a late prehistoric Tewa masonry structural site, possibly a fieldhouse. LA 27043 (124 flakes) is a Late Archaic lithic reduction area with earlier and later components also probably present. LA 47940 (230 flakes) is a multicomponent site with lithic debris from early Archaic, late Archaic, developmental Pueblo, and historic occupations. It is crossed by a wagon road. At least one pithouse (Archaic?) was present on the site.

It is our opinion that the Abiquiu flake data base is directly and appropriately comparable with the Alibates collections. Both data sets are drawn from sites dominated by cobble reduction, but are located very near to massive lithic material outcrops of unexcelled quality and super-regional importance. Both sets of sites probably have Archaic and Developmental period components, overlain by Late Prehistoric and Protohistoric assemblages. Both sets of sites lie in similar canyon bench settings, overlooking permanent canyon bottom water sources and have been impacted by recent traffic, erosion, and intensive cattle grazing.

Abiquiu Flake Types

The typology used for classifying Abiquiu flakes was developed by Rancier with the assistance of W. J. Whatley and Lee Heinsch. It divided flakes into primary, secondary, and tertiary reduction stages, based on dorsal cortex. It classified flakes into core flakes and biface flakes. Core flake types recognized included decortication flakes, undifferentiated interior core flakes, core shaping flakes, and core recovery flakes. Biface flakes were classified as trimming or thinning flakes. Other flake types were recognized, but the overwhelming majority of fully-analyzed Abiquiu flakes fell into the classes listed above.

Preliminary comparative analysis of data from the Alibates sites and of the Abiquiu flake data set consisted of data evaluation, discarding of a few obvious outlier cases, and calculation of area estimates by multiplying item length by item width.

Because the distributions of both weight and area were strongly left-skewed, and because area is proportional not to weight but to the 2/3 power of weight, both weight (gm) and area (mm^2) were transformed into their Naperian (base *e* 2.71828....) logarithms. The resulting data sets were examined, within flake type and cortex range categories, for correlation of the logarithm of area (hereafter, LAREA) with the logarithm of weight (LWGT). Linear regressions of LAREA on LWGT were carried out using the standard model

$$\mathrm{LAREA} = b_0 + (b_1 * \mathrm{LWGT}) + \epsilon$$

The results (Tables 1, 2) were remarkable. Within each of the Abiquiu cortex-flake type groups, LAREA was found to be very highly and linearly correlated to LWGT. Moreover, it appears that little overlap existed between cortex-type groups, within the Abiquiu flake types.

Correlations between LAREA and LWGT were also high for the Alibates data sets, in which all items classified as flakes were analyzed, subdivided into groups by sites and by cortex presence or absence. Due to the definitional difficulty of separating primary ($> 50\%$ cortex) from secondary ($0 < \% \leq 50\%$ cortex) flakes in the Alibates assemblages, for which overall rather than dorsal cortex was estimated, all non-tertiary debitage was pooled by site for the Alibates collections in this analysis.

Values for linear equation parameters estimated in the regression analyses, as listed in Tables 1 and 2, are plotted in Figure 37.

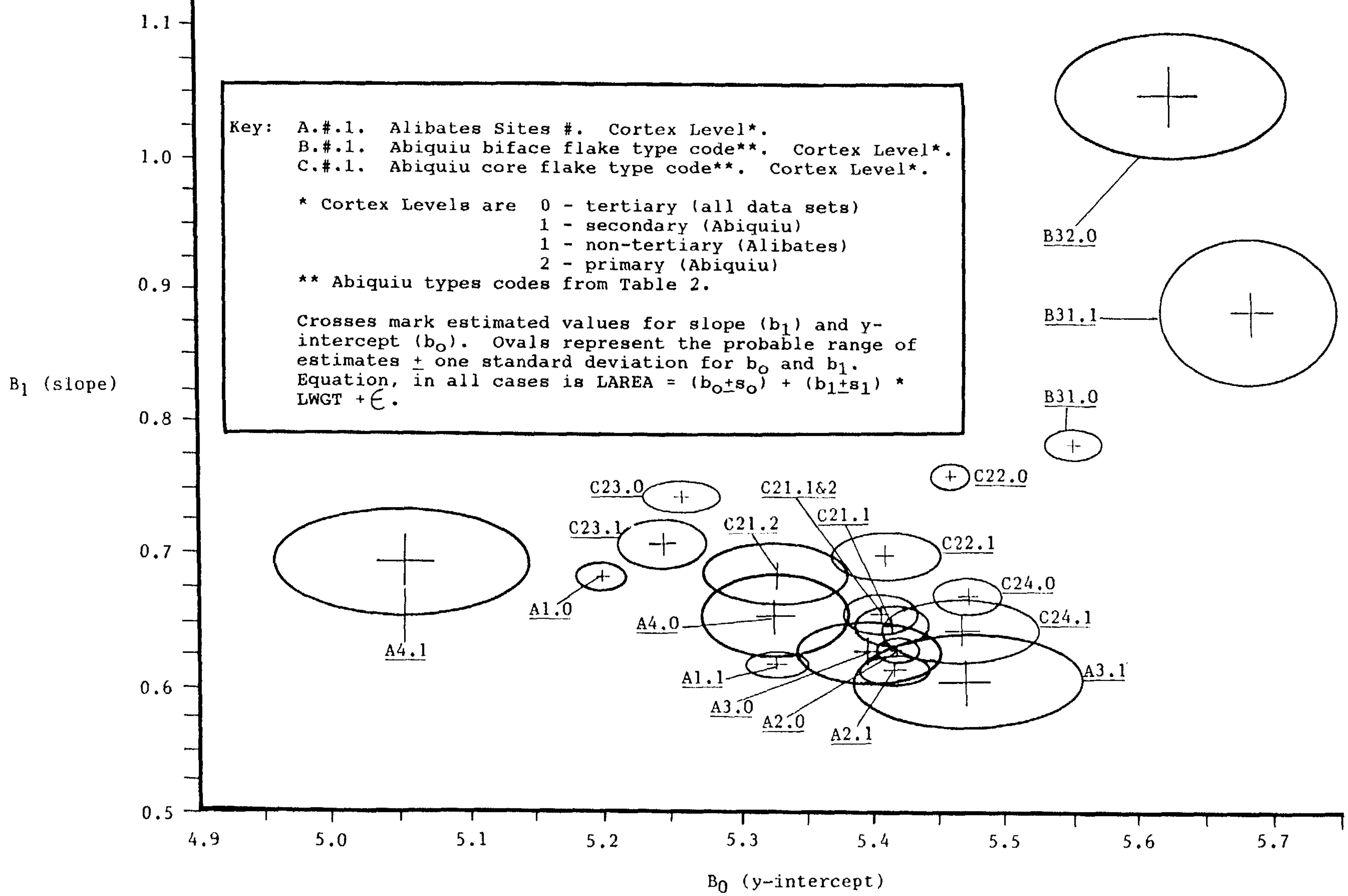
Table 1
Alibates Flake Data: Linear Regression of LAREA on LWGT by Site
[under the model LAREA = $b_0 + (b_1 * LWGT) + e$]

														ANOVA			
														Sum of Squares			
Site	Cortex Level	No. Cases	R	R^2	S_R	b_0	$\pm S_{b_0}$	T	P (2 tailed)	b_1	$\pm S_{b_1}$	T	P (2 tailed)	Regression	Residual	F ratio	P
ALFL-86-1	Tertiary	878	0.923	0.852	0.349	5.193	0.019	277.10	0.000	0.680	0.010	70.938	0.000	613.02	106.71	5032.	0.000
ALFL-86-1	Secondary and Primary	896	0.900	0.810	0.410	5.324	0.030	180.35	0.000	0.619	0.010	61.636	0.000	638.314	150.212	3799.	0.000
ALFL-86-2	Tertiary	765	0.934	0.873	0.309	5.415	0.018	298.86	0.000	0.628	0.009	72.286	0.000	499.508	72.939	5225.	0.000
ALFL-86-2	Secondary and Primary	395	0.950	0.903	0.261	5.412	0.031	177.43	0.000	0.612	0.010	177.428	0.000	251.047	26.871	3671.	0.000
ALFL-86-3	Tertiary	113	0.907	0.823	0.400	5.390	0.055	98.770	0.000	0.626	0.028	22.745	0.000	82.972	17.803	517.3	0.000
ALFL-86-3	Secondary and Primary	41	0.936	0.876	0.288	5.465	0.097	56.189	0.000	0.604	0.036	16.576	0.000	22.797	3.236	274.8	0.000
ALFL-86-4	Tertiary	70	0.935	0.874	0.324	5.322	0.056	95.010	0.000	0.653	0.030	21.713	0.000	41.531	7.144	471.4	0.000
ALFL-86-4	Secondary and Primary	29	0.970	0.942	0.275	5.067	0.097	52.066	0.000	0.693	0.033	20.908	0.000	33.078	2.043	437.1	0.000
ALFL-86-6	Excluded due to probable power auger damage																

Table 2
Abiquiu Flake Data Base: Linear Regressions of LAREA on LWGT
[under the model LAREA = $b_0 + (b_1 * LWGT) + e$]

															ANOVA Sum of Squares			
Flake Type	Abiquiu Type Code	Cortex Level	No. Cases	R	R^2	S_R	b_0	$\pm S_{b_0}$	T	P (2 tailed)	b_1	$\pm S_{b_1}$	T	P (2 tailed)	Regression	Residual	F ratio	P
Core: decortication	21.1	secondary	286	0.950	0.903	0.293	5.409	0.026	212.05	0.000	0.639	0.012	51.454	0.000	227.019	24.353	2647.	0.000
Core: decortication	21.2	primary	45	0.979	0.959	0.237	5.317	0.053	100.18	0.000	0.682	0.022	31.671	0.000	56.363	2.416	1003.	0.000
Core: interior	22.0	tertiary	738	0.942	0.888	0.367	5.456	0.014	401.51	0.000	0.754	0.010	76.506	0.000	790.45	99.395	5853.	0.000
Core: interior	22.1	secondary	71	0.967	0.935	0.294	5.403	0.040	135.59	0.000	0.696	0.022	31.597	0.000	86.03	5.95	998.4	0.000
Core: trimming	23.0	tertiary	182	0.942	0.887	0.356	5.253	0.031	170.92	0.000	0.740	0.020	37.603	0.000	179.15	22.81	1414.	0.000
Core: trimming	23.1	secondary	54	0.981	0.962	0.209	5.238	0.033	158.49	0.000	0.703	0.019	36.223	0.000	57.55	2.28	1312.	0.000
Core: recovery	24.0	tertiary	219	0.953	0.909	0.289	5.468	0.029	190.97	0.000	0.666	0.014	46.182	0.000	177.85	18.09	2132.	0.000
Core: recovery	24.1	secondary	56	0.961	0.923	0.263	5.462	0.064	85.52	0.000	0.641	0.025	25.374	0.000	44.53	3.735	643.8	0.000
Biface: trimming	31.0	tertiary	366	0.919	0.844	0.416	5.543	0.023	245.82	0.000	0.780	0.018	44.426	0.000	341.42	62.968	1974.	0.000
Biface: trimming	31.1	secondary	35	0.940	0.884	0.358	5.673	0.066	86.340	0.000	0.879	0.055	15.878	0.000	32.289	4.227	252.1	0.000
Biface: shaping	32.0	tertiary	129	0.844	0.713	0.429	5.615	0.087	64.655	0.000	1.044	0.059	17.770	0.000	58.141	23.383	315.8	0.000

Figure 37
Regression Coefficients and Standard Errors for Abiquiu Flake Types by Reduction Stage Versus Alibates Flakes by Site and Reduction Stage (from Tables 1 and 2)



Key: A.#.1. Alibates Sites #. Cortex Level*.
B.#.1. Abiquiu biface flake type code**. Cortex Level*.
C.#.1. Abiquiu core flake type code**. Cortex Level*.

* Cortex Levels are 0 - tertiary (all data sets)
1 - secondary (Abiquiu)
1 - non-tertiary (Alibates)
2 - primary (Abiquiu)

** Abiquiu types codes from Table 2.

Crosses mark estimated values for slope (b_1) and y-intercept (b_o). Ovals represent the probable range of estimates ± one standard deviation for b_o and b_1. Equation, in all cases is LAREA = $(b_o \pm s_o) + (b_1 \pm s_1) *$ LWGT $+ \epsilon$.

Examination of this figure reveals several important patterns and trends.

The most obvious trend visible in Figure 37 is the strong segregation of the Abiquiu biface flake regression parameter pairs from all non-biface regression parameter pairs. This reflects the empirical fact that biface (i.e., dominantly pressure and soft hammer) debitage is consistently thinner per unit area than is core (i.e., dominantly hard hammer or indirect percussion) debitage.

Almost as clearly marked is the tendency for Abiquiu tertiary core flake parameter pairs to exhibit greater slopes (b_1) than do Alibates tertiary flake parameter pairs. None of the tertiary Alibates parameter pair 1-sigma confidence ovals overlap with any of the Abiquiu tertiary core flake parameter pair 1-sigma confidence ovals.

Only one Alibates non-tertiary flake parameter pair confidence oval (Alibates Site 3 nontertiary) overlaps substantially with any Abiquiu core flake parameter pair oval. The Abiquiu data subset thus overlapped represents secondary core recovery flakes (Type C 24.1 on Figure 37).

The overlap between linear trends most clearly visible in Figure 37 is between Alibates tertiary flake collections (especially from Sites 2, 3, and 4) and Abiquiu primary (Type 21.2) and non-tertiary (Types 21.1 and 24.1) flake collections.

These patterns strongly suggest that Alibates flake assemblages are composed of cases which are overall thicker per unit surface area than are the bulk of well-defined Abiquiu flakes. To further evaluate the significance of this apparent trend, adjacent subgroup regression patterns for Alibates and Abiquiu were compared using dummy variable multiple regression methods, which provide an unusually well-controlled multivariate analysis of covariance (MANCOVA). The MANCOVA approach suggested by Kleinbaum, Kupper, and Muller (1988:260-296) is followed with the exception of their method of constructing contrast matrices. This approach is now outlined.

In dummy variable MANCOVA, regression analysis results from two separate samples are compared to assess, specifically, the likelihood that the two samples could have been drawn from identical populations. More generally, the method is a powerful method for quantifying the actual differences between two samples in terms of the significance of their regression trends. The model is formulated as follows:

> Model the combined data set $\{(x_{1,i}, y_{1,i}) ; (x_{2,j}, y_{2,j})\}$ for the data from all <u>i</u> members of sample 1 and all <u>j</u> members of sample 2 as:

$$y = b_o + b_1X + b_2Z + b_3XZ$$

where Z is a dummy variable indicating group membership. In the present analysis Z=+1 for (Alibates) sample 1 and Z=-1 for (Abiquiu) sample 2. The resulting equation then may be fitted as an ordinary linear model.

If separate regressions on samples 1 and 2 produce regression parameter estimates (A,B) and (C,D) as:

(sample 1) $y = A + Cx + e$, and
(sample 2) $y = B + Dx + e$, then

the combined regression analysis will produce parameter estimates:

$A = b_o + b_2$,

$B = b_o - b_2$,

$C = b_1 + b_3$, and

$D = b_1 - b_3$

One may then test, by the usual Analysis of Variance methods, the triplet of hypotheses:

1. H_o: $b_2 = 0$,
2. H_o: $b_3 = 0$, and
3. H_o: $b_2 = 0$ <u>and</u> $b_3 = 0$

These hypotheses are equivalent phrasings of the verbal hypotheses:

1. The two sample trends have the same regression intercept;

2. The two sample trends have the same regression slope (i.e., are parallel);

3. The two sample regressions are not different (i.e., are co-linearly identical, hence are probably drawn from similar populations).

Significance statistics produced by testing the three null hypotheses provide a convenient measure of differences between samples, regardless of significance levels.

The triplet hypotheses were not tested for all possible comparisons between Alibates and Abiquiu samples. Rather, Figure 37 was inspected to determine those pairs of regression trends which most nearly resembled each other; only these were tested. The pairs compared and the MANCOVA hypothesis test data for the triplet hypotheses for each test pair are presented below in Table 3.

The results of the MANCOVA tests indicate that there is little reason to reject the hypothesis that most regression trends studied have the same intercept value (b_o); of 13 test pairs,

Table 3

MANCOVA analyses (condensed) comparing selected Alibates flake assemblages with selected Abiquiu flake assemblages, under the model $Y = b_0 + b_1X - b_2Z + b_3ZX$

[Alibates Z=1; Abiquiu Z=-1]

Alibates			Abiquiu			Parameter estimates		ANOVA: $H_0(b_2=0)$				ANOVA: $H_0(b_3=0)$				ANOVA: $H_0(b_2=b_3=0)$				
Site No.	Cortex Level	No. of Cases	Type No.	Cortex Level	No. of Cases	b_2	b_3	Sum of Squares	Degrees of Freedom	F Ratio	P (1-tail)	Sum of Squares	Degrees of Freedom	F Ratio	P (1-tail)	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	P (1-tail)
1	P,S	896	21	P,S	331	-0.036	-0.014	0.430	1;1223	2.976	0.085	0.361	1;1223	2.492	0.115	3.586	2;1222	1.793	12.376	0.000
2	P,S	395	21	P,S	331	0.008	-0.017	0.014	1; 722	0.188	0.665	0.385	1; 722	5.151	0.023	0.855	2; 721	0.428	5.734	0.003
3	P,S	41	21	P,S	331	0.035	-0.021	0.041	1; 368	0.496	0.482	0.104	1; 368	1.265	0.261	0.131	2; 367	0.066	0.799	0.450 *
1	P,S	896	22	S	71	-0.040	-0.038	0.265	1; 963	1.635	0.201	0.947	1; 963	5.840	0.016	2.458	2; 962	1.229	7.579	0.001
2	P,S	395	22	S	71	0.004	-0.042	0.002	1; 462	0.034	0.854	0.973	1; 462	13.695	0.000	1.425	2; 461	0.712	10.033	0.000
3	P,S	41	22	S	71	0.031	-0.046	0.029	1; 108	0.342	0.560	0.392	1; 108	4.610	0.034	0.695	2; 107	0.348	4.088	0.019
2	P,S	395	24	S	56	-0.025	-0.014	0.034	1; 447	0.498	0.481	0.074	1; 447	1.083	0.298	0.672	2; 446	0.336	4.908	0.008
3	P,S	41	24	S	56	0.002	-0.019	0.000	1; 93	0.001	0.976	0.054	1; 93	0.725	0.397	0.207	2; 92	0.104	1.361	0.256 *
2	t	765	24	t	219	-0.026	-0.015	0.210	1; 980	2.261	0.133	0.428	1; 980	4.610	0.032	2.443	2; 979	1.221	13.147	0.000
3	t	113	24	t	219	-0.039	-0.020	0.211	1; 328	1.932	0.165	0.215	1; 328	1.973	0.161	1.562	2; 327	0.781	7.135	0.001
4	t	70	24	t	219	-0.073	-0.006	0.540	1; 285	6.094	0.014	0.014	1; 285	0.157	0.692	1.429	2; 284	0.714	8.054	0.000
2	t	765	22	t	738	-0.021	-0.083	0.351	1;1495	3.054	0.081	10.472	1;1459	91.086	0.000	17.466	2;1498	8.733	75.950	0.000
3	t	113	22	t	738	-0.033	-0.054	0.217	1; 847	1.569	0.211	2.995	1; 847	21.642	0.000	7.567	2; 846	3.784	27.344	0.000

---

* Non-distinguishable cases; hypothesis of co-linearity not rejected

only one is significant at better than the 0.05 level and only three at better than the 0.10 level. There is rather less reason to suppose that most trends have the same regression slope (b_1); of 13 tests, seven are significant at the 0.05 level, but only the same seven are significant at the 0.10 level.

It seems clear that only two pairs may reasonably be seen as having sampled similar distributions; these are Site 3 tertiary vs. Abiquiu decortication core flakes (Types 21.1 and 21.2 pooled), which has a probability value of 0.450, and Site 3 non-tertiary vs. Abiquiu secondary core recovery flakes, with a probability value of 0.256. We conclude that Alibates flakes from Sites 1-4, with only a few exceptions, tend to be significantly thicker and heavier per unit surface area than are any of the comparable common core flake types studied at Abiquiu.

The exceptions to this generalization are themselves revealing. The Abiquiu flake types which tend most to resemble Alibates flakes in metric terms are pooled decortication primary and secondary flakes (Types 21.1 and 21.2), and secondary core recovery flakes (Type 24.1). Core recovery flakes, on average, are much heavier than are other core flakes because they are often struck far from any platform edge, so as to drive beneath an error (snap, hinge, etc.) which otherwise would have ended a core's usefulness. They are, in consequence, best viewed as transitional between hard-hammer (hertzian/stiffness) conchoidal flakes on the one hand and bipolar (hertzian/compression or wedging/compression) non-conchoidal flakes on the other. The pooled decortication flake sample is, of course, likely to represent one of the heaviest and "least conchoidal" of all core flake assemblages, because of the need to strike deep beneath a cobble's surface flaws and cortical ring crack fields when removing cortical flakes.

In short, Alibates assemblages from Sites 1-4 most resemble only the "least conchoidal" of the Abiquiu conchoidal flake types to which they were compared. In fact, only the Site 3 non-tertiary assemblage may be said to resemble any Abiquiu single flake type pattern very closely.

In order to better evaluate these comparisons, the Rancier replication assemblage was sampled and variables monitored on the sampled replicate flakes. The data from the replicate flakes were processed by logarithmic transformation as were the Abiquiu and Alibates archeological cases.

To achieve better resolution for comparison, the Alibates flake data were culled, only proximal, lateral, and complete flakes being kept in the sample. They were then transformed for comparison as follows:

> For all Alibates sample flakes, the expected value of LAREA was calculated. Two equations were used, the choice depending on whether the flake was of tertiary or

non-tertiary debitage. For tertiary debitage, the estimating equation was the overall trend equation for all Alibates tertiary flakes:

$$\widehat{LAREA} = 5.335 + 0.64 * LWGT$$

For non-tertiary flakes, the similar equation was

$$\widehat{LAREA} = 5.375 + 0.61 * LWGT$$

A new variable, LARESID (Log Area Residual) was calculated as:

$$LARESID = LAREA - \widehat{LAREA}$$

Similar calculations were made for the Rancier replication sample. Data and calculations for the replication sample are tabulated in Table 4 and plotted in Figure 38. Also included in the sample was an exceptionally large hertzian cone, probably a "bipolar core" fragment, from Alibates Site 2, FS 220 (see also Figure 34 item a, and Figure 35) chosen because it typified the extreme definitional limit of recognizable debitage within the Alibates assemblages.

Mechanical Classification of the Alibates Collections

Using the patterns exhibited in Figure 38, the debitage analyzed for the Alibates sites were mechanically classified into reduction types, depending on their original classification as angular type debris, distal flakes, flake segments, flakes (whole, lateral, or proximal), and their values for area, weight, LWGT, LAREA, and LARESID, all defined as for the Abiquiu data set above. These classes are:

Type A (Angular Debris): all items originally classified as angular debris.

Type I (Flake Fragments): all items originally classified as distal flakes or flake segments.

Type S (Flakes too small to classify): all flakes, not in Types A or I above, having a weight of one gram or less.

Type U (Unclassifiable typical flakes): all items, not in Types A, I, or S, having

- $LAREA < 5.7 + 0.5 * LWGT$, and
- $LAREA > 4.875 + 0.875 * LWGT$

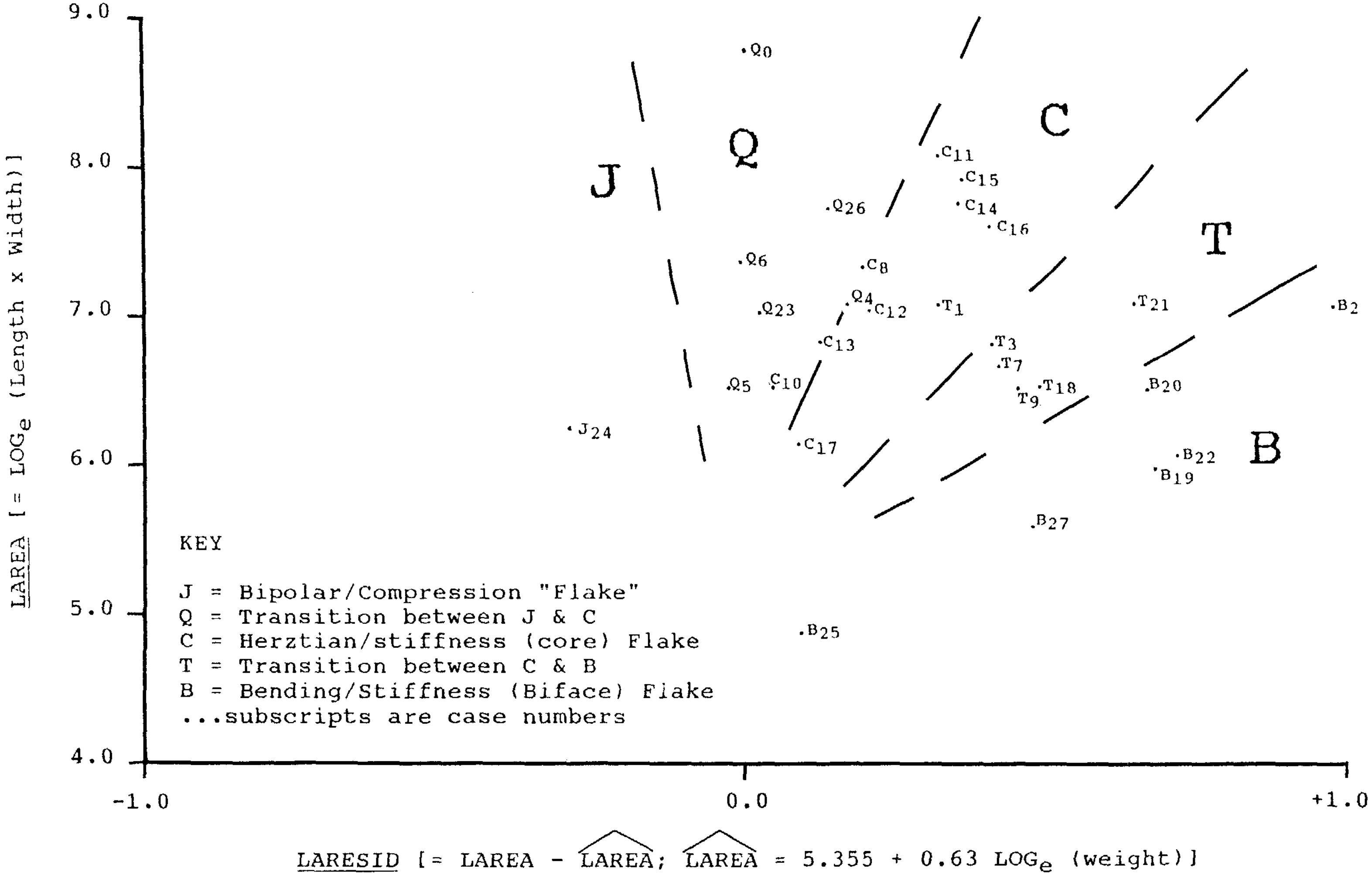
This class represents the area of the variable space in which regression lines for LAREA on LWGT converge.

Types B, T, C, Q, J (Mechanically Classified Flakes): include only items not classifiable as Types A, I, S, or U.

Table 4
Calibration Data for Alibates/Abiquiu Comparative Flake Study
(Rancier Replication Set)

Item		Comment	WGT	LGT	WID	LAREA	LWGT	LAREA	LARESID
Alibates #0	Q_0	Possibly utilized big hertzian cone "flake"	214.0	78	83	8.78	5.37	8.77	0.01
Rancier #1	T_1	Lipped soft hammer (biface) flake, CTX=0	9.0	45	26	7.06	2.20	6.74	0.32
Rancier #2	B_2	Lipped soft hammer (biface) flake, CTX=20%	3.0	30	37	7.01	1.10	6.04	0.97
Rancier #3	T_3	Lipped soft hammer (biface) flake, CTX=0	5.0	40	22	6.78	1.61	6.37	0.41
Rancier #4	Q_4	Core recovery flake, CTX=0	11.0	36	32	7.05	2.40	6.87	0.18
Rancier #5	Q_5	Core recovery flake, CTX=0	6.0	35	18	6.45	1.79	6.48	-0.03
Rancier #6	Q_6	Core recovery flake, CYX=0	24.0	44	36	7.37	3.18	7.37	0
Rancier #7	T_7	Core recovery flake?, very thin obsidian	4.0	43	18	6.65	1.39	6.22	0.43
Rancier #8	C_8	Core flake, CTX=100%, plain platform	17.0	40	37	7.30	2.83	7.10	0.20
Rancier #9	T_9	Core? flake, CTX=0, platform is flaw surface	3.0	35	19	6.50	1.10	6.04	0.46
Rancier #10	C_{10}	Core flake, CTX=60%, platform is 100% CTX	6.0	26	26	6.52	1.79	6.47	0.05
Rancier #11	C_{11}	Core flake (blade), CTX=0	41.0	68	45	8.03	3.71	7.71	0.32
Rancier #12	C_{12}	Core flake (blade), CTX=0	10.0	43	26	7.02	2.30	6.81	0.213
Rancier #13	C_{13}	Core flake (blade), CTX=0	8.0	36	25	6.80	2.08	6.67	0.13
Rancier #14	C_{14}	Core flake (blade), CTX=50%	27.0	68	34	7.75	3.30	7.39	0.36
Rancier #15	C_{15}	Core flake, interior, CTX=0	30.0	55	48	7.88	3.40	7.51	0.37
Rancier #16	C_{16}	Core flake, interior, CTX=0	18.0	46	43	7.59	2.89	7.18	0.41
Rancier #17	C_{17}	Core flake, primary, CTX=100%	3.0	23	20	6.13	1.10	6.05	0.08
Rancier #18	T_{18}	Thick biface flake, CTX=0	3.0	24	28	6.51	1.10	6.04	0.47
Rancier #19	B_{19}	Biface flake, CTX=0	0.9	24	16	5.95	-0.11	5.267	0.683
Rancier #20	B_{20}	Biface flake, CTX=0	2.0	30	21	6.45	0.69	5.78	0.67
Rancier #21	T_{21}	Rough biface flake, CTX=0?	5.5	37	32	7.08	1.705	6.43	0.65
Rancier #22	B_{22}	Nice biface flake, CTX=0	1.0	26	16	6.03	0	5.335	0.695
Rancier #23	Q_{23}	Bipolar "flake", CTX=100%	14.0	40	27	6.98	2.63	6.979	0.03
Rancier #24	J_{24}	Bipolar "flake", CTX=100%	6.5	39	13	6.23	1.87	6.51	-0.28
Rancier #25	B_{25}	Biface pressure flake, tiny, CTX=0	0.4	14	9	4.84	-0.91	4.75	+0.09
Rancier #26	Q_{26}	Sheared core, bipolar, CTX=60%	36.0	48	46	7.70	3.58	7.56	+0.14
Rancier #27	B_{27}	Biface thinning flake, CTX=0	0.7	22	12	5.58	-0.36	5.10	+0.48

Figure 38
Rancier Replication Sample, Tabulated from
Table 4, Showing Classification Regions



- Type B (biface flakes): all those items with

  $\text{LAREA} \leq 5.5 + 2.0 * \text{LARESID};$

- Type T (biface-core transition flakes): all those items with

  $\text{LAREA} \leq 5.5 + 3.65 * \text{LARESID};$

- Type C (true core flakes; i.e., hertzian-stiffness flakes): all those items (not B or T) with

  $\text{LAREA} \leq 5.5 + 11.5 * \text{LARESID};$

- Type Q (transitional stiffness-compression flakes; i.e., "thick core flakes"): all those items (not B, T, or C) with

  $\text{LAREA} > 5.5 + 11.5 * \text{LARESID}$, and
  $\text{LAREA} \geq 5.5 - 20 * \text{LARESID};$

- Type J (most bipolar debitage; most extreme hertzian-compression and wedging-compression "flakes"): all those items with

  $\text{LAREA} < 5.5 - 20 * \text{LARESID}$

The areas of the LAREA vs. LARESID plane defined by these criteria are shown in Figure 39. Counts for each of the mechanical flake classes for each major provenience in the Alibates study are given in Table 5. Table 6 presents Pearson correlations calculated on counts for all types between pairs of (proveniences) from Table 5, while Table 7 presents Pearson correlations calculated across all proveniences for pairs of types from Table 5.

Examination of these data reveal several differences in the relative abundances of debitage types from different proveniences. From Table 7, it is clear that all debitage types are closely correlated in their relative abundances across the Alibates collections. Most clearly similar are Types A, J, and Q, the least "conchoidal" debitage types. Similar to each other but clearly unlike the A,J,Q group are B, T, and C, the most "conchoidal" types. Types I and U, the flakes unclassifiable because of fragmentation or method limitations, are intermediate between the "conchoidal" and "non-conchoidal" clusters. Type S, the very small flakes, do not covary strongly with any other types; they are, however, clearly most different from Types B, T, and Q. This observation suggests that most small flakes and small flake fragments are not associated with biface reduction, but with breakage or reduction which produced core flakes, angular debris, and bipolar or compression "flakes". In other words, Type S microflakes seem to be core preparation flakes and/or incidental shatter.

Figure 39
Mechanical Classification Domains for Alibates Debitage

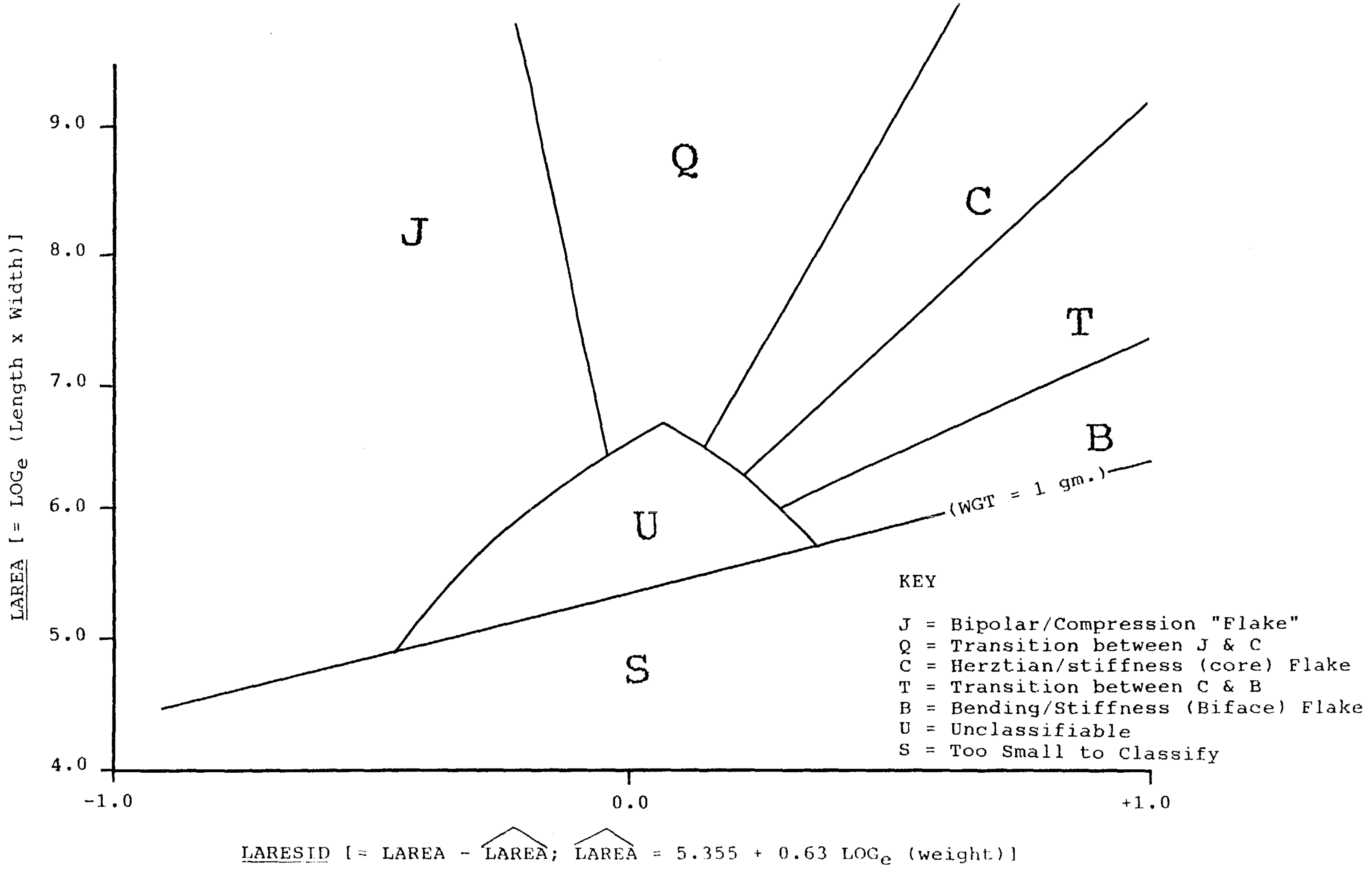


Table 5

Numbers and Percentages of Items by Provenience for Mechanically Classified Types: All Alibates Debitage

Site	Datum	Type A Angular		Type B Biface Flakes		Type C Core Flakes		Type I Distal and Segment Flakes		Type J Bipolar and Compression Flakes		Type Q Core-Compression Transition Flakes		Type S Flakes Too Small to Resolve		Type T Biface-Core Transition Flakes		Type U Unclassified Flakes		ROW TOTAL
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
1	-	531	22.90%	44	1.90%	181	7.81%	796	34.33%	192	8.28%	301	12.98%	119	5.13%	41	1.77%	114	4.92%	2319
2	-	8	11.59%	1	1.45%	9	13.04%	34	49.28%	0	0.00%	5	7.25%	7	10.14%	1	1.45%	4	5.80%	69
2	BM R24R	15	16.13%	1	1.08%	11	11.83%	36	38.71%	5	5.38%	22	23.66%	2	2.15%	0	0.00%	1	1.08%	93
2	CL 72+00	27	17.53%	3	1.95%	22	14.29%	48	31.17%	3	1.95%	27	17.53%	7	4.55%	9	5.84%	8	5.19%	154
2	JB	43	10.39%	22	5.31%	55	13.29%	180	43.48%	14	3.38%	39	9.42%	23	5.56%	13	3.14%	25	6.04%	414
2	JE	25	16.89%	2	1.35%	20	13.51%	49	33.11%	10	6.76%	28	18.92%	5	3.38%	6	4.05%	3	2.03%	148
2	JR	59	16.03%	11	2.99%	52	14.13%	140	38.04%	18	4.89%	39	10.60%	18	4.89%	11	2.99%	20	5.43%	368
2	LT 62+50	3	9.38%	0	0.00%	4	12.50%	13	40.63%	1	3.13%	6	18.75%	4	12.50%	0	0.00%	1	3.13%	32
2	ST	16	19.75%	3	3.70%	12	14.81%	24	29.63%	7	8.64%	13	16.05%	1	1.23%	3	3.70%	2	2.47%	81
3	-	42	21.43%	11	5.61%	13	6.63%	61	31.12%	10	5.10%	22	11.22%	23	11.73%	7	3.57%	7	3.57%	196
4	-	13	11.61%	5	4.46%	12	10.71%	35	31.25%	7	6.25%	17	15.18%	13	11.61%	2	1.79%	8	7.14%	112
6	Area 1	2	3.77%	1	1.89%	1	1.89%	30	56.60%	2	3.77%	0	0.00%	17	32.08%	0	0.00%	0	0.00%	53
6	Area 2	6	54.55%	0	0.00%	1	9.09%	2	18.18%	0	0.00%	0	0.00%	2	18.18%	0	0.00%	0	0.00%	11
6	Area 3	23	11.92%	7	3.63%	8	4.15%	88	45.60%	2	1.04%	4	2.07%	52	26.94%	2	1.04%	7	3.63%	193
COLUMN TOTALS		813	19.16%	111	2.62%	401	9.45%	1536	36.20%	271	6.39%	523	12.33%	293	6.91%	95	2.24%	200	4.71%	4243

Table 6
Correlations between Sites and Subsites in Abundance Spectra, Over all Debitage Types*

SITE	DATUM	1 Total	2 -	2 BMR24R	2 CL 72+00	2 "JB"	2 "JE"	2 "JR"	2 LT 62+50	2 "ST"	3 Total	4 Total	6 Area 1	6 Area 2	6 Area 3
1	Total	1.000													
2	-	0.860	1.000												
2	BMR24R	0.917	0.845	1.000											
2	CL 72+00	0.912	0.871	0.960	1.000										
2	"JB"	0.864	0.986	0.877	0.884	1.000									
2	"JE"	0.933	0.852	0.989	0.976	0.880	1.000								
2	"JR"	0.938	0.965	0.921	0.943	0.975	0.940	1.000							
2	LT 62+50	0.848	0.936	0.929	0.903	0.926	0.912	0.920	1.000						
2	"ST"	0.936	0.796	0.952	0.947	0.836	0.977	0.923	0.824	1.000					
3	Total	0.956	0.875	0.855	0.868	0.848	0.865	0.901	0.853	0.847	1.000				
4	Total	0.889	0.946	0.930	0.899	0.935	0.909	0.936	0.990	0.836	0.890	1.000			
6	Area 1	0.655	0.867	0.600	0.580	0.807	0.590	0.737	0.816	0.488	0.770	0.823	1.000		
6	Area 2	0.590	0.331	0.326	0.441	0.257	0.391	0.416	0.260	0.475	0.661	0.320	0.252	1.000	
6	Area 3	0.718	0.889	0.629	0.640	0.819	0.625	0.776	0.824	0.539	0.842	0.842	0.983	0.404	1.000

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* Each debitage type constituted one case for this analysis.

Table 7
Correlations Between Frequencies of Debitage Types *

Mechanically Classified Debitage Types	Angular Debris	Biface Flakes	Core Flakes	Distal and Segment Flakes	Bipolar/ Compression Flakes	Core/ Compression Transition Flakes	Flakes too small to classify	Biface/ Core Transition Flakes	Unclassified Flakes
Angular Debris	1.000								
Biface Flakes	0.905	1.000							
Core Flakes	0.964	0.952	1.000						
Distal and Segment Flakes	0.988	0.950	0.985	1.000					
Bipolar/Compression Flakes	0.998	0.898	0.962	0.985	1.000				
Core/Compression Transition Flakes	0.996	0.909	0.975	0.986	0.996	1.000			
Flakes too small to classify	0.915	0.891	0.870	0.932	0.904	0.889	1.000		
Biface/Core Transitional Flakes	0.951	0.954	.0986	0.968	0.944	0.962	0.863	1.000	
Unclassified Flakes	0.986	0.951	0.989	0.997	0.983	0.987	0.917	0.973	1.000

---

* Each site or subsite constituted one case for this analysis.

Looking at comparisons in type frequencies between sites (Table 6) we see that there are several groups which are especially closely correlated. These are:

<u>Group 1</u> including Site 2: Datums CL 72+00, BMR24R, JE, and ST;

<u>Group 2</u> including Site 2: Datums JB, JR, LT 62+50, and blank, and Site 4;

<u>Group 3</u> including Sites 1 and 3;

<u>Group 4</u> including Site 6 Areas 1 and 3;

<u>Group 5</u> made up only of Site 6 Area 2.

Group 5 is very unlike any other group and seems to be most unlike Groups 1 and 4. Groups 2 and 3 are intermediate between the three extremes of pattern represented by Groups 1, 4, and 5.

Examination of the collections which make up these groups reveals (Table 5) that Group 5 (Site 6 Area 2) is characterized by a sparse assemblage containing only angular debris, flake fragments, microflakes, and a single core flake. Its apparent distinctiveness is based on too few items (11 total, with only 5 flakes) to classify.

Group 4 (Site 6 Areas 1 and 3) is characterized by very low frequencies of Types A, C, J, Q, and T, very high frequencies of Types I and S, and rather average frequencies of Type B. Inasmuch as this assemblage was recovered by power augering and test pit excavations in known subsurface cultural midden deposits, it is likely to include many small retouch flakes and flake fragments, both culturally produced and produced by power auger breakage. The strong contrast of Group 4 with other assemblages suggests that it nevertheless includes relatively little of the cobble quarry debitage which seems to characterize other assemblages studied in this project.

Of the other groups, the one which most resembles Group 4 seems to be Group 2, which has high frequencies of Types C and S, generally high values for Type I, low frequencies of Type A, and generally low frequencies of Types Q and J. Group membership in this case is mostly determined by those types more generally abundant; Site 4 would not be classified with this group on the basis of frequencies for Types I, J, and Q.

Group 1 seems most distinctive from Group 4. It has very high frequencies of Types C and Q and possibly of Type T, very low frequencies of Type S, low frequencies of Type U, and perhaps of Types A, B, and I, and rather variable frequencies for Type J.

Group 3 is the most "typical" of the five groups, mostly because of the numerical dominance of Site 1 in the overall analysis collections. It differs from other groups mainly in its abundance of Type A and its very low frequencies of Type C.

Overall, the Alibates study assemblages are not greatly different. With the exception of the Site 6 collections, all tend to have high frequencies of distal flakes and flake segments (Type I) and angular debris (Type A). Analytically, these are the types least certainly classifiable by reduction technique.

Next most abundant overall are, in declining order, core-compression transitional flakes (Type Q), core flakes (Type C), small flakes (Type S), and compression flakes (Type J). These are the types most likely to arise in reduction episodes where items are being broken with a hard hammer and with little regard for the placement of blows relative to distance from the edge of an intended platform. Blows rather far from an edge produce Type Q, blows nearer the edge produce Type C, blows on an edge (or overforced blows) produce showers of Type S flakes, and blows farthest from an edge produce Type J.

Overall least abundant are (in descending order), unclassifiable, non-distinctive medium-small flakes (Type U), biface flakes (Type B), and biface-core transition flakes (Type T). These, of course, are the flakes most generally considered useful as acute edge cutting tools and also for production of tool preforms. These are also the flake types to be expected in greatest abundance as a result of manufacturing-stage work in production of bifaces and thin unifaces and also as a result of tool resharpening work.

In fact, even if the frequencies for the thin, large types (B and T) are pooled, the overall study collection frequencies for the pooled "large thin" type is only 4.86%. Only three collections (Site 2 CL 72+00; Site 2 JB; and Site 3) have pooled "large thin" frequencies in excess of 7.5% of their total assemblage sizes.

For comparison, no site has a "large thin" frequency approaching the collection's overall core-flake abundance levels (9.45%); only Site 3 and Site 6 Area 3 produced "large thin" percentages greater than their specific core flake percentages (9.18% vs. 6.63% and 4.69% vs. 4.15%, respectively).

In any extensive cultural reduction episode, and even in natural breakage events, a few flakes of the "large thin" size classes will be produced; similarly, discoidal core reduction episodes or tool production acts are likely to produce a low but consistently present complement of flakes which fall into the C class based on size and weight.

However, these incidental products are rare; they probably cannot account for non-conchoidal breakage (Types A, J, and probably most of Q) being common relative to types C, B, and T. They may account for occasional items of Types B and/or T in an assemblage dominated by C-type flakes. Viewed from this perspective, it is clear that Site 1, Site 4, and Site 2 loci BMR24R, JE, and perhaps LT 62+50, are mostly composed on non-conchoidal reduction. Site 2 loci CL 72+00, JB, and ST probably contain both non-conchoidal and normal core reduction. Site 2 loci JR and blank seem to contain mostly normal core reduction debitage. Site 3 is problematic; it appears to consist of a non-conchoidal assemblage very much like that from Site 1, overlain by a smaller assemblage of biface and biface-core transitional debitage. Site 6 Areas 1 and 2 are not clearly classifiable owing to their small assemblage sizes. Site 6 Area 3, however, clearly has an assemblage composed mostly of biface and core conchoidal debitage.

Analysis of Other Variables within the Mechanical Class Framework

Observations were made for all debitage items on the following metric variables: total cortex percentage, weight, length, width, and rework level. In addition, metric observations for flakes included number of platform scars and percentage of platform cortex. Total piece scar (facet or distinct surface) counts were made for all flakes and for some angular pieces.

Non-metric, subjective, or classificatory observations included cortex type, completeness, estimated heat treatment, dominant color, secondary color, color pattern, and plausibility as cultural debitage.

Data on these variables are presented below (Tables 8 through 17) organized by site and provenience and by mechanically classified debitage type.

Heat Treatment of Debitage:

Heat treatment, recorded as N (no) or Y (yes), was assessed for all debitage (Table 8). The results indicate certain patterned differences both between loci and between types within a locus. Most collections tended to have about equal proportions of heat-treated and not heat-treated items overall, with a tendency for not-heat-treated items to be slightly more common. Collections with unusually common heat treatment are Site 3, Site 4, and Site 6 Areas 1 and 2 (pooled) which had heat-treated proportions of 85%, 95%, and 89%, respectively. Collections with unusually rare heat-treatment were made from Site 2 loci ST and JB, with heat-treated proportions of 34% and 37%, respectively.

Within assemblages, the potential for meaningful comparisons is of course limited by total assemblage size and by collection sizes within types. Only collections with over 15 cases were considered. Several patterns were noted. Comparing cases where angular debris (Type A) deviates strongly from the overall pattern of an assemblage, it tends to show lower than average heat-treatment frequencies (Site 2 loci JE and ST; Site 6 Area

Table 8
Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Heat Treatment by Locus

Site	Datum	HT?	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
1	-	N	264	49.72%	18	40.91%	69	38.12%	402	50.50%	72	37.50%	101	33.55%	56	47.06%	15	36.59%	54	47.37%	1051	45.32%
		Y	267	50.28%	26	59.09%	112	61.88%	394	49.50%	120	62.50%	200	66.45%	63	52.94%	26	63.41%	60	52.63%	1268	54.68%
		Subtotal	531	22.90%	44	1.90%	181	7.81%	796	34.33%	192	8.28%	301	12.98%	119	5.13%	41	1.77%	114	4.92%	2319	100.00%
2	-	N	6	75.00%	1	100.00%	0	0.00%	15	44.12%	0	0.00%	2	40.00%	4	57.14%	0	0.00%	1	25.00%	29	42.03%
		Y	2	25.00%	0	0.00%	9	100.00%	19	55.88%	0	0.00%	3	60.00%	3	42.86%	1	100.00%	3	75.00%	40	57.97%
		Subtotal	8	11.59%	1	1.45%	9	13.04%	34	49.28%	0	0.00%	5	7.25%	7	10.14%	1	1.45%	4	5.80%	69	100.00%
2	BM R24R	N	9	60.00%	1	100.00%	4	36.36%	24	66.67%	2	40.00%	10	45.45%	2	100.00%	0	0.00%	0	0.00%	52	55.91%
		Y	6	40.00%	0	0.00%	7	63.64%	12	33.33%	3	60.00%	12	54.55%	0	0.00%	0	0.00%	1	100.00%	41	44.09%
		Subtotal	15	16.13%	1	1.08%	11	11.83%	36	38.71%	5	5.38%	22	23.66%	2	2.15%	0	0.00%	1	1.08%	93	100.00%
2	CL 72+00	N	13	48.15%	3	100.00%	11	50.00%	29	60.42%	2	66.67%	11	40.74%	4	57.14%	4	44.44%	5	62.50%	82	53.25%
		Y	14	51.85%	0	0.00%	11	50.00%	19	39.58%	1	33.33%	16	59.26%	3	42.86%	5	55.56%	3	37.50%	72	46.75%
		Subtotal	27	17.53%	3	1.95%	22	14.29%	48	31.17%	3	1.95%	27	17.53%	7	4.55%	9	5.84%	8	5.19%	154	100.00%
2	JB	N	26	60.47%	15	68.18%	29	52.73%	129	71.67%	8	57.14%	21	53.85%	18	78.26%	10	76.92%	16	64.00%	272	65.70%
		Y	17	39.53%	7	31.82%	26	47.27%	51	28.33%	6	42.86%	18	46.15%	5	21.74%	3	23.08%	9	36.00%	142	34.30%
		Subtotal	43	10.39%	22	5.31%	55	13.29%	180	43.48%	14	3.38%	39	9.42%	23	5.56%	13	3.14%	25	6.04%	414	100.00%
2	JE	N	17	68.00%	1	50.00%	7	35.00%	34	69.39%	5	50.00%	16	57.14%	3	60.00%	2	33.33%	1	33.33%	86	58.11%
		Y	8	32.00%	1	50.00%	13	65.00%	15	30.61%	5	50.00%	12	42.86%	2	40.00%	4	66.67%	2	66.67%	62	41.89%
		Subtotal	25	16.89%	2	1.35%	20	13.51%	49	33.11%	10	6.76%	28	18.92%	5	3.38%	6	4.05%	3	2.03%	148	100.00%
2	JR	N	32	54.24%	7	63.64%	23	44.23%	71	50.71%	10	55.56%	22	64.71%	10	55.56%	6	54.55%	9	45.00%	190	52.34%
		Y	27	45.76%	4	36.36%	29	55.77%	69	49.29%	8	44.44%	12	35.29%	8	44.44%	5	45.45%	11	55.00%	173	47.66%
		Subtotal	59	16.25%	11	3.03%	52	14.33%	140	38.57%	18	4.96%	34	9.37%	18	4.96%	11	3.03%	20	5.51%	363	100.00%

Table 8 (continued)
Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Heat Treatment by Locus

Site	Datum	HT?	Angular #	Angular %	Biface Flakes #	Biface Flakes %	Core Flakes #	Core Flakes %	Distal and Segment Flakes #	Distal and Segment Flakes %	Bipolar and Compression Flakes #	Bipolar and Compression Flakes %	Core-Compression Transition Flakes #	Core-Compression Transition Flakes %	Flakes Too Small to Resolve #	Flakes Too Small to Resolve %	Biface-Core Transition Flakes #	Biface-Core Transition Flakes %	Unclassified Flakes #	Unclassified Flakes %	ROW TOTAL	
2	LT 62+50	N	1	33.33%	0	0.00%	2	50.00%	7	53.85%	0	0.00%	3	50.00%	3	75.00%	0	0.00%	1	100.00%	17	53.13%
		Y	2	66.67%	0	0.00%	2	50.00%	6	46.15%	1	100.00%	3	50.00%	1	25.00%	0	0.00%	0	0.00%	15	46.88%
		Subtotal	3	9.38%	0	0.00%	4	12.50%	13	40.63%	1	3.13%	6	18.75%	4	12.50%	0	0.00%	1	3.13%	32	100.00%
2	ST	N	13	81.25%	1	33.33%	8	66.67%	15	62.50%	5	71.43%	6	46.15%	0	0.00%	1	33.33%	2	100.00%	51	62.96%
		Y	3	18.75%	2	66.67%	4	33.33%	9	37.50%	2	28.57%	7	53.85%	1	100.00%	2	66.67%	0	0.00%	30	37.04%
		Subtotal	16	19.75%	3	3.70%	12	14.81%	24	29.63%	7	8.64%	13	16.05%	1	1.23%	3	3.70%	2	2.47%	81	100.00%
3	-	N	7	16.67%	1	8.33%	2	15.38%	11	18.03%	1	9.09%	1	4.35%	6	20.69%	0	0.00%	1	12.50%	30	14.56%
		Y	35	83.33%	11	91.67%	11	84.62%	50	81.97%	10	90.91%	22	95.65%	23	79.31%	7	100.00%	7	87.50%	176	85.44%
		Subtotal	42	20.39%	12	5.83%	13	6.31%	61	29.61%	11	5.34%	23	11.17%	29	14.08%	7	3.40%	8	3.88%	206	100.00%
4	-	N	1	7.69%	1	20.00%	1	7.69%	3	7.89%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	6	5.17%
		Y	12	92.31%	4	80.00%	12	92.31%	35	92.11%	7	100.00%	17	100.00%	13	100.00%	2	100.00%	8	100.00%	110	94.83%
		Subtotal	13	11.21%	5	4.31%	13	11.21%	38	32.76%	7	6.03%	17	14.66%	13	11.21%	2	1.72%	8	6.90%	116	100.00%
6	Areas 1 & 2	N	1	12.50%	0	0.00%	0	0.00%	2	6.25%	1	50.00%	0	0.00%	4	21.05%	0	0.00%	0	0.00%	8	11.27%
		Y	7	87.50%	1	100.00%	2	100.00%	30	93.75%	1	50.00%	0	0.00%	15	78.95%	6	100.00%	1	100.00%	63	88.73%
		Subtotal	8	11.27%	1	1.41%	2	2.82%	32	45.07%	2	2.82%	0	0.00%	19	26.76%	6	8.45%	1	1.41%	71	100.00%
6	Area 3	N	15	65.22%	1	14.29%	2	25.00%	42	47.73%	1	50.00%	0	0.00%	21	40.38%	1	50.00%	0	0.00%	83	43.01%
		Y	8	34.78%	6	85.71%	6	75.00%	46	52.27%	1	50.00%	4	100.00%	31	59.62%	1	50.00%	7	100.00%	110	56.99%
		Subtotal	23	11.92%	7	3.63%	8	4.15%	88	45.60%	2	1.04%	4	2.07%	52	26.94%	2	1.04%	7	3.63%	193	100.00%

3). For core flakes (Type C), deviations tend to be toward higher than average heat treatment (Site 1; Site 2 locus JB). Distal flakes and flake segments (Type I) tend to have low heat treatment (Site 2 loci BMR24R, CL 72+00, JB, and JE). Core-compression transition flakes (Type Q) had higher than average heat treatment in four cases (Site 1; Site 2 loci CL 72+00 and JB; and Site 3) but lower heat treatment in Site 2 locus JR. Small flakes (Type S) were typically somewhat low in heat treatment; in one case this trend was marked (Site 2 locus JB). In one case (Site 1) biface-core transition flakes (Type T) were strongly more heat-treated than the overall assemblage.

In response to a suggestion for research made in the Scope of Work, Sites 3 and 4 were examined in more detail to determine if the areas to the north and south of the existing roadway exhibited differences in apparent heat-treatment. The Site 3 results are as follows: 94 items north of the road were judged to have been heat-treated; 11 items north of the road were judged as not heat-treated; 71 items south of the road were judged as heat-treated; and 19 items south of the road were judged as not heat-treated. The Site 4 data are as follows: north of the road were 100 heat-treated and 5 not heat-treated items; south of the road were 6 heat-treated and 1 not heat-treated items.

It is apparent that a higher proportion of heat-treated materials was present, on both sites, to the north of the road. This result is surprising; the known brush fires burned only on the <u>south</u> side of the road. This result may be interpreted in several ways. First, our methods for recognition of heat-treatment may be inadequate. Second, brush fires may not affect heat-treatment on archeological scatters. Third, the effect of brush fires may be to <u>obscure</u> heat-treatment by micro-crazing and surface roughening. In any event, patterned contrasts between the burned and unburned portions of the site are weak; they are significant in the statistical sense:

$$(X^2_{\text{Site 3}} = 4.21,\ p \cong 0.04;\ X^2_{\text{Site 4}} \text{ uncalculated})$$

but probably not in the methodological sense.

Color:

Color was observed for all debitage. Color was described as three variables: dominant (most common) color, secondary (next most common) color, and pattern (arrangement) of color. Colors were coded as red, brown, purple-violet, white, and yellow. Color patterns were recorded as banded, graded, or mottled. The banded description was used only when color bands were common, clearly demarked, and prominent. Otherwise, "banded" objects were classed as mottled. Graded was recorded when no clearly demarked color changes at all were present.

Table 9

Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Dominant Color by Locus

Site	Datum	Dominant Color	Angular #	Angular %	Biface Flakes #	Biface Flakes %	Core Flakes #	Core Flakes %	Distal and Segment Flakes #	Distal and Segment Flakes %	Bipolar and Compression Flakes #	Bipolar and Compression Flakes %	Core-Compression Transition Flakes #	Core-Compression Transition Flakes %	Flakes Too Small to Resolve #	Flakes Too Small to Resolve %	Biface-Core Transition Flakes #	Biface-Core Transition Flakes %	Unclassified Flakes #	Unclassified Flakes %	ROW TOTAL	
1	-	B	190	35.78%	7	15.91%	44	24.31%	228	28.64%	59	30.73%	86	28.57%	19	15.97%	5	12.20%	24	21.05%	662	28.55%
		P	92	17.33%	4	9.09%	35	19.34%	135	16.96%	22	11.46%	51	16.94%	24	20.17%	9	21.95%	21	18.42%	393	16.95%
		R	35	6.59%	1	2.27%	9	4.97%	43	5.40%	7	3.65%	11	3.65%	10	8.40%	1	2.44%	6	5.26%	123	5.30%
		W	164	30.89%	31	70.45%	84	46.41%	298	37.44%	89	46.35%	132	43.85%	51	42.86%	24	58.54%	58	50.88%	931	40.15%
		Y	50	9.42%	1	2.27%	9	4.97%	92	11.56%	15	7.81%	21	6.98%	15	12.61%	2	4.88%	5	4.39%	210	9.06%
		Subtotal	531	22.90%	44	1.90%	181	7.81%	796	34.33%	192	8.28%	301	12.98%	119	5.13%	41	1.77%	114	4.92%	2319	100.00%
2	-	B	5	62.50%	0	0.00%	2	22.22%	15	44.12%	0	0.00%	1	20.00%	2	28.57%	0	0.00%	2	50.00%	27	39.13%
		P	1	12.50%	1	100.00%	1	11.11%	11	32.35%	0	0.00%	1	20.00%	1	14.29%	1	100.00%	2	50.00%	19	27.54%
		R	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	20.00%	0	0.00%	0	0.00%	0	0.00%	1	1.45%
		W	2	25.00%	0	0.00%	6	66.67%	6	17.65%	0	0.00%	2	40.00%	3	42.86%	0	0.00%	0	0.00%	19	27.54%
		Y	0	0.00%	0	0.00%	0	0.00%	2	5.88%	0	0.00%	0	0.00%	1	14.29%	0	0.00%	0	0.00%	3	4.35%
		Subtotal	8	11.59%	1	1.45%	9	13.04%	34	49.28%	0	0.00%	5	7.25%	7	10.14%	1	1.45%	4	5.80%	69	100.00%
2	BM R24B	B	8	53.33%	0	0.00%	3	27.27%	7	19.44%	3	60.00%	6	27.27%	0	0.00%	0	0.00%	0	0.00%	27	29.03%
		P	4	26.67%	1	100.00%	5	45.45%	8	22.22%	0	0.00%	3	13.64%	0	0.00%	0	0.00%	0	0.00%	21	22.58%
		R	0	0.00%	0	0.00%	0	0.00%	3	8.33%	0	0.00%	3	13.64%	0	0.00%	0	0.00%	0	0.00%	6	6.45%
		W	3	20.00%	0	0.00%	3	27.27%	15	41.67%	2	40.00%	9	40.91%	2	100.00%	0	0.00%	1	100.00%	35	37.63%
		Y	0	0.00%	0	0.00%	0	0.00%	3	8.33%	0	0.00%	1	4.55%	0	0.00%	0	0.00%	0	0.00%	4	4.30%
		Subtotal	15	21.74%	1	1.45%	11	15.94%	36	52.17%	5	7.25%	22	31.88%	2	2.90%	0	0.00%	1	1.45%	93	100.00%
2	CL 72+00	B	8	30.77%	1	33.33%	5	22.73%	15	32.61%	1	33.33%	7	25.93%	3	42.86%	3	33.33%	2	25.00%	45	29.80%
		P	6	23.08%	0	0.00%	5	22.73%	17	36.96%	2	66.67%	11	40.74%	3	42.86%	1	11.11%	4	50.00%	49	32.45%
		R	2	7.69%	0	0.00%	1	4.55%	3	6.52%	0	0.00%	1	3.70%	0	0.00%	1	11.11%	0	0.00%	8	5.30%
		W	10	38.46%	1	33.33%	9	40.91%	9	19.57%	0	0.00%	8	29.63%	1	14.29%	4	44.44%	2	25.00%	44	29.14%
		Y	0	0.00%	1	33.33%	2	9.09%	2	4.35%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	5	3.31%
		Subtotal	26	37.68%	3	4.35%	22	31.88%	46	66.67%	3	4.35%	27	39.13%	7	10.14%	9	13.04%	8	11.59%	151	100.00%
2	JB	B	23	53.49%	5	22.73%	18	32.73%	68	37.78%	7	50.00%	16	41.03%	6	26.09%	3	23.08%	8	32.00%	154	37.20%
		P	12	27.91%	8	36.36%	21	38.18%	52	28.89%	4	28.57%	11	28.21%	8	34.78%	6	46.15%	9	36.00%	131	31.64%
		R	2	4.65%	2	9.09%	2	3.64%	11	6.11%	1	7.14%	1	2.56%	2	8.70%	0	0.00%	0	0.00%	21	5.07%
		W	3	6.98%	7	31.82%	13	23.64%	36	20.00%	2	14.29%	7	17.95%	6	26.09%	4	30.77%	7	28.00%	85	20.53%
		Y	3	6.98%	0	0.00%	1	1.82%	13	7.22%	0	0.00%	4	10.26%	1	4.35%	0	0.00%	1	4.00%	23	5.56%
		Subtotal	43	62.32%	22	31.88%	55	79.71%	180	260.87%	14	20.29%	39	56.52%	23	33.33%	13	18.84%	25	36.23%	414	100.00%

Table 9 (continued)
Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Dominant Color by Locus

Site	Datum	Dominant Color	Angular #	Angular %	Biface Flakes #	Biface Flakes %	Core Flakes #	Core Flakes %	Distal and Segment Flakes #	Distal and Segment Flakes %	Bipolar and Compression Flakes #	Bipolar and Compression Flakes %	Core-Compression Transition Flakes #	Core-Compression Transition Flakes %	Flakes Too Small to Resolve #	Flakes Too Small to Resolve %	Biface-Core Transition Flakes #	Biface-Core Transition Flakes %	Unclassified Flakes #	Unclassified Flakes %	ROW TOTAL	
2	JE	B	9	36.00%	0	0.00%	4	20.00%	12	24.49%	3	30.00%	6	21.43%	1	20.00%	1	16.67%	3	100.00%	39	26.35%
		P	8	32.00%	0	0.00%	4	20.00%	9	18.37%	4	40.00%	10	35.71%	0	0.00%	0	0.00%	0	0.00%	35	23.65%
		R	3	12.00%	0	0.00%	0	0.00%	5	10.20%	1	10.00%	0	0.00%	3	60.00%	2	33.33%	0	0.00%	14	9.46%
		W	4	16.00%	2	100.00%	11	55.00%	22	44.90%	2	20.00%	12	42.86%	1	20.00%	2	33.33%	0	0.00%	56	37.84%
		Y	1	4.00%	0	0.00%	1	5.00%	1	2.04%	0	0.00%	0	0.00%	0	0.00%	1	16.67%	0	0.00%	4	2.70%
		Subtotal	25	36.23%	2	2.90%	20	28.99%	49	71.01%	10	14.49%	28	40.58%	5	7.25%	6	8.70%	3	4.35%	148	100.00%
2	JR	B	15	25.42%	2	18.18%	6	11.54%	36	25.71%	8	44.44%	12	30.77%	3	17.65%	3	27.27%	3	15.00%	88	23.98%
		P	11	18.64%	2	18.18%	18	34.62%	24	17.14%	2	11.11%	10	25.64%	3	17.65%	2	18.18%	4	20.00%	76	20.71%
		R	10	16.95%	0	0.00%	5	9.62%	14	10.00%	1	5.56%	1	2.56%	1	5.88%	2	18.18%	1	5.00%	35	9.54%
		W	17	28.81%	6	54.55%	20	38.46%	55	39.29%	5	27.78%	16	41.03%	9	52.94%	4	36.36%	11	55.00%	143	38.96%
		Y	6	10.17%	1	9.09%	3	5.77%	11	7.86%	2	11.11%	0	0.00%	1	5.88%	0	0.00%	1	5.00%	25	6.81%
		Subtotal	59	85.51%	11	15.94%	52	75.36%	140	202.90%	18	26.09%	39	56.52%	17	24.64%	11	15.94%	20	28.99%	367	100.00%
2	LT 62+50	B	1	33.33%	0	0.00%	0	0.00%	3	23.08%	0	0.00%	3	50.00%	3	75.00%	0	0.00%	1	100.00%	11	34.38%
		P	0	0.00%	0	0.00%	0	0.00%	4	30.77%	1	100.00%	2	33.33%	0	0.00%	0	0.00%	0	0.00%	7	21.88%
		R	0	0.00%	0	0.00%	0	0.00%	1	7.69%	0	0.00%	1	16.67%	0	0.00%	0	0.00%	0	0.00%	2	6.25%
		W	1	33.33%	0	0.00%	3	75.00%	2	15.38%	0	0.00%	0	0.00%	1	25.00%	0	0.00%	0	0.00%	7	21.88%
		Y	1	33.33%	0	0.00%	1	25.00%	3	23.08%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	5	15.63%
		Subtotal	3	4.35%	0	0.00%	4	5.80%	13	18.84%	1	1.45%	6	8.70%	4	5.80%	0	0.00%	1	1.45%	32	100.00%
2	ST	B	3	18.75%	0	0.00%	1	8.33%	11	45.83%	1	14.29%	2	15.38%	0	0.00%	0	0.00%	0	0.00%	18	22.22%
		P	9	56.25%	3	100.00%	4	33.33%	5	20.83%	2	28.57%	6	46.15%	1	100.00%	1	33.33%	0	0.00%	31	38.27%
		R	2	12.50%	0	0.00%	0	0.00%	1	4.17%	0	0.00%	2	15.38%	0	0.00%	1	33.33%	0	0.00%	6	7.41%
		W	2	12.50%	0	0.00%	7	58.33%	7	29.17%	3	42.86%	3	23.08%	0	0.00%	1	33.33%	1	50.00%	24	29.63%
		Y	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	14.29%	0	0.00%	0	0.00%	0	0.00%	1	50.00%	2	2.47%
		Subtotal	16	23.19%	3	4.35%	12	17.39%	24	34.78%	7	10.14%	13	18.84%	1	1.45%	3	4.35%	2	2.90%	81	100.00%
3		B	7	16.67%	2	18.18%	2	15.38%	13	21.31%	3	30.00%	3	13.64%	3	13.04%	1	14.29%	0	0.00%	34	17.35%
		P	11	26.19%	1	9.09%	3	23.08%	3	4.92%	2	20.00%	4	18.18%	3	13.04%	0	0.00%	2	28.57%	29	14.80%
		R	4	9.52%	0	0.00%	1	7.69%	7	11.48%	0	0.00%	4	18.18%	1	4.35%	2	28.57%	0	0.00%	19	9.69%
		W	19	45.24%	8	72.73%	7	53.85%	33	54.10%	5	50.00%	10	45.45%	16	69.57%	4	57.14%	5	71.43%	107	54.59%
		Y	1	2.38%	0	0.00%	0	0.00%	5	8.20%	0	0.00%	1	4.55%	0	0.00%	0	0.00%	0	0.00%	7	3.57%
		Subtotal	42	60.87%	11	15.94%	13	18.84%	61	88.41%	10	14.49%	22	31.88%	23	33.33%	7	10.14%	7	10.14%	196	100.00%

Table 9 (continued)
Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Dominant Color by Locus

Site	Datum	Dominant Color	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
4	-	B	3	23.08%	0	0.00%	1	8.33%	2	5.71%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	12.50%	7	6.25%
		P	4	30.77%	1	20.00%	1	8.33%	8	22.86%	2	28.57%	8	47.06%	6	46.15%	0	0.00%	1	12.50%	31	27.68%
		R	3	23.08%	0	0.00%	2	16.67%	5	14.29%	0	0.00%	4	23.53%	3	23.08%	0	0.00%	2	25.00%	19	16.96%
		W	3	23.08%	4	80.00%	8	66.67%	19	54.29%	5	71.43%	5	29.41%	4	30.77%	2	100.00%	4	50.00%	54	48.21%
		Y	0	0.00%	0	0.00%	0	0.00%	1	2.86%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	0.89%
		Subtotal	13	18.84%	5	7.25%	12	17.39%	35	50.72%	7	10.14%	17	24.64%	13	18.84%	2	2.90%	8	11.59%	112	100.00%
6	Areas 1 & 2	B	5	62.50%	0	0.00%	0	0.00%	15	46.88%	1	50.00%	0	0.00%	6	31.58%	0	0.00%	0	0.00%	27	42.19%
		P	2	25.00%	0	0.00%	1	50.00%	4	12.50%	0	0.00%	0	0.00%	1	5.26%	0	0.00%	0	0.00%	8	12.50%
		R	0	0.00%	0	0.00%	0	0.00%	2	6.25%	0	0.00%	0	0.00%	1	5.26%	0	0.00%	0	0.00%	3	4.69%
		W	1	12.50%	1	100.00%	1	50.00%	10	31.25%	1	50.00%	0	0.00%	10	52.63%	0	0.00%	0	0.00%	24	37.50%
		Y	0	0.00%	0	0.00%	0	0.00%	1	3.13%	0	0.00%	0	0.00%	1	5.26%	0	0.00%	0	0.00%	2	3.13%
		Subtotal	8	11.59%	1	1.45%	2	2.90%	32	46.38%	2	2.90%	0	0.00%	19	27.54%	0	0.00%	0	0.00%	64	100.00%
6	Area 3	B	15	65.22%	1	14.29%	3	37.50%	40	45.45%	0	0.00%	0	0.00%	28	53.85%	1	50.00%	3	42.86%	91	47.15%
		P	3	13.04%	0	0.00%	2	25.00%	9	10.23%	0	0.00%	0	0.00%	4	7.69%	0	0.00%	0	0.00%	18	9.33%
		R	0	0.00%	1	14.29%	0	0.00%	3	3.41%	0	0.00%	0	0.00%	2	3.85%	1	50.00%	1	14.29%	8	4.15%
		W	5	21.74%	4	57.14%	3	37.50%	26	29.55%	0	0.00%	3	75.00%	13	25.00%	0	0.00%	3	42.86%	57	29.53%
		Y	0	0.00%	1	14.29%	0	0.00%	10	11.36%	2	100.00%	1	25.00%	5	9.62%	0	0.00%	0	0.00%	19	9.84%
		Subtotal	23	33.33%	7	10.14%	8	11.59%	88	127.54%	2	2.90%	4	5.80%	52	75.36%	2	2.90%	7	10.14%	193	100.00%

Dominant colors (Table 9) were variable between assemblages. White was most common (6 of 13 cases), followed by brown (5 of 13) and purple (2 of 13). Second most common dominant colors were brown (6 cases), white (4 cases), and purple (3 cases). Red and yellow were consistently more rare as dominant colors than were any of white, brown, and purple, except in Sites 3, 4, and 6; these are also the sites with high heat treatment levels.

In secondary colors (Table 10), the most common was always brown. In Sites 1 and 2, the second and third most common secondary colors were always purple and white or white and purple. In Sites 3 and 4, and Site 6 Areas 1 and 2, red was either the second or third most common color; again, this may be associated with heat treatment.

No patterns of color frequency differences between artifact classes were found for dominant colors. For secondary colors, collections of Types B, C, and T were found to have, usually, more brown and Types A, I, and S less brown that their overall assemblages.

In color patterning (Table 11), it was found that few objects were coded as banded. Those coded as banded tended to be small and mostly from Types B, S, and T. It may be that this is a perceptual error in definition; small objects which have bands of the same width as larger objects may be, because of their size, more likely to produce an overall impression of "bandedness". Otherwise, no trends in color patterns were found.

Cortex Type:

Analysis of cortex type patterns (Table 12), which were recorded for all debitage as cobble, tabular, or none/don't know, indicated that no strong trends characterized the entire study collection. Tabular cortex tended overall to be more common than cobble cortex, but Site 1 and Site 2 locus JR had more cobble than tabular cortex. Site 4 and Site 2 loci BMR24R, LT 62+50, and ST had no clear dominance by either cortex type.

No clear trends in cortex type could be found within debitage types. Core-compression transitional flakes appear to be dominantly tabular, but the trend is not strong.

It is suspected that our criteria for recognition of cortex type are not fully reliable, leading to poor resolution of this variable.

Table 10
Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Secondary Color by Locus

Site	Datum	Secondary Color	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
1	-	B	204	38.64%	23	52.27%	76	41.99%	322	40.66%	81	42.19%	147	48.84%	46	38.66%	20	48.78%	48	42.11%	967	41.83%
		P	82	15.53%	13	29.55%	55	30.39%	140	17.68%	37	19.27%	67	22.26%	20	16.81%	8	19.51%	25	21.93%	447	19.33%
		R	61	11.55%	6	13.64%	19	10.50%	83	10.48%	22	11.46%	32	10.63%	20	16.81%	5	12.20%	9	7.89%	257	11.12%
		W	110	20.83%	1	2.27%	22	12.15%	146	18.43%	34	17.71%	40	13.29%	17	14.29%	6	14.63%	18	15.79%	394	17.04%
		Y	71	13.45%	1	2.27%	9	4.97%	101	12.75%	18	9.38%	15	4.98%	16	13.45%	2	4.88%	14	12.28%	247	10.68%
		Subtotal	528	22.84%	44	1.90%	181	7.83%	792	34.26%	192	8.30%	301	13.02%	119	5.15%	41	1.77%	114	4.93%	2312	100.00%
2	-	B	3	37.50%	1	100.00%	6	66.67%	7	20.59%	0	0.00%	3	60.00%	1	14.29%	1	100.00%	2	50.00%	24	34.78%
		P	3	37.50%	0	0.00%	0	0.00%	8	23.53%	0	0.00%	0	0.00%	4	57.14%	0	0.00%	0	0.00%	15	21.74%
		R	0	0.00%	0	0.00%	1	11.11%	5	14.71%	0	0.00%	1	20.00%	0	0.00%	0	0.00%	1	25.00%	8	11.59%
		W	1	12.50%	0	0.00%	2	22.22%	8	23.53%	0	0.00%	1	20.00%	1	14.29%	0	0.00%	1	25.00%	14	20.29%
		Y	1	12.50%	0	0.00%	0	0.00%	6	17.65%	0	0.00%	0	0.00%	1	14.29%	0	0.00%	0	0.00%	8	11.59%
		Subtotal	8	11.59%	1	1.45%	9	13.04%	34	49.28%	0	0.00%	5	7.25%	7	10.14%	1	1.45%	4	5.80%	69	100.00%
2	BM R24R	B	6	40.00%	1	100.00%	7	63.64%	18	50.00%	0	0.00%	9	40.91%	2	100.00%	0	0.00%	0	0.00%	43	46.24%
		P	2	13.33%	0	0.00%	1	9.09%	9	25.00%	2	40.00%	8	36.36%	0	0.00%	0	0.00%	0	0.00%	22	23.66%
		R	0	0.00%	0	0.00%	0	0.00%	2	5.56%	1	20.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	3.23%
		W	6	40.00%	0	0.00%	3	27.27%	3	8.33%	2	40.00%	3	13.64%	0	0.00%	0	0.00%	0	0.00%	17	18.28%
		Y	1	6.67%	0	0.00%	0	0.00%	4	11.11%	0	0.00%	2	9.09%	0	0.00%	0	0.00%	1	100.00%	8	8.60%
		Subtotal	15	21.74%	1	1.45%	11	15.94%	36	52.17%	5	7.25%	22	31.88%	2	2.90%	0	0.00%	1	1.45%	93	100.00%
2	CL 72+00	B	13	48.15%	2	66.67%	14	63.64%	22	45.83%	1	33.33%	16	59.26%	3	42.86%	4	44.44%	3	37.50%	78	50.65%
		P	3	11.11%	1	33.33%	4	18.18%	7	14.58%	0	0.00%	6	22.22%	1	14.29%	2	22.22%	1	12.50%	25	16.23%
		R	2	7.41%	0	0.00%	2	9.09%	8	16.67%	0	0.00%	1	3.70%	1	14.29%	0	0.00%	1	12.50%	15	9.74%
		W	6	22.22%	0	0.00%	2	9.09%	7	14.58%	1	33.33%	3	11.11%	0	0.00%	1	11.11%	2	25.00%	22	14.29%
		Y	3	11.11%	0	0.00%	0	0.00%	4	8.33%	1	33.33%	1	3.70%	2	28.57%	2	22.22%	1	12.50%	14	9.09%
		Subtotal	27	39.13%	3	4.35%	22	31.88%	48	69.57%	3	4.35%	27	39.13%	7	10.14%	9	13.04%	8	11.59%	154	100.00%
2	JB	B	19	44.19%	7	31.82%	29	50.00%	67	37.22%	5	35.71%	13	33.33%	8	34.78%	8	61.54%	10	40.00%	166	39.81%
		P	11	25.58%	6	27.27%	9	15.52%	35	19.44%	1	7.14%	10	25.64%	6	26.09%	0	0.00%	7	28.00%	85	20.38%
		R	3	6.98%	2	9.09%	7	12.07%	18	10.00%	3	21.43%	7	17.95%	4	17.39%	1	7.69%	5	20.00%	50	11.99%
		W	8	18.60%	6	27.27%	9	15.52%	44	24.44%	4	28.57%	6	15.38%	3	13.04%	4	30.77%	2	8.00%	86	20.62%
		Y	2	4.65%	1	4.55%	4	6.90%	16	8.89%	1	7.14%	3	7.69%	2	8.70%	0	0.00%	1	4.00%	30	7.19%
		Subtotal	43	62.32%	22	31.88%	58	84.06%	180	260.87%	14	20.29%	39	56.52%	23	33.33%	13	18.84%	25	36.23%	417	100.00%

Table 10 (continued)
Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Secondary Color by Locus

Site	Datum	Secondary Color	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
======	=====	=========	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	=======	
2	JE	B	8	32.00%	1	50.00%	9	45.00%	22	44.90%	7	70.00%	19	67.86%	1	20.00%	3	50.00%	0	0.00%	70	47.30%
		P	8	32.00%	1	50.00%	4	20.00%	12	24.49%	0	0.00%	4	14.29%	0	0.00%	1	16.67%	0	0.00%	30	20.27%
		R	1	4.00%	0	0.00%	4	20.00%	3	6.12%	1	10.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	9	6.08%
		W	6	24.00%	0	0.00%	1	5.00%	8	16.33%	2	20.00%	5	17.86%	3	60.00%	2	33.33%	2	66.67%	29	19.59%
		Y	2	8.00%	0	0.00%	2	10.00%	4	8.16%	0	0.00%	0	0.00%	1	20.00%	0	0.00%	1	33.33%	10.	6.76%
		Subtotal	25	36.23%	2	2.90%	20	28.99%	49	71.01%	10	14.49%	28	40.58%	5	7.25%	6	8.70%	3	4.35%	148	100.00%
2	JR	B	19	32.20%	5	45.45%	28	53.85%	70	50.00%	8	44.44%	19	48.72%	7	38.89%	5	45.45%	11	55.00%	172	46.74%
		P	13	22.03%	3	27.27%	6	11.54%	26	18.57%	3	16.67%	7	17.95%	3	16.67%	4	36.36%	5	25.00%	70	19.02%
		R	13	22.03%	2	18.18%	9	17.31%	13	9.29%	2	11.11%	4	10.26%	3	16.67%	1	9.09%	4	20.00%	51	13.86%
		W	10	16.95%	0	0.00%	7	13.46%	24	17.14%	3	16.67%	7	17.95%	4	22.22%	0	0.00%	0	0.00%	55	14.95%
		Y	4	6.78%	1	9.09%	2	3.85%	7	5.00%	2	11.11%	2	5.13%	1	5.56%	1	9.09%	0	0.00%	20	5.43%
		Subtotal	59	85.51%	11	15.94%	52	75.36%	140	202.90%	18	26.09%	39	56.52%	18	26.09%	11	15.94%	20	28.99%	368	100.00%
2	LT 62+50	B	2	66.67%	0	0.00%	3	75.00%	5	38.46%	1	100.00%	1	16.67%	1	25.00%	0	0.00%	13	40.63%	26	41.27%
		P	1	33.33%	0	0.00%	1	25.00%	2	15.38%	0	0.00%	0	0.00%	2	50.00%	0	0.00%	7	21.88%	13	20.63%
		R	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	33.33%	0	0.00%	0	0.00%	2	6.25%	4	6.35%
		W	0	0.00%	0	0.00%	0	0.00%	3	23.08%	0	0.00%	1	16.67%	1	25.00%	0	0.00%	5	15.63%	10	15.87%
		Y	0	0.00%	0	0.00%	0	0.00%	3	23.08%	0	0.00%	2	33.33%	0	0.00%	0	0.00%	5	15.63%	10	15.87%
		Subtotal	3	4.35%	0	0.00%	4	5.80%	13	18.84%	1	1.45%	6	8.70%	4	5.80%	0	0.00%	32	46.38%	63	100.00%
2	ST	B	11	68.75%	1	33.33%	7	58.33%	9	37.50%	2	28.57%	8	61.54%	0	0.00%	3	100.00%	2	100.00%	43	53.09%
		P	3	18.75%	0	0.00%	4	33.33%	6	25.00%	2	28.57%	2	15.38%	0	0.00%	0	0.00%	0	0.00%	17	20.99%
		R	0	0.00%	0	0.00%	0	0.00%	4	16.67%	0	0.00%	1	7.69%	1	100.00%	0	0.00%	0	0.00%	6	7.41%
		W	1	6.25%	1	33.33%	0	0.00%	3	12.50%	1	14.29%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	6	7.41%
		Y	1	6.25%	1	33.33%	1	8.33%	2	8.33%	2	28.57%	2	15.38%	0	0.00%	0	0.00%	0	0.00%	9	11.11%
		Subtotal	16	23.19%	3	4.35%	12	17.39%	24	34.78%	7	10.14%	13	18.84%	1	1.45%	3	4.35%	2	2.90%	81	100.00%
3	-	B	25	59.52%	5	45.45%	7	53.85%	28	45.90%	5	50.00%	8	36.36%	12	52.17%	4	57.14%	5	62.50%	99	50.25%
		P	7	16.67%	3	27.27%	2	15.38%	11	18.03%	3	30.00%	6	27.27%	3	13.04%	0	0.00%	0	0.00%	35	17.77%
		R	4	9.52%	1	9.09%	2	15.38%	11	18.03%	1	10.00%	5	22.73%	4	17.39%	0	0.00%	1	12.50%	29	14.72%
		W	4	9.52%	1	9.09%	2	15.38%	9	14.75%	1	10.00%	1	4.55%	2	8.70%	3	42.86%	0	0.00%	23	11.68%
		Y	2	4.76%	1	9.09%	0	0.00%	2	3.28%	0	0.00%	2	9.09%	2	8.70%	0	0.00%	2	25.00%	11	5.58%
		Subtotal	42	60.87%	11	15.94%	13	18.84%	61	88.41%	10	14.49%	22	31.88%	23	33.33%	7	10.14%	8	11.59%	197	100.00%

Table 10 (continued)
Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Secondary Color by Locus

Site	Datum	Secondary Color	Angular #	Angular %	Biface Flakes #	Biface Flakes %	Core Flakes #	Core Flakes %	Distal and Segment Flakes #	Distal and Segment Flakes %	Bipolar and Compression Flakes #	Bipolar and Compression Flakes %	Core-Compression Transition Flakes #	Core-Compression Transition Flakes %	Flakes Too Small to Resolve #	Flakes Too Small to Resolve %	Biface-Core Transition Flakes #	Biface-Core Transition Flakes %	Unclassified Flakes #	Unclassified Flakes %	ROW TOTAL	
4	-	B	5	38.46%	2	40.00%	3	25.00%	18	51.43%	3	42.86%	4	23.53%	2	15.38%	1	50.00%	2	25.00%	40	35.71%
		P	2	15.38%	0	0.00%	4	33.33%	4	11.43%	1	14.29%	1	5.88%	4	30.77%	0	0.00%	2	25.00%	18	16.07%
		R	2	15.38%	2	40.00%	5	41.67%	6	17.14%	2	28.57%	4	23.53%	5	38.46%	0	0.00%	1	12.50%	27	24.11%
		W	4	30.77%	1	20.00%	0	0.00%	7	20.00%	1	14.29%	6	35.29%	2	15.38%	0	0.00%	2	25.00%	23	20.54%
		Y	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	11.76%	0	0.00%	1	50.00%	1	12.50%	4	3.57%
		Subtotal	13	18.84%	5	7.25%	12	17.39%	35	50.72%	7	10.14%	17	24.64%	13	18.84%	2	2.90%	8	11.59%	112	100.00%
6	Areas 1 & 2	B	4	44.44%	1	100.00%	2	100.00%	10	31.25%	2	100.00%	0	0.00%	7	36.84%	0	0.00%	0	0.00%	26	40.00%
		P	0	0.00%	0	0.00%	0	0.00%	4	12.50%	0	0.00%	0	0.00%	4	21.05%	0	0.00%	0	0.00%	8	12.31%
		R	0	0.00%	0	0.00%	0	0.00%	5	15.63%	0	0.00%	0	0.00%	4	21.05%	0	0.00%	0	0.00%	9	13.85%
		W	1	11.11%	0	0.00%	0	0.00%	11	34.38%	0	0.00%	0	0.00%	3	15.79%	0	0.00%	0	0.00%	15	23.08%
		Y	4	44.44%	0	0.00%	0	0.00%	2	6.25%	0	0.00%	0	0.00%	1	5.26%	0	0.00%	0	0.00%	7	10.77%
		Subtotal	9	13.04%	1	1.45%	2	2.90%	32	46.38%	2	2.90%	0	0.00%	19	27.54%	0	0.00%	0	0.00%	65	100.00%
6	Area 3	B	1	4.35%	3	42.86%	1	12.50%	33	37.50%	2	100.00%	2	50.00%	16	30.77%	1	50.00%	2	28.57%	61	31.61%
		P	10	43.48%	1	14.29%	2	25.00%	21	23.86%	0	0.00%	0	0.00%	6	11.54%	0	0.00%	2	28.57%	42	21.76%
		R	4	17.39%	1	14.29%	4	50.00%	6	6.82%	0	0.00%	2	50.00%	9	17.31%	1	50.00%	2	28.57%	29	15.03%
		W	3	13.04%	2	28.57%	1	12.50%	12	13.64%	0	0.00%	0	0.00%	8	15.38%	0	0.00%	0	0.00%	26	13.47%
		Y	5	21.74%	0	0.00%	0	0.00%	16	18.18%	0	0.00%	0	0.00%	13	25.00%	0	0.00%	1	14.29%	35	18.13%
		Subtotal	23	33.33%	7	10.14%	8	11.59%	88	127.54%	2	2.90%	4	5.80%	52	75.36%	2	2.90%	7	10.14%	193	100.00%

Table 11. Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Pattern of Color by Locus

Site	Datum	Pattern of Color	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
1	-	B	18	3.39%	3	6.82%	17	9.39%	41	5.15%	24	12.57%	26	8.64%	6	5.04%	3	7.32%	10	8.77%	148	6.38%
		G	125	23.54%	5	11.36%	34	18.78%	163	20.48%	21	10.99%	43	14.29%	31	26.05%	6	14.63%	19	16.67%	447	19.28%
		M	388	73.07%	36	81.82%	130	71.82%	592	74.37%	146	76.44%	232	77.08%	82	68.91%	32	78.05%	85	74.56%	1723	74.33%
		Subtotal	531	22.91%	44	1.90%	181	7.81%	796	34.34%	191	8.24%	301	12.99%	119	5.13%	41	1.77%	114	4.92%	2318	100.00%
2	-	G	4	50.00%	0	0.00%	0	0.00%	14	41.18%	0	0.00%	2	40.00%	0	0.00%	0	0.00%	1	25.00%	21	30.43%
		M	4	50.00%	1	100.00%	9	100.00%	20	58.82%	0	0.00%	3	60.00%	7	100.00%	1	100.00%	3	75.00%	48	69.57%
		Subtotal	8	11.59%	1	1.45%	9	13.04%	34	49.28%	0	0.00%	5	7.25%	7	10.14%	1	1.45%	4	5.80%	69	100.00%
2	BM R24R	B	1	6.67%	0	0.00%	0	0.00%	1	2.78%	0	0.00%	2	9.09%	0	0.00%	0	0.00%	0	0.00%	4	4.30%
		G	5	33.33%	0	0.00%	6	54.55%	6	16.67%	1	20.00%	5	22.73%	1	50.00%	0	0.00%	1	100.00%	25	26.88%
		M	9	60.00%	1	100.00%	5	45.45%	29	80.56%	4	80.00%	15	68.18%	1	50.00%	0	0.00%	0	0.00%	64	68.82%
		Subtotal	15	16.13%	1	1.08%	11	11.83%	36	38.71%	5	5.38%	22	23.66%	2	2.15%	0	0.00%	1	1.08%	93	100.00%
2	CL 72+00	B	0	0.00%	0	0.00%	1	4.55%	2	4.17%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	1.95%
		G	6	22.22%	3	100.00%	7	31.82%	15	31.25%	0	0.00%	14	51.85%	2	28.57%	1	11.11%	6	75.00%	54	35.06%
		M	21	77.78%	0	0.00%	14	63.64%	31	64.58%	3	100.00%	13	48.15%	5	71.43%	8	88.89%	2	25.00%	97	62.99%
		Subtotal	27	17.53%	3	1.95%	22	14.29%	48	31.17%	3	1.95%	27	17.53%	7	4.55%	9	5.84%	8	5.19%	154	100.00%
2	JB	B	0	0.00%	0	0.00%	0	0.00%	4	2.22%	0	0.00%	1	2.56%	0	0.00%	0	0.00%	0	0.00%	5	1.21%
		G	21	48.84%	3	13.64%	17	30.91%	54	30.00%	5	35.71%	11	28.21%	8	34.78%	5	38.46%	11	44.00%	135	32.61%
		M	22	51.16%	19	86.36%	38	69.09%	122	67.78%	9	64.29%	27	69.23%	15	65.22%	8	61.54%	14	56.00%	274	66.18%
		Subtotal	43	10.39%	22	5.31%	55	13.29%	180	43.48%	14	3.38%	39	9.42%	23	5.56%	13	3.14%	25	6.04%	414	100.00%
2	JE	B	0	0.00%	0	0.00%	1	5.00%	2	4.08%	0	0.00%	3	10.71%	0	0.00%	1	16.67%	0	0.00%	7	4.73%
		G	7	28.00%	0	0.00%	3	15.00%	12	24.49%	3	30.00%	5	17.86%	0	0.00%	2	33.33%	1	33.33%	33	22.30%
		M	18	72.00%	2	100.00%	16	80.00%	35	71.43%	7	70.00%	20	71.43%	5	100.00%	3	50.00%	2	66.67%	108	72.97%
		Subtotal	25	16.89%	2	1.35%	20	13.51%	49	33.11%	10	6.76%	28	18.92%	5	3.38%	6	4.05%	3	2.03%	148	100.00%
2	JR	B	1	1.69%	0	0.00%	2	3.85%	2	1.43%	0	0.00%	1	2.56%	0	0.00%	1	9.09%	1	5.00%	8	2.18%
		G	13	22.03%	5	45.45%	17	32.69%	46	32.86%	6	33.33%	13	33.33%	4	23.53%	6	54.55%	5	25.00%	115	31.34%
		M	45	76.27%	6	54.55%	33	63.46%	92	65.71%	12	66.67%	25	64.10%	13	76.47%	4	36.36%	14	70.00%	244	66.49%
		Subtotal	59	16.08%	11	3.00%	52	14.17%	140	38.15%	18	4.90%	39	10.63%	17	4.63%	11	3.00%	20	5.45%	367	100.00%

Table 11. Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Cortex Type by Locus (continued)

Site	Datum	Pattern of Color	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
2	LT 62+50	B	0	0.00%	0	0.00%	1	25.00%	0	0.00%	0	0.00%	1	16.67%	1	25.00%	0	0.00%	0	0.00%	3	9.38%
		G	1	33.33%	0	0.00%	1	25.00%	3	23.08%	0	0.00%	1	16.67%	0	0.00%	0	0.00%	1	100.00%	7	21.88%
		M	2	66.67%	0	0.00%	2	50.00%	10	76.92%	1	100.00%	4	66.67%	3	75.00%	0	0.00%	0	0.00%	22	68.75%
		Subtotal	3	9.38%	0	0.00%	4	12.50%	13	40.63%	1	3.13%	6	18.75%	4	12.50%	0	0.00%	1	3.13%	32	100.00%
2	ST	B	0	0.00%	1	33.33%	0	0.00%	2	8.33%	0	0.00%	1	7.69%	0	0.00%	0	0.00%	0	0.00%	4	4.94%
		G	10	62.50%	0	0.00%	5	41.67%	13	54.17%	2	28.57%	3	23.08%	0	0.00%	3	100.00%	1	50.00%	37	45.68%
		M	6	37.50%	2	66.67%	7	58.33%	9	37.50%	5	71.43%	9	69.23%	1	100.00%	0	0.00%	1	50.00%	40	49.38%
		Subtotal	16	19.75%	3	3.70%	12	14.81%	24	29.63%	7	8.64%	13	16.05%	1	1.23%	3	3.70%	2	2.47%	81	100.00%
3	-	B	4	9.52%	1	9.09%	0	0.00%	2	3.28%	0	0.00%	0	0.00%	2	8.70%	0	0.00%	0	0.00%	9	4.59%
		G	8	19.05%	0	0.00%	0	0.00%	3	4.92%	0	0.00%	1	4.55%	2	8.70%	0	0.00%	0	0.00%	14	7.14%
		M	30	71.43%	10	90.91%	13	100.00%	56	91.80%	10	100.00%	21	95.45%	19	82.61%	7	100.00%	7	100.00%	173	88.27%
		Subtotal	42	21.43%	11	5.61%	13	6.63%	61	31.12%	10	5.10%	22	11.22%	23	11.73%	7	3.57%	7	3.57%	196	100.00%
4	-	B	0	0.00%	0	0.00%	2	16.67%	1	2.86%	0	0.00%	0	0.00%	1	7.69%	0	0.00%	0	0.00%	4	3.51%
		G	0	0.00%	0	0.00%	1	8.33%	1	2.86%	0	0.00%	3	17.65%	4	30.77%	0	0.00%	2	20.00%	11	9.65%
		M	13	100.00%	5	100.00%	9	75.00%	33	94.29%	7	100.00%	14	82.35%	8	61.54%	2	100.00%	8	80.00%	99	86.84%
		Subtotal	13	11.40%	5	4.39%	12	10.53%	35	30.70%	7	6.14%	17	14.91%	13	11.40%	2	1.75%	10	8.77%	114	100.00%
6	Areas 1 & 2	B	0	0.00%	0	0.00%	0	0.00%	3	9.38%	0	0.00%	0	0.00%	1	5.26%	0	0.00%	0	0.00%	4	6.25%
		G	4	50.00%	1	50.00%	0	0.00%	8	25.00%	0	0.00%	0	0.00%	4	21.05%	0	0.00%	0	0.00%	17	26.56%
		M	4	50.00%	1	50.00%	1	100.00%	21	65.63%	2	100.00%	0	0.00%	14	73.68%	0	0.00%	0	0.00%	43	67.19%
		Subtotal	8	12.50%	2	3.13%	1	1.56%	32	50.00%	2	3.13%	0	0.00%	19	29.69%	0	0.00%	0	0.00%	64	100.00%
6	Area 3	B	0	0.00%	0	0.00%	0	0.00%	4	4.55%	0	0.00%	0	0.00%	4	7.69%	0	0.00%	0	0.00%	8	4.15%
		G	13	56.52%	0	0.00%	2	25.00%	34	38.64%	1	50.00%	1	25.00%	19	36.54%	1	50.00%	3	42.86%	74	38.34%
		M	10	43.48%	7	100.00%	6	75.00%	50	56.82%	1	50.00%	3	75.00%	29	55.77%	1	50.00%	4	57.14%	111	57.51%
		Subtotal	23	11.92%	7	3.63%	8	4.15%	88	45.60%	2	1.04%	4	2.07%	52	26.94%	2	1.04%	7	3.63%	193	100.00%

Table 12. Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Cortex Type by Locus

Site	Datum	Cortex Type	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
1	-	C	159	29.94%	2	4.55%	57	31.49%	218	27.39%	69	35.94%	123	40.86%	18	15.13%	10	24.39%	27	23.68%	683	29.45%
		N	270	50.85%	34	77.27%	60	33.15%	427	53.64%	83	43.23%	111	36.88%	87	73.11%	23	56.10%	71	62.28%	1166	50.28%
		T	102	19.21%	8	18.18%	64	35.36%	151	18.97%	40	20.83%	67	22.26%	14	11.76%	8	19.51%	16	14.04%	470	20.27%
		Subtotal	531	22.90%	44	1.90%	181	7.81%	796	34.33%	192	8.28%	301	12.98%	119	5.13%	41	1.77%	114	4.92%	2319	100.00%
2	-	C	1	12.50%	0	0.00%	0	0.00%	3	8.82%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	4	5.71%
		N	6	75.00%	1	50.00%	7	77.78%	27	79.41%	0	0.00%	3	60.00%	6	85.71%	1	100.00%	4	100.00%	55	78.57%
		T	1	12.50%	1	50.00%	2	22.22%	4	11.76%	0	0.00%	2	40.00%	1	14.29%	0	0.00%	0	0.00%	11	15.71%
		Subtotal	8	11.43%	2	2.86%	9	12.86%	34	48.57%	0	0.00%	5	7.14%	7	10.00%	1	1.43%	4	5.71%	70	100.00%
2	BM R24R	C	2	13.33%	0	0.00%	5	45.45%	6	16.67%	2	40.00%	3	13.64%	0	0.00%	0	0.00%	0	0.00%	18	19.35%
		N	9	60.00%	1	100.00%	3	27.27%	26	72.22%	2	40.00%	9	40.91%	2	100.00%	0	0.00%	1	100.00%	53	56.99%
		T	4	26.67%	0	0.00%	3	27.27%	4	11.11%	1	20.00%	10	45.45%	0	0.00%	0	0.00%	0	0.00%	22	23.66%
		Subtotal	15	16.13%	1	1.08%	11	11.83%	36	38.71%	5	5.38%	22	23.66%	2	2.15%	0	0.00%	1	1.08%	93	100.00%
2	CL 72+00	C	6	22.22%	0	0.00%	3	13.64%	5	10.42%	1	33.33%	5	18.52%	1	14.29%	1	11.11%	1	12.50%	23	14.94%
		N	17	62.96%	2	66.67%	11	50.00%	35	72.92%	2	66.67%	13	48.15%	5	71.43%	7	77.78%	7	87.50%	99	64.29%
		T	4	14.81%	1	33.33%	8	36.36%	8	16.67%	0	0.00%	9	33.33%	1	14.29%	1	11.11%	0	0.00%	32	20.78%
		Subtotal	27	17.53%	3	1.95%	22	14.29%	48	31.17%	3	1.95%	27	17.53%	7	4.55%	9	5.84%	8	5.19%	154	100.00%
2	JB	C	3	6.98%	0	0.00%	10	18.18%	19	10.56%	2	14.29%	5	12.82%	1	4.35%	1	7.69%	2	8.00%	43	10.39%
		N	26	60.47%	21	95.45%	34	61.82%	126	70.00%	6	42.86%	17	43.59%	19	82.61%	11	84.62%	20	80.00%	280	67.63%
		T	14	32.56%	1	4.55%	11	20.00%	35	19.44%	6	42.86%	17	43.59%	3	13.04%	1	7.69%	3	12.00%	91	21.98%
		Subtotal	43	10.39%	22	5.31%	55	13.29%	180	43.48%	14	3.38%	39	9.42%	23	5.56%	13	3.14%	25	6.04%	414	100.00%
2	JE	C	5	20.00%	0	0.00%	2	10.00%	7	14.29%	0	0.00%	4	14.29%	0	0.00%	0	0.00%	1	33.33%	19	12.84%
		N	11	44.00%	2	100.00%	12	60.00%	28	57.14%	7	70.00%	13	46.43%	5	100.00%	6	100.00%	1	33.33%	85	57.43%
		T	9	36.00%	0	0.00%	6	30.00%	14	28.57%	3	30.00%	11	39.29%	0	0.00%	0	0.00%	1	33.33%	44	29.73%
		Subtotal	25	16.89%	2	1.35%	20	13.51%	49	33.11%	10	6.76%	28	18.92%	5	3.38%	6	4.05%	3	2.03%	148	100.00%
2	JR	C	16	27.12%	1	9.09%	11	21.15%	24	17.14%	4	22.22%	5	12.82%	1	5.56%	2	18.18%	4	20.00%	68	18.48%
		N	31	52.54%	8	72.73%	32	61.54%	97	69.29%	12	66.67%	27	69.23%	15	83.33%	9	81.82%	15	75.00%	246	66.85%
		T	12	20.34%	2	18.18%	9	17.31%	19	13.57%	2	11.11%	7	17.95%	2	11.11%	0	0.00%	1	5.00%	54	14.67%
		Subtotal	59	16.03%	11	2.99%	52	14.13%	140	38.04%	18	4.89%	39	10.60%	18	4.89%	11	2.99%	20	5.43%	368	100.00%

Table 12. Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Cortex Type by Locus (continued)

Site	Datum	Cortex Type	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
2	LT 62+50	C	0	0.00%	0	0.00%	2	50.00%	2	15.38%	0	0.00%	1	16.67%	0	0.00%	0	0.00%	0	0.00%	5	15.63%
		N	3	100.00%	0	0.00%	2	50.00%	9	69.23%	0	0.00%	2	33.33%	4	100.00%	0	0.00%	0	0.00%	20	62.50%
		T	0	0.00%	0	0.00%	0	0.00%	2	15.38%	1	100.00%	3	50.00%	0	0.00%	0	0.00%	1	100.00%	7	21.88%
		Subtotal	3	9.38%	0	0.00%	4	12.50%	13	40.63%	1	3.13%	6	18.75%	4	12.50%	0	0.00%	1	3.13%	32	100.00%
2	ST	C	6	37.50%	0	0.00%	5	41.67%	3	12.50%	0	0.00%	2	15.38%	0	0.00%	0	0.00%	0	0.00%	16	19.75%
		N	7	43.75%	3	100.00%	4	33.33%	16	66.67%	5	71.43%	9	69.23%	1	100.00%	2	66.67%	2	100.00%	49	60.49%
		T	3	18.75%	0	0.00%	3	25.00%	5	20.83%	2	28.57%	2	15.38%	0	0.00%	1	33.33%	0	0.00%	16	19.75%
		Subtotal	16	19.75%	3	3.70%	12	14.81%	24	29.63%	7	8.64%	13	16.05%	1	1.23%	3	3.70%	2	2.47%	81	100.00%
3	-	C	3	7.14%	0	0.00%	0	0.00%	4	7.69%	1	10.00%	2	9.09%	0	0.00%	1	14.29%	0	0.00%	11	5.88%
		N	31	73.81%	11	100.00%	7	53.85%	34	65.38%	7	70.00%	15	68.18%	19	82.61%	4	57.14%	7	100.00%	135	72.19%
		T	8	19.05%	0	0.00%	6	46.15%	14	26.92%	2	20.00%	5	22.73%	4	17.39%	2	28.57%	0	0.00%	41	21.93%
		Subtotal	42	22.46%	11	5.88%	13	6.95%	52	27.81%	10	5.35%	22	11.76%	23	12.30%	7	3.74%	7	3.74%	187	100.00%
4	-	C	1	7.69%	1	20.00%	1	8.33%	3	10.34%	2	28.57%	3	17.65%	0	0.00%	0	0.00%	2	25.00%	13	12.26%
		N	10	76.92%	4	80.00%	9	75.00%	25	86.21%	3	42.86%	10	58.82%	12	92.31%	1	50.00%	6	75.00%	80	75.47%
		T	2	15.38%	0	0.00%	2	16.67%	1	3.45%	2	28.57%	4	23.53%	1	7.69%	1	50.00%	0	0.00%	13	12.26%
		Subtotal	13	12.26%	5	4.72%	12	11.32%	29	27.36%	7	6.60%	17	16.04%	13	12.26%	2	1.89%	8	7.55%	106	100.00%
6	Areas 1 & 2	C	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
		N	7	87.50%	1	100.00%	2	100.00%	29	90.63%	2	100.00%	14	82.35%	2	100.00%	0	0.00%	0	0.00%	57	89.06%
		T	1	12.50%	0	0.00%	0	0.00%	3	9.38%	0	0.00%	3	17.65%	0	0.00%	0	0.00%	0	0.00%	7	10.34%
		Subtotal	8	12.50%	1	1.56%	2	3.13%	32	50.00%	2	3.13%	17	26.56%	2	3.13%	0	0.00%	0	0.00%	64	100.00%
6	Area 3	C	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	14.29%	1	0.52%
		N	19	82.61%	5	71.43%	4	50.00%	74	84.09%	1	50.00%	3	75.00%	42	80.77%	2	100.00%	5	71.43%	155	80.31%
		T	4	17.39%	2	28.57%	4	50.00%	14	15.91%	1	50.00%	1	25.00%	10	19.23%	0	0.00%	1	14.29%	37	19.17%
		Subtotal	23	11.92%	7	3.63%	8	4.15%	88	45.60%	2	1.04%	4	2.07%	52	26.94%	2	1.04%	7	3.63%	193	100.00%

Rework on Debitage:

Rework, recorded as the number of different levels of patination/ recortication on surfaces, was assessed for all debitage (Table 13). The results indicate (1) clear contrastive patterning between mechanically defined types considered over all assemblages, (2) no clear patterning in rework within individual assemblages, and (3) contrasting broad patterns in rework levels between sites or loci.

Overall, angular debris, bipolar-compression flakes, and core-compression transitional flakes (Types A, J, and Q) exhibited substantially more frequent rework than did core flakes and unclassified flakes (Types C and U). Still less heavily reworked were distal flakes and flake segments (Type I); this type nearly always displayed the same levels of rework as did its overall parent assemblages. Most rarely reworked were biface flakes, biface-core transition flakes, and small flakes (Types B, T, and S).

This pattern was not expected. Rather, it was expected that Types B, T, and S would display higher rework due to natural post-depositional damage. This pattern may suggest that relatively thick, heavy objects were deliberately and preferentially selected for rework; no natural process is known which would consistently damage smaller, more delicate flakes <u>less often</u> than it damaged the thick types, A, J, and Q.

Assemblages having high overall rework levels included Site 1 and Site 2 loci BMR24R, JE, JR, and LT 62+50. Low levels of rework were characteristic of Site 2 locus blank, of Site 4, and of all three areas of Site 6. Site 2 loci CL 72+00, JB, and ST, and Site 3 had intermediate rework levels.

Length of Debitage:

The descriptive dimensional variables (length, width, weight, and type) were fully discussed above, in the course of presentation of the mechanical classification methodology. In that discussion, <u>length</u> and <u>width</u> were combined to form <u>area</u> with further discussion in terms of area only.

In order to examine the possibility that use of area in this analysis had obscured important variation, length was also analyzed singly (Table 14). Length patterns were found within the study collection in terms of differences between mechanically defined types and also in terms of differences between assemblages.

Central tendencies in length fall into three groups for the overall study collection. High length values (means of 37-50 mm) characterize Types Q, A, C, and J. Lower length values (means of

Table 13. Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Rework by Locus

Site	Datum	Rework Level	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes		ROW TOTAL	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
1	-	0	273	51.41%	36	81.82%	129	71.27%	510	64.07%	98	51.04%	154	51.16%	94	78.99%	35	85.37%	84	73.68%	1413	60.93%
		1	245	46.14%	8	18.18%	51	28.18%	268	33.67%	87	45.31%	140	46.51%	25	21.01%	5	12.20%	30	26.32%	859	37.04%
		2	13	2.45%	0	0.00%	1	0.55%	18	2.26%	7	3.65%	6	1.99%	0	0.90%	1	2.44%	0	0.00%	46	1.98%
		3	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	0.33%	0	0.00%	0	0.00%	0	0.00%	1	0.04%
		Subtotal	531	22.90%	44	1.90%	181	7.81%	796	34.33%	192	8.28%	301	12.98%	119	5.13%	41	1.77%	114	4.92%	2319	100.00%
2	-	0	5	62.50%	1	100.00%	9	100.00%	28	82.35%	0	0.00%	2	40.00%	6	85.71%	1	100.00%	2	50.00%	54	78.26%
		1	3	37.50%	0	0.00%	0	0.00%	6	17.65%	0	0.00%	3	60.00%	1	14.29%	0	0.00%	2	50.00%	15	21.74%
		Subtotal	8	11.59%	1	1.45%	9	13.04%	34	49.28%	0	0.00%	5	7.25%	7	10.14%	1	1.45%	4	5.80%	69	100.00%
2	BM R24R	0	5	33.33%	1	0.00%	9	81.82%	27	75.00%	3	60.00%	12	54.55%	2	100.00%	0	0.00%	0	0.00%	59	63.44%
		1	9	60.00%	0	0.00%	2	18.18%	9	25.00%	2	40.00%	10	45.45%	0	0.00%	0	0.00%	1	100.00%	33	35.48%
		2	1	6.67%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1.08%
		Subtotal	15	16.13%	1	1.08%	11	11.83%	36	38.71%	5	5.38%	22	23.66%	2	2.15%	0	0.00%	1	1.08%	93	100.00%
2	CL 72+00	0	15	55.56%	3	100.00%	17	77.27%	35	72.92%	2	66.67%	15	55.56%	6	85.71%	9	100.00%	6	75.00%	108	70.13%
		1	9	33.33%	0	0.00%	5	22.73%	13	27.08%	1	33.33%	12	44.44%	1	14.29%	0	0.00%	2	25.00%	43	27.92%
		2	3	11.11%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	1.95%
		Subtotal	27	17.53%	3	1.95%	22	14.29%	48	31.17%	3	1.95%	27	17.53%	7	4.55%	9	5.84%	8	5.19%	154	100.00%
2	JB	0	20	46.51%	21	95.45%	38	69.09%	134	74.44%	7	50.00%	19	48.72%	21	91.30%	10	76.92%	21	84.00%	291	70.29%
		1	23	53.49%	1	4.55%	17	30.91%	45	25.00%	7	50.00%	19	48.72%	2	8.70%	3	23.08%	4	16.00%	121	29.23%
		2	0	0.00%	0	0.00%	0	0.00%	1	0.56%	0	0.00%	1	2.56%	0	0.00%	0	0.00%	0	0.00%	2	0.48%
		Subtotal	43	10.39%	22	5.31%	55	13.29%	180	43.48%	14	3.38%	39	9.42%	23	5.56%	13	3.14%	25	6.04%	414	100.00%
2	JE	0	16	64.00%	2	100.00%	13	65.00%	34	69.39%	3	30.00%	11	39.29%	3	60.00%	6	100.00%	3	100.00%	91	61.49%
		1	8	32.00%	0	0.00%	7	35.00%	13	26.53%	7	70.00%	14	50.00%	2	40.00%	0	0.00%	0	0.00%	51	34.46%
		2	1	4.00%	0	0.00%	0	0.00%	2	4.08%	0	0.00%	3	10.71%	0	0.00%	0	0.00%	0	0.00%	6	4.05%
		Subtotal	25	16.89%	2	1.35%	20	13.51%	49	33.11%	10	6.76%	28	18.92%	5	3.38%	6	4.05%	3	2.03%	148	100.00%
2	JR	0	23	38.98%	9	81.82%	36	69.23%	92	65.71%	6	33.33%	19	48.72%	14	77.78%	9	81.82%	11	55.00%	219	59.51%
		1	31	52.54%	2	18.18%	16	30.77%	46	32.86%	12	66.67%	20	51.28%	4	22.22%	2	18.18%	9	45.00%	142	38.59%
		2	5	8.47%	0	0.00%	0	0.00%	2	1.43%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	7	1.90%
		Subtotal	59	16.03%	11	2.99%	52	14.13%	140	38.04%	18	4.89%	39	10.60%	18	4.89%	11	2.99%	20	5.43%	368	100.00%

Table 13. Numbers and Percentages of Items by Provenience for Mechanically Classified Types: Rework by Locus (continued)

Site	Datum	Rework Level	Angular #	Angular %	Biface Flakes #	Biface Flakes %	Core Flakes #	Core Flakes %	Distal and Segment Flakes #	Distal and Segment Flakes %	Bipolar and Compression Flakes #	Bipolar and Compression Flakes %	Core-Compression Transition Flakes #	Core-Compression Transition Flakes %	Flakes Too Small to Resolve #	Flakes Too Small to Resolve %	Biface-Core Transition Flakes #	Biface-Core Transition Flakes %	Unclassified Flakes #	Unclassified Flakes %	ROW TOTAL	
2	LT 62+50	0	0	0.00%	0	0.00%	2	50.00%	9	69.23%	0	0.00%	3	50.00%	4	100.00%	0	0.00%	1	100.00%	19	59.38%
		1	3	100.00%	0	0.00%	2	50.00%	3	23.08%	1	100.00%	3	50.00%	0	0.00%	0	0.00%	0	0.00%	12	37.50%
		2	0	0.00%	0	0.00%	0	0.00%	1	7.69%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	3.13%
		Subtotal	3	9.38%	0	0.00%	4	12.50%	13	40.63%	1	3.13%	6	18.75%	4	12.50%	0	0.00%	1	3.13%	32	100.00%
2	ST	0	12	75.00%	3	100.00%	8	66.67%	16	66.67%	4	57.14%	8	61.54%	1	100.00%	3	100.00%	2	100.00%	57	70.37%
		1	4	25.00%	0	0.00%	4	33.33%	7	29.17%	3	42.86%	5	38.46%	0	0.00%	0	0.00%	0	0.00%	23	28.40%
		2	0	0.00%	0	0.00%	0	0.00%	1	4.17%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	1.23%
		Subtotal	16	19.75%	3	3.70%	12	14.81%	24	29.63%	7	8.64%	13	16.05%	1	1.23%	3	3.70%	2	2.47%	81	100.00%
3	-	0	30	71.43%	11	100.00%	6	31.58%	43	70.49%	4	40.00%	12	54.55%	22	95.65%	5	71.43%	5	71.43%	138	68.32%
		1	12	28.57%	0	0.00%	13	68.42%	17	27.87%	5	50.00%	9	40.91%	1	4.35%	2	28.57%	2	28.57%	61	30.20%
		2	0	0.00%	0	0.00%	0	0.00%	1	1.64%	1	10.00%	1	4.55%	0	0.00%	0	0.00%	0	0.00%	3	1.49%
		Subtotal	42	20.79%	11	5.45%	19	9.41%	61	30.20%	10	4.95%	22	10.89%	23	11.39%	7	3.47%	7	3.47%	202	100.00%
4	-	0	7	53.85%	5	100.00%	10	83.33%	26	74.29%	6	85.71%	10	58.82%	11	84.62%	1	50.00%	7	87.50%	83	74.11%
		1	6	46.15%	0	0.00%	2	16.67%	9	25.71%	1	14.29%	7	41.18%	2	15.38%	1	50.00%	1	12.50%	29	25.89%
		Subtotal	13	11.61%	5	4.46%	12	10.71%	35	31.25%	7	6.25%	17	15.18%	13	11.61%	2	1.79%	8	7.14%	112	100.00%
6	Areas 1 & 2	0	7	87.50%	1	100.00%	1	50.00%	32	100.00%	2	100.00%	0	0.00%	19	100.00%	0	0.00%	0	0.00%	62	96.88%
		1	1	12.50%	0	0.00%	1	50.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	3.13%
		Subtotal	8	12.50%	1	1.56%	2	3.13%	32	50.00%	2	3.13%	0	0.00%	19	29.69%	0	0.00%	0	0.00%	64	100.00%
6	Area 3	0	21	91.30%	6	85.71%	7	87.50%	83	94.32%	2	100.00%	2	50.00%	49	94.23%	2	100.00%	5	71.43%	177	91.71%
		1	2	8.70%	1	14.29%	1	12.50%	5	5.68%	0	0.00%	2	50.00%	3	5.77%	0	0.00%	2	28.57%	16	8.29%
		Subtotal	23	11.92%	7	3.63%	8	4.15%	88	45.60%	2	1.04%	4	2.07%	52	26.94%	2	1.04%	7	3.63%	193	100.00%

Table 14
Length by Locus

Site	Datum	Angular Mean	Angular S.D.	Biface Flakes Mean	Biface Flakes S.D.	Core Flakes Mean	Core Flakes S.D.	Distal and Segment Flakes Mean	Distal and Segment Flakes S.D.	Bipolar and Compression Flakes Mean	Bipolar and Compression Flakes S.D.	Core-Compression Transition Flakes Mean	Core-Compression Transition Flakes S.D.	Flakes Too Small to Resolve Mean	Flakes Too Small to Resolve S.D.	Biface-Core Transition Flakes Mean	Biface-Core Transition Flakes S.D.	Unclassified Flakes Mean	Unclassified Flakes S.D.
1	-	38.06	20.26	21.29	4.92	40.75	15.70	28.51	15.82	37.92	15.90	47.96	16.86	22.11	10.00	29.27	9.95	21.95	6.12
2	-	41.50	28.93	23.00	NV	49.44	13.92	20.35	12.57	--	--	48.00	8.37	16.43	5.32	19.00	ND	21.75	6.50
2	BM R24R	63.67	25.45	24.00	NV	34.00	8.80	33.64	16.26	47.20	25.92	44.45	16.73	19.00	ND	--	--	27.00	ND
2	CL 72+00	53.93	31.53	20.33	1.53	42.23	13.86	28.98	17.00	39.33	17.04	50.52	19.97	19.57	5.26	29.56	6.75	25.50	6.93
2	JB	39.21	18.32	21.68	4.28	40.49	10.34	28.70	14.04	36.14	15.25	42.90	13.33	17.30	5.48	29.84	8.60	24.64	6.58
2	JE	44.40	24.06	21.50	ND	46.45	18.05	34.12	19.75	45.00	21.97	61.71	29.55	15.80	4.49	24.00	5.37	20.33	7.23
2	JR	45.56	24.59	24.27	3.20	36.04	10.71	28.71	16.73	46.28	23.32	46.21	19.33	16.50	4.38	26.91	4.99	22.25	5.20
2	LT 62+50	49.67	13.28	--	--	29.75	4.35	31.69	18.30	29.00	ND	73.50	11.26	17.50	2.89	--	--	26.00	ND
2	ST	66.50	28.58	23.67	4.04	41.58	12.00	41.37	22.45	42.00	12.64	41.69	16.39	25.00	ND	24.67	6.03	29.50	ND
3	-	41.93	20.26	27.54	3.41	38.46	12.81	27.53	12.28	37.30	21.63	46.55	14.99	16.30	5.68	29.14	6.89	29.00	8.62
4	-	38.23	36.26	23.00	7.56	41.75	21.62	27.01	18.26	28.14	3.53	49.71	16.35	15.07	5.18	22.50	ND	22.50	7.05
6	Area 1	25.00	ND	16.00	ND	30.00	ND	13.33	6.01	23.50	ND	--	--	12.59	4.64	--	--	--	--
6	Area 2	19.33	17.13	--	--	62.00	ND	11.50	ND	--	--	--	--	11.50	ND	--	--	--	--
6	Area 3	19.82	18.41	22.71	5.59	39.38	14.01	15.91	9.96	33.00	ND	50.50	10.72	12.56	4.18	30.50	ND	21.86	7.13
	MEAN	41.915		22.42		40.88		26.53		37.07		50.31		16.95		26.54		24.36	

ND = sparse or poor data
NV = no variance
-- = no cases

22-27 mm) characterize Types T, I, U, and B. Type S, as expected, had a very low mean length (16.95 mm).

Not all types exhibited similar ranges of variation. If ranges of variation be considered in proportion to mean lengths, Types A, C, and I clearly have less length regularity than do Types B, T, and U; these latter types are more standardized.

For locus-by-locus comparisons, it is useful to consider those assemblages which have unusually high or low means for a type, relative to the overall trends for that type. Viewed in this perspective, Site 2 (loci BMR24R, JR, and ST) and Site 3 tended to have unusually high length values for several types, while Site 4 and Site 6 Areas 1 and 2 tended to have substantially lower length values for several types. Site 2 locus blank and Site 6 Area 3 had both low and high extremes, but tended toward more low extremes than high extremes.

The picture that emerges is that subsurface assemblages tend to exhibit shorter debitage, type by type, than do surface assemblages. Thicker flake types (A, C, I) tend to be more variable than do thinner types, even after allowing for the increase in variation due to mean tendency (scale-factor).

Total Cortex Coverage Percentage:

Total cortex coverage was monitored for all debitage as estimated percentage of cortex cover of the entire artifact (Table 15). No attempt was made to define ventral surfaces, hence totally cortical primary flakes may be expected to exhibit, in this system, only 50-60% cortex.

Considered over the entire study collection, a clear trend emerges in which larger and "less conchoidal" pieces tend to have more cortex coverage than do smaller and "more conchoidal" pieces. In fact, the order of types in terms of mean cortex coverage recapitulates very closely the order of relative thinness as defined for the mechanical classification scheme. In order from most to least cortex, based on overall means of means, the types and their cortex percentages are J (8.8%), Q (8.23%), C (6.71%), U (4.69%), I (4.57%), A (3.81%), T (2.33%), B (1.82%), and S (1.65%).

This ordering displays clear breaks. Types J and Q, the non-conchoidal flake types, are much higher in cortex on average than is Type C. Type C (core flakes) is in turn higher than the three unclassifiable types: U, I, and A. These types are, in turn, substantially higher than the thin conchoidal types: T, B, and S.

This trend suggests two inferences. The first is that the degree of control exhibited in reduction is directly related to the stage of reduction, even in initial quarrying and material

Table 15
Total Cortex Percentage by Locus

Site	Datum	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	-	7.44	11.22	3.98	9.70	14.02	16.49	9.36	13.52	11.45	13.94	13.79	15.83	4.47	9.95	5.41	9.79	5.47	10.38
2	-	3.13	7.70	0.00	ND	2.00	4.44	3.06	6.48	--	--	10.00	16.49	1.00	2.65	0.00	ND	2.00	4.00
2	BM R24R	4.60	6.78	0.00	ND	13.45	13.80	2.64	7.14	7.80	8.38	10.73	13.17	0.00	ND	--	--	0.00	ND
2	CL 72+00	4.74	10.31	1.00	1.73	14.32	17.65	3.68	7.32	21.67	37.52	7.30	11.82	2.71	4.72	0.89	1.76	4.75	13.44
2	JB	5.42	9.41	0.45	2.13	7.00	12.48	5.50	10.90	13.71	17.98	9.23	12.04	2.74	8.32	1.15	3.36	4.56	10.31
2	JE	6.08	9.55	0.00	ND	2.35	4.16	7.24	12.79	3.40	5.82	10.39	13.51	0.00	NV	0.00	NV	17.10	26.89
2	JR	5.32	8.03	9.09	18.05	7.59	12.40	5.87	11.16	5.44	11.85	4.59	8.66	4.36	10.46	4.91	11.25	7.55	13.05
2	LT 62+50	0.00	NV	--	--	1.50	3.00	7.08	15.45	4.00	ND	10.17	9.09	0.00	NV	--	--	5.00	ND
2	ST	6.18	8.14	0.00	NV	7.42	10.26	4.42	8.33	3.71	8.58	5.70	10.60	0.00	ND	1.67	2.89	0.00	ND
3	-	2.88	5.98	0.00	NV	6.08	9.22	4.74	9.36	5.30	10.13	5.96	12.03	1.57	4.12	3.28	4.72	0.00	NV
4	-	3.00	5.80	3.60	8.05	5.50	13.83	3.57	6.65	12.57	14.41	8.94	14.51	1.23	4.44	6.00	ND	5.12	9.79
6	Area 1	0.00	ND	0.00	ND	0.00	ND	0.90	2.78	0.00	ND	--	--	2.98	7.04	--	--	--	--
6	Area 2	0.83	2.04	--	--	0.00	ND	3.00	ND	--	--	--	--	0.00	ND	--	--	--	--
6	Area 3	3.65	8.74	3.71	8.20	12.75	16.00	2.94	8.03	16.50	ND	2.00	4.00	2.44	5.96	0.00	ND	4.71	8.88
	MEAN	3.805		1.82		6.71		4.57		8.80		8.23		1.55		2.33		4.69	

ND = sparse or poor data
NV = no variance
-- = no cases

testing. The second, competing inference is that thin reduction items cannot be produced in the presence of cortical surfaces; this interpretation would suggest that reduction stages on these sites are even earlier than the mechanical classification results would suggest.

The general trend in Table 15 is toward means being associated with high standard deviations. Only Types A, C, J, and Q have more than one or two cases in which the sample standard deviation does not exceed the mean by more than 50%. This indicates that most types have a strongly left-skewed distribution, with many cortex flakes having little cortex and only a few flakes with high cortex coverage.

The four types, A, C, J, and Q, are, of course, the four least conchoidal (i.e., most angular) types and the types which probably have more cortex overall. Thus their lower variance/mean ratios indicate only that their distributions are probably less left-skewed; i.e., that they are, overall, the most cortical types.

If the cases in which extreme high or low average cortex within a type are considered, then Site 1 is found to have anomalously high average cortex for all but two types. Site 6 Area 1 is found to have very low cortex over all types. Site 2 loci blank, BMR24R, JE, LT 62+50, and ST, and also Site 3 and Site 6 Areas 2 and 3 have rather low overall cortex, all types considered; Site 2 loci CL 72+00 and JR have fairly high cortex overall. Site 2 locus JB and Site 4 show neither high nor low trends.

Platform Scar Counts:

The number of pre-detachment platform scars was counted for all complete, proximal, and lateral flakes. The results are summarized in Table 16, by locus and by mechanical classification types.

No clear patterns were discovered in this variable. It appears that Site 2 loci blank and JE, Site 4, and Site 6 Area 2 had mean platform scar counts for several types higher than the overall average value for the specific type considered. Site 2 locus LT 62+50, Site 3, and Site 6 Areas 1 and 3 had considerably fewer scars than the overall trend would predict.

Site 1 and Site 6 Area 3 had unusually high standard deviations, relative to mean values for this variable; in 4 and 3 cases respectively, their estimated sample standard deviations were greater than their means for types.

For the entire Alibates assemblage, Type C flakes have the highest average number of platform scars (1.97), followed in descending order by Type Q (1.84), Type S (1.81), Type B (1.75), Type J (1.65), Type U (1.60), and Type T (1.55). The tendency

Table 16
Platform Scars by Locus

Site	Datum	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	-	NA	NA	1.57	1.44	1.39	1.46	NA	NA	1.55	2.11	1.72	1.86	1.09	0.99	1.17	1.00	1.55	1.28
2	-	NA	NA	3.00	ND	1.67	0.71	NA	NA	--	--	1.60	0.89	2.00	0.81	2.00	ND	3.50	1.73
2	BM R24R	NA	NA	0.00	ND	1.18	0.60	NA	NA	2.20	3.27	2.31	2.23	2.00	ND	--	--	1.00	ND
2	CL 72+00	NA	NA	1.33	0.58	1.68	1.17	NA	NA	1.58	1.53	1.55	1.34	2.00	2.16	1.55	0.88	2.00	1.51
2	JB	NA	NA	1.68	1.32	2.16	2.10	NA	NA	2.00	1.56	2.15	1.91	1.13	1.18	1.31	1.38	1.40	1.19
2	JE	NA	NA	4.00	2.83	2.05	1.82	NA	NA	2.20	1.31	1.61	1.68	1.20	1.10	1.83	1.17	2.00	1.73
2	JR	NA	NA	1.27	1.19	1.85	1.42	NA	NA	1.67	2.28	1.54	1.19	2.45	4.51	2.45	1.21	1.85	1.57
2	LT 62+50	NA	NA	--	--	1.75	0.50	NA	NA	1.00	ND	1.83	1.17	1.25	0.50	--	--	1.00	ND
2	ST	NA	NA	3.00	2.65	2.67	2.43	NA	NA	1.86	1.68	1.46	1.51	4.00	ND	1.00	1.00	1.00	ND
3	-	NA	NA	1.00	0.45	1.31	1.25	NA	NA	0.90	0.32	1.73	1.42	1.00	0.60	1.14	0.90	0.86	0.69
4	-	NA	NA	1.20	0.84	1.50	0.90	NA	NA	1.71	0.95	2.53	1.73	2.00	1.15	2.00	ND	2.00	1.20
6	Area 1	NA	NA	1.00	ND	1.00	ND	NA	NA	1.00	ND	--	--	1.12	0.60	--	--	--	--
6	Area 2	NA	NA	--	--	6.00	ND	NA	NA	--	--	--	--	3.00	ND	--	--	--	--
6	Area 3	NA	NA	2.00	2.24	1.38	1.69	NA	NA	2.00	ND	2.00	1.83	1.04	1.17	1.00	ND	1.00	1.15
		=======		=======		======		=======		======		======		======		======		======	
	MEAN	NA		1.75		1.97		NA		1.65		1.84		1.81		1.55		1.60	

ND = sparse or poor data
NV = no variance
NA = not applicable
-- = no cases

for core flakes to have higher average platform scar counts than do biface and biface-core transitional flakes is surprising; it may simply indicate that the bulk of "biface" and "transitional" flakes from assemblages dominated by Types Q, J, and C are really either very early-stage biface reduction products or else are not biface reduction products at all. In contrast, there can be no doubt that many of the objects studied are in fact well-produced core flakes struck from prepared platforms.

Total Surface Scars/Facets:

This variable represents a count of each discrete scar or facet other than cortical facets. It was recorded for all non-angular debitage, for all angular debris from Sites 3, 4, and 6, and from a sample of angular debris from Sites 1 and 2. The angular debris data from Sites 1 and 2 are omitted from Table 17, which summarizes facet count observations.

A clear trend is visible in this table. Types tend to have scar counts which are correlated with their overall relative thickness. Judging from means of means (uncorrected for sample sizes), the types and their means of means for total scar count are, in descending order: J (8.96), A (8.86), Q (8.78), C (7.40), T (7.06), U (7.05), I (7.02), B (6.47), and S (5.67). This ordering displays clear breaks. Types J, A, and Q (the non-conchoidal types) have almost nine scars per piece on average. The conchoidal types C and T and the unclassified types U and I have about seven scars on average. The thin types B and S have about six scars.

These tendencies reflect several facts observed qualitatively during analysis:

1. Of the thin flakes that were seen, very few exhibited the complex dorsal flake scar patterns typical of true biface flakes; this would imply that they are either vry early-stage or very late-stage biface flakes or that they are not biface flakes at all.

2. Many of the non-conchoidal flakes (Types J and Q) exhibited overall-prismatic compression cleavage, with numerous secondary flaw or reflection fractures, and no true ventral surface.

In comparing assemblages, no clear trends were seen. However, there is a tendency for collections from Site 2 loci to exhibit, for all types, more scars than do other collections. This trend does not include Site 2 locus ST which has relatively few scars for Types S, T, and U. Other assemblages with relatively few scars include those from Sites 1 and 6. Sites 3 and 4 have scar counts very near the mean for most types. This trend has no obvious interpretation.

Table 17
Total Scars by Locus

Site	Datum	Angular		Biface Flakes		Core Flakes		Distal and Segment Flakes		Bipolar and Compression Flakes		Core-Compression Transition Flakes		Flakes Too Small to Resolve		Biface-Core Transition Flakes		Unclassified Flakes	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	-	ND	ND	5.89	1.78	6.69	2.37	6.93	4.45	7.70	2.59	7.91	2.80	6.20	--	6.27	1.60	7.10	1.95
2	-	ND	ND	7.00	ND	8.56	1.74	6.88	2.18	--	--	8.60	2.41	5.86	1.68	8.00	ND	9.75	2.06
2	BM R24R	ND	ND	4.00	ND	7.00	2.10	7.78	2.04	9.40	3.21	9.27	2.05	6.00	ND	--	--	5.00	ND
2	CL 72+00	ND	ND	7.67	2.89	7.41	2.13	7.23	2.29	8.66	4.04	8.89	3.08	6.00	1.29	7.11	2.21	7.75	1.67
2	JB	ND	ND	6.91	1.41	8.78	1.99	7.33	2.25	8.57	2.38	9.18	2.58	6.43	1.47	7.85	1.77	7.04	1.62
2	JE	ND	ND	10.00	ND	8.20	2.46	7.88	2.78	11.30	3.24	8.96	3.41	7.60	1.95	7.50	3.39	8.33	5.13
2	JR	ND	ND	6.18	1.54	8.00	2.34	7.24	2.65	9.39	2.23	8.67	1.90	5.94	1.59	6.55	1.29	6.85	1.35
2	LT 62+50	ND	ND	--	--	7.75	2.36	8.77	3.54	11.00	ND	9.50	2.51	6.00	1.15	--	--	7.00	ND
2	ST	ND	ND	6.33	1.53	7.50	2.43	8.21	1.93	9.43	2.51	8.23	1.74	4.00	ND	6.33	2.08	3.50	ND
3	-	9.12	3.06	6.45	2.38	7.31	2.66	6.61	2.02	8.50	2.07	9.09	1.54	5.17	1.34	7.00	1.92	7.86	2.48
4	-	10.31	3.38	6.20	2.86	7.83	1.34	7.26	2.79	7.57	2.07	8.76	2.41	5.92	1.25	7.00	ND	7.75	2.25
6	Area 1	10.00	ND	5.00	ND	7.00	ND	5.40	1.10	9.00	ND	--	--	4.65	1.12	--	--	--	--
6	Area 2	7.00	1.79	--	--	5.00	ND	5.00	ND	--	--	--	--	4.50	ND	--	--	--	--
6	Area 3	7.87	3.27	6.00	0.82	6.50	1.41	5.80	1.62	7.00	ND	8.25	2.63	5.10	1.18	7.00	ND	6.71	1.70
MEAN		8.86		6.47		7.40		7.02		8.96		8.78		5.67		7.06		7.05	

ND = sparse or poor data
-- = no cases

Cores: Description and Analysis

Cores from the Alibates sites were classified and described in a manner intended to maximize comparability with debitage. Thus, all variables monitored for flakes were also monitored for cores.

For two of the debitage set variables (platform scar number and platform cortex percent), definitions applied to cores were changed so as to allow inferences about the characters of flakes produced from the cores studied. Platform scar count for cores was recorded as the average number of scars which would have been observed on the platforms of flakes definitely detached from a core, had the refitted flakes rather than the cores been the object of study. Platform cortex percentage was defined similarly.

In addition, four new observational variables were recorded for the cores examined. These were: definite flake scar number, length of last detached flake, width of last detached flake, and core type.

Facets on a core were counted as definite flake scars if platform remnants and any clear detachment traits (such as hackles, ripples, negative bulbs, Wallner lines, etc.) were visible, and if scars exceeded 15 mm in greatest dimension. The scar judged to have been the locus of last detachment was measured (length and width). These observations, together with platform characteristics, were observed as direct indicators of the character of flakes produced.

Finally, all cores were classified as tested rocks, irregular polyhedral (amorphous) cores, bifacial or unifacial discoid cores, or prismatic blade cores.

Excluding formal tools (e.g., Stage 2 bifaces) and cores recycled as SOFTs, 143 cores were recognized in the Alibates collections (Table 18). Absolute frequency of individual core types within a single locus ranged from zero to 24 items (tested cobbles from Site 1). Formalized core type frequencies ranged from 0 to 13 items (irregular polyhedrals in Sites 2 locus JR). Excluding tested rocks, total core frequency ranged from 0 to 19 items (Site 2 locus JR). Site 2 locus LT 62+50 had the highest relative abundance of cores (21.9%) and of formal cores (15.6%) relative to debitage.

The most common core type was tested rocks (60 items) followed closely by irregular polyhedrals (50 items). Bifacial/discoid cores were moderately common (20 items, 0.5% of total debitage frequency). Polyhedral blade and unifacial/discoid cores were rare (9 and 4 items, respectively). Cores of different types were not uniformly present in all proveniences. Uniface/discoidal cores occurred only in Site 2 (loci BMR24R, CL 72+00, JB, and JE with one each). Blade cores occurred only in Sites 1, 3, and 4. Biface/discoidal cores occurred in Site 1, in Site 2

Table 18
Core Type Frequencies by Locus with Percentages of Debitage Frequencies

Site	Locus	Biface Discoid		Irreg. Polyhed.		Prismatic Blade		Tested Cobble		Uniface Discoid		Total Cores		Total Formal Cores		Total Debitage
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
1		1	0%	8	0.3%	7	0.3%	24	1.0%	-	-	40	1.7%	16	0.7%	2319
2	-	-	-	1	1.4%	-	-	-	-	-	-	1	1.4%	1	1.4%	69
2	BMR24R	-	-	2	2.2%	-	-	3	3.2%	1	1.1%	6	6.5%	3	3.2%	93
2	CL 72+00	-	-	5	3.2%	-	-	5	3.2%	1	0.6%	11	7.1%	6	3.9%	154
2	JB	4	1.0%	5	1.2%	-	-	4	1.0%	1	0.2%	14	3.4%	10	2.4%	414
2	JE	4	2.7%	1	0.7%	-	-	6	4.1%	1	0.7%	12	8.1%	6	4.1%	148
2	JR	6	1.7%	13	3.6%	-	-	5	1.4%	-	-	24	6.6%	19	5.2%	362
2	LT 62+50	1	3.1%	4	12.5%	-	-	2	6.3%	-	-	7	21.9%	5	15.6%	32
2	ST	-	-	6	7.4%	-	-	2	2.5%	-	-	8	9.9%	6	7.4%	81
3		4	2.0%	3	1.5%	1	0.5%	8	4.1%	-	-	16	8.2%	8	4.1%	196
4		-	-	2	1.8%	1	0.9%	-	-	-	-	3	2.7%	3	2.7%	112
6	pooled	-	-	-	-	-	-	1	0.4%	-	-	1	0.4%	0	0.0%	267
TOTAL		20		50		9		60		4		143		83		4243
% of Debitage		0.5%		1.2%		0.2%		1.4%		0.1%		3.4%		2.0%		

loci JB, JE, JR, LT 62+50, and in Site 3. Irregular polyhedrals occurred everywhere but in Site 6. Tested rocks occurred everywhere but in Site 4 and in Site 2 locus blank.

No clear correlations were found between overall abundance by provenience or abundance by type for cores versus abundance by types or by provenience for debitage. Because of the low frequencies of cores overall and especially within individual loci, further analysis of core characteristics will be carried out for all cores of a type, disregarding provenience.

Metric Observations on Cores:

Metric variables for cores by core type are summarized in Table 19. Patterns in this table which are especially well-marked will now be discussed. Tested rocks on average have fewer overall scars, more cortex, greater weight, and fewer definite flake scars than does any other type. Tested cobbles are exceeded slightly in average core length and width only by irregular polyhedrals. Only prismatic blade cores have, on average, fewer platform scars per flake detachment than do tested rocks. Only uniface discoids have, on average, more platform cortex per flake detachment and shorter produced flakes than do tested rocks. Both prismatic and uniface cores produced narrower flakes on average than did tested rocks. At the other extreme, uniface discoids had, on average, the highest overall scar counts, the lowest total weight, the lowest overall width, and the highest counts for definite flake detachments. As noted above, they also had the highest product flake platform cortex percentages and the lowest product flake length.

Biface discoids had the least total cortex and the least product flake platform cortex. With irregular polyhedrals, they also had the greatest product flake width. Irregular polyhedrals had, on average, the highest product flake platform scar counts and the greatest product scar length.

Polyhedral blade cores, surprisingly, had the lowest overall average length, and as noted above, both the lowest average product flake platform scar count and the narrowest product flakes.

Biface cores and tested cobbles had last-produced flake sizes and shapes which were almost identical. Irregular polyhedral flakes produced slightly larger, longer flakes on average than did biface cores; uniface cores produced smaller and generally broader flakes than did biface cores. Prismatic blade product flakes, of course, were typically much narrower than flakes from other core types.

When compared to actual flake assemblages, it is clear that the last produced flake population (as inferred from core scars) is typically longer than the average for flake types B, I, S, T, and

Table 19
Continuous Measurement Variables for Cores (all loci pooled)

		MEASURED FOR THE OVERALL PIECE					ESTIMATED FROM THE SIGNIFICANT DETACHMENTS			ESTIMATED FROM THE LAST DETACHMENT	
Core Type		Total Scars	Total Cortex %	Total Weight	Length	Width	No. of Platform Scars	% of Platform Cortex	Real Scar Count	Scar Length	Scar Width
Tested	$\bar{x}$	8.63	60.5	290.6	82.7	60.3	0.88	44.25	2.65	31.02	31.87
Cobble	s	4.99	27.1	412.7	29.7	22.4	1.24	46.27	1.73	16.00	11.50
Irregular	$\bar{x}$	18.5	26.4	237.7	85.8	63.1	1.42	20.24	5.2	35.00	32.40
Polyhedral	s	8.9	24.0	261.8	24.8	20.3	1.06	33.70	3.3	35.00	13.80
Biface/	$\bar{x}$	18.0	18.0	122.1	77.3	58.7	1.35	4.00	8.6	31.20	32.40
Discoid	s	5.0	24.3	70.6	21.6	12.6	0.75	12.10	2.3	14.10	11.80
Uniface	$\bar{x}$	23.5	32.5	109.3	79.3	51.0	1.0	44.80	12.0	26.30	31.00
Discoid	s	12.9	27.5	31.2	17.6	6.7	0.8	41.60	9.6	18.80	6.60
Prismatic	$\bar{x}$	11.2	30.3	162.2	71.1	59.3	0.8	22.00	3.6	31.30	18.60
Blade	s	4.0	36.0	123.9	24.4	17.4	0.4	43.70	1.7	12.20	6.90

U and typically shorter than the average for flake types C, J, and Q. Recalling that statistics for all flake types included some incomplete pieces, this trend may be interpreted to mean that the cores which produced many of the Types B and S flakes and some of the Type T and U flakes were probably removed from the sites, perhaps as later-stage bifaces. In contrast, the sources of the larger flake types C, J, and Q were not commonly found on the Alibates sites, unless they were represented by cores which had been exploited to the point at which C, J, and Q flakes of typical size could no longer be detached.

This last interpretation is likely. Properly set-up cores would not have been used to produce the uncontrollable non-conchoidal types Q and J. Rather, large material blocks would have been reduced down to usable core sizes by breakage of the sort that produces compression/bipolar flakes. Once at this stage, the core could produce relatively few Type C flakes before product flake size became reduced to the size typical of the cores actually found.

These observations suggest the inference that much of the conchoidal reduction debris analyzed for this project was generated in further rework of angular debris, cores, and flakes of Types Q, J, and C. These reworked items were probably removed from the sites by the original artisans and/or by later scavengers or collectors. The remaining cores, therefore, may represent failures, spent nuclei, or rejected blanks rather than completed but abandoned export items or still-productive, usable nuclei.

Descriptive Observations on Cores:

Non-metric observations were carried out for all cores exactly as for debitage. Variables observed were cortex type, completeness, heat treatment, rework level, dominant color, secondary color, and pattern of color. As was done for the metric variables reported above, these variables will be discussed without regard to provenience; sample sizes are too small to allow meaningful comparisons on a locus-by-locus basis.

Cortex Type

Of the cortex types observed, tabular cortex was most common only for biface/discoid cores (Table 20). Cobble cortex was much more common than tabular cortex for tested rocks; irregular polyhedral cores tended also to be made from cobbles, as perhaps did prismatic blade cores.

For every core type except tested rocks, the undetermined cortex type was substantially more common than either cobble or tabular cortex. This observation may indicate that the ratio of tabular to cobble cortex as observed is not reliable. If more tabular

Table 20
Core Type Frequency Compared to Debitage Frequency by Cortex Type

	Cortex Type		
Type	Cobble	None/Unknown	Tabular
CORES			
Biface/Discoid	4	10	6
Irregular Polyhedral	15	29	6
Prismatic Blade	3	5	1
Tested Cobble	50	5	5
Uniface/Discoid	1	2	1
All Cores Total/Percent	73/51%	51/36%	19/13%
Formal Cores Total/Percent	23/28%	46/55%	14/17%
DEBITAGE			
All Debitage Total/Percent	904/21%	2494/59%	845/20%
Conchoidal Flake Types:			
B (biface flakes)	4 4%	93 83%	15 13%
S (small flakes)	21 8%	219 79%	36 13%
T (biface-core flakes)	15 16%	66 69%	14 15%
C (core flakes)	96 24%	187 47%	118 29%

pieces were reduced, overall, but most were reduced to the point that cortex type could not be determined, then the resulting frequency patterns would incorrectly suggest that cobble reduction was much more common.

This interpretation may be supported by observations on overall debitage cortex frequencies as compared to overall core and formal core cortex frequencies. In the debitage collections, tabular cortex is almost as common (20%) as cobble cortex (21%), but 59% of the assemblage is of unknown cortex type. When cores other than tested rocks are considered, cobble cortex is unexpectedly common (28%) but tabular and unknown cortex types are proportionally as common as for debitage (17% and 55%, respectively). Even more suggestive is the tendency for the "conchoidal" flake types to have more tabular than cobble cortex in direct proportion to their thinness and inferred overall reduction stage.

The suggested inference is that more formalized core types tended to be made more often from less tumbled tabular materials than were tested rock cores. It may be that the most formalized types (e.g., bifaces) were made preferentially from tabular materials, but this inference is strongly supported only by the debitage data.

Rework

Rework levels for cores, recorded by Bertram, may not be strictly comparable with rework levels for debitage, recorded by Hoagland, because of the subjective differences in the definition of cortical surfaces, vs. old patinated surfaces. In comparison with debitage, it is likely that core rework levels as recorded are slightly higher than they would have been using Hoagland's debitage rework criterion.

The data (Table 21) indicate that rework is least common on prismatic blade cores. Tested cobbles were next most rarely reworked, followed closely by biface/discoidal cores. Uniface/discoidal cores were quite commonly reworked by later peoples; this generalization is based on a small sample. Finally, irregular polyhedral cores seem to have been reworked repeatedly over long periods; only this type exhibited two or three levels of rework (10% and 2%, respectively).

It should be recognized that observed rework frequency differences between types may have been influenced by sample size, especially for prismatic blade and uniface/discoidal cores (9 and 4 examples, respectively). However, it is unlikely that sampling size would have excluded common rework of the second or third levels for tested cobbles (60 cases) and probably also for biface/discoidal cores (20 cases).

Table 21
Core Type by Rework Level

	REWORK LEVEL				
	0	1	2	3	Total
CORE TYPE					
Biface/ Discoid	12/15/60 *	8/14/40	0/0/0	0/0/0	20/14/100
Irregular Polyhedral	25/31/50	19/34/38	5/100/10	1/100/2	50/35/100
Prismatic Blade	6/07/67	3/05/33	0/0/0	0/0/0	9/06/100
Tested Cobble	37/46/62	23/41/38	0/0/0	0/0/0	60/42/100
Uniface Discoid	1/01/25	3/05/75	0/0/0	0/0/0	4/03/100
TOTAL	81/100/57	56/100/39	5/100/3	1/100/1	143

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* Count / Column % / Row %

It is possible that rework was incorrectly identified in cases where objects were flaked, heat-treated, and then reflaked. Every effort was made to refer differences between surfaces which seemed to reflect heat treatment to that variable, rather than to rework.

Heat Treatment

Heat treatment frequency, observed as for debitage, is tabulated in Table 22. Examination of the tabulated data reveals that heat treatment was much more commonly recorded for bifacial (85%) and unifacial (100%) discoidal cores than for other types (TC - 72%; IP - 70%; PB - 67%). These frequencies are consistent with expectations; the production of smaller, thinner biface flakes and the controlled reduction of blanks are much easier using heat-treated materials. Prismatic blades, by contrast, may be more difficult to produce without breakage using heat-treated material.

Completeness

Cores were recorded as complete unless their most recent fracture surface appeared to be a non-directed failure of the core material induced by an attempt at normal reduction. Completeness was found to vary considerably among core types (Table 23).

Bifacial discoid cores were overwhelmingly complete (85%). This observation is unusual in our experience. The relative rarity of broken bifaces may indicate either exceptional skill or exceptional selectiveness on the part of the knapper. Irregular polyhedral, tested rock, and uniface discoidal cores were less often complete. Prismatic blade cores, however, were rarely complete (22%). No ready interpretation for this pattern was discovered; it may be that prismatic blade cores were commonly refurbished by bipolar-compression truncation, thus providing a new platform. If so, then the "core recovery flakes" so produced would have been coded regularly as core segments.

Color

Color (Table 24) was observed as for debitage; that is, as dominant color, secondary color, and color pattern.

The most common dominant color was brown for all types except prismatic blade cores. However, only irregular polyhedral and tested rock cores were clearly dominated by brown. Bifacial and unifacial discoid cores had white as a dominant color almost as often as brown. The clear dominance of purple for prismatic blade cores is a direct reflection of material selection. Most such cores came from Site 1; the Site 1 blade cores were made not from typical Alibates "chert" but from a grainy, partly

Table 22
Core Type by Heat Treatment

CORE TYPE	HEAT TREATMENT No	HEAT TREATMENT Yes	Total
Biface/Discoid	3/08/15 *	17/16/85	20/14/100
Irregular Polyhedral	15/39/30	35/33/70	50/35/100
Prismatic Blade	3/08/33	6/06/67	9/06/100
Tested Cobble	17/45/28	43/41/72	60/42/100
Uniface Discoid	0/0/0	4/04/100	4/03/100
TOTAL	38/100/27	105/100/73	143

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* Count / Column % / Row %

Table 23
Core Type by Completeness: Item Counts

CORE TYPE	COMPLETENESS Segment	COMPLETENESS Whole	Total
Biface/Discoid	3	17	20
Irregular Polyhedral	18	32	50
Prismatic Blade	7	2	9
Tested Cobble	27	33	60
Uniface Discoid	1	3	4
TOTAL	56	87	143

Table 24
Core Type by Color: Item Counts

CORE TYPE	Brown	Purple	Red	White	Yellow	Total
DOMINANT COLOR						
Biface/Discoid	8	5	0	7	0	20
Irregular Polyhedral	22	8	4	13	3	50
Prismatic Blade	2	7	0	0	0	9
Tested Cobble	26	10	1	16	7	60
Uniface/Discoid	2	0	1	1	0	4
TOTAL	60	30	6	37	10	143
SECONDARY COLOR						
Biface/Discoid	8	6	1	3	2	20
Irregular Polyhedral	19	17	4	10	0	50
Prismatic Blade	5	2	1	1	0	9
Tested Cobble	24	16	2	15	3	60
Uniface/Discoid	1	2	0	1	0	4
TOTAL	57	43	8	30	5	143

PATTERN OF COLOR

	Banded	Graded	Mottled
Biface/Discoid	0	5	15
Irregular Polyhedral	2	12	36
Prismatic Blade	0	5	4
Tested Cobble	1	20	39
Uniface/Discoid	0	0	4

silicified dolomite with very good flaking qualities and a texture which originally led analysts to classify it as Dakota quartzite.

Secondary color was dominated by brown for all core types except uniface/discoidal cores, which are subject to extreme sampling error (n=4). The next most common secondary color was purple in all other cases, and the third most common secondary color was white.

Patterns of dominant and secondary color frequencies are thus not very different from those reported above for debitage, with the exception of the grainy dolomite blades and blade cores. Other difference between cores and debitage is that debitage from sites with common heat treatment tended to show red as a relatively important secondary color (rank 2 or 3). Cores, which would be expected to exhibit common heat treatment, did not tend to have red as an important secondary color. Color patterns for cores, as with debitage, tended to emphasize mottled patterns and to be almost lacking in clear banded patterns (see discussion of this distinction in debitage color patterns above). Otherwise, no clear trends were noted.

SOFTS: Description and Analysis

Those items which were judged to have possible cultural edge damage but which were not reasonably classified as formal tools were assigned to the class of SOFTs. Items within this class were classified and described in a manner intended to allow direct comparison with debitage. All variables monitored for debitage were also monitored for SOFTs.

In addition, seven new variables were monitored. These variables, chosen for their value in assessing the significance of edge damage, were: estimated average number of micro-retouch or wear scars per centimeter of damaged/modified edge; perceived variance in micro-retouch or wear scar size; dominant form of use-wear; secondary use-wear form; subjective plausibility as a tool; edge type based on shape; and number of discrete edges represented on each SOFT analyzed.

Excluding formal tools, 223 edge-worn items were recognized in the Alibates collections (Table 25). Absolute item frequency of individual reworked items of one type within a single locus ranged from zero to 39 items (compound edges from Site 1). Total number of utilized/damaged edges per locus ranged from zero to 196 edges (again, Site 1).

The most common SOFT type was the compound edge; i.e., items having more than one type of edge (90 items; 40.4%). Less abundant were convex edges (45 items; 20.2%) and straight-edged items (59 items; 26.5%). Fairly rare were concave edges (14

Table 25
SOFT Edge Type by Provenience

Site		Convex		Straight		EDGE TYPE Concave		Denticulated		Point		Compound		Total		Total	Soft Item #/
No.	Locus	No.	Row%	No.	Row%	No.	Row%	No.	Row%	No.	Row%	No.	Row%	No.	Row%	Debitage	Debitage #
ITEM COUNTS																	
1	-	21	23%	22	24%	6	7%	3	3%	1	1%	39	42%	92	100%	2319	0.0397
2	BMR24R	1	8%	6	46%	0	0%	1	8%	0	0%	5	38%	13	100%	93	0.1400
	CL 72+00	4	18%	5	23%	0	0%	2	9%	1	5%	10	45%	22	100%	154	0.1429
	JB	2	11%	4	22%	1	6%	1	6%	0	0%	10	56%	18	100%	414	0.0435
	JE	2	12%	5	29%	3	18%	0	0%	0	0%	7	41%	17	100%	148	0.1149
	JR	5	19%	8	31%	3	12%	3	12%	0	0%	7	27%	26	100%	362	0.0718
	LT 62+50	1	50%	0	0%	0	0%	0	0%	0	0%	1	50%	2	100%	32	0.0625
	ST	2	14%	5	36%	0	0%	1	7%	1	7%	5	36%	14	100%	81	0.1728
3		1	13%	2	25%	1	13%	1	12%	0	0%	3	37%	8	100%	196	0.0408
4		5	56%	1	11%	0	0%	0	0%	0	0%	3	33%	9	100%	112	0.0804
6		1	50%	1	50%	0	0%	0	0%	0	0%	0	0%	2	100%	267	0.0075
TOTAL		45	20%	59	27%	14	6%	12	5%	3	1%	90	40%	223	100%	4243	0.0526
EDGE COUNTS																	
1	-	30	15%	34	17%	8	4%	4	2%	1	1%	119	61%	196	100%	2319	0.0845
2	BMR24R	2	6%	11	34%	0	0%	1	3%	0	0%	18	56%	32	100%	93	0.3441
	CL 72+00	4	7%	6	10%	0	0%	6	10%	1	2%	41	70%	58	100%	154	0.3766
	JB	2	4%	5	10%	1	2%	6	12%	0	0%	37	73%	51	100%	414	0.1232
	JE	2	5%	9	24%	3	8%	0	0%	0	0%	23	62%	37	100%	148	0.2500
	JR	5	10%	15	30%	4	8%	5	10%	0	0%	20	41%	49	100%	362	0.1354
	LT 62+50	1	33%	0	0%	0	0%	0	0%	0	0%	2	67%	3	100%	32	0.0938
	ST	3	9%	10	31%	0	0%	1	3%	1	3%	17	53%	32	100%	81	0.3951
3		1	7%	2	14%	1	7%	1	7%	0	0%	9	64%	14	100%	196	0.0714
4		6	27%	1	5%	0	0%	0	0%	0	0%	15	68%	22	100%	112	0.1964
6		1	50%	1	50%	0	0%	0	0%	0	0%	0	0%	2	100%	267	0.0075
TOTAL		57	12%	94	19%	17	3%	24	5%	3	1%	301	61%	496	100%	4243	0.1169

items; 6.3%) and denticulate pieces (12 items; 5.4%). Pointed tools were very rare (3 items; 1.3%).

Relatively little variation in abundance of items of different SOFT types was noted between proveniences. Site 2 locus BMR24R may have an unusually high frequency of straight-edged pieces. Site 2 locus JB seems to be low in straight-edge pieces, but high in compound edges. Site 2 locus JE may have a high proportion of concave edges. Site 2 locus JR may have a high proportion of denticulates and a low proportion of compound tools. Site 4 seems to be high in convex SOFTs.

Considered from the viewpoint of overall number of use edges, those extreme cases listed above on the basis of numbers of items remain extreme cases. Other extreme cases are also detectable due to the increase in sample size when edges are counted. These include Site 1 (high in convex edges), Site 2 locus CL 72+00 (high in denticulate and compound edges; low in straight edges), Site 2 locus JB (high in denticulated edges, low in convex and straight edges), Site 2 locus JR (high in straight and concave edges), and Site 2 locus ST (high in straight edges).

In terms of overall assemblage proportions, Site 1 and 6 seem to have relatively few SOFTs; Site 2 locus BMR24R, CL 72+00, JE, and ST seem to be rather high. If the number of edges is compared to debitage frequency, this pattern in unchanged, except that Site 3 also is seen to be unusually poor in damaged/used edges. Overall, there seems to be great variation in proportional abundance of SOFTs, compared both as item counts and also as edge counts, with debitage. Site 2 locus ST is highest (items/debitage count = 0.1728; edges/debitage count = 0.3951) and Site 6 is lowest (items/debitage count = 0.0075).

Descriptive Observations on SOFTs: Assemblage Validation

In analysis of edge-damaged items, expedient tools, retouched flakes, and/or utilized debitage, it is appropriate to inquire first whether the items in question are really artifacts at all, or whether they are in fact debitage or natural breakage products damaged by trampling, mechanical impacts, traffic, frost action, or colluvial processes. Distinction of natural from cultural damage is an especially difficult problem when the putatively cultural assemblage under study is drawn from surface collections. Objects in these collections must be expected to exhibit breakage due to colluvial movement, cattle trampling, automobile traffic, and other disturbance processes.

As use-wear analysis has matured, and as attention has been focused on natural edge damage mechanisms, it has become clear that natural processes can produce most of the types of small-scale and microscopic edge damage which have been shown to result from actual stone tool use.

Schnurrenberger and Bryan (1985) have rightly emphasized that successful distinction of natural breakage from cultural stone modification depends more on the patterns of damage than on the kinds of damage observed. As an example, a variety of low-energy disturbance mechanisms can produce feathered micro-wear, a characteristic wear pattern on acute flake edges in which microflakes have feathered (as opposed to stepped or hinged) terminations. A variety of mechanisms can also produce the ultra-microscopic abrasion and/or rounding classified in this study as "polish" (e.g., colluvial movement in fine silty soils, aeolian dust-blasting, chemical erosion). However, these mechanisms surely would not operate selectively and only on <u>acute</u> edges to the exclusion of <u>other</u> edges.

Thus, if polish on artifacts is consistently found in association with feathered wear but not in association with abraded or step/scalar wear, one may reasonably infer that the polish and feathered wear are functionally associated as products of tool use, precisely as they are known to associate in knife/saw use of flakes to cut relatively soft materials (Hayden 1979).

Conversely, if polish within an assemblage is found to associate randomly with other wear types, one would necessarily be led to question the cultural significance of polish for that assemblage. Some forms of tool use tend not to produce polish; most forms of tool use produce polish only after substantial use of the tool. Use of stone tools on very hard wood or bone tends not to produce polish, but rather produces step-scalar wear and crushing.

The approach taken here, consequently, is to examine an assemblage for contrasting and/or complementary associations of wear patterns on different edge types. It is asserted that one may then, within limits, infer cultural tool use more or less to the degree that these patterns are found to characterize an assemblage.

Microwear Patterns

Analysis of wear patterns on the Alibates SOFTs (Table 26) strongly suggests that many of the items examined have cultural wear. Dominant wear overwhelmingly was found to be step-scalar attrition, but straight-edged items also exhibited an unusually high frequency of feathering wear.

Secondary wear was less completely dominated by step-scalar attrition. Secondary abrasion was unusually common on convex edges and secondary polish was unusually common on straight edges. Step-scalar secondary wear was disproportionately common on denticulated and compound edges. Compound edges displayed unusually low frequencies of secondary polish; straight edges displayed unusually low frequencies of secondary step-scalar attrition.

Table 26
SOFT Microwear Patterns by Edge Type (Item Count)

EDGE TYPE

DOMINANT WEAR TYPE	Convex No.	Convex %	Straight No.	Straight %	Concave No.	Concave %	Denticulated No.	Denticulated %	Point No.	Point %	Compound No.	Compound %	Total No.	Total %
Abrasion	0	0%	2	3%	1	7%	1							
8%	1	33%	6	7%	11	5%								
Feathering	2	5%	8*	13%	0	0%	0							
0%	1	33%	5	6%	16	7%								
Polish	1	2%	0	0%	0	0%	0	0%	1					
33%	1	1%	3	1%										
Step/Scalar	41	93%	50	83%	13	93%	11	92%	0	0%	78	87%	193	87%
TOTAL	44	100%	60	100%	14	100%	12	100%	3	100%	90	100%	223	100%

EDGE TYPE

SECONDARY WEAR TYPE	Convex No.	Convex %	Straight No.	Straight %	Concave No.	Concave %	Denticulated No.	Denticulated %	Point No.	Point %	Compound No.	Compound %	Total No.	Total %
Abrasion	11*	25%	10	17%	3	21%	0	0%	1	33%	15	17%	40	18%
Feathering	3	7%	6	10%	2	14%	0	0%	1	33%	3	3%	15	7%
Grinding	1	2%	0	0%	0	0%	0	0%	0	0%	0	0%	1	0%
Polish	7	16%	18*	30%	2	14%	2	17%	0	0%	10°	11%	39	17%
Step/Scalar	22	50%	26°	43%	7	50%	10*	83%	1	33%	62*	69%	128	57%
TOTAL	44	100%	60	100%	14	100%	12	100%	3	100%	90	100%	223	100%

SECONDARY WEAR

DOMINANT WEAR	Abrasion #	Abrasion Col%	Abrasion Row%	Feathering #	Feathering Col%	Feathering Row%	Grinding #	Grinding Col%	Grinding Row%	Polish #	Polish Col%	Polish Row%	Step-Scalar #	Step-Scalar Col%	Step-Scalar Row%	Total #	Total Col%	Total Row%
Abrasion	0	0%	0%	1	6.7%	9.0%	0	0%	0%	0	0%	0%	10*	8.0%	91.0%	11	4.9%	100%
Feathering	3	7.5%	19.0%	0	0%	0%	0	0%	0%	9*	23.0%	56.0%	4°	3.1%	25.0%	16	7.2%	100%
Polish	1	2.5%	33.0%	0	0%	0%	0	0%	0%	0	0%	0%	2	1.6%	66.0%	3	1.3%	100%
Step Scalar	36	90.0%	19.0%	14	93.3%	7.0%	1	100.0%	0.5%	30	77.0%	16.0%	112	87.5%	58.0%	193	86.5%	100%

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* Unusually high
° Unusually low

Overall, primary feathering was positively associated with secondary polish, primary abrasion was positively associated with secondary step-scalar wear, and primary feathering was negatively associated with secondary step-scalar attrition.

These patterns of wear co-occurrence tend to indicate that many convex SOFTs actually functioned as informal convex-edge tools for work on medium to hard materials and that many straight-edge pieces were actually used as knives or saws on materials of low to medium hardness.

Patterns of wear for compound tools are harder to define or interpret. Although edge-by-edge data were not recorded for compound SOFTs, the impression was that compound tools had mostly denticulated, concave, and convex edges. Most compound items also appeared to have been very heavily used, assuming that the damage observed was actually wear.

Rework

Rework was observed for SOFTs (Table 27), as far as possible, in a manner comparable to the observations for debitage. This means that the micro-damage which led us to classify an object as a SOFT was not included in the different damage levels counted in rework observations.

In theory, we would expect natural (non-tool-related) damage to occur mostly at random within a locus and within a flake class. This expectation would lead us to predict that edge damage events would generally happen to a given object only rarely, and that multiple edge damage events on a single naturally-damaged object would often be of different ages. Yet the types which had the greatest average number of edges per piece (denticulate tools and compound edges) had the lowest overall rework levels, suggesting that many items are not natural damage products. A related argument leads to a similar conclusion. If natural damage occurs approximately at random, then one would expect that objects with two damaged edges would be much rarer than objects with one damaged edge segment. Similarly, objects with three, four, or more edge-damaged segments should display progressively much lower frequencies.

In fact, there were 88 objects with one damaged edge, 62 objects with two damaged edges, 35 with three edges, 23 with four edges, and 15 with more than four edges. Due to the complexity of observation category definitions, it is not feasible to develop a mathematical probability model for natural damage against which to compare these counts, but it seems likely that far too many objects having several damaged edges are present in the Alibates collection, on the assumption that damage is mostly natural. The implied conclusion is that a substantial proportion of the SOFTs are not naturally damaged items, but are indeed expedient tools or informal tools, many of which had more than one used edge.

Table 27
Rework Level by SOFT Edge Type (Item Count)

REWORK LEVEL	EDGE TYPE													
	Convex		Straight		Concave		Denticulated		Point		Compound		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0	29	66%	38	63%	8	57%	9	75%	3	100%	66	73%	153	69%
1	14	32%	22	37%	6	43%	3	25%	0	0%	23	26%	68	30%
2	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	1	0.5%
3	1	1%	0	0%	0	0%	0	0%	0	0%	1	1%	1	0.5%
TOTAL	44	100%	60	100%	14	100%	12	100%	3	100%	90	100%	223	100%

Once a flake was selected for utilization, it was, one infers, very likely to be utilized repeatedly and in various ways.

Heat Treatment

Analysis of heat treatment (Table 28) also suggests that many of the Alibates SOFTs are actually tools, rather than flakes with naturally damaged edges. Straight-edge tools displayed the highest frequency of positive heat-treatment judgments (75% of 60 cases) while denticulate edges displayed the lowest level (42% of 12 cases). Concave edges may also have high heat treatment (79%) but the sample, size (14) is small.

These patterns are consistent with general expectations. Denticulating seems to represent a method of producing general-purpose edge tools without much investment of shaping effort, but straight-edge tools are much more easily made on heat-treated material.

Other types had more typical heat-treatment frequencies: convex (64%), point (67%), and compound (63%), as compared to the overall collection's (66%) frequency of positive heat-treatment judgments.

Microwear Scar Size Variation

Examination of scar size variation (Table 29) proved less informative than expected. The high frequency of low variation levels for convex SOFTs and of high variation levels for denticulate and compound pieces may reflect the relative ease of producing regular retouch on convex surfaces vs. the tendency for concave surfaces to chip unevenly. The observation for compound tools is trivial; any object with both convex and concave or denticulated surfaces would automatically be expected to show high scar variation. From this perspective, microscar-size variation for compound-edge SOFTs might even be reasonably argued to be surprisingly <u>low</u>.

Plausibility as Tools

Judgments on edge types as to their subjective plausibility as tools (Table 30) was also rather uninformative. Only convex SOFTs seemed unusual; they had a rather lower plausibility tendency than other types. This may reflect only the relatively low degree of difference observable between experimentally reproduced but casually used convex tools vs. naturally damaged convex-edge flakes.

This variable is probably of limited value. Its inclusion in the analysis was only an experiment aimed at objectifying basically subjective impressions of grip, item freshness, edge-damage

Table 28
Heat Treatment by SOFT Edge Type (Item Count)

HEAT TREATED?	EDGE TYPE Convex		Straight		Concave		Denticulated		Point		Compound		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No	16	36%	15	25%	3	21%	7	58%	1	33%	33	37%	75	34%
Yes	28	64%	45	75%	11	79%	5	42%	2	67%	57	63%	148	66%
TOTAL	44	100%	60	100%	14	100%	12	100%	3	100%	90	100%	223	100%

Table 29
SOFT Edge Damage Scar Size Variation by Edge Type (Item Count)

SCAR SIZE VARIATION	EDGE TYPE Convex		Straight		Concave		Denticulated		Point		Compound		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
High	17	39%	26	43%	6	43%	7	58%	0	0%	51	57%	107	48%
Moderate	6	14%	8	14%	2	14%	2	17%	1	33%	10	11%	29	13%
Low	21	48%	26	43%	6	43%	3	25%	2	67%	29	32%	87	39%
TOTAL	44	100%	60	100%	14	100%	12	100%	3	100%	90	100%	223	100%

Table 30
SOFT Edge Damage Subjective Plausibility by Edge Type

PLAUSIBILITY * AS A TOOL	EDGE TYPE												Total	
	Convex		Straight		Concave		Denticulated		Point		Compound			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
H	6	14%	14	23%	4	29%	4	33%	3	100%	18	20%	49	22%
M	16	36%	27	45%	5	36%	5	42%	0	0%	37	41%	90	40%
L	22	50%	19	32%	5	36%	3	25%	0	0%	35	39%	84	38%
TOTAL	44	100%	60	100%	14	100%	12	100%	3	100%	90	100%	223	100%

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* Based on subjective judgments relating to grip, freshness of damage, heft, and other factors

freshness, suitability of items for their most probably inferable functions, etc. The experiment may not have been successful.

Color

Color for SOFTs (Table 31) was analyzed exactly as for debitage; analysis was again done by Hoagland for the sake of consistency. Color frequencies for various edge types differed in some cases. Convex-edge pieces tended to have more white and less purple cases of dominant color. Straight-edged pieces displayed low frequencies of purple as a dominant color. Concave-edged items had high frequencies of purple and of brown as dominant colors; red was unusually common as a secondary color and brown unusually rare. Denticulated SOFTs tended more commonly than the averages to have purple as a common dominant color, white as a common secondary color, and brown as a rare secondary color. Compound tools tended to have more purple and less brown as primary colors. Too little data were acquired (3 cases) to generalize about pointed SOFTs.

In color patterns, banding was rare, as it was for debitage. Within the SOFT collections alone, convex-edged items had the most banding and straight-edged items the least. Very little difference was observed between types in their relative frequencies of mottled vs. graded color patterns.

Cortex Type

Cortex type for SOFTs was observed as for debitage (Table 32). Here, clear contrasts were found between SOFT types and between SOFTs vs. debitage and cores. Convex and straight-edged pieces tended to have much less tabular cortex and more cobble cortex than did other SOFT types, all debitage, conchoidal debitage (Types C, T, and B), or formal cores other than irregular polyhedral cores. If one assumes that tabular materials were relatively preferred for controlled reduction and tool production (as the debitage and core data suggest), then these patterns are somewhat surprising for straight-edged tools, which would be expected to be more carefully prepared, given the inference of knife/saw use made above.

The dominance of cobble cortex on convex-edge items is less surprising. Convex edge tools, especially uniface tools, are relatively easy to make on any rough flake, using hard hammer retouch only.

Denticulates were more often made on flakes with recognizable cortex than were other types. This is not surprising, given the inference advanced above that denticulated tools are more likely than are other types to be produced casually as very expedient general purpose tools.

Table 31
SOFT Edge Type (Item Count) by Color

EDGE TYPE

DOMINANT COLOR	Convex		Straight		Concave		Denticulated		Point		Compound	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Brown	19	43%	25	42%	5	36%	5	42%	0	0%	26	29%
Purple	8	18%	15	25%	6	43%	6	50%	2	67%	30	34%
Red	1	2%	2	3%	0	0%	0	0%	0	0%	7	8%
White	14	32%	13	22%	3	21%	0	0%	1	33%	21	24%
Yellow	2	5%	4	7%	0	0%	1	8%	0	0%	5	6%
TOTAL	44	100%	59	100%	14	100%	12	100%	3	100%	89	100%

SECONDARY COLOR	Convex		Straight		Concave		Denticulated		Point		Compound	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Brown	18	41%	27	48%	4	29%	2	17%	2	67%	46	52%
Purple	9	20%	17	29%	3	21%	3	25%	0	0%	21	24%
Red	4	9%	1	2%	3	21%	2	17%	1	33%	7	8%
White	8	18%	11	19%	2	14%	3	25%	0	0%	13	15%
Yellow	5	11%	2	3%	1	7%	2	17%	0	0%	3	3%
TOTAL	44	100%	59	100%	14	100%	12	100%	3	100%	89	100%

COLOR PATTERN	Convex		Straight		Concave		Denticulated		Point		Compound	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Banded	3	7%	0	0%	0	0%	0	0%	0	0%	3	3%
Graded	17	39%	24	41%	6	43%	5	42%	1	33%	34	38%
Mottled	24	54%	35	59%	8	57%	7	58%	2	67%	53	59%
TOTAL	44	100%	59	100%	14	100%	12	100%	3	100%	89	100%

Table 32
SOFT Edge Type (Item Count) by Cortex Type

CORTEX TYPE	EDGE TYPE													
	Convex		Straight		Concave		Denticulated		Point		Compound		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cobble	10	24%	16	27%	2	14%	3	27%	1	33%	14	16%	46	21%
Unknown	29	71%	40	67%	10	72%	6	55%	2	67%	60	70%	147	68%
Tabular	2	5%	4	6%	2	14%	2	18%	0	0%	12	14%	22	11%
TOTAL	41 +3*	100%	60	100%	14	100%	11 +1*	100%	3	100%	86 +4*	100%	215 +8*	100%

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* 8 miscoded cases were dropped.

Metric Observations on SOFTs:

Observations on several metric variables were made on the SOFT collections. These are tabulated by edge type for all items and also for those pieces made on definite flakes (i.e., those pieces with a definite striking platform), in Table 33. Both general debitage statistics (means and standard deviations for total surface scar count, total surface cortex percentage, weight, length, width, platform scar count, and platform cortex percentage) and variables specific to SOFT characterization (means and standard deviations on average retouch/use microflake density per cm of used edge and on number of edges per item) are tabulated.

Examination of relative proportions of SOFTs with different edge types and for SOFTs <u>with</u> vs. <u>without</u> <u>platforms</u> (i.e., made on flakes vs. made on fragments) indicates no strong trend in debitage type selection for production of various SOFT types, although convex edges may tend to be made more often on pieces without clear detachment platforms (25 vs. 19 cases).

In comparison with the overall SOFT collections, convex-edged items were found to have fewer total scars; to have more total cortex; to tend to be longer, narrower, and heavier; to have more platform cortex on average; to have relatively large retouch/use microflakes scars on edges; and to have typically only one damaged or used edge per piece.

In contrast, straight-edged SOFTs were found to have lower total cortex; to be made on lighter, shorter, and thinner pieces; to have more platform scars; to have less platform cortex; and to have typically about two edges or damaged areas per piece.

Concave-edged items had relatively low weights, low widths, few platform scars, no platform cortex, high retouch scar densities (i.e., small average microflake scar size), and about one used/damaged edge per piece.

Denticulates, on formal grounds, were expected to resemble concave SOFTs, but this tendency was not apparent. Denticulates had, on average, high numbers of total scars, very little cortex, low weight for average length and high width (i.e., tended to be thin), rather few retouch microscars per centimeter of damaged edge, and typically about two edges per piece.

Only three pointed SOFTs were recorded; none were made on pieces clearly retaining their detachment platform. This small sample tended, in comparison with the total SOFT collection, to have fewer total scars, fairly high cortex, low length and low width, but average weight (i.e., were not made on thin pieces), many retouch microscars per cm of edge, and only one pointed edge per item.

Table 33
Continuous Variable Measurements for SOFTs

Edge Type	Data * Set	Number of Cases	Total Surface Scars		Total Surface Cortex %		Weight		Length		Width		Platform Scar Count		Platform Cortex %		Mean Retouch Density (scars/cm)		Number of Edges per Item		WGT/ LGT x WID
			$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	
Convex	All	44	8.5	4.4	16.8	28.4	45.2	66.3	45.5	19.1	36.8	17.0	NA	NA	NA	NA	8.6	3.4	1.3	0.5	0.027
	Flakes Only	19	6.9	3.0	27.4	34.8	43.9	55.7	50.1	18.9	37.6	16.6	1.3	1.1	46.9	50.8	7.7	2.1	1.3	0.6	0.023
Straight	All	60	9.2	3.8	20.7	26.0	34.3	45.8	43.7	18.7	37.7	15.4	NA	NA	NA	NA	10.0	4.6	1.6	0.8	0.021
	Flakes Only	29	8.4	3.1	16.3	24.3	25.9	19.5	42.3	12.5	39.6	13.1	1.9	2.0	13.7	34.7	9.1	3.5	1.8	0.9	0.015
Concave	All	14	9.3	4.5	20.4	26.0	41.9	51.9	52.6	21.6	37.4	17.8	NA	NA	NA	NA	11.0	2.5	1.2	0.6	0.021
	Flakes Only	8	7.9	2.6	22.5	28.8	28.1	18.0	48.4	18.2	34.3	16.3	1.1	0.4	0	0	11.4	2.5	1.1	0.4	0.017
Denticulate	All	12	9.8	4.2	18.0	24.4	51.8	43.2	54.4	16.3	48.7	20.3	NA	NA	NA	NA	9.5	4.3	2.0	1.5	0.020
	Flakes Only	6	9.7	3.2	16.0	18.4	31.8	26.5	46.0	13.8	47.7	13.3	1.5	0.5	16.5	40.4	8.2	2.8	2.0	1.1	0.014
Point	All	3	6.3	1.2	21.7	37.5	13.0	19.0	27.0	13.7	26.7	17.6	NA	NA	NA	NA	11.0	5.6	1.0	0	0.018
	Flakes Only	0	NO DATA																		
Compound	All	90	8.9	4.7	17.6	26.3	40.8	65.9	48.1	23.1	42.9	31.3	NA	NA	NA	NA	9.3	7.4	3.3	1.3	0.020
	Flakes	49	8.5	3.4	19.0	26.9	40.7	73.0	48.9	22.3	46.1	39.7	1.9	1.5	12.7	31.9	10.3	9.8	3.4	1.3	0.018

* All includes all items within an edge type class; but
Flakes includes only those objects with a recognizable detachment platform.

NA - not applicable

Compound SOFTs, by definition, are a heterogeneous collection; this is reflected in larger standard deviations relative to means for most variables, as compared to other edged pieces. This trend is not reflected, however, in total cortex percent or platform cortex percent; probably this simply indicates that no strong selection for primary, secondary, or tertiary debitage took place for <u>any</u> of the edge categories.

In almost all categories, standard deviation/mean ratios are lower for definite flake SOFTs than for the category when both flake and fragment SOFTs are included. This may indicate that flakes were preferred for edge tool production, but that any appropriately-sized object might sometimes be used for a SOFT.

<u>Formal Tools</u>

Although many items in the Alibates collections displayed some degree of rework or use, most were judged to be best classified as cores or SOFTs. Only seven items were classified as formal tools; included were two scrapers, four bifaces, and a hammerstone/toother/pecker which may also exhibit use as a scraper. These items will now be described.

Hammerstone/Toother/Pecker (Site 2, FS 443, Item 3):

This object (refer back to Figure 33:a) is an angular natural clast or bipolar/wedging fragment of Alibates with numerous flaw or remineralized surfaces. It weighs 160 gm, measures 67x63x34 mm, and is red, reddish to orange-brown, brown, purple-brown, and cream-white in color. In shape, it is oval or trapezoidal with rounded corners. Three of the corners are heavily battered, with numerous overlapping truncated or shattered hertzian cone fragments. Some abrasion is also visible on the battered vertices. One short area of step-fractured edge displays scraper microwear. This item seems to be a pounding tool which was probably used to macerate dried meat or plant products and/or to "retooth" groundstone tools such as manos and metates (Dodd 1979, esp. pp. 236-239).

Multiple Scraper (Site 2, FS 543, Item 1):

This object (refer back to Figure 33:d) is a core flake or wedging flake of Alibates with one heavily recorticated dorsal facet, suggesting that it was struck from much older debitage or a tabular quarry stone. It weighs 53 gm, measures 58x45x19 mm, and is of finely banded purple, pinkish brown, white, brown, and yellow stone. A completely remineralized flaw or microfault was cross-cut by the flake; the chert filling the flaw is blood-red and vitreous. In shape, the object is roughly rectangular. One lateral edge of the flake exhibits unifacial retouch to produce a straight-to-convex edge. The other lateral edge and the distal end of the flake were retouched to form two concave unifacial edges each and an additional small concave edge at the distal-lateral corner, for a total of five discernable concave edges. At 40x magnification, the straight-to-convex edge exhibits moderate step-scalar wear with some abrasion and polish on projections. The concave edges exhibit massive stepped wear; occasional projections appear abraded or slightly polished.

If this tool had been somewhat less heavily retouched and used, it probably would have been classified as a compound SOFT; functionally, it probably represents an unusually well-formed and heavily used equivalent of the compound SOFTs, most of which had several concave edges. This piece also exhibits prehension polish on the proximal end and dorsal surface; prehension polish was rarely observed on SOFTs. No functional interpretation for this tool is suggested, other than that it was used in a variety of ways to work moderately soft to moderately hard materials.

Side Scraper (Site 1, FS 177, Item 1):

This object (refer back to Figure 33:c) is a modified natural fragment or flaw spall of Alibates. One end is rather freshly snapped, exposing fine-grained and typically glossy, mottled, white, light brown, and light brownish-purple silicified dolomite. One face and the one used lateral edge are recorticated to mottled, dull white. The other surface is drab, grainy, mottled pale tan and brown; this surface may represent old flaws or may have been roasted. The object weighs 31 gm, measures 53x37x12 mm, and is roughly rectangular in shape.

Only one long edge is utilized. The worked edge's shape is straight. Rework/use flaking is unifacial. At 40x magnification the edge is seen to be composed of stacked step micro-fractures; back from the edge as much as 1.1 mm are ring cracks indicating other step microfractures which did not produce detachments.

Little distinct polish or abrasion was seen on most of the utilized edge of this piece, but some unutilized edges were very rounded and tumbled. Presumably, these edges pertain to old vertices of a tumbled larger object, from which this piece later spalled. One end of the utilized edge was also heavily abraded, rounded, and polished. It is suggested that this piece may have been used, perhaps several millennia ago, to work rather soft materials such as cottonwood or green horn. It may then have been discarded and much later have been retouched and reused to scrape very hard material, such as dry bone or Osage Orange wood.

Stage 2 Bifaces (Site 1, FS 114, Item 5; Site 2, FS 89, Item 2):

These items (refer back to Figure 32:b,c) are both made from Alibates, but in neither case is it possible to determine the debitage type of the parent blank. The piece from Site 1 has 5%

cortex, which is tabular in appearance but includes numerous small ring cracks. The piece from Site 2 has no cortex.

The Site 1 biface weighs 96 gm, is 80x56x22 mm in dimension, and is mottled in brown, light brown, white, yellow, and purplish brown. Numerous ring cracks are present on both cortical and flake scar surfaces. It is roughly oval in shape. A total of 10 productive flake scars and 19 small shaping scars or failed detachments are represented on its faces. Neither use wear nor preparatory grinding is evident on any edge. Although one portion of a lateral edge is badly stepped, the piece is not classifiable as either a failed biface or spent core. It was typed as a Stage 2 biface on the basis of symmetry, size, and shaping effort.

The Site 2 biface weighs 27 gm. It is 53x35x12 mm in dimension and is ovoid-triangular in shape. In color, it is mottled to banded in white, pale brown to cream white, and darker browns grading to red and purple. The thickest portion of this biface lies at one edge. Approximately 20% of the circumference was never flaked to an acute edge, but is truncated perpendicular to the plane of symmetry of the piece. This perpendicular edge surface displays at least four ring cracks, the largest of which is only 1.25 mm in diameter. If these are the impact scars of failed thinning strokes, then the knapper cannot have been skilled, as any one of the four implied strokes would have shattered the object had it carried through to a detachment.

Four or five productive flake scars are present on the object, along with 22 shaping scars or failed detachments, indicating that the piece had been reduced for shaping purposes and not merely as a core. No edge grinding or use wear was detected on this piece, which may have been abandoned because the knapper was too unskilled to complete its thinning by the standard alternate stroke method.

Possible Stage 3 Biface/Tool (Site 2, FS 544, Item 1):

This piece (refer back to Figure 32:d) was recovered from Test Pit 9. It weighs 19 gm and is 58x32x10 mm in dimension. It was minimally reworked from a tertiary flake. Its colors are mottled gray-brown, purplish-brown, red, brown, purple, and green-brown. All colors are quite dark. It is leaf-shaped to triangular in shape.

Classification of this piece is problematic. It has well-executed straight-to-convex unifacial retouch along one entire side and most of the end, with rough bifacial retouch of the opposite side. Distinction of the original dorsal scars from rework scars is not possible. It is evidently a biface preform made on a flake which required little rework for shaping. Both the unifacial edge and the reworked end display use rounding, polish, and line abrasion, together with relict areas of coarse grinding (probably for edge platform preparation). Arguably, the piece could be classified as a SOFT with dominant knife wear, as an unusually large "guitar pick scraper" preform (Etchieson and Couzzourt 1987:7-3), or as a biface early preform or late roughout which simply required little shaping. The piece clearly was not a production failure, but it may have simply been lost.

Projectile Point (Site 2, FS 181, Item 3):

This piece (Figure 40; refer also back to Figure 32:e) is a corner-notched dart point, hence a Stage 4-5 biface. Its material was identified by Rancier (field notes) as Tecovas jasper. We would agree that its color range seems consistent with Tecovas and unusual for Alibates, but we would not rule out Alibates as a possible source. In color, it is dark golden yellow-brown with reddish-brown, red, brown, yellow, and white mottling.

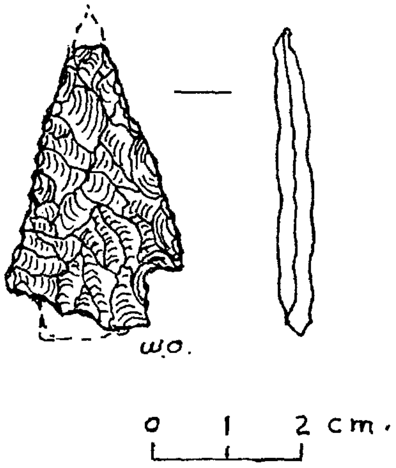

Figure 40
ALFL-86-2, FS 181, Item 3, Projectile Point
See Figure 32, Item E for photograph

Overall, the piece is 38 mm long, is 5.7 mm thick at the haft, is 14.7 mm wide from barb to barb, and has a haft width of 14.5 mm. It weighs 4.7 gm. The piece is skillfully flaked bifacially. The tip was either worked to a rounded outline or reworked after damage. Most of the base was broken away, probably on impact. The blade edge adjacent to the better-preserved barb is much more steeply beveled (bifacially) than is the opposite edge. No obvious edge or tip wear was seen upon 40x examination; no haft or transport polish was noted. Typologically, this piece might be classified as a Bulverde or Marshall point in the Texas typology, but the base is too fragmented to allow precise type assignment.

LITHIC ANALYSIS SUMMARY

Of the 5,052 lithic items examined in this study, 436 items were classified as non-cultural, 4,243 items as debitage, 143 items as cores, 223 items as SOFTs, and 7 items as formal tools. Of debitage items, 813 were classified as angular debris and 3,430 as flakes.

Using a mechanical classification system referenced to a standard provided by Rancier's analysis of similar sites from Abiquiu Reservoir, New Mexico, and based on the Rancier replication debitage collection, the flakes from Alibates were subclassified according to their dimensional and cortical properties. These mechanical types and their frequencies were biface flakes (111), biface-core transition flakes (95), core flakes (401), core-compression transition flakes (523), bipolar/compression "flakes" (271), flake fragments (1,536), indeterminate/unclassifiable flakes (200), and flakes too small to classify (293).

Of the cores encountered in this analysis, 60 were classified as tested rocks, 50 were classified as irregular polyhedrals, 20 were typed as biface-discoids, 9 as prismatic blade cores, and 4 as uniface discoids. A total of 223 SOFTs, having a total of 496 discrete modified edges, were analyzed. Of the SOFT edges described, 301 occurred on tools with multiple edges of more than one profile, 94 on tools with only straight edges, 57 on tools with only convex edges, 24 on tools with only denticulated edges, 17 on tools with only concave (spokeshave) edges, and 4 on tools with only pointed (drill/perforator/burin) edges. Of the seven formal tools described, one was a hammerstone/toother/pecker, one was a multiple scraper, one was a side scraper, two were stage 2 bifaces, one was a possible stage 3 (guitar pick/preform) biface, and one was a projectile point.

When the Alibates debitage assemblages are considered as wholes on a locus-by-locus basis, they are consistently composed of artifacts which are thicker for a given cortex level and size than are comparable cobble and tabular reduction and quarry assemblages at Abiquiu Reservoir. When mechanically classified, the Alibates collections are dominated by rather thick core flakes, by large pieces of debris from bipolar and crushing reduction, and by pieces intermediate in character between core flakes and bipolar shatter. Evidence of biface rework is rare in all sites except for Site 6, which is represented only by subsurface collections from fairly clear archeological context. The surface collections from Site 2 Locus JR and from the Site 2 subsurface tests in Loci JR and JB (referred to as "Locus Blank") seem to have substantial quantities of core flakes. A small assemblage of biface reduction debitage may be intermixed with a much richer shatter scatter at Site 3.

Heat treatment on debitage was rare in Sites 1 and 2, but was more common in Sites 3, 4, and 6. No evidence was found to suggest that heat treatment in Sites 3 and 4 was produced by a recent brush fire. Rework on older pieces was nowhere common; in general, it was most often observed on large, thick pieces. Contrary to expectation, core flakes tended to exhibit much more platform preparation than did flakes mechanically classified as biface debitage. Overall object flake-scar count was highest for larger, thicker debitage, but was relatively much lower for flakes classified as biface debitage.

As expected, heat treatment on cores was most common on biface/discoids and uniface/discoids. The cores recovered seem to have been exploited past their ability to produce large flakes and then abandoned on sites. Later rework was most common on uniface/discoids and irregular polyhedral cores. Little evidence of material selection difference between tabular and cobble Alibates sources was found, but the thinner flake types may tend to have been produced more often from tabular materials.

Of the 223 SOFTs (informal tools) described from the Alibates collection, an undetermined but substantial proportion appear to have been culturally utilized tools, rather than naturally damaged items. Several lines of evidence support this conclusion. Straight-edged SOFTs tended to be more often heat-treated and tended to exhibit unusually high frequencies of microwear characters consistent with their edge morphology. Denticulated SOFTs tended to be heat-treated less often than did other edge types. Rework patterns did not correlate with number of tool edges, suggesting that the incidence of multiple damage events on SOFTs was too high for natural random events to account for the retouched edge patterns observed.

Formal tools were far too uncommon to allow formulation of generalizations about them. None are atypical, given the range of artifact forms and types reported for the Alibates area.

COMPARISONS AND INTERPRETATIONS

Only one detailed large-scale lithic analysis was located which could be compared with the NPS Alibates study. This was Bandy's (1976) reanalysis of the "knapping area" collections from Site 41PT8, the Turkey Creek site. This collection appears to be rather clearly associated with a small Antelope Creek residential complex, although Etchieson and Couzzourt's (1987) ceramic collection from the site may indicate that a Woodland component could also be present.

Bandy's study did not use the same defining debitage characteristics as were employed in the present study. The author would argue that Bandy's types are in part, intentionate, or volitionally defined. In other words, for Bandy, a flake's type was determined both by its objective characteristics and also by the knapper's volitional intention or objective in removing the flake. The knapper's intent can be inferred, but cannot be known except in the case of replicate assemblages.

This problem of definitional comparability meant that Bandy's Antelope Creek assemblage and his replication assemblage could not be numerically classified into a form comparable to that used in this present analysis. Comparisons must therefore be qualitative.

It is clear from Bandy's discussion that his archeological assemblage was dominated by hard-hammer and soft-hammer biface flakes of various sorts. He (1976:79-80) concluded that the knapping area represented a location at which debris from biface rework was discarded. He suggested that thick, rough bifaces or quarry blanks were imported to Site 41PT8, where they were further reduced to produce trade pieces or formal tools, mostly of the "thin oval biface", "guitar pick preform", or "knife" type. He speculated that materials were brought in from the nearby Alibates quarries and that finished pieces were exported from the site.

The differences between Bandy's assemblage and the collections from ALFL-86-1, -2, -3, -4, and -6 are apparent. Biface debitage was not abundant on any of the NPS sites. Cobble cortex was common, although Bandy's inferred material source would suggest that his assemblage was dominated by tabular cortex. Examination of Bandy's illustrations clearly indicate that few, if any, of his flakes would have been mechanically classified as Types Q or J, which together made up 56.7% of the fully classified flakes from the NPS sites.

It would appear that the NPS sites described here represent a new type of site not hitherto fully described for the Alibates area. This site type is composed of massive, casually produced reduction products. Much working of cobble materials is evident, although the probably superior Alibates Quarries tabular sources are nearby. Tools on these sites seem to be expediently used flakes and angular fragments, rather than carefully prepared formal tools. Little formal tool manufacture is evident, unless the SOFTs represent the remnants of production of non-lithic tools such as projectile shafts or bone tools.

Collections from the NPS sites were almost certainly contaminated by debris from recent breakage events (rockhounds, amateurs, etc.); the sites may also have been collected repeatedly in the past by artifact hunters, depleting the study collection's formal tool component.

Nevertheless, it seems clear that, in the local context, a new type of site has been described here; this site type is apparently not closely related to the system of intensive lithic quarrying and standardized, high quality manufacture of formal tools which is generally expected of sites within the Alibates area.

An exception to this pattern seems to be represented by Site 6 and to a lesser degree by the subsurface assemblage from Site 2 analyzed above as Site 2 locus blank. These collections appear to contain far less massive reduction debitage and rather more of the small flakes associated with normal tool manufacture and use, as compared with the surface collections from Sites 1, 2, 3, and 4. Unfortunately, the subsurface samples are small and difficult to compare to other data.

RECOMMENDATIONS

This study has produced results which may have important theoretical, methodological, and management implications. These will now be discussed, beginning with the more specific management implications.

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

1. The results of the CGI analysis tend to confirm the NPS field crew's judgments presented by Rancier (this volume). Inasmuch as substantial quantities of data have been recovered from the proposed impacts areas of Sites 1, 2, 3, and 4, clearance is recommended for the proposed disturbance to these sites.

2. The striking differences observed between the surface collections from Sites 1, 2, 3, and 4 as opposed to the subsurface collections from Site 2 Locus JR and from Site 6 strongly indicate that important contrastive data may be recovered from controlled, broad-scale excavation of these sites. Clearance is therefore not recommended for the immediate area of Test Pit 1 and the associated test trenches at Site 2; clearance is not recommended for areas of Site 6 which were found to have subsurface cultural deposits.

3. The presence on these sites of non-conchoidal reduction on Alibates cobbles as a dominant lithic reduction strategy is surprising, especially considering the ease of access to (and probable superiority of) the tabular material available at the Alibates Quarries. It is likely either that a time period other than the Antelope Creek phase is represented, or that a hitherto-unsuspected component of Antelope Creek adaptation is manifest on these sites. If either is true, then an important interpretive dimension has been added to our picture of local prehistory. Further research will be required to establish the validity and meaning of this new component of the local archeological record.

METHODOLOGICAL IMPLICATIONS AND RECOMMENDATIONS

The lack of adequate methodological tools for the analysis of non-conchoidal reduction lithic assemblages was keenly felt in this study. A range of possible future research emphases can be suggested which, if successfully implemented, would permit a far more satisfactory evaluation of sites resembling the distinctly odd NPS sites. Some of these are presented below.

1. The question of breakage mechanisms for much of the NPS collections remains open. Research is needed relating the velocity, force, and hardness of large hammers of stone, steel, etc. to the character of breakage products generated by impacts.

2. There can be little doubt that some of the breakage studied in this report is modern. Methods are needed for the recognition of genuinely modern breakage in sites known to have been worked over by amateurs and rockhounds.

3. Some of the breakage observed was undoubtedly due to ground-loading, landslides, and colluvial movement. Can methods be developed to allow natural breakage to be recognized?

4. The novel methods employed to produce a mechanical flake classification in this study were crude, but promising. They may merit further development, emphasizing their desirable qualities of objectivity, generality, and replicability.

5. Methods for recognizing heat treatment in this study were unsatisfactory. Objective measures of change which can be unambiguously related to heating of stone should be pursued in the laboratory.

6. Statistically useful measurement of color on multicolored materials remains an intractable problem, but one meriting further research and new avenues of approach.

THEORETICAL IMPLICATIONS AND QUESTIONS

As with most lithic analyses, little theory was available to help frame research or interpret results. General lithic analysis theory is clearly underdeveloped (c.f., the discussions at the recent NMAC/Ghost Ranch Lithic Concordance, in prep) and suffers from shortcomings too broad to raise in this report. Much less ambitious theoretical questions may, however, be raised appropriately as they were highlighted by this analysis. Several of these questions are presented below.

1. Under what circumstances would groups be expected to engage in systematic, intensive quarrying of lithic resources?

2. Under what circumstances would groups which routinely quarried high-quality stone be expected to engage in the reduction of inferior stone from surface deposits near the quarries?

3. If groups quarry systematically and regularly reduce stone with great skill for use/export, would these groups be expected to possess a separate and less sophisticated stone technological system? In other words, is a dual lithic economy to be expected?

These more theoretical questions raise research questions which bear directly on further work at Alibates Flint Quarries National Monument. Among these questions are:

1. Do Alibates silicified dolomite tools made from cobble sources occur commonly in Antelope Creek sites within the monument? If so, what tool forms and inferred or deduced functions are represented?

2. If sites such as ALFL-86-6 are excavated, they will probably contain numerous formal and informal tools as well as debitage which can be specifically related to particular aspects of lithic tool manufacture. In these sites located within the cobble source areas, does the manufacture of certain types of tools draw selectively on cobble material sources?

3. Quarrying, as carried out at Alibates, seems to have been rather labor intensive. Perhaps cobble reduction sites pertain to periods (protohistoric, Archaic, etc.) when few people were locally in residence and when demand could be satisfied by casually breaking cobbles, selecting only the very best material and the most appropriately shaped breakage products for further work or export. In other words, is cobble technology at and near the Alibates quarries a temporally diagnostic indicator?

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Figure 11

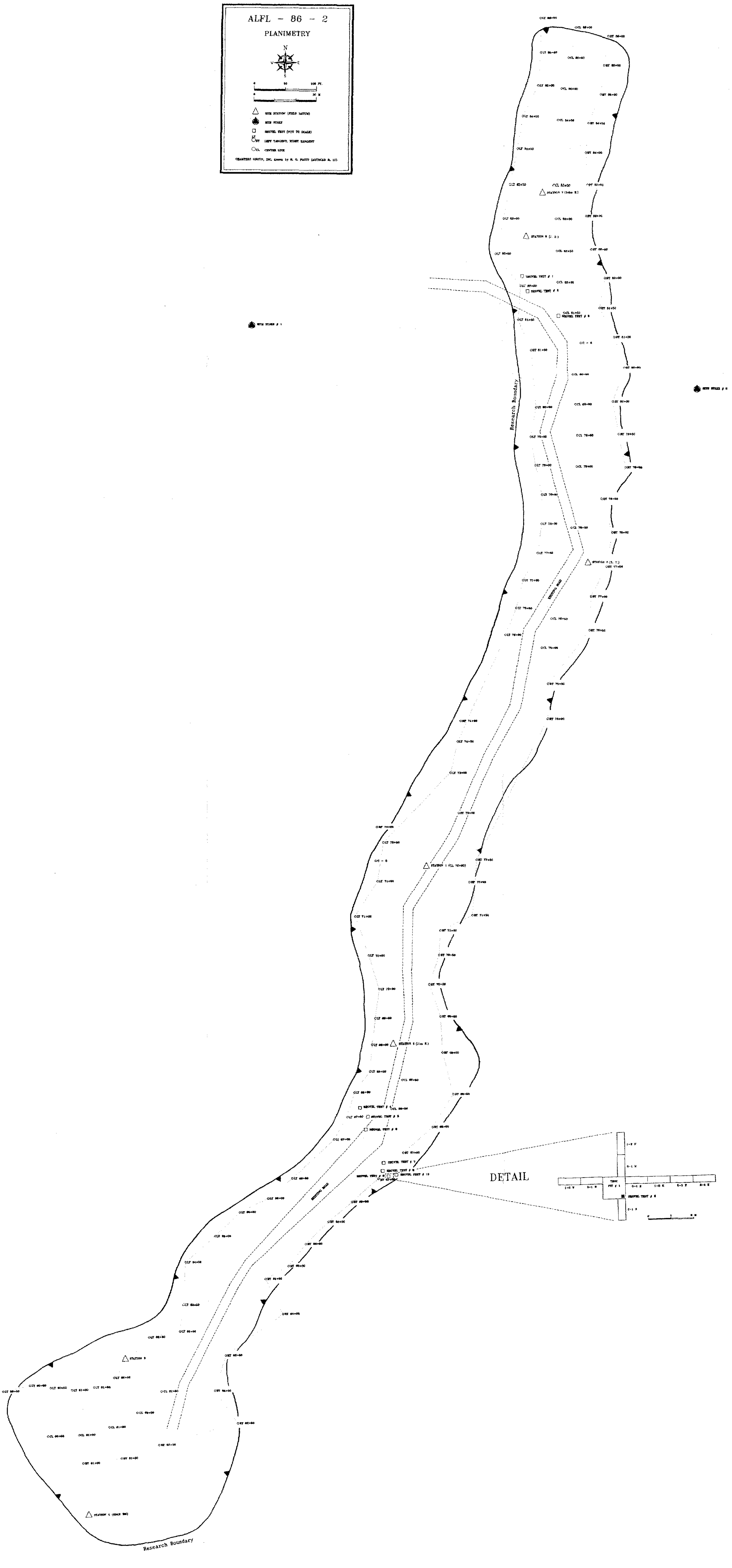
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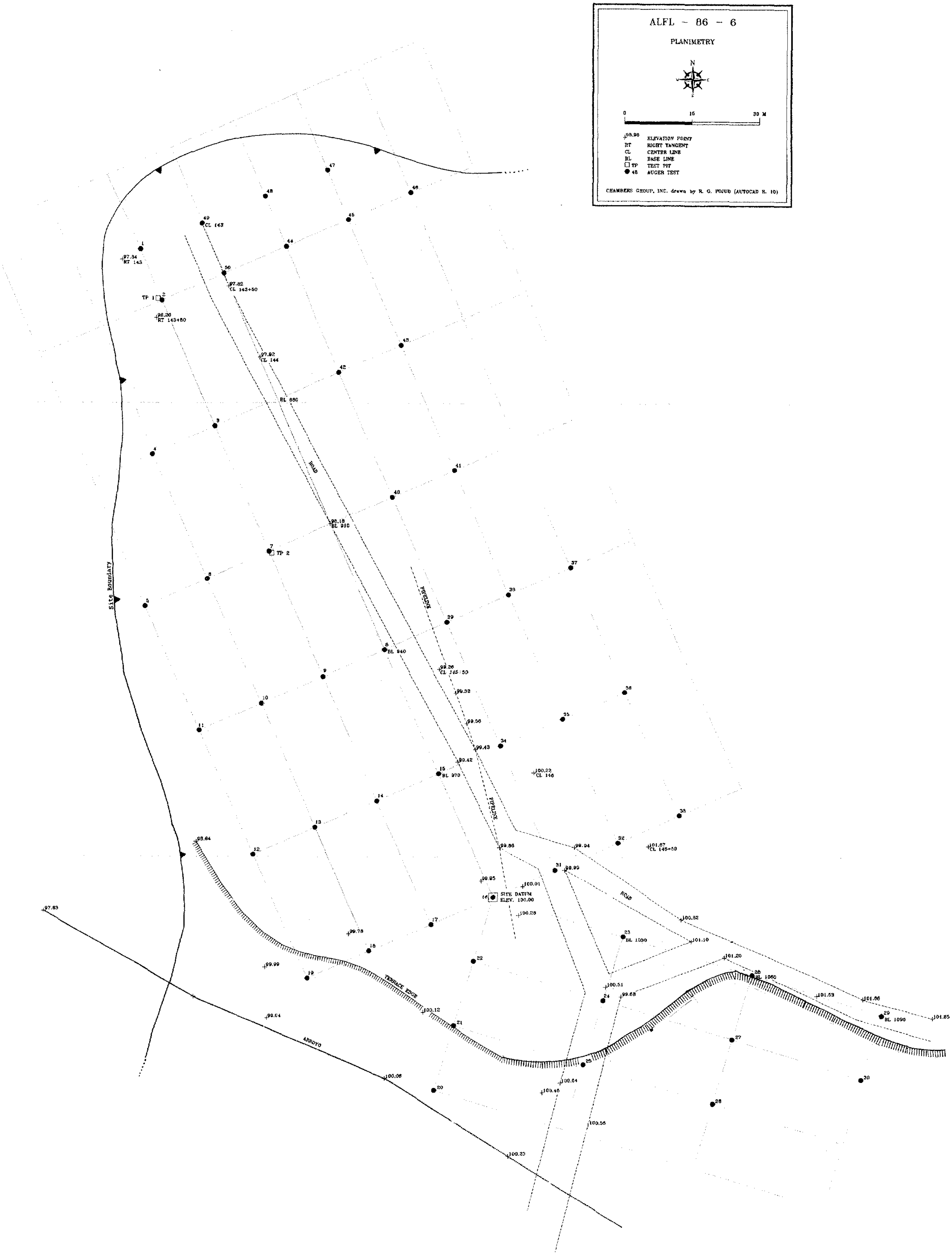
Figure 24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15 BL 970
100.22 CL 146
14
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29 BL 1090
101.85
99.04
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ARROYO
25
100.06
100.64
30
20
100.46
26
100.55
100.23