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Chapter 9

Investigating the provenance of the early pottery from Tell Sabi Abyad

Marie Le Mière, Valérie Thirion-Merle and Maurice Picon (†)

9.1. Introduction

The earliest pottery currently known from Upper Mesopotamia (Le Mière 2009) dates back to the beginning of the 7th millennium BC. It was found at a series of sites situated in the *Jezirah*, stretching from the upper Tigris to the Euphrates valley, as well as from three sites in the northern Levant (Fig. 9.1). This pottery is extremely uniform and is characterised by its exclusively mineral temper, which is usually large in size and abundant. Previous chemical analyses that processed material from nine of the *Jezirah* sites revealed imports present together with local production at most of these sites. This mixture of local and imported material seems to be another character of this early pottery (Le Mière 2013, 325). The earliest pottery from Tell Sabi Abyad, the so-called Early Mineral Ware (Chapter 4 3), presents all the technical and morphological characteristics of the *Jezirah* early pottery and clearly also belongs to this Upper Mesopotamian group.¹

To investigate whether the early pottery from Tell Sabi Abyad was locally made and/or imported, chemical analyses of this material were carried out on a total of 57 samples from the Initial Pottery Neolithic and Early Pottery Neolithic periods. These results add to a large number of previously analysed pottery samples from Tell Sabi Abyad of later periods (186 samples) as well as from many other Neolithic sites of the Balikh valley (31 sites, 158 pottery samples). Together with a rather large series of clay samples ($n = 25$) collected in the Balikh valley and ten samples of diverse elements of architecture from Tell Sabi Abyad, this material constitutes a solid database of local and regional references.

9.2. Analytical procedures and sampling

The analytical method applied to this ceramic material was chemical analyses by Wavelength Dispersive X-Ray Fluorescence Spectrometry (WD-XRF), and

followed the standard procedures of the Archaeology and Archaeometry Laboratory (CNRS–University of Lyon). This procedure supplies the bulk chemical composition of the ceramic (matrix and sandy fraction), and consequently the composition of the material used in its manufacturing (Picon and Le Mière 1987; Thirion-Merle 2014). Measurement is carried out on glass tablets of a homogenous composition that contain 800 mg of the powdered sample mixed with fluxes. For each sample, twenty or twenty four (for the most recently analysed samples) components were determined: ten major² and fourteen traces.³

Several uni-, bi- and multivariate statistical data treatments have been applied to interpret the chemical results. Among the multivariate methods used, here we present results mainly from the cluster analysis, which is a statistical treatment that uses Euclidian distances, calculated in this case on 17 chemical components (Na, P, La, Y, Th, Pb and Cu have not been used because they are not relevant and/or measurement of several of them is below the quantitative limit). The resulting dendrogram (see for example Pl. 22) represents the relative distances between samples, where the most similar samples are linked at the lowest distances (see Baxter 1994; Picon 1984). Thus, on the dendrogram, we have clusters of individuals of similar compositions and all the more similar as they are linked at a lower level.

This study focuses on the earliest pottery from Tell Sabi Abyad. Since the number of analysed samples from Tell Sabi Abyad is very large (242), only the pottery from the earliest periods, the Initial and Early Pottery Neolithic as well as Pre-Halaf and early Transitional, were selected, which numbers 138 samples. Additionally, five clay samples collected on the site itself or nearby were included, as were ten samples of architectural elements, and one of a sling-bullet made of unfired clay. Table 9.1 presents the analysed samples by categories:

Table 9.1 Tell Sabi Abyad. Analysed samples used in this study. A: Initial and Early Pottery Neolithic; B: Pre-Halaf and early Transitional

Sample type	Sample numbers	Total
<i>A. Earlier periods: Initial and Early Pottery Neolithic</i>		
Early Mineral Ware	SBA 230–231, 233–238, 243–248, 263, 270–271, 281, 284	19
Fine Mineral Tempered Ware	SBA 232, 259, 272–280, 282–283; 285–286	15
Plant Tempered Ware (Standard Ware)	SBA 239–242, 249–258, 260–262, 264–269	23
Total		57
<i>B. Later periods: Pre-Halaf and early Transitional</i>		
Fine Mineral Tempered Ware	SBA123, 164	2
Grey Black Ware	SBA 6–7, 102, 104–105, 107	6
Plant Tempered Ware (Standard Ware)	SBA 1–4, 11–12, 114–116, 118–119, 124–148, 150, 153, 159–160, 163, 165–167, 185	45
Mineral Coarse Ware	SBA 50, 120–122	4
Dark-Faced-Burnished Ware	SBA 8–9, 14, 103, 106, 108–112	10
Orange Ware	SBA 45, 113, 117, 156–157, 202–209, 215	14
Architectural elements	SBA 78–81, 83–88	10
Sling-bullet	SBA 149	1
Clays	SBA 59–61, 63, 82	5
Total		97

the characteristics of each ware are given in Chapter 4. We draw attention here to the fact that the plant-tempered (Standard Ware) pottery of the early periods, from the Initial and Early Pottery Neolithic periods, is characterised by the frequent occurrence of very large plant inclusions when in later periods, the Pre-Halaf and early Transitional, those inclusions gradually disappear; and a fabric characterised by small plant temper appears alongside the more common ceramic with large plant tempered fabric (Le Mière and Nieuwenhuys 1996, table 3.2a, note 1).

9.3. Classifying the Tell Sabi Abyad ceramics by chemical composition

Most of the samples present calcareous compositions, sometimes with very high contents, although, as shall be detailed below, we also identified several examples of non-calcareous pottery. In order to classify the analyses and to test any resemblances, multivariate statistical data treatment was processed. The cluster analysis dendrogram is presented on the upper part of Plate 22. This classification shows eight groups (named group 1 to group 8) and several isolated sherds.

Group 1 is the largest one, including 81 samples, and is 53% of the whole sample. It is chemically very homogeneous and is composed essentially of plant tempered ware (Standard Ware) sherds with a few Fine Mineral Tempered Ware examples. It very likely represents the local production since this group includes not only what is usually considered as locally produced, namely the plant tempered pottery, but also all the architectural elements as well as the sling-bullet and

several clay samples collected around the site. The mean composition of this group is given Table 9.2, with those of the other groups.

Group 2 is mainly composed, as group 1, of plant tempered ware (Standard Ware) sherds, with only one Fine Mineral Tempered Ware example. However, these plant-tempered sherds differ from those of group 1 by the size of their plant inclusions, which is small (see above). The group is chemically homogeneous, it is less calcareous than group 1 with lower contents of correlated strontium and it has higher contents of iron and nickel. Nevertheless it shares many common characteristics with group 1.

Next to group 2 in Plate 22 (upper part) we find two Fine Mineral Tempered Ware samples. These present several compositional particularities, amongst them a high content of manganese. Nevertheless, their compositions are very similar to those of group 1 and, though marginal, we can consider these samples also as local productions, probably made of raw material from different clay pits. Group 3 is also chemically homogeneous and includes only early Fine Mineral Tempered Ware samples. This group is much more calcareous than group 1 (m CaO=36.2% versus 18.9%).

Actually, if we consider groups 1–3, as well as the unclassifiable samples situated between them, all of them have common characteristics which differ from those of most of the groups situated further to the right on the dendrogram. All of them are calcareous, having low contents of rubidium and with similar contents of manganese and most of the other traces; most of the samples also possess less than 1% of titanium. These groups gather together the main part of the samples (68.5% of the whole sample) and also include the local references,

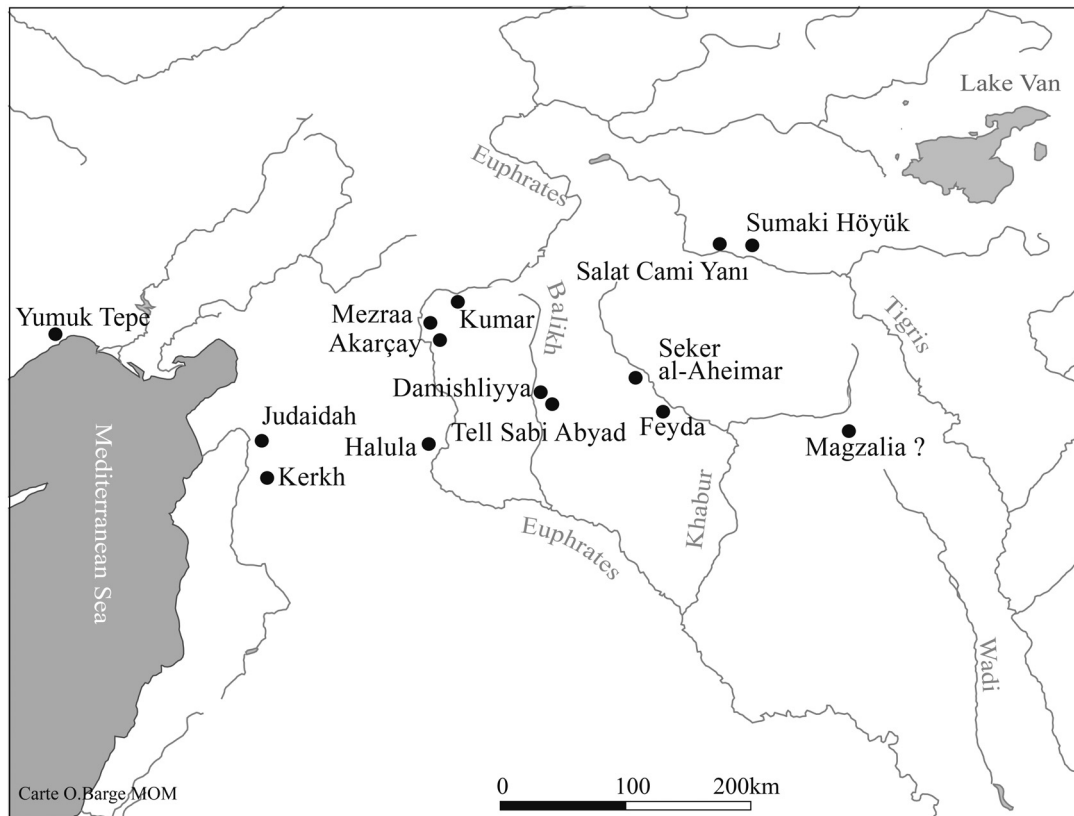


Fig. 9.1 Map showing the locations of early Pottery Neolithic sites in the Jezirah and the Northern Levant (image O. Barge; *Maison de l'Orient et de la Méditerranée*).

clays and architectural elements. Therefore they would represent the local production, with the diverse groups displaying different local or sub-local productions.

Group 6 is composed of three Mineral Coarse Ware samples, characterised by very high contents of calcium and low contents of titanium. They do not really form a homogeneous compositional group as some of their components strongly vary. The fabrics of those three sherds present a lot of white inclusions which are clearly crushed calcite (Le Mière and Picon 2003).

Except this group 6, the remaining groups (4, 5, 7, and 8), differ clearly from the chemical composition of the local productions, as mentioned above. Group 4 and group 7, both include solely samples of Orange Fine Ware. The composition of these two groups have several characteristics in common, namely a high content of rubidium and a low content of nickel. The two groups also display some differences: in group 4 iron, manganese, zinc contents are low, whereas in group 7 the calcium content is very low and barium rather high. As already discussed elsewhere, both Orange Fine Ware groups are probably imports, from an as yet unprovenanced source (Le Mière and Picon 2008).

Group 8 also gathers together all the samples of a single, very distinct, category of pottery, Dark-Faced Burnished Ware. This group presents a very peculiar chemical composition: it is non-calcareous and characterised by high contents of iron and correlated vanadium, very high

contents of magnesium, and overall very low contents of titanium. The chromium and nickel contents are also notably high. These compositions are very typical of clays found in ophiolitic areas, which do not surround Tell Sabi Abyad. Such geological areas can be found in northern Syria along the Mediterranean coast and in southern Turkey along the Taurus. Hence, this group has been recognised as most probably imported from these regions (Le Mière and Picon 1987; Picon and Le Mière 1987).

Group 5, finally, gathers together all the Early Mineral Ware samples. This group is actually composed of two clearly distinct sub-groups, here termed groups 5a and 5b. Early Mineral Ware (EMW) in general is characterised by the presence of many black basalt inclusions (Chapter 5), but our analysis indicates that there are two types of fabrics: the first one is very light in colour, contains small inclusions of basalt and is painted; all the samples of this type gather in sub-group 5a. The second type of fabric is darker in colour and contains basalt inclusions of a larger size, and sometimes can be very large; the samples of this type gather in sub-group 5b.

Thus, our analysis suggests an important sub-division in the general category of Early Mineral Ware, one that has so far not been identified in either the macroscopic description (Chapter 4), or the petrographic analysis (Chapter 5).⁴ The characteristic fabrics of these two sub-groups can be seen in Plate 23.1. The two sub-groups differ in the content of calcium, with the sub-group 5a showing

Table 9.2 Tell Sabi Abyad. Mean and standard deviation of the eight compositional groups (majors are given in percentage of oxide, traces in parts per million of metal)

Group 1 (n=81)																					
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La*	Ba	V	Ce	
m	18.92	7.10	0.876	3.11	50.26	13.45	4.25	0.1317	1.21	0.49	200	574	70	124	257	158	29	356	142	75	
s	4.19	0.54	0.079	0.43	2.79	1.04	0.53	0.0256	0.40	0.22	22	183	10	21	40	16	11	66	16	12	
s%	22	8	9	14	6	8	12	19	33	45	11	32	14	17	16	10	37	19	11	16	
La * : mean calculated on 54 values (other <1.q.)																					
Group 2 (n=12)																					
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La*	Ba	V	Ce	
m	12.10	8.89	0.898	2.74	52.37	14.88	5.58	0.1809	1.80	0.38	186	415	62	141	289	261	17	339	171	69	
s	1.95	0.64	0.048	0.24	1.17	0.74	0.65	0.0433	0.27	0.06	12	70	12	17	65	30	6	65	12	5	
s%	16	7	5	9	2	5	12	24	15	17	6	17	19	12	22	11	38	19	7	7	
La * : mean calculated on 8 values (other <1.q.)																					
Group 3 (n=9)																					
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La*	Ba	V	Ce	
m	36.23	6.24	0.887	2.43	39.32	10.77	3.03	0.1394	0.56	0.22	170	456	47	111	281	131	n.c.	294	128	109	
s	4.85	0.52	0.109	0.29	3.20	0.80	0.22	0.0229	0.13	0.04	17	112	8	17	53	10	n.c.	58	13	23	
s%	13	8	12	12	8	7	7	16	23	16	10	25	16	16	19	7	n.c.	20	10	22	
n.c. = not calculated																					
Group 4 (n=5)																					
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La*	Ba	V	Ce	
m	14.11	5.72	0.903	4.08	54.04	15.83	3.91	0.0569	0.90	0.29	201	273	118	68	227	94	34	224	165	73	
s	2.79	0.12	0.102	0.76	1.16	1.45	0.53	0.0065	0.21	0.07	31	53	15	11	38	21	11	24	15	11	
s%	20	2	11	19	2	9	14	11	23	25	15	19	13	16	17	23	33	11	9	15	
La * : mean calculated on 4 values (other <1.q.)																					
Group 5: 5a (n=7)																					
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	
m	26.91	10.72	1.786	1.18	39.27	11.32	6.27	0.1738	1.88	0.34	116	508	18	103	228	172	n.c.	148	191	40	
s	4.47	0.62	0.123	0.21	2.41	0.76	0.54	0.0209	0.15	0.08	9	27	3	9	21	25	n.c.	17	15	10	
s%	17	6	7	18	6	7	9	12	8	23	7	5	19	9	9	15	n.c.	12	8	25	
n.c. = not calculated																					

<i>Group 5: 5b (n=11)</i>																					
	<i>CaO</i>	<i>Fe₂O₃</i>	<i>TiO₂</i>	<i>K₂O</i>	<i>SiO₂</i>	<i>Al₂O₃</i>	<i>MgO</i>	<i>MnO</i>	<i>Na₂O</i>	<i>P₂O₅</i>	<i>Zr</i>	<i>Sr</i>	<i>Rb</i>	<i>Zn</i>	<i>Cr</i>	<i>Ni</i>	<i>La</i>	<i>Ba</i>	<i>V</i>	<i>Ce</i>	
m	10.45	12.47	2.183	1.96	49.07	15.04	6.06	0.1589	2.04	0.38	168	410	36	122	301	186	n.c.	268	239	51	
s	2.11	1.00	0.352	0.38	1.94	0.56	0.90	0.0157	0.45	0.10	17	78	7	11	63	40	n.c.	93	19	10	
s%	20	8	16	19	4	4	15	10	22	27	10	19	20	9	21	21	n.c.	35	8	19	
n.c. = not calculated																					
<i>Group 6 (n=3)</i>																					
	<i>CaO</i>	<i>Fe₂O₃</i>	<i>TiO₂</i>	<i>K₂O</i>	<i>SiO₂</i>	<i>Al₂O₃</i>	<i>MgO</i>	<i>MnO</i>	<i>Na₂O</i>	<i>P₂O₅</i>	<i>Zr</i>	<i>Sr</i>	<i>Rb</i>	<i>Zn</i>	<i>Cr</i>	<i>Ni</i>	<i>La</i>	<i>Ba</i>	<i>V</i>	<i>Ce</i>	
m	42.87	4.90	0.574	1.83	34.31	9.53	4.58	0.1051	0.80	0.30	145	861	44	86	183	117	n.c.	215	92	57	
s	6.95	0.54	0.062	0.44	4.60	0.95	0.29	0.0337	0.15	0.05	15	610	13	10	16	18	n.c.	34	14	8	
s%	16	11	11	24	13	10	6	32	19	15	10	71	30	12	8	16	n.c.	16	15	14	
n.c. = not calculated																					
<i>Group 7 (n=9)</i>																					
	<i>CaO</i>	<i>Fe₂O₃</i>	<i>TiO₂</i>	<i>K₂O</i>	<i>SiO₂</i>	<i>Al₂O₃</i>	<i>MgO</i>	<i>MnO</i>	<i>Na₂O</i>	<i>P₂O₅</i>	<i>Zr</i>	<i>Sr</i>	<i>Rb</i>	<i>Zn</i>	<i>Cr</i>	<i>Ni</i>	<i>La</i>	<i>Ba</i>	<i>V</i>	<i>Ce</i>	
m	2.22	8.85	1.079	3.91	55.76	24.15	2.82	0.0985	0.66	0.27	163	189	161	154	126	79	63	604	152	112	
s	1.82	0.30	0.058	0.27	1.24	1.79	0.26	0.0145	0.26	0.09	24	24	19	11	8	9	14	48	11	9	
s%	82	3	5	7	2	7	9	15	39	33	14	12	12	7	6	11	22	8	7	8	
<i>Group 8 (n=10)</i>																					
	<i>CaO</i>	<i>Fe₂O₃</i>	<i>TiO₂</i>	<i>K₂O</i>	<i>SiO₂</i>	<i>Al₂O₃</i>	<i>MgO</i>	<i>MnO</i>	<i>Na₂O</i>	<i>P₂O₅</i>	<i>Zr</i>	<i>Sr</i>	<i>Rb</i>	<i>Zn</i>	<i>Cr</i>	<i>Ni</i>	<i>La*</i>	<i>Ba</i>	<i>V</i>	<i>Ce</i>	
m	4.90	11.08	0.425	1.51	52.72	18.44	9.23	0.1657	1.14	0.22	86	156	15	95	522	247	20	118	251	45	
s	0.98	0.42	0.078	0.16	1.51	1.15	1.53	0.0136	0.14	0.07	13	34	4	12	81	53	6	30	40	4	
s%	20	4	18	11	3	6	17	8	13	34	15	22	29	12	15	21	30	25	16	9	
La* : mean calculated on 4 values (other <1.q.)																					

much higher percentages (21–35% versus 8–14%). The whole of group 5 is chemically characterised by a very high content of iron with correlated vanadium, very high contents of titanium and magnesium, and low contents of potassium with correlated rubidium: such characteristics are linked to the presence of basalt inclusions. Such chemical compositions do not show any resemblance at all with any of the local groups at Tell Sabi Abyad, regardless of period. We also tested resemblances with all the available data from the Balikh valley pottery and clays, which led to a similar conclusion. Most probably the entire group of Early Mineral Ware was imported to Tell Sabi Abyad.

To complete the presentation of the Tell Sabi Abyad chemical analyses, two samples were not included in the cluster analysis: SBA237 (Early Mineral Ware sample) and SBA273 (early Fine Mineral Tempered Ware) because of their very particular compositions. SBA237 contained a huge percentage of calcium oxide (63%) which impacted the percentage of all of the other chemical components. Therefore this sample is unclassifiable. The second one, SBA273, contained 2858 ppm of strontium, which is a particularly high fraction. If we make a cluster analysis omitting the strontium, this sample integrates group 1, one of the local production groups.

9.4. Discussing the Tell Sabi Abyad results

For the purposes of this contribution we focus on two important questions: the choice of clays and local versus non-local production.

Groups 1, 2, and 3 represent diverse local or sub-local productions. Since each group consists primarily of one type of pottery – plant tempered fabrics⁵ in group 1, plant tempered fabrics⁶ with very fine plant inclusions in group 2, and Fine Mineral Tempered Ware of the earlier periods in group 3 – it would seem that potters selected their raw material according to specific productions. If group 1 includes samples of all periods, all samples of group 2 belong to the later periods, fine plant tempered pottery appearing only during the Pre-Halaf period. Hence the difference of clay in this case might be related to the type of pottery produced, the large plant tempered pottery from the Pre-Halaf period belonging to group 1 and not to group 2. Group 3 consists only of Fine Mineral Tempered Ware from the earlier stages of the sequence and the later Fine Mineral Tempered Ware samples belong to diverse groups. Therefore, this suggests that, in this case, the clay corresponding to the composition of this group was used at a certain period and was later abandoned.

As mentioned above, our group 5, comprising the Early Mineral Ware, includes two sub-groups divided on the basis of calcium percentages. This division matches differences mainly of colour. The samples from sub-group 5a have a fabric and surface of whitish or cream colour, whereas 5b samples are much darker, with a light brown to dark grey or even black colour. The distinctive light colour is partly due to the high percentages of calcium and

a firing temperature over 800° C, while the dark colour of the Early Mineral Ware can be attributed to a firing temperature lower than 800° C, as discussed previously (Le Mière *et al.* 2017).

Significantly, the white colour of sub-group 5a seems to be related to an important factor characterising this sub-group: all the samples studied so far are painted. The white colour was apparently produced purposefully to enhance the decorative effect of the reddish painting. Thus, we can infer a specific choice of calcareous clay since the higher percentage of calcium is not due to added inclusions, as it would be in the case of calcite for example, since the added inclusions of this sub-group are basaltic ones.

The principal result of the chemical analyses carried out on the early pottery from Tell Sabi Abyad is that during the Initial Pottery Neolithic period the so-called Early Mineral Ware, which constituted the single ceramic category of this period, was in all likelihood imported. There seems to have been no local production of pottery at the site. The situation during the Initial Pottery Neolithic thus appears to have been very different from what happened during the subsequent Early Pottery Neolithic and even later periods, when a large part of the pottery was locally produced and some part imported as well. In this regard the situation at Tell Sabi Abyad represents a unique case. All the other *Jezirah* sites studied so far, even when the analysed sample was very small, revealed, beside the probable imports, a local production of the earliest pottery (Le Mière 2009).

When one talks about imports, the question immediately arises over the provenance of these imports. The basalt temper and the corresponding compositional characters of Early Mineral Ware indicate a basaltic environment. However, although basalt was used at Tell Sabi Abyad, for example for making grinding stones, the surrounding Balikh valley is not a basaltic area (Ponikarov 1963a, 1963b, 1963c, map J-37-III and J-37-IV). Early basalt tempered pottery is not very common but it does exist elsewhere, namely at Tell Seker al-Aheimar in the Khabur valley and at Sumaki Höyük in the upper Tigris region. The nearly identical visual resemblance between the painted samples from Tell Sabi Abyad and those from Tell Seker al-Aheimar (Pl. 23.3 and 4), suggest a comparison of the chemical compositions of pottery from these sites.

9.5. Comparing Tell Sabi Abyad and Seker al-Aheimar

In order to facilitate the comparison between Tell Sabi Abyad and Tell Seker al-Aheimar pottery we present the chemical composition of pottery from Tell Seker al-Aheimar in order to characterise the main groups and to distinguish the local production from probable imports (Le Mière 2009, fig. 29.4).

A total of 160 sherds have been analysed so far, including samples of every category of pottery (Nishiaki and Le Mière 2005), as well as two samples of local clay collected near the site (Table 9.3). The dendrogram of all these samples is given in the lower half of Plate 22. We can

Table 9.3 Tell Seker al-Aheimar. Analysed samples used in this study

Sample type	Sample numbers	Total
Early Dark Ware	SEK 41, 45, 47–56, 85–86, 90–94, 96–105, 109, 139	31
Basalt Tempered Ware	SEK 1–4, 6–7, 10, 35–40, 42–44, 46, 83, 87–89, 106–108, 110–111, 136–137, 140, 162	30
Basalt and Plant Tempered Ware	SEK 5, 8–9, 11–16, 22–23, 60, 62–63, 95, 147–148	17
Plant Tempered Ware	SEK 17–21, 24–27, 59, 61, 64–66, 84, 118, 120, 123, 125, 143	20
Fine Mineral Tempered Ware	SEK 28–30, 67, 113–117, 119, 121–122, 126–132, 138, 141, 144–145, 149–150, 152–156	30
Grey-Black Ware	SEK 31–32, 124, 142, 146, 151	6
Pseudo-Orange Ware	SEK 33–34, 68–82, 112, 133–135, 157–161	26
Clays	SEK 57–58	2
Total		162

observe several groups, whose average compositions are given in Table 9.4; beside these groups there are several isolated samples. We will not examine in detail the seven compositional groups A-G but just mention what is the most relevant to the present discussion for each of them.

The first two groups, group A and group B, have very similar compositions (Table 9.4). Group A gathers together Early Dark Ware and group B gathers together different types of pottery including Plant Tempered Ware, Basalt and Plant Tempered Ware, three Early Dark Ware samples and Fine Mineral Tempered Ware as well as two local clay samples. Group C, composed exclusively of Fine Mineral Tempered Ware, is more calcareous and has a few other compositional differences in its content of iron, titanium or manganese and nickel. Nevertheless it presents common characteristics with the previous two groups. Group B gathers together practically all the plant tempered pottery as well as the local clay samples, and it is the largest group (52 samples, 32.1% of the whole sample); together with Groups A and C, group B can be considered as diverse groups of local production.

Group D and group E are both composed of Basalt Tempered Ware sherds with, respectively, three and 25 samples. The principal difference between groups D and E is their calcium content, which is higher for group D than for group E: the painted samples are more calcareous (Pl. 23.2). Group E presents a high content of iron (and correlated vanadium), titanium, magnesium, sodium and nickel, most probably due to its basaltic inclusions. If we take into account the basalt contribution in the composition of this group, it appears to be very similar to the composition of group B. Group D, beside its common characteristics with group E, shows some similarities to the local clays. The two groups of Basalt Tempered Ware can also be considered as locally produced, with basalt being common in the geological environment of Tell Seker al-Aheimar (Ponikarov 1963a, 1963b, map J-37-V, XI).

The remaining two groups F and G are both chemically very different from the previous groups, as well as from each other. Group F, made up of Early Dark Ware and Basalt Tempered Ware, is very heterogeneous. It is very calcareous with lower contents of iron and nickel. Group G, which exclusively contains one special type of pottery,

the so-called Pseudo-Orange Ware, is a non-calcareous group with a very high content of titanium, a high content of rare earth elements (Ce, La, Y), as well as low content of magnesium, nickel and chromium. The compositions of each of these last two groups are very peculiar. They must be related to geological environments completely different to Tell Seker al-Aheimar and its surroundings, and are most likely imports.

To compare the compositions of the productions found at Tell Sabi Abyad to those found at Tell Seker al-Aheimar, we have used cluster analysis in the same way, but for reasons of legibility the dendrogram exclusively deals with the ceramic material from the earliest periods of both sites. These are the Initial Pottery Neolithic and the Early Pottery Neolithic phases from Tell Sabi Abyad, and the Pre-Proto-Hassuna phase at Tell Seker al-Aheimar (Nishiaki and Le Mière 2005). The dendrogram is presented in Plate 24.

We can observe that pottery from Tell Sabi Abyad and Tell Seker al-Aheimar gathers in separate groups which correspond to the groups of each site with a few exceptions: some samples are isolated or in a marginal position to the main groups. The remarkable exception is the integrated clustering of all the Tell Sabi Abyad Early Mineral Ware groups with the Tell Seker al-Aheimar Basalt Tempered Ware groups. This large basalt tempered pottery group (marked by a bracket on Pl. 24) is, like the Tell Sabi Abyad Early Mineral Ware group and Tell Seker al-Aheimar Basalt Tempered Ware one, separated into two sub-groups (see above). This corresponds to the two types of fabrics of this ware, less calcareous and more calcareous.

Thus, the basalt tempered pottery discovered at Tell Sabi Abyad and at Tell Seker al-Aheimar have very probably been made with the same clay materials. Since the Basalt Tempered Ware from Tell Seker al-Aheimar is very likely locally produced, the Tell Sabi Abyad pottery was likely imported from Tell Seker al-Aheimar. The possibility that basalt tempered pottery would have been produced elsewhere and that another site could be an alternative for the provenance of Tell Sabi Abyad material should also be considered. As mentioned above, to date only one other site has provided early pottery of

Table 9.4 Tell Seker al-Aheimar: Mean and standard deviation of the seven compositional groups (majors are given in percentage of oxide, traces in parts per million of metal)

Group A (n=18)																										
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	Y	Th*	Pb	Cu		
m	15.23	7.72	1.027	2.45	55.76	12.83	3.39	0.1354	0.90	0.36	164	582	41	103	236	136	28	315	149	74	27	12	12	14	40	
s	1.86	0.46	0.082	0.24	1.36	0.55	0.21	0.0085	0.16	0.11	12	187	4	9	53	10	5	55	13	13	1	2	3	3	4	
s%	12	6	8	10	2	4	6	6	18	29	7	32	9	9	23	7	19	17	9	18	5	13	20	11		
Th* : mean calculated on 11 values (other <1.q.)																										
Group B (n=52)																										
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	Y	Th*	Pb*	Cu		
m	18.40	8.66	1.451	2.73	49.58	12.95	4.58	0.1390	1.00	0.31	199	486	49	114	307	144	27	303	179	75	29	12	17	17	39	
s	4.39	0.92	0.287	0.55	2.46	1.18	0.77	0.0161	0.19	0.08	23	137	9	17	53	23	5	57	22	13	2	2	4	7		
s%	24	11	20	20	5	9	17	12	19	26	12	28	19	15	17	16	19	19	13	17	7	14	26	17		
Th* : mean calculated on 36 values (other <1.q.), Pb* : mean calculated on 45 values (other <1.q.)																										
Group C (n=15)																										
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	Y	Th*	Pb*	Cu		
m	32.67	5.30	0.637	2.32	43.78	9.53	4.70	0.0917	0.60	0.22	165	422	36	102	247	96	20	265	100	79	28	12	17	17	33	
s	3.34	0.36	0.046	0.29	2.24	0.65	0.58	0.0178	0.11	0.04	18	91	5	21	39	8	3	63	18	15	2	1	5	7		
s%	10	7	7	13	5	7	12	19	18	19	11	21	14	20	16	8	17	24	18	19	6	12	31	20		
Th* : mean calculated on 8 values (other <1.q.), Pb* : mean calculated on 6 values (other <1.q.)																										
Group D (n=3)																										
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	Y	Th	Pb	Cu		
m	33.25	8.66	1.072	1.75	37.44	10.43	5.55	0.1069	1.40	0.17	114	499	31	87	256	155	20	252	171	46	17	12	n.c.	35		
s	6.54	0.89	0.150	0.50	3.56	1.13	0.86	0.0081	0.30	0.02	6	48	8	9	14	37	6	70	11	4	3	3	n.c.	3		
s%	20	10	14	28	9	11	16	8	21	12	6	10	24	10	5	24	33	28	6	8	16	24	n.c.	8		
n.c. = not calculated																										
Group E (n=27)																										
	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	Y	Th*	Pb*	Cu		
m	14.22	11.67	1.994	1.83	46.89	13.92	6.91	0.1620	1.81	0.38	188	589	29	113	294	197	25	444	221	64	24	12	14	51		
s	3.77	0.89	0.239	0.27	2.22	1.10	0.83	0.0102	0.36	0.07	27	181	8	8	34	23	5	191	16	14	2	1	3	6		
s%	26	8	12	15	5	8	12	6	20	19	14	31	29	7	11	12	20	43	7	23	7	12	21	11		
Th* : mean calculated on 7 values (other <1.q.), Pb* : mean calculated on 12 values (other <1.q.)																										

Group F (n=9) (These values are only indicative since this group is very heterogeneous and should rather be considered as an ensemble)

	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	Y	Th*	Pb	Cu
m	49.67	6.28	0.913	1.55	28.87	7.52	3.80	0.1362	0.85	0.21	124	767	23	74	198	73	14	398	118	53	21	13	n.c.	38
s	4.61	1.30	0.250	0.35	2.56	1.15	0.64	0.0118	0.21	0.06	12	109	5	12	30	16	6	205	27	26	2	2	n.c.	7
s%	9	21	27	23	9	15	17	9	24	28	9	14	22	16	15	22	44	52	23	49	11	17	n.c.	20

Th* : mean calculated on 6 values (other <1.q.)

n.c. = not calculated

Group G (n=25)

	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr	Sr	Rb	Zn	Cr	Ni	La	Ba	V	Ce	Y	Th	Pb	Cu
m	0.99	8.20	2.520	2.38	56.03	27.94	1.08	0.0378	0.38	0.24	540	330	81	61	188	65	93	186	208	195	68	30	32	24
s	0.25	1.14	0.188	0.38	2.18	1.43	0.14	0.0145	0.20	0.08	37	124	10	11	37	7	15	34	22	35	5	3	8	7
s%	3	1	1	2	0	1	1	4	5	3	1	4	1	2	2	1	2	2	1	2	1	1	2	3

a similar type, namely that from Sumaki Höyük (Erim-Özdoğan 2011). A good sample of this material has been chemically analysed, and the results show that the composition of the Basalt Tempered Ware from this site is completely different of that of both Tell Seker al-Aheimar and Tell Sabi Abyad. We may therefore safely exclude the possibility that the Tell Sabi Abyad Early Mineral Ware was imported from Sumaki Höyük (Table 9.5).

9.6. Concluding remarks

The provenance investigations of the early pottery from Tell Sabi Abyad lead to consider that all of this pottery very probably was imported and likely from Tell Seker al-Aheimar. We will discuss the limits of these results as well as some of their implications concerning the first stages of pottery craft in *Jezirah*.

Our results pose two important issues, *viz.* the reliability of the chemical analyses, and the possible alternatives to Tell Seker al-Aheimar as a provenance. With regard to the first issue, it is necessary to insist on the obvious: chemical analyses can give only probabilities, never absolute results. Neither our interpretation of the local production of Basalt Tempered Ware from Tell Seker al-Aheimar nor the common production of this group and of the Early Mineral Ware from Tell Sabi Abyad are certain, they are only very probable.

As to the second issue, Sumaki Höyük is the only site which to date has provided early pottery with a basalt mineral temper. If our chemical analyses exclude it as a possible provenance for Tell Sabi Abyad Early Mineral Ware, the available data to scrutinise the provenance of the earliest pottery in the *Jezirah* are still limited. Currently we know of just a dozen sites for the whole *Jezirah*. Therefore new candidates for Tell Sabi Abyad Early Mineral Ware provenance could appear in future field research. Our current interpretation of its provenance from Tell Seker al-Aheimar should be taken as provisional.

Having said this, the statistical probabilities are fully supported by non-chemical arguments, in particular the striking visual similarity between the painted samples from both sites (see Pl, 23.3 and 4). Such similarity is particularly conspicuous in the context of the earliest pottery, which is rather unstandardised. Thus, it would appear that for the first time in Near Eastern archaeology, chemical analyses of Neolithic pottery from a large number of sites have provided such a close match between pottery groups coming from two different sites that we may hypothesise an exact provenance.

The insight that early pottery containers were circulating from village to village should by itself not come as a surprise when considering the known circulation of diverse types of materials and objects already since the beginning of the Neolithic period, such as obsidian among many others. But it does suggest that at the start of the Initial Pottery Neolithic this new craft was already developed enough to produce a surplus. This could be an additional sign that the earliest pottery currently found in

Table 9.5 Sumaki Höyük. Mean and standard deviation of Basalt Tempered Ware groups

	CaO	Fe ₂ O ₃	TiO ₂	K ₂ O	SiO ₂	Al ₂ O ₃	MgO	MnO	Na ₂ O	P ₂ O ₅	Zr		
m	12,88	11,48	2,508	1,50	50,96	13,65	3,02	0,1720	2,22	1,34	225		
s	4,29	1,44	0,401	0,29	3,22	0,77	0,28	0,0174	0,48	0,34	15		
s%	33	13	16	20	6	6	9	10	22	26	7		
	Sr	Rb	Zn	Cr	Ni	La*	Ba	V	Ce	Y	Th	Pb*	Cu
m	361	43	114	94	59	42	1532	200	90	44	n.c.	14	26
s	59	6	10	25	17	9	750	47	11	5	n.c.	4	4
s%	16	15	8	27	29	20	49	24	12	11	n.c.	26	16

Majors are given in percentage of oxide, traces in parts per million of metal. *N* = 15; La *: mean calculated on eight values (other <1.q.); Pb *: mean calculated on nine values (other <1.q.)

the *Jezirah* does not represent the real beginning of the potter's craft. Although it is always found in very small quantities in the levels where it appears and although it generally presents a large variability, it is yet technically very advanced and does not display characteristics which strongly suggest the beginning of the technique.

In the case of Tell Sabi Abyad, since no local production of the earliest pottery could be identified, this new technique was very likely imported. The probable imports of early pottery at Tell Sabi Abyad from Tell Seker al-Aheimar concern a certain amount of pottery and suggest rather close relations between the two sites. The distance between them, some 120 km as the crow flies, would not have been an insurmountable obstacle. The ceramic provenance data point to a degree of regional mobility of people and goods not yet testified by other archaeological data. This deserves much further investigation.

Notes

1 The preliminary results of this study have previously been presented as a poster at the XIXth GMPCA symposium (Caen, 22–26 April 2013) by two of the authors (M. Le Mière and M. Picon).

- 2 Sodium oxide (Na₂O), magnesium oxide (MgO), alumina (Al₂O₃), silica (SiO₂), phosphorus oxide (P₂O₅), potassium oxide (K₂O), calcium oxide (CaO), titanium oxide (TiO₂), manganese oxide (MnO) and iron oxide (Fe₂O₃). For simplification, the term 'oxide' will be omitted for these components in the remainder of the text.
- 3 Vanadium (V), chromium (Cr), nickel (Ni), zinc (Zn), rubidium (Rb), strontium (Sr), zirconium (Zr), barium (Ba), lanthanum (La) and cerium (Ce); and for some samples also copper (Cu), yttrium (Y), lead (Pb) and thorium (Th).
- 4 It is indeed somewhat surprising that this division was not made in these previous analyses. In the macroscopic inspection in the field, surface colour was in fact taken into account in the initial categorization and counting; this led to a diffuse differentiation between what distinguished a 'lighter' from a 'darker' Early Mineral Ware. In the absence of petrographic analyses to support this distinction, it was not recorded in the subsequent statistical analysis (Nieuwenhuyse, pers. comm., October 2015). The sample subsequently submitted for petrographic analyses (Chapter 5) was small and apparently did not include any examples of the painted, light-coloured Early Mineral Ware.
- 5 In Chapter 4 the plant-tempered category is described as Standard Ware.
- 6 Termed Standard Ware.