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KAMAN-KALEHÖYÜK 15

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Cover symbol: stamp seal made of ivory from Stratum II, Kaman-Kalehöyük

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CONTENTS

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Investigating Iron Age Trade Ceramics at Kaman-Kalehöyük

Peter GRAVE and Lisa KEALHOFER
Armidale, Australia *Santa Clara, Calif.*

INTRODUCTION

During the Iron Age major changes occurred in political and economic organization across Anatolia. After the collapse of the Bronze Age empires, smaller scale local polities developed and expanded in various regions (Phrygia, Urartu, Lydia, and Neo-Hittites). Our understanding of the interconnections between these polities during their development is limited. The aim of the Anatolian Iron Age project (http://aia.une.edu.au) is to study trade ceramics at key Iron Age sites around western Anatolia, in order to better understand how these polities interacted. The project uses a combination of methods to evaluate trade, including typology and INAA and ICP-MS to assess provenience and technological characteristics and to distinguish local from imported wares.

Kaman-Kalehöyük is one of the key sites currently being excavated in central Anatolia with a long Iron Age sequence. The Iron Age pottery has been studied extensively by Kimoyoshi Matsumura as part of his doctoral thesis. In 2004, we collected 168 samples of ceramics from Iron Age contexts at the site for INAA analysis. The results of this work suggest that the Kaman-Kalehöyük data set includes at least four major groups, two of which are likely to represent imports. Within the largest group, the complexity of subgroupings suggests there are either distinct technological traditions or imports within a more localized region.

METHODOLOGY

In order to evaluate trade wares at any site, sampling must include ceramics representing the range of local variation as well as samples thought to represent trade wares. Our preliminary sampling strategy therefore included a large number of local wares as well as ceramics that were thought to be different from local wares (from Iron Age contexts).

Our strategy included identifying sampling contexts that were chronologically coherent. Within these contexts, we sampled the range of wares present. All samples were photographed prior to sampling, and their provenience information recorded along with any identifying characteristics. We used a diamond band saw to sample ca. 1 gram from one side of the sherd.

The choice of analytical technique is related to the nature of the study: in order to look at trade ceramics, a technique is needed that has long term stability and is accurate and precise over a wide range of elements (Grave *et al*. 2005). Instrumental Neutron Activation Analysis (INAA) meets these requirements and has been a method of choice for ceramic characterization in Western Anatolia (e.g., Akurgal 2002; Gomez *et al*. 2002; Henrickson and Blackman 1996; 1999; Hill *et al*. 2004; Mommesen *et al*. 1988; Mommsen *et al*. 2002; Neff 2000; Speakman *et al*. 2004). The use of ICP-MS, while not discussed for the 2004 sample, can provide an even more sensitive characterization of composition (up to 60 elemental isotopes), and will be used on selected samples in the future.

One of the long term goals of AIA is to link our data sets into previously collected INAA datasets from other laboratories in Europe and the US.

Of the 168 samples collected, 155 samples were large enough to submit for INAA (Table 1). The remainder of the (smaller) samples will be analyzed by ICP-MS. Samples were pre-treated in the lab prior to submission; each sample was soaked in de-ionized water to remove contaminants introduced by ground water in

the site (Unruh and Johnson 2005). This is particularly critical for accurately identifying and matching imported wares across the region.

Data Analysis Methods

The INAA geochemical results are analyzed through a combination of multivariate techniques, Principle Components Analysis (PCA) and Canonical Variate Analysis (CVA), used iteratively. PCA is a mathematical technique that allows n-dimensional identification of sample groups; CVA is a statistical technique that allows us to test and optimize these initial group classifications. PCA involves a linear transformation of the original data such that the majority of data variation is accounted for on the first few components (Pollard and Hall 1986; Tangri and Wright 1993). Typically, for highly structured data, the first four components account for around 70% of the total variation (Grave *et al*. 2005). While PCA describes the largest amount of variability in the first three to four components, significant chemical subgroups can still be found in subsequent components.

In our methodology, the first step of multivariate analysis is the application of PCA to the geochemical data set. Using software that allows a dynamic three-dimensional rotation of the graphed PCA results (JMP IN 5.1), groups are identified based on sample contiguity. Each group is assigned a number. Outlying samples are identified and removed from subsequent analysis.

Based on these preliminary groups, we then employ a second multivariate technique, CVA, to evaluate these group identifications. Using CVA we create a discriminant function model to reassess the original elemental dataset using stepwise element selection (selecting elements that best contribute to group identification). Our initial PCA group identifications are then compared with the model enabling us to identify samples that are misclassified. We then iteratively re-assign these samples until an optimized model is achieved, and no further reclassifications are possible. This multivariate analysis facilitates graphic comparison of the datasets (e.g., Grave *et al*. 2000; Tufte 1983) providing an effective visual summary of the structure of the data.

For interpreting these groups we have several working assumptions: 1) in a given dataset, the largest grouping is most likely to represent locally produced ceramics, 2) conversely, smaller groups are more likely to be imported ceramics, and 3) subsets within larger groups are most likely to reflect local resource variations and/or technological differences in production. However, multivariate distance alone is not the same as absolute geographic distance: similar sample chemistries can occur over a large geographical region, while distinct chemistries can occur in relatively close geographic proximity.

RESULTS

Analysis of the geochemical data (Table 2) allowed us to distinguish nine compositional groups. Of these nine groups, Group 1, composed of only 5 sherds, is geochemically distant (on the graph; Fig.1). Of the remaining groups, Group 2, with 11 samples, is the next most geochemically distant.

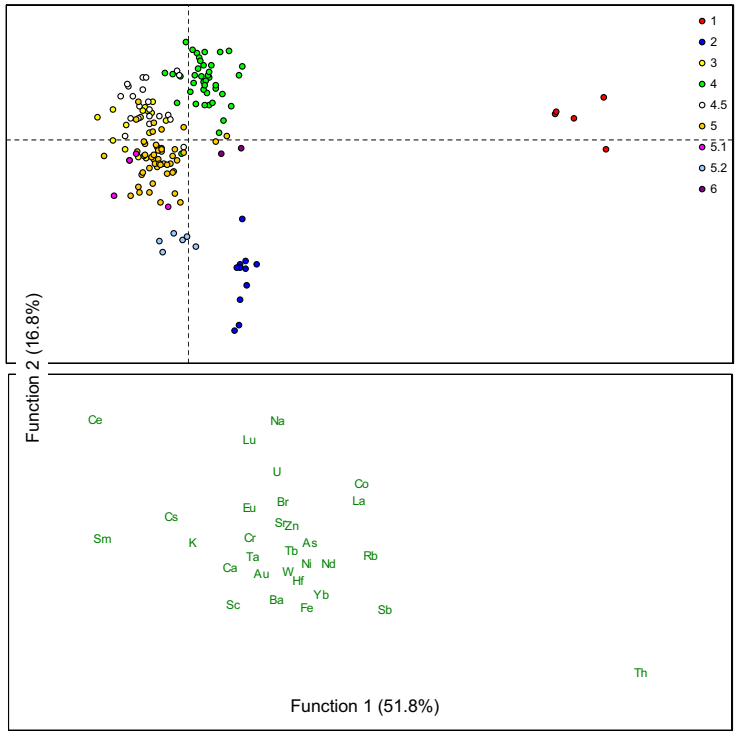

Fig.1 Canonical Variates Analysis scatterplot for the full INAA dataset showing relative position of groups (above), contribution of discriminating elements (below) and % variation accounted for on each CVA function.

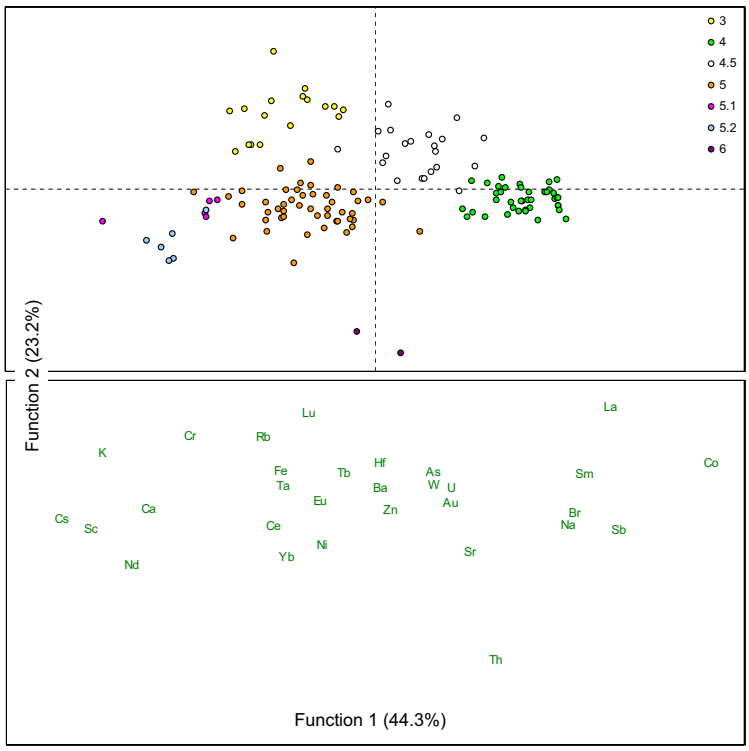

Fig.2 Canonical Variates Analysis scatterplot on the INAA subset with groups 1 and 2 removed showing relative position of groups (above), contribution of discriminating elements (below) and % variation accounted for on each CVA function.

If we remove these two groups, and reanalyze the remaining samples (Fig.2), the overall compositional similarity of the remaining groups is highlighted, but patterns within this cluster are now more apparent. For example Group 6, with two samples, now appears as a compositional outlier. The remaining cluster can be divided into groups by partitioning compositional trajectories (group 4 and 4.5) or by identifying clear spatial separation (groups 3 and 5 with 2 subgroups). Figure 3, an analysis of Group 5 and its subgroups, illustrates this spatial definition showing where group coherence and separation is apparent.

Based on the size and compositional similarity of groups 3, 4, and 5, these samples appear to be locally produced (Fig 4). If we look more closely, however, smaller discrete subgroups within this local sample raise questions about production techniques and/or location.

Having defined the geochemical patterning in these samples, we can now turn to the stylistic content of the geochemical groups (Figs 5-7 illustrate representative types for each group). The vast majority of the samples come from jars.

Group 1 (5): Despite being a small group, this group is stylistically heterogeneous, including brown line on buff and one polychrome jar. The group also includes one bowl rim, a relatively rare form.

Group 2 (11): This group includes polychrome geometric (4), brown on buff hatched triangles (5), and one figurative type.

Group 3 (17): The fabrics in this group are generally quite fine and also include a range of decoration from hatching on white or buff, to polychromes, and a sherd attributed to “East Greek” style.

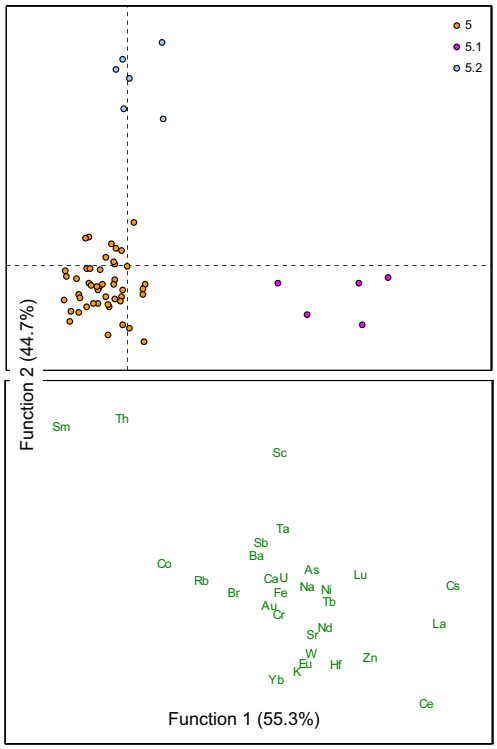

Fig.3 Canonical Variates Analysis scatterplot on the INAA subset for group 5, 5.1 and 5.2 highlighting the distinctiveness of local production trajectories for groups (above) and discriminating elements (below) and % variation accounted for on each CVA function.

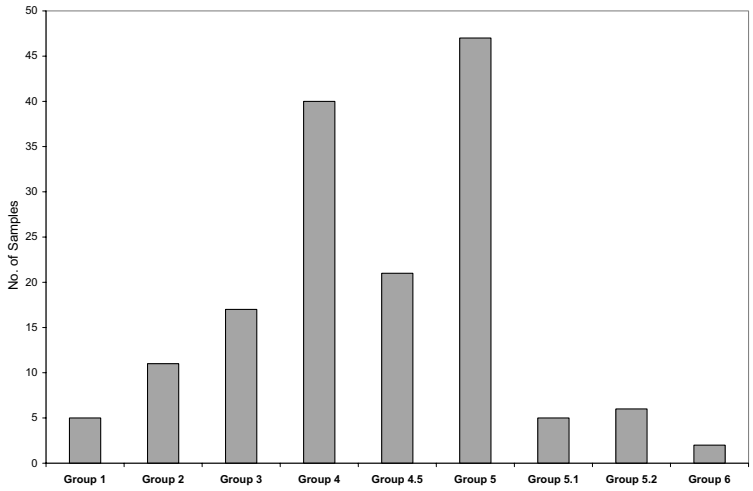

Fig.4 Frequency histogram of sample membership in the nine compositional groups.

Group 4 (40): The fabrics in this group are generally coarser and seem to belong to larger vessels. Styles are diverse from hatching on cream or buff, and polychrome, to two medieval glazed wares.

Group 4.5 (21): This group is similar to Group 4, but seems to represent a group of relatively finer fabrics.

Group 5 (47): This group, the largest, contains a similar diversity of brown on white or buff decoration (hatching, circles, zigzags), some figurative sherds, polychromes (red, brown, cream), and three black polished sherds. Not surprisingly this group includes a larger range of forms, from bowls and small jars to larger forms.

Group 5.1 (5): This small group is stylistically diverse, and includes several eroded and weathered sherds. One modeled sherd is particularly distinctive.

Group 5.2 (6): This group, on the other hand, is stylistically comparatively homogeneous. All but one of the samples is brown hatched triangles. Of these five, four are quite finely decorated.

Group 6 (2): These two sherds have a very fine fabric and are finely decorated with geometric and curvilinear patterns.

DISCUSSION

If we go back to our question about the evidence for trade wares at Kaman-Kalehöyük, we can say that at least a small percentage of the sample is clearly non-local. As discussed above, compositional distance alone is not sufficient to argue for non-local fabrics. For Groups 1 and 2 it is *the combination* of small group size with compositional and stylistic distinctiveness that indicates they are the products of two discrete non-local centres. Within the remaining sample that appears to be local, there are further clear compositional groups. Groups 4 and 4.5 define larger and coarse ware vessels, while Groups 3, 5 and 6 are all fine wares. The differences between these groups fall along several different trajectories: function (groups 4 and 4.5), different resource areas and/or different technological traditions. It is as yet unclear whether these are contemporary or sequential.

If we compare these data with the stylistic evidence, most of the compositional groups (particularly the larger groups) do not readily match stylistically coherent groupings. This would seem to suggest that local producers are making and/or emulating a wide range of styles. The main exception to this is Group 5.2, which shows considerable stylistic homogeneity and may well represent the output of a single workshop. Group 6, while composed of two sherds, also appears to be the output of a single workshop.

The black polished wares highlight possible limitations with INAA. Group 5, while geochemically coherent, includes black polished sherds (508, 520, 524) that might be from Gordion and a sherd (648) which is thought to be East Greek. It might be that the 30 elements used in INAA may not provide sufficient resolution to distinguish the geographic separation of some Turkish ceramics. In an attempt to improve the resolution of our analytic program, we are adopting more sensitive, if less stable, techniques such as ICP-MS. As another line of evidence, we are also building up a sample of sediments from catchments around Iron Age sites in western and central Anatolia

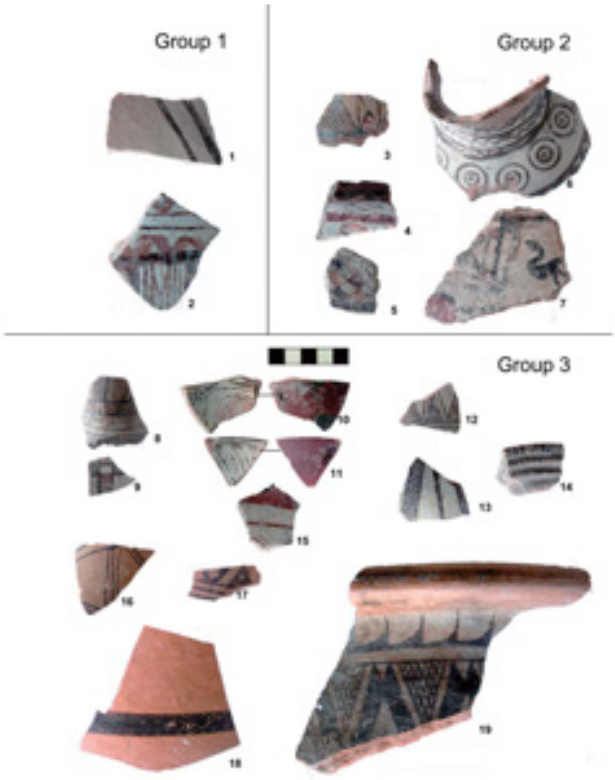

Fig.5 Representative types for Groups 1-3: *(numbers in parenthesis refer to AIA catalogue entries of table 1)* **Group 1**: 1 (547), 2 (623); **Group 2**: 3 (636), 4(637), 5(658), 6(652), 7(674); **Group 3**: 8(574), 9(586), 10(661), 11(650), 12(610), 13(530), 14(569), 15(556), 16(579), 17(580), 18(647), 19(557).

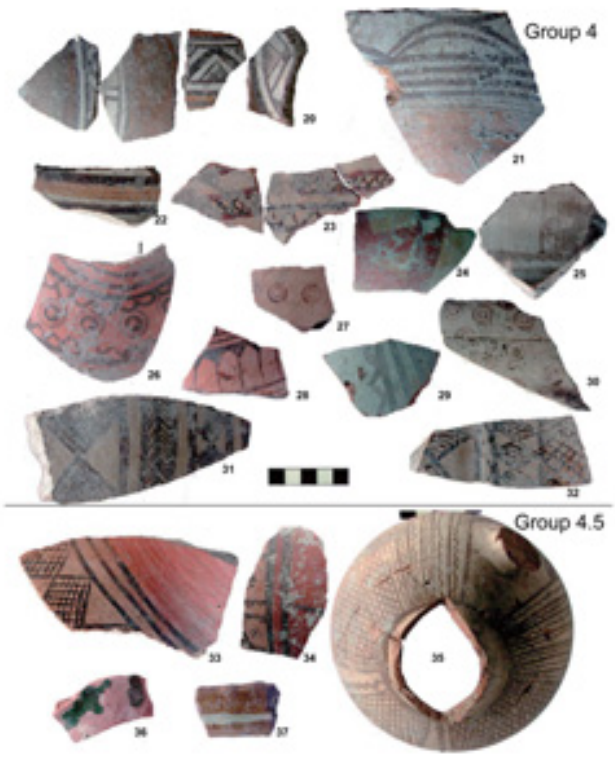

Fig.6 Representative types for Groups 4 and 4.5: *(numbers in parenthesis refer to AIA catalogue entries of table 1)* **Group 4**: 20(531), 21(558), 22(562), 23(598), 24(563), 25(561), 26(619), 27(612), 28(575), 29(602), 30(560), 31(614), 32(621); **Group 4.5**: 33(549), 34(646), 35(670), 36(588), 37(628).

Fig.7 Representative types for Groups 5-6: *(numbers in parenthesis refer to AIA catalogue entries of table 1)* **Group 5**: 38(655), 39(662), 40(581), 41(538), 42(559), 43(657), 44(649), 45(671), 46(540), 47(622), 48(550), 49(529), 50(609), 51(632), 52(648), 53(508); **Group 5.1**: 54(627), 55(584), 56(565); **Group 5.2**: 57(577), 58(616); **Group 6**: 59(660), 60(656).

for geochemical analysis. This should help us resolve whether or not there is geochemical ambiguity using INAA.

CONCLUSION

The samples in this study demonstrate a remarkable diversity in ceramic wares present at Kaman-Kalehöyük in the Iron Age. If the black polished wares are locally produced, they are virtually indistinguishable from those at Gordion (both stylistically and geochemically) (see http://aia.une.edu.au/Data Transfer/Black Polished Poster EMAC 05). This would suggest that Iron Age elites at Kaman-Kalehöyük are reproducing similar contexts/relationships to those known from the Phrygian capital of Gordion.

Based on Kaman-Kalehöyük's position, well inland in central Anatolia, a large number of ceramic imports would not be expected during the Iron Age. Given the caveats about geochemical distance, only a very small percentage (ca. 3%) of the sample appears to be clearly imported. This highlights the importance of reproduction and emulation by local Iron Age producers. Stylistic criteria, in this case, would not be reliable indicators of imported wares but a significant marker of local cultural development.

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Peter Grave
Senior Lecturer
Dept. of Archaeology and Paleoanthropology
University of New England
Armidale, NSW 2351
Australia
pgrave@une.edu.au

Lisa Kealhofer
Associate Professor
Anthropology Dept. Santa Clara University
Santa Clara, CA 95050
USA
lkealhofer@scu.edu

Table 1 Sample catalogue with compositional, contextual and descriptive data

INAA	AIA No.	Date Ref	Sector	Grid	Provisional Layer	Context	Inventory	Form	Description
1	522		N-XVI	XXXV-53	㉕	R346	03001097	jar	plum' ware (slip)
1	535	030715	N-XXXIII	XXXIII-52	②	-	03001110	jar	brown on white
1	547	030709	N-XXXIII	XXXIII-53	①	-	03001122	jar	brown on white
1	554	030711	N-XXV-II	XLII-53/54	②	P2628	03001129	bowl rim	(int) brown on creamy yellow
1	623	030725	N-IX	XXVIII-55	⑮	-	03001198	jar - large	brown on white polychrome
2	537	030702	N-XXXIII	XXXIII-52	①	-	03001112	platter	polychrome
2	546	030722	N-XXXI	XLV-51	⑳	-	03001121	jar - shoulder	brown on white
2	555	030711	N-XXV-II	XLII-53/54	②	P2628	03001130	jar	hatched triangles
2	591	030902	N-XV-XVI	XXXV/XXXVI-53	⑨	P2683	03001166	jar	brown hatched and checkered decoration
2	636	030923	N-XXXII	XLIII-51	⑬	-	03001211	jar	polychrome - brown hatched triangles, red band, red infilled triangles
2	638	030721	N-XXXIII	XXXIII-53	③	-	03001213	jar	brown lines and zigzag on buff
2	652	890711	S-XIV	LXVIII-57	②-ⓐ	-	89002121	jar - rim/neck	brown on white - zigzags and lines
2	658	930825	N-XIV	XXXIX-52	⑭-ⓐ	-	93001089	jar	polychrome - checkerboard pattern
2	666	900721	N-VI	XXXIV-55	㊾	-	90001404	jar - handle attachment	fiber temper
2	669	900719	N-VI	XXXIV-55	㊾	-	90001407	jar	brown line decoration - Fiber temper
2	674			LXX-44	-	surface	KL85- 689 85000001	jar	polychrome - figure?
3	509		N-XVI	XXXV-52	㉔	R346	03001084	jar	brown polished
3	530	030709	N-XVI	XXXV-52	㉔	-	03001105	jar	brown on white - hatched
3	557	030919	N-XV- XVI	Section baulk	⑯	-	03001132	jar - neck/rim	large storage jar rim & neck - brown hatched
3	567	030722	N-XVI	XXXV-53	㉓	-	03001142	jar	jar - brown on white - hatched triangles
3	569	030718	N-XXXI	XLIV-51	⑱	R343	03001144	jar rim	ribbed - brown lines on white
3	574	030807	N-XVI	XXXIV-52	㊴	-	03001149	jar neck?	Fine line - polychrome - brown and red hatching on white
3	578	030704	N-XXXII	XLII-51	①	-	03001153	jar	brown on white
3	579	030716	N-XVI	XXXIV-52	㉜	P2631	03001154	jar	fine - brown on buff
3	580	030820	N-XVI	XXXV-52	㉜	-	03001155	jar	burnished - brown on buff
3	586	030820	N-XVI	XXXV-52	㉜	-	03001161	jar	fine line brown hatched decoration
3	610	030827	N-XVI	XXXIV-52	㊽	-	03001185	jar - small	brown solid and hatched triangles on white
3	615	030804	N-XVI	XXXIV-52	㉝	-	03001190	jar -small rim	brown on white
3	647	900710	S-XIII	LXVIII-55	⑦	-	90001396	jar	E Greek? Banded buff ware
3	650	900623	S-XIV	LXVIII-56	⑤-ⓑ		90001398	bowl/cup rim	purple exterior, brown on white interior - dots
3	659	930804	N- XXIII	XLII-56	④	-	93001090	jar	gray lines, gray fabric
3	661	900622	S-XIV	LXIX-57	③	No.2	90001401	bowl	bowl - exterior plum, interior polychrome
4	510		N-XVI	XXXV-52	㉔	R346	03001085	jar	buff, micaceous
4	511		N-XVI	XXXV-52	㉔	R346	03001086	jar	streaky slip/paint
4	512		N-XVI	XXXIV-52	㉙	R347	03001087	jar	Alisar IV style
4	517		N-XVI	XXXV-52	㉖	R346	03001092	jar	brown on white decoration
4	518		N-XVI	XXXV-53	㉕	R346	03001093	jar	brown bands on polished surface
4	526		N-XVI	XXXV-52	㉔	R346	03001101	jar	red band decoration (fugitive now)
4	531	030919	S-LVII	LV-48	㉑	P746?	03001106	jar - large	polychrome gritty

4	532	030716	N-XV	XXXVI-53	㊴	-	03001107	jar	brown line on red
4	533	030716	N-XV	XXXVI-53	㊴	-	03001108	jar - medium	brown line on white (red)
4	534	030626	N-XVI	XXXIV-53	㉚	-	03001109	jar - large	white w/bands, strip burnished neck
4	543	030625	N-XXXI	XLV-50	⑧	R341	03001118	jar	brown on red
4	544	030723	N-XV	XXXVII-52	⑥①	-	03001119	jar	brown on white
4	545	030903	N-XVI	XXXV-53	㉜	-	03001120	jar	brown on white
4	548	030812	S-LVIII	LVI-48	㉓	-	03001123	jar	brown on white - circles
4	552	030625	N-VII	XXXIII-54	-	-	03001127	jar	Brown on white circles
4	553	030708	N-XV	XXXVII-52	⑤⑨	-	03001128	jar	Brown lines on white
4	558	030701	N-XIII-XXV Section baulk	XLII-53	㉜	P2620	03001133	jar - large	brown on white, red zone
4	560	030723	N-XV	XXXVII-52	⑥③	P2636	03001135	jar	brown circles on white
4	561	030625	N-XXXI	XLV-50	⑧	R341	03001136	jar	Brown on white - thick line
4	562	030718	N-XXXI	XLV-51	⑰	-	03001137	jar	bichrome on white
4	563	030707	N-VII	XXXII-55	㊾	W41W42 R283	03001138	jar	Red bands on buff
4	570	030617	N-XXXI	XLIV-50	④	-	03001145	jar	brown curved lines on red
4	575	030918	N-XV	XXXVI-52	⑤⑧	-	03001150	jar	zone decorated - brown on buff
4	583	030729	N-XXXI	XLV-50	⑬	H260	03001158	jar rim	red burnished, brown decoration
4	590	030923	N-XVI	XXXV-52	㊵	-	03001165	jar	crude brown on red burnished
4	596	030729	N-XXXI	XLV-50	⑭	-	03001171	jar - small, shoulder/ handle	polychrome
4	597	030805	N-XVI	XXXIV-52	㉝	-	03001172	jar	brown on buff
4	598	030618	N-XXXI	XLIV-50	④	-	03001173	jar	red and brown on white
4	602	030722	N-XVI	XXXV-53	㉓	-	03001177	jar	red line and zigzag on white
4	606	030716	N-XXXI	XLV-51	⑯	-	03001181	jar	red curved lines and zigzag on white - jar lid?
4	607	030822	N-XV	XXXVI-52	⑤⑦	-	03001182	jar rim - flared	brown on white
4	612	030918	N-XV	XXXVI-52	⑤⑧	-	03001187	jar	brown circles on white
4	614	030707	N-VII	XXXII-55	㊾	R283 W41; W42	03001189	jar	fine brown herring bone and hatch on white
4	618	030808	N-XVI	XXXIV-52	㊲	-	03001193	jar - small	brown on red
4	619	030721	N-XXXI	XLV-51	⑱	-	03001194	jar	brown circles and curved lines on red
4	620	030901	N-XIII	XLI-52	clean	-	03001195	jar	red and brown on white
4	621	030812	N-XXXIII	XXXIII-52	④	-	03001196	jar - large	brown on white
4	631	030922	N-XXXII	XLIII-51	⑬	-	03001206	jar	green glazed - Seljuk
4	633	030822	N-XV	XXXVI-53	㊶	-	03001208	jar	wide brown lines some curved
4	634	030822	N-XV	XXXVI-53	㊶	-	03001209	jar	brown hatching and lines on buff
4	675	960826	N-XXIX	XLVII-50	II	No.29 ?	96001406	jar	drill hole - fine brown decoration, hatch geometrics - tondo
4.5	513		N-XVI	XXXIV-52	㉙	R347	03001088	bowl - carinated	micaceous slip
4.5	521		N-XVI	XXXV-53	㉕	R346	03001096	jar	Gray, micaceous slip?
4.5	525		N-XVI	XXXV-52	㉔	R346	03001100	bowl? Thin	red slip
4.5	528	030715	N-XXXI	XLIV-51	⑰	-	03001103	jar	brown on white decoration
4.5	541	030822	N-XVI	XXXIV-52	㊼	-	03001116	jar neck	brown on white (local?)
4.5	542	030722	N-XXXI	XLV-51	⑳	-	03001117	jar	brown on red, curvilinear
4.5	549	030617	N-V	XXXVI-55	-	-	03001124	jar - large, neck	polychrome

4.5	573	030704	N-XVI	XXXV-53	㉒	-	03001148	jar	fine line - hatched and checkered
4.5	582	030717	N-XVI	XXXIV-52	㉘	-	03001157	jar - shoulder	brown herring bone and hatch decoration -elaborate
4.5	585	030708	N-XVI	XXXV-52	㉔	-	03001160	jar	burned - brown line decoration?
4.5	588	030923	N-XXXII	XLIII-51	⑬	-	03001163	jar	green glazed - Seljuk
4.5	589	030909	N-XV-XVI	Section baulk	⑪	-	03001164	jar	brown hatched on burnished buff
4.5	608	030806	N-XXV-II	Section baulk XLII-53/54	㉓	-	03001183	jar neck	brown on red
4.5	624	030729	N-XXXI	XLV-50	⑭	-	03001199	jar rim	brown band on white
4.5	628	030922	N-XXXII	XLII-50	③	-	03001203	jar handle	glazed, clear and cream (Seljuk)
4.5	646	KL91	N-XVIII	XXXIX-57	②	KL91-P79	91001954	jar	imitation Rhodian - polychrome
4.5	664	900821	N-VI	XXXV-55	㊽-⑨	-	90001402	jar	Kaman 2D
4.5	665	900828	N-VI	XXXIV-55	㊷	-	90001403	jar	fiber temper
4.5	667	900903	N-VI	XXXIV-55	㊷	-	90001405	jar	panel/band decoration
4.5	670	881011	N-V	XXXVIII-55	㉙-ⓑ	KL88-1011	88000498	jar	"Gordion" jar - brown on white - lines and zigzags
4.5	673	960830	S-XXVII	LVII-53	⑨	P599	96001536	jar	brown line on buff
5	508		N-XVI	XXXV-52	㉔	R346	03001083	jar	black burnished
5	514		N-XVI	XXXIV-52	㉙	R347	03001089	jar	Gray fine ware
5	515		N-XVI	XXXV-52	㉖	R346	03001090	jar	Red band decoration
5	516		N-XVI	XXXV-52	㉖	R346	03001091	jar	incised line decoration (3)
5	519		N-XVI	XXXV-53	㉕	R346	03001094	bowl - carinated	micaceous slip
5	520		N-XVI	XXXV-53	㉕	R346	03001095	jar	black burnished, ridges
5	523		N-XVI	XXXV-53	㉕	R346	03001098	jar/jug small	buff, fine
5	524		N-XVI	XXXV-52	㉔	R346	03001099	jar	black polished
5	527	030714	N-XXXIII	XXXIII-52	①	-	03001102	jar	polychrome - hatched
5	529	030619	N-XVI	XXXV-53	⑳	-	03001104	jar	fine line - hatched
5	536	030701	N-XIII-XXV	XLII-53	㉜	P2620	03001111	jar rim	brown on white decoration
5	538	030903	N-XVI	XXXV-52	㉜	-	03001113	jar	Checkerboard design, polychrome
5	540	030707	N-XVI	XXXV-53	㉒	-	03001115	jar rim	brown lines on white
5	550	030627	N-XXV-XXVI	XLIII-52	⑬	P1877	03001125	jar	brown on white decoration
5	551	030715	N-XXXIII	XXXIII-52	②	-	03001126	jar	brown on white decoration
5	556	030711	N-XXV-II	XLII-53/54	②	P2628	03001131	jar	red lines and circles
5	559	030618	N-XXXI	XLIV-50	④	-	03001134	jar - small	brown on white, red zone
5	568	030708	N-XVI	XXXV-52	㉔	-	03001143	bowl rim	brown lines on white
5	571	030711	N-XV	XXXVII-52	㊶	-	03001146	jar	brown zigzag on red
5	572	030721	N-XVI	XXXV-52	㉕	-	03001147	bowl rim	buff
5	576	030724	N-XXXI	XLIV-51	⑲	R343	03001151	jar rim	brown on white decoration
5	581	030917	N-XXXII	XLII-50	⑦	W4	03001156	jar	polychrome jar
5	587	030820	N-XVI	XXXV-52	㉜	-	03001162	jar	brown line and zigzag
5	593	030731	N-VIII	XXXI-55	㊻	P2647	03001168	jar	red triangles on white - carinated
5	594	030813	N-XVI	XXXV-52	㉚	-	03001169	jar spout?	Red and brown lines on white
5	595	030716	N-XVI	XXXIV-52	㉜	P2631	03001170	jar - vertical rim	fine white - brown line decoration
5	601	030722	N-XXXIII	XXXIII-53	③	-	03001176	jar? Rim	molded knob - brown on white
5	605	030722	N-XXXI	XLV-51	⑳	-	03001180	jar	brown lines on red
5	609	030827	N-XVI	XXXV-53	㉚	-	03001184	jar neck	hatched geometrics, brown on white
5	611	030811	N-VIII	XXX-54	⑭	-	03001186	jar	red ridges, burnished

5	617	030918	N-XXXII	XLII-51	⑫	-	03001192	jar neck	brown on white, modeled; fine white fabric
5	622	030909	N-XXXII	XLIII-51	⑫	-	03001197	jar	brown thin lines on white
5	625	030729	N-XXXI	XLV-50	⑭	-	03001200	jar - small	fine brown circles on white
5	630	030911	N-XV	XXXVI-53	㊷	-	03001205	jar	brown line on white
5	632	030226	N-XXXI	XLIV-51	⑬	-	03001207	jar - strap handle large	brown circles on buff
5	635	030923	N-XXXII	XLIII-51	㊸	-	03001210	jar rim	lug? Polychrome red band brown hatch
5	637	030716	N-XV	XXXVI-53	㊴	-	03001212	jar spout?	Red burnished, white paint
5	648	900712	S-XIII	LXIX-54/55	⑦	-	90001409	jar - small rim	Greek? brown lines
5	649	900729	N-XIX N-XVII	XXXVII-57 XL-57	④	P705	90001397	jar neck	polychrome
5	651	890908	N-VI	XXXIV-55	㊽	-	89002120	bowl - ring base	black exterior
5	653	910826	N-XVIII	XXXVIII-57	③	-	91001955	jar	bichrome on buff - black and brown
5	655	900709	S-XXXI	LXXI-56	⑤	-	90001400	bowl rim	orange and brown dots
5	657	-	S-XXII	LXV-52	Gu XXII	R17 removing wall KL89-P357	89002122	jar	brown on white - hatched and triangles
5	662	920808	N- XXIII	XLIII-56	⑥ & ②	-	92002809	bowl	Brown dots on buff
5	668	900721	N-VI	XXXIV-55	㊾	P402	90001406	jar	fiber temper - band decoration
5	671	970721	N- XXIX	XLVII-50	⑬	No.5	97001476	jar -small	brown on white - horses
5.1	539	030911	S-LVIII	LVII-49	㉟	P744	03001114	jar	zigzag decoration
5.1	565	030716	N-XV	XXXVI-53	㊴	-	03001140	jar neck	brown on white, circles and bands
5.1	584	030923	N-XXXII	XLII-51	⑬	-	03001159	jar	molded dec - painted rec, brown, white - figure?
5.1	603	030722	N-XVI	XXXV-53	㉓	-	03001178	jar	red circles and curved lines on white
5.1	627	030825	N-XVI	XXXV-53	㉚	-	03001202	jar	brown hatched geometrics on white
5.2	564	030701	N-X	XXVI-55	②	-	03001139	jar	brown hatched on white
5.2	577	030903	N-XV-XVI	Section baulk	⑪	-	03001152	jar	brown hatched, red line, on buff
5.2	600	030729	N-XXXIII	XXXII-53	①	-	03001175	jar	red and brown checkerboard on white
5.2	616	030821	N-XXXII	XLII-50	③	R356	03001191	jar	brown hatched triangles on white
5.2	663	940809	S- LII	LII-50	⑭	R44	94001661	jar/jug	brown on buff, large hatched triangles
5.2	672	980710	N- XXVI	XLVI-52	⑪	-	98001434	jar - medium / large - ledge rim	black burnished
6	656	910819	-	-	-	From the surface of east slope	91001956	pot - small	brown circles on buff - lines and zigzags
6	660	860805	N-VI	XXXV-55	⑬-ⓚ	-	86000808	jar	red band, wavy brown lines
Outlier	592	030826	N-XVI	XXXV-53	㉚	-	03001167	jar	brown hatched triangles
Outlier	599	030808	N-XXXII	XLII-50	①	-	03001174	jar	fine brown on white
Outlier	604	030827	N-XVI	XXXV-53	㉚	-	03001179	jar neck?	Brown lines on white
Outlier	613	030729	N-XVI	XXXV-52	㉔	R346	03001188	closed vessel	fine brown line on white
Outlier	626	030729	N-XXXI	XLV-50	⑭	-	03001201	jar	brown lines - curved and straight - on red
Outlier	629	030627	N-XXXI	XLIV-51	⑭	-	03001204	cup? Rim	very fine brown on buff
Outlier	654	900709	S-XVII	LXXI-55	④	-	90001399	bowl/cup	smoothed buff

Table 2 Summary of the INAA dataset by group.

	Group 1	*n=5*	Group 2	*n=11*	Group 3	*n=17*	Group 4	*n=40*	Group 4.5	*n=21*	Group 5	*n=47*	Group 5.1	*n=5*	Group 5.2	*n=6*	Group 6	*n=2*
element	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*	*Avg.*	*%Stdev.*
Sb	8.74 ±	69.98	13.28 ±	100.8	1.16 ±	107.54	3.72 ±	91.93	2.1 ±	52.87	2 ±	57.66	2.94 ±	19.63	4.65 ±	35.64	2.4 ±	35.36
As	69.6 ±	50.97	112.64 ±	54.76	39.65 ±	68.51	91.33 ±	44.78	80.33 ±	63.19	68.79 ±	76.69	59.8 ±	36.64	71 ±	56.89	35 ±	16.16
Ba	514 ±	14.34	858.18 ±	29.89	547.65 ±	24.11	725 ±	13.46	732.38 ±	18.8	593.62 ±	38.43	818 ±	39.54	491.67 ±	36.73	600 ±	30.64
Br	0.65 ±	138.75	1.17 ±	71.58	0.62 ±	125.97	1.64 ±	64.39	2.91 ±	147.95	1.54 ±	58.51	0.64 ±	103.77	1.47 ±	35.47	0.8 ±	17.68
Ca%	3.24 ±	71.64	4.12 ±	47.27	4.49 ±	64.42	4.69 ±	21.44	4.54 ±	31.3	9.61 ±	26.64	6.16 ±	12.92	9.87 ±	23.94	16.5 ±	4.29
Ce	158.2 ±	12.14	41.18 ±	33.49	77.06 ±	17.59	111 ±	13.66	84.05 ±	18.17	60.87 ±	27.48	47.4 ±	33.28	28.5 ±	13.99	126.5 ±	21.8
Cs	37.94 ±	86.89	10.02 ±	13.07	9.96 ±	43.86	9.48 ±	14.94	8.09 ±	16.73	7.75 ±	39.25	22.14 ±	55.12	17.07 ±	49.09	10.9 ±	40.22
Cr	44.88 ±	99.53	148.82 ±	20.73	216.61 ±	45.77	151.05 ±	18.62	171.5 ±	26.41	169.65 ±	70.56	57 ±	32.4	167.62 ±	32.54	53.9 ±	73.2
Co	7.34 ±	61.5	15.91 ±	41.74	27.29 ±	24.74	19.1 ±	10.05	22.29 ±	19.15	18.81 ±	38.87	9.3 ±	55.98	24.83 ±	10	8.25 ±	47.14
Eu	1.08 ±	21.97	0.62 ±	49.98	1.4 ±	14.29	1.51 ±	11.9	1.38 ±	15.64	1.06 ±	15.77	1.01 ±	14.07	0.67 ±	17.2	1.4 ±	10.1
Au	6.01 ±	172.96	4.73 ±	201.91	0.95 ±	289.07	0.63 ±	350.66	5.19 ±	85.71	1.18 ±	209.29	1.21 ±	221.76	2.84 ±	154.77	- ±	-
Hf	8.74 ±	8.85	3.77 ±	19.55	5.19 ±	18.91	6.37 ±	10.92	5.37 ±	22.26	3.78 ±	24.23	4.28 ±	27.57	2.22 ±	11.56	4.05 ±	19.21
Fe%	2.47 ±	34.46	5.6 ±	12.35	5.44 ±	16.61	4.77 ±	8.26	4.85 ±	13.78	4.04 ±	22.26	3.47 ±	32.27	4.84 ±	21.28	2.68 ±	17.18
La	100.98 ±	18.18	27.27 ±	29.46	39.62 ±	16.55	61.64 ±	12.46	45.58 ±	18.92	34.2 ±	28.61	28.1 ±	38.57	16.32 ±	18.06	73.85 ±	20.2
Lu	0.29 ±	17.93	0.22 ±	29.26	0.44 ±	16.95	0.42 ±	10.5	0.39 ±	11.95	0.3 ±	12.36	0.33 ±	15.35	0.26 ±	8.2	0.26 ±	16.32
Nd	39.4 ±	20.27	16.36 ±	35.24	34.88 ±	18.35	42.38 ±	15.23	35.48 ±	13.39	26.7 ±	22.63	21.2 ±	18.69	13.33 ±	12.25	47.5 ±	22.33
K%	5.24 ±	16.89	2.23 ±	29.03	3.71 ±	22.25	2.96 ±	16.15	3.6 ±	25.01	3.32 ±	27.33	3.04 ±	23.33	2.18 ±	30.16	3.35 ±	6.33
Rb	258 ±	15.84	78.45 ±	13.81	135.29 ±	21.25	119.43 ±	9.79	114.14 ±	10	103.49 ±	24.65	92.2 ±	24.31	78.67 ±	30.12	117 ±	39.89
Sm	5.53 ±	16.02	2.7 ±	47.81	6.5 ±	17.76	7.64 ±	12.83	6.51 ±	11.49	4.69 ±	18.01	3.6 ±	17.17	2.56 ±	0.88	6.96 ±	17.79
Sc	5.62 ±	80.73	25.66 ±	33.57	20.88 ±	9.57	15.64 ±	7.34	17.94 ±	16.63	15 ±	30.92	13.36 ±	42.91	24.55 ±	13.98	9.09 ±	18.83
Na%	0.99 ±	54.76	0.27 ±	45.85	0.68 ±	32.6	1.36 ±	11.1	1.2 ±	35	0.85 ±	28.88	0.88 ±	39.11	0.37 ±	14.98	0.2 ±	54.39
Sr	62.01 ±	223.57	91.83 ±	172.24	37.07 ±	282.58	323.75 ±	71.1	179.53 ±	110.69	397.66 ±	50.05	92.01 ±	223.58	111.67 ±	156.17	910 ±	29.53
Ta	1.72 ±	42.6	0.74 ±	43.55	1.52 ±	32.7	1.7 ±	31.01	1.35 ±	39.16	0.94 ±	58.12	0.29 ±	215.84	0.39 ±	107.14	1.25 ±	16.97
Tb	0.54 ±	61.28	0.27 ±	138.02	1.02 ±	17.79	0.95 ±	26.72	0.92 ±	40.21	0.66 ±	48.6	0.6 ±	56.82	0.39 ±	107.14	0.8 ±	17.68
Th	81.16 ±	15.42	14.45 ±	21.07	13.56 ±	27.22	28.08 ±	16.46	16.75 ±	30.82	14.65 ±	37.4	11.28 ±	32.56	10.53 ±	34.21	40.6 ±	14.98
W	8.2 ±	10.2	5.36 ±	26.72	2.18 ±	61.16	4.53 ±	28.74	2.67 ±	55.91	3.04 ±	42.22	2.2 ±	20.33	2 ±	70.51	3.5 ±	20.2
U	15 ±	22.61	3.54 ±	26.57	2.57 ±	24.01	4.89 ±	43.64	3.06 ±	30.24	3.22 ±	29.82	2.08 ±	28.52	1.68 ±	30.85	5.85 ±	22.97
Yb	1.58 ±	24.68	1.37 ±	29.97	2.85 ±	17.08	2.68 ±	11.46	2.52 ±	14.23	1.95 ±	13.46	2.1 ±	15.79	1.67 ±	11.17	1.55 ±	4.56
Zn	119.6 ±	13.76	132.73 ±	14.72	115.18 ±	14.71	112.48 ±	12.12	108.95 ±	14.76	97.11 ±	19.09	84 ±	31.67	89.83 ±	22.84	119 ±	60.61

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