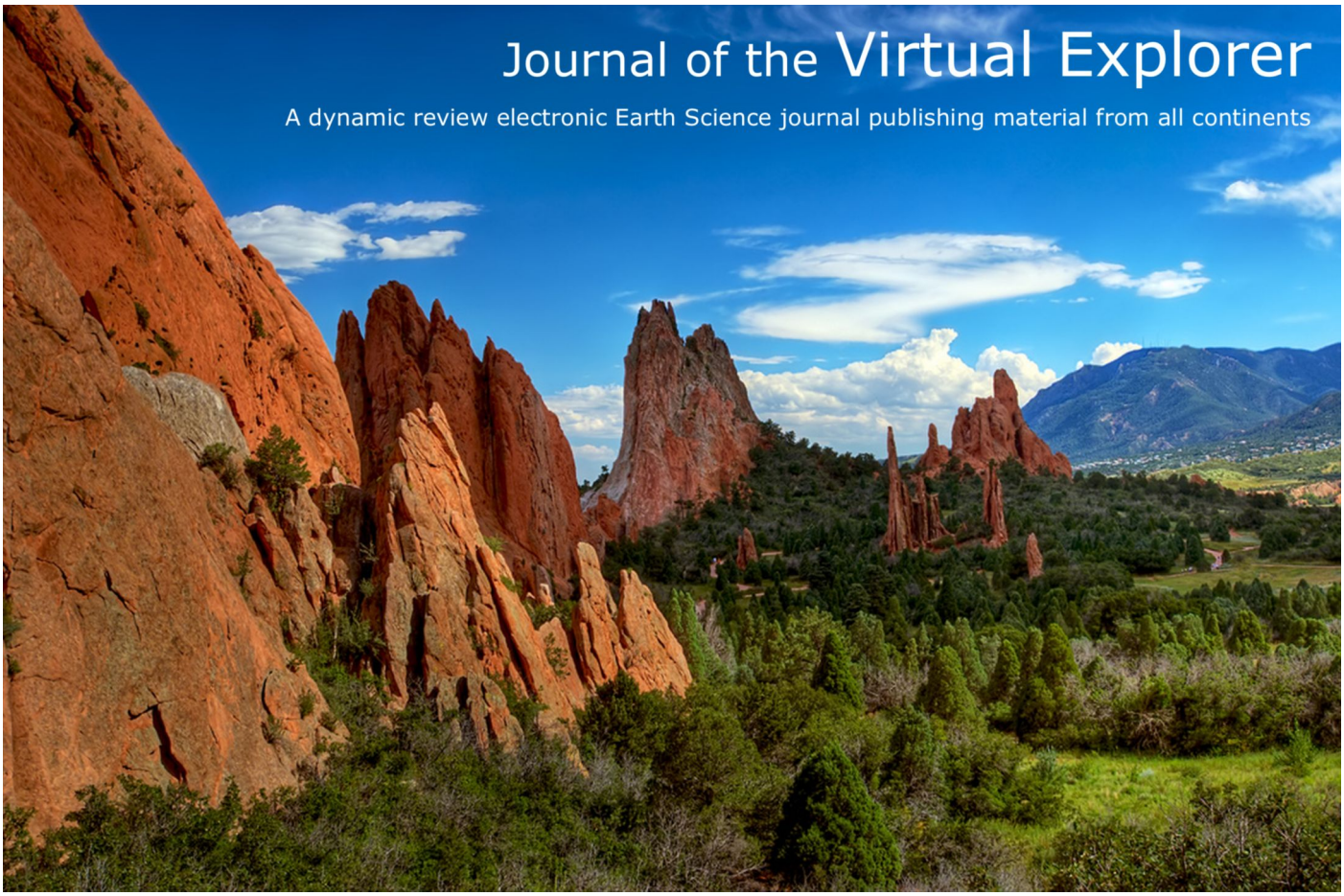

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The ancient harbour system of Catania (Italy): new evidence from the reinterpretation of geo-archaeological data, literary sources and historical iconographic documentation

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Abstract: The analysis of literary sources and historical iconographic documentation, combined with geological data and archaeological records, provides new evidence for the ancient harbour system of Catania. Taking into account the tectonic uplift, during the Greek colonization period the area of Piazza Duomo - the most depressed of the city at the mouth of the Amenano river - was located a few meters below the sea-level. We infer that it was the probable site of a natural inner harbour as a landing place for the first colonists who founded Catania in the 8th century B.C. According to the literary sources, beside the small river port used for commercial purpose, during the Greek and Hellenistic period the large beach located immediately south of the town, now covered by the 1669 lava flow, was used for military purposes. During the Roman period, alluvial episodes and infilling processes led to the final abandonment of the harbour area. Later on, many attempts were made to build a larger and multifunctional harbour, as shown by ancient cartography here considered. From the Roman period to the 19th century, a weak outer mole repeatedly suffered destruction by marine storms from the east. A conclusive role has been played by the 1669 lava flow that not only covered the beach used in the Greek period for military purposes, but also formed a large promontory south of the mouth of the Amenano river, favouring further fluvial-coastal deposition. Finally, the whole area has been absorbed in the town-planning changes related to the modern harbour of Catania.

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Introduction

Geological factors coupled with topographic and archaeological interdisciplinary studies on many harbours around the Mediterranean Sea, as well as the North Sea, the Baltic Sea and the Atlantic Ocean, have recently brought to light noteworthy environmental or landscape changes that have been demonstrated to be crucial for better understanding more conventional features of port archaeology. One of most stimulating topics for geo-archaeological studies, based on interdisciplinary analysis of natural and cultural formation processes, is represented by the ancient harbour system of Catania (Fig. 1a), located along the Ionian coast of Sicily (see inset in Fig. 2). This is an area prone to tectonic uplift and characterized by strong crustal seismicity (Monaco and Tortorici, 2000; Monaco *et al.*, 2002). Moreover, the city is located on the lower southern slope of the Mt. Etna volcanic edifice, on a flight of Pleistocene coastal-fluvial terraces at the border of the Simeto river plain (Fig. 3a), and was exposed in pre-historical and historical times to repeated lava flow invasions and main flooding events. Despite the recurrence of several earthquakes and eruptions (Boschi and Guidoboni, 2001), the urban area has developed in this complex setting since the 8th century B.C., when Greek colonists from Chalkida founded *Katane* on the Montevergine hill (between the present Castello Ursino and Piazza Dante, see Fig. 3a).

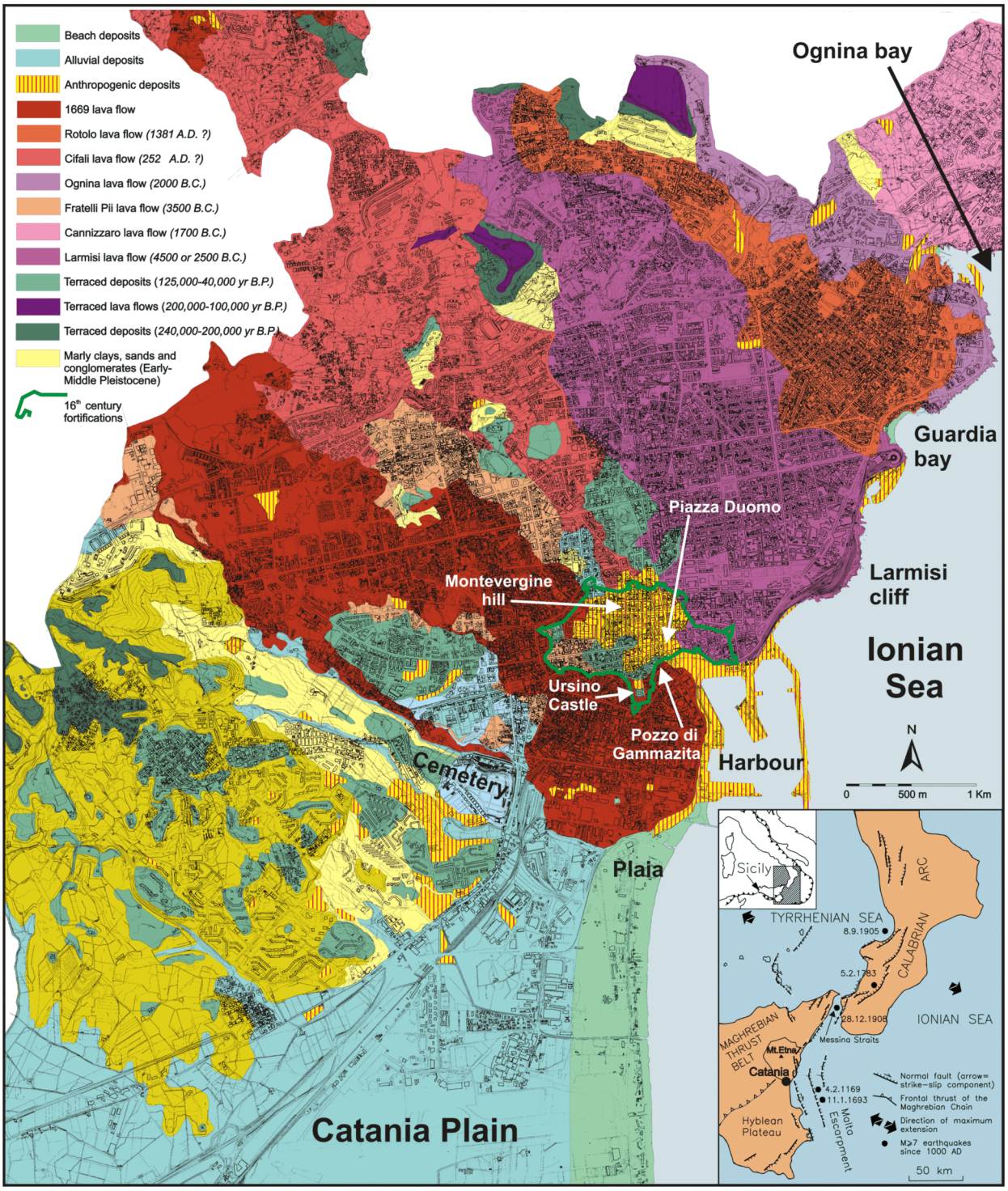
In the history of Catania the ancient harbour system has always represented a continuous problem that generated a political debate centred around the lack, along that segment of the Ionian coast of Sicily, of a natural bay well sheltered and purposeful (D'Arrigo, 1956; Coco and Iachello, 2003). Generally speaking, we can asses that to a wealthy harbour corresponds an efficient and well-organized harbour system; this assumption cannot be applied to Catania that appears instead to be characterised by a never-ending aim toward a urban model of a "city dreaming an harbour which might keep up with his ambitions" (Aymard, 2003). Although the constant persistence of this difficulty, since the Greek Archaic period the city of Catania was closely connected with the main maritime routes linked with the Greek markets of the central Mediterranean (including the islands of the Aegean sea). This apparently flourishing condition lasted until the end of the 19th century, although the politicians were often expressing their grievances over the functional inadequacy of the harbour. Notwithstanding these problems, Catania continued to play a main role in the rising of trade and agro-export industries, especially dealing with sulphur (Barone, 1987), and several harbour-planning projects were proposed.

The diachronic reading of historic and archaeological evidence stratified in the coastal landscape of Catania shows that geomorphology or natural factors are both constant reference points for planning both urban spaces and harbour related equipment. Taking into account the new publications on Catania about archaeology (Patanè, 1993-94, Tortorici, 2002; Branciforti, 2005) as well as geo-vulcanology (Boschi and Guidoboni, 2001; Tanguy, 2007), also considering the observations already discussed by the authors (Castagnino, 1994, Monaco *et al.*, 2000, Castagnino Berlinghieri and Monaco, 2008), this work provides a fresh interdisciplinary perspective which combines new data of each related field involved. The investigation of all of these data, which were analysed also in view of the military and commercial functional needs of the ancient city, sheds new light on few crucial questions about the ancient topography and makes it possible to project new hypotheses about the ancient waterfront and the precise functional areas of the harbour system of Catania starting from the Greck Arcaic age until the late-Roman period.

Figure 1. View of Catania and Mt. Etna

a) Aerial view of Catania and Mt. Etna in the background. b) View from the south of the western wall of the Swabian Castle (Castello Ursino, see Fig. 2 for location); the 1669 lava leaning against the wall is visible. c) Water canal in the Terme Achilleane thermal baths (see Fig. 6 for location). d) The Amenano fountain (Fontana dell'Amenano, see Fig. 6 for location). e) Aerial view of the modern harbour area of Catania; arrows show the location of Piazza Duomo (on the left) and the gate "del Porticello" on the 16th century fortifications (on the right). f) The Gammazita pit (Pozzo di Gammazita, see Fig. 2 for location); the 1669 lava leaning against the 16th century fortifications is visible.

Figure 2. Geological map of central Catania



Schematic geological map of the urban area of the city of Catania (from Monaco *et al.*, 2000, modified). Inset shows the seismotectonic features of the central Mediterranean area.

Figure 3. Catania 1849

a

b

a) Catania, view from the south-west in the coloured lithograph of Schultz (Paris, 1849). In the foreground the 1669 lava flow and the Ursino Castle are evident, to the right the harbour and the cathedral, to the left the Monastery of San Nicolò L'Arena and in the background the Mt.Etna volcanic edifice lying on a large Middle Pleistocene fluvial-coastal terrace. b) The Catania harbour and Mt. Etna in the steel engraving of W. Floyd (from Mediterranean scenery, W.L. Leitch, London, 1845). Note the front of the 1669 lava flow and the "Marina" beach on the left.

Geological data

From a geological point of view, three distinct sectors constitute the urban area of Catania (Fig. 2): the flat southern area, a portion of the Holocene coastal-alluvial plain of the Simeto river facing the Ionian Sea, characterised by a large sandy beach (the Plaia); the hilly south-western area, characterised by the marine deposits of the Lower-Middle Pleistocene cycle and the overlying flight of coastal-alluvial terraces, remnants of ancient coastal plains uplifted by tectonic processes; the central area, where the palaeo-valleys incised in the Pleistocene sedimentary substratum, characterised by several morphological terraces, have been filled by pre-historical and historical Etnean lava flows that, flowing from the NW to the SE, poured into the Ionian Sea.

According to Monaco *et al.* (2000) the old city, which lies on fragmentary Greek ruins and is bordered by the 16th century town walls (Fig. 2), developed on two morphologic terraces located at elevation of about 40 m a.s.l. (above sea level) (Montevergine) and 15 m a.s.l. (Ursino Castle), locally covered by the lateral fronts of the Fratelli Pii, Cifali and 1669 lava flows (Fig. 2). In fact, bore-holes carried out on the top of the Montevergine hill showed the occurrence of 20 m thick fluvial-coastal coarse polygenic sands that would have been deposited during the 60 ka sea level high-stand (Monaco *et al.*, 2000). Moreover, bore-holes in the courtyard of the Ursino Castle (about 15 m a.s.l.) revealed the occurrence of fluvial-coastal silty sands and conglomerates deposited during the 40 ka sea level high-stand. Before the lava flow invasion, both these platforms should have constituted small terraces on the top of low sedimentary hills facing the coast, morphologically similar to the present cemetery hill (Fig. 2). These data confirm the palaeogeography deduced by the *ante*-1669 iconographic and cartographic documentation (see for example Fig. 4a, and discussion below) and allow us to imagine the geological setting of the region where the Greek colonists founded *Katane*: a flat hill (Montevergine) facing the sea towards the south-east, where the mouth of the short Amenano river offered a natural shelter to small boats. To the east, at the bottom of the hill, the large Larmisi lava flow extended as far as the sea (Fig. 2). On the southern slope, in a favorable orographic position overlooking the Catania Plain and the Plaia sandy beach, the theatre was built (Holm, 1925). Further southward, a lower morphologic terrace dominated the coast and represented a favorable site for defensive military structures (e.g. the Ursino Castle, built in the 13th century by the Swabian emperor Frederick the second).

The geological analysis, compared with *ante*-1669 cartography (see Fig. 4), shows that until the 17th century the old city mostly expanded on sedimentary terrain, as shown by the 16th century town walls whose southern layout was influenced by the outer-edges of morphological terraces. Only after the last eruption (1669 A.D.) and the last strong earthquake (1693), the city developed also above the pre-historical and historical lava flows. It's worth noting that in the sector within the 16th century walls, the uppermost stratigraphic level consists of several metres thick ruins derived by the destruction due to the occurrence of the 1693 earthquake and by the following levelling of the main streets (Fig. 2).

In order to reconstruct the ancient harbour system of Catania, it is fundamental to fit the evolution of the coastline in the general context of the geological evolution of the area that mostly depends on Mt. Etna lava flow invasion, sedimentary processes and Holocene sea level change. The coastal morphology reflects the complex geological evolution as it is characterised by irregular basaltic cliffs in the northern sector, where distinct lavas flowed into the sea, and a linear sandy beach to the south, where the Catania alluvial plain extends. The 20 km long, north-south striking Plaia beach in the southern sector is the result of the coastal-alluvial deposition of sediments mostly transported by the Simeto river to the Ionian Sea. Before the lava invasions, it probably extended to the north, as suggested by bore-hole data and testified by the small sandy beach in the Ognina bay (Fig. 2). The northern sector is characterised by two basaltic promontories, corresponding to the pre-historical Larmisi and Ognina lava flows, showing up to 15 m high sea cliffs deriving from processes of retreat of the coastal profiles due to the continuous sea erosion. To the south, a third lower basaltic promontory is formed by the 1669 lava flow, at present completely covered by the docks of the Catania port. Bore-hole data (Monaco *et al.*, 2000) and historical documents (Fig. 4) suggest an up to 2 km seaward shifting of the coastline since the pre-historical times, due to the flowing into the sea of the Larmisi, Ognina and 1669 lavas.

The *Larmisi lava flow* (Sciuto Patti, 1872) is the oldest and the largest in the urban area of Catania and extends from the north-western outskirts to the sea, where it

forms a 2 km long and 10-15 m high cliff (the Larmisi cliff). The age of this lavas, above which most of the modern city has been built, is debated: Sciuto Patti (1872) subdivided it in two different flows, a southern one (the Larmisi lava) of prehistoric age, and a northern one (the Carvana lava) referred to the 122 B.C. eruption. This latter is attributed to the 252 A.D. eruption by Tanguy (1980), on the basis of archeomagnetic analysis. Moreover, following Gemmellaro (1858), we think that no lava flow reached Catania during the 122 B.C. event, whose historic descriptions seems rather referable to a summit explosion or a destructive earthquake (see also Mercalli, 1883). Other authors referred the whole lava flow to the 252 A.D. eruption (AA.VV., 1979; Romano and Sturiale, 1981; 1982; Lo Giudice and Novelli, 1998). In our opinion the Carvana and Larmisi lavas are the product of a single eruptive event that gave rise to the lava flow here named "Larmisi" in prehistoric times. As a matter of fact, a *terminus ante quem* is represented by the archaeological remnants of the old Bronze age (2000-1400 B.C.) which have been found in lava tunnels of the northern portion of this lava flow (e.g. Grotta Petralia; Grotta di Novalucello I, Privitera, 1998; Centro Speleologico Etneo, 1999). Considering the evident incongruence, it has been recently attributed to pre-protohistorical times (~4500 B.C.) on the basis of morphologic data (Monaco *et al.*, 2000) and to protohistorical times (~2500 B.C.) by absolute age determination (Tanguy *et al.* 2007).

The *Ognina lava flow* is well exposed in the 1.5 km long and 5-10 m high cliff between the Ognina and the Guardia bays and has been referred to pre-historical times by Sciuto Patti (1872). Successively, several authors (Sartorius Von Waltershausen, 1880; AA.VV., 1979; Romano and Sturiale, 1981; 1982; Chester *et al.*, 1985) attributed this lava flow the 426 B.C. eruption as they thought that it would have been produced by one of the three eruptions that, according to literary sources, reached the Catania area during the Greek colonization (693 B.C., 476 B.C. and 426 B.C.; Thucydides VI, 50-51, 72, 74, 88, 94). This attribution can be confuted if we critically revise the literary sources: in fact, only the 476 B.C. lava flow surely reached the sea (see Pindar, 1st Pithic Ode; Thucydides, book III, 116, and relative discussion in Chevallier, 1924; Tanguy, 1980; 1981; Tanguy and Kieffer, 1993; Tanguy and Patanè, 1996), whereas the 693 B.C. and 426 B.C. lava flows have not clearly been still located. Moreover, the absolute age (about 2000 B.C.) recently determined by Tanguy *et al.* (2007) supports the primary age attribution of Sciuto Patti (1872). This suggests that the coastal morphology at the time of the Greek colonization should have been very similar to the present.

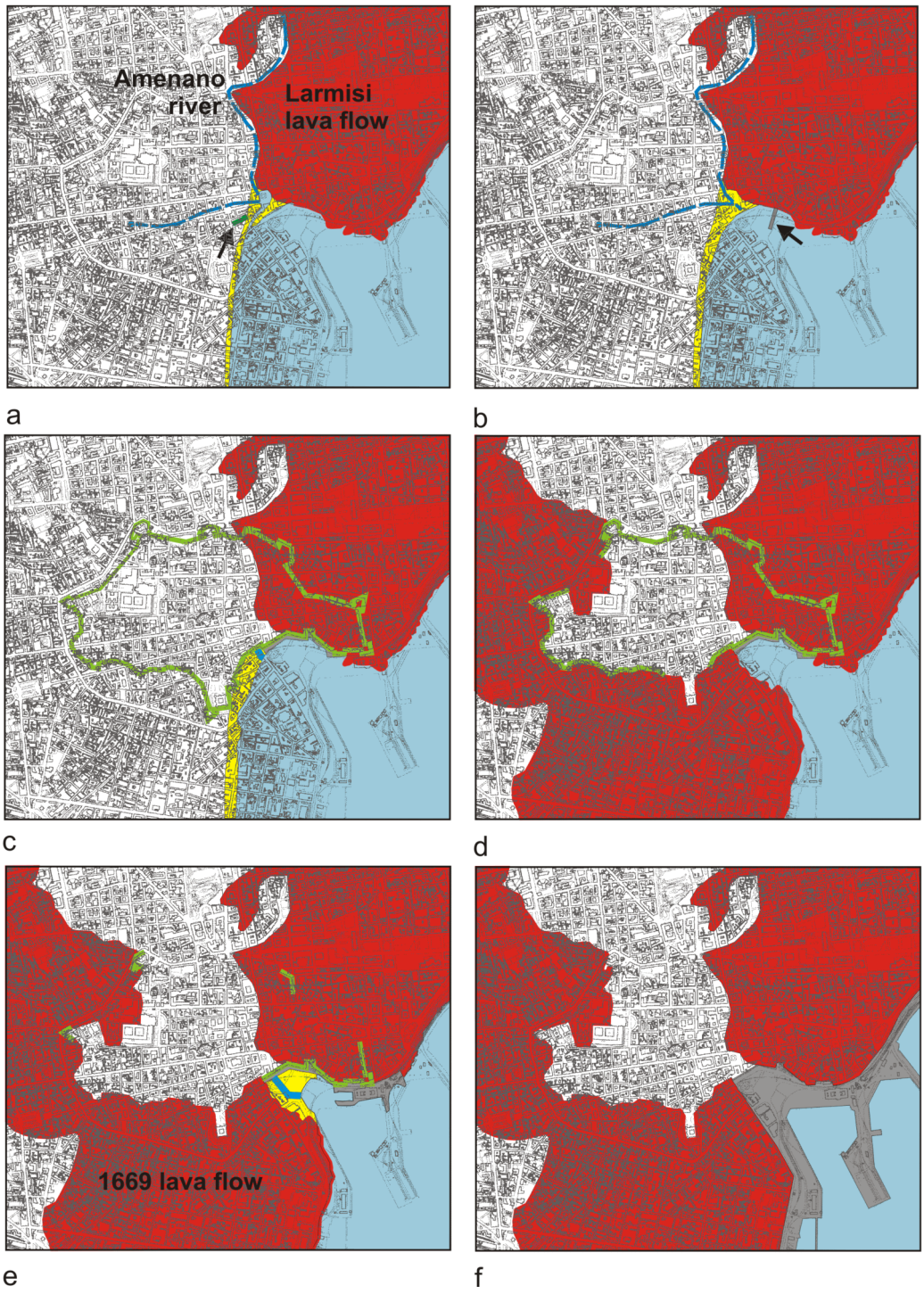
The Ognina lava flow, together with the Rotolo lava flow, almost entirely filled a large bay occurring north of the Larmisi cliff, between Guardia and Ognina (Fig. 2). The *Rotolo lava flow* (Sciuto Patti, 1872) has been generally attributed to the 1381 eruption (Recupero, 1815; Gemmellaro, 1858; Sartorius Von Waltershausen, 1880; Sciuto Patti, 1872) on the basis of a manuscript of Simone da Lentini registered in the archives of the Catania Cathedral. This interpretation has been successively confirmed (AA.VV., 1979; Romano and Sturiale, 1981; 1982; Chester *et al.*, 1985), even though recent archaeomagnetic analyses suggest an age attribution to the 12th century (Tanguy, 1980; 1981; Tanguy *et al.* 2007). Despite the Rotolo lava flow is at the present almost completely covered by modern buildings of the northern quarters of Catania, its boundary can be precisely drowned from the 1845 Sartorius Von Waltershausen map and from the 1929 Istituto Geografico Militare (scale 1:25,000) topographic map. In order to reconstruct the ancient coastal morphology, it's useful to outline that during the 1381 eruptive event (started on 6 August at an altitude of 350 m a.s.l.) two distinct lava fronts reached the sea, partially filling the small bays of Ognina and Guardia (Recupero, 1815).

To the south, the *1669 lava flow* forms a basaltic promontory (Fig. 2) completely covered since the beginning of the last century by the building of the western wharves of the Catania harbour. According to historic chronicles (Tedeschi Paternò, 1669), the eruption started on 11 March in the Nicolosi area, at an altitude of 900 m a.s.l., and gave rise to three main lava flows, one of which on 12 April reached the western fortifications of Catania that deviated the lava flow to the south where, surrounded the Ursino Castle on 14 April (Fig. 1b), it reached the beach below on 23 April, flowing into the sea for 500 m with a 1.5 km large front. It gave rise to a small bay (Fig. 4d-e), initially used as natural harbour to throw in dry the boats, successively filled by coastal fluvial sediments to form the ancient "Spiaggia della Marina" (Fig. 3b) and finally absorbed in the urban transformations.

Figure 4. *Ante*-1669 cartography

a) Catania and Mt. Etna, panoramic view from the south in the drawing of T. Spannocchi (1578; from Giuffré, 1981); note the Ursino Castle along the seaside and the large sandy dune belt south of the castle. b) Catania in the map of F. Negro (about 1637; from Aricò, 1992); to the right, the western boundary of the Larmisi lava flow is evident. c) Bird's-eye-view of Catania and Mt. Etna in the copper engraving of N. Van Aelst (Rome, 1592); note the location of the pier nearby the fortification gate "del Porticello". d) Fresco of G. Platania in the Catania cathedral; e) The 1669 lava flow and the 16th century fortifications in the drawing of don Carlos de Grunenbergh (1673, from Boscarino, 1976).

Figure 5. Harbour reconstructions



Reconstruction of the geological and anthropogenic modifications of the coastline in the harbour area of Catania; in yellow the beach and spit deposits, in red the lava flows, in blue the Amenano river and related canals, in green the 16th century fortifications, in grey the maritime works. a) Greek Archaic period (hypothesis); arrow shows the archaeological remains of Via Zappalà Gemelli. b) Roman period (hypothesis); arrow shows the possible location of the pier in opus pilarum. c) In 1637 A.D. (from the map of F. Negro). d) In 1669 A.D. (from the maps of don Carlos de Grunenbergh and Istituto Geografico Militare). e) In 1832 A.D. (from the Map of Catania of S. Ittar); f) Present.

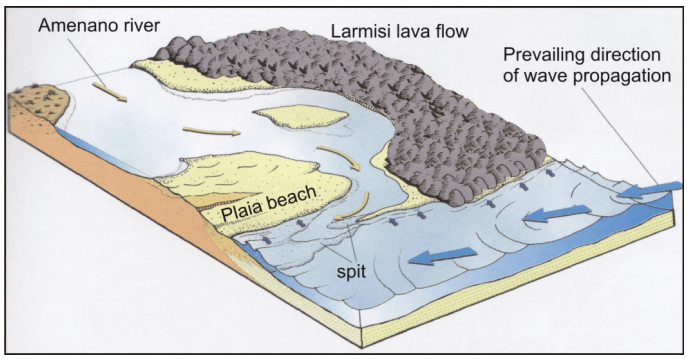
Due to the lava flow invasions of the ancient drainage system, several changes occurred in the hydrographic network crossing the Catania urban area. A few pond and lacustrine environments developed and disappeared in the pre-historical and historical times, some of which are testified by the present toponymy (e.g. Cifali, Via Lago di Nicito). Moreover, considering that Etnean lavas represent a good aquifer for their high permeability and for the presence of an impermeable substratum represented by the Pleistocene clays, a complex groundwater system has developed. However, groundwater natural discharge often occurs at the contact between lavas and clays at several springs both in the town (Leucatia, Cifali, in the past Piazza S. Maria di Gesù) and along the coastline (in the small Ognina and San Giovanni Li Cuti ports). In the southern coastal stretch, covered by the 1669 lava flow, springs are clearly shown by the *ante*-1669 iconographic and cartographic documentation (Fig. 4). The great availability of spring water has certainly played a primary role both in the choice of the location of the colony in Greek Archaic age, and in the location of the thermal bath system in Roman age (Terme dell'Indirizzo, Terme della Rotonda, Terme Achilleane, Fig. 1c and 6).

Figure 6. Map of canal system

Map of the canal system explored by the Centro Speleologico Etneo in the Piazza Duomo area (by R. Bonaccorso, in Bonaccorso and Lo Giudice, 2002).

An important fresh water spring fed the Amenano river (Fig. 5a) that presently flows as a canal below the surface in Piazza Duomo (it is visible in the homonymous fountain located in the south-western corner of the square, Figs. 1d, 2 and 6) as far as the harbour area, only outcropping at the Villa Pacini. The origin of this small river has been always debated: it probably represents the emergence of a system of canals, partially of Roman age and rearranged during the 18th century (Bonaccorso and Lo Giudice, 2002; Fig. 6), that concentrate in the Piazza Duomo all the waters that probably bogged the more depressed sectors of the town (see discussion below about the possible Roman age of the land reclamation works). In particular, a canal along the Via Garibaldi suggests a western provenance of the Amenano river, at the bottom of the southern slope of the Montevergine hill (see also Sciuto Patti, 1872), whereas a canal along the Via Merletta suggests a northern provenance, along the present Via Etnea (see also Ferrara, 1829; Holm, 1925; Lo Giudice and Novelli, 1998), between the eastern slope of the Montevergine hill and the western front of the Larmisi lava flow, whose boundary is clearly reported in the map drawn by Negro in 1637 (Fig. 4b). Probably, when the Greeks founded *Katane* both small rivers existed, whose springs were fed by a large hydrogeologic basin located north-west of the town in the Etnean basalts covering the impermeable sedimentary substratum, and flowed together in the Piazza Duomo area (Fig. 5a). The mouth was located between the basaltic Larmisi promontory and the northern end of the Plaia beach.

Figure 7. Palaeogeography of the Piazza Duomo area



Hypothetic reconstruction of the palaeogeography of the Piazza Duomo area in Catania during the Greek Archaic period (from Longhitano, 2000, modified).

Because of modern levelling and urbanization of the Piazza Duomo area (see Fig. 1e), the present road surface, located at an elevation of 6 m above sea level, do not allow to recognize the ancient functional levels documented by the archaeological stratigraphy (Landolina, 1870; Tomasello, 1979; Dato, 1983). However, taking into account the tectonic uplift rates of the Etnean coastal area during the Holocene (2-3 mm/yr, Firth *et al.*, 1996) and the sea level rise rates in the last 5000 years (about 1 mm/yr, Lambeck *et al.*, 2004; Monaco *et al.*, 2004), the field surface of the Piazza Duomo area, presently located by geophysical surveys at about 5 m below the road surface (Imposa *et al.*, 2002; see also the floor elevation of the Terme Achilleane, Fig. 1 c), should have been located below the sea level (b.s.l.) at the time of the Greek colonization (about 2500 years ago):

Present field surface: 1 m a.s.l.

Tectonic uplift rate: 2 mm/yr

2 mm x 2500 years = 5 m

5 m – 1 m (present field surface) = 4 m

2500 years ago the field surface should have been located at - 4 m b.s.l.

But we must consider also the sea level rise in the last 2500 years (2 m)

Field surface elevation of Piazza Duomo area 2500 years ago = - 4 m + 2 m = - 2 m b.s.l.

Moreover, on the basis of geomorphologic considerations and bore-hole data, we can infer that in this area the Amenano river formed at its mouth a small coastal lagoon sheltered to the east by the basaltic Larmisi promontory and bounded towards the sea by a sandy spit (Fig. 7). This typically occurs at river mouths in coastal-alluvial plains flanked by rocky headlands because of the interplay between sea currents and sediment transport. As a matter of fact, recent bore-hole data suggest that the southern sector of Piazza Duomo (Palazzo dei Chierici; C. Zocco, personal communication) is characterized by a marine sedimentary succession, that can be interpreted as a coastal spit deposit, overlain by an alluvial interval. Conversely, west of Piazza Duomo (Via Vittorio Emanuele) probable lacustrine deposits occur under the road surface. Due to natural changes (tectonic uplift, alluvial-coastal deposition) and to numerous urbanistic arrangements occurred since the Roman colonization, the lagoon disappeared (see below).

Reinterpretation of literary sources and iconographic documentation

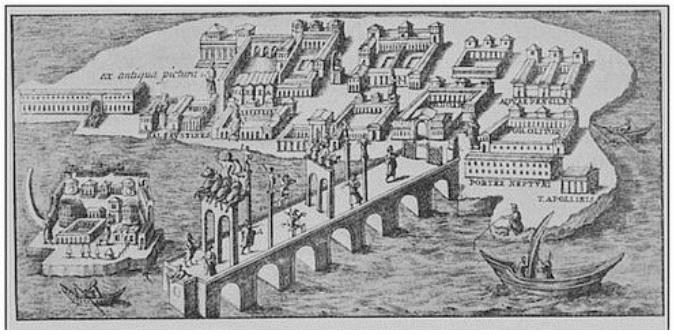
Even if the literary sources lack data and do not allow us to frame the site in a precise port typology, they give some indirect clues on maritime topography that can be reconsidered in the light of the geomorphologic components of the coastal landscape. Thucydides (VI, 72) reports that «...Athenians passed with the fleet to Nasso and Catania...» but never referring to the word “port”; Diodorus of Sicily (XIV, 61, 4), about four centuries after Thucydides, reminds a *"Aighialòs tōn Katanáiōn"* (Castagnino, 1994), that is a sandy shore. Diodorus of Sicily, in particular, emphasizes that during the second Punic war, because of a sudden storm, the Carthaginian general Imilcon had to land the ships in Catania, where the Carthaginian general Mago was waiting him with its fleet (XIV, 59; XIV, 61,4). In another passage, Diodorus of Sicily (XIV, 60, 6-7), reports that after the battle the Carthaginian anchored in Catania their triremis, without specifying if they sheltered in a harbour. Diodorus of Sicily uses the verb *"hormízō"* that, in *strictu sensu*, means “to anchor” and it doesn't implicate neither the concept of harbour nor the possibility of assuring the ship to berth bollards. It is worth noting that, even though he was telling not contemporary events, he never used the term “port”. The reinterpretation of these literary sources would suggest a coastal morphology characterized by a sandy shore, suitable for beaching military ships according to an established practice of ancient sailing. Moreover, it is evident the lacking of a real military harbour armed with arsenals, benches, docks and endowed with the necessary structures of logistic support for a fleet.

Strabo (VI, 3,19) provides another interesting topographic information. Dealing with the eastern Sicily towns, he remembers that «...several rivers, descending from Mt. Etna, flow into the sea and form easy ports at their mouths» (Ambrosoli, 1833). Moreover, this geographer considers Catania one of the most important coastal sites, and points out that it is crossed by the Amenano river (Strabo, V, 3,13), whose mouth is located south of the town. It is worth noting the accuracy of his observation that, realizing the economic importance of the combination “land-river” in the Roman colony's financial system, obviously underlines the presence of the Amenano river. In fact, under the emperor Augustus, Catania was considered *caput rei frumentariae* (Cicero, Verr., II, 3, 83) and the development of an important wheat market is

confirmed by an epigraph (CIL XIV, 364; Manganaro, 1988) that tells the *patronus C. Granius Maturus*, pertaining to the guild of *fabri navales* operating simultaneously in the two commercial centres of Ostia and Catania. Another important literary sources (Cicero, Verr., II, 3, 83) reports that the ships arriving or transiting at Catania had to pay the city a *vicesima portorii*, a kind of customs duty *ad valorem*, equal to the 5% of the estimated value of the load. In this context, a fragmentary inscription, treating of administrative customs, refers to the coordination of the *portorium* carried out by an imperial procurator who provided the monitoring of *conductores* for tax collection (Manganaro, 1988).

Another important fragmentary epigraph, found nearby the nowadays Catania fish market and reconstructed by Manganaro (1959), adds important information to the limited but significant technical data drawn from literary sources. This epigraph reports the occurrence of ancient harbour structures that needed to be consolidated as they were damaged by storm (*procella*). Reference to pier (*moles*) and to the construction technique in *opus pilarum (pila pa[cta...])* (piers connected by arches, see Fig. 8) would suggest the occurrence of a system of defence and, at the same time, of service to a small commercial harbour area. The reference to the destructive action of a storm allows us to interpret the pier as an external protection work, exposed to dominant winds, needing an emergency in order to ensure a safe shelter to ships (*navigis adpulsis scabro litori*). Moreover, the same inscription reports a *meatus urbis* referring to works of water canalization in the city with suitable drainage technique. The parallel reference to *moles* and *meatus urbis* suggests a temporal correlation in the realization of the two works, that were strategic and functional for the restoration and reorganization of the harbour area, which became necessary in consequence of both destruction of the external pier by marine storms and flooding of the city. Both structures were probably gravitating around of the lower sector of the town (the *Platea Magna* area, the present Piazza Duomo, Fig. 1e). In fact, the epigraph suggests that works of water canalization should have occurred in the city, probably where the mouth of the Amenano river was located (see previous chapter). In this depressed sector, flooding events and accumulation of fluvial coastal sediments could have caused the silting up of a lagoon previously used as internal harbour. During the Roman colonization, it was filled by sediments and reclaimed, the water canalized in order to feed thermal baths (e.g. Terme dell'Indirizzo, Terme Achilleane, Fig. 6) and fountains. These latter are clearly documented in the *ante*-1669 iconographic and cartographic documentation (Fig. 4) and are still visible in the Piazza Duomo area, such as the Amenano and Sette Canali fountains, or were buried by the 1669 lava flow and successively excavated (e.g. young hostel in Piazza Currò, Pozzo di Gammazita, Figs. 1f and 2). The age of the first building stage of the thermal baths (3rd century A.D.) help us to frame chronologically the natural event. This represents a *terminus ante quem* also for the restoration of the harbour pier mentioned by the discussed epigraph whose location, while precisely unknown, probably reflect a sheltering system for the harbour entrance.

Figure 8. Arched pier of Roman Puteoli



The arched pier of Roman Puteoli (from Dvorak and Mastrolorenzo, 1991), labelled "from a Roman picture after Bellori" in reference to Fragmenta vestigii veteris Romae by J.P. Bellori (1615-1696).

The analysis of coastal morphology with respect to the prevailing wind directions (from the east: Sirocco and Levant) allow us to infer the location of the Roman pier in the Larmisi lava flow, eastern-facing the homonymous promontory (Fig. 5b). This location is suggested by the need of sheltering from the Sirocco and Levant storms the bay occurring between the Larmisi promontory and the Plaia beach. In this bay the mouth of the Amenano river and/or of the canal system reclaiming the most depressed sector of the town was located. This setting is confirmed by the drawing of N. Van Aelst (ordered by the nobleman A. Stizia in 1592 A.D.), one of the oldest view of Catania (Fig. 4c), a bird's-eye-view that shows the urban plan of the town along the Ionian coast and Mt. Etna volcano in the background. In this view, a small pier is showed, located in the most functional position in order to shelter the southern coastal sector of the city, the

most suitable to accommodate a port, from the prevailing meteo-marine agents.

The interpretation of the iconographic and cartographic documentation earlier than the 1669 eruptive event (see also Pagnano, 1992), that deeply modified the coastal morphology, provides some evidence concerning the Middle age harbour structures and the primary morphology of the beach occurring at the foot of the low hill dominated by the Swabian castle (the Ursino Castle). A shore extending from the Piazza Duomo area to the south is clearly represented in the map drawn by F. Negro in 1637 A.D. (Fig. 4b) and in the bird's-eye-view drawn by N. Van Aelst in 1592 A.D. (Fig. 4c). The most complete and picturesque bird's-eye-view of Catania and Mt. Etna was drawn by T. Spannocchi in 1578 (Fig. 4a). In particular, in the 10th table of the *Description de las Marinas de todo el Reino de Sicilia del Cavallero Tribucio Spanoqui*, the castle, presently located about 1 km on-land, appears positioned along a wide sandy beach. This fortified square structure, built according to the Swabian military standard, was conveniently located by the emperor Frederick the Second on the shore, in a position that dominated the most strategic points of the town, in order to defend it against attacks from the sea. In particular, in the Spannocchi's view the Ursino Castle seems to be built on a small terrace at the top of a low hill dominating the sea and parallel to the coastline below. This latter is characterized by a wide sandy beach (later covered by the 1669 lava flow), that appears to be in continuity with the present Plaia beach. In the written text accompanying the Spannocchi's view, it is clearly affirmed that in 1578 A.D. Catania «...do not have a harbour nor a shelter for ships …». This lack is evident also in the accurate 1637 A.D. Negro's map (Fig. 4b) that reports the word "porto" in correspondence of the narrow inlet, visible also in the Spannocchi's view, located east of the cathedral where opened the gate "del Porticello" (or "Porta Vega") in the 16th century fortifications (Fig. 1e). On the contrary, the 1592 Van Aelst's view (Fig. 4c), portrays a small pier placed right in of the same inlet called «*portus*», where ships are not docked. Here, the ships appears far moored in a dispersed manner in the bay between the basaltic Larmisi headland and the beach below the Ursino Castle.

Another important iconographic source is represented by the giant wall fresco, entitled "Catania during the 1669 eruption", realized in 1679 A.D. in the Catania Cathedral and attributed to the painter Giacinto Platania (Fig. 4d). With images very efficacious and rich in evocative details, the artist manages to visually communicate the violence of the lava burying the beach adjacent to the Ursino Castle, as far as the bastions of the castle, and completely changing the primary morphology of the coastline. Even here we note the presence of a small pier in front of the gate "del Porticello" on which many citizens are waiting in line to escape by sea to the disaster. In order to understand the morphological change of the coastline caused by the 1669 lava flow in the southern sector of the town, it is very useful to compare Figs. 4b and 4e.

The analysed cartographic and iconographic documentation allow us to reconstruct the morphologic changes of the beach, now obliterated by the 1669 lava flow and urban works, that stretched from the Larmisi basaltic cliff to the south (see also D'Arrigo, 1929). It's worth noting that in 1578 A.D. the city was not equipped with a port at the mouth of the Amenano river, in the northernmost sector of the beach. The comparison between the descriptions of Spannocchi (1578, Fig. 4a) and Negro (1637, Fig. 4b), on the one hand, and the descriptions of Van Aelst (1592, Fig. 4c) and Platania (1679, Fig. 4d), on the other hand, also suggests that during the period between 1578 and 1669, this bay was alternatively sheltered by a small pier. The analysis of literary sources, iconographic documentation and meteo-marine data, suggests that the pier could have been located in the same position of the pier in *opus pilarum* used during the Roman colonization and that was restored in the Late Roman period (Fig. 5b). As a matter of fact, for its exposure to the devastating storms from the east, this harbour structure went through several stages of destruction (Fig. 5c) and reconstruction, as documented by the Late Roman epigraph (see above). After the 1669 eruptive event, and the consequent formation of a deep and small bay north of the lava flow (Fig. 5d), this coastal stretch underwent abundant coastal-alluvial deposition (Fig. 5e) and was later incorporated into the urban transformation (Fig. 5f).

Archaeological data

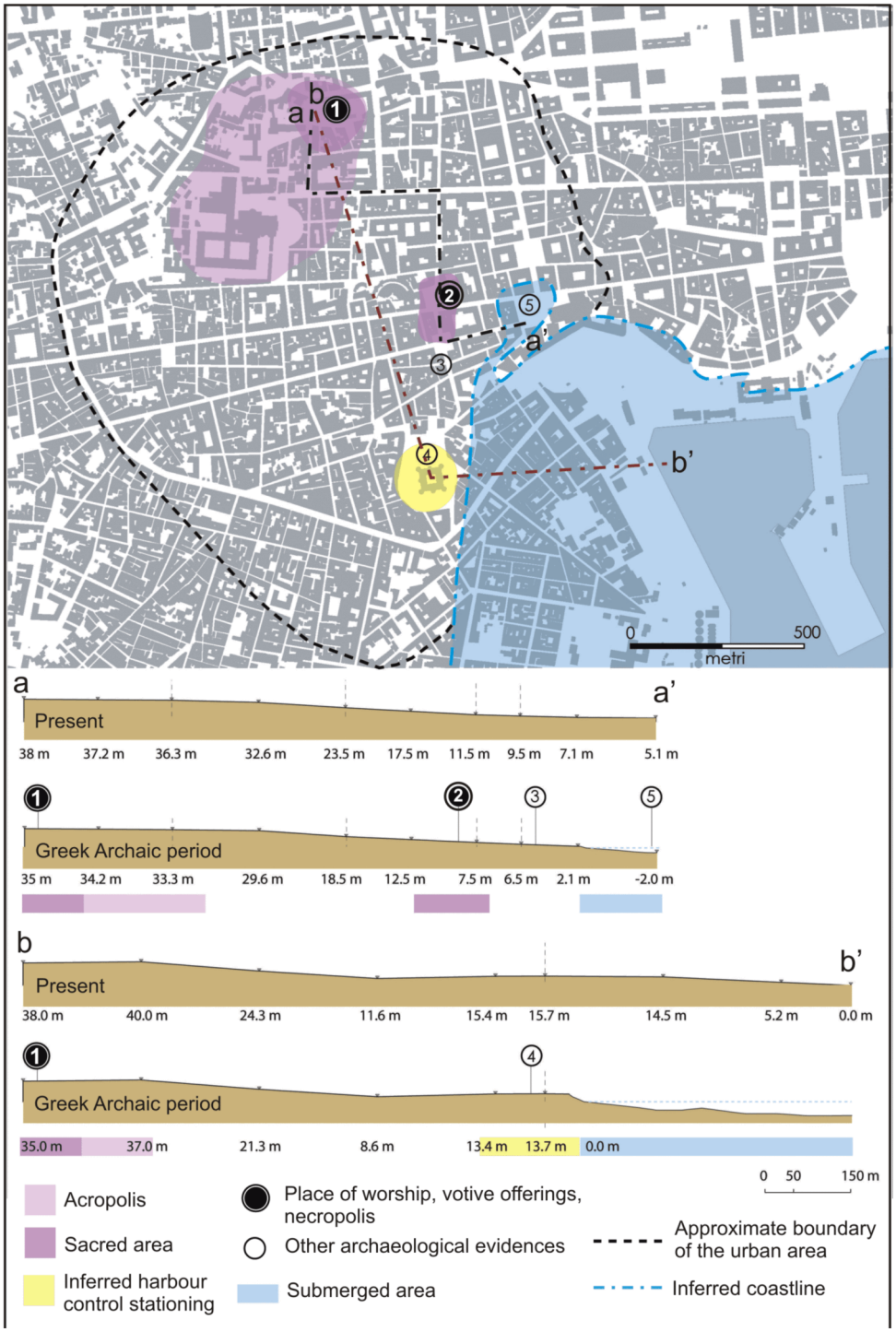
To the current state of researches (see also Castagnino Berlinghieri and Monaco, 2008), at least two distinct components seem to characterise the harbour area of the colony *Katane* during the Greek period (Fig. 9): downtown, on the top of a morphological terrace (the present

Ursino Castle area at 15 m a.s.l.), there was a stronghold of control overlooking the sea; in the area of the present Piazza S. Francesco d'Assisi votive offerings were located, belonging to a feasible coastal sanctuary that was closely connected to the port system. Uptown, on the top of higher morphological terrace (the Montevergine hill), the Greek acropolis and the early urban compound (a sort of primary form of urban organization) are attested by archaeological evidence dated to the 6th century B.C. (Frasca, 2000). The east-west oriented wall discovered within the Ursino Castle, associate with proto-Archaic Greek pottery shreds (Patanè, 1993-1994), suggest that this area was regularly used by Greek colonists since the 8th century BC. In particular, the remains of these masonry structures underline the importance of the strategic stronghold place in a coastal dominant position with specific control functions, most likely related to defence and security of the harbour (Fig. 9). These data confirm the possible occurrence of an inner natural harbour located in the present Piazza Duomo area at the mouth of the Amenano river (Fig. 5a), used as a landing place by the first Greek settlers who founded *Katane* in the 8th century B.C. Successively, during the entire Greek period, it was also exploited as a transit area for maritime trade. As a matter of fact, the meaningful votive offerings discovered in Piazza San Francesco (*ex voto* in ceramics, belonging to various typologies) are witness of long-routes trade relationships with central and eastern Mediterranean since the Greek Archaic period.

The vestiges of "*taluni avanzi di arte antica*" (some remains of ancient art) identified by Sciuto Patti (1896) in Via Zappalà Gemelli (Fig. 9), that appears located along the western edge of the hypothesised harbour area, were probably built as foundation for the construction of an upper platform, probably conceived in connection with the nearby Piazza San Francesco votive offerings area, as part of a feasible coastal sanctuary (see discussion in Castagnino Berlinghieri and Monaco, 2008). To the south, the coastline located at the bottom of the Ursino Castle (buried by the 1669 lava flow) appears as the same stretch of sandy beach referred by Thucidides (III, 116), that was probably used as a military base of Athens within the Athenians and his allies naval manoeuvres against Syracuse during the War of the Peloponnesus in the 5th century BC. Literary sources also suggest that a sandy beach, the *"Aighialòs tōn Katanáiōn"* (Diod. XIV, 61, 4), was still used as a military base during the Second Punic War. As regards the coastline north of Piazza Duomo, we can assume that the coastal morphology at the time of the Greek colonization should have been very similar to the present (see Geological data). The two bays of Guardia and Ognina (Fig. 2) were only partially invaded by small branches of the 1381 lava flow. Literary sources also suggest that this coastal stretch may have hosted a small port, which was not directly connected with the urban centre of Catania being placed to the north (see also Tortorici, 2002), probably in the so-called Porto Ulisse at the bay of Ognina (Castagnino, 1994).

After the Roman conquest of the city in 263 B.C., Catania became a "Roman colony" under Augustus in 21 B.C. In that period the harbour area was gradually involved in an intense period of upgrading of the entire city, from the Montevergine hill to the downtown, that was improved until the 3rd century A.D. Natural transformations probably occurred at the mouth of the Amenano river and in the inner harbour area, that was subjected to silting process. It resulted from the combination of fluvial-coastal sedimentation along with sea-levels rising and tectonic uplifting. A comparison between the river harbours of Ostia and Catania could be very useful in order to understand how technical challenges and risks related to the infilling phenomena can be approached differently. As regards the Ostia harbour, located at the mouth of the Tiber river, the silting problem was solved in a radical way by abandoning the port itself in order to build another one, much safer and more convenient than the river harbour, in a place a few kilometres to the north. In the Catania harbour area, conversely, the water flowing on the surface was canalized in a system of underground canals, also in order to gain ground on the sea. The *meatus urbis* (works of water canalization), mentioned in the marble epigraph (Manganaro, 1959), seems to refer to this sector of the city. Along with the development of maritime infrastructures to better support the inner harbour, dating from the mid-Republican age to the first-Imperial age, considerable clean-up operation of the port took place from mid-3rd century A.D. Mostly, the Piazza Duomo area was reclaimed and the water fed at least two thermal baths (Terme Achilleane, Terme dell'Indirizzo). At this stage seems to be dated the building of an outer defence system, made in *opus pilarum* (piers connected by arches), in order to broaden the harbour area (Fig. 5b).

Figure 9. Main Greek Archaic features in Catania



Location of the main Greek Archaic features in Catania (from Castagnino Berlinghieri and Monaco, in press); (1) ex Reclusorio della Purità; (2) Piazza San Francesco; (3) Via Zappalà Gemelli; (4) Ursino Castle; (5) ancient harbour (hypothesis). The sections below illustrate the change of the topographic elevation (a.s.l.) from the Greek archaic period to the present. For the reconstruction of the old elevation, we subtracted from the present elevation 3 m, obtained by the vertical tectonic uplift (about 5 m, considering an uplift rate of 2 mm/yr) minus the sea level rise (about 2 m in the last 2500 years). Moreover, we subtracted from the present elevation also the thickness of remains of anthropogenic origin and of the 1669 lava flow (only in the B-B' section) obtained by bore-holes (see Monaco *et al.*, 2000).

If we assume that in Roman times the harbour was equipped with port-related structures, such as moles, quays and warehouses for storage of goods, the fifteen east-west oriented parallel walls discovered (Sciuto Patti, 1856) in old excavations under the Palazzo del Duca Tremestieri, located in Via Lincoln (nowadays Via Sangiuliano, 300 m north of Piazza Duomo), could be referred to maritime infrastructure to store merchandise. Even though we have an incomplete picture of these ruins, because at the time not properly documented, they clearly show the presence of a large complex, which consists of long rectangular rooms as part of a whole project that works on the repetition of equivalent forms, with a plan reminding the arrangement of the Roman *horrea* (Staccioli, 1962). This is confirmed by the discovery of *in situ* part of columns and mosaics. This would suggest that this plan of walls was provided by an open central area preceded by a colonnade, as for example in Horrea I, VIII, 2 of Ostia. The design aspects, together with its location close to the road network of the Imperial age documented in Via Crociferi, allow us to evaluate its possible chronological correlation within the urban-planning system right along the main road leading to the port. Similarly to other sites characterized by river harbours, we can also identify a control tower for maritime and commercial harbour activities in the rectangular structure identified in old excavations (Musumeci, 1819; Ferrara, 1829; Gemmellaro 1852) along the ancient Via del Corso (nowadays Via Vittorio Emanuele, near Piazza Duomo). This structure can be interpreted as the basement of a "lookout tower", similar to that occurring in the Ostia river harbour (Calza *et al.*, 1953), rather than as the "remains of the triumphal arch of Marcello" (see Rizza, 1981, 28-29, 41-42) or the "podium of a worship building dated to proto-imperial period" (see Buscemi, 2006, p. 159, note 13).

Conclusions

The analysis of literary sources and historical iconographic documentation, combined with geological data and archaeological records, sheds new light on a few crucial questions about the ancient topography and makes it possible to formulate new hypothesis about the evolution of the ancient military and commercial functional areas of the harbour system of Catania. Taking into account the tectonic uplift (about 2 mm/yr), the area of Piazza Duomo, the most depressed of the city at the mouth of the Amenano river, in the Greek colonization period was located a few meters below the sea-level. This area was successively transformed and levelled, so the present road surface do not allow to appreciate the functional level of use (documented in the archaeological stratigraphy). However, we infer that it was the probable site of a natural inner harbour that was properly perceived at the mouth of the Amenano river as a landing place for the first colonies who founded Catania in the 8th century B.C., and later on as sheltered transit area for maritime exchange during all the Greek Age. The shoreline of the inner port was also protected eastward by a natural landward barrier made of sand. The archaeological evidence arising from the Acropolis, located on Monte Vergine Hill, with the sacred area also arranged with a proper altar (area Purità) since the Arcaic age, and from the supposed Sanctuary of Piazza San Francesco, in the downtown area, clearly suggest intense long-routes relationships. In the area of Ursino Castle, that is located on the top of a 15 m high natural terrace at that time straight facing the sea, a possible strong-hold place was built for the purpose of controlling the harbour movements. According to the literary sources, beside the small river port used for commercial purpose, during the Greek and Hellenistic period the large Plaia beach located immediately south of the town, at present covered by the 1669 lava flow, was used for military purpose. Thucidides (III, 116) mentions Catania during the struggle between Athens and Sparta, as do Diodorus of Sicily (XIV, 59,3; 61,4) writing about the second Punic war: the literary sources here analysed seem to suggest that during the two mentioned wars, the military base for the fleet allied with Catania were positioned on the external southern sandy flat coastline.

During the Roman period, the harbour-town of Catania, first as *civitas decumana* and from 21 B.C. as a colony, had to face environmental changes related to alluvial episodes and infilling process of the natural harbour by coastal-fluvial deposition. As in the inner port-town of Ostia at the mouth of the Tiber River, a similar process led to the final abandonment of the harbour area, where the *Platea Magna* was built. In fact, from the early Roman Age onwards, the marshy area was probably reclaimed using special drainage techniques, by which part of the fresh waters were underground canalised and used to supply at least two thermal buildings located downtown (Terme Achilleane, Terme dell'Indirizzo).

Later on, many attempts were done to built a larger and multifunctional harbour, as shown by ancient cartography here considered. To face such unfavourable situation and its adverse marine conditions, since the Roman period a pier was built on the south-eastern side, probably in the area known as “Porticello”, in order to shelter the port from the force of the prevailing winds and waves. This hypothesis is also testified by a late-Roman epigraphy which kept memory of the restoration of *moles* and *meatus urbis* which were probably both gravitating round the *Platea Magna* area and repeatedly destroyed by marine storms. The outer mole testified by a late-Roman epigraphy was built using the *opus pilarum* system in order to shelter a small commercial functional area, while the *meatus urbis* allowed the canalisation of the water with convenient drainage technique. From the Roman period to the 19th century, the weak outer mole, abutted on the basaltic Larmisi promontory, repeatedly suffered the destruction by marine storms from the east. A conclusive role has been played by the 1669 lava flow that not only covered the beach at the bottom of the Castello Ursino hill, used in the Greek period for military purpose, but also formed a large promontory south of the mouth of the Amenano river, favouring further fluvial-coastal deposition. Finally, the whole area, between the end of the 19th century and the first half of the 20th century has been absorbed in the town-planning changes related to the modern harbour of Catania.

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