MONITORING ADMINISTRATIVE SPHERES OF ACTION IN LATE PREHISTORIC NORTHERN MESOPOTAMIA WITH THE AID OF CHEMICAL CHARACTERIZATION (INAA) OF SEALING CLAYS

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This paper reports the results of an attempt to define the geographical range and a limited number of characteristics of a fourth millennium B.C. administrative system through chemical characterization of its primary administrative tool—sealing clays. The focus of this study is sealings from levels XII to VIII at Tepe Gawra and from three possible economic or political partners of Gawra—contemporary Nineveh and Arpachiyah, and later Tell Brak. The technique used is instrumental neutron activation analysis (hereafter INAA). This analysis complements a series of other studies of seals and sealings and other artifacts from fourth millennium B.C. Tepe Gawra (Rothman 1988, in prep., n.d.1, n.d.2).

Background

Societies in which many communities unite under centralized administrative (as opposed to dispersed kinship or community) organizations—chiefdoms and states—have developed in all regions of the world. Scholars of this phenomenon appear to agree that at the heart of understanding the formation of such societies are three factors: (1) the functions of the union that impel its formation (including the interaction of the polity with other polities), (2) the organization of its leadership, administration, and economic activities, and (3) the geographical and population size of the resulting economic and social spheres of action (e.g., Wright 1977; Adams 1981; Carneiro 1981; Earle 1978, 1987; Blanton 1976; Blanton et al. 1981; Wheatley 1971; Kowaleski et al. 1983). In the Middle East during the millennium before writing was invented, the primary evidence of the operation of such administrative organizations is the seal and its impressions on clay.

The use and information content of seals and sealings

In the absence of a writing system, seals or, more importantly, the clay sealings pressed around the shoulders or in the mouths of jars, on doors, sacks, bales, and clay envelopes with counters (*bullae*) provided a mechanism for the record keeping necessary to coordinate or regulate economic activity in such administrative systems (see Rothman 1988:7f. for the distinction between coordination and regulation). Sealings offered a means to restrict access to goods that were being stored at a given location, transported from one part of a site to another (for example, from a storeroom to a kitchen), or from one site to another. To the extent that these restricted goods provided foodstuffs for religious institutions, armies, or administrators, their control represented control of the activities of those institutions. To the extent that they were raw materials or tools for production, their control represented control of craft production and ultimately, of the exchange of goods produced. To the extent that restricted goods were icons or other materials for religious ritual, their control represented oversight of religious practice.

Sealings may also have served ancient leaders and their administrative agents as physical records for the

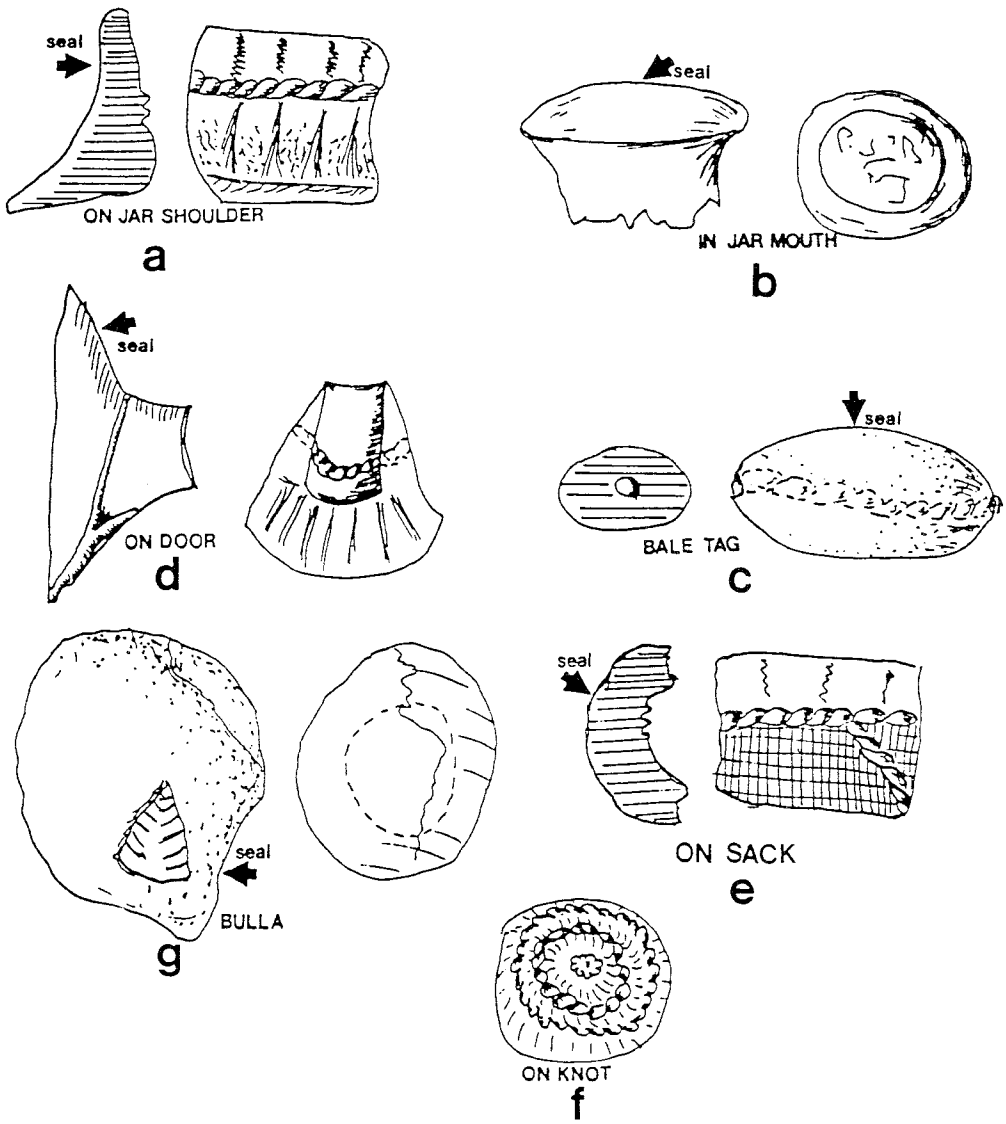


Fig. 1a-g:
Sealings from Tepe Gawra, showing the various types related to function.

storage or controlled movement of specific foodstuffs, raw materials, or finished products. At Arslantepe in south-eastern Turkey, for example, more than 200 sealings were found in room 206A in the gateway complex of the site (Palmieri 1981:104), stacked in layers (originally on shelves?) according to whether they had sealed doors, jars, or sacks (A. von Wickede, pers. comm.). Presumably, these items represented the records of 200 transactions involving stored or transported goods. As the containers or storerooms were opened and their contents distributed to the appropriate authority, the record of their receipt was placed in room 206A for retention, or was dumped in that room after a periodic audit.

The information contained in the sealings takes several forms. First, the reverse of the sealing is an inverse image of the object onto which the sealing was pressed (Fig. 1a-g). The most common sealing at Gawra is the one placed around the shoulder of a jar (a). Hide was placed over the mouth and neck of the jar down to its shoulder and was secured around the jar neck with string or leather thongs. Levigated or naturally occurring fine clay was then pressed around the jar's neck over the string and hide to the shoulder of the jar, and was impressed, often several times, with a seal of one or another design (see Ferioli and Fiandra 1983:489, fig. 14). The reverse of the sealing forms an 80 to 90 degree angle, showing the impression of the hide and string (about midpoint) on one side and impressions of the hide and the smooth ceramic shoulder of the jar on the other

side. Jar mouth sealings are usually mushroom shaped stoppers with smooth sided shafts and wider tops whose undersides have the impression of the jar's rim (b). Sometimes, however, they are slightly concave tabs, whose undersides have the impression of grass or basketry which was stuffed into the jar's mouth.

Bale tags (c) are small ovoids of clay placed around a string and then sealed. Presumably, the string was tied around a bale, although it could have been tied to a basket or sack. The bale tag could even have been pressed around the ends of the string which were looped over the jar's top (for the last, see Ferioli and Fiandra 1983:486, fig. 12). Door sealings (d) in the late prehistoric period were placed up against the jamb around a peg onto which a string would be knotted. The string was passed through a small hole in the door, knotted on its reverse side (see Ferioli et al. 1975:fig. 6 for an illustration). Later, larger door knobs were used. The reverses of late prehistoric door sealings have impressions of the reed or chaff of the doorjamb or adjoining wall, the smooth shape of the peg, and a bit of the string. Box sealings are sometimes confused with those from doors, as they sometimes used the same locking mechanism. They are squared and have the impression of a smooth corner and the texture of wood or reed. Sack sealings (e) were placed around the constricted part of the sack where the rope was tied. The remaining piece generally is concave. On the sack it would have looked like a napkin ring (see Ferioli and Fiandra 1983:483, fig. 9). Sometimes, a wooden stick was placed in the sack mouth to improve sealing adhesion (Ferioli and Fiandra 1983:478, fig. 6).

Knot impressions (f) might be pieces of sack, jar shoulder, or door sealings, or might have been wrapped around a bundle of reeds, straw, or whatever. Basket sealings, which look like the illustrated "knot" (f) without the string, were placed over the narrow lids of jar shaped baskets (only one was identified at Gawra). The last of the sealings are *bullae* (g). Although the term is sometimes used generically for all sealings, here it refers to hollow clay balls whose exterior was sealed and whose interior contained small counters or tokens (see Schmandt-Besserat 1978). Wright et al. (1980) refer to these objects as "message units," because they appear to have been used to record counts of restricted items which could not be sealed directly (for example, sheep).

The second kind of information represented on sealings is the seal's design. In the absence of written records, seal designs must have served to some degree

> to furnish those people at the top level of responsibility with seals which, by their design, would indicate to any viewer within reach of a particular economic system that an object was sealed under the direct responsibility of those individuals. (Nissen 1977:16)

Alternatively, seal designs may have represented particular institutions (Rothman n.d.1). The stamp seals impressed on late prehistoric sealings include small geometric designs and representations of animals and men (see, for example, Fig. 2). Among seals with figural design, some are simple with representations of a single figure (often crudely modelled), while others are much more complex (often larger) with coherent scenes of well-modelled figures. For example, a more complex seal design might illustrate a predation scene of dogs chasing wild animals. Nissen (1977:20) proposes that the variation in seal design "could mean that the individualistic seals signifying individual, i.e., higher responsibility should be associated with higher rank in that [administrative] system of hierarchies, the simple-design seals with lower rank." In administrative terms, were this correlation true, it would mean that those who used geometric seals were of lower rank than those who used figural seals. Those who used the more complex seals would be of higher rank than those who used simpler figural seals. Either some sanction would have been placed on using complex design seals, or they would have been costlier to produce and therefore available only to those of greater economic means. An analysis of the distribution of seal designs at Gawra levels XI/XA to VIII (Rothman 1988) suggests that geometric seals may not have been lower in status, but generic seals for institutions, like the corporate seal of modern companies (Rothman 1989). Officials of varying status could have used them. Some difference between simple and complex seal use is indicated. Like the signatures of persons with positions of differing status in a modern corporation, the simple versus complex design may have marked the status differences among leadership social identities, not in every case, but in general. Although these correlations are suggested, they cannot yet be proven to be true. Nonetheless, some correlation of design elements and the social status of the person or persons using the seal follows logically from what is known of prehistoric and especially early historic sealing behavior (see Steinkeller 1977; Hallock 1977; Larsen 1977; Winter 1987).

The most important remaining piece of information contained in sealings is the source of the clay. To understand the nature and geographical extent of the leadership and administrative organizations whose record keeping systems are represented in these sealings, it is important to know *where* sealings originated. Sealed items might represent stored goods, or the circulation of restricted materials on one site or among a very small number of nearby sites, suggesting a small, local administrative organization. Sealed items might instead come from some distance away, implying the existence of organized systems of intraregional exchange, regulated by leadership groups in the societies involved. A third possibility is that the pres-

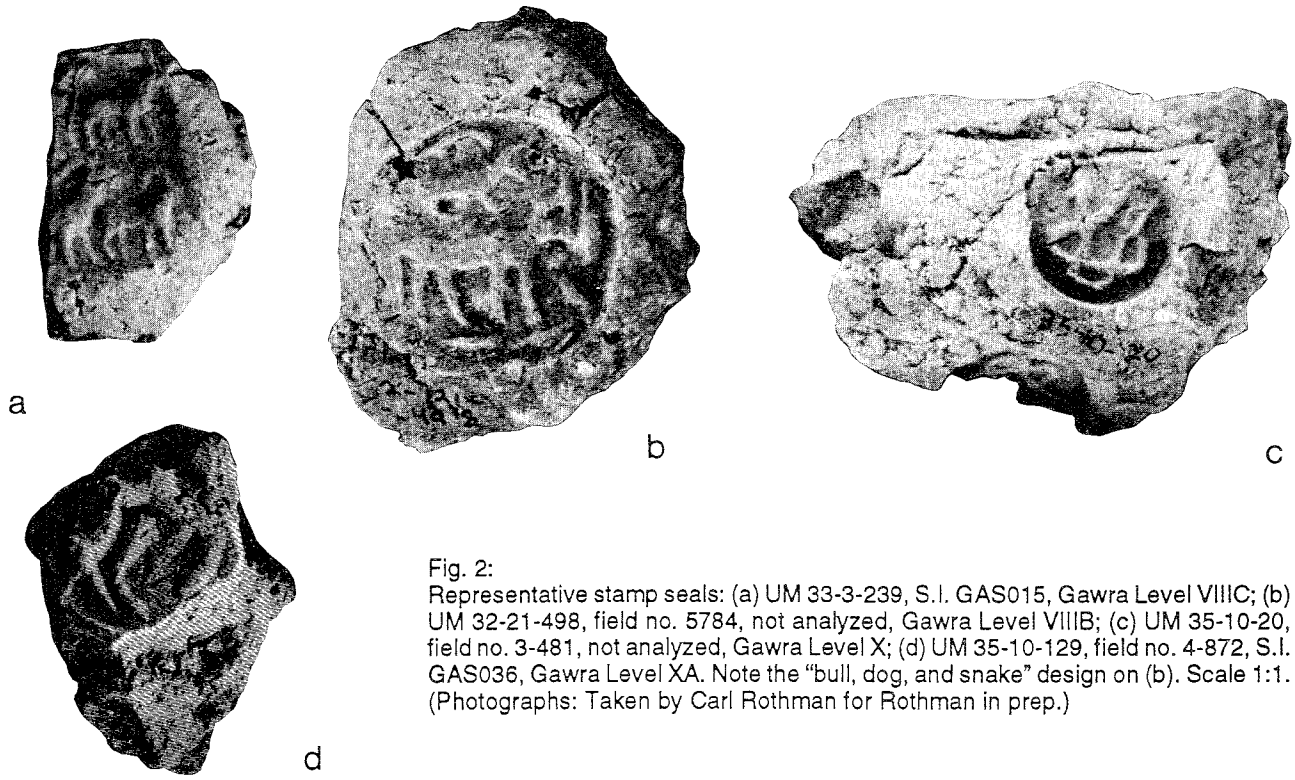


Fig. 2:
Representative stamp seals: (a) UM 33-3-239, S.I. GAS015, Gawra Level VIIIC; (b) UM 32-21-498, field no. 5784, not analyzed, Gawra Level VIIIB; (c) UM 35-10-20, field no. 3-481, not analyzed, Gawra Level X; (d) UM 35-10-129, field no. 4-872, S.I. GAS036, Gawra Level XA. Note the "bull, dog, and snake" design on (b). Scale 1:1. (Photographs: Taken by Carl Rothman for Rothman in prep.)

ence of sealings from more distant sites might suggest the existence of a larger polity, centered some distance away, of which the site in question is a part.

Background to research design

During the fourth millennium B.C. a number of complex societies evolved in various parts (sub-regions) of Greater Mesopotamia. Recent research suggests that the earliest known state-level societies (those of considerable scale with three hierarchical levels in their leadership organizations) may have developed in the southern alluvium of Iraq and the Susiana Plain of southwestern Iran at this time (Adams and Nissen 1972; Johnson 1973; Wright and Johnson 1975; Adams 1981:74f.). Other studies indicate that institutionally organized trade and other kinds of formalized interactions developed between those southern polities and societies in highland Iran and northern Mesopotamia (Beale 1973; Algaze 1986; Rothman 1988). At the same time, interactions among these so-called "peripheral" societies seem as important to understanding their cultural dynamics as contacts with the South. Most significantly, the economic expansion evidenced in the interaction of North, South, and East necessitated the development of more complex social structures to coordinate production and exchange than had existed previously. Ceremonial and trading centers (like those described for China by Wheatley [1971]) evolved in a number of key locations in the North. However, during the fourth millennium B.C. none of the northern polities so far studied evolved social structures that could be termed state-level.

The major impetus for conducting chemical characterization of sealing clays by INAA was to define the geographical extent of the administrative network that included Tepe Gawra during the fourth millennium B.C. This was done in coordination with a major re-study of the stratigraphy, chronology, function, seals, and sealings of Gawra levels XI/XA[1] to VIII, based on original archival materials (Rothman 1988, in prep.). That study found an unusually high number of seals and sealings for a site of barely one hectare.[2] The thesis of the original research was that the presence of so many seals and sealings (over 400) indicated that Gawra was either the center of a small multi-settlement complex society or the center of a secondary segment of a larger complex society. Gawra thus provides an opportunity to address the questions raised at the outset of this article. First, what was the impetus for the development of social complexity at that time and place? That is, what functions were performed by the residents of Tepe Gawra, where "function" is defined as kinds of activities needed to maintain the residents of the site and service a local or more regional population. Second, if seals and sealings represent a formal leadership grouping, what functions were leaders directly involved in? Third, if Gawra were serving a population larger than its own residents, how extensive might the territory occupied have been?

The first step in finding answers to these questions involved spatial distributions of functional artifacts (craft

tools, domestic items, artifacts used in ritual, objects of personal adornment, food preparation and serving vessels) as agglomerated data and in their original findspots. In this way, for each level and sub-level phase, the range of functions and the functional content of individual buildings and open spaces could be determined. Then seals and sealings of differing use (bale tags, *bullae*, etc.) and design complexity were mapped onto the functional spaces delineated. Thus, some idea of the activities coordinated or regulated by leaders and their agents, and the structure of that leadership could be approximated.

Of the sites in the northeastern quadrant of the Assyrian Plains (east of the Tigris River, north of the Greater Zab River and west of the Kurdish hills) thought to have fourth millennium B.C. deposits (Abu al-Soof 1968), Nineveh (Mallowan 1933), Arpachiyah (Mallowan and Cruikshank Rose 1935), and Gawra (Speiser 1935; Tobler 1950) have been excavated to one degree or another (Fig. 3). Nineveh, on the Tigris bank opposite Mosul,

> lies on one of the best, certainly the most frequented of the Tigris crossings. Its communications are easy in any direction and it is the focus of greater routes serving all the other settled regions of the Near East. It is surrounded on all sides by a broad, fertile and well-watered country which will support a prosperous economy and considerable population. (Oates 1968:21)

During the fourth millennium B.C. Nineveh may have reached 12 ha in size, based on the spread of beveled rim bowls on its surface (Mallowan 1933). Arpachiyah is a small site east of Nineveh. It is often said to contain only sixth and fifth millennium B.C. Halaf and 'Ubaid Period deposits, but the latest levels (TT 1-2) may date to the fourth or early third millennium B.C., based on seal design (von Wickede 1987:153f.) and the use of plano-convex bricks (Mallowan and Cruikshank Rose 1935:16). One of Arpachiyah's functions was the production of fine pottery. A study by INAA of pottery clay from Gawra and Arpachiyah (Davidson and McKerrell 1980) suggests that Halafian ceramics from Arpachiyah were sent to Gawra (therefore clay sources for potting at Gawra and Arpachiyah are distinguishable using chemical characterization).

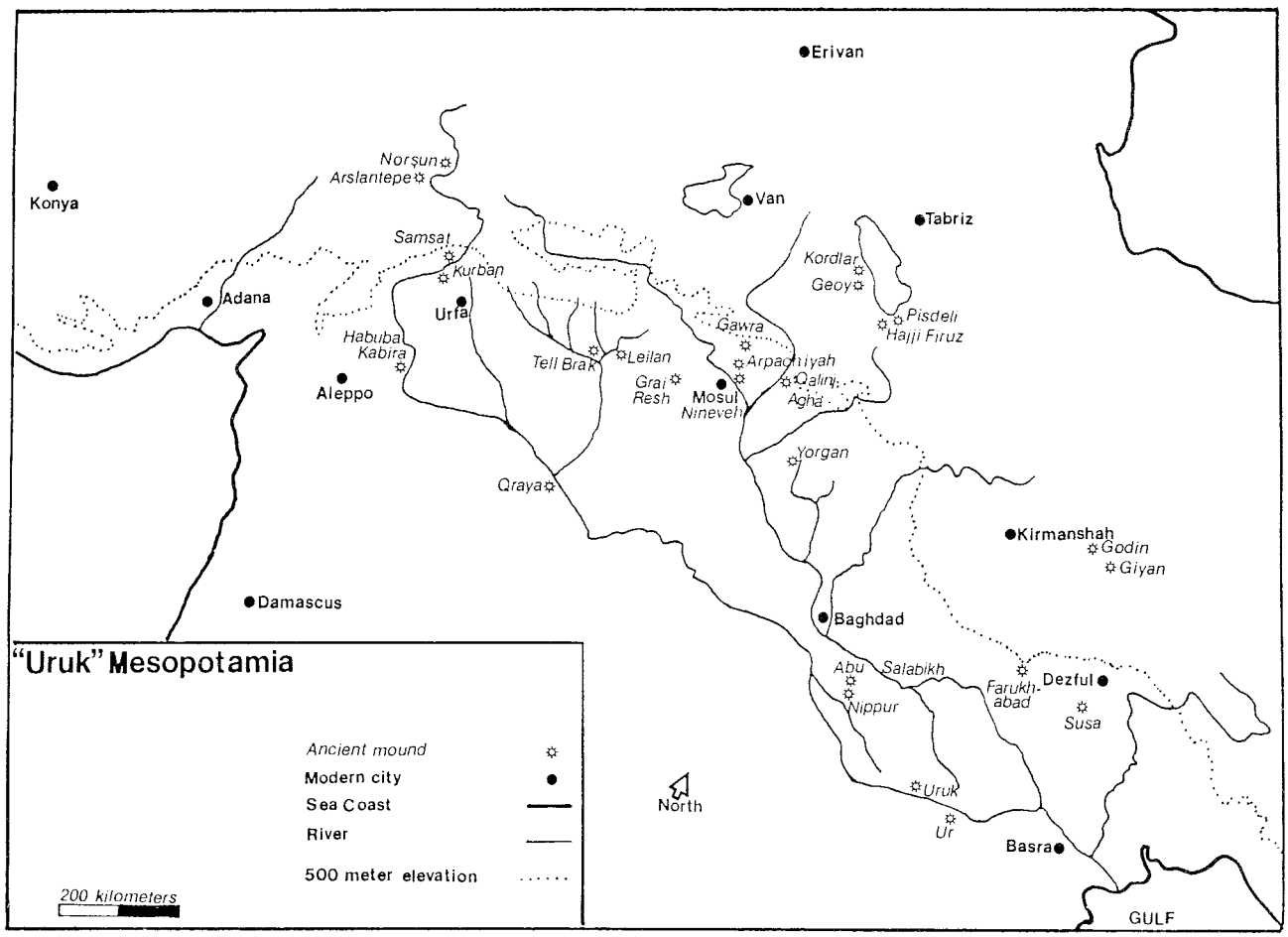


Fig. 3:
Map of sites mentioned in text.

Fig. 4:
Tepe Gawra from the west, 1937.
(Photograph: Courtesy of The University Museum, neg. no. 44944.)

The site of primary interest here, Tepe Gawra, is located 30 km northeast of Nineveh, along a tributary of the Khosr River, by a natural spring flowing from underground in the nearby hills (Fig. 4). The site sits by one of very few natural passes through the Jebel Maqlub, which places it on one of the traditional routes into the Kurdish hills and onward to highland Iran, Turkey, and beyond. Based on the Central Place Theory as applied in Mesopotamia (see Johnson 1973) and theories of Nineveh's role in the region (Algaze 1986), the size and position of Nineveh would suggest that it was a central place and that Gawra was a small secondary center. This was the initial proposition to be tested, although the stylistic dissimilarities between Gawra and Nineveh's artifacts are not typical of a primary center and its subordinate sites.

Research design and sample

Samples for neutron activation were sought from Gawra, Nineveh, and Arpachiyah, the supposition being that all three sites would have evidence of at least some sealings from the same source. These would have been pressed onto containers for tribute or tax payments to Nineveh or allocations of restricted goods from Nineveh to Gawra and Arpachiyah.

The first category of artifact chosen for sampling was sealing clay from contemporaneous strata (Gawra XII to VIII, Nineveh III and IV, Arpachiyah TT 1-2). Within this category were sealings representing the widest ranges of objects on which sealings were pressed, of seal design complexity, and of provenience within different functional areas (temples, workshops, domiciles, etc.). This range of selection was possible for Gawra. No clear architecture was found in the deep sounding at Nineveh (Mallowan 1933) or "the superficial strata" at Arpachiyah (Mallowan and Cruikshank Rose 1935:98) from which samples were available. Therefore, we are unable to reconstruct the functional contexts of the sealings from the latter two sites.

Door sealings are useful for establishing the composition of "local" clays. Wherever the persons doing the sealing were from, they would likely have used clay available at the site. Door sealings at Gawra were sampled from each level and sub-level phase possible. In addition,

a second category of object, spindle whorls, was sampled. The crudest spindle whorls were chosen for sampling, under the assumption they, too, would have been made of the same local clay. Although better made spindle whorls might have been traded, these crude examples probably would not have been exchanged.

Table 1 lists the objects analyzed by INAA. For the Tepe Gawra samples, the objects' field number, museum number, Smithsonian sample number, level or sub-level phase, excavation square, use, design complexity, proposed functional association and published illustrations are listed. For seal design complexity, "C" is complex, "S" simple, "G" geometric. Detailed explanations of the reason for assigning "functional associations" and design complexity can be found in Rothman (1988:212-445). Some of the sealings from XA, XI, XIA, and XIB[3] have been reassigned to a phase or level different from that in the original publications, based on absolute elevations in field notes and a re-analysis of site stratigraphy (Rothman 1988). The samples from Nineveh and Arpachiyah include, as much as possible, a similar set of information. In addition, samples of sealing clay from one of the major centers of northern Mesopotamia in the fourth millennium B.C., Tell Brak, became available and were also analyzed.[4]

Analytical procedures

The samples were analyzed by INAA using analytical procedures similar to those described in Blackman (1984). Twenty-eight elements were sought and twenty-four were quantified. Table 2 presents a summary of the analytical parameters.

All of the clay sealings and tablets from Tepe Gawra housed at The University Museum had been fired for conservation purposes. The firing temperature had been over 800° C and we assumed a standard procedure with equal times for all clay artifacts. Firing at or above 800° C calcines the calcium carbonate found in most Near Eastern clays, driving off CO_2. The calcium then reacts with excess SiO_2 in the clays to form high temperature calcium silicate minerals. The conservation firing to which the Gawra sealings had been subjected alters the mass of the samples by eliminating CO_2, but is not sufficient to volatilize any of the elements sought in this study. The effect of the firing is, therefore, an apparent increase in *all* elemental concentration, by some constant factor, over that in an unfired sample. The spindle whorls from Gawra and Nineveh had not been fired and the samples, as received, were not of sufficient mass to allow for firing before analysis. Therefore, before any direct comparison of the concentration data from the Gawra sealing samples to those from the other sites could be undertaken, mathematical corrections for the differences induced by firing had to be made.

The initial assumption of relatively constant temperature and duration for the conservation firing of the Gawra sealings proved to be problematic at best. Either the firing temperature had not been constant among the several conservation firings, or groups of sealings had been fired for differing periods of time, or both. To demonstrate the effect that the variable conservation has on the chemical analytical data, three sealings were selected for comparison: field numbers 5-1300, 5-1301, and 5-1303D. All bear impressions of the same seal, are from the shoulders of jars, and were found in enclosure 27 in Gawra phase XI of level XI/XA. It is therefore reasonable to assume that they may represent fragments of the same sealing or sealings from the same clay batch. Any variance in chemical composition among them represents a combination of natural heterogeneity in the sealing clay, analytical error, and differences induced by firing. Sealing 5-1301 had consistently higher concentration values than the other two sealings, which means it was fired at a higher temperature or longer than the other two. If the concentration data for all elements in sealings 5-1300 and 5-1303D are fitted to the value for Scandium (Sc) in sealing 5-1301, with an analytical error of less than ± 0.01 at one standard deviation, any differences due to firing are eliminated. The fitting was accomplished by determining the ratio of the Sc concentration in the sealing 5-1301 to the Sc concentration in each sample to be fitted and multiplying all other elemental concentrations by this number. Table 3 presents the mean values and the coefficients of variation for the raw data and the Sc fitted data for 20 elements in the three sealings. The fitted data show a considerable decrease in variance for 19 of 20 elements reported. Only potassium (K) shows an increase in the fitted data.

In order to eliminate the "noise" introduced by the conservation firing of the Gawra sealings and to render the unfired samples directly comparable to the Gawra sealing clay data, *all* data were fitted to the Sc concentration in sealing 5-1301 in the manner described above. The initial sorting of the fitted chemical data for the Gawra clay sealings and spindle whorls was accomplished using an average link hierarchical aggregative clustering algorithm on a mean euclidean distance matrix. The elements used in this cluster analysis are designated with an asterisk in Table 2. Replicate analyses (S.I. numbers GAS001, GAS006, and GAS020) were not included. The results of the cluster analysis produced a single large cluster containing most of the Gawra sealing samples (including all of the door sealings sampled) and a scattering of unclustered samples (including all of the spindle whorls).

The single cluster was presumed to represent a chemical compositional group of clays from a source at or near Tepe Gawra and the unclustered samples to represent individual examples of sealings from multiple other sources. The statistical validity of this cluster was tested with a multivariate statistical program based on Mahalanobis distance measurements and Hotelling's T^2 statistic using the same

Table 1a. Sample description: Sealings, Tepe Gawra.

Field Number		University Museum Number	Level, Phase	Smith-sonan Number	Exc. Sq.	Use	Com plex ity	Functional Association*	Publication**
1660A	a#	31-52-386B	VIIIA	GAS063	5K	jar shoulder	C	room 804, temple	1 LVI,11
1661		31-52-387	VIIIA	GAS004	5K	jar shoulder	C	room 804, temple	1 LVIII,32
5495		32-21-492	VIIIA	GAS011	6K	unclear	S	room 801, temple	1 LVI,12
5612	a	32-21-493	VIIIAB	GAS010	7M	jar shoulder	C	rm 812, warehouse	1 LVI,11
5642		32-21-494	VIIIA	GAS012	9Q	jar mouth	C	in dom./workshop	1 LVIII,33
5777		32-21-497	VIII	GAS064	9M	bale tag	C	in dom./workshop	1 LVIII,39
5789		32-21-499	VIII	GAS065	10O	on sack	C	craft area & domicile	1 LVIII,40
5820	b	32-21-501	VIIIB	GAS005	7K	jar mouth	C	dom. warehouse worker	unpublished
5821	b	32-21-502	VIIIB	GAS066	7K	on reeds	C	dom. warehouse worker	unpublished
5822	b	32-21-503	VIIIB	GAS067	7K	on sack	C	dom. warehouse worker	unpublished
5830	b	32-21-504	VIIIB	GAS068	5O	on sack	C	shrine/craft area/dom.	unpublished
5848	b	32-21-505	VIIIB	GAS069	7K	on sack	C	dom. warehouse worker	unpublished
5863	g	32-21-506	VIII	GAS076	5Q	jar shoulder	S	shrine/craft/domicile	1 LVII,18
5863	g	32-21-506	VIII	GAS006	5Q	jar shoulder	S	shrine/craft/domicile	1 LVII,18
5881	c	32-21-509	VIIIBC	GAS013	5M	jar shoulder	C	shrine/craft/domicile	unpublished
5882	c	32-21-510	VIIIBC	GAS070	5M	jar shoulder	C	shrine/craft/domicile	unpublished
5883		32-21-511	VIIIBC	GAS071	5M	unclear	S	shrine/craft/domicile	unpublished
5907		32-21-513	VIIIBC	GAS072	6Q	jar shoulder	S	shrine/craft/domicile	1 LVI,13
5944		no number	VIIIA	GAS014	9M	unclear	C	craft & animal pens	1 LVIII,31
5954AD		32-21-516	VIIIA	GAS073	9M	unclear	C	work area & animal pens	1 LVIII,38
6077		32-21-522	VIII	GAS003	9M	string:unclear	S	craft & animal pens	1 LVII,27
6079		32-21-519	VIII	GAS074	9M	unclear	S	work area & animal pens	1 LVII,15
3-115		33-3-53	VIII	GAS075	10Q	unclear	S	dom?/craft	unpublished
3-188		33-3-88	VIIIC	GAS008	8M	bale tags	C	in 'hammam'	unpublished
3-?		33-3-239	VIIIC	GAS015	8M	knot	S	in 'hammam'	unpublished
3-173		33-3-80	IX	GAS018	6J	jar shoulder	C	near spec. func. area	unpublished
3-189	h	33-3-89	IX	GAS019	8M	door	C	room 902, temple	2 CLXIX,165
3-189	h	33-3-89	IX	GAS020	8M	door	C	room 902, temple	2 CLXIX,165
3-196		33-3-92	IX	GAS021	8M	bale tag	S	room 902, temple	unpublished
3-197		33-3-93	IX	GAS022	8M	door?	S	room 902, temple	unpublished
3-200		33-3-95	IX	GAS023	8M	door	S	room 902, temple	2 CLXVI,118
3-245		33-3-120	IX	GAS024	7M	jar shoulder	S	in/near temple room	unpublished
3-362		33-3-176	X	GAS025	9O	jar shoulder	S	in/near domicile	unpublished
3-376A		33-3-186	X	GAS026	8O	jar shoulder	S	in/near dom.	2 CLXX,184
3-495BC	e	35-10-18	X	GAS029	9Q	jar shoulder	S	dom./receiving depot?	2 CLXVIII,149
3-498		35-10-23	X	GAS031	8J	jar shoulder	S	trash from temple	unpublished
3-499		35-10-21	X	GAS030	8J	jar shoulder	S	trash from temple	unpublished
4-668		35-10-24	X	GAS032	10K	jar shoulder	S	leader's house?/mudhif?	unpublished
6-29		37-16-17	X	GAS060	8M	over thong	S	in/near temple	unpublished
6-210C	e	37-16-16	X	GAS059	8J	unclear	S	trash from temple	2 CLXVIII,150
no #		33-3-245	X	GAS077	6O	jar shoulder	S	dom./workshop	unpublished
5-1259		36-6-19	X	GAS078	6J	tag	S	courtyard by tomb shaft	2 CLXVI,116
4-797		35-10-118	XA	GAS034	4K	jar mouth	C	by temple altar	unpublished
4-872		35-10-129	XA	GAS036	6K	unclear	S	rm 13 by oven/work area	unpublished
5-1254		36-6-44	XA	GAS045	5J	jar shoulder	S	debris kitchen enclosure	unpublished
5-1258		36-6-40	XA	GAS042	6J	hide impress	S	debris open courtyard	unpublished
5-1552		36-6-42AB	XA	GAS044	7O	tag?	S	ashes dom. room 18	unpublished
4-848		35-10-122A	XI	GAS035	4J	unclear	C	temple room 2	unpublished
4-850		35-10-130	XI	GAS037	4J	door?	S	temple room 2	unpublished
4-888		35-10-124	XI	GAS079	5M	jar shoulder	S	refuse kiln work area	unpublished
4-990	f	35-10-136	XI	GAS039	6M	jar shoulder	C	near kiln work area	unpublished
4-1064		35-10-133	XI	GAS038	6Q	tab:jar mouth?	S	in front manypurpose bldg	unpublished
4-1077		35-10-127	XI	GAS080	6M	flat tube	S	cloth workshop	unpublished
4-1268		36-6-123	XI	GAS048	5K	tag? jar	S	open area east of 39	unpublished
5-1279		36-6-132	XI	GAS051	5J	bale tag	S	floor kitchen enclosure	unpublished
5-1300	d	36-6-115	XI	GAS046	6J	jar shoulder	S	enclosure work area	unpublished
5-1301	d	36-6-127	XI	GAS049	6J	jar shoulder	S	enclosure work area	2 CLXVIII,153
5-1303D	d	36-6-118	XI	GAS047	6J	jar shoulder	S	enclosure work area	unpublished
5-1310B	f	36-6-41	XI	GAS043	6K	knot	C	room 34 with trash	2 CLXIX,164
5-1370		36-6-130	XI	GAS050	6K	on string	G	st. 39 near cloth shop	2 CLXI,61
7-64		38-13-15	XI	GAS061	10M	reeds= door?	S	W. trench, near oven	2 CLXVI,120
7-84		38-13-21	XI	GAS062	10M	jar shoulder?	G	W. trench w/7 other	2 CLXI,59
4-1206		35-10-186	XIAB	GAS041	6O	door	G	by wall tripartite bldg	2 CLIX,18
5-1399		36-6-213	XIA	GAS057	4J	jar shoulder	C	in debris with others	
5-1429		36-6-212	XIAB	GAS056	4M	bale tag	C	on floor with others	
5-1488		36-6-209	XIA	GAS054	6K	unclear	C	on floor near Round Hse	
5-1573		36-6-208	XIB	GAS053	5J	bale tag	C	on floor in corner	
5-1594		36-6-121	XIA	GAS009	7K	door	C	on floor Round House	2 CLXIX,161
5-1625	k	36-6-206	XIA	GAS001	6O	box?	C	in wall Round House	2 CLXIV,97
5-1625	k	36-6-206	XIA	GAS052	6O	box?	C	in wall Round House	2 CLXIV,97
5-1651		36-6-210	XIA	GAS055	7M	jar shoulder	S	room M Round House	2 CLXVIII,154
5-1376		36-6-216	XIA	GAS058	4K	jar shoulder	S	near grave	unpublished
5-1595		36-6-309	XII	GAS082	5Q	jar shoulder	S	by rooms in entry road	2 CLXII,78
5-1239		36-6-305	XII	GAS083	4M	flat tab	S	S. of White Room	2 CLXX,179

* see Rothman 1988

** 1 = Speiser (1935), 2 = Tobler (1950)

\# a; b; c; d; e; and f = groups with the same seal impression; g; h; and k = replicate analyses

Table 1b. Sample description: Spindle whorls, Tepe Gawra; sealings and spindle whorls, Nineveh, Arpachiyah, and Tell Brak.

Tepe Gawra

Field Number	University Museum Number	Level, Phase	Smithsonian Number	Exc. Sq.	Artifact Type
3-69	33-3-34	VIII	GAS007	9M	spindle whorl
3-45	33-3-19	VIII	GAS016	6J	spindle whorl
3-164	33-3-74	IX	GAS017	8M	spindle whorl
no #	35-10-6	X	GAS028	5J	spindle whorl
3-1040	33-3-258	X	GAS027	10O	spindle whorl
no #	35-10-58	XI	GAS033	7Q	spindle whorl
no #	35-10-157	XIA	GAS040		spindle whorl

Nineveh and Arpachiyah

Site	BM Ext. Number	BM Lab. Number	Smithsonian Number	Artifact Type	Publication*
Nineveh	124345	28519u	NVS001	sealing	1933 LXIV,2
Nineveh	138454	28520x	NVS002	sealing	1933 LXIV,4
Nineveh	138457	28521x	NVS003	sealing	1933 LXIV,7
Nineveh	138458	28522t	NVS004	sealing	1933 LXIV,8
Nineveh	124329	28523r	NVS005	sealing	1933 LXIV,10 (?)
Nineveh	124334	28524p	NVS006	sealing	1933 LXIV,19
Nineveh	138554	28525y	NVS007	sealing	1933 LXIV,20
Arpachiyah	127700	28530t	ARS001	sealing	1935 IX a,606
Arpachiyah	127702	28531r	ARS002	sealing	1935 IX a,612
Nineveh	138700	28526w	NVS008	spindle whorl	1933 LXIX,6
Nineveh	137195	28527u	NVS009	spindle whorl	1933 LXIX,10
Nineveh	138698	28528S	NVS010	spindle whorl	unpublished
Nineveh	138699	28529q	NVS011	spindle whorl	unpublished

Tell Brak

Ashmolean Number	Smithsonian Number	Buchanan (1966)	Artifact Type	Provenience/Date
3	BRS001	270	sealing	Site FS, level b (Early Dynastic)
5	BRS002	811	sealing	Site ER (Ur 111)
10	BRS003	714	sealing	Site ER, Bread Pit (Akkadian)
20	BRS004	814	sealing	Site ER, Contract Room (Early Dynastic)
26	BRS005	734	sealing	Site ER (Ur 111)
28	BRS006	758	sealing	Site ER in ash pit (Akkadian)
42	BRS007	755	sealing	Site ER (Ur III)
55	BRS008	756	sealing	Site ER, Contract Room (Akkadian)
137	BRS009	804	sealing	Site CH, level A (Ur 111)
158	BRS010	718	sealing	Above 1938 Shaft (not datable)
162	BRS011	754	sealing	Above 1938 Shaft (not datable)
170	BRS012	358	sealing	Site JNP, T, Halaf Court (Ur 111?)
200	BRS013	unpub.	sealing	
211	BRS014	764	sealing	Site CH, west of Ox Room, Level B, 1 (Akkadian)
213	BRS015	764	sealing	Site CH, west of Ox Room, Level 8, 1 (Akkadian)

*1933 = Mallowan (1933); 1935 = Mallowan and Cruikshank Rose (1935)

Table 2. Summary of INAA experimental parameters.

Element	Nuclide	Gamma Ray Energy (Kev)	Conc. in Standard SRM 1633[1]	Count[2]	Analytical Precision SRM 679[3]
Na	Na-24	1369	0.32%	1	2.3%
K *	K -42	1525	1.61%	1	8.2%
Ca *	Ca-47	1297	4.70%	1	n.d.
Sc	Sc-46	889	27.0 ppm	2	1.4%
Cr *	Cr-51	320	131. ppm	2	3.1%
Fe *	Fe-58	1099 & 1292	6.20%	2	2.9%
Co	Co-60	1173 & 1333	41.5 ppm	2	1.5%
Zn *	Zn-65	1115	213. ppm	2	3.5%
As	As-76	559	61.0 ppm	1	6.0%
Br	Br-82	554	8.6 ppm	1	n.d.
Rb *	Rb-86	1077	125. ppm	2	9.1%
Sr *	Sr-85	514	1700. ppm	2	n.d.
Zr *	Zr-95	757	301. ppm	2	n.d.
Sb *	Sb-122	564	6.9 ppm	1	9.9%
Cs *	Cs-134	796	8.6 ppm	2	2.7%
Ba *	Ba-131	496	2700. ppm	1	13.2%
La *	La-140	1596	82.0 ppm	1	1.4%
Ce	Ce-141	145	146. ppm	2	1.8%
Nd *	Nd-147	91	64.0 ppm	1	n.d.
Sm *	Sm-153	103	12.9 ppm	1	1.6%
Eu	Eu-152	1408	2.5 ppm	2	2.2%
Tb *	Tb-160	879	1.9 ppm	2	12.9%
Yb *	Yb-175	396	6.4 ppm	1	4.8%
Lu *	Lu-177	208	1.0 ppm	1	6.7%
Hf *	Hf-181	482	7.9 ppm	2	3.5%
Ta *	Ta-182	1221	1.8 ppm	2	7.0%
Th *	Pa-233	312	24.8 ppm	2	2.2%
U	Np-239	106	11.6 ppm	1	15.9%
W	W -187	686	5.5 ppm	1	n.d.

n.d. = not determined

[1] Ondov et al. (1975) and Certificate of Analysis SRMs 1632 and 1633, National Bureau of Standards
[2] count 1: 1 hour after a 5/day decay; count 2: 2 hours after a 30/day decay
[3] Blackman (1986)
* Elements used in probability calculations

set of 13 elements as in the cluster analysis (see Bieber et al. 1976). Multiple iterations of the program, removing samples with less than a 0.05 probability of group membership, yielded an internally consistent chemical group of 55 Gawra sealing samples. This group is taken to represent clays local to Gawra based on the spatial and temporal distribution of the sealings at Gawra and is hereafter termed the "Gawran Clay Group" (hereafter GCG). Table 4 presents the descriptive statistics of the GCG for both raw and fitted data and Table 5a shows the probability of membership of each sample in the GCG.

Tables 5b-d show the results of the statistical comparison of the ungrouped Gawra sealings (hereafter NGC [Non-Gawran Clay]), the spindle whorls, and the sealings from Nineveh, Arpachiyah, and Tell Brak to the GCG. All Arpachiyah, Nineveh, and Brak sealings are rejected from membership in the GCG at the 99% confidence level, as are all spindle whorls from both Gawra and Nineveh. A total of 17 seal impressed clays from excavations at Gawra are also rejected from the GCG with a high probability, 15 at the 99% confidence interval and two at the 98% level. These exogenous sealings do not form a single group, but appear to come from many different sources. No single binary set of elements can therefore be used to distinguish all the foreign sealings from the GCG sealings. Plots of the Ca/Sr ratios to the Fe/Cr ratios do, however, separate most

Table 3. Data from sealings 5-1300 (GAS046), 5-1301 (GAS049), and 5-1303D (GAS047) comparing means and coefficients of variation for raw concentration data and the data after fitting to the Sc concentration in sealing 5-1301.

	Raw data		Fitted data	
Element	Mean	Coefficient of variation	Mean	Coefficient of variation
Na %	0.322	6.9	0.354	3.1
K %	1.86	11.7	1.97	14.3
Ca %	16.7	14.6	18.5	7.5
Sc ppm	13.3	8.8	14.6	0.0
Cr ppm	233.	12.2	256.	3.9
Fe %	3.72	8.6	4.09	0.7
Zn ppm	93.4	16.3	102.	7.6
Rb ppm	61.1	17.0	66.9	7.8
Sr ppm	421.	14.3	463.	7.3
Sb ppm	0.83	12.4	0.92	4.5
Cs ppm	3.35	20.6	3.67	14.3
La ppm	25.1	8.6	27.6	0.4
Ce ppm	44.0	8.6	48.5	1.1
Sm ppm	4.22	7.5	4.65	1.5
Eu ppm	0.91	10.1	1.00	2.3
Yb ppm	2.09	8.7	2.30	0.3
Lu ppm	0.38	12.3	0.42	3.7
Hf ppm	3.76	14.0	4.13	5.1
Ta ppm	0.81	15.2	0.82	6.9
Th ppm	6.70	9.0	7.43	0.3
mean coefficient of variation		11.9		4.6

Table 4. Descriptive statistics for the Gawran Clay Group: Raw data and data normalized to Sc concentration of 14.6 ppm. (N = 55)

	Raw data		Fitted data	
Element	Mean	1 sigma %	Mean	1 sigma %
Na %	0.346	18.8	0.390	20.7
K %	1.85	18.5	2.07	16.2
Ca %	15.6	11.7	17.5	12.8
Sc ppm	13.0	5.5	14.6	0.0
Cr ppm	235	8.3	265.	7.1
Fe %	3.67	5.6	4.13	1.2
Zn ppm	126.	31.5	144.	29.9
Rb ppm	65.6	9.8	73.8	8.9
Sr ppm	410	21.4	460.	21.0
Sb ppm	0.938	16.3	1.06	16.2
Cs ppm	3.50	8.6	3.94	7.6
Ba ppm	331.	30.0	373.	31.6
La ppm	25.0	5.2	28.1	1.9
Ce ppm	44.2	5.6	49.7	2.5
Sm ppm	4.21	5.6	4.74	1.9
Eu ppm	0.886	5.8	0.997	1.9
Tb ppm	0.605	11.5	0.682	10.1
Yb ppm	2.15	7.1	2.41	5.5
Lu ppm	0.340	9.7	0.383	8.2
Hf ppm	3.69	5.9	4.15	3.8
Ta ppm	0.819	14.9	0.922	14.7
Th ppm	6.70	5.8	7.53	2.5
U ppm	1.51	22.4	1.69	21.2

of the exogenous sealings and will serve to demonstrate the distinctions.

Figure 5 plots the Brak sealings (open squares) and the Nineveh samples (solid triangles) with the 95% confidence ellipse for the GCG. Samples from both sites show good separation from the GCG, with only a single sample from each site within the 95% GCG ellipse. Figure 6 shows the 95% confidence ellipse for the GCG with the exogenous sealings from Gawra plotted as solid triangles. Overall, 17 exogenous sealings fall well outside the 95% confidence ellipse. (The three seemingly in the ellipse are out in another dimension.) The scatter of points shows that these sealings do not belong to a single group. The three exogenous sealings that fall within the 95% GCG ellipse can each be separated using a different set of elements.

Results

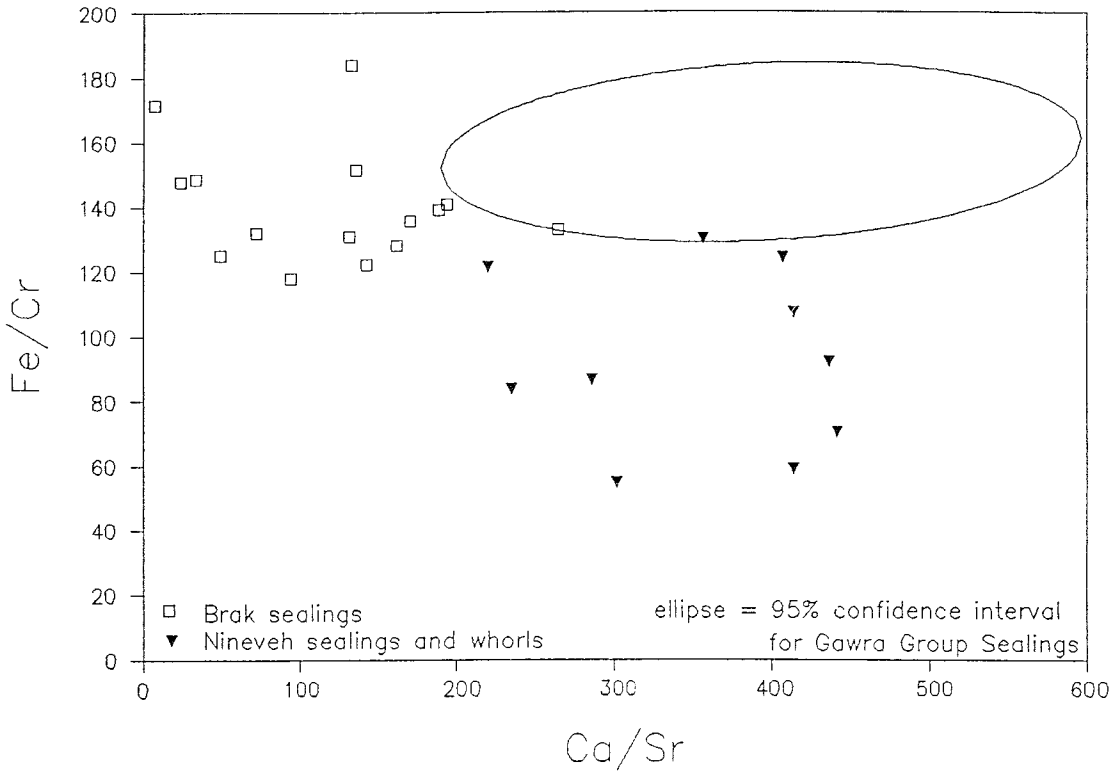
The chemical characterization by INAA yielded the following general results. The attempt to use spindle whorls to identify local clay sources also used in sealing activities was unsuccessful. Although it is still likely that the crude spindle whorls from Gawra and from Nineveh were made of local clays, they proved to be of little use in characterizing the chemical composition of local sealing clay sources. The Gawra spindle whorls were all excluded from the GCG sealing population at the 99% confidence level and were also dissimilar to any other sealing sampled. The reason for their strong exclusion most probably lies in pretreatment of the clay materials used in the sealing process. The sealing clays all appear to be fine, well levigated clays, although in a very few examples clays did contain visible white grit inclusions, as if levigated and initially tempered pottery clays were used. In these cases sampling was designed to avoid these very visible inclusions. On the other hand, the material used to make the crude spindle whorls appears to be unlevigated and full of visible inclusions. Either the clays for the spindle whorls were from sources other than those used for the sealing clays or the presence of the coarser size fractions in the spindle whorls alters the chemical composition. In either case the spindle whorl clays could not be used to establish the "local" clay composition for comparison with the sealings.

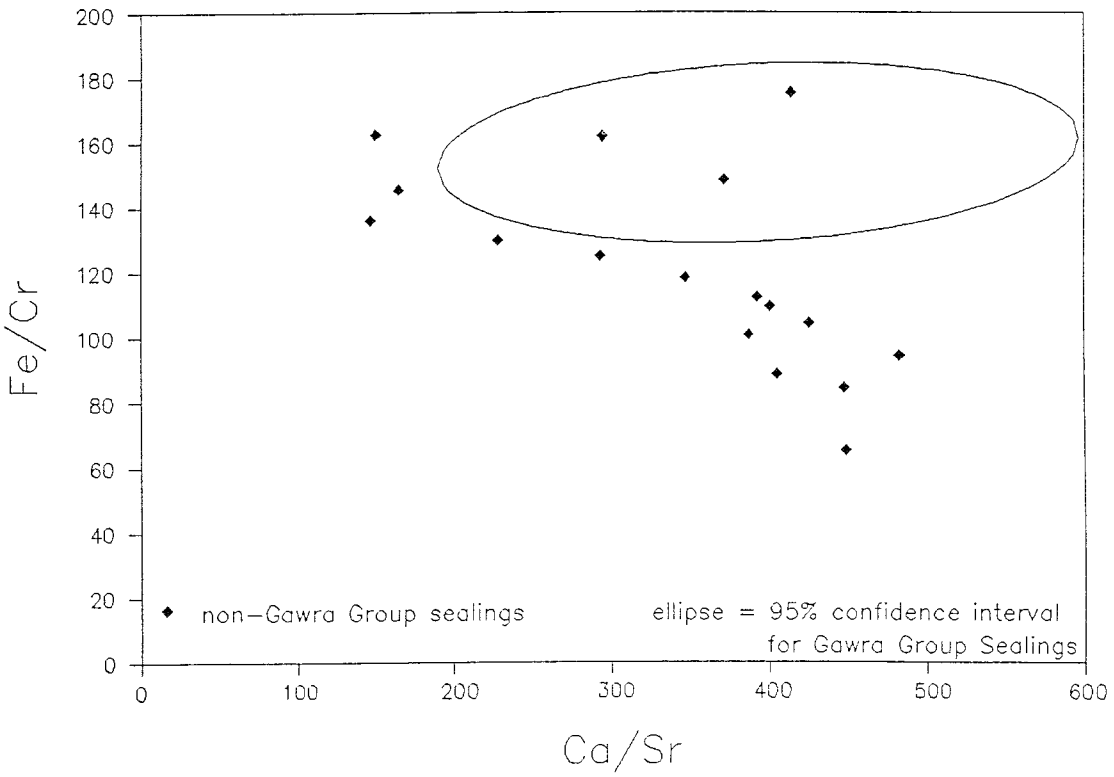
Table 5. Mahalanobis distance calculation based on elements: K, Ca, Cr, Fe, Zn, Rb, Sr, Cs, La, Sm, Yb, Hf, and Th indicating the probability of individual sample membership in the Gawran Clay Group.

Smithsonian Sample Number	Probability	Smithsonian Sample Number	Probability	Smithsonian Sample Number	Probability
Gawran Clay Group (GCG) sealings					
GAS008	45.3	GAS035	94.8	GAS059	80.2
GAS009	34.8	GAS036	70.0	GAS060	89.7
GAS011	47.0	GAS037	70.6	GAS062	90.4
GAS012	89.4	GAS038	37.4	GAS064	82.1
GAS013	99.5	GAS039	17.8	GAS066	66.4
GAS014	90.5	GAS041	25.1	GAS067	41.4
GAS018	83.4	GAS042	94.1	GAS069	43.0
GAS019	82.6	GAS043	89.5	GAS070	83.8
GAS021	82.2	GAS044	87.6	GAS071	96.7
GAS022	19.1	GAS045	68.3	GAS072	92.6
GAS023	73.3	GAS046	91.6	GAS074	94.4
GAS024	54.1	GAS047	43.7	GAS075	43.6
GAS025	66.7	GAS048	44.2	GAS076	73.9
GAS026	53.9	GAS049	88.7	GAS077	71.6
GAS029	97.8	GAS050	51.2	GAS079	34.3
GAS030	41.5	GAS051	58.2	GAS080	94.7
GAS031	91.0	GAS055	87.1	GAS081	43.3
GAS032	87.2	GAS058	90.0	GAS082	75.5
GAS034	77.9				
Non-Gawran Clay (NGC) sealings from excavations at Gawra					
GAS003	0.0	GAS053	0.0	GAS065	1.8
GAS004	0.0	GAS054	0.0	GAS068	0.0
GAS005	0.0	GAS056	0.0	GAS073	0.0
GAS010	0.0	GAS057	0.0	GAS078	0.0
GAS015	0.0	GAS061	2.2	GAS083	1.0
GAS052	0.0	GAS063	0.0		
Gawra and Nineveh spindle whorls					
GAS007	0.0	GAS028	0.0	NVS008	0.0
GAS016	0.0	GAS033	0.0	NVS009	0.1
GAS017	0.0	GAS040	0.0	NVS010	0.0
GAS027	0.0			NVS011	0.0
Tell Brak, Arpachiyah, and Nineveh sealing clay					
BRS001	0.0	BRS009	0.0	ARS002	0.2
BRS002	0.0	BRS010	0.0	NVS001	0.0
BRS003	0.0	BRS011	0.0	NVS002	0.1
BRS004	0.0	BRS012	0.0	NVS003	0.0
BRS005	0.0	BRS013	0.0	NVS004	0.0
BRS006	0.0	BRS014	0.0	NVS005	0.0
BRS007	0.0	BRS015	0.0	NVS006	0.0
BRS008	0.0	ARS001	0.2	NVS007	0.0

Fig. 5: ►
Plot of clay groups of Tell Brak and Nineveh sealings.

Fig. 6: ►
Plot of clay groups of Tepe Gawra sealings.


200
180
160
140
120
100
80
60
40
20
0
Fe/Cr
0
100
200
300
400
500
600
Ca/Sr
Brak sealings
Nineveh sealings and whorls
ellipse = 95% confidence interval
for Gawra Group Sealings


200
180
160
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120
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Fe/Cr
0
100
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400
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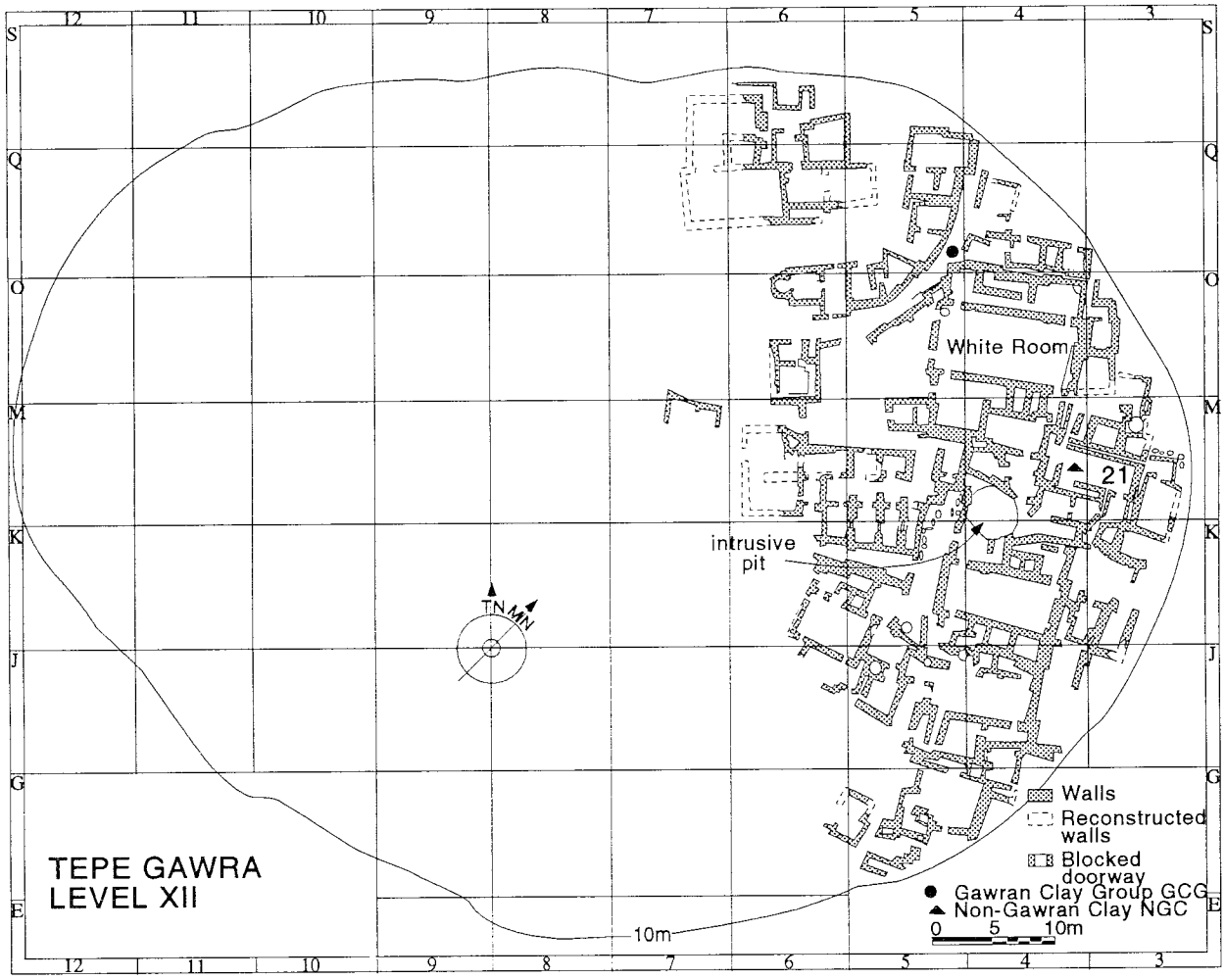
Ca/Sr
non-Gawra Group sealings
ellipse = 95% confidence interval
for Gawra Group Sealings



The sealing clays sampled were generally free of inclusions and the results of their activation present a picture of sealing behavior consistent with the functional analysis of the Gawra levels and sub-level phases tested (Rothman 1988). The key general results of the INAA were:

1. Gawra sealings fell first into an extremely consistent and large Gawran Clay Group—GCG—(including all the door sealings sampled) and second into clays of varying compositions which can be termed simply non-Gawran Group clay (NGC). The NGC clays cannot be statistically attributed to any other common source or sources, although by inspection some seem closer to one another than others. Levels XI/XA to IX stand out by having almost no sealings of NGC clays.[5]
2. All of the Nineveh sealing samples were excluded from the GCG composition at the 99% confidence level and, although not statistically verifiable due to the small sample size, showed little similarity to the NGC clay from Tepe Gawra.
3. Both of the Arpachiyah samples were excluded from the GCG at the 99% confidence level.
4. None of the spindle whorl samples from Nineveh or Gawra matched either the sealing clays from their own or the other sites.
5. All Tell Brak sealings were excluded from the GCG at the 99% confidence interval. The Brak samples also did not appear to match any of the other samples from the three Tigris River drainage sites, although this could not be rigorously tested with the small sample size available.

The raw data for this analysis can be found in the Appendix.

Interpretation of the results of instrumental neutron activation analysis

The cultural implications of the results reported above most significantly challenge the initial Central Place proposition that Gawra was a secondary center of Nineveh, as the sealing clay compositions show no movement of sealed goods between these two sites. While it remains possible that the small sample of sealing clays from Nineveh

◄ Fig. 7:
Gawra, level XII.

is not representative of the site as a whole, it is highly unlikely that all the analyzed sealings could be derived from a site or sites other than Nineveh. Perhaps, during the fourth millennium B.C. the other prehistoric mound of Nineveh, Nebi Yunus, was a more important center of political and economic activity than the Kuyunjik mound, which was sampled. However, at this point the question raised earlier about a lack of shared artifact styles supports the null hypothesis that no dominant-subordinate relation existed between Gawra and Nineveh. Styles are often used by archaeologists to measure the degree of regular contact or social identity between contemporaneous sites.

If Gawra were not a secondary center of Nineveh, but perhaps the center of a small polity encompassing the edge of the piedmont and foothills beyond, what do differences among levels XII to VIII say about the territory and characteristics of Gawra's administration over approximately a millennium? Here the mapping of GCG and NGC sealings onto the functional areas of Gawra delineated for levels XI/XA to VIII (Rothman 1988) and for XIA/B and XII (Rothman in prep.) come into play.

One theoretical approach to this question can be framed in terms of a theory presented by Kowaleski et al. (1983). They propose that in a centralized system with small territories and small populations, economic activity mediated through one central site will be greater than the integration among smaller sites or contact between small sites and other polities. That is, a small polity is a closed, highly centralized system. In a system with a much larger territory, the amount of economic or social activity mediated through the center will be lower relative to the interactions among residents of smaller sites and contact of those residents with sites in other polities. That is, larger systems are less extremely centralized and more integrated and open to other polities. By logical extension, a system occupying a small territory can also be open if the administrative system is not yet capable of controlling the flow of goods and information. For Gawra, these propositions have considerable explanatory weight.

Level XII (Fig. 7)
GCG=1, NGC=1

Level XII was occupied at a time when the 'Ubaid Period typical of the fifth millennium B.C. was being transformed into the Uruk or Late Chalcolithic Period of the fourth in Mesopotamia. Where the 'Ubaid is characterized by the replication of chiefdom-level polities and surprising stylistic uniformity, the Uruk is marked by differing stylistic and political developments in each of five subregions, eventually including the development of states in the South. Gawra during XII is marked by tight clusters of buildings with domestic remains and considerable craft activity involving weaving and wood working. A number of tripartite buildings, especially a large building with white plastered walls (the White Room in squares 5O and 4O) by the planned entryway to the site, may indicate some social differentiation or administrative development. That white-plastered building yielded maceheads, many sealings, some personal ornaments, and a few tools. The level ended in a military conflagration (fire and a skeleton in the street with a stone or sling missile in its back). Taken together, the evidence of XII suggests a large village or small town with a chiefly house. Little suggests a developed administrative mechanism with control far into its hinterland. For example, the large religious buildings evident in earlier XIII and again from XI/XA to VIII are absent. If the idea that centralization of religion (sanctification) is a prerequisite for building an early centralized administrative apparatus is correct (Wheatley 1971), XII appears to lack that characteristic. As one might expect of a small site with little developed administration, one (field no. 5-1595) of the two sealings sampled was made of the GCG clay and the other (5-1239) was of NGC clay. As will again be the case in level XIA/B, the GCG sealing of XII (from the shoulder of a jar) was found in a trashy deposit near the large White Room complex. The NGC sealing was from a complex (built around central hall 21) in squares 3M and 4M, containing both domestic pottery (including a beveled rim bowl-like Wide Flower Pot) and textile making tools (spindle whorls primarily).

Level XIA/B (Figs. 8, 9)
GCG=5, NGC=5

Level XIA/B has two phases distinguishable in the southeastern and western excavated areas of the mound. The earlier XIB phase has very much the same look as XII and seems a rebuilding after the fire in XII. There are again no large temples evident. Buildings are small and tightly clustered. During the occupation of XIA, the large thick-walled building, the Round House, was built, as apparently was a gateway structure in the northeast. The Round House presents the picture of a fortress for the common defense. It has unusually thick walls, a sunken entry ramp, and storerooms, including grain storage in room G (Tobler 1950:23). Maceheads were found in the structure. If XIA/B, especially XIA with its Round House building, represented a major elaboration of centralized administration, one would expect mostly sealings from nearby sites and GCG clay, according to Kowaleski's theory. That is, one would expect a closed system with a narrow territory. However, of ten sealings tested, five were of NGC, five of GCG clay. The only sealing definitely of the earlier XIB phase is a bale tag found in the midst of a building with domestic artifacts and storage bins. It was made of NGC clay. The other four NGC sealings were also found in such

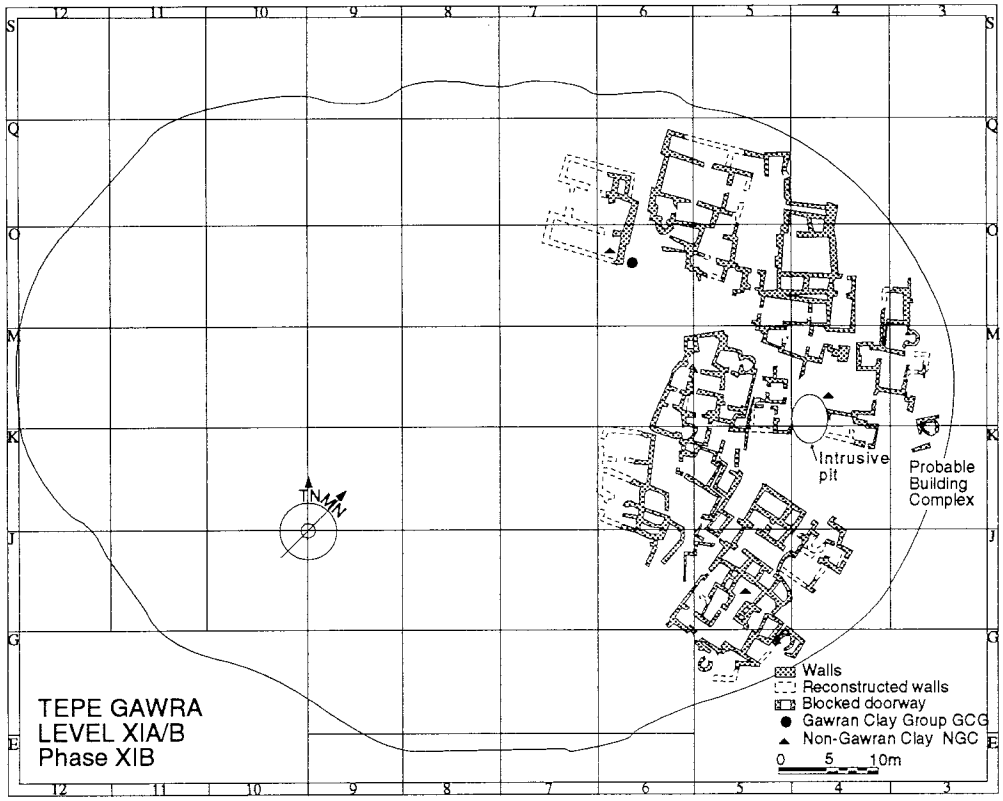


Fig. 8:
Gawra, level XIA/B, phase XIB.

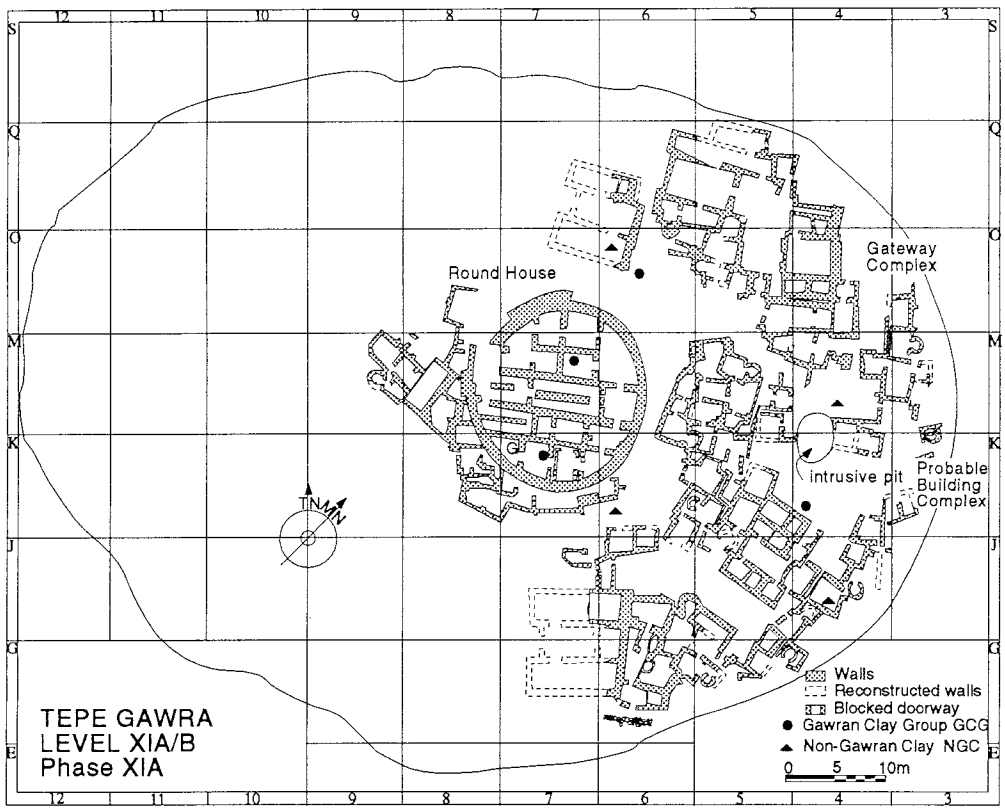


Fig. 9:
Gawra, level XIA/B, phase XIA.

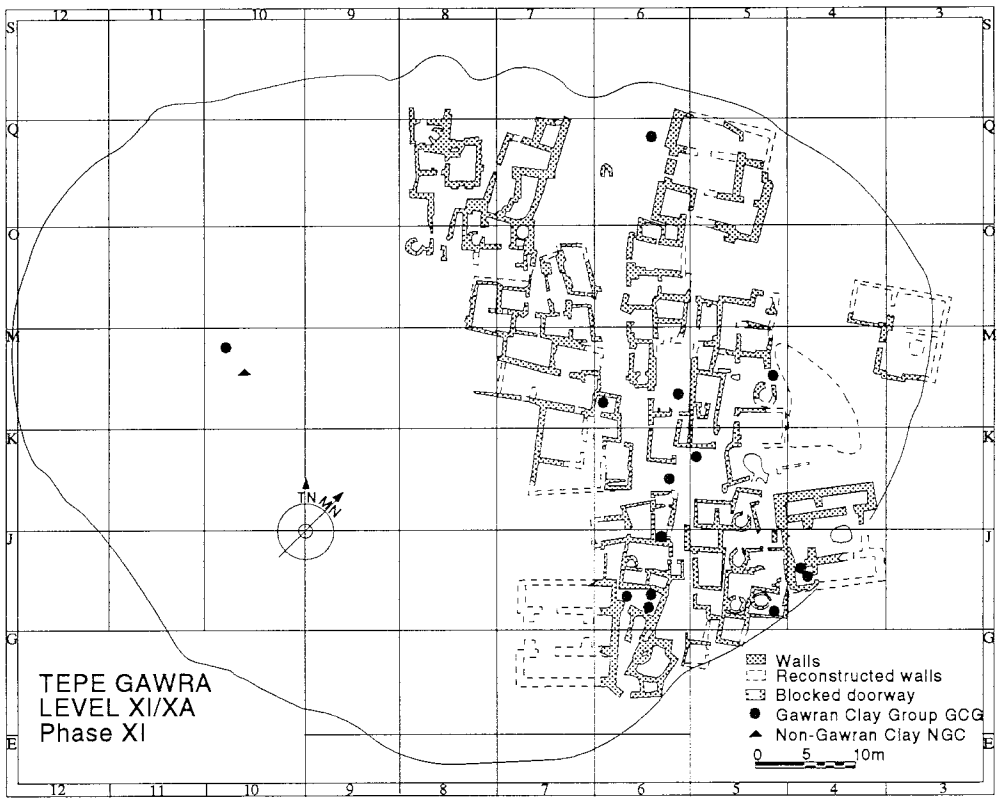


Fig. 10:
Gawra, level XI/XA, phase XI.

seemingly domestic contexts. Both sealings found in the Round House (including a door seal) were of local GCG clay. In short, XIA/B seems best to fit a situation in which important individuals with contacts across some distance (the residents of small domestic buildings with NGC sealings) appear to be provisioning the Round House for common defense. They seal goods stored or opened in the Round House with the local GCG clay. XIA, like XII, appears to have ended in flames, although direct evidence of military conflict was not recovered.

Level XI/XA, phase XI (Fig. 10)
GCG=14, NGC=1

By the time Gawra is rebuilt in the XI phase of XI/XA, social and political conditions appear to have changed dramatically. A much larger area of the mound was also excavated, compared with XII-XIA/B. Functional analysis showed that phase XI of level XI/XA combined centralized religious activity, a major kitchen (probably for the temple), and a considerable amount of specialized craft production (where "specialized" indicates production of more than needed for local consumption). This specialization was reflected in two room blocks that had considerable evidence of cloth manufacture (bobbins, loom weights, loom bases), in one case to the exclusion of other types of functional artifacts (in squares 5M and 6M). There was also evidence of concentrations of wood working tools and materials, of the firing of pottery and clay items (double voluted clay objects called hut statues [see Rothman 1988:226-230] and animal figurines). A number of room blocks appear to be domiciles because of the preponderance of food preparation and serving ceramics and their architectural shape and size. Sealings were found in association with each of the specialized religious and economic activity areas, but in none of the houses. Seal impressions of complex design were found in two craft areas and the temple. Compared to other functional types, door sealings had a greater percentage of complex impressions. Geometric "corporate" stamp seals were recovered only from buildings with religious, social, or major production functions. Sealings found in each of these areas were made of GCG clay. Only one sealing from the West Trench was made of NGC clay, and its assignment to XI is questionable. Compared to the situation in XIA/B, the evidence of functional analysis suggests just the sort of center of a small, somewhat isolated polity (presumably of village communities and transhumant or nomadic groups) that the Kowaleski model would predict. The distribution of sealings indicates control of specialized functions, while the chemical compositional analysis suggests that the sealings represent localized accounting activities, with little or no evidence of sealed goods entering Gawra during this time.

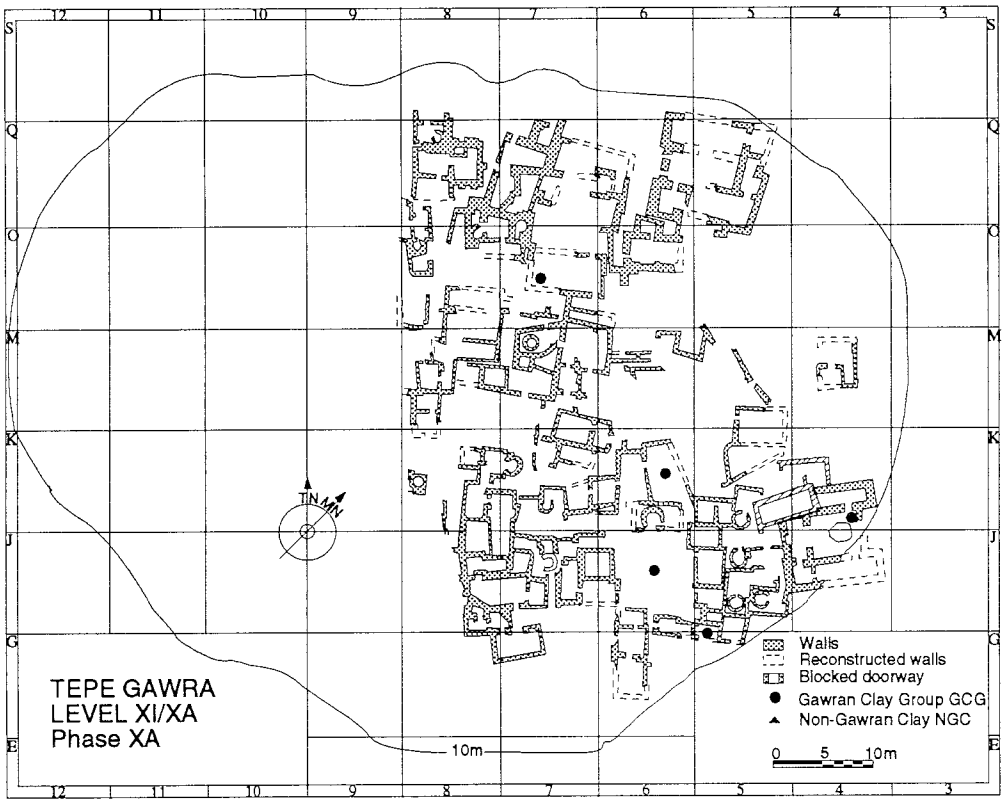


Fig. 11:
Gawra, level XI/XA, phase XA.

Fig. 12:
Gawra, level X.

Level XI/XA, phase XA (Fig. 11)
GCG=5, NGC=0

The later XA phase of level XI/XA showed a decline in manufacture, particularly of cloth, and a continuation of the religious ritual and some wood working. Sealings were again clustered in specialized religious, production, or social areas, suggesting control of specialized functions. As Fig. 11 illustrates, all sealing clays were of local origin, suggesting a small, closed system.

Level X (Fig. 12)
GCG=9, NGC=1

Analysis of artifacts from level X at Gawra continues to indicate a centralized role for religious ritual. Some craft activity was also evident, but most was now scattered among buildings that by shape, number of rooms, and artifactual content were also domiciles. One exception was a kiln (space 1083) in the courtyard south of two domiciles by the east wall of the temple. Unlike phase XI, seals and sealings were found in these houses, in addition to trash deposits apparently from the temple. For the first time since the Round House of XIA (see above), a major building with no evidence of religious ritual activity was unearthed in the southwestern part of the level X mound (rooms 1054 to 1070). This building had food storage and preparation areas on its southern flank. Its interior contained fine domestic serving and food preparation vessels and a hut statue, but no craft tools. It can be interpreted as a leader's house or the equivalent of a modern hospitality house (*mudhif*). The one sealing from level X impressed with a complex seal was found in this building. As before, all the activity areas (now including houses and the major southwestern building) contained sealings of local clay. The one exception was in a context where it may have been carried down by the shaft of tomb 202 (5-1259).

Level IX (Fig. 13)
GCG=6, NGC=0

Level IX was very closely modelled on level X in architectural plan and function. The central religious temple was the focus of activity and of sealing remains, especially in storeroom 902. A possible copy of the southwestern building was uncovered in a badly disturbed condition. The whole eastern part of the mound surface was also disturbed by construction in level VIII. The first clear evidence of a shop in which seals and beads were carved (908, 909) was found in level IX. In this level, the religious institution was the main concern of the leadership organization, based on sealing remains. All sealings sampled were made from local GCG clay, indicating a continuation of the small, closed system.

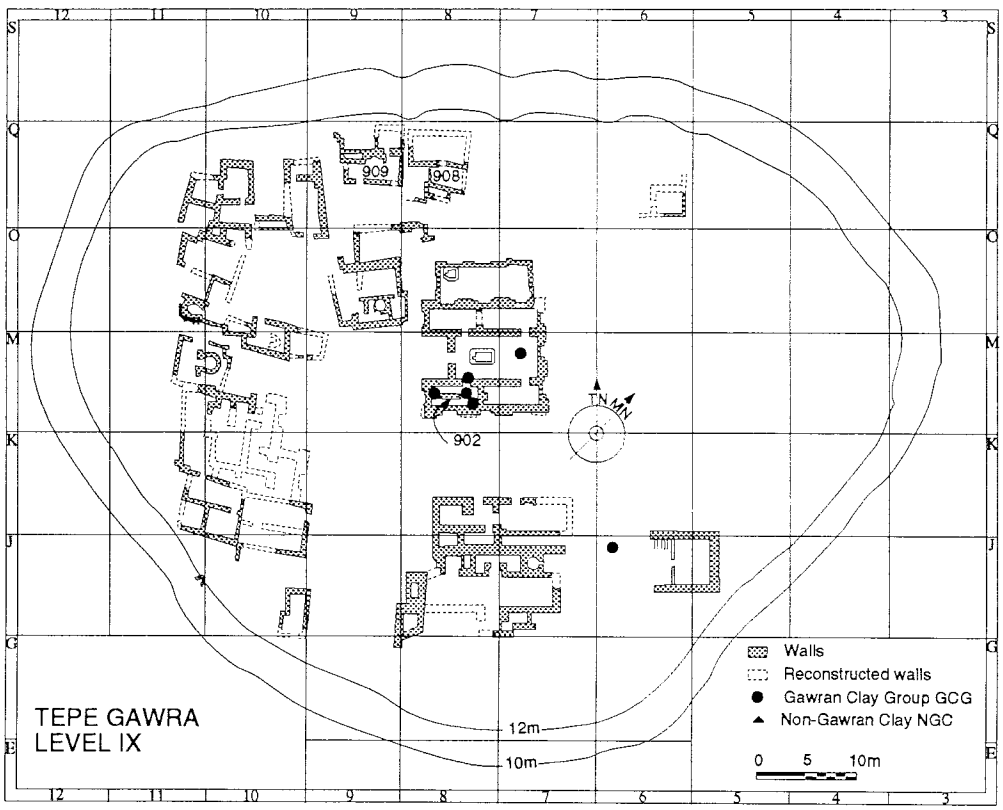


Fig. 13:
Gawra, level IX.

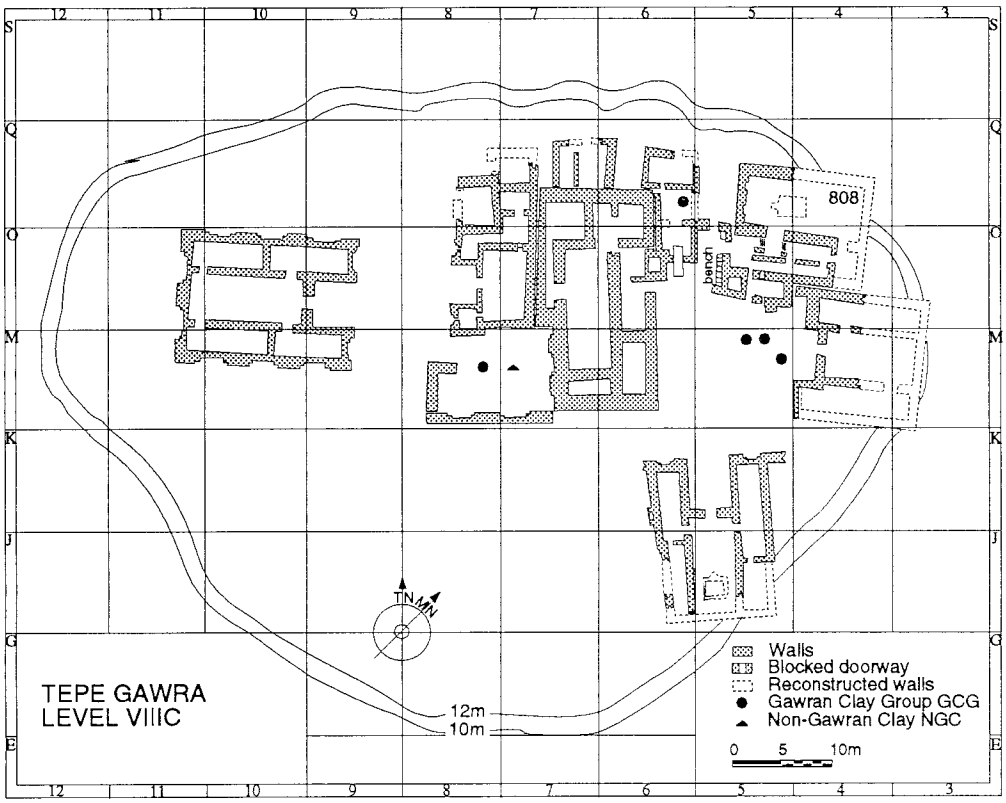


Fig. 14:
Gawra, level VIIIC.

Level VIII (Figs. 14-16)
GCG=15, NGC=9

Based on functional and compositional analysis, levels XI/XA to IX were ceremonial and administrative centers for small, closed polities. They had varying evidence of craft activity. Level VIII presents a somewhat different picture. The architecture is different. The buildings that continue through the three phases of level VIII are sizable, pre-planned structures, situated at the edge of the mound. Contrary to the analysis of Speiser (1935), only the southeastern tripartite building in squares 5-6/J-K appears dedicated to religious ritual. Room 808 of the large northeastern building was a shrine room, but other rooms (including a possible second floor) evidence craft and domestic activity of persons possessing unusually fine goods. The western tripartite building of VIIIC (Fig. 14) and VIIIB (Fig. 15) has evidence of considerable craft and some domestic activity. It also contained a room filled with grain in which beveled rim bowl-like Wide Flower Pots were stacked. Speiser's so-called "Central Shrine" is, instead, a house with craft workrooms. In VIIIB and A, the first clearly defined storehouses (in squares 7M and 8M) were built in the middle of the mound (Figs. 15 and 16). Also different from phase XA to level IX, craft production and commercial activity increase dramatically in phases VIIIB and A. Like phase XI, all buildings with specialized religious, craft, or political significance had sealings, while more domestic buildings like the "Central Shrine" had none (the three seals found there were more likely manufactured than utilized there).

Unlike XI/XA to IX, the presence of sealings made both of GCG and NGC clay in numerous locations on the mound of VIII suggests that the system of which Gawra was a part had opened up or expanded somewhat. The actual source(s) of this NGC clay have not been identified, so the extent of the expansion of the administrative sphere remains unknown. Those sources may not be far from Gawra at all. What remains to be determined is whether Gawra was the center of that expansion or a subsidiary part. Nineveh would be an unlikely primary center of Gawra for the reasons sketched above, but other sites north and west of Gawra (like Tell Brak) could be, although the distances between them are great.

The distribution of the sealings sampled permits several interpretations. In VIIIA two pieces of the same NGC sealing from the shoulder of a jar were found in the warehouse in 7M and the southeast temple (5612, 1660A). A second exogenous sealing (1661) and a sealing of GCG (5495) were recovered from rooms 804 and 801 respectively. From phase VIIIB (Fig. 15), there are nine sealings impressed with the "bull, dog, and snake" design (see Fig. 2b), five of which were analyzed. Four of these sealings were associated with the tripartite building immediately south of the warehouse. Of those, three are made of Gawran Group

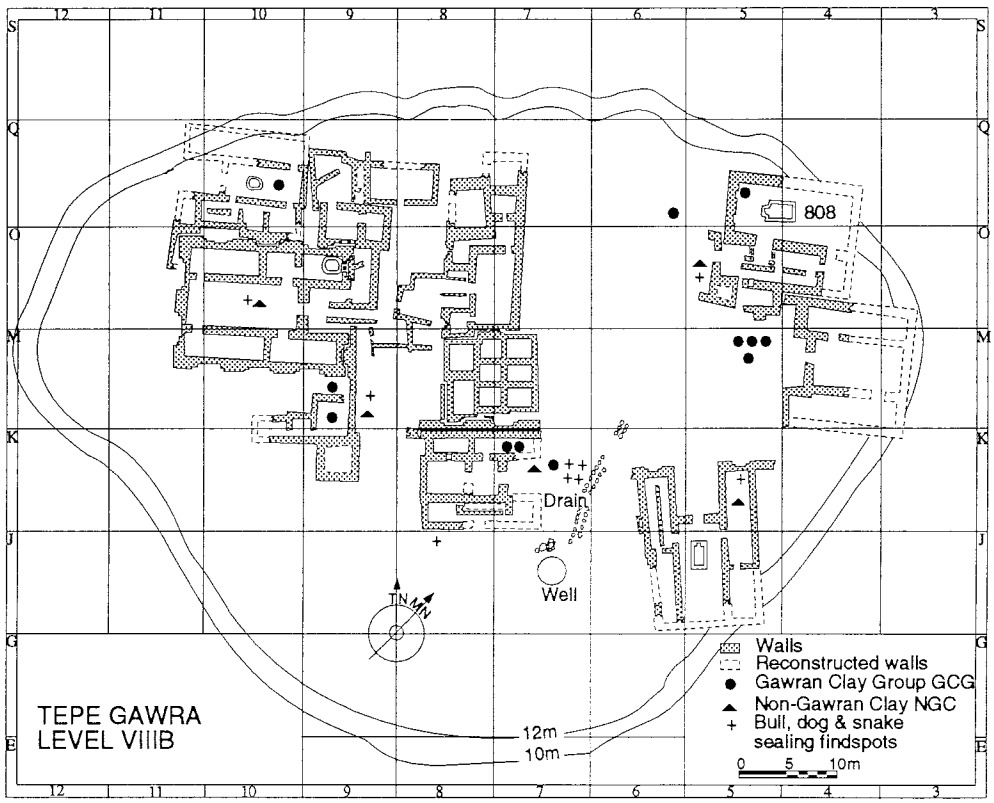


Fig. 15:
Gawra, level VIIIB.

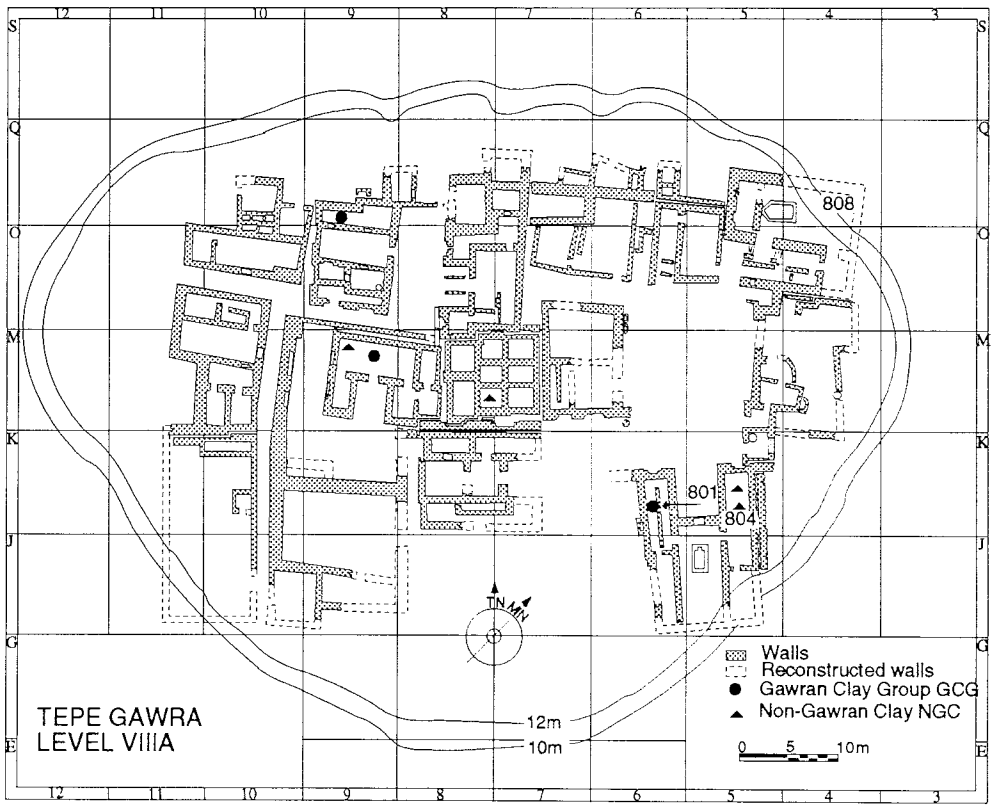


Fig. 16:
Gawra, level VIIIA.

clay (5821, 5822, 5848), one (5820) is not. A NGC sealing with this same bull, dog, and snake seal impression (5830)[6] was found in or near the large northeastern building with room 808, housing religious and craft activities and domestic goods typifying persons of special status (see Rothman 1988:430-433). In addition, unanalyzed sealings impressed with the bull, dog, and snake seal were located near the western tripartite building, in the southeastern temple, and near the western mound edge in square 12K. Both GCG and NGC sealing clays were excavated near these same buildings. These distributions suggest that some goods were being sealed off the mound and shipped to the central storehouse, the adjoining tripartite building, or directly to activity areas of special interest to administrators of the Gawran population. The influx of exogenously sealed goods could imply administered trade or incorporation of Gawra into a larger polity with another center. However, in some cases, contents with the same foreign sealing (as a record of receipt) were opened in the warehouse and sent to a religious, craft, or political institution critical to the leadership organization (e.g., 5612 and matching sealing 1660A). This implies some internal routing of sealed goods by an administrator at Gawra. Again, such routing could imply that the Gawran administrator was of secondary rank to someone at a more central site. However, the fact that GCG and NGC sealings were impressed with the same bull, dog, and snake seal would suggest that the individual office holder or office was active both at Gawra and some distance away. A pattern of administrators being stationed at one site, but travelling to other places to audit or claim goods or raw materials for shipment back to their home site under seal is attested in historical texts of the third and second millennia B.C. on the southern alluvium (e.g., see Cocquerillat 1967 for date audits). In short, this distribution of the bull, dog, and snake design suggests that Gawra was a center of an expanded territory. At the same time, the presence of NGC sealings without the bull, dog, and snake impression would question the degree of control of the office or official with the one seal. So this expanded administrative sphere of VIII would be less centralized than, for example, phase XI, but the administrative organization may have become elaborated through the mechanism of the central warehouse.

The differences between the pattern of VIII and XII/XIA/B are particularly interesting in regard to the percentages of GCG/NGC sealings. In all three levels, a large proportion of sealings are exogenous. However, whereas the exogenous sealings in VIII are broken off and discarded in or near specialized buildings, presumably controlled by administrators, in XII and XIA/B, the situation is the opposite. The GCG sealings are in the Round House. The NGC sealings are in clusters of residences.

In sum, Gawra during level VIII times had ceremonial, administrative, and craft/commercial functions. There is the evidence of centralized storage and redistribution functions being formalized for the first time. Chemical compositional analysis indicates that Gawra became a secondary part of a larger polity, simply expanded its sphere of control, or altered its administrative structure. Until the source(s) of the exogenous clay are found and more is known about other nearby sites of fourth millennium B.C. date, all these alternative explanations are possible.

If XI/XA to IX represents the time of a small, locally controlled sphere of administrators in what one could call the Gawra polity and VIII represents a time of larger, and more open sphere, either with Gawran leaders controlling more territory and population or becoming part of a larger polity, but not its center, the time of XIA/B and XII typifies a third possibility. Preliminary functional analyses present a different cultural interpretation than that of levels XI/XA to VIII. These still preliminary analyses suggest that both XII and XIA were large villages with some specialized, but not physically segregated, craft production (probably including cloth making). Each level has one building whose size and layout suggests a special social function (the Round House of XIA and the White Room of XII), but the level of administrative elaboration appears low compared to the later levels.

Conclusions

The picture emerging from this study of Tepe Gawra clay sealings is one of an uncentralized, weak administrative organization in XII and XIA/B. By XI, administrators control some segments of a small territorial system, which is closed and highly centralized. The administrative system of XI/XA, with a tight focus on accounting and control of local movement and storage of goods, persists through level IX. By level VIII the administrative domain has expanded, but unlike XIA and XII, the evidence suggests even more elaborated administrative mechanisms at Gawra than during XI/XA to IX. Whether the administration of Gawra VIII is controlling a larger polity than before or is the center of a secondary segment of an even larger polity with a primary center elsewhere cannot be determined with currently available evidence. Figure 17 illustrates these changes in spheres of action over the periods in question as a histogram of the percentage of Gawran Group Clay to Non-Gawran Clay in the sampled sealings. In the earliest period, XII-XIA, literally half of the sealings analyzed are made of NGC clay. In the second period, only two sealings are made of NGC clay and both of those are from contexts that may lump them with VIII or XIA. The rest are all made of GCG clay. In the latest period, VIII, more than half the sealings sampled are from the Gawran clay source, but a large proportion are from one of a number of possible NGC sources. This interpretation of Gawra accords well with the evidence from a similar study of the late fourth to early

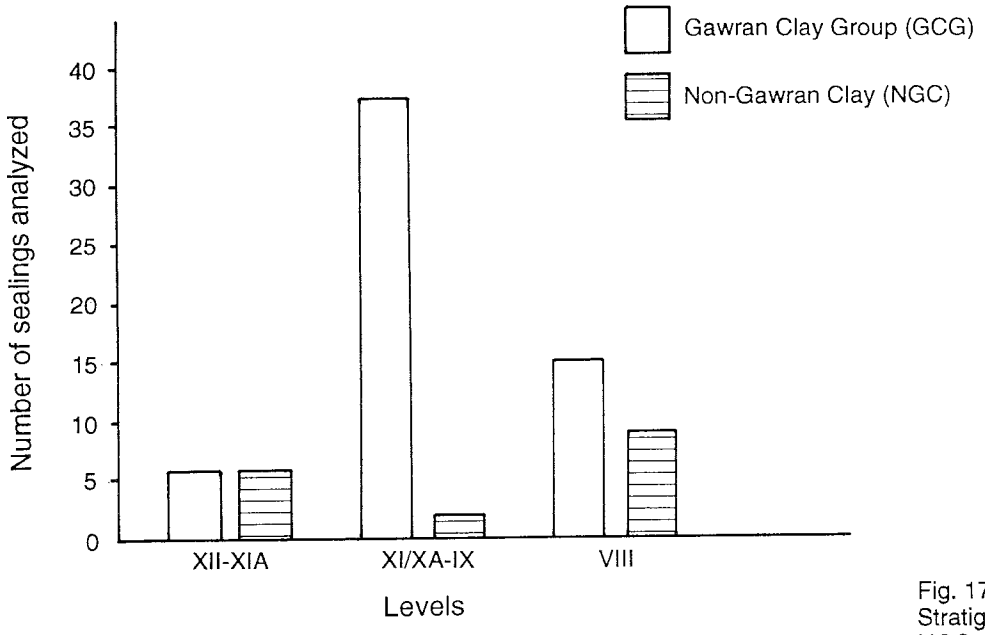


Fig. 17:
Stratigraphic distribution of GCG and NGC clays.

third millennium B.C. Banesh Phase occupation at Tal-e Malyan in the southwestern highlands of Iran (Blackman and Zeder 1986), where a similar tight local administrative focus also precedes a later expansion in the Kaftari Phase (Blackman 1989).

Chemical characterization of sealing clays by INAA, used in conjunction with iconographic, and more traditional contextual studies, thus has been shown to provide a very powerful tool for the further investigation and interpretation of the development of ancient complex societies.

Acknowledgments

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Notes

1. Stratigraphic analysis showed that the major buildings at the edges of the XI mound continued into what Tobler called "level" XA. Building blocks in the center of the XI mound were replaced by new construction in XA. In short, XA and XI are two phases of one level, XI/XA, as VIIIC-A are three phases of one level, VIII.

2. Gibson (Colloques 1980:96) asserts that there is a terraced lower town off the main Gawra mound. He is unable to date this proposed lower town. Arguing in favor of a lower town is the small mound Khirbet Na'aman, 600 m from the main mound, with Gawra VI remains. Arguing against it are excavations off the main mound in area A and the northeastern base, which yielded Halafian material, suggesting a large village earlier in date than any of the material excavated on the main mound.

3. The full explanation of the split between phases XIA and XIB will appear in a monograph, *Fourth Millennium B.C. Tepe Gawra* (Rothman in prep.).

4. Although the large fourth millennium B.C. mound of Tell Brak may have been an economic partner of Tepe Gawra, the sealing clays available to us were of a much later date. The Brak data were run against the Tepe Gawra, Nineveh, and Arpachiyah data in hopes that Khabur Basin clays might identify some of the sealing clay sources that had been identified as not local to Tepe Gawra. As the Results section of this paper reports, that hoped-for result was not achieved. However, the Brak data included here are already of utility in the second author's study of clays from Tell Leilan, and are reported for their negative evidence in the Tigris drainage and their association with other Khabur sites.

5. Consult Tables 1 and 5 for detailed results of levels XII-VIII. Two sealings, one from XI and one from X, present stratigraphic problems. Sample 7-64 from phase XI is not a member of the GCG. Sealing 7-64 is from the West Trench, where the stratigraphic distinction between phase XI and level XIA is very difficult to draw. Similarly, only sealing 5-1259 (from X) is not of GCG. However, it was found under a wall in an open courtyard very near the shaft of tomb 202 sunk from level VIII. Possibly it was not in its original context.

6. The grouping of 5820 and 5830 of VIII and 7-64 of XI as non-Gawran clay contradicts the results from Rothman (1988). This is because the fitting of data and the problem of multiple firing temperatures and times was not appreciated at the time those preliminary results were reported.

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Appendix. Raw concentration data for the samples run in this investigation.

Tepe Gawra Seal Impressed Clays

	Na %	K %	Ca %	Sc ppm	Cr ppm	Fe %	Zn ppm	Rb ppm	Sr %	Sb ppm	Cs ppm	Ba ppm	La ppm	Ce ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm	Hf ppm	Ta ppm	Th ppm	U ppm
GAS001	0.299	1.57	17.2	13.8	254.	3.98	99.3	65.3	0.050	0.944	4.01	424.	27.2	47.1	4.54	0.948	0.661	2.34	0.366	4.06	0.793	7.16	1.85
GAS003	0.475	2.19	15.5	12.9	313.	3.91	282.	62.8	0.053	0.920	3.30	317.	25.0	44.2	4.18	0.873	0.802	2.37	0.325	3.67	0.708	6.64	1.73
GAS004	0.279	3.69	13.6	14.9	294.	4.76	224.	72.9	0.091	n.d.	2.39	372.	28.6	49.9	4.79	1.01	1.12	2.70	0.372	4.28	0.889	7.78	1.70
GAS005	0.435	1.94	16.3	12.9	276.	3.75	155.	61.4	0.111	0.776	3.00	566.	24.8	44.8	4.22	0.885	0.703	2.15	0.343	3.83	0.760	6.76	1.72
GAS006	0.650	1.62	15.1	13.6	240.	4.05	268.	68.7	0.033	1.20	3.93	264.	26.5	47.3	4.44	0.944	0.631	2.58	0.305	4.13	0.832	7.71	1.24
GAS008	0.340	1.67	15.8	12.3	221.	3.62	124.	68.4	0.043	1.07	3.45	311.	23.6	42.3	3.98	0.828	0.656	2.25	0.293	3.46	0.830	6.47	1.53
GAS009	0.289	1.88	13.6	13.2	237.	3.86	100.	76.4	0.037	1.11	3.74	445.	25.1	42.4	4.27	0.893	0.682	2.56	0.344	3.50	1.01	6.76	1.41
GAS010	0.318	2.76	15.9	12.9	319.	4.14	144.	61.2	0.070	1.13	3.24	259.	25.0	44.3	4.24	0.881	0.693	2.33	0.287	3.62	0.851	6.92	1.30
GAS011	0.308	1.37	17.1	12.1	236.	3.52	116.	69.2	0.032	0.904	3.54	233.	23.7	40.6	3.87	0.809	0.665	2.28	0.312	3.61	1.30	6.35	1.24
GAS012	0.351	1.41	17.9	12.6	209.	3.55	128.	65.2	0.038	0.942	3.41	366.	24.3	43.4	4.06	0.851	0.653	1.96	0.387	3.71	0.719	6.27	1.82
GAS013	0.306	1.75	14.0	13.8	271.	3.90	120.	66.8	0.037	0.929	3.78	269.	26.4	47.9	4.46	0.920	0.596	2.27	0.359	3.88	0.836	7.06	1.53
GAS014	0.338	1.73	13.8	13.9	260.	3.92	171.	71.3	0.039	1.09	3.93	333.	26.7	47.2	4.47	0.944	0.607	2.25	0.347	4.07	0.925	7.59	1.43
GAS015	0.291	1.55	14.2	13.1	450.	3.79	202.	61.5	0.032	1.14	3.52	400.	25.9	45.7	4.39	0.914	0.540	2.15	0.353	3.62	0.815	6.97	1.29
GAS018	0.348	1.75	13.2	13.2	255.	3.75	118.	69.3	0.023	1.07	3.66	299.	25.5	47.8	4.25	0.885	0.647	2.36	0.296	3.72	0.902	7.08	1.47
GAS019	0.331	1.50	13.6	12.2	199.	3.44	81.3	57.1	0.032	0.826	3.43	237.	23.6	41.5	3.93	0.824	0.504	2.10	0.321	3.40	0.741	6.52	0.98
GAS020	0.349	1.61	14.6	12.6	206.	3.54	81.1	56.5	0.041	0.889	3.64	323.	23.8	43.1	3.97	0.851	0.551	2.03	0.301	3.40	0.923	6.49	1.02
GAS021	0.305	1.79	13.3	13.9	237.	3.92	120.	72.8	0.031	0.861	4.05	358.	26.8	46.0	4.42	0.918	0.740	2.41	0.316	3.78	0.836	7.14	2.36
GAS022	0.284	1.50	15.7	12.4	243.	3.49	178.	61.1	0.034	0.933	3.24	481.	25.5	44.2	4.17	0.873	0.589	2.09	0.348	3.74	0.759	6.35	1.30
GAS023	0.390	2.00	14.7	13.1	231.	3.80	106.	61.7	0.044	0.893	3.22	383.	24.9	44.3	4.16	0.863	0.561	2.22	0.337	3.66	0.809	6.58	1.48
GAS024	0.358	1.79	13.8	13.5	255.	3.81	122.	63.7	0.042	0.964	4.15	352.	25.8	44.0	4.39	0.891	0.502	2.17	0.418	3.84	0.891	6.79	n.d.
GAS025	0.448	1.99	15.3	11.8	219.	3.34	140.	53.7	0.039	0.646	3.13	n.d.	23.4	39.9	3.91	0.807	0.607	2.06	0.271	3.42	0.834	6.47	0.97
GAS026	0.643	1.65	15.5	12.0	236.	3.41	136.	63.4	0.039	0.625	3.08	711.	23.6	42.1	3.91	0.826	0.449	2.14	0.323	3.80	0.785	6.19	1.60
GAS029	0.317	1.61	14.1	13.3	229.	3.77	118.	66.1	0.040	0.923	3.48	149.	25.5	44.2	4.30	0.910	0.673	2.12	0.321	3.64	0.755	6.89	1.32
GAS030	0.353	1.63	14.9	13.2	299.	3.76	127.	65.2	0.051	0.929	3.69	321.	25.0	44.9	4.20	0.897	0.684	2.12	0.310	3.76	0.820	6.68	1.29
GAS031	0.380	1.73	14.4	12.3	212.	3.49	111.	67.8	0.040	0.861	3.48	237.	23.9	42.8	4.00	0.826	0.543	2.00	0.325	3.77	0.836	6.28	1.44
GAS032	0.373	1.81	13.4	14.0	246.	3.95	138.	75.9	0.034	0.927	3.99	n.d.	26.4	48.0	4.49	0.962	0.710	2.20	0.342	4.11	0.867	7.36	1.83
GAS034	0.382	1.63	13.8	12.5	224.	3.54	80.9	57.5	0.055	0.918	3.46	343.	24.3	41.8	4.10	0.836	0.497	2.02	0.356	3.61	0.771	6.65	1.48
GAS035	0.324	1.69	14.1	12.0	199.	3.38	85.9	60.7	0.041	0.877	3.46	345.	23.5	41.0	3.93	0.817	0.571	1.96	0.318	3.40	0.783	6.41	1.05
GAS036	0.256	1.46	13.3	12.6	247.	3.48	82.6	56.9	0.044	1.08	3.40	594.	23.5	41.8	3.93	0.877	0.570	1.98	0.284	3.44	0.769	6.41	0.85
GAS037	0.423	1.74	14.4	11.8	215.	3.32	89.5	64.4	0.048	0.820	3.36	379.	22.9	39.7	3.81	0.809	0.533	1.80	0.340	3.40	0.804	6.17	1.17
GAS038	0.271	1.78	17.7	13.6	220.	3.80	248.	76.4	0.030	1.14	3.68	344.	25.8	44.9	4.33	0.957	0.627	2.16	0.371	3.69	0.718	6.97	1.61
GAS039	0.311	1.91	14.7	12.9	249.	3.60	288.	61.7	0.037	0.920	3.42	438.	24.7	44.3	4.18	0.863	0.579	2.24	0.318	3.71	0.794	6.65	1.28
GAS041	0.378	1.48	15.3	11.7	233.	3.28	89.1	66.1	0.043	1.03	3.33	376.	22.9	40.7	3.88	0.796	0.556	1.91	0.314	3.64	0.757	6.52	1.19
GAS042	0.344	1.85	14.7	13.3	217.	3.76	112.	66.1	0.037	0.966	3.86	292.	25.8	45.2	4.33	0.899	0.622	2.15	0.400	3.90	0.838	6.93	2.23
GAS043	0.348	2.07	13.6	13.2	265.	3.72	144.	60.8	0.034	0.650	3.30	324.	25.6	44.6	4.28	0.918	0.634	2.18	0.358	3.78	0.867	6.79	1.38
GAS044	0.272	1.61	13.9	13.3	258.	3.77	129.	61.7	0.033	1.17	3.53	180.	25.6	44.0	4.24	0.910	0.729	2.22	0.342	3.52	0.881	6.79	1.04
GAS045	0.386	1.89	16.9	11.8	216.	3.33	84.7	54.5	0.045	0.664	3.25	285.	23.0	40.3	3.83	0.818	0.533	1.82	0.295	3.28	0.256	5.93	1.10
GAS046	0.300	1.67	14.4	12.4	208.	3.46	85.3	53.8	0.036	0.740	3.29	282.	23.4	40.8	3.96	0.828	0.545	1.96	0.355	3.42	0.697	6.28	0.92
GAS047	0.321	2.10	16.9	12.8	228.	3.61	83.9	56.5	0.043	0.815	2.69	207.	24.3	43.1	4.12	0.891	0.485	2.02	0.357	3.49	0.791	6.53	1.94
GAS048	0.282	1.64	12.4	12.9	232.	3.66	91.4	67.1	0.039	1.07	3.56	353.	26.0	45.3	4.41	0.918	0.605	2.24	0.352	3.58	0.897	6.81	1.58
GAS049	0.344	1.82	19.3	14.6	264.	4.07	111.	72.9	0.048	0.944	4.06	340.	27.5	48.2	4.57	1.01	0.664	2.30	0.438	4.37	0.940	7.43	1.36
GAS050	0.275	1.50	18.9	12.0	231.	3.35	88.5	61.9	0.039	0.899	3.35	217.	22.7	39.9	3.81	0.800	0.548	2.09	0.322	3.42	0.805	5.94	1.48
GAS051	0.350	1.55	20.0	12.4	193.	3.46	164.	69.0	0.043	1.11	3.48	306.	23.8	42.2	3.99	0.865	0.577	1.91	0.333	3.67	0.748	6.38	2.25
GAS052	0.300	1.59	20.3	13.5	411.	3.87	104.	64.0	0.042	1.18	3.66	269.	25.6	46.6	4.33	0.927	0.622	2.35	0.366	3.85	0.877	6.81	1.72
GAS053	0.622	1.61	19.3	12.3	350.	3.52	91.0	58.6	0.050	1.14	3.28	359.	24.4	42.7	4.09	0.865	0.578	2.38	0.366	3.85	0.743	6.12	1.60
GAS054	0.473	1.42	18.1	11.0	276.	3.10	105.	57.5	0.046	0.703	2.78	215.	23.4	40.2	3.85	0.845	0.495	2.00	0.303	4.08	0.723	5.90	1.60
GAS055	0.286	1.73	12.7	13.0	243.	3.66	98.4	68.2	0.026	1.05	3.68	288.	24.3	43.0	4.09	0.875	0.575	2.19	0.310	3.53	0.759	6.70	1.52
GAS056	0.410	1.80	18.4	13.4	439.	3.88	105.	50.9	0.045	0.877	3.23	291.	25.5	44.7	4.28	0.904	0.568	1.96	0.380	3.65	0.793	6.92	1.66
GAS057	0.314	1.66	20.6	13.1	590.	3.83	95.3	71.3	0.046	1.21	3.59	203.	25.3	43.6	4.26	0.881	0.658	2.08	0.361	3.81	0.800	6.75	1.60
GAS058	0.279	1.78	17.2	13.0	217.	3.67	104.	72.8	0.030	0.977	3.65	262.	25.1	44.2	4.20	0.891	0.505	2.22	0.364	3.73	0.740	6.44	1.57
GAS059	0.371	1.77	14.0	13.0	243.	3.70	160.	71.3	0.041	1.15	3.74	n.d.	24.9	44.6	4.23	0.885	0.617	2.12	0.327	3.96	0.879	6.62	1.90
GAS060	0.371	2.08	17.5	13.8	232.	3.94	153.	62.7	0.038	0.659	3.57	321.	26.4	47.2	4.48	0.918	0.625	2.34	0.405	3.91	0.966	7.11	1.34
GAS061	0.473	2.75	16.6	12.5	202.	3.53	109.	59.7	0.040	0.750	3.45	232.	23.0	41.0	3.90	0.818	0.492	1.98	0.340	3.44	0.736	6.31	1.32
GAS062	0.318	1.81	16.9	12.9	218.	3.64	120.	72.8	0.036	0.841	3.56	286.	24.5	43.9	4.09	0.895	0.528	1.97	0.359	3.62	0.863	6.50	1.61
GAS063	0.345	2.06	16.7	12.9	354.	3.69	128.	69.5	0.039	1.00	3.69	574.	25.2	44.2	4.31	0.893	0.607	2.25	0.366	3.71	0.847	6.61	1.86
GAS064	0.305	2.12	17.5	12.9	239.	3.64	185.	65.9	0.039	0.944	3.50	418.	24.6	43.6	4.25	0.883	0.687	2.07	0.303	3.56	0.755	6.75	1.88
GAS065	0.524	3.40	17.3	13.6	236.	3.81	121.	55.2	0.059	0.728	2.47	200.	25.7	46.3	4.39	0.904	0.571	2.33	0.337	3.87	0.802	7.10	1.57
GAS066	0.342	2.20	18.5	14.4	243.	4.04	209.	65.0	0.057	0.938	3.10	408.	27.1	48.3	4.66	0.993	0.628	2.32	0.359	4.05	0.929	7.26	1.86
GAS067	0.390	2.72	16.6	13.4	236.	3.78	147.	56.8	0.072	0.718	3.18	386.	25.4	45.6	4.34	0.927	0.684	2.21	0.361	3.72	0.809	6.76	1.75
GAS068	0.432	2.64	16.1	12.4	240.	3.48	240.	53.5	0.098	0.800	3.01	605.	24.3	41.5	4.05	0.838	0.757	2.08	0.331	3.44	0.662	6.38	2.20
GAS069	0.441	2.94	16.0	13.7	243.	3.84	142.	54.1	0.068	0.766	2.72	387.	25.9	46.5	4.48	0.931	0.536	2.24	0.360	3.93	0.863	7.08	1.83
GAS070	0.385	2.24	15.8	13.6	231.	3.85	150.	77.3	0.039	0.995	3.75	288.	26.9	47.0	4.57	0.962	0.522	2.14	0.358	3.93	0.791	7.10	1.91
GAS071	0.349	2.44	17.0	14.2	261.	4.01	161.	66.2	0.046	1.04	3.92	328.	27.8	51.1	4.69	0.977	0.689	2.31	0.346	4.05	0.853	7.41	1.51

Appendix. (continued)

	Na %	K %	Ca %	Sc ppm	Cr ppm	Fe %	Zn ppm	Rb ppm	Sr %	Sb ppm	Cs ppm	Ba ppm	La ppm	Ce ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm	Hf ppm	Ta ppm	Th ppm	U ppm
Tepe Gawra Seal Impressed Clays																							
GAS072	0.409	2.08	16.7	13.2	255.	3.70	133.	65.0	0.042	0.836	3.57	210.	25.6	46.5	4.41	0.918	0.612	2.21	0.338	3.67	0.843	6.93	1.74
GAS073	0.294	2.29	14.5	14.0	365.	3.99	219.	65.6	0.036	1.20	3.99	372.	26.5	47.9	4.56	0.925	0.652	2.36	0.371	3.87	0.904	6.82	1.49
GAS074	0.310	1.98	17.4	13.4	230.	3.81	139.	73.5	0.038	0.951	3.80	347.	26.5	47.5	4.53	0.918	0.618	2.24	0.372	3.87	0.908	6.97	1.44
GAS075	0.351	2.51	16.5	13.4	236.	3.78	125.	77.6	0.049	1.05	3.72	537.	25.9	46.6	4.43	0.942	0.736	2.26	0.355	3.74	0.830	6.70	1.84
GAS076	0.336	2.13	16.6	13.6	230.	3.85	100.	69.0	0.042	0.853	3.43	269.	25.5	46.1	4.48	0.908	0.665	2.25	0.356	3.80	0.838	6.97	1.64
GAS077	0.366	2.10	18.1	12.4	242.	3.50	112.	61.2	0.041	0.752	3.27	313.	24.0	41.7	4.11	0.861	0.637	2.16	0.318	3.44	0.757	6.17	1.55
GAS078	0.349	2.11	16.1	14.3	336.	3.96	501.	80.7	0.047	1.17	3.68	297.	27.5	48.4	4.55	0.959	0.538	2.33	0.385	4.22	1.01	7.33	1.61
GAS079	0.247	1.21	15.0	12.6	228.	3.52	92.9	67.1	0.041	1.15	3.40	286.	24.2	44.1	4.14	0.861	0.566	2.21	0.369	3.50	0.713	6.38	1.62
GAS080	0.261	1.62	16.0	12.0	225.	3.42	99.1	59.4	0.048	1.19	3.24	259.	23.2	42.3	3.96	0.826	0.565	1.92	0.313	3.45	0.687	6.11	1.73
GAS081	0.393	1.61	15.8	13.0	243.	3.72	155.	75.5	0.038	1.15	3.78	297.	24.7	43.4	4.22	0.879	0.693	1.89	0.290	3.67	0.817	6.68	1.14
GAS082	0.488	2.64	14.8	13.7	250.	3.92	157.	63.4	0.053	1.27	3.09	236.	25.8	46.7	4.47	0.925	0.661	2.27	0.328	3.82	0.867	7.33	1.12
GAS083	0.286	1.52	16.0	11.3	214.	3.17	77.3	61.5	0.043	0.944	3.11	230.	22.3	39.7	3.88	0.785	0.655	1.95	0.345	3.20	0.817	6.43	1.00
Tepe Gawra Spindle Whorls																							
GAS007	0.400	1.92	15.2	12.6	226.	4.11	88.1	51.5	0.069	0.783	3.19	458.	24.3	43.6	4.12	0.861	0.624	2.17	0.311	3.53	0.873	6.32	1.38
GAS016	0.430	2.58	10.2	14.5	284.	3.97	93.8	68.5	0.037	0.537	3.24	355.	20.8	37.0	3.43	0.785	0.407	1.78	0.292	2.81	0.706	6.12	1.56
GAS017	0.407	2.41	9.48	15.7	290.	4.40	111.	67.3	0.036	0.685	3.32	597.	20.9	38.6	3.62	0.822	0.470	1.99	0.321	3.10	0.793	6.32	1.51
GAS027	0.608	1.80	13.1	10.4	315.	2.94	106.	44.5	0.050	0.685	2.32	352.	21.7	37.7	3.61	0.766	0.498	1.89	0.333	3.57	0.721	5.77	1.42
GAS028	0.335	1.59	11.2	14.4	579.	4.30	95.1	48.3	0.033	0.578	2.74	141.	22.4	40.5	3.85	0.839	0.579	2.01	0.312	3.19	0.670	5.97	1.47
GAS033	0.465	1.90	12.6	10.2	300.	2.81	71.9	46.1	0.057	0.553	1.72	543.	18.6	34.6	3.18	0.678	0.314	1.66	0.235	2.88	0.836	4.79	1.49
GAS040	0.336	2.01	13.1	13.3	206.	3.81	95.3	59.6	0.092	0.849	3.10	324.	24.9	44.7	4.20	0.879	0.585	2.32	0.323	3.66	0.883	6.64	2.88
Nineveh Seal Impressed Clays																							
NVS001	0.531	2.01	18.1	11.5	280.	3.01	118.	63.8	0.044	0.500	3.24	217.	22.2	40.0	3.84	0.813	0.640	1.91	0.311	3.60	0.615	5.98	1.42
NVS002	0.505	1.70	19.2	10.3	225.	2.93	130.	58.6	0.054	0.531	2.42	205.	20.5	35.4	3.44	0.728	0.471	1.85	0.344	3.03	0.714	5.40	3.16
NVS003	0.703	2.19	14.6	11.4	369.	3.20	125.	67.6	0.051	0.841	2.58	422.	22.0	39.1	3.70	0.830	0.493	2.06	0.269	3.56	0.650	5.81	3.66
NVS004	0.670	2.29	16.3	11.8	350.	2.94	123.	58.1	0.069	0.679	2.25	256.	23.6	41.4	3.93	0.804	0.634	2.08	0.333	3.37	0.811	6.27	3.09
NVS005	0.319	1.33	17.3	10.9	248.	3.01	95.3	55.3	0.079	0.483	2.61	322.	20.0	36.1	3.42	0.708	0.518	1.92	0.300	2.90	0.689	5.56	1.23
NVS006	0.469	1.92	14.5	11.5	350.	3.23	131.	68.2	0.033	0.628	2.85	319.	22.5	39.9	3.83	0.800	0.543	2.03	0.305	3.80	0.750	5.75	1.85
NVS007	0.703	1.41	16.5	8.89	267.	2.47	92.7	60.1	0.038	0.653	1.98	374.	20.2	34.0	3.40	0.724	0.499	1.91	0.305	3.44	0.531	5.00	1.10
Nineveh Spindle Whorls																							
NVS008	0.785	1.63	16.3	9.64	456.	2.70	90.8	47.0	0.039	0.555	2.11	308.	21.6	38.5	3.67	0.798	0.547	2.10	0.299	4.14	0.708	5.27	1.62
NVS009	0.408	1.86	15.8	13.1	299.	3.72	120.	69.8	0.039	0.798	3.29	391.	23.7	42.5	3.97	0.853	0.552	1.96	0.318	3.21	0.787	6.40	1.21
NVS010	0.649	1.61	18.3	9.93	501.	2.76	82.8	48.9	0.061	0.955	2.28	370.	18.7	33.1	3.24	0.718	0.518	1.75	0.303	3.46	0.635	5.08	1.38
NVS011	0.360	1.93	13.2	15.4	566.	3.99	137.	60.4	0.030	1.259	2.74	n.d.	16.2	27.5	2.65	0.614	0.310	1.51	0.234	2.31	0.581	4.75	0.91
Arpachiyah Seal Impressed Clays																							
ARS001	0.417	1.44	18.3	11.5	226.	3.25	99.5	64.3	0.065	0.879	3.24	488.	22.5	40.0	3.78	0.838	0.558	2.05	0.281	3.36	0.708	6.30	1.35
ARS002	0.372	1.46	17.3	11.7	200.	3.24	112.	71.0	0.051	0.617	3.20	233.	22.1	38.3	3.72	0.789	0.615	1.97	0.324	3.03	0.625	5.85	1.51
Tell Brak Seal Impressed Clays																							
BRS001	0.308	0.99	22.7	8.59	208.	2.46	52.1	37.8	0.242	0.676	2.26	330.	17.9	31.5	3.08	0.625	0.315	1.48	0.256	2.70	0.545	4.65	1.96
BRS002	0.432	1.47	14.1	10.7	207.	3.07	66.7	61.0	0.604	0.752	2.94	417.	21.6	39.5	3.61	0.743	0.538	1.81	0.315	3.33	0.710	5.89	2.34
BRS003	0.442	1.86	18.0	10.1	192.	2.86	68.7	50.8	0.538	0.494	2.51	330.	21.6	37.8	3.54	0.735	0.502	1.72	0.352	3.07	0.659	5.97	2.07
BRS004	0.414	1.38	17.3	9.84	216.	2.86	74.0	63.1	0.240	0.861	2.86	398.	22.0	38.5	3.55	0.738	0.465	1.67	0.264	3.31	0.638	6.47	1.79
BRS005	0.380	1.33	17.2	9.38	226.	2.77	62.8	49.7	0.121	0.830	2.82	372.	20.0	35.5	3.30	0.693	0.461	1.65	0.281	2.77	0.723	5.62	1.85
BRS006	0.256	1.02	16.3	9.64	148.	2.54	60.5	36.4	2.37	0.637	1.84	705.	16.6	27.5	2.88	0.597	n.d.	1.43	0.216	2.09	0.485	4.11	2.90
BRS007	0.480	1.91	15.5	11.9	272.	3.41	68.4	47.6	0.317	0.745	3.04	320.	24.1	44.2	3.92	0.839	0.579	1.94	0.299	3.59	0.815	6.53	1.79
BRS008	0.371	1.75	14.2	12.4	194.	3.57	73.8	72.6	0.107	0.804	3.43	321.	25.2	46.5	4.13	0.867	0.615	1.94	0.325	3.27	0.805	6.82	1.72
BRS009	0.406	1.55	18.3	9.66	187.	2.84	59.3	61.2	0.135	0.327	2.72	358.	21.2	37.3	3.40	0.735	0.509	1.93	0.229	3.18	0.685	6.19	2.70
BRS010	0.457	1.89	16.9	11.9	259.	3.45	72.8	59.4	0.064	0.662	3.16	n.d.	25.5	46.2	3.79	0.883	0.682	2.05	0.321	3.74	0.883	6.87	1.46
BRS011	0.470	1.23	18.7	9.14	206.	2.65	52.5	61.7	0.116	0.723	2.52	305.	19.1	35.2	3.15	0.667	0.488	1.85	0.319	2.90	0.605	5.04	3.26
BRS012	0.521	1.79	16.8	11.1	247.	3.24	67.6	45.2	0.128	0.590	2.65	201.	24.3	44.4	3.98	0.815	0.619	2.02	0.287	3.66	0.698	6.64	0.81
BRS013	0.398	1.46	17.6	10.8	224.	3.16	55.2	61.4	0.091	0.789	3.01	508.	23.7	42.9	3.89	0.802	0.480	1.87	0.340	3.40	0.714	6.37	1.81
BRS014	0.524	1.43	16.2	10.7	219.	3.05	56.5	66.8	0.086	0.643	2.97	574.	25.0	45.6	4.02	0.820	0.558	1.96	0.348	3.84	0.800	6.07	2.15
BRS015	0.494	1.52	14.1	10.5	220.	2.99	65.6	60.0	0.083	0.778	3.01	n.d.	22.9	38.7	3.73	0.764	0.458	2.03	0.324	3.53	0.760	6.89	2.52

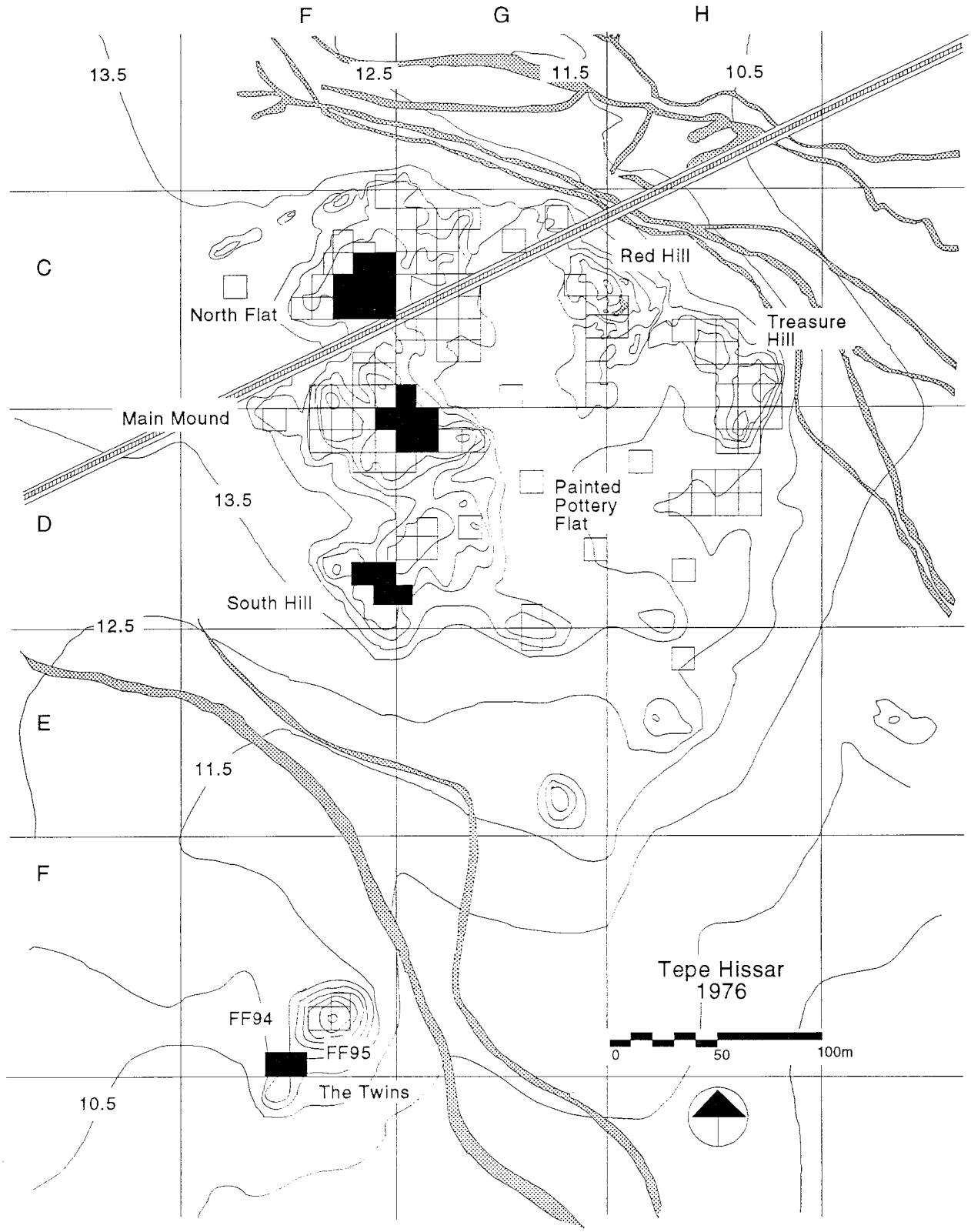

Fig. 1:
Tepe Hissar: Site plan and 1976 areas of investigation.
(After: Dyson and Tosi 1989:fig. 2.)