Geomorphology and geoarchaeology of three sites in the Potenza Valley Survey Project (The Marches, Italy): Potentia, Montarice and Helvia Recina

Tanja GOETHALS, Morgan de DAPPER, Frank VERMEULEN

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Géomorphologie et géoarchéologie de trois sites dans le projet " Potenza Valley Survey " (les Marches, Italie) : Potentia, Montarice et Ricina. Le fleuve Potenza (775 km²) est un de ces cours d'eau parallèles qui dévalent le versant oriental de l'Apennin d'Ombrie et des Marches (Fig. 1), en Italie centrale. En 2000, le projet géoarchéologique " Potenza Valley Survey " s'est établi par une collaboration entre les départements d'archéologie et de géographie de l'Université de Gand. Les objectifs principaux sont l'étude de l'évolution et les influences mutuelles du paysage et de l'occupation humaine dans la vallée du fleuve Potenza durant le premier millénaire qui a précédé notre ère et le millénaire qui l'a suivi ; et la mise en place d'une méthodologie géoarchéologique.

Cette contribution traite de l'intégration de diverses techniques géomorphologiques et archéologiques afin de résoudre quelques questions spécifiques qui concernent trois sites dans la vallée du fleuve Potenza : Potentia, Montarice et Ricina. Dans le cas de la ville romaine de Potentia (Fig. 3 et 4), située dans la plaine côtière du fleuve Potenza, il s'agissait de retrouver les anciens tracés du fleuve et les diverses positions du littoral. Le site protohistorique de Montarice (Fig. 5 et 6), sur une colline qui surplombe la plaine côtière, a été étudié relativement aux autres sites protohistoriques le long de la côte Adriatique. On s'est aussi intéressé à la question des ressources en eau et à leur distribution dans la ville romaine de Ricina (Fig. 7), sur la rive gauche du fleuve Potenza à 15 km de la côte. Pour répondre à ces questions il a été procédé à l'examen des sources écrites, des cartes topographiques et géologiques et des photos aériennes, mais également à des sondages et profils géoélectriques, à des forages à la tarière, à des datations radiométriques 14C et à des datations par luminescence stimulée optiquement. Des analyses malacologiques ont également été réalisées.

Introduction

The Potenza valley has been studied since 2000 in the geoarchaeological framework of the project "The Potenza Valley Survey. From Acculturation to Social Complexity in Antiquity: A Regional Geo-Archaeological and Historical Approach". The multidisciplinary nature of the project is reflected in the collaboration of the Department of Archaeology and Ancient History of Europe and the Department of Geography of the Ghent University (Belgium) (Vermeulen & Boullart, 2001; Vermeulen et al., 2002; Vermeulen, 2003).

Two goals were set: to understand the evolution and mutual influence of the landscape and human occupation in the Potenza valley during the 1st millennium Before Common Era (BCE) and the 1st millennium Common Era (CE), corresponding to the Piceni, Roman and early medieval cultures; and to refine the geoarchaeological methodology. In this contribution, the settings of two Roman sites (Potentia and Helvia Recina) and one Iron Age site (Montarice) in this valley are analyzed, illustrating this methodology.

The focus of Mediterranean archaeological research has shifted in the past years, from excavation to prospection, and from strictly archaeological to geoarchaeological. Interdisciplinary studies, initiated in this time-

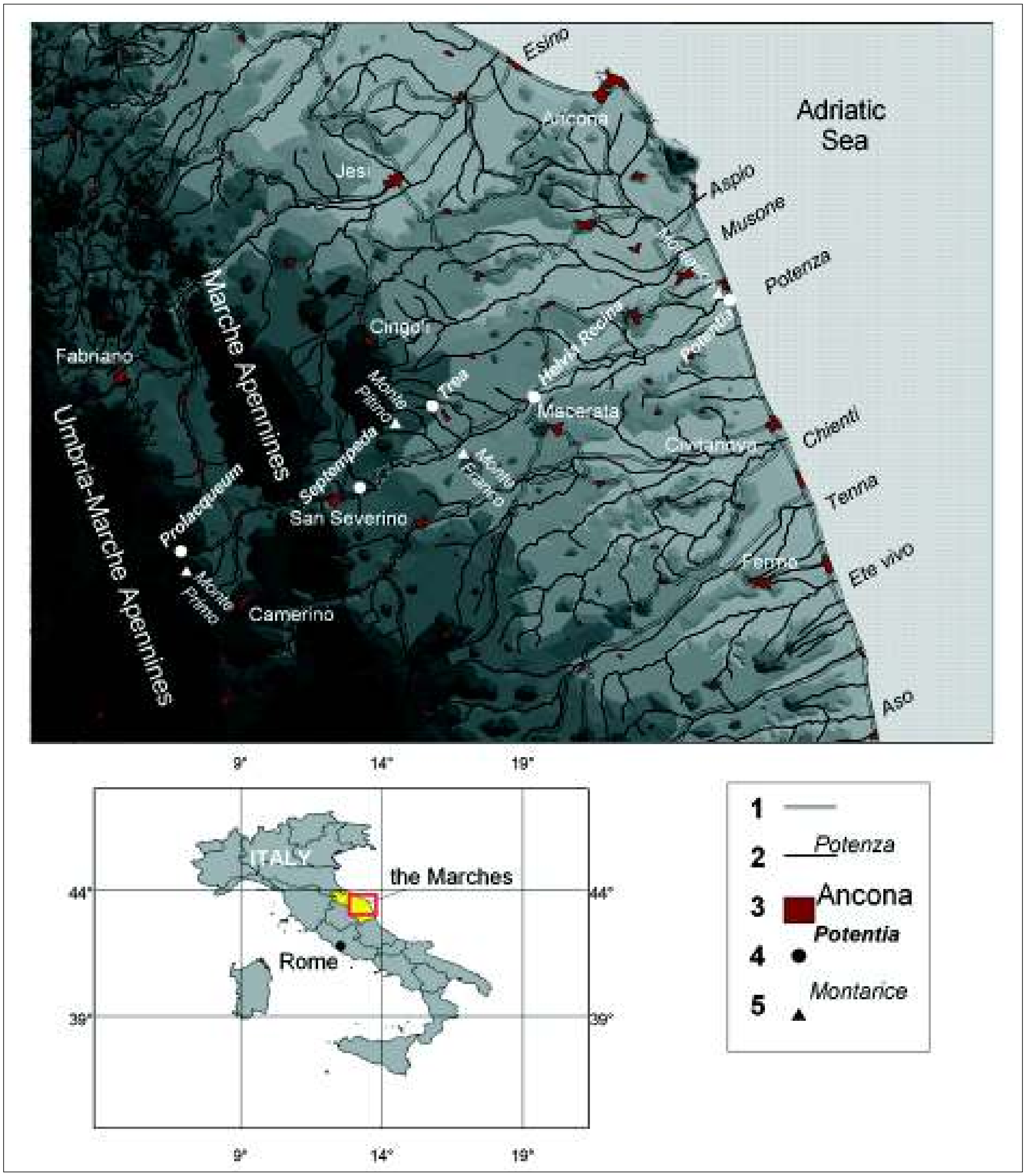

Fig. 1. Location of the study area in Italy and the Marche region. Source data provided by the Ufficio Cartografia e Informazioni Territoriali, Regione Marche. 1: road network; 2: streams; 3: agglomerations; 4: Roman cities; 5: protohistorical sites.

frame, complete the classical research methods. Thus, the Potenza Valley Survey project was established in collaboration with the regional archaeological service (*Sopraintendenza per i Beni Archeologici delle Marche*): the archaeological service provided the excavation reports and communicated about the current level of archaeological knowledge in the region. The Potenza Valley Survey project sums the results of the implementation of new techniques in order to solve unanswered questions concerning the situation of sites in relation to the hydrography, the presence of smaller archaeological sites, the different aspects of the past landscape, and the influence of geomorphology on the Roman road networks.

Localisation

The Potenza river is one of the streams that water in parallel the eastern side of the Umbria-Marche and Marche Apennines (Fig. 1). Its elongated basin (775 km²), situated entirely in the *Provincia di Macerata*, is perpendicular on the main relief units. From the Apennine mountain ridges to the Adriatic Sea it traverses two mountain chains, oriented NNW–SSE and built up in folded Mesozoic limestone and marls; the gravely piedmont at their feet consisting of interfingering dejection cones; and the hilly terrains of the Adriatic foreland modeled on detritic Pliocene to Quaternary deposits (clays, sands and conglomerates) (Servizio geologico d'Italia, 1967). These deposits, more and more recent from west to east, now slope monoclinally ENE-wards, attesting their establishment by progradation and tilting following the quaternary upheaval of the Apennines (starting approximately 0.6 Ma ago, Ambrosetti et al., 1982).

All streams south of Ancona flow WSW-ENE-wards parallel to each other, in elongated, asymmetrical basins – their thalwegs being situated at the southern border of the alluvial plain. Traffic and trade throughout history were concentrated along the axes of the river valleys. The Potenza valley bottom was such a corridors, hosting a branch of the Via Flaminia from Rome to Ancona. In early-medieval times, the valley was situated on the border between the Byzantine areas in the north and the Longobard zones in the south, which adds to its geographical importance.

The Potenza river basin has continuously been occupied since the first millennium BCE, and even before that. However, prefered location of the population varied throughout those last 3000 years. The Iron Age Piceni culture reoccupied the elite sites of the Bronze Age and their surroundings, on hilltops overlooking the river. Four of those sites are well-known: Monte Primo, Monte Pitino, Monte Franco and Montarice (Fig. 1). Also smaller (scattered) sites are present, almost without exception near water sources, be it a well or a river confluence. The Roman age sites are situated lower in the landscape: of the four Roman towns and one vicus known along the river valley – Potentia, Helvia Recina, Trea, Septempeda and Prolacqueum (Fig. 1) – only Trea is not located on the alluvial plain. They were all abandoned in medieval times and either never overbuilt (Potentia, Septempeda) or only partially overbuilt (Helvia Recina, Trea, Prolacqueum). Therefore all five large sites provide optimal opportunities for survey techniques such as remote sensing.

Geoarchaeology

Geoarchaeology sensu strictu has been defined by G. Rapp and C.L. Hill (1998) as the use of geologic concepts, methods, and knowledge base in the direct solution of archaeological problems. Such solutions can range from deciding on the integrity of artefact sets or the chronological context, to a broader approach determining palaeo-landscape habitat and human-environment interactions.

Geoarchaeology is a young and dynamic science, still to be defined clearly. According to G. Rapp and C.L. Hill (1998) the fluidness of the definition itself is a manifestation of the classification process within science. After taking into consideration of a number of projects that have been labelled as geoarchaeological, this definition can change to integration of geo-sciences and archaeology to come to a holistic image of the interaction between man and his environment – in past times.

This contribution specifically deals with three palaeo-environments and their reconstructed evolution through different geomorphological and archaeological techniques. After archaeological surface survey and a reconnaissance phase in which existent literature, maps and aerial photographs are consulted, a geomorphological survey is carried out: the topography is analysed and the outcropping sediments and rocks are mapped. In areas where erosion is equal to or greater than accumulation, the evidence is

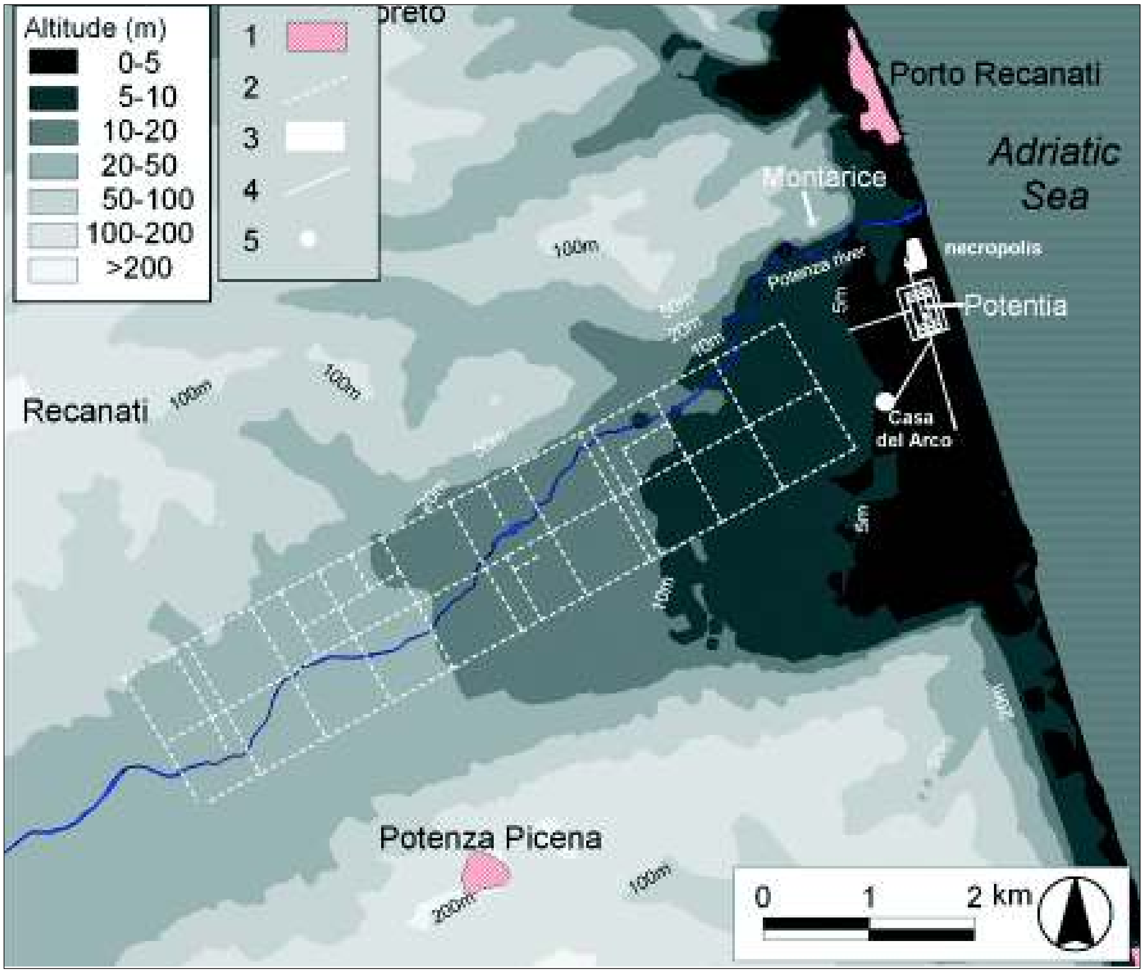

Fig. 2. Location of Potentia and Montarice in the coastal plain. 1: agglomerations; 2: centuriation of Potentia; 3: necropolis of Potentia; 4: street pattern of Potentia; 5: Casa del Arco site.

located near the surface, and geomorphological survey is extended consequently. In areas where accumulation is greater than erosion, such as alluvial plains, techniques that pierce the subsoil are proper, such as augerings and geoelectrical survey. Topographic survey is necessary in such areas with microrelief, since a small altitudinal difference, not even indicated on topographical maps, can have important consequences on the land use possibilities. Once the sediment succession is understood, the hypotheses made regarding the age and environment of the events can be confirmed or rejected by methods such as dating with OSL or ^{14}C, mollusc analysis and pollen analysis (not applied in this project). The final result is to be presented in the form of a geomorphological map.

Potentia

Archaeological setting. Roman colonisation of the Marche region emerged in the third century BCE on the coast, with the founding of multiple harbour towns that controlled over the Adriatic Sea (Paci, 2001), even though the presence of the Via Flaminia would induce one rather to think the influence from Rome invaded the region from the west. Examples of such colonies are Firmum Picenum (Fermo), Pisaurum (Pesaro), Auximum (Osimo), Numana and Cluana and later on Fanum Fortunae (Fano), Sena Gallica (Senigallia) and Cupra Marittima (Cupramarittima).

The harbour town Potentia was the first town to be founded in the Potenza valley, in 184 BCE. The street plan of the city, as reconstructed by the archaeological team, is rectangular, having the decumanus maximus WSW–ENE oriented (252–72°N) and the cardus maximus NNW–SSE oriented (342–162°N), which is almost parallel to the coastline (343–163°N).

During Roman times, the swampy alluvial plain inland of Potentia was centuriated for cultivation for the first time. The system consisted of squares of 20×20 actus or 705×705m, with two longitudinal axes, one of them corresponding with the actual Strada Regina (SS16), oriented WSW-ENE (242-62°N) (Fig. 2; Alfieri, 1968).

When the town was abandoned in early medieval times, its inhabitants probably fled to the nearby hilltop sites such as Potenza Picena (founded in the 10th century) and Recanati (founded in the 8th and 9th centuries). Later on, the town of Porto Recanati was founded (in the 13th century), north of the Potenza river mouth, on a marine terrace at the base of an inactive cliff. However, a Romance church preceded the town of Porto Recanati in the 11th century.

Geomorphological setting of the coastal plain. On the 3.6 km wide coastal plain of the Potenza the Holocene and historical changes are due to an interaction of both anthropogenic changes and natural sea level changes. During the early Holocene, in response to the Flandrian transgression, the coastline at the Marchean river mouths retrograded to about 4 or 5 km inland of the present coastline (Coltorti, 1989). According to Coltorti (1989) the coast of the Marches was apperead at that time like an alternation of rocky promontories and pocket beaches and the shoreline did not move substantially until at least 4,000 years ago, in spite of the sediments which were transported to the sea by the meandering streams. Indeed the maximum sea level was reached in the period between 7,000 and 4,000 years ago according to G. Calderoni et al. (1996). *However, according to our own fieldwork, it is difficult to believe that there was no trace of the beach ridge on which Potentia is situated.*

Sediments started to accumulate at the Potenza river's mouth about 4,000 years ago, according to M. Coltorti (1997), as a consequence of the first systematic land reclamation and following soil erosion in the middle courses of the river during the Bronze and Iron Ages. According to K.W. Butzer (1982) slash-and-burn was gradually replaced by sedentary agriculture. Other authors invoke a climatic worsening of the Boreal to Sub-Atlantic time span, which would have caused a reduction of the vegetation density upon the slopes, leading to soil erosion and increase of streams' solid load (Vita-Finzi, 1969; Delano-Smith, 1979). Whatever the cause is, the aggradation of floodplains at least during protohistory is amply testified in the Mediterranean context (e.g. Bruneton et al., 2001 for the Rhône valley; and Marchetti, 2002 for the Po plain) and even on European scale (Taylor & Lewin, 1997 in Wales).

Simultaneously, the decrease in the rate of sea level rise led to a new sedimentation equilibrium. In the 3rd century BCE the coastline was rectilinear, the sandy-gravely beach ridges being in a direct line with the cliffs, and coastal lagoons and swamps situated behind those beach ridges (Ortolani & Alfieri, 1979). Thus during the Roman Age, the transported fine sediments were trapped at the river mouth by the beach ridges and settled in the lagoons. Stagnant waters from the resulting swamps engendered malaria.

Roman roads were constructed on the beach of the internal lagoons, because the beaches of the bays themselves were not stable and could be pierced during storm tides. Roman ports such as Cupra Marittima, Torre di Palma and Martinsicuro (Truentum) were constructed "at the foot of active marine cliffs", uninfluenced by river dynamics (Alfieri, 1983; Coltorti, 1997).

Most river sedimentation took place during the Roman Age and the early Middle Ages, diminishing afterwards due to anti-erosion measures, population decline and natural reforestation after the "barbaric invasions". This sedimentation filled the lagoons and swamps, turning them gradually into dry land. During the Medieval Climatic Optimum

Fig. 3. Overview of the fieldwork in the Potenza coastal plain. 1: present Potenza river bed; 2: presumed and attested past river beds mentioned in the text; 3: augering locations; 4: location of the section of fig. 5. I: Roman and medieval river bed; II: presumed Roman course of U. Moscatelli and L. Vettorazzi (1988); III: terrace gravel; IV: pre-Roman course of M. Ortolani & N. Alfieri (1947); V: present course of the river Potenza; VI: late-medieval course of M. Ortolani & N. Alfieri (1947). Background: rectified aerial photograph of the IGM nr. 1150 – Flight of 30/03/1994.

(8^{th}–12^{th} century CE) deforestation and population pressure again helped increase the solid loads of rivers, thus favouring coastline progression (Aringoli *et al*, 2003). At that time the coastal plain was covered with thick forests, which were cut down from the 15^{th} century onwards for land reclamation (Baldetti et al., 1983).

The marine terrace at the base of the cliffs north and south of the Potenza river valley, making these cliffs inactive, was probably free of floods in the Middle Ages. After all, the first buildings on this kind of marine terraces were constructed in the 11^{th} century, e.g. at Porto Recanati, which provides at least a terminus ante quem date. The only active cliffs are present along the Monte Conero massif and in the north of the Marches. The terrace is nowadays about 500 m wide and situated 5 to 6 m above sea-level. M. Coltorti (personal communication) attributed this marine terrace to the Holocene unit “Sintema del fiume Musone (MUS)”, and indeed the terrace must have originated in the later Holocene, when the Flandrian transgression slowed down, and the uplift of the coastal region outbalanced the sea-level rise.

A new generation of beach ridges – parallel to the previous ones – resulted from spit elongation by longshore drift, the spits attached to the marine terrace. This occurred probably from the 16th century to the end of the 19th century, as many authors record a seaward migration of the coastline in the Marches of up to more than 500 m (Giarizzo, 1963; Ortolani & Alfieri, 1979; Jacobelli et al., 1982; Anselmi, 1986). According to M. Coltorti (1997), the lower tracts of the rivers were at that time strongly aggrading in a braidplain system, because of the deforestation for land reclamation or *appoderamento* of the entire periadriatic zone. The remaining coastal swamps, amongst them the ones of the Potenza river, were filled up with sediments; forests were cut down; and many rivers were diverted and/or straightened. The anti-erosion measures and reforestation of the slopes with the "alberata" system stopped the coastline progression of the by fluvial sediment supply in the 20th century.

The low rectilinear coast is now under erosion, with Monte Conero massif north of the Potenza coastal plain as principal source of sediments with , but the principal redistributing wind is the southwest sirocco (Curzi, 1986). Periodical floods at present still affecting large part of the coastal plain, e.g. in December 1982 and November 1999 (personal communication of inhabitants). These floods are of marine origin, depositing marine shells at the surface (pelican's foot or Aporrhais pespelicani; Van Damme, 1984).

Georarchaeological results. The Potenza did not always follow its present course in the extreme north of the coastal plain. Based of historical data, field work and marks on aerial photographs, remains of previous river beds have been identified, both south of the present course of the Potenza.

One river bed, 500 to 600 m south of Potentia, certainly existed in Roman times, since a Roman bridge was built over it at the Casa del Arco site (Fig. 3, I; Ortolani & Alfieri, 1947; field-checked). The road crossing the bridge leads from Urbs Salvia over Pausulae to Potentia. Parts of the bed appear on oblique low-altitude aerial photographs. An augering (Fig. 3, 1; Casa del Arco) close to the bridge revealed a fining upward profile: gravel starting at a depth of 400 cm below the surface indicating the thalweg of the river, with above a fine sand deposition between 210 and 400 cm indicating river bank breakdown material, topped by 210 cm of fine sandy clay flood sediments. The surface is at 410 cm above sea level, which agrees with the ground water table in the augering 400 cm depth. A ^{14}C-dating on some pieces of charcoal, a few mm large, found in the gravel lag of the river, indicated the interval 630 ± 25 BP or between 1290 and 1400 CE. Two datings higher in the profile were progressively younger: 355 ± 30 BP or between 1450 and 1640 CE at 240 cm depth and 80 ± 25 BP or after 1690 CE at 150 cm depth. This is the same course of which sediments appear in the deep augering on fig. 4, the incision being dated here at 100 BCE to 60 CE and the filling at 1520 to 1660 CE.

This implies that the Roman course was not only in use during Roman Age, but also during the Middle Ages, up to the 14th century. Analogous sediment successions have been found in three other augering profiles, which allows an approximated reconstruction of the course. However, this bed cuts partly through the Roman centuriation system of the fertile "Ager Potentinus". The mouth of this bed has either moved to a more northward course, or formed a delta system. M. Ortolani and N. Alfieri (1947) already identified the morphology of a fossil delta, which they ascribed to the Roman Age at this location. Fact is that at least two debouchments are present (Fig. 3, a and b). The northernmost has erased part of the city structures, as indicated on oblique low-altitude aerial photographs. This may have played a role in the abandonment of the city, together with the upcoming malaria thriving in the nearby marshy conditions. The exact location of the Roman harbour has certainly been influenced by these river dynamics.

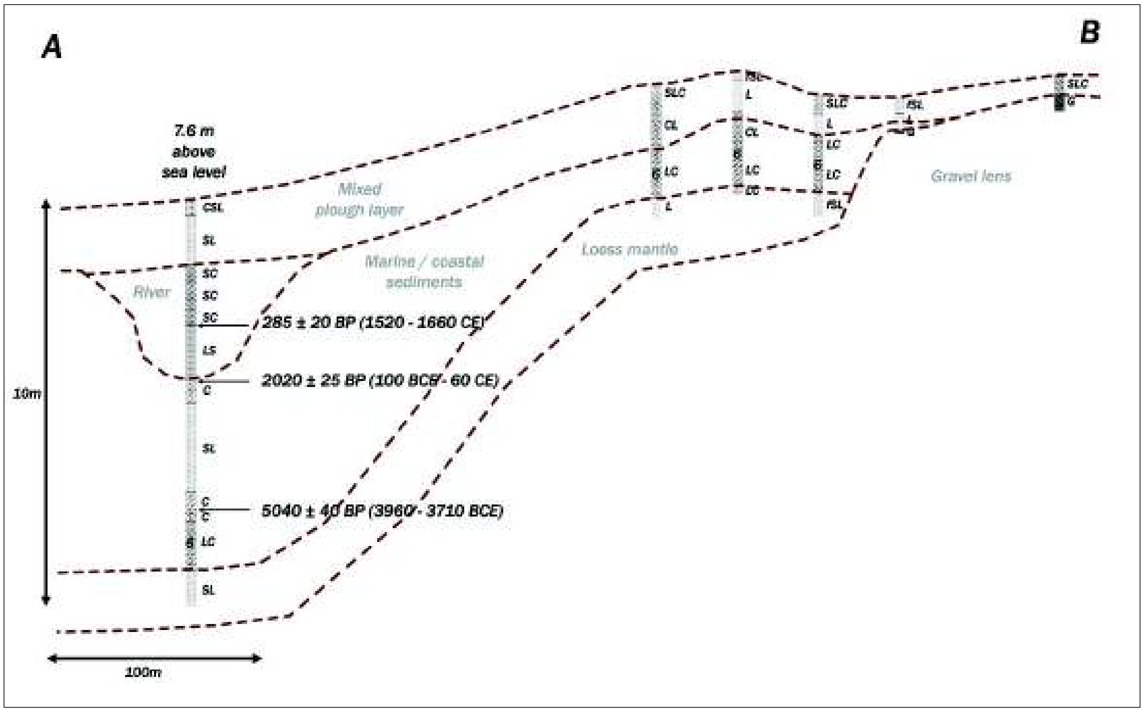

Fig. 4 Approximate north-south augering section through the coastal plain. The location is indicated on figure 4. C: clay; CL: clayey loam; CSL: clayey sandy loam; fSL: fine sandy loam; G: gravel; L: loam; LC: loamy clay; LS: loamy sand; SC: sandy clay; SL: sandy loam; SLC: sandy loamy clay; 6: marine shells.

The “Roman course” (Fig. 3, II) assumed by U. Moscatelli and L. Vettorazzi (1988) and G. Paci (2001) for the Roman Age Potenza, is based on archaeological finds and directions of groundwater flow. However, this hypothesis can be rejected, since loose and permeable late-Quaternary sediments underlie the coastal plain up to a depth of at least 10m, so groundwater flow does not represent the superficial historical courses.

Traces of crop marks and soil marks on aerial photographs have been identified in the field as an extensive gravel deposit (Fig. 3, III), occurring on surface of 1.5 km in lenght and 100 to 150 m wide. Its thickness could not be explained. This seems a remaining terrace of an older bed, although it is situated closer to the surface than the Roman bed, at 120 cm depth below the surface (at augering 9, see fig. 3, surface at 500 cm above sea level) instead of 400 cm. An OSL-dating nearby (Fig. 3, OSL) on quartz in a loamy sand lens of 30 cm, taken from 160 cm in depth, indicated an age of 3600 ± 400 years. The thinner sediment cover can be explained by the greater distance from the present Potenza and the slightly higher topographical position of the gravel beds. The transition between this terrace and the floodplain is illustrated with the augering section of fig. 4.

M. Ortolani & N. Alfieri (1947) supposed the pre-Roman course to have been in the very south of the coastal plain, as precursor of the Fosso Pilocco streamlet. This hypothesis is based on the morphology of a fossil delta. This could not be verified by field-checking, since large part of the Fosso Pilocco’s bed is now fortified, as well as the mouth. However, this is very much possible, since it satisfies the asymmetry-postulation of the Marchean rivers, and it could have been responsible for the breakdown of the terrace mentioned in the previous paragraph. However, the diversion from the present Potenza river is probably more upstream than their design. In that case M. Ortolani and N. Alfieri’s postulation (1947), that the “has a tendency to move northwards and never vice versa”, is correct.

The present course of the Potenza river (Fig. 3, V), one km north of Potentia, is clearly artificial. All rivers in the Marches show a marked asymmetry, towards being displaced to the south, with a well developed terrace sequence on their left banks and a stunted terrace sequence at their right banks. The cause is still a matter of discussion (Dramis et al., 1992; Rasse, 1994; Coltorti et al., 1995), but the result is unarguable. Paradoxically, the Potenza river flows nowadays at the foot of the northern interfluve and the Montarice site, displaced to the very north of the coastal plain. Only the Musone river, neighbouring the Potenza river to the north, does the same. However, in the case of the Musone, ample passages point to a deliberate rerouting for land reclamation (Ortolani & Alfieri, 1947). In the late Middle Ages and early Renaissance, large tracts of land in the Marchean coastal plains were reclaimed (Cencini & Varani 1991; Nanni & Vivalda 1987). Less sources mention the Potenza, but M. Buli and M. Ortolani (1947) cite the consent of Pope Gregory IX (1170-1241) given to the inhabitants of Porto Recanati to make the rivers Potenza, Musone and Aspio debouch together. At the new mouth, a new harbour would be built. Though this project was clearly neglected and finally abandoned in 1474, this illustrates the ideas that occupied the government. There is, on the other hand, also the epigraph which M. Ortolani and N. Alfieri (1947) mentioned, now situated near the railway station of Porto Recanati, which reads: "Arcus hic est pars pontis Potentiae veteris dictae le Fiumarelle" or "this arch is part of the bridge over the old Potentia, called Fiumarelle". This could be a diverted arm of the Potenza (Fig. 3, VI) or an attempt to fulfil the task to which Pope Gregory IX consented.

In the framework of the project, geoelectrical and geomagnetical measurements have been carried out, in order to survey the texture of the subsoil and the city structures. The weakening of the signals in both cases on the inland side of Potentia, can be explained by the morphology of the beach ridges: a steep seaward slope and a gentle landward slope, identical to the currently active beach ridge. As the beach ridge surface slopes gradually landwards, so does the city of Potentia, built on this surface. Later on, floods deposited sediments behind the ridges and thus covered the structures with a gradually thickening clayey layer, which explains the fading geophysical signals.

Montarice

During aerial surveys and subsequent field walks, a major protohistorical site was checked at Montarice, at the end of the northern interfluve of the Potenza coastal plain (Fig. 2). This site had been described in literature. Linear traces in a field of sunflowers attracted E. Percossi Serenelli (1995) to presume the ancient enclosure of this imposing site which might be the location of a Piceni settlement. A following small-scale excavation indicated Bronze Age occupation and "sporadic Iron Age material" (unpublished excavation by D. Lollini in 1976; mentioned in Percossi Serenelli, 1985). A field check within the framework of the Potenza Valley survey of the general topography and of some of the internal traces and spots indicated that this site was no doubt also very important in the Iron Age, as a pre-urban circumvallated site or oppidum (Boullart, 2003). The site was probably only recently ploughed up and discovered, as can be appreciated from the large number and the slight wear of the found sherds (Boullart, 2003).

The Montarice site is situated on a slightly east/seaward-sloping surface of about 4.2 ha large, at 45 to 53 m altitude, covered with a thick – probably early-Pleistocene – marine gravel stratum upon a substrate of marine sandstones and clays (Fig. 5), which also crop out at Monte dei Priori, on the opposite side of the Potenza valley). During the Flandrian transgression the plateau functioned as a real headland overlooking the bay at the Potenza river mouth. The entrance road to the site was located in the south of the hill in the 19th century (IGM map 1/25.000 of 1892 – F118 III NE Loreto), coming from the nearby Colle Burchio, until the construction of the motor-

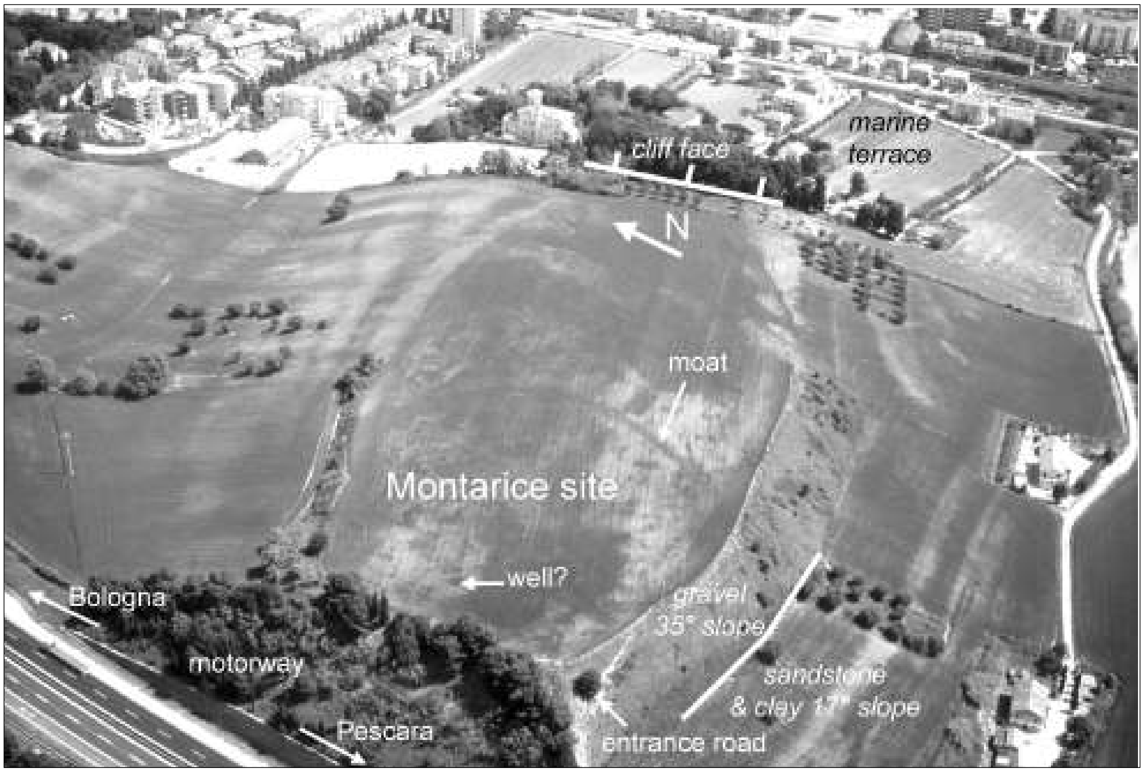

Fig. 5. Overview of the Montarice site with indication of the special features: in italics geological features, in regular print archaeological features. North arrow is drawn by approximation. Background: contrast-enhanced oblique aerial photograph taken by Jacques Semey.

way Bologna-Pescara. It is not excluded that this entrance road goes back to much older times.

Steep slopes – 35° – border the plateau except on the east-side. On that side linear traces on aerial photographs suggest an ancient enclosure. The steep slope at the west-side is probably due to the recent construction of the motorway Bologna-Pescara, annihilating part of the site, but the others seem natural (Fig. 5).

Consequently, the defence of the site could be secured by the raising of only one or two enclosures: one which is attested on the aforementioned eastside and possibly one somewhere on the west-side; the other slopes, covered with slope-waste material and probably overgrown with a spiny bush-vegetation at that time, provided natural defence. Moreover, the site enjoys ample view on the coastal plain of the Potenza. This leads to suspect the site had a role in the control over the river mouth and of the Adriatic shore by the local Piceni-elite.

Below the steep edge on the south-facing slope, a dark greyish zone of earth mixed with many artefacts has been distinguished, which can be identified as either an outflow zone of the site, or an isolated unit. At the end of the southern interfluve of the Potenza coastal plain, the Monte dei Priori location, a smaller protohistorical site is attested in a similar position as the Montarice site. It either preceded Montarice, or it was its counterpart (Boullart, 2003).

The genesis of the 35° south-slope can be questioned. The first impressions were about that slope being part of an undercut bank of a river, but which river? More likely slope instability was engendered by a mass movement: slope would be part of the apical detachment zone of a rotational landslide (Fig. 6). At the opposite side of the motorway Bologna-Pescara, south of Colle Burchio, such a landslide of the same size and one the same lithologies figures. The Montarice landslide would be older, as the traces are more eroded than the Colle Burchio landslide

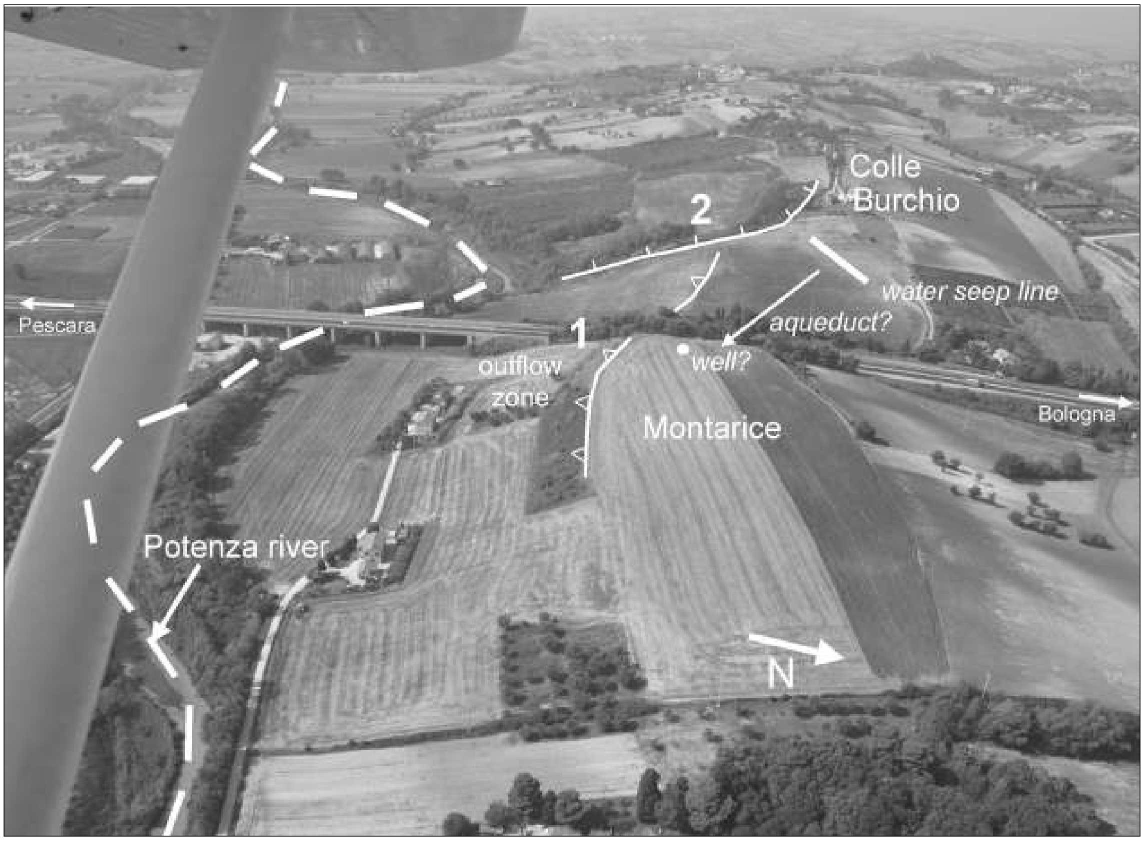

Fig. 6. Montarice and Colle Burchio landslides (in regular print) and water problematics (in italics). 1: Montarice landslide scar; 2: Colle Burchio landslide scar. North arrow is drawn by approximation. Background: oblique aerial photograph taken by Rudi Goossens.

traces, but still visible as soil marks. In that case, the entrance road to Montarice mentioned before is built on the top edge of a landslide lobe. This could also explain the “bumpy” morphology with irregular contour ridges of the slope, the dark greyish outflow zone of archaeological material mentioned before and the fan-like accumulation of material at the foot of the slope, which made even the present artificial course of the Potenza take an outward bend.

The geological situation provides also an easy source of water, as the gravel terrace stocks plenty of water. Even at present water seeps out of the terrace after a slightly rainy day, this beeing probably one of the triggers of the mass movements. Roughly two ways of procuring water are at hand: either wells were dug into the above terrace, or the water was captured below, at the base of the gravel terrace (Fig. 6). Capture at the base of the gravel terrace is a plausible solution. Along the seep line, capture is difficult, but at the downhill end of the seep line, where flow is gathered in a single well, the yield would be consistent. Since the terrace slopes eastward, the best capture point would be on the south-slope of Colle Burchio. The motorway is constructed in this point, which makes sense because two river gullies had created a saddle there previously. However, it includes either an aqueduct or manual labour to bring the water up to the site. The aqueduct hypothesis is least likely, since this aqueduct would have to cross a gap of more than 10m deep and 160m wide, which would only be done if no other options were available. The well-hypothesis is likely. Digging a well in terrace material is not the easiest job, but in the long-run a profitable solution. A round soil mark of 4.5 m on the aerial photographs of Montarice can easily correspond to a well.

This setting has geological analogies along the entire Adriatic coast, with a late-

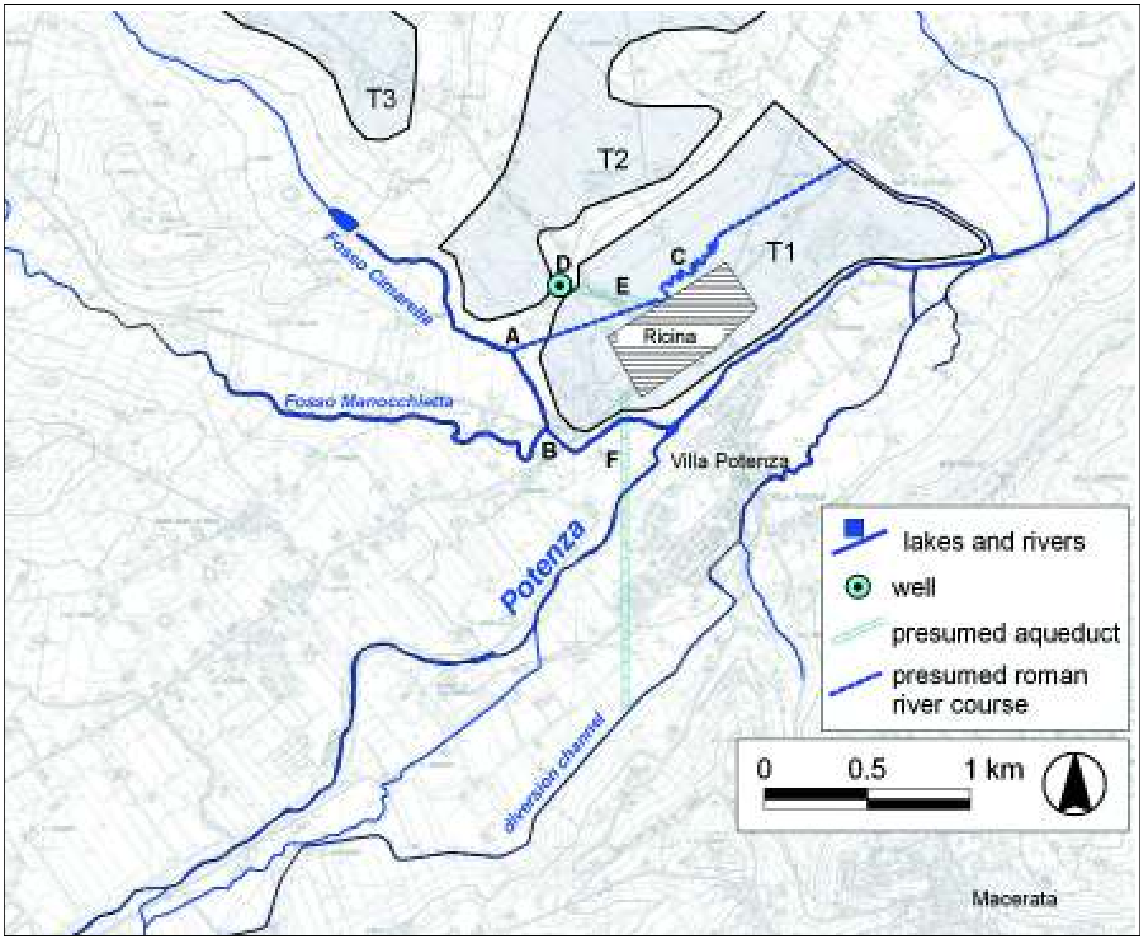

Fig. 7. Situation of Helvia Recina and location of research points cited in the text. A, B, C, D, E, F: points cited in the text; T1, T2, T3: terraces of the Potenza river. Background: topographical map IGM on a scale of 1/10,000.

Pleistocene marine terrace upon a late-Tertiary substratum, ending with a cliff and steep lateral slopes. It is an ideal situation for defensive hilltop sites with control over the river and over the coast, for observing the maritime commercial routes of Greek merchants (Luni, 1992). Iron Age sites in the same situation in the Marche region have been found and excavated at Montedoro di Scapezzano near Senigallia, and near Pesaro (Boullart, 2003).

Helvia Recina

Helvia Recina is a Roman town situated at 15 km from the coast. The first mention of the city is in 40 BCE, so we can assume that the founding of the city took place about a century later than Potentia. The city is built on the late-Pleistocene river terrace on the left bank of the Potenza river (Fig. 7). A large part of the city's structures is covered by the present town Villa Potenza. Little traces are left: only the theatre, a mosaic floor, and remnants of baths, a bridge and the decumanus maximus. The remainder is overbuilt, covered with sediments or taken away to provide building material for the nearby city of Macerata. But some can be seen as crop marks, such as part of the city structures, and a cistern.

The Potenza is supposed to have been navigable up to Helvia Recina, as most of the rivers of the Marches have been navigable until the 15th century (Coltorti, 1991). Just like Potentia, the town was abandoned during early medieval times and the inhabitants probably also fled to nearby hilltop sites, in this case to Macerata. This relocation to higher grounds was later labelled as the "incastellamento" movement.

Three topics were raised by the archaeological team, all relevant to the water resources of the city: the presence of a meandering rivulet just north of the city in Roman Age, the origin of the water when Helvia Recina was founded and the origin of water for the baths.

The possible presence of a rivulet in Roman Age, id est during the occupation of Helvia Recina, was indicated by grass marks on an aerial photograph of 01/05/2003. The rivulet is not active nowadays. Geo-electrical measurements enabled the precise localisation of the river course, at the points with the highest resistivity values. Augerings at these points revealed gravel outcroppings – with upward fining sediments above – at diverse depths below the surface, corresponding with consecutive thalwegs.

Geomorphological evidence proves that that the rivulet was beheaded at point A (Fig. 7), where the present Fosso Cimarella abruptly changes in direction to debouch in Fosso Manocchietta. First, the rivulet has to meet the carrying capacity demand for gravel of up to 3cm (found in the augerings), in a meandering channel pattern (which normally takes less bedload sediments than a braiding channel pattern). This implies that the rivulet had a quite large watershed, which can only be the watershed of Fosso Cimarella. Moreover, the part of present day Fosso Cimarella between point A (Fig. 7) and the debouchment in Fosso Manocchietta (Fig. 7, B) has an artificial morphology: a narrow bed (1.6 m) with no gravel bars (one would expect gravel deposits in a natural bed, given the area of the watershed) and a left bank of which the lower part slopes 37° and the upper part 5°; while upstream the bed is 6 m large out, of which only 2 m were in use in October 2004, and has banks sloping 30° to 34° uniformly. Moreover, the debouchment of the Fosso Cimarella is fortified with concrete and hanging 2 m above Fosso Manocchietta. And finally a depression in the landscape is still present between the beheading point and the grass marks of a meandering channel (Fig. 7; C), in some places with outcropping gravel, as seen on the field and derived from the contour lines of the topographic map at a scale of 1/10,000.

Unfortunately, it was not possible to extract an uncontaminated charcoal sample for ^{14}C-dating from the augerings. However, it can be presumed that this rivulet was present during Roman Age, out of reasons. Firstly, M. Coltorti (1991) mentions that the streams in the Marche region had a meandering middle course in Roman times, which converted progressively to braided from the Middle Ages to the end of the 19th century. Thus, a younger age would imply a braided channel pattern, which is not the case here. An older stream, on the other hand, would be buried deeper under the surface of alluvium and colluvium. Secondly, the Romans could derive profit from the rivulet: it represents the northern limit of the city, provided them with extra protection, could serve as wash-place and perhaps even had recreational values. However, direct water supply was not possible, since the rivulet is situated lower than the city topographically. In the populous Late Middle Ages, on the other hand, the need for reclamation of all land, even marginal land, was high. Thus it is much more likely that the river has been diverted in late-medieval times, simultaneously with the diversions of the coastal plain, than in Roman times.

To fill the town cistern for daily use, the Romans would have needed a small but steady amount of water, available at a low energy cost. The rivulet is not ideal, since it is situated lower than the cistern and thus would require pumping up or manual transport of the water. Upstream however, a well was found (Fig. 7, D). According to locals, the well was perennial until about a decade ago, so it is logical to assume its functioning also in Roman Age. Indeed, the well is situated on the escarpment between two terraces of the Potenza river (Fig. 7, T1 and T2). The gravel of the upper terrace stores water at its base like a sponge, releasing gradually the water along a seep line, where the interface between the terrace and the bedrock crops out. Although it is not a proof, it can be taken into consideration that a ditch now leads straight from the well to the location of the cistern (Fig. 7, E).

A considerably larger amount of water than this would have been needed by the time the baths were built (in the 2nd century CE, Mercando 1977–1980). According to excavations, the cistern could hold vast quantities of water. This could be linked with the presence of crop marks in the field between the Fosso Manocchietta and the Potenza river (Fig. 7, F), located 6 m apart, approximately 5 m x 2 m large, aligned almost perfectly on north-south direction. Augerings revealed that the crop marks occur on river terrace gravels covered with a layer of fine sediments 40 cm thick. At the crop marks, the gravel begins deeper under the surface, at 55 cm, as if a hole was made in it to host a pole or pillar and after this was removed (to be re-used as building material), the hole was filled with finer sediments. It could well be aqueduct arcade or venter bridge pillars. It has been mentioned that the depth of the 15 cm poles of in the gravel is little, but this can be attributed to the collapsing of the walls of the pole-holes before the sediment cover was deposited. Given the asymmetry of the Potenza river valley, the terraces north of Potenza are located further apart than the ones south of Potenza., and thus the south is better suited for water captation. At present, a diversion channel of Potenza (Fig. 7) is used for hydroelectricity. When producing the line of the aqueduct southward (Fig. 7, E), the field work team encountered remains of conglomerate conduit parts with a large radius of curvature, consisting of conglomerate with a kind of cement on the interior, exactly at the crossing with the channel. The channel has a rate of descent of 1.5 m/km, slower than Potenza river's rate of descent 6.4 m/km. Consequently, on the 4 km between the diversion of the channel and the arrival south of the city, the altitude gain of the channel over the Potenza is 20 m. Considering the altitude of Helvia Recina, the aqueduct would have had a mean descent rate of 6 to 8 m/km, which is high but not improbable. It would lead to a high water velocity and thus possible erosion on the conduit, avoiding accumulation of calcium carbonates and sediments in the conduit. This is a system that is relatively easy to construct and to maintain.

The age of the aqueduct is not determinable: the cement could have been renewed regularly as long as the aqueduct was in use, so this dating possibility is out, and the typology and material of the conduit parts is so simple that it could be Roman as well as fairly recent according to Roman ceramics specialists. Despite the absence of foolproof evidence, it is likely that the aqueduct was built duringRoman Age and afterwards either abandoned or re-used and fortified. First of all, the construction has Roman finger prints all over it, the Romans being obsessed with building aqueducts only for the supply of water for baths (even if they had relied quite happily on wells for drinking water in the centuries before; Hodge, 1989), and the almost perfect north-south orientation is typically Roman. Moreover, although the Romans preferentially built aqueducts 1 m below or at ground level, they frequently used closed inverted siphons on pillars (a so-called venter bridge) to cross river depressions (Hodge, 1989). The Romans had no difficulty in making lead pipes that could withstand the pressure, but as lead was heavy and expensive to transport, the siphon part had to be as small as possible, by reducing the altitudinal range. Consequently, it would only be near the river that the conduit would be raised above ground level, on the venter bridge. This can explain why the crop marks are only found at this point. Secondly, after Roman Age, no city was to be supplied with water any more, hence the question rises: for what purpose a later societies would it build an aqueduct. One could argue that the water could be used for agriculture in the floodplain. This is true, but it is doubtful that they would go through the trouble of both digging a channel and building an aqueduct on good agricultural hilly land just to provide some more water to the floodplain where the water from the well could be used as well for irrigation purposes.

Conclusions

It has been made clear in this contribution that at the various sites and settings of the geoarchaeological project, different questions pop up and a new approach is needed. Around Potentia and Helvia Recina, situated on the coastal plain influenced by coastal processes, and the alluvial plain with dominant accumulation respectively, the main research methods were augering, resistivity survey and levelling.

Montarice on the other hand is a hilltop site, with erosion processes, landslides and remnant terraces, so the evolution in Quaternary geology is more important and has to be studied through geomorphologic reasoning and comparison with analog sites.

The geomorphologic research in the Potenza valley survey project, and especially in the coastal plain, has entered a phase of specific problem solving. In the future, the study of the environmental situations of sites will continue, through detailed geomorphological mapping and a land evaluation of the study area in central Potenza valley. The foundations are laid; the work itself is under construction.

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Tanja Goethals, Department of Geography, Ghent University (B) - tanja.goethals@ugent.be
Morgan De Dapper, Department of Geography, Ghent University (B) - morgan.dedapper@ugent.be
Frank Vermeulen, Department of Archaeology and Old History of Europe, Ghent University (B) - frank.vermeulen@ugent.be