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Dario CALDERONE, Giovanni DE GIORGIO, *Archaeology and geomorphology of an area: new interpretations of long-term settlement logics from Prehistory to the Byzantine period across the central-eastern slopes of the Etna volcano*

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ARCHAEOLOGY AND GEOMORPHOLOGY OF AN AREA: NEW INTERPRETATIONS OF LONG-TERM SETTLEMENT LOGICS FROM PREHISTORY TO THE BYZANTINE PERIOD ACROSS THE CENTRAL-EASTERN SLOPES OF THE ETNA VOLCANO

Dario Calderone¹, Giovanni De Giorgio²

Keyword: geomorphology, archaeology, GIS, Etna, viability, topography, interdisciplinarity.

Parole chiave: geomorfologia, archeologia, GIS, Etna, viabilità, topografia, interdisciplinarietà.

Abstract:

The archaeological analysis of Sicilian territories between the Ionian coast and the Etna central-eastern slopes has historically posed challenges for archaeologists. For a long time, it was believed that the interpretation of archaeological data was completely compromised by the marshy nature of the coastal areas, intense human activity through time, and the impact of numerous lava flows, especially in higher altitude areas like the municipality of Mascali (CT). This town was destroyed in the 1928 eruption. This study addresses these challenges by combining the extant archaeological evidence with the study of the geomorphology and geology of the area, especially the superimposition of the various settlements in the region from prehistory to Late Antiquity to shed light on how different human communities inhabited the area over the centuries. Combining information from known archaeological contexts with the geomorphological study of the landscape makes it possible to gain a deeper understanding of the relationship between humans and their local environment. The presence of archaeological sites in correspondence with specific geological formations, such as essential deposits of blue clays, elucidates the relationship between natural resources, settlements, roads, and ports. This, in turn, enables the formulation of new hypotheses regarding the exploitation of the land, with particular reference to the Roman and Byzantine periods, highlighting the strong links between this area of Sicily and those further North, in correspondence with the port of Naxos (modern Giardini-Naxos, ME).

L'analisi archeologica dei territori siciliani compresi tra la costa ionica e le pendici centro-orientali dell'Etna ha storicamente rappresentato una sfida per gli archeologi. Per molto tempo si è ritenuto che l'interpretazione dei dati archeologici fosse completamente compromessa dalla natura paludosa delle aree costiere, dall'intensa attività umana nel tempo e dall'impatto di numerose colate laviche, soprattutto nelle aree più elevate come il comune di Mascali (CT), insediamento distrutto dall'eruzione del 1928. Questo studio affronta queste sfide, combinando le evidenze archeologiche esistenti con lo studio della geomorfologia e della geologia dell'area, in particolare la sovrapposizione dei vari insediamenti nella regione dalla preistoria alla tarda antichità, per far luce su come le diverse comunità umane abbiano abitato la zona nei secoli. La combinazione di informazioni provenienti da contesti archeologici noti con lo studio geomorfologico del paesaggio permette di comprendere più a fondo il rapporto tra l'uomo e il suo ambiente. La presenza di siti archeologici in corrispondenza di specifiche formazioni geologiche, come i depositi essenziali di argille blu, chiarisce la relazione tra risorse naturali, insediamenti, viabilità e porti. Questo, a sua volta, permette di formulare nuove ipotesi sullo sfruttamento del territorio, con particolare riferimento al periodo romano e bizantino, evidenziando i forti legami tra quest'area della Sicilia e quelle più a Nord, in corrispondenza del porto di Naxos (moderna Giardini-Naxos, ME).

1. Introduction

Historically, volcanoes have favored human settlement due to fertile soils and numerous water supplies. The violent and sudden destruction of ancient and modern cities by sudden volcanic outbursts is an extraordinary event. Typically, volcanic activity is a low-intensity phenomenon which, nevertheless, continuously modifies the surrounding landscape, an unsteady human-volcano equilibrium has developed in many places of the world³.

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³ CRONIN *et alii* 2008.

Settlements are established in specific locations to maximize the benefits of the local terrain, with resource exploitation playing a critical role in their organization. The accessibility of raw materials is, therefore, of utmost importance. Studying the anthropic landscape⁴ is a complex task involving analyzing settlement distribution. The study often starts with a detailed analysis of a single site and then moves on to macro areas. The landscape is seen as a witness to the past and still bears traces of its transformations throughout history⁵.

Nowadays, volcanic landscapes are incredibly different from ancient ones. It is, therefore, compelling to develop solutions to inquire into human-volcano relationships. Many researchers have analyzed this question. The results of numerous research studies are collected in two volumes edited by La Rosa, Branciforti, and Privitera⁶. In these books, researchers have evaluated how the volcano's presence has influenced human decisions over the centuries in the Catania city area and the Etna.

Recently, Rodolfo Brancato has adopted a similar approach to studying areas surrounding Etna, like the plain of Catania and the Aci territory⁷. He studied the evolution of settlement patterns in a territory by examining its long history. This involves identifying sites that have overlapped multiple archaeological contexts over the centuries. By doing so, we can understand how landscapes have been settled over time.

To further enhance research in this field, we require additional support from the Geoarchaeology approach⁸. It examines the geomorphological changes that have impacted the preservation and destruction of archaeological sites throughout history⁹.

A geoarchaeological study is an environmental approach that examines the relationship between ancient human settlements and the surrounding natural environment. The research conducted by Stefano Branca demonstrates how collaboration between archaeologists and geologists can help analyze the impact of volcanic events on human activities in the areas surrounding Mount Etna¹⁰.

Those types of studies help us understand the impact of physical context on the archaeological site's history. It investigates the availability of natural resources and the changes in the landscape over time. By exploring these factors, we can better understand why people settle in certain areas and engage in specific economic activities¹¹.

The territory studied results from continuous stratification from ancient times to today¹². Starting from all these considerations, in this research, the authors aim to show a method based on geomorphological and topographical studies to analyze the relationship between humans and volcanoes during the ages. Interdisciplinarity, in this way, connects fields like geology and archaeology¹³.

D.C.

2. The case study of Central-eastern Etna

The research mainly considers the geographical area included within the ancient County of Mascali, established by Carlo V and entrusted to the management of bishop Caracciolo in 1540¹⁴ (fig. 1). The county probably consisted of the central-northern slope of the Etna volcano, which today comprises parts of the municipalities of Mascali, Riposto, Giarre, Fiumefreddo di Sicilia, Sant'Alfio and Milo (CT). The county extended from the coastline in the direction of Etna for about 13 km¹⁵ and included areas between the Mangano stream to the South and the Fiumefreddo River to the North. Mascali was the county's oldest and most influential settlement, but it was destroyed in 1928 by a sudden eruption of lava¹⁶ (fig. 2).

The relationship between humans and nature near a Quaternary volcanic complex, such as Etna, differs significantly from other geographical contexts. Periodic lava flows and pyroclastic fallout characterize Mount Etna's activity, the deposits of which naturally must have affected the inhabitants' relationship with the landscape.

In general, the geography of Sicily should not be understood as having had a mechanical and passively conditioning effect on the development, exploitation, and movement of local populations on the island¹⁷. Still, it is not the same for the communities living at Etna's foot. The continuous eruptions would have most likely conditioned the relationship between these peoples and the sea if we consider that the eruptions have often modified the hydrographic structure and the physiognomy of the natural ports, as happened with the port of Catania in 1669 when the line of the coast was

⁴ TILLEY 1994.

⁵ GIANNITRAPANI 2021, p. 487.

⁶ BRANCIFORTI, LA ROSA 2010; LA ROSA, PRIVITERA 2007.

⁷ BRANCATO 2020; BRANCATO, TORTORICI 2021.

⁸ LORETO, MARCOLONGO 2023.

⁹ MASTROIANNI, GISOTTI 2020; FOUACHE 2013.

¹⁰ BRANCA *et alii*, 2021; TANGUY *et alii* 2012.

¹¹ LORETO, MARCOLONGO 2023, p. 13.

¹² CAMBI 2015, p. 245.

¹³ BROGIOLO 2017.

¹⁴ FRESTA 1988, p. 25.

¹⁵ IACHELLO 1991, pp. 27-28; SPINA 2018, ALIBRANDI 2023.

¹⁶ BRANCA *et alii* 2017.

¹⁷ GIANNITRAPANI 2017.

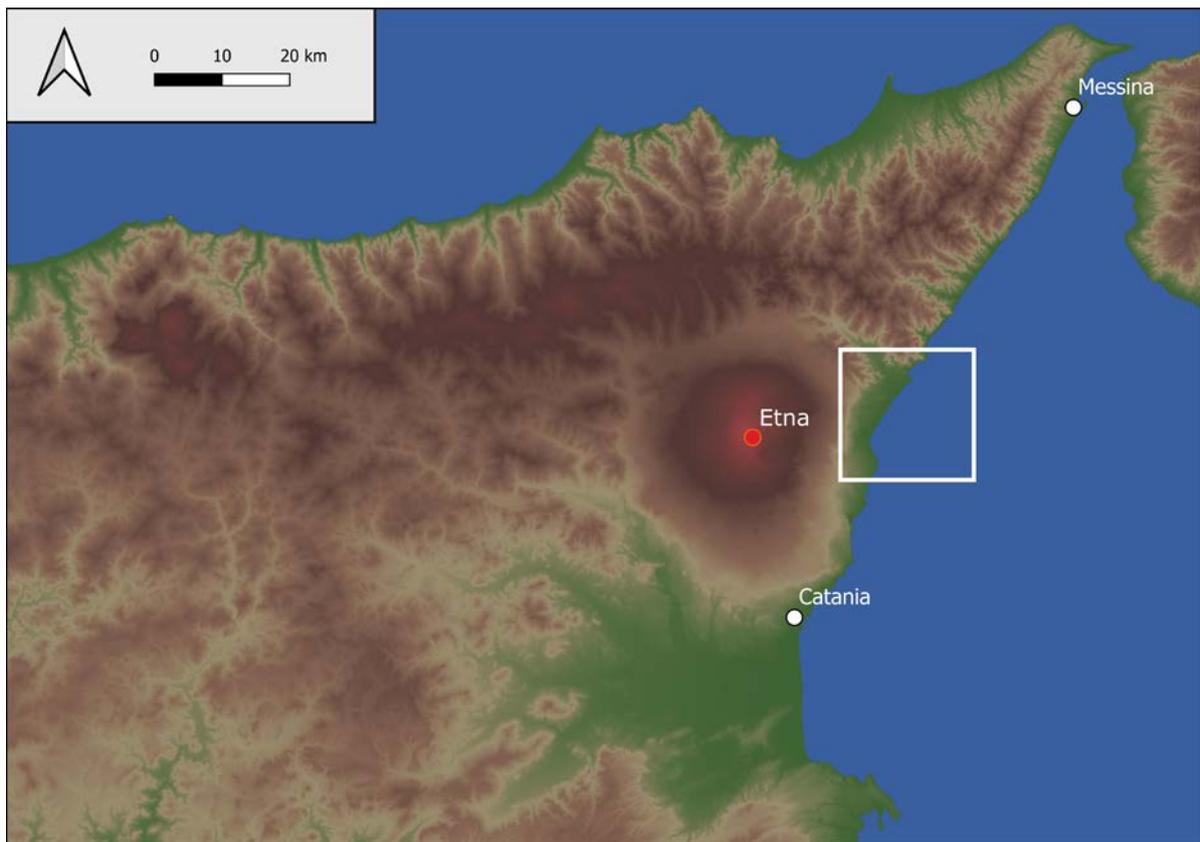


Fig. 1. Image of Sicily. In the box, the studied area. DEM TINITALY at 10m, reworked by D. Calderone (TARQUINI *et alii* 2007; TARQUINI *et alii* 2023).

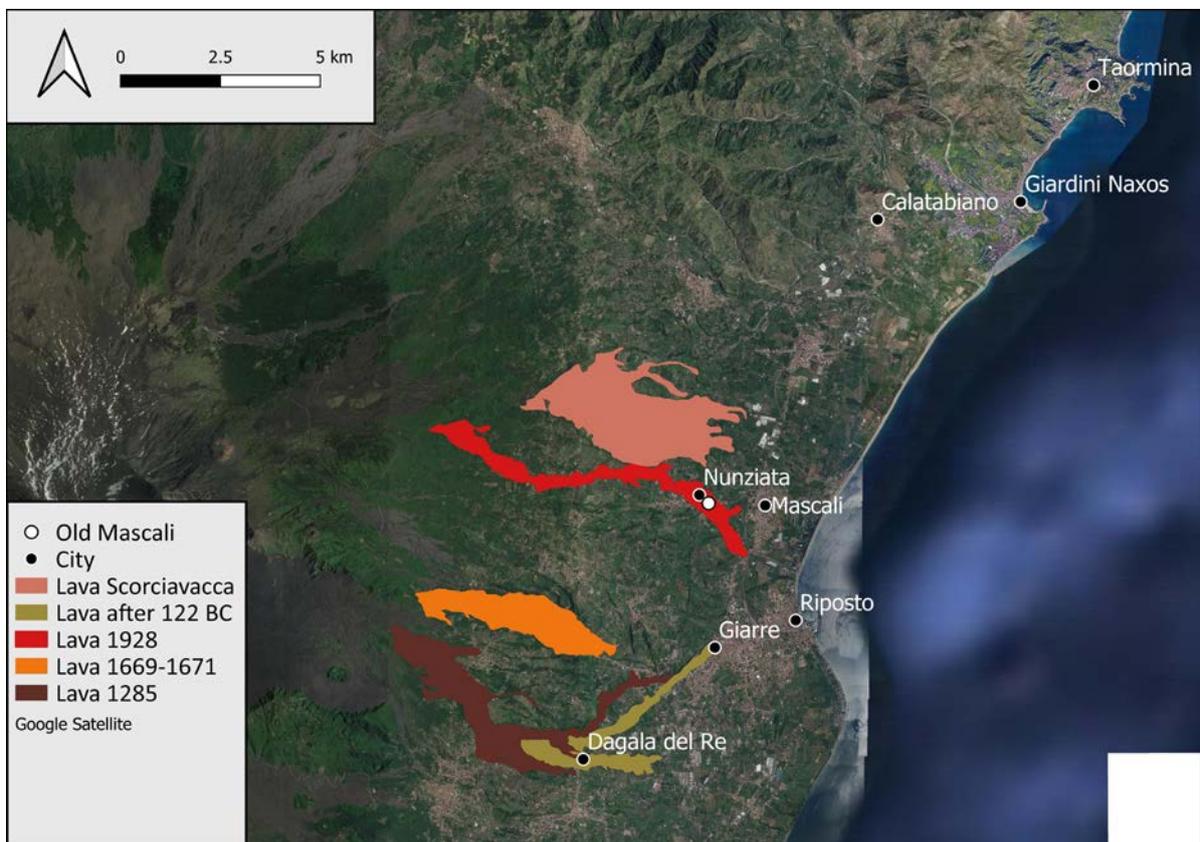


Fig. 2. The lava flows during historical periods. Image generated using Google Map ©2015.

moved by the lava towards the sea¹⁸. As a result of Etna's frequent activity, the reconstruction of the anthropic landscape¹⁹ of the territory between the Ionian coast and the central-eastern area of Etna has posed a difficult challenge for scholars. This is particularly true for the area between Mascali, Riposto, and Giarre (CT) municipalities. For example, this area, and all of the eastern slopes of Etna more generally, has shown little evidence of frequentation between 13.000 and 6.000 BC due to intense volcanic activity²⁰. These data contribute to our understanding of how much human communities are conditioned by the volcano's presence and how they cause numerous problems for archaeological research.

The first problem concerns the presence of numerous lava flows on the eastern slopes of Etna and the irreversible damage they have caused to archaeological contexts. On the other hand, the volcano has made the land exceptionally fertile, thus favoring the growth of agricultural activities and anthropization. Modern farming, settlement, and commercial activities have also led to a severe landscape upheaval, making research difficult for archaeologists. As a result, there are many unanswered archaeological questions. So far, the exact route of the roads that passed through this area from Messina to Catania in the Greek and Roman periods is still unclear. The relationship between this part of the territory and the most important cities from the Roman period to late antiquity, such as Naxos and Catania, has also not been investigated. Furthermore, there has yet to be a systematic study of the relationship between the various archaeological sites in the area. Though many of these have been studied in depth in the past, the reasons that prompted the communities to occupy these areas and the relationship between the settlements of sites belonging to the same period have not been adequately explored. These issues are compounded by the fact that few historical sources are available. Therefore, it has not been possible to reconstruct the history of the eastern region of Etna under study here, which comprises about 60 km², even though numerous traces of occupation have been documented ranging from prehistory to the end of the Middle Ages²¹.

Over this long chronological arc, some cases of minor but very important remains that have survived that, if analyzed with the study of the area's geomorphology, can significantly improve our understanding of the relationship between human populations and the landscape over the centuries. By combining the information on the extant archaeological contexts with the geomorphological study of the area, this study has been able to formulate new hypotheses on the ancient routeways, settlements logics, and the exploitation of the territory for productive purposes, especially when it comes to the transition from the Roman to the Byzantine period. The data demonstrate that during this period, there were very close relations between this part of the island and those further north, with particular reference to the port of Capo Schisò in Giardini Naxos (CT). According to the authors, the final result demonstrates that the data available is sufficient to precisely define the settlement methods that affected this territory from prehistory to Byzantine.

2.1. Geological context

Mount Etna is a stratovolcano located at the front of the Magrebid chain, on the footwall of a late Quaternary crustal-scale transtensional fault system²² that runs in the Ionian offshore. The volcano's eastern and southern sectors are located mainly on the middle to upper Pleistocene foreland clay succession²³, deposited along the flexed margin of the Pelagian Block. Normal faults dominate the lower eastern Etnean slope. The fault segments form a 30-km-long system descending to the Ionian Sea, which defines the present topography and hydrography of the eastern slope and shows steep scarps, known as "Timpe," that are morphologically very young, having been formed between the late Pleistocene and Holocene. The most impressive escarpments, up to 200 m high, extend discontinuously for about 20 km from the municipality of Sant'Alfio (CT) to Acireale (CT).

The fault system on the lower eastern slope is comprised of sedimentary and volcanic rocks from the Lower Pleistocene to the historic period²⁴. On the lower northeastern slope of Etna, Pleistocene sediments consist of calcarenites and marly clays that form the structure of the isolated Serra S. Biagio hill along the Ionian coast, which is discordantly covered by alluvial conglomerates wealthy in volcanic clasts.

Pleistocene marine sediments are also represented by limited and discontinuous outcrops of marly clays distributed along a basal ridge-oriented East-West below the volcanic cover represented by the southern watershed of the Alcantara River paleovalley²⁵. More evidence of clay outcrops can be found in the CARG mapping at sheet 625 (Acireale) and in the Geological-Technical Map of the Municipality of Mascali prepared for the Seismic Microzonation project.

G. De G.

¹⁸ NICOLETTI 2015, p. 25.

¹⁹ TILLEY 1994.

²⁰ BRANCA *et alii* 2021.

²¹ *Piano Paesaggistico*, Ambiti 8, 11, 12, 13, 14, 16, 17 for the province of Catania, D. A. 31/GAB 3/10/2018. For consultation see: <http://www.sitr.regione.sicilia.it/geoportale>.

²² MONACO *et alii* 1997.

²³ WEZEL 1967.

²⁴ ROMANO, TANGUY, KIEFFER, 1993; CORSARO *et alii*, 2002; BRANCA *et alii*, 2011.

²⁵ BRANCA, FERRARA, 2001.

2.2. Archaeological Context

In the area spanning from the mouth of the Alcantara River to the municipality of Riposto (CT), approximately 15 km south, there is a significant concentration of archaeological sites dating from prehistory to the Middle Ages. There is also evidence of numerous archaeological sites (Tab. 1 and fig. 3) relating to different periods between the Alcantara River and the Fiumefreddo River. These sites are situated at a range of different altitudes but are generally located near the coastline.

Image ID	Site name	City	Type	Period
7	San Biagio 1	Fiumefreddo/Calatabiano (CT)	Pottery scatter	Prehistoric
12	Nunziatella 1	Nunziata/Macali (CT)	Pottery scatter	Prehistoric
2	Imperio 1	Calatabiano	Lithic scatter	Prehistoric
4	San Marco	Calatabiano	Pottery scatter	Greek
6	Chiusa Carpinato 1	Calatabiano	Settlement	Greek
17	Contr. Coste II (1)	Giarre (CT)	Pottery scatter	Greek
14	San Giovanni 1	Giarre	Pottery scatter	Greek
10	Santa Venera 1	Masali	Pottery scatter	Greek
3	Quadarato 1	Calatabiano	Settlement	Greek
19	Torre Archirafi	Riposto (CT)	Necropolis	Greek
5	Pianotta	Calatabiano	Necropolis	Roman
1	Cast. Calatabiano 1	Calatabiano	Pottery scatter	Roman
6	Chiusa Carpinato 2	Calatabiano	Settlement	Roman
2	Imperio 2	Calatabiano	Villa	Roman
3	Quadararo 2	Calatabiano	Settlement	Roman
9	Torre Rossa	Fiumefreddo	Tomb	Roman
8	Liberto	Fiumefreddo	Productive area	Roman
7	San Biagio 2	Fiumefreddo/Calatabiano	Pottery scatter	Roman
12	Nunziatella 2	Masali	Pottery scatter	Roman
12	Nunziatella 3	Masali	Early Christian church	Roman/Byzantine
11	Nunziata	Masali	Villa, Mosaic	Roman
10	Santa Venera 2	Masali	Pottery scatter/structure	Roman
13	Tagliaborse	Masali	Pottery scatter	Roman
15	Contrada Coste	Giarre	Pottery scatter	Roman
17	Contr. Coste II (2)	Giarre	Pottery scatter	Roman
18	Contr. Cozzi	Riposto	Pottery scatter	Roman
7	San Biagio 3	Fiumefreddo/Calatabiano	Pottery scatter	Byzantine
1	Cast. Calatabiano 2	Calatabiano	Pottery scatter	Byzantine
16	Torrrente Macchia	Giarre	Necropolis	Byzantine
14	San Giovanni 2	Giarre	Pottery scatter	Byzantine
20	Dagala del Re	Santa Venerina (CT)	Tricora church	Byzantine

Tab. 1. Table of the sites under study, their ID number, site name, type, and generical chronological period. Sometimes, according to previous research, it is not possible to provide a more precise chronology (*Piano Paesaggistico* 2018; MAGRO 2015; PRIVITERA 2015, TAORMINA 2015). In paragraph 4, each archaeological area in the table will be described in more detail.

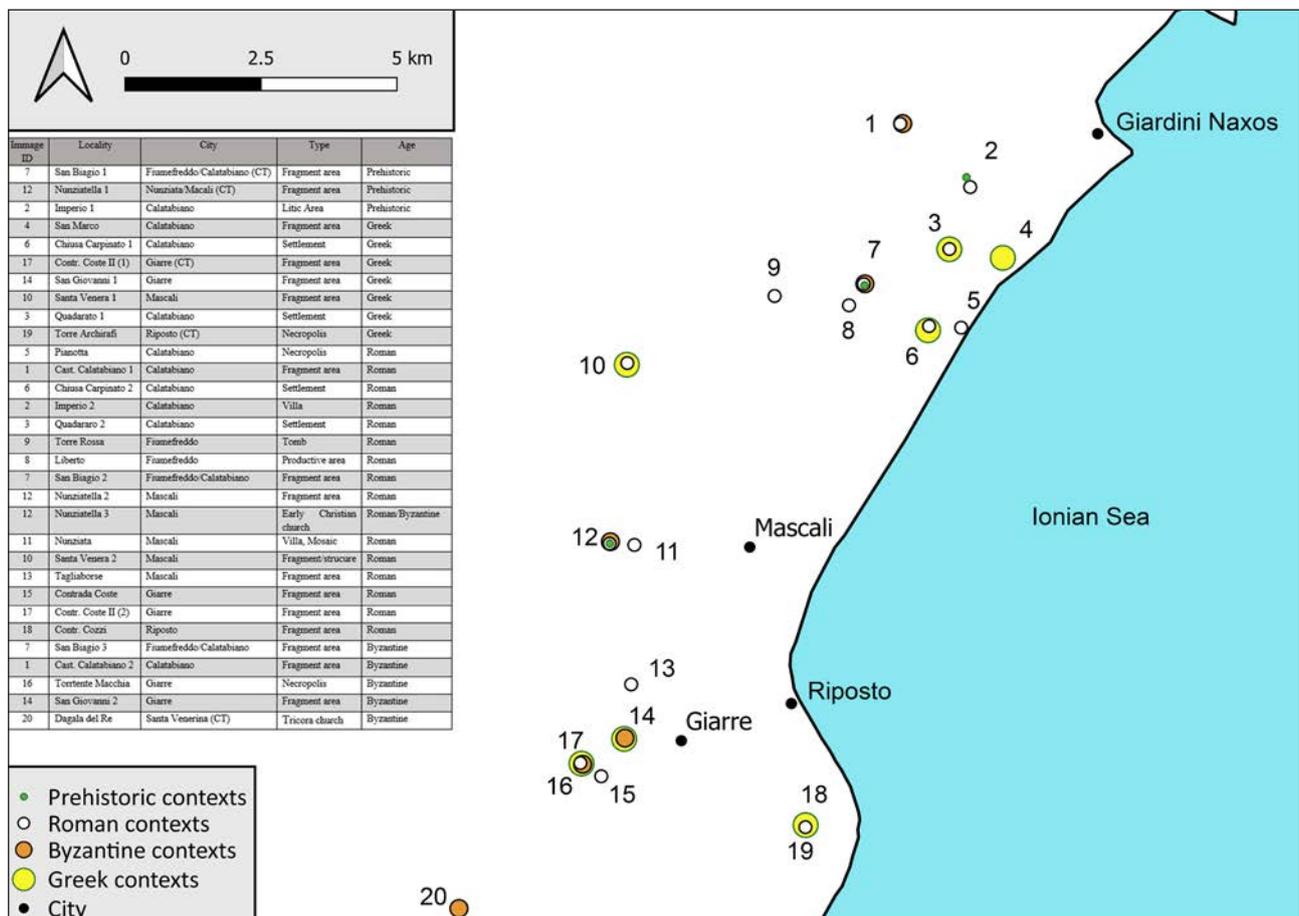


Fig. 3. Distribution of archaeological remains on the territory. The numbers in the map correspond to the ID number in Table 1, for identifying archaeological areas.

In the *località* of San Biagio, between the municipalities of Fiumefreddo and Calatabiano (CT), there are documented Prehistoric, Roman, and Byzantine period sites²⁶. A short distance away, near the beach, in the locality of Pianotta, there is a necropolis from the Roman Imperial period²⁷. Further north, in the direction of Etna, there is another large Roman funerary monument dated between the 1st and 2nd centuries A.D., the so-called Torre Rossa²⁸. Other Greek and Roman-era remains are reported around those funerary areas²⁹. In the locality of Santa Venera, there is plenty of archaeological evidence related to the Greek and Roman periods³⁰. In the locality of Nunziata (Mascalì, CT), there is a proto-Christian basilica³¹, part of the Nunziatella church complex. Here, the constant presence of pre-Historic³², Roman, and Byzantine human communities is well documented. Remains of a black-and-white mosaic depicting an apparent divinity, perhaps Triton, were reported by Paolo Orsi in 1930 in the Bulletin of the Municipal Archaeological Commission of Rome³³. The mosaic has unfortunately been lost, but from the analysis of the photos of the time, it is thought to date to the 1st or 2nd century A.D. The remains of two tombs from the 4th or 3rd century B.C. are even more ancient³⁴, demonstrating the presence of settlement in the area during the Hellenistic period. Other significant remains are the objects and jewels, datable between the 1st and 2nd centuries A.D.³⁵, found near the basilica. The Nunziatella church is located near the old settlement of Mascalì, which is probably full of other important archaeological information but was unfortunately destroyed by an eruption in 1928.

Mascalì was mentioned by the geographer Idrisi in *A quartile Masqalah*, which describes it as a place rich as water, according to the translation by Michele Amari³⁶. Another Arab source, Yaqut Mu'gam, mentions Mascalì as a

²⁶ Piano Paesaggistico 2018, FRASCA 2017, p. 58.

²⁷ MAGRO 2015, p. 9.

²⁸ PRIVITERA 2013, pp. 15-38.

²⁹ Piano Paesaggistico 2018; MAGRO 2015.

³⁰ Piano Paesaggistico 2018.

³¹ TAORMINA 2015.

³² PRIVITERA 2015.

³³ ORSI 1930, p. 143.

³⁴ TAORMINA 2015, p. 112.

³⁵ PRIVITERA, GRASSO 2012, pp. 85-91.

³⁶ AMARI 1880, pp. 116, 126.

town on the slopes of Etna, based on an older source, according to Amari of the XI, namely Abù Ali Hasan, author of the *Chronicle of Sicily*. The source mentions ancient remains relating to various disappeared peoples distributed throughout Etna and numerous woods and orchards³⁷. After the eruption in the previous century, the city was rebuilt at a lower altitude than the previous one. Due to the 1928 eruption, a great void was created in the documentation, especially from an archaeological point of view, given that it is no longer possible to study the buildings and structures of the oldest settlement in the area. During the Middle Ages, another eruption destroyed the territory of ancient Mascali. According to the latest analysis, this is the lava flow of Scorcivacca, which dates back to 1020/40 AD.³⁸ (fig. 2).

Despite the numerous lava flows, the area surrounding Mascali shows signs of occupation from Prehistory to the medieval period. The territory is mentioned in the 6th century A.D. in a letter from Pope Gregory the Great sent to the bishop of Taormina. The letter refers to a monastery located in the territory of Mascali³⁹. However, it is impossible to deduce the exact location of the monastery based on information in the letter. The monastery might be related to the Paleochristian basilica of the 5th - 6th century. A.D.⁴⁰ in Nunziata (CT), but no concrete evidence supports this interpretation. Nevertheless, evidence from the Roman period has been documented around the basilica, indicating that Etna was inhabited from at least the Roman period until late antiquity. The wide range of topographical data related to human activities in this area of Sicily from the Prehistoric period to the Middle Ages necessitates careful consideration.

Naturally, the abundant presence of the archaeological remains confirms the existence of numerous roads or paths connecting the many different sites in the area. Unfortunately, there is no archaeological evidence specifically attesting to these ancient routeways. Consequently, previous studies in this field of research have primarily based on ancient sources.

D.C.

2.3. Issues with roads in the territory in the long-term

Several studies in the past have analyzed and related the archaeological remains in the area, particularly from the medieval through the modern periods⁴¹.

However, the absence of archaeological evidence for roads in this part of the island is the primary problem for interpreting the ancient road system. However, the area under study is between two critical ancient cities, Naxos and Catania, and for this reason should not be considered a marginal area. Indeed, during the Roman period, the Via Pompeia was present in this area of Etna. The Romans used this road, known from the 1st century B.C., to connect Messina to Syracuse via Catania⁴². According to many scholars, the road from Messina followed the coastline through Naxos, then crossed the bridge over the Alcantara River, and began to head towards the more inland areas, following the Strada Statale 114 from Calatabiano to Fiumefreddo⁴³.

The presence of roads that, during the Middle Ages, connected the area of Catania with those of Mascali was also hypothesized by Lucia Arcifa. According to the scholar, the Byzantines preferred to use the roads in hilly areas, as in the case of the road from Catania to Mascali that passes through Fleri and Milo (CT)⁴⁴. During this research, to reconstruct ancient pathways and settlement logic in this region on the eastern slopes of Etna, we considered the ancient sources, the geological context, and the presence of lava flows. We combined these elements with the area's location and distribution of archaeological contexts.

D.C.

3. Methods

To understand the origin and formation of the archaeological sites, it is necessary to analyze the landscape, the set of geomorphological, topographical, geological, and hydrological characteristics of the area under study and trace the most significant changes that it has undergone over time⁴⁵. For this reason, after analyzing each archaeological context individually, we proceeded to relate them, studying their common elements. The use of a Geographic Information System (GIS) proved beneficial in this case, as it allows for interactive analysis of layers of environmental, naturalistic, and archaeological data, and thus allows for the study of characteristics of the landscape that include both natural and anthropic elements⁴⁶.

First, each archaeological context in the area was positioned in the GIS environment and was divided into Prehistoric, Greek, Roman, and Byzantine chronological phases, which represent the known chronologies of sites in

³⁷ AMARI 1880, p. 204.

³⁸ SPERANZA 2006; BRANCA *et alii* 2015.

³⁹ Gregorio Magno, *Epistulae*, in P. L., libro 3, col. 657, lettera LIX.

⁴⁰ BUDA 2015.

⁴¹ SORBELLO 2014a, SORBELLO 2014b; IACHELLO 1991.

⁴² UGGERI 1987, pp. 85-90.

⁴³ SIRENA 2011, p. 62.

⁴⁴ ARCIFA, MILITELLO 2005; ARCIFA 2009, pp. 84-86.

⁴⁵ KEMPF 2020; GIANNITRAPANI 2018.

⁴⁶ UZUNOV 2013, p. 119.

the area (Tab. 2). Subsequently, the lava flows and most significant geological features, such as areas with clay, alluvial terraced deposits, and marshes that affected this area in historical times were vectorized and included in the GIS⁴⁷.

Name	Age
Prehistoric	Bronze Age, 2500-1100 B.C.
Iron Age	Indigenous cultures 11 th - 8 th B.C.
Greek	Greek colonial (Archaic) to Hellenistic period, 8 th – 3 rd centuries B.C.
Roman	Republican and Imperial Periods, 3 rd century B.C. – 5 th century A.D.
Byzantine	6 th – 9 th centuries A.D.

Tab. 2. Table of the Chronology of Archaeological Sites in Sicily (TUSA 1999, *Piano paesaggistico* 2018; MAGRO 2015; PRIVITERA 2015, TAORMINA 2015).

These choices were made to investigate settlement dynamics and their possible relationships with environmental and geomorphological factors⁴⁸. A unique attribute table was created for each archaeological site, having generally identified the reference period according to the scheme already described. The attributes within the database of sites included their absolute chronology, the locality in which they were found, a description of the archaeological context, their typology, and the reference bibliography.

This method allowed us to observe and compare the presence of outcrops of clay deposits mentioned above and how they correspond with archaeological sites. The settlements within the sites studied follow the topography in a particular way. In the area between Fiumefreddo (CT) and Torre Archirafi (Riposto-CT), sites are not found in coastal regions but at altitudes between 200 m and 250 m above sea level, precisely where the outcrops clay deposits lie.

These considerations result from studying the previous bibliographic material and the work carried out in the field. First, we controlled not only the geological and archaeological features of the areas under study but also each area's topographic links and interactions (for example, intervisibility, connections through natural paths, etc.).

We performed a viewshed analysis from each archaeological area to study the level of intervisibility between areas rich in clay and the remains of settlements from Prehistory to the Roman period. Subsequently, we focused our attention on the viability that connects them and their relationship with the sea; after that, we analyzed the possibility of observing the ports, such as those of Capo Schisò in Giardini Naxos, from these positions. The use of the GIS application was necessary at this early phase in the study, as it made it possible to precisely control the exact position of the archaeological sites, the relationship between the altitude of the settlements, and the geographic position of the coast and natural ports. Contour lines were extracted by using the contouring tool in ArcGIS Pro based on a DEM with 2 m resolution, which allowed for a deeper analysis in the second phase of the research, in which the 3D viewer tool was imported into the GIS to identify the easiest route to reach the hills from the coast, considering that Mount Etna's eruptions have created a landscape with many steep slopes. Finally, we compared the natural passages with the hypothesized historical pathways. Using the GIS, we observed that the historical road system continues to exploit these passages, and even the modern roads are at the same altitude as the ancient settlements, which generally lead directly to the port of Capo Schisò.

D. C., G. De G.

4. Results of studies on the routeways

The area under study is characterized by a sizeable clayey formation⁴⁹, which, likely due to its low permeability, sustains the presence of water as is shown by the presence of the Fiumefreddo River and five springs.

⁴⁷ BRANCA *et alii* 2015.

⁴⁹ BRANCA *et alii* 2015.

⁴⁸ GIOIA *et alii* 2016; CHU, NETT 2021.

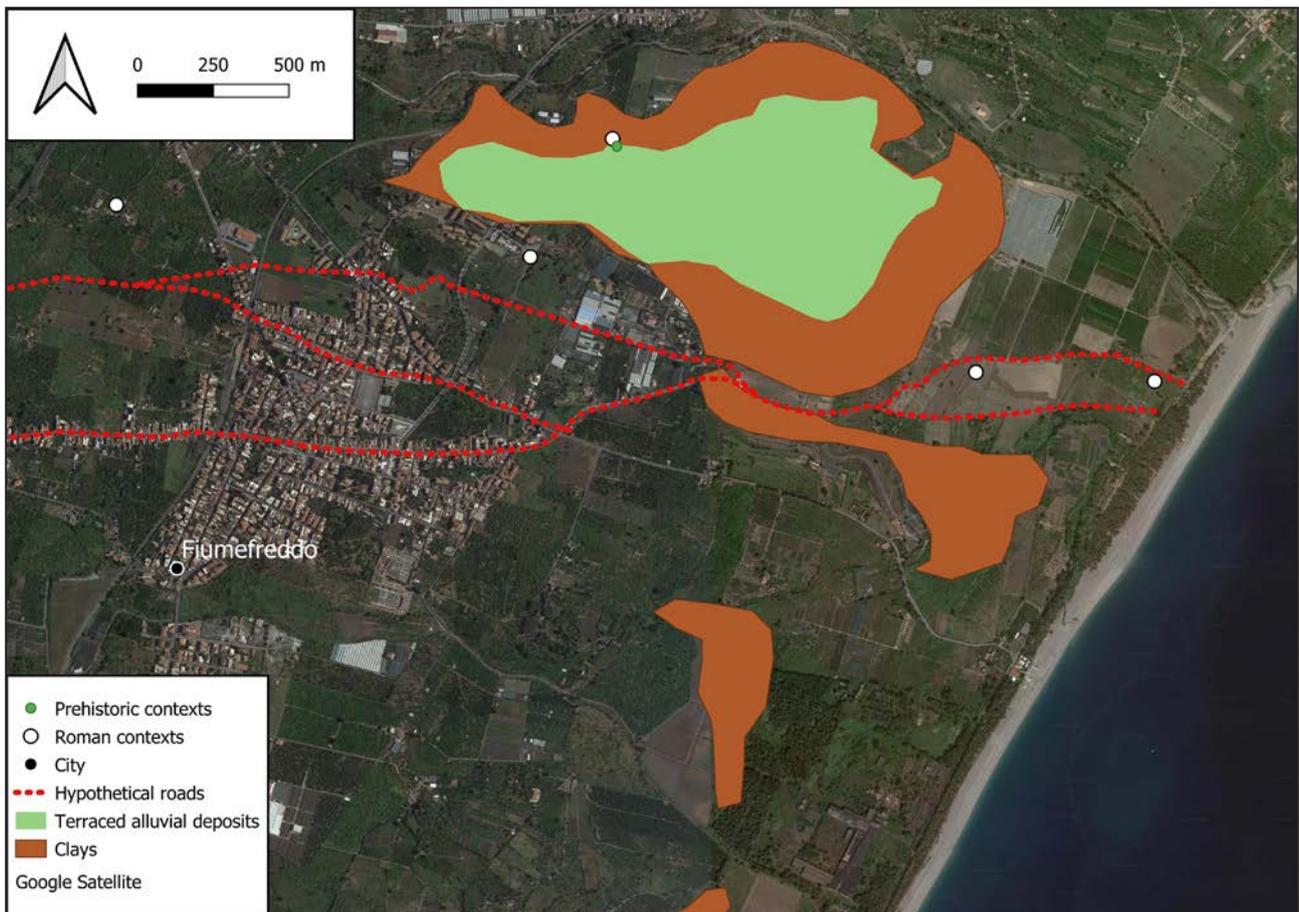


Fig. 4. Hypothetical reconstruction of the road network concerning the distribution of archaeological sites and the presence of clay deposits. Image generated using Google Map ©2015.

Around the clay formation, there are archaeological remains from every era, like in the locality of San Biagio (Fiumefreddo-Calatabiano (CT)), with the overlapping of Prehistoric, Roman, and Byzantine archaeological remains⁵⁰. Here, there is the protected area of the Fiumefreddo Nature Reserve. It is the last holdout of an ancient swamp called the Gurna that still exists⁵¹. In the nearby locality of Pianotta, there is a necropolis dated to the Roman Imperial period⁵². In the direction of Etna, there is the Roman funerary monument of Torre Rossa⁵³. Other remains from the Greek and Roman periods have been reported between the two areas with burials⁵⁴.

All these archaeological sites are perfectly aligned along a line of about 5 km, following the direction of the river Fiumefreddo. This disposition does not seem accidental and could be the indication of the ancient presence of a road that descended from the volcano towards the sea, or of the area in which the via Pompeia⁵⁵, or a derivation of it, moved away from the coast to head towards the foot of Etna, in the direction of a higher altitude. Not surprisingly, the area is dominated by a small hill comprising terraced alluvial deposits. This hill is crossed by a road used today to reach the beach from the village of Fiumefreddo (CT) (fig. 4).

This hypothetical path unites two large deposits of clay. In addition to the one already mentioned, a large deposit is located higher up, corresponding with another locality with significant archaeological remains (fig. 5).

More specifically, from the municipality of Fiumefreddo to the territory of Giarre (CT), about 10 km further south of the Fiumefreddo River, it can be observed that the archaeological sites are at a higher altitude. All the archaeological sites from prehistory to the Middle Ages are between 180 and 300 m a.s.l. The first of these sites is in Santa Venera, where traces of Greek and Roman occupation have been reported⁵⁶. This area is rich in water, and

⁵⁰ *Piano Paesaggistico* 2018, FRASCA 2017, p. 58.

⁵¹ CARVENI *et alii* 2006.

⁵² MAGRO 2015, p. 91.

⁵³ PRIVITERA 2013, pp. 15-38.

⁵⁴ *Piano Paesaggistico* 2018; MAGRO 2015.

⁵⁵ SIRENA 2011; UGGERI pp. 205-207.

⁵⁶ *Piano Paesaggistico* 2018.

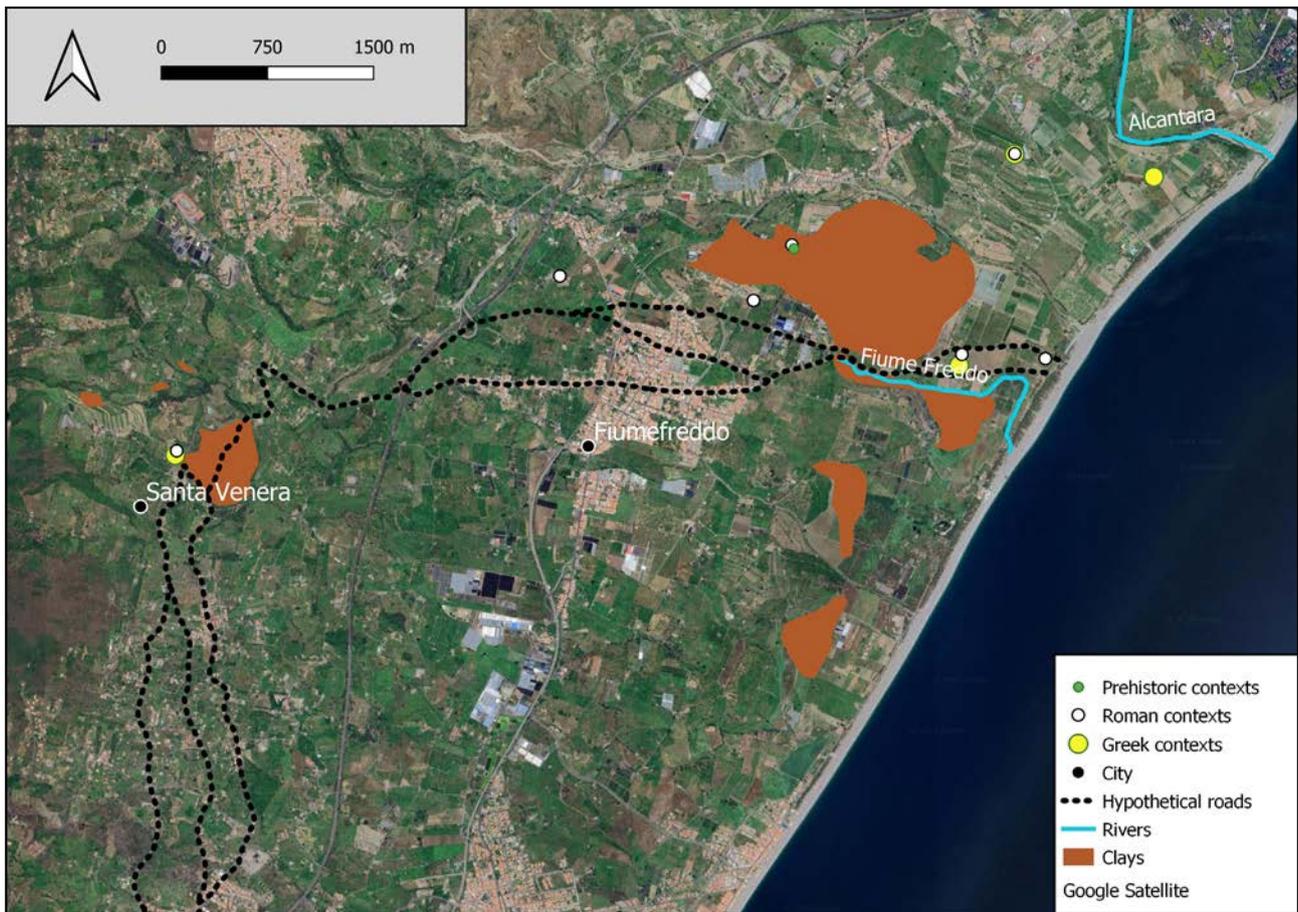


Fig. 5. The area between San Biagio and Santa Venera. Hypothetical reconstruction of the road network concerning the distribution of archaeological sites and the presence of clay deposits. Image generated using Google Map ©2015.

its location corresponds with a sizeable clayey deposit. From this place, it is possible to observe the whole landscape between the mouth of the Alcantara and the beaches of Mascali and Riposto (CT). Likely, this archaeological context was partly destroyed by the medieval lava of Scorciavacca⁵⁷. In any case, two archaeological sites with the same phases of inhabitation are located in correspondence with clay formations. For this reason, it is possible to imagine the existence of a road from the sea to the volcano and vice versa that connected these two areas to perhaps help in the exploitation and exportation of raw materials or the production and exportation of goods. It is possible that there was also a dock for storing goods⁵⁸.

Proceeding south, maintaining the same altitude as Santa Venera, we arrive in Nunziata (Mascali, CT), in the area of the proto-Christian basilica⁵⁹. The continuous inhabitation of this area from Prehistory to the Middle Ages demonstrates that this area had a significant role, and, from this position, it is possible to monitor the whole landscape at a lower altitude, between the mouth of the Fiumefreddo River and the beach of Riposto. Archaeological excavations have demonstrated the presence of a Byzantine kiln of the same type as one found in Naxos⁶⁰, perhaps dating to the 6th or 7th centuries. This could demonstrate that in the Byzantine period, the area was in close contact with the settlement of Naxos, which, even during the Roman and Byzantine periods, continued to be a very active settlement, thanks to its port above all⁶¹. The presence of clayey deposits, woods, water, and fertile territory made the connection between the territory of Mascali and that of Naxos convenient. We can assume that this connection was possible from its settlement in the Greek period through the Middle Ages, also due to a very close topographical link with the area near the mouth of the Alcantara and the port of Capo Schisò. About 2.5 km further South of Nunziata, at the same altitude, other Roman archaeological remains were found in Tagliaborse, and continuing up to 4 km South are present other Greek,

⁵⁷ BRANCA *et alii* 2015.

⁵⁸ PERI 1978, p. 42.

⁵⁹ TAORMINA 2015.

⁶⁰ LENTINI 1982, pp. 177-180.

⁶¹ MUSCOLINO 2009; ARCIFA 2018.



Fig. 6. Distribution of streams and archaeological areas concerning the Circumetnea and contemporary roads. Image generated using Google Map ©2015.

Roman, and Byzantine sites in the territory of the municipality of Giarre, on the edge of the Macchia stream⁶². These archaeological sites are also located at the same altitude. Furthermore, still today, this area is affected by the passage of essential roads, such as the motorway, the Nunziata-San Giovanni provincial road, or the Circumetnea railway line, which, before heading towards Riposto, crosses the area between the archaeological remains present in the locality of Santa Venera, almost up to the locality of Tagliaborse (fig. 6).

D.C.

5. Discussion

The data show that some of the most crucial transportation works, such as the railway line and the provincial road, exploit the same advantageous altitude that previous communities inhabited on the slopes of Etna from prehistoric times through the Byzantine period and, therefore, perhaps these works trace the same or similar paths used in antiquity. Furthermore, even the Roman Via Pompeia, according to many scholars, after crossing the Alcantara bridge, rose in altitude on its way to the territory of Acireale (CT) and moved away from the coast to take advantage of passages at higher altitudes⁶³. This was probably due to topographical reasons, which still make it easier to cross these areas of Etna today. The settlements were much older than the more organized forms of viability, as evidenced by prehistoric archaeological contexts in areas that Greek, Roman, and Byzantine communities subsequently occupied. The presence of regions with signs of prehistoric occupation in the same places where Greco-Roman and Byzantine buildings and settlements were founded helps us to identify the natural passages exploited since prehistoric times by communities that did not yet have the need and the technologies to modify the landscape and create real roads⁶⁴. In this case, the

⁶² *Piano Paesaggistico* 2018, UGGERI 2005, p. 206.

⁶³ SIRENA 2011, UGGERI 2005, pp. 199-214.

⁶⁴ GIANNITRAPANI, SPECIALE 2020; CALDERONE 2020.

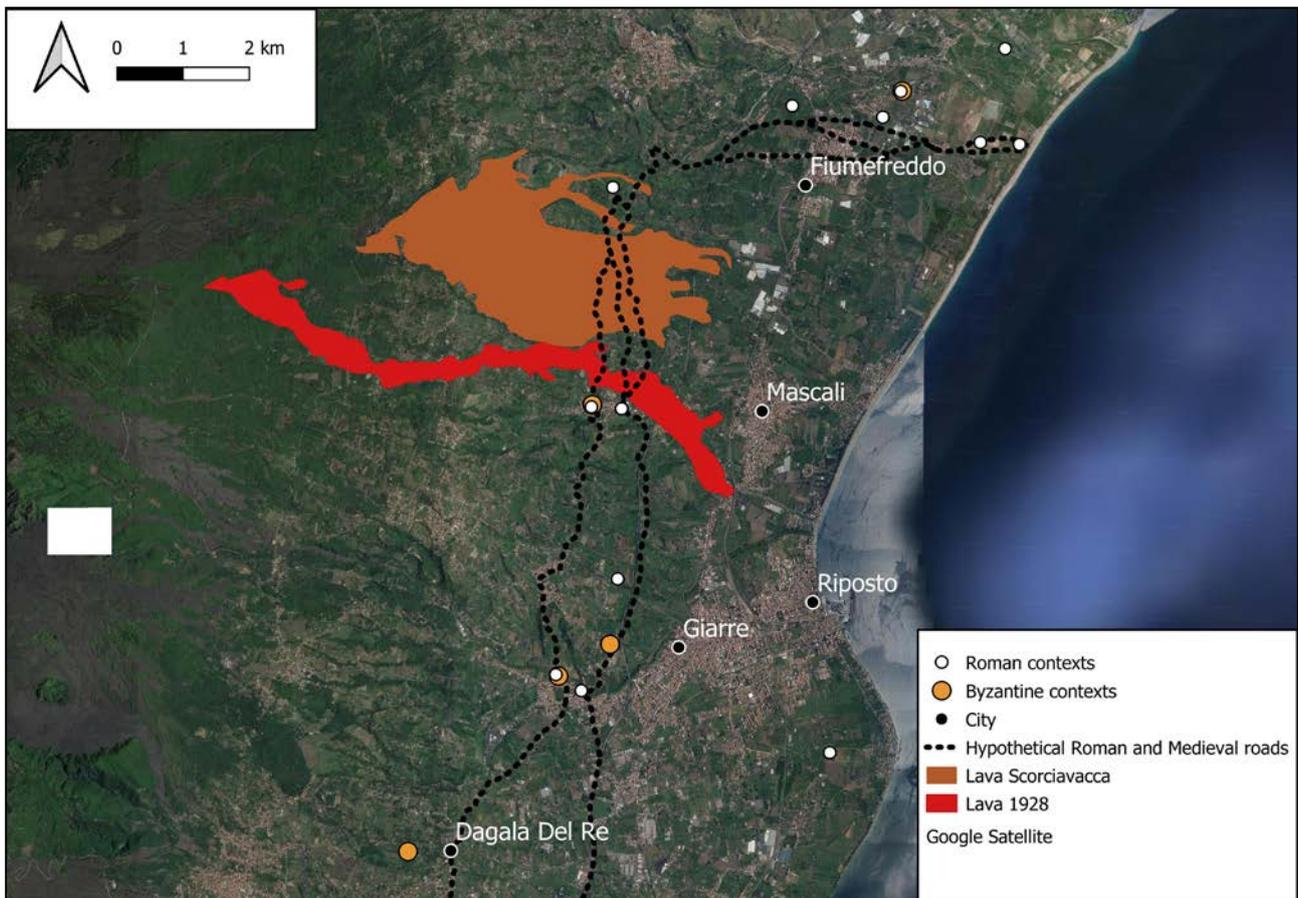


Fig. 7. Hypothetical reconstruction of Roman and Medieval routes, concerning the presence of lava flow.

choice to always live in the same places can also be justified by the presence of clay, a raw material that was as useful to prehistoric communities as it was to Byzantine ones.

Between the 1600s and 1800s, larger settlements near the coast began to develop, such as Riposto and Giarre (CT)⁶⁵. Before this period, all the archaeological evidence in the area was never found below 180 m a.s.l. Moreover, for this reason, it is not excluded that the Via Pompeia exploited the higher altitude passages, such as those described. However, suppose the Via Pompeia was between the archaeological areas of Santa Venera and Nunziata. In that case, it is no longer possible to reconstruct the Roman road for at least 3 km due to the lava flows from Scorciavacca that date to 1020 +/- 40 AD⁶⁶ and 1928, which during the late 10th or early 11th century and the first half of the 1900s most certainly intercepted the road, and changed the topography of the area. The presence of raw materials, water, woods, and passages that are easy to cross make the higher areas more favorable and safer than the coastal ones. Not surprisingly, during the Byzantine era, other monasteries were founded in the same regions (such as in Nunziata) or a little higher up, as in Dagala del Re⁶⁷. Therefore, also starting from the studies of Lucia Arcifa⁶⁸, we have selected some specific areas that could be used for the passage of these roads, considering the positioning of the archaeological sites, and the presence of the oldest roads and railways in the area (fig. 7).

It is possible that there were marshes in the coastal areas. Still, the presence of Roman tombs, such as those of Pianotta in Calatabiano (CT)⁶⁹ in correspondence with the only areas where the marsh is still present today, suggests that this was not a sufficient reason to justify the absence of archaeological remains from Prehistory to the Byzantine era between the Municipalities of Riposto and Fiumefreddo. Instead, we believe that the abundance of archaeological remains at a higher altitude confirms the possibility of a precise strategy for controlling and exploiting the territory. This led to the need to occupy the most accessible areas to cross, in this way, it is possible to easily cross the numer-

⁶⁵ SPINA 2015, IACHELLO 1991.

⁶⁶ BRANCA *et alii* 2015.

⁶⁷ CASSANITI 2014; LOJACONO 1960.

⁶⁸ ARCIFA, MILITELLO 2005; ARCIFA 2009, pp. 84-86.

⁶⁹ MAGRO 2015.

ous seasonal streams in the areas closest to the coast. Furthermore, these streams and rivers were likely exploited to efficiently transport products and raw materials from the hilly areas to the beach, towards some piers south of Naxos, as indicated by some medieval sources⁷⁰. All the sites with signs of occupation are intervisible and seem to follow a settlement logic that favors control of the region starting from the mouth of the Alcantara, a strategic place, as demonstrated by the construction of the medieval castle of Calatabiano⁷¹, positioned right at the mouth of the river. These advantages are not present in the flat areas between the territory of Giarre and Fiumefreddo, up to the coast, where the only higher relief, about 100 m above sea level, is that of the *local* S. Biagio, between Fiumefreddo and Calatabiano. It is no coincidence that in this place, there are, as mentioned, archaeological remains from prehistory to the Middle Ages⁷².

D.C.

6. Conclusions

The most important implication of this research is that humanity has adapted to an often complex environment from Prehistory to the present day. For this reason, the study considered reference points that have remained stable over the millennia, such as the natural port of Capo Schisò. This place has remained constant over the last few millennia despite the volcanic activity in the surrounding areas. The communities that lived in the central-eastern area of Etna probably knew that it represented the only adequate and stable port. The landfalls further south, in the direction of Catania, were perhaps more unstable. There were not many habitable areas, rich in raw materials and easy to defend, and, despite the eruptions, the way of inhabiting the territory has remained consistent from prehistory to the Middle Ages. In this way, the settlements have been stacked on top of each other over the millennia, always maintaining the same altitude. Only during the modern era, with its completely different technical capabilities and needs compared to previous periods, were along the coast, such as Riposto (CT), or in flatter areas, such as Giarre (CT).

Starting from the assumption that the only stable port was that of Naxos and that the permanently habitable areas were all at the same altitude, the road network must also have had to adapt. The routes must undoubtedly have been numerous, but the travelers along the way, which in the case of this research started from the port of Naxos to the areas of Riposto-Giarre, covering about 15-20 km, would have needed supplies and safe places to spend the night. Despite the environmental changes due to eruptions and anthropological activities over the centuries, the extant archaeological data allow us to study the area's archaeological topography and settlement dynamics effectively.

In the future, we would like to carry out more in-depth analyses. For instance, using remote sensing for the archaeological survey on the slopes of Mount Etna, as done by Andrea Gennaro in other areas of the volcano⁷³. Using aerial LiDAR technology, we will obtain other important information, as in the case studies of environmental geological analyses⁷⁴.

D.C.

⁷⁰ PERI 1978.

⁷¹ ARCIFA 2009, pp. 84-91.

⁷² *Piano Paesaggistico* 2018.

⁷³ GENNARO *et alii* 2019; GENNARO 2023a; GENNARO 2023b.

⁷⁴ BISSON *et alii* 2021; BISSON *et alii* 2016; BEHNCKE *et alii* 2016; PISANI *et alii* 2012.

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