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Elymian regional interaction in Iron Age western Sicily: a preliminary neutron activation study of incised/impressed tablewares

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Abstract

Neutron activation analysis of indigenous ceramics from western Sicily reveals five compositional clay types used in production, suggesting specific exchange patterns around the 5th century BCE, at a time of escalating Greek and Phoenician colonial intrusions. A sample of 62 incised/impressed tableware specimens suggests that ceramic manufacture was organized on a regional level with distinct patterns of intra-group trade of vessels, and that the distribution of these ceramics has important implications for the refinement of cultural–historical affiliations of western Sicily at this time. In fact, the spatial distribution of one of these compositional groups appears to directly correspond with epigraphic data regarding the presence of the Elymians centered at Segesta.

Keywords: Ceramics; Iron Age; Elymi; Neutron activation analysis; Pottery production; Sicily

1. Introduction

The excavations at Monte Polizzo (Sicilian–Scandinavian Project, Trapani province, western Sicily) seek to detail the foundations of indigenous social organization in the face of first millennium BCE Greek and Phoenician colonization. Western Sicily is the only part of the Mediterranean where Greeks and Phoenicians settled in close proximity to one another, and nearby an indigenous tribe known as the Elymians who subsequently developed an important regional polity by 500 BCE. The topic of indigenous regional interaction is usually ignored within the greater framework of classical studies and Greek and Phoenician colonial contact [5,6,8,11,19], although the work at Monte Polizzo (locally pronounced as Pólizzo) seeks to valuate indigenous autonomous political development as social and economic functions.

The origins of the Elymians are difficult to trace, however many scholars consider them a distinctive manifestation of the broader indigenous Sican ethnic groups present in Sicily, existing perhaps as an amalgam of local peoples and Anatolian or Italic immigrants [4,7,12,13 (p. 227), 17,24]. According to literary sources such as Diodorus, Pausanias, and Thucidides, the Elymians occupied the far western reaches of Sicily, controlling two important strongholds near the western coast: Segesta and Eryx (modern Erice). These strongholds served to counterbalance the political influence of the nearby Phoenician colony of Motya (est. 720 BCE) and the Greek city of Selinus (est. 628 BCE). The Elymians were renowned for their political astuteness and

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longevity. They maintained a fairly stable and long-term relationship with the Phoenicians and Carthaginians. Segesta helped thwart the Greek incursion of Pentathlos in 580 BCE and joined in an Athenian alliance against the expansionistic plans of Dionysius of Syracuse. There was some fallout with Carthage in 397 BCE, but otherwise Segesta stayed loyal until the wars with Pyrrhus in the 270s and its ultimate defection to Rome in 262 BCE.

In western Sicily two major stylistic types define the final indigenous ceramic horizon: (1) incised/impressed, and (2) matte-painted wares. Found primarily at interior proto-urban hilltop settlements such as Monte Polizzo, research conducted within the last 10 years has shed new light on indigenous ceramic production and use. Both types are distinguished by decorative attributes and fabric type [17,23], and document the occurrence of localized ceramic production between the 9th and 5th centuries BCE [25]. The stamped/incised style generally gave way to matte-painted styles after 600 BCE at two eastern settlements [17,18], although stamped/incised wares remain the predominant style at Monte Polizzo into the 5th century BCE [14]. After 600 BCE increasing quantities of Greek ceramics eventually permeate these interior hilltop assemblages. Moreover, a series of short inscriptions found at Segesta were written using Greek script, but are thought to represent a non-Greek Elymian language (see [12]).

Tusa [24] divides these materials into two phases, the earliest dubbed as "proto-Elymian" (9th–8th century BCE) incised designs consisting of simple horizontal lines, meanders, and zig-zags. He argues that these earlier materials have affinities with nearby southern Italian and Maltese wares. Tusa's second phase (7th–5th century BCE) consists of star, triangle and losange incised/impressed designs, and the simple geometric motifs of the black matt painted wares. However, others have argued that it is difficult to connect these pottery styles to an Elymian territory or phase of use, suggesting rather that the spatial and temporal similarities of these design types document a more homogeneous confederation of indigenous settlements (see [9 (p. 87), 21,22]).

In this paper, we summarize the results of ceramic compositional analysis of 62 indigenous incised/impressed sherds collected from 12 indigenous hilltop settlements (Table 1). These hilltop settlements were bastions of indigenous culture, all existing during a period of rapid transformation as Greek and Phoenician settlers began to colonize between the 8th and 5th century BCE [2,3,13,14,17,20,24]. Some of these sites date to the 10th or 9th centuries BCE (e.g. Monte Finistrelle, Scirinda and Sant' Angelo Muxaro), while others rise as late as the 6th century BCE. Despite their varied occupation sequences, these sites all share important characteristics such as hilltop topography and material culture, including incised/impressed ceramic designs (see [13 (p. 219), 18]).

Table 1
Summary of ceramics analyzed by INAA from each site and their corresponding decorative motif

Site	Simple banded	Complex banded	Cerchielli	Denti di lupo	Total
Castello della Pietra	0	0	0	1	1
Entella	0	0	1	1	2
Montagne Grande	2	1	1	0	4
Monte Finistrelle	3	3	0	0	6
Monte Maranfusa	1	0	0	3	4
Monte Polizzo	4	2	0	16	22
Montignoli	1	0	1	7	9
Salemi	5	2	0	0	7
Sant Angelo Muxaro	0	0	1	1	2
Scirinda	0	0	2	0	2
Segesta	0	1	1	0	2
Selenunte	0	0	1	0	1
Total	16	9	8	26	62

The sample includes pottery from recent excavations and extant museum collections.

Our goal is to obtain a more precise understanding of indigenous incised/impressed ceramic production and exchange during what many assume was a period of Hellenistic enculturation and economic integration. Two questions become predominant: (1) were indigenous ceramics produced in a limited number of locations or were they manufactured at many different places? And (2) were these ceramics distributed close to their production centers or were they broadly dispersed among the various settlements? The identification of ceramic compositional groups should provide some insight into how indigenous ceramic production was organized. If only a few groups exist then the clay procurement/processing step of ceramic manufacture would have been specialized to some degree. If many compositional groups exist then this step was probably less specialized. Spatial patterning of these compositional groups should also be indicative of regional interaction and exchange. The concentration of compositional groups to only a few settlements will suggest the presence of limited exchange networks and marginal economic integration between settlements, whereas a more widespread distribution of compositional groups indicates a high degree of economic integration with very open exchange networks.

2. Methods

Table 1 shows a total of 62 incised/impressed sherds that were collected from 12 different indigenous hilltop settlements. Approximately half of the analyzed specimens were acquired from existing museum collections; the other half of the samples were obtained from recent excavations at Monte Polizzo and Salemi. Our sample

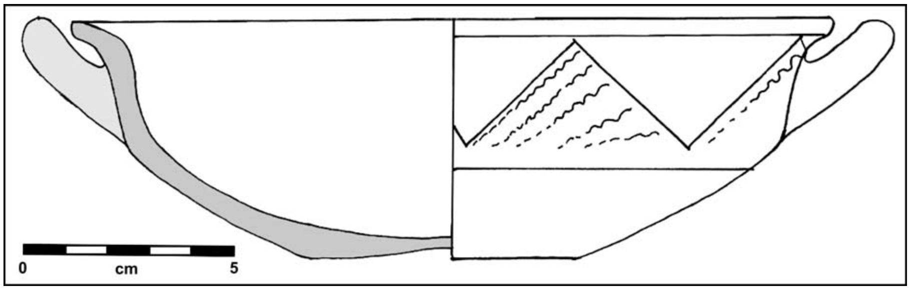

Fig. 1. Typical "attingitoi" cup with raised handles, from Salemi (sample EEB026).

strategy was strictly based upon availability; we sampled any diagnostic ceramic sherd or pot that we could find. Many of the museum pieces were difficult to locate because they were bulk-stored with other finds for more than a decade. Some also lacked detailed provenance records, although we know that all were recovered from household or trash pit contexts. Temporally, we treat these ceramics as a single analytical unit because of the general similarity in production of these two styles, because of their homogeneous use for over five centuries, and because of the irregularities in provenance.

All analyzed sherds are indigenous household tableware vessels; open-rimmed "scodelloni" bowls and "attingitoi" cups with raised handles, as well as close-rimmed jars and jugs (see [17,23 (p. 109)]). No other finer quality indigenous ceramics were made at the time, and often these household ceramics doubled as burial offerings. An example of a typical incised/impressed vessel is shown in Fig. 1. These wares are typically handmade or slow wheel thrown. Clay fabrics are of a varied nature, but vessels appear to be made using either a coarse and granular or a fine and compact fabric. Vessel colors range from gray, to red, to whitish, but often possess a gray interior. Preliminary petrological analysis of five different incised vessels from Monte Maranfusa has also revealed a series of subordinate fabric types that fit into these two general categories [1,23 (p. 111)]. Some vessels also possess an almost burnished surface, and/or a thick white or red slip [21, p. 97].

Design motifs follow four basic patterns: (1) simple banded, (2) complex banded (3) "cerchielli" star stamps, and (4) complex zig-zags or meanders. Simple-banded styles are incised parallel horizontal, vertical, or zig-zag lines. Complex banded are incised parallel lines filled with additional incised or impressed striped or wavy lines. Star motifs, or "cerchielli," are clusters of stamped circular or concentric ring patterns. Complex zig-zags, also called "denti di lupo" or wolf's teeth, are incised parallel lines filled with additional incised or impressed striped or wavy lines. Meanders are curvilinear designs filled in the same fashion.

Geographically, these sites may be broken down into three geographic areas as shown in Fig. 2. In the far west are four sites located within the "historically defined" boundary of Elymian territory. These sites include Segesta ($N = 2$), Montagne Grande ($N = 4$), Monte Polizzo ($N = 22$), and Salemi ($N = 7$). Monte Polizzo and Salemi are currently being excavated under the aegis of the Sicilian–Scandinavian Archaeology Project. A second group of sites are located along the Belice River valley. These include Monte Finestrelle ($N = 6$), Monte Maranfusa ($N = 4$), Entella ($N = 4$), Castello della Pietra ($N = 1$), Montagnoli ($N = 9$), and Selinus ($N = 1$). Selinus represents the only non-indigenous coastal Greek colony, but historically had regular contact with the Elymians. The third group of sites consists of the south-central Iron Age settlements of Scrinda ($N = 2$) and Sant' Angelo Muxaro ($N = 2$).

We of course acknowledge that these data represent a relatively small preliminary sampling. The museum finds are underrepresented in terms of sample size compared to the excavation samples; the six sites (Castello della Pietra, Entella, Sant'Angelo Muxaro, Scirinda, Segesta, and Selinus) represented by two or fewer samples precludes conclusive discussions of exchange for now. Nonetheless, these data represent a very important preliminary analysis in a region of the world where there has been almost no scientific analysis of pottery to date. Taken as a whole, we argue that the spatial coherence of our visible ceramic groups represent genuine regional patterns that merit some discussion, and should contribute to the ongoing debates regarding the role of indigenous regional exchange as well as the role of Greek and Phoenician trade influence.

Each collected sample was drilled at a cleaned edge with no more than 500 mg of clay powder being removed from the interior of the sherd using an electric drill and tungsten/diamond bit. Sherds were drilled at the fractured edges so that slipped surfaces could be avoided. Care was taken to preserve sherd integrity for future museum display. Powdered pottery samples were placed in a polyethylene vial for transportation to the laboratory.

Instrumental Neutron Activation Analysis (INAA) was conducted at the Archaeometry Laboratory at the University of Missouri Research Reactor (MURR). The

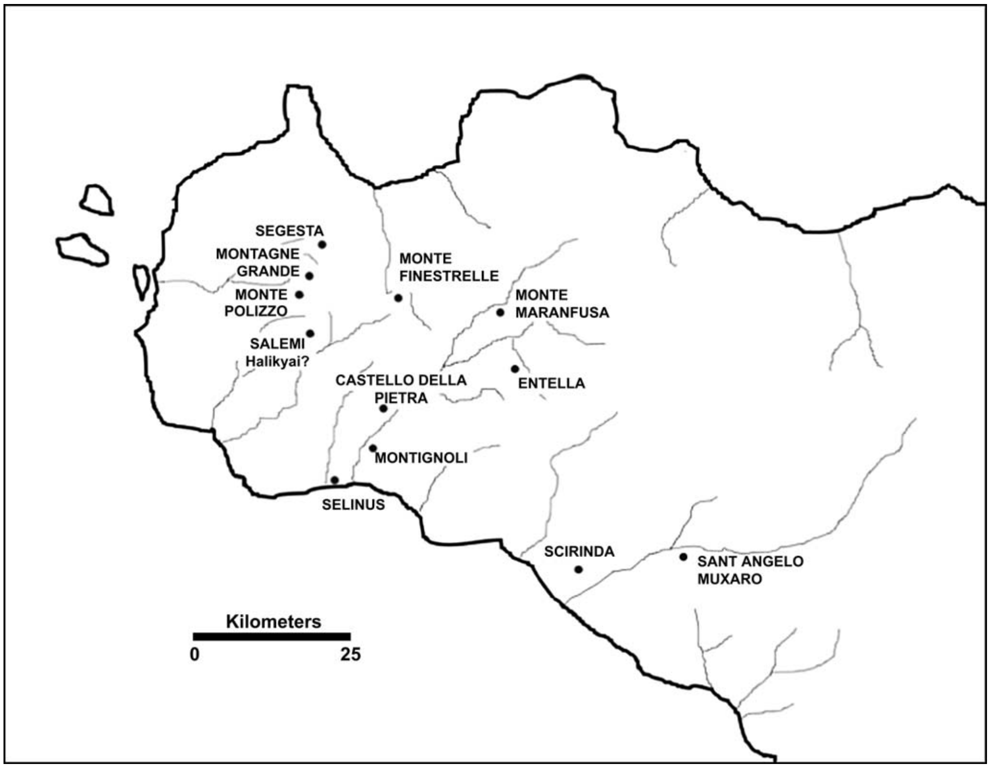

Fig. 2. Map of western Sicily, showing the major sites mentioned in the text.

powdered pottery samples were oven-dried at 100 °C for 24 h. Portions of approximately 150 mg were weighed into small polyvials used for short irradiations. At the same time, 200 mg of each sample was weighed into high-purity quartz vials used for long irradiations. Along with the unknown samples, reference standards of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay.

At MURR, INAA of pottery and clays consists of two irradiations and a total of three gamma counts [10]. Short irradiations involve a pair of samples being transported through a pneumatic tube system into the reactor core for a 5-s neutron irradiation using a flux of 8×10^{13} n cm^{-2} s^{-1}. After 25-min of decay, the samples are counted for 720-s using a high-resolution germanium detector. This count yields data for nine short-lived elements: Al, Ba, Ca, Dy, K, Mn, Na, Ti, and V. For the long irradiation, bundles of 50 or 100 of the encapsulated quartz vials are irradiated for 24-h at a flux of 5×10^{13} n cm^{-2} s^{-1}. Following the long irradiation, samples are permitted to decay for seven days, and then are counted for 2000 s (the "middle count") on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements: As, La, Lu, Nd, Sm, U, and Yb. After an additional two-week decay, a second count of 10,000 s is carried out on each sample. This measurement permits quantification of 17 long-lived elements: Ce, Co, Cr, Cs, Eu, Fe, Hf, Ni, Rb, Sb, Sc, Sr, Ta, Tb, Th, Zn, and Zr.

As is customary in ceramic provenance studies at MURR [10,14,15] parts-per-million data were converted to base-10 logarithms of concentrations. Use of log concentrations compensates for differences in magnitude between major elements, such as Al, and trace elements, such as the rare earth or lanthanide elements (e.g., La, Ce, Sm, Dy, and Yb). Transformation of data to base-10 logarithms also yields a more nearly normal distribution for many trace elements.

The resulting data were analyzed using an array of multivariate statistical procedures. The underlying objectives of the use of multivariate statistical techniques to INAA data are to facilitate identification of compositional groups. Principal components analysis (PCA)—a pattern-recognition procedure—was used to provide an idea of the subgroup structure of chemical compositional data. PCA calculates the orientations and lengths of axes of greatest variance in the data. Employing PCA in an RQ-mode technique allows the simultaneous plotting of elements and samples that contribute to group separation. The R-mode loadings provide the coordinates of the original elemental concentrations and the Q-mode loadings give the coordinates of the objects [15,16]. To evaluate the coherence of each group, the Mahalanobis

Table 2
Descriptive information, chemical group assignments, and membership probabilities for the 62 incised/impressed sherds from western Sicily analyzed by INAA

Analytical i.d.	Chem. group assignment	Site	Decoration motif	Probability of membership in EL-1	Probability of membership in EL-2
EEB001	EL-1	M. Polizzo	denti di lupo	76.204	0.164
EEB003	EL-1	M. Polizzo	denti di lupo	95.841	0.376
EEB004	EL-1	M. Polizzo	denti di lupo	7.665	1.418
EEB005	EL-1	M. Polizzo	denti di lupo	98.387	1.165
EEB006	EL-1	M. Polizzo	denti di lupo	96.022	0.034
EEB007	EL-1	M. Polizzo	denti di lupo	28.853	0.079
EEB008	EL-1	M. Polizzo	denti di lupo	15.105	0.032
EEB009	EL-1	M. Polizzo	denti di lupo	62.431	0.077
EEB010	EL-1	M. Polizzo	denti di lupo	23.873	0.029
EEB011	EL-1	M. Polizzo	denti di lupo	16.228	0.023
EEB019	EL-1	Montignoli	denti di lupo	90.205	0.566
EEB021	EL-1	Montignoli	denti di lupo	26.316	0.221
EEB026	EL-1	Salemi	complex banded	80.996	0.225
EEB029	EL-1	Salemi	simple banded	32.384	3.776
EEB032	EL-1	M. Polizzo	meander	36.509	0.038
EEB035	EL-1	M. Polizzo	denti di lupo	22.077	0.176
EEB038	EL-1	M. Polizzo	meander	75.51	0.11
EEB042	EL-1	M. Polizzo	simple banded	99.63	0.303
EEB050	EL-1	M. Polizzo	simple banded	19.315	0.726
EEB074	EL-1	M. Polizzo	meander	90.312	0.033
EEB075	EL-1	M. Polizzo	simple banded	18.119	1.126
EEB076	EL-1	M. Polizzo	complex banded	59.578	0.039
EEB077	EL-1	M. Polizzo	denti di lupo	25.215	0.03
EEB078	EL-1	M. Polizzo	complex banded	97.2	0.062
EEB080	EL-1	Segesta	cerchielli	22.971	0.087
EEB081	EL-1	Segesta	complex banded	25.326	0.089
EEB083	EL-1	M. Grande	cerchielli	71.373	0.22
EEB092	EL-1	Salemi	simple banded	52.681	1.192
EEB098	EL-1	M. Grande	simple banded	2.087	1.528
EEB099	EL-1	M. Grande	simple banded	75.515	0.047
EEB100	EL-1	M. Grande	complex banded	13.366	0.133
EEB157	EL-1	Salemi	simple banded	26.33	0.157
EEB159	EL-1	Salemi	simple banded	8.495	0.041
EEB160	EL-1	Salemi	simple banded	29.804	0.038
EEB162	EL-1	M. Polizzo	simple banded	86.618	0.027
EEB012	EL-2	C. d. Pietra	denti di lupo	1.423	62.324
EEB014	EL-2	Scirinda	cerchielli	6.034	63.929
EEB015	EL-2	Montignoli	cerchielli	0.687	19.243
EEB018	EL-2	Montignoli	simple banded	0.106	67.364
EEB020	EL-2	Montignoli	denti di lupo	2.837	12.632
EEB022	EL-2	Montignoli	denti di lupo	2.943	86.482
EEB023	EL-2	Montignoli	denti di lupo	0.969	57.954
EEB025	EL-2	Montignoli	denti di lupo	2.984	77.92
EEB071	EL-2	M. Maranfusa	denti di lupo	0.706	70.67
EEB058	EL-3	M. Finistrelle	complex banded	0	0.027
EEB059	EL-3	M. Finistrelle	simple banded	0	0.013
EEB060	EL-3	M. Finistrelle	complex banded	0	0.022
EEB061	EL-3	M. Finistrelle	simple banded	0	0.014
EEB119	EL-3	M. Finistrelle	simple banded	0	0.013
EEB122	EL-3	M. Finistrelle	complex banded	0	0.858
EEB013	EL-4	Scirinda	cerchielli	0.004	0.751
EEB016	EL-4	S. A. Muxaro	cerchielli	0.114	0.222
EEB017	EL-4	S. A. Muxaro	denti di lupo	0.038	0.248
EEB024	EL-4	Montignoli	denti di lupo	0.079	0.611
EEB166	EL-4	Entella	cerchielli	0	0.21
EEB168	EL-4	Entella	denti di lupo	0	0.862
EEB070	EL-5	M. Maranfusa	denti di lupo	0	0.131
EEB072	EL-5	M. Maranfusa	simple banded	0.006	0.662

(*continued on next page*)

Table 2 (*continued*)

Analytical i.d.	Chem. group assignment	Site	Decoration motif	Probability of membership in EL-1	Probability of membership in EL-2
EEB073	EL-5	M. Maranfusa	denti di lupo	0	0.112
EEB002	unassigned	M. Polizzo	denti di lupo	0.386	0.816
EEB082	unassigned	Selenunte	cerchielli	0.007	0.325
EEB121	unassigned	Salemi	complex banded	0.002	0.196

Probabilities are jackknifed for specimens included in each group.

distances were used to calculate multivariate probabilities of group membership. Specimens whose Mahalanobis distance lay outside the 1% probability cut-off relative to all groups were left unclassified. Although great care was taken to minimize contamination from drilling the pottery during the sampling process, the potential for contamination nonetheless exists. Nickel was below detection limits in many of the samples—which is the norm in many parts of the world—and was subsequently removed from consideration during the quantitative analysis of data. In some cases, data generated for chromium appeared to have unusually high values. Because the samples were prepared by drilling, there is a real possibility that the high chromium values represent contamination from sample preparation (despite the fact that the bit used was identified by the manufacturer as being a tungsten/diamond bit). Consequently, we decided that the most conservative approach would be to remove the element chromium from consideration during the analysis of data. We recognize that chromium is an important element in compositional studies of pottery in the Mediterranean, and plan to reanalyze duplicate samples of some of the high Cr sherds to ascertain if the high chromium values are indeed real, or if they do in fact result from contamination.

3. Results and discussion

INAA of ceramics from western Sicily resulted in the identification of five compositional groups: EL-1, EL-2, EL-3, EL-4, and EL-5. Table 2 lists the descriptive information, chemical group assignments, and membership probabilities for the 62 incised/impressed sherds analyzed by INAA. Table 3 lists the average elemental breakdown of each chemical compositional group. Probabilities are based on the first seven principal components, which account for more than 92% of the cumulative variation in the dataset. Probabilities are jackknifed for specimens included in each group. Because of the small number of samples assigned to EL-3, EL-4, and EL-5, these samples were projected against EL-1 and EL-2. Ideally, future analyses will help to refine the three smaller groups and permit more rigorous testing of the compositional groups. The probabilities of group membership listed in Table 2 suggest that the subgroup structure proposed herein is statistically viable. Although there are no posterior misassignments based on Mahalanobis distances, a few of Mahalanobis distance-based probabilities of group membership exceed 1% for both groups, which indicates that the multivariate distributions of the two groups overlap to some extent. A variance–covariance matrix biplot based on PCA of the complete data set is shown in Fig. 3. This biplot provides a means for assessing the contribution of various elements to the identified subgroup structure. Fig. 4 is a bivariate plot of strontium and calcium that further demonstrate the subgroup partitioning.

Table 2 lists the distribution of samples by archaeological site and chemical compositional group. The identification of five compositional groups among 12 different settlements suggests that ceramic manufacture was specialized to some degree. Although the exact sources of the clays used for manufacturing these ceramics and the location of most workshops remains uncertain at this time, each of the compositional groups appears to have spatially restricted distributions as shown in Fig. 5.

The EL-3 compositional group ($N = 6$), defined by high levels of strontium, was found exclusively at the site of Monte Finistrelle. Samples assigned to EL-5 ($N = 3$) were also found exclusively at the site of Monte Maranfusa, although one sample from this site is assigned to EL-2. The distribution of EL-3 in particular suggests that at least some processes of settlement formation in the early Iron Age had the effect of limiting access to clay resource zones or trading partners. Monte Finistrelle represents one of the earliest of these Iron Age settlements, after the collapse of many of the Bronze Age settlements (Table 4).

The remaining three compositional profiles transgress the boundaries of individual sites, suggesting a more fluid exchange network presumably due to preferential selection of different finished wares, or the movement of peoples between settlements, or perhaps widespread geographic heterogeneity within raw materials from this regions. The spatial distribution of EL-2 ($N = 9$) spans the Belice valley from the coastal fringes to the central interior, and includes the settlements of Castello della

Table 3
Ceramic summary, mean and standard deviation of elements by chemical compositional group

Element	EL-1	EL-2	EL-3	EL-4	EL-5
As	10.22 ± 4.19	11.96 ± 4.64	16.65 ± 13.42	11.61 ± 8.00	5.21 ± 0.55
La	37.64 ± 4.94	36.37 ± 2.89	42.13 ± 3.99	38.22 ± 5.65	39.41 ± 3.57
Lu	0.40 ± 0.04	0.41 ± 0.03	0.41 ± 0.02	0.36 ± 0.07	0.34 ± 0.02
Nd	37.32 ± 11.36	35.35 ± 2.45	41.54 ± 8.51	34.40 ± 6.54	36.74 ± 8.25
Sm	6.86 ± 1.09	6.42 ± 0.45	7.33 ± 0.57	6.66 ± 1.01	6.30 ± 0.57
U	2.93 ± 0.56	3.35 ± 0.54	4.41 ± 0.75	3.63 ± 0.99	3.28 ± 0.61
Yb	2.84 ± 0.37	2.77 ± 0.31	2.74 ± 0.28	2.45 ± 0.45	2.34 ± 0.04
Ce	81.58 ± 10.70	78.00 ± 5.08	88.33 ± 8.97	80.77 ± 13.43	78.18 ± 5.50
Co	14.25 ± 4.17	12.63 ± 1.48	13.27 ± 1.32	14.26 ± 2.79	15.33 ± 1.14
Cs	4.76 ± 1.19	4.99 ± 0.92	4.50 ± 0.67	5.48 ± 1.08	5.90 ± 0.94
Eu	1.41 ± 0.19	1.31 ± 0.10	1.45 ± 0.16	1.33 ± 0.22	1.27 ± 0.09
Fe (%)	4.68 ± 0.91	4.27 ± 0.36	4.71 ± 0.47	4.53 ± 0.74	4.48 ± 0.23
Hf	9.15 ± 1.35	8.36 ± 1.09	6.11 ± 0.63	5.54 ± 1.56	4.70 ± 0.38
Rb	78.3 ± 15.9	89.4 ± 12.8	70.9 ± 11.0	92.3 ± 19.5	98.0 ± 8.2
Sb	0.49 ± 0.13	0.54 ± 0.07	0.63 ± 0.21	0.95 ± 0.51	0.70 ± 0.15
Sc	12.75 ± 1.77	13.04 ± 1.33	14.24 ± 1.10	14.39 ± 2.14	14.11 ± 1.34
Sr	89.20 ± 81.1	345.0 ± 77.0	4423.0 ± 1193.3	1021.3 ± 262.8	437.3 ± 145.5
Ta	1.36 ± 0.16	1.40 ± 0.07	1.45 ± 0.13	1.36 ± 0.26	1.25 ± 0.11
Tb	0.90 ± 0.18	0.84 ± 0.08	0.90 ± 0.11	0.76 ± 0.11	0.77 ± 0.01
Th	11.30 ± 1.37	11.01 ± 0.52	12.08 ± 1.19	11.08 ± 1.78	10.54 ± 0.48
Zn	95.1 ± 15.3	102.2 ± 18.9	103.0 ± 9.7	109.0 ± 13.8	127.0 ± 7.3
Zr	222.8 ± 37.3	189.7 ± 23.1	167.9 ± 12.5	140.1 ± 28.1	139.4 ± 21.9
Al (%)	7.64 ± 1.08	7.37 ± 0.65	8.56 ± 0.78	8.27 ± 1.27	8.08 ± 0.97
Ba	448 ± 224	575 ± 319	1206 ± 398	414 ± 194	2400 ± 1793
Ca (%)	1.61 ± 0.70	5.08 ± 0.86	6.23 ± 2.57	7.94 ± 4.10	9.07 ± 0.95
Dy	5.06 ± 0.62	4.76 ± 0.45	5.28 ± 0.54	4.67 ± 0.62	4.21 ± 0.20
K (%)	1.44 ± 0.28	2.07 ± 0.27	1.40 ± 0.35	2.08 ± 0.23	1.98 ± 0.16
Mn	354 ± 149	422 ± 105	472 ± 138	461 ± 180	632 ± 366
Na	2475 ± 629	5051 ± 1238	3069 ± 1353	5894 ± 3060	2778 ± 386
Ti	4921 ± 783	4679 ± 427	4957 ± 587	4402 ± 797	4245 ± 783
V	124.9 ± 21.3	118.3 ± 20.0	132.6 ± 14.4	141.5 ± 29.9	146.0 ± 19.0

All data are in ppm except for aluminum, calcium, iron, and potassium which are indicated as a percentage of total sample.

Pietra, Monte Maranfusa, Montignoli, and Scirinda. This distribution suggests very fluid exchange. The distribution of EL-4 ($N = 6$) includes four sites, spanning the southeastern region of the surveyed settlements. The best provenienced ceramics are two EL-4 samples analyzed from misfired vessels located near a pottery kiln at Entella. EL-4 samples were not only found at this kiln, but also among the other southeastern settlements of Montignoli, Sant' Angelo Muxaro, and Scirinda.

Interestingly, the spatial distribution of EL-1 ($N = 35$) includes the settlements of Segesta, Montagne Grande, Monte Polizzo, and Salemi, all located west of the Belice valley. This western distribution appears to correspond with epigraphic data regarding the presence of an Elymian ethic identity (ca. 5th century BCE) centered at Segesta. Although the majority of samples were found at Monte Polizzo (due to a sampling bias), it appears that all five settlements shared a common clay source, although at this point the geographic extent of this source is unknown. This suggests strong economic ties, either via a single ceramic producer or the sharing of a single clay source by multiple producers. Although two EL-1 samples were found further east at Montagnoli, no other known ceramic compositional types (except for some unassigned ceramics) were found further west. This suggests at least some minimal east–west exchange or contact, although it appears that indigenous tablewares were traveling from east-to-west only. Interestingly, Montagnoli appears to be a nexus of ceramic exchange – samples from this site were assigned to three different compositional groups. It is strategically located in the geographic middle of our sampling area, and argued to be a late 8th to 7th century political center where its sanctuary served as a meeting place for elites [3].

4. Conclusion

These results add a new dimension to the study of indigenous Iron Age pottery and regional interaction in western Sicily through the identification of five compositional groups. The location of probable production sources and the exchange links between settlements implies that ceramic manufacture was organized on a regional basis, yet certain patterns of intra-group trade did exist. The varied locations of these groups correlate with our understanding of the basic geographical and

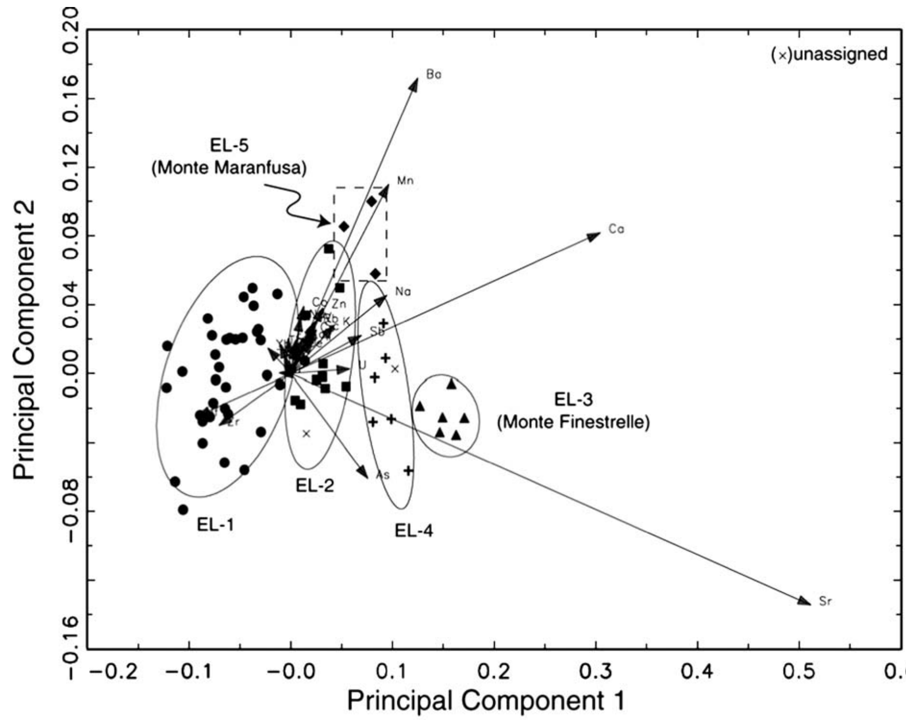

Fig. 3. Variance–covariance matrix biplot of principal components 1 and 2 shown with the element coordinates. Ellipses indicate 90% probability level for group membership.

historical structure of western Sicily. We argue that indigenous regional interaction was fairly complex during what many argue to be a period of Hellenistic influence and enculturation. Most interesting is that there appears to be a specific nesting of exchange networks (ceramic compositional groups) operating within a broader homogeneous confederation of indigenous settlements (stylistically similar incised/impressed wares). Moreover, the spatial distribution of one of these compositional groups appears to directly

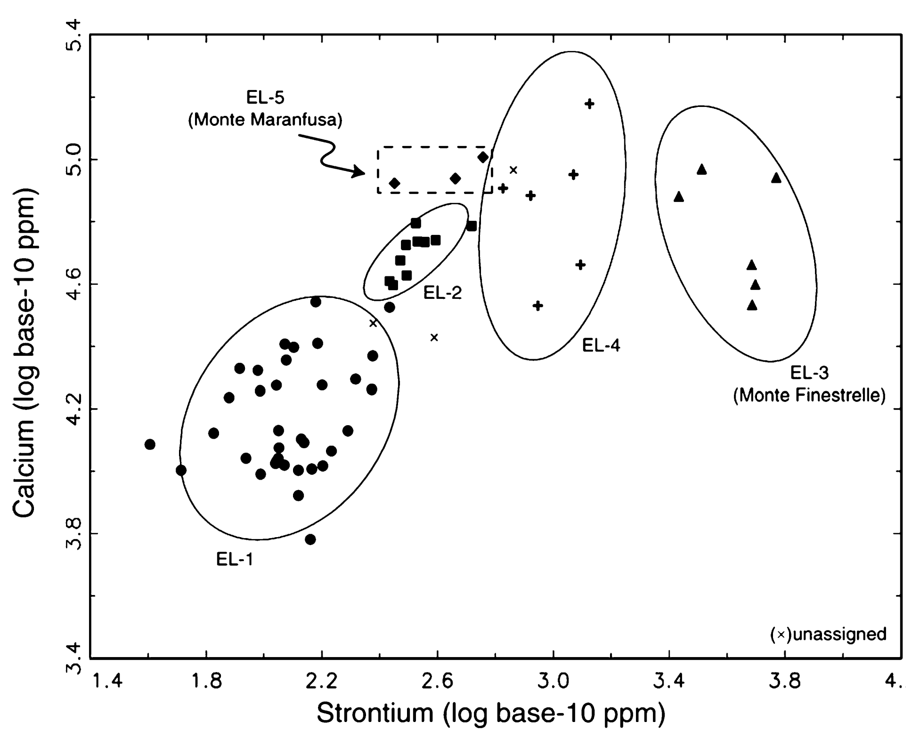

Fig. 4. Bivariate plot of strontium and calcium base-10 logged concentrations. Ellipses indicate 90% probability level for group membership.

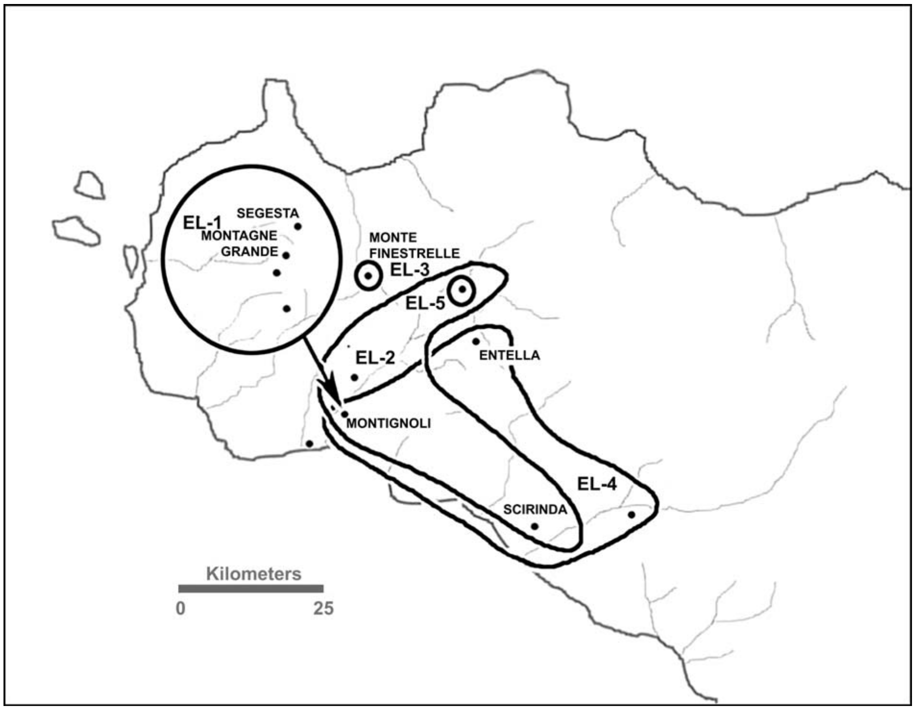

Fig. 5. Map of western Sicily, showing the major ceramic compositional groups mentioned in the text.

Table 4
Ceramic summary, Iron Age sites by chemical compositional group

Site	EL-1	EL-2	EL-3	EL-4	EL-5	Unas.	Total
Castello della Pietra	0	1	0	0	0	0	1
Entella	0	0	0	2	0	0	2
Montagne Grande	4	0	0	0	0	0	4
Monte Finistrelle	0	0	6	0	0	0	6
Monte Maranfusa	0	1	0	0	3	0	4
Monte Polizzo	21	0	0	0	0	1	22
Montignoli	2	6	0	1	0	0	9
Salemi	6	0	0	0	0	1	7
Sant Angelo Muxaro	0	0	0	2	0	0	2
Scirinda	0	1	0	1	0	0	2
Segesta	2	0	0	0	0	0	2
Selenunte	0	0	0	0	0	1	1
Total	35	9	6	6	3	3	62

Excavation and museum samples collected for neutron activation.

correspond with epigraphic data regarding the presence of an Elymian ethic identity centered at Segesta. Future work needs to include larger data sets of ceramic samples to improve the level of precision and refine our models of indigenous exchange. The patterns of vessel movement documented by these data seem to suggest local indigenous specialization with distinct exchange networks across the landscape in certain areas.

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References

[1] R. Alaimo, R. Giarusso, I. Iliopouos, G. Montana, Risultati delle indagini mineralogico-petrografiche su reperti ceramici, in: F. Spatafora, Monte Maranfusa, Beni Culturi, Palermo, 2003, pp. 425–441.

[2] G. Castellana, L'insediamento di Montagnoli nei pressi di Selinunte, in: G. Nenci, S. Tusa, V. Tusa (Eds.), Gli elimi e l'area elima, Palemo, 1988–89, pp. 326–331.

[3] G. Castellana, Nuovi data sull' insediamento di Montagnoli presso Menfi, in: Terze Giornate internazionali di Studi sull' area elima, Pisa-Gibellina, 2000, pp. 263–271.
[4] I. Concorida, La Sicilia Antica, Edizioni Campo, Alcamo, 1998.
[5] S. De Vido, Gli Elimi: storie di contatti e di rappresentaziono, Pisa, 1997.
[6] S.F. De Angelis, Ancient past, imperial present: the British Empire in T.J. Dunbabin's The western Greeks, Antiquity 72 (1998) 539–549.
[7] S.F. De Angelis, Equations of culture: the meeting of natives and Greeks in Sicily (ca. 750–450 BC), Ancient West and East 2 (2003) 19–50.
[8] M. Dietler, The Iron Age in Mediterranean France: colonial encounters, entanglements, and transformations, Journal of World Prehistory 11 (3) (1997) 269–358.
[9] C.A. Di Noto, La ceramica indigena a decorazione geometrica incisa ed impressa, in: G. Nenci (Ed.), Entella I, Scuola Normale Superiore, Pisa, 1995, pp. 77–110.
[10] M.D. Glascock, Characterization of archaeological ceramics at MURR by neutron activation analysis and multivariate statistics, in: H. Neff (Ed.), Chemical Characterization of Ceramic Pastes in Archaeology, Prehistory Press, Madison, Wisconsin, 1992, pp. 11–26.
[11] E. Giannitrapani, Public archaeology and prehistory in Sicily, Antiquity 72 (1998) 739–743.
[12] I. La Rosa, The impact of the Greek colonists on the non-Hellenic inhabitants of Sicily, in: G. Pugliese Carratelli (Ed.), The Western Greeks, Thames and Hudson, London, 1996, pp. 523–532.
[13] R. Leighton, Sicily before History: An Archaeological Survey from the Palaeolithic to the Iron Age, Cornell University Press, Ithaca, N.Y., 1999.
[14] I. Morris, T. Jackman, E. Blake, S. Tusa, Stanford University excavations on the acropolis of Monte Polizzo, Sicily, II: preliminary report of the 2001 season, Memoirs of the American Academy in Rome 47 (2002) 153–198.
[15] H. Neff, RQ-mode principal components analysis of ceramic compositional data, Archaeometry 36 (1994) 115–130.
[16] H. Neff, Quantitative techniques for analyzing ceramic compositional data, in: D.M. Glowacki, H. Neff (Eds.), Ceramic Production and Circulation in the Greater Southwest: Source Determination by INAA and Complementary Mineralogical Investigations, Monograph 44, Cotsen Institute of Archaeology, University of California, Los Angeles, 2002, pp. 15–36.
[17] G. Nenci, La ceramica indigena a decorazione geometrica incis ed impress, in: G. Nenci (Ed.), Entella I, Scuola Normale Superiore Di Pisa, Pisa, 1995, pp. 77–162.
[18] D. Palermo, Tradizione undigena e apporti greci nelle culture della Sicilia centro-meridionale; il caso di Sant'Angelo Muxaro, in: R. Leighton (Ed.), Early Societies in Sicily. New Developments in Archaeological Research, Accordia Specialist Studies on Italy 5, London, 1996, pp. 147–154.
[19] G. Pugliese Carratelli, The western Greeks, Thames and Hudson, London, 1996.
[20] F. Spatafora, Monte Maranfusa (scavi 1986–7), in: G. Nenci, S. Tusa, V. Tusa (Eds.), Gli elimi e l'area elima, Palermo, 1988/1989, pp. 293–299.
[21] F. Spatafora, Gli Elimi e l'Eta del Ferro nella Sicilia occidentale, in: R. Leighton (Ed.), Early Societies in Sicily, New Developments in Archaeological Research, Accordia Specialist Studies on Italy 5, London, 1996, pp. 155–165.
[22] F. Spatafora, La ceramica indigena a decorazione impressa e incisa nella Sicilia centro-occidentale: diffusione e pertinenza etnica, Sicilia Archaeologica 29 (1996) 91–110.
[23] F. Spatafora, Monte Maranfusa. Beni Culturi, Palemro, 2003.
[24] S. Tusa, La Sicilia Nella Preistoria, second ed., Sellerio, Palermo, 1992.
[25] S. Vassallo (Ed.), Colle Madore: un caso di ellenizzazione in terra sicana, Palermo, 1999.