OBSIDIAN AS TEMPER IN THE NEOLITHIC POTTERY FROM YIALI, GREECE

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The petrographic analysis of a small ceramic sample from the volcanic island of Yiali, SE Aegean, has showed that obsidian occurs as a deliberate inclusion in at least one fabric group, possibly to provide the vessel with some functional advantage. The volcanic characteristics of most fabrics match the geological background of Yiali, which suggests that this small island hosted ceramic production with additional clays imported from the outside.

KEYWORDS: YIALI, NEOLITHIC POTTERY, OBSIDIAN, TEMPER, LOCAL PRODUCTION, ADAPTATION, EXPERTISE, RAW MATERIAL NETWORKS

BACKGROUND TO THE SITE

Yiali is a small island in the Dodecanese, SE Aegean (Fig. 1), and has a total area of about 6 km^2. It is situated between the islands of Kos and Nisyros and consists of two high massifs of volcanic rocks joined by a low narrow isthmus (Fig. 1). To the SW lies a 160 m. high deposit of white rhyolitic pumice lapilli of Pleistocene date (<160,000 years, see Smith *et al*. 1995), and to the NE are obsidian and perlitic lava flows of relatively recent date (Di Paola 1974; Vougioukalakis 1993; Stiros and Vougioukalakis 1996; Vougioukalakis in press). Both volcanic massifs are today extensively quarried by mining companies.

The island was occupied during the late 5th and the 4th mil. B.C. (Late Aegean Neolithic II), at a stage when the nember of island sites increased throughout the Aegean basin. The Neolithic occupation (Sampson 1987, 108; Sampson 1988) covered extended areas on the neck (Fig. 1a:1) and the SW half of the island, as indicated by the abundance of surface ceramics and lithic tools on the plateau of the southern massive peak (Fig. 1a:2) and its slopes further to the South (Fig. 1a:3,4). However, apart from an intact building of stone foundations (Fig. 1a:5), and some stone walls, no other structures exist in this vast area, suggesting that the occupation mainly comprised of perishable materials. Two Neolithic sites were also located in the NE half and the southmost promontory of the island (Fig. 1a:6,7), again without any building remains.

Yiali obsidian

The obsidian sources of Yiali, after which the island was named ('yiali' being the greek word for 'glass'), have been well studied with the volcanic glass present in all the stratigraphic horizons of the island. Obsidian domes are found in the northern part (Fig. 1a,b), mainly in the valley where this joins with the isthmus (Fig. 1a:A), and on the coastal area to the East and North (Fig. 1a:B-F), but they are the result of a variety of volcanic episodes.

Yiali obsidian is not black and clear (Buchholtz and Althaus 1982), like the material from Melos, Cyclades, whose use extended throughout the Aegean and mainland Greece during the Neolithic and the Bronze Age. On the contrary, it contains a lot of white spots (spherulites) because of its high degree of hydration after its extrusion, which gave it a spotty texture. Spot density varies, but even when low, it makes the material unsuitable for chipping tools, since Yiali obsidian breaks easily and does not form good edges. The presence of numerous obsidian chips of Melian origin on Yiali implies that the Neolithic settlers imported the raw material from the Cyclades in addition to the use of their own rock. It was noticed recently that some obsidian of clear glassy quality and black colour does exist in the form of lithic clasts inside the thick pumice deposit of the southern half of Yiali, but whether it was accessible and exploited by the Neolithic population remains to be established.

Yiali Neolithic pottery

Yiali Neolithic wares are generally coarse with plain appearance. The surface, in most cases, is left unslipped and unburnished or is lightly polished (ca. 85%). Only in fewer instances is the surface burnished or covered with thick red or brown clayish slips (Fig. 2b) or a dark red pigment. Applied decoration is also rare (ca. 15%), while painted patterns do not exist (Sampson 1988, 75-102). Surface pigments seem to have been applied when the pot had dried, as both macroscopic and microscopic examination show a clear border between the pigment layer and the body of the pot. These pigments are then polished or burnished by rubbing with a pebble or bone object. Pots seem to have been fired in open fires at low temperature (700-800 degrees), as suggested by the microscopic examination of the fabrics, discussed below.

The shape repertory consists of a variety of about 60 forms (Sampson 1988, 161-163), most of which are open (33 in total), while broad-mouthed and closed shapes occur more rarely. Open shapes mainly consist of bowls and dishes of variable form and size, but also of fruitstands, baking pans, ladles, and large basins with perforations along the rim ('cheese-pots'). Broad- and narrow-mouthed vases are mainly deep, with thick-walled oval bodies ending in convex or straight out-curving necks. All shapes are of domestic character: open forms point to 'table ware', jars probably have served as containers for storage and transportation of foodstuffs, while some medium-sized vases of globular body and rounded base are likely to have been cooking vessels.

The scarcity of architectural evidence and the disintegration of the dietary remains due to an acid environment makes the pottery of Yiali our main interpretative tool for understanding the site. When macroscopic examination of some Yiali sherds revealed that obsidian was an occasional inclusion, a programme of petrographic analysis has commenced, addressing a number of questions: whether this was a deliberate choice by the potters and, secondly, what might have been considered that were the practical needs and pottery traditions guiding this technological preference. More broadly the presence of local rocks and clays in the fabrics suggests the existence of a local ceramic industry, and is a good example of adaptation and flexibility regarding the limits set by the local geology. Ultimately it may provide information on whether the Neolithic population was permanently occupying the island.

Thin sections from 37 ceramic samples from various shapes of pots were examined under a polarising microscope, in order to characterize the rocks and minerals included in the clay fabrics.

Most samples (17 pieces) were collected on the plateau of the SW half of the island (Fig. 1a:2), in the course of a systematic survey which occurred in 1998. Some samples (9 pieces) come from the excavation of two Neolithic buildings (Fig. 1a:4,5) and from a survey collection (4 samples) (Fig. 1a:3). Finally a small number of samples (5 pieces) was collected at the SW side of the island's neck (Fig. 1a:1). Also sampled and examined by thin section were two local sediments, the so-called Palaeosols, which are found on top of the large pumice deposit of the SW part (2 samples), to check their relation with the clays.

YIALI CLAY FABRICS

Seven compositional groups were identified on the basis of the type, size and frequency of inclusions. The petrographic examination of the clays have showed that obsidian occurs both in the fine (<0.1 mm) and the coarse (0.1-2.00 mm) fraction.

The fine fraction is more or less the same in six of the fabrics, and is constituted mainly by pumice, perlite and obsidian. Distinguishing between all these fine volcanic glass grains has not been easy in the cases when size was very small and structure was unclear. When size has made such identification possible, particles of a vesicular structure have been attributed to pumice, particles of perlitic fluidal texture and glassy groundmass have been identified as perlitic liparites, and the clear glassy grains of angular shape as obsidian. Feldspars are also present, as well as quartz of variable frequency between the samples.

The coarse fraction includes mainly fragments of volcanic material, such as dacite-andesite, pumice, obsidian, as well as pyroxene, plagioclase, quartz, isolated phenocrysts and hornblende. Their different distribution in the fabric suggests six compositional groups in addition to another of a non-volcanic origin (Fig. 2-3, Table 1):

1. Dacite-Andesite Fabric

It is dominant among Yiali fabrics (samples **6, 9, 19, 21, 25, 30**; Fig. 2a). It contains coarse fragments of porhyritic dacite-andesite with abundant phenocrysts (andesine plagioclase, pyroxene, rarely hornblende) in a microcrystalline or cryptocrystalline groundmass. Discrete phenocrysts of the same type or parts of them also occur in the fabric, as occasionally do pumice grains (samples **2, 7, 10, 12**). Particles differ considerably in size indicating low sorting of the clays. There is no evidence that the coarse inclusions were deliberately selected to serve as temper, but it seems that they consisted part of some soil with which the basic matrix was tempered. The shapes in which this fabric occurs are open bowls, two-handled deep pots and broad-mouthed deep jars.

2. Mixed Volcanic Fabric

Fragments of pumice outnumber the dacite-andesite fragments (samples **1, 3, 8, 14, 15, 20, 26, 27, 34, 37**; Fig. 2b). Some obsidian particles are observable, though in small quantities. All fragments differ considerably in size. All sampled pots belong to open shapes.

3. Microcrystalline Fabric

Pumice and dacite-andesite fragments predominate over isolated discrete quartzite, plagioclase or pyroxene (samples **11, 22, 23, 24, 35**; Fig. 2c). Particles differ considerably in size. Fragments of pumice and dacite-andesite are very few or totally absent. Shapes are mostly open, and one pot is a distinctive cooking vessel.

4. Sorted Andesite Fabric

It contains andesite grains of the same structure as in the above fabrics, but in unimodal size and well rounded (samples **16, 31**). This suggests that the grains had been selected by sieving out of some soil, and then added as temper to a claymass of distinct phenocysts and pumice grains, very similar to the above unsorted fabrics. Shapes of sampled pots are not diagnostic.

No	Form	Surface OUT/IN			Firing Cond.	Core	Fabric	Area
		Colour	Burnish	Slip				
1	Open bowl	R/Br-R	Bu/Bu	Sl/Sl	Mixed	Br-G	**Mixed Volcanic**	Plateau
2	Base	R/Br-G	Pol/Un	Sl/Un	Mixed	Br-G	**Dacite-Andesite**	Plateau
3	Open bowl	R-Br/Br-G	Pol/Pol	Sl/Un	Mixed	l. Br	**Mixed Volcanic**	Plateau
4	Broad-mouthed, necked	R-Br/G	Un/Un	Un/Un	Mixed	Br	**OBSIDIAN**	Plateau
5	Deep open bowl	d. Br/d. Br	Un/Un	Un/Un	Reduc	d. Br	**OBSIDIAN**	Plateau
6	Deep cup	Br-G/Br-G	Un/Un	Un/Sl	Reduc	G	**Dacite-Andesite**	Plateau
7	Broad-mouthed, necked	G/G	Un/Un	Un/Un	Reduc	G	**Dacite-Andesite**	Plateau
8	Phiale	Br-R/Br-R	Un/Un	Un/W	Mixed	G-Br	**Mixed Volcanic**	Plateau
9	Broad-mouthed, necked	R/R	Un/Pol	Un/Sl	Oxid	R	**Dacite-Andesite**	Plateau
10	Deep broad-mouthed	G/l. Br	Un/Un	Un/Un	Reduc	d. G	**Dacite-Andesite**	Plateau
11	Open	Br-R/Or-R	Un/Un	W/Sl	Mixed	G	**Microcrystalline**	Plateau
12	Broad-mouthed, necked	Br-R/d. Br	Un/Pol	Sl/Sl	Mixed	d. G	**Dacite-Andesite**	Plateau
13	Base	G/R	Pol/Pol	Un/Un	Mixed	G-R	**Fine Grained Glass**	Plateau
14	Base	Br/R	Un/Pol	Un/Un	Mixed	G	**Mixed Volcanic**	Plateau
15	Open	R/R	Pol/Pol	Sl/Sl	Reduc	G	**Mixed Volcanic**	Plateau
16	Closed?	Wh(salt)/R	Un/Un	Un/Un	Oxid	R	**Sorted Andesite**	Plateau
17			Sediment				**Lower Palaeosol**	Plateau
18			Sediment				**Upper Palaeosol**	Plateau
19	Closed?	Br/R-Br	Un/Un	Un/Un	Mixed	d. Br	**Dacite-Andesite**	NB2-Cem
20	Open	Br/R-Br	Pol/Pol	Sl/Sl	Mixed	l. G	**Mixed Volcanic**	NB2-Cem
21	Open bowl	d. Br-G/G	Un/Un	Un/Un	Reduc	d. G	**Dacite-Andesite**	NB2-Cem
22	Open bowl	R/R	Pol/Pol	Pigm/Pigm	Mixed	G	**Microcrystalline**	NB2-Cem
23	Open	l. Br/l. R-Br	Pol/Pol	Sl/Sl	Mixed	G	**Microcrystalline**	NB2-Cem
24	Open	R/Br	Un/Un	Un/Sl	Oxid	l. R	**Microcrystalline**	NB2-Cem
25	Open bowl	l. Br/Br	Un/Un	Slip/Un	Mixed	Br	**Dacite-Andesite**	NB2-Cem
26	Broad-mouthed, necked	R/R-Br	Un/Un	Un/Un	Mixed	d. G	**Mixed Volcanic**	NB2-Cem
27	Deep open bowl	R/R-Br	P/Un	Pigm/Un	Mixed	Br	**Mixed Volcanic**	Cem
28	Base, closed?	l. R/Br	Un/Un	Un/Un	Mixed	G	**Microcrystalline**	Cem
29	Closed?	R/Br	Pol/Un	Sl/Un	Oxid	Red	**OBSIDIAN**	Cem
30	Closed?	L. Br/l. Br	Un/Un	Un/Un	Mixed	d. G	**Dacite-Andesite**	Cem
31	Closed?	R/Br	Pol/Un	Sl/Un	Oxid	l. Br	**Sorted Andesite**	Neck
32	Base, closed?	R/Or-R	Un/Un	Un/Un	Oxid	R	**Sandstone**	Neck
33	Closed?	R/R	Un/Un	Un/Un	Oxid	R	**OBSIDIAN**	Neck
34	Closed?	R/Br	Un/Un	Un/Un	Mixed	Br	**Mixed Volcanic**	Neck
35	Cooking-pot	l. Br/l. Br	Un/Un	Un/Un	Mixed	d. Br	**Microcrystalline**	Neck
36	Closed?	Br/Br	Un/Un	Un/Un	Mixed	d. G	**OBSIDIAN**	Plateau
37	Open bowl	Br/Br	Un/Un	Un/Un	Mixed	d. Br	**Mixed Volcanic**	NB1

Table 1 *Fabrics. Br=Brown, Bu=Burnished, Cem=Cemetery, d.=deep, G=Grey, l.=light, NB1 or NB2=Neolithic Building 1 or 2, Or=Orange, Oxid=Oxidised, Pol=Polished, R=Red, Reduc=Reduced, Sl=Slipped, Un=Unpolished or Unslipped, W=Washed, Wh=Whittish*

5. Obsidian Fabric

It contains coarse obsidian grains within pumice and perlite glass, while dacite-andesite fragments, and phenocrysts, mostly feldspars, are few or absent (sample **4, 5, 29, 33, 36**; Fig. 3). The frequency of obsidian grains is very high compared to the other fabrics described above, which makes this fabric very distinguishable, and indicates that obsidian on its own was a deliberate tempering choice. These obsidian grains, however, can be interpreted either to indicate the use of Melian obsidian or the use of a local source without spherulites. One such source has been recently located (see above), and concerns obsidian crops included inside the lower pumice deposit. Future research by trace element analysis is expected to provide consistent information on the provenance of this obsidian. Concerning the pots these sherds belong to, both open and closed vases have been observed: sample **4** comes from the neck of a deep bowl, relatively narrow mouthed; sample **5** comes from an open deep bowl with straight walls, while the rest sherds (**29, 33, 36**) are of a non-diagnosic shape, but belong to vases with untreated inner surface.

6. Fine Grained Volcanic Glass Fabric

On the contrary to the above fabrics consisting of coarse grains, this fabric contains very rare coarse particles (sample **13**). The presence of obsidian here is high, along with the presence of perlitic glass, feldspars and quartz. The few coarse grains come from the same rocks and minerals with the fine fraction. It seems that this fabric is the result of a well-sieved clay mass, probably produced by the mixing of a very fine plastic material and some local, well-sorted soil temper. It is notable that this fabric also bears evidence for tempering with some organic material, perhaps plant fibres. The sample belong to a fruitstand base.

7. Sandstone Fabric

It is of non-volcanic composition, totally distinct to the rest fabrics, and evidently imported to Yiali. (sample **32**). It is made of sedimentary materials, dominated by coarse fragments of microsandstone and flint, within a clay matrix of argillaceous minerals with no evident relation to the clay of the above fabrics. The shape is not diagnostic.

Apart from tempering choices, thin section examination has also helped in the definition of other major fields regarding the technology of the pottery production, such as surface treatment and firing conditions. Concerning materials used for surface treatment (about 250 μm), we observed two main groups: red slips comprising a fine clay-rich layer, with similar petrographical characteristics with the fine fraction of the fabrics (Fig. 2b), and a thick (30 μm) dark red pigment, fine grained, which seems to have been applied after the vessel had dried, according to the well defined limits between pigment and clay core. As for the vitrification degree, the micromass is mostly optically active, which suggests that firing temperature did not exceed 700 to 800 ^{0}C. Most samples indicate a mixed atmosphere, while reducing and oxidising conditions are rarer.

CLAY AND INCLUSION PROVENANCE

The petrographic examination of Yiali fabrics have showed that a limited range of rocks and minerals was used, which are mainly compatible with an origin on the island. However, the geology of Kos and Nisyros as well as that of the surrounding islands is also volcanic, and has been affected by the same volcanic episodes that produced Yiali pumice deposits and obsidian-perlitic domes. In fact, Nisyros has rocks of all stages of volcanic glass, such as dacites-andesites, rhyolites and thick pumice deposits from several Pleistocene eruptions, the same that had covered Yiali, but has no obsidian. It should be noticed that dacito-andesites, which often occur in Yiali fabrics, do not exist on Yiali, unless within a local soil sediment (see *infra*), while in Nisyros they occupy extensive areas of deposition. This rock is also dominant on the islet of Aghios Antonios, off the east shore of Yiali. In addition the geology of Yiali seems to be in close relation with that of western Kos, which is occupied by tuffs resting on Neogene limestones. Kelepertsis and Reeves (1987/88), who have studied the trace element composition of these rocks, give a full petrographic description of these tuffs (calc-alkaline high-K dacite-andesites, rhyolites, pumice, perlite), indicating not only their close relation to Yiali tuffs, but also that they have similar petrographic characteristics, possibly owing to the same volcanic origin.

Within this attempt to identify the raw materials in the Yali fabrics as local or imported, we have observed the presence of certain materials of definitely non-Yiali origin. Indeed Yiali pottery production would not have been possible if it was only limited to local materials, because some of the basic pottery constituents did not exist on the island and had to be carried from an 'outside' source. One major question concerns the provenance of the clay matrix. The surface and core colour of the samples (red, dark grey) are due to iron-rich clays fired in oxidizing and reducing atmospheres. However, there is no source of such argillaceous material on the island of Yiali, and the only possible sources of local plastic material that the potters might have used would not have produced such colours. Taking into account that the fine fraction of the fabrics points to the use of local soils, it is rather possible that clay mixing had occurred between local clays and a clay of non-Yiali origin. For this reason we have sampled and examined in thin section two local sediments, the so-called Upper and Lower Palaeosol, which seem to be the only local sources of plastic material available, and present close resemblance to the clay fabrics examined.

The Palaeosols (Sampson 1988) overlie the huge pumice deposit at the height up to 120 m., in the SW half of the island (Fig. 4a). They are up to 0,50 m. deep or less and alternate with a later pumice layer - the 'upper pumice' -, as well as with thin epiclastic, shallow marine and aeolian pumice deposits, and with a calcareous sandstone sediment (Stiros and Vougioukalakis 1996), all of which cover the lower, currently quarried, pumice deposit of the SW half. A full stratigraphy is preserved in the middle of the plateau, while towards the slopes to the west and the east these Palaeosols are exposed to the surface due to intense erosion.

Lower Palaeosol (red) and Upper Palaeosol (greenish brown) consist of the same pyroclastic materials which produced the upper pumice deposit lying between them (Stiros and Vougioukalakis 1996). Some degradation processes (oxidation, weathering etc.) must have increased their content in clay minerals, also increasing their plasticity. However their content in clay minerals is still low compared to the proportion of volcanic glass (pumice, perlitic liparites and obsidian) and to the rare microcrystalline dacite-andesite particles and isolated phenocrysts, making the use of a complementary clay material necessery for the local potters,

However, between the upper and deeper Palaeosol of Yiali there is an obvious difference of texture, in terms of grain size and proportion of each mineral group in the groundmass. The Upper Palaeosol (Fig. 4b,c) is poor in clay minerals, being overwhelmed by vesicular pumice, perlitic glass and angular obsidian particles. Some part of phenocrysts are also present, mainly green hornblende which is responsible for the greenish-brown colour of this soil. This sediment is loose and of low plasticity, although fibrous crystals of sericites and illites are observable.

The Lower Palaeosol (Fig. 4d) is, on the other hand, more plastic and compact, because of a higher content of clay minerals, probably originating from the degradation of glass. Pumice and obsidian grains are coarser compared to the Upper Palaeosol, while in this sediment there exist fragments of dacito-andesite rocks of microcrystalline structure. Pyroxenes and hornblende are frequent to few, which explains why this sediment has a red to red-brown colour, instead of greenish. The material has sufficient plasticity to be called a 'clay-bed'. The petrographic characteristics of the clays compared to the features of Lower Palaeosol (plasticity, similarities of rocks and minerals) point towards the use of this soil in the local ceramic industry. The association between this Palaeosol sediment and Yiali pottery has also been confirmed by the application of magnetic susceptibility to a broad ceramic sample from Yiali (Sampson and Liritzis 1998, 103, fig. 10).

It should be noticed however that in the NE half of Yiali there is another possible source for plastic material: it is a formation of grey fall-out perlitic ash of different geological date and chemical composition in comparison with the SW sediments. This material is worthy of note as, when mixed with water, it the compactness and plasticity of clay. On account of this property it is quarried today and used as an ingredient in cement. The possibility that the local ceramic industry took advantage of this material as soil-temper in a pure clay base should not be excluded, although, the low-firing choices of Yiali industry, around 700-800 ^{0}C, would have left such a material unbaked.

Looking for the possible provenance for the iron-rich Yiali fabrics' plastic base, we regard nearby Kos as a probable source, since this island is rich in clay deposits and has a long pottery tradition (Kantzia 1994). Sediments of marls and marly limestones of Late Miocene-Pliocene and Pleistocene age occupy the central and western part of Kos (Kelepertsis and Reeves 1987/88, 444 and fig. 2). This is the reason why pottery workshops were established in the area of Kardamaina (central-south Kos) and Kephalos (west Kos) since antiquity. Local pottery worksops have been active until late '70s, while a modern industry of tiles still exploits the same material. On the opposite, Nisyros disposes of no argile, and according to local information never were there any pottery workshops on the island (Sampson 1997, 245).

DISCUSSION

Based on the above data we come to the following interpretation scheme:

The number of seven fabrics out of 37 samples is an indication that fabric variability at Yiali is not low. Although the word 'fabric' is used for a group presenting a relatively high degree of similarity (Whitbread 1986), most of Yiali fabrics merge into one another, the differences in petrographic identity, grain size and distribution being rather small and not adequate to form well differentiated groups. The poor sorting of clays, the coarse and plain forms of vases also suggest that the natural materials were slightly manipulated by the potter at Yiali.

Yiali Palaeosols, especially the Lower Palaeosol, seem to be associated with the Neolithic fabrics of Yiali, indicating that a local ceramic industry existed on the island and was taking advantage of the available geological resources. None of the Palaeosols however seem to serve as the unique source for Yiali clays, but both occur in addition to clays and pigments of non-Yiali origin. It is equally possible that, apart from the Palaeosols of the SW part, some other places on Yiali have provided early potters with clay materials. No doubt that the examination of more samples from Yiali, but also Kos, Nisyros and the surrounding islets will help us understand how short-distance distribution of raw materials occurred within the islands.

Most fabrics do not seem to have been subject to any special sorting or deliberate tempering of some particular rock, as suggested by the variation of the size and type of inclusions. The *Fine Grained Volcanic Glass Fabric* provide the sole evidence on persistent levigation of clays to produce a thin grained fabric. *Dacite-Andesite Fabric* and *Obsidian Fabric* are based on the mixture of the same clays as the other local fabrics, but were subject to further tempering with the addition of fragments of one certain rock (dacite-andesite and obsidian respectively), probably deliberately crushed and sorted to a consistent size. Obsidian, in particular, is part of the fine fraction when it belongs to the local clayish material (Palaeosol or other) mixed with the clay base. In the *Obsidian Fabric* though it belongs to the coarse fraction; its even distribution and consistent size suggest that it is a deliberate inclusion (smashed or or sieved), pointing to an intentional technological choice by the potter. One could argue that the obsidian temper has a specific functional advantage for the pot, but what this is (improves wall strength or temperature resistance), it is not easy to answer yet. Obsidian temper exists in a range of vessels from Melos and Crete since at least the EBA (Vaughan 1989), but in these cases, it does not indicate any specific functional value.

The local production of pottery points to a permanent occupation, if not year-round, certainly of a long while. The shape repertoire on the other hand testifies to a broad variety of big- and medium-sized vessels, and to a huge volume of ceramic material in use. Such a volume and such a quantity could not have been carried by boat from the opposite coasts, and therefore point to a local industry taking care of the domestic needs, as detected by the subsistence strategy of the settlers. As a conclusion, the production of ceramics at Yiali is an 'internal' activity, during which the potter is probably collecting the raw materials out of an area in his immediate vicinity. This is an indicator of self-sufficiency. At the same time, the same people depend on the outside, both in terms of raw materials, and finished products. The local population is therefore depending on a network of exchanges, orders and intermediate people, through which the outside materials and objects flow to the island to complement the local needs. The movement of ceramic raw materials or finished pots, along with the importation of other materials such as copper from Lavrion, obsidian from Melos, millstones from the surrounding islands, suggest a network of contacts or a social sphere around the island's natural limits, which broaden the island's small world and inside which raw materials, finished products, but also ideas and people come and go.

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REFERENCES

Buchholz, H. G., and Althaus, E., 1982, *Nisyros, Giali, Kos. Ein Vorbericht uber Archaologisch-Mineralogische Forschungen auf Griechischen Inseln.*

Davis, E., 1967, Zur Geologie und Petrologie der Inseln Nisyros und Yali (Dodecanese), *Proceedings of the Academy of Athens*, **42**, 235-252.

Di Paola, G. M., 1974, Volcanology and petrology of Nisyros island (Dodecanese, Greece), *Bulletin Volcanologique*, **38**, 944-987.

Kantzia, H., 1994, Ena kerameiko ergastirio amphoreon tou protou misou tou 4ou ai. p.Chr. stin Ko, in *Epistimoniki Sinantisi gia tin Ellinistiki Kerameiki*, Athens Archaeological Society Monographs **137**, Athens.

Kelepertzis, A., and Reeves, R., 1987/88, The geochemistry of the volcanic rocks of Kos island, Aegean sea, Greece, *Annales Géologiques des Pays Helléniques*, **33**, 443-462.

Sampson, A., 1987, *The Neolithic Period in the Dodecanese*, Archaeologikon Deltion Monographs, **35**, Athens.

Sampson, A., 1988, *The Neolithic Settlement of Yiali, Nisyros*, Athens.

Sampson, A., 1997, *The Ethnoarchaeology of Yiali, Nissyros. Island Transhumance in the SE Aegean*, Dodecanesian Society for Literature and Arts, Athens.

Sampson, A. and Liritzis, I., 1998, Archaeological and archaeometrical research at Yiali, Nisyros, *Turkish Academy of Sciences Journal of Archaeology,* **2**, 101-115.

Smith, P. E., York, D., Chen, Y., Evensen, N. M., 1995, The timing of ancient Greek paroxysm on the island of Kos: towards a more precise calibration of the Mediterranean Deep-Sea Record, *AGU December 1995 (Fall Meeting)*, Abstracts F 712.

Stiros, S., and Vougioukalakis, G., 1996, The 1970, Yali (SE edge of the Aegean volcanic arc) earthquake swarm: surface faulting associated with a small earthquake, *Annales Tectonicae*, **10** (1-2), 20-30.

Vougioukalakis, G., 1993, Volcanic stratigraphy and evolution of Nisyros island, *Bulletin of Geological Society of Greece*, **28**, 239-258.

Vougioukalakis, G., in press, *Geological map of Greece, 1:25000 scale: Nisyros and neigbouring islets*, IGME, Athens.

Vaughan, S. J., 1989, Petrographic analysis of the Early Cycladic wares from Akrotiri, Thera, in *There and the Aegean World* III, 99-111.

Whitbread, I. K., 1986, The characterisation of argillacious inclusions in ceramic thin sections, *Archaeometry*, **28**, 79-88.

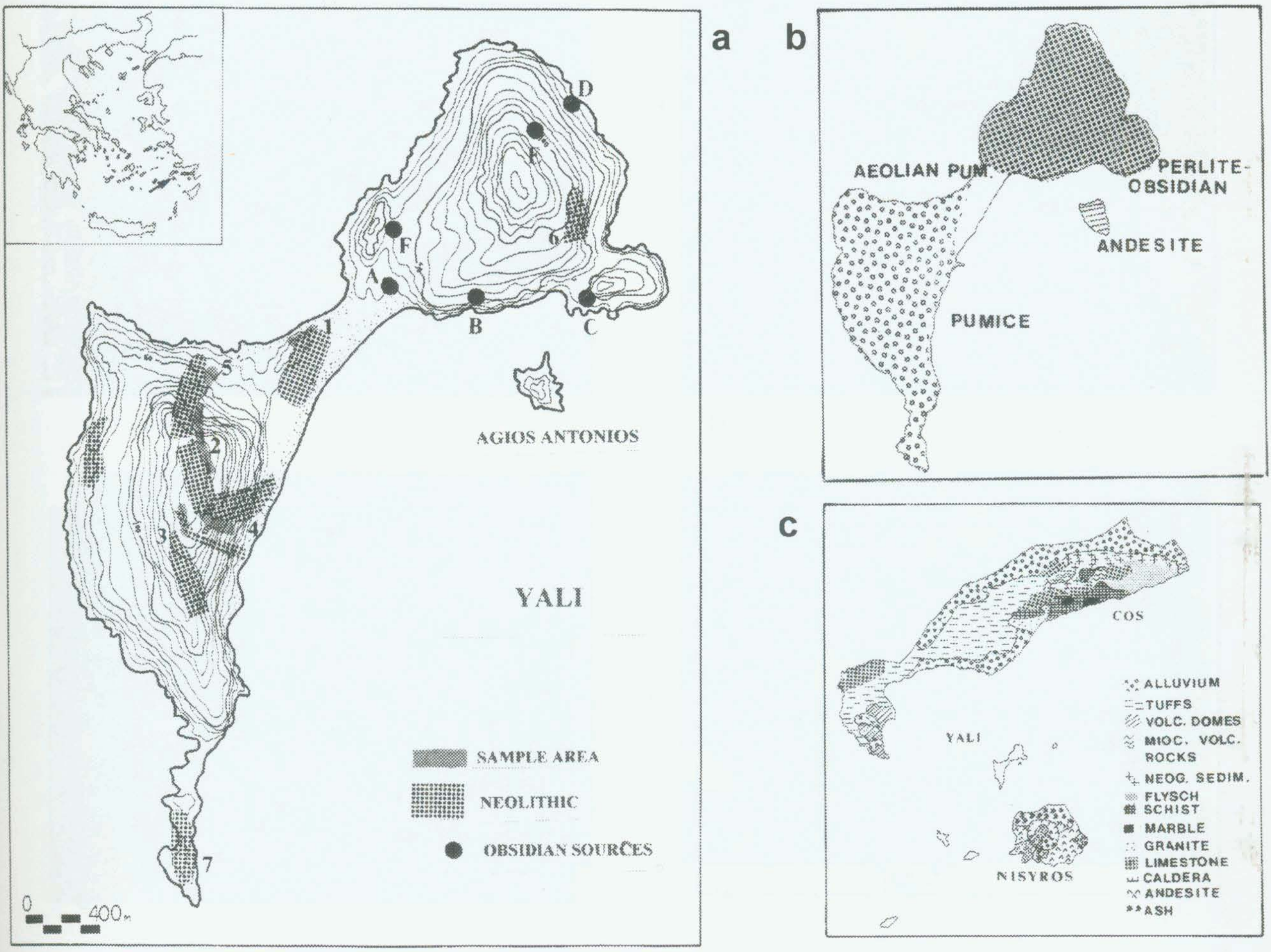

Figure 1 *a. Map of Yiali with Neolithic sites and obsidian sources (after Sampson 1988); b. Simplified geological map of Yiali (after G. Vougioukalakis, Nisyros, 1998, 44.); c. Geological map of the island of Cos.*

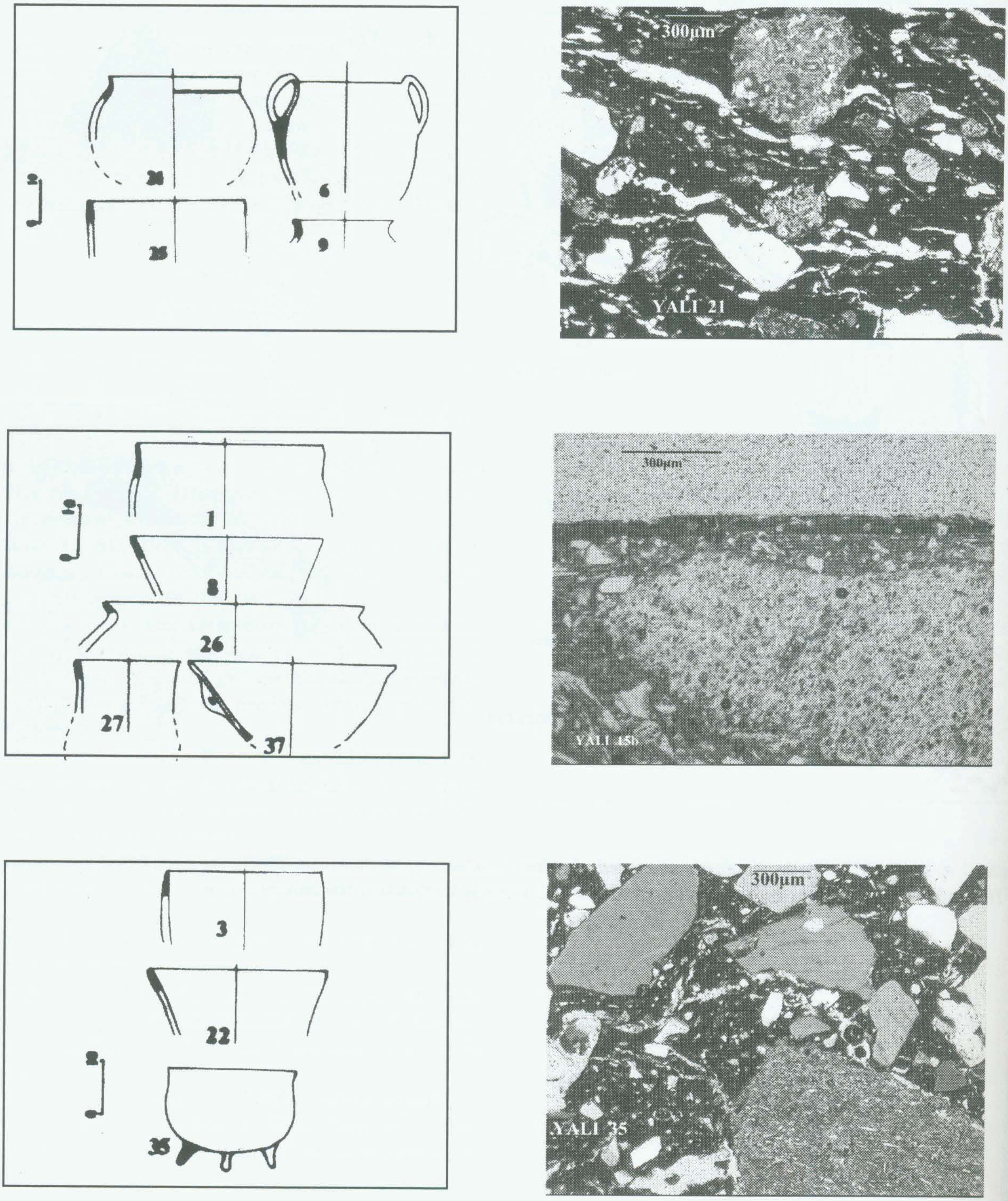

Figure 2 *Pottery shapes and thin sections of: a. Dacite-Andesite Fabric, sample 19, cross polarised nicols; b. Mixed Volcanic Fabric, sample 15, plane polarised nicols; Microcrystalline Fabric, sample 35, cross polarised nicols.*

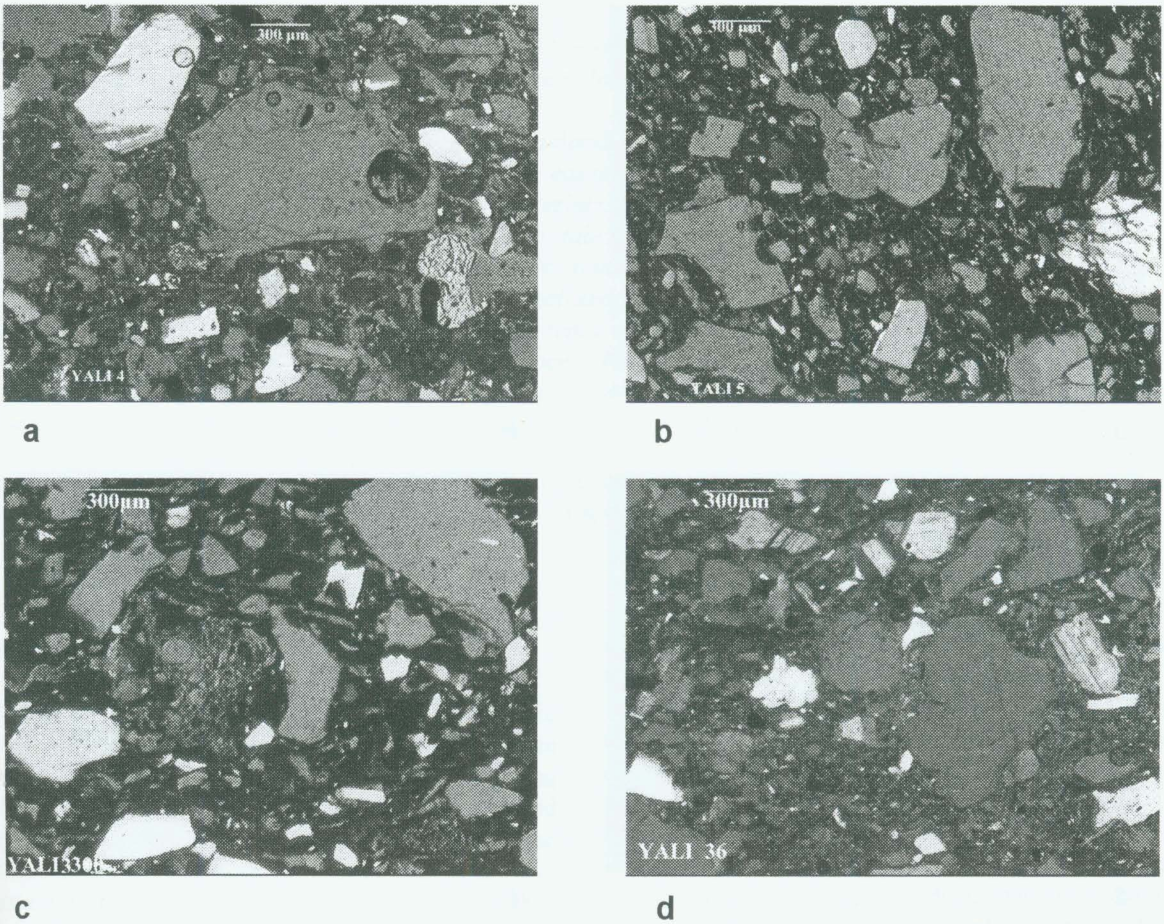

Figure 3 *Thin sections of Obsidian Fabric, semi-cross polarized nicols: a. sample 4; b. sample 5; c. sample 33; d. sample 36.*

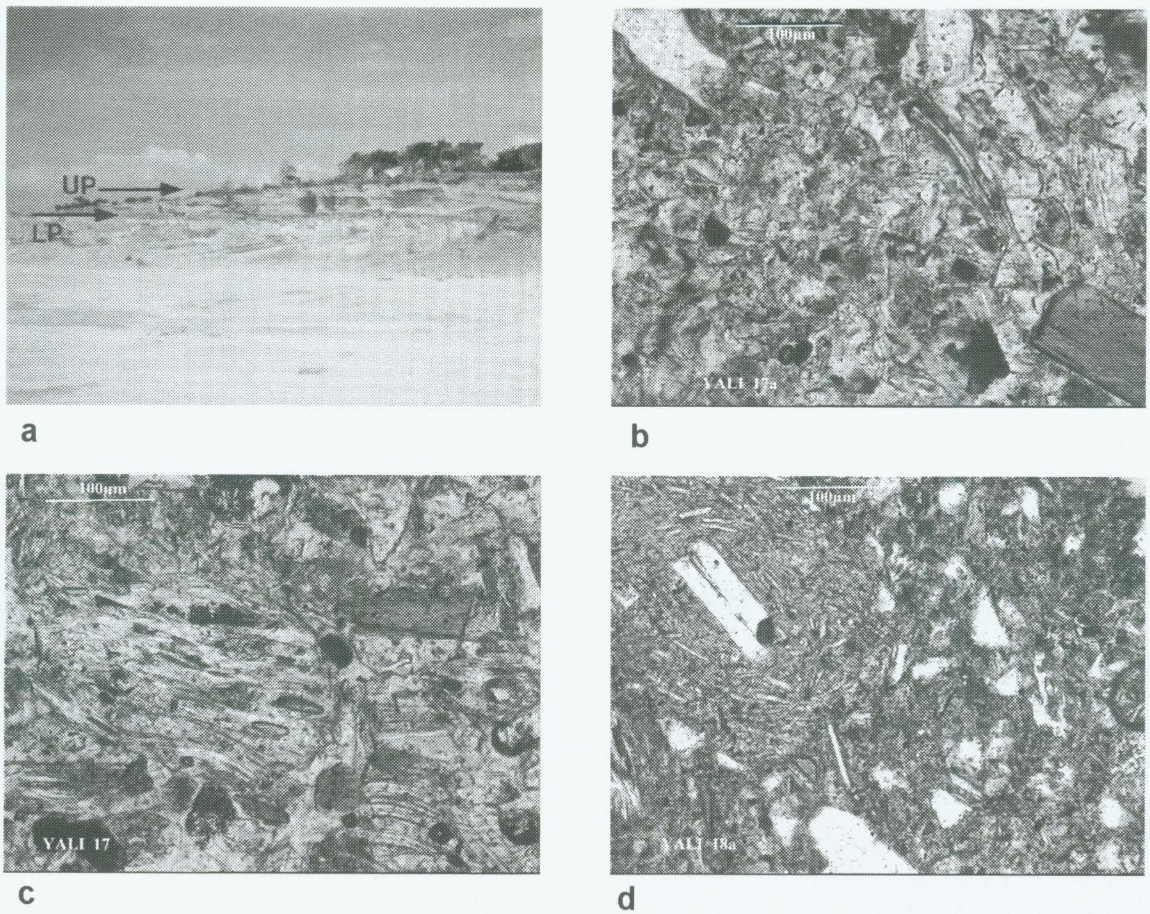

Figure 4 *a. Yiali, SW part, view from the east: The stratigraphy of Upper Palaeosol (UP) and Lower Palaeosol (LP); b, c. Thin sections of Upper Palaeosol, plane polarised nicols; d. Thin section of Lower Palaeosol, plane polarised nicols.*