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ABSTRACT

The operations of the Dolores Archaeological Program Reductive Technologies Laboratory from March, 1979, to February, 1980, are summarized. Preliminary analysis (completed in January, 1980) and intensive analysis activities are presented, as are the administrative activities of the laboratory. The ways in which lithic analysis systems articulate with the program research design are discussed. The size of the lithics colletions from program sites is presented in a table which forms Appendix A. Also appended to the report are explanations of the flaked lithic debitage and flaked lithic implement analysis systems, and the outline for intensive analysis of flakes.

INTRODUCTION AND OVERVIEW

On 1 November 1979, the Dolores Archaeological Program (D.A.P.) hired a new task specialist to direct the operation of the reductive technology laboratory. Since the period of this report prior to 1 November is known only indirectly to the present task specialist, it will be covered rather briefly; the four-month period from November through February will receive more detailed coverage.

During the report period, the staff complement of the reductive technology laboratory ranged from three full-time analysts and one assistant task specialist to five and one-half analysts, the assistant, and the task specialist. A total of approximately 1,840 person days were spent in laboratory activity; this is the equivalent of slightly more than seven full-time positions.

Preliminary analysis of all excavation and survey materials was completed for the three major lithics data files on 18 January 1980. Preliminary item counts for the three files are as follows: flaked lithic tools, 9,961; nonflaked lithic tools, 6,258; and flaked lithic debitage, 102,141. Final editing will increase these preliminary totals slightly but should not significantly alter their relative proportions. Appendix A presents a chart of all D.A.P. excavated sites, with artifact totals for each lithic-data category.

The remainder of the report period was spent in training for the early stages of an intensive flake analysis which will be discussed below, along with plans and needs for other intensive analysis programs. Finally, this report will consider several administrative and interpretive concerns, including specific points of articulation between the D.A.P.

Lithics Research Design and both preliminary and intensive analysis programs.

SUMMARY OF ACTIVITIES: MARCH THROUGH OCTOBER 1979

During the four months prior to March 1979, the reductive technology task specialist was involved in equipping the lab, hiring and training an analytic staff, developing and revising the basic preliminary analysis systems, instituting the preliminary analysis, and planning for detailed analysis programs, especially those identifying and cataloging locally available lithic resources.

Between March and October 1979, major activities included the continued training of staff in both preliminary analysis routines and entry of data into the computer; the generation of dictionaries for lithic and geologic items appropriate to or used within, the D.A.P. analytic system; a literature review on various topics of immediate concern, particularly those dealing with geologic and raw material aspects of lithic analysis; planning for intensive analysis programs, again focusing strongly on such geologically oriented programs as lithic heat-treating experimentation and lithic raw material source location; and general lab administration, particularly communication with the D.A.P. lithics consultant, Dr. R. Knudson of the University of Idaho, Moscow.

SUMMARY OF ACTIVITIES: NOVEMBER 1979 THROUGH FEBRUARY 1980

Preliminary Analysis Program

Major Data Files

On 1 November 1979, approximately 70 percent of the preliminary analysis, or 17,000 out of 24,000 field provenience units, had been completed for the three major reductive technology data files: flaked lithic implements, nonflaked lithic implements, and flaked lithic debitage. Of this analyzed material, approximately 70-80 percent had been entered into the computerized data-management systems. The analysis staff appeared to be working well under the temporary supervision of the assistant task specialist, but there were no well-defined research methods, purposes, or priorities.

It was decided that the assistant task specialist would continue to direct the preliminary analysis, that no changes would be made in the analysis formats, and that attention would be directed toward maintaining analytic consistency. The task specialist would concentrate on producing explicit statements defining how the analysis was being done and how the results might be interpreted within some specific behavioral model(s); on developing intensive analysis programs and secondary data-file organization; and on administrative/interpretive tasks.

The assistant task specialist was very effective in directing the preliminary analysis to completion on 18 January 1980, well ahead of schedule. The analysis crew then began work on a detailed flake analysis program and on the several secondary data sets for which the reductive technology laboratory is responsible.

By February 1980, detailed explanations of both the flaked lithic tool and the flaked lithic debitage preliminary analysis systems had been developed; the task specialist had also suggested interpretations of the resulting data. These are attached as Appendix B (Flaked Lithic Tools Interpretive Suggestions) and Appendix C (Flaked Lithic Debitage Interpretive Suggestions). The explanatory interpretive statement for nonflaked tools and debitage is in draft form and will be finalized shortly.

In producing these interpretive guides it became apparent that the preliminary analysis systems for both flaked and nonflaked implements were unnecessarily cumbersome. Many of the coding variables (the attributes or characteristics of tools which are evaluated) and the specific values of these variables (the various states in which the attributes can occur on the tools) were necessarily formulated without a detailed knowledge of the data to be analyzed. They were therefore constructed with a cover-all-the-possibilities approach. Now that a specific knowledge of the data is emerging from the preliminary analysis (Phagan [1]), several of the variables and variable values are recognized as inadaquate, inappropriate, or unnecessary.

As a first step in the essential process of improving the fit between the analytic systems and the D.A.P. data base, several of the original variables in both the flaked and nonflaked analysis outlines have been restructured. All of these restructured variables combine several very specific values which have few or no cases, into more general values with more cases. This restructuring has been done by a recoding program in the computer files, and these recoded variables are incorporated into the interpretive guides (Appendices B and C). For example, Variable 12A for flaked lithic implements, "Grain Size," is a recoding into only four

general values of the 37 specific raw materials values of Variable 12, "Lithic Material Class," many of which had no cases. These four grain-size values of the recoded Variable 12A correspond directly to the values used to describe flaked lithic debitage, so that direct raw material comparisons can now be made between implements and debitage. In all, nine recoded variables have been generated for flaked lithic tools and three for nonflaked tools. Ease and clarity of interpretation have been improved by this variable recoding, as has the security of behavioral assumptions based on them.

Secondary Data Files

A great deal of effort had previously gone into various forms of geologic research, both in the D.A.P. area and in surrounding areas. Information from this research, however, was neither well-organized nor readily available to crew chiefs or other D.A.P. personnel for report preparation. These geologic and lithic raw material data were summarized in two ways. First, a memorandum was distributed on 18 December 1979 which defined the locally available resources as highly varied in nature and quality, and as readily available within the program area. Suggestions were made on apparent cultural interpretability of this information and on orientations for future investigation. Second, a large project area map with overlays was prepared to locate flakeable raw materials at three levels of availability: geologic formations, at or near the surface, in which appropriate materials may occur; known modern outcroppings or actual surface exposures of appropriate material; and sites with cultural indications of actual use in prehistoric lithic-resource procurement. D.A.P. excavated sites are also located on the map to show precise distances to various raw material sources.

After completion of the preliminary analysis, the lab crew analyzed the lithics from the priority bulk soil samples. Slightly modified versions of the debitage analysis systems were used (primarily the flaked lithic debitage program). Materials from 171 samples taken from 17 sites were analyzed, and coding forms have been submitted for computer entry.

Analysis of the bone implements has, because of its rather low priority, been repeatedly delayed. Only materials from the 1978 excavations are available. The assistant task specialist has been given major responsibiltiy for this data set, and progress has been made in structuring the bone-tool analysis and in coordinating with the faunal analysis system. In lieu of concise analysis results, a basic bibliography of appropriate references, including photocopied illustrations of materials from surrounding areas, was compiled and distrubuted to crew chiefs involved in interpreting this data. In addition, the bone implements themselves have been arranged by site and are available in the lab for examination by crew chiefs.

At the January 1980 D.A.P. all-staff meetings, the reductive technology laboratory was given responsibility for three small data files: shell, other organic, and other inorganic materials. Since there are relatively few items in any of these files, a description rather than a classification was judged most appropriate. Lists for each file have been prepared which include site number, field provenience unit number, catalog number, a brief description of each item, and its weight. These lists are being typed and will be available shortly.

Summary of Preliminary Analysis

While it is still a bit early for detailed evaluation, it does appear that the preliminary analysis systems are monitoring significant variability within the D.A.P. lithic materials. Both for individual sites and for several temporal/spatial/site-type groupings of sites, the variability so far observed seems to be great enough and consistent enough for solid interpretability.

While the preliminary analysis is producing good analytic data, there are several ways in which all three of the analysis systems can be improved: information can be retrieved more efficiently, computer-input accuracy can be improved, and several variables can be added, deleted, or altered. All analytic systems will be carefully evaluated for revision prior to their use on the 1980 excavation materials.

Intensive Analysis Programs

The D.A.P. Lithic Research Design lists four intensive-analysis programs which are the responsibility of the lithics task specialist:

- all projectile points (production, use, style, temporality)
- sampled flake debitage (production)
- sampled flaked tools (production, use)
- sampled nonflaked tools (production, use, style, temporality)

It has long been obvious that all these analyses could not be accomplished within the time and personnel framework of past and present budgets. The projectile point analysis and the functional analysis of flaked lithic implements have received higher priority, while the flaked debitage and the nonflaked implement analyses have been ranked lower. Due to constraints in both analytic techniques and characteristics of material to

be analyzed, the four analysis programs have actually developed into the following:

- all projectile points (a macro-examination of production, style, and temporality)
- sampled flake debitage (a macro-examination of production and temporality)
- sampled flaked tools, including projectile points (a macro-examination of function)
- sampled nonflaked tools (a macro-examination of production, style, and temporality, with an element of macro-examination for tool use)

When preliminary analyses were completed in mid-January, a very careful consideration of analysis programs and priorities was made. Important elements in this consideration were the nature and complexity of the various analysis programs; the amount of time and personnel available; special equipment necessary for the micro-analysis program; scheduling implications of each program with respect to data-processing resources; analysis supervison and other necessary tasks; and project priorities.

The temporal-stylistic analysis of projectile points was delayed until the summer months of 1980. Since the assistant task specialist was planning to resign from that position as of May 1980, this budgeted salary could instead be used to hire a short-term advanced-level lithics and computer analyst to take full responsibility for the projectile-point study. This position was advertised and several excellent applicants are being reviewed. This analysis is being planned as a three-month study, from June through August 1980, with a complete report due on 31 August. Projectile-point typology and temporal sensitivity will be important elements in the analysis.

Since data from the projectile-point study will not be available for inclusion by crew chiefs in preliminary site reports, a bibiliography of relevant literature, along with photocopies of comparable material and pertinent interpretations, has been compiled and distributed to crew chiefs. In addition, all projectile points have been photographed, and the points themselves are arranged by site and available in the laboratory for crew chiefs to examine.

The flake analysis was seen as the most appropriate intensive-analysis program to undertake. It was a system which could be quickly put into workable shape; it required simple and straightforward analysis with minimal time for staff training; results could be directly and securely interpreted within a technological framework as well as indirectly interpreted within a functional one; it would articulate well with both the Lithic and the general D.A.P. Research Designs at several points; it would produce a fairly independent body of data, free from traditional assumptions, which would be supplementary in situations of reduced ceramic, faunal, or other data and complementary in situations of greater data availability; and it could be reduced or expanded to maximize available analytic resources. In addition, some directly comparable data have recently become available from the Coal Gasification Plant Project (Chapman [2]) which confirm such flake data as both technologically interpretable and useful in making broad temporal or functional assessments.

A sampling structure was designed to select flake samples from the range of time, location, and site type represented in the D.A.P. materials. Sites with significant aceramic components would be especially well represented in the sample as would earlier Archaic-Basketmaker III

sites. In addition, archaeological situations likely to represent flaking-activity loci (chipping stations) would be analyzed. Central-limits theory indicates that at least 30 flakes per archaeological unit (such as a pitstructure or a roomblock) should be sampled, with perhaps as many as 100 flakes sampled per site.

While it was necessary to minimize the number of debitage lots which were processed for sampling analysis, caution was taken to prevent any single lot from contributing inordinately to the sample. If possible, no more than 10 flakes were selected from any single debitage lot. Sampling was done with a two-stage strategy: first, debitage lots within the selected archaeological units were chosen randomly, and then flakes were selected randomly from these lots.

An analysis system consisting of 22 data variables, identification variables, and a coding form (Appendix D) was developed, and this flake analysis has been applied to over 3,000 flakes from 26 D.A.P. sites. Coding forms are being submitted for computer entry.

The microscopic functional (use-wear) analysis of both projectile points and other implements has been delayed until after the 1980 funding decision for two reasons. First, recent developments in the field of microscopic use-wear analysis strongly indicate that such an analysis is most productive when conducted on a scale which is considerably beyond the present personnel and equipment capacities of the D.A.P. Second, while functional analysis can produce detailed information regarding fairly specific prehistoric uses of stone tools, activity areas, and sites, it is expensive and thus should be applied only to carefully selected samples to test hypotheses generated from interpretation of preliminary analysis results.

If the funding decision is positive, the D.A.P. should budget for such an analysis to be conducted during the fall, winter, and spring of 1980-1981. Preferably, either a well-qualified analyst should be hired to do the study, or arrangements to train such a person should be made. Another less desirable possibility is to contract for such a study to be conducted by a specialist elsewhere. In any case, considerable administrative input and economic commitment will be necessary before an effective microscopic use-wear analysis can begin.

An intensive production/use/stylistic/temporality analysis of the nonflaked lithic implements has been postponed for several reasons. In most American archaeology, including Southwestern archaeology, ground-stone implements have been given short shrift. Site reports normally contain a few photos or brief descriptions of ground-stone items, but actual typologies are either nonexistent or so truncated as to be nearly useless. Categories which do traditionally appear have usually been defined by agreement or fiat and are therefore only minimally useful in producing or testing relevant cultural hypotheses. Unfortunately, the D.A.P. preliminary-analysis system for nonflaked lithic implements to date provides no exception to this rule. There are very few organized models or precedents to direct the development of an adequate analytic system. Behavioral models of ground-stone-tool production or use, either from replicative experiments or ethnographic observation, are few, inadequate, and conflicting.

A serious effort has recently been made to produce for the D.A.P. a nonflaked lithics interpretive guide to parallel that for flaked lithics. The result is a very preliminary and tentative theoretical model of ground-stone-tool production and use behavior. Without such a model one

can only guess at the attributes which may or may not be relevant, and units of observation tend to be like shots in the dark. The only way to demonstrate behavior from artifacts is first to have postulated artifacts from behavior.

For flaked-stone technology the D.A.P. analytic system is sound and useful because it was developed and is being interpreted within coherent and rather well-understood models of stone-tool production and use. Attributes have been selected and measured to reveal patterned behavior consistent with the models. Conversely, because such models for ground-stone implements have been lacking, attributes of the analytic system are culturally meaningless, inconsistent, or even contradictory in organizing information to reveal associated prehistoric production or use behavior.

For example, even the single, very tentative generalization that trough metates precede slab metates in Anasazi culture cannot be tested with the D.A.P. preliminary data because neither type of metate has been adequately defined within a behavioral model to allow segregation of appropriate attribute states which might resolve the question. In short, the D.A.P. ground-stone preliminary analysis will be only minimally useful in generating statements concerning Anasazi behavior. The present data may be of limited use in suggesting differential raw material selection, item-breakage patterns, or relative proportions of poorly defined traditional tool types.

What is needed for the D.A.P. ground-stone-tool analysis is the development of at least a theoretical model of tool production and use, supported if possible by experimental and/or ethnographic studies, which can then be used to select attributes that permit examination of the model

in terms of the data. This will be most appropriate as an intensive analysis program, at least for application to data already processed through the preliminary analysis. For future excavation materials, a significant restructuring of the preliminary analysis may largely preclude the need for intensive analysis of most ground-stone tools. Present priorities are first, to complete the ground-stone interpretive guide, which will include a tentative theoretical model of tool production and use as well as suggestions for interpreting the preliminary analysis data; second to refine the model and develop an intensive analysis system for major portions of the ground-stone artifacts; and third, to restructure the preliminary system for analysis of future excavated ground-stone material.

Administrative Activities

Administrative concerns during the period November 1979 through February 1980 have primarily involved problems associated with computerized processing of the preliminary analysis data, with confirming the accuracy of these data, and with coordinated presentation and interpretation of these data in site reports and in lithic-overview reports.

As early as mid-November it was recognized that the availability of adequate computer-processed lithic data in time for scheduled site-report preparation was questionable. Specific problems have included lost data, dirty files, incomplete files, duplicated data, input-merging difficuties, typographical errors, file security, slow output, down time, and data processing personnel problems. Several administrative procedural revisions and personnel changes have relieved many of the problems,

particularly since mid-February, but data output will lag behind report-preparation needs for at least several months.

Reporting has been strongly standardized on a project-wide basis, particularly with reference to the internal breakdown of site data, and all data have been structured to deal with these larger research needs of the D.A.P. In addition to this standardized data output, special site-data treatment is available to crew chiefs on a limited and approved basis. The task specialist has scheduled individual meetings with all crew chiefs and locality supervisors to discuss this standardized data presentation in all site reports and to arrange for presentation of special data requests.

All three major lithic-data files have recently been cross-checked with the paper records (which are accepted as authoritative) for file accuracy. Discrepancies as high as 20 percent have been found for some sites; this is an obviously unacceptable error factor. Computer programs for error location and for duplicate-line location are being developed and run on all three files, and a line-by-line check is being made of all sites which show as much as a 2 percent discrepancy between the paper records and the computer file. Most of the errors appear to be occasional wild values for some variables, duplicate lines, or errors in merging input with permanent files. The remaining lab crew will, as its final job under the present budget, locate and correct these file errors. The first priority of the entire lab staff is to produce clean files. The data-processing staff will be requested to rerun the standard output for sites with a 5 percent error or greater, and crew chiefs will be requested to alter the data for sites with a smaller error.

Since a great many research questions will continue to be answered on the basis of the paper files, without computer processing, rather strenuous measures have been taken to insure file safety and accuracy. Files are maintained in fire-proof cabinets and are not taken from the laboratory. Duplicates are sent to Salt Lake City for computer entry, which has produced a duplicate copy for a growing proportion of the paper file.

The task specialist, in cooperation with the D.A.P. photography laboratory and other task specialists, has produced guidelines for site-report illustrations and photographs. The additive analysis laboratory staff is now in the process of transferring such lithic materials from permanent storage to the photography laboratory.

SUMMARY: ARTICULATION OF LITHIC ANALYSIS WITH D.A.P. RESEARCH DESIGN PROBLEM DOMAINS

The following brief comments are preliminary in nature and are designed to give some early status indication of the lithic data with respect to various problem domains of the D.A.P. research design. These comments should suggest areas of data strength or weakness, improvements in lithic analysis systems, and supplementary or complementry research efforts in lithic or other data sets.

Problem Domain 1: Ecological Adaptations

A lithic evaluation of prehistoric ecological adaptations to the D.A.P. area will focus on patterns of local versus nonlocal raw material availability and utilization. Preliminary indications are that, for both flaked and nonflaked production technologies, lithic raw materials of good quality were readily available on a local basis. Within the program boundaries there occurs a variety of flakeable quartzites and cherts, as well as sandstones and granitics suitable for producing a wide range of ground-stone-implement variability.

Almost anywhere within the D.A.P. area a single individual (or small task group) could easily have traveled to a location of good quality resources for either flaked or ground implements, collected suitable material, reduced its weight and volume to either cores or roughly shaped preforms, and returned to his village or hamlet within a single day. This sort of raw material procurement could have been scheduled during all but the most severe winter months and even then would have been possible on a limited basis for emergency needs. Such a procurement pattern need not have required special social task groupings, nor would it have often

resulted in the short occupation, specialized site types produced by such task groups. Therefore, most raw-material-procurement locations in the D.A.P. area may more accurately be described as limited activity loci, and are unlikely to contain features other than small, shallow, warming hearths. They should be located below, or occasionally just above, surface outcroppings of workable stone, which are numerous in the D.A.P. area now and were probably numerous during the entire occupation of the area. Such activity loci should contain high proportions of relatively large, thick, irregular flakes, especially cortex-bearing flakes, as well as much production shatter and low proportions of well-worked items, even broken ones.

Within such a technological system of minimal scheduling and energy expenditure in raw material procurement, a highly expedient lithic technology would have been likely, and exceptions probably indicate some culturally significant circumstance. Since procurement input was minimal and replacement easy, production input might also have been minimal, with well-shaped or highly stylized items representing a low proportion of the tool complex, particularly if populations were permanent in the area. Implements would probably have been curated only to the extent that they represented high production input, high functional importance, high ceremonial value, or some combination. If an implement is easy to make, it is easy to discard, and vice versa.

The preliminary lithic analysis programs, especially for flaked lithics, have been designed to evaluate relative production input, and preliminary results appear quite promising for interpreting prehistoric behavior within this technological model. Permanent, year-round occupation components in the D.A.P. appear to be broadly consistent with

such an expedient technological system, with high proportions of utilized flakes and other items having relatively little production input. There is, however, some distinct variability within this pattern which may be interpretable as temporal or functional variation. During the entire Anasazi occupation of the area, there appears to have been very little external influence on the systematics of stone-tool production, either in raw materials or know-how. Changes in lithic technology were apparently relatively small and evolutionary and suggest general systemic stability.

Several D.A.P. sites have possible Archaic components, and at least some of these sites do, in fact, demonstrate a quite different technological pattern. They contain significantly greater variability in raw materials, which may be a fairly direct reflection of the greater mobility of Archaic populations. In addition, implement sizes, proportions of implement types, patterns of production input, breakage patterns, and apparent item curation are markedly different in these possible Archaic components. These data, along with information from the detailed flake analysis, have considerable potential for identifying Archiac components solely on the basis of lithic technological patterns, even with small, otherwise nondiagnostic assemblages.

Problem Domain 2: Paleodemography

This problem domain is normally addressed only indirectly, if at all, with lithic data. There is, with respect to needed lithic raw materials, no obvious limiting function of the environment on population. The lithic carrying capacity of the D.A.P. area is essentially unlimited, and any differential utilization of raw material resources probably reflects simple cultural preferences or changing needs within technological systematics, rather than depletion of primary resources or large-scale

importation. To some degree, raw artifact numbers may, in very gross terms, give some indication of relative population size or occupation span.

Problem Domain 3: Community Organization and Settlement Pattern

As suggested in the Lithics Research Design, a major contribution of lithic data to this problem domain will be in evaluating the D.A.P. system of site typology. Sites within types should generally demonstrate less variability than sites across types. Early indications from the preliminary analysis are that, in fact, such major site types as activity loci, unit hamlets, and villages do cohere as artifactually definable types. This evaluation can be considerably refined in sensitivity and is readily quantifiable with existing data.

Another aspect of organizational patterning to which the lithic analysis data are particularly suited is that of site function. Regularity in proportion of artifact types, in artifact gross morphology, or in such detailed morphological attributes as polish or striations can be inferred to indicate regularity in site or artifact use. Preliminary analysis already indicates rather consistently patterned artifact variability within and between major site groupings.

In addition, it is apparent that specific implement-manufacturing behavior has been monitored in several instances: numerous hammerstones, shaped-bone items, and flakes of distinctive raw materials, as well as exhausted cores and broken implements of the same materials, have been excavated with good control and close association. Both manufacturing and functional implications from such evidence are fairly direct and secure and can be extended to other situations of demonstrated temporal, spatial, and content similarity.

Problem Domain 4: Trade and Foreign Relations

The general D.A.P. pattern of local lithic raw material utilization, which was discussed in the context of Problem Domain 1, has one rather notable exception. Within the projectile-point component of the D.A.P. assemblage, there is significantly greater variety in raw material, most of which is nonlocal. These nonlocal materials certainly indicate some sort of contact with other areas, some of which are several hundred kilometers distant. The nature of the occurrence of these materials may have several cultural implications.

Projectile points in the D.A.P. collection also seem to occur in a bimodal pattern with reference to production technology: they are either quite thin, symmetrical, and well made, with both faces completely covered with regularly spaced scars; or they are rather asymmetrical, expediently produced flake points, with significant proportions of original flake surfaces on one or both faces of the point. It is within the former group that nonlocal materials appear most frequently. Many items are of obsidian, chalcedony, or very vitreous and homogeneous cherts, all of which are of noticeably higher flaking quality. Implications are that items of relatively high technological production input are also high in raw material acquisition input.

It is apparent that a very expedient technology such as that of the Anasazi may not represent a lack of production know-how so much as a lack of need or motivation within an efficiency model of behavior. In addition, even within the agricultural Anasazi economy, hunting and its accompanying complex of technological activities were apparently important elements, either as a result of their direct contribution to the economy or of the social status of their practitioners. Further, the production

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input variability within projectile points indicates some functional or social differentiation within the sphere of hunting activity. This may be temporally related variability, as in the development of an increasingly expedient and localized projectile-point manufacture, possibly reflecting a decreasingly important hunting element in the society; or it may reflect a sort of cultural neoteny, a retention of Archaic hunting-and-gathering values and behavior in the horticultural system, perhaps as an indication of the continued economic importance of animal products, or as part of a ritual status-defining mechanism, or as an element in the developing sex-role patterns of Anasazi culture. An increasingly significant, female-dominated horticultural element in the society might have been offset by a well-defined male-focused element in which men were highly mobile and within which status could be achieved through production technology, raw material procurement, or other rankable activities.

The D.A.P. projectile points will be intensively analyzed during June, July, and August 1980, with these and other research questions in mind. For example, a research problem closely related to trade and foreign relations is that of determining individual and group mobility. The noticeably greater variety of raw materials, particularly better-quality nonlocal materials, for all implement types in the D.A.P. sites with possible Archaic components, may be a direct indicator of the greater mobility of these social units. The extent to which such raw material variety is present in later Anasazi sites and the manner in which that variability is patterned may indicate the extent and patterning of Anasazi mobility. More specifically directed data collection and analysis may provide evidence relevant to these research questions.

Problem Domain 5: Cultural Process

Many of the questions or topics discussed in Problem Domains 1-4, above, are relatable to cultural process when they are definable or controllable within a diachronic framework. The D.A.P. chronology is good and is improving; analysis of several such topics will be possible using lithic data.

A factor which directly affects the selection of appropriate diachronic lithic studies is that production technology is a relatively stable cultural subsystem, and changes within it should normally occur rather slowly. It is therefore more appropriate for examining long-term cultural process or traditions rather than short-term "fads." Lithic-production technology is the use of primary tools in producing secondary stone tools. Considerable variation may occur fairly quickly in assemblages of secondary stone tools, and this variability may be analytically recognized as changes in typology of the items. The entire range of items, however, is very likely to have been produced within a single relatively stable basic system of lithic-production technology.

When occasional rather sudden changes do occur in such basic technological systems, they should mark significant and revolutionary episodes of cultural development and are likely to be accompanied by marked alterations in population size or patterning. If physical or social changes in the environment are sufficiently large or rapid to heavily tax basic adaptive strategies, if creating new versions of secondary tools within the basic production technology is inadequate to cope with the new environmental stress, or if basic raw materials are exhausted or become unavailable, then even such drastic measures as migration or warfare may be preferable to the confusion and disorientation

of a too-rapid change in basic technologicl systems. It is within such broad interpretive models that larger questions of cultural process, such as sudden major population shifts out of the D.A.P. area, should be addressed with lithic data.

APPENDIX A

DOLORES ARCHAEOLOGICAL PROGRAM TOTAL LITHIC ARTIFACTS

DOLORES ARCHAEOLOGICAL PROGRAM
LITHIC ARTIFACTS

Site #	Flaked Lithic Tools	Nonflaked Lithic Tools	Flaked Lithic Debitage	Total
5MT0023	2,553	1,262	28,356	32,171
5MT2151	1,340	800	19,606	21,746
5MT2160	1	2	16	19
5MT2161	259	138	4,263	6,000
5MT2162	7	16	62	85
5MT2169	4	1	20	25
5MT2191	83	117	511	711
5MT2192	70	64	791	925
5MT2193	175	139	1,278	1,592
5MT2194	93	63	639	795
5MT2198	53	40	351	444
5MT2199	85	7	1,380	1,472
5MT2202	136	58	1,323	1,517
5MT2203	12	9	130	151
5MT2205	7	12	42	61
5MT2235	534	347	3,961	4,842
5MT2236	53	33	456	542
5MT2242	168	230	5,031	5,429
5MT2320	91	128	854	1,073
5MT2844	6	6	62	74
5MT2848	36	39	274	349
5MT2853	16	12	53	81
5MT2854	1,035	550	8,463	10,048
5MT2857	3	2	7	12
5MT2858	106	114	658	878
5MT4475	1,240	1,080	8,624	10,944
5MT4512	75	95	951	1,121
5MT4513	3	3	56	62
5MT4545	294	169	2,437	2,900
5MT4614	362	228	2,813	3,403
5MT4640	2	4	44	50
5MT4642	1	9	44	54
5MT4644	757	311	3,706	4,774
5MT4649	3	0	3	6
5MT4650	47	11	100	158
5MT4651	6	0	40	46
5MT4671	219	130	3,816	4,165
5MT4681	12	27	415	454
5MT4682	12	0	489	501
5MT4763	2	2	16	20
Totals	9,961	6,258	102,141	119,700

NOTE: The horizontal and vertical totals do not agree (by 1340 items). This is for the most part due to a difference in date of generation for some of the figures. Files are constantly being edited, and totals will not agree until editing is complete.

APPENDIX B

INTERPRETIVE SUGGESTIONS FOR FLAKED LITHIC DEBITAGE

MEMORANDUM 28 NOVEMBER 1979

TO: Breternitz, Farley, Kane, Knudson, Lipe, Lucius, Rohr, Ryan
Crew Chiefs
Locality Supervisors

FROM: C. Phagan

RE: Interpretative suggestions for flaked lithic debitage

An important thing to remember about this particular data set is that it is totally in lots of material rather than individual items. Individual items are not weighed, for instance; they're only counted. The only way to make statements about individual "things" is via an "average" thing. Another important thing with the analytic structure (it's true of all the lithic data sets) is that some variables are recorded at a nominal level, some at an ordinal level, and some at an interval level, which can make a great deal of difference in the propriety of various statistics and their interpretability in cultural terms.

"Debitage" is no necessarily a culturally interpretable category. Some of it is definitely the result of patterned behavior, but some of it may be completely unassociated with behavior (except for the varied collecting tendencies of crew chiefs), and more of it, while it may have been associated with prehistoric behavior, is uninterpretable because we don't know how to recognize/analyze that association. Generally, the most secure interpretive comments will focus on Variable A8, or those items which, by the presence of "striking platforms," we know to be cultural (see specific suggestions with that variable, below).

VARIABLE A4 - Material Type

This is essentially a four-category ranking of the "knappability" of the raw material in terms of its "grain" or crystalline size. This "knappability," or general suceptibility of the material to controlled fracture, is a complex characteristic with many more variables than "grain size." However, the assumption here is that grain size is as directly related to such workability as any single variable, and that a division on this basis could, within reasonable limits, be interpreted as a measure of such workability. While this division of the grain size continuum is somewhat arbitrary, consistently applied relative definitions should be as analytically significant as, if not more significant than, absolute petrologic definitions.

Category 1 (coarse, greater than 0.25 mm) will probably be the least-used category, and is reserved for really cruddy, very coarse materials. The absolute grain size (0.25 mm) has not been actually measured, and is more heuristic than literal. Materials will be primarily the coarser sandstone, quartzites, and basalts. A likely reason for their scarcity in the archaeological record here is the apparent availability of "better" stuff, though their occasional "thoughness" might make them work the extra production input for some heavier tasks.

Most items will fall into Categories 2 (finely granular), 3 (detrital(?)), and 4 (nongranular). Again, the specific grain size is not as significant as consistent placement into relative categories. Cherts are seldom placed in Category 3 unless they are extremely coarse or contain many larger crystalline or structural inclusions, and are normally placed in Cateogry 4. Quartzites and sandstones are never placed in Category 4, and may range from 1 to 3, depending on their degree of silicification or metamorphism, and their grain size.

Category 4 (nongranular) is reserved for such better quality materials as chalcedonies, cherts, obsidian, etc. Items should demonstrate this raw material quality across the entire piece for placement into this category.

The coarser materials should correlate with thicker, shorter, heavier flakes, and with larger, thicker implements, especially large, crude bifaces. If this isn't the case, we should probably start looking for some cultural factor(s) which are overriding the obvious technological expect- ations. Functionally, coarser materials produce rougher surfaces with higher friction coefficients, as well as greater edge serration. Within some basic functional efficency model, the coarser materials would be generally less suitable for slicing, cutting, piercing, and some scraping tasks, and are suitable for sawing, grinding, pounding, or abrading tasks. It should be possible to generate from the computer a "granularity index," or a single number which can be used for quick-and-dirty comparison of this variable within or between sites:

$$\frac{(\# \times 1) + (\# \times 2) + (\# \times 3) + (\# \times 4)}{\text{total \# of items}}$$

It just means that a summation of the number of items in each coarseness category times a numerical ranking for that coarseness (which is simply the numbered ranking of the categories themselves) divided by the total number of items will give an index value between 1 and 4. Lower values are coarser, and significant differences within or between sites might be interpretable in the above framework.

VARIABLE A5 - Quantity of Items

Number, of course, isn't nearly as interesting or easily interpretable as relative frequency, and I'd strongly suggest the use of percentages wherever possible. A direct comparison of the relative proportions of debitage in each of the coarseness categories with (1) relative proportions of implements in the same categories may suggest differential implement production and/or utilization; or with (2) relative proportions of locally available raw materials in the categories may suggest differential procurement and/or production patterns. For the first we'll have to reorder the implement raw material categories into directly comparable units, but that should be no problem for the computer. For the second, we need some better handle on the "local availability" of various raw materials. We are in the process of generating a map with overlays which will minimally summarize much of the relevant information that R. Moore collected, as well as some considerable input from the survey crew. It should be ready by early January. This comparison will have to be without

the help of the computer. I'd anticipate this comparison to be potentially relevant for only some of the sites, and I'd surely want supplementary corroboration from other data, but it's comething to look for.

VARIABLE A6 - Weight in Grams

While total weight of debitage may be a useful figure for comparison, depending on the nature of the site or FS (Field Specimen Number) group involved, an "average" weight will be technologically more appropriate, at least to the extent that debitage is asociated with technology (see Variable A8). Within limits, this average weight is the best indication of the size of the debitage items. In using this average weight figure, anticipate that even very small differences may have significance, since we may be dealing with quite small values from sites or groups of FSs with large numbers of items. In some FS item lots, one or a very few items may heavily skew this average weight (either up or down), and these cases are being noted in the "general observations record" (which are available for your perusal in the lithics laboratory). I would certainly anticipate that the average weight of Category 1 items will be greatest, and Category 4 items least, with any deviation from this trend suggesting the possibility of some cultural explanation.

VARIABLE A7 - Items with Weathering

"Weathering" here is equivalent to "cortex," and some cultural/technological assumptions are necessary in order to interpret the relative presence of this variable. Cortex represents the "natural" shape of a rock, and in the process of impressing a "cultural" shape upon the material, all or most of the cortex is usually removed. Further, this removal of the cortex necessarily tends to occur rather early in the production (actually "reduction") process, so that by the mid-stages of either biface or well-worked uniface production, the cortex is about gone and the shape is definitely cultural rather than natural. Also, some cortex is less desirable because it is frequently softer than "good rock" and doesn't transmit force into the mass of stone as readily or as regularly: and, of course, most cortex is ugly; so it is eliminated!

However, screwing up the model is the fact that it doesn't work nearly so neatly outside the biface/well-worked uniface/regular core framework: simple flakes work OK, even if their surfaces are half cortex. And, even in biface reduction, natural surfaces may sometimes by carefully selected and preserved on the implement, as in the rounded cobble backing for flake-knives or hand-held choppers. In other words, the security of interpreting this variable will depend on an overall evaluation/comparison of the flaked lithic technological system under consideration, particularly the flaked implements.

With these cautions in mind, we can interpret an increasingly high proportion of cortex in the debitage as an increased technological input toward its removal from the implements. If the cortex is in the debitage, then it can't be on the implements, and if it's not on the implements, then it must be in the debitage--somewhere! Maximum cortex in the debitage is therefore indicative of preliminary shaping of raw material into cultural forms, and this is usually done at or near "quarry sites" since

rock is heavy, and since even primitive efficiency models of human energy expenditure nearly demand this concession to herniation. Minimum cortex in the debitage, conversely, indicates final thinning, shaping, or sharpening of implements, blanks, or preforms: activity normally performed at specialized sites or areas within sites, depending on the scale of application.

VARIABLE A8 - Quantity of Items with Striking Platforms

This is not the number of flakes, or even of whole flakes, but the number of flakes which retain their striking platforms. While this is not quite as culturally interpretable as whole flakes or total number of flakes, it nevertheless should have a consistent correlation with those categories, and we can fairly confidently apply some quantitative implications about flakes to the data. (The laboratory crew estimates that perhaps 60-70 percent of the debitage is flakes, and of those flakes, perhaps 50-60 percent retain striking platforms.) Flakes, incidentally, are even better artifacts from which to interpret implement production than are the implements themselves: flakes are real artifacts!

Unlike implements, flakes aren't normally curated or transported from the locus of their production, either by the producers or the various disturbers of the archaeological record. They are, therefore, much more reliable indicators of the specific locations of various production and associated activities than are the implements. In addition, the relative proportions of flakes within each of the four debitage raw material categories may indicate which of those categories contain the implements most produced/modified/used at the site or area. This may be especially interpretable when compared with one or more implement attributes from the same FS group, site, or locality, such as raw material category, manufacturing stage, functional suitability category, "morpho-use" form, etc.

The relative proportions of flakes to "cores" (as used here, cores are not only the garden-varities of flake or blade cores, whether stylized or not, but crude and well-worked bifaces and unifaces as well--any chunk or rock from which flakes have been repeatedly removed) may suggest which implement categories are going produced/modified/used. Here there are admittedly some assumptions about implement use necessitating prior production as well as later modification and/or discard, and about the locations and sequences of these actions; but then, social science is just full of assumptions. In addition, the relative "absence" of either flakes or cores from an archaeological assemblage is recognized as negative evidence, which never proves anything; but if enough of its is present and uncontradicted, it allows you bet that things don't fall up. If the sample is adequate, enough consistent negative evidence can be awfully persuasive and therefore interpretable, particularly at this preliminary level of analysis.

Either an SPSS CROSSTABS routine (where it seems archaeologically appropriate) or some work with a calculator may produce quite a variety of potentially interpretable comparisons, both within the debitage categories and with implement categories.

- Do smaller flakes retain more cortex than larger? And does material type affect this?

- How consistently do the average weight of flakes and the average weight of implements compare, either within or between archaeological units? (Large flakes from small cores/implements is very different techologically than small flakes from small cores, or than small flakes from large cores; and differential technology should indicate differential functions!?)
- How, or how consistently, does the proportion of debitage displaying cortex compare with the proportion of implements displaying cortex, either within or across archaeological units?
- A simple comparison of the number of flakes to the number of implements may suggest some kind(s) of technological or functional behavior, especially when supported or suggested by other data. In fact, perhaps the greatest significance of the debitage data file, especially the flakes, is its relatively independent and unprejudiced nature and its utility in directly confirming the technological correlates of other hypotheses.

VARIABLE A9 - Number of Obsidian Items (not on the printed code forms)

These items are infrequent, but are, of course, directly interpretable in terms of long-distance raw material procurement. This number is NOT included in the A4-4 count, so that a total count of items in the nongranular category must be adjusted to include the obsidian items. (However, if the obsidian item has a striking platform, it IS included in the A8-4 total.)

These are by no means exhaustive suggestions for the data's interpretability. If the particulars of your site(s) or locality suggest others, by all means talk with me about it, even is this data coding arrangement is not set up specifically to handle it.

APPENDIX C

INTERPRETIVE SUGGESTIONS FOR FLAKED LITHIC IMPLEMENTS

MEMORANDUM 14 January 1980

TO: Breternitz, Farley, Kane, Knudson, Lipe, Lucius, Rohr, Ryan
Crew Chiefs, Locality Supervisors

FROM: C. Phagan

RE: Interpretive suggestions for flaked lithic implements

This outline is primarily to assist crew chiefs in understanding and interpreting the Flaked Lithics Preliminary Sort Outline (7/20/79), Subroutine B: Tools/cores. It should answer several questions about how the flaked tools were analyzed, what the variables mean, and how they might be most usefully interpreted.

It is important to remember that this is a preliminary analysis sorting outline. Its purposes are to produce a maximum of descriptive information with a minimum of analytic effort, and to organize a very large body of data. It should produce minimally comparable and interpretable units/categories, as well as basic information for designing the most appropriate detailed analysis programs.

This preliminary analytic system is maximally flexible, with broad implications for function, technology, and style. Some of its variables constitute an implement taxonomy, while others are an attribute classification. This emphasis on analytic scope and latitude of interpretation means that some problems should be anticipated where, for instance, variable expressions of technological attributes don't coincide with expressions of stylistic or functional types/attributes. It also means that cultural inferences drawn from the analysis may vary considerably in their security level, should be judiciously applied in the context of other site data, and should be considered suggestive rather than conclusive.

While some inconsistencies may be or have been introduced into the system through such factors as personnel changes and the simple accumulation of analytic experience, considerable effort has been made to minimize this variability. Given the interpretive cautions mentioned above, that the data base is quite large, and that sampling is not involved in its application, the system should tolerate even some considerable degree of such variability without sacrificing its utility.

In the computer output for Flaked Lithic Implements, identification variables are as follows: VAR 1 is state; VAR 2 is county; VAR 3 is site number; VAR 4 is the FS number; VAR 5 is the material identification (always flaked lithic); VAR 6 and VAR 7 are the type and number of special specimens; and VAR 8 is a number of indeterminate items. Actual attribute analysis of each item begins with VAR 9 (VAR B-1 in the Flaked Lithic Preliminary Sort Outline), the catalogue item number. This is a four-digit number assigned by the lab crew as a sequential numbering of items within each FS. The number 0001 is always reserved for the first lot of undifferentiated material (debitage), and individual implements or fragments and cores or fragments can begin with any number above 0001.

VAR 10 in the flaked lithic computer printout (VAR B-2) is a three-digit point location number which may or may not have been assigned by the crew chief.

VAR 11, temporal designation, has not been assigned and is not presently printed out.

VAR 12 in the printout (VAR B-4 on the Sort Outline and Coding Form) is raw material class. Possible values range from very general categories to rather specific, and were apparently selected on the basis of petrology, geology and archaeology reports from the entire Southwest region, and imagination. Many of the values either do not occur in the D.A.P. archaeological collection, or have not been recognized by the lab crew, and high proportions of some values may represent analytic selection or preference rather than Anasazi selection or preference. At this preliminary stage of analysis, only the most glaring levels of inter- or intrasite variability should be considered culturally indicative. In an effort to make this variable more useful, and for direct comparison with the raw material categories defined for flaked lithic debitage (VAR A-4 on the Sort Outline and Coding Form), the 36 possible values have been recoded into the same 4 categories recognized for debitage: coarse, finely granular, detrital, and nongranular.

VAR 12A in the printout is this recoded raw material attribute on the basis of grain size. Several comments in the 28 November 1979 memo regarding interpretive suggestions for flaked lithic debitage [Appendix B] are relevant and should be consulted.

VAR 13, lithic material color (VAR B-5 on the Coding Form), has not been printed out as part of the standard preliminary output, but it may be requested on a special basis.

VAR 14, specific lithic resource identification (VAR B-6 on the Coding Form), should be considerably more useful than other raw material variables, since its values have been selected on the basis of actual occurrence in both the D.A.P. area and the archaeological collection, as well as reported archeological occurrences in the Four Corners region. High proportions of value "00" should be anticipated, since the lab crew was instructed to place items in categories only if there is reasonable certainty that it actually belongs there, and since the comparative collections of the materials are "classic type specimens" which do not represent the range of variability in the lithic class. The variability which is recorded, however, should have high reliability.

Since several of the values for this variable are lithic materials locally available in the D.A.P. area, and several others are from known and restricted nonlocal sources, interpretation should be closely coordinated with summarized information on locally and nonlocally available materials. This information is available in the lithics lab, and in a memo from Phagan and Snyder dated 18 December 1979.

VAR 15, item weight (VAR B-7 on the Coding Form), because of the continuous nature of the variable, is processed by a CONDESCRIPTIVE routine and occurs as the last variable in the computer printout. Significant differential in mean implement weight among archaeological units could indicate a task differential among those units, assuming an adequate sample

from the units and a fairly direct correlation between implement weight and some task categories. In addition, range of implement weight may perhaps be correlated with range of task categories, though the correlation is far from simple or direct.

VAR 16, item condition (VAR B-8 on the Coding Form), is an attempt to isolate and identify patterns of implement breakage, which may be correlated with site function(s). It is suggested that perhaps a CROSSTABS routine correlating this variable with Variable 24 (tool morpho-use from) may be more useful since it would indicate which types of implements were broken or whole. In terms of the analytic application of this variable, placement into some of the categories is difficult because some prior referent as to "completeness," either explicit or implicit, is required in order to evaluate "incompleteness."

VAR 16A is a recoding of the Variable 16 values into what may, in some cases, be a more useful form. In both this variable and Variable 16 (above), the terms "medial," "distal," and "proximal" are generally applicable primarily to distinctly "ended" items, such as projectile points, drills, or very elongated scrapers, all of which should occur rather rarely in most archaeological assemblages. Largely to increase the size of these groups, the eight Variable 16 values for broken items (1 through 8) have been recoded into only four variables: medial, distal, proximal, and indeterminant. Even these may be readily combined further into such values as "terminal" or simply "broken."

VAR 17, thermal alteration (VAR B-9 on the Coding Form), is an attempt to identify the practice of heat treating, or "annealing," lithic raw material in order to improve its flaking qualities in some way. Considerable analytic caution has been exercised to distinguish between this annealing, or "pre-production heat," and "burning," which is normally "post-production heat," and which has very different interpretability. Recognition of annealing is much more difficult than burning, but if it is recognized it represents the presence of a rather complex technological activity. Burning, however, may indicate intentional or accidental destruction, or simply an item that fell in the fire.

VAR 18, culturally significant adhesions (VAR B-10 on Coding Form), is a rather straightforward record of the occurrence of several categories of adhesions on implements. Even though they probably occur only rarely, they can be directly interpreted in functional terms if appropriately analyzed further.

VAR 19, facial designation (VAR B-11 on Coding Form), is a variable with primary reference to further technological analysis. It has little direct interpretability at this preliminary stage, and is not included with the standard computer output. It is, however, important to understand that this variable separates the items into three major categories, each of which is further described, analyzed, and interpreted in quite distinct ways. If an item is repeatedly and randomly placed on a flat surface and gravity orients the item in a restricted number of positions, the item possesses "faciality." For most facial items in New World flaked lithics, this number is two, i.e., items with a flattened cross-section and a distinct plane of greatest area.

These flattened or facial items are further divided into two major categories on the basis of the manner in which the two faces, or flattened surfaces, are produced. "Bifaces" have both faces (not just their margins) produced primarily by the removal of several flakes, leaving on the faces the scars of these flake removals. "Unifaces" have only one face so produced, while the other face may be either produced by a single (or perhaps a very few) flake removal(s), or may be the natural flattened surface of the stone. Items which lack the "faciality" described above are termed "cores," "nodules," "nucleiform pieces," etc.

In order to distinguish and identify the surfaces of both bifaces and unifaces, the distinction "dorsal" and "ventral" is made in one of several of the following ways. (1) If an item demonstrates on one of its faces the characteristic single flake scar surface indicating that the item was removed as a flake from a core, that face is "ventral" (or "struck," or "inner," etc.), even though it may have been further modified: the opposite face is "dorsal." (2) If any of the natural cortex surface of the stone remains on only one face of the item, that face is dorsal and the opposite face is ventral. (3) Lacking either of these technical features to distinguish the two faces, a distinctly plano-convex cross-section of the item is used, in which case "plano" is ventral and "convex" is dorsal. (4) Lacking even this distinction, a traditional laboratory designation is made using the labeled face as ventral; the opposite face is dorsal. If the item is not labeled, one face is arbitrarily selected as ventral and labeled with a "V"; again, the opposite face is dorsal.

The wording of Value 1 for this variable is somewhat misleading, in that items which lack faciality should be coded with this value, including all except extremely flattened cores, nodules, worked hammerstones, and cobble tools. Value 2 includes most bifaces, particularly those having both faces covered with flake scars, or with some cortex remaining on both faces. Value 3 includes bifaces with technically defined ventral or dorsal faces (1 through 3 above), unifaces, flake tools, and utilized flakes.

VAR 20, item thinning stage evaluation, dorsal face, and
VAR 21, item thinning stage evaluation, ventral face, (VAR B-12 and B-13 on Coding Form) are variables whose most appropriate interpretation depends on an understanding of some lithic technological factors and assumptions.

For at least some tasks, thin implements are of sufficiently greater efficiency than thick ones to justify considerable investment in their production or acquisition. Within the realm of stone implements, this thinness naturally occurs very rarely, and must be either diligently sought or diligently produced. Both are presumed to be cultural processes involving several steps or stages, each necessitating energy input. This energy may be mental or physical, but in either case it is technological, learned, patterned, and therefore subject to anthropological analysis and interpretation.

Another prerequisite for appropriate understanding of this variable is the acceptance of a "thinning-edging" distinction. This is primarily a technological distinction between production or selection of the implement's section, or its thinness, and its edge, or margin characteristics, including edge angle and plan outline, or facial shape. Both technologically and

analytically there does seem to be good reason to distinguish between "thinning" and "edging," though the two are certainly overlapping concepts and activities. Indeed, some edge characteristics, such as edge angle, are heavily constrained by the item's section.

Thinness in flaked stone implements can be achieved in three basic ways: (1) select a thin rock to start with, (2) produce a thin rock by starting with a thick one and removing everything that isn't thin, or (3) produce a thin rock by starting with a thick one and removing from it a thin one. (It's tempting to arrange these in an increasing order of technological complexity, particularly since this is apparently the order of their phylogenetic development during the Paleolithic, but this may be an erroneously simplistic arrangment.) Within the first, thinning can easily be separated from edging, since thinness is selected and edging is produced.

Within the second, usually referred to as "facial reduction" (either bifacial or unifacial), in which thinness is produced in the item by removing flakes from it, the separation of thinning from edging is more problematic. In the bifacial reduction process from nodule to projectile point, for example, there is a general progression from initial thinning stages or operations to final edge shaping stages or operations: section precedes plan. However, even in early thinning stages where the primary focus of energy input is toward removal of flakes to produce thinness, there is still a secondary concern with producing that thinness within the constraints of the intended final edge shape. As the bifacial reduction process continues, the focus of attention gradually shifts from section to plan, though even during final edge or plan shaping, maintenance of the appropriate thin section is never out of mind. Because of this technological overlapping of the two concerns, an analytic distinction between them is necessarily somewhat arbitrary and indistinct, and must focus on the apparent primary result (and presumably the intent) of the attribute(s) being examined.

This analytic line between thinning and edging is best made on the basis of the "invasiveness" of flakes/scars onto the face(s) of the study item. In order to produce thinness in an item, flakes, which necessarily originate at the edge or margin of the item, must "invade," or extend past, the item's mid-point. These can readily be termed "primary thinning flakes," since thinning is an obvious and primary result, regardless of any additional effect on the margin. Flakes which extend from the margin well onto the face but not past the mid-point (arbitrarily 1/4 to 1/2 the distance across the item) are "secondary thinning flakes." These flakes produce some lateral item thinness, and may also rather significantly affect the item's plan, or margin shape. Flakes which extend onto, or invade the face of the item for only a short distance (less than 1/4 the distance across the item) result in minimal thinning, maximal shaping of the item, and are termed "trimming" or "shaping" flakes.

Still considering the bifacial reduction mode of producing item thinness, various analysts have suggested different definable and interpretable stages in the process. Muto [3], focusing heavily on "cultures," suggests "blank - preform - finished item," which is somewhat difficult to apply

analytically because a prior knowledge of what the finished items are supposed to look like is necessary before these stage definitions are possible. This is particularly problematic in cultural situations with considerable "finished item" variability, either synchronically or diachronically. Phagan [4] has suggested a "crude - well-worked - stylized" division of the bifacial reduction continuum. However, this scheme is also difficult to apply analytically because it requires a priori and complex technological definitions of each stage, which may or may not be appropriate to all cultural situations.

Callahan [5], also focusing on technology, has proposed a series of stages labeled "edged - primarily thinned - secondarialy thinned - shaped - highly stylized," and these stages of the biface reduction process have been used as the basis for the D.A.P. Variable 20 and 21 categories. Because there are more stages in this breakdown of the technological/analytical process, definitions of each are somewhat more arbitrary, complex, and difficult to apply, especially in the later reduction stages. Distinctions between "secondarily thinned," "shaped," and "highly stylized" are sometimes extremely difficult to distinguish in the archaeological data, even though they may be technologically definable as production stages. In addition, consistent application of this terminology can be extremely confusing. For example, within this variable, "edging" is used to indicate the earliest stage of biface reduction, in which rough, irregular "edges" are created from which primary thinning flakes can be removed. In addition, "edging" is used to define the final stages of reduction in which small, short flakes are removed to produce the final regularized edge or plan shape.

Despite these application problems, this five-stage production sequence is theoretically a more powerful analytic device, particularly for cultural situations with very high proportions of bifacial reduction in the technological profile and/or reduced variability within the biface assemblage. In addition, for more variable technological profiles in the archaeological record, this analytic structure is sufficiently flexible to combine different categories for consideration as grouped data. Optimum evaluation of the thinning-edging continuum may, in at least some of the D.A.P. data subfiles, require a regrouping of the variable values.

The third way to achieve thinness in flaked stone implements is the removal of (large?) thin flakes from thicker cores, with either utilizatin of the thin flake "as is," or its modification, primarily by "edging," into a more stylized implement. The temptation toward judging this method of producing thinness as always simpler than bifacial reduction should be rejected. Cultural energy input into this thinness technique is primarily in knowledge and skill rather than physical energetics, and in many cases this cultural energy input may be quite substantial. Examples would be the consistent production of very regular flakes or blades, and the acquisition and efficient utilization of exceptionally good quality lithic material.

VAR 20 and 21 values are a roughly ranked evaluation of the cultural energy invested in the thinness of the dorsal and ventral faces of flaked stone implements. Since a single surface such as "dorsal" cannot be "thin,"

this variable is actually, of course, referring to the flatness and/or smoothness of the item faces. However, for the sake of consistency, "thinness" will continue as the used term. (Note: The term "cross-facial thinning" which occurs in the preliminary sort outline is superfluous and somewhat confusing, and should be ignored. All thinning of faces is "cross-facial," in that force is applied at the margin and directed across the plane of the piece, resulting in flakes which carry across the face of the item.)

Value 1 includes all nonfacial items such as cores, nodules, or nucleiform pieces; there is no apparent cultural concern for thinness.

Value 2 is primarily for items whose dorsal or ventral thinness is the result of selecting or producing items that are already thin, and which retain some cortex on the face under consideration. The term "flake" in this value is not used in its standard technological sense, but in a much more general sense of a flattened or facial item/surface. Also, the term "unthinned" does not mean that the item is thick. It may, in fact, be quite thin, but its thinness is not primarily the result of removing flakes from the face. Utilized cortex flakes belong in this category, as well as more regularized scraper or other forms made from cortex flakes or flattened pieces on which the margin shaping has not significantly thinned the item. The term "utilized" here is applied rather generously, and is recognized by the presence of polish, edge rounding (other than the hinge termination of the study flake), striation, or utilization scars. These utilization scars may be difficult to distinguish from final production stage shaping scars, but are best recognized by their irregularity in spacing along an edge or margin, or their irregularity in size or termination.

Value 3 is much the same as for 2, except for the required absence of all cortex from the study face prior to the production of the study item or flake. (Note: If the cortex had been removed after the study item was produced or selected, it would necessarily have been "thinned," and therefore go into a higher value for the variable.) This cortex removal indicates greater cultural input prior to the selection or production of the study item than if cortex remains on the face. The memo on flaked lithic debitage of 28 November 1979 [Appendix B] contains suggestions regarding the significance and interpretability of cortex, or "weathering." This is the appropriate category for utilized flakes or blades without cortex, or for regularized scrapers or other implements, even occasional projectile points, made on such flakes or blades. The critical factor is that after the study item's selection or production, no further thinning of the item occurs; only edge shaping. In fact, of course, very considerable cultural energy may be involved in the production of a thin, regular study item, but that doesn't count in this particular variable.

Value 4 is the initial stage of facial reduction, and the term "edged" here is in Callahan's sense of the preliminary shaping of an irregular or nodular piece into one with definite edges from which primary thinning flakes will then be removed. If any cortex is present, the item goes into this category. Any item thinning that may occur in this initial edge formation is

incidental, and does not affect its placement in this value. A few flake scars may extend well across the item's face(s). These items should be markedly thicker in relation to their length or width than items in succeeding values (6-9). "Faces" of items in this category are quite likely to display rather strong surface irregularities, prominent ridges and depressions, high proportions of naturally fractured stone and of hinge- or step-fracture flake terminations.

Value 5 is much the same as 4, except that no cortex remains on the item face(s), and at least some scars will therefore extend to or past the item's mid-point. It is assumed that somewhat more thinning of the item may have occurred than in Value 4, but that the primary result of the flaking is still the initial production of an edge appropriate for the further thinning of the face(s). Facial flaking characteristics are similar to Value 4.

Value 6 represents Callahan's "primary thinning stage," in which major surface irregularities are removed, a production stage very roughly equivalent to Muto's "blank" and Phagan's "crude biface." Major energy investment is normally in the removal of several critical primary thinning flakes. Because the faces of the item being thinned are usually rather irregular, the shape of these thinning flakes will also be irregular, though they and their resultant scars will often be quite long, since they frequently extend to or beyond the item's mid-point. The faces in this category should be noticeably smoother and flatter than items in Values 4 or 5, and item sections will be noticeably thinner.

Value 7 is Callahan's "secndary thinning stage," and is again roughly equivalent to Muto's "preform" and Phagan's "well-worked biface." These faces should be consistently smoother and flatter than those in lower values, and most flake scars should be invasive to or beyond the item's mid-point. Flake scars should also be generally wide in relation to their length, and should be rather regularly shaped and spaced. The item may have a fairly regular outline, produced at least partially by shorter flakes around the margin which obscure or remove the proximal portions of the longer primary thinning flake scars. In most cases the item will have a definite "length" and "width"; but will lack a specialized haft element. Section symmetry may be quite regular, though plan symmetry is likely to be less well developed. Both the technological and analytical emphasis is still on the item's thinness, though considerable plan regularity may be produced on at least portions of the item.

Value 8 represents the definite shift of technological and analytic focus from section to plan; and plan symmetry becomes quite regular while maintaining thinness and section regularity. Surfaces are quite smooth and flattened, and many items will have specialized haft elements. Flake scars will be generally quite regular in size and shape, and most of the margins are likely to be formed by short shaping flakes, including significant areas of pressure flaking. Average, garden-variety projectile points and bifacial "knives" belong in this category, as do most drills (even though they may be relatively thick in relation to their width) and the dorsal faces of well-made, symmetricl unifacial scrapers.

Value 9 is reserved for the "really neat stuff": highly symmetrical in both plan and section; very stylized; and with the face(s) usually completely covered by pressure flake scars which are consistently long and narrow, most of which extend to or past the mid-line, and which are often not proximally obscured by shorter margin shaping flakes. Larger items may occasionally have small areas near the center of the face(s) which retain scars from primary or secondary thinning flakes.

Now, after all that jargon, we should consider at least a few general interpretive comments or suggestions. Again, the point of the whole variable is to evaluate the cultural energy invested in the production of artifact surfaces and resultant item thinness. Higher production energy investment should indicate higher cultural significance along some parameter(s). If it's worth all that input, it must be important for something! Experience with the Anasazi tradition will certainly be helpful in suggesting which specific cultural parameters are likely to be involved. From a general technological/cultural perspective I would anticipate most of the following:

(1) Items with higher values for production energy input should generally be made of the "better" types of raw material.

(2) Items with higher energy input values should not be "abandoned" as frequently as lower value items: i.e., this may be an effective statistical measure of the "curated" or "expedient" nature of the item (Binford [6, 7], Binford and Binford [8], and Gould et al. [9]).

(3) Since carefully producing facial flatness is, in effect, carefully producing item thinness, that thinness must be important enough to expend the necessary energy. Presumably that importance is directly related to the function(s) to be performed with the thin implement. (Should such things as status indication be completely ruled out in this technological situation within the Anasazi tradition?) An ethnographically based functional model--or a technologically focused one--suggests that implement thinness is related primarily to "precision" rather than "strength" tasks; those such as cutting, incising, or piercing, and that such tasks are most likely to be performed on softer materials such as meat or hides. The relative presence of these high input, thin items in archaeological situations may therefore be interpreted as the relative presence and/or importance of these functions in the cultural situation represented.

(4) The differential input of technological knowledge, skill and energy is itself a cultural phenomenon which is directly interpretable and comparable. Implement production behavior may well be useful in discovering or assuming some things about basic subsistence behavior, and we must use it in this and all other reasonable ways. But systems of implement production *per se* are just as cultural, just as learned, just as patterned, and perhaps even more securely interpretable as are, for example, systems of house construction or food procurement. In fact, implement production preceeds and is basic to such other adaptive systems, and Variables 20 and 21 provide a mechanism by which one aspect of production technology can be described, evaluated, quantified, interpreted, and compared.

For Variables 20 and 21, description and comparison can be made at any level from a single artifact face to an entire flaked lithic assemblage, though preliminary D.A.P. reports will probably concentrate on the larger units. Since the values of the variables are ranked from least production

energy input to greatest, a numerical "average" can rather easily be generated for quick-and-dirty description and comparison. Such an "index of faciality" is generated by multiplying the number of items in each value by that value's ranked number (1-9), summing these, and dividing by the total number of items. The resulting index value will be a number between 1 and 9, which can be readily used as a numerical description of the relative cultural input into facial thinness for archaeological study units, or as a comparison among or between such units.

If such an index is to be used for implements rather than for faces, the index values for Variables 20 and 21 should be added. The resulting index value will be between 2 and 18.

Since many implements have considerably different production thinning input on their dorsal and ventral faces, index values for Variables 20 and 21 will be different. Almost invariably, the index value for dorsal faces (VAR 20) will be higher than for ventral faces (VAR 21), and the numerical difference in these two can readily be interpreted as the "degree of unifaciality" in the archaeological unit under consideration. For example, an archaeological unit with relatively many unifacial scrapers, presumably representing activity associated with those scrapers, should display relatively lower ventral values (VAR 21) and higher dorsal values (VAR 20), and therefore a relatively great difference between the two, and a relatively large numerical degree of unifaciality. On the other hand, an archaeological unit with relatively many well-worked bifaces and projectile points, on which both dorsal and ventral faces are considerably thinned, will have a relatively small difference between the two, and a relatively low degree of unifaciality. A "utilized flake" industry would also demonstrate a low degree of unifaciality, but as a result of low dorsal and ventral index values rather than high values, as for the well-worked biface industry.

Values 2 through 5 of VAR 20 and 21 also specify the presence or absence of cortex in distinguishing technologically between categories of both "unthinned flakes" and "edged pieces." Since this attribute has technological interpretability independent of the process of facial reduction (though certainly related to it), a recode of Variables 20 and 21 has been arranged (VAR 20A and 21A) in which faces with cortex have been isolated from faces without cortex. From this, a simple cortex index can be quickly generated for interpretation and comparison (see comments in memo of 28 November 1979 [Appendix B] on interpretive suggestions for flaked lithic debitage). These recoded variables (20A and 21A) will not be included as standard preliminary computer output, but will be available on a special request basis.

VAR 22, EU shaping stage, is designed to focus analytic attention on the production and placement of "useable edges" on the implement. A basic assumption underlying the interpretability of this variable is that the primary utility of a flaked stone implement is centered at the contact between the implement and the object acted upon. Such contacts are normally either implement "edges" or the abrupt junction of two or more edges in a "projection." Knudson has organized the description and analysis of these contacts as "Employable Units," or "EUs," with detailed observation of such attributes as length, curvature, edge angles, etc., and this analytic structure has been incorporated into the D.A.P. Lithic Research Design [10].

At this preliminary analysis level, critical information is the manner in which contact edges are produced, and their placement on the implement margins. Values for the variable are simply combinations of these two information categories. With reference to the manner in which implement edges are produced, the Flaked Lithic Preliminary Sort Outline uses the terms "unifacial" and "bifacial." This is confusing terminology, since "facial" is a term normally describing surfaces and the manner of their production, while attention here is to the production of edges. Much more appropriate terms are "unidirectional" and "bidirectional"; indicating the application of flake removing force in either one or both directions across the plane of the item. If a given edge is produced on the implement by flaking in both directions across the plane of the item (i.e., both upward and downward across the horizontal plane) the edge shaping is "bidirectional," as in most well-worked bifaces. If the edge is produced by flaking in only one direction across the plane of the item (i.e., either upward or downward across the horizontal plane) the edge shaping is "unidirectional," as in many scrapers produced on flakes. The length or invasiveness of the flakes onto the face(s) is irrelevant to the description of the edge, though these edge shaping flakes are frequently rather short and non-invasive, creating an "acute edge angle." "Retouch" is also a frequently used term which is rather awkward in its consistent application. In fact, several terms indicate the same general technological process, and are often used in confusing and inconsistent ways: "touched" and "retouched," "sharpened" and "resharpened," "backed," "blunted," "edged," "re-edged," or "edge shaped" are all terms indicating a flaking pattern or activity which primarily affects or shapes or reshapes the edge of an item without seriously influencing its section or plan. Some imply the production or restoration of primary efficiency to "working edge"; some imply a treatment of the edge opposite such a "working edge," though the morphological distinction between such edge treatments may be extremely difficult to distingush; and some are simply general terms indicating edge treatment, without specific functional implications. Many years of confusing terminology can't be quickly and easily corrected: just be as specific and consistent as possible in report preparation. So much for terminology!

Values for this variable are possible combinations of the production and placement of edge EUs on implements, generally ranked from least technological input to greatest. The assumptions on which this ranking is arranged are that greater technological attention (more decisions, more actions) is involved in producing a bidirectional edge than a unidirectional one, and that more attention is involved in creating these edges entirely around all margins of the item than around only some margins.

Value 0 indicates that the item is heavily burned or damaged, and cannot be adequately evaluated.

Value 1 is a category in which any EUs on the implements have been selected rather than produced by flaking. Utilized flakes should appear here, as well as thicker items such as cores that do not demonstrate deliberately produced EUs.

Value 2 items demonstrate unidirectional shaping of EUs on only one or a few of the item's margins. Most simple end- or side-scrapers should appear here, as well as some "gravers," "irregular scrapers," "beaks," "notches," "spokeshaves," some "denticulates," etc.

Value 3 is much the same as 2, except that these unidirectional EUs extend around all, or nearly all, of the item's margins. This distinction is only quantitative, and it is recognized that, for this and perhaps other values of the variable, some smaller completely-worked items may actually represent less technolgoical input than some larger partially-worked pieces. These cases should be rare, however, and should not seriously alter the evaluation of adequately large artifact populations.

Values 4 through 7 are categories of increasingly greater technological input on the basis of increasing proportions of bidirectionally shaped EUs located on increasing proportions of the item's margins.

Interpretability of this ranked technological variable corresponds closely to that for VAR 20 and 21, including the generation of numerical indexes of technological production input. In fact, if interpretations based on Variables 20 and 21 differ significantly from that based on Variable 22, one or the other, or both, of the interpretive structures should probably be challenged.

Since this variable is a combination of both EU formation and EU placement, it is easily recoded to isolate either as an independent variable for more specific interpretation. Both recoded variables have been generated as VAR 22A and 22B. Values for VAR 22A, EU Formation, are: (1) unidirectional, (2) bidirectional, (3) both, and (4) neither. Values for VAR 22B, EU Placement, are: (1) some edges, (2) all edges, and (3) no edges. Of these, interpretation of EU Placement may also, at least in some cases, be an indication of implement specialization or generalization. Implements with EUs completely around their margins, and which represent maximum technological input, might well be expected to be maximally curated, as well as suited to a wider range of tasks.

Neither VAR 22, 22A, nor 22B have been included in the standard preliminary computer output, but they are available on a special request basis.

VAR 23, Core Form, is intended to be a simple division of cores or nucleiform items into several categories on the basis of some rather traditional (but often poorly-defined) New World core types. Terminology within the variable is therefore rather inconsistent, as are the basic definitions of the values; i.e., some are defined by number and preparation of platforms plus morphology; some by number and preparation of platforms plus direction of flake removal; some add, in addition, the relative proportion of the platform area which is "worked"; and some are defined only by the technological method of removing flakes. As a consequence, the value categories are not mutually exclusive, and placement of some cores must be made on an implicit priorities basis. The variables may, however, allow limited comparison of the D.A.P. materials with other collections.

Because the D.A.P. lab crew has worked out an agreed-upon and fairly consistently-applied set of core definitions and placement priorities, it is possible to recode the variables into three general categories which can be more consistently defined, exemplified, and interpreted. In addition, they are ranked from least to greatest technological input, and an "index of core preparation" can be readily generated. The recoded values for Variable 23A, Core Specialization, are:

Value 1, Unspecialized Core Forms, includes generally irregular forms from which one or a few flakes have been removed, regardless of the flaking technique used. Directionality of the flake removing force(s) is not significant for this value, though seldom would more than two or three flakes be removed from a single platform surfce area by forces applied in approximately the same direction. Platform areas may be selected or prepared, though evidence of highly focused platform preparation would seldom be expected.

Value 2, Specialized Core Forms, includes those cores which demonstrate, by their more regular shape and greater number and regularity of flake removal scars, significantly more technological attention or cultural input. This may include both multidirectional and unidirectional forms ("directionality" here refers to the direction of the flake-removing forces), crude discoidal forms, and most cores from whcih more than "a few" (four to six?) flakes have been removed. In addition, seldom will more than four to six flakes be removed from a single platform surface, since this is likely to constitute the next higher core form value.

Value 3, Highly Specialized Core Forms, is reserved for cores from which many very regularly shaped flakes or blades have been/may be produced. Since regularity of core shape is one primary factor which controls regularity of flake shape, core mor hology should display marked regularity, or at least that portion of the core from which flakes are removed (the core "face," even though it is not quite the same as biface "face"). This category will include "polyhedral" (?) cores, very regular discoidal cores, Levallois-like cores, microblade forms, or Mesoamerican-type blade cores. These should be rare in the D.A.P. assemblage, though an occasionaly very regular example might be expected to occur as a result of unusually appropriate raw material shape rather than planned production of regular core morphology.

These three values are, of course, only rather arbitrary quantitative distinctions in a technological continuum. Three criteria are involved in making these distinctions: regularity of shape in both flakes and cores, repetition in directionality of flake-removing force applications, and the number of those forces applied. Specific definitions of the values, such as the numbers mentioned above, are not as important for any interpretations they may allow as they are for permitting consistent placement of items within the technological framework. Interpretations are best kept within this technological context, and made on a relative rather than an absolute basis.

Core "exhaustion" is not directly involved in this variable, except that as repeated flake removals occur, the regularity of the core increases, and its value for this ranked technological input variable also increases. An additional factor to consider in interpreting this variable is the direct and absolute relationship between core shape regularity and flake shape regularity: technologically one cannot occur consistently without the other. Pretty flakes come from pretty cores! If one occurs in the archaeological record without the other, some cultural explanation is demanded.

VAR 29, Item Morpho-Use Form, consists of values or categories selected on thc basis of traditonally used New World or Southwestern artifact "types." Some of the implement types are defined by morphology, some by presumed function, some by technology, a few by some combinations of these, and others have never been defined at all. It is to be expected, since values are not

mutually exclusive categories, that difficulty in placing some items will occur. In general, when placement into more than one value is possible, the item should be included with the higher numbered value, since the variable values are generally ranked from least to greatest assumed item task specialization (this is NOT the same as increasing production technology input). For example, if an item is reasonably both a "thin side-worked uniface" (#13) and a "graver on a thin unifacially worked form" (#27), place the items in the latter category, since 27 is a higher value than 13 (this is essentially the intent of the phrase "without accessory form(s)").

The ranking of values by increasing implement specialization is not only present within the variable values as an entire group, but also within any smaller grouping of values such as "unifaces" or "gravers." Projectile points, however, are NOT so ranked, but are simply a listing of morphological/technological categories which may be compared and interpreted "as is," or in varying combinations. Thus, the creation of an "index of implement specialization" is possible, but is not as simple or straightforward as indexes suggested for other variables.

For values that distinguish between "thick" and "thin" items which are otherwise similar, the distinction is made on the basis of a 2:1 width-to-thickness ratio. However, this ratio may be tempered somewhat by such factors as gross piece size (larger items tend toward a slightly thicker evaluation, and vice versa), abruptness of any retouched or working edges (steep or acute angle margins tend toward a slightly thicker evaluation, especially on larger items, and vice versa), and an excessive length dimension (comparatively longer items tend toward a slightly thinner ranking than shorter items, and vice versa).

For Values 5 and 6, "bifacial," "unifacial," and "edging" are used in the same sense as for Variable 20 and 21, Values 4 and 5, indicating the initial shaping and force direction of thick, irregular pieces. Nonprojectile point bifaces, Values 16 and 17, are distinguished from most projectile points on the basis of (a) a general lack of plan symmetry, (b) a relatively larger size than most projectile points, or (c) relatively rounded "bases" and/or blunted "tips" in those forms to which these terms apply.

Projectile points are recognized as highly problematic categories for both description and interpretation, and this preliminary analysis is deliberately NOT an attempt to resolve the difficulties of Southwestern projectile point typologies. It is rather the selection of a limited number of major attribute combinations along only three dimensions: basic shape, stem characteristics, and notch characteristics. In some cases these attribute combinations were selected for their general descriptive latitude, and in others for their correspondence with recognized Southwestern "types," especially within the Mesa Verde sequence, which may have temporal significance (Values 35, 36, 38. See A.C. Hayes and J. A. Lancaster [11:144-146]). Value 42, "projectile point, unidentifiable" does NOT mean an item which is difficult to place into one of the other projectile point categories. It is used only for points which are too fragmentary for placement into a more specific value. It is recognized that some items must be "stretched and pushed" considerably in placing them into a given category. This has been deliberately selected for the preliminary analysis over either a very large "catch-all" category, or a continually-expanding list of

specifically detailed categories. The intensive projectile point analysis will consider typology in several ways and at several levels.

Two separate recodings of the variable values have been generated, more general artifact categories which may, in some cases, improve or supplement the variable's interpretation. VAR 29A, Morpho-Use #2, rearranges the values into these very broad categories: (1) utilized flakes, (2) cores, (3) unifaces, (4) bifaces, and (5) other forms. VAR 29B, Morpho-Use #3, recodes the values into: (1) utilized flakes, (2) cores, (3) choppers and scraper planes, (4) thick scrapers, (5) thin scrapers, (6) bifaces, (7) projectile points, and (8) specialized forms. For particular interpretive or comparative situations, one of these may be more suitable than the original variable. Standard preliminary analysis output will include VAR 29 and 29B, and 29A is available on a special request basis.

APPENDIX D

FLAKE INTENSIVE ANALYSIS OUTLINE

FLAKE INTENSIVE ANALYSIS OUTLINE

NUMBER OF SPACES	VARIABLES AND VALUES
9	VAR 1 Site Number. Written as the Smithsonian designation with state, county, and sequential designation; the last four digits are the sequential designation, and they are justified from the right with zeroes in the empty spaces (e.g., 5MT23 is written as "05MT0023").
2	VAR 2 Material Identification 00: Indeterminate 01: Ceramics 02: Non-human bone 03: Flaked lithics 04: Non-flaked lithics 05: Shell 06: Vegetal 07: Human Bone 08: Other inorganic materials 09: Other organic materials 10: Historic 11: Other materials not specified above
6	VAR 3 Field Specimen Number. Justified from the right with zeroes in empty spaces (e.g., FS 9 is recorded as "0009" here).
3	VAR 4 Flake Catalogue Item Number. Assigned to each flake squentially within the FS; justified from the right with zeroes in empty spaces.
3	VAR 5 Point Location Number. Justified from the right with zeroes in empty spaces; if no point location is recorded for the item recorded here, fill in with zeroes.
1	VAR 6 External Temporal/Cultural Association[1] 0: Indeterminate 1: Archaic tradition; not further specified 2: Deposits mixed; Archaic and Anasazi 3: Anasazi Tradition, Sagehen Phase; Sagehill subphase (A.D. 600-750) 4: Anasazi Tradition, Sagehen Phase; Windy Wheat Subphase (A.D. 750-825) 5: Anasazi Tradition, McPhee Phase; House Creek Subphase (A.D. 825-900) 6: Anasazi Tradition, McPhee Phase; Cline Subphase (A.D. 900-975) 7: Anasazi Tradition, McPhee Phase, Grass Mesa Subphase 8: Anasazi Tradition; Sundial Phase (A.D. 1000-1200) 9: Anasazi Tradition; deposits mixed

[1]Since this outline was written the D.A.P. phase scheme has been modified (Kane [12]).

1 VAR 7 Internal Temporal/Cultural Association

0: Indeterminate
1: Element 1
2: Element 2
3: Element 3
4: Element 4
5: Element 5
6: Element 6
7: Mixed elements, different components
8: Mixed elements, same component
9: Other

2 VAR 8 Spatial/Functional Assignment

00 Indeterminate
01 Limited activity area; not further specified
02-09 Unassigned

(10's, 20's, 30's Seasonal designation; missing numbers are unassigned)

10 Seasonal area: not further specified
11 Seasonal area, field house: not further specified
12 Seasonal area, field house: surface rooms
13 Seasonal area, field house: pit rooms
14 Seasonal area, field house: materials processing
16 Seasonal area, field house: unspecified non-structural unit
18 Seasonal area, field house: midden
20 Seasonal use, hunting camp: not further specified
39 Seasonal area: other

(40's through 70's Habitation designation; missing numbers are unassigned)

40 Habitation: not further specified
41 Habitation, pithouse: antechamber
42 Habitation, pithouse: south room
43 Habitation, pithouse: south end
44 Habitation, pithouse: central hearth association
45 Habitation, pithouse: main chamber: not further specified
46 Habitation, pithouse: main chamber, north room or area: not further specified
47 Habitation, pithouse: roof or 5-10 level
50 Habitation, pitstructure: main chamber, north room, peripheral areas
51 Habitation, pitstructure, bench
52 Habitation, pitstructure, other
60 Habitation, room block: not further specified
61 Habitation, room block: storage room(s)
62 Habitation, room block: living room(s)
63 Habitation, room block: courtyard
64 Habitation, room block: other
65 Habitation, room block: roof or 5-10 level

60 Habitation, room block: not further specified
61 Habitation, room block: storage room(s)
62 Habitation, room block: living room(s)
63 Habitation, room block: courtyard
64 Habitation, room block: other
65 Habitation, room block: roof or 5-10 level
66 Habitation, non-structural unit: not further specified
67 Habitation, non-structural unit: north of pithouse
68 Habitation, non-structural unit: east of pithouse
69 Habitation, non-structural unit: west of pithouse
70 Unassigned
71 Habitation, non-structural unit: borrow
72 Habitation, non-structural unit: materials processing
73 Habitation, non-structural unit: other
75 Habitation, refuse deposit: midden
76 Habitation, refuse deposit: strata in pitstructure
78 Habitation, base camp: not further specified

(80's and 90's Combination designation)
80 Mixed deposits; not functionally differentiated
81 Indeterminate Archaic function, Anasazi is erosional or minimal use
82 Archaic camp, Anasazi limited activity area: not further specified
84 Archaic seasonal use, Anasazi limited activity area
85 Archaic seasonal use, Anasazi habitation
90 (Anasazi plus Anasazi)

2 VAR 9 Raw Material
00: Indeterminate
01: Quartzite, coarse
02: Quartzite, medium
03: Quartzite, fine
04: Morrison quartzite, coarse
05: Morrison quartzite, medium
06: Morrison quartzite, fine
07: Chert, not otherwise specified here
08: Chert, clastic
09: Chert, chalcedonic
10: Chert, Burro Canyon
11: Chert, Brushy Basin
12: Chert, Morrison
13: Chert, Washington Pass
14: Chert, Jasper
15: Obsidian
16: Chalcedony
17: Silicified Wood
18: Siltstone, not otherwise specified here
19: Siltstone, Mancos
20: Sandstone
21: Basalt
22: Diorite
23: Igneous other

While this raw material attribute is not itself a part of the fracture process, it is nevertheless critical to it and is a significant element in the larger technological process. Flake attributes resulting from similar stoneworking techniques may be quite different in different raw materials, and comparisons within and between such raw material types may be most revealing. The selection of the stone is among the initial decisions made in production technology, and the environmental or cultural constraints imposed upon that selection are crucial to an understanding of that technological system. Categories of raw material have their greatest archaeological significance as "natural" categories, readily definable by aboriginal craftsmen, rather than defined in technical petrologic terms. As with most discrete attributes, 00 is used to record cases in which no determination can be made.

VAR 10 Flake Length. Record flake length to the nearest millimeter along the flake's bulbar axis, or axis of percussion (Figure 3.D.1). Significance of this attribute is primarily related to fracture surface area and force amount required for flake detachment, and therefore indirectly to the technique of force application.

2 VAR 11 Flake Width. Record maximum flake width in millimeters, measured at right angles to the bulbar axis (Figure 3.D.1). If the flake width is greater than 99 mm, record as 99. The primary significance of flake width is, like length, its relationship to fracture area, force required for detachment, and technique of force application.

2 VAR 12 Flake Thickness. Record maximum flake thickness in millimeters, measured perpendicular to the plane of the fracture surface (Figure 3.D.1). Flake thickness is dependent primarily on the point of force application (PFA) location relative to the core face, the geometry of that core face, and the direction of force application. Locating the PFA closer to the edge of the platform results in a thinner flake, and vice versa (Faulkner [13:110-115]). The direction of force application may also affect flake thickness and the relative position of maximum thickness. The primary interpretability of flake thickness lies in its affect on the flake index. The flake index is generated by dividing the length x width by flake thickness, or

$$\frac{\text{flake length x flake width}}{\text{flake thickness}}$$

Technologically, there are no great problems in producing either large thick flakes or small, thin ones, but production of the large, thin flakes necessary in the manufacture of most well-proportioned stone implements demonstrates careful control over many fracture variables. Relatively low values of this index indicate smaller, thicker flakes, while higher values indicate larger, thinner flakes requiring much more careful control of fracture variables. The primary interpretive value of this index is in providing a single, easily comparable, quantitative measure of general flake production control.

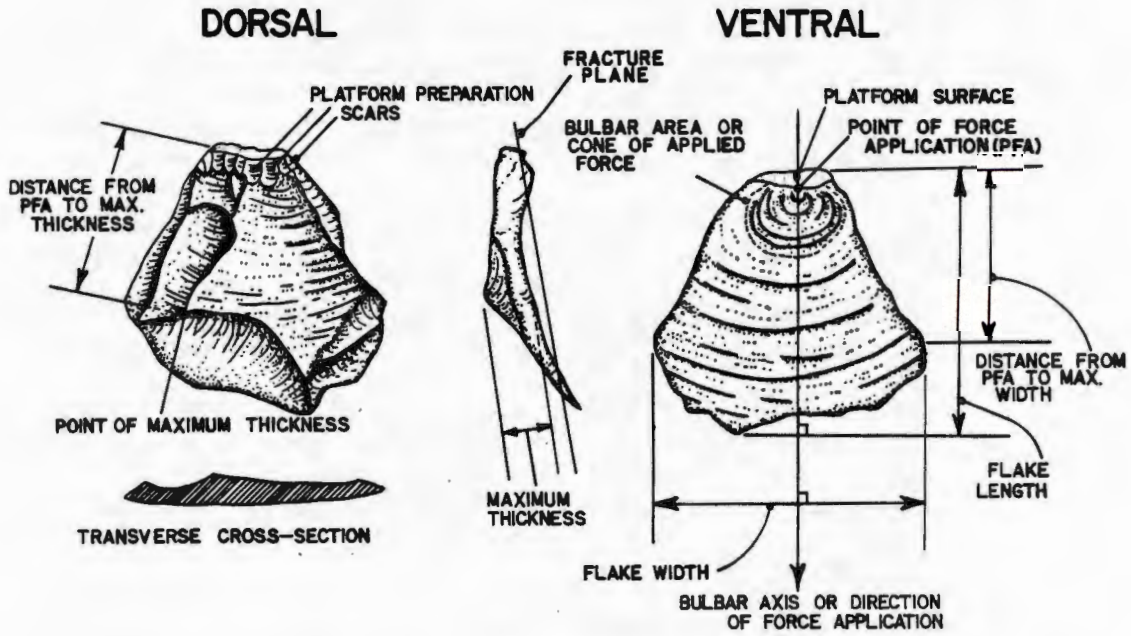

Figure 3.D.1 Measurement of flake characteristics.

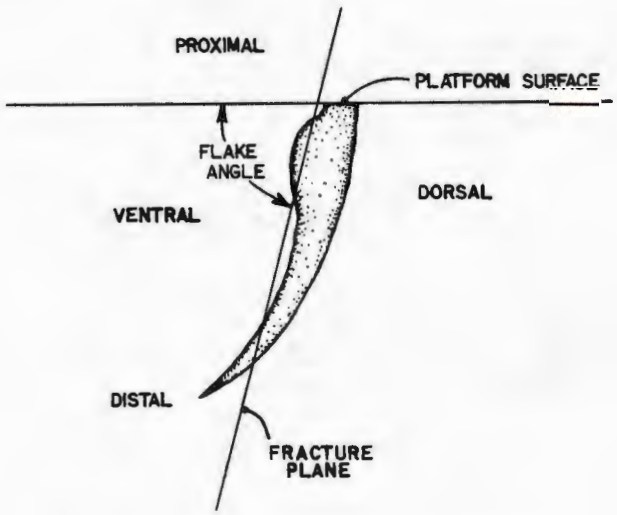

Figure 3.D.2 Average ventral plane.

1 VAR 13 Plan Outline. An evaluation of the generalized plan view of the flake.

0: Indeterminate
1: Squared (L = +W)
2: Rectangular (L < 2W)
3: Distally expanding (L > W)
4: Rounded
5: Oval
6: Parallel-sided (and L > 2W)
7: Distally contracting
8: Wider than long (L < W)
9: Irregular, other

Since flake outline is determined primarily by the geometry of the core face as it is intersected by the fracture plane, any very regular outline is indicative of a carefully prepared or selected core geometry, and relatively high frequencies of such flakes suggest consistency in controlling fracture and producing regular core face geometry. Values 3 and 4 are particularly suggestive of well-controlled biface thinning. High frequencies of two and six indicate good control, careful platform preparation, and the production of blades. Values 7 and 8 suggest shaping rather than thinning concerns, with less attention to platform preparation, as in the initial shaping of flake or blade cores, or the final shaping of bifaces, in which case the flakes are very small and short.

2 VAR 14 Platform Remnant Depth. Record the maximum depth or thickness (dorsal-ventral) of the platform remnant on the extreme proximal end of the flake, measured to the nearest millimeter. If the platform consists only of the PFA, record as 01 mm. Generally, deeper platforms indicate less platform treatment such as isolation or surface preparation prior to force application, since platform treatment tends to reduce platform remnant size by locating the PFA closer to the core edge. More specifially, platform remnant depth is determined primarily by the distance of the PFA from the edge of the core, and reducing this distance is facilitated by most kinds of platform preparation.

2 VAR 15 Platform Remnant Width. Record the maximum platform remnant width to the nearest millimeter at the flake's extreme proximal end. Reduced platform width is indicative of platform treatment prior to force application, and lower values can be interpreted as more careful attention to such platform preparation. The positioning and isolation of the PFA is particularly related to platform remnant width, since isolating the intended PFA as a small projection at the core edge severely reduces the amount of that edge removed with the flake. In some cases of careful PFA isolation and force application, flakes are produced on which the platform remnant is very little larger than the PFA itself. Such control is especially important in the production of regular blades and very thin bifaces.

1 VAR 16 Platform Remnant Surface. An evaluation of the nature of the platform surface remnant.

0: Indeterminate
1: Cortex, or natural surface of the stone
2: Cortex + any other value
3: A single flake scar
4: Two or three flake scars
5: 4 or more (probably very small) flake scars
6: A ground surface

While these categories are somewhat arbitrary, they nevertheless represent definable stages in the technological continuum of platform surface treatment. Higher values represent generally greater concern with such surface preparation, presumably to provide greater control over those fracture variables associated with the PFA nature and location. A high proportion of cortex platforms is not necessarily technological "crudity," but simply may be technologically preliminary, or it may represent careful selection of appropriate platform surface and orientation rather than their production. Quarry activity should probably be characterized by rather low mean values for this flake attribute, whereas the final production of blades or bifaces would be characterized by rather high mean values.

3 VAR 17 Platform angle. Measure, to the nearest five degrees, the angle between the surface of the platform remnant and the average ventral flake surface (Figure 3.D.2). If the platform consists only of the PFA or is otherwise not measureable, record 000 for platform angle. Some observers, in recording this angle, have preferred to "measure stone" (Knudson [14:174]), rather than measuring the supplementary "air" angle (Wilmsen [15:14-17]). Three reasons for choosing to "measure air" were: to deal primarily with smaller figures; ease of reading the polar coordinate grid on which measurements were taken; and ease of comparability with a corresponding angular measurement between the core platform and the core face. Care should be taken in comparative situations to deal with equivalent angles.

1 VAR 18 Platform Preparation Scars. Code the presence and intensity of scars indicating the positioning and isolation of the intended PFA. These small scars are located on the extreme proximal end of the flake's dorsal surface, and their fracture originates from the platform surface (Figure 3.D.1). They are produced by the removal of any overhang left of the core from prior flake removals (Figure 3.D.3)

0: Indeterminate
1: No preparation
2: Rubbing/crushing only
3: 1-3 distinct scars present - no magnification necessary
4: 4 or more distinct scars present
5: combine 2 & 3
6: combine 2 & 4

Higher values for this flake attribute indicate greater concern for the isolation, positioning, and preparation of the platform surface prior to flake removal.

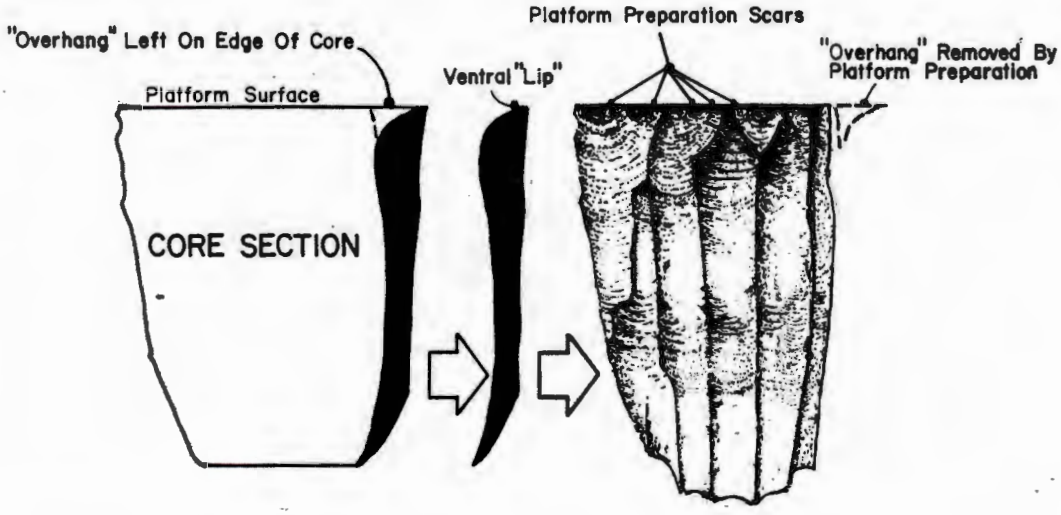

Figure 3.D.3. Platform preparation: blade core.

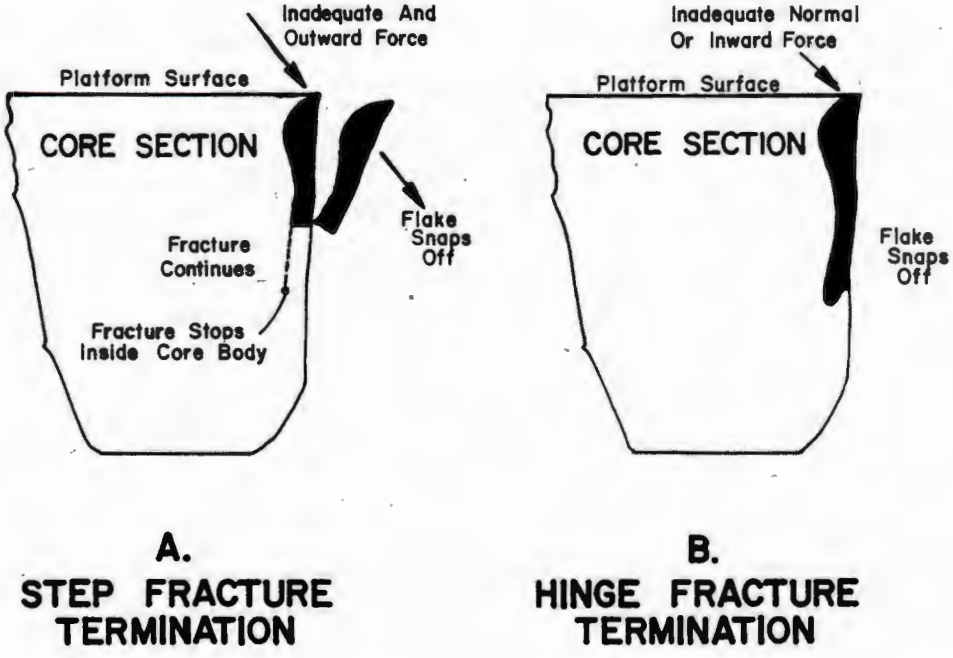

Figure 3.D.4 Fracture terminations.

1 VAR 19 Ventral Lip. Code the presence and prominence of a lip, or projection at the extreme proximal end of the ventral flake surface (Figure 3.D.3). The frequent suggestion of this attribute as potentially significant in distinguishing soft from hard percussor techniques, indicates the need to quantify its prominence, despite obvious difficulties in measurement. The following system of evaluation is admittedly somewhat subjective and arbitrary, but is based on the fact that the ring crack which initiates fracture always occurs at right angles to the surface against which force is applied. Both the depth to which this crack penetrates and the subsequent angular alteration in its direcion contributes to the prominence of the ventral lip.

0: Indeterminate
1: No ventral lip
2: Slight ventral lip
3: Moderate ventral lip
4: Strong ventral lip

Definitions of the above attribute states are as follows: "Slight" is difficult to see, but well enough defined to peel a fingernail shaving when the flake is held at a 45° angle against the nail and dragged lightly across it. "Moderate" lips are clearly visible, even though still small, and will easily catch under a fingernail. "Strong" implies an obvious, clearly visible state of the attribute.

Lower values for this attribute may indicate relatively harder force-applying implements, correspondingly smaller PFAs, and may also suggest angles of force application with strong outward components. Such control combinations might be expected in the initial shaping by percussion of various larger core types, or the production of rather large, thick, unspecialized flakes. Conversely, higher values may indicate relatively softer flaking tools, larger PFAs, and inward-directed force components such as might be produced in the removal of thinning flakes from bifaces.

Sufficient differences among observers in the interpretation of this attribute indicate the need for caution in applying such conclusions, particularly in the absence of other supporting evidence. However, if sample size is adequate and supplementary attributes are considered, this flake attribute may prove to be a sensitive technological indicator of flaking tool hardness or other variables.

1 VAR 20 Distal Margin Termination. Code for the one predominant type of distal margin termination. When in doubt, use the lower number.

0: Indeterminate
1: Tapered, feathered; with shallow angle (< 20°)
2: Tapered, with steep angle (> 20°)
3: Squared or broken; "step" fracture termination
4: Rounded or "hinged"

This characteristic is closely related to the amounts of force applied. Of particular importance are the hinge and step flake terminations. Attribute state 1 is associated with optimum force amounts, while 4 is associated with inadequate force amounts. State 3 may indicate inadequate force amounts delivered with an outward component, resulting in a step termination, or it may indicate post-production breakage (Figure 3.D.4).

1 VAR 21 Lateral Margin Terminations. Code for the one predominant type of lateral margin termination. When in doubt, use the lower number.

0: Indeterminate
1: Tapered, feathered; with shallow angle (< 20°)
2: Tapered, with steep angle (≥ 20°)
3: Squared, broken, irregular
4: Combine 1 & 2
5: Any other combination

1 VAR 22 Bulb Acumination. An evaluation of the relative "pointedness" of the bulb of force, located on the extreme proximal portion of the ventral flake surface. An exact definition is probably impossible, and is not as important as consistently applied relative definition.

0: Indeterminate
1: Acuminate
2: Moderately truncated
3: Heavily truncated

1 VAR 23 Bulb Prominence. Refers to both the rise of the bulbar area above the average ventral flake surface and the relative abruptness of that rise. Again, an absolute definition is probably impossible, and is not as important as consistent application.

0: Indeterminate
1: Heavily pronounced
2: Moderately pronounced
3: Moderately diffuse
4: Very diffuse

1 VAR 24 Flake Curvature (ventral surface). An evaluation of the curvature of the ventral profile and its orientation with the platform remnant at the flake's proximal end. An area of slight ventral convexity near the proximal end, corresponding to the flake's bulb of applied force, is expected and discounted in evaluating flat and gently concave categories; 2 and 3 below. In all illustrations, ventral is down.

0: Indeterminate
1: Reverse
2: Flat
3: Slight — Rise < 1/8 cord
4: Moderate — Rise = 1/4 - 1/8 cord
5: Strong — Rise > 1/4 cord

Relatively high frequencies of 2 and 3 suggest greater control of all critical fracture variables. High frequencies of 4 suggest a relatively hard percussor and inward-directed force application. High frequencies of 5 may indicate primarily shaping rather than thinning concerns, or attention to producing implement plan rather than section. State 5 of this attribute also suggests rather low core mass.

1 VAR 25 Cortex. Code the presence and relative amounts of cortex, or the natural surface of the stone, on the flake's dorsal side. The following categories are used to quantify the proportional area of cortex remaining on the flake.

0: Indeterminate
1: No cortex
2: Less than 1/4 cortex
3: 1/4 - 1/2 cortex
4: 1/2 - 3/4 cortex
5: More than 3/4 cortex
6: All cortex.

Since the dorsal surface of a flake is the same as the core face prior to the flake's removal, any characteristics of the dorsal flake surface can be considered characteristics of the core face. The removal, for example, of all traces of cortex from the core face prior to flake removal results in a flake with no traces of cortex on its side. An implicit assumption in assigning significance to this attribute is that cortex is normally not as desirable as freshly fractured material, either because of a difference in some quality of the stone itself or in the regularity of the two kinds of surfaces or edges.

The lower the mean value for this attribute, the greater the core preparation input prior to flake removal and vice versa. Larger percentages of flakes with high proportions of cortex suggest quarry sites at which primary shaping of cores or blanks is a major activity. Smaller, more regularly shaped flakes with smaller proportions of cortex suggest secondary shaping of blanks into preforms or finished implements. A correlation of this cortex attribute with flake size and the presence of cortex on implements should suggest production technology and raw material utilization in a given situation.

2 VAR 26 Scar Number. Record the number of distinct flake scars on the dorsal side of the flake. Each scar on the flake's dorsal side corresponds to a flake removed from the core face prior to detachment of the study flake. A flake with six distinct scars on its dorsal side indicates at least six flake removal operations in preparing the core face for the detachment of this flake. Normally, then the greater the mean value of this attribute the greater the technological input in preparation for flake removal. A readily recognizable exception to this rule is the production of blades, in which only a few very carefully patterned scars form the core face, and therefore the dorsal side of the removed flake (blade).

1 VAR 27 Scar Size. Code patterns in the size of scars on the flake's dorsal side.

0: Indeterminate
1: Predominantly small scars
2: Predominantly medium sars
3: Predominantly large scars
4: Small and medium scars
5: Small and large scars
6: Medium and large scars
7: No pattern or regularity apparent

In making these determinations, "predominantly" means 2/3 or more, "small" is less than 3 mm in maximum dimension, "medium" is 3 - 15 mm in maximum dimension, and "large" is any scar over 15 mm in maximum dimension. Any observable regularity in the size of the dorsal scars suggests a corresponding regularity of behavior in the preparation of the core face.

1 VAR 28 Scar Pattern. Code readily observable patterns in the arrangement or orientation of scars on the flake's dorsal side.

0: Indeterminate
1: Patterned parallel with bulbar axis
2: Patterned perpendicular with bulbar axis
3: Patterned diagonally with bulbar axis
4: Patterned radially from margins ("opposite")
5: No pattern obvious

The prime elements considered in this attribute are the regularity in placement of the PFAs and in the direction of the removal forces for the flakes that formed the core face, and subsequently the dorsal side of the removed flake. Value 1 indicates the removal of the study flake by a force applied in the same direction as those that prepared the core face: in other words, this flake is one of a series of flake removals, all by forces applied in the same direction. This suggests the careful preparation of a core with a rather large platform surface from which a whole series of flakes are subsequently removed, such as in the production of regular blades or large bifaces. Values 2 through 4 indicate that the study flake was removed by a force applied in a different direction from those that formed the core face, and indicate very careful planning and control. Such flakes might be expected in the preparation of cores, smaller bifaces, and Levallois flakes.

1 VAR 29 Scar Hinging. Code the occurrence and relative intensity of the hinged termination of the dorsal scars.

0: Indeterminate
1: No dorsal scars hinged
2: Fewer than 25% hinged dorsal scars
3: 25-75% hinged dorsal scars
4: Over 75% hinged dorsal scars

On the assumption that hinging is a technological goof, higher mean values for this attribute suggest relatively poorer control of critical force application variables. Conversely, lower mean values suggest better variable control.

1 VAR 30 Dorsal Surface Regularity/Smoothness. An evalution of the regularity of the dorsal surface of the flake. Observed characteristics may be the result of deliberate production (flaking) or merely a natural surface which has been selected for. In evaluating this attribute, both size and relative height/depth of the ridges are taken into account.

0: Indeterminate
1: Smooth, flat, consistent across entire face, produced from regular core faces
2: In the middle
3: Rough, irregular, inconsistent across entire face

PAGE SUMMARY

Number of Debitage Items

A count of the total number of debitage items in the F.S. unit. This includes whole flakes, partial flakes, chunks, etc., none of which show signs of use wear or deliberate retouch or working of any sort.

Number of Flakes

A count of the total number of flakes in the debitage category for the F.S. unit. "Flake" is defined as: any lithic item which has a platform and/or exhibits a characteristic ventral surface. Includes both whole and partial flakes.

Number of Whole Flakes

A count of the total number of whole flakes in the debitage category for the F.S. unit. "Whole flake" is defined as: any flake on which the striking platform (and thus, the PFA) and the original distal and lateral margins have been preserved relatively intact. In order to be considered "whole," it must be possible to measure the flake's maximum length, width, thickness, and the various platform dimensions specified in the foregoing analysis outline; also an assessment of the nature of the distal and lateral terminations must be possible.

Number of Flakes Analyzed

A count of the total number of (whole) flakes which were actually included in the analysis.

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