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# Pottery production at Velia: Ceramic raw materials and archaeometric analyses

## 1. Introduction

The local production of pottery, bricks and tiles has been assumed for Velia as well as for many other colonies in Magna Graecia at a rather early stage of research, but the characteristics and the development of this production remained unknown for a long time.[1] As the archaeological indicators for pottery production like kilns, spacers or misfired pieces are few, the studies of pottery from the Austrian team at Velia were complemented by archaeometric analyses, namely thin section and heavy mineral analyses, conducted by the present author.[2] The identification of the local production resulted mainly from the comparison of pottery with local clay resources, but also from the fact that coarse wares, bricks, and tiles displayed very similar element patterns and thus could be assumed to be local.

## 2. Ceramic raw materials

In the course of the FACEM-project numerous clay and raw materials from various production centres in Southern Italy have been collected and analyzed (fig.1). This present report, however, gives only an overview on the petrographic and mineralogical analyses and a characterisation of the locally or regional available raw materials of Velia.[3] A small geological survey was undertaken into the surroundings of Velia in the 1990s (fig.2). Based

[1] Gassner et al. 2014. For the period of the 1970s see foremost Morel 1970; Morel 1974, 146-51; Morel 1999, 13-5.

[2] These analyses have been funded by two projects of the Austrian Science Fund FWF (P 10476-SPR from 1994-1997; P20597-G02 from 2008-2011). For the permission to sample various materials we are most grateful to the following *Soprintendenti* per Salerno, Benevento e Avellino, first of all to Giuliana Tocco Sciarelli, then Maria Luisa Nava and now to Adele Campanelli. For the archaeological publications see Gassner 2000a; Gassner 2000b; Trapichler 2000; Gassner 2003a; Gassner 2003b; Trapichler 2003b; Gassner 2006; Trapichler 2006; see also the preliminary reports Trapichler 2003a; Trapichler 2011; Gassner 2009; Gassner and Trapichler 2010; Gassner and Trapichler 2011; Gassner and Trapichler forthcoming. For the archaeometric analyses see the preliminary reports of Gassner and Sauer 2002; Gassner et al. 2003; Sauer 2003; in general see also Gassner 2009.

[3] The topic has also recently been dealt with in Gassner et al. 2014.

on geological maps and literature, available at its time (1994),[4] it was tried to obtain an overview on the locally available clay resources and to get reference samples of potential ceramic raw materials. More than 70 samples of locally available clays, silts and sands were taken from natural and artificial outcrops and have been analyzed (tab.1). It was also possible to retrieve samples from drill cores of several wells, drilled in the vicinity and within the excavation site, originally taken for paleo-climatologic and geomorphological research (fig.3).[5] In this paper the emphasis is put on the provenance aspect to identify and characterise the local products. For better comparability, both the clay raw materials and the pottery have been analysed with the same petrographic methods (see *infra*).


Fig.1. Analyzed clay and raw materials from production centres in Southern Italy.

[4] Based on Cocco 1971a; Cocco 1971b; Ortolani et al. 1991, 163-69, 4.
[5] Ortolani 1999.

### 2.1. Overview of local ceramic raw materials

The locally available ceramic raw materials of Velia and their petrographical and mineralogical composition are a result of the regional geology of the hinterland and the Pleistocene to recent, local sedimentation history.

Within the area of the ancient town of Velia and its surroundings following geological formations occur (fig.2).[6]

- The oldest (basal) formation outcropping at Velia and its surroundings is the cretaceous Ascea Formation (Formazione di Ascea, Cenomanian to Neocomian age). Their flyschoid sediments consist of intercalated, fine grained, greyish to greenish siltstones, partially calcite cemented, fine grained sandstones and shale. Most of the hills and mountains on both sides of Velia belong to this formation.
- The Cretaceous succession of the Ascea Formation is unconformly overlain by the coarse grained sediments of the Centola Formation, probably of Pliocene age. The formation is characterised by sandy, very coarse grained conglomerates to boulder beds (e. g, the hill of the Castelluccio belongs to it).
- Pleistocene terrace deposits are developed for example in the South-Eastern part of the town (so-called Vignale) and along the northern flank of the Fiumarella valley. Other occurrences of such sediments are North of Velia along the Alento and Palistro valley (e.g. clay pit near Casal Velino, see fig.2 n. 14) Their sediments are composed of successions of sand, loam, shale with paleosol horizons. Important are also intercalations of partly strongly weathered, pyroclastics and tuffite horizons.
- The youngest sediments are Holocene to recent alluvial, colluvial and eluvial sediments, mainly gravel, sands and loams occurring in and along the flanks of the valleys of Alento, Fiumarella and Palistro. The most important local sources for ceramic raw materials are colluvial and Pleistocene terrace sediments, subordinate also reworked flysch sediments.

[6] The nomenclature is based on Cocco 1971a; Cocco 1971b; Ortolani et al. 1991, 165; Sauer 1999.

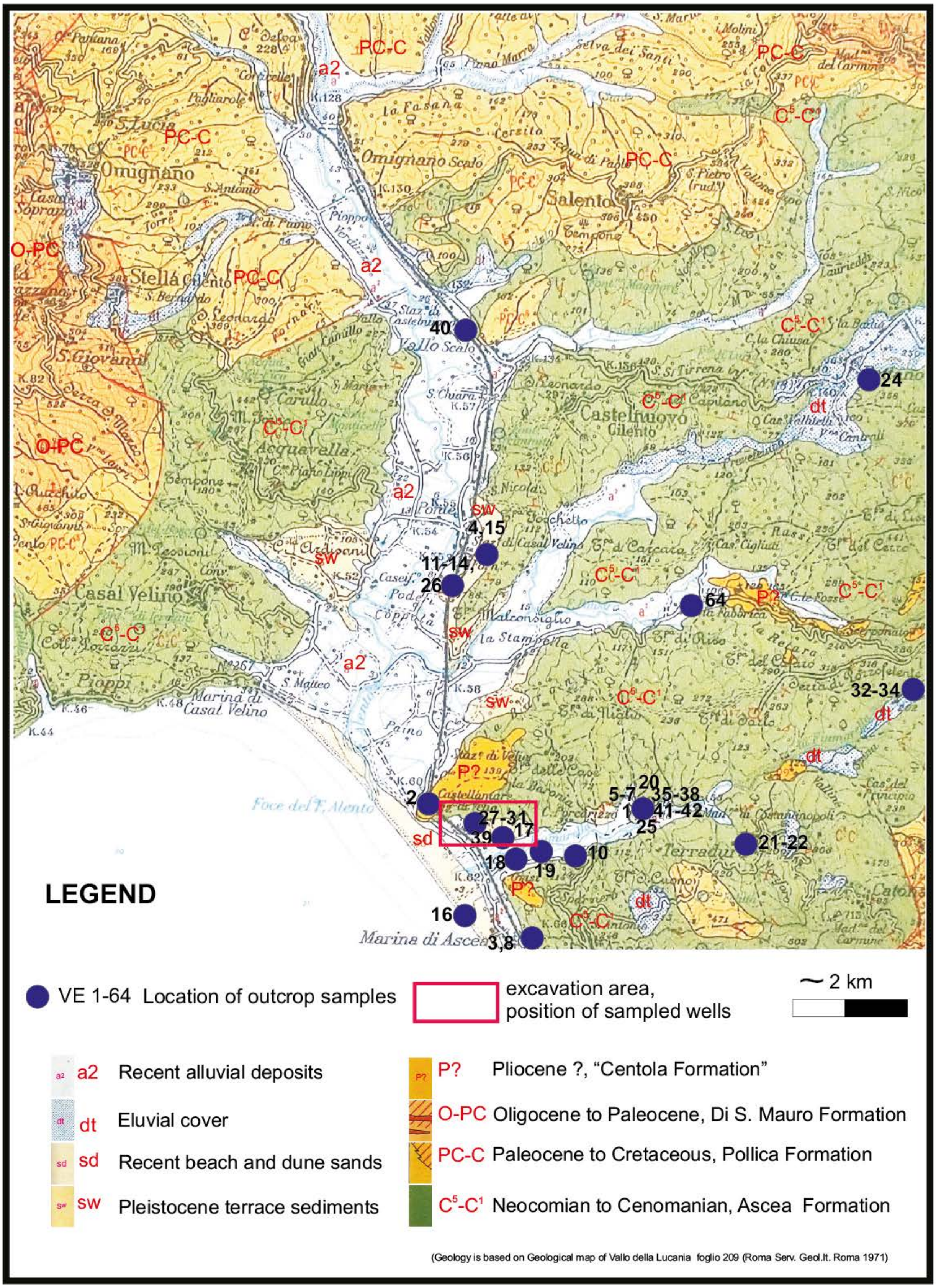


Fig.2. Location of relevant raw material samples at Velia and its surroundings shown on a simplified geological map (R. Sauer, based on Cocco 1971b). The numbers indicate findspots with the abbreviation VE in chapter.

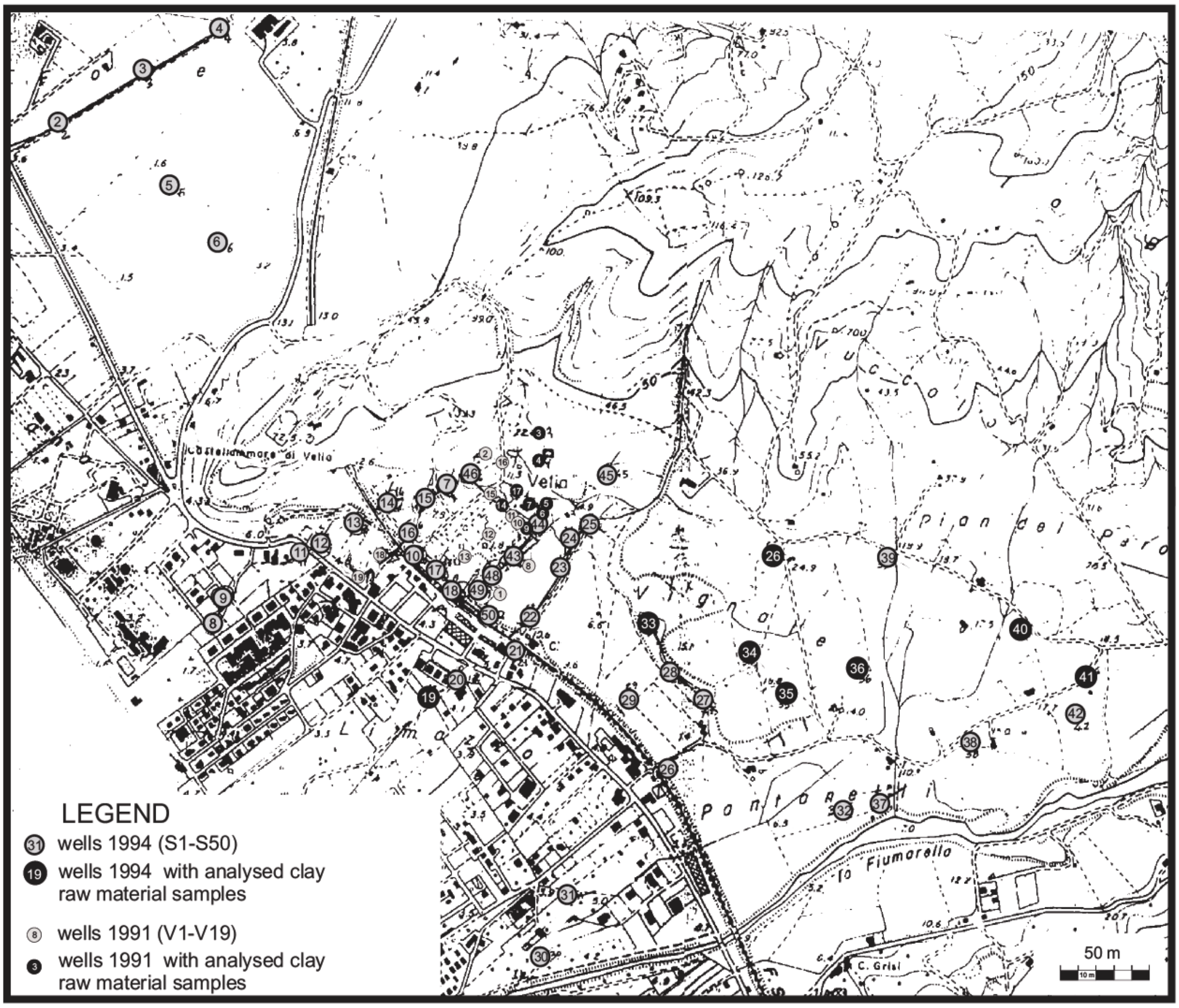


Fig.3. Location of drill cores at Velia.

## 2.2. Summarized petrographical and mineralogic characteristics of potential local Velinian ceramic raw materials

### 1. Pleistocene terrace deposits with silty clays within the area of Velia at the Vignale

(tab.1, fig.3, pl.1 – 2)

Samples: S33/1; S34/2; S35/4; S35/3; S36/5

*Matrix*:

Fine grained to slightly micaceous. Partly fine grained iron oxide globulae (former pyrite) can be observed.

*Natural temper grains*:

Predominant mono- and polycrystalline quartz, subordinate potassium feldspars, (partly sericitised) and brownish iron oxide concretions, rare heavy minerals (mainly titan oxides, zircon), quartzite, sand/siltstone grains, muscovite, biotite/oxidised sheet silicates, traces of chert, altered volcanic rock fragments and sanidine.

Typical are flysch-shale and quartzite fragments and frequent iron oxide cemented aggregates. Some samples are slightly contaminated with altered tuffite particles. Chert and quartzite particles show partially iron oxide rimmed molds of dissolved carbonate rhombohedrons.

*Heavy mineral composition*:

Typical are the dominances of brookite/anatase and subordinate zircon, rare also titanite, tourmaline and rutile can be found. Only as traces clinopyroxenes, epidote/clinozoisite and hornblende occur.

Such clays have been used most likely for the production of common ware and of amphorae (see fabric types RVGK01-1b and RVA001a).

**2. Paleosol horizons with altered pyroclastic layers intercalated in Pleistocene terrace deposits within the area of Velia** (tab.1, fig.2-3, pl.3 – 4)

Samples: VE 39b; several wells S34/1; S34/1A; S35/1; S36/4; V4/2; V4/3; V5/3; V5/4; V5/5; V6/1; V6/2; V7/1

*Matrix*:

Extremely fine grained, practical devoid of mica. Consists probably mainly of smectite rich clay originating from decomposed volcanic ash.

*Natural temper grains*:

Predominant sanidine and partly strongly altered volcanic glass particles, subordinate quartz, volcanic rock fragments and brown iron oxide aggregates, rare biotite, sericitised feldspars, heavy minerals (mainly clinopyroxene, titan oxides, hornblende/amphibole) can be observed. Typical is the abundance of altered volcanic ash fragments. In one sample also abundant diatoms could be observed (S36/4).

*Heavy mineral composition*:

The mineral composition is dominated by brownish amphibole and clinopyroxene. Admixtures of such clays have been most likely observed in local common ware and amphorae fabrics (see fabric types RVGK01-1b and RVA001a).

**3. Sandy loams from colluvial sediments in the area of Velia (e. g Vignale)**

(tab.1, fig.2, pl.5 – 6)

Samples: VE 27; VE 28; VE 29; VE 30; VE 31

*Matrix*:

The slightly micaceous matrix shows variable contents of fine mica.

*Natural temper particles*:

Predominant are brown iron oxide concretions, shale and siltstone fragments as well as mono and polycrystalline quartz. Subordinate potassium feldspars (partly sericitised), rare muscovite, plagioclase, rare heavy minerals, quartzite, muscovite, volcanic rock fragments can be found. Typical is the abundance of flysch fragments (shale, siltstone, quartzite clasts).

*Heavy mineral composition*:

The heavy mineral composition is dominated by brookite/anatase and subordinate clinopyroxene, rare zircon; Very rare also amphibole, rutile, titanite, tourmaline and garnet can be found. Such clays have been used mainly for mud bricks

**4. Colluvium and Pleistocene terrace deposits with abundant reworked flysch clasts in the Northern part of the La Fiumarella valley (brick kiln)** (tab.1, fig.2, pl.7 – 10)

Samples: VE/01; VE/05; VE/06; VE/09; VE/10; VE/22; VE/25; VE/35; VE/36; VE/37; VE/37; VE/38; VEL41/96; VEL42/96

*Matrix*:

Fine grained to slightly micaceous.

*Natural temper grains*:

Predominant mono and polycrystalline quartz and brownish iron oxide agglomerates, subordinate potassium feldspars (partly sericitised), rare muscovite, sand/siltstone grains, quartzite, crystalline rock fragments, heavy minerals (mainly clinopyroxenes, titan-oxides, hornblende/amphibole), traces of volcanic rock fragments and siliceous microfossils.

Typical is the abundance of flysch to shale and quartzite fragments.

*Heavy mineral composition*:

The heavy minerals are dominated by brookite/anatase, and subordinate zircon, rare clinopyroxene, rare rutile, titanite, tourmaline, garnet, epidote/clinozoisite and amphibole can be found.

**5. Various loam and silty clay deposits within Pleistocene terrace sediments and alluvial sediments from the Alento valley (e.g. clay pit)** (tab.1, fig.2, pl.11 – 12)

Samples: VE/11; VE/12; VE/13; VE/14; VE/26

*Matrix*:

The matrix shows variable mica contents and is very poorly sorted, natural temper is present.

*Natural temper particles*:

Mainly quartz and feldspar (mainly potassium feldspars, partly sericitised, very rare plagioclase, sanidine) and muscovite and brown iron oxide concretions, very rare heavy minerals (mainly clinopyroxene, titan oxides), quartzite, sand/siltstone grains, muscovite, chert and volcanic rock fragments. Typical is the increased mica content. Occasionally also decomposed carbonate concretions (most likely rhizolites) can be observed.

*Heavy mineral composition*:

Typical are dominances of brookite/anatase, clinopyroxene and zircon; accessory tourmaline, garnet, rutile and epidote/clinozoisite and hornblende/amphibole can be found.

**6. Reworked and weathered clays in the area of the flysch zone "Formazione di Ascea" in the near surroundings of Velia** (tab.1, fig.2 – 3, pl.13)

Samples: S26/2; VE/03; VE/04A; VE08; VE/15; VE/21; VE24; VE/32; VE/33; VE/34; VE/40/96; VEL/64

These raw materials show often a very heterogeneous composition and are very poorly sorted and often non plastic. Typical are the abundance of partly very coarse grained, heavily weathered and oxidised flysch components (weathered quartzitic sand and siltstones, fine grained shale clasts, etc. Sometimes also admixtures of paleosols with traces of volcanic material can be found. Few samples showed also poorly preserved carbonate aggregates (partly probably remains of rhizolites) and possible traces of gypsum.

*Heavy mineral composition*:

Typical are dominances of brookite/anatase and subordinate clinopyroxene and zircon; accessory hornblende/ amphibole, rutile, titanite, garnet and epidote/clinozoisite can be found.

This material seems to be only usable for the production of bricks/tiles.

**2.3. Remarks to the use of local clays**

Local common wares, but also kitchen ware and amphorae were manufactured in general from silty alluvial clays and paleosols (partially mixed with weathered volcanic tuffite horizons) derived mainly from the pleistocene terrace sediments. Occasionally, however, also reworked clays of the Ascea Formation were used.

Tiles, bricks and mud bricks were produced from all available Velinian raw materials, but sandy colluvial loams like those occurring in the Fiumarella valley near S. Maria were of particular importance (see fig.2). This fact is also emphasized by the localisation of a kiln for Hellenistic bricks in this area (see supra), but also mud bricks of the Archaic period were mainly made from colluvial sediments. Also the silty alluvial clays of the Alento valley were used until a few years ago by a modern brick plant near Casalvelino (fig.2, n. 11-14). Calcareous clays, especially suitable for the production of fine wares have not been found in the near surroundings of Velia so far.

The significant mineralogical-petrographical composition of the sediments occurring in the region of Velia easily allow to distinguish between pottery produced from local Velinian raw materials and imported wares of various other production sites (see fig.4 – 5). The main characteristic, common to all ceramic raw materials utilized at Velia, is the nearly complete absence of carbonate grains (with the exception of rare, heavily altered calcite vein and calcilutite fragments derived from the flysch zone). Typical is also the abundance of sericitised feldspars and a heavy mineral assemblage typically rich in brookite/anatase etc. (fig.4).

The region of Paestum, for example is distinguished by the abundance of carbonate grains in their temper grains due to the influence of a nearby carbonate source, see also further examples from southern Italy on fig.1 and fig.5.

## 3. Archaeometric analyses of pottery and raw materials

Following analyses have been performed:

**Thin section analyses**

From all samples petrographical thin sections have been prepared. Also clay and loam samples were analyzed by thin sections after having been fired to 750°C. As earlier studies of clays and tiles from Ischia[7] have shown that most of these samples were artificially tempered with sand grains, we tried to analyze both separately, the natural temper of the clay/loam matrix and the possibly artificially added sand temper. Artificial tempering is often characterized by a significant hiatus in grain size between natural temper and the intentionally added, better sorted sand (bimodal grain size distribution). Based on observations of unfired, intentionally sand tempered ceramic, the grain size >200µ has been selected for differentiation of artificial temper.

The poorly sorted particles of the grain size interval from 15µ to 200µ have been counted as natural temper. Of course this differentiation is only valid for obvious artificially tempered clays with a clear bimodal grain size distribution. In samples with no obvious intentional temper, e.g. no visible bimodal grain size distribution, like in natural raw materials, all particles >15µ have been counted as natural temper.

[7] These observations result from the analyses of tiles raw material and unfired bricks from the kilns under the church of S. Restituta, see Gassner and Sauer 2002, 553; see now also Olcese 2012, 345-48.

The thin-section analyses were mainly used to characterise the various fabrics by their typical texture (optical properties of matrix, amount of temper, grain size, sorting, pore types, etc.) and also to obtain some provenance information by analysing the mineralogical-petrographical composition of their inclusions (temper).

First by means of point counting analysis, partly also with standard comparison charts the proportion of matrix to temper was estimated (= volume percent). Grains > ≈15µ were considered as "temper". For a standardised characterisation of the "temper" particles and to enable graphical presentation of the results, the following method, developed for semi quantitative estimation of the proportions of different temper grains occurring in the ceramic thin-sections, was used.

The relative grain proportions were classified as follows:

a) occurrence within one (representative) field of view

- "dominant" (more than 20 grains): A (80)
- "very frequent" (10-19 grains): B (50)
- "frequent" (5-9 grains): C (30)
- "subordinate" (2-4 grains): D (15)

b) occurrence within 5 fields of view

- "moderate" (5-9 grains): E (10)
- "rare" (2-4 grains): F (5)

c) The very rare constituents were classified as follows

- "very rare" (more than one occurrence per thin section) G (3)
- "traces" (one occurrence): H (1)

All samples were analyzed with the same magnification (200X). For graphical presentation the estimated verbal frequencies were then replaced by the numbers (given in parentheses). Graphical comparisons with results derived by conventional particle counting (e.g. 300 temper grains per thin-section) showed a very good practical comparability within the main constituents. But the now applied method however is significantly faster. Furthermore it showed also better results for the minor, but often more significant constituents, due to the fact that one is forced to screen the entire thin-section. Grain size was estimated by measuring of 50 temper grains. Sorting and roundness was estimated by standard comparison charts.[8]

**Heavy mineral analyses**

In the case of sufficient sample material (>5g) it was possible to perform also heavy mineral analyses. Heavy mineral analyses[9] provide provenance information and facilitate to differentiate between the imported wares and local products.[10]

For a quantitative analysis of the heavy mineral composition of pottery, the heavy minerals need to be concentrated.[11] To do this, the pottery samples have been first disaggregated with a mortar and pestle. Then the grain size fraction 0.125 – 0.04 mm has been gained by wet sieving. This fraction was then cleaned with diluted hydrochloric acid to remove iron oxide incrustations on the surface of the heavy minerals. Because apatite is soluble in hydrochloric acid, apatite normally was not counted. The cleaned grain fraction was then used for heavy mineral separation. The liquid used for separation was bromoform (with a density of 2.85). The obtained heavy mineral fractions were then mounted on glass slides with epoxy resin. The heavy minerals have been analyzed and counted by means of a polarising microscope. If possible always 200 translucent grains have been counted. The results of the heavy mineral analyses are presented in form of graphs and tables.

In general the heavy mineral analysis was very successful. Since some heavy minerals can be become altered during high firing temperatures, very high fired samples are not suitable or should be taken with caution for provenances studies, because some heavy minerals could be difficult to identify or are already missing (like e.g. garnets). The intentional addition of sand temper can influence the quantity and relative percentage of the heavy minerals. Several tests on locally available clays, sand and siltstones have been performed to be able to interpret this possible effect. During firing tests also the influence of firing temperature on heavy minerals has been studied. With the exception of some highly calcareous fine ware fabrics (partly not enough material was available) and overfired samples, the heavy mineral analyses showed good results.

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[8] e.g. in Orton et al. 1993, 239.

[9] For a modern textbook on heavy minerals see also Mange and Maurer 1992, 147-55. For applications of heavy mineral analyses etc. see also Mange and Wright 2007, 1283-85.

[10] Peacock 1967; see also Williams 1983.

[11] See also Sauer 1989 – 91.

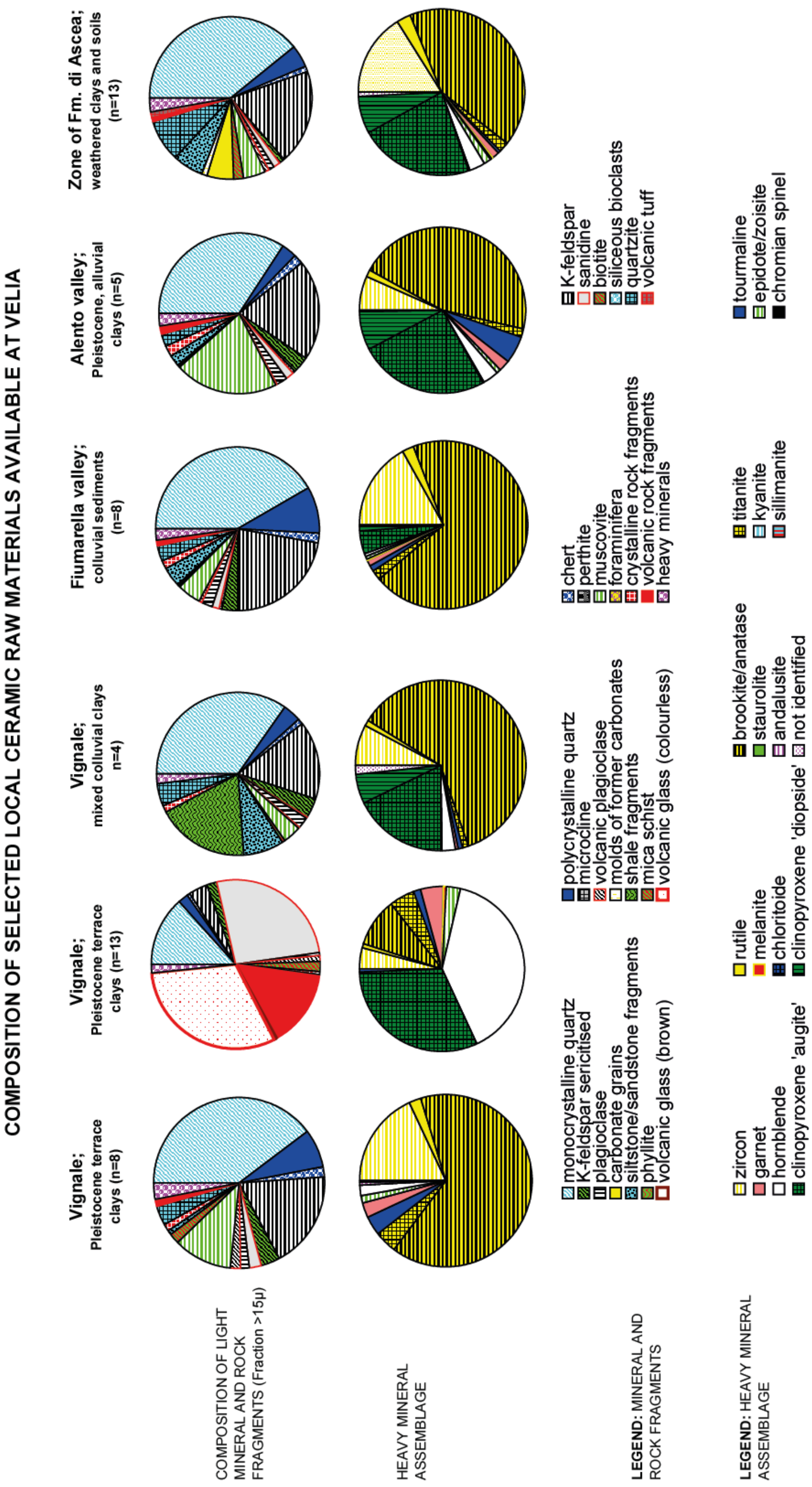


Fig.4. Local ceramic raw materials available at Velia.

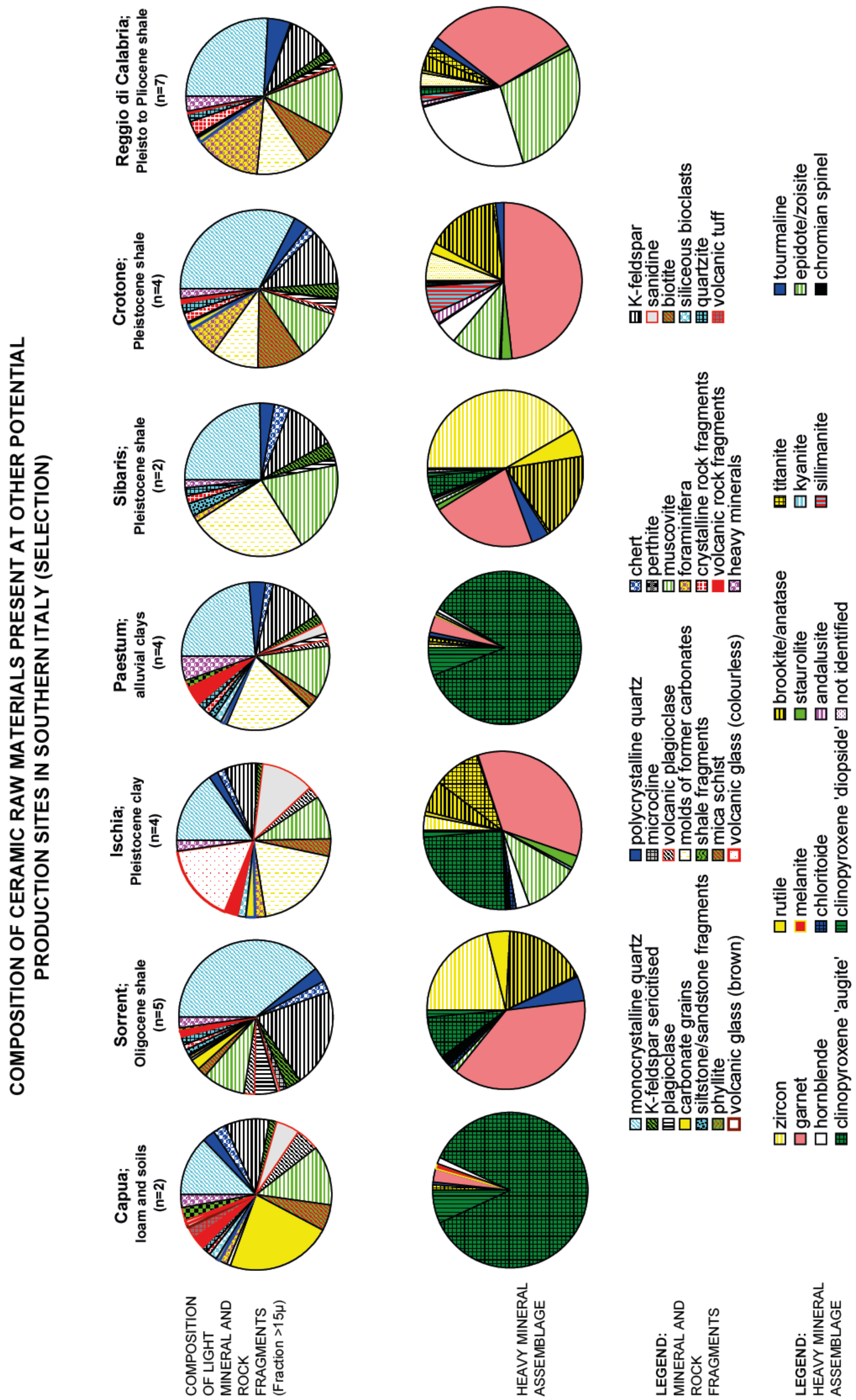


Fig.5. Ceramic raw materials present at other potential production sites in Southern Italy.

| Sample number | Location of outcrop and drill core samples (depth in m below surface) | Field description | Sediment type |
|---|---|---|---|
| VE 01 | Chapel S. Maria | weathered flysch clay or terrace loam, paleosol | Colluvium or terrace |
| VE 02 | Castelluccio, Velia | loam from weathered conglomerate | Colluvium |
| VE 03 | Marina di Ascea | weathered flysch clay, soil | weathered, reworked flysch sed. |
| VE 04a | Casal Velino Scalo | grey, reddish, brownish, fine clay, soil | weathered, reworked flysch sed. |
| VE 05 | Road in the Fiumarella valley, near the torretta | sandy brown clay (loam) | Colluvium or terrace |
| VE 06 | Outcrop near the torretta in the Fiumerella valley | clay | Colluvium or terrace |
| VE 07 | Fiumarella, brick kiln | river sand | Colluvium |
| VE 08 | Marina di Ascea | weathered flysch clay | Colluvium |
| VE 09 | Fiumarella valley | weathered flysch clay or terrace loam | weathered, reworked flysch sed. |
| VE 10 | Fiumarella valley | weathered flysch clay or terrace loam, paleosol | Colluvium |
| VE 11 | Clay pit of brick plant at Casalvelino | sandy clay, paleosol | Pleistocene terrace |
| VE 12 | Clay pit of brick plant at Casalvelino | sandy clay | Pleistocene terrace |
| VE 13 | Clay pit of brick plant at Casalvelino | sandy clay | Pleistocene terrace |
| VE 14 | Clay pit of brick plant at Casalvelino | sandy clay | Pleistocene terrace |
| VE 15 | Casal Velino Scalo | grey, reddish, brownish, fine clay, crumbly soil | weathered, reworked flysch sed. |
| VE 16 | Beach near Marina di Ascea | recent beach sand, mixed with VE 14 | sand |
| VE 17 | Marina di Ascea, 400 m south of the ancient town | ? sandy soil or weathering clay | Colluvium |
| VE 18 | Fiumarella valley, 300 m southeast of tower C 9 | river sand | sand |
| VE 19 | Fiumarella valley | soil | Colluvium |
| VE 20 | Fiumarella valley, 500m north of the chapel of S. Maria | weathered calcareous shale | weathered, reworked flysch sed. |
| VE 21 | 1,5 km northwest of Terradura | reddish brownish, flysch clay, weathering soil | weathered, reworked flysch sed. |
| VE 22 | 1,5 km northwest of Terradura | soil | weathered, reworked flysch sed. |
| VE 24 | Pattano, north of Velia | soil or weathering loam | weathered, reworked flysch sed. |
| VE 25 | Fiumarella valley, near ancient kiln brick | weathered flysch clay or terrace loam, paleosol | Colluvium or terrace |
| VE 26 | Clay pit of brick plant at Casalvelino | silty shale, paleosol | Pleistocene terrace |
| VE 27 | Velia, Vignale | soil or weathering loam, crumbly | Colluvium |
| VE 28 | Velia, recent water well | soil or weathering loam, crumbly | weathered, reworked flysch sed. |
| VE 29 | Velia, recent water well | soil or weathering loam, crumbly | weathered, reworked flysch sed. |
| VE 30 | Velia, recent water well | soil or weathering loam, crumbly | weathered, reworked flysch sed. |
| VE 31 | Velia, recent water well | soil or weathering loam, crumbly | weathered, reworked flysch sed. |
| VE 32 | Fiumarella valley, road near St. Babara | weathered flysch clay | weathered, reworked flysch sed. |
| VE 33 | Fiumarella valley, road near St. Babara | weathered flysch clay | weathered, reworked flysch sed. |
| VE 34 | Fiumarella valley, road near St. Babara | weathered flysch clay | weathered, reworked flysch sed. |
| VE 35 | Fiumarella valley, near ancient brick kiln | sandy clay | Colluvium or terrace |
| VE 36 | Fiumarella valley, near ancient brick kiln | sandy clay | Colluvium or terrace |
| VE 37 | Fiumarella valley, near ancient brick kiln | sandy clay | Colluvium or terrace |
| VE 38 | Fiumarella valley, near ancient brick kiln | sandy clay | Colluvium or terrace |
| VE 39 | Velia, Masseria Cobellis | coarse grained, sandy loam | Colluvium or terrace |
| VE 39b | Velia, Masseria Cobellis | sandy clay | Pleistocene terrace |
| VE 40/96 | Vallo Scalo | weathered flysch clay or terrace loam | weathered, reworked flysch sed. |
| VE 41/96 | Fiumarella valley, S. Maria | weathered flysch clay or terrace loam | weathered, reworked flysch sed. |
| VE 42/96 | Fiumarella valley, S. Maria | weathered flysch clay or terrace loam | Colluvium |
| VEL64/97 | Palistro valley near Petrosa | weathered flysch clay or terrace loam | weathered, reworked flysch sed. |
| Zeus | Velia, terrace of Zeus | fine to coarse grained sand | Colluvium |
| wells 1994 | | | |
| S19/4 | -16.5 m | loamy sand | Colluvium |
| S26/1A | -1.4 m | loamy sand | Colluvium |
| S26/1B | -1.4 m | loamy sand, paleosol, altered tuffite | Pleistocene terrace |
| S26/2 | -14 m | silty clay | reworked flysch sediments |
| S33/1 | -11 m | silty clay with plant remains | Pleistocene terrace |
| S34/1 | -4 m | paleosol, altered tuffite | Pleistocene terrace |
| S34/1A | -4.5 m | paleosol, altered tuffite | Pleistocene terrace |
| S34/2 | -11 m | greyish-green, silty clay | Pleistocene terrace |
| S34/3 | -14.9 m | loamy sand | Pleistocene terrace |
| S35/1 | -3.7 m | paleosol, altered tuffite | Pleistocene terrace |
| S35/3 | -10.3 m | silty clay | ?Pleistocene terrace |
| S35/4 | -11.3 m | silty clay | ?Pleistocene terrace |
| S36/1 | -4 m | weak loamy sand | Pleistocene terrace |
| S36/4 | -8.2 m | black clay with plant remains, tuffitic | Pleistocene terrace |
| S36/5 | -9.4 m | silty, greyish-greenish clay | Pleistocene terrace |
| S36/6 | -12.7 m | loamy sand, reworked flysch | Pleistocene terrace |
| S40/1 | -9.2 m | loam, reworked flysch, paleosol | Colluvium or terrace |
| S40/2 | -17 m | clay, reworked flysch, paleosol | Colluvium or terrace |
| S41/1 | -1.3 m | colluvial clay | Colluvium |
| wells 1991 | | | |
| V 03/1 | -3.6 m | greyish, loamy sand | Pleistocene terrace |
| V 03/2 | -7.8 m | coarse grained sand | Pleistocene terrace |
| V 04/1 | -1.9 m | aeolic sand, tuffitic influence or washed out | Pleistocene terrace |
| V 04/2 | -6.45 m | altered tuffite | Pleistocene terrace |
| V 04/3 | -7 m | altered tuffite | Pleistocene terrace |
| V 05/1 | -1.2 m | aeolic sand, tuffitic influence or washed out | Pleistocene terrace |
| V 05/2 | -3.4 m | coarse, loamy sand | Pleistocene terrace |
| V 05/3 | -3.8 m | paleosol, altered tuffite | Pleistocene terrace |
| V 05/4 | -5 m | paleosol, altered tuffite | Pleistocene terrace |
| V 05/5 | -5.3 m | altered tuffite | Pleistocene terrace |
| V 06/1 | -2.4 m | paleosol, altered tuffite | Pleistocene terrace |
| V 06/2 | -4.3 m | altered tuffite | Pleistocene terrace |
| V 07/1 | -2.6 m | altered tuffite | Pleistocene terrace |
| V 07/2 | -5 m | loamy sand | Pleistocene terrace |
| V 07/3 | -6.6 m | coarse grained sand | Pleistocene terrace |
| V 07/4 | -7.8 m | coarse grained sand | Pleistocene terrace |
| V 09/1 | -2.5 m | fine to medium grained sand with tuffite fragments | Colluvium |
| V 14/1 | -2.7 m | fine to medium grained sand with tuffite fragments | Colluvium |
| V 17/1 | -5.3 m | loamy sand | Pleistocene terrace |

Tab.1. Characteristics of local Velinian raw materials.

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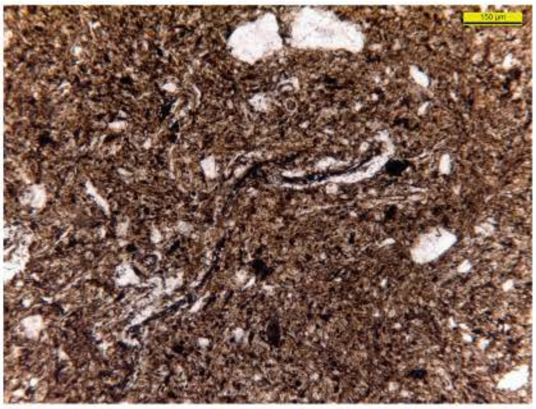
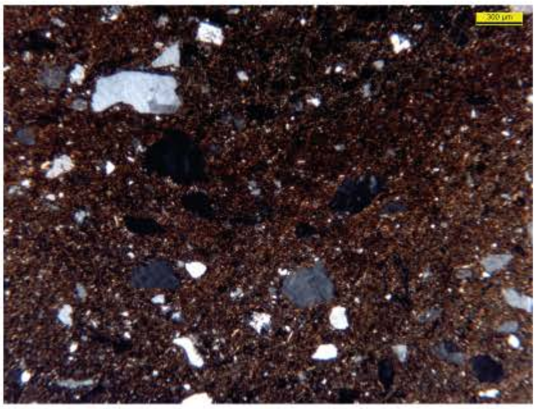
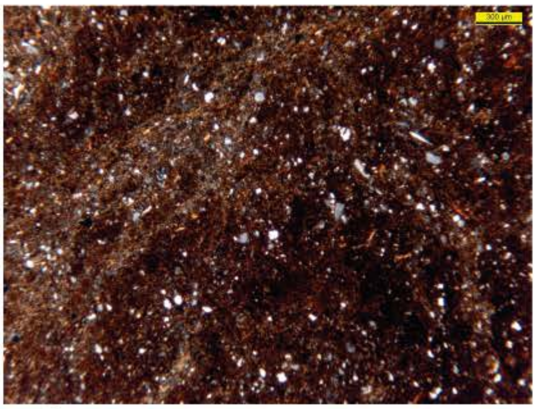
Pl. 1



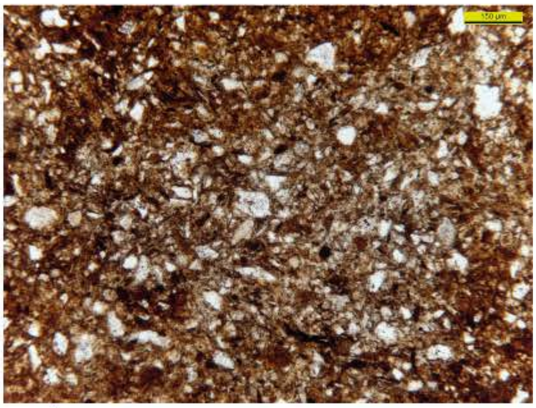
S33/1
pleistocene terrace deposit
core sample
silty/sandy clay with plant remains
thin section overview; //pol



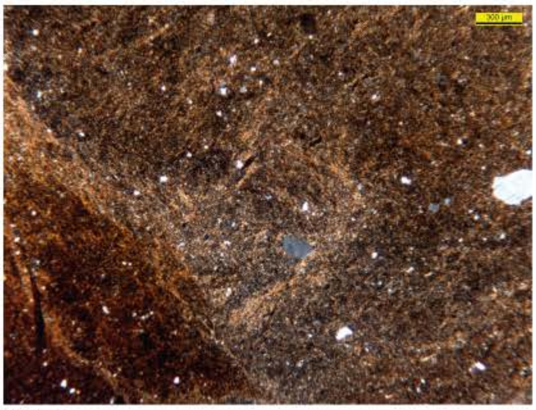
S33/1
pleistocene terrace deposit
core sample
silty/sandy clay with plant remains
thin section overview; #pol



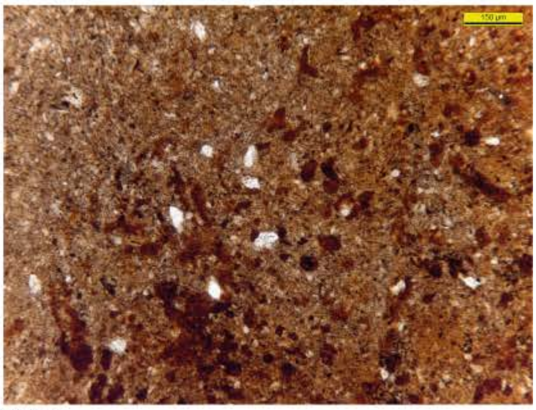
S34/2
pleistocene terrace deposit
core sample
silty clay
thin section overview; #pol



S34/2
pleistocene terrace deposit
core sample
silty clay
thin section overview; //pol

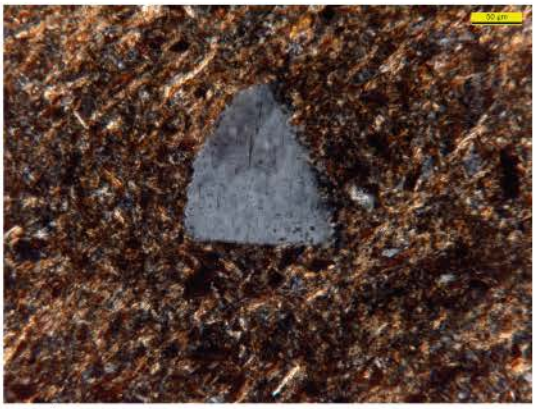


S36/5
pleistocene terrace deposit
core sample
silty clay
thin section overview; #pol

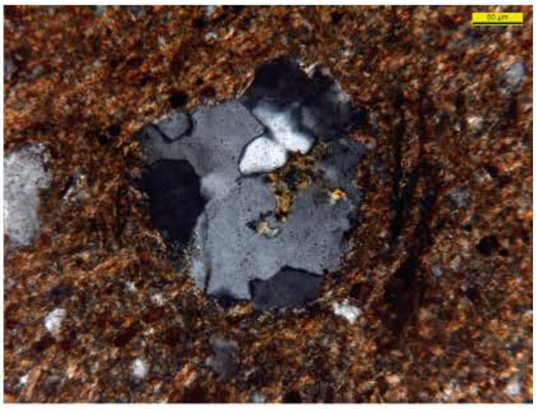


S36/5
pleistocene terrace deposit
core sample
silty clay
thin section overview; //pol

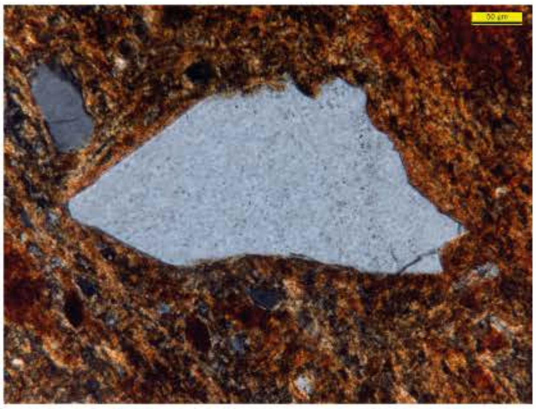
Pl. 2



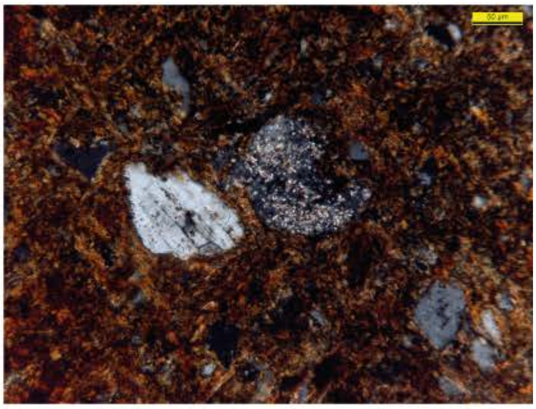
S33/1
pleistocene terrace deposit
core sample
k-feldspar grain
#pol



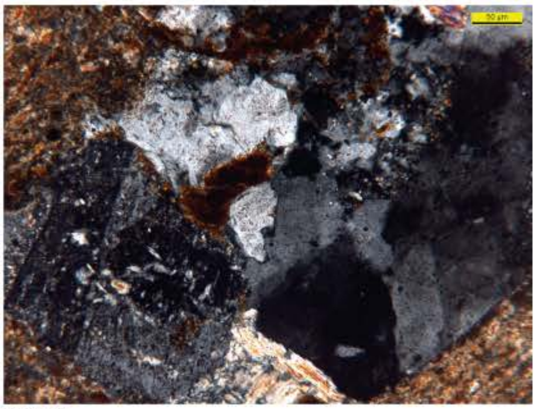
S33/1
pleistocene terrace deposit
core sample
polycrystalline quartz grain
#pol



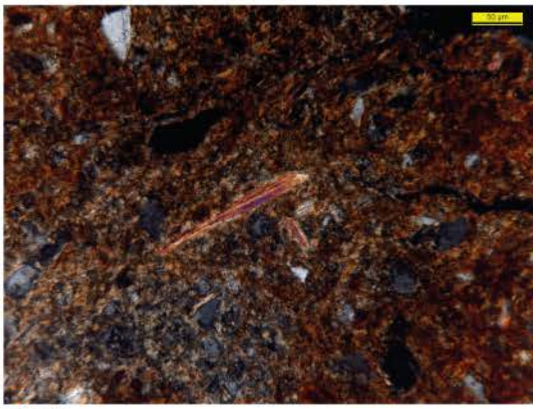
S35/3
pleistocene terrace deposit
core sample
monocrystalline quartz grain
#pol



S35/3
pleistocene terrace deposit
core sample
feldspar grains
#pol

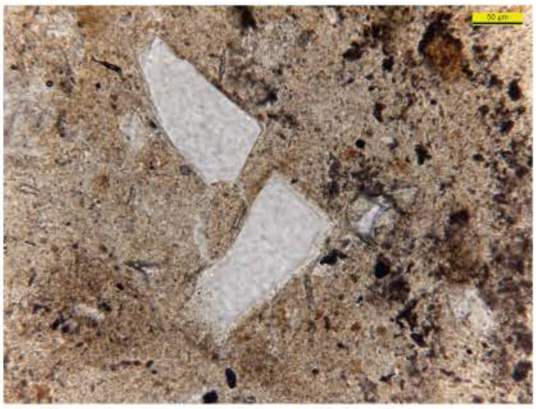


S33/1
pleistocene terrace deposit
core sample
crystalline rock fragment
#pol

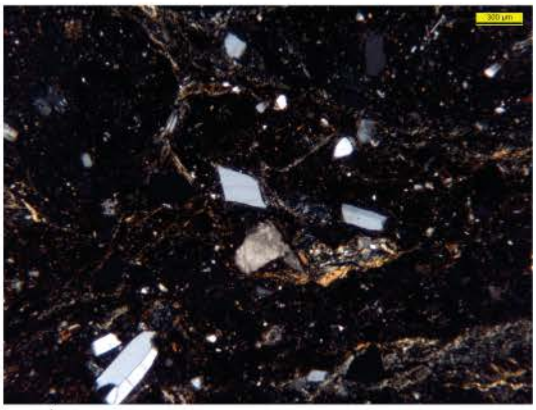


S34/2
pleistocene terrace deposit
core sample
muscovite flake
#pol

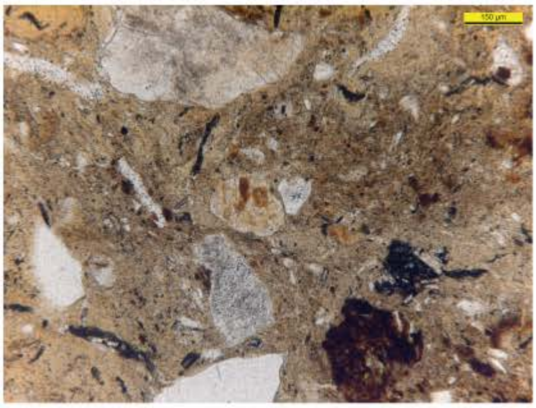
Pl. 3



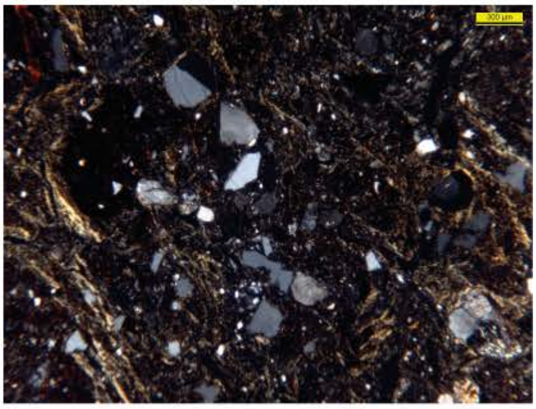
S34/1
pleistocene terrace
core sample
sanidine grains
//pol



S34/1
pleistocene terrace
core sample
sanidine
thin section overview; #pol

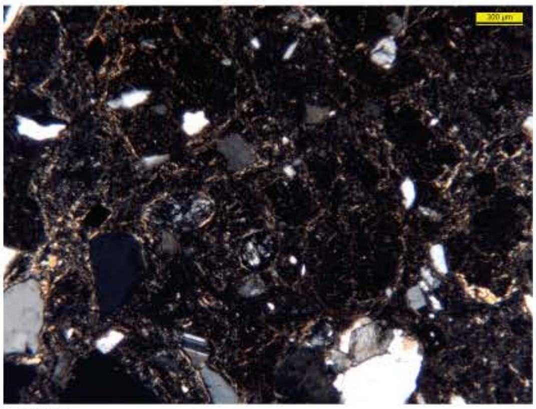


S35/1
pleistocene terrace
core sample
altered pyroclastic layer
thin section overview; //pol



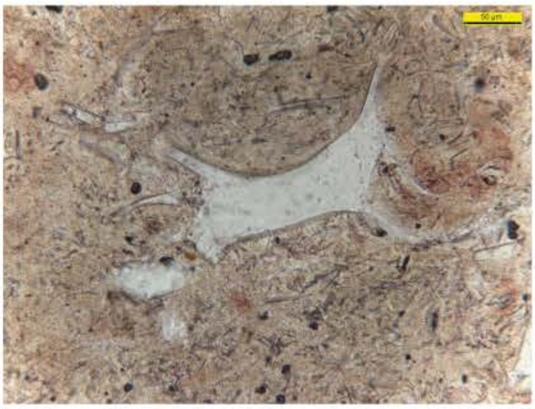
S35/1
pleistocene terrace
core sample
sandy clay, altered pyroclastic layer
thin section overview; #pol

V04/3
pleistocene terrace
core sample
sandy clay mixed with altered pyroclastic layer
thin section overview; #pol

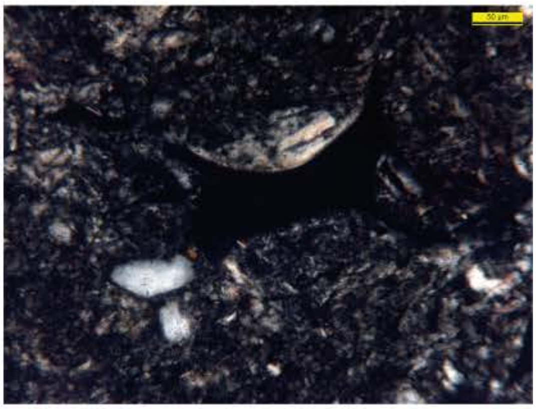


V05/5
pleistocene terrace
core sample
sandy clay mixed with altered pyroclastic layer
thin section overview; #pol

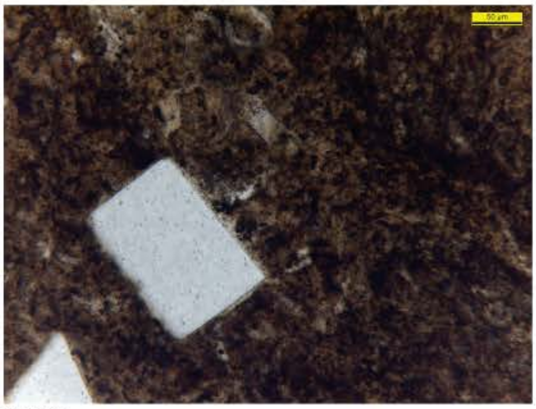
Pl. 4



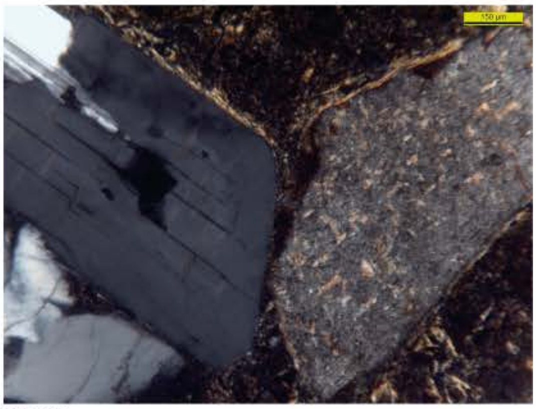
V04/3
pleistocene terrace
core sample
volcanic glass fragments, shards
//pol



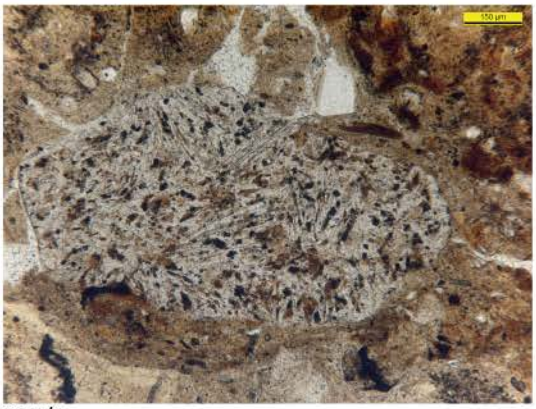
V04/3
pleistocene terrace
core sample
partly altered volcanic glass fragments, shards
#pol



S36/4
pleistocene terrace
core sample
sanidine
#pol



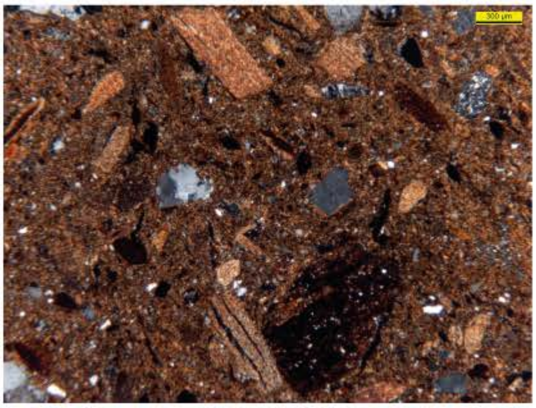
V04/2
pleistocene terrace
core sample
volcanic feldspar and sericitised k-feldspar
#pol



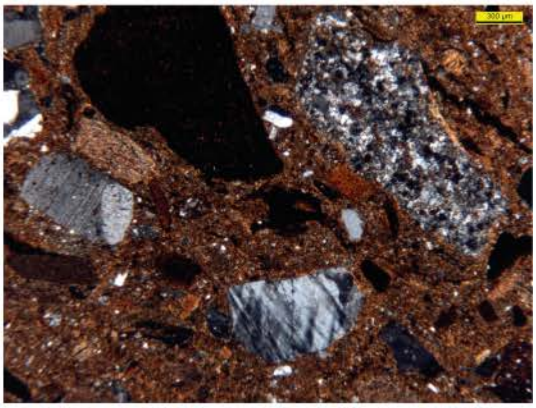
S35/1
pleistocene terrace
core sample
volcanic rock fragment
thin section overviewe; //pol

S34/1A
pleistocene terrace
core sample
biotite flake
//pol

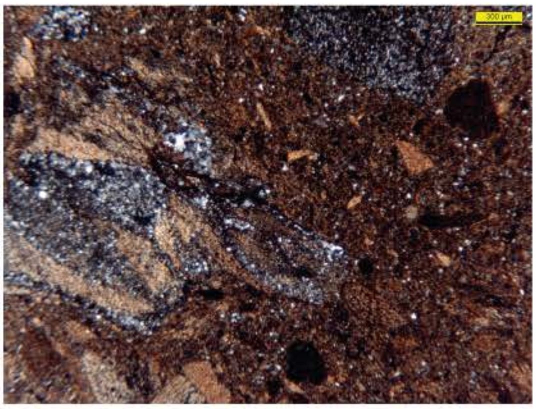
Pl. 5



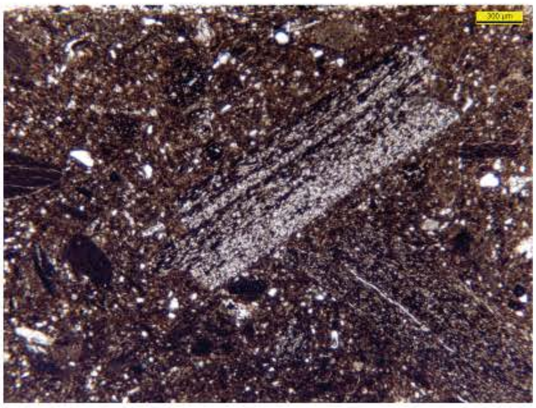
VE27
Colluvium
Velia, Vignale
sandy loam
thin section overview; #pol



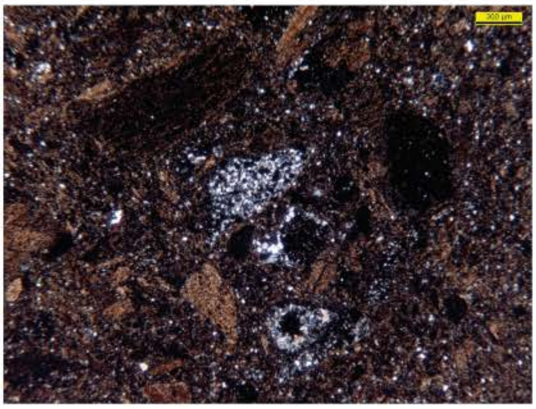
VE27
Colluvium
Velia, Vignale
sandy loam
thin section overview; #pol



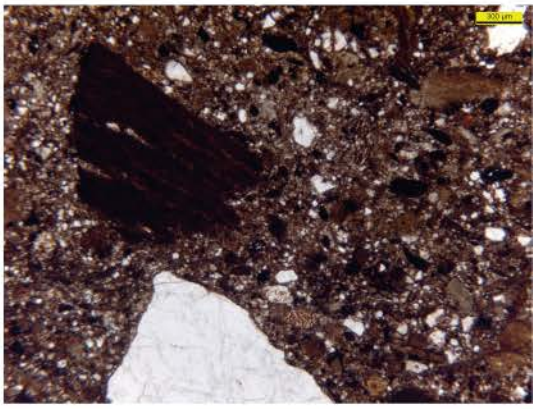
VE28
Colluvium
Velia, Vignale
sandy loam, quartzitic and flysch shale fragments
thin section overview; #pol



VE29
Colluvium
Velia, Vignale
layered siltstone fragment
thin section overview; //pol



VE29
Colluvium
Velia, Vignale
sandy loam
thin section overview; #pol

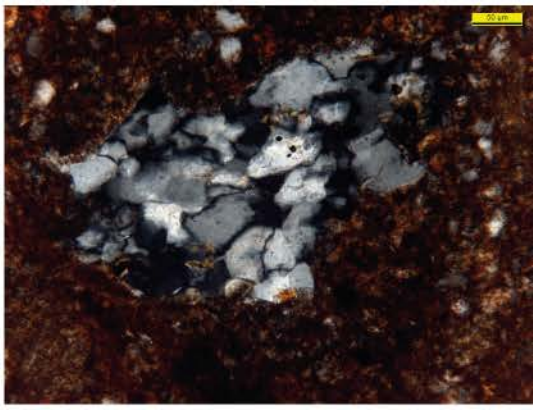


VE29
Colluvium
Velia, Vignale

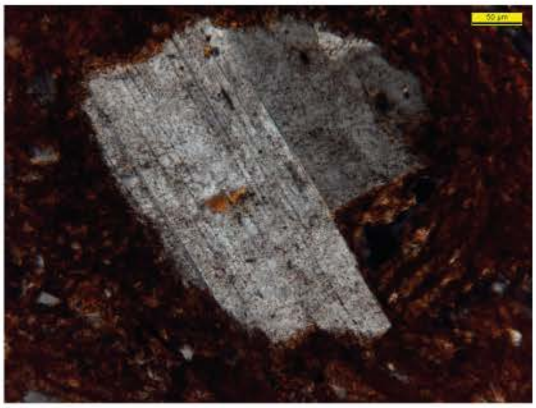
thin section overview; //pol

Pl. 6

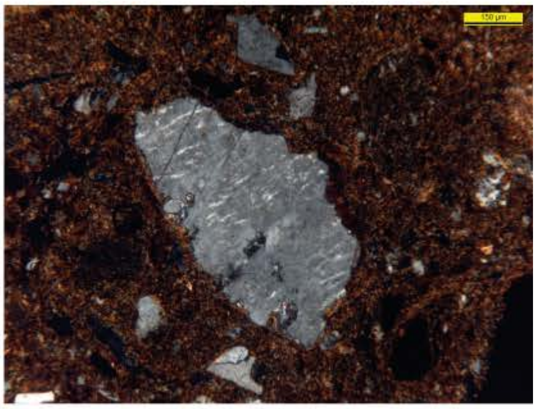
VE27
Colluvium
Velia, Vignale
clay clasts (flysch material)
//pol



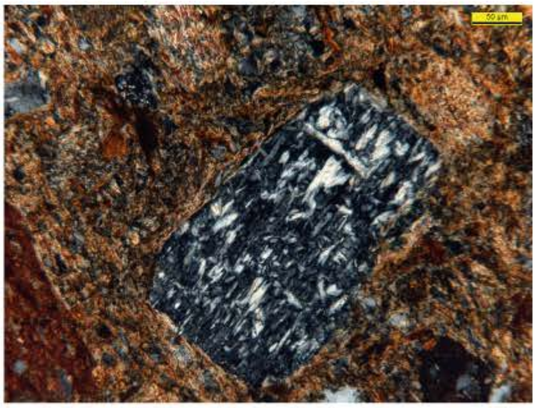
VE30
Colluvium
Velia, Vignale
quartzite with sericite
#pol



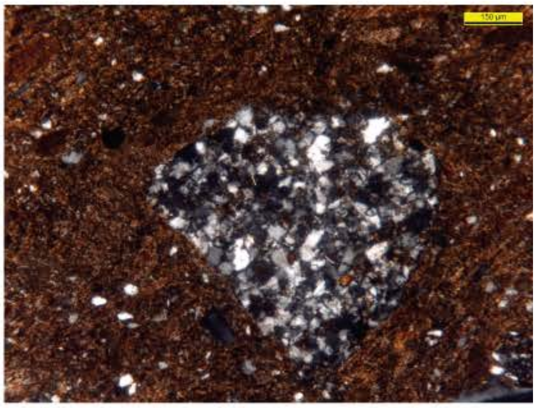
VE30
Colluvium
Velia, Vignale
plagioclase
#pol



VE30
Colluvium
Velia, Vignale
perthite
#pol

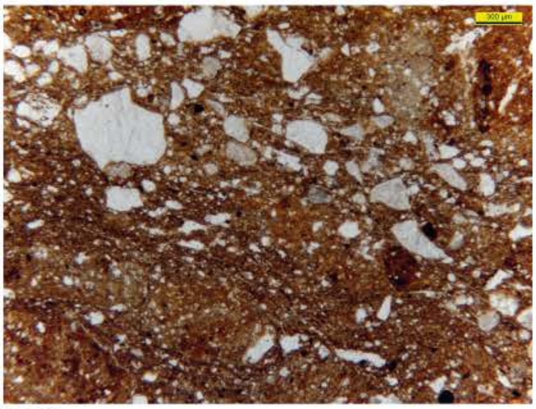


VE27
Colluvium
Velia, Vignale
sericitised plagioclase
#pol

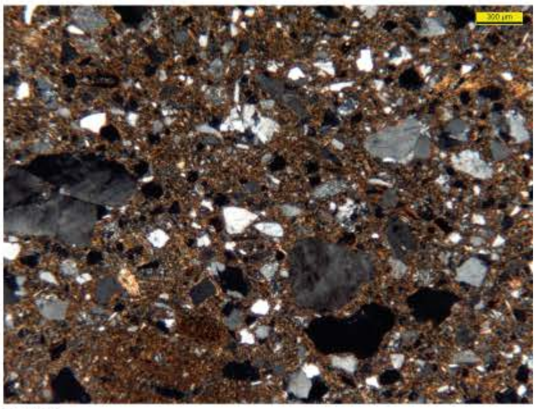


VE30
Colluvium
Velia, Vignale
quartz cemented siltstone
#pol

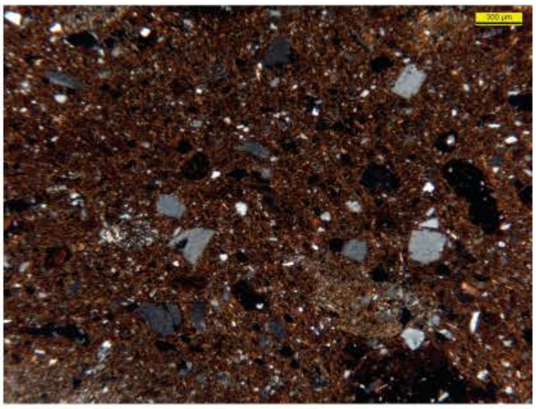
Pl. 7



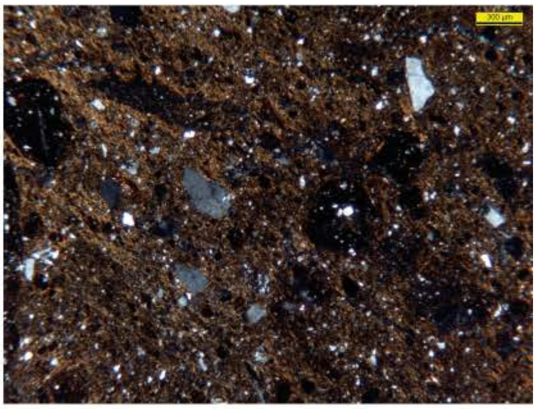
VE01
Colluvium
Chapel S. Maria
sandy loam
thin section overview; //pol



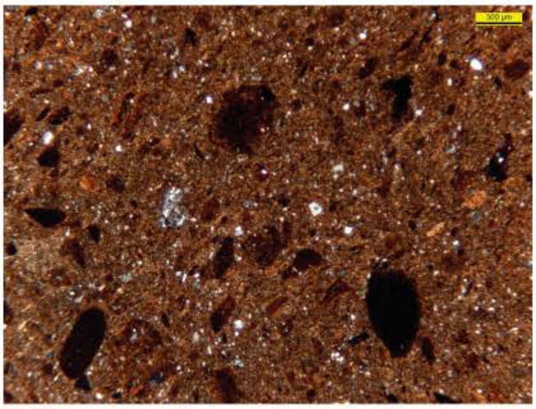
VE01
Colluvium
road in the Fiumarella valley near the Toretta
sandy loam
thin section overview; #pol



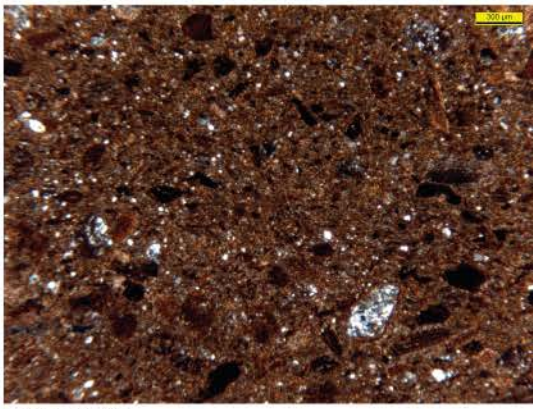
VE10
Colluvium
Fiumarella valley
weathered flysch clay/terrace loam paleosol
thin section overview; #pol



VE10
Colluvium
1.5 km north west of Terradura
soil/ weathered flysch
thin section overview; #pol

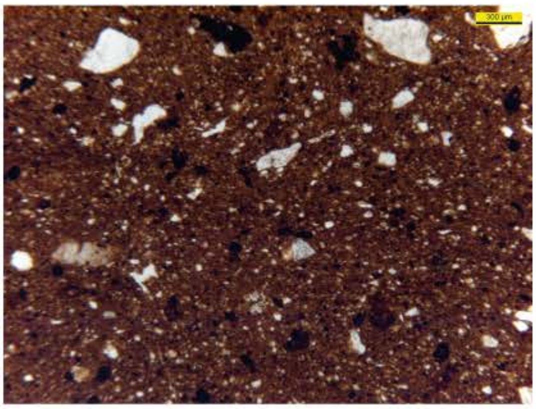


VE25
Colluvium
Fiumarella valley near ancient kiln
soil/weathered flysch clay
thin section overview; #pol

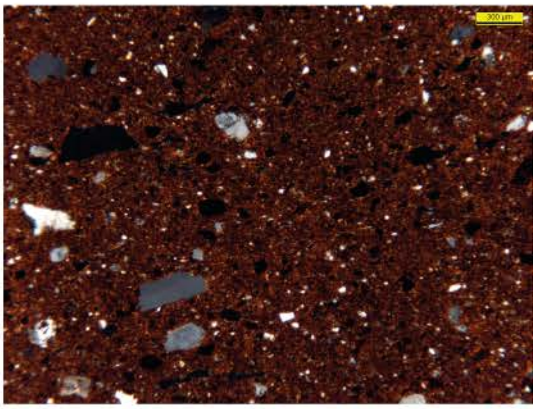


VE38 700°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; #pol

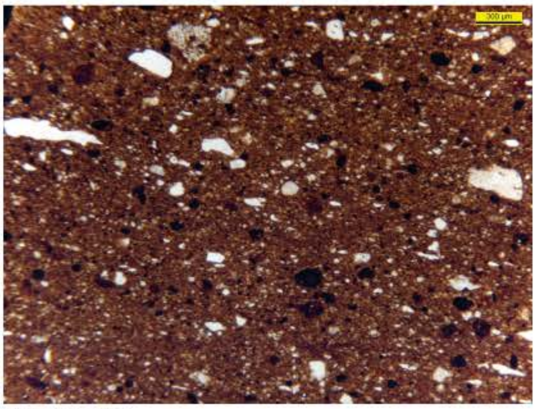
Pl. 8



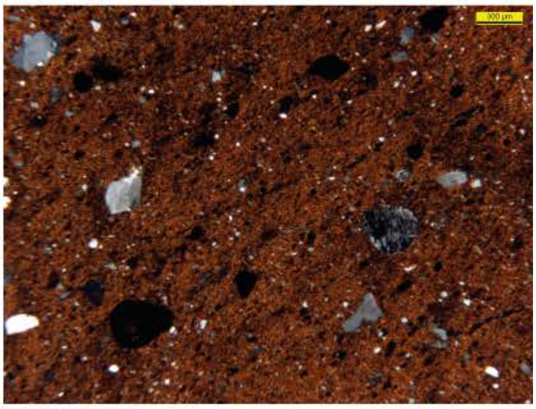
VE37 700°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; //pol



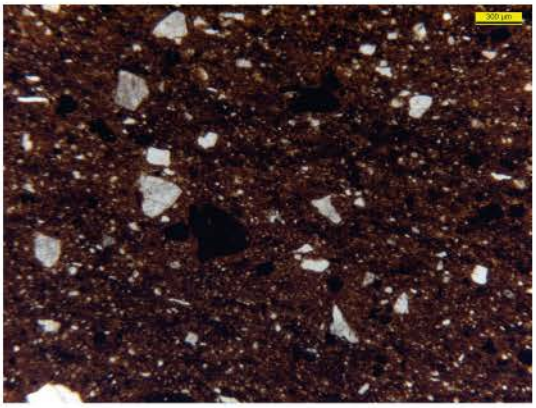
VE37 700°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; #pol



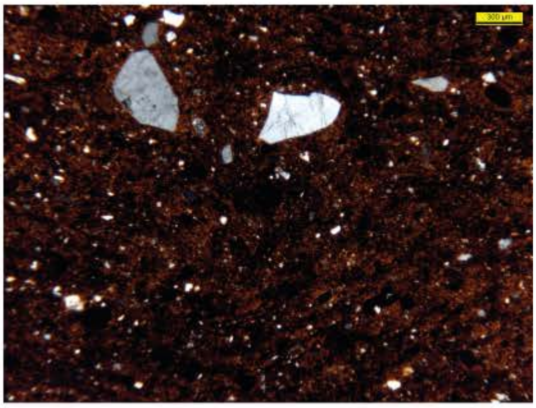
VE37 800°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; //pol



VE37 800°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; #pol

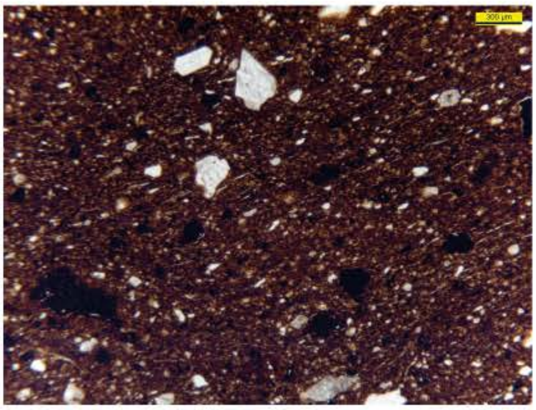


VE37 900°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; //pol

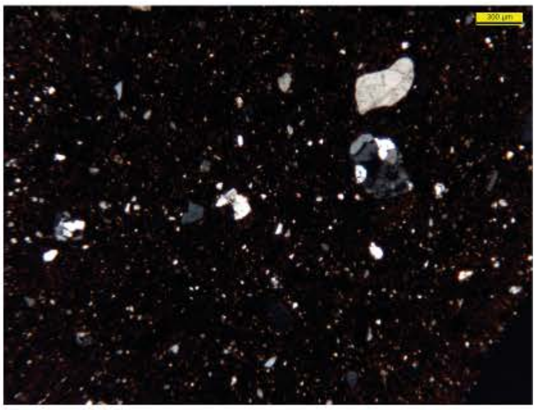


VE37 900°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; #pol

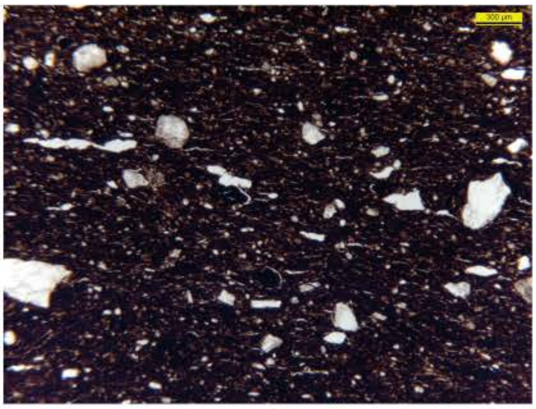
Pl. 9



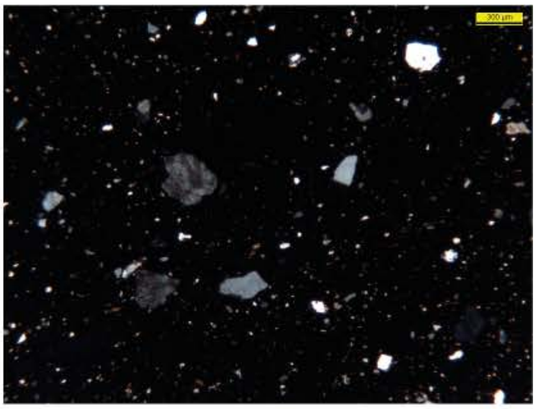
VE37 1000°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; //pol



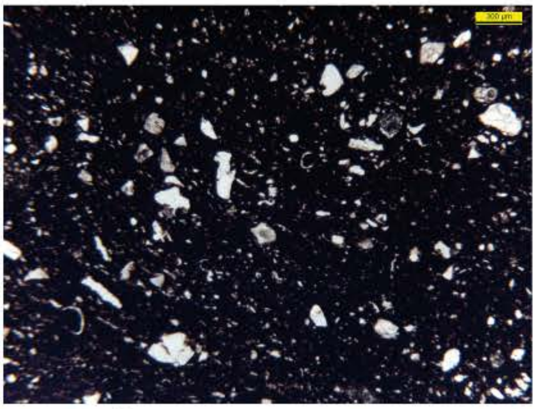
VE37 1000°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; #pol



VE37 1100°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; //pol



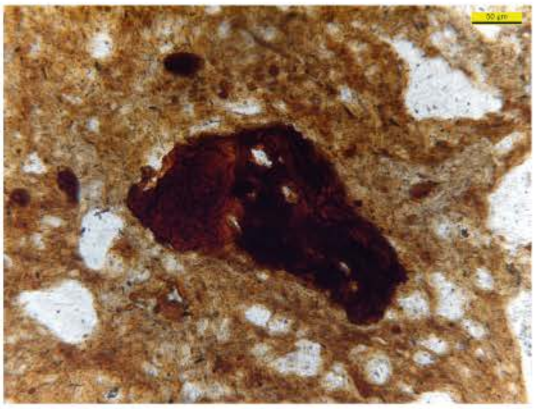
VE37 1100°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; #pol



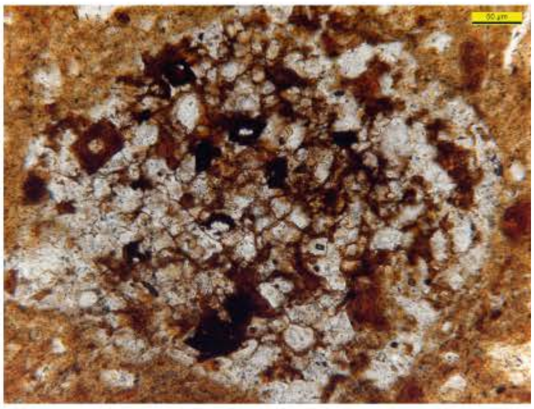
VE37 1200°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; //pol

VE37 1200°C
Colluvium
Fiumarella valley near ancient brick kiln
sandy clay
thin section overview; #pol

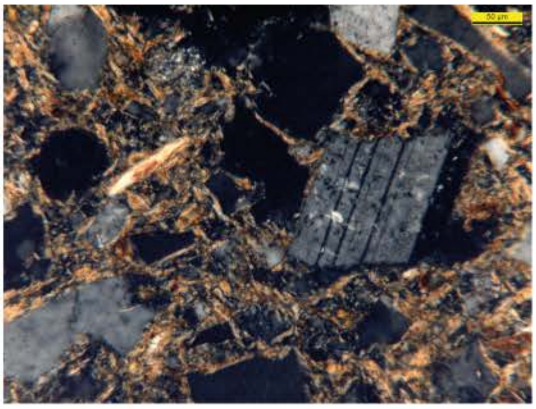
Pl. 10



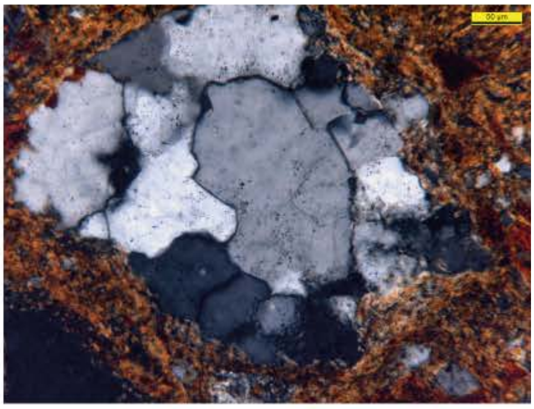
VE01
Colluvium
Fiumarella valley near ancient brick kiln
iron oxide
//pol



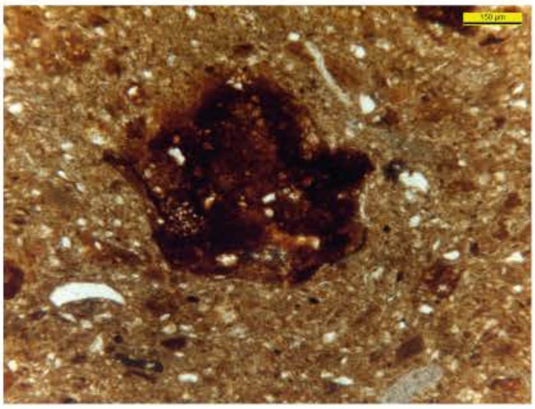
VE01
Colluvium
Fiumarella valley near ancient brick kiln
iron oxide cemented sandstone grain
//pol



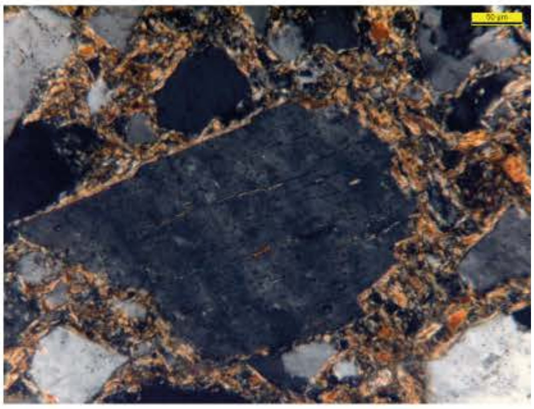
VE05
Colluvium
road in the Fiumarella valley near the toretta
plagioclase and mica
#pol



VE01
Colluvium
Fiumarella valley near ancient brick kiln
polycrystalline quartz
#pol

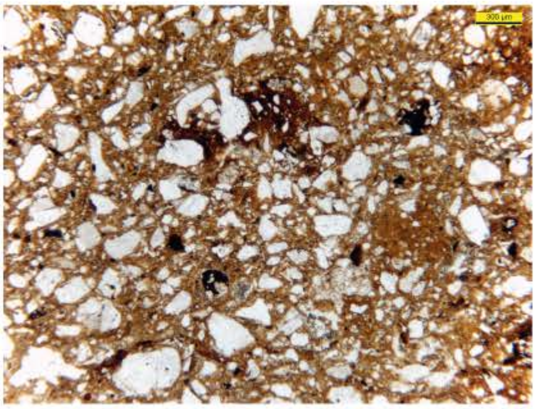


VE25
Colluvium
Fiumarella valley near ancient kiln
iron oxide cemented agglomerate
//pol

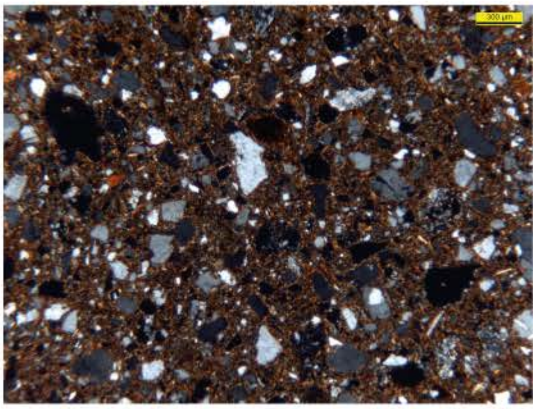


VE05
Colluvium
road in the Fiumarella valley near the toretta
K-feldspar
#pol

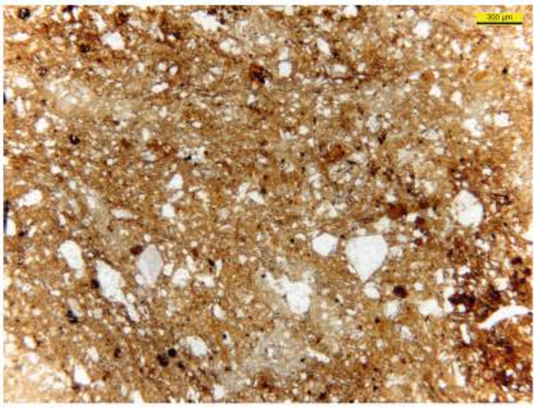
Pl. 11



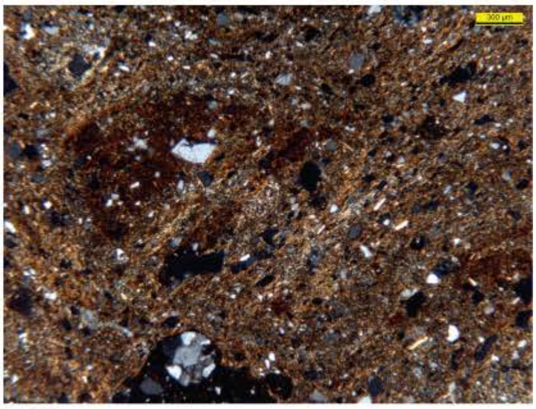
VE11
pleistocene
clay pit of brick plant at Casalvelino
sandy clay
thin section overview; //pol



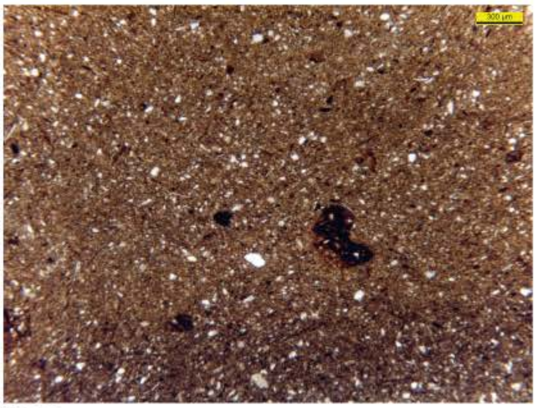
VE11
pleistocene
clay pit of brick plant at Casalvelino
sandy clay
thin section overview; #pol



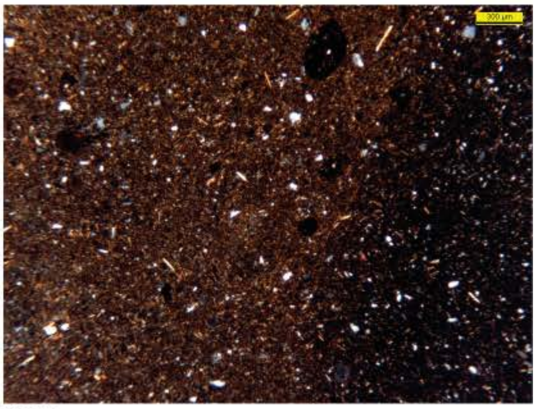
VE12
pleistocene
clay pit of brick plant at Casalvelino
sandy clay
thin section overview; //pol



VE12
pleistocene
clay pit of brick plant at Casalvelino
sandy clay
thin section overview; #pol

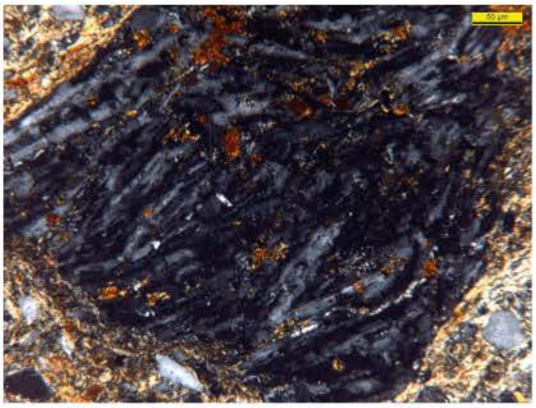


VE26
pleistocene
clay pit of brick plant at Casalvelino
silty shale
thin section overview; //pol

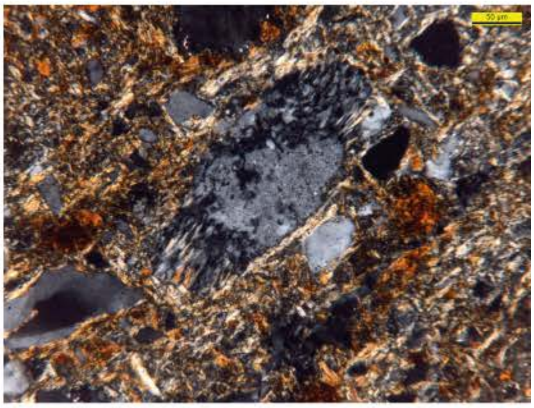


VE12
pleistocene
clay pit of brick plant at Casalvelino
silty shale
thin section overview; #pol

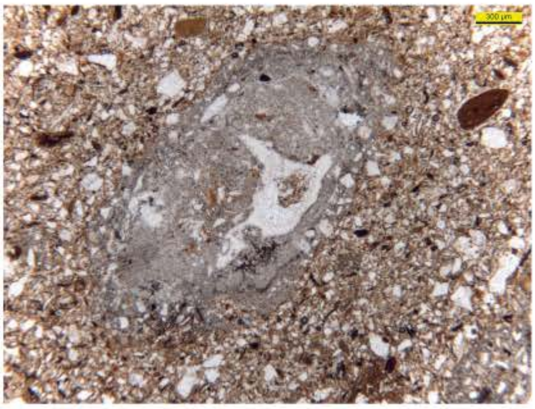
Pl. 12



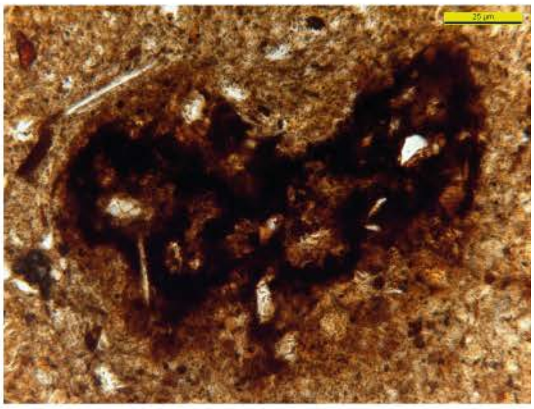
VE12
pleistocene
clay pit of brick plant at Casalvelino
volcanic rock fragment
#pol



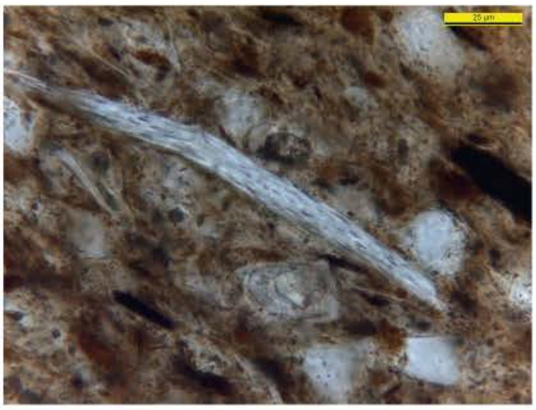
VE12
pleistocene
clay pit of brick plant at Casalvelino
volcanic rock fragment
#pol



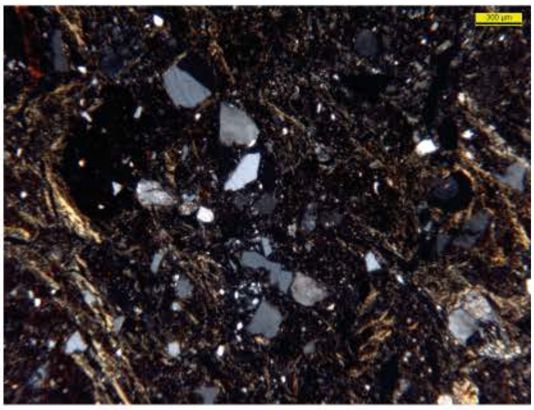
VE13
pleistocene
clay pit of brick plant at Casalvelino
carbonate concretion, rhizolite
//pol



VE26
pleistocene
clay pit of brick plant at Casalvelino
iron oxide cemented agglomerate
//pol

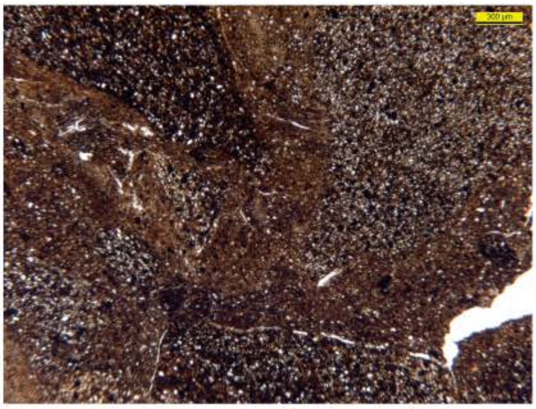


VE26
pleistocene
clay pit of brick plant at Casalvelino
muscovite flake
//pol

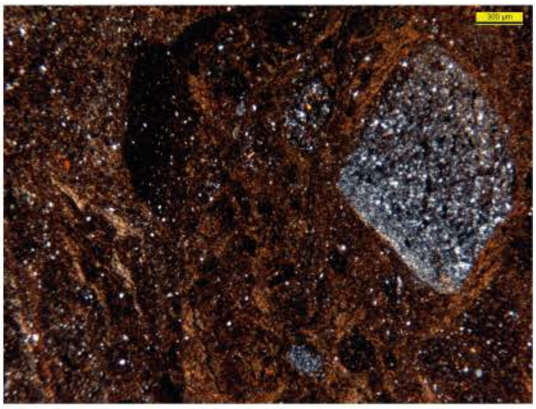


VE26
pleistocene
clay pit of brick plant at Casalvelino
muscovite flake
#pol

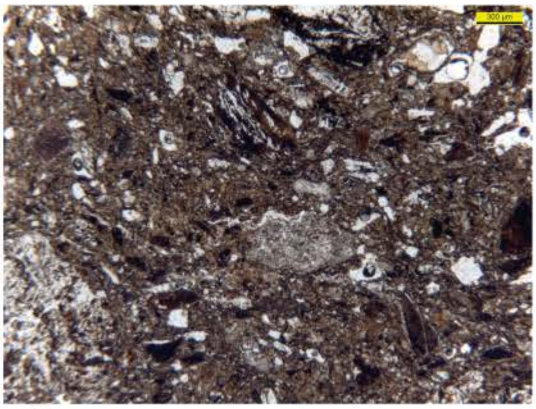
Pl. 13



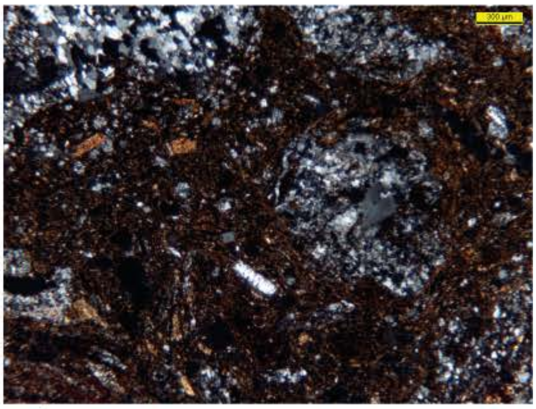
S26/2
Formazione di Ascea
core sample
silty clay
thin section overview; //pol



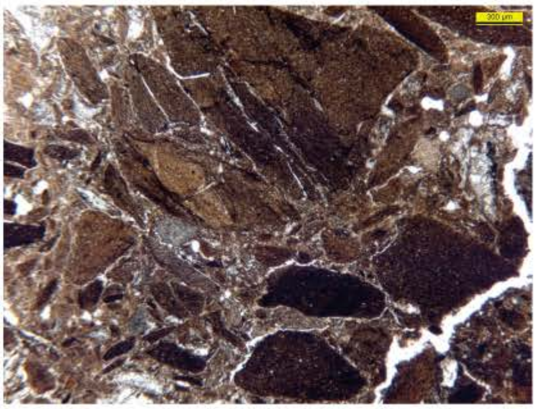
S26/2
Formazione di Ascea
core sample
silty clay
thin section overview; #pol



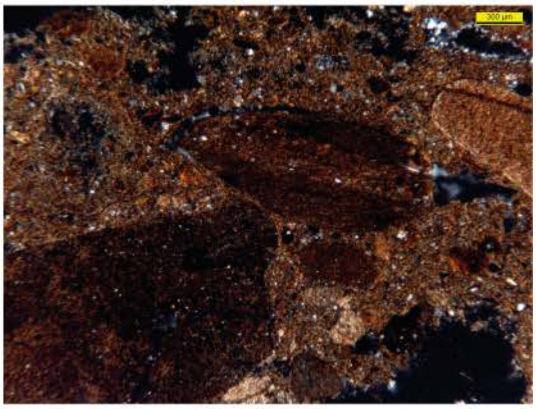
VE/03
Formazione di Ascea
Marina di Ascea
weathered flysch clay, soil
thin section overview; //pol



VE/03
Formazione di Ascea
Marina di Ascea
weathered flysch clay, soil
thin section overview; #pol



VE/15
Formazione di Ascea
Marina di Ascea
weathered flysch clay, soil
thin section overview; //pol



VE/24
Formazione di Ascea
Marina di Ascea
weathered flysch clay, soil
thin section overview; #pol