MYCENAEAN POTTERY FROM NORTHERN ITALY. ARCHAEOLOGICAL AND ARCHAEOMETRIC STUDIES *

by RICHARD E. JONES, LUCIA VAGNETTI, SARA T. LEVI, JOHN WILLIAMS, DAVID JENKINS, ARMANDO DE GUIO

1 – INTRODUCTORY REMARKS

In the distribution map of Mycenaean pottery in the central Mediterranean a small cluster of findspots is located in the North-East of peninsular Italy, between the Po and the Adige, two major rivers that have always played a very significant role in the interregional communication network during the Bronze Age (Fig. 1)[1].

The five sites concerned – Fondo Paviani, Fabbrica dei Soci, Castello del Tartaro, Frattesina and Montagnana – have been explored with different methods and to varying extent. Frattesina and Montagnana have been partially excavated, while the other sites have been studied through systematic surveys and specific subsurface investigation methodologies, within the framework of the *Alto e Medio Polesine e Basso Veronese* project

---

* For permits and assitance during sampling all the authors are grateful to Drs. E. Bianchin Citton, A. M. Bietti Sestieri, M. De Min, R. Peretto, L. Salzani. This work was done under the auspices of EC grant CT94-0615 NCSR for the Human Capital & Mobility Program's "Technology and Mobility in Prehistoric Europe" Project. Support from the Institute for Aegean Prehistory has been fundamental for the archaeological aspect. At SURRC we thank A. Wilson for considerable technical assistance, and Dr. A. B. Mackenzie. Dr. J. E. Tomlinson kindly made available reference data for the Peloponnese in advance of its publication. Dr. C. Balista's help in geological sampling and fieldwork has been instrumental to the above study. Dr. M. Bettelli's suggestions and Dr. P. Bellintani's bibliographical information have been very appreciated. Figs. 1-3 have been prepared by A. Mancini. Some of the thin sections are the work of A. Coeli.

[1] In this article the Mycenaean sherds allegedly found at Torcello in the lagoon of Venice, are not considered. They have recently been the subject of somewhat speculative studies (Di Filippo Balestrazzi 2000; Braccesi 2001). A comment by one of the present authors will be published separately.

SMEA 44/2 (2002) p. 221-261.

(Balista, De Guio *et al.* 1990-91, 1997; De Guio 1995a,b, 1996, 2000, 2002; De Guio *et al.* 1989, 1990, 1992, 1995, 1999).

A total of ten sherds of Mycenaean fabric have been collected; all of them have been submitted to archaeometric examination, as part of a long-standing project of analyses of Mycenaean pottery from the central Mediterranean: many of its results have already been published, while others are in progress (Jones *et al.* 2002; Vagnetti *et al.* in preparation).

The main aim of the present paper is, on the one hand, the illustration, discussion and interpretation of the Mycenaean sherds found in this area, considered in their archaeological context; on the other hand a detailed presentation, discussion and interpretation of the available archaeometric evidence concerning the Mycenaean sherds, as well as a set of local hand-made burnished ware (Impasto), which is well suited to petrographic characterization of this type of finds. The two data sets are also discussed together, and in the more general framework of what we know about the circulation of the Mycenaean pottery in Bronze Age Italy.

(L.V.)

2 – Character of the sites and circumstances of finds

A) *Fondo Paviani, Legnago (VR)*

Inland site, located between the Rivers Adige and Tartaro, in the area known as Valli Grandi Veronesi. Reference map IGM 1:25.000 F° 63 II N.O. (Valli Grandi Veronesi). Latitude: 47° 07' 09" N; Longitude: 1° 09' 42" W; Height a.s.l.: 9.

Discovered in 1974, through surface finds. Since 1989 intensive surface and subsurface exploration, integrated by photointerpretation (*Alto-Medio Polesine – Basso Veronese* project). Ca 600 m to the NW of the site a Bronze Age necropolis was identified by C. Balista and investigated through surface exploration and stratigraphic tests.

Bank and ditch Terramara structure. Thanks to a section, extended over a length of ca 80 m, which in the NE part of the site cuts part of the bank and the ditch and uncovers a portion of the inner site area, four anthropogenic phases have been recognized.

Phase 1: *palafitta*-type dwellings, with a wooden structure above wet ground, with pits of various types in sandy patches of the ground.

Phase 2: excavation of the ditch and construction of the bank, built with selected sediments from the subtratum. The quadrangular outline, with rounded corners, is clearly visible from the air. Total extent of the site, ca. 16 ha.

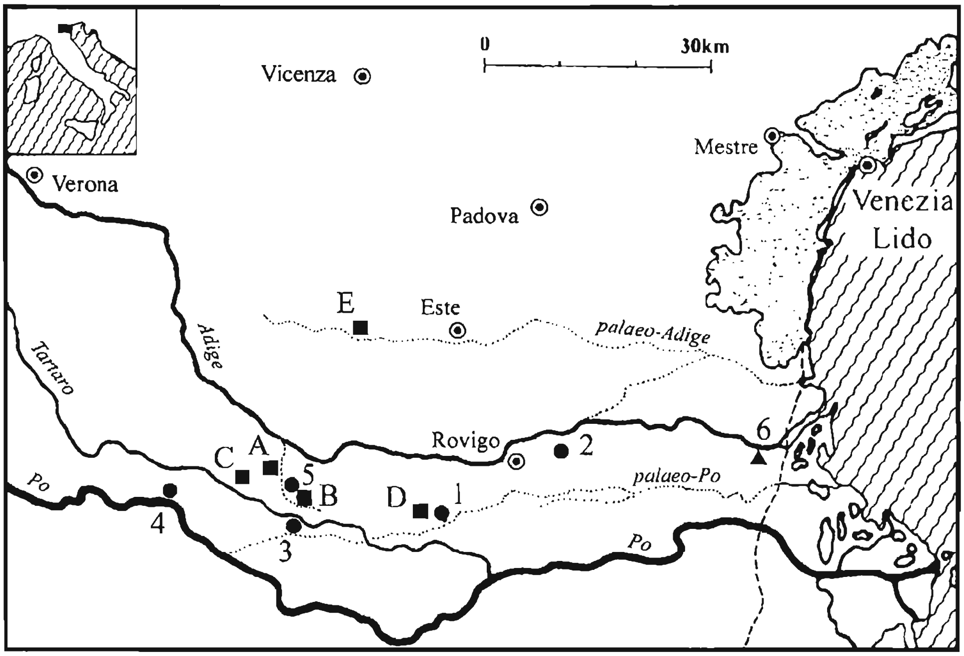


Fig. 1 – Location of Bronze Age sites in the lower Po valley in relation to the current and palaeo-river course: A) Fondo Paviani, B) Fabbrica dei Soci, C) Castello del Tartaro, D) Frattesina di Fratta Polesine, E) Montagnana, 1) Villamarzana, 2) San Martino *loc.* Saline, 3) Canova, 4) Mariconda di Melara, 5) Stanghelle, 6) Corte Cavanella (roman site).

Phase 2/3: 'near-site' and *inter*-site evidence concerning: a) an enclosure to the E of the ditch extending over 7 ha; b) an irrigation system of small concentric channels; c) a series of structures possibly belonging to a system of road/ditch/channel, going towards Castello del Tartaro, difficult to date and certainly refurbished in Roman times. Similarly uncertain is the chronology of the gate (*porta a tenaglia*), identified in the middle of the E section of the ditch and probably later than its first phase of construction.

Phase 3: main post-ditch settlement period; dwellings are no longer of the *palafitta* type, but at ground level. Numerous pits were found where building material, such as daub and plaster, as well as food remains, have been disposed. The final part of the phase is characterized by activity on the ditch, probably related to the ditch being taken out of use.

Phase 4: abandonment. Marshy deposit with sparse traces of human activity, earlier than the alluvial layers which sealed the site.

The site is characterized by evidence of craft production, such as metalwork, and by the presence of amber, glass beads, bone and antler material, very close to those found at Frattesina.

Occupation goes certainly back to the Middle Bronze Age 2B (if not earlier) and continues until the Final Bronze Age 1B.

Four radiocarbon dates (Whitehouse 1997) range between the 17th and the 12th/11th century BC. Phase 1: OxA-4648, c. 1620-1450 cal. BC (1σ); phase 3: Ox-A4649, c. 1410-1220 cal. BC (1σ); phase 4: OxA-4650, c. 1380-1130 cal. BC (1σ) and 1410-1020 cal. BC (2σ).

Two Mycenaean sherds have been found in the site area: **FPA1** (Fig. 2:1), surface find by C. Balista (in 1978), along a stratigraphy in the *intra*-site area; **FPA2** (Fig. 2:2), surface find by C. Balista (in 1991) on ploughzone (field 2 – central *intra*-site area; possibly phase 3).

Bibliographical references: Fasani, Salzani 1975; Salzani 1976; Malgarise 1989-90; De Guio, *et al.* 1990; 1992; Tozzi, Harari 1990; Salzani 1996; Bagolan *et al.* 1997; Balista, De Guio 1997; Balista *et al.* 1997; 1998.

B) *Fabbrica dei Soci, Villabartolomea (VR)* [2]

Inland site, located between the Rivers Adige and Tartaro, in the area known as Valli Grandi Veronesi. Reference map: IGM 1:25.000 F° 63 II N.E. (Castagnaro). Latitude: 45° 05' 07" N; Longitude 1° 07' 02" W; Height a.s.l.: m 9.7.

The first explorations of the site were by M. Fioroni and F. Zorzi. Rescue excavations and surface investigation carried out by Salzani have both outlined its importance and attracted great attention in relation to the new series of studies on Terramare problems. The nearby necropolis of Franzine Nuove is probably related to the site.

Through the integrated study of the data, gathered from old and new explorations and through the application of various methodologies (excavation, stratigraphic sections, surveys, deep cores, line sampling, remote sensing, image processing etc., within the *Alto-Medio Polesine – Basso Veronese* project) it has been possible to detect four main phases of occupation.

Phase 1: The earliest embanked settlement (*terramara piccola*) lies above a phase of formation of the channel's natural banks; it seems to cover an area of ca. 1-1.5 ha.

[2] Recent finds from Lovara, in the same territory of Villabartolomea (kind communication by Luciano Salzani), are still under study and will be analysed chemically by ICP.

Phase 2-3: *terramara grande* with two sub-phases, each one characterized by the building/refurbishing of the large bank. Gate in the middle of the E bank. Dwellings have been identified towards the centre of the settlement, founded on a silt layer and built with wattle and daub technique. Levi and Perin (in Balista, De Guio 1990-91, ftn. 41) have estimated ca. 44 huts (ca 500/800 inhabitants) on the basis of surface clusters. Storage areas (silos and pits, as well as above-ground granaries) are located between the inhabited area and the bank, and evidence for metalwork production occurs in Field 1 (fragments of ingots and slags: De Guio *et al.* 1989).

Phase 4: abandonment, marked by the bank's progressive decay and various and differentiated alluvial processes.

Occupation goes back to the Middle Bronze Age 3B and continues until the Final Bronze Age 1A.

Two radiocarbon dates (Whitehouse 1997) concern respectively phase 1: BM-2757, c. 1739-1262 cal. BC (1σ) with medium chronology around 1510 BC, and phase 2-3 (sub-phase 1): OxA-3328 c. 1527-1409 cal. BC [1σ]), with medium chronology around 1480 BC.

Four Mycenaean sherds have been found inside the settlement area: **FDS1** (Fig. 2:3), surface find by F. Soriani (in 1988) in the NE corner; **FDS2** (Fig. 2:4), from a 'surface context' (found by S.T.L., in 1989), near the gate along the east bank; **FDS3** (Fig. 2:6), surface find by G. Belluzzo (in 1992), in the ploughzone, after rain, towards E, beyond the Lazise drain; **FDS4** (Fig. 2:7), surface find by G. Belluzzo (in 1992), in the ploughzone, after rain, towards E, beyond the Lazise drain.

Bibliographical references: Salzani 1977; 1988; De Guio *et al.* 1989; 1990; Malgarise 1989-90; Balista, De Guio 1990-91; Tozzi, Harari 1990; De Guio 1995a; 1995b; Bagolan *et al.* 1997.

C) *Castello del Tartaro, Cerea (VR)*

Inland site, located between the Rivers Adige and Tartaro, in the area known as Valli Grandi Veronesi. Reference map: IGM 1:25.000 F° 63 II N.O. (Valli Grandi Veronesi). Latitude: 45° 06' 53" N; Longitude: 1° 13' 35" W; Height a.s.l.: 9.5.

The site, identified by De Bon in 1926 through its bank, has been surveyed and partially excavated by Puglisi, Zorzi and Calzolari. Salzani (1989a) has investigated the nearby necropolis. Since 1994 it has been under investigation through various methodologies in the framework of the *Alto-Medio Polesine – Basso Veronese* project (De Guio *et al.* 1995).

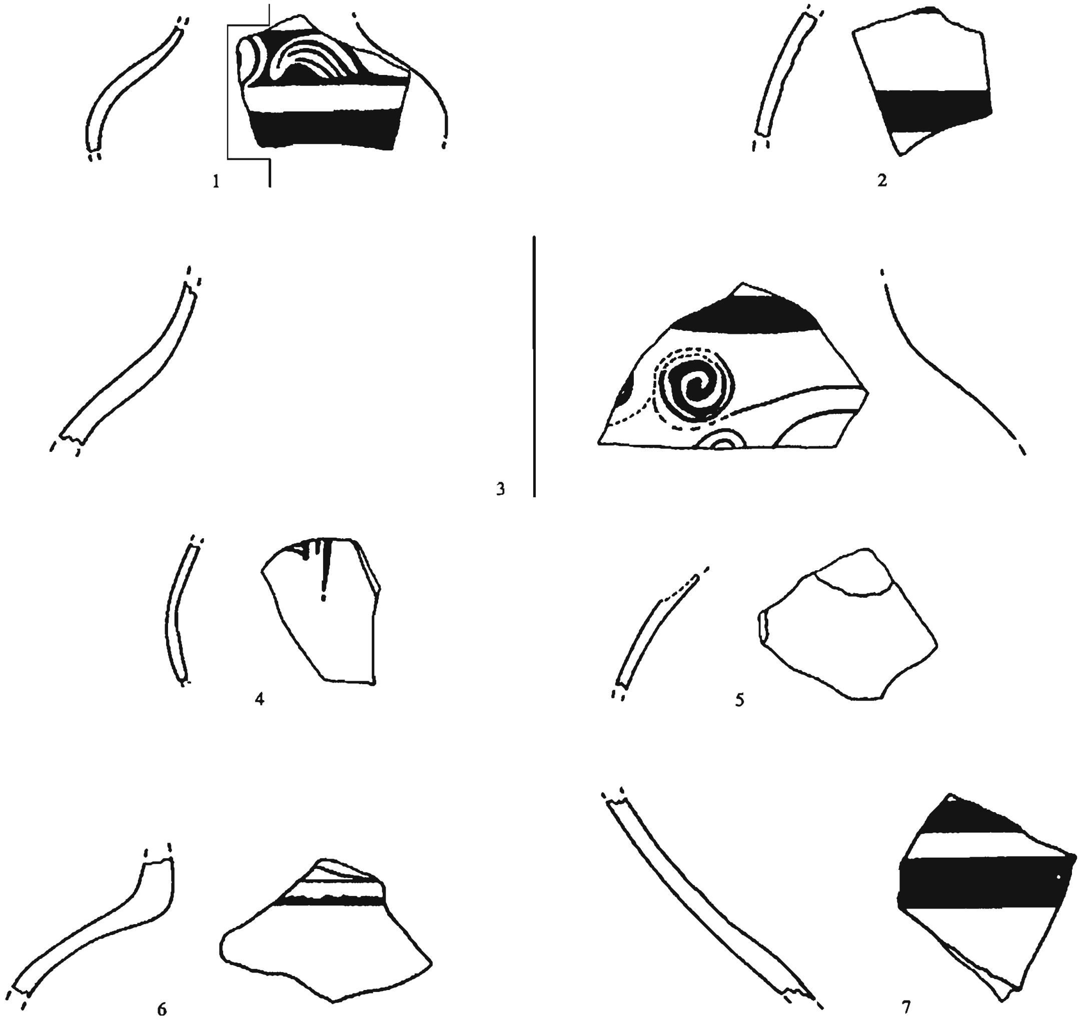


Fig. 2 – Mycenean sherds from Fondo Paviani (1, 2), Fabbrica dei Soci (3, 4, 6, 7), Castello del Tartaro (5). Scale 1:2.

Through the integrated study of data gathered from the earliest investigation and from current research, four main phases have been detected within the overall occupation of the site.

Phase 1: a pre-bank settlement (possibly *palafitta*-like dwellings but apparently in an already dry, non-wetland setting) with a spatial extent probably coinciding with that of the following phase.

Phase 2 and 3: two main sub-phases of occupation related to the newly

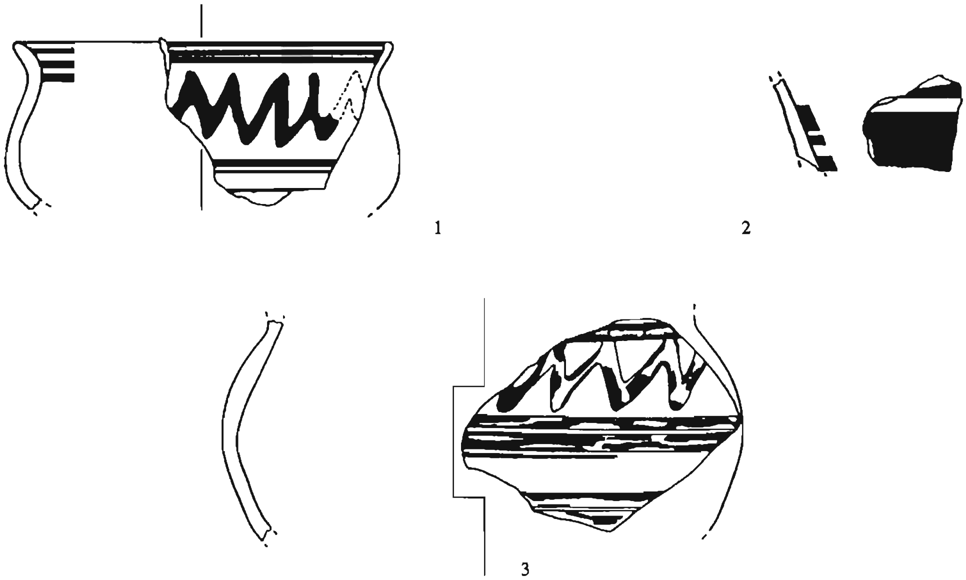


Fig. 3 – Mycenean sherds from Frattesina (1, 2) and Montagnana (3). Scale 1:2.

built bank-settlement (radiometric dates from under the bank and at the beginning of the bank-phase overlap, providing a close time span for its construction).

Phase 4: after abandonment (at the end of the Recent Bronze Age), flooding processes have been identified, dating to the beginning of the Iron Age.

The main structural/infrastructural features are: a) the bank and ditch settlement structure (terramara). The bank (c. 13 m. wide; 2 m. max. surviving height), with its rectangular shape (with rounded corners) and traces of a possible gate in the southwestern side, enclosed an area of ca. 11 ha. Its external ditch was ca. 40 m wide, only partially investigated, up to 2 m max depth; b) a trapezoidal 'enclosure' attached to the main bank and ditch complex on the eastern side, delimited by a smaller scale bank and ditch combination and enclosing an area of ca. 8 ha. This may have been a multifunctional activity area, possibly used for intensive agriculture, storage, breeding, specialized production; c) a 'near site' network of small drainage channels. The whole seems to suggest intensive (basically horticultural) agriculture, relying also on extensive use of manuring; d) an "off-site" network of drainage channels, extending over a large area, the layout of which clearly points to a true structured agricultural landscape, with regular patches of drained fields.

Occupation starts in the Middle Bronze Age 3A-Recent Bronze Age 2, with possible earlier start (Middle Bronze Age 2) for the pre-bank phase.

Two radiocarbon dates (Whitehouse 1997) refer to phases 2 and 3: OxA-5492: c. 1525-1419 cal BC [1σ] (under the bank); OxA-5493: c. 1520-1419 cal BC [1σ] (beginning of the bank-phase).

One plain wheel-made sherd compatible with Mycenaean technology and quality: **CTA1** (Fig. 2:5), surface find by C. Balista (in 1992), in the inner site area, next to the bank along its S side, associated with overfired impasto material; possibly "post-bank" phase.

Bibliographical references: Salzani 1989a; Tozzi, Harari 1990; Bagolan *et al.* 1997; Balista, De Guio 1997; Balista *et al.* 1998; De Guio *et al.* 1999.

D) *Frattesina, Fratta Polesine (RO)*

Inland site, located along the south bank of an ancient river bed of the Po (*Po di Adria*). Reference map: IGM 1:25.000 F° 64 III SE (Rovigo); Latitude: 45° 01' 21" N; Longitude: 0° 47' 54" W; Height a.s.l.: 6.

Discovered in 1967, after deep agricultural activity. Surface investigation and soundings have been carried out (1968-1973) by Centro Polesano di Studi storici, Archeologici ed Etnografici (Rovigo). From 1974 to present systematic research and excavation of the site is in progress by the Soprintendenza alla Preistoria e all'Etnografia and the Soprintendenza Archeologica del Veneto, under the direction of A. M. Bietti Sestieri. In 1978 geophysical prospection and deep cores were carried out by Fondazione Lerici. Two nearby necropolises have been identified and excavated: fondo Zanotto, located to the E-SE from the settlement, by M. De Min in 1979; fondo Chinaglia, location Le Narde to the NW of the settlement, beyond the ancient river bed, excavated between 1985 and 1989, by L. Salzani.

The site is probably the major one of a series of settlements located along the south bank of the ancient *Po di Adria*. The supposed settlement extent is ca. 20 ha, although the explored section is limited to ca. m. 800 × 200.

Three chronological phases have been recognized during the settlement excavation and a fourth one (the earliest) is surmised through the typology of material from surface collection, preserved in the Rovigo Museum. Their range falls within the Final Bronze Age and the Iron Age. Absolute dates reported here refer to traditional chronology, pending radiometric dates[3].

[3] A mention of C14 dates for the site can be found in Anzidei, Bietti Sestieri 1984, 103, where a chronology between 1020-660 B.C. is reported. However, no detailed report of these dates seems to be known.

Phase 1: Early Protovillanovan (late 12^{th} cent. B.C.). Known only through museum material. The excavation has not yet investigated the deepest layers.

Phase 2: Protovillanovan (11^{th} – first half 10^{th} cent. B.C.). Earliest layers of the settlement and part of the tombs in the Zanotto necropolis; Narde necropolis. Dwellings of this phase are small structures (ca. 4 × 6 m) thickly distributed over the entire settlement.

Phase 3: Late Protovillanovan to Iron Age (second half 10^{th} cent. B.C.- first half 9^{th}). In the settlement this layer is separated from the previous one by a sandy alluvial deposit. Large structures are built above the sandy alluvial deposit which seals the remains of the previous phase. Several tombs of the Zanotto necropolis and scanty surface remains of Le Narde necropolis.

Phase 4: Iron Age (second half 9^{th} – early 8^{th} cent. B.C.). Identified in the settlement, during 1989 investigation, thanks to remains of a palisade(?) and substantial remains of wattle and daub belonging to structures.

The site is characterized by several specialized craft productions related to local and imported materials, such as metal, bone and antler, amber, ivory, vitreous materials (including glazed pottery). Fragments of ostrich eggs are also present. Such activities and materials show intense connections with the Eastern Mediterranean, the north Adriatic area, the East Alpine region and Etruria, through a medium and long-distance trade network.

Two Mycenaean sherds: **FRA1** (Fig. 3:1) from surface; **FRA2** (Fig. 3:2) found during 1974 excavation.

Bibliographical references: many publications prior to 1986 are collected in *Padusa* 20, 1984 (publ. 1986) under the title *Preistoria e Protostoria del Polesine* (abbr. *Pr.Prot.Polesine*). Bietti Sestieri 1982; 1990; 1996, 274-77; 1997; Anzidei, Bietti Sestieri 1984; De Min, Gerhardingher 1986; Salzani, 1987; 1989b; 1990-91; Bellintani 1992; 2000; Arenoso Callipo, Bellintani 1994; Pearce 2000.

E) *Borgo San Zeno, Montagnana (PD)*

Inland site, located on the north bank of the Palaeo-Adige river, marked by dunes, to the E-SE of the medieval town of Montagnana. Reference map: IGM 64 IV SO (Montagnana). Latitude: 45° 13' 46" N; Longitude: 0° 58' 38" W; Height a.s.l.: 13.

Discovered in the seventies after deep agricultural works. Chance finds, rescue excavations and stratigraphic soundings have been followed by systematic archaeological exploration 1988-1995 and deep core soundings (1989, 1992).

Large settlement site (maximum extension ca. 65 ha). Three main phases have been identified, covering a long span of time from the Middle Bronze Age to the Early Iron Age. Absolute dates reported here refer to traditional chronology, pending radiometric dates.

Phase 1: the earliest archaeological evidence goes back to the Middle and Recent Bronze Age. Remains of dwelling structures, outlined by post-holes, small channels and shallow foundations for wooden structures. Site's occupation is interrupted before the end of the Recent Bronze Age, by an overflow of the Palaeo-Adige river.

Phase 2: Final Bronze Age and Early Iron Age (11^{th}-9^{h} cent. B.C.). The settlement is characterized by three main reconstruction/refurbishment sub-phases. Two types of structure have been identified: a) rectangular dwelling structures, ca. 6 × 7 m, each with a hearth located in central position; b) workshop areas, with large working clay platforms and pottery kilns. There is evidence for craft specialization related to pottery production and bone and antler manufacture. Evidence for metalwork is given by a number of stone moulds.

The range of finds place the site in close relation to Frattesina and to other sites located along the River Po, in easy communication with the Adriatic coast.

Phase 3: Iron Age (late 9^{th}-early 8^{th} cent. B.C.) The site is abandoned as a consequence of flooding by the Palaeo-Adige river.

Funerary areas have been located at various spots and are mainly dated to the Final Bronze Age. Both inhumation and cremation are represented. In the Early Iron Age the main funerary area is the Ca' Nogare necropolis (cremation), located across the Palaeo-Adige river bed, on its south bank.

One Mycenaean sherd: **MON1** (Fig. 3:3), from surface.

Bibliographical references: De Min, Bietti Sestieri 1979; Bietti Sestieri 1982, 203; Bianchin Citton *et al.* 1998, 233-446 (with detailed bibliography).

(A.D.G., L.V.)

3 – The Mycenaean pottery. Catalogue and comment

Fondo Paviani

FPA1 (Fig. 2:1). Sherd from a closed vessel (juglet or small jar). Very fine grey-greenish clay. Black, non-lustrous paint, very worn. Two bands on the shoulder; series of concentric semicircles, reserved on the upper band. H. 4.4; w. 3.8; th. 0.2/0.25; max. est. diam. 9.4. Legnago, Museo Civico, inv. 36171. Vagnetti 1979; 1982, 208; 1996, 179, fig. 1:1; Bettelli, Vagnetti 1997, fig. 356:1.

FPA2 (Fig. 2:2). Sherd from a closed vessel. Buff-pinkish clay (5YR7/4) with micaceous inclusions. Pale yellow slip (10YR8/3); two horizontal bands in brown paint (10R5/6). H. 3.9; w. 3.8; th. 0.4. Legnago, Museo Civico.
Vagnetti 1996, 179, fig. 1:2; Bettelli, Vagnetti 1997, fig. 356:2.

Fabbrica dei Soci

FDS1 (Fig. 2:3). Two joining sherds from a closed vessel, part of the shoulder and neck base. Pale brown clay, whitish slip, orange paint. Horizontal band at neck base, two rows of running spirals on the shoulder. H. 5.2; w. 7.4; th. 0.4/0.7; max. pres. diam. 25.
Salzani 1988, 262, fig. 10; Vagnetti 1996, 179, fig. 1:3; Bettelli, Vagnetti 1997, figs. 356:3, 357.

FDS2 (Fig. 2:4). Two joining sherds from a closed (?) vessel. Buff clay with micaceous inclusions and grey core (7.5R6/4). Whitish, powdery slip (5YR8/2) and trace of painted decoration in reddish colour (10R5/6); undetermined angular pattern. H. 3.7; w. 3; th. 0.3.
Vagnetti 1996, 179, fig. 1:4; Bettelli, Vagnetti 1997, fig. 356:4.

FDS3 (Fig. 2:6). Sherd from a closed vessel; lower part of the body. Buff-pinkish clay, slip of the same colour. Two horizontal bands in orange-brown paint. H. 7.5; w. 4.5; th. 0.5/0.6.
Vagnetti 1996, 179, fig. 1:7; Bettelli, Vagnetti 1997, fig. 356:7.

FDS4 (Fig. 2:7). Sherd from a closed vessel, neck base and part of the shoulder. Buff clay, cream-yellow slip, powdery and worn. Band of brown paint at neck base. H. 5.7; w. 5.5; th. 0.5/0.9.
Vagnetti 1996, 179, fig. 1:6; Bettelli, Vagnetti 1997, fig. 356:6.

Castello del Tartaro

CTA1 (Fig. 2:5). Sherd from a closed vessel, with handle attachment; part of the shoulder. Buff porous clay (7.5YR7/2) with micaceous inclusions; very pale surface (7.5YR8/2); no slip, no decoration preserved. H. 3.9; w. 4; th. 0.2/0.4.
Vagnetti 1996, 179, fig. 1:5; Bettelli, Vagnetti 1997, fig. 356:5.

Frattesina

FRA1 (Fig. 3:1). Inv. 149500. Cup with S-shaped profile, everted lip, rounded rim, handle attachment on the rim. Very fine pale grey-whitish clay (10YR8/2) with micaceous inclusions and powdery surface; brown paint, very fugitive (10YR3/1 to 4/3). Rim decorated with group of thin bands, three outside and four inside; other groups of thin bands along and under the maximum diameter. Large zig-zag pattern under the lip. Ca. one third preserved; broken near the handle attachment. H. 4.9; w. 6.9; th. 0.5/0.6; rim diam. 11.3.
Bietti Sestieri 1982, pls. 76:1, 77:1-2 left.

FRA2 (Fig. 3:2). Inv. 149501. Sherd from an open vessel with slightly convex wall. Buff-orange clay with some micaceous inclusions (2.5YR6/8); brown-orange lustrous paint (2.5YR5/8). Horizontal bands of various thickness on both surfaces. H. 2.5; w. 2.7; th. 0.45/0.6.
Bietti Sestieri 1982, pls. 76:2, 77:1-2 right.

Montagnana

MON1 (Fig. 3:3). Sherd from a closed vessel of globular shape; part of the shoulder and neck base. Very fine pale grey-whitish clay (10YR8/2), with micaceous inclusions and powdery surface. Brown paint, very fugitive (10YR5/3 to 7.5YR4/3). Large zig-zag pattern on the shoulder, between a band at neck base and a group of two bands at the maximum diameter. Two more bands at the lower limit of the sherd. H. 6.1; w. 8.2; th. 0.4/0.5; max. est. diam. 15.4.
Vagnetti 1998, 329-30, figs. 192-93.

From a typological point of view the ten fragments considered here are mostly undiagnostic; only four of them offer a typological and, tentatively, a chronological classification. In particular **FPA1** belongs to the shoulder of a small closed vessel, probably a juglet, decorated with a series of reserved concentric semicircles on a dark band. Shape and pattern are ubiquitous, but the special technique of reserving the pattern against a dark background finds frequent parallels at Perati in LH IIIC middle (Iakovidis 1969-70, II, figs. 64:24-26, 29, 45; 107:366; 110: 412, 916; 112:460; Mountjoy 1999, fig. 222:455).

A similar date is suggested for the sherd **FDS1**, belonging to a large amphora or to a collar-necked jar. The pattern, composed of rows of running spirals, finds a parallel at Phylakopi on Melos, in LH IIIC middle (Mountjoy 1999, fig. 376:186).

FRA1 and **MON1** are very similar in quality and in decoration. A tight zig-zag pattern, carelessly drawn in fugitive light brown paint, is the main decoration on both the pieces. Although the zig-zag pattern is very common on Mycenaean pottery over a long span of time, one can quote some pieces displaying a closer similarity to the two examples under discussion. First of all, the pattern appears on a number of pieces from Porto Perone (Taylour 1958, tav. 14:23; Fisher 1988, figs. 35:231; 37:241), Coppa Nevigata (Belardelli 1993, fig. 1:4) and from Broglio di Trebisacce (Bettelli 2002, fig. 66:54). In Greece an amphoriskos from Delphi, attributed to LH IIIC early (Mountjoy 1999, fig. 303:175) and some later pieces from the Ionian Islands are the closest parallels for the Montagnana sherd (*ibid.*, fig. 163:25; Benton 1938-39, tav.5:39a; Souyoudzoglou-Haywood, 1999, pl. 3:1142). The type of very tight zig-zag pattern is frequent also in Crete (Sackett, Popham 1965, figs. 8:a-d, 9:a-c).

In general, all the proposed parallels fall within the LH/LM IIIC, with a bias towards the middle (Fondo Paviani and Fabbrica dei Soci) and late phase (Frattesina and Montagnana), which is generally consistent with the Final Bronze Age. Most of the pieces are surface finds which does not offer a very sound base towards the chronological correlation with the local sequence.

The group of sites to the west (Verona province) belong to the bank and ditch type, differentiatied from the typical Terramare area. These sites have their *floruit* in the recent Bronze Age and come to an end, either at the end of the period or at the very beginning of the Final Bronze Age (Bagolan *et al.* 1997; De Guio 2000). Traces of specialized craft activities, partially related to exotic raw material (amber, glass etc.) characterize these sites as the forerunners of sites, such as Frattesina, located more to the East, in the Polesine region, which are thriving in the Final Bronze Age.

(L.V.)

4 – Chemical analysis

The purpose of the chemical analysis was to determine the sources of the Mycenaean pottery in question. This investigation, which has formed part of the long-standing component of the study of Mycenaean and Aegean-type pottery in Italy involving laboratory analysis (Jones *et al.* 2002), began a number of years ago when Jones and Vagnetti (1991, 134, 139; 1992) reported the results of analysis of three of the sherds studied here, those from Frattesina and Montagnana. The reference material for the present study consisted mostly of examples of the contemporary hand-made burnished ware (Impasto) whose petrographic characterisation is described in the following section. That the Impasto has a fabric that is coarser textured than that of the Mycenaean sherds creates something of a problem, but this is partly obviated by the inclusion in the chemical reference group of some clay[4] and daub samples having a finer clay. Ideally clay prospection would have been carried out on a systematic basis, but this was unfortunately not possible and indeed may well be a fruitless task without recourse to coring because the surface deposits of clay available at the end of the Bronze Age will have long since been buried by later sedimentation in the valley. This issue, already discussed by Jones *et al.* (2002, 175), together with that of the small number of individual samples places limitations on the level of

[4] Clays have been collected near the site of Stanghelle, 1 km NW from Fabbrica dei Soci, with the assistance of the geoarchaeologist Claudio Balista.

interpretation that it is possible to make from the chemical data: the present study is perforce preliminary, and its results will hopefully guide the priorities of subsequent work. As regards those regions beyond the Po valley in Italy that were regarded at the outset to be potentially relevant to this work for comparative purposes, there were chemical reference data sets for Apulia (Jones 1993; Jones, Levi 2002), the Plain of Sybaris (Jones *et al.* 1994; Jones 2001) and to a lesser extent central Italy (Jones *et al.* 2002). For Greece, large data banks for Mycenaean pottery obtained by different laboratories were available from sites and regions throughout the Peloponnese, many parts of central Greece, as well as the Ionian Islands.

Material

The Mycenaean sherds (termed below the test material) are listed and described above in § 3. Impasto, daub and clays (termed below reference material) are listed and briefly described in Table 1. The former were small in size and were sampled by breaking off a small fragment from each sherd which was then cleaned of any weathered layer or decoration before grinding to powder in an agate mortar; the yields were 100mg or less, that is half the amount that would normally be taken by the present analysts. By contrast, the reference samples presented no such problem: several hundred mg of the reference samples were prepared in the same manner with ease.

The data sets for comparative pottery from Greece, which appear in Table 3, are in two forms: composition groups recently derived from neutron activation analysis (NAA) data for mainly Mycenaean pottery including material of LH IIIC date and probable local manufacture from sites in the western Peloponnese (see below), and from previously unpublished atomic absorption spectrometry (AAS) data for Mycenaean pottery of likely local manufacture, selected by Dr K.A. Wardle (Jones, Vagnetti 1991, 135), from LH IIIC chamber tombs on Kephallonia, and from Thermon and Astakos, Grabes.

Analysis

Two techniques of chemical analysis have been employed:

(1) atomic absorption spectrometry (AAS) for three test samples from Frattesina and Montagnana, carried out in the Fitch Laboratory, British School at Athens, and whose results have previously been reported (Jones, Vagnetti 1991; 1992). The samples were dissolved with the lithium metaborate fusion method, calibrations were prepared with six ceramic standards, and the concentrations of ten elements in their oxide form were determined (Liddy 1989; 1996, 466-71).

Site	Sample	Ware	Description and provenance
Fondo Paviani	FPA3	Impasto	decorated jar with everted rim (ISPF27), US6 m22-23
Fondo Paviani	FPA4	Impasto	cup with handle (ISPF14), m50 lower
Fondo Paviani	FPA5	Impasto	carinated cup (ISPF15), US25 m44-45
Fondo Paviani	FPA6	Impasto	deep bowl with cordon (ISPF18), US25 m44-45
Fondo Paviani	FPA7	Impasto	large everted rim decorated (ISPF21), m50 upper
Fabbrica dei Soci	FDS5	Daub	cluster A
Fabbrica dei Soci	FDS6	Impasto	cup with handle (ISPF234), context ζ cluster Z
Fabbrica dei Soci	FDS7	Impasto	ovoid jar (ISPF239), context ζ cluster Q
Fabbrica dei Soci	FDS8	Impasto	bowl (ISPF240), context ζ cluster Q
Fabbrica dei Soci	FDS9	Impasto	large everted rim decorated (ISPF278), context μ cluster B
Castello del Tartaro	CTA2	Daub	
Castello del Tartaro	CTA3	Impasto	carinated cup
Castello del Tartaro	CTA4	Impasto	bowl with cordons
Castello del Tartaro	CTA5	Impasto	biconical vessel decorated
Castello del Tartaro	CTA6	Impasto	cooking pot?
Frattesina	FR1-6, 10-18, 20	Impasto	US5/NO II2
Frattesina	FR7	Daub?	pyramid, US5/NO II2
Frattesina	FR8, 9, 19	Daub	US5/NO II2
Canova	CAN1	Impasto	large everted rim decorated, ISPF56
Canova	CAN2	Impasto	rim of a jar, ISPF57
Canova	CAN3	Impasto	simple cordon, ISPF66
Canova	CAN4	Impasto	carinated cup, ISPF19
Canova	CAN5	Impasto	everted rim, ISPF18
Stanghelle	LAG2, 3	Clay	

Table 1 – Reference impasto pottery and daub analysed chemically from sites in the Po Valley.

(2) Instrumental neutron activation analysis (NAA) carried out at the Scottish Universities Research & Reactor Centre (SURRC) at East Kilbride in 1994-95, using the analytical technique described by Topping, Mackenzie (1988); calculations leading to the determination of elemental concentrations were using the SURRC programme NAA of Harris (1982). As a control on inter-sample variability in neutron flux, iron wire or foil (Specpure) was placed between each sample vial for irradiation and corrections were made on the basis of induced activity of Fe^{59}. The following elements were determined: Na, K, La, Sm, Cr, Fe, Co, Rb, Sb, Cs, Ce, Eu, Tb, Lu, Hf, Ta, U, Sc and Yb. The three samples analysed in (1) were re-analysed by NAA in 1997, this time the irradiation being made at the Imperial College London's swimming-pool type 'Consort' reactor at Silwood Park, Ascot, using the in-core irradiation system (ICIS) with a typical flux of 1×10^{12} n/cm^2/sec; this was followed by gamma-ray spectroscopy at SURRC, as previously described.

Throughout the NAA programme, two well-characterised ceramic standards, the Edinburgh (Topping, Mackenzie 1988) and Podmore

(Hoffmann *et al.* 1988) clays, were employed in each batch of thirteen samples. One reason for adopting the latter standard was to test the comparability with NAA data (for the common elements) generated by the group from the Chemistry department at Manchester University which has already established comparability with the large Asaro-Perlman NAA database (from Berkeley, California) for mainly decorated Mycenaean pottery made at Late Bronze Age centres throughout the Peloponnese and beyond (Tomlinson 1997). This issue is still being monitored and its results reported more fully elsewhere (Vagnetti *et al.* in prep.), but for the present the compositions of the Podmore standard analysed in the two laboratories seem to be sufficiently similar to allow the present dataset *cautious* access to the Asaro-Perlman database. This is an important development since another NAA laboratory, that at Bonn University, which also makes extensive use of the Asaro-Perlman database (Mommsen *et al.* 2002), has made recent, valuable extensions to that database. As regards the elements common to NAA and AAS, Jones (*et al.* 1995) has found acceptable comparability at a simple, univariate level.

The composition data, either in natural form or normalised to the scandium content to filter out anomalies introduced by differences in texture (Aitchison 1986), were examined by univariate and various multivariate methods (cluster analysis by Ward's method and principal components analysis), using initially MV-Nutshell (Wright 1994) followed by the SYSTAT statistical package. Classification of the test and reference sample compositions from the Po valley is presented in the form of a PC plot. The compositions of the test samples were then compared individually, element by element, with the characteristics of the reference groups outside the Po valley (Table 3), the intention of this exercise being to identify either trends in similarity or, more easily, what could be said to be significantly dissimilar. The absence of Ca, Mg and Mn determinations by NAA in all the test samples meant that the extent of comparability with the AAS data sets was limited to only four elements, Na, K, Fe and Cr.

Results

The chemical compositions of the test and reference samples are given in Table 2. Taking the suite of elements determined by AAS first, **FRA1** and **MON1** are similar in composition, bearing the distinctive features of very high calcium and low iron contents which together are likely to be responsible for the very pale fabric colour. **FRA2**, on the other hand, has lower calcium and higher iron and aluminium contents. The chromium and nickel contents of all three samples are low.

Treating collectively the NAA compositions of all the test and reference samples, three groupings were identifiable in the dendrogram from Ward's method cluster analysis, following Sc normalisation: (a) a group made up entirely of material from Frattesina with negative and positive scores on the first and second principal components (PCs) respectively, (b) three Aegean-type samples, two from Fabbrica dei Soci (**FDS3** and **FDS4**) and one from Fondo Paviani (**FPA2**) with negative scores on both PCs, and (c) a rather ill-defined grouping made up of the remaining samples, with one Impasto from Canova, **CAN3**, appearing as an outlier owing to anomalous Eu, Fe, Hf, K, La, Lu and Ta contents. These three groupings retain their identity in the PC plot (Fig. 4a) which was run in the absence of **CAN3**. Interestingly, the relationship between **FRA1** and **FRA2** and **MON1** which all belong to (c) indicates that the distinctions made above in terms of their major element contents do not seem to extend to the trace elements.

The compositions of the reference material, which are quite varied, form the loosely defined group (a and c in Fig. 4a). This relative variability should not cause surprise in the light of the petrographic compositions (described in the following section) which are indicative of a number of hand-made pottery traditions operating in the region. More specifically, the different tempering recipes are reflected chemically as the examples of the grog tempered and calcareous fabrics classified separately from each other and from the untempered fabric in the cluster analysis dendrogram. Looking beyond the present study area, similar chemical (major/minor rather than trace element composition) variability has been found in Impasto and raw materials from sites on the southern flank of the Po Valley: MBA-RBA Impasto from two sites close to Imola (Amadori *et al.* 1996) and Impasto and clay/soil from four sites near Modena (Levi, Ghittoni 1997). NAA compositions of four Roman sherds from Corte Cavanella (Rovigo; fig. 1) published by Calogero (1986) paint a similar picture. As a result of the range of raw materials used in making Impasto, it is notable that whereas the Frattesina reference group stands apart chemically from the other sites, for instance in having higher chromium contents, the latter are scarcely, if at all discriminated from one another. No explanation can as yet be made of this unexpected chemical differentiation of Frattesina from the other sites.

Some of the Mycenaean sherds – **FDS2**, **FPA1**, **CTA1** as well as **FRA1**, **FRA2** and **MON1** – form a loose grouping encompassing Group (c) that is the local reference material from all the sites with the exception of Frattesina. As such, they could in principle be classified as products of the valley, albeit not from clays exploited in the vicinity of Frattesina for Impasto production. However, as inspection of the individual compositions in Table 2 reveals, this resemblance is superficial: Ce, Cs, Hf, La, Th and Ta

A

Sample	Class	Al	Ca	Mg	Mn	Ni
FRA1	M	14	30	1,2	1080	100
FRA2	M	24,2	10,4	2,0	790	140
MON1	M	13,4	30	1,4	1100	120

Table 2 – The compositions of the samples arranged according to class. M: Mycenaean, I: Impasto, C: clay/silt, D: daub. Al, Ca, Mg, Fe, Na and K are expressed as % element, the remainder as ppm of element.
A. AAS data. The compositions of the test samples from Frattesina and Montagnana were first published in element oxide form (Jones, Vagnetti 1992). B. NAA data.

B

Sample	Class	Ce	Co	Cr	Cs	Eu	Fe	Hf	K	La	Lu	Na	Th	Rb	Sc	Sm	Ta	Tb	Yb	Sb
FPA1	M	55,0	12,8	97	6,83	1,24	3,30	3,75	1,80	26,4	0,4	0,54	13,03	117	12,3	6,48	1,17	0,88	2,71	1,01
FPA2	M	71,5	33,8	357	7,54	1,78	7,36	4,94	2,12	38,2	0,6	0,45	17,81	150	27,5	9,01	1,49	1,20		1,78
FDS1	M	44,2	23,2	71	3,59	0,90	2,76	2,06	0,90	22,5	0,4	0,28	9,02	64	9,8	3,67	0,68	0,52	1,57	0,90
FDS2	M	69,6	19,2	101	5,81	1,29	3,70	3,33	1,40	34,4	0,5	0,52	12,02	104	13,3	5,40	1,03	0,96	2,74	0,82
FDS3	M	62,9	23,8	300	7,01	1,23	5,09	4,06	2,18	33,8	0,6	0,83	13,04	153	22,7	5,95	1,10	1,09	3,00	1,08
FDS4	M	75,9	31,5	328	7,36	1,47	6,94	4,34	2,51	37,9	0,7	0,93	16,54	162	27,9	9,16	1,42	1,23	2,57	1,06
CTA1	M	60,7	29,0	95	5,48	1,22	3,29	3,02	1,16	28,5	0,3	0,40	12,58	90	12,8	5,65	1,09	0,84	2,62	0,73
FRA1	M	61,0	9,0	113	4,70	1,07	2,82	2,87	1,84	31,8	0,3	0,48	10,88	106	12,3	3,93	1,11	0,74		1,28
FRA2	M	70,6	14,1	138	8,23	1,44	4,52	4,97	3,16	36,4	0,4	0,84	15,42	155	15,8	6,13	1,55	0,86		
MON1	M	55,1	11,1	100	4,98	1,12	2,45	2,76	1,66	27,2	0,3	0,48	10,73	111	10,9	4,13	0,95	0,74		0,83
FPA3	I	79,5	15,8	136	8,92	1,63	4,02	6,26	2,15	44,2	0,6	0,94	15,99	168	16,6	7,49	1,43	1,07	3,29	1,05
FPA4	I	99,1	22,0	195	15,70	2,15	6,49	6,91	2,48	48,9	0,8	0,69	21,08	245	23,0	9,13	1,98	1,49	3,88	1,59
FPA5	I	81,7	36,8	139	9,51	1,42	4,95	6,21	2,27	41,6	0,6	0,70	16,19	181	17,0	6,80	1,37	1,02	3,31	1,16
FPA6	I	48,7	30,3	95	6,86	1,01	3,23	3,15	1,72	27,7	0,4	0,56	11,02	104	11,9	4,96	0,94	0,69	2,10	1,08
FPA7	I	95,3	19,4	145	8,60	1,79	5,13	6,48	2,05	44,1	0,5	0,54	17,07	171	18,6	7,61	1,31	1,32	2,83	1,20
FDS5	D	81,6	14,1	93	9,62	1,69	3,62	5,88	2,68	41,3	0,6	1,38	15,74	160	15,8	6,96	1,34	1,01	3,10	0,60
FDS6	I	89,7	30,3	155	9,28	1,89	5,13	5,98	2,08	48,0	0,7	0,67	17,25	165	18,3	10,51	1,76	1,12	3,68	0,96
FDS7	I	73,7	34,1	107	7,15	1,63	3,75	5,58	1,99	38,3	0,6	1,04	16,32	159	15,2	7,05	1,28	1,17	2,94	0,88
FDS8	I	79,9	24,8	145	9,33	1,87	5,65	4,53	1,91	47,4	0,7	0,53	15,81	157	18,2	11,25	1,44	1,19	3,64	0,98
FDS9	I	95,7	20,1	172	9,98	1,97	5,65	4,88	2,09	46,6	0,5	0,43	17,85	173	21,1	8,32	1,49	1,44	3,05	2,01
CTA2	D	69,5	26,1	90	6,46	1,37	3,57	4,22	1,92	33,1	0,4	0,68	14,13	129	13,8	6,00	1,25	1,09	2,49	0,79
CTA3	I	96,2	19,9	106	9,68	1,73	4,46	7,48	2,19	45,5	0,6	1,19	19,11	195	17,9	8,03	1,52	1,31	3,74	0,90
CTA4	I	55,4	13,8	128	6,52	1,28	3,27	2,82	1,12	27,9	0,4	0,25	11,25	114	13,5	5,52	0,97	0,77	2,45	0,72
CTA5	I	90,7	23,3	146	9,55	1,76	4,98	7,28	1,98	45,1	0,6	0,84	19,37	182	18,9	8,11	1,53	1,33	4,11	1,27
CTA6	I	94,5	23,1	136	9,97	1,94	4,93	6,75	2,49	49,5	0,5	0,85	17,27	172	18,7	8,59	1,57	1,33	2,67	1,06
FR1	I	68,9	20,1	241	7,71	1,24	3,59	4,03	2,70	28,6	0,4	1,16	13,90	181	16,5	7,11	1,03	1,04	2,08	2,34
FR2	I	76,0	29,6	274	9,22	1,38	5,02	3,82	2,50	34,5	0,4	0,83	16,73	213	20,2	5,84	1,32	1,20	2,34	2,34
FR3	I	86,2	26,3	299	11,46	1,62	5,39	3,80	2,86	38,5	0,5	0,80	18,39	225	23,1	9,18	1,37	1,16	2.90	2,57
FR4	I	83,7	28,1	337	12,36	1,71	5,91	4,73	3,20	43,0	0,5	0,92	19,19	241	24,2	7,35	1,51	1,02	2,69	1,75
FR5	I	64,5	21,4	240	7,30	1,40	3,93	3,66	2,51	33,3	0,4	1,17	13,36	174	16,2	7,91	1,12	0,86	1,87	1,45
FR6	I	83,9	20,5	282	9,88	1,49	4,61	4,91	3,04	41,2	0,5	1,14	17,40	220	21,9	9,96	1,36	1,10	5,31	1,58
FR7	D	78,2	28,5	320	11,77	1,55	5,69	3,96	4,74	39,6	0,4	1,23	17,40	242	21,8	6,75	1,34	0,95	2,81	2,60
FR8	D	57,6	23,2	213	6,90	1,23	2,67	4,56	2,69	27,1	0,2	0,89	11,64	133	13,6	4,86	1,14	0,78		1,44
FR9	D	53,9	20,0	193	5,73	1,24	4,40	4,50	2,00	25,6	0,4	0,84	11,47	112	13,6	4,98	1,05	0,82	5,26	1,84
FR10	I	61,5	21,7	246	9,75	1,36	4,61	4,02	2,84	31,7	0,3	0,71	15,03	175	18,3	4,77	1,15	0,93		1,69
FR11	I	65,1	24,6	297	10,94	1,43	4,92	3,17	2,73	30,6	0,3	0,62	16,32	189	20,5	5,31	1,26	0,97		1,92
FR12	I	71,3	23,7	257	9,68	1,58	4,96	4,29	2,63	39,1	0,4	0,70	17,30	174	19,4	6,38	1,78	0,95	2,71	
FR13	I	68,6	19,6	255	10,42	1,40	4,10	3,95	2,90	31,7	0,4	0,76	15,47	183	19,1	5,52	1,30	0,85		1,07
FR14	I	69,7	21,9	259	11,06	1,39	3,75	3,70	2,54	39,2	0,3	0,77	15,88	186	19,1	6,13	1,35	0,90		1,40
FR15	I	59,9	22,9	226	9,61	1,32	3,64	4,04	2,58	37,3	0,3	0,84	14,57	177	18,0	4,71	1,23	0,82	4,83	1,49
FR16	I	65,0	22,7	300	11,10	1,44	4,38	3,82	3,10	41,3	0,3	0,85	16,81	189	20,3	6,17	1,23	0,81		1,52
FR17	I	48,3	16,8	208	8,21	1,22	3,13	3,46	2,64	28,4	0,3	1,01	12,34	157	14,8	4,70	1,03	0,49		2,22
FR18	I	62,3	26,5	272	10,12	1,30	4,65	3,33	2,53	36,7	0,3	0,75	15,01	184	19,2	4,60	1,29	0,81		1,89
FR19	D	50,9	28,1	198	6,92	1,21	3,44	4,51	2,36	29,5	0,3	0,92	12,24	142	14,6	5,01	1,05	0,78		1,41
FR20	I	65,0	23,2	254	9,76	1,31	4,50	3,74	2,60	36,5	0,3	0,71	14,95	182	18,7	5,71	1,25	0,76		1,43
CAN1	I	110,2	17,3	148	8,74	1,92	6,03	7,09	2,27	47,5	0,6	0,72	20,20	165	20,0	11,81	1,45	1,69	3,41	1,84
CAN2	I	94,2	17,0	147	7,62	1,97	6,56	7,18	2,96	53,8	0,6	0,80	18,72	151	19,7	13,07	1,59	1,42	4,05	0,90
CAN3	I	105,3	22,3	200	3,76	2,71	7,24	9,50	1,24	61,5	0,7	0,54	17,23	74	24,5	11,20	2,34	1,61	20,47	0,77
CAN4	I	71,7	20,0	195	9,24	1,52	6,33	5,23	2,35	39,9	0,4	0,69	16,16	173	18,5	7,01	1,44	0,96	3,14	1,09
CAN5	I	93,7	19,4	132	9,22	1,77	7,27	7,37	2,27	45,8	0,6	0,73	17,85	174	18,4	11,43	1,38	1,33	3,91	1,29
LAG2	C	91,4	13,8	104	8,44	1,57	4,25	7,25	2,28	40,3	0,4	1,24	15,93	137	16,4	9,49	1,37	1,10	2,25	1,25
LAG3	C	86,9	25,8	130	16,02	1,72	6,01	4,70	2,27	45,6	0,6	1,19	18,70	194	20,8	8,51	1,58	1,27	3,63	1,63

A

Group	Al	Ca	Mg	Fe	Ti	Na	K	Mn	Cr	Ni
Kephallonia										
Group A (12)										
x	7.0	5,5	1,2	4	0,6	0,73	1,59	316	286	102
s.d.	2.33	1	0,3	0,6	0,05	0,17	0,36	85	41	24
Group B (9)										
x	8,3	5,3	2,3	4,5	0,66	0,92	1,73	755	320	126
s.d.	1,7	2,4	0,3	0,9	0,05	0,38	0,51	123	48	16
Astakos, Grabes (10)										
x	7,7	5,1	2,7	5,7	0,38	1,17	2,86	1247	272	126
s.d.	1,1	1,6	0,3	1,3	0,11	0,46	0,56	270	20	16
Thermon (11)										
x	7,95	5,9	2,8	7	0,51	1,04	2,76	1224	286	141
s.d.	1,1	2,4	0,4	0,9	0,21	0,16	0,4	200	14	24
Kirrha (20)										
x	12,3	8,2	2,4	7,1	0,59	1,2	-	971	262	255
s.d.	1,3	2,3	0,4	0,8	0,71	0,3		180	48	73

B

Group	Al	Ca	Mn	Ni	Ce	Co	Cr	Cs	Eu	Fe	Hf
MBP (275)	8,31	9,53	925	212	62,2	28,8	243	9,06	1,19	5,33	3,62
S	4,3	14	8,2	12	2,7	5,2	8,2	7,6	7,5	3,7	13
ACHP (32)	8,03	5,55	971	220	61	28,3	274	6,48	1,26	5,41	4,15
S	4,1	32	17	12	4,3	5,4	6,8	9,6	6,3	3,4	10
THEP (24)	6,87	9,21	887	544	52,4	39,9	499	5,02	1,18	5,53	3,26
S	5	25	16	13	4,2	11	14	16	7,2	4,8	8,7

Group	K	La	Lu	Na	Th	Rb	Sc	Sm	Ta	Tb	Yb
MBP (275)	2,57	31,9	0,39	0,59	11	156	21,5	5,12	0,82	0,78	2,7
S	15	3,3	5,1	27	3	12	4	2,7	4,6	8,1	5,1
ACHP (32)	2,44	30	0,42	0,82	11	139	21,4	5,31	0,85	0,81	2,84
S	13	3,2	5,1	18	3,1	16	4	3,7	5,2	8,1	4,5
THEP (24)	2,18	24,8	0,34	0,54	8,41	111	20,7	4,43	0,76	0,71	2,28
S	14	4,4	6	17	5,8	14	2,5	3,5	9,6	11	4,4

Table 3 – Reference data: A. Composition characteristics (mean (x) and standard deviation (s.d.); percentage element except the trace elements in ppm) of groups of Mycenaean pottery from western Greece (AAS, Fitch Laboratory, Athens; previously unpublished, but see Jones, Vagnetti 1991, 135). B. Composition characteristics of NAA groups Mycenae-Berbati (MBP), Achaia-Elis (ACHP) and Thebes (THEP): mean and S (in % of mean). Number of samples in brackets. From Mommsen *et al.* 2002, Appendix 1(1) and 1(5).

contents are generally lower in the Mycenaean sherds than in the Impasto. More coherent similarity is to be found with groups of Mycenaean decorated pottery of probable local manufacture at sites to the south as shown in the PC plot and the Ward's method dendrogram of the relevant data (Figs. 4b

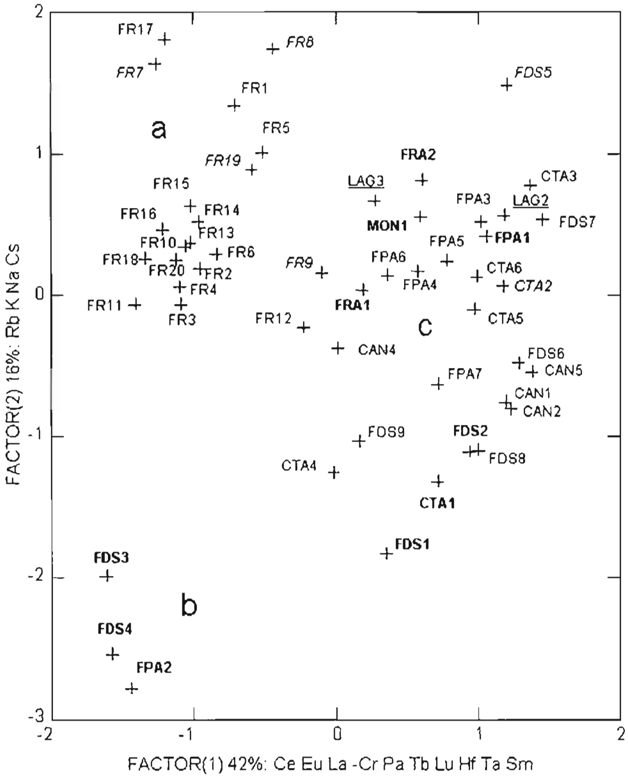


Fig. 4a – Principal Components analysis plot of the test and reference samples. Sc normalised data. PC1 and PC2 account for 42 and 16% of the total variance respectively. The elements loading each PC are indicated. Impasto: plain text, Mycenean: bold, daub: italic, clay: underlined.

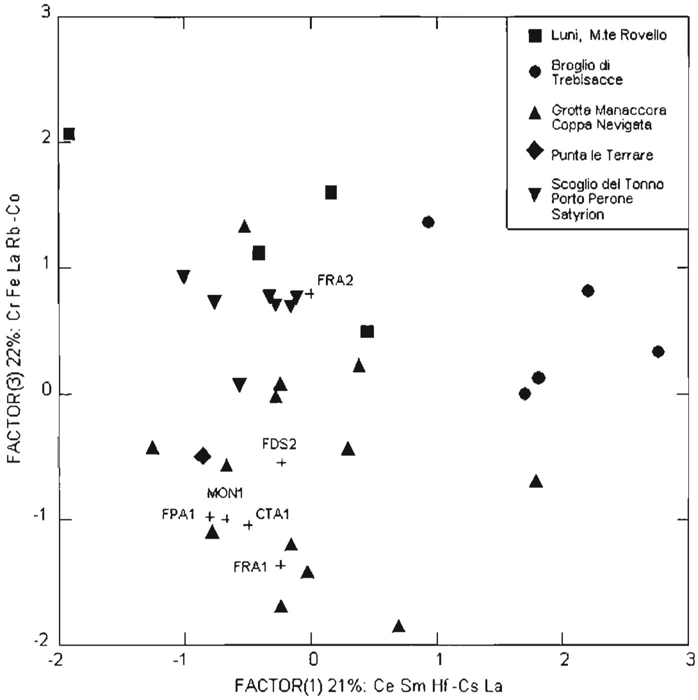


Fig. 4b – Principal Components analysis plot of the Mycenaean samples from the Po Valley (except FDS1) together with examples of decorated Mycenaean pottery, probably locally made in Apulia (Grotta Manaccora, Coppa Nevigata, Punta le Terrare and sites in the Taranto area), central Italy (Luni and M.te Rovello) and Calabria (Broglio di Trebisacce). PC1 and PC3 account for 21 and 22% of the total variance respectively. The elements loading each PC are indicated.

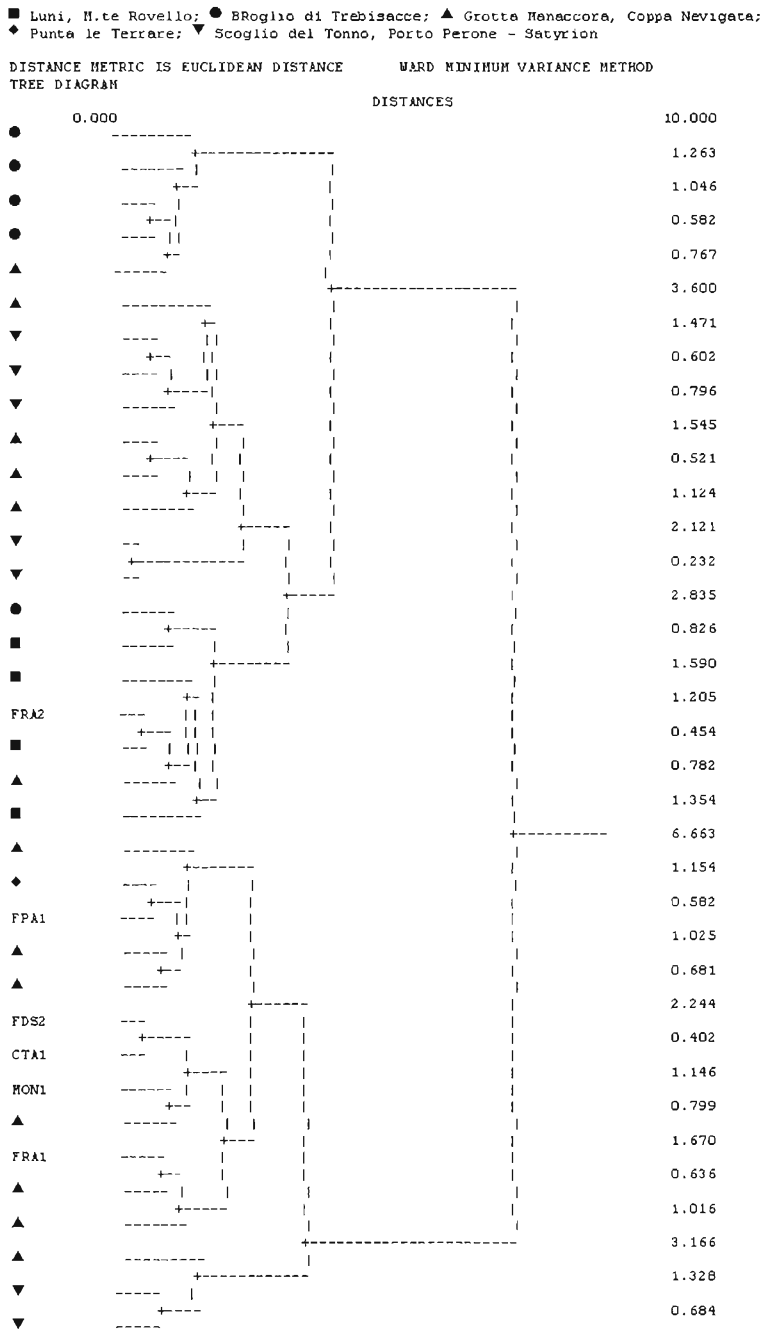


Fig. 5 - Dendrogram from Ward's method cluster analysis of the same data set as Fig. 4b.

and 5; see also Fig. 2 in Jones *et al.* 2002): bearing in mind that less than half the compositonal variance is represented in the former (Fig. 4b), **FDS2**, **FPA1** and **CTA1** relate to some of the Mycenaean material from Apulia (Coppa Nevigata and the Taranto area), and **FRA2** with material from Luni in central Italy, or even further south from the Plain of Sybaris in Calabria. **MON1** and **FRA1** also find resemblance with Apulia, a region where the fine-textured clays are known to be calcareous, albeit not as calcareous as in these two samples. The dendrogram (Fig. 5) bears out this picture. In sum, sources within the Po Valley cannot be excluded for these six Mycenaean sherds, but the balance of evidence points to the south. That leaves **FDS1** which has an anomalous composition since all the measured elements are in low concentrations. This sample is classified on the extremity of Group (c) in Fig. 4a, and was excluded from the classification leading to Figs. 4b and 5.

As for the three remaining Mycenaean samples, they can be treated together in the sense of their classification in Fig. 4a, yet visual examination of their individual compositions reveals that **FPA2** resembles **FDS4** more than **FDS3**. The fundamental point is that the character of their compositions, in particular their relatively high Cr, Co and Fe contents, brings them closer to the imported than to the local Mycenaean pottery found in southern Italy. There are some significant differences in composition, notably in Cr, Co and Fe, with, for instance, the locally or regionally made Mycenaean pottery from Apulia (Scoglio del Tonno, Porto Perone, Coppa Nevigata) (Jones, Levi 2002). Since a case can, therefore, be made to classify these three samples as Aegean, we can turn to the relevant reference data there (Table 3). Taking the AAS data from western Greece first, comparison with the two Kephallonia groups, although very limited in terms of the number of common elements, is not strong: the K and Fe contents are lower on Kephallonia. On the other hand, resemblance is somewhat better in the case of Astakos, Thermon and Kirrha. As regards NAA reference data for the Peloponnese, there is a measure of similarity between the three samples and Mommsen *et al.* (2002) groups for Achaia-Elis and the Argolid (Table 3); the agreement is reasonable for such frequently diagnostic elements as Co, Cr, Cs, Rb and Hf but poor for Sm, Ta and Tb. On balance, it seems reasonable to say that at least one source in eastern or western Peloponnese or western Greece is implicated, but not in Boeotia (Table 3) or Attica and probably not on Kephallonia.

(R.E.J., S.T.L.)

5. – Petrographic analysis

The petrography of a sample of 60 sherds and related materials has been investigated in thin-section from 9 Late Bronze Age sites in the lower Po valley[5] (Fig. 1, Tab. 4). The study seeks to understand the organisation of the domestic pottery industry which supplied these sites. This is approached through the petrographic description of the main paste compositions and, where possible, the identification of sources of raw materials by linking the petrographic data to the local geology. However, such a linkage is difficult in a sedimentary environment where rock outcrops are absent or peripheral, and the local material comprises derived superficial deposits. The geology of the lower Po floodplain is dominated by mixed holocene alluvium derived from a range of remote outcrops, mostly metamorphic from within the Alps, although there are isolated exposures of Tertiary volcanics and limestone to the North at Colli Euganei (De Pieri, Gregnanin 1982). The picture is further complicated by the presence of the river Adige with its own catchment to the north of the Po, and evidence for a network of divergent Po and Adige fossil, or 'palaeo-*' courses with their associated alluvial deposits (Peretto 1986).

Following a macroscopic examination of the pottery in the Museums of Rovigo, Este and Adria, an initial sample of 41 sherds and related materials was selected to include the range of observed fabric types. This was later augmented with a further 20 samples from Fondo Paviani, Fabbrica dei Soci, Canova and Castello del Tartaro. Included are coarse and fine textured Impasto wares from domestic and funerary contexts (including sherds belonging to typologically defined vessel forms), and examples of more specialised materials such as daubs, floor pavements, clay oven covers and wall plaster linings. Where sufficient sherd material was available, a portion was reignited at 500°C to clarify opaque reduced material, and the original and reignited sherd then impregnated with resin and a thin-section prepared. This was examined under a polarising microscope and the components identified petrographically and a 500 point count analysis made of their proportions (*i.e.* vol.% void, matrix, grains, clast types and grog). In four cases where sufficient (*i.e.*>50g) material was available the heavy (S.G.>2.95) fine-sand (63-200μm) fraction was separated and its mineralogy identified (Williams, Jenkins 1997; 1999; Jenkins *et al.* 1999).

---

[5] Samples from Fabbrica dei Soci, Fondo Paviani, Castello del Tartaro and Canova (western group) are the same as the ones analysed chemically (see Tab. 1).

	sherds	daub	plaster	total
Eastern group - 3 sites:				
Frattesina di Fratta Polesine	18	1	2	21
Villamarzana	5	1	-	6
San Martino loc. Saline	4	1	-	5
Western group - 5 sites:				
Fondo Paviani	5	-	-	5
Fabbrica dei Soci	4	1	-	5
Castello del Tartaro	4	1	-	5
Canova	5	-	-	5
Mariconda di Melara	2	-	1	3
Northern group - 1 site:				
Montagnana	4	1	-	5

Table – 4. List of sites and materials investigated by petrography.

The Petrographic Data

Petrographic examination identified a limited assortment of ceramic compositions which were characterised by a predictably small range of clast and non-plastic constituents. Overall, the sherds tend to be relatively dense, but range from fine to coarse textured.

A) *Matrix Properties.* Properties relating to the paste matrices, such as texture, density, clay mineral aggregate birefringence, mineralogy of the detrital fine sand/silt fraction and identification of bioliths, can be assessed qualitatively but are difficult to quantify. They do, however, refer to the environment from which a sediment is derived or contribute information on the processes involved in pottery making. All the paste matrices have well sorted textures within the clay/silty-clay range. Aggregate birefringence, arising from the parallel orientation of the clay fraction, varies from weak in the denser clay-rich matrices to strong in the siltier matrices. A detrital mineral suite, more easily identified in the silt-rich matrices, comprises angular silt/fine-sand quartz, orthoclase and plagioclase in descending order and rare pyroxene and amphibole; fresh flakes and bleached shreds of muscovite and biotite, whilst common, are inconsistently distributed but are more evident in the siltier matrices. Calcite also shows a variable distribution, being abundant in a few matrices as shell and bioclastic matter or as disseminated angular grains, and is the main component in a small number of others as a calcite mud/micrite: in 20 matrices it occurs as disseminated angular grains. In other sections the dissolution of calcite clasts has left distinctive voids with arched, oblate or circular outlines. Other bioliths have also been identified, and in particular siliceous spicules and diatom tests which are abundant in some sherds. Further analysis might allow these to be linked with specific (*i.e.* fresh water, estuarine or marine) environments. On the basis of texture three matrix types are identified:

– a moderately micaceous, clay-rich body containing a disseminated detrital silt fraction. Aggregate birefringence of the clay fraction is weakly developed. This matrix type appears in all sites within the area;
– a porous, silt-rich body containing a common to abundant detrital angular silt fraction; mica is sparse to abundant and the aggregate birefringence is moderate. This matrix type is found in the eastern and northern group of sites;
– a dense matrix containing abundant angular silt/fine-sand. Mica is usually abundant and the aggregate birefringence is moderate to strong. This matrix type is predominantly associated with the western sites.

B) *Clast and other inclusions*. The paste compositions are further characterised by the presence of distinctive clast and non-plastic constituent. The four principal types recognised are:

Grog Fragments: grog is the commonest constituent in the 61 samples analysed, its concentration varying from absent in five pastes, to rare (0.2-5.0%) in four, to common/abundant (5.0-15.0%) in the majority (52). Particles are generally angular and vary in size from fine (<0.25mm) to coarse sand (0.25-2.00mm), to fine gravel sized granules (>2.00mm). The grog fragments generally mirror the paste compositions of their host sherd, and in some instances are vitrified (isotropic). Occasionally more than one generation can be identified in a single sherd. They can be classified according to the type of grog observed as follows:

– fine textured matrices varying from clay rich to fine sand-rich. They are the commonest and most abundantly represented type (42 samples);
– fragments that contain an exclusive suite of metamorphic clasts (18 sherds);
– a rare but distinctive fragments containing clasts of a trachytic rock (1 sherd).

Clasts: these components are distinctive in thin section but quite variable in distribution. Some pastes contain a only few clasts (<0.5%), in others they are common but never abundant and in 80% they are of secondary importance to grog. Clasts vary in size between 0.15 and 0.75mm with exceptional examples up to 3.5mm in diameter. Rounded/sub-rounded outlines are common but some clasts are noticeably sub-angular to sub-rounded. The following lithic groups have been recognised:

– metamorphic: quartz showing strain extinction, metaquartzite containing muscovite and developing schistose structures and large muscovites, sometimes distorted;

– igneous: rocks with distinctive microcrystalline textures in which microphenocrysts of nepheline(?) and felspar are present. Originally these rocks may have been porphyritic but, due to disaggregation, the groundmass and phenocrysts rarely occur together. A rock with a trachytic texture is particularly distinctive;

– sedimentary: rare fragments of a chert-like rock and fine felspathic sandstone. Angular fragments of a calcareous mudstone containing microfossils are also present.

Bioclasts: fragmented, carbonate shell and foraminiferal debris is abundant in three sherds.

Glass Particles: isotropic coloured glass is present in seven pastes as discrete angular/sub-rounded fragments 0.25-0.75mm in size, some displaying perlitic and vesicular structures. Colours include bluish-black, beige and light yellow but the predominant colour is from bright to dark orange brown.

Paste Classification

The classification of specific paste compositions is complicated by the variable distribution of the four principal paste components, and further compounded by the variety of clay matrices that occur. The main difficulty concerns those pastes with varying frequencies of grog, clasts and bioclasts. The classificatory scheme developed is based on proportions of the principal components as measured by point count analysis, such as "%grog-%clasts-%matrix". It comprises the following four types:

– *Clay Matrix compositions*: clasts and grog are absent. In some bioclasts are identifiable from negative void structures but are of limited distribution. Such pastes present in 7 sherds from 5 of the sites investigated and are characteristically associated with fine-textured specialist fabrics such as clay daubs, linings and floor plasters.

– *Pastes + bioclasts*: a specialist paste in which bioclasts account for 17-29 vol.%, grog and lithic clasts being absent. It has a distribution restricted to 3 sherds from three of the sites in the western group[6] (Fig. 6a).

[6] Castello del Tartaro (sample **CTA4**), Fabbrica dei Soci (sample **FDS9**) and Canova (sample **CAN3**). From a visual examination of the pottery from these sites it appears that this type of paste is often present in jars with a yellowish paste, that can be dated to the Recent Bronze Age.

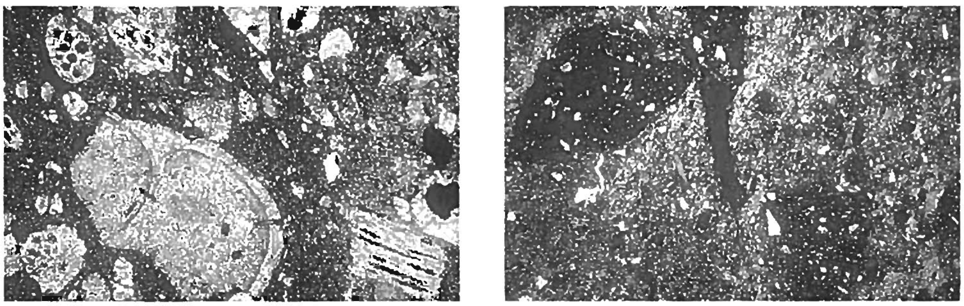
– *Pastes + grog*: numerically the largest paste group and represented at all the sites investigated[7]. Grog is the principal aplastic component but varies from 4-19 vol.%. Solitary clasts are occasionally present and probably derive from the original clay body. Pastes with grog are used for both fine and coarse textured pottery and are considered to be the standard fabric type of the region (Fig. 6b).

– *Pastes + grog + clasts*: these pastes contain >5% clasts and grog and form a sub-type of the *Pastes + grog* group above. The variable presence of clasts makes it difficult to establish whether they have been artificially introduced in the same manner as the grog or belong naturally to the clay sediment. The petrology of the clasts, as noted above, allows for the further sub-division of the fabrics into those containing *igneous, metamorphic,* and (in three sherds) *calcareous mudstone*.

This paste classification is also reflected in the difference in chemical composition of grog and bioclast tempered samples (*see* § 4).

Discussion

This discussion will concentrate on two aspects of the analysis: first, whether any potential sources may be identified for the raw materials; second, whether specific paste types are associated with particular sites.



a b

Fig. 6 – Photomicrographs of thin sections, crossed polarizers × 10 (frame 2.4 × 3.6 mm), a) sample **CTA4** with bioclasts; b) sample **FDS8** with grog.

[7] The abundance of grog in Italian Bronze Age pottery has been pointed out, particularly in sedimentary areas, in various petrographic studies (Levi *et al.* 1999, 244). In the Po Valley there is the evidence of the sites in the area of Modena (Levi, Loschi Ghittoni 1997) and in the area of Imola (Amadori *et al.* 1996).

Both these aspects will be of relevance when discussing the organisation of pottery making in the Po valley.

A) *Sourcing of raw materials*. In view of the spatial distribution of the archaeological sites, it is likely that clays from a number of different sources were used for making the pottery, although it could also be argued, but with less conviction in the present context, that textural variations may reflect natural gradations within a given sediment source, as indeed may be witnessed in the banded lenses that have been observed in some of the sherd matrices. However, regardless of all inherent variations in texture, the matrices all share a common feature of having originated within well-sorted fluviatile deposits of a type that is abundant in a large depositional basin such as the lower Po valley. These sediments sometimes contain fine granular calcite, bioclasts, small concretions of calcareous ooze or fragments of a micrite which may or may not be original constituents in these sediments. Although the accompanying detrital mineral suite is generally uninformative, whenever small polymineralic rock fragments are identified they indicate a source dominated by metamorphic rock types.

The clast petrology generally confirms this conclusion since the most consistently represented rock clasts are metaquartzite/schist. Comparison with two modern stream sediments collected from localities in the beds of the Po and Adige, again show that these metamorphic rock types dominate the coarse sand fraction. The presence of two distinctive igneous rock types is a major, if unexpected, addition to the clast mineralogy in the pottery pastes, the igneous rock with the microcrystalline texture being common in the sample of modern sediments from the Po and sparse in that from the Adige. In contrast the trachytic rock is only seen in 11 sherds from five sites including, in particular, Montagnana: it does not appear in the two river sediments. Its source might possibly be traced to the volcanic outcrops of the Colli Euganei that lie immediately east of Este (Fig. 1). However, the copious use of grog within these pottery pastes further reinforces the picture of a ceramic industry that appears to be self-supporting and reliant upon local source materials. Grog is a versatile and available ingredient in pottery production and one that would be exploited in a region where natural rock fillers were scarce.

The presence of small amounts of coloured glass particles in seven of the sherds is intriguing. Natural glass of volcanic origin is a possible constituent in the Po valley sediments, but the fresh angular condition of some of the grains is incompatible with such a mature fluviatile sediment. Prehistoric glass making was one of the sophisticated crafts practised at Frattesina (Angelini *et al.* forthcoming) and glass particles are primarily, but not exclusively, associated with pottery pastes from this site. However, it must be noted that particles of orange coloured glass have also been found in a separate, chronologically later (*etrusco-padana*) sherd analysed incidentally from the site of San Cassiano di Crespino in the Po delta region. Moreover, in the modern Po river sediment, highly abraded particles of an orange coloured glass with rounded/sub-rounded outlines are again present. The presence of glass, whatever its origin, is another facet that ties the pottery to the local environment.

Further supporting evidence has been obtained from the heavy mineral analyses made of an eastern and western sediment sample from both the Po and Adige and from seven sites from the area inbetween, together with four sherds for which sufficient sample was available (Fig. 7). The very similar two mineral assemblages from the Po can be distinguished from those of the Adige in having higher clinozoisite, orthopyroxene and glaucophane and lower clinopyroxenes contents, results which compare closely with previous alluvial/coastal sediment analyses (Jobstraibizer, Malesani 1973): the seven sites between the two rivers have assemblages suggesting admixtures of these two sources. This links the two sherds from Frattesina to the sediments of the Po, but that from Montagnana – whilst closer in composition to the Adige sediment – differs in having higher zircon, brown amphiboles and apatite, but lower garnet, clinopyroxenes and clinozoisite contents. The separate *etrusco-padana* sherd from San Cassiano di Crespino differs in heavy mineralogy to an even greater extent with assemblages dominated by clinopyroxene and apatite. Although sources of raw materials can therefore be strongly linked petrographically and mineralogically with the local river sediments in general terms, precise source locations for sherds cannot be identified at present: however, greater precision might be achieved through further heavy mineral and biolith analysis.

C) *Association of paste types with sites*. The classification based on petrographic analysis reveals a continuum of fine-textured matrices into which grog, in varying proportions, has been deliberately added to supplement components, some of which may have been original constituents in the primary sediments. On a triangular fabric diagram (Fig. 8; 'fine matrix+grains; coarse/clasts+grog; voids') the non-sherd materials form a distinct group devoid of filler, whilst sherds from the eastern and northern group of sites tend to have more filler (and also more silt-rich matrices), those from the western sites being finer (with clay-rich matrices) – except for the three distinctive sherds tempered with carbonate bioclasts. In choice of filler, the distinction is even clearer, a triangular plot

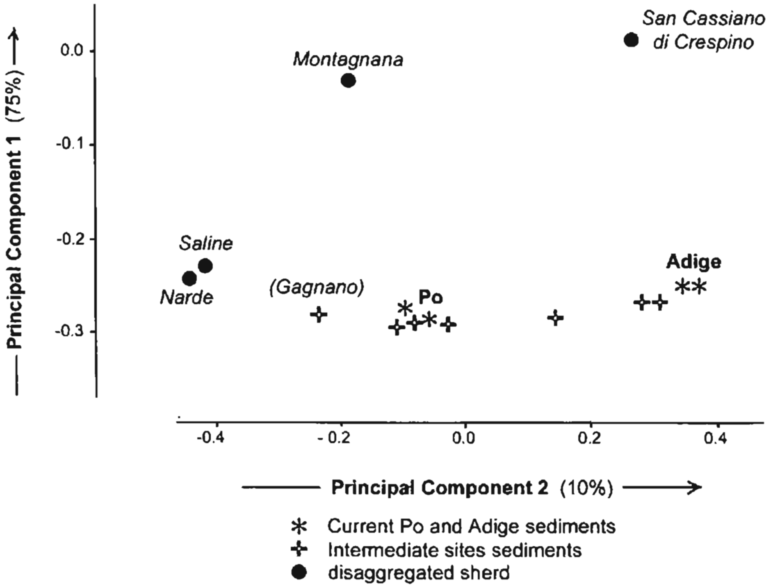


Fig. 7 – Plot of first two Principal Components from heavy mineral analyses of 4 sherds (Narde = Frattesina) and 11 sediments.

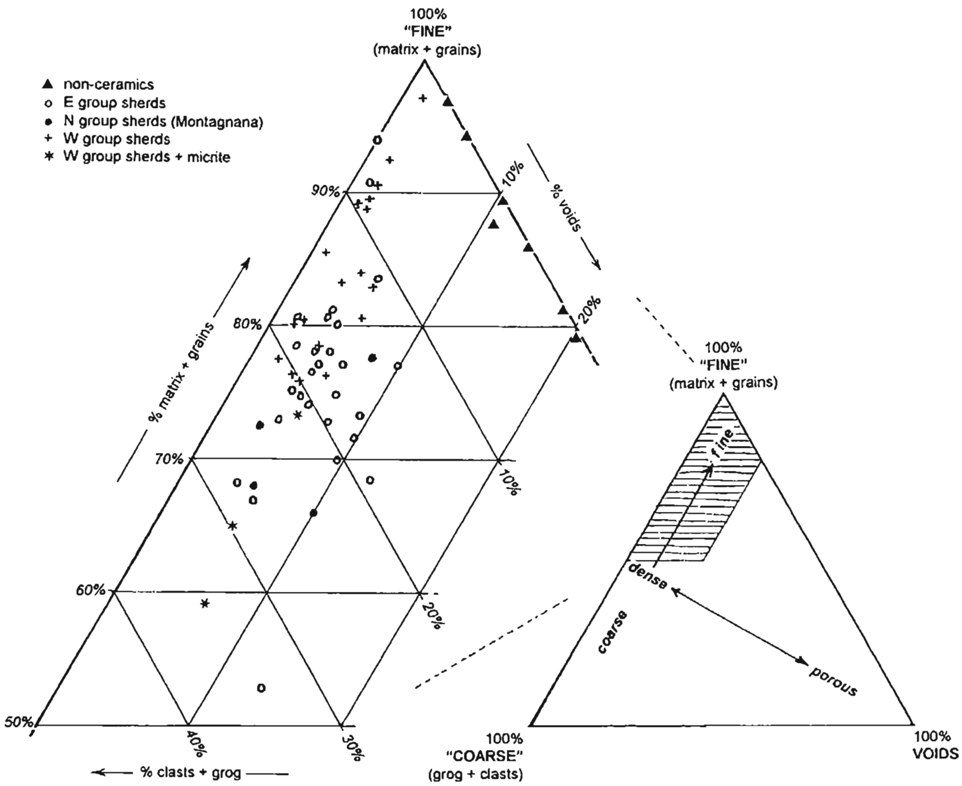


Fig. 8 – Classification of sherds by fabric.

(Fig. 9: 'clasts; grog; matrix+grains') showing a complete separation of the eastern and northern group of sites, characterised by a higher grog content, as compared to the western group of sites: different selections of materials were clearly adopted. However, in terms of clast composition (Fig. 10, triangular plot: 'metamorphic; igneous; others'), the distribution is more random with a less clearly defined pattern, sherds from the eastern group tending to be slightly richer in metamorphic clasts, and those from the western sites in igneous clasts; sherds from the northern site of Montagnana, however, are distinctly richer (>60%) in igneous clasts.

Finally, all the 22 different physical and petrographic attributes measured for the pots can be reduced by Principal Component Analysis (Fig. 11) in which the first two components account for 79% of the variance. These components are dominated by the percentages of grog and grains, with minor contributions from the percentages of voids, specific grains (amphiboles/clinopyroxenes) and clasts (rhyolites, syenites, sandstones, bioclasts and glass). Here the majority of the eastern group (70%) form a distinct separate cluster, as do those of the western group containing bioclasts. Those of the northern group, the non-bioclastic western group, and the non-ceramic groups, also comprise defined, but overlapping, clusters. The remaining 10 pots of the eastern group also overlap with these latter groups raising the possibility that they may represent vessels exchanged between the eastern group and neighbouring communities within the lower Po valley.

Conclusion

Although the Lower Po Valley was an unpromising environment, devoid of rock outcrops and dominated by homogenised river sediments, this petrographic study has shown that 'signature' lithic clasts and mineral assemblages can be recognised and matched to localised river deposits. The results summarised here suggest that, on the basis of fabric, several separate production centres existed in the western and the eastern areas of the Po valley, with the northern site of Montagnana using similar materials but from a different, as yet unidentified, source. Finer resolution might be achieved by further biolith and heavy mineral analyses, and additional sampling of local sediments. From a technological standpoint it is clear that the potters used a variety of fine textured clay bodies, some of which were devoid of coarse clastic components and some of which contained varying amounts of original bioclastic detritus, lithic clasts or calcareous mudstone. It follows that supplementary grog was introduced into these clays as a filler although there may have also been deliberate enrichment with further

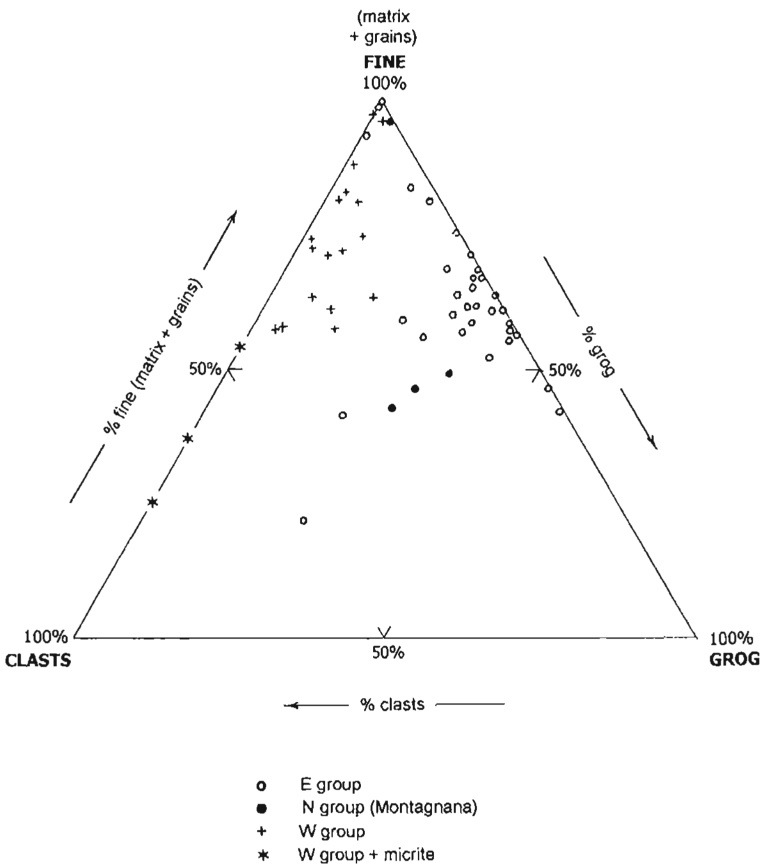


Fig. 9 – Classification of sherds by type of filler.

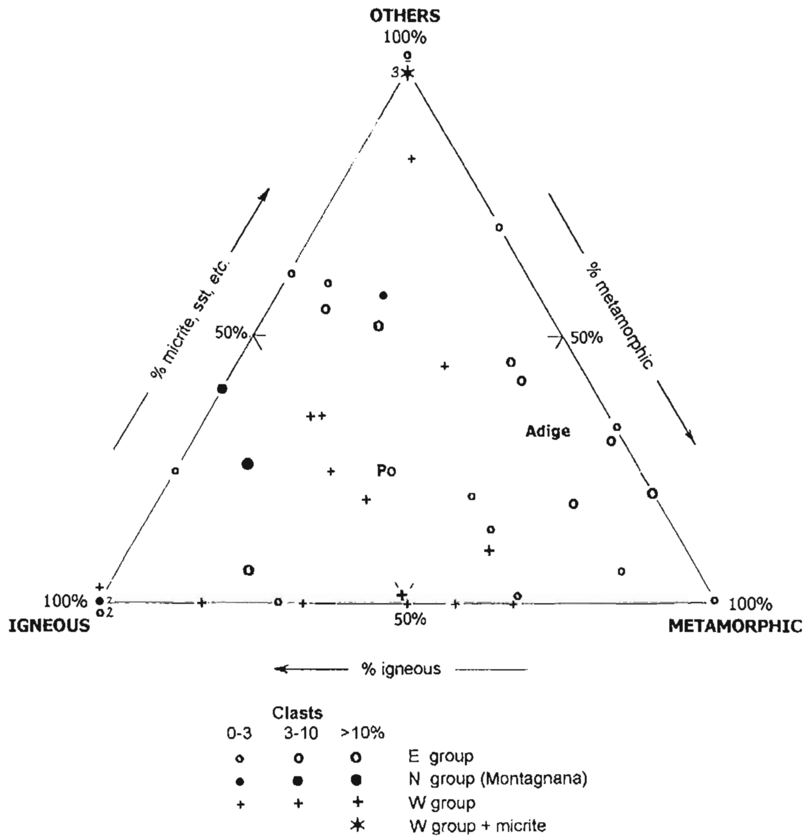


Fig. 10 – Classification of sherds by lithology of clasts.

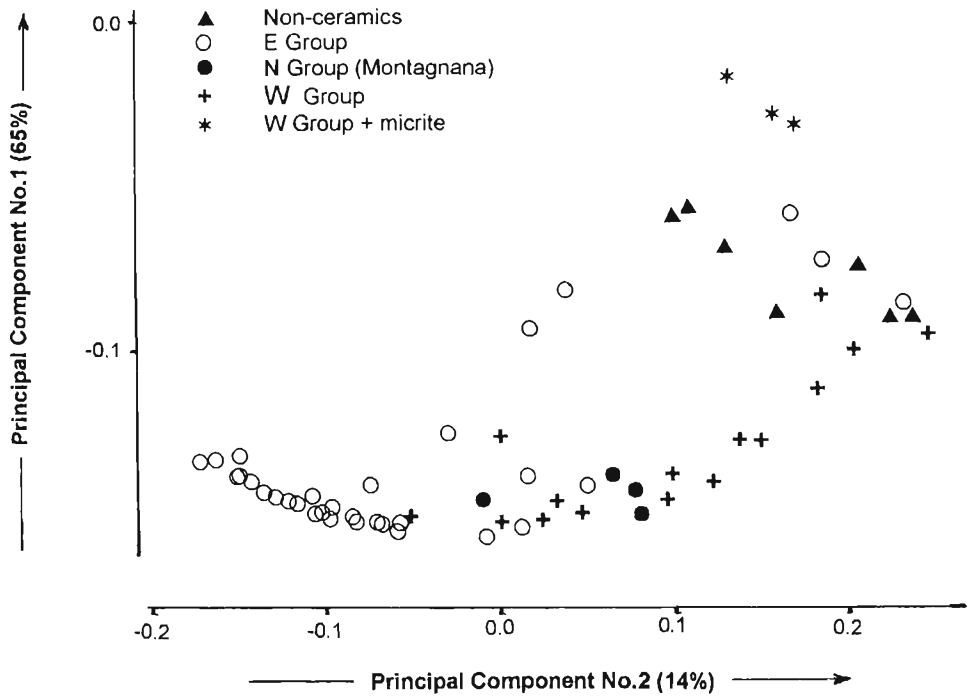


Fig. 11 – Classification of sherds by 22 properties (excluding % matrix).

additions of the clastic ingredients. The impression gained from this study is of a well organised, versatile and resourceful industry utilising local raw materials to produce a range of impasto wares and associated clay based domestic materials which fulfilled the requirements of the Bronze Age communities of the lower Po valley.

(J.W., D.J., S.T.L.)

6 – Final remarks

Summary of analytical data

The results of chemical analysis suggest that the decorated Mycenaean sherds seem to fall into two groups: a small group (**FPA2**, **FDS1** and **FDS3**) and the remainder. Taking the latter group, the indications are that their compositions are more consistent with origins to the south of the Po Valley, specifically with groups of Mycenaean decorated pottery of probable local manufacture from sites to the south, than in the valley itself. This view takes account of the problem confronting the chemical approach, that is that most of the reference material for the sites in the Po Valley consisted of Impasto whose fabric is dissimilar to that of the Mycenaean pottery. Thus **FDS2**, **FPA1** and **CTA1** resembles in composition some of the Mycenaean decorated material from Apulia, and **FRA2** is closer to the corresponding material from central Italy or even further south in Calabria. **MON1** and **FRA1** also find resemblance with Apulia, a region where the fine-textured clays are known to be calcareous, albeit not as calcareous as in these two samples. **FDS1** cannot be placed.

Turning to the first group, the general character of its three member compositions is more typical of what is found in Greece than in Italy. At least one source is represented by the samples. A search of the available databases for Mycenaean pottery from centres in central and southern Greece suggests that the origin(s) lie in either western or eastern Peloponnese, possibly in Akarnania and coastal Phokis but probably not on Kephallonia, and definitely not in Boeotia or Attica.

The contribution of the petrographic study, the largest of its kind yet undertaken in the region, has been firstly to establish where Impasto production was taking place in the lower Po Valley and to elucidate some technological aspects. Different production centres have been identified: a northern group is characterized by igneous filler, while the distinction between eastern and western groups is more subtle, the former group being slightly richer in metamorphic clasts and the latter in igneous clasts. Some other differences can be interpreted as technological variability within a common tradition: the pottery of eastern and northern groups are characterized by silt-rich matrices, more filler and an abundance of grog; the western group is finer, with a clay-rich matrix, an abundance of clasts and the presence of grog. Finally, a distinctly different production has been identified in some western sites on the basis of abundant large bioclasts. Altogether the picture emerges of a well organised, versatile and successful industry using local raw materials. It is reassuring to note that the grog, calcareous and the fine-textured fabrics each had identifiably different chemical compositions.

Archaeological remarks

The archaeological implications deriving from this study of the finds and from the results of archeometric analyses are of some importance and certainly place the Mycenaean sherds from the Po valley in a new methodological dimension.

First of all, the compositions display a variety within the same site, indicating a plurality of origins. Second, although one has to be necessarily cautious in defining the places of manufacture of the vessels, there is evidence for at least two different cases: imports from Greece and imports from other parts of Italy.

Unfortunately, the three sherds, possibly related to the Peloponnese and/ or to the western part of Greece (**FPA2, FDS3, FDS4**), are typologically, and chronologically, undiagnostic. The remaining sherds, possibly related to Italo-Mycenaean workshops located in southern Italy (Apulia), seem to reinforce the hypothesis of internal circulation within Italy of this kind of material. A similar case has already been identified at Casale Nuovo (Latium), where the composition of some sherds is related to southern Italy, in particular to the Sybaris area (Jones, Vagnetti 1992; Angle *et al.* 1993).

While the first case fits well with the general pattern of Bronze Age exchanges between the Aegean and the Central Mediterranean, the second case brings a different element into the picture and recommends a careful and differentiated treatment of the archaeological evidence, especially when integrated into a general historical framework. Indeed, it appears more and more necessary to use the available archaeological information critically and always to take into consideration, in the appropriate methodological way, the chronological range, quality, quantity, function and context of the finds, which in some cases may reveal a significantly different pattern.

In any case, the pottery evidence examined in this paper, although scanty and to some extent tantalizing, seems particularly significant if combined with other elements that link the Po valley to the eastern Mediterranean as well as to Central Europe at the end of the Bronze Age. In particular we know that exotic raw materials such as ivory, on one hand, and amber on the other, converged and were processed at Frattesina in the Final Bronze Age (Bietti Sestieri 1997). A special class of ivory combs, particularly abundant at Frattesina, is known from many findplaces in Italy and from Cyprus (Vagnetti 1986; 2001). Glass and glass-making constitute equally important evidence for specialized craftmanship, which developed locally, but probably not unrelated in origin to the long-distance trade of glass ingots of Near Eastern origin (Pulak 1998, 202; Angelini *et al.* forthcoming, with full bibliography).

In order to better understand the role of the Adriatic in its connection between the Eastern Mediterranean, the Aegean, southern Italy and the Po valley, it would be important to study in detail, and also from an archeometric point of view, the scanty but increasing evidence for

Mycenaean finds in the middle Adriatic area (Treazzano di Monsampolo, Ancona)[8]. On the basis of the results presented in this paper, one can definitely emphasize the importance of a multi-disciplinary approach in order to put the archaeological finds in their appropriate historical perspective.

(R.E.J., L.V., S.T.L.)

Richard E. Jones
Dep. of Archaeology, University of Glasgow
Gregory Buildings-Lilybank Gds.
Glasgow G12 8QQ – Scotland U.K.

Lucia Vagnetti
Istituto di Studi sulle Civiltà
dell'Egeo e del Vicino Oriente (CNR)
Via Giano della Bella, 18
I – 00162 Roma

Sara T. Levi
Istituto Universitario Suor Orsola Benincasa
Via Suor Orsola, 10
I-80135 Napoli

John Williams
University of Wales, Bangor
Gwynedd LL57 27F U.K.

David Jenkins
University of Wales, Bangor
Gwynedd LL57 27F U.K.

Armando De Guio
Dip. Scienze dell'Antichità
Università di Padova
piazza Capitaniato, 7
I – 35139 Padova

REFERENCES

Aitchison J.A. 1986, *The Statistical Analysis of compositional data*, London.

Amadori M. L., Desogus P., Fabbri B., Levi S. T., Pacciarelli M. 1996, La tecnologia di produzione delle ceramiche da Monte Castellaccio e S. Giuliano indagata attraverso analisi archeometriche, in *Musei Civici di Imola. La collezione Scarabelli, 2. Preistoria*, Bologna, 355-415.

Angelini I., Artioli G., Bellintani P., Diella V., Polla A., Residori G. forthcoming, Project "Glass materials in the Protohistory of North Italy": a first summary, *in Atti del II Congresso Nazionale di Archeometria* (Bologna 29 genn.-1 febbr. 2002), in press.

Angle M., Conti A. M., Costantini L., Dottarelli R., Gianni A., Jones R. E., Persiani C., Vagnetti L. 1993, Prime testimonianze micenee nel Latium vetus, *ParPass*, 48, 190-217.

[8] We thank Dr. E. Percossi, of the Soprintendenza Archeologica delle Marche (Ancona) for preliminary information concerning some recent finds from Tolentino. For the few other finds from Marche see Lollini 1982; Silvestrini 1991.

Anzidei A. P., Bietti Sestieri A. M. 1984, Scavo dell'abitato di Frattesina, in F. Parise Badoni, M. Ruggeri Giove eds., *Norme per la redazione della scheda del saggio stratigrafico*. Istituto Centrale per il Catalogo e la Documentazione, Roma, 103-28.

Arenoso Callipo C.M.S., Bellintani P. 1994, Dati archeologici e paleoambientali del territorio di Frattesina di Fratta Polesine (RO) tra la tarda età del bronzo e la prima età del ferro, *Padusa*, 30, 7-65.

Bagolan M., Levi S. T., Vanzetti A. 1997, Bassa Veronese: siti dell'età del Bronzo Recente, che sovente iniziano nel corso del Bronzo Medio, in Bernabò Brea *et al.* 1997, 357-60.

Balista C., Bagolan M., Cafiero F., De Guio A., Levi S. T., Vanzetti A., Whitehouse R., Wilkins J. 1998, Bronze-Age "Fossil Landscapes" in the Po Plain, Northern Italy, in B. Hänsel ed., *Mensch und Umwelt in der Bronzezeit Europas*, Kiel, 493-99.

Balista C., Cafiero F., De Guio A. 1997, Castello del Tartaro, Fondo Paviani, Fabbrica dei Soci, in Bernabò Brea *et. al.* 1997, 240-49.

Balista C., De Guio A. *et al.* 1990-91, Il sito di Fabbrica dei Soci (Villabartolomea-VR): oltre la superficie, *Padusa*, 26-28, 9-85.

Balista C., De Guio A. 1997, Ambiente ed insediamenti dell'età del bronzo nelle Valli Grandi Veronesi, in Bernabò Brea *et al.* 1997, 137-60.

Belardelli C. 1993, Aegean-type pottery from Coppa Nevigata, Apulia, in C. Zerner *et al.* eds., *Wace and Blegen. Pottery as evidence for trade in the Aegean Bronze Age, 1939-1989*. Proc. of the Int. Conference held at the American School of Classical Studies at Athens (dec. 1989), Amsterdam, 347-52.

Bellintani P. 1992, Frattesina di Fratta Polesine: il materiale ceramico conservato presso il Museo Civico di Rovigo. Classificazione, suddivisione in fasi e alcune considerazioni sulla cronologia del Bronzo finale nella pianura padana orientale, *Padusa*, 28, 245-97.

Bellintani P. 2000, Il medio Polesine tra la tarda età del Bronzo e l'inizio dell'età del Ferro, in Harari, Pearce 2000, 47-84.

Benton S. 1938-39, Excavations at Ithaca, III. The Cave at Polis, *BSA*, 39, 1-16.

Bernabò Brea M., Cardarelli A., Cremaschi M. eds. 1997, *Le terramare. La più antica civiltà padana*, Milano.

Bettelli M. 2002, *Italia meridionale e mondo miceneo*, Firenze.

Bettelli M., Vagnetti L. 1997, Aspetti delle relazioni fra l'area egeo-micenea e l'Italia settentrionale, in Bernabò Brea *et al.* 1997, 614-19.

Bianchin Citton E., Gambacurta G., Ruta Serafin A. eds. 1998, ... *"presso l'Adige ridente" ... Recenti ritrovamenti archeologici da Este a Montagnana*, Padova.

Bietti Sestieri A. M. 1982, *Frattesina*, in Vagnetti 1982, 201-7.

Bietti Sestieri A. M. 1990, La campagna 1989 nell'abitato protostorico di Frattesina di Fratta Polesine, *Quad.Arch.Veneto*, 6, 64-6.

Bietti Sestieri A. M. 1996, *Protostoria. Teoria e pratica*, Roma.

Bietti Sestieri A. M. 1997, Il territorio padano dopo le terramare, in Bernabò Brea *et al.* 1997, 757-67.

Braccesi L. 2001, *Hellenikòs Kolpos. Supplemento a Grecità adriatica* (Hesperìa 13), Roma.

Calogero S. 1986, Caratterizzazione di frammenti ceramici dello scavo di Corte Cavanella mediante analisi per attivazione neutronica e spettroscopia Moessbauer, in De Min, Peretto 1986, 325-9.

De Guio A. 1995a, Alto-Medio Polesine-Basso Veronese: from a "landscape archaeology" to an "archaeology of the mind", in N. Christie ed., *Settlement and economy in Italy 1500 BC to AD 1500*, Papers of the Fifth Conference on Italian archaeology, Oxford, 13-24.

De Guio A. 1995b, Surface and subsurface: deep ploughing into complexity, in W. Hensel, S. Tabaczynski, P. Urbanczyk eds., *Theory and practice of archaeological research*, II, Institute of Archaeology and Ethnology, Polish Academy of Sciences, Warszawa, 329-414.

De Guio A. 1996, Archeologia della complessità e pattern recognition di superficie, in E. Maragno ed., *La ricerca archeologica di superficie in area padana*. Atti del Workshop di Villadose (ottobre 1994), Stanghella, 275-317.

De Guio A. 2000, Ex Occidente lux: linee di un percorso critico di rivisitazione del Bronzo Finale nel Veneto, in Harari, Pearce 2000, 259-357.

De Guio A. 2002, Dinamiche non lineari del potere: teorie-metodi di riferimento e caso di studio dell'età del Bronzo nella Pianura Padana (Italia), in M. Molinos, A. Zifferrero eds., *Primi popoli d'Europa. Proposte e riflessioni sulle origini della civiltà nell'Europa mediterranea*, Firenze 81-110.

De Guio A., Whitehouse R. D., Wilkins J. eds. 1989, Progetto Alto-Medio Polesine-Basso Veronese: terzo rapporto, *Quad.Arch.Veneto*, V, 181-216.

De Guio A., Whitehouse R. D., Wilkins J. eds. 1990, Progetto Alto-Medio Polesine-Basso Veronese: quarto rapporto, *Quad.Arch.Veneto*, VI, 217-38.

De Guio A., Whitehouse R. D., Wilkins J. eds. 1992, Progetto Alto-Medio Polesine-Basso Veronese: quinto rapporto, *Quad.Arch.Veneto*, VIII, 173-90.

De Guio A., Whitehouse R. D., Wilkins J. eds. 1995, Progetto Alto-Medio Polesine-Basso Veronese: ottavo rapporto, in *Quad.Arch.Veneto*, XI, 166-78.

De Guio A., Whitehouse R. D., Wilkins J. eds. 1999, Progetto Alto-Medio Polesine-Basso Veronese: decimo rapporto, *Quad.Arch.Veneto*, XV, 101-16.

De Min M., Bietti Sestieri A. M. 1979, I ritrovamenti protostorici di Montagnana: elementi di confronto con l'abitato di Frattesina, in *Il Bronzo Finale in Italia*. Atti XXI Riun. Scientifica I.I.P.P., Firenze, 205-19.

De Min M., Gerhardingher E. 1986, Frattesina di Fratta Polesine. L'abitato protostorico, in De Min, Peretto 1986, 117-41.

De Min M., Peretto R. eds. 1986, *L'Antico Polesine. Testimonianze archeologiche e paleoambientali*. Catalogo delle esposizioni di Adria e Rovigo, Rovigo.

De Pieri R., Gregnanin A. 1982, Trachyte amphiboles in the Euganean hills (North-eastern Italy), *Società Italiana di Mineralogia e Petrologia* 38(2), 657-66.

Di Filippo Balestrazzi E. 2000, Tre frammenti micenei da Torcello, *Hesperìa* 10, Roma, 203-23.

Fasani L., Salzani L. 1975, Nuovo insediamento dell'età del Bronzo in località Fondo Paviani presso Legnago (Verona), *Boll. Mus. Civico St. Nat. Verona*, II, 259-81.

Fisher E. A. 1988, *A comparison of Mycenaean Pottery from Apulia with Mycenaean Pottery from Western Greece*, Unpublished Ph. D. Thesis. University of Minnesota.

Harari M., Pearce M. eds. 2000, *Il Protovillanoviano al di qua e al di là dell'Appennino*. Atti della giornata di studio, Pavia, Collegio Ghislieri (giugno 1995), Como.

Harris I. 1982, *NAA – neutron activation analysis programme*, Scottish Universities Research & Reactor Centre (SURRC).

Hein A., Beier Th., Mommsen H. 2002, A complete chemical grouping of the Perlman/Asaro Neutron Activation Analysis Databank on Mycenaean and Minoan Pottery, in V. Kilikoglou, A. Hein, Y. Maniatis eds., *Modern trends in scientific studies on Ancient Ceramics* (BAR, Int. Series 1011), Oxford, 143-50.

Hoffman S.M.A., Newton G.W.A., Robinson V. J., French E. B., Perlman I. 1988, *Interim report on the chemical analysis of some LBA pottery from the NE Peloponnese and Crete*, Unpublished paper presented to the *International Archaeometry Symposium in Toronto*.

Iakovidis S. 1969-70, *Perati. To nekrotaphion*, Athens.

Jenkins D. A. 1987, Report on the petrography of pottery from Trefignath and Din Dryfol, in C. A. Smith and F. M. Lynch, *Trefignath and Din Dryfol: the excavation of two megalithic tombs in Anglesey*. Cambrian Archaeological Monograph, no. 3, Aberystwyth, 60-73.

Jenkins D., Williams J., Levi S. T. 1999, Petrographic analysis in provenancing and classification of sherds: the lower Po Valley – a case study, in *4th European Meeting on Ancient Ceramics*, Andorra (1997), 175-81.

Jobstraibizer L., Malesani L. 1973, I sedimenti dei fiumi Veneti, *Mem. Soc. Geol. It.*, 12, 441-52.

Jones R. E. 1993, Laboratory Analyses of Aegean-type Late Bronze Age Pottery in Italy: review and future prospects, *SMEA*, 32, 131-34.

Jones R. E. 2001, A provenance study of the Aegean-type and other pottery by chemical analysis, in Trucco, Vagnetti 2001, 331-37.

Jones R. E. *et al.* 1995, Physico-chemical analyses applied to a selection of pottery from Lerna IV, Appendix III, in J. B. Rutter, *Lerna: a preclassical site in the Argolid III. The pottery of Lerna IV*, Princeton, 663-749.

Jones R. E., Lazzarini L., Mariottini M., Orvini E. 1994, Studio minero-petrografico e chimico di ceramiche protostoriche da Broglio di Trebisacce, in R. Peroni, F. Trucco eds., *Enotri e Micenei nella Sibaritide*, Taranto, 413-54.

Jones R. E., Levi S. T. 2002, I dolii cordonati e la ceramica grigia, protogeometrica e di impasto dal sito di Torre Castelluccia, in M.A. Gorgoglione ed., *Atti del Convegno di Sudio "Strutture e modelli di abitati del Bronzo tardo da Torre Castelluccia a Roca Vecchia"*, Pulsano (nov. 1996), Manduria, 93-115.

Jones R. E., Levi S. T., Vagnetti L. 2002, Connections between the Aegean and Italy in the Later Bronze Age: the ceramic evidence, in V. Kilikoglou, A. Hein, Y. Maniatis eds., *Modern trends in scientific studies on Ancient Ceramics* (BAR, Int. Series 1011), Oxford, 171-84.

Jones R. E., Vagnetti L. 1991, Traders and Craftsmen in the Central Mediterranean. Archaeological Evidence and Archaeometric Research, in N. H. Gale (ed.), *Bronze Age Trade in the Mediterranean*. Papers presented at the Oxford Conference (dec. 1989), (SIMA XC), Jonsered, 127-47.

Jones R. E., Vagnetti L. 1992, Traders and Craftsmen in the Central Mediterranean. Archaeological Evidence and archaeometric Research (an addendum), *BSA*, 87, 231-35.

Levi S. T. *et al.* 1999, *Produzione e circolazione della ceramica nella Sibaritide protostorica, I. Impasto e dolii*, Firenze.

Levi S. T., Loschi Ghittoni A. G. 1997, Gli impasti ceramici dei siti terramaricoli del territorio modenese, in Bernabò Brea *et al.* 1997, 487-97.

Liddy D. J. 1989, A provenance study of decorated pottery from an Iron Age cemetery at Knossos, Crete, in Y. Maniatis ed., *Archaeometry*, Amsterdam, 559-70.

Liddy D. J. 1996, A chemical study of decorated Iron Age pottery from the Knossos North Cemetery, in J. N. Coldstream, H. W. Catling, eds., *Knossos North Cemetery: Early Greek Tombs* II (BSA Supplementary vol. 28), London, 465-514.

Lollini D. 1982, Treazzano di Monsampolo, in Vagnetti 1982, 197-99.

Malgarise A. 1989-90, *Progetto Alto-Medio Polesine – Basso Veronese: un esempio di ricerca archeologica di superficie* (tesi di laurea, A.A. 1989-90), Università di Padova – Dipartimento di Scienze dell'Antichità, relatore prof. L. Capuis.

Mommsen H., Beier Th., Hein A. 2002, A complete chemical grouping of the Berkeley neutron activation analysis data on Mycenaean pottery, *J.Arch.Sc.*, 29, 613-37.

Mountjoy P. A. 1999, *Regional Mycenaean Decorated Pottery*, Rahden.

Pearce M. 2000, Metals make the world go round: the copper supply for Frattesina, in C.F.E. Pare ed., *Metals make the World go round. The supply and circulation of Metals in Bronze Age Europe.* Proc. of a Conf. held at the Univ. of Birmingham (June 1997), Oxford, 108-15.

Peretto R. 1986, Ambiente e strutture antropiche nell'antico Polesine, in De Min, Peretto 1986, 21-100.

Pulak C. 1998, The Uluburun shipwreck: an overview, *Intern.Jour.Naut.Arch.*, 27, 188-224.

Sackett L.H., Popham M.R. 1965, Excavations at Palaikastro VI, *BSA*, 60, 248-315.

Salzani L. 1976, Fondo Paviani (Legnago-Verona), *Boll. Mus. Civico St. Nat. Verona*, III, 587-90.

Salzani L. 1977, Un fondo di capanna a Fabbrica dei Soci (Villabartolomea), *Boll. Mus. Civico St. Nat. Verona*, IV, 543-61.

Salzani L. 1987, Un nuovo ripostiglio di bronzi da Frattesina, *Padusa*, 23, 219-225.

Salzani L. 1988, Rinvenimenti vari nel Veronese. Villabartolomea. Fabbrica dei Soci, *Quad.Arch.Veneto*, IV, 262-3.

Salzani L. 1989a, Cerea, Castello del Tartaro, *Quad.Arch.Veneto*, V, 170-73.

Salzani L. 1989b, Necropoli del Bronzo Finale alle Narde di Fratta Polesine. Prima nota, *Padusa*, 25, 5-42.

Salzani L. 1990-91, Necropoli del Bronzo Finale alle Narde di Fratta Polesine. Seconda nota, *Padusa*, 26-27, 125-206.

Salzani L. 1996, Necropoli dell'età del Bronzo a Scalvinetto di Legnago (VR). Campagne di scavo 1991 e 1994, *Padusa*, XXX, 67-83.

Silvestrini M. 1991, Ancona, località Montagnolo: insediamento dell'età del bronzo, in *Scavi e ricerche nelle Marche. Introduzione alla mostra*, Urbino, 13-15.

Souyoudzoglou-Haywood C. 1999, *The Ionian Islands in the Bronze Age and Early Iron Age, 3000-800 BC*, Liverpool.

Taylour W. 1958, *Mycenaean Pottery in Italy and adjacent Areas*, Cambridge.

Tomlinson J. E. 1997, Statistical evaluation of the Asaro-Perlman neutron activation data on Mycenaean pottery from the Peloponnese, *BSA*, 92, 139-64.

Topping P. G., Mackenzie A. B. 1988, A test case of the use of neutron activation analysis for clay source characterisation, *Archaeometry*, 30:1, 92-101.

Tozzi P., Harari M. 1990, *Tempi di un territorio. Atlante aerofotografico delle Valli Grandi Veronesi*, Parma.

Trucco F., Vagnetti L. eds. 2001, *Torre Mordillo 1987-1990. Le relazioni egee di una comunità protostorica della Sibaritide*, Roma (Incunabula Graeca CI), 341-5.

Vagnetti L. 1979, Un frammento di ceramica micenea da Fondo Paviani (Legnago), *Boll. Mus. Civico St. Nat. Verona*, 6, 599-610.

Vagnetti L. 1982 ed., *Magna Grecia e Mondo Miceneo. Nuovi Documenti.* Catalogo della mostra tenuta nel Museo di Taranto in occasione del XXII Convegno di Studi sulla Magna Grecia, Napoli.

Vagnetti L. 1986, Cypriot elements beyond the Aegean in the Bronze Age, in V. Karageorghis ed., *Acts of the International Symposium "Cyprus between the Orient and the Occident"*, Nicosia 201-14.

Vagnetti L. 1996, Ceramiche di tipo egeo dal Basso Veronese, in Belluzzo G., Salzani L. eds., *Dalla terra al Museo. Mostra di reperti preistorici e protostorici degli ultimi dieci anni di ricerca dal territorio veronese*, Legnago, 179-84.

Vagnetti L. 1998, Un frammento ceramico di tipo egeo da Montagnana-Borgo San Zeno, in Bianchin Citton *et al.* 1998, 329-0.

Vagnetti L. 2001, L'artigianato dell'avorio e del corno, in Trucco, Vagnetti 2001, 341-5.

Vagnetti *et al.* in preparation, *The Mycenaeans and Italy: the archaeometric dimension (1980-2000).*

Whitehouse R. 1997, Le datazioni radiocarboniche delle Valli Grandi Veronesi, in Bernabò Brea *et al.* 1997, 161.

Williams, J.Ll.W., Jenkins, D.A. 1997, Provenancing of prehistoric and Roman pottery using petrographic and mineralogical analysis: case studies from North Wales, in A. Sinclair, E. Slater, J. Gowlett eds., *Archaeological Sciences 1995*, Oxford, 92-9.

Williams, J.Ll.W., Jenkins, D.A. 1999, A Petrographic Investigation of a Corpus of Bronze Age Cinerary Urns from the Isle of Anglesey, *Proc.Prehist.Soc.*, 65, 189-230.

Wright R.V.S. 1994, *The MV-NUTSHELL brochure: a concise introduction to multivariate archaeology*, Sydney.