

MAP OF THE NATURAL AND CULTURAL HERITAGE IN THE LANDSCAPE OF THE CARIGNANO WINE DISTRICT OF THE SULCIS REGION (SW SARDINIA)

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Abstract: “*Carignano del Sulcis*” is a much appreciated wine, ruby red with a dry, sapid and harmonious flavour. It is produced exclusively from vineyards trained as alberate and trellised alberate. The area of production, which includes all administrative territories of many Sulcis communities, features a complex and varied landscape from the geological and geomorphological standpoints. It has a high degree of geodiversity and density of sites of great geomorphological and landscape interest whose salient characteristics are described below. The work presents the results of an inventory of the natural (geosites, geomorphosites, parks and nature reserves) and cultural heritage (archaeological sites, industrial archaeology sites, sites of architectural, historic and traditional interest) classified and georeferenced within their landscape units, together with a part of the wine-producing areas. From the overall picture of the heritage emerges a high degree of multiplicity of the natural and cultural heritage that may play an important role as a possible motor for truly sustainable development from the standpoint of geo- and cultural tourism more in general.

Key words: landscape, geosites, cultural heritage, Carignano wine, Sulcis.

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INTRODUCTION

Objective of the study and methods of investigation

This work proposes an analysis of the distinctive features in the soil of “*Carignano del Sulcis*” vineyards (Figure 1). To this end, a careful investigation of its

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geological and geomorphological nature was performed. It involved the retrieval of knowledge acquired by several authors and the use of existing official geothematic maps (APAT, 2009, 2012; Assorgia et al., 1992, 1992a). The investigation was carried out by direct inspection and aerial photo interpretation at different scales to map not only the main vineyards, but also the main physical features of the landscape. The sites of geological and geomorphological interest were also studied through field survey with special features by means of which it is possible to analyse and identify the territory geological history, the evolution of its landscape features and the processes that have moulded them.

With the same approach similar studies were performed to identify and trace the boundaries of sites of great natural interest, with special reference to areas recognized as such by law (Regional Law 31/89 on parks and nature reserves pursuant to Directive 92/43/EEC “*Habitat*”).

At the same time, by means of bibliographic and iconographic research, using both historical and recent sources and work in the field, a systematic inventory of important cultural assets of historical-archaeological and historical-architectural interest, including those of anthropic and historical-technical interest, was compiled (Figure 1).



Figure 1. Geographic identification of the study area
(Source: Authors' elaboration from Sardegna Geoportale, 2013)

The information collected was georeferenced and processed by means of GIS software, after which it was used to draw up a specific thematic map of “*Carignano del Sulcis*” vineyards following classification, assessment and adoption of specific legends. The purpose of the map is for use as an instrument providing an immediate, essential synthesis of the existing natural and cultural heritage extant on the soil of the renowned wine and may represent a valid instrument for fruition and exploitation of the land in an area that still presents evident conditions of economic and social distress.

In this sense, the legends provided with the map, divided according to the type of heritage, highlight the diversity and wealth of natural and cultural sites contained in it.

Geological features

From the geological standpoint, the area of the soils on which the vineyards grow is characterized by lithologies dating from the Paleozoic to the recent Quaternary (Assorgia et al., 1992), as shown in the legend of the map of the natural and cultural heritage in the landscape of the Carignano wine district of the Sulcis region (SW Sardinia).

The oldest ones are ascribable to the Cambrian-Ordovician „*pre-discordance*” Sardinian sedimentary succession of southwestern Sardinia, amply described in the literature (Carmignani et al., 2001). Subdivided into classic formational groups from bottom to top, they constitute the Nebida Formation, the Gonnesa Formation, the Campo Pisano Formation and the Cabitza Formation. These formations outcrop essentially in the reliefs surrounding the northern, eastern and southern sectors of the area examined.

The Nebida Formation (Lower Cambrian) is divided into the Matoppa Member and the Punta Manna Member. The Matoppa Member is characterized by metasandstones and metasiltites, with flat parallel laminations alternating with decimetric banks of quartzose metasandstones with rare carbonate levels and discontinuous levels of dark metalimestones with *Archaeocyatha* (Lower Cambrian). The lithofacies in the Punta Manna Member are distinguished at the base by oolitic and oncolitic limestones with subordinate intercalations of metasandstones and metasiltites.

Ascribable to the Gonnesa Formation (Lower Cambrian) are the striped dolostone member with well-stratified and laminated light grey dolostones, often with stromatolithic laminations and nodules and levels of dark flintstone at the base, the ceroid limestone member, characterized by dolostone and massive dolomitic limestones from yellowish to brown, and the member of ceroid limestones with dolostones and massive, grey to hazel, sometimes blackish and often dolomitized dolomitic limestones.

The Campo Pisano formation (Lower to Middle Cambrian) consists of alternations of metalimestones, pink marly metalimestones, grey metasiltites and grey-pink metalimestones with a nodular structure, sometimes silicified, rich in fossil fragments.

The Cabitza formation (Middle Cambrian - Lower Ordovician) is instead characterized by a rhythmic alternation of metasiltitic and metaclayey centimetric layers, red-violet and green in colour of tidal origin, graded grey-green metasiltitic layers and quartzose-feldspar metasandstones with flat parallel crossed and gibbous laminations.

These are followed above by heterometric, polygenic metaconglomerates and metabreccias alternating with metasiltites and purplish metasandstones (Monte Argentu formation; Middle to Upper Ordovician) which bear witness to the results of an important tectonic phase (the “*Sardinian Phase*”) and a long period of continentality.

The calc-alkaline nature of the Sardinian plutonic association of the Upper Carboniferous-Permian is highlighted by an intrusive complex characterized by granitic rocks, prevalently reddish in colour (microsieno granites, leukosienogranites and microgranodiorites), and prevalently quartz hydrothermal seams, which outcrop widely in the southeastern sector of the area examined.

The Mesozoic marine ingressions involved this sector of Sardinia only marginally, with limestone dolomitic sediments of the Middle Triassic-Middle Jurassic, present in the area of Porto Pino, to the southwest of the area studied.

More significant is instead the presence of the paleogene sedimentary succession which deposited in a large gulf, clearly of tectonic setup. It begins with limestones, cemented breccias and rare carbonaceous levels, dolostones with quartzose and limestone clasts and purplish-red silty clays, quartzose-feldspar sandstones with frequent traces of bioturbation and heterometric and polygenic conglomerates which are part of the Cixerri Formation, referring to the Middle Eocene-Oligocene. These lithologies, which often compose the soils of “*Carignano del Sulcis*” vineyards, outcropping diffusely at the base of the ignimbritic plains and

generically of the tertiary lava spreads, go to make up the supporting base of the alluvial and detritic-colluvial covers of the Quaternary.

A special mark on the Sulcis landscape is left by the Oligo-Miocene volcanic highlands connected to geodynamic processes that led to the detachment of the Sardinia-Corsica microplate from the European continent. The latter are well represented in this area (Assorgia et al., 1992) by pyroclastic flow deposits in ignimbritic facies, with a composition from hyper-alkaline to comenditic rhyolitic (Monte Sirai group) and by andesites and basaltic andesites in cupoliform masses and massive flows with flow structures (Carbonia group). To this lithostratigraphic ensemble also belong the filonian bodies with an andesitic and basaltic composition oriented approximately in the E-W, NE-SW and N-S directions, well-represented on the map.

To the Pleistocene are ascribable conglomerated and ancient alluvions, terraced with subordinate limes and sands (lithofacies of the Portosuso subsystem), while to the Holocene are connected alluvial deposits, they too sometimes weakly terraced, eluvio-colluvial deposits, slope and landslide deposits. Anthropogenic deposits, sometimes potentially questionable, are prevalently represented by mine tailings present around the area of the Rosas mines.

Geomorphology

Closed in by the metamorphic and granitic reliefs of the Paleozoic and open to the west towards the Gulf of Palmas, the “*Carignano del Sulcis*” landscape is distinguished on the inside by the characteristic ignimbritic highlands of Monte Narcao, Mont’Essu and Sa Corona Arrubia on the slopes of which can be seen the sequence of the Oligo-Miocene volcanic products represented by the pyroclastic flow deposits in ignimbritic facies and massive flows, quite evident at the summit and tabular fills delimited by steep rocky scarps (Figure 2). Correlated to the same volcanic events are the cupoliform masses consisting of andesites and basaltic andesites, with evident flow structures that make up the reliefs of Monte Pisanu, Serra sa Perda and Serra de Mesu to the north of the Monte Pranu reservoir.

As concerns the Monte Essu plateaux and the many other sites of archaeological and geomorphological interest and the forms connected to ground water, the hydrographic network is dominated by three fluvial courses characterized by a fairly sinuous and meandering course in correspondence to the plain and by fairly deep incisions, with a rich array of minor branches of varying orders having a dendritic pattern, within the granitic and metamorphic reliefs. The Riu Mannu of Narcao, coming from the reliefs of the northeast sector starting from Monte Orri (723 m), which empties into the Monte Pranu reservoir, is considered the basic tributary of Rio Palmas, which collects the waters that flow out of the Monte Pranu reservoir at Tratalias and discharges them into the gulf of the same name on the southwestern coast of the island.

Its main affluent, Riu Mannu of Santadi, from the confluence to its point of origin at Monti Mannu (726 m), flows practically southward for about 16 km, with an interesting and lush valley floor which still requires proper works to control it. More to the west of the previous ones is Riu Gutturu Ponti which, starting from the reliefs to the north of Terraseo, flows for some 14 km before discharging into the Monte Pranu reservoir.

This reservoir, which has a net capacity of approximately 50 million cubic meters of water for industry, irrigation and drinking, was built between 1948 and 1951 along Rio Palmas. In 1989, thanks to the excellent characteristics of its shore, it was declared a nature reserve pursuant to Regional Law 31/1989. Another important infrastructure of the same kind for the supplying of water has been added.

It is of smaller capacity (about 8.5 million m³) and is formed by the Bau Pressiu dam set in the alternation of grey-green metasandstones and metasilts of the Paleozoic schist basement, in a beautiful scenic context determined by the morphological contrast between the granitic landscape and the landscape modelled in schistose-metamorphic rocks.

In correspondence to the prevalently gravelly and sandy Pleistocene alluvial deposits, there are evident terraced forms of fluvial origin characterized by weakly inclined surfaces delimited by scarps which are the expression of more or less prolonged episodes of erosion by the same water courses, caused by eustatic variations, as at Crabi, Punta Serra Manna and Tattinu where in particular the fluvial incisions are impressed on previous alluvial conoids.

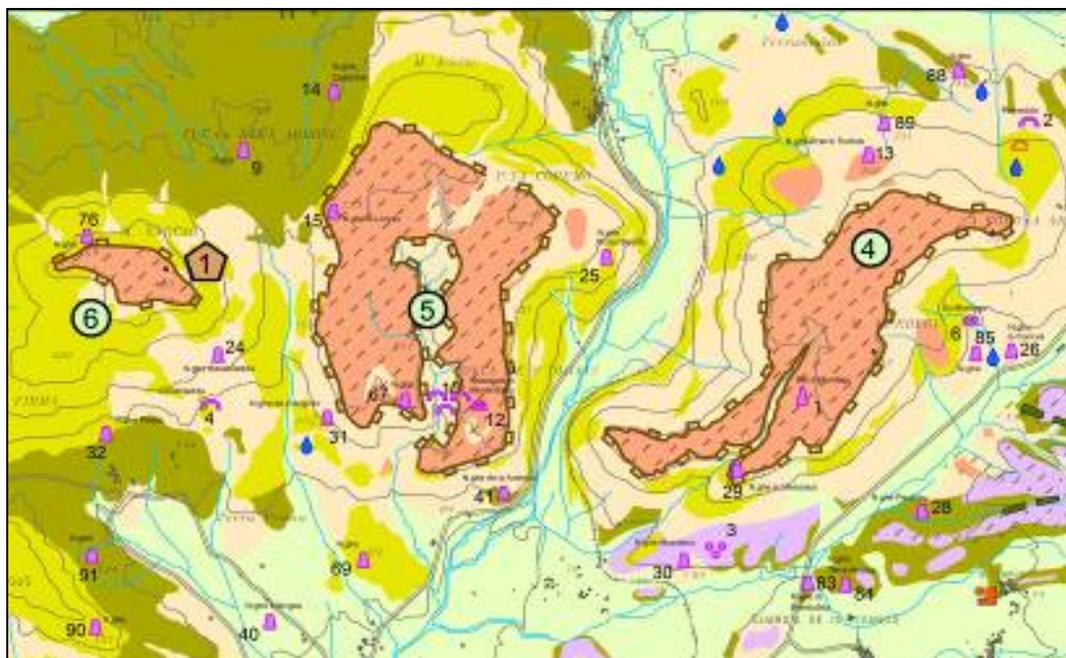


Figure 2. The ignimbritic plateaux of Monte Narcao (circle 6), Mont'Essu (circle 5) and Sa Corona Arrubia (circle 4). The volcanic sequence of monte Norcao (pentagon1), The pentagon shape identifies geosites, the circles identify geomorphosites and the relative number identifies each object, while the colour specifies the genetic process (Source: Map of the natural and cultural heritage in the wine of landscape "Carignano del sulcis" Di Gregorio F., Frongia P., Piras G., 2013)

The reliefs composed of massive limestone and stratified Cambrian dolostones bear witness to peculiar evolutionary processes of karstic hypogean and epigean nature, such as the splendid underground concretizations of the caves of Is Zuddas and Su Benatzu created by the incessant action of water, located to the south of the town of Santadi. The reliefs of Punta Portellitus and Monte Tamara to the southeast of Nuxis, but also those of Tattinu, are particularly rich in underground karstic environments and surface forms connected with the dissolving of the rock by acid water, in particular furrowed fields (Barca & Gregorio, 1999). The Bacchera and Cava Romana caves to the south of Nuxis are worthy of mention. The slopes of Monte S'Orcu, to the north of Perdaxius, those of Monte Ega and Punta Pitturra to the north of Narcao, as well as between Punta Masonis and Guardia Manna to the north of Rio Murtas, a suburb of Narcao, present interesting karstic forms underground and

evident epigean structures connected with processes of dissolution of carbonatic rocks, among which are also small dolines.

In this landscape characterized by a great lithologic, chronostratigraphic and geomorphological diversity, a systematic survey identified and classified in terms of genetics numerous geological and geomorphological sites of special educational scientific and cultural touristic interest, such as „*Sa Fraigada*” (Figure 3). After proper georeferencing they were included in a database and reported on the map of natural and cultural sites of the „*Carignano del Sulcis*” landscape. These elements were more properly distinguished as geological sites when they have considerable importance in the reading and interpretation of geological features of an area, such as Monte Narcao and Monte Sa Turri formations and volcanic structures and geomorphosites, where they represent a unique genetic model and geomorphological evolution.



Figure 3. The Sa Fraigada geomorphosite is a large *tafone* formed by meteoric erosion of a *tor* modeled in Sulcis pink granites (Source: Di Gregorio F.)

Other features of the natural and cultural heritage

Besides the geographical and physical heritage ascribable to the lithological and morphological diversity described above, the land under examination also features quite interesting archaeological, historic and architectural sites, not to mention those of industrial archaeology owing to the presence of mines and mining settlements, some of which have been well restored for use in the fields of tourism and cultural initiatives, thanks also to their being part of the Geomining, Historical and Environmental Park of Sardinia which has been included among the UNESCO sites. In the last century, the region was involved in the exploitation of many important mines with stratiform and/or paleokarstic ore deposits, prevalently of Pb, Zn and Ba and with hydrothermal and/or thermal-metamorphic annexes. Together with the important changes of the land and issues connected with water and soil pollution,

these activities have also produced interesting and varied mining landscapes, with extraordinary examples of industrial archaeology such as the Rosas washery and mining town, Mont'Ega and the Sa Marchesa mines.

Together with mining resources, the mountains have contributed to the setting up of activities connected with woodland exploitation. The old abandoned Pantaleo-Santadi-Portobotte railway, built at the beginning of the 20th century by the Compagnie des Hauts Fourneaux, was not only for transporting ore from the San Leone mine, but also for that of charcoal produced in the Pantaleo woodland. Of the industrial railway, which was active up to 1957, as well as some fine buildings restored in the area of Pantaleo's woodland, now state-owned, some parts used for ore transportation to Porto Botte in the Gulf of Palmas are now used as part of the local road network.

There also remains the winding narrow-gauge Siliqua-Calasetta passenger railway between the castle of Siliqua and Terrubia, which was active from 1926 to 1968 and the flat part of which is now in use as part of the rural road network. Also extant are interesting and admirable engineering works, such as daring arched bridges, level-crossings and local stations.

Connected with the mutually profitable relationship between humans and the land and its resources are the traditional historic settlements of Medau and Furriodroxiu, the aggregations of houses and stalls used in the process of colonization of the land by farmers and livestock breeders all over the Sulcis region.

Among the exceptional historic and architectural assets are churches of great historic value such as Sant'Elia of Nuxis near the nuragic sacred well at Tattinu and Santa Maria di Monserrato at Tratalias.

The Sulcis region is also characterized by a vast mountainous area of natural and vegetational interest in the eastern sector, which is included in the Sulcis regional park and protected under the provisions of Regional Law 31/1989; the same law protects the nature reserve of the Monte Pranu reservoir, around which several geosites generically referable to tertiary volcanism were identified in the course of this study.

THE GEOARCHAEOLOGICAL HERITAGE

Within the context of this rich and varied landscape there is also an geoarchaeological patrimony of extraordinary interest thanks to its density and chronological diversity. The most important of these are described below.

The megalithic monuments: The Giants' Tomb of Sa Fraigada

At the foot of the Monte Nieddu (1041 m a.s.l.) granite complex, along the steep banks of the Baccu Mannu stream in a scenic context of great beauty, rise the peaks of Sa Punta de su Casteddu, so-called because they resemble the walls of a castle. During the Middle Bronze Age, around 1300 B.C. (Atzeni, 1972; Moravetti, 1985), at this site, which forms a natural outcrop, nuragic peoples erected an extraordinary megalithic monument, a *Tomba di Giganti* (giants' grave) (Figure 4), the popular name for a monumental collective grave. Set at the top of the relief, beside a tunnel created by weathering (*fraigada*, Sardinian for eroded), this structure is composed of a vestibule made of two courses of cyclopean granite blocks arranged in a semicircle; at the center is a rectangular entrance oriented southwards surmounted by a huge architrave with a pediment of sub-rectangular blocks rising to a height of about 4 meters.

The interior is a long corridor used as the burial chamber, with overhanging walls covered with large stone slabs. The grave, with an overall length of 14 meters, is closed to the north by an apse. The floor plan and cross-section propose a stylized taurine protome and the appearance of an upside-down boat. In connection with the

grave, along the gully providing access to the tomb there are traces of a village with round huts built of dry walls which were probably covered with leafy branches. Today they are immersed in the lush vegetation. In defence of the settlement and the entire funerary structure are imposing walls reaching 1.5 m in thickness which obstructed all possibilities of access to the rugged needles of the steep slopes.

The Nuraghe Mannu, located at no more than 500 m to the north, built making use of a rocky outcrop, was the residence of the people who administered the economic resources of that land, characterized mostly by the presence of iron ore from the nearby Bacchiseddu mine, the fertile soils in the valley and the lush pastures on the surrounding slopes. The Sa Fraigada settlement was the logical outpost.



Figure 4. The Giants' Tomb of “*Sa Fraigada*” and a 3D model (Source: Piras G.)

The prehistoric necropolis with rupestrian graves at Montessu (Villaperuccio)

The Montessu necropolis covers an extensive natural amphitheatre at a place known as Su Crabi di Montessu, located on the southern slopes of the Sa Pranedda plateau (216 m), 2 km to the northwest of Villaperuccio. The graves were dug with picks into a consistent wall of relatively soft and compact tufaceous volcanic rock by peoples of probable middle eastern origin which have been assigned to contexts of the Ozieri culture (3500-2800 B.C.). The hypogea fit into the Sardinian *domus de janas* typology of prenuragic age: they are classified on the basis of their floor plans and have one or more cells (Atzeni, 1972). The three-grave sanctuaries are extraordinary, with monumental entrances behind ample megalithic enclosures and large chambers for religious ceremonies.

On the walls of some of the graves are decorative and symbolic motifs connected with the veneration of the dead: silhouettes of mother goddesses, taurine protomes

symbolizing fertility and rebirth (Lilliu, 1987), often decorated with red bands representing blood, the source of life for these ancient peoples. These are all testimonials of faith, undeniable signs of heartfelt religiousness expressed simply yet rich in spirituality as well as an expression of artistic skill.

The hypogean temple of Su Benatzu (Santadi)

From the archaeological standpoint, the discovery of the Su Benatzu karstic cave in 1968 was the most extraordinary one of the last century in Sardinia (Todde, 1972). Situated near the hamlet of Su Benatzu in the municipality of Santadi, the vast karstic cave presents a room used in nuragic times as a temple dedicated to water divinities (Maxia, 1972), and reveals an aspect of the naturalistic religion connected to a chthonian cult of the divinities of the nether world. On the back wall is a stalagmite, probably purposely broken, which served as an altar on which were placed bronze objects: a sacrificial knife and a votive boat. Beside it, distinct and precious, was a small ornamental tripod of skilful making, with geometric designs in relief, bull heads and spherical pendants of the Cypriot-Mycenaean tradition. Half hidden by the ashes in the hearth numerous terracotta pots, more than two thousand in all were deposited in three heaps (Sedda, 1971), they are now in Santadi's archaeological museum. The votive hoard consisted of 109 metal objects of copper, bronze and gold which included daggers, swords, spearheads, bracelets and pins. The gold objects were a crested ring and a rectangular blade.

The Sacred Well of Tattinu (Nuxis)

It has now been acknowledged by all scholars that the highest architectural expression of nuragic peoples was reached in the construction of sacred wells, ceremonial places dedicated to the water divinities (Lilliu, 1972).

In the 13th century B.C., on the southwestern slopes of Monte Nieddu in the territory of Nuxis, nuragic peoples built a well temple to gratify the religious beliefs of the communities in the area, where probably disputes between tribes and families were settled, political alliances were negotiated and the defence of the area against dangers from the outside was planned (Atzeni, 1987). The sacred area consisted of a vestibule where purification rites were performed and offerings were made before descending a stairway of 18 stone steps of irregular shape to the water basin. An underground stone tholos or beehive structure protected the spring. The surrounding area features the remains of circular huts which were probably built as shelters for pilgrims coming from settlements in the area. One fairly large one in particular, perhaps the assembly hut, was probably used by tribal chiefs and priests to discuss economic matters, social relations and perhaps tribal alliances.

Nuragic settlements

Archaeological research has established that the height of human domination of the lands in the Lower Sulcis was reached sometime around the 15th century B.C. (Pracchi, 1963). This is proved by the numerous characteristic megalithic tholos towers strongly concentrated in hilly areas and on slopes in defence of the fertile lands in the valleys.

Placed at the top of hills, in sight of one another so as to delimit specific lands, more than ninety nuraghes, villages and megalithic circles indicate the socio-economic importance of the area and the functions it was to perform. Thus we have the Murrecci quadrilobate complex controlling the Su Benatzu valley and especially the hypogean temple of the now famous Su Benatzu or Pirosu cave, where the extraordinary archaeological findings described above were brought to light.

The same can be said for the Sanna and Is Collus nuraghes which dominated the fluvial valleys of Rio Mannu and the Pani Loriga hill. The Muentinu and Serr'e Murdegu nuraghes on the ignimbritic tablelands of Pranedda overlooked Nuxis. The Sessini and Munserrau nuraghes defended accesses to the fertile Villaperuccio valley.

However, these imposing towers are not to be considered merely as watchtowers: they were part of a system connecting them closely together to delimit lands, thus indicating communities which used the habitat for the purpose of collectively managing their economic assets and equitably distributing the resources from farming, animal husbandry and mining. All this explains the choice of settling on the high ground, the low hills or foothills, always in connection with the run-off of water to ensure its use for farming and livestock breeding. This multiplicity of functions also explains the lack of nuragic settlements in impervious mountainous areas unsuitable for agriculture.

The Pani Loriga Phoenician-Punic fortress (Santadi)

The Pani Loriga archaeological site is quite important in the study of the Phoenician-Punic colonization of the Sulcis region. Founded in the 7th century BC by Phoenician colonists who had previously settled along the entire southwestern coast of Sardinia, the settlement survived for a long period, as can be seen from evidence brought to light during excavations (Barreca, 1983; Moscati, 1979). The village rises on a hill no more than 200 meters in height. A ravine, the sides of which are in some places quite steep, divides the plain. The relief, magmatic in origin, rises isolated in the middle of the Santadi plain along the Rio Mannu basin, at the crossroads of two important commercial routes. The first, following the bed of the Rio Mannu of Narcao, made it possible to reach the Campanasissa pass and from there the large geographic region known as the Campidano of Cagliari. The second is that of the Rio Mannu of Santadi, whose valley places in communication the Sulcis region with the wetlands and Gulf of Cagliari.

The importance of the site is immediately apparent: it rises as a defensive bastion, but its economic function is also important in that it gave control over the vast Sulcis coastal plain as well as providing important agricultural produce and the possibility of controlling and exploiting the ores of which the surrounding land is rich. Besides the settlement, only partially excavated, there are two other areas for the necropolises; one with graves for the cremated and the other for chamber graves in which were found precious and elegant votive offerings. From the study of these, a Phoenician presence in the 7th century BC (Moscati, 1979) for Pani Loriga has been established, while a Phoenician presence is certain starting from the 5th century BC (Barreca, 1983).

The Byzantine church of Sant'Elia (Nuxis)

Below the slopes of Monte Nieddu, the Tattinu valley has always played an important role in human occupation of the land. Already in prehistoric times people exploited the main karstic caves, as can be seen from the settlements dating back to the 6th millennium BC.

During the age of the nuraghes, the sacred well at Tattinu, an early pagan religious monument, was erected for veneration of water. Later, some time around 1000 BC, in the historic period, the Byzantines built a rural Christian sanctuary dedicated to Sant' Elia at a short distance from the pagan temple. Small in size, typical of small rural churches, its floor plan is that of the Greek cross with four arms: a pseudo tambour covered by a conical cupola is placed where they cross. The roof of the arms is double pitched.

The walls are characterized by the irregularity of the ashlar; the quoins are well laid and intagliated. A cornice of projecting eaves placed under the pitches of the roof follow the entire perimeter of the building and are the only decoration of the monument. The plain main entrance is in the western façade and surmounted by an arched bell gable. The interior is simple and austere, with a modest altar situated at the end of the eastern arm.

The Archaeological Museum of Santadi

Situated in the old town centre, at the foot of the park on the hill of San Nicolò, this modern museum houses the findings from excavations and archaeological studies performed in the Lower Sulcis region as well as from the numerous archaeological sites of which the land has a wealth. The findings placed chronologically trace a vast cultural panorama starting from the 6th millennium BC up to the final stages of Roman civilization in the 4th century AD. The Neolithic is represented by findings relating to the first human settlements in the karstic caves of Perda Tuvura, Cirixi and Tattinu eight thousand years ago.

These were followed by the creation of villages composed of huts in the open, the birth of agriculture and animal husbandry. Millstones, pestles, axes, arrow- and spearheads, knives, obsidian scrapers, whorls and pottery impressed with matting reveal the activities of everyday life. The later ages of the metals are represented by plaques, axes, copper daggers and an interesting silver bead from a necklace. Lead is represented by clamps still attached to pottery showing that repairs were already in use. A vast exhibition of pottery from the Early Bronze Age comes from excavations and research in the Montessu necropolis, associated with fine copper daggers and vitreous paste necklace beads.

But the most noteworthy aspect of the museum's treasures is the display of thousands of pots, daggers and bronze votive tripods of Cypriot inspiration found in the hypogean temple in the Su Benatzu cave. The Semitic world is represented by grave goods from the cemetery of the cremated in the Phoenician-Punic settlement of Pani Loriga.

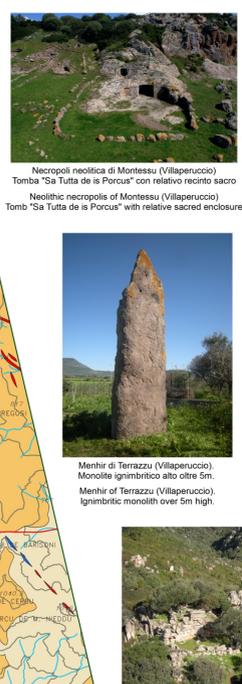
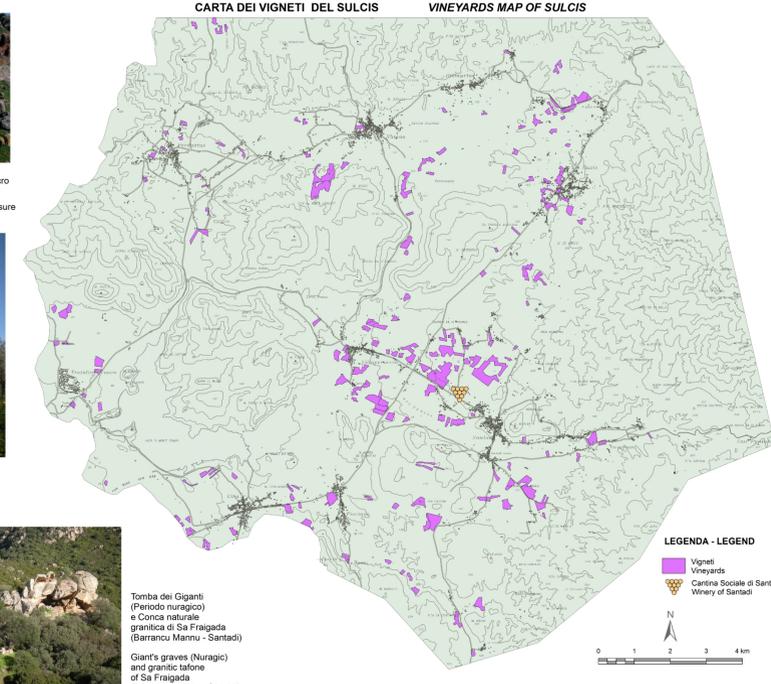
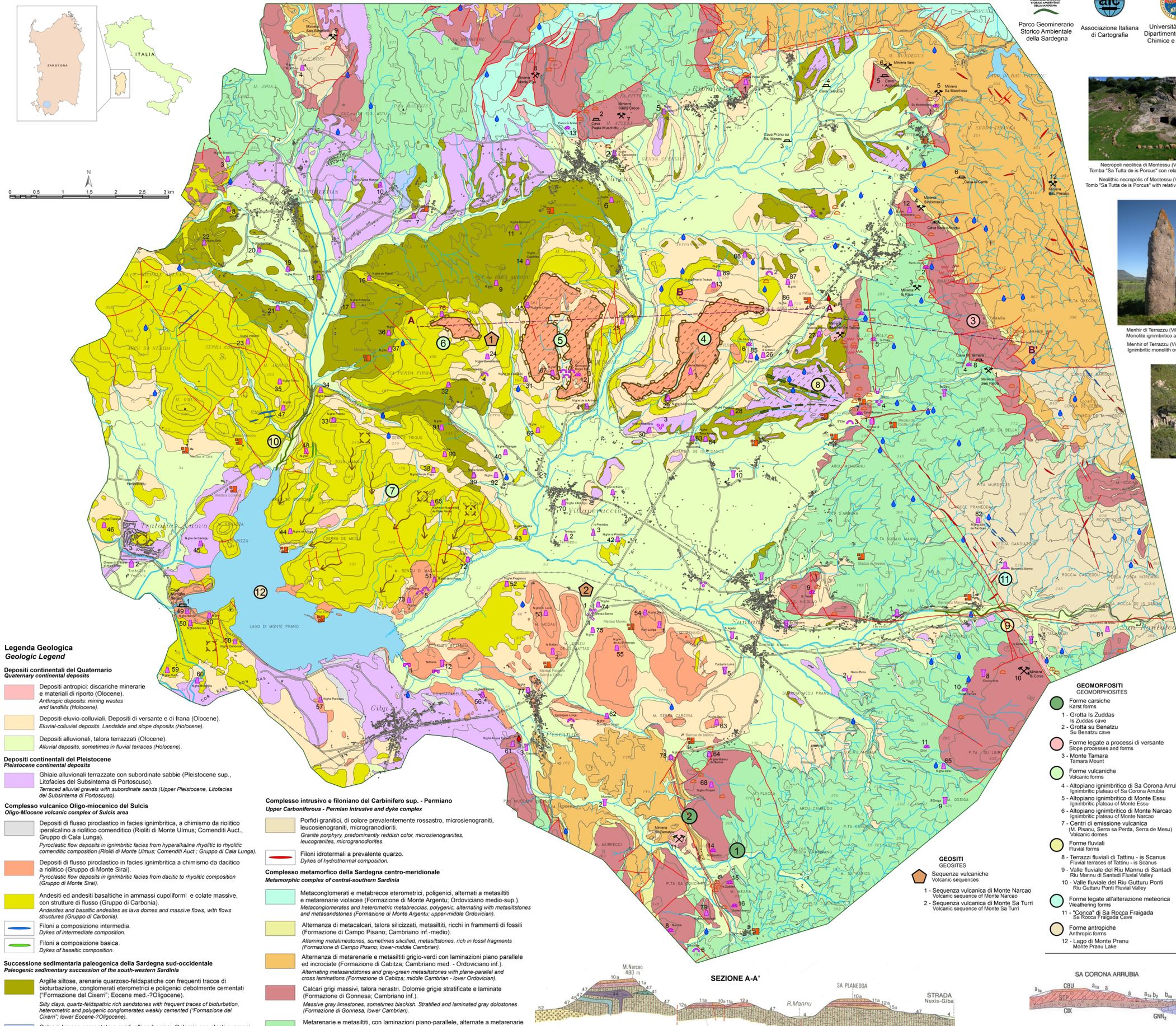
The exhibition closes with a cross-section of Roman civilization, both republican and imperial, with grave goods, cinerary urns, wine amphoras and a limestone bust probably representing the god Bacchus. The restoration laboratory contains a large amount of material which will become the nucleus of the museum when the planned exhibition takes place.

CONCLUSIONS

The natural and cultural assets are synthesized in the Map of the natural and cultural heritage in the landscape where „*Carignano del Sulcis*” wine is produced (SW Sardinia)(Figure 5). The information collected through bibliographic analyses, interpretation of aerial photographs and field surveys is presented on the map which was created on a GIS support so as to correctly georeference the several elements.

The map represents a fundamental and direct instrument for locating the territory's heritage and will be especially useful in formulating ideas and drawing up plans for fruition and sustainable exploitation of the environment.

In this sense, the legends provided with the map, subdivided by the type of heritage, highlight the diversity and wealth of natural and cultural assets contained in it. In particular, the research performed has brought to the fore that in the area studied there are numerous geosites and geomorphosites, the latter the result of different genetic processes: weathering (tafoni and tors), karstic (caves with relative concretions), volcanic and structural (tabular ignimbritic plateaux) and so on.



Legenda Geologica
Geologic Legend

Depositi continentali del Quaternario
Quaternary continental deposits

- Depositi antropici: discariche minerarie e materiali di riporto (Olocene). Anthropogenic deposits: mining wastes and landfills (Holocene).
- Depositi eluvio-colluviali. Depositi di versante e di frana (Olocene). Eluvial-colluvial deposits. Landslide and slope deposits (Holocene).
- Depositi alluvionali, talora terrazzati (Olocene). Alluvial deposits, sometimes in fluvial terraces (Holocene).

Depositi continentali del Pleistocene
Pleistocene continental deposits

- Ghiaie alluvionali terrazzate con subordinate sabbie (Pleistocene sup., Litofacies del Subinterna di Portoscuso). Terraced alluvial gravels with subordinate sands (Upper Pleistocene, Litofacies del Subinterna di Portoscuso).

Complesso vulcanico Oligo-miocenico del Sulcis
Oligo-Miocene volcanic complex of Sulcis area

- Depositi di flusso piroclastico in facies inghimbrica, a chimismo da rilitico iperalcalino a rilitico comenditico (Riolti di Monte Ulmus, Comenditi Auct., Gruppo di Cala Lunga). Pyroclastic flow deposits in ignimbritic facies from hyperalkaline rhyolitic to rhyolitic comenditic composition (Riolti di Monte Ulmus, Comenditi Auct., Gruppo di Cala Lunga).
- Depositi di flusso piroclastico in facies inghimbrica a chimismo da dacitico a rilitico (Gruppo di Monte Sirai). Pyroclastic flow deposits in ignimbritic facies from dacitic to rhyolitic composition (Gruppo di Monte Sirai).

Complesso intrusivo e filoniano del Carbinifero sup. - Permiano
Upper Carboniferous - Permian intrusive and dyke complex

- Porfidi granitici, di colore prevalentemente rossastro, microsenograniti, leucosienograniti, microgranodioriti. Granite porphyry, predominantly reddish color, microsenogranites, leucogranites, microgranodiorites.
- Filoni idrotermali a prevalente quarzo. Dykes of hydrothermal composition.

Complesso metamorfico della Sardegna centro-meridionale
Metamorphic complex of central-southern Sardinia

- Metaconglomerati a metabreccie eterometriche, poligenici, alternati a metasilitti e metarenarie violacee (Formazione di Monte Argentu, Ordoviciano medio-sup.). Metaconglomerates and heterometric metabreccias, polygenic, alternating with metasilts and metarenaries (Formation of Monte Argentu, upper-middle Ordovician).
- Alternanza di metacalcari, talora silicizzati, metasilitti, ricchi in frammenti di fossili (Formazione di Campo Pisano, Cambriano inf.-medio). Alternating metacalcarenites, sometimes silicified, metasilts, rich in fossil fragments (Formation of Campo Pisano, lower-middle Cambrian).
- Alternanza di metarenarie e metasilitti grigio-verdi con laminazioni piano-parallele ed incrociate (Formazione di Cabitza, Cambriano med. - Ordoviciano inf.). Alternating metarenaries and metasilts grey-green with plane-parallel and cross laminations (Formation of Cabitza, middle Cambrian - lower Ordovician).
- Calcarei grigi massivi, talora nerastri. Dolomie grigie stratificate e laminare (Formazione di Gonnesa, Cambriano inf.). Massive gray limestones, sometimes blackish. Stratified and laminated gray dolostones (Formation of Gonnesa, lower Cambrian).
- Metarenarie e metasilitti, con laminazioni piano-parallele, alternate a metarenarie quarzose, con rari livelli carbonatici. Alla base calcari oolitici e oncolitici (Formazione di Nebida, Cambriano inf.). Metarenaries and metasilts, with plane-parallel laminations, alternate to quartziferous metarenaries, with rare carbonatic levels. Oolitic limestones and oncolites at the bottom (Formation of Nebida - Lower Cambrian).

Successione sedimentaria paleogenica della Sardegna sud-occidentale
Paleogene sedimentary succession of the south-western Sardinia

- Argille silteuse, arenarie quarzose-feldspatiche con frequenti tracce di bioturbazione, conglomerati eterometrici e poligenici debolmente cementati ("Formazione del Cixerri", Eocene inf.-med./Oligocene). Silty clays, quartz-feldspathic rich sandstones with frequent traces of bioturbation, heterometric and polygenic conglomerates weakly cemented ("Formation of Cixerri", lower Eocene - Oligocene).
- Calcarei, breccie cementate e rari livelli carbonatici. Dolomie con clasti quarzosi e calcari ("Lignifero" Auct., Eocene inf.-med.). Limestones, cemented breccias and rare coal levels. Dolostones with quartz clasts ("Lignifero" Auct., lower-middle Eocene).

GEOMORFOLOGIA
Geomorphology

Forme carsiche
Karst forms

- Grotta Is Zuddas Is Zuddas cave
- Grotta su Benatzu Su Benatzu cave
- Monte Tamara Tamara Mount

Forme vulcaniche
Volcanic forms

- Altopiano inghimbrico di Sa Corona Arrubia Ignimbritic plateau of Sa Corona Arrubia
- Altopiano inghimbrico di Monte Essu Ignimbritic plateau of Monte Essu
- Altopiano inghimbrico di Monte Narcao Ignimbritic plateau of Monte Narcao
- Centri di emissione vulcanica (Mt. Pisano, Serra sa Perra, Serra de Mesu) Volcanic domes
- Forme fluviali Fluvial forms
- Terrazzi fluviali di Tattinu - is Scanus Fluvial terraces of Tattinu - is Scanus
- Valle fluviale del Rio Mannu di Santadi Fluvial valley of Rio Mannu of Santadi
- Valle fluviale del Rio Gutturu Ponti Rio Gutturu Ponti Fluvial Valley

Forme legate all'alterazione meteorica
Weathering forms

- Forme antropiche Anthropogenic forms
- Lago di Monte Pranu Monte Pranu Lake

SITI DI INTERESSE GEOLOGICO-GEOMORFOLOGICO
SITES OF GEOLOGICAL-GEOMORPHOLOGICAL INTEREST

Elementi strutturali
Structural elements

- Faglie e fratture Faults and fractures
- Idrografia Hydrology
- Corsi d'acqua River
- Sorgenti Source
- Sorgenti termali Hot source

Forme fluviali e di versante dovute al dilavamento
Fluvial and slope forms

- Gole e canali fluviali Gorges and fluvial channel
- Terrazzi fluviali Fluvial terrace
- Conoidi alluvionali inattivi Inactive alluvial fans

Forme strutturali e vulcaniche
Structural and volcanic forms

- Orli di scarpate rocciose Edge
- Altopiani inghimbrici Ignimbritic plateaus
- Cupole laviche Lava domes
- Colate con evidenti direzioni di flusso Volcanic flows

Forme carsiche
Karstic forms

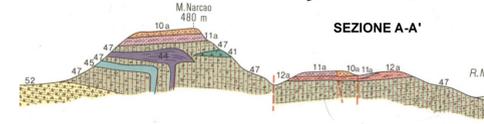
- Grotte Caves
- Area a campi solcati Karren field
- Doline Dolines

SITI DI INTERESSE STORICO-TECNOLOGICO
SITES OF HISTORICAL AND TECHNOLOGICAL INTEREST

- Dighe e bacini Dams and reservoirs
- Cave abbandonate Abandoned quarries
- Miniere abbandonate Abandoned mines
- Terrazzi fluviali Fluvial terrace
- Insediamenti storico-tradizionali Historical settlements
- Ferrovie storiche dismesse Historical railway abandoned
- Ferrovie ex-Meridionali della Sardegna Linea Siliqua-Calasetta (1926-68)
- Ferrovie industriali Pantaleo-Porto Botte (1914-57)
- Chiese di interesse storico-architettonico Architectural and historical interest Church

SITI DI INTERESSE STORICO-ARCHEOLOGICO
SITES OF HISTORICAL-ARCHEOLOGICAL INTEREST

- Necropoli a Domus de Janas Burial niches
- Monte Essu (Villaperuccio)
- Pranedda (Nuxis)
- S. Elia (Nuxis)
- Conchilieddu (Villaperuccio)
- Marchiana (Villaperuccio)
- Conchitta (Santadi)
- Corongiu Longu (Piscinas)
- Menhir Menhir
- Serra Murduge (Nuxis-Narcao)
- Terrazzu (Villaperuccio)
- Is Pireddas (Villaperuccio)
- Grotta con tracce di insediamenti Caves with traces of settlement
- Su Montixeddu (Nuxis)
- Perdu Cuccu (Nuxis)
- Bacchera (Nuxis)
- Tamara (Nuxis)
- Is Piras (Nuxis)
- Su Murduge (Nuxis)
- Cava Romana (Nuxis)
- Nurchis (Santadi)
- S. Paolo (Santadi)
- Perda Tuvura (Santadi)
- Cirix (Santadi)
- Conca de is Ominis (Villaperuccio)
- Cuccuru Sollais (Narcao)
- In Zuddas (Santadi)
- Monte Meana (Santadi)
- Tombe dei giganti Giant's graves
- Teresoli (Santadi)
- Barrancu Mannu (Santadi)
- Is Santus (Nuxis)
- Pozzi sacri Sacred pits
- Tattinu (Nuxis)
- Nanni Ecca (Santadi)
- Nuraghi (*) Nuraghes (*)
- Nuraghe 11 Nuraghe 11
- Villaggio nuragico Nuragic village
- Merau Sanna (Santadi)
- Is Collus (Santadi)
- N-ghe Muertinu (Villaperuccio)
- Tattinu (Nuxis)
- Insediamenti punici Punic's settlements
- Fortezza di Pani Logu (Santadi)
- Is Mattas (Piscinas)
- Corona Arrubia (Nuxis)
- Insediamenti romani Roman's settlements
- Su Tipu (Nuxis)
- Murrucchi (Santadi)
- Cracchera (Piscinas)
- S. Agata (Santadi)
- Funtane Lurra (Santadi)
- Su Vaticanu (Santadi)
- Is Cereanus (Santadi)
- Crucurcinos (Santadi)
- S'Ossiga (Santadi)
- Is Prodis (Nuxis)
- Is Arrigru (Nuxis)
- Bettiana
- Strade romane Roman bridges
- Merau Sanna (Santadi)
- Ponti romani Roman bridges
- Riu di Piscinas (Piscinas)



Per le caratteristiche geologiche e litostratigrafiche si è fatto riferimento ai seguenti lavori:
 APAT - Dipartimento Difesa del Suolo-Servizio Geologico d'Italia, Carta Geologica d'Italia alla scala 1:50.000, Foglio 564 "Carbonia" (2012); Foglio 565 "Capoterra" (2009).
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 Barca S., Di Gregorio F. (1999), Paesaggi e Monumenti geologici della Provincia di Cagliari, Saredid srl, Cagliari.

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Giuseppe PIRAS, Remo FORRESU

From the standpoint of the cultural heritage, the area presents an extraordinary array of archaeological sites, from the Neolithic to the modern era, representing a unique identity patrimony in the Mediterranean context: about 90 nuraghes, giants' graves, sacred wells, hypogean temples, two important Punic sites, *domus de janas* and *menhirs* dating back to the Neolithic, an important road built by the Romans and the remain of recent infrastructures such as the abandoned Pantaleo-Porto Botte and Siliqua-Calasetta railway lines, sites of industrial archaeology such as the Rosas, Sa Marchesa and Montega mines.

Aknowlegments

Work carried out at the Laboratorio di Geologia ambientale e termografia of the Dipartimento di Scienze della Terra of the Università di Cagliari (Laboratory manager: Prof. Felice Di Gregorio)

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