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32nd INTERNATIONAL GEOLOGICAL CONGRESS

GEOLOGICAL FEATURES AND THE HISTORICAL AND ARTISTIC HERITAGE OF VITERBO, CITY OF POPES, EMPERORS AND THERMOMINERAL WATER

Leader: U. Chiocchini

Associate Leaders: A. Lanconelli, S. Madonna

Florence - Italy
August 20-28, 2004

During-Congress **D06**

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AUTHORS:
U. Chiocchini[1], A. Lanconelli[2], S. Madonna[1]

[1]Dipartimento di Geologia, Ingegneria Meccanica, Idraulica e Naturalistica per il Territorio (GEMINI), Università della Tuscia, Viterbo - Italy
[2]Archivio di Stato di Roma - Italy

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Front Cover:
The old walls at Porta Faul, western side of Viterbo

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Introduction

The city of Viterbo is situated on the northwestern slopes of the Cimini Mountains (the Region of Latium) and its gently dipping landscape was shaped during the huge, mainly ignimbritic explosive eruption of the Pleistocene Cimini - Vicano Volcanic District (Figure 1). The field trip will allow participants to observe inside the inner parts of the main products of the volcanic activity. The surrounding areas are also characterised either by springs of thermomineral water, utilized since Roman times for therapeutic purpose, or by some quarries of a particular lithified gray tuff locally known as "peperino". Viterbo has an important historical and artistic heritage, since it is one of the best-preserved medieval cities in Latium. Today we can still see the formidable walls and buildings constructed between XII and XIII centuries. The city is situated along the main medieval road that connected the north and Rome – the Francigena Way traveled by pilgrims and German emperors – and was disputed for a long time between popes and emperors, who all left their marks on the city.

Regional geologic setting

The urban area of Viterbo rises on a Pleistocene volcanic territory, shaped during two different magmatic cycles: the felsic cycle of the Tuscan - Latium Province which gave birth to the Volcanic District of the Cimini Mountains (Marinelli, 1967); and the potassic cycle of the Comagmatic Latium Province represented by the Vicano Volcanic District. There are also more recent deposits consisting of some alluviums and eluvial-colluvial deposits. The volcanic substratum is made of either Tolfa Flysch or units of the Pliocene – Pleistocene neoautochthonous cycles outcropping essentially along the northern and eastern edges of the volcanic units (Sollevanti, 1983; Borghetti *et alii*, 1981, 1983). The Tolfa Flysh has been classified in different ways: by Boccaletti et *alii,* 1980 as an internal Austroalpine unit; as a part of the Tolfa Formation according to Abbate and Sagri, 1970; as Tolfetani Flysch according to Fazzini *et alii*, 1972, tectonically capping the Meso-Cenozoic units of the Tuscan - Umbria - Marche Domain (western sector; Figure 1B).

The Cimino and the Vicano Volcanic Districts are completely different from each other, both temporally and for the magmas they produced.

The magmatism of the Latium Province is characterised by two series: the KS and the HKS , typical of the Vicano District.

Rocks of felsic volcanism are considered hybrid because they are connected to a process of crustal melting of magmas rising from the mantle combined with the felsic magmas produced by anatexis processes. Potassic magmas rise from the mantle following a process of assimilation and differentiation. The formation of felsic magmas, including the geodynamic environment where the volcanic territory of the Cimini Mountains lays, are very complex and not well defined until now.

The Cimino Volcanic District

The activity of this district developed between 1.35 and 0.8 Ma in three different stages.

Some endogenous lavic domes were first set in place through some NW–SE trending fractures. Then a particularly energetic eruption followed, caused by riodacitic magma rising from the same fractures from which the domes had previously originated. The product of this eruption was a lithoid ignimbrite with a typical flame structure (Typical Peperino *Auct*.). The flow direction and distribution suggest that the magma expanded mainly north-east (Lardini and Nappi, 1987).

The second stage of the eruption occurred through some transversal fractures, with a quartz-latitic magma which determined the formation of some lavic domes. Some eruptions followed along the same fractures: the first were hydromagmatic eruptions producing pyroclastic surges, the second eruptions were characterised by a gas-rich magma producing another pyroclastic flow.

The third stage gave birth to a central volcano corresponding to the present-day Mt. Cimino. The activity started building the apparatus that consists of the superposition of quartz-latitic magmas, followed by latitic and olivine-latitic magmas rising from some lateral mouths.

The distribution of the volcanic rocks in the Cimini area is quite limited, and to the west it does not include the Vicano District, as is attested to by the lack of products of this area in the pyroclastic rocks of the Vicano Volcanic District.

The Vicano Volcanic District

There are lots of controversies regarding the evolution of this district. According to Nicoletti (1969) it formed between 0.82 and 0.52 Ma; the latter refers to the Vicano Tufo Rosso a Scorie Nere Unit. According

Figure 1 - Location of the Viterbo area and its main structural features. a) normal fault; b) main positive structural axis and c) main negative structural axis, obtained by gravimetric survey; d) normal fault obtained by seismic and geoelectric survey; e) normal fault detected on the base of field evidence; f) drilling by the Terny Company (1, 2 , 3, 4, 5), INPS (U) and wells of ENEL and ENEL-AGIP joint venture (F1, C1, V1, V2, VT1); g) location of the stratigraphic – structural sections A – A', B- B', C – C' (cfr. fig. 4); h) main thermomineral springs (Ba, Bagnaccio; Ca, S. Caterina; Bu, Bullicame).

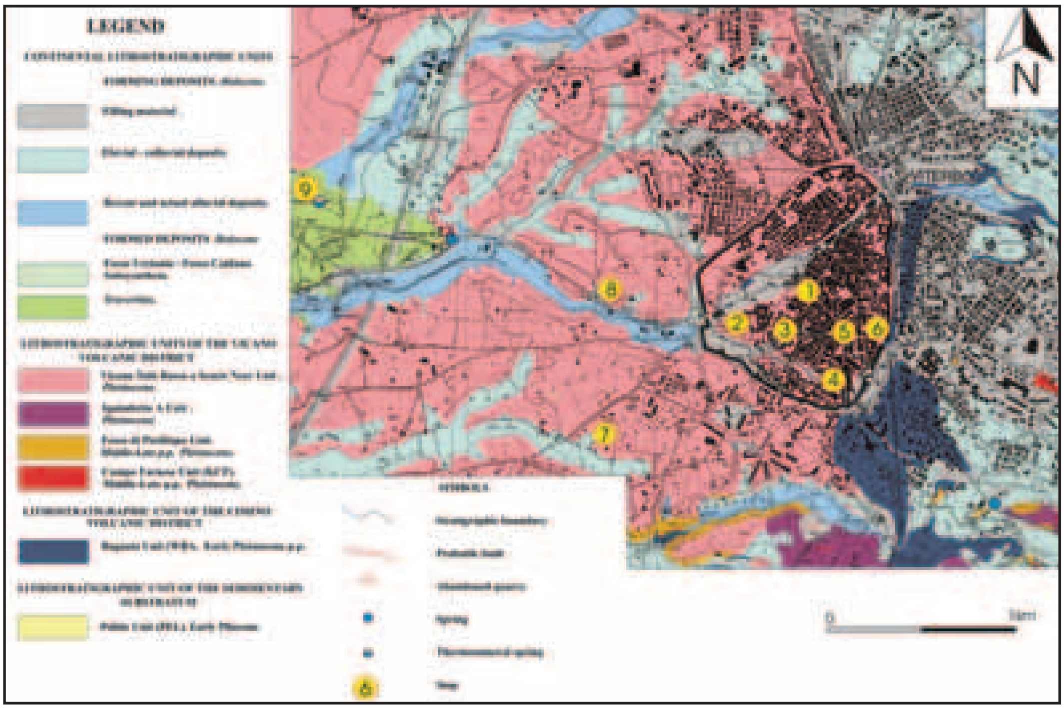

Figure 2 - Geologic map in the Viterbo urban area.

to Borghetti *et alii* (1981) this area developed between 0.4 and 1.144 Ma while according to Boccaletti *et alii* (1987) it developed between 0.7 and 0.25 Ma. The Consiglio Nazionale delle Ricerche (1987) estimates it rose between 0.7 and 0.14 Ma, while Bertagnini and Sbrana (1986) identify four different stages according to different kinds of eruptions.

The first stage was characterised mainly by an explosive Plinian eruption which deposited pumices on the northern side of the district. The second, mainly characterised by a lava eruption, led to the formation of the stratovolcano. The third was again an explosive Plinian eruption with the emission of the main pyroclastic formations (ignimbrite A, B, C, D; Locardi, 1965). The study of ignimbrite A and B showed that the deposits were the products of Plinian eruptions. In the case of ignimbrite C, also known as Vicano Tufo Rosso a Scorie Nere, the eruption is much more complicated: after a Plinian eruption some fractures led to the emission of the wide plateau of ignimbrite C. Then followed a collapse which led to the formation of a crateral lake. Finally, the fourth explosive eruption was characterised by a hydromagmatic circumcaldera explosive activity and a final effusive intracaldera activity.

Lithostratigraphy

The stratigraphic data of a geological survey (Figure 2) show that the reconstruction of the pyroclastic units' succession in the Cimino and Vicano Districts is quite clear. The Vicano District units, indeed, (the Campo Farnese Unit, the Fosso di Piedilupo Unit, the Ignimbrite A Unit and the Vicano Tufo Rosso a Scorie Nere Unit) lay on the older Bagnaia Unit (Typical Peperino *Auct*.) of the Cimino District.

In the Viterbo urban area the substratum of pyroclastic units varies from east to west. The data obtained from the drillings in the urban area and the excavations carried out for the building of houses along the road leading to San Martino point out that the substratum is made of Lower Pliocene marine pelites, lying immediately below the Bagnaia Unit, up to the Bullicame-Riello area; to the west, instead, it is characterised by the Tolfa Flysch. The same subsoil data show that the Ligurian and Austroalpine units form the substratum of the Pliocene deposits of the Vulsino, Cimino, Vicano and Sabatino districts (Baldi *et alii*, 1974).

The formations are those found within geological sheets 354 "Tarquinia" and 355 "Ronciglione" at a scale of 1: 50.000 (Servizio Geologico Nazionale, in press), neighbouring the urban area of Viterbo, and according to the directions of the Servizio

Geologico Nazionale (1992). The description of the lithologic features of the volcanic units is the result of observations on some stratigraphic sections and many single outcrops.

Lithostratigraphic units of the Cimino Volcanic District

The Bagnaia Unit

This formation – also known as "Typical Peperino" (Sabatini, 1912 a; 1912 b), Quartz-latitic Ignimbrite (Servizio Geologico d'Italia, 1970) and Ignimbrite cimina (Nappi, 1985; Lardini and Nappi, 1987) – characterises the whole urban area of Viterbo both in the surface outcrops and in the subsoil. It is composed of grey lithoid tuff with a pipernoid structure and small, flat, blackish scoriae in a fine ash matrix. This unit is medium- to thick-bedded, often with the black scoriae aligned at the base of beds and sometimes with a pillar jointing. Its outcropping thickness is between 2 and 10 m.

The Bagnaia Unit has been used since ancient times for building purposes or as a decorative stone (Pinzari *et alii*, 1986). In the Viterbo urban area, along the . Cassia Road, at Km 80,300, in Via Belluno and Via della Palanzana, there are three abandoned quarries of this stone. Its deposit was the result of Early p.p Pleistocene pyroclastic flows.

Lithostratigraphic units of the Vicano Volcanic District

The Campo Farnese Unit

This unit outcrops only in the south-eastern side of the Viterbo urban area in Via della Pila, though it has been found also in the subsoil of St. Carlo at Pianoscarano. This unit consists of light-grey vesciculated and fractured lava also known as Petrisco *Auct*. It is composed of big leucite and sanidine phenocrysts. Its outcropping thickness is about 5 m, while in the St. Carlo boring at Pianoscarano its thickness reaches 44 m. A 6-m-thick level of almost loose tuff is intercalated in the lava succession of the drill. The age is Mid-Late p.p. Pleistocene.

The Fosso di Piedilupo Unit

The literature calls it "Vicano Stratified Multicolour Tuff" (Tufi Stratificati Varicolori Vicani; Mattias and Ventriglia, 1970) the Rio Ferriera Formation (Perini *et alii*, 1997). It characterises the eastern and southern areas of Viterbo.

It is composed of levels of whitish pumices, scoriaceous lapilli, and slightly-cemented dark-yellowish ashes, with intercalations of thick and very thick, bedded, brown paleosoils. Sometimes there can be found fragments of different kinds of lava. The pumice levels show normal and reverse grading and are the result of various Plinian eruptions.

Two kinds of Plinian pumices have been identified: Vico α and Vico β (Cioni *et alii*, 1987). The former characterises proximal areas and consequently such Viterbo urban area as the Strada Pontesodo and Strada Roncone neighbourhoods. It is composed at the base of trachytic pumices, juvenile scoriae and lithic fragments, capped by an ash deposit and a level of pyroclastic surge, sometimes with a chute and pool structure, and finally a level of latitic pumices. Its radiometric age ($^{39}Ar/^{40}Ar$) is 0,42 Ma (Villa, 1987).

The outcropping thickness of this unit is 1-2 m to about 20 m.

The Fosso di Piedilupo Unit is the result of some Mid-Late p.p. Pleistocene Plinian eruptions and pyroclastic surges.

The Ignimbrite A Unit

It can be found in the southern part of Viterbo and is composed of Plininan fallout deposits represented by a well sorted level of pumices and lithic fragments. They are capped by some deposits of pyroclastic flows composed of black scoriae and squashed bombs containing crystals of leucite and, subordinately, lithic fragments in a partially-welded, red-violet, ash matrix. The black scoriae contain crystals of clinopyroxene, leucite, biotite, plagioclase and sanidine.

Generally, the pyroclastic deposit is quite welded, and in the outcrops a certain discontinuity between the rich, welded and homogeneous pumice part and the more erodable and often partially-removed ash part is evident. The outcropping's thickness varies from a few metres up to 30-40 m. The pyroclastic rocks of this unit are used as building material and is known as "pozzolana". Two abandoned quarries have been found along the Cassia Road at km 80.

There is not an absolute dating of this unit in the present literature.

The deposit of the Ignimbrite A Unit is due to some the Mid-Late p.p. Pleistocene pyroclastic flows and Plinian falls.

The Vicano Tufo Rosso a Scorie Nere Unit

This is the unit which mostly characterises the urban area of Viterbo. It is formed by a fall of lapilli and light phonolitic-tephritic Plinian pumices, followed by a pyroclastic flow deposit. It consists of two or more flow units forming massive deposits. The first flow unit is composed of an agglomerate rich in lithic fragments, followed by the typical flow unit consisting of the reddish massive tuff(?) with black scoriae and porphyritic bombs containing leucite and sanidine, or by grey, slightly welded pyroclastic deposits ("pozzolana" *Auct.*). The lithic fragments

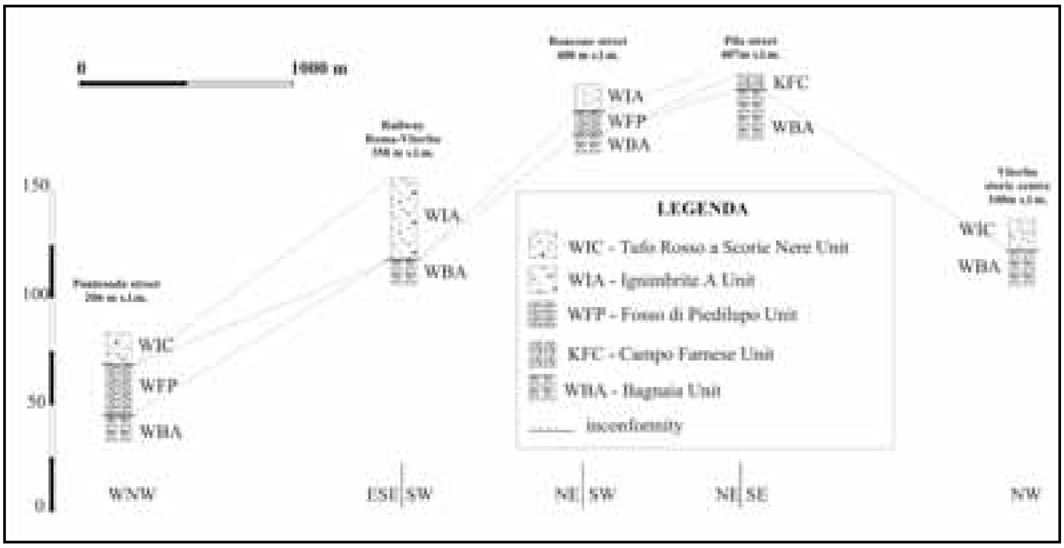

Figure 3 - Outline of the stratigraphic relationships among the volcanic units in the urban Viterbo area.

are partly derived from the sedimentary substratum (marls and marly limestones of the Tolfa Flysch), and the rest are lava rocks with leucite and sanidine. The red or yellowish matrix is due to the weathering processes and is composed of cloritic, clayey, zeolitic and limonitic minerals (Bertini *et alii*, 1971).

The most widely-spread facies is the typical reddish massive tuff with black scoriae and bombs, whereas the grey facies mostly characterises the area along Via Bagni, where it is also possible to observe a small cut filled with medium - fine grey-yellowish epiclastic deposits. The Vicano Tufo Rosso a Scorie Nere Unit is also affected by joints, which facilitate weathering of the rock mass, and by several anthropic cavities. The rock mass weathering is particularly evident along the city walls in Via del Pilastro which have already undergone some restructuring work.

The outcropping thickness varies from 1-2 m up to 25-30 m. Absolute dating of this unit shows various contrasting dates: according to Evernden and Curtis (1965) it dates back to 0.95 Ma, according to Nicoletti (1969) to 0.520 Ma, while Borghetti *et alii* (1981) and Sollevanti (1983) estimate it at around 0.55 ±1. 015 Ma, and Laurenzi and Villa (1987) date it back to 0.151 ± 0.3 Ma.

The deposit of this unit is due to Mid-Late p.p. Pleistocene pyroclastic flows and Plinian falls.

Continental lithostratigraphic units

These Holocene units include:

- recent alluvial heterogenic and heterometric deposits with a sandy-silty matrix, 8 to 10 m thick, and terraced alluvial deposits along the Urcionio torrent;
- eluvial-colluvial deposits, particularly wide-spread in the Viterbo urban area. They are produced by the weathering of pyroclastic units, with subsequent deposition in small valleys or depressions. They consist of heterometric and heterogenic or monogenic deposits with sandy-silty or pelitic matrix, 0,5 to 6 m thick. Often the eluvial-colluvial deposits are deeply reworked due to the anthropic activity of agricultural areas, or they are terraced and/or mixed with filling material;
- travertine deposits characterising the main thermomineral springs (Bullicame, Carletti, Zitelle and Bagnaccio; drillings by the Terni Company: Zitelle, Bacucco, S. Sisto, S. Salvatore and Bagnaccio). These travertines show a variable degree of diagenesis: on the surface they are crumbly and soft, while they are lithoid in the subsoil. They are typically porous and contain shells of gasteropods and vegetal fragments encrusted with calcium carbonate. The deposition of travertine is still continuing due to the action of the thermomineral waters flowing from the Bullicame spring. They are medium – thick bedded with subhorizontal attitude and with intercalations of brown silty-sandy paleosoils and/or alluvial deposits.

In the urban Viterbo area there are also some anthropic filling materials or materials reworked by anthropic activity, at places intercalated or mixed with alluvial and/or eluvial-colluvial deposits. These materials are connected to various kinds of centuries-old anthropic activities (excavations, landfills, levelling) and can be found in embankments, artificial hills, filling deposits of ancient river beds, or in connection with the building of infrastructures.

Relations among the lithostratigraphic volcanic units

The oldest unit is the Bagnaia Unit of the Cimino Volcanic District, capped by the units of the Vicano District in varying degrees from place to place (Figure 3). The contact between the various units is identified by the symbol of unconformity: this shows both the lack of continuity of deposition due to processes that produced the pyroclastic materials (pyroclastic flows, pyroclastic surges, etc.), and the presence of erosional stages.

The Ignimbrite A Unit outcrops in the southern part, near the railway connecting Rome to Viterbo, above the Bagnaia Unit, and it sharply ends at the level of Strada Roncone and at the railway itself (Figure 3). This succession is extremely important because it had not been identified by previous authors. In the nearby area, between Strada Roncone and S. Maria in Gradi, the succession is composed of the Bagnaia Unit followed by the Fosso di Piedilupo Unit and the Ignimbrite A Unit, while in Via della Pila the Bagnaia Unit is capped by the Campo Farnese Unit. In the central area, i.e. downtown Viterbo, the Bagnaia Unit is capped by the Vicano Tufo Rosso a Scorie Nere Unit, while in the southwestern side, near Strada Pontesodo, it is capped by the Fosso di Piedilupo Unit and the Vicano Tufo Rosso a Scorie Nere Unit (Figure 3).

The Bagnaia Unit and the Vicano Tufo Rosso a Scorie Nere are respectively situated at the base and on the top of the succession and represent continuous volcaniclastic bodies; the Fosso di Piedilupo Unit and the Ignimbrite A Unit, instead, show more irregular geometries and variable thicknesses, due to the differing natures of the depositional processes of pyroclastic materials and to the palaeomorphology of the bottom and top surfaces of the pyroclastic formations, which also underwent erosional processes after the several eruptive stages of both volcanic

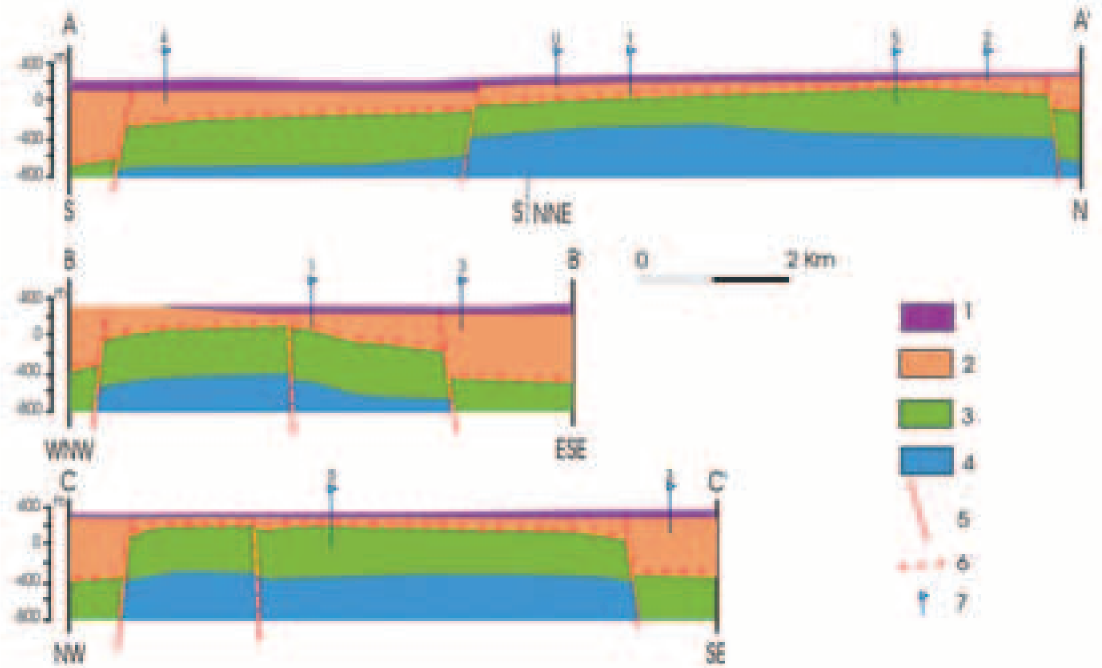

Figure 4 - Stratigraphic-structural sections of zone West of the urban area of Viterbo, reconstructed by means of geophysical prospecting and drilling by the Terni Company. 1) pyroclastic rocks of the Vicano District (Middle-Late p.p. Pleistocene); 2) Tolfa Flysch (Late Cretaceous-Eocene); 3) Scaglia and Maiolica of the Tuscan – Umbria – Marche successions (Cretaceous-Oligocene); 4) units of the Tuscan - Umbria - Marche successions from Maiolica to Calcare massiccio (Early Jurassic-Cretaceous); 5) normal fault; 6) thrust; 7) drilling (1) Zitelle; 2) Bacucco; 3) S. Salvadore; 4) S. Sisto; 5) Bagnaccio; 6) Uliveto). From Chiocchini et alii (2001).

districts.

Tectonics

The geological surveying did not bring out any significant tectonic elements. In the oucrop at the Porta Romana railway station a N 80° E normal fault was found in the Bagnaia Unit, with an inclination of 60° and 32 cm of vertical displacement. Two other small NW-SE and WNW-ESE faults were found along Strada Roncone. They are responsible for the repetition of the succession composed of the Fosso di Piedilupo Unit and the Ignimbrite A Unit, with a displacement of a few metres. These faults are connected to local deformations younger than the deposition of the Ignimbrite A Unit, and therefore not older than the Late Pleistocene. The geologic sections show that the pyroclastic units have a sub-horizontal attitude.

Some neo-tectonic studies (Conti *et alii*, 1980; Consiglio Nazionale delle Ricerche, 1987) show that in the area of Viterbo and the Cimini Mountains there are three, differently-developed, NW-SE trending belts. The western belt, close to Viterbo, is part of an uplifting structure during the Pliocene and the Quaternary. The central belt, stretching along the centre of the Cimini Mountains and the Lake of Vico, is characterised by a lowering in the Early Pliocene and an uplift until the Early Pleistocene. The eastern belt suffered a lowering in the Mid-Early Pliocene and a standstill or uplifting during the Late Pliocene and the Quaternary.

The volcanic area of the Cimino District corresponds to a graben axis and the alignment of the domes makes it possible to distinguish a NW-SE trending fracture zone of regional significance, active in the Early Pleistocene and responsible for the beginning of the eruptive activity in the district itself (Borghetti *et alii*, 1981; 1983) as well as in the areas of Radicofani and Torre Alfina (Barberi *et alii*, 1994). The tectonic movements are, therefore, characterised by an uplifting between the Vezza creek to the north and the Tiber River to the east. This uplifting is also connected to the reascending of the Cimino magma. A further and more evident uplifting can be found in the axial area of the domes; it is linked to the location of the domes themselves, which are aligned NW-SE along a narrow belt (Borghetti *et alii*, 1981, 1983; Sollevanti, 1983; Lardini and Nappi, 1987).

The analysis of the stratigraphic relationships among the different volcanic formations and their radiometric dating allowed for (Borghetti *et alii*, 1981) dating the age of the caldera collapse, which occurred after the deposition of the Vicano Tufo Rosso a Scorie Nere Unit (0.155 Ma). After the formation of the caldera, phreatomagmatic phenomena affected the eastern bordering faults of the collapse. The vertical movements previously described are prolonged and affected the Bagnaia Unit (about 1.35-1.2 Ma) but not the Vicano Tufo Rosso a Scorie Nere Unit (0.15 Ma; Borghetti *et alii*, 1981).

The uplifting of the area ended before the Vico structure was erected. The tectonic movements which followed the formation of the Cimino District had different characteristics and directions; the anti-Apennine systems have been also active, above all the Orte-Vico fault, to which is probably linked the feeding system of the Vico Volcano (Borghetti *et alii*, 1981; Sollevanti, 1983; Lardini and Nappi, 1987). A magnetometric land survey shows that the domes buried under the Vico products on the eastern side of the Vicano District follow the same trend as the Cimino one (Borghetti *et alii*, 1981).

The information obtained from the Terni Company, based on a survey carried out in 1950-51 to look for geothermic energy in the 13-km-long and 3-km-wide belt west of Viterbo, contributed to the stratigraphic and structural reconstruction of the city area. This survey was carried out with geoelectric, seismic and gravimetric prospecting and with 5 drillings (Conforto, 1954a; 1954b). These latter, in particular, showed (Chiocchini *et alii*, 2001; Figure 4):

- possible overthrusting of the Tolfa Flysch onto the Scaglia-Maiolica succession of the Tuscan - Umbria – Marche Domain, connected to the Miocene tectonic movements in the central and northern Apenines, according to the data on the Sabatini, Cimini and Vulsini Mounts (Baldi *et alii*, 1974) as well as in southern Tuscany (Abbate and Sagri, 1970; Boccaletti *et alii*, 1987);
- the splitting of the substratum, made up of the units of the Tuscan - Umbria – Marche Domain, is connected to the neotectonic movements with normal faults, also oriented N-S and E-W, which enabled the recognition of an uplifted belt (structural high) 3 km wide and 13 km long. This is oriented N-S between M. Razzano and Vetralla; M. Razzano is the zone connecting this structural high to the one of Castell’Azzara-M. Razzano trending NW-SE (Baldi *et alii*, 1974; Barberi *et alii*, 1994). The Pleistocene potassic volcanism in Tuscany and Latium mainly concentrates on the eastern side of this structural high.

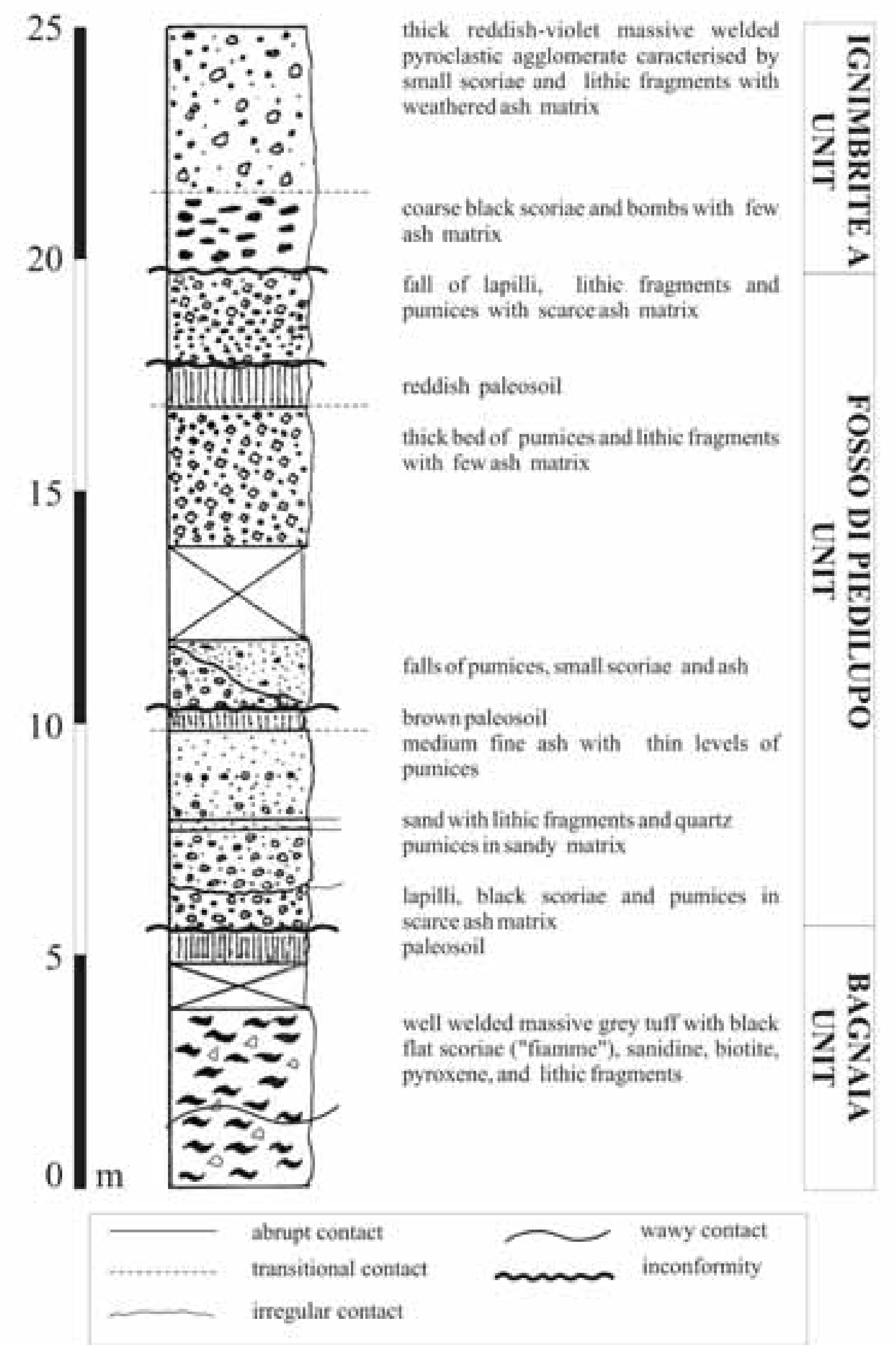

Figure 5 - The Strada Roncone section.

Field trip itinerary

This itinerary is divided into three parts: the first 6 stops concentrate on the historical and cultural aspects of the city; from stop 7 to 9 the attention is shifted onto the geological characteristics of the territory, while stop 10 focuses on the quarrying of the "Typical Peperino" in an area not far from the centre of Viterbo.

Medieval Viterbo

Viterbo was first mentioned in the VIII century as a Lombard castle. In the following centuries the Papacy and the Empire contended for its possession because of its strategic position on the northern road towards Rome (Via Francigena). Popes and Emperors granted the city lots of aid and support: Viterbo soon became a populous and rich centre, and by the end of the XI century it was already organized as a free city. In 1167 Emperor Frederick I (Barbarossa – "Redbeard") started building a palace, a small Lombard castle, which in 1193 then became the bishop's residence, and grant Viterbo city status. Fredrick II of Swabia tried to besiege it in 1243, but thanks to its towered and well-preserved walls, built between the XI and the XIII century, Viterbo did not surrender. Since then the city has always been faithful to the Popes who, during the XIII century, spent a lot of time in the beautiful Papal Palace rising near the Cathedral.

During the trip you may admire the artistic fountains embellishing most of the squares of the medieval centre. They are built according to an ingenious system of canalization exploiting the natural ditches flowing down from the Cimini Mountains which supplied all the districts and the inhabitants of the city with fresh water.

Stop 1:

Location: Piazza del Plebiscito

This is the centre of the city. On the west side there is the Town Hall, built between 1460 and 1500; it is built over an airy portico and has two orders of windows (guelph and arched) with the coat of arms of Pope Sixtus IV (1471-1484) in the middle.

On the northern side of the square there is the Palace of the Podestà, also known as "Palazzo del Capitano del Popolo" (1247), with a 44 m tower to the side erected in 1487; on the eastern side of the square is St. Angelo in Spada, one of the most ancient churches of Viterbo, as is testified by documents of the XI century.

On the right side of the portal there is a Roman sarcophagus depicting some hunting scenes which is popularly known as the tomb of the beautiful Galiana, whom the city legends portray as an incredibly beautiful woman, the pride of Viterbo.

The trip continues along via St. Lorenzo: on the right it opens up to the sight of a small square surrounded by some medieval houses and towers. At the bottom of the road there is the small Chiesa del Gesù – in the Middle Ages dedicated to St. Silvestro (XI century) – testimony of a bloody event which occurred in 1272 and which became famous all over Europe: Guido and Simone of Montfort, in order to revenge their father who had been killed by the King of England, stabbed Henry of Wales, son of King Richard of England, in front of the altar as he was hearing the Mass on his way back from the crusade.

The trip continues till the triangular Piazza della Morte (from the name of the church rising there), with its XIII century fountain (on the upper side) and the Loggia della Morte, a Romanesque building with a portico standing on some pillars, and the remians of a ruined tower. Then you will cross the bridge of the Cathedral, over a tuffaceous cliff, and you'll reach Piazza St. Lorenzo with Palazzo Farnese (XV century) on the right, named after the important family of Pope Paul III (1534-49).

Stop 2:

Location: Piazza S. Lorenzo

The Lombard castle rising in this square was the centre of Viterbo. It was sheltered on three sides by the steep flanks of a tuffaceous cliff and on the last side it was protected by a ditch dividing the spur and cutting off the castle. The Cathedral, dating back to the XII century, was modified (the inside and the façade) in the XVI century, though still preserving a beautiful gothic bell tower from the XIV century. On the right there rises one of the town's most important monuments, the Palace of the Popes, built in 1257-66 as a residence for the Popes. The loggia, with 7 interlaced arches, is extremely refined, and opens onto the beautiful sight of the city and of its medieval walls.

Stop 3:

Location: S. Maria Nuova

Going back to Piazza della Morte you can reach the Church of S. Maria Nuova, built in the XII century over the ruins of another important church built in the year 1080. The simple internal structure is enriched by a XV century trussed roof and by some XIII-X century frescos and paintings.

Stop 4:

Location: St. Pellegrino

St. Pellegrino is a rare example of a XIII century medieval neighbourhood hosting well-preserved towers, houses, *bifore* (double lancet windows), bridges and *profferli* (external artistic stairs). On the left, immediately after the small church of St. Pellegrino, there is the Palace of the Alessandri family, a typical example of a XIII century house.
On the left end of Via St. Pellegrino, the trip continues to Via St. Pietro and Via delle Fabbriche until Fontana Grande (Big Fountain), in the Middle Ages called "Fontana del Sepale".

Stop 5:

Location: Fontana Grande

This is the biggest and most ancient fountain of Viterbo, which was used as a model all over the region. It was started in 1206 and finished in 1279; it is composed of a Greek-cross-shaped pool in wich a small pillar supports two basins placed one upon another and surmonted by a pinnacle. The trip continues up to Via Cavour until the Church of St. Sisto.

Stop 6:

Location: Church of St. Sisto

This Romanesque church was built in the IX century, enlarged in the XII century, and then restored after the serious damage caused by the bombings of World War II (summer 1944). A simple façade characterises the lower part; beside the transept, which was built later, rises the IX century bell tower (with its artistic "trifora"- triple lancet windows). Behind it, close to the town's ancient walls, there is a XII century bell tower. Inside, the church is characterised by a trussed roof and a 17-step staircase ascending towards the presbytery, which is divided into three naves by two big columns. The high altar is composed of architectonic fragments dating back to the IV-V century and probably belonging to an early Christian Church; on the right you can admire a XV century painting by the Florentine artist Neri di Bicci.

Stop 7:

Location: Strada Roncone

Here a measured section shows the succession consisting, from the bottom, of the Bagnaia Unit, then followed by the Fosso di Piedilupo Unit and the Ignimbrite A Unit (Figure 5).
Age: from Early to Middle-Late p,p. Pleistocene.
The section starts with the Bagnaia Unit made up of medium-to coarse-grained wavy bedded well-welded grey tuff with black, flat scoriae and sanidine, biotite, pyroxene and lithic fragments. A short piece of covered section is followed by a reddish sandy-clayey palaeo-soil, characterising a period of interval before the next Vico eruptive activity. This starts with the Fosso di Piedilupo Unit and is characterised by three intervals of fall deposits.
The first interval consists of pumiceous lapilli, blackish scoriae, pumices and ashes with small levels of pumices. A second level of brown, clayey-sandy and sandy - clayey palaeosoil follows, characterising the first interruption of eruptions.
The second interval starts again with fall deposits consisting of a thick bed of pumices and ashes, interrupted by a short covered tract, followed by a thick bed of pumices and lithic fragments (sometimes marls and marly limestones from the Tolfa Flysch) and by a third level of reddish sandy-clayey palaeosoil. This level marks a second interruption in the eruptions.
The third interval is made up solely of a fall of lapilli, lithic fragments and pumices with scarce matrix.
The succession ends with the Ignimbrite A Unit composed of a 5-m-thick reddish-violet agglomerate characterised by black scoriae and bombs at the base, followed by smaller black scoriae and lithics with a weathered ash matrix.
These intervals represent, on the whole, a key level called Vico α.

Stop 8:

Location: Porta Faul – Via del Pilastro – Strada Bagni

This area is characterised by the two facies of the Vicano Tufo Rosso a Scorie Nere Unit laying over the Bagnaia Unit.
Age: Middle-Late p.p. Pleistocene.
From Porta Faul the trip continues towards Via del Pilastro along the town's ancient walls, built over the Vicano Tufo Rosso a Scorie Nere Unit. This is characterised by the typical facies made of a lithoid, welded agglomerate with big, black scoriae and bombs with leucite in a reddish zeolitized ash matrix. Further on, at the base of the agglomerate there is a level of reddish palaeosoil. A few metres ahead it is possible to see a reinforcement of the agglomerate, by means of bolts and ties, damaged by the weathering and by some sub-vertical fractures of the rock mass.
From Via del Pilastro, down to Porta Faul, along Via Bagni, the lithoid reddish agglomerate is characterised,

at the beginning, by the Vicano Tufo Rosso a Scorie Nere Unit with some anthropic caverns.

Along the first straight part of the road, the agglomerate is no longer lithoid because it is less welded and firm, its colour turning from red to grey. This is the second facies of the Vicano Tufo Rosso a Scorie Nere Unit which interpenetrates with the reddish lithoid one, as is confirmed by various stratigraphic logs of drillings carried out in the urban area of Viterbo. The interpenetration of welded facies with less welded ones has not yet been completely explained; it could be linked to the complex processes of weathering of the Vicano Tufo Rosso a Scorie Nere Unit.

Further along this tract of Via Bagni the grey facies shows a clear V-shaped cut. Its walls are about 30° inclined, it is 40 m wide and is filled with epiclastic grey-yellowish materials with lapilli, pumices, and lava cobbles. The cut is NE-SW oriented. It is probably a small valley of a creek which flowed into the right side of the nearby Urcionio creek, thus suggesting that an erosive stage followed the deposition of the Vicano Tufo Rosso a Scorie Nere Unit.

Stop 9:

Location: Bullicame

This area hosts the thermomineral water of the Bullicame spring and its travertine deposits.

The Bullicame spring is very famous and was mentioned also in ancient times by Dante Alighieri in Canto XIV of his “Inferno”. Dante’s quotation is also written on a plaque situated near the spring.

The spring discharge is around 10 - 12 l/sec and its sulfate-calcic-alcaline-earthy waters spring out at a temperature from 57° to 60°. The mining concession for the exploitation of the spring is in the hands of the town council and the water is used for therapeutic treatments in the facilities of the Terme dei Papi owned by the town itself and rising about one km away from the hot spring.

The chemical and physical properties of this water can be exploited for the therapeutic treatment of chronic breathing problems, bone and skin diseases, as well as for problems with the genital apparatus and metabolic disorders.

The spring is responsible for the deposit of travertine materials widely scattered centrifugally around the source. Stratigraphic data of some drills carried out in the nearby area show that in a more ancient period, probably the Holocene, a marsh developed around the spring.

The travertine shows a variable degree of diagenesis: on the surface it is more crumbly and soft, while it is lithoid in the subsoil. It is typically porous and contains gasteropoda shells and vegetal fragments encrusted with calcium carbonate. The travertine deposits are medium-thick bedded with sub-horizontal attitude and with intercalations of brown silty-sandy paleosoils and/or alluvial deposits.

The travertine is 30 m thick and thins to 10 m towards the south, where it is limited by the flow of the Urcionio creek (according to the Gigliola drilling byINPS).

The deposition of travertine still continues thanks to the spring of hot water containing various nannobacteria which change according to the morphology of the calcium carbonate. Aragonite is the main precipitate ($CaCO_3$ rhombic) because waters are hotter than 40°. Within a few cm of the spring mouth no carbonate seems to precipitate, but on the surface there are floating rafts of radial fibrous aragonite spherules and fuzzy dumbbells. Downflow about 70 m, temperature falls to 53° and pH rise to 7.1; over most of this course a soft aragonite-needle mush is precipitated. According to Folk (1990) a stretch of shallow, agitated water is characterised by thick masses of filamentous S-oxidizing nannobacteria, forming long crisp streamers encrusted by radial arrays of aragonite needles. Needles are later engulfed by steep-rhombic calcite crystals. Slimey, dark-green segmented threads occur; they have mucous films with some gothic-arched calcite crystals inside.

Sliminess probably contributes to the formation of calcite by slowing the precipitation rate. At cooler pools far downflow (35°C and pH = 7.5), distorted calcite crystals form in the shape of long parallelograms.

Nannobacteria can be perfectly observed by SEM inspection (Folk, 1990). They appear as swarms of ovoids, spheres, grape-like clusters and chains, 0,5-1 μ wide. Most bacteria are calcified inside, but the tough cell wall remains; the process of acidification makes the cell walls collapse. Nannobacteria lying on the surface of carbonate crystals are attached to freely - suspended mucous strands and sheets. The nannobacteria are incorporated within calcite crystals to be revealed by etching. They can be found in today’s precipitates as well as in older diagenized travertine. A NASA researcher has found in the famous meterorite from Mars nannobacteria just like those discovered by Folk (1990) in the thermomineral springs of Viterbo (Folk, personal communication).

Older aragonite travertine converted to mosaic sparry calcite, 0,2 –1 μ , is characterised by microfluorite cubes as F was expelled onto recrystallized aragonite,

as in the case of the microfluorite at Yellowstone (Folk, 1990).
The isotopic data (Manfra *et alii*, 1976) show that the travertine CO_2 is connected to the chemical decomposition of marine carbonate formations, and that the deposition of travertine was due to water with an isotopic composition similar to the one measured in today's groundwater.

Stop 10:

Location: Vitorchiano
Visit to a quarry of grey "Typical Peperino"
(the Bagnaia Unit).
The present mining level is 35 m below ground level because the superficial part of the formation is heavily weathered. The mining is carried out following degrading horizontal slices with straight step by means of a self-moving toothed-chain shearer. These machines have a 1.60 m web where a chain runs equipped with tungsten-carbide teeth. The web enters the rock and moves horizontally and vertically along a slightly inclined track; the field is divided into 1.50 m horizontal slices and cross-cuts, exploiting possible fractures of the rock itself. The absence of critical conditions of stability in the excavation areas, the wall height, as well as the future settlement of the extractive area allowed the building of 2-m-long steps along the whole perimeter. As for the cultivation of each step six months are needed; the amount of material cut in a year reaches 6000 mc of which 30-40% is used for commercial purposes. Blocks destined to sawing (2,5/3 x 1,50 x 1,50 m) are moved by a trihedral derrick and transported to a sawmill, where they are cut into 2-cm-thick sheets by means of diamond blades.

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Back Cover:
field trip itinerary

FIELD TRIP MAP

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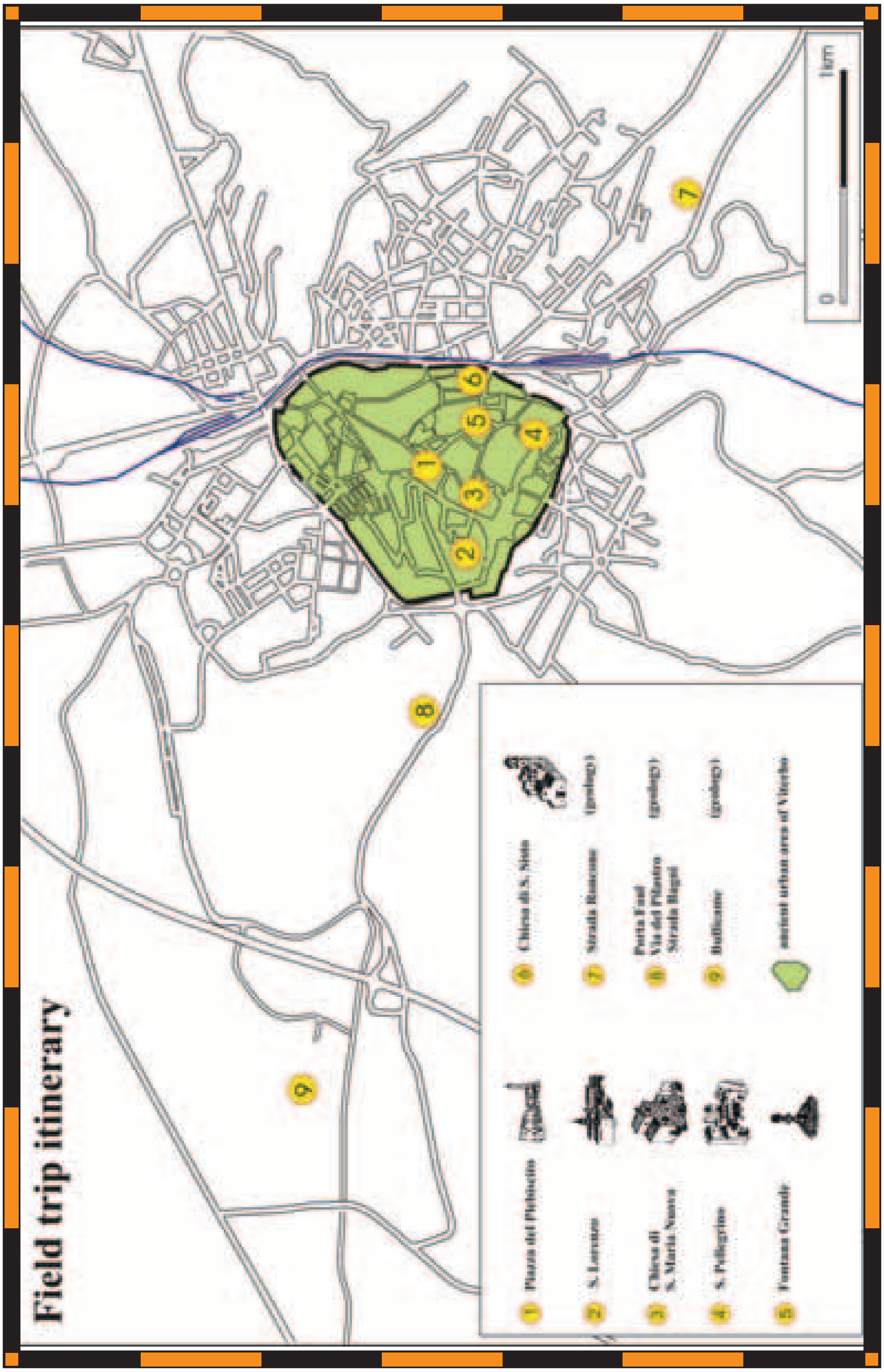

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