

## 6

### A STATISTICAL COMPARISON OF AURIGNACIAN AND MOUSTERIAN ASSEMBLAGES

Rebecca C. MILLER and Marie-Blanche MISHOE

#### SUMMARY

There are four archaeological strata at Le Trou Magrite, two identified as Aurignacian and two as Mousterian. The goal of this analysis is to compare the lithic components of each pair of strata in order to identify similarities and differences with respect to raw materials utilized, kinds of debitage produced on different raw materials or by potentially different techniques (e.g., flake versus blade blank production and use), and kinds of tools produced. This study demonstrates similarities between and variability within technological aspects of typologically-defined industries, which may be affected by factors related to quality and abundance of different kinds of raw materials.

#### DESCRIPTION OF DATA AND VARIABLES

The data analyzed are the lithic components from Strata 2-5. Briefly, the data include two types of observations : 1) piece-plotted artifacts and 2) artifacts collected by spit and quarter meter square as "spit bag contents". Piece-plotted artifacts are generally artifacts greater than or equal to 1 cm that are individually plotted in three dimensions, and then individually weighed, measured, and classified. During laboratory field analysis, spit bag contents are sorted according to raw material type, portion, and debitage type and then weighed as sub-groups and counted.

Categorical variables include the following : 1) raw material type, 2) Upper Paleolithic tool type, and 3) blank, debris or debitage type. Raw material for each artifact was identified using a geological list of raw material types which were then grouped into seven classes (Table 6.1). For those artifacts which are retouched tools, the de Sonneville-Bordes/Perrot typelist was used to identify 'Upper Paleolithic tool types' which were then further grouped into seven broad tool classes (Table 6.2). 'Blank, debris or debitage type' refers to the kinds of lithic debitage produced during reduction sequences, such as cortical flakes, trimming flakes, flake blanks, blade blanks, or cores.

**Table 6.1: Raw material types**

1	flint
2	chert
3	phtanite
4	limestone
5	quartzite
6	ochre/hematite
7	other

*Note: type 7 was excluded from analysis.*

**Table 6.2: Grouped Upper Paleolithic tool types**

1	endscrapers
2	burins, percoirs, becs
3	blades, continuously retouched pieces
4	notches and denticulates
5	sidescrapers, raclettes
6	composite tools
7	diverse

*Note: diverse tools (consisting of Late Upper Paleolithic tools in secondary context) were excluded from analysis.*

**Table 6.3: Grouped blank or debitage types**

1	trimming flakes
2	shatter
3	flakes
4	blades
5	burin spalls
6	cores
7	chunks
8	fire-cracked rock

*Note: fire-cracked rock was excluded from analysis.*

Artifacts were categorized into 30 types, which were then further grouped into eight broad classes (Table 6.3).

Three variables - length, width, and thickness - were measured on piece-plotted artifacts as indicators of size. For spit bags, artifacts were grouped by raw material/debitage type combinations and then weighed by groups.

All statistical analyses were performed at the 95% significance level and utilize frequency rather than weight data.

## SUMMARY OF ANALYSES PERFORMED

- Part 1 : Comparison between strata of frequencies for each categorical variable (raw material, tool<sup>1</sup>, and debitage classes).
- Part 2 : Comparison between strata of frequencies for cross-tabulated categorical variables :
- tool class and raw material class
  - tool class and debitage class (see Part 3)
  - debitage class and raw material class
- Part 3 : Comparison of size variables between tools made on flakes or blades and flake/blade blanks (debitage types 3 and 4)
- Part 4 : Inter-strata analysis of whole blades :
- comparison of frequencies of raw materials producing blades
  - comparison of size of whole blades
  - comparison of size of blades between raw material classes
- Part 5 : Inter-strata comparison of cortical vs. non-cortical flint debitage
- Part 6 : Analysis of variability of edge angles for endscrapers

## RESULTS

- Part 1 : Comparison between strata of frequencies for each categorical variable (raw material, tool, and debitage classes).

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<sup>1</sup> Comparison of tool classes is between Strata 2 and 3 only because of the small sample size for Strata 4 and 5.

Table 6.4. Raw Material Frequencies: Strata 2-5

----- STRATUM=2 -----

Grouped Material

MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	3188	61.2	3188	61.2
chert	131	2.5	3319	63.8
phtanite	38	0.7	3357	64.5
limestone	1711	32.9	5068	97.4
quartzite	137	2.6	5205	100.0

----- STRATUM=3 -----

Grouped Material

MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	936	35.8	936	35.8
chert	114	4.4	1050	40.1
phtanite	17	0.6	1067	40.8
limestone	1458	55.7	2525	96.5
quartzite	92	3.5	2617	100.0

----- STRATUM=4 -----

Grouped Material

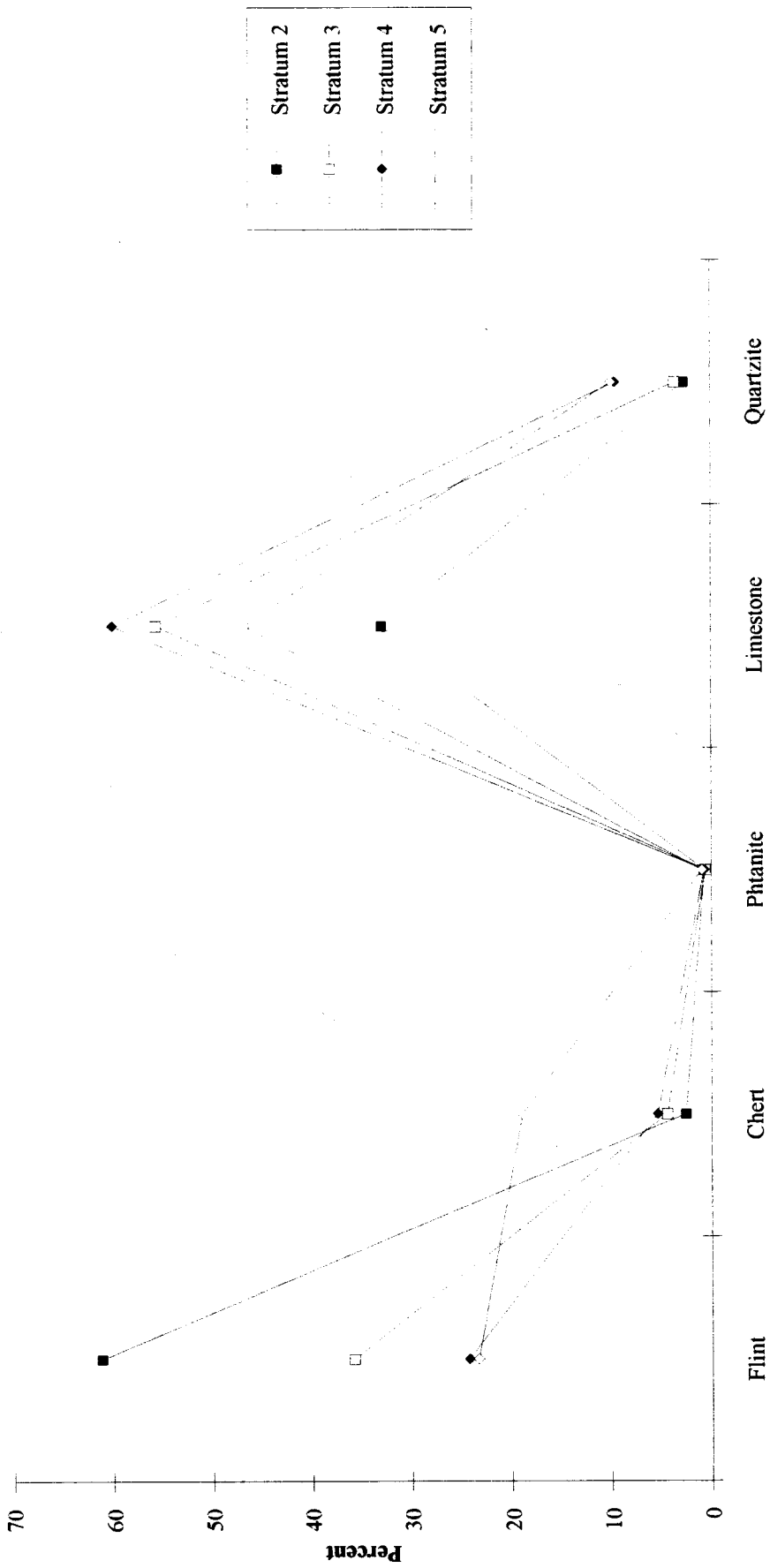
MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	36	24.3	36	24.3
chert	8	5.4	44	29.7
phtanite	1	0.7	45	30.4
limestone	89	60.1	134	90.5
quartzite	14	9.5	148	100.0

----- STRATUM=5 -----

Grouped Material

MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	26	23.4	26	23.4
chert	21	18.9	47	42.3
phtanite	1	0.9	48	43.2
limestone	52	46.8	100	90.1
quartzite	11	9.9	111	100.0

**Percent Raw Material  
Strata 2-5**



**Figure 6.1**

## 1) Raw material class (Table 6.4, Figure 6.1)

**Strata 2 and 3.** Comparing Strata 2 and 3, the p-value for the chi-square test is 0.000 (df=4, value=462.334, n=7822). Strata 2 and 3 are significantly different with respect to frequencies of raw materials by count. They differ in use of flint and limestone while use of chert, phtanite and quartzite is not significantly different between strata. Stratum 2 has a much higher relative frequency of flint than Stratum 3 (61.25% vs. 35.77%). Stratum 3 has a higher relative frequency of limestone than Stratum 2 (55.71% vs. 32.87%).

**Strata 2 and 4.** Comparing Strata 2 and 4, the p-value for the chi-square test is 0.000 (df=8, value=113.904, n=5353). Strata 2 and 4 are significantly different with respect to use of flint (61.25% vs. 24.32%) and limestone (32.87% vs. 60.14%).

**Strata 2 and 5.** Comparing Strata 2 and 5, the p-value for the chi-square test is 0.000 (df=10, value=331.364, n=5464). Strata 2 and 5 differ primarily with respect to use of flint (61.25% vs. 23.42%), chert (2.52% vs. 18.92%), limestone (32.87% vs. 46.85%), and quartzite (2.63% vs. 9.91%).

**Strata 3 and 4.** Comparing Strata 3 and 4, the p-value for the chi-square test is 0.001 (df=8, value=239.062, n=2765). Strata 3 and 4 are also significantly different with respect use of flint (35.77% vs. 24.32%) and quartzite (60.14% vs. 55.71%), while chert, phtanite and limestone were not significantly different.

**Strata 3 and 5.** Comparing Strata 3 and 5, the p-value for the chi-square test is 0.000 (df=4, value=63.379, n=2728). Strata 3 and 5 differ with respect to use of flint (35.77% vs. 23.42%), chert (4.36% vs. 18.92%), limestone (55.71% vs. 46.85%), and quartzite (3.52% vs. 9.91%).

**Strata 4 and 5.** Comparing Strata 4 and 5, the p-value for the chi-square test is 0.010 (df=5, value=15.088, n=261). Strata 4 and 5 differ with respect to limestone (60.1% vs. 46.0%) and chert (5.41% vs. 18.58%). They are not significantly different with respect to flint, phtanite, and quartzite.

Figure 6.1 shows the frequencies for Strata 2-5 and indicates that Stratum 3 is more similar to Stratum 4 than to Stratum 2 with respect to raw material. There is a general trend from Stratum 5 to Stratum 2 reflecting an increase in the use of flint and a decrease in chert and quartzite. For limestone, the frequency increases from Stratum 5 to Stratum 4, followed by a decreasing trend through Stratum 2, with a substantial decrease between Strata 3 and 2.

Flint is from non-local sources, Obourg flint near Mons, and Maastrichtian flint in eastern Belgium and southern Holland. Phtanite is found near Ottignies. Limestone is local, found in the limestone cliffs. Quartzite is also locally available in the form of river cobbles. Both flint and phtanite are of good quality, suitable for a range of reduction techniques. Limestone and quartzite are of lesser quality, but are still useable.

### 2a) Upper Paleolithic tool type (Table 6.5, Figure 6.2)

Comparing Strata 2 and 3, the p-value for the chi-square test is 0.191 (df=5, value=7.430, n=208). The two strata are not significantly different with respect to tool types present. However, Figure 6.2 shows the existence of some minor differences in frequencies of blade tools, notches and denticulates, and sidescrapers. There is an inverse relationship between blades and notches/ denticulates. Stratum 2 has a higher frequency of blades while Stratum 3 has a higher frequency of notches/denticulates. Stratum 2 also has a higher frequency of sidescrapers/raclettes while Stratum 3 has a higher frequency of burins/perçoirs/beccs; however, these differences are not statistically significant.

### 2b) Middle Paleolithic tool type (Table 6.5a)

The small sample size of Mousterian tools from Strata 4 and 5 prevents statistical comparison of these strata. Table 6.5a summarizes their frequencies.

### 3) Blank or debitage type (Table 6.6, Figure 6.3)

**Strata 2 and 3.** Comparing Strata 2 and 3, the p-value for the chi-square test is 0.000. The two strata are significantly different with respect to blank or debitage type. They primarily differ in relative frequencies of shatter, flakes, and blade blanks. Stratum 2 has a higher relative frequency of shatter than Stratum 3 (12.55% vs. 4.51%) as well as a slightly higher frequency of blade blanks (10.84% vs. 8.22%). Stratum 3 has a higher relative frequency of flakes than Stratum 2 (60.02% vs. 49.81%).

**Strata 2 and 4.** Comparing Strata 2 and 4, the p-value for the chi-square test is 0.000 (df=7, value=80.937, n=5346). Stratum 4 has a higher relative frequency of cores and a lower relative frequency of trimming flakes and shatter while Stratum 2 has an opposite relationship.

**Strata 2 and 5.** Comparing Strata 2 and 5, the p-value for the chi-square test is 0.000 (df=14, value=366.102, n=7933). Stratum 5 has the lowest relative frequency of trimming flakes, and shatter, and a higher relative frequency of flakes and chunks relative to Stratum 2.

**Strata 3 and 4.** Comparing Strata 3 and 4, the p-value for the chi-square test is 0.000 (df=7, value=49.828, n=2758). The two strata are also significantly different with respect to blank or debitage type, primarily trimming flakes and flakes. Stratum 3 has a higher frequency of trimming flakes than Stratum 4 (21.60% vs. 14.08%) and a higher frequency of flakes (60.02% vs. 51.41%). Stratum 4 also has a higher frequency of cores than either Stratum 3 or Stratum 2.

**Strata 3 and 5.** Comparing Strata 3 and 5, the p-value for the chi-square test is 0.000 (df=7, value=136.629, n=2729). The differences are similar to the comparison between Strata 2 and 5.

Table 6.5: Upper Paleolithic Tool Classes - Strata 2 and 3

----- STRATUM=2 -----

TOOLS M1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
endscrapers	27	25.5	27	25.5
burins/perçoirs/becs	4	3.8	31	29.2
retouched blades, CRPs	37	34.9	68	64.2
notches/denticulates	25	23.6	93	87.7
sidescrapers/raclettes	11	10.4	104	98.1
composite	2	1.9	106	100.0

----- STRATUM=3 -----

TOOLS M1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
endscrapers	27	26.5	27	26.5
burins/perçoirs/becs	8	7.8	35	34.3
retouched blades, CRPs	26	25.5	61	59.8
notches/denticulates	35	34.3	96	94.1
sidescrapers/raclettes	5	4.9	101	99.0
composite	1	1.0	102	100.0

TABLE OF STRATUM BY TOOLS M1

STRATUM	TOOLS M1							Total
Frequency								
Expected								
Deviation								
Percent								
Row Pct								
Col Pct	endscrap	burins	blades	not/dent	sidescrp	compos		
2	27	4	37	25	11	2		106
	27.519	6.1154	32.106	30.577	8.1538	1.5288		
	-0.519	-2.115	4.8942	-5.577	2.8462	0.4712		
	12.98	1.92	17.79	12.02	5.29	0.96		50.96
	25.47	3.77	34.91	23.58	10.38	1.89		
	50.00	33.33	58.73	41.67	68.75	66.67		
3	27	8	26	35	5	1		102
	26.481	5.8846	30.894	29.423	7.8462	1.4712		
	0.5192	2.1154	-4.894	5.5769	-2.846	-0.471		
	12.98	3.85	12.50	16.83	2.40	0.48		49.04
	26.47	7.84	25.49	34.31	4.90	0.98		
	50.00	66.67	41.27	58.33	31.25	33.33		
Total	54	12	63	60	16	3		208
	25.96	5.77	30.29	28.85	7.69	1.44		100.00

Percent Tool Classes  
Strata 2 and 3

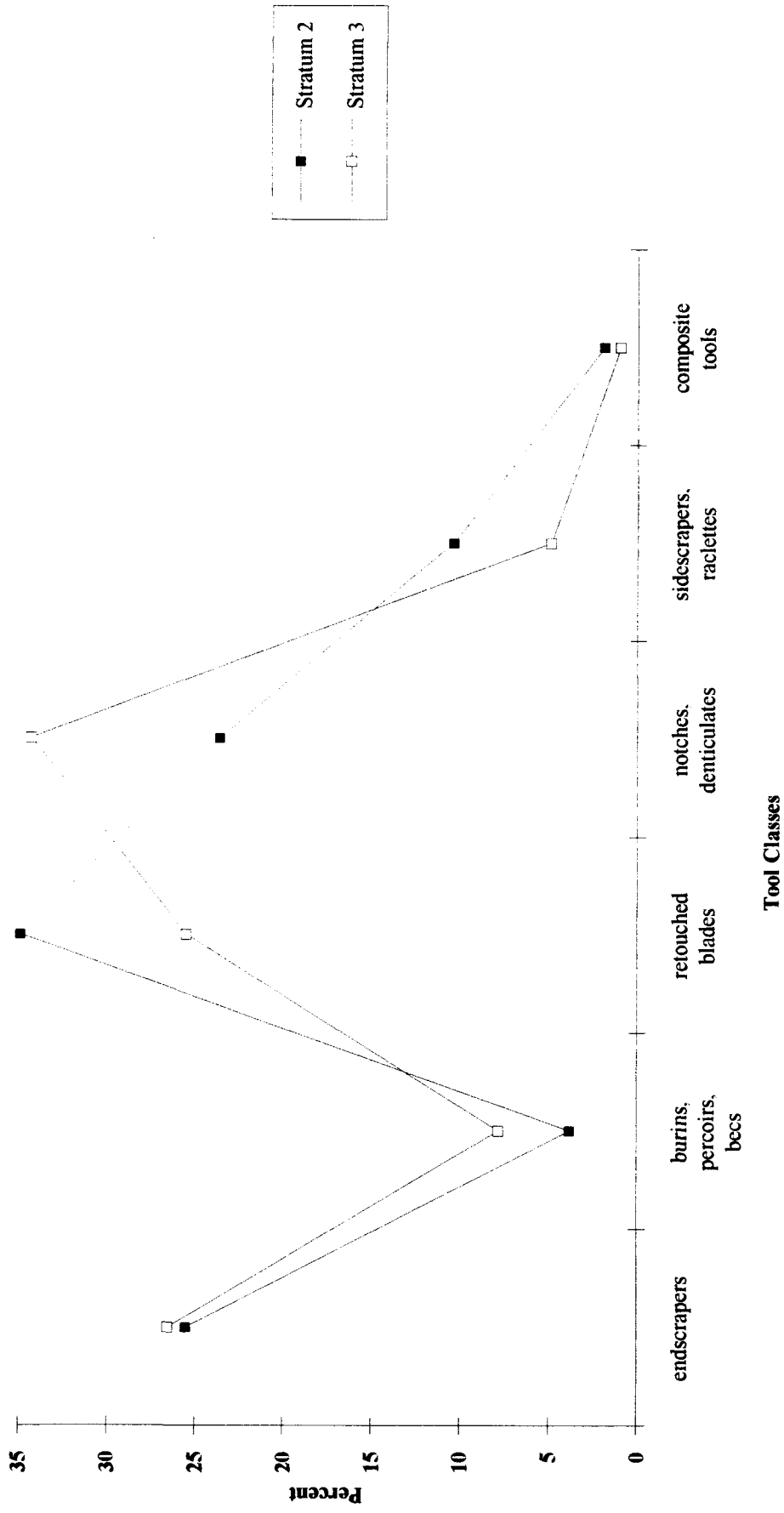


Figure 6.2

**Table 6.5a.** Frequencies of Middle Paleolithic Tools for Strata 4 and 5

----- STRATUM=4 -----				
MPCODE1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Sidescrapers	1	33.3	1	33.3
Notches	2	66.7	3	100.0

----- STRATUM=5 -----				
MPCODE1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Levallois flake	1	16.7	1	16.7
Sidescrapers	2	33.3	3	50.0
Burins	1	16.7	4	66.7
Raclettes	1	16.7	5	83.3
Denticulates	1	16.7	6	100.0

Table 6.6. Debitage Frequencies: Strata 2-5

----- STRATUM=2 -----				
Grouped Debitage				
DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	1053	20.2	1053	20.2
shatter	653	12.5	1706	32.8
flakes	2592	49.8	4298	82.6
blades	564	10.8	4862	93.4
burin spalls	6	0.1	4868	93.5
cores	32	0.6	4900	94.2
chunks	304	5.8	5204	100.0

----- STRATUM=3 -----				
DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	565	21.6	565	21.6
shatter	118	4.5	683	26.1
flakes	1570	60.1	2253	86.3
blades	215	8.2	2468	94.5
burin spalls	2	0.1	2470	94.6
cores	10	0.4	2480	94.9
chunks	132	5.1	2612	100.0

----- STRATUM=4 -----				
DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	20	14.2	20	14.2
shatter	7	5.0	27	19.1
flakes	73	51.8	100	70.9
blades	14	9.9	114	80.9
cores	1	0.7	115	81.6
chunks	26	18.4	141	100.0

----- STRATUM=5 -----				
DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	6	5.5	6	5.5
shatter	1	0.9	7	6.4
flakes	62	56.4	69	62.7
blades	10	9.1	79	71.8
cores	5	4.5	84	76.4
chunks	26	23.6	110	100.0

Table 6.6, continued

TABLE OF STRATUM BY DEBCODE

STRATUM	DEBCODE(Grouped Debitage)				
Frequency					
Percent					
Row Pct					
Col Pct	trimming	shatter	flakes	blades	Total
2	169	99	1103	377	1955
	4.94	2.89	32.21	11.01	57.10
	8.64	5.06	56.42	19.28	
	57.29	63.87	54.02	66.73	
3	106	51	839	165	1270
	3.10	1.49	24.50	4.82	37.09
	8.35	4.02	66.06	12.99	
	35.93	32.90	41.09	29.20	
4	15	4	54	13	106
	0.44	0.12	1.58	0.38	3.10
	14.15	3.77	50.94	12.26	
	5.08	2.58	2.64	2.30	
5	5	1	46	10	93
	0.15	0.03	1.34	0.29	2.72
	5.38	1.08	49.46	10.75	
	1.69	0.65	2.25	1.77	

STRATUM	DEBCODE(Grouped Debitage)			
Frequency				
Percent				
Row Pct				
Col Pct	burinspl	cores	chunks	Total
2	6	21	180	1955
	0.18	0.61	5.26	57.10
	0.31	1.07	9.21	
	75.00	56.76	55.90	
3	2	10	97	1270
	0.06	0.29	2.83	37.09
	0.16	0.79	7.64	
	25.00	27.03	30.12	
4	0	1	19	106
	0.00	0.03	0.55	3.10
	0.00	0.94	17.92	
	0.00	2.70	5.90	
5	0	5	26	93
	0.00	0.15	0.76	2.72
	0.00	5.38	27.96	
	0.00	13.51	8.07	
Total	8	37	322	3424
	0.23	1.08	9.40	100.00

Percent Debitage Classes  
Strata 2-5

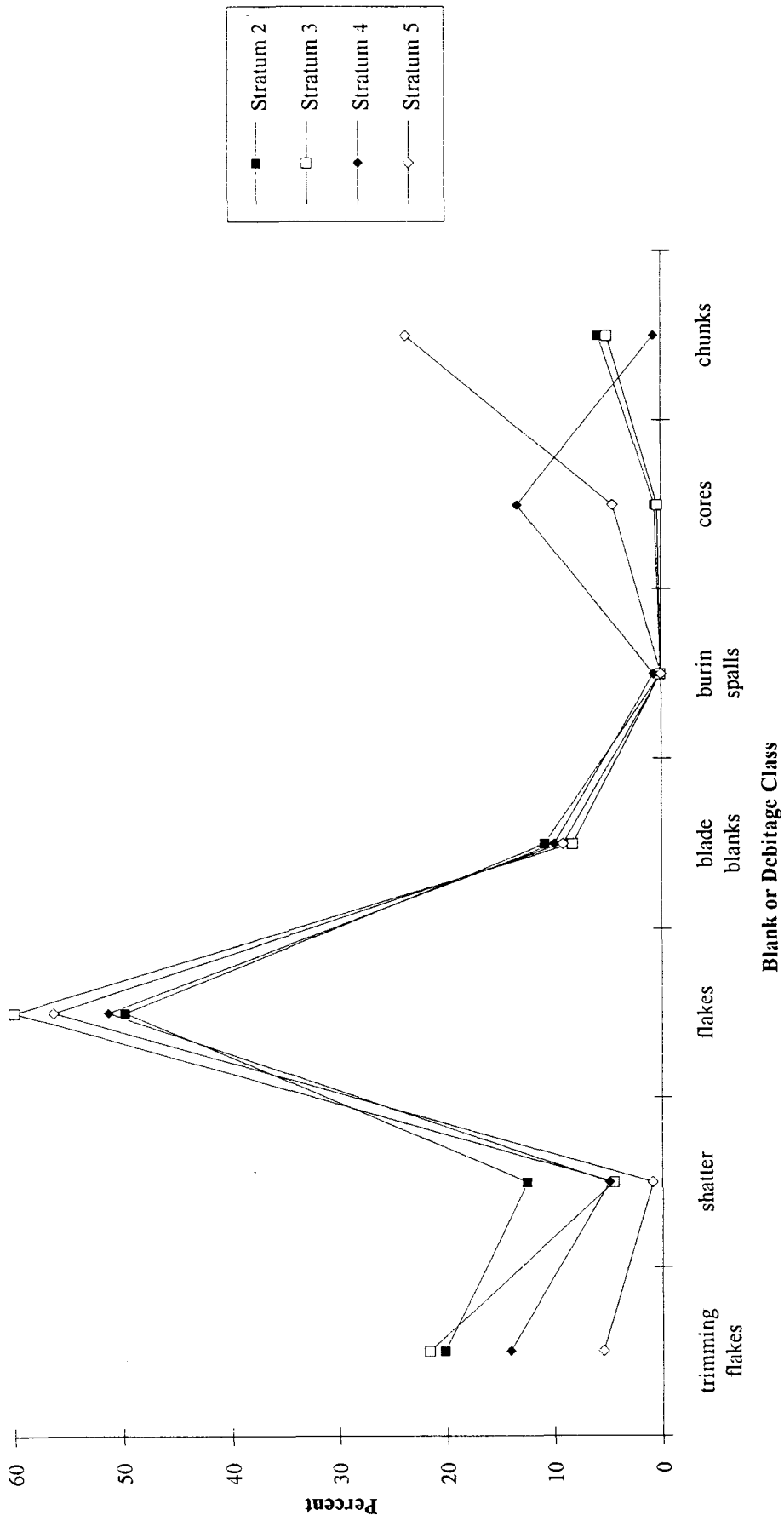


Figure 6.3

Figure 3

**Strata 4 and 5.** Comparing Strata 4 and 5, the p-value for the chi-square test is 0.028 (df=6, value=14.153, n=255). The two strata are significantly different with respect to trimming flakes (14.08% vs. 5.31%), shatter (4.93% vs. 0.88%), cores (0.70% vs. 4.42%). They are similar with respect to flakes, blades, and chunks.

Figure 6.3 shows the frequencies for Strata 2-5 and indicates that with respect to debitage frequencies, Stratum 3 is more similar to Stratum 2 than to Stratum 4, an interesting fact since Stratum 4 may be assigned to the "Mousterian" while Strata 3 and 2 are assigned to "Aurignacian" on the basis of retouched tool assemblages. Interestingly, there is *not* a significant increase in the frequency of blade blanks from Stratum 5 through Stratum 2. The relative frequency is very gradually decreasing from Stratum 5 to 3, with a slight increase (0.65 to 0.73) from Stratum 3 to Stratum 2. For flake blanks, there is a decrease from Stratum 5 to 4, an increase from 4 to 3, followed by a substantial decrease from 3 to 2, which perhaps corresponds to the increase in blades.

**Part 2 :** Comparison between strata of frequencies for cross-tabulated categorical variables :

1) Tool class and raw material class (Tables 6.7 and 6.8, Figure 6.4)

Due to small sample sizes for retouched tools, this analysis can only be used to compare Strata 2 and 3.

No tools were produced on phtanite in Stratum 3 and very few in Stratum 2. Therefore, the chi-square test was performed with phtanite excluded.

For Stratum 2 (phtanite excluded), the p-value for the chi-square test is 0.349 (df=15, value=16.516, n=102). When phtanite is included, similar results are obtained. Different tool types are not being made preferentially on different raw materials. However, Table 7a shows that far more tools are being produced on flint and limestone than on chert, phtanite, or quartzite. The general pattern is one in which flint and limestone are chosen over other materials, but where specific tool types are not made preferentially on different materials.

For Stratum 3, the p-value for the chi-square test is 0.426 (df=15, value=15.364, n=102). Tools are again produced non-differentially on different raw materials.

Figure 4 shows side-by-side frequency charts for Strata 2 and 3.

2) Debitage class and raw material class (Tables 6.9 and 6.10, Figures 6.5 and 6.6)

**Stratum 2.** For Stratum 2 (Table 6.9), the p-value for the chi-square test is 0.000 (df=24, value=928.131, n=5204). The range of debitage types produced is non-randomly distributed across raw material types. For flint, frequencies of trimming flakes and shatter are higher than expected, and frequencies of flakes, blades, and chunks are lower than expected. For limestone, the exact opposite is true, possibly due to lack of

Table 6.7. Tool Class\*Material Class: Stratum 2

TABLE 1 OF TOOLSM1 BY MATCODE  
CONTROLLING FOR STRATUM=2

TOOLSM1	MATCODE(Grouped Material)					Total
Frequency						
Expected						
Deviation						
Percent						
Row Pct						
Col Pct	flint	chert	phtanite	limestne	quartzte	
end-	23	0	1	2	1	27
scrapers	19.358	0.7642	0.5094	5.8585	0.5094	
	3.6415	-0.764	0.4906	-3.858	0.4906	
	21.70	0.00	0.94	1.89	0.94	25.47
	85.19	0.00	3.70	7.41	3.70	
	30.26	0.00	50.00	8.70	50.00	
burins,	4	0	0	0	0	4
perçoirs,	2.8679	0.1132	0.0755	0.8679	0.0755	
beccs	1.1321	-0.113	-0.075	-0.868	-0.075	
	3.77	0.00	0.00	0.00	0.00	3.77
	100.00	0.00	0.00	0.00	0.00	
	5.26	0.00	0.00	0.00	0.00	
retouched	27	2	1	7	0	37
blades	26.528	1.0472	0.6981	8.0283	0.6981	
	0.4717	0.9528	0.3019	-1.028	-0.698	
	25.47	1.89	0.94	6.60	0.00	34.91
	72.97	5.41	2.70	18.92	0.00	
	35.53	66.67	50.00	30.43	0.00	
notches,	14	0	0	10	1	25
denti-	17.925	0.7075	0.4717	5.4245	0.4717	
culates	-3.925	-0.708	-0.472	4.5755	0.5283	
	13.21	0.00	0.00	9.43	0.94	23.58
	56.00	0.00	0.00	40.00	4.00	
	18.42	0.00	0.00	43.48	50.00	
side-	7	1	0	3	0	11
scrapers	7.8868	0.3113	0.2075	2.3868	0.2075	
	-0.887	0.6887	-0.208	0.6132	-0.208	
	6.60	0.94	0.00	2.83	0.00	10.38
	63.64	9.09	0.00	27.27	0.00	
	9.21	33.33	0.00	13.04	0.00	
composite	1	0	0	1	0	2
tools	1.434	0.0566	0.0377	0.434	0.0377	
	-0.434	-0.057	-0.038	0.566	-0.038	
	0.94	0.00	0.00	0.94	0.00	1.89
	50.00	0.00	0.00	50.00	0.00	
	1.32	0.00	0.00	4.35	0.00	
Total	76	3	2	23	2	106
	71.70	2.83	1.89	21.70	1.89	100.00

Percent Tool Types by Raw Material (phtanite excluded)  
Strata 2 and 3

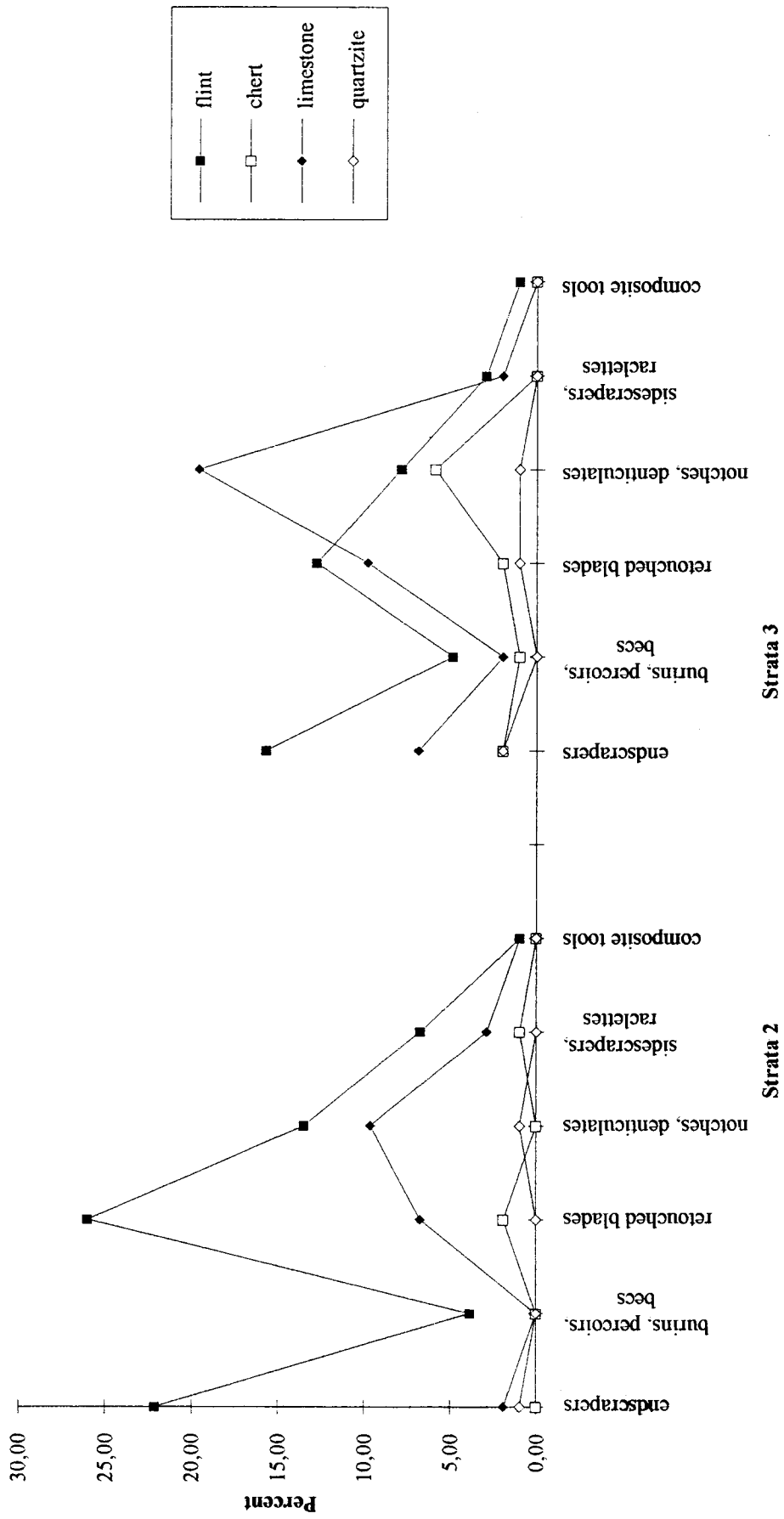


Figure 6.4

**Table 6.8.** Debitage Class\*Material Class: Stratum 2

TABLE 1 OF DEBCODE BY MATCODE  
CONTROLLING FOR STRATUM=2

DEBCODE(Grouped Debitage)	MATCODE(Grouped Material)					Total
Frequency	flint	chert	phtanite	limestne	quartzte	
Expected						
Deviation						
Percent						
Row Pct						
Col Pct						
trimming	948	12	3	85	5	1053
flakes	645.07	26.305	7.6891	346.21	27.721	
	302.93	-14.3	-4.689	-261.2	-22.72	
	18.22	0.23	0.06	1.63	0.10	20.23
	90.03	1.14	0.28	8.07	0.47	
	29.74	9.23	7.89	4.97	3.65	
shatter	587	12	0	53	1	653
	400.03	16.312	4.7683	214.7	17.191	
	186.97	-4.312	-4.768	-161.7	-16.19	
	11.28	0.23	0.00	1.02	0.02	12.55
	89.89	1.84	0.00	8.12	0.15	
	18.41	9.23	0.00	3.10	0.73	
flakes	1205	67	25	1201	94	2592
	1587.9	64.75	18.927	852.21	68.237	
	-382.9	2.2498	6.073	348.79	25.763	
	23.16	1.29	0.48	23.08	1.81	49.81
	46.49	2.58	0.96	46.33	3.63	
	37.80	51.54	65.79	70.19	68.61	
blade blanks	274	19	7	239	25	564
	345.51	14.089	4.1184	185.44	14.848	
	-71.51	4.9108	2.8816	53.565	10.152	
	5.27	0.37	0.13	4.59	0.48	10.84
	48.58	3.37	1.24	42.38	4.43	
	8.59	14.62	18.42	13.97	18.25	
burin spalls	5	1	0	0	0	6
	3.6756	0.1499	0.0438	1.9727	0.158	
	1.3244	0.8501	-0.044	-1.973	-0.158	
	0.10	0.02	0.00	0.00	0.00	0.12
	83.33	16.67	0.00	0.00	0.00	
	0.16	0.77	0.00	0.00	0.00	
cores	16	1	1	11	3	32
	19.603	0.7994	0.2337	10.521	0.8424	
	-3.603	0.2006	0.7663	0.4789	2.1576	
	0.31	0.02	0.02	0.21	0.06	0.61
	50.00	3.13	3.13	34.38	9.38	
	0.50	0.77	2.63	0.64	2.19	
chunks	153	18	2	122	9	304
	186.23	7.5942	2.2198	99.951	8.0031	
	-33.23	10.406	-0.22	22.049	0.9969	
	2.94	0.35	0.04	2.34	0.17	5.84
	50.33	5.92	0.66	40.13	2.96	
	4.80	13.85	5.26	7.13	6.57	
Total	3188	130	38	1711	137	5204
	61.26	2.50	0.73	32.88	2.63	100.00

Table 6.9. Debitage Class\*Material Class: Stratum 3

TABLE 2 OF DEBCODE BY MATCODE  
CONTROLLING FOR STRATUM=3

DEBCODE(Grouped Debitage)		MATCODE(Grouped Material)									
Frequency	Expected	Deviation	Percent	Row Pct	Col Pct	flint	chert	phtanite	limestne	quartzte	Total
trimming	340	6	2	210	7						565
flakes	202.25	24.659	3.6773	315.38	19.035						
	137.75	-18.66	-1.677	-105.4	-12.04						
	13.02	0.23	0.08	8.04	0.27						21.63
	60.18	1.06	0.35	37.17	1.24						
	36.36	5.26	11.76	14.40	7.95						
shatter	63	6	2	46	1						118
	42.24	5.1501	0.768	65.867	3.9755						
	20.76	0.8499	1.232	-19.87	-2.975						
	2.41	0.23	0.08	1.76	0.04						4.52
	53.39	5.08	1.69	38.98	0.85						
	6.74	5.26	11.76	3.16	1.14						
flakes	404	74	9	1015	68						1570
	562	68.522	10.218	876.36	52.894						
	-158	5.4778	-1.218	138.64	15.106						
	15.47	2.83	0.34	38.86	2.60						60.11
	25.73	4.71	0.57	64.65	4.33						
	43.21	64.91	52.94	69.62	77.27						
blade	94	7	1	107	6						215
blanks	76.962	9.3836	1.3993	120.01	7.2435						
	17.038	-2.384	-0.399	-13.01	-1.243						
	3.60	0.27	0.04	4.10	0.23						8.23
	43.72	3.26	0.47	49.77	2.79						
	10.05	6.14	5.88	7.34	6.82						
burin	1	0	0	1	0						2
spalls	0.7159	0.0873	0.013	1.1164	0.0674						
	0.2841	-0.087	-0.013	-0.116	-0.067						
	0.04	0.00	0.00	0.04	0.00						0.08
	50.00	0.00	0.00	50.00	0.00						
	0.11	0.00	0.00	0.07	0.00						
cores	1	5	0	3	1						10
	3.5796	0.4364	0.0651	5.5819	0.3369						
	-2.58	4.5636	-0.065	-2.582	0.6631						
	0.04	0.19	0.00	0.11	0.04						0.38
	10.00	50.00	0.00	30.00	10.00						
	0.11	4.39	0.00	0.21	1.14						
chunks	32	16	3	76	5						132
	47.251	5.7611	0.8591	73.681	4.4472						
	-15.25	10.239	2.1409	2.3185	0.5528						
	1.23	0.61	0.11	2.91	0.19						5.05
	24.24	12.12	2.27	57.58	3.79						
	3.42	14.04	17.65	5.21	5.68						
Total	935	114	17	1458	88						2612
	35.80	4.36	0.65	55.82	3.37						100.00

Table 6.10: Flake/Blade Blanks versus Tools: Stratum 2

----- STRATUM=2 -----

TABLE OF TOOLSM1 BY DEBCODE

TOOLSM1	DEBCODE(Grouped Debitage)			
Frequency				
Percent				
Row Pct				
Col Pct	flakes	blades	Total	
.	1025	353	1378	<- Blank sample
	69.26	23.85	93.11	
	74.38	25.62		
	92.93	93.63		
end-	21	5	26	<- Tool sample
scrapers	1.42	0.34	1.76	to end of table
	80.77	19.23		
	1.90	1.33		
burins,	4	0	4	
perçoirs,	0.27	0.00	0.27	
becks	100.00	0.00		
	0.36	0.00		
retouched	22	10	32	
blades	1.49	0.68	2.16	
	68.75	31.25		
	1.99	2.65		
notches,	19	6	25	
denti-	1.28	0.41	1.69	
culates	76.00	24.00		
	1.72	1.59		
side-	9	2	11	
scrapers	0.61	0.14	0.74	
	81.82	18.18		
	0.82	0.53		
composite	2	0	2	
tools	0.14	0.00	0.14	
	100.00	0.00		
	0.18	0.00		
diverse	1	1	2	
	0.07	0.07	0.14	
	50.00	50.00		
	0.09	0.27		
Total	1103	377	1480	
	74.53	25.47	100.00	

Percent Debitage Classes by Raw Material  
Strata 2 and 3

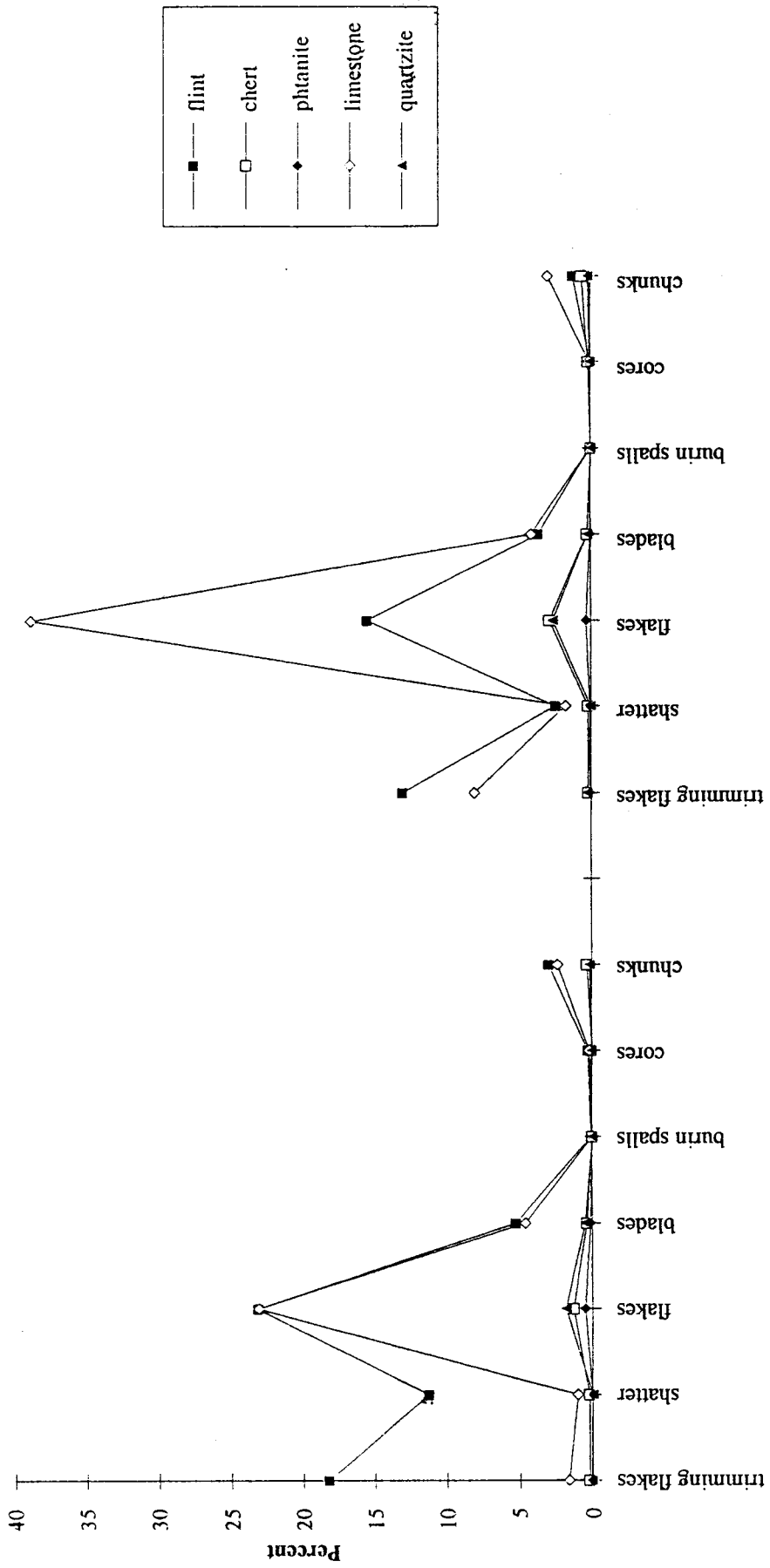


Figure 6.5

Percent Debitage Classes by Raw Material  
Strata 4 and 5

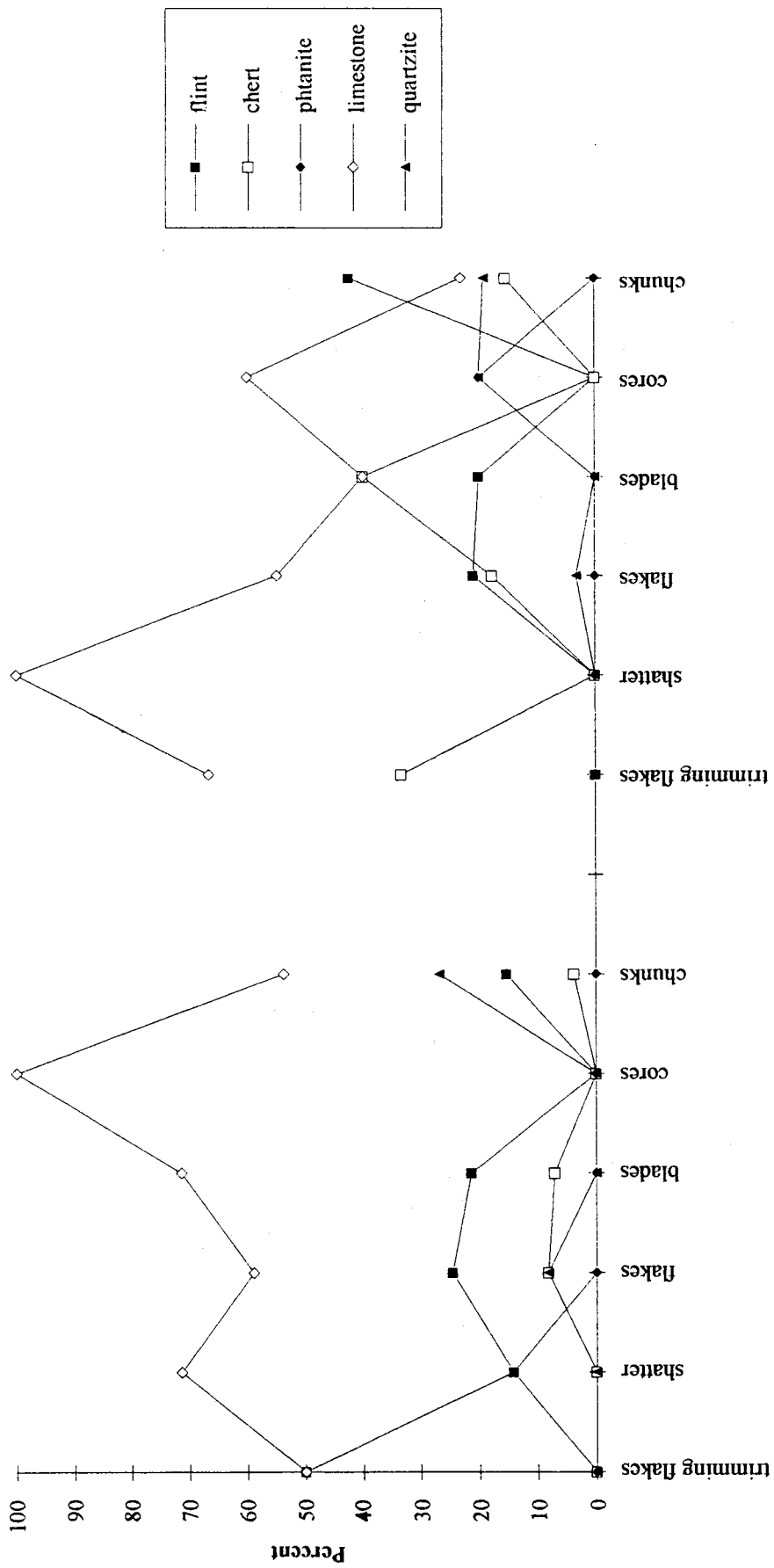


Figure 6.6

identification of limestone shatter which look like natural roof fall spall and which erode more than flint shatter. For chert, frequencies of trimming flakes are lower than expected and frequencies of chunks are higher than expected. For all other debitage classes, flint and limestone are similar and differ as a group from chert, phtanite, and quartzite.

**Stratum 3.** For Stratum 3 (Table 6.10), the p-value for the chi-square test is 0.000 (df=24, value=330.460, n=2612). The range of debitage types produced is again non-randomly distributed across raw material types. For flint, frequencies of trimming flakes, shatter, and blades are higher than expected and frequencies of flakes and chunks are lower than expected. For limestone, the frequency of flakes is higher than expected and frequencies of trimming flakes, shatter, and blades are lower than expected. For chert, the frequency of trimming flakes is lower than expected.

Figure 6.5 shows side-by-side frequency charts for Strata 2 and 3.

**Stratum 4.** For Stratum 4, the chi-square test was not performed due to small sample size. Qualitatively, the following is observed. For trimming flakes, 50% were produced on flint and 50% on limestone. For flakes, 58.9% were produced on limestone and 24.6% on flint. for blades, 71.4% were produced on limestone and 21.43% on flint.

**Stratum 5.** For Stratum 5, the p-value for the chi-square test is 0.000 (df=3, value=75.362, n=113). For trimming flakes, 66.7% were produced on limestone and 33.3% on chert. For flakes, 54.8% on limestone and 20.9% on chert. For blades, 40% on limestone, 40% on chert, and 20% on flint.

Figure 6.6 shows side-by-side frequency charts for Strata 4 and 5.

**Part 3 :** Comparison of size variables between tools made on flakes or blades and flake-blade debitage (types 3 and 4) (Table 6.11)

This section compares the size measurements (length, width, and thickness) between flake and blade blanks and tools made on flakes and blades for Strata 2 and 3 only. In Table 6.11, the frequency tables show the samples being compared. Tests of normality for each of these variables showed that none were normally distributed, and that log transformation was necessary. Two-sample t-tests (alpha = .05) between blanks and tools were performed for each variable, using piece-plotted artifacts, and the results are summarized below. A similar analysis was attempted to compare core tools with cores/chunks; however, the small sample size for core tools prevented reliable results from being obtained.

Strata 2 and 3 are similar for the logs of all three size variables, with the pattern in both strata that tools are significantly different from unretouched flake and blade blanks in  $\log(\text{length})$  and  $\log(\text{thickness})$  but similar in  $\log(\text{width})^2$ . For all variables and

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<sup>2</sup> While the results of t-tests on the original variables are given, the results are spurious because the assumption of normality is not met.

Table 6.11: Flake/Blade Blanks versus Tools: Stratum 2

----- STRATUM=2 -----

TABLE OF TOOLSM1 BY DEBCODE

TOOLSM1	DEBCODE(Grouped Debitage)			
Frequency				
Percent				
Row Pct				
Col Pct	flakes	blades	Total	
	1025	353	1378	<- Blank sample
	69.26	23.85	93.11	
	74.38	25.62		
	92.93	93.63		
end- scrapers	21	5	26	<- Tool sample to end of table
	1.42	0.34	1.76	
	80.77	19.23		
	1.90	1.33		
burins, perçoirs, beccs	4	0	4	
	0.27	0.00	0.27	
	100.00	0.00		
	0.36	0.00		
retouched blades	22	10	32	
	1.49	0.68	2.16	
	68.75	31.25		
	1.99	2.65		
notches, denti- culates	19	6	25	
	1.28	0.41	1.69	
	76.00	24.00		
	1.72	1.59		
side- scrapers	9	2	11	
	0.61	0.14	0.74	
	81.82	18.18		
	0.82	0.53		
composite tools	2	0	2	
	0.14	0.00	0.14	
	100.00	0.00		
	0.18	0.00		
diverse	1	1	2	
	0.07	0.07	0.14	
	50.00	50.00		
	0.09	0.27		
Total	1103	377	1480	
	74.53	25.47	100.00	

for both strata, tools are larger than flake and blade blanks. Thus, even accounting for possible reduction of tools in resharpening and use, tools are still larger than blanks. There seems to be selection by size of blanks for retouch into tools. The similarity between blanks and tools for width may be due to side edge retouching on tools. One hypothesis is that the original blanks selected for sidescrapers may have been selected for size, but edge resharpening would reduce the width of tools to be comparable to that of unretouched blanks.

TABLE 6.12

STRATUM 2

Variable	p-value	Results	Blanks vs. Tools
length	0.0615	Ho accepted	
width	0.2095	Ho accepted	
thickness	0.0389	Ho rejected	T>B
log (length)	0.0131	Ho rejected	T>B
log (width)	0.2836	Ho accepted	
log (thickness)	0.0041	Ho rejected	T>B

STRATUM 3

Variable	p-value	Results	Blanks vs. Tools
length	0.0004	Ho rejected	T>B
width	0.1796	Ho accepted	
thickness	0.0003	Ho rejected	T>B
log (length)	0.0001	Ho rejected	T>B
log (width)	0.3300	Ho accepted	
log (thickness)	0.0005	Ho rejected	T>B

When flake and blade blanks and tools made on flake and blade blanks are pooled (that is, pooling all artifacts of debitage types 3 and 4, whether they are tools or not) to compare size differences between strata, the following results are obtained. Strata 2 and 3 are significantly different with respect to log(width) and log(thickness) such that blanks and tools in Stratum 2 are wider and thicker. Even in variables where

the null hypothesis is accepted, the means of measurements of artifacts in Stratum 2 are slightly higher.

TABLE 6.13  
COMPARISON OF STRATA 2 AND 3 :

Variable	p-value	Results	2 versus 3
length	0.2536	Ho accepted	
width	0.0000	Ho rejected	2>3
thickness	0.0096	Ho rejected	2>3
log (length)	0.2363	Ho accepted	
log (width)	0.0000	Ho rejected	2>3
log (thickness)	0.0207	Ho rejected	2>3

**Part 4 :** Analysis of whole blades :

A series of analyses on whole blades were also performed in order to describe the similarities or differences in whole blades between Strata 2 and 3, examining the raw materials on which blades were produced, the overall size difference in blades between the two strata, and a comparison of the size of blades between raw material types. The data set was composed of all lithics with debitage type 4 (blades) and with portion equal to "W" (whole).

1) comparison of frequencies of raw materials producing blades between strata

Comparing Strata 2 and 3 (see Figure 6.5), the p-value for the chi-square test comparing between strata was 0.290 (df=3, value=3.749, n=82). Therefore, the null hypothesis is accepted that the two strata are not significantly different with respect to the distribution of blades across raw material types. The distribution of blades across raw material types is similar for both strata. There is an inverse relationship between flint and limestone that is not statistically significant.

2) comparison of size of whole blades

Two-sample t-tests were performed for each size variable to compare the two strata. There are no significant differences between the two strata for any size variable.

### 3) comparison of size of blades between raw material types

Two-way MANOVA analysis was performed to compare the log-transformed size measurements on whole blades to determine similarities or differences in size due to stratum or raw material. The results show that only log(length) and log(thickness) are significantly different among blades and that the differences are due only to raw material and not to differences between strata. Multiple comparisons using least-squares means additionally showed that the only differences are between flint and limestone. This likely reflects differences in original raw material size.

#### **Part 5:** Inter-strata comparison of cortical versus non-cortical flint debitage

This section compares cortical versus non-cortical flint between Strata 2 and 3. The p-value for the chi-square test is 0.021 (df=1, value=5.297, n=1392), indicating that the two strata are significantly different. Stratum 2 has more cortical flint debitage than expected while Stratum 3 has less.

#### **Part 6:** Variability of edge angles for endscrapers (Figures 6.7 and 6.8)

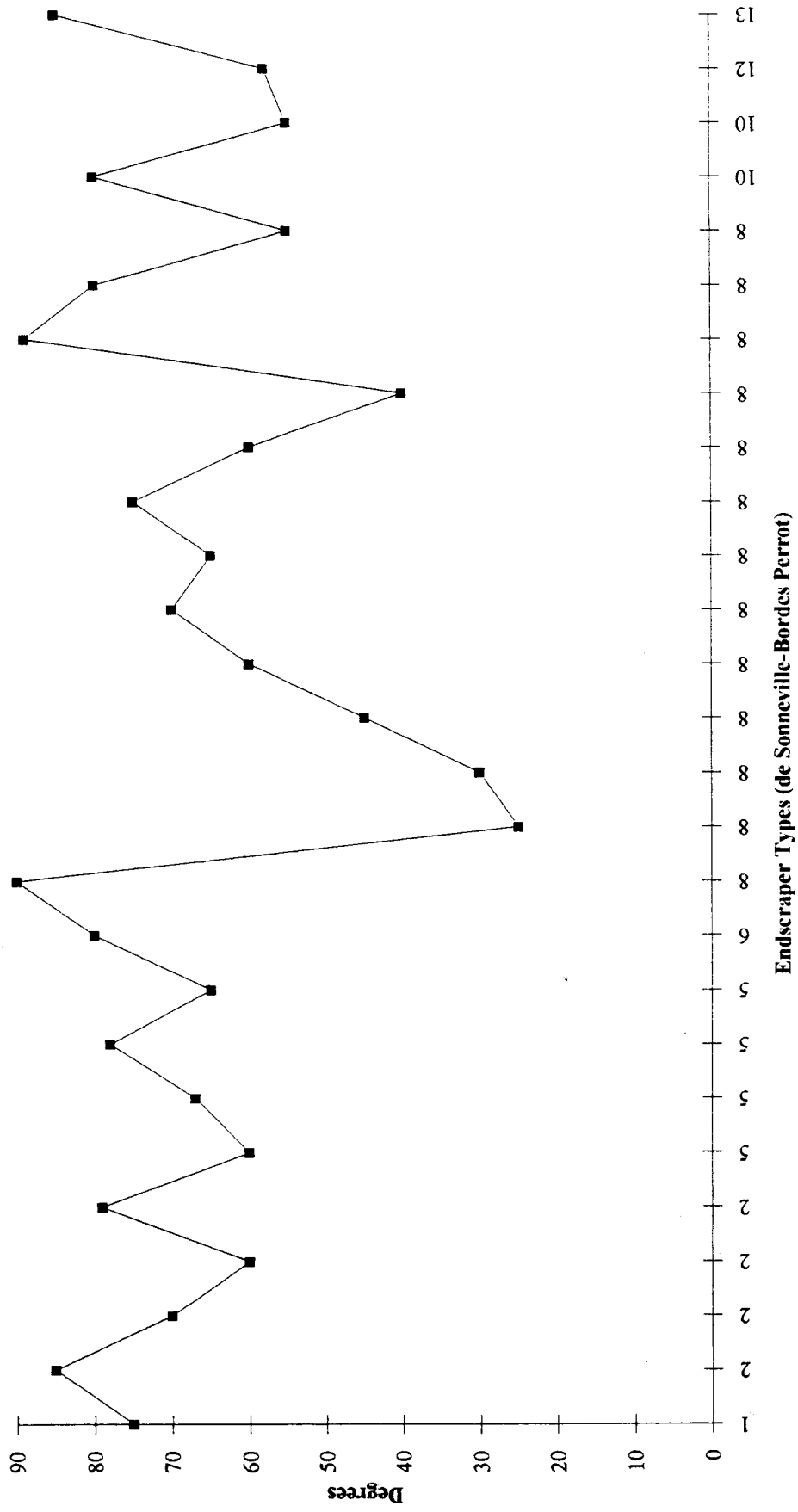
This section examines the edge angles of the retouched edge of endscrapers to determine if patterning exists. In order to determine if thickness affected edge angles, a regression analysis was performed. This resulted in a p-value of 0.0187 (alpha=.05), indicating that thickness was a predictor of edge angle. However, the  $R^2$  was only .1077, indicating that thickness only accounts for 10.77% of the variability in edge angle. Figures 6.7 and 6.8 show the edge angles for endscrapers from Strata 2 and 3. The samples are too small to produce statistically significant results. Qualitatively, however, type 8 endscrapers in Stratum 2 (n=13) show a range of variability from 25-90 degrees. Comparing Strata 2 and 3, the ranges seem to be similar.

## DISCUSSION

The comparisons of raw material frequency between strata show an increase in the use of flint from Stratum 5 to Stratum 2, with a substantial increase from Stratum 3 to Stratum 2. For limestone, there is an increase from Stratum 5 to Stratum 4, followed by a decrease to Stratum 2 and is most common in Strata 4 and 5. Quartzite is present in similar frequencies for Strata 4 and 5 and in similar frequencies for Strata 2 and 3 with a decrease from 4/5 to 2/3. Chert is most common in Stratum 5 with a decrease to similar frequencies for Strata 2-4. Phtanite is negligible in Strata 4 and 5 and in very low frequency in Strata 2 and 3.

These changes in frequency suggest an increased utilization of non-local raw material (flint) as opposed to locally available chert, limestone, and quartzite river cobbles. The Mousterian levels have higher frequencies of local raw material while non-local flint predominates the Aurignacian levels.

**Edge Angle for Endscraper  
Stratum 2**



**Figure 6.7**

Edge Angles for Endscrapers  
Stratum 3

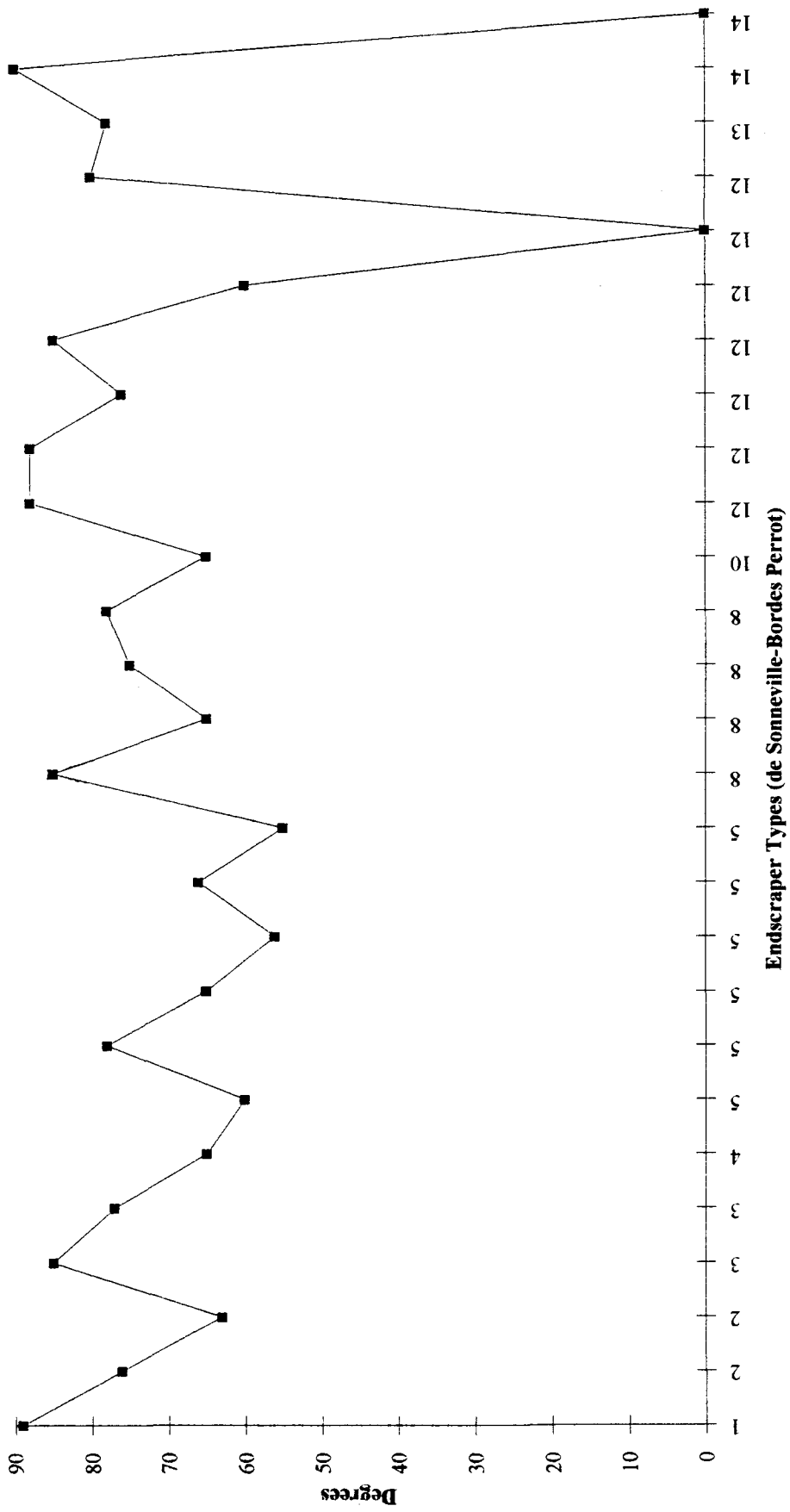


Figure 6.8

Comparison of the tool classes for Strata 2 and 3 show that they are not significantly different. However, there is an inverse relationship between blades and notches/denticulates and of the other tool classes, endscrapers are most common.

Comparison of the debitage classes between strata show that flakes have the highest frequency for all four strata and they are not substantially different. The frequency of blades does not increase in time and remains low in relation to flakes. Trimming flakes show some increase from Stratum 5 to Stratum 2. Cores and chunks are most common in Strata 4 and 5 and decrease in Strata 2 and 3. The relative frequencies of trimming flakes/shatter versus cores/chunks indicate that core reduction and blank production may have occurred at the site for Strata 4 and 5 while tool production from cores or blanks prepared elsewhere occurred at the site for Strata 2 and 3.

Flint is the raw material of choice for all tool classes in Stratum 2 and predominates in Stratum 3 except for notches and denticulates which are made in highest frequency on limestone. Limestone is the second most common raw material for all tool classes in both Strata 2 and 3.

Flint and limestone are again most common across all debitage classes in Strata 2 and 3 with a much higher frequency of limestone flakes in Stratum 3. For Strata 4 and 5, limestone is the raw material of choice across all debitage classes, and in much lower frequency, flint and chert are utilized. The primary shift from Strata 4 and 5 to Strata 2 and 3 is a decrease in limestone and an increase in flint, although both continue to be the two highest.

The comparison between flake/blade blanks and tools made on flakes and blades shows that tools are thicker and longer than blanks in Strata 2 and 3. This indicates that there is selection by size of removals for retouch into tools. Thus, even with resharpening of endscrapers (which are predominant in Strata 2 and 3), tool length is still longer than blank length. When flake/blade blanks and tools are pooled, those of Stratum 2 are wider and thicker than those of Stratum 3.

Comparison of frequencies of whole blades between Strata 2 and 3 shows that they are not significantly different and that they are not produced differentially on raw materials. A two-way MANOVA on the size measurements with both stratum and material class as factors showed that differences in  $\log(\text{length})$  and  $\log(\text{thickness})$  were due only to differences in material. However, the differences in material are only between flint and limestone which have the highest frequency in both strata. These differences are also very slight and may not be behaviorally significant.

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