10.1.7 Analysis of Delaware Site Archaeological Data by Durland Shumway

PENNSTATE

Tel: (814) 863-0281
Fax: (814) 863-7114

Statistical Consulting Center
Department of Statistics
Eberly College of Science

The Pennsylvania State University
323 Thomas Building
University Park, Pa 16802

January 24, 2012

Archeological & Historical Consultants, Inc
101 North Pennsylvania Ave
PO Box 482
Centre Hall, PA 16828

Re: Analsyis of Delaware Site Archeological Data (SCC# 10-3-004).

Dear Melissa,

It was a pleasure to work on your project for the Delaware site study. We focused our analysis on exploring patterns of association for microtools and grooved abraders, along with diagnostic artifacts, other (non-diagnostic) artifacts such as scrapers, and lithic materials.

Measures of association are reasonably straight-forward for data that consists of continuous variables, and comparable methods can be used for strictly categorical variables. The major challenge for your study data was that the distribution of microtools and grooved abraders was clearly non-normal and consisted of an 'overabundance' of 0 entries (Figures 1 and 2).

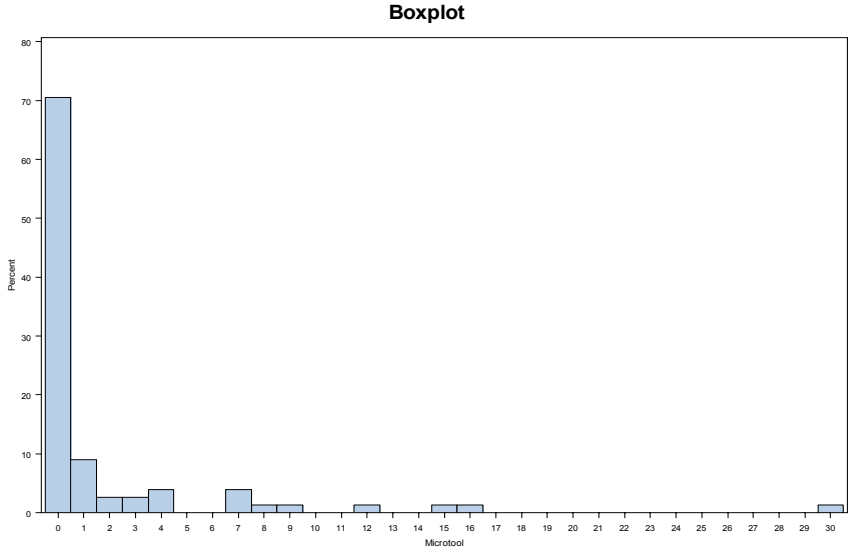


Figure 1 Data Distribution of Microtools

Note the very large proportion of '0' values. This over-abundance of 0 occurrences across the features is even more pronounced for the grooved abraders (below).

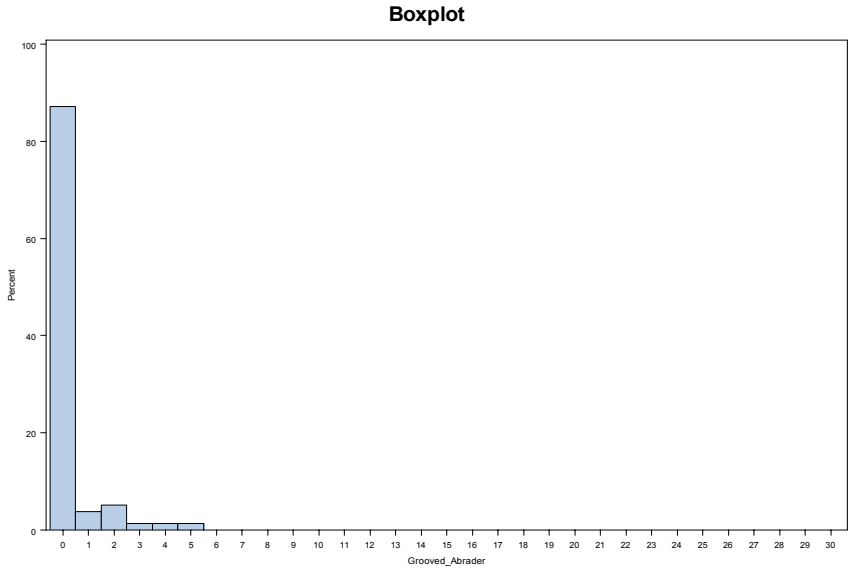


Figure 2 Data Distribution of Grooved Abraders

In both cases, the data is very left-skewed and dominated by the presence of zero values. As a result, the data are not amenable for normal methods for assessing the degree of association and relationships with other variables. We explored some options to transform the data (e.g. a logarithmic transformation), but these were not satisfactory. In the end, we used a strategy which first divided the data by presence/absence of microtools or grooved abraders. This binary dataset enabled categorical hypothesis tests of independence and association. Following that, we employed methods for continuous data (e.g. correlation and regression) using the data for which microtools or grooved abraders were present.

The details of our strategy was as follows: First we evaluate the entire dataset, that is, over all features. We create a 'binary' dataset with new variables based on the presence / absence of microtools, grooved abraders, and other artifact types found in the study. This enables us to evaluate the likelihood of occurrence of each of these types of artifacts with other artifact occurrence. Some of the other artifacts are 'diagnostic' and have the potential to reveal patterns related to occupation periods. These tests consist of constructing contingency tables and testing for independence using a Chi-Square analysis. In many cases, however, there were too few observations for a valid Chi-Square test of independence and Fisher's Exact test was used instead.

Secondly, we evaluate the probability of finding a microtool or grooved abrader given the presence or absence of other diagnostic artifacts. This was accomplished by fitting logistic regression models. A logistic regression model was also used to evaluate the likelihood of finding a microtool or grooved abrader with increasing amounts of various rock types (continuous variables).

We then looked at diagnostic artifacts by feature type to see if patterns existed. We then used the subset data for which microtools or grooved abrader were present - only involving 28 features - and explored associations within this data subset. We also condensed the diagnostic artifacts

into four 'periods' and evaluated the co-occurrence of microtools and grooved abraders within these periods.

We then turned attention to artifact densities, calculated by the artifact counts divided by the volume of excavated material at that feature. Artifact densities then form continuous variables and enabled us to use multiple linear regression to determine what were the best predictors of microtool and grooved abrader densities.

Finally, we evaluated the spatial distribution of each of these artifacts using a statistical measure of spatial autocorrelation, Moran's I statistic.

Results

Categorical Section 1: Presence/Absence Data, Contingency Tables
A. Microtools

The FREQ Procedure

Table of Microtools by Grooved Abraders			
Microtools	**Grooved Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	53 96.36	2 3.64	55
Present	15 65.22	8 34.78	23
Total	68	10	78

Statistics for Table of Microtools by Grooved Abraders

The contingency table above shows count data for the 78 features in the study, simultaneously categorized by the presence or absence of two categorical variables. We test the Null hypothesis that the frequencies of occurrence in the categories of one of the variable are independent of the frequencies of occurrence in the categories of the other variable. The test statistic for this Null hypothesis is the Chi-square, but use of the Chi-square requires minimum cell sizes of 5. When cell sizes are less than 5, Fisher's exact test is recommended and we will use it here.

Fisher's Exact Test	
Two-sided Pr <= P	6.153E-04

Sample Size = 78

The p-value for Fishers test is 0.0006 and because this value is less than 0.05, we reject the Null hypothesis. From this process we conclude that the frequency of occurrence of grooved abraders is not independent of the occurrence of microtools, and in features where microtools are found, there is a greater likelihood of finding grooved abraders. To express this increase in likelihood,

we turn to a logistic regression, a related method that expresses the conditional likelihood as an odds ratio.

The LOGISTIC Procedure

Response Profile		
Ordered Value	**Grooved Abraders**	**Total Frequency**
1	Present	10
2	Absent	68

Probability modeled is Grooved Abraders='Present'.

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-3.2771	0.7203	20.6984	<.0001
Microtools	1	2.6485	0.8429	9.8725	0.0017

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
Microtools	14.133	2.709	73.746

From this we see that you are 14.133 times more likely to find a grooved abraders at a feature when Late Archaic points are present at that feature. To verify the statistical significance of this increase in likelihood, for comparison a value of 1.0 for the odds ratio indicates 'equal likelihood'. We can see that the 95% Confidence Interval for the odd ratio estimate of 14.133 is 2.7-9 – 73.746, and does <u>not</u> contain the value of 1.0. Therefore, we are confirming that this result is statistically significant at the 0.05 level.

The same analysis was run for each of the other artifacts and lithics (results shown below). In cases where the contingency table (Fishers Exact test) was significant, a logistic regression was used to report the odds ratio.

Over All Features

The FREQ Procedure

Table of LA Points by Microtools			
LA Points	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	51 79.69	13 20.31	64
Present	4 28.57	10 71.43	14
Total	55	23	78

Statistics for Table of LA Points by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	4.178E-04

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	**Microtools**	**Total Frequency**
1	Present	23
2	Absent	55

Probability modeled is Microtools='Present'.

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
LA Points	9.807	2.647	36.337

Over All Features

The FREQ Procedure

Table of LA-MW Points by Microtools			
LA-MW Points	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	54 72.00	21 28.00	75
Present	1 33.33	2 66.67	3
Total	55	23	78

Statistics for Table of LA-MW Points by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.2062

Sample Size = 78

Over All Features

The FREQ Procedure

Table of EW Ceramics by Microtools			
EW Ceramics	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	48 68.57	22 31.43	70
Present	7 87.50	1 12.50	8
Total	55	23	78

Statistics for Table of EW Ceramics by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.4244

Sample Size = 78

Over All Features

The FREQ Procedure

Table of MW Ceramics by Microtools			
MW Ceramics	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	54 71.05	22 28.95	76
Present	1 50.00	1 50.00	2
Total	55	23	78

Statistics for Table of MW_Ceramics by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.5055

Sample Size = 78

Over All Features

The FREQ Procedure

Table of LW_Ceramics by Microtools			
LW_Ceramics	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	49 69.01	22 30.99	71
Present	6 85.71	1 14.29	7
Total	55	23	78

Statistics for Table of LW_Ceramics by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.6669

Sample Size = 78

Over All Features

The FREQ Procedure

Table of Scrapers by Microtools			
Scrapers	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	53 73.61	19 26.39	72
Present	2 33.33	4 66.67	6
Total	55	23	78

Statistics for Table of Scrapers by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.0588

Sample Size = 78

Over All Features

The FREQ Procedure

Table of Hammers by Microtools			
Hammers	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	48 73.85	17 26.15	65
Present	7 53.85	6 46.15	13
Total	55	23	78

Statistics for Table of Hammers by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.1866

Sample Size = 78

Over All Features

The FREQ Procedure

Table of jaspers by Microtools			
jaspers	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	8 88.89	1 11.11	9
Present	47 68.12	22 31.88	69
Total	55	23	78

Statistics for Table of jaspers by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.2680

Sample Size = 78

Over All Features

The FREQ Procedure

Table of all cherts by Microtools			
All cherts	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
0	18 100.00	**0** **0.00**	18
1	37 61.67	23 38.33	60
Total	55	23	78

Statistics for Table of all cherts by Microtools

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

Over All Features

The FREQ Procedure

Table of quartzes by Microtools			
quartzes	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	17 100.00	**0** **0.00**	17
Present	38 62.30	23 37.70	61
Total	55	23	78

Statistics for Table of quartzes by Microtools

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

Over All Features

The FREQ Procedure

Table of quartzites by Microtools			
quartzites	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	28 90.32	3 9.68	31
Present	27 57.45	20 42.55	47
Total	55	23	78

Statistics for Table of quartzites by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.0021

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	**Microtools**	**Total Frequency**
1	Present	23
2	Absent	55

Probability modeled is Microtools='Present'.

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
quartzites	6.914	1.840	25.975

Over All Features

The FREQ Procedure

Table of rhyolites by Microtools			
rhyolites	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	49 76.56	15 23.44	64
Present	6 42.86	8 57.14	14
Total	55	23	78

Statistics for Table of rhyolites by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.0213

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	**Microtools**	**Total Frequency**
1	Present	23
2	Absent	55

Probability modeled is Microtools='Present'.

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
rhyolites	4.356	1.304	14.551

Over All Features

The FREQ Procedure

Table of argillites by Microtools			
argillites	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	39 86.67	6 13.33	45
Present	16 48.48	17 51.52	33
Total	55	23	78

Statistics for Table of argillites by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	3.778E-04

Sample Size = 78
The LOGISTIC Procedure

Response Profile		
Ordered Value	**Microtools**	**Total Frequency**
1	Present	23
2	Absent	55

Probability modeled is Microtools='Present'.

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
argillites	6.906	2.304	20.696

Over All Features

The FREQ Procedure

Table of Steatites by Microtools			
Steatites	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	53 71.62	21 28.38	74
Present	2 50.00	2 50.00	4
Total	55	23	78

Statistics for Table of Steatites by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.5770

Sample Size = 78

Over All Features

The FREQ Procedure

Table of Hematites by Microtools			
Hematites	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	35 87.50	5 12.50	40
Present	20 52.63	18 47.37	38
Total	55	23	78

Statistics for Table of Hematites by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.0011

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	Microtools	Total Frequency
1	Present	23
2	Absent	55

Probability modeled is Microtools='Present'.

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Hematites	6.299	2.029	19.555

Over All Features

The FREQ Procedure

Table of tases by Microtools			
tases	Microtools		
Frequency Row Pct	Absent	Present	Total
Absent	5 83.33	1 16.67	6
Present	50 69.44	22 30.56	72
Total	55	23	78

Statistics for Table of tases by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	0.6641

Sample Size = 78

Over All Features

The FREQ Procedure

Table of util_flakes by Microtools			
util_flakes	**Microtools**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	48 82.76	10 17.24	58
Present	7 35.00	13 65.00	20
Total	55	23	78

Statistics for Table of util_flakes by Microtools

Fisher's Exact Test	
Two-sided Pr <= P	1.301E-04

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	**Microtools**	**Total Frequency**
1	Present	23
2	Absent	55

Probability modeled is Microtools='Present'.

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
util_flakes	8.914	2.840	27.981

B) Grooved_Abraders

The FREQ Procedure

Table of LA_Points by Grooved_Abraders			
LA_Points	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	59 92.19	5 7.81	64
Present	9 64.29	5 35.71	14
Total	68	10	78

Statistics for Table of LA_Points by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.0138

Sample Size = 78
The LOGISTIC Procedure

Response Profile		
Ordered Value	**Grooved_Abraders**	**Total Frequency**
1	Present	10
2	Absent	68

Probability modeled is Grooved_Abraders='Present'.

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
LA_Points	6.556	1.578	27.237

The FREQ Procedure

Table of LA_MW_Points by Grooved_Abraders			
LA_MW_Points	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	66 88.00	9 12.00	75
Present	2 66.67	1 33.33	3
Total	68	10	78

Statistics for Table of LA_MW_Points by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.3412

Sample Size = 78

The FREQ Procedure

Table of EW_Ceramics by Grooved_Abraders			
EW_Ceramics	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	60 85.71	10 14.29	70
Present	8 100.00	**0** **0.00**	8
Total	68	10	78

Statistics for Table of EW_Ceramics by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.5865

Sample Size = 78

The FREQ Procedure

Table of MW_Ceramics by Grooved_Abraders			
MW_Ceramics	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	66 86.84	10 13.16	76
Present	2 100.00	**0** **0.00**	2
Total	68	10	78

Statistics for Table of MW_Ceramics by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	1.0000

Sample Size = 78

The FREQ Procedure

Table of LW_Ceramics by Grooved_Abraders			
LW_Ceramics	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	63 88.73	8 11.27	71
Present	5 71.43	2 28.57	7
Total	68	10	78

Statistics for Table of LW_Ceramics by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.2188

Sample Size = 78

The FREQ Procedure

Table of Scrapers by Grooved_Abraders			
Scrapers	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	63 87.50	9 12.50	72
Present	5 83.33	1 16.67	6
Total	68	10	78

Statistics for Table of Scrapers by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.5739

Sample Size = 78

The FREQ Procedure

Table of Hammers by Grooved_Abraders			
Hammers	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	59 90.77	6 9.23	65
Present	9 69.23	4 30.77	13
Total	68	10	78

Statistics for Table of Hammers by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.0564

Sample Size = 78

The FREQ Procedure

Table of jaspers by Grooved_Abraders			
jaspers	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	9 100.00	**0** **0.00**	9
Present	59 85.51	10 14.49	69
Total	68	10	78

Statistics for Table of jaspers by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.5947

Sample Size = 78

The FREQ Procedure

Table of all_cherts by Grooved_Abraders			
all_cherts	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
0	18 100.00	**0** **0.00**	18
1	50 83.33	10 16.67	60
Total	68	10	78

Statistics for Table of all_cherts by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.1052

Sample Size = 78

The FREQ Procedure

Table of quartzes by Grooved_Abraders			
quartzes	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	17 100.00	**0** **0.00**	17
Present	51 83.61	10 16.39	61
Total	68	10	78

Statistics for Table of quartzes by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.1066

Sample Size = 78

The FREQ Procedure

Table of quartzites by Grooved_Abraders			
quartzites	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	31 100.00	**0** **0.00**	31
Present	37 78.72	10 21.28	47
Total	68	10	78

Statistics for Table of quartzites by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.0049

Sample Size = 78

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

The FREQ Procedure

Table of Rhyolites by Grooved Abraders			
Rhyolites	**Grooved Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	57 89.06	7 10.94	64
Present	11 78.57	3 21.43	14
Total	68	10	78

Statistics for Table of Rhyolites by Grooved Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.3735

Sample Size = 78

The FREQ Procedure

Table of argillites by Grooved_Abraders			
argillites	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	44 97.78	1 2.22	45
Present	24 72.73	9 27.27	33
Total	68	10	78

Statistics for Table of argillites by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.0015

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	Grooved_Abraders	Total Frequency
1	Present	10
2	Absent	68

Probability modeled is Grooved_Abraders='Present'.

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
argillites	16.500	1.971	138.154

The FREQ Procedure

Table of Steatites by Grooved_Abraders			
Steatites	Grooved_Abraders		
Frequency Row Pct	Absent	Present	Total
Absent	65 87.84	9 12.16	74
Present	3 75.00	1 25.00	4
Total	68	10	78

Statistics for Table of Steatites by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.4291

Sample Size = 78

The FREQ Procedure

Table of Hematites by Grooved_Abraders			
Hematites	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	40 100.00	**0** **0.00**	40
Present	28 73.68	10 26.32	38
Total	68	10	78

Statistics for Table of Hematites by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	3.757E-04

Sample Size = 78

The LOGISTIC Procedure
WARNING: The validity of the model fit is questionable.

The FREQ Procedure

Table of tases by Grooved_Abraders			
tases	**Grooved_Abraders**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	5 83.33	1 16.67	6
Present	63 87.50	9 12.50	72
Total	68	10	78

Statistics for Table of tases by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.5739

Sample Size = 78

The FREQ Procedure

Table of util_flakes by Grooved_Abraders			
util_flakes	Grooved_Abraders		
Frequency Row Pct	Absent	Present	Total
Absent	55 94.83	3 5.17	58
Present	13 65.00	7 35.00	20
Total	68	10	78

Statistics for Table of util_flakes by Grooved_Abraders

Fisher's Exact Test	
Two-sided Pr <= P	0.0021

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	Grooved_Abraders	Total Frequency
1	Present	10
2	Absent	68

Probability modeled is Grooved_Abraders='Present'.

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
util_flakes	9.872	2.244	43.428

C) Other Tables, based on List of Questions 12/1/2011

The FREQ Procedure

Table of EW_Ceramics by LA_Points			
EW_Ceramics	**LA_Points**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	57 81.43	13 18.57	70
Present	7 87.50	1 12.50	8
Total	64	14	78

Statistics for Table of EW_Ceramics by LA_Points

Fisher's Exact Test	
Two-sided Pr <= P	1.0000

Sample Size = 78

The FREQ Procedure

Table of EW_Ceramics by rhyolites			
EW_Ceramics	**rhyolites**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	58 82.86	12 17.14	70
Present	6 75.00	2 25.00	8
Total	64	14	78

Statistics for Table of EW_Ceramics by rhyolites

Fisher's Exact Test	
Two-sided Pr <= P	0.6291

Sample Size = 78

Other Tables, based on List of Questions 12/1

The FREQ Procedure

Table of EW_Ceramics by argillites			
EW_Ceramics	**argillites**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	41 58.57	29 41.43	70
Present	4 50.00	4 50.00	8
Total	45	33	78

Statistics for Table of EW_Ceramics by argillites

Fisher's Exact Test	
Two-sided Pr <= P	0.7157

Sample Size = 78

Other Tables, based on List of Questions 12/1

The FREQ Procedure

Table of EW_Ceramics by Steatites			
EW_Ceramics	**Steatites**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	66 94.29	4 5.71	70
Present	8 100.00	0 0.00	8
Total	74	4	78

Statistics for Table of EW_Ceramics by Steatites

Fisher's Exact Test	
Two-sided Pr <= P	1.0000

Sample Size = 78

Other Tables, based on List of Questions 12/1

The FREQ Procedure

Table of Steatites by Rhyolites			
Steatites	**Rhyolites**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	61 82.43	13 17.57	74
Present	3 75.00	1 25.00	4
Total	64	14	78

Statistics for Table of Steatites by Rhyolites

Fisher's Exact Test	
Two-sided Pr <= P	0.5546

Sample Size = 78

The FREQ Procedure

Table of argillites by rhyolites			
argillites	**rhyolites**		
Frequency Row Pct	**Absent**	**Present**	**Total**
Absent	42 93.33	3 6.67	45
Present	22 66.67	11 33.33	33
Total	64	14	78

Statistics for Table of argillites by rhyolites

Fisher's Exact Test	
Two-sided Pr <= P	**0.0056**

Sample Size = 78

The LOGISTIC Procedure

Response Profile		
Ordered Value	**rhyolites**	**Total Frequency**
1	Present	14
2	Absent	64

Probability modeled is rhyolites='Present'.

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
argillites	7.000	1.767	27.737

Categorical Section 2: Diagnostic Groups

The FREQ Procedure

Table 3 of Microtools by Grooved_Abraders			
Controlling for diagnostic_group=LA_points only			
Microtools	**Grooved_Abraders**		
Frequency Col Pct	**Absent**	**Present**	**Total**
Absent	2 33.33	**0** **0.00**	2
Present	4 66.67	4 100.00	8
Total	6	4	10

Fisher's Exact Test	
Two-sided Pr <= P	0.4667

Sample Size = 10

The FREQ Procedure

Table 2 of Microtools by Grooved_Abraders			
Controlling for diagnostic_group=EW or MW Ceramics or LA_MW_points			
Microtools	**Grooved_Abraders**		
Frequency Col Pct	**Absent**	**Present**	**Total**
Absent	7 70.00	**0** **0.00**	7
Present	3 30.00	1 100.00	4
Total	10	1	11

Statistics for Table 2 of Microtools by Grooved_Abraders
Controlling for diagnostic_group=EW or MW Ceramics or LA_MW_points

Fisher's Exact Test	
Two-sided Pr <= P	0.3636

Sample Size = 11

The FREQ Procedure

Table 1 of Microtools by Grooved Abraders			
Controlling for diagnostic group=LW Ceramics only			
Microtools	**Grooved Abraders**		
Frequency Col Pct	**Absent**	**Present**	**Total**
Absent	5 100.00	1 50.00	6
Present	**0** **0.00**	1 50.00	1
Total	5	2	7

Statistics for Table 1 of Microtools by Grooved Abraders
Controlling for diagnostic group=LW Ceramics only

Fisher's Exact Test	
Two-sided Pr <= P	0.2857

Sample Size = 7

Feature Types and Diagnostic Groups

Data: Only Features with Diagnostics Present

The FREQ Procedure

Table of Feature_Type by diagnostic_group				
Feature_Type	**diagnostic_group**			
Frequency Col Pct	**LW Ceramics only**	**EW or MW Ceramics or LA_MW_points**	**LA_points only**	**Total**
AIA	1 14.29	2 18.18	1 10.00	4
CYL	1 14.29	0 0.00	3 30.00	4
BASIN	2 28.57	4 36.36	1 10.00	7
TAS	0 0.00	2 18.18	0 0.00	2
PIT	3 42.86	3 27.27	5 50.00	11
Total	7	11	10	28

Co-occurrence – Only looking at features in which both Microtools and Grooved_abraders are present.

The FREQ Procedure

Table 1 of Feature_Type by diagnostic_group				
Controlling for co_occur=no				
Feature_Type	**diagnostic_group**			
Frequency Col Pct	**LW Ceramics only**	**EW or MW Ceramics or LA_MW_points**	**LA_points only**	**Total**
AIA	1 16.67	2 20.00	1 16.67	4
CYL	1 16.67	0 0.00	2 33.33	3
BASIN	2 33.33	4 40.00	0 0.00	6
TAS	0 0.00	2 20.00	0 0.00	2
PIT	2 33.33	2 20.00	3 50.00	7
Total	6	10	6	22

Table 2 of Feature_Type by diagnostic_group				
Controlling for co_occur=yes				
Feature_Type	**diagnostic_group**			
Frequency Col Pct	**LW Ceramics only**	**EW or MW Ceramics or LA_MW_points**	**LA_points only**	**Total**
AIA	0 0.00	0 0.00	0 0.00	0
CYL	0 0.00	0 0.00	1 25.00	1
BASIN	0 0.00	0 0.00	1 25.00	1
TAS	0 0.00	0 0.00	0 0.00	0
PIT	1 100.00	1 100.00	2 50.00	4
Total	1	1	4	6

Continuous Variable Section

Correlations among densities.
Here only features with presence of microtools or grooved abraders are considered. The top number in each cell is the correlation coefficient (can be either positively or negatively correlated), and the bottom number is the p-value for the test of significance for the correlation coefficient. Significant correlations are in **Bold**.

Non-Zero Microtool Features

Pearson Correlation Coefficients, N = 23
Prob > |r| under H0: Rho=0

	LA Point	LA-MW Point	EW Ceramic	MW Ceramic	LW Ceramic	Jasper	Rhyolite	Argillite	Quartz	Quartzite	All Chert	Microtool	Grooved Abrader	Scraper	Hammer-stone	Steatite	Hematite	FCR
LA Point	1	0.31573	-0.13595	0.12386	-0.13595	0.25463	-0.10122	**0.3867**	0.17655	0.22151	0.33029	0.15957	0.27971	0.07337	-0.067	0.15752	0.39918	**0.56823**
		0.1422	0.5362	0.5734	0.5362	0.241	0.6458	**0.0683**	0.4203	0.3097	0.1237	0.4671	0.1961	0.7394	0.7613	0.4729	0.0592	**0.0047**
LA-MW Point	0.31573	1	-0.05906	-0.05906	-0.05906	-0.11301	-0.01199	**0.66673**	-0.06395	0.09681	-0.11117	-0.11767	-0.01415	0.14774	-0.05041	-0.08548	-0.03468	-0.05889
	0.1422		0.789	0.789	0.789	0.6077	0.9567	**0.0005**	0.7719	0.6604	0.6136	0.5928	0.9489	0.5011	0.8193	0.6982	0.8752	0.7895
EW Ceramic	-0.13595	-0.05906	1	-0.04545	-0.04545	-0.17158	0.04296	0.09928	-0.12734	-0.22206	-0.14371	-0.22791	-0.13179	-0.0916	-0.10723	-0.06579	-0.15377	-0.11164
	0.5362	0.789		0.8368	0.8368	0.4337	0.8457	0.6522	0.5626	0.3085	0.513	0.2956	0.5489	0.6776	0.6263	0.7655	0.4836	0.6121
MW Ceramic	0.12386	-0.05906	-0.04545	1	-0.04545	0.00436	0.01901	-0.13046	0.02832	0.05022	-0.02873	-0.23741	-0.13179	-0.0916	-0.10723	-0.06579	-0.11299	-0.19583
	0.5734	0.789	0.8368		0.8368	0.9842	0.9314	0.553	0.8979	0.82	0.8965	0.2754	0.5489	0.6776	0.6263	0.7655	0.6077	0.3705
LW Ceramic	-0.13595	-0.05906	-0.04545	-0.04545	1	-0.10647	-0.07082	-0.14206	-0.09669	-0.17703	-0.13276	-0.18603	0.18347	-0.0916	-0.10723	-0.06579	-0.10341	-0.0948
	0.5362	0.789	0.8368	0.8368		0.6287	0.7481	0.5179	0.6608	0.4191	0.5459	0.3954	0.402	0.6776	0.6263	0.7655	0.6387	0.667
Jasper	0.25463	-0.11301	-0.17158	0.00436	-0.10647	1	0.14815	0.21227	**0.928**	**0.83953**	**0.89029**	**0.72031**	**0.52781**	-0.03046	**0.6738**	0.11612	**0.71272**	**0.7874**
	0.241	0.6077	0.4337	0.9842	0.6287		0.4999	0.3309	**<.0001**	**<.0001**	**<.0001**	**0.0001**	**0.0096**	0.8903	**0.0004**	0.5978	**0.0001**	**<.0001**
Rhyolite	-0.10122	-0.01199	0.04296	0.01901	-0.07082	0.14815	1	0.30517	-0.04025	0.21107	0.08503	**0.44692**	-0.14189	-0.14272	-0.0745	0.02024	-0.09883	0.11574
	0.6458	0.9567	0.8457	0.9314	0.7481	0.4999		0.1568	0.8553	0.3337	0.6997	**0.0325**	0.5184	0.5159	0.7355	0.927	0.6537	0.599
Argillite	0.3867	**0.66673**	0.09928	-0.13046	-0.14206	0.21227	0.30517	1	0.163	0.34002	0.23818	0.2885	0.09322	-0.10292	0.02722	0.00973	0.17496	0.3485
	0.0683	**0.0005**	0.6522	0.553	0.5179	0.3309	0.1568		0.4574	0.1124	0.2738	0.1819	0.6722	0.6403	0.9019	0.9648	0.4246	0.1032
Quartz	0.17655	-0.06395	-0.12734	0.02832	-0.09669	**0.928**	-0.04025	0.163	1	**0.77875**	**0.81229**	**0.58899**	0.41112	-0.14082	**0.81076**	0.11696	**0.71497**	**0.64791**
	0.4203	0.7719	0.5626	0.8979	0.6608	**<.0001**	0.8553	0.4574		**<.0001**	**<.0001**	**0.0031**	0.0513	0.5216	**<.0001**	0.5951	**0.0001**	**0.0008**
Quartzite	0.22151	0.09681	-0.22206	0.05022	-0.17703	**0.83953**	0.21107	0.34002	**0.77875**	1	**0.86908**	**0.53474**	**0.4902**	-0.13323	**0.54454**	0.22958	**0.76492**	**0.61875**
	0.3097	0.6604	0.3085	0.82	0.4191	**<.0001**	0.3337	0.1124	**<.0001**		**<.0001**	**0.0086**	**0.0176**	0.5445	**0.0072**	0.292	**<.0001**	**0.0016**
All Chert	0.33029	-0.11117	-0.14371	-0.02873	-0.13276	**0.89029**	0.08503	0.23818	**0.81229**	**0.86908**	1	**0.60091**	**0.60075**	0.00535	**0.62898**	**0.43326**	**0.78445**	**0.82098**
	0.1237	0.6136	0.513	0.8965	0.5459	**<.0001**	0.6997	0.2738	**<.0001**	**<.0001**		**0.0024**	**0.0024**	0.9807	**0.0013**	**0.0389**	**<.0001**	**<.0001**
Micro-tool	0.15957	-0.11767	-0.22791	-0.23741	-0.18603	**0.72031**	**0.44692**	0.2885	**0.58899**	0.53474	0.60091	1	0.3473	-0.04569	0.36506	0.05446	**0.46848**	**0.71225**
	0.4671	0.5928	0.2956	0.2754	0.3954	**0.0001**	**0.0325**	0.1819	**0.0031**	0.0086	0.0024		0.1044	0.836	0.0867	0.8051	**0.0242**	**0.0001**
Grooved Abrader	0.27971	-0.01415	-0.13179	-0.13179	0.18347	**0.52781**	-0.14189	0.09322	0.41112	0.4902	0.60075	0.3473	1	0.07152	0.14822	-0.04193	**0.49923**	**0.61231**
	0.1961	0.9489	0.5489	0.5489	0.402	**0.0096**	0.5184	0.6722	0.0513	0.0176	0.0024	0.1044		0.7457	0.4997	0.8494	**0.0153**	**0.0019**
Scraper	0.07337	0.14774	-0.0916	-0.0916	-0.0916	-0.03046	-0.14272	-0.10292	-0.14082	-0.13323	0.00535	-0.04569	0.07152	1	0.04728	0.10874	0.06345	-0.05408
	0.7394	0.5011	0.6776	0.6776	0.6776	0.8903	0.5159	0.6403	0.5216	0.5445	0.9807	0.836	0.7457		0.8304	0.6214	0.7736	0.8064
Hammer-stone	-0.067	-0.05041	-0.10723	-0.10723	-0.10723	**0.6738**	-0.0745	0.02722	**0.81076**	0.54454	0.62898	0.36506	0.14822	0.04728	1	0.34261	**0.54502**	0.40261
	0.7613	0.8193	0.6263	0.6263	0.6263	**0.0004**	0.7355	0.9019	**<.0001**	0.0072	0.0013	0.0867	0.4997	0.8304		0.1095	**0.0072**	0.0568
Steatite	0.15752	-0.08548	-0.06579	-0.06579	-0.06579	0.11612	0.02024	0.00973	0.11696	0.22958	0.43326	0.05446	-0.04193	0.10874	0.34261	1	0.36842	0.29332
	0.4729	0.6982	0.7655	0.7655	0.7655	0.5978	0.927	0.9648	0.5951	0.292	0.0389	0.8051	0.8494	0.6214	0.1095		0.0837	0.1743
Hematite	0.39918	-0.03468	-0.15377	-0.11299	-0.10341	**0.71272**	-0.09883	0.17496	**0.71497**	0.76492	0.78445	0.46848	**0.49923**	0.06345	**0.54502**	0.36842	1	0.61794
	0.0592	0.8752	0.4836	0.6077	0.6387	**0.0001**	0.6537	0.4246	**0.0001**	<.0001	<.0001	0.0242	**0.0153**	0.7736	**0.0072**	0.0837		0.0017
FCR	**0.56823**	-0.05889	-0.11164	-0.19583	-0.0948	**0.7874**	0.11574	0.3485	**0.64791**	**0.61875**	**0.82098**	**0.71225**	**0.61231**	-0.05408	0.40261	0.29332	**0.61794**	1
	0.0047	0.7895	0.6121	0.3705	0.667	**<.0001**	0.599	0.1032	**0.0008**	**0.0016**	**<.0001**	**0.0001**	**0.0019**	0.8064	0.0568	0.1743	**0.0017**	

Non-Zero Microtool features
Stepwise Selection results

The REG Procedure
Model: MODEL1
Dependent Variable: d_microtool

Number of Observations Read	23
Number of Observations Used	23

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	3	399.76179	133.25393	14.65	<.0001
Error	19	172.80645	9.09508		
Corrected Total	22	572.56824			

Root MSE	3.01580	**R-Square**	0.6982
Dependent Mean	6.28601	**Adj R-Sq**	0.6505
Coeff Var	47.97647		

Parameter Estimates						
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Variance Inflation**
Intercept	1	2.49614	0.92289	2.70	0.0140	0
d_mw_ceramic	1	-8.28024	4.22528	-1.96	0.0649	1.00036
d_jasper	1	0.02106	0.00401	5.25	<.0001	1.02244
d_rhyolite	1	0.49397	0.17863	2.77	0.0123	1.02279

Positive coefficient for jasper and rhyolite. Negative coefficient for density of MW ceramics.

Here we are trying to model the probability of finding a microtool using the continuous density estimates for the other variables.

All features

The LOGISTIC Procedure

Response Profile		
Ordered Value	**Microtools**	**Total Frequency**
1	Present	23
2	Absent	55

Probability modeled is Microtools='Present'.

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-0.8718	0.2483	12.3273	0.0004

However, none of the variables were entered into the stepwise logistic regression.

Running the same set of analyses for grooved_abraders.

Nonzero Grooved_abrader features

The REG Procedure
Model: MODEL1
Dependent Variable: d_grooved_abrader

Number of Observations Read	10
Number of Observations Used	10

No variable met the 0.1500 significance level for entry into the model.

Here we find that none of the independent variables met the criterion to enter the model. On the other hand, for grooved abraders we see that the logistic regression did run and that microtool density was a significant predictor for the probability of finding a grooved abrader. The odds ratio (below) of 1.195 indicates that for every unit increase in microtool density, you are 1.195 times more likely to find a grooved abrader.

All features

The LOGISTIC Procedure

Response Profile		
Ordered Value	**Grooved_Abraders**	**Total Frequency**
1	Present	10
2	Absent	68

Probability modeled is Grooved_Abraders='Present'.

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-2.4239	0.4382	30.5964	<.0001
d_microtool	1	0.1783	0.0707	6.3620	0.0117

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
d_microtool	1.195	1.041	1.373

Relative Densities. These values were computed by totaling the counts of all artifacts and lithics and using this total as a denominator. Note that density / total density = (count/volume)/(total/volume)=count/total. Thus, relative densities are simply counts of items / total count. Because relative density is computed on a per-feature basis, the relative density values can differ from density results.

The CORR Procedure

Pearson Correlation Coefficients, N = 23 Prob > |r| under H0: Rho=0																		
	LA Point	**LA-MW Point**	**EW Ceramic**	**MW Ceramic**	**LW Ceramic**	**Jasper**	**Rhyolite**	**Argillite**	**Quartz**	**Quartzite**	**All Chert**	**Micro-tool**	**Grooved Abrader**	**Scraper**	**Hammer-stone**	**Steatite**	**Hematite**	**FCR**
LA Point	1	0.18397	-0.1564	0.20261	-0.1564	-0.0686	-0.0858	-0.0541	-0.1436	0.09534	-0.15587	0.08276	-0.3029	0.24864	0.1875	0.37367	**0.43791**	-0.147
		0.4008	0.476	0.3538	0.476	0.7557	0.697	0.8063	0.5132	0.6652	0.4776	0.7074	0.16	0.2526	0.3916	0.079	**0.0366**	0.5034
LA-MW Point	0.18397	1	-0.0651	-0.0651	-0.0651	-0.1003	-0.0019	0.21217	-0.0417	0.30811	-0.09051	-0.0869	0.16998	0.37939	0.14938	-0.0877	-0.11328	-0.0762
	0.4008		0.7681	0.7681	0.7681	0.6489	0.993	0.3311	0.8503	0.1526	0.6813	0.6933	0.4381	0.0742	0.4963	0.6908	0.6068	0.7297
EW Ceramic	-0.15641	-0.0651	1	-0.0455	-0.0455	-0.0716	**0.4195**	0.20384	-0.0496	-0.22886	0.12694	-0.1437	-0.1107	-0.0886	-0.10111	-0.0613	-0.11507	0.04627
	0.476	0.7681		0.8368	0.8368	0.7455	**0.0463**	0.3509	0.8222	0.2935	0.5638	0.5129	0.6151	0.6876	0.6462	0.7813	0.6011	0.8339
MW Ceramic	0.20261	-0.0651	-0.0455	1	-0.0455	0.09225	0.02808	-0.0805	0.05622	0.10728	-0.04826	-0.2493	-0.1107	-0.0886	-0.10111	-0.0613	-0.09828	-0.2048
	0.3538	0.7681	0.8368		0.8368	0.6755	0.8988	0.7151	0.7989	0.6261	0.8269	0.2513	0.6151	0.6876	0.6462	0.7813	0.6555	0.3486
LW Ceramic	-0.15641	-0.0651	-0.0455	-0.0455	1	0.07782	-0.0855	-0.0773	-0.0475	-0.1331	-0.10706	0.03235	**0.63617**	-0.0886	-0.10111	-0.0613	0.11167	-0.0396
	0.476	0.7681	0.8368	0.8368		0.7241	0.6983	0.7258	0.8295	0.5449	0.6268	0.8835	**0.0011**	0.6876	0.6462	0.7813	0.612	0.8575
Jasper	-0.06862	-0.1003	-0.0716	0.09225	0.07782	1	0.09621	**-0.4379**	**-0.5057**	0.13092	**-0.71786**	-0.2847	0.09805	0.08566	-0.21929	-0.1235	-0.18477	**-0.5541**
	0.7557	0.6489	0.7455	0.6755	0.7241		0.6623	**0.0366**	**0.0138**	0.5516	**0.0001**	0.188	0.6563	0.6975	0.3147	0.5746	0.3987	**0.0061**
Rhyolite	-0.08582	-0.0019	**0.4195**	0.02808	-0.0855	0.09621	1	0.11421	-0.1608	0.03286	-0.0473	-0.3541	-0.1966	-0.1666	-0.14524	-0.0821	-0.15728	-0.0383
	0.697	0.993	**0.0463**	0.8988	0.6983	0.6623		0.6039	0.4637	0.8817	0.8303	0.0974	0.3685	0.4473	0.5085	0.7095	0.4736	0.8623
Argillite	-0.05411	0.21217	0.20384	-0.0805	-0.0773	**-0.4379**	0.11421	1	-0.0897	-0.18824	0.10582	-0.1367	-0.1725	-0.1131	-0.11591	-0.0789	-0.1829	0.01284
	0.8063	0.3311	0.3509	0.7151	0.7258	**0.0366**	0.6039		0.684	0.3897	0.6308	0.5339	0.4314	0.6075	0.5984	0.7203	0.4035	0.9536
Quartz	-0.14364	-0.0417	-0.0496	0.05622	-0.0475	**-0.5057**	-0.1608	-0.0897	1	-0.34466	0.39425	0.3167	-0.2093	-0.1956	-0.14524	-0.1361	-0.21255	**0.80347**
	0.5132	0.8503	0.8222	0.7989	0.8295	**0.0138**	0.4637	0.684		0.1073	0.0627	0.1409	0.3377	0.3711	0.5085	0.5357	0.3302	**<.0001**
Quartzite	0.09534	0.30811	-0.2289	0.10728	-0.1331	0.13092	0.03286	-0.1882	-0.3447	1	-0.12692	**-0.4284**	-0.0213	-0.0977	-0.0373	-0.1195	-0.00899	**-0.4625**
	0.6652	0.1526	0.2935	0.6261	0.5449	0.5516	0.8817	0.3897	0.1073		0.5639	**0.0414**	0.9233	0.6573	0.8658	0.5871	0.9675	**0.0263**
All Chert	-0.15587	-0.0905	0.12694	-0.0483	-0.1071	**-0.7179**	-0.0473	0.10582	0.39425	-0.12692	1	0.26497	-0.0151	-0.0032	0.01064	0.21068	-0.19036	**0.55549**
	0.4776	0.6813	0.5638	0.8269	0.6268	**0.0001**	0.8303	0.6308	0.0627	0.5639		0.2218	0.9454	0.9885	0.9616	0.3346	0.3843	**0.0059**
Micro-tool	0.08276	-0.0869	-0.1437	-0.2493	0.03235	-0.2847	-0.3541	-0.1367	0.3167	**-0.42837**	0.26497	1	0.28734	0.25405	0.0263	0.17634	0.15388	**0.53899**
	0.7074	0.6933	0.5129	0.2513	0.8835	0.188	0.0974	0.5339	0.1409	**0.0414**	0.2218		0.1837	0.2421	0.9052	0.4209	0.4833	**0.008**
Grooved Abrader	-0.3029	0.16998	-0.1107	-0.1107	**0.63617**	0.09805	-0.1966	-0.1725	-0.2093	-0.02125	-0.01512	0.28734	1	0.20841	0.14893	-0.1088	0.14026	-0.148
	0.16	0.4381	0.6151	0.6151	**0.0011**	0.6563	0.3685	0.4314	0.3377	0.9233	0.9454	0.1837		0.3399	0.4976	0.6211	0.5233	0.5003
Scraper	0.24864	0.37939	-0.0886	-0.0886	-0.0886	0.08566	-0.1666	-0.1131	-0.1956	-0.09773	-0.00318	0.25405	0.20841	1	0.29433	0.17402	0.15491	-0.1442
	0.2526	0.0742	0.6876	0.6876	0.6876	0.6975	0.4473	0.6075	0.3711	0.6573	0.9885	0.2421	0.3399		0.1728	0.4271	0.4803	0.5115
Hammer-stone	0.1875	0.14938	-0.1011	-0.1011	-0.1011	-0.2193	-0.1452	-0.1159	-0.1452	-0.0373	0.01064	0.0263	0.14893	0.29433	1	0.34917	**0.71765**	-0.1073
	0.3916	0.4963	0.6462	0.6462	0.6462	0.3147	0.5085	0.5984	0.5085	0.8658	0.9616	0.9052	0.4976	0.1728		0.1025	**0.0001**	0.6259
Steatite	0.37367	-0.0877	-0.0613	-0.0613	-0.0613	-0.1235	-0.0821	-0.0789	-0.1361	-0.11948	0.21068	0.17634	-0.1088	0.17402	0.34917	1	0.24105	0.08707
	0.079	0.6908	0.7813	0.7813	0.7813	0.5746	0.7095	0.7203	0.5357	0.5871	0.3346	0.4209	0.6211	0.4271	0.1025		0.2678	0.6928
Hematite	**0.43791**	-0.1133	-0.1151	-0.0983	0.11167	-0.1848	-0.1573	-0.1829	-0.2126	-0.00899	-0.19036	0.15388	0.14026	0.15491	**0.71765**	0.24105	1	-0.2194
	0.0366	0.6068	0.6011	0.6555	0.612	0.3987	0.4736	0.4035	0.3302	0.9675	0.3843	0.4833	0.5233	0.4803	**0.0001**	0.2678		0.3145
FCR	-0.14698	-0.0762	0.04627	-0.2048	-0.0396	**-0.5541**	-0.0383	0.01284	**0.80347**	**-0.46247**	**0.55549**	**0.53899**	-0.148	-0.1442	-0.10734	0.08707	-0.21941	1
	0.5034	0.7297	0.8339	0.3486	0.8575	**0.0061**	0.8623	0.9536	**<.0001**	**0.0263**	**0.0059**	**0.008**	0.5003	0.5115	0.6259	0.6928	0.3145	

The REG Procedure
Model: MODEL1
Dependent Variable: rd_microtool

Number of Observations Read	23
Number of Observations Used	23

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	5	0.00425	0.00084998	6.46	0.0015
Error	17	0.00224	0.00013164		
Corrected Total	22	0.00649			

Root MSE	0.01147	**R-Square**	0.6551
Dependent Mean	0.02295	**Adj R-Sq**	0.5536
Coeff Var	49.99341		

Parameter Estimates						
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Variance Inflation**
Intercept	1	0.00237	0.00469	0.51	0.6196	0
rd_la_point	1	3.60180	1.35612	2.66	0.0166	1.24254
rd_la_mw_point	1	-4.13314	2.26414	-1.83	0.0855	1.17153
rd_lw_ceramic	1	-2.73371	1.23727	-2.21	0.0412	1.80797
rd_grooved_abrader	1	2.56492	0.64011	4.01	0.0009	2.13347
rd_tas	1	1.16708	0.25114	4.65	0.0002	1.07446

Note the we see a positive coefficient for LA_point (3.6) whereas we see negative coefficients for LA_MW_ceramics (-4.1) and LW_ceramics (-2.7). This reinforces the idea that microtools are associated with the Late Archaic.

The REG Procedure
Model: MODEL1
Dependent Variable: rd_grooved_abrader

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	5	0.00037761	0.00007552	24.64	0.0042
Error	4	0.00001226	0.00000306		
Corrected Total	9	0.00038987			

Root MSE	0.00175	**R-Square**	0.9686
Dependent Mean	0.00790	**Adj R-Sq**	0.9293
Coeff Var	22.17050		

Parameter Estimates						
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Variance Inflation**
Intercept	1	0.00137	0.00114	1.20	0.2973	0
rd_la_point	1	-1.30470	0.61398	-2.13	0.1008	4.12619
rd_la_mw_point	1	1.94512	0.57599	3.38	0.0279	1.14861
rd_lw_ceramic	1	0.94839	0.15262	6.21	0.0034	1.23565
rd_argillite	1	0.02343	0.00747	3.13	0.0350	4.41270
rd_microtool	1	0.21713	0.03460	6.28	0.0033	1.21549

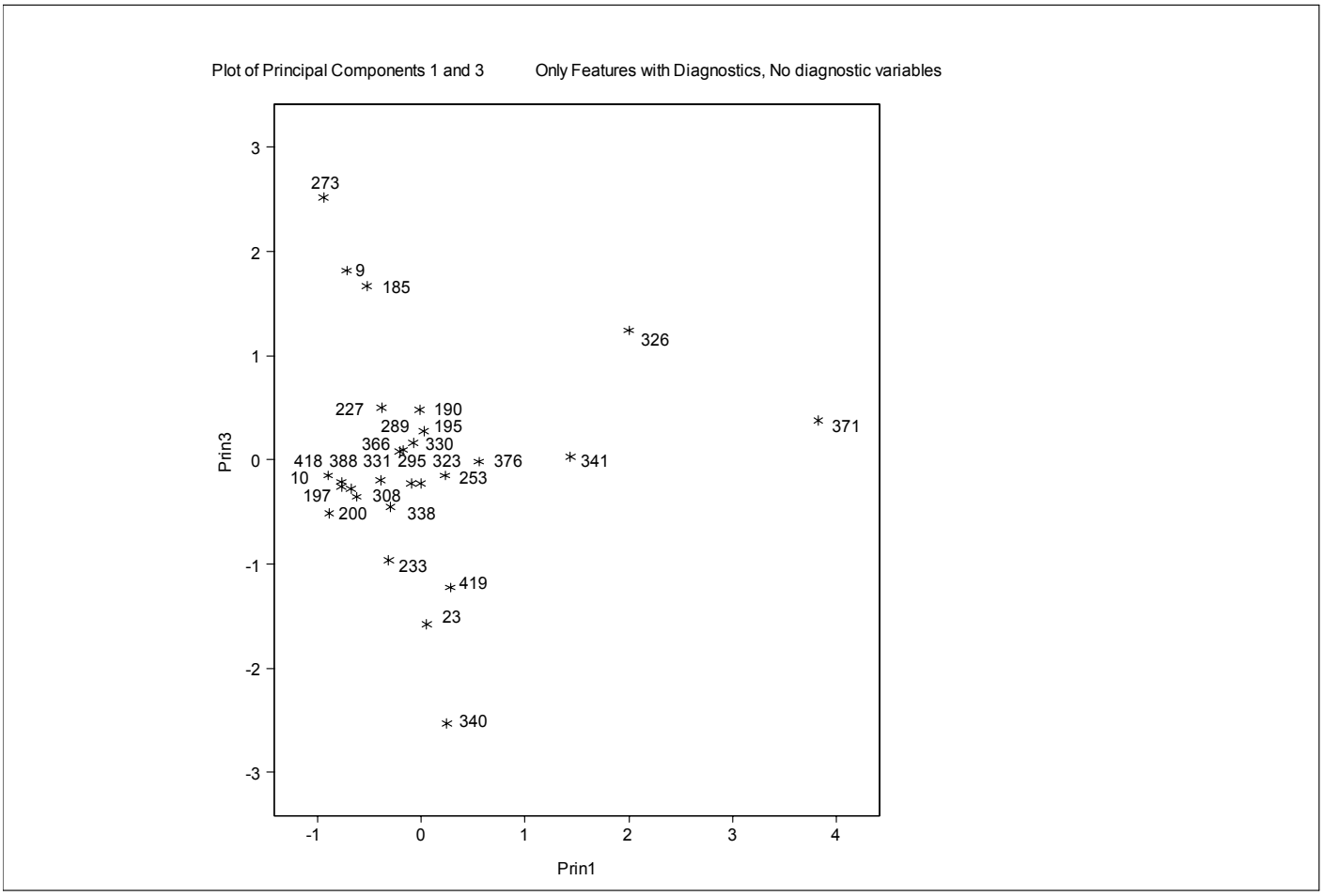
We see a negative coefficient for Grooved abraders with LA_points, but a strong positive coefficient for LA_MW_points. The potential overlap in time-periods with this system of diagnostic grouping may be responsible for this apparent inconsistency with the results for microtools.

The logistic regression for the presence of microtools or grooved_abraders did not run using the relative density values is not shown here.

Section 3: Multivariate Analyses

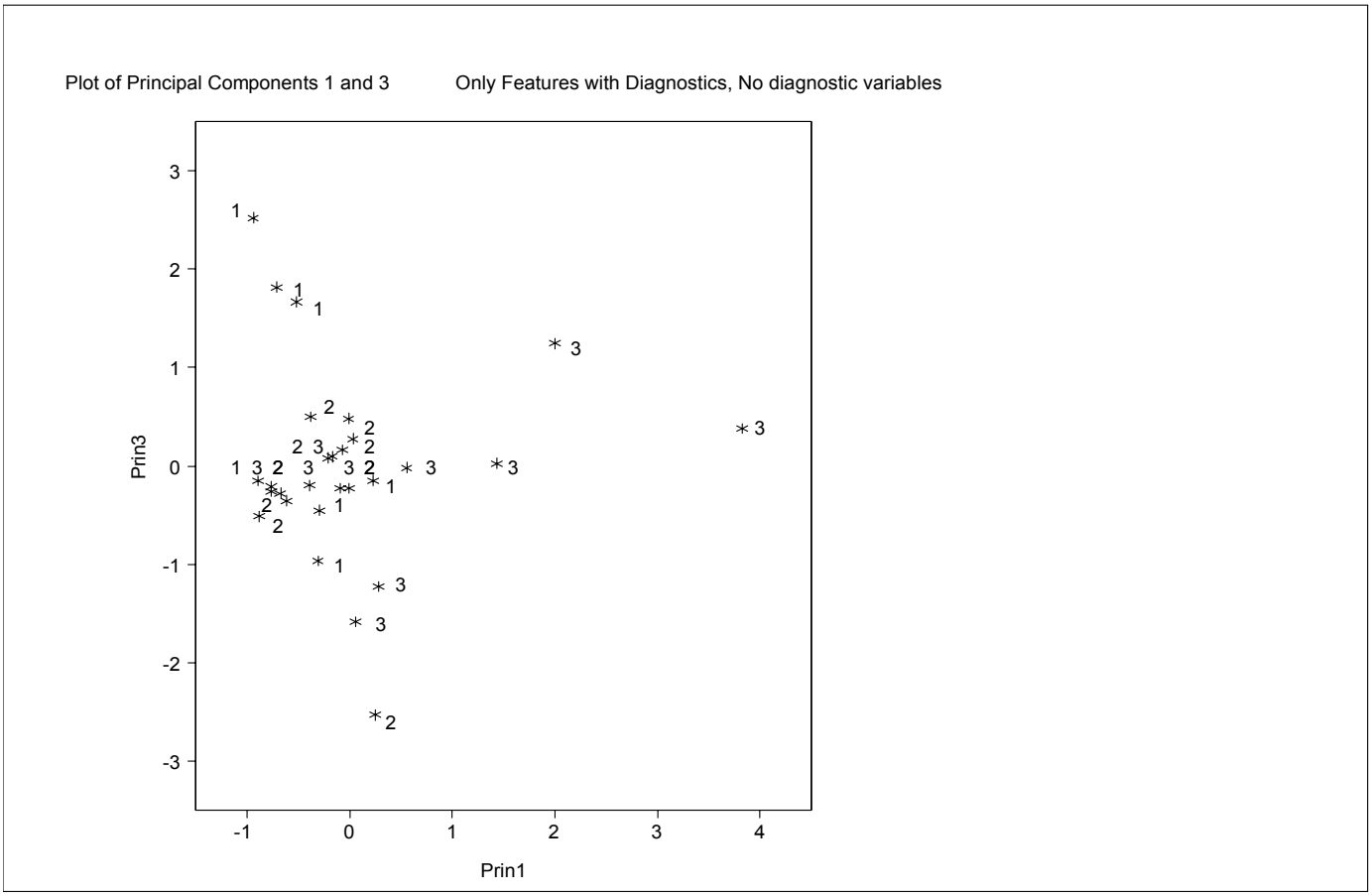
Section 1: Principal Component Analysis (PCA) (Without the diagnostic variables)

PCA axis 1 vs. 3



Coverting the PCA plot to show diagnostic groups

```
proc format;
      value GRP /* Diagnostic_groups */
         1 = 'LW Ceramics only'
         2 = 'EW or MW Ceramics or LA_MW_points'
         3 = 'LA_points only'
```



We see that the first principal axis is a separation reflecting Late Archaic points only features. Principal axis 3 shows a separation in the positive direction with Late Woodland Ceramic features and in the negative direction with LA_point&EW&MW_Ceramic features. Keeping in mind that the PCA analysis was run only on lithics (i.e., not including the diagnostic artifact densities) it is meaningful to look at the loadings of the lithic variables on these PCA axes. The coefficients (below) indicate the relative contribution of each lithic type to the PCA axis.

	Prin1	Prin2	Prin3
d_jasper	**0.386089**	-.066037	-.013279
d_rhyolite	-.071738	-.044616	-.088281
d_argillite	0.036231	-.551182	-.148858
d_quartz	**0.366629**	-.152538	0.047293
d_quartzite	**0.377206**	0.018816	0.009371
d_all_chert	**0.396294**	0.082805	-.006260
d_microtool	**0.379766**	0.146824	-.100725
d_grooved_abrader	**0.293413**	-.171894	-.195929
d_scraper	0.040288	**0.529684**	-.579770
d_hammerstone	-.070471	**0.257314**	**0.665828**
d_steatite	0.151748	**0.441244**	0.162350
d_hematite	**0.308651**	0.119283	**0.213709**
d_tas	**0.235649**	-.229267	**0.259776**

Multivariate Analysis of Variance (MANOVA)

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall diagnostic_group Effect H = Type III SSCP Matrix for diagnostic_group E = Error SSCP Matrix S=2 M=5 N=5.5					
Statistic	**Value**	**F Value**	**Num DF**	**Den DF**	**Pr > F**
Wilks' Lambda	0.19501087	1.26	26	26	0.2770
Pillai's Trace	1.07934191	1.26	26	28	0.2727
Hotelling-Lawley Trace	2.72106030	1.29	26	18.824	0.2887
Roy's Greatest Root	2.02700100	2.18	13	14	0.0803
NOTE: F Statistic for Roy's Greatest Root is an upper bound.					
NOTE: F Statistic for Wilks' Lambda is exact.					

The multivariate analysis of variance (MANOVA) is testing whether the *suite* of variables (lithics) collectively differs significantly among the diagnostic groups. The F-tests shown indicate that the differences were not statistically significant. The follow-up univariate (one lithic variable at a time) ANOVA's, however, do point to significant differences among diagnostic groups for some variables. We then use univariate ANOVA's to identify which of the variables are significant.

Individual (Univariate) ANOVAs for Lithics

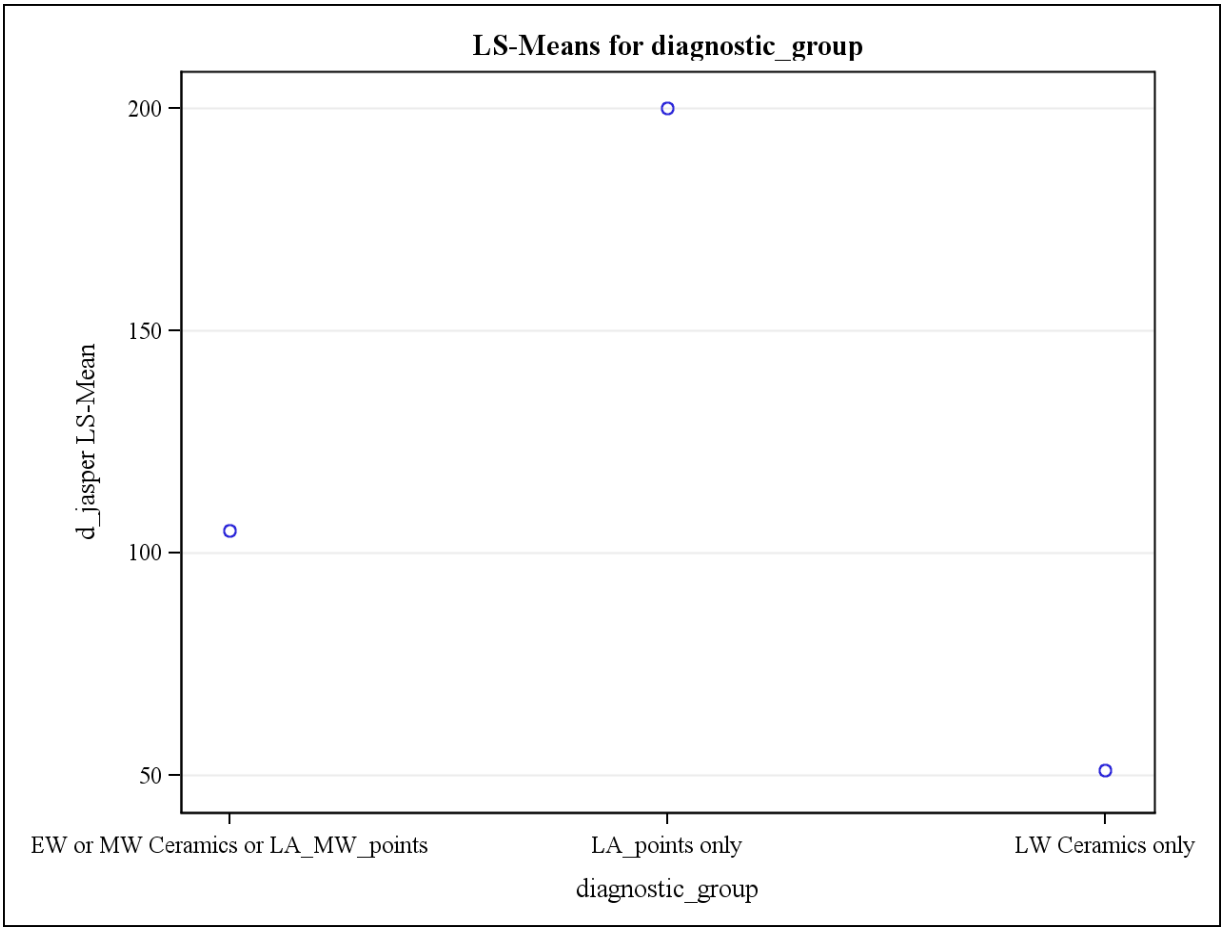
Dependent Variable: d_jasper

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	98887.40305	49443.70152	2.86	**0.0759**

This p-value is used to test the Null Hypothesis of equal means among the diagnostic_groups. Here it is not significant because p>0.05.

Least Squares Means

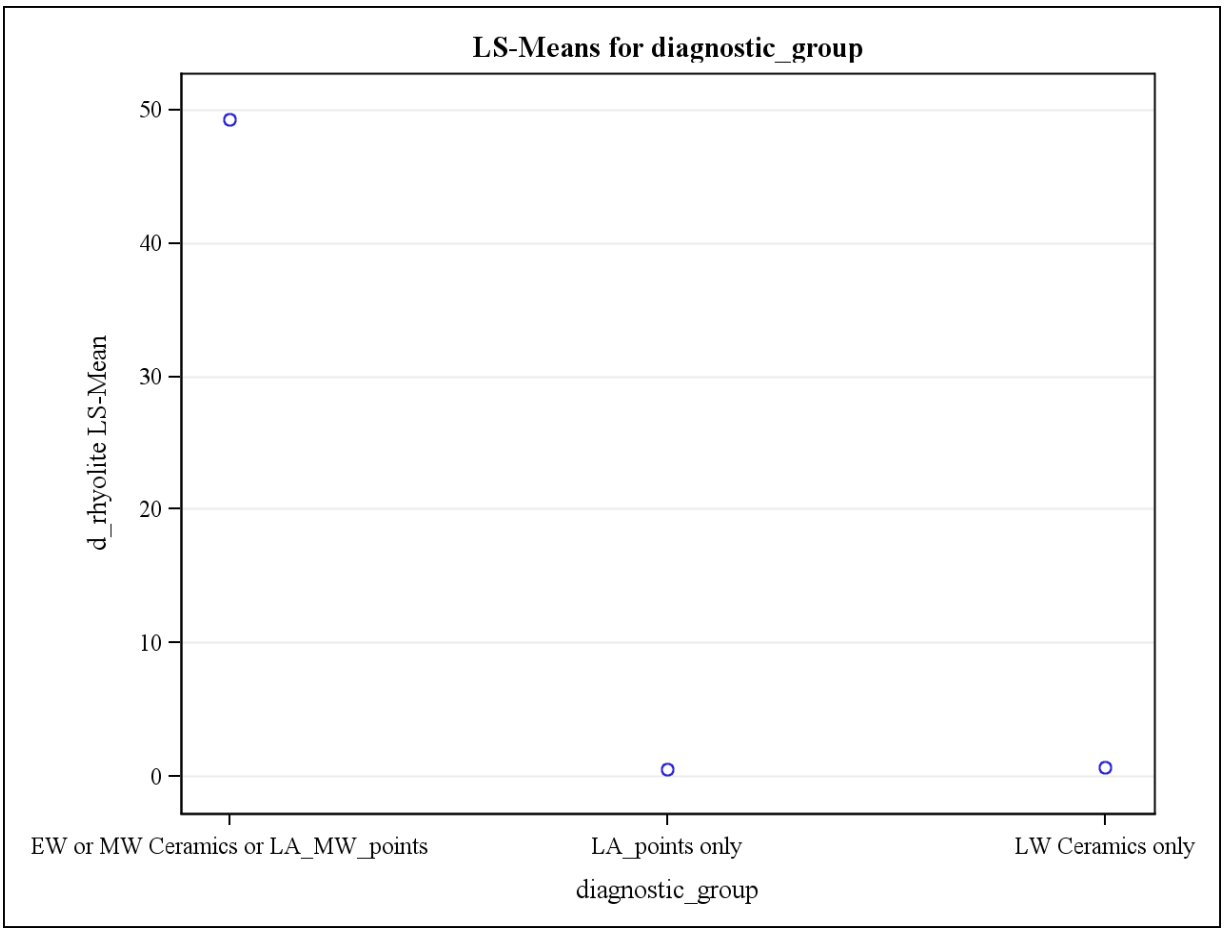
diagnostic_group	d_jasper LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	104.836364	39.615116	23.247504	186.425223
LA_points only	200.040000	41.548685	114.468882	285.611118
LW Ceramics only	51.214286	49.660177	-51.062762	153.491334



Dependent Variable: d_rhyolite

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	15858.79671	7929.39836	0.76	0.4800

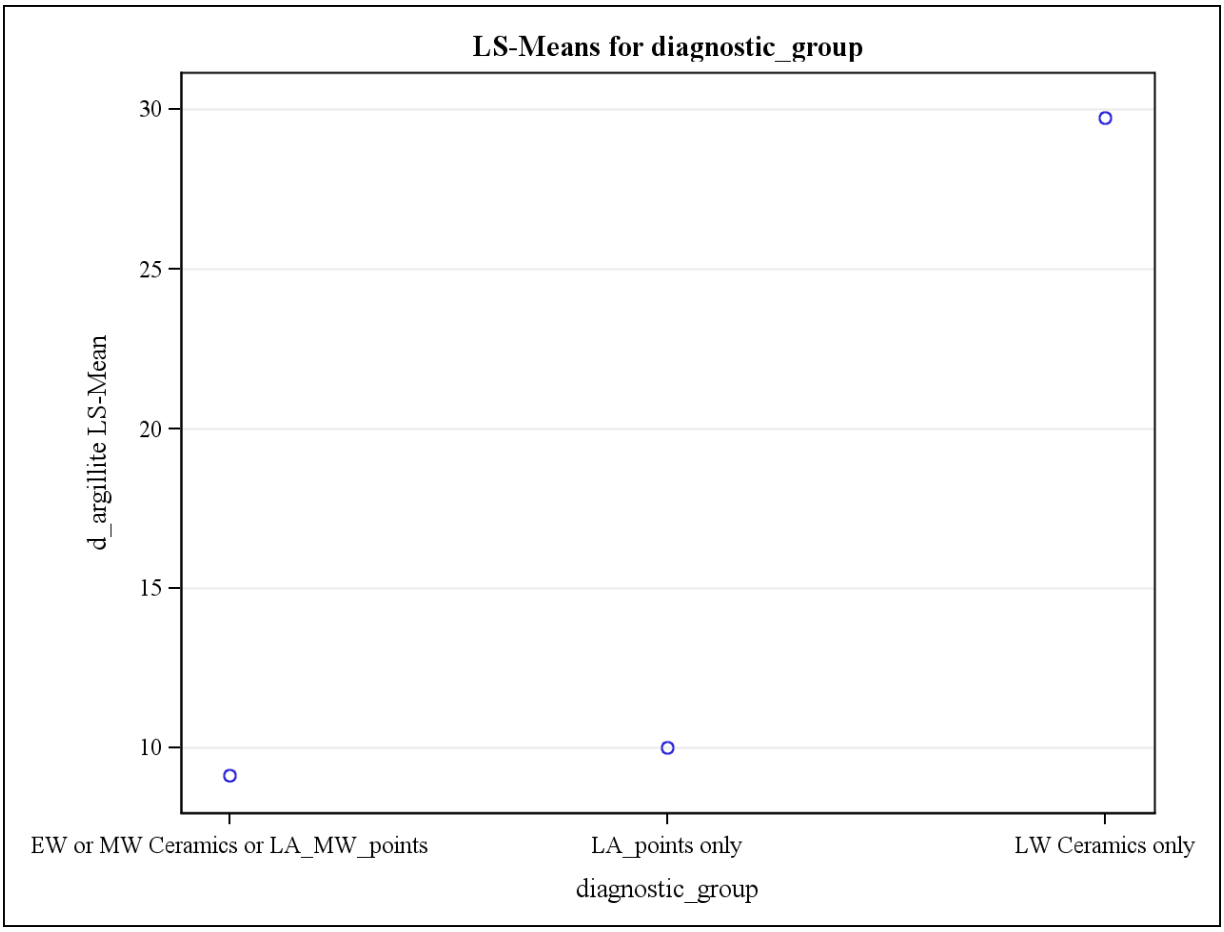
diagnostic_group	d_rhyolite LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	49.3000000	30.8783924	-14.295240	112.895240
LA_points only	0.4900000	32.3855312	-66.209250	67.189250
LW Ceramics only	0.6857143	38.7081134	-79.035138	80.406566



Dependent Variable: d_argillite

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	2141.236136	1070.618068	1.73	0.1974

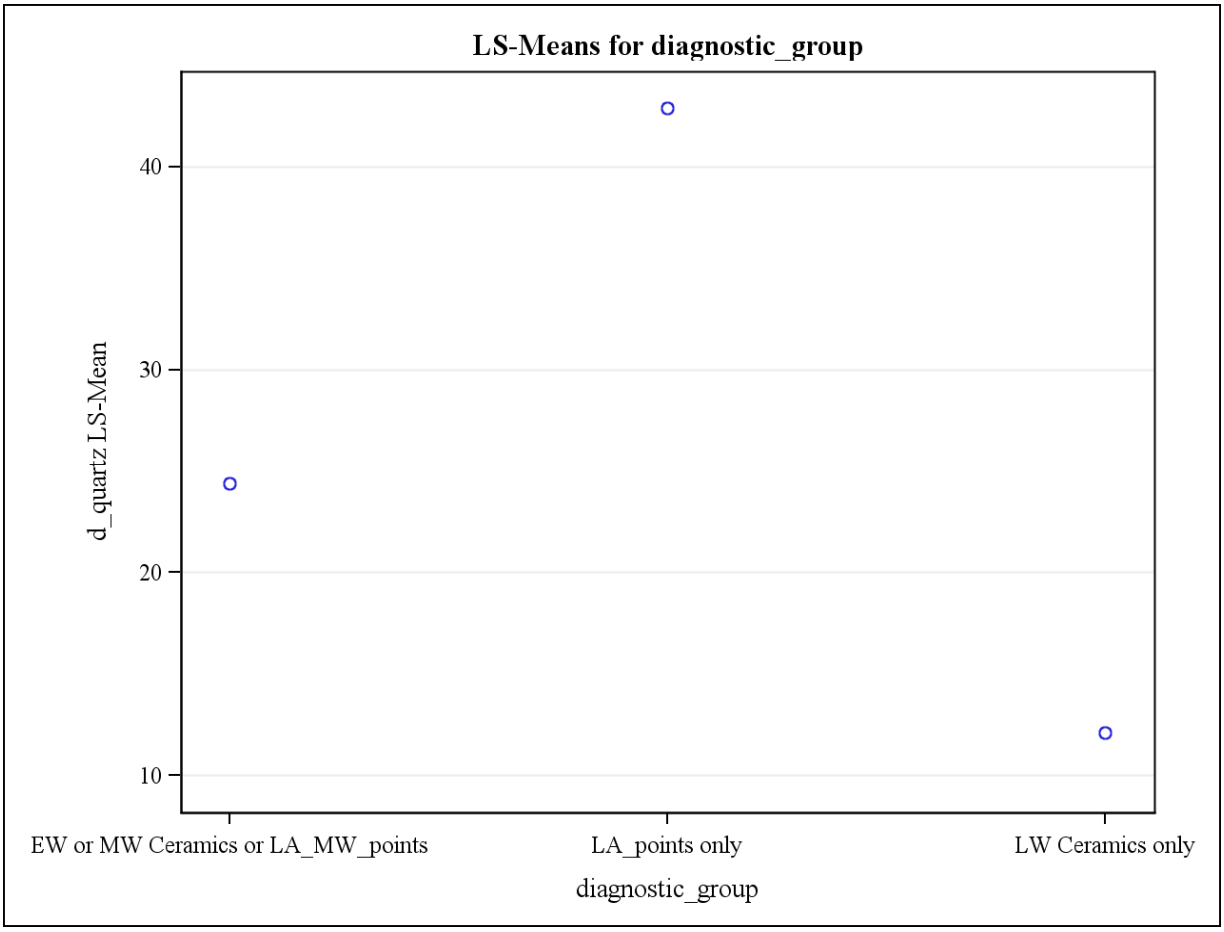
diagnostic_group	d_argillite LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	9.1181818	7.4955902	-6.319275	24.555639
LA_points only	10.0000000	7.8614413	-6.190941	26.190941
LW Ceramics only	29.7142857	9.3962196	10.362409	49.066162



Dependent Variable: d_quartz

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	4132.208545	2066.104273	2.03	0.1520

diagnostic_group	d_quartz LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	24.3636364	9.6109918	4.569428	44.157845
LA_points only	42.8800000	10.0800933	22.119659	63.640341
LW Ceramics only	12.0857143	12.0480158	-12.727639	36.899067

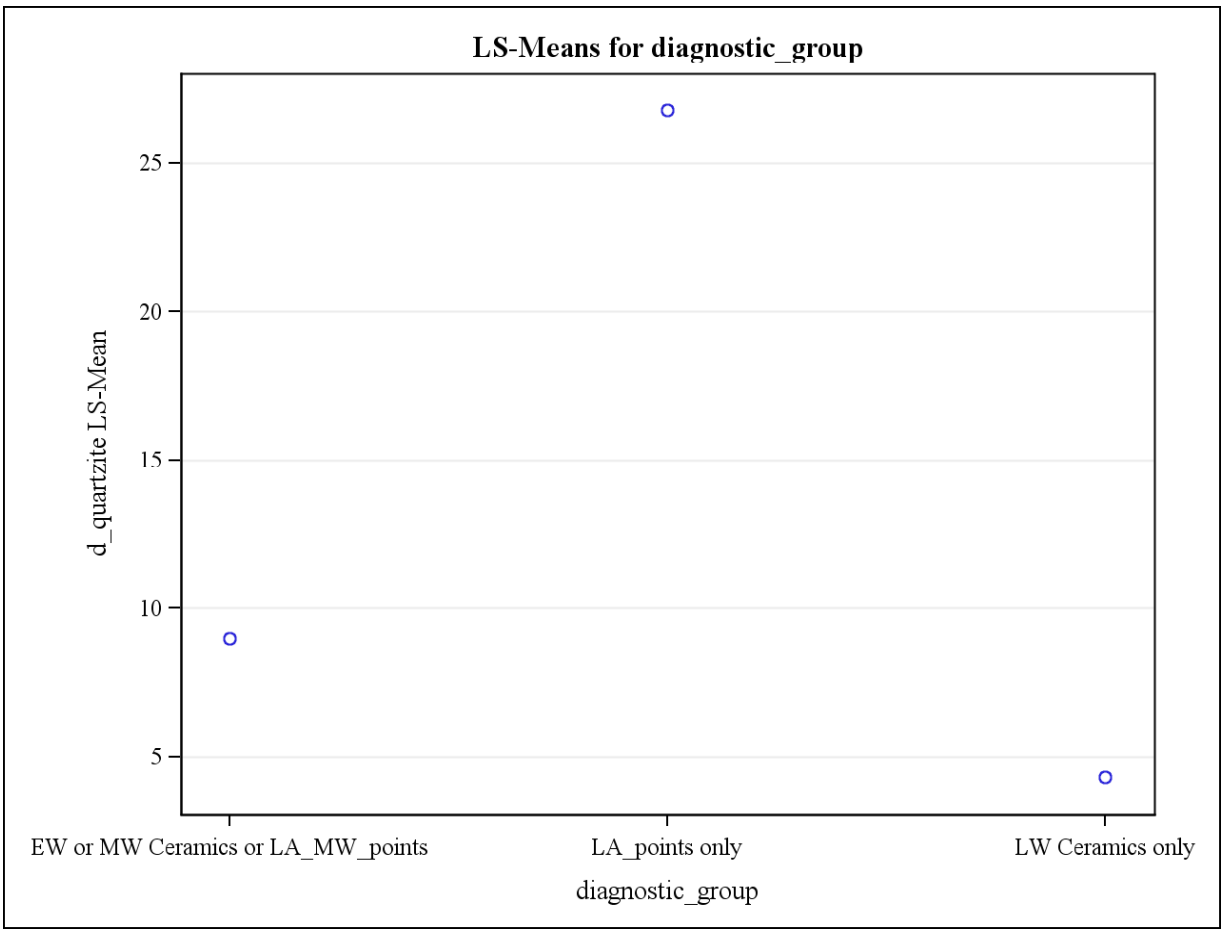


Dependent Variable: d_quartzite

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	2566.156208	1283.078104	4.22	**0.0264**

Here we see that we Reject the Null hypothesis of equal means among diagnostic_groups. Quartzite density was higher for the LA_Points only group compared to the others.

diagnostic_group	d_quartzite LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	8.9818182	5.2602941	-1.851960	19.815597
LA_points only	26.7800000	5.5170430	15.417437	38.142563
LW Ceramics only	4.3142857	6.5941277	-9.266574	17.895146

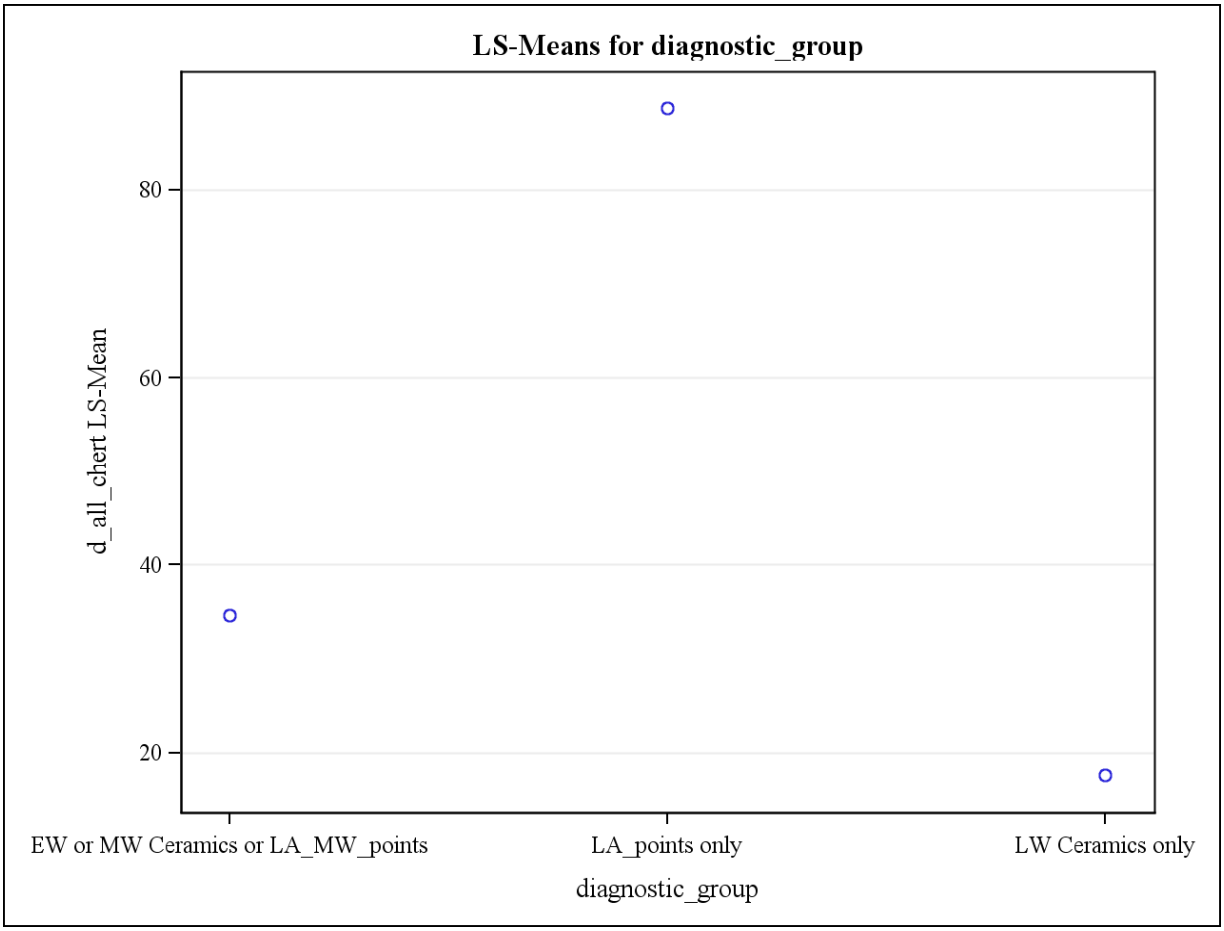


Dependent Variable: d_all_chert

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	24918.36169	12459.18085	4.36	**0.0237**

Again, we reject the Null hypothesis and find that all_chert density was higher for the LA_points only group.

diagnostic_group	d_all_chert LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	34.5909091	16.1146467	1.402173	67.779645
LA_points only	88.6800000	16.9011840	53.871360	123.488640
LW Ceramics only	17.6000000	20.2007786	-24.004282	59.204282

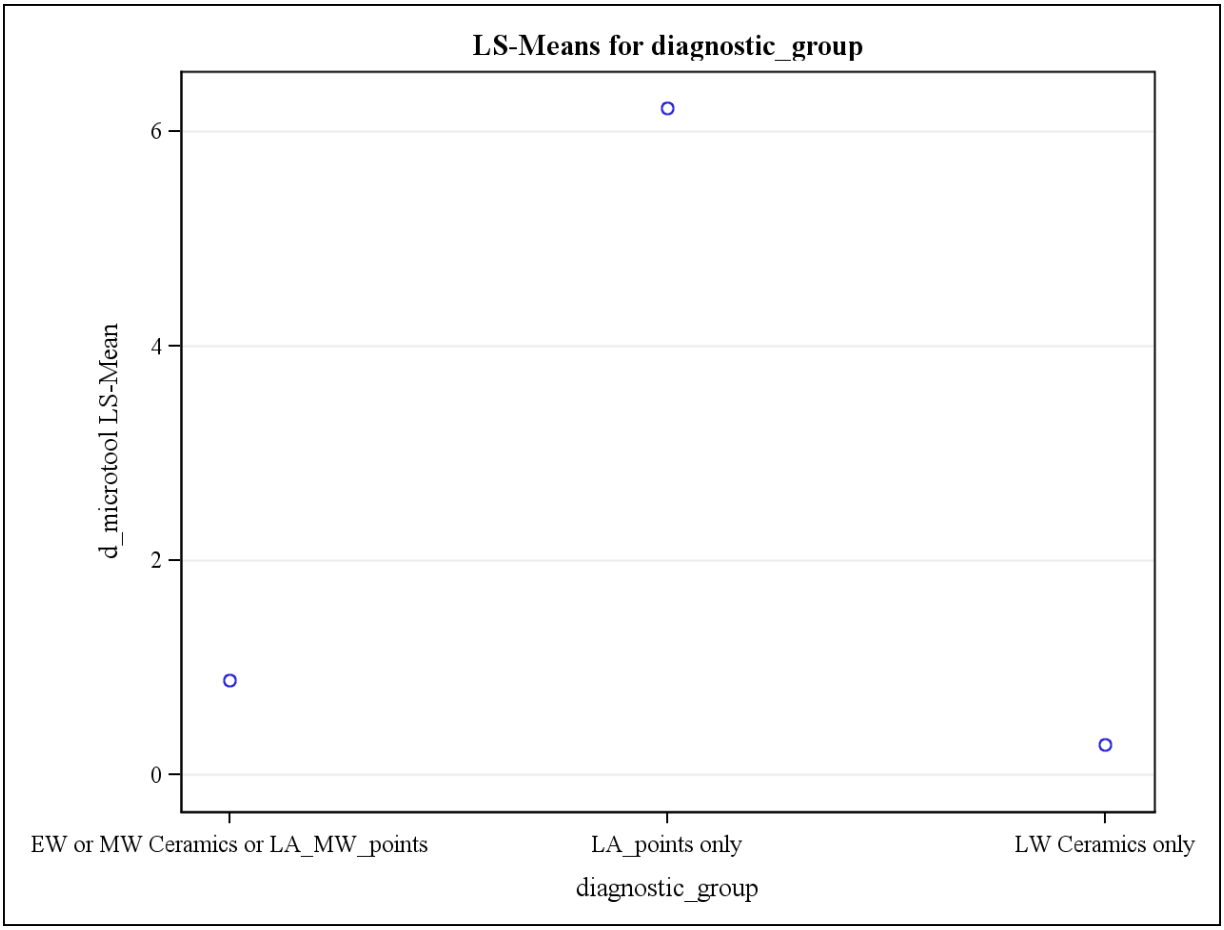


Dependent Variable: d_microtool

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	200.6964634	100.3482317	6.90	**0.0041**

Microtool density was higher for LA_points only diagnostic group.

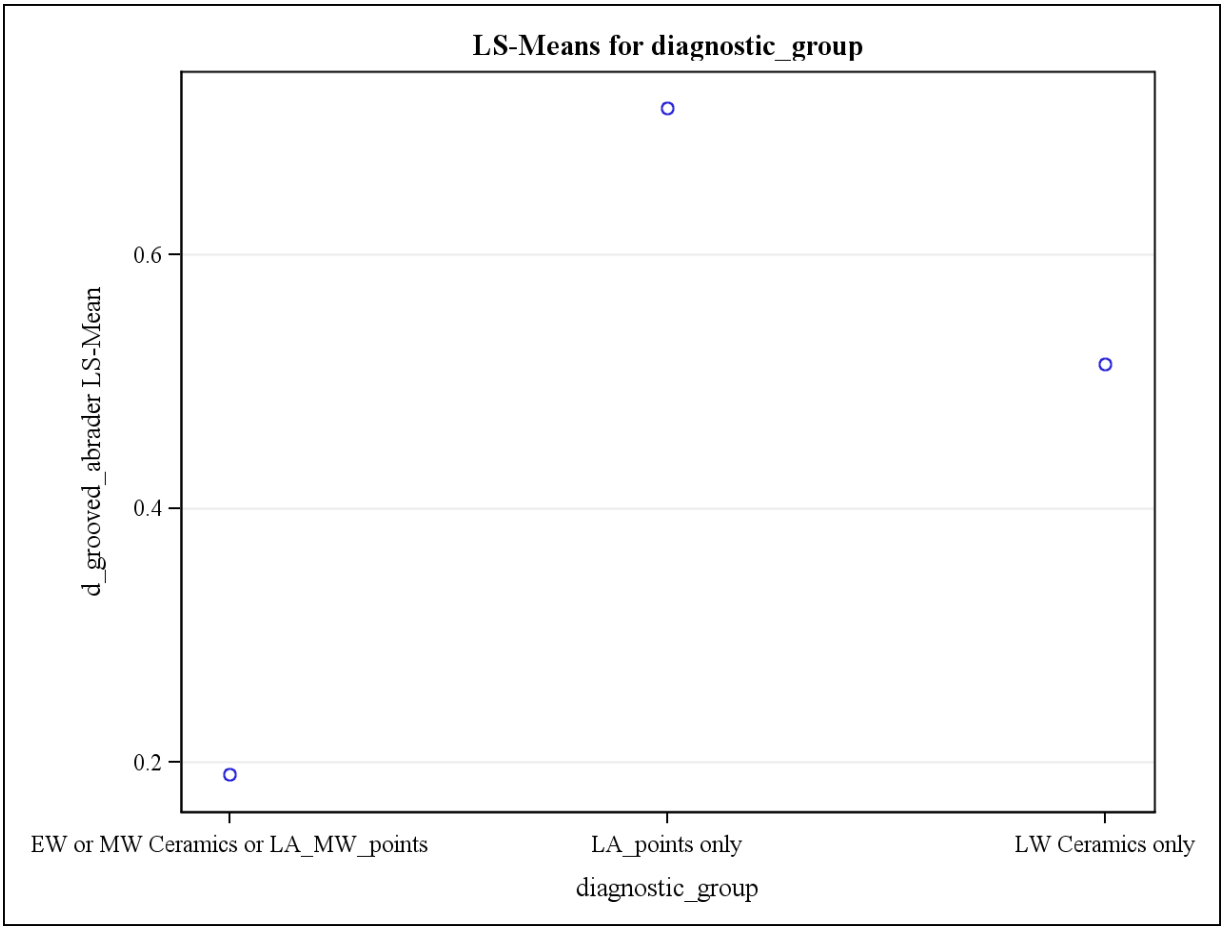
diagnostic_group	d_microtool LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	0.88136868	1.14950183	-1.486075	3.248812
LA_points only	6.21154340	1.20560769	3.728548	8.694539
LW Ceramics only	0.27605245	1.44097680	-2.691695	3.243800



Dependent Variable: d_grooved_abrader

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	1.47012624	0.73506312	0.82	0.4539

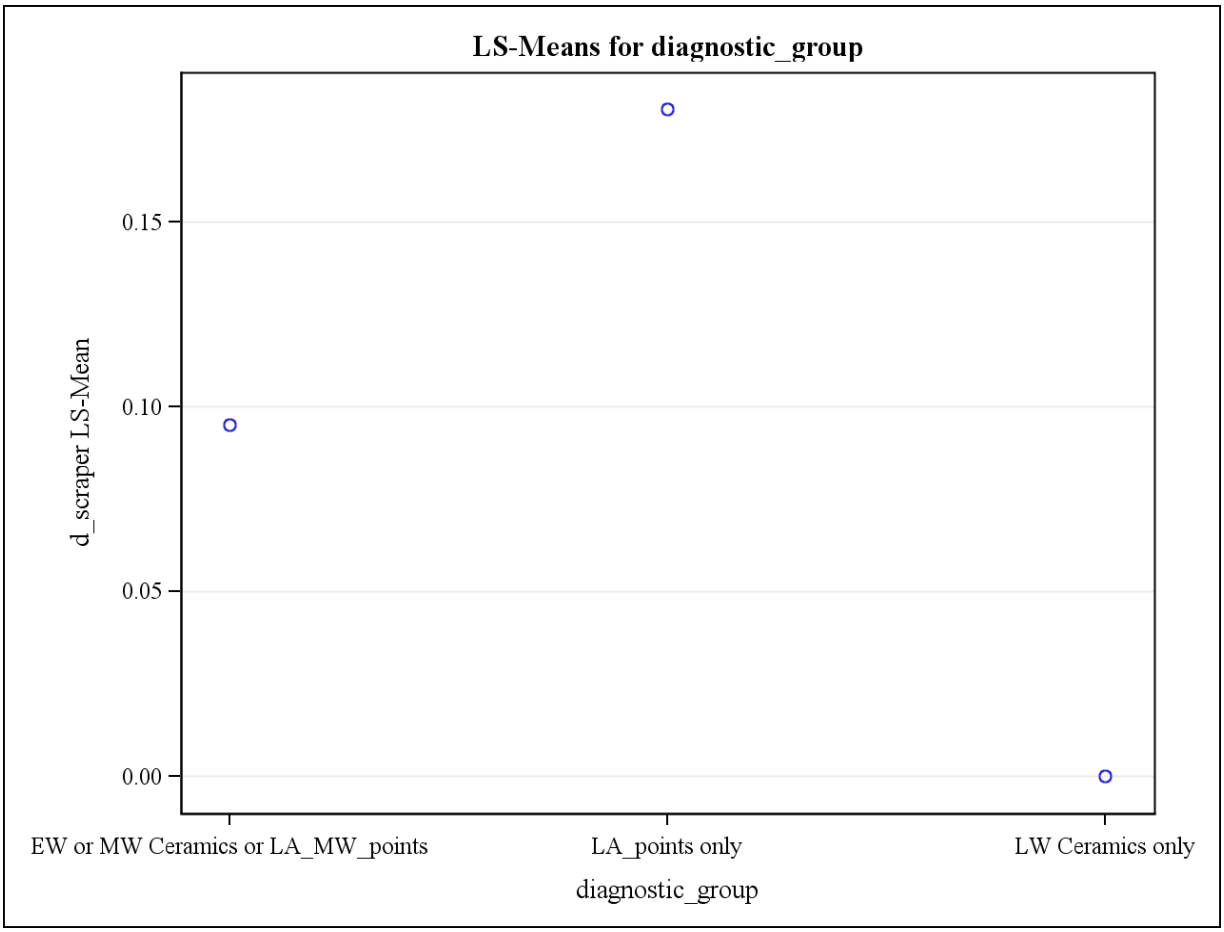
diagnostic_group	d_grooved_abrader LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	0.19038553	0.28629704	-0.399254	0.780025
LA_points only	0.71494196	0.30027087	0.096523	1.333361
LW Ceramics only	0.51425900	0.35889233	-0.224894	1.253412



Dependent Variable: d_scraper

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	0.13489228	0.06744614	0.91	0.4136

diagnostic_group	d_scraper LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	0.09519277	0.08187518	-0.073432	0.263818
LA_points only	0.18045714	0.08587141	0.003602	0.357313
LW Ceramics only	0.00000000	0.10263597	-0.211383	0.211383

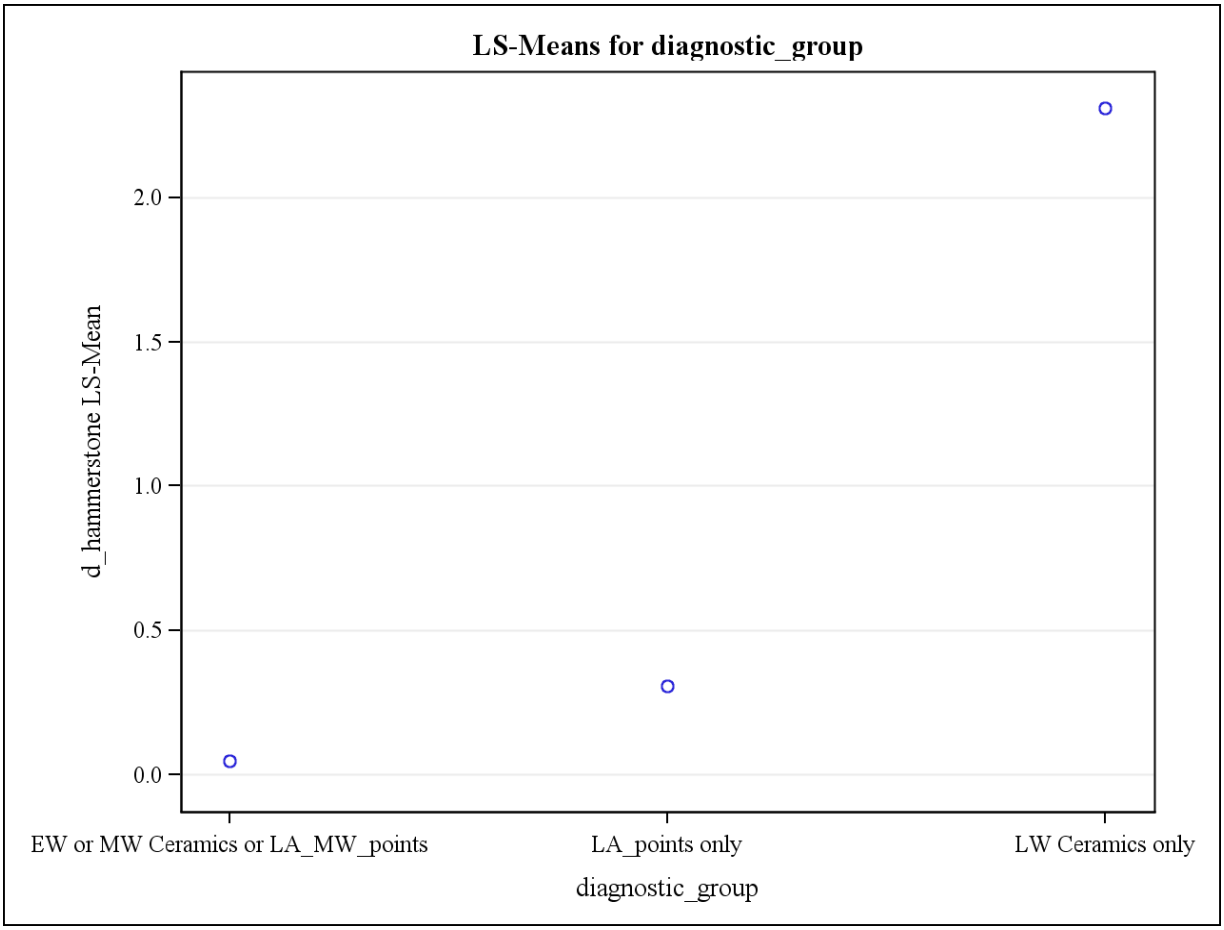


Dependent Variable: d_hammerstone

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	24.33774099	12.16887049	5.10	**0.0139**

Here hammerstone density was higher for the LW_ceramics group ($p<0.05$).

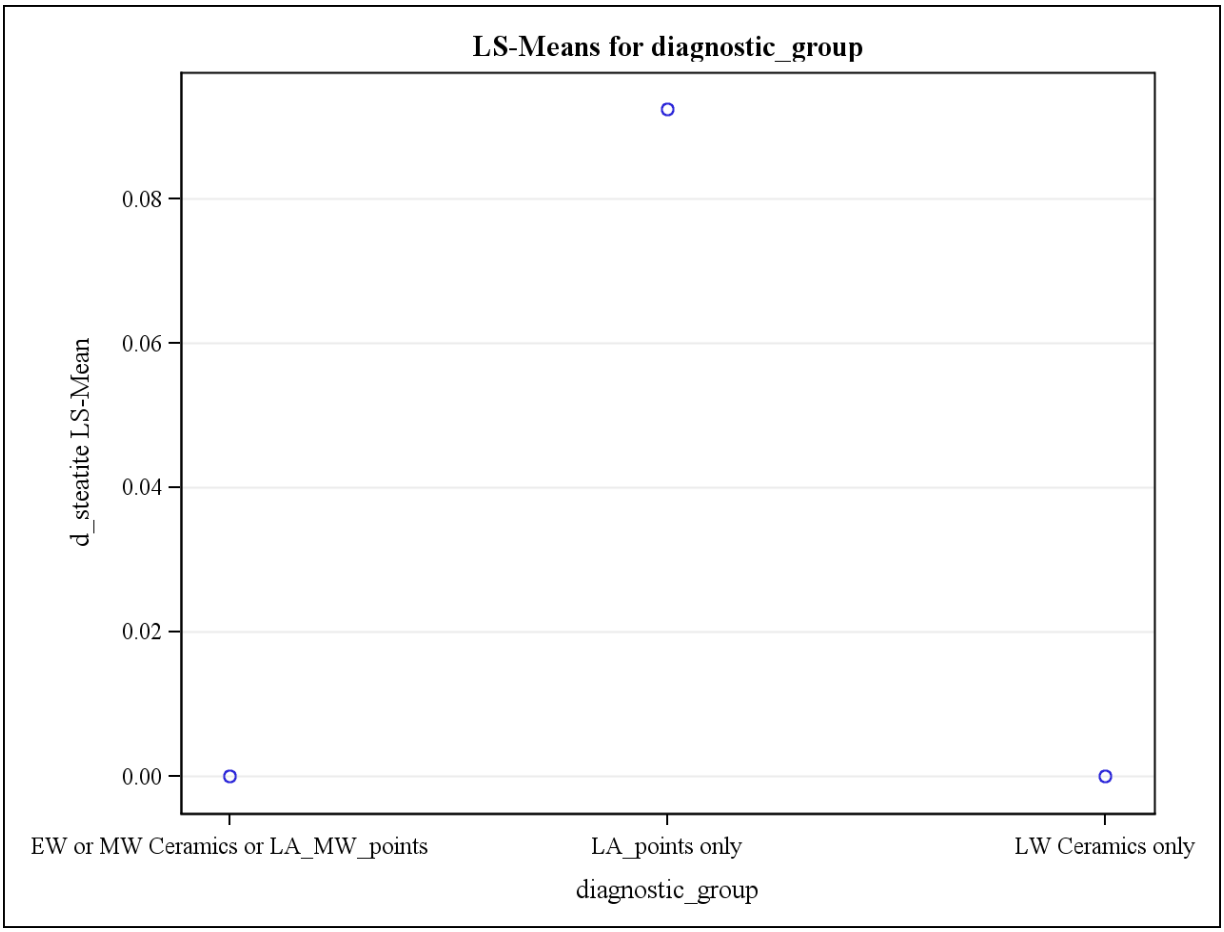
diagnostic_group	d_hammerstone LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	0.04759638	0.46573286	-0.911598	1.006791
LA_points only	0.30620682	0.48846475	-0.699805	1.312219
LW Ceramics only	2.30827374	0.58382704	1.105859	3.510688



Dependent Variable: d_steatite

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	0.05487499	0.02743750	2.01	0.1553

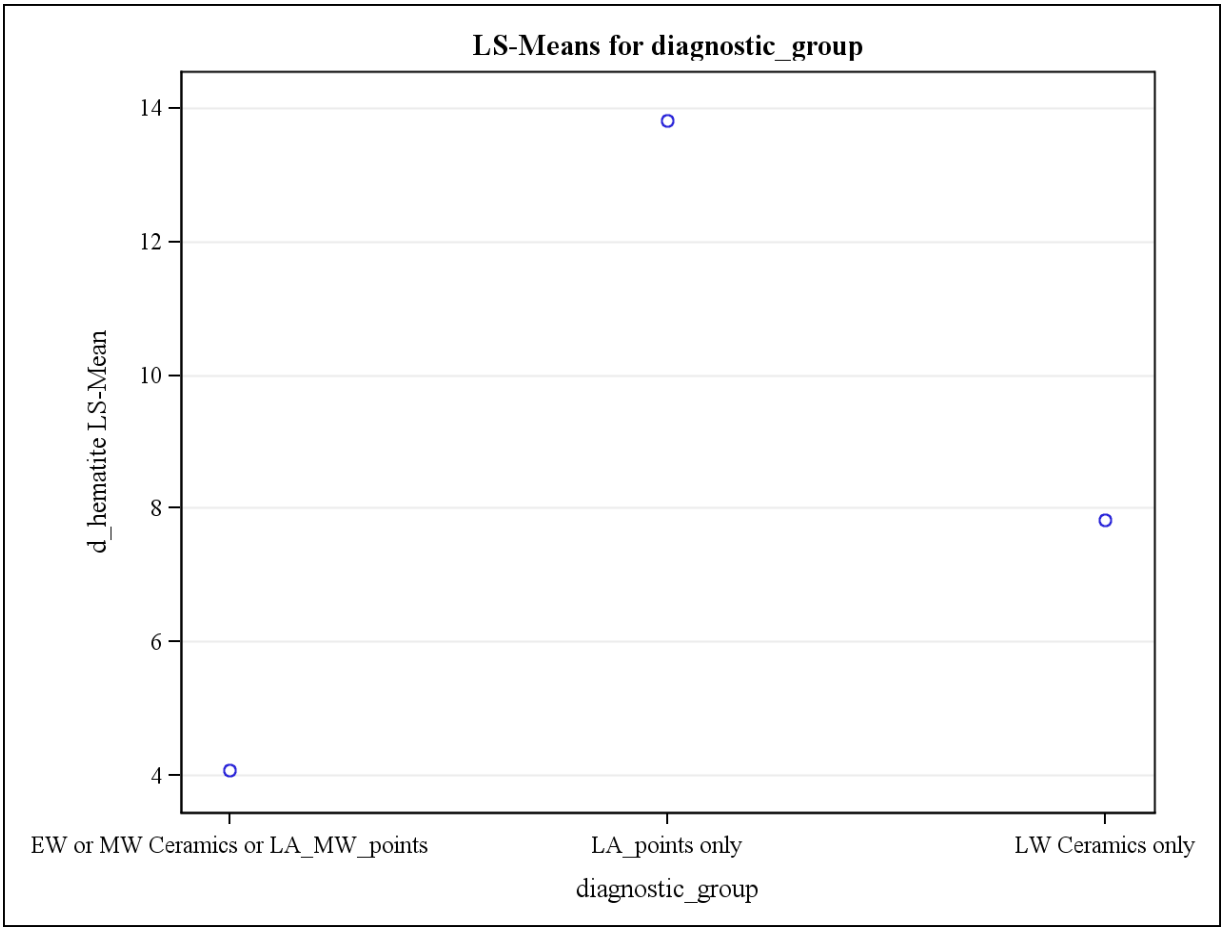
diagnostic_group	d_steatite LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	0.00000000	0.03523951	-0.072577	0.072577
LA_points only	0.09239107	0.03695951	0.016272	0.168511
LW Ceramics only	0.00000000	0.04417506	-0.090980	0.090980



Dependent Variable: d_hematite

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	499.5842093	249.7921046	2.59	0.0947

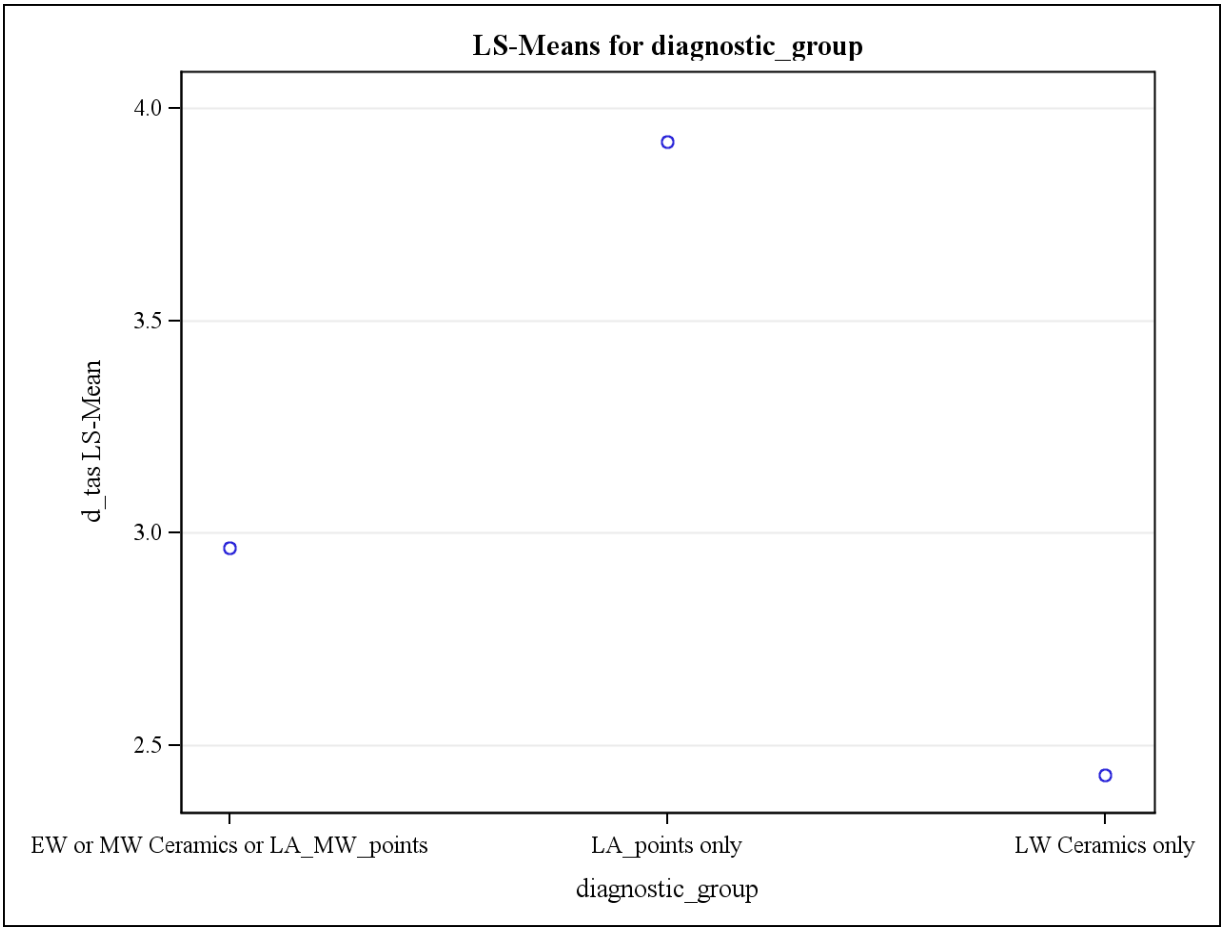
diagnostic_group	d_hematite LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	4.0801924	2.9586441	-2.013249	10.173634
LA_points only	13.8058660	3.1030521	7.415011	20.196722
LW Ceramics only	7.8256578	3.7088567	0.187124	15.464191



Dependent Variable: d_tas

Source	DF	Type III SS	Mean Square	F Value	Pr > F
diagnostic_group	2	9.94140260	4.97070130	0.57	0.5721

diagnostic_group	d_tas LSMEAN	Standard Error	95% Confidence Limits	
EW or MW Ceramics or LA_MW_points	2.96363636	0.88956729	1.131538	4.795734
LA_points only	3.92000000	0.93298605	1.998479	5.841521
LW Ceramics only	2.42857143	1.11513161	0.131915	4.725228



Spatial Analysis

Spatial Autocorrelation: Moran's I Statistic

We employed a measure of spatial association, the Global Moran's I statistic to characterize the spatial occurrence of microtools and grooved abraders.

Data: All features
The VARIOGRAM Procedure
Dependent Variable: Microtool

Number of Observations Read	78
Number of Observations Used	78

Pairs Information	
Number of Lags	11
Lag Distance	16.36
Maximum Data Distance in ECoord	116.70
Maximum Data Distance in NCoord	114.70
Maximum Data Distance	163.63

Pairwise Distance Intervals				
Lag Class	**Bounds**		**Number of Pairs**	**Percentage of Pairs**
0	0.00	8.18	343	11.43%
1	8.18	24.54	919	30.61%
2	24.54	40.91	846	28.18%
3	40.91	57.27	263	8.76%
4	57.27	73.63	150	5.00%
5	73.63	90.00	146	4.86%
6	90.00	106.36	106	3.53%
7	106.36	122.72	106	3.53%
8	122.72	139.09	96	3.20%
9	139.09	155.45	27	0.90%
10	155.45	171.81	0	0.00%

Autocorrelation Statistics						
Assumption	**Coefficient**	**Observed**	**Expected**	**Std Dev**	**Z**	**Pr > |Z|**
Normality	Moran's I	**0.114**	-0.013	0.0197	6.438	**<.0001**

The Moran's I statistic measures spatial autocorrelation using both location and metric values simultaneously. The final interpretation of this statistic indicates whether the spatial pattern of the variable of interest is random, clustered, or dispersed. Morans index will be positive if the pattern is clustered, near 0 when spatially random, and negative when over-dispersed. In the case of microtools, the Moran's coefficient is positive (0.114) and is statistically significantly different from 0, indicating that features with abundant microtools tend to be clustered.
For grooved abraders, we found a very similar result:

Autocorrelation Statistics						
Assumption	**Coefficient**	**Observed**	**Expected**	**Std Dev**	**Z**	**Pr > |Z|**
Normality	Moran's I	**0.115**	-0.013	0.0197	6.51	**<.0001**

Again we conclude that the spatial pattern is non-random and is clustered for grooved abraders. This result is not surprising given the level of association between these two types of artifacts seen in the previous sets of analyses.

Summary

In this revised report, we corrected an earlier oversight on the units of measurement for some variables – some original units were treated as counts rather than densities and affected some statistical analyses involving continuous variables in the draft report. The categorical portion of the report (e.g. contingency tables) remains the same as the draft report except that new diagnostic groupings were used.

We also added a multivariate analysis which included principal components analysis and also a multivariate analysis of variance. The PCA analysis added further support for the conclusion that there were patterns of association in densities of lithic materials and these were linked to diagnostic grops. Individual (univariate) follow-up ANOVA's were used to identify which lithic materials varied significantly among diagnostic groups.

The results of our analyses suggest that the occurrence of microtools and grooved abraders at the Delaware site are linked and associated with the late archaic period. Deviations from a strict pattern of encountering these artifacts with late archaic features may be the result of multiple occupations and / or the potential mixing of materials within a feature.

If you have any questions about the material presented, please feel free to contact us. We at the SCC would like to thank you for your interest in our Center and hope to have the opportunity to work with you on this project.

Sincerely,

Durland Shumway, Ph.D
Faculty Consultant
Telephone: 865-3541
Email: dshumway@stat.psu.edu