Apuane Geopark

Application Dossier
of the Apuan Alps Regional Park
for Membership in the
European and Global Geoparks Network
under the auspices of Unesco

Revised text
15th March 2011

www.apuanegeopark.it

A – DEFINITION OF THE EUROPEAN GEOPARK TERRITORY

A.1 – NAME OF SITE APPLYING TO BECOME A EUROPEAN GEOPARK

"Apuane Geopark" is the short name of the area proposed for membership in the European and Global Unesco Geoparks Network. In particular, the term "Apuane" named after the local mountain range which, in turn, is named after the Ligurian tribe that inhabited the area until the 3rd century B.C.

The area proposed as Geopark comprises the whole 'Apuan Alps Regional Park' and its surrounding areas including adjacent quarries, as enshrined in Tuscany Regional Act no. 65 of 11 August 1997 and subsequent amendments and supplements.

A.2 – LOCATION

The territory proposed as Geopark is situated in the Apuan Alps mountain subregion. It is located in central Italy or, more precisely, in north-west Tuscany, on the northern limits of the Italian peninsula, where the transition between the Middle-European and Mediterranean biogeographical regions occurs. The mountain range of the Apuan Alps rises in this transition area. It stretches from north-west to south-east separating from the Apennines to the west, which makes it geographically isolated. As a matter of fact, the Apuan subregion is well-defined and delimited by the river Serchio (to the north-east, east and south), torrent Aulella, tributary of river Magra (to the north and north-west) and the borders of the Apuan-Versilian plain (to the south-west) which briefly divides the mountain range from the Ligurian Sea. Within the aforementioned borders, the Apuan Alps stretch over an overall area of about 1080 km^2 and have the shape of an irregular trapezium on the map, with the larger base measuring 58 km and running parallel to the coast and its 35 km smaller base corresponding to the upper course of the river Serchio for an average width of 22 km in its central part.

figure 1 – Geographical location of the Apuan Alps in north-west Tuscany (central Italy)

A.3 – SURFACE AREA AND GEOGRAPHIC AND HUMAN ELEMENTS

The area proposed for the membership in the European and Global Geoparks Networks coincides with the territory of competence of the Apuan Alps Regional Park. Zonation was established by the map annex to Tuscany Regional Law no. 65/1997 and can only be modified as regards the surface area with the Plan for the Park only, on the initiative of the Authority managing the protected area following the approval by the Tuscan regional administration. The surface area proposed as Geopark totals 493.87 km^2, 205.98 km^2 of which is the Park area, 271.07 km^2 of protected surrounding areas and 16.82 km^2 nearby area for mining activities ("adjacent quarry area").

The candidate territory is situated within the administrative borders of 20 municipalities and it is entirely included in the provinces of Lucca and Massa Carrara which belong to the Region of Tuscany. There are fourteen municipalities within the province of Lucca: Camaiore, Camporgiano, Careggine, Castelnuovo di Garfagnana, Fabbriche di Vallico, Gallicano, Minucciano, Molazzana, Pescaglia, Piazza al Serchio, Seravezza, Stazzema, Vagli Sotto and Vergemoli, for a total of 338.04 km^2. There are six municipalities within the province of Massa Carrara: Carrara, Casola in Lunigiana, Fivizzano, Fosdinovo, Massa and Montignoso, for a total of 155.83 km^2.

According to the most recent estimate, the population of the Geopark area amounts to 16,150 inhabitants, 742 of whom live within the Park and 15,408 in the surrounding areas. Overall, the average population density is 32.7 inhabitants/km^2, of which 3,6 inhabitants/km^2 in the Park area and 53,5 in the surrounding areas.

A.4 – ORGANIZATION IN CHARGE OF THE EUROPEAN GEOPARK ZONE

The application for membership in the European and Global Geoparks Network, under the auspices of Unesco, is submitted by the regional authority governed by public law responsible for the management of the Regional Park, under Tuscany Regional Law no. 5 of 21 January 1985 and subsequent amendements and supplements (the name of the board is *Parco Regionale delle Alpi Apuane* – Regional Park Authority of the Apuan Alps).

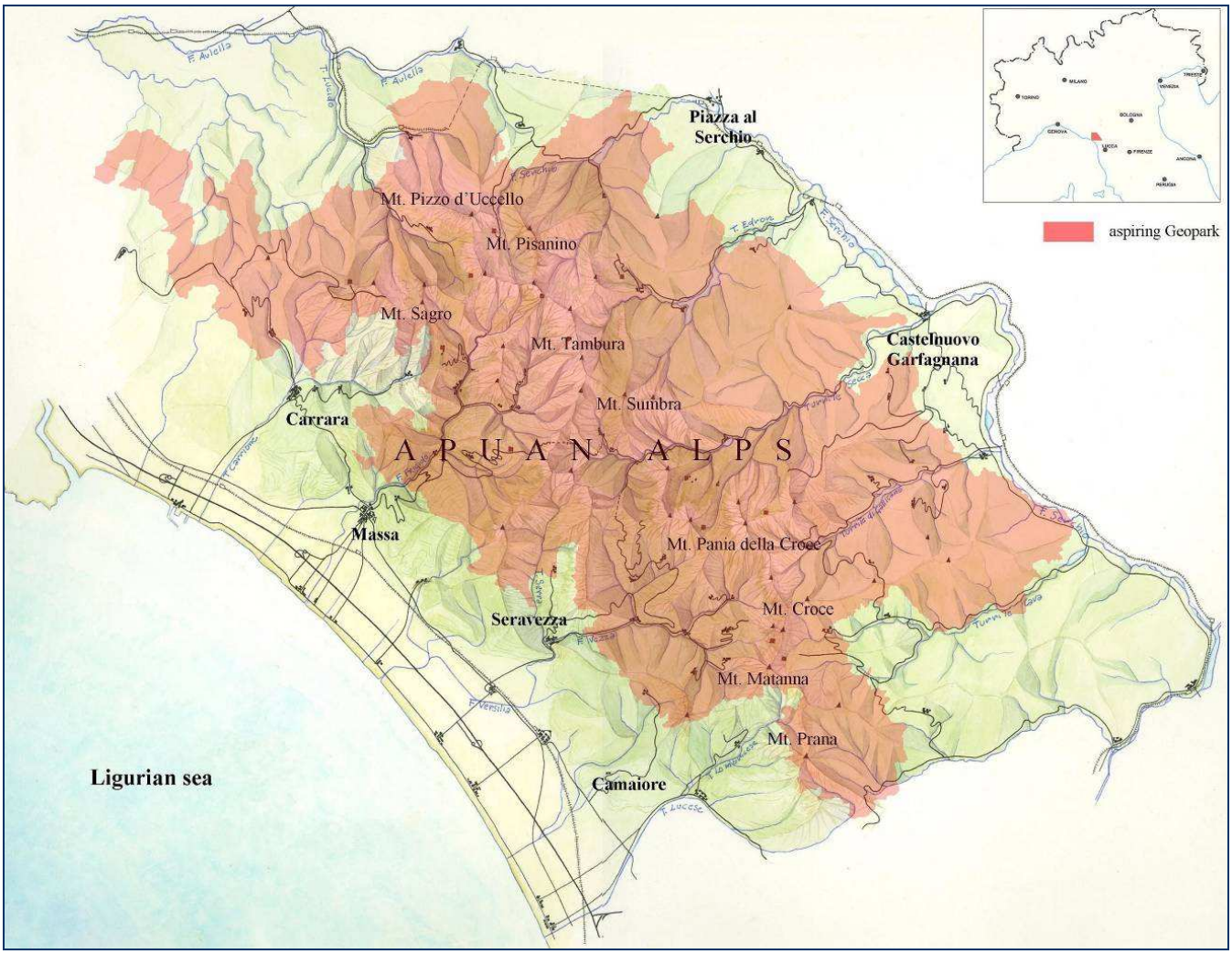

figure 2 – Map showing the boundaries of the territory considered

The Park Authority – which in 1997 was harmonized with principles and typologies enshrined in the national framework law on protected areas (no. 394/91) – aims at improving living conditions of local communities by safeguarding nature, landscape and environment and striking a delicate balance between economic activities and the ecosystem. According to the Charter approved in 1999, the goals of the Park Authority include the re-establishment of the natural and historical environment and the recovery of structures altered by the social use.

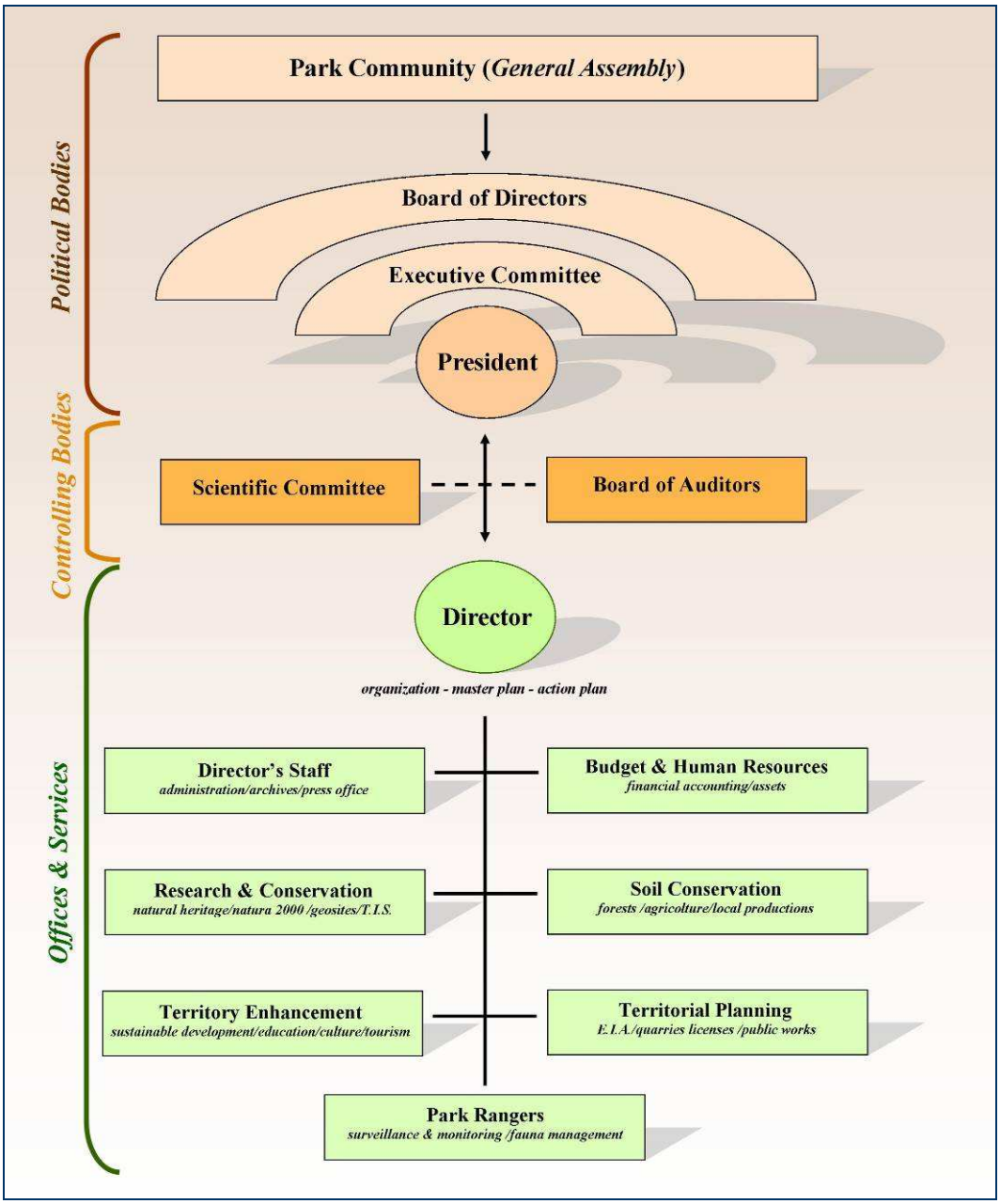

figure 3 – Organization structure of the Apuan Alps Regional Park (aspiring Geopark)

Contact Person
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Role: Park Director
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Identity Card of the Park
Authority: Parco Regionale delle Alpi Apuane (Regional Park Authority of the Apuan Alps) – Stazzema (Lucca)
Administrative Units: via Corrado Del Greco, 11 – 55047 Seravezza (Lucca); via Simon Musico, 8 – 54100 Massa; Casa del Capitano, Fortezza di Mont'Alfonso – Castelnuovo di Garfagnana (Lucca)
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Provinces (2): Lucca and Massa Carrara
Municipalities (20): Camaiore, Careggine, Carrara, Casola in Lunigiana, Fabbriche di Vallico, Fivizzano, Gallicano, Massa, Minucciano, Molazzana, Montignoso, Pescaglia, Seravezza, Stazzema, Vagli Sotto and Vergemoli (in the area of the park); Camporgiano, Castelnuovo di Garfagnana, Fosdinovo and Piazza al Serchio (in surrounding areas only)
Foundation: Tuscany Regional Law no. 5 of 21 January 1985; it became a regional organization governed by public law with Tuscany Regional Law no. 65 of 11 August 1997
Master plan for the Park: it is the main instrument of planning for the park and its surrounding areas. It was adopted by the Park Board of Directors' decision no. 46 of 29 November 2007
Long term socio-economic plan (Action Plan): it is the main instrument defining actions aimed at protection, conservation, promotion and enhancement. It was adopted by the Park Community's decision no. 4 of 27 April 2010
Park Community: it has advisory functions and gives binding decisions on planning and regulatory actions in the protected area as well as on estimated budget and on the actual cost. It is the local autonomies' assembly, consisting of Mayors and Presidents of Municipalities, Union Municipalities and Provinces which are situated, even partially, in the territory of the Park
Board of Directors: it is the executive body which decides on planning and regulatory actions, estimated budget and the actual cost. It is formed by the President and twelve members elected by the Regional Council among qualified experts on the basis of their technical-scientific qualifications or administrative experience with the following criteria: a) seven members appointed by the Park Community; b) three members proposed by environmental protection associations and some scientific organizations: the National Lincean Academy, the Italian Botanical Society, the Italian Zoological Union, the National Research Council of Italy (CNR), the Universities of Tuscany; c) two members chosen by the Regional Council
Executive Committee: it is the executive body responsible for the management executive plan. It is formed by the President and four members appointed by and within the Board of Directors
President: the legitimate representative of the Park Authority appointed by the Regional Council among the candidates proposed by the Park Community
Director: he/she implements the decisions made by executive bodies and coordinates the organization and the staff of the board; he/she is chosen through a public competition among graduates with work experience and suitable for the position of Park Director
Scientific Committee: gives opinions on the main planning and regulatory actions regarding the protected area as well as advisory opinions on environmental protection and preservation. It is formed by seven teachers from the Universities of Tuscany and CNR researchers with expertise in the following areas: geology, botany, zoology, agronomy, forestry, ecology, urban policies

A.5 – ENCLOSURES

The territory of the proposed Geopark roughly coincides with the central area of the Apuan Alps subregion. Said area has a rough rectangular shape with a great difference between large and small bases as the areal development follows the mountain range from north-west to south-east. Deviations from the ideal geometric shape can be found at the ends of the range including the extreme foothills of the Apuan Alps, whereas the excluded subcircular area, extending inside the coastal mountainside, coincides with the Industrial Marble Basins of Carrara and Massa.

The proposed area includes all the high slopes next to the main watershed of the mountain range and the deep Apuan valleys. This is why the height difference ranges from 1,947 meters a.s.l. of Mt. Pisanino to 45 meters a.s.l. of the river Frigido located in S. Lucia (near Massa).

B – SCIENTIFIC DESCRIPTION OF THE EUROPEAN GEOPARK TERRITORY

B.1 – DEFINITION OF THE GEOGRAPHIC REGION IN WHICH THE TERRITORY IS LOCATED

The peaks of the Apuan Alps got the name Alps thanks to their original shape which is different from that of the Northern Apennines. They also differ for their lithologies which are mainly carbonate. The morphological watershed divides the coastal mountainside from the inland one, showing some differences in the structure and development of the hydrographic network. The western side of the Apuan Alps, which is intensively carved by watercourses, is characterized by sheer slopes steeply descending towards deep valley bottoms, whereas secondary ridges branch off towards the coastal plain and form the basins of the rivers Carrione, Frigido, Versilia (streams Serra-Vezza) and Fosso di Camaiore (streams Lucese-Lombricese). The inland side slopes more gently to Aulella and Serchio valleys and is characterized by subranges which, starting from the ridge, create transversal valleys, which either run parallel or diverge.

The main range of the Apuan Alps originates from mild hills located to the east of Sarzana and runs from the west to the east to the northern crest of Mt. Cavallo, meeting, in the following sequence, Mt. Borla, Mt. Spallone, Mt. Sagro, Mt. Rasori, Mt. Grondilice and Mt. Contrario. At this height, the Apuan ridge creates an arch and goes towards south-east and then south-west, through the peaks of Mt. Tambura, Mt. Alto di Sella, Mt. Macina, Mt. Pelato and Mt. Altissimo. From here, the watershed goes towards east, meets Mt. Corchia and Mt. Pania della Croce and continues towards south-east through Mt. Forato, Mt. Nona and Mt. Matanna until Mt. Prana. From this crest the mountain range continues for further fifteen kilometres but it is characterized by hills only.

In their central part, the Apuan Alps create a rocky barrier which is more evident on the coastal side. It is characterized by an average height of more than 1600 m and has sheer and rugged slopes soaring steeply. The relief energy is therefore remarkable. There are often differences in height of more than a thousand metres, which hamper humid western winds, thus contributing to heavy orographic rain. The sharp orography and the proximity to the sea are responsible for large quantities of meteoric water, which exceeds 3000 mm per year at the higher altitudes, making the Apuan Alps one of the Italian regions with the highest rainfall rate.

The main mountainsides are characterized by varied morphologies and different climate conditions, as the Apuan Alps are also a barrier for cold northern winds. The western side, protected by the mountain range and subject to sea mitigation, has a warm and humid climate with relatively cool summers and mild winters, whereas the opposite side is characterized by continental features with a short hot summer and a long cold winter.

B.2 – GENERAL GEOLOGICAL DESCRIPTION

B.2.1 – **History of research and geological knowledge**

During the 18th century several naturalists showed their growing interest in the Apuan Alps which had become a privileged research field for hydrogeological studies and geo-mineral research in Italy. Here, Antonio Vallisnieri *senior* (1661-1730) developed and tested the new theory on the underground water cycle (1704-1715), thanks to the close relation between water springs and karst cavities. Meanwhile, explorations of mines and studies on mineralization took off, with the active participation, among others, of Giovanni Targioni Tozzetti (1712-1783), Giovanni Arduino (1714-1795) and Lazzaro Spallanzani (1729-1799). As a result, the first geological descriptions of the Apuan Alps was produced, based on Arduino's chronostratigraphic approach and pointing out the ancient core of the mountain range consisting of schist "*primitive rocks*" covered by "*secondary rocks*". In 1833, for the first time the Apuan Alps are shown in a geological cross-section in a work by Paolo Savi (1798-1871) who gives a 'Plutonic' interpretation of the mountain range [intrusion of a deep magma body and formation of an ancient orographic ridge – called "metalliferous chain" – originally situated in the area from La Spezia to Mt. Argentario].

For almost half a century, literature on geology was dominated by the scientific contributions of Italian and foreign geologists (Coquand, Pareto, Puggard, Simi, Cocchi, De Stefani) who used to support the well-established theory of the Apuan Alps as a single anticline of Plutonic origin. Research is, nevertheless, rich in surprises and important discoveries. In 1872, Antonio Stoppani (1824-1891) and Igino Cocchi (1827-1913) in two different studies found the first morainic deposits in the Apuan Alps and presented them to the scientific community as the first Apennine marks of the Quaternary Glaciations.

Modern geology began with a systematic survey of the Apuan Alps completed between 1879 and 1890 by Bernardino Lotti (1847-1933) and Domenico Zaccagna (1851-1940). The two engineers of the Geological Royal Committee belonged to the 'autochthonist' school of thought assigning the Apuan rocks to a single stratigraphic sequence excluding any possibility of nappe overlapping. Therefore, they proposed a folding tectonics characterized by regular folds with double vergence without dealing with the existence of faults. The map drawing was completed by Zaccagna alone, who retrieved and developed the contemporary studies by Igino Cocchi (1827-1913) and Carlo De Stefani (1850-1924), in compliance with the geological survey project presented at the Second International Congress in Bologna in 1881. The scientific commitment was matched with the institutional interest of the Geological Committee, which aimed at providing the Apuan

marble mining industry with an useful instrument in a historic moment of remarkable spreading of quarrying activities beyond the traditional basins of Carrara, Massa and the area of Versilia.

In 1917, despite their sheer 'autochthonist' approach, the Zaccagna and Lotti's geological map enabled, Stanislaw Lencewicz (1889-1944) to reinterpret the structure of the mountain range from an 'allochthonist' perspective, showing the tectonic duplication of the Tuscan sequence. For the very first time in the history of the Apuan Alps and Apennines the allochthonous origin of nappes was recognized, though it had already been proposed by Lugeon and Argand for the Pennine Alps (1905) on the basis of the overthrusting of two equivalent stratigraphic sequences. In the following two decades the geological studies, especially by experts from the central European school and culture, enabled the identification of a 'tectonic window' in the central part of the Apuan range. In particular, in 1926, Norbert Tilman (1883-1947) described the Apuan Alps as a complex structure of folded sedimentary sequences which are overturned, faulted and tectonically overlapped. After the Second World War the main subject of geological studies was the gravitational sliding of nappes, which led Carlo Migliorini (1891-1953) to formulate the theory of 'composite wedges' (1948), according to which nappes may gradually slip for hundreds of kilometres through different and subsequent phases thanks to a limited number of inclined surfaces. The interpretation was then retrieved and developed by Giovanni Merla (1906-1983) and Livio Trevisan (1909-1996), who, shortly afterwards, described a gravitational sliding of nappes progressively moving from the Tyrrhenian to the Adriatic area thanks to the upthrust of subsequent tectonic 'ridges' or 'wrinkles'. In the same period, Felice Ippolito (1915-1997) carried out geological-petrographic studies on the Apuan Alps and Pisani Mountains assigning the Apuan rocks to three superposed sequences. The 'Autochthonous' sequence is the deepest one and is overthrusted by an equivalent lithological sequence, called 'Tuscan Nappe' which is in turn topped by the 'Ligurian Unit'.

In the 1960's the Apuan Autochthon is described, especially by Enzo Giannini (1919-1992), as the most remarkable part of a structural high (geoanticline) which divides the two main basins, the 'inland' (eugeosyncline) and the 'outer' one (miogeosyncline). The Apuan tectonic ridge was allegedly overthrusted by the Tuscan and Ligurian units because of tangential pushes by the oceanic area towards the foreland, thus leading to the late formation of rigid structures such as *horsts* (Apuan) and *grabens* (Serchio Valley).

The quality leap in the interpretation of the evolution of the Apuan Alps and Northern Apennines was made thanks to the theoretical support of 'plate tectonics' or 'global tectonics' with the identification of the physical "engine" able to provide the necessary push for large translations of nappes. After 1975, a series of studies on the geometry of polyphase deformations, created by the superposition of different tectonic phases, took place within a framework consistent with the Cenozoic paleographic evolution and crustal movements of the western Mediterranean area.

B.2.2 – **Geological description**

B.2.2.1 – ***Geological Interpretation of the Apuan Alps***

The current interpretation model of the Apuan Alps was defined in 1990 when Carmignani and Kligfield (and, separately, Coli) noted closes analogies between the evolution of the Apuan-Apennine area and northern American *Core Complex*, where more recent structures of extensional tectonics superimposed upon older compressive deformations. Nowadays, almost the entire scientific community agrees on the interpretation of the Apuan Alps and the Northern Apennines as the complex result of two different and subsequent deformation phases: the first compressional-collisional and the second extensional. The Apuan Alps and the Northern Apennines belong to the same thrust and fold mountain belt originated during the Cenozoic by the overthrusting of the Ligurian Units, derived from the ocean (Alpine Tethys) internal domain, onto the external Tuscan and Umbria-Marche continental margin domains. The complex tectonic evolution of the area showed a first phase of deformation and metamorphism within a collisional geodynamic context. It was then followed by a second phase within an extensional tectonic regime. Specifically, a first ductile compressive phase (D_1) was followed by a second ductile extensional deformation (D_2) which led to the isostatic readjustment of the thickened crust. In other words, the first phase of crustal shortening (D_1), mainly characterized by thrusts and folds, was followed by a second phase of exhumation of the orogen (D_2), characterized by the development of low-angle shear zones and normal faults.

A large tectonic window formed in the Apuan Alps, thus exposing the 'Metamorphic Complex of the Apuan Alps'. It is the deepest structural level outcropping in the internal parts of the Northern Apennines and it is therefore a key area to understand mechanisms and geodynamic processes which led to the formation of the Apenninic range, because it represents one of the best known examples of direct superposition of units with upper-crustal tectonic evolution over a metamorphic complex deeply deformed at mid-crustal level.

In particular, two superposed units, both belonging to the metamorphic succession of the Tuscan Domain, are identifiable in the Apuan tectonic window. The lower unit is the Autochthonous Auct. with extensive outcrops across the main ridge, both on the coastal and inland mountainsides, whereas the Massa Unit, on top of it, is only found in the westernmost part of the tectonic window. The Massa Unit is composed of a Paleozoic basement on which lays in unconformity a thick Triassic sedimentary sequence characterized by Ladinian basic metavolcanic rocks. The Mesozoic cover begins with quartz metaconglomerates associated with metasandstones, metasiltstones and black phyllites which can be interpreted as continental and/or coastal siliciclastic deposits. Upward, they are followed by mainly calcareous rocks (marbles, metabreccias, calcareous schists and carbonate phyllites), deriving from carbonate shelf and neritic-pelagic deposits, intercalated with alkaline metabasites. The sequence ended with Carnian phyllites of continental-coastal origin and levels of anagenites: metaconglomerates with mainly quartz and quartzite clasts.

The Autochthonous *Auct*. too is formed by a Paleozoic basement, deriving from previous orogenic structures, with an initial age presumably dating back to the Cambrian. A metasedimentary sequence, showing ages from the Late Triassic up to the Oligocene, unconformably lies upon the crystalline basement, like in the Massa Unit.

The Meso-Cenozoic cover begins with a classic "Verrucano" characterized by polygenic conglomerates, calcareous metasandstones and siliciclastic dolomites intercalated with metabreccias presumably deriving from a transitional (from continental to littoral) depositional environment. They are followed by the "Grezzoni" dolomites of the Late Triassic carbonate shelf, which are followed by micritic fossiliferous metalimestones of the "Colonnata" limestones and marlstones. They are then followed by the *Megalodont*-bearing Marbles intercalated with polygenic metabreccias and chloritoid schists which testify episodes of emersion of the carbonate platform with the formation of lateritic-bauxitic layers and the deposition of debris flows at the bottom of the tectonically active scarps.

Marbles with different dolomitization levels, crystalline dolomites, marbles and monogenic metabreccias are typical of the overlying formations of Dolomitic marbles and Marbles s.s., witnessing to the development of a new carbonate platform formed after that of the "Grezzoni" dolomites in the Late Triassic. Upward, pinkish marbles, metalimestones with cherts, calcschists and quartzites are a sign of the drowning of the marble carbonate platform and the beginning of an hemipelagic sedimentation.

Possible time displacement among the different subsiding blocks brought about the formation of very different depositional environments with "reduced" and/or "condensed" sequences, the first evidence of which is polygenic metabreccias characterized by a phyllitic matrix. The sequence ends with metalimestones with cherty bands and nodules, calcschists, Nummulite limestones, sericitic phyllites and quartz-feldspatic metasandstones belonging respectively to pelagic and foredeep deposits reaching the Late Oligocene.

In conclusion, there is a strong correlation between the rocks of the Paleozoic basement of the Massa Unit and those of the Autochthonous *Auct*. which show analogous deformation and a similar greenschist facies metamorphism owing to the Hercynian orogeny. The same situation repeats when comparing the two metasedimentary covers because, despite the first being less thick than the second, their rocks are characterized by the same Alpine metamorphism, whose greenschist facies paragenesis shows differences in temperature and pressure conditions, higher in the Massa Unit.

In the proposed Geopark territory, rocks of the non-Metamorphic Succession of Tuscan Domain outcrop beyond the borders of the tectonic window. They are related to a single unit, commonly known as Tuscan Nappe geometrically overlying the Metamorphic Complex of the Apuan Alps (made up by the Massa Unit and the Autochthonous *Auct*.). The Tuscan Nappe rocks belong to the Meso-Cenozoic cover, the Paleozoic basement not being present at all. There are closed and frequent correlations as regards lithology, depositional environment and age between the geological formations of Autochthonous *Auct*. and Tuscan Nappe. The main difference lays in the degree of metamorphism which is absent or very weak in the Tuscan Nappe. It is in turn overthrusted by the Ligurian Units *s.l.*, which crop out mainly in the northern part of the Geopark area, being represented by Helminthoid Flysch (Late Cretaceous) with basal complex characterized by ophiolitic detritism and olistolites and by shaly-calcereous deposits and calcareous turdidites ranging in age from Late Cretaceous to Eocene.

The proposed territory is also characterized by post-orogenic deposits which cover the whole time frame from the Late Miocene to today. This is particularly the case of polygenic Breccias of Metato (which derived from formations of the Tuscan Domaine cover), glacial and fluvio-glacial deposits (Middle-Late Pleistocene) as well as alluvial, slope and landslide deposits (Holocene).

The complex geological history of the Apuan Alps is responsible for the great geodiversity of rocks and minerals of the territory. The composition of lithotypes, the Hercynian and Alpine deformations, metamorphism and hydrothermalism brought about a remarkable variety of minerals. Witness the large number of minerals found in the area, achieving the total of about 200. For the first time 18 mineral species have been discovered and described in the Apuan Alps [allanite-(La), apuanite, bottinoite, carraraite, dessauite, garavellite, grumiplucite, marrucciite, meneghinite, moëloite, pellouxite, pillaite, rouxelite, scainiite, stibivanite-2O, versiliaite, volaschioite, zaccagnaite, zincalstibite] most of which are exclusive to this area.

B.2.2.2 – ***Apuan Alps Marble***

The metasedimentary sequences of the Apuan Alps Metamorphic Complex contain, at different "stratigraphic" levels, marble, marble metabreccias and calcschists, from which the vast array of ornamental stones of this region are extracted.

Brief history - The quarrying of the Apuan metalimestones is the longest lasting such activity in the world and probably it is also the most fruitful in terms of quantity and quality of ornamental stones exctracted in the region. As far as we know, the beginning of the exploitation of the Apuan quarries and the first marble artifacts ever made date back to Etrurian populations, in the second half of the 6th cent. B.C. Until the beginning of the 2nd cent. B.C., the basins of Carrara and Ceragiola-Solaio in Versilia allegedly provided the artisan workshops of Pisa Emporium with a fairly good quantity of material, that enabled a significant and continuous production of statues, stones, bases and other more complex funerary monuments.

With the foundation of the colony of Luni (177 B.C.) the Romans took an immediate interest in the quarrying areas of the hinterland near the Apuan Alps, slightly north east to what today is Carrara. They were particularly interested in the production of these stones. Yet, the extraordinary boom of the Roman quarrying activity, making widespread and intensive use of Apuan metalimestones, only started in the early Roman Empire. *Lunense* Marble, according to the then name of *Carrara* marble, was

used in a huge number of sculptures and employed as building material for a remarkable number of civil and religious monuments in Rome and in almost every city of the western provinces of the Empire. During the Roman Times all marble commodity varieties from the Carrara area [bianco ordinario, bianco venato, nuvolato, bardiglio, statuario, calacatta, arabescato, paonazzo, zebrino, etc.)] were extracted. The 3rd cent. saw the most widespread and intense use of *Lunense* Marble but after that period its production decreased considerably, although an account by Rutilio Namaziano shows evidence of its presence in 415 (or 417 A.D.). Quarrying activities in Luni stopped after the late Roman times, but left remarkable signs in the Carrara territory in the form of blocks, artifacts and parts of ancient quarries that survived to subsequent expansions of the same quarrying areas.

During the Early Middle Ages quarrying activities probably ended or were limited to local use of little importance and difficult to keep record of. Yet, the recovery of activities and the interest in Carrara marble were already evident at the end of the 12th cent., under Luni Bishops. Witness some supply contracts and Frederick Barbarossa's 1185 imperial diploma. Quarrying activities in the Versilia marble basins, between Pietrasanta and Seravezza, were resumed more or less in the same period as those in Carrara. The quarrying reached its peak during the second half of the 14th century in a period of intense urban renewal in Pisa and Lucca. Thanks to the Apuan marble's aptness to be modelled the interest in quarrying activities and in the production of pieces of art increased during the Late Middle Ages. Builders of churches and houses in the cities of Genoa, Siena, Florence, Rome, Orvieto, etc., constantly turned to Carrara for the supply of marble, also used in coverings and architectural works. However, it was during the Renaissance that, more than in any other historical period, a huge number of sculptors (Michelangelo, Sansovino, Baccio Bandinelli, Nicolò Tribolo, Ammannati, Giambologna, etc.) turned to the Apuan Alps to buy and often extract white marble, which was demanded by the major Italian Signories.

During the 17th and the 18th cent. the Baroque style brought about radical changes in the European catholic churches on the wake of the Counter Reformation. Polychrome marbles triumphed, marble inlays were resumed and the use of a specific Apuan metabreccia prevailed in religious architecture. The marble market thus saw the introduction of a new product, "*mischio di Seravezza*", mostly known as "*breccia violetta*" or "*medicea*" (violet or Medici's breccias), this last name witnessing the interest of the Tuscan Grand Dukes in this rare Apuan stone, to the point that they promoted and spread its use wherever possible. In the nineteenth century the industrial Revolution boosted the whole marble production sector, which vigorously recovered in Carrara and Versilia mainly thanks to foreign capitals and entrepreneurs (Walton, Robson, Henraux, Dalgas, Ferrugento, etc.) whereas it remained on a small scale in Massa. The technology revolution began around 1880 with the introduction of the helicoidal wire by the Belgian Chevalier. The wire, propelled by an engine, gradually replaced the ancient techniques of hand percussion drilling, which had not changed for centuries. From that moment on the Apuan Alps marble industry benefited from innovation. The production increased and the Apuan quarrying in Lunigiana and Garfagnana expanded as never before.

Apuan stones, often grouped together under the trade name of "Carrara marbles", have always been famous and appreciated for their aesthetic value. Over time research on quarrying activities has focused on almost every outcropping metalimestones, metabreccias and calcareous schists, introducing in the market a huge number of commodity varieties with the most varied names and uses. Despite cyclical fluctuations, the Apuan marble production increased throughout the 20th century, with the exception of the two World Wars and the years following the 1929 crisis. Around 1980, quarrying activities were further boosted by the introduction of the diamond wire, which made the first cutting phase (when a block is cut from the mountain) faster, more precise and easier if compared with the helicoidal wire. This new technology came a few years after the traditional transportation method on sledges ("*lizze*") through "*vie di lizza*" was abandoned and replaced by road transport along new uphill roads leading to the quarries.

Quarrying tradition, technical expertise, technological innovation and fame of marble were not strong enough to effectively tackle the consequences of globalization, which prefers stones and marbles of emerging economies. The past 20 years have been marked by a substantial stagnation, if not a slight decrease in the production, whereas the demand for ornamental stones has increased in the global market.

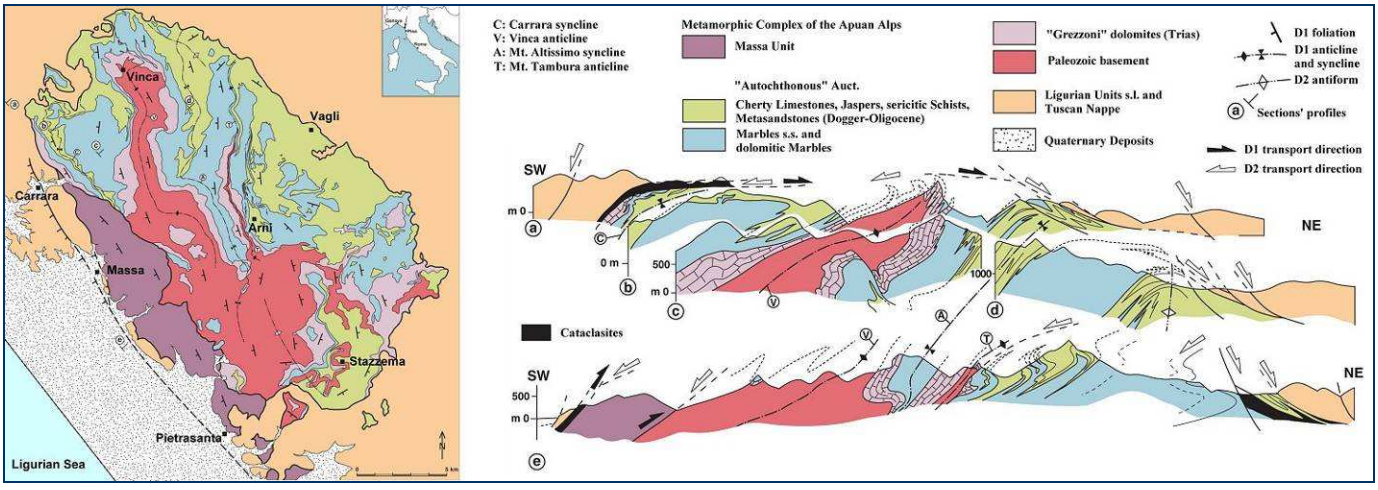


figure 4 – Tectonic map and geological sections of the Apuan Alps (Carmignani* et al.*, 2006)

Geological and petrographic features **-** In about 27 centuries of quarrying activity in the Apuan Alps, the opportunity of obtaining ornamental stones has been seized in all the formations and carbonate (or mainly carbonate) levels which could offer a slight chance of finding materials suitable for polishing. The list of different types of exctracted marble is impressive. There are 14 'commodity varieties' [ordinario, statuario, bianco, grigio, venato, zebrino, arabescato, calacatta, breccia rossa, fantastico, cipollino, breccia di Seravezza, rosso rubino and nero di Colonnata) yet, as many as 279 different 'commercial varieties' have been identified. They sometimes have the same name indicating different lithotypes in different areas of the Apuan Alps or different names indicating the same lithotype in different zones.

In the Autochthonous *Auct*. various formations both from the Triassic (Vinca's formation, Seravezza's Breccias and *Megalodont*-bearing Marbles) and the Early Jurassic are characterized by metalimestones and mono or polygenic metabreccias, with different lithologic and aesthetic ornamental features (Dolomite marble, Marble *s.s*. and Zebrino marble). Moreover, black marble levels with Brachiopods, Crinoids and Mollusca are locally present on the top of "Grezzoni" Dolomites of Norian age [nero di Colonnata (Colonnata black)], as are few gray metalimestone beds, devoid of quartzite intercalations within the formation of cherty Limestones from the Middle-Late Jurassic [grigio di Pescina (Pescina grey)]. The upper part of the Mesozoic-Tertiary cover of the Autochthonous *Auct*. is characterized by marble lythotypes with different levels of purity, polygenic metabreccias and calcschists. (Arnetola's formation, Calcschists and "Cipollini"). Finally, it is noteworthy that the interest of the quarrying industry in the quartz-feldspathic-micaceous metasandstones from the Pseudomacigno formation (Late Oligocene) – ending the Autochthonous *Auct.* Succession – for the production of the commodity variety known as pietra del Cardoso (Cardoso stone).

In the Massa Unit marble lithologies are only typical of the Late Anisian-Ladinian formation of marble with Crinoids with typical metalimestones and muscovite metabreccias (verdello, pavonazzetto viola-porpora), since the sequence ended in the Trias.

Quarrying activities in the Apuan Alps have not been limited to the economically profitable rocks of the 'Metamorphic Complex' – comprising of the Autochthonous *Auct.* and the Massa Unit – but have also been carried out in the sequence known as the Tuscan Nappe, whose formations outcrop beyond the outer margin of the Apuan tectonic window, usually at the foothills of the main range border. Where *Rhaetavicula contorta* Limestones and marlstones (Rhaetian) and the "massiccio" Limestone (Early Lias) touch one another there are sometimes discontinuous lenses of black or dark grey autoclastic calcareous metabreccias, recemented by yellow or white marly matrix (Castelpoggio portoro/portargento in the area of Lucese). In a higher stratigraphic position, from the red nodular limestones (ammonitiferous Limestone, Early Lias) derive some typical ornamental stones used in the past (rosa di Camaiore, rosso di Pescaglia). The formations of Jaspers (Malm) and Tuscany "Scaglia" (Early Cretaceous-Paleogene) provide calcilutitic and siliceous-marly limestones known as rosso di Castelpoggio and violetto di Castelpoggio. Finally, extensive outcrops of quartz-feldspathic-micaceous sandstones of the Macigno formation (Late Oligocene-Early Miocene) have been excavated here and there to obtain "pietra serena" and local variations, widely used in the architectural elements of historic buildings in the Serchio Valley and the city of Lucca.

B.2.3 – **Geomorphological description**

B.2.3.1 – ***Relief landforms***

The Apuan Alps are characterized by a physical landscape with Alpine features or perhaps features more similar to those of the Lombard Prealps, if the famous comparison by Antonio Stoppani in *"Il bel paese"* (The beautiful Country) (1876) is to be recalled. The geologist compared the fields of the Po Plain to the Ligurian Sea because of their being flat at the foot of the mountains. The range's sharp and therefore "Alpine" morphology is more evident on the coastal side. The inland side has similar characteristics but its profile is slightly more gentle. As a matter of fact, there is "asymmetry" on the main two sides of the range because of different levels of steepness and the overall direction of the mountain range owing to structural more than morphogenetic reasons.

The particular distribution of ductile and brittle structural elements, on which played mainly the fluvial morphogenetic action, has contributed to the "asymmetry" between the two main sides of the Apuan Alps. On the coastal side, the Apuan Alps create a vertical barrier with narrow and deep valleys, whereas on the inland side slopes descend, more regularly and more similarly to the Northern Apennines' morphology. Yet, the range never lowers in a uniformed fashion as the slope is regularly interrupted by terrains with low inclination. Moreover, the inclination angle is different but constant on the two main sides. Orographic anomalies are concentrated within certain altitudes (500-650; 750-850; 900-1,050; 1,200-1,250; 1,500-1,600 m) and bear the marks of past morphological features. Supposedly, they are orographic terraces which were ancient basal levels during phases of tectonic quiet, then re-carved by superficial running water during uplift phases. The heritage of a relatively mature morphology is still visible in some embedded meanders which are scattered along the narrow Apuan thalwegs. In fact, these meanders have superposed on higher and wider valleys, cutting the bedrock, during a phase of relif-rejuvenating.

The layout of the hydrographic network in the Apuan Alps has been affected by differences in the structural setting and the morphological "asymmetry" of the main mountain sides. On the coastal side, where slopes are steeper, valleys are radially arranged and join together at lower altitudes. On the inland side, which is less steep, each watercourse keeps its initial direction, perpendicular to the main ridge. Parallel valleys prevail on the eastern side, whereas the western side is characterized by more or less complex systems of converging valleys with dendritic or subdendritic hydrographic networks.

Apuan watercourses belong to three different categories, depending on whether they flow into the Ligurian Sea or they are tributaries of the Rivers Serchio or Magra. The western side is characterized by rivers with steep upper courses reaching the sea after crossing the short coastal plain largely originated by their deposits. The whole coastal surface, amounting to 315 km^2, is divided into hydrographic basins of different dimensions, of which that of River Versilia accounts for 1/3 and is twice as large as the surface covered by the Carriona and Frigido watercourses.

Most of the inland side of the range, amounting to 545 km^2, belongs to the hydrographic basin of the River Serchio as parallel valleys are crossed by its right tributaries. All tributaries have a length comprised between 9 and 14 km. The longest is Serchio di Minucciano, followed in order by Tùrrite Secca, Tùrrite di Gallicano, Èdron and Tùrrite Cava. In the northern area of the inland side, totalling almost 220 km^2, watercourses, starting from streams Lucido and Bàrdine descending from the Apuan mountains, join River Magra through the stream Aulella. The presence of highly permeable carbonate rocks across the main ridge contributes to the existence of intermittent watercourses with semi-permanent or temporary regimes, especially in their upper courses. A well-know case is the karst circulation of River Tùrrite Secca, which is characterized by a 4 km-long underflow when flowing along the Mt. Sumbra southern side.

B.2.3.2 – ***Karst landforms***

Despite heavy rains, the central part of the main range is arid and bare on the surface, as rainwater is immediately absorbed by the carbonate bedrock and released in large, complex hypogean karst Systems. Water flows down into the mountains and, upon reaching the impermeable Paleozoic basement, it emerges from karst springs located between 200 and 500 m of altitude. The phenomenon is evident on the coastal side and it is often the reason for the extension of the hydrogeological basin, larger than their hydrographic basin. Water is captured from the eastern to the western side of the ridge through underground paths in karst aquifers. This creates larger catchment areas for Rivers Frigido, Versilia and Carriona compared to those created on the surface by the watersheds.

Despite large areas of carbonate rocks outcrop, the epigean karst forms in the Apuan Alps are not well developed in medium and large scale. In these formations harsh and steep orographic features contributed to other morphogenetic processes, which is why epigean phenomena are mainly represented by small karst landforms. They are particularly common on pure calcareous rocks (Marble and "massiccio" Limestone) characterized by intense fracturation, high infiltration and scarce vegetation cover. The most common microforms, the karren, are solution pits, grooves and runnels. Karren fields are widespread at high altitudes, where the snow is more persistent and rocks are more fractured forming a karst landscape with clints and grikes. Dolines and shallow wells are less frequent and amount to 180 units in the whole mountain range. They are morphoscultpures of various dimensions, from metres to decametres long, often quite deep and therefore with a bowl or funnel-like shape or even snow dolines. Dolines are usually either isolated or gathered in small groups (Campocecina, Spallone, Pian della Fioba, Passo Sella, Vetricia, etc.) in areas with little inclination and facing north-eastern quadrants. The north-eastern side of Mt.Tambura in Carcaia and, to a lesser extent, the northern side of Mt. Pisanino are characterized by an unusual karst landscape with numerous concave dissolution forms. Epigean forms have seen a reduced development, whereas hypogean karst phenomena in the Apuan Alps acquire paramount importance and extreme value. The Apuan Alps boast 19 out of the 50 deepest caves and 8 out of the 50 longest karst cavities in Italy. The proposed Geopark is also home to Italian all-time records: Abisso Paolo Roversi (Paolo Roversi Abyss), the cave with the largest difference in heights (1350 m) and Antro del Corchia, the longest karst Complex (~ 53 km).

So far speleological research has found more than a thousand karst caves formed by gravitative hypogean circulation, both in vadose and phreatic conditions, from high-altitude infiltration areas to low-altitude emergence areas. The Apuan caves are mainly characterized by wells, sometimes in a sequence, which have developed in the vertical transfer zone of infiltration water. They were originated from small superficial absorption fractures which then expanded and deepened by corrosion until they reached huge differences in heights, sometimes exceeding a kilometre. Caves originated by horizontal water transfer are less frequent but not unusual. They are characterized by sub-horizontal tunnels and labyrinths on gentle slopes originated near the saturated zone during phases of tectonic quiet of the Apuan Alps. There are tipically phreatic morphologies (pressure conduits) or morphologies conducting rainwater (canyons).

Karst Complexes with a spatial mix of wells and tunnels as a result of polyphasic evolution are rarer. They derive from the superposition of different generations of caves with horizontal features associated to phases of tectonic inactivity and vertical features which formed after the relief-rejuvenations. The largest cavities of the Apuan Alps belong to this special category and Antro del Corchia is its main example. As a matter of fact, the Apuan Alps still preserve traces of "ancient" karst phenomena, probably dating back to the first phases of denudation/erosion of carbonate rocks of the "Metamorphic Complex". Witness the numerous "relict" tunnels along the higher ridges of the mountain chain, which are characterized by cavities with large section and reduced linear development. Therefore, they are truncated segments of once larger karst Systems formed by the progressive erosion of mountain sides and the general deepening of the valleys.

B.2.3.3 – ***Glacial landforms***

In the Apuan Alps, the Quaternary Glaciation left clear and remarkable traces of diffuse erosion and deposit landforms despite the moderate height of mountain peaks and their vicinity to the sea. The mountain range provides an obstacle to Atlantic humid currents and nowadays causes heavy orographic rain. It is likely that during cold phases in the Pleistocene it was responsible for heavy solid precipitation leading to the formation of perpetual snowfields. The glacial phenomenon mainly developed on the inland side of the mountain range, yet recognizable and remarkable traces are also found on the coastal side.

Since glaciers were exposed to the north-east and located on a more gentle slope, they could build up more and survive longer, compared to the opposite side which was hampered by the relief-energy and its exposure to southern quadrants.

Attempts to piece together the glacial extension of the Apuan Alps led to the identification of twelve large valley glaciers on the inland side of the range. The main glacier (Orto di Donna-Val Serenaia-La Mandria) is likely to have extended over more than 12 km^2 with a length of 6 km. The side exposed to the sea saw the formation of few perpetual snowfields in the shape of cirque, slope, niche, mountain, valley glaciers. The terminal part of the tongue of the Pizzo d'Uccello glacier reached Solco d'Equi Terme at a lower altitude of 475 m a.s.l. Whereas, the ice tongue of Arnetola basin, along Edron valley, is thought to have descended to 550 m a.s.l. The formation of terminal moraines at a low altitude shows the exceptional nature of the glaciation in the Apuan Alps. As a matter of fact, it is different from what happened in the whole Apennines and the western Alps at similar altitudes. Apuan glaciers descended to very low altitudes and this was accompanied by the exceptional low level of the snow line. More recent calculation methods estimate that the ideal line of balance between the accumulation and fusion of snow was to be found at around 1250-1300 m a.s.l., at least on the northern side of the range.

The formation of glaciers in the Apuan Alps is unanimously linked to the Würm on the basis of deductive reasoning, even though a Pre-Würm (Riss?) glaciation has been also suggested by the occurrence of cemented glacial deposits covered by more recent melted moraine deposits (Passo del Vestito, Val Terreno, Solco d'Equi). The glacial growth kinematics is unknown, whereas the retreat was quick and not uniform, considering the small number of documented late glacial phases. The Apuan glaciation has preserved the main erosion forms. The glacial cirque is the most widespread morphosculpture in the whole range but it is rarely found in its typical form with semicircular vertical cliffs, a flat bottom and a reverse slope threshold (Grotta Giuncona, Cervaiole and Catino del Sagro are among the best preserved). A number of crests (Mt. Sumbra, Corchia and the south-east side of Mt. Altissimo) are characterized by close or coalescent small cirques perfectly carved on southward-looking carbonate walls. Saddles, which lower Apuan crests, especially along the main watershed, enabled glaciers to cross mountain sides. Transfluence saddles are more common (Foce Giovo, Focolaccia, Passo Sella, Foce di Mosceta), whereas diffluence saddles are rarer (Foce Pianza, Passo del Vestito).

The inland side (Pianizza, Fatonero, Orto di Donna) houses typical U-shaped glacial valleys with a parabolic cross-section and overdeepened glacial basins which have often been characterized by peat bogs and wetlands (Mosceta, Fociomboli, Campocatino, Pianellaccio, etc.). Valley steps, perhaps linked to a stop of the glacier retreat are more often found in the furthest northern area of the Apuan Alps (Orto di Donna, Acqua Bianca, Pisanino), whereas "Marmitte dei Giganti" (Giant's pot-holes) along the ditches Fatonero and Angullaja (southern side of Mt. Fiocca and Mt. Sumbra) are likely to have a fluvioglacial origin. Finally, roches moutonnées are not widespread. The only few examples can be found in Val Serenaia and Arnetola. Depositional landforms predominantly comprise glacial ridges mainly showing terminal moraines and to a lesser extent lateral and stadial moraines. Terminal arches are well recognizable in various inland Apuan valleys (i.e. Canale del Libardo in Gramolazzo), whereas Campocatino depression boasts the best preserved morainic amphitheatre characterized by concentric circles of ridges. Huge glacial erratics are found in the valleys of Rivers Edron and Serchio di Gramolazzo. In particular, marble erratics have been subject to quarrying activity in Vagli di Sopra and Campocatino.

As it is well known, nowadays there are no active glaciers in the Apuan Alps. Perpetual snowfields have been preserved at the bottom of high-altitude karst wells ("snow holes"), especially in the group of Pania della Croce, even at a few metres depth. On the surface there are places maintaining their snow cover until the hot season and even late summer. A case in point is the place at the bottom of the northern wall of Mt Pizzo d'Uccello which is indicated with the name "Corners of old snow" on the maps of the Italian Military Geographical Institute (IGMI).

figures: 5a (left) Glacial landforms in the northern slope of Mt. Cavallo (1882 m)
5b (right) Entrance to Abisso Revel's cave (Panie Group)

B.3 – LISTING AND DESCRIPTION OF THE GEOLOGICAL SITES PRESENT ON THE TERRITORY OF THE GEOPARK

B.3.1 **Census and filing**

The Park Authority carried out the first systematic census of the Apuan Alps geosites in order to better assess the environmental and landscape heritage of the area. The census was carried out during the drafting of the Plan for the Park framework (1996-2001), and was then resumed for a subsequent planning assessment stage aiming at defining specific rules on the safeguarding and preservation of geosites. First of all, the census provided the opportunity to underline the interest in the geological heritage of the Apuan Alps shown by the scientific community. Secondly, it has spread information on the high geodiversity, enabling public opinion to recognize its value and participate in conservation and enhancement strategies.

The identification of the most relevant sites in the Apuan geological heritage achieved the goal of rendering them fundamental elements of landscape and environment and protecting them from anthropic modifications. As a matter of fact, the Plan for the Park considers the registered geosites "structural invariants", that is natural elements which ought to be protected from negative changes or overexploitation, which may pose a threat. During the first census 253 geological and geomorphological sites were identified. These sites can legitimately be considered geosites according to the ProGEO criteria and the ISPRA form (the Higher Institute for Environmental Protection and Research).

The main criteria applied in the choice of these geosites were as follows: uniqueness within the regional area/national territory; representativeness or exemplarity of a specific process; scientific importance and contextual interest; conservation status and risk of deterioration (natural/anthropogenic); educational and tourist importance; landscape, historical, cultural and ecological values.

In order to focus on the geological and geomorphological peculiarities, twenty-nine relevant categories of geosites representing the main processes (responsible for the genesis and the evolution of the territory) have been identified: tectonic window, tectonic unconformity, tectonic interference, isolated peak, ridge, natural arch, cuèsta, great wall, gorge, embedded meander, old river-bed, pothole, U-shaped valley, glacial cirque, overdeepened basin, glacial saddle, roche moutonnée, moraine ridge, cemented moraine, erratic block, karren field, doline field, doline, karst cave, ice cave, spring, thermal spring, mineral site, paleontological site. Attention was paid to those elements testifying, in a clear and illustrative way, to a past event of the geological history, helping understand the territorial evolution of each sector of the Park.

The full list of 253 geosites is inserted in the following pages and a detailed analysis of 55 main geosites of the area proposed as Geopark is also present. The sites of higher geological value, representing one or more processes for every main category are identified. Each selected geosite has an inventory card with a description of the level of interest and a geological and environmental explanation. Their location is referred to sixteen Park sectors, corresponding to the most important Mount here located, as shown in figure below.

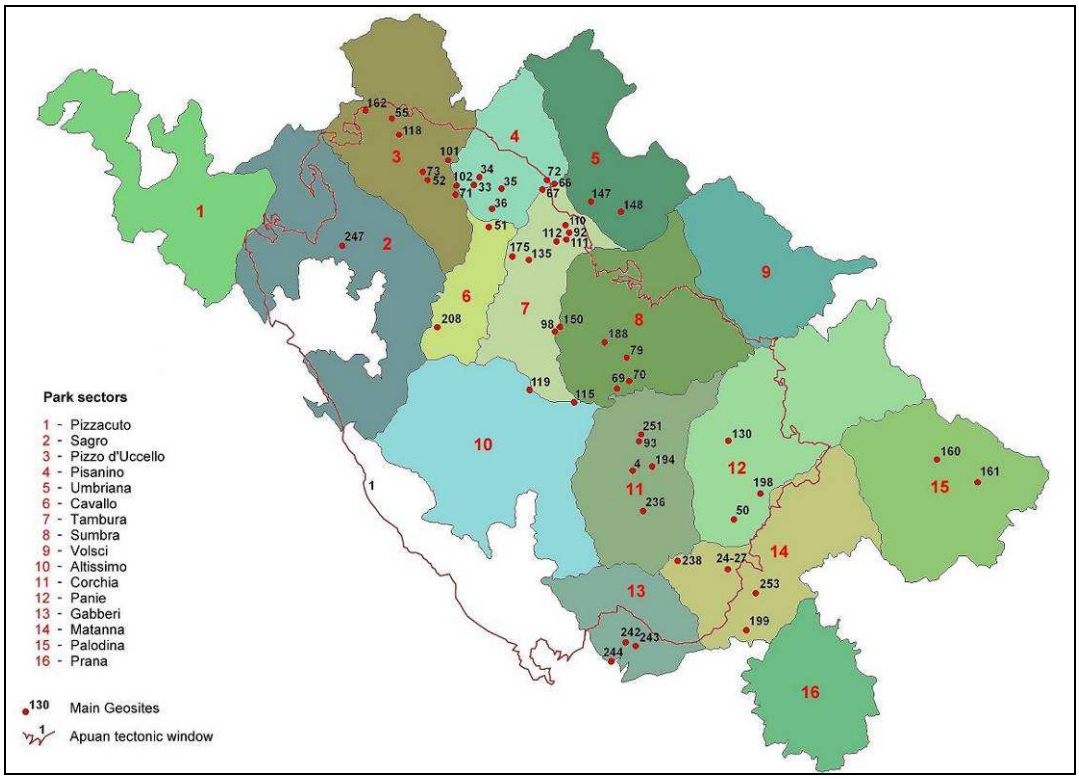


figure 6 –Park sectors and main geosites location

List of the Geosites identified and registered in the aspiring Geopark's territory, ordered by typology and indicating their location (Park sector)

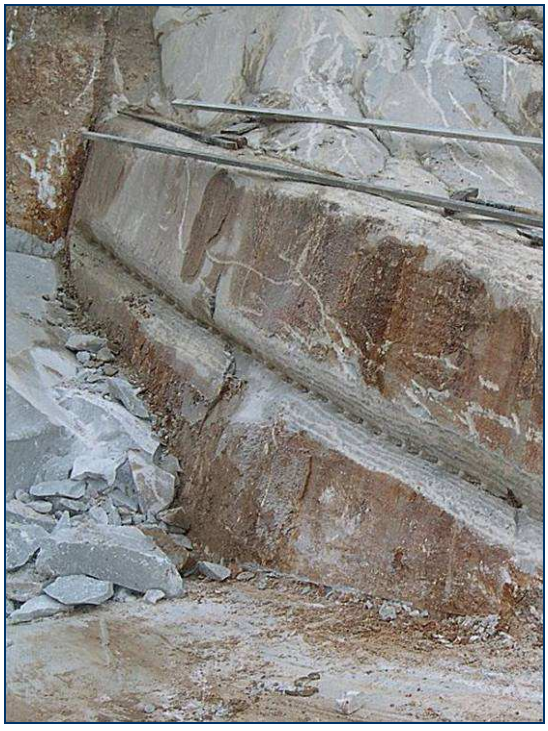
typology	n.	geosite	park sector
tectonic window	**1**	Apuan Alps	1-16
	2	Tenerano	2
	3	Sant'Anna	13
tectonic unconformity	**4**	Corchia (*west and south*)	11
tectonic interference	**5**	Pizzo d'Uccello	3
isolated peak	**6**	Guglie della Vaccareccia	3
	7	Torre Val d'Alberghi	3
	8	Torrione Figari	3
	9	Punta Quèsta	3
	10	Torre di Monzone	2
	11	Puntone della Piastra	2
	12	Pizzo del Cotonificio (Pizzacuto)	2
	13	Punta Carina	6
	14	Punta Graziosa, Sicilia, Ferro	6
	15	Guglia di Piastramarina	6
	16	Torre dei Campaniletti	7
	17	Torrioni di Passo Croce	11
	18	Torre di Corchia	11
	19	Guglia di Piatreto	11
	20	Torre occidentale	11
	21	Rocchette	12
	22	Torre Oliva	12
	23	Torrioni del Pizzo delle Saette	12
	24	Procinto	14
	25	Torrione Bacci (Bimbo)	14
	26	Piccolo Procinto	14
	27	Bimba	14
	28	Pietralunga del Gabberi	13
ridge	**29**	Nattapiana	3
	30	Capradossa	3
	31	Pizzo d'Uccello (*south*)	3
	32	Garnerone-Grondilice	3
	33	Bagola Bianca	4
	34	Forbice	4
	35	Mirandola	4
	36	Pisanino-Zucchi	4
	37	Contrario-Cavallo	6
	38	Cresta Botto	6
	39	Coda del Cavallo	6
	40	Focoletta-Macina	7
	41	Vestito-Pelato	10
	42	Altissimo	10
	43	Cresta degli Uncini	10
	44	Rovaio-Spigolo del Gesù	12
	45	Pania della Croce-Pizzo delle Saette	12
	46	Omo morto	12
	47	Pania Secca (*north*)	12
	48	Gran Pilastro (*south-east*)	12
	49	Gialunga	12
natural arch	**50**	Forato	12
cuèsta	**51**	Pizzo Altare	4
great wall	**52**	Pizzo d'Uccello (*north*)	3
	53	Altissimo (*south*)	10
	54	Nona (*west*)	14
gorge	**55**	Solco d'Equi	3
	56	Serchio di Gramolazzo	3/4
	57	Canale dell'Inferno	9
	58	Valle Alberghi	3/6
	59	Fosso Tambura	7
	60	Torrente Serra	10
	61	Canale Levigliese	12
	62	Fosso Apraia	8/9
	63	Rio Lombricese	14/16
enbedded meander	**64**	Le Tagliate	8/11
	65	Turrite-Anguillaja	8/11
old river bed	**66**	Piano di Gorfigliano (*north*)	4
	67	Piano di Gorfigliano (*south*)	4
pot-hole	**68**	Valle Alberghi	3/6
	69	Fosso del Fato Nero	8
	70	Fosso dell'Anguillaja	8
U-shaped valley	**71**	Orto di Donna-Serenaia	3/4
	72	Piano di Gorfigliano	4/5
glacial cirque	**73**	Pizzo d'Uccello (*north*)	3
	74	Grondilice (*north-east*)	3
	75	Cavallo (*north-west*)	6
	76	Spallone-Foce di Pianza	2
	77	Catino del Sagro	2
	78	Roccandagia	7
	79	Sumbra (*south*)	8
	80	Grotta Giuncona	10

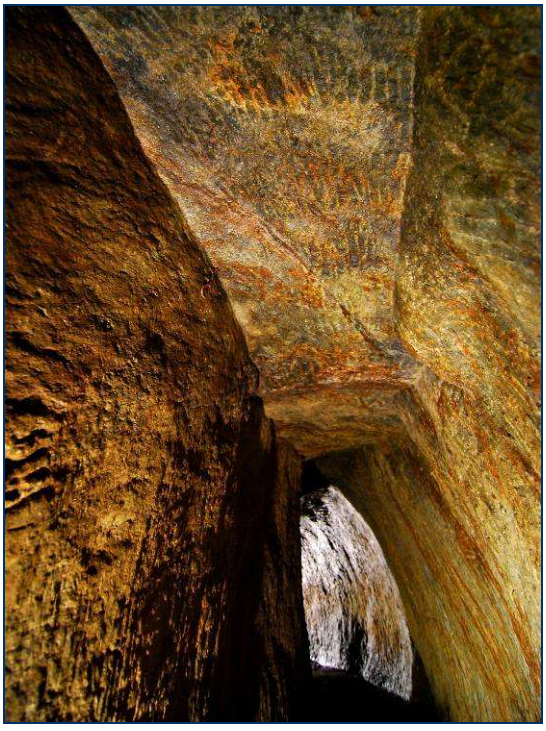
typology	n.	geosite	park sector
glacial cirque	**81**	Altissimo (*south*)	10
	82	Cervaiole	10
	83	Retrocorchia	11
	84	Corchia (*south*)	11
	85	Pizzo delle Saette (*west*)	12
	86	Pizzo delle Saette (*north*)	12
	87	Pania Secca (*north*)	12
	88	Pania Secca (*south-east*)	12
	89	Canale dell'Inferno	12
	90	Prati di Valli	12
overdeeppened basin	**91**	Pianellaccio	4
	92	Campocatino	7
	93	Fociomboli	11
	94	Mosceta	11
glacial saddle	**95**	Passo Giovo	3
	96	Foce di Pianza	2
	97	Passo della Focolaccia	6/7
	98	Passo Sella	7/8
	99	Passo del Vestito	7/10
	100	Foce di Mosceta	11/12
roche moutonnée	**101**	La Tecchiarella	3
	102	Val Serenaia	3/4
moraine ridge	**103**	Foce Rifogliola	4
	104	Canale Libardo	4
	105	Fosso Sirchia, Pianellaccio (*north*)	4
	106	Fosso Sirchia, Pianellaccio (*south*)	4
	107	Gorfigliano	4
	108	Pesciola	5
	109	Case Walton	2
	110	Campocatino (*north*)	7
	111	Campocatino (*south*)	7
	112	Campocatino (*west*)	7
	113	Vagli Sopra	7
	114	Arni	7/8
	115	Campagrina (*Stoppani's moraine*)	10/8
	116	Puntato	11
	117	Pianiza, Alpe di S. Antonio	12
cemented moraine	**118**	Valtredi, Solco d'Equi	3
	119	Gobbie	10
	120	Val Terreno	11
erratic block	**121**	Rondinella	7
	122	Pastificio Vagli	7
	123	Valle dell'Edron	7
karren field	**124**	Catino del Sagro	2
	125	Orto di Donna	3
	126	Cavallo (*north*)	6
	127	Valle di Arnetola	8
	128	Passo Sella	7/8
	129	Sumbra (*south*)	8
	130	Vetricia	12
	131	Valle dell'Inferno	12
	132	Prana	16
doline field	**133**	Mirandola	4
	134	Foce di Cardeto	4
	135	Carcaraia	7
	136	Bergiola Foscalina	2
	137	Penna	15
doline	**138**	Castri	4
	139	Calamaio	4
	140	Bandita	2
	141	Caporinella	2
	142	Alpe di Burla	2
	143	Ballerino	2
	144	Catino del Sagro	2
	145	Spallone	2
	146	Campaccio di Carcaraia	7
doline	**147**	Tontorone	5
	148	Corona	5
	149	Torre	8
	150	Passo Sella	8
	151	Fiocca (*north-east*)	8
	152	Sumbra (*north-west*)	8
	153	Pian della Fioba	10
	154	Corchia (*north*)	11
	155	Montalto	11
	156	Bucaccia di Grottorotondo	12
	157	Tre Corna	14
	158	Catino d'Àleva	14
	159	Matanna	14
	160	Pian di Lago-Pian di Corte	15
	161	Penna	15

typology	n.	geosite	park sector
karst cave	**162**	Buca e Tecchia d'Equi	3
	163	Buca delle Ombre	3
	164	Buca Nuova	3
	165	Abisso Olivifer	3
	166	Speluca della Fanaccia	4
	167	Complesso Pannè-MC5-Pannino	4
	168	Tecchia di Tenerano	2
	169	Complesso della Rocca di Tenerano	2
	170	Abisso dello Smilodonte	2
	171	Tanone di Torano	2
	172	Complesso della Carcaraia	7
karst cave	**173**	Abisso Perestroika	7
	174	Abisso Mani Pulite	7
	175	Abisso Roversi	7
	176	Complesso della Tambura	7
	177	Cavità relitte del Sella	7
	178	Abisso Guaglio	7
	179	Abisso Pozzi	7
	180	Abisso Coltelli	7
	181	Abisso Mandini	7
	182	Buca di Renella	6
	183	Buca dell'Onice	6
	184	Abisso Eunice	8
	185	Complesso Simi-Pelegalli-Mamma Ghira	8
	186	Complesso Gnomo-Giardino	8
	187	Buca Go Fredo	8
	188	Abisso dei Draghi Volanti	8
	189	Buca Grande del Pelato	10
	190	Complesso Pelato-Astrea-Generatore	10
	191	Abisso Zuffa-Gomito-Ribaldone	10
	192	Abisso dei Fulmini	10
	193	Abisso Milazzo	10
	194	Complesso del Corchia	11
	195	Buca dell'Osso	11
	196	Abisso Revel	12
	197	Buca del Vento del Trimpello	12
	198	Tana che Urla (*Vallisneri's cave*)	12
	199	Grotta all'Onda e Buca del Tasso	14
ice cave	**200**	Foce di Cardeto	4
	201	Valle dell'Inferno	12
spring	**202**	Equi (Buca-Barrila)	3
	203	Lucido di Vinca	2-3
	204	Carbonera	2
	205	Torano	2
	206	Tana dei Tufi	2
	207	Cartaro	2

typology	n.	geosite	park sector
spring	**208**	Frigido	6
	209	Aiarone	8
	210	Renara	10
	211	La Polla di Altagnana	10
	212	La Polla dell'Altissimo	10
	213	La Pollaccia	11
	214	Chiesaccia	12
	215	Polla dei Gangheri	12
	216	Fontanacce	14
	217	Botronchio	14
	218	Grotta all'Onda	14
	219	Mulinette	13
	220	Mulini di S. Anna	13
thermal spring	**221**	Equi	3
	222	Acqua Salata di Monzone	2/3
	223	Acqua Nera di Monzone	2/3
mineralogical site	**224**	Àiola	3
	225	Fondone	3
	226	Gorfigliano	4
	227	Foce Tambura	7
	228	Bascugliani	8
	229	Nocchia	8
	230	Col di Beteto	8
	231	Fiocca-Faniello	8
	232	Scortico-Ravazzone	2
	233	Frigido	2
	234	Colle Panestra	12
	235	Trimpello	12
	236	Levigliani	11
	237	Tana-Pruno	11
	238	Buca della Vena	14
	239	Canale della Radice-Mulina	13
	240	Bottino-Gallena	13
	241	Argentiera-La Rocca	13
	242	Buca dell'Angina	13
	243	Arsiccio	13
	244	Valdicastello-Pollone	13
paleontological site	**245**	Grondilice (*north-east*)	3
	246	Poggio Troncone	2
	247	Foce di Pianza	2
	248	Ponte Storto	1/2
	249	Cima d'Uomo	2
	250	Fatonero	8
	251	Fociomboli	11
	252	Ceto	11
	253	Alto Matanna	14

figures: 7.a (left) "Tagliata" (marble cutting) in Carbonera's Roman quarry (I cent. A.D.) – 7.b (right) Argentiera-La Rocca medieval Mine





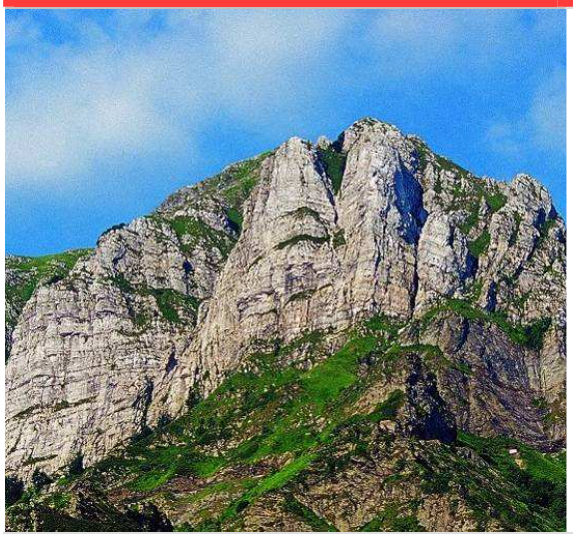
1 Apuan tectonic window

geological and environmental description

The inner part of the Apuan Alps is characterized by a large tectonic window with the shape of an irregular ellipsis. It is a typical geological structure formed by the erosion of the thrust system, which exposes the deepest structural units of the Northern Apennines made of a metamorphic complex originated during the Alpine orogeny. The Apuan tectonic window is one of the best examples of direct overlapping of high-crustal tectonic units over a metamorphic complex deeply deformed at mid-crustal level. Consequently, the Apuan Alps are a key to the interpretation of the Northern Apennines' tectonic evolution during the Cenozoic.
The Apuan tectonic window was already pinpointed by proGEO (1996) as an important element of the European geological heritage, as it is a peculiar geological structure at international level in the field of Earth Sciences. This territory is a large structural geosite of European importance, not least owing to its historical contribution to the development of geological knowledge.

4 Corchia Hercynian unconformity

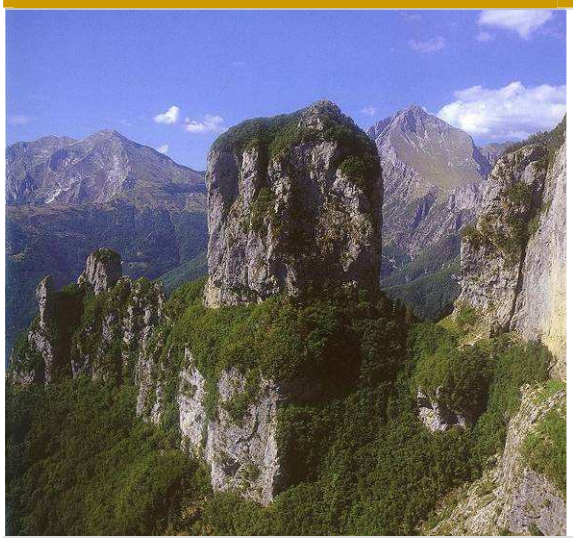
geological and environmental description



The Mesozoic-Tertiary cover of the Apuan Alps is angularly discontinuous with regards to the Paleozoic basement previously involved in the Hercynian deformation and metamorphism (greenschist facies).
The regional angular unconformity at the basis of the Alpine cover, (Mesozoic-Tertiary) stratigraphically lying over Paleozoic formations, is more evident on the western side of Mt. Corchia, near Passo Croce (1149 m). This area is characterized by a well-exposed typical Upper Cambrian-Silurian/Devonian section of the Tuscan basement. The Hercynian discontinuity is located between the graphitic-lydite phyllites (Silurian?-Devonian) and the basal siliciclastic rocks of "Verrucano" (Triassic).
The Hercynian discontinuity of Mt. Corchia is a very important geosite already indicated in the international list by proGEO (1996). This valuable element of the geological heritage is often visited during fields trips by Earth Sciences Departments.

24-27 Procinto's crags and aiguilles

geological and environmental description

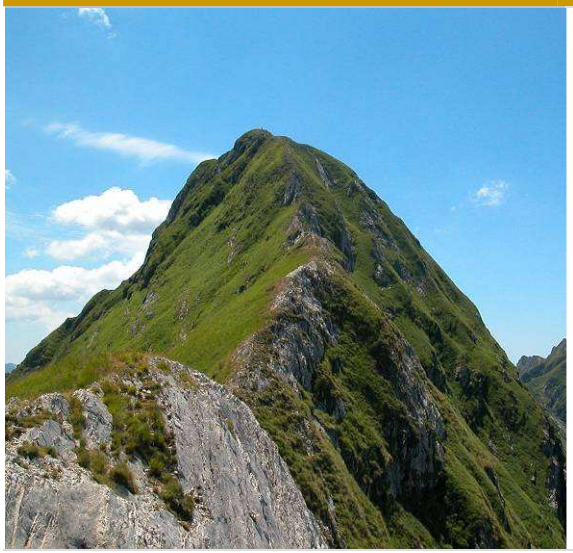


Mt. Procinto (1173 m) is the highest landform of the homonymous mountain range, a series of well-aligned rocky crags and isolated pinnacles made of Norian "Grezzoni" Dolomite. Mt. Procinto resembles a quadrangular "monolith" and has no vegetation covering its perpendicular slopes, which rise about 150 m above an almost vertical cylindrical base, approximately a hundred meters high. The top of the landform – called "il Giardino" (the Garden) – is cone-shaped and covered with thick timber vegetation (beeches and European hop-hornbeams). This "roof botanical garden", just a hectare wide, hosts almost 200 vegetable species, among which many endemic, relic and significant species of the Apuan flora.
The Procinto range is one the most characteristic orographic structures in the Apuan Alps, resembling, in small scale, the distinctive dolomite landforms. In this almost unique place in the Northern Apennines, the selective erosion of carbonate formations shaped the most known and representative examples of "gothic" natural architecture.

33-36, 51

Pisanino's ridges

geological and environmental description

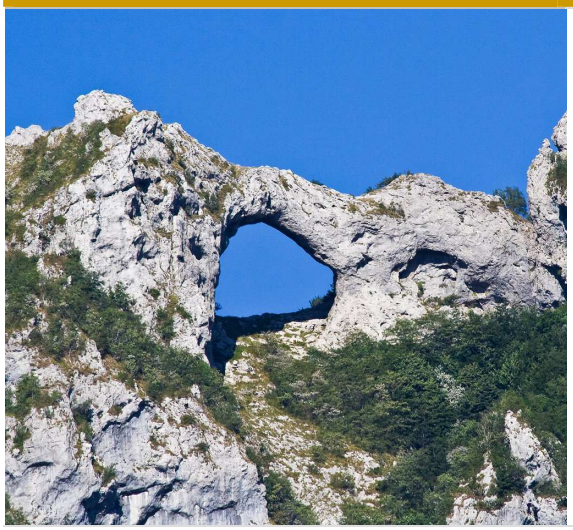


Mt. Pisanino's (1947 m) orographic knot is characterized by three main rocky ridges, whose planar angles measure about 120°, and which meet on the summit of the Apuan Alps's highest peak. This unusual morphology is situated beyond the same mountain range main watershed, along the joint with Mt. Cavallo's (1882 m) second peak. The secondary watershed, running northwards, divides Orto di Donna Serenaia's valley (west) from Acqua Bianca's valley (east).
Pisanino's rocky ridges, at times sharp and with significantly steep slopes, overhang the already high thalwegs of the Apuan Alps northern sector, with abrupt height differences, close to 900 m.
The relief great energy is linked to structural factors, largely depending on the ductile tectonics of the first compressive phase of the Metamorphic Complex and concretely affected by composite post-Miocenic fragile deformations.
Pisanino's rocky ridges are interesting at regional level, at least for their rareness. The geosite is characterised by an extreme steepness of the slope and a significant height difference.

50

Forato's natural arch

geological and environmental description



It is a rock arch placed beneath Mt. Forato's north and south forked peaks, which reach an altitude of 1208 and 1230 m respectively. The place belongs to the Panie mountain range and is situated in the Apuan Alps south-central sector, along the divide of the same range. This natural architecture has considerable dimensions: a 32 m span and a maximum height of 26 m, whereas the minimum rock thickness of the arch measures between 8 and 12 m both in horizontal and vertical cross sections. This "orographic window" is a secondary form of land moulding, deriving from the landform selective deterioration. Several factors contributed to the natural arch morphogenesis: first of all the erosion caused by rainwater and currents, then the chemical dissolution of the carbonate rock slopes and the role played by wind and cryoclastism.
The natural arch is one of the largest in Italy. Its great visibility from afar, thanks to the absence of visual obstacles in the nearby area, contributes to its scenic-aesthetic value.

52, 73

Pizzo d'Uccello northern side

geological and environmental description

Pizzo d'Uccello northern side (1782 m) is the most impressive and majestic side in the Apuan Alps. Its maximum height difference amounts to almost 700 m, whereas its inclination measures an average of 70° and almost reaches 90° underneath its summit. The face mainly consists of "Grezzoni" dolomites from the Norian age and, to a lesser extent, of Marmi a Megalodonti formations from the Rhaetian and dolomite Marbles from the Early Lias.
The relief morphology at the bottom of the northern side, is characterized by small cirques and glacial exaration cirque-like formations. They are the upper extreme limits reached by the Solco d'Equi würmian glacier. During the late Pleistocene, the long and high Pizzo d'Uccello northern side offered a shelter and, therefore, guaranteed the conservation of huge glacial masses along the relief northern slopes.
Large sub-vertical sides, as those of Pizzo d'Uccello, are not found anywhere else in Tuscany and are very rare along the whole Apennines.

55, 118 Solco d'Equi's fluvio-glacial fissure

geological and environmental description

Solco d'Equi is a narrow gorge in the Apuan Alps northern sector, where the relief is characterised by a high level of energy and slopes overhanging the thalweg. This deep fissure, which follows a sinuous course, is almost 1.5 km long and is found at the end of a small valley, sloping down from the northern face of Pizzo d'Uccello (1782 m). The attractive morphology is a consequence of separate and combined river and glacial moulding processes, in combination with cryoclastic degradation and karst dissolution processes.

During the last Glaciation, a small glacier sank along Solco d'Equi, thanks to its favourable north exposure. During its maximum expansion, the ablation zone reached a minimum altitude of 475 m, the lowest in the entire Apuan area.

In particular, Valtredi's cemented moraine have been attributed to a pre-Würm glaciation, since they are placed below typical melted glacial sediments, without gradual transitions.

66-67, 72 Gorfigliano fluvio-glacial plane

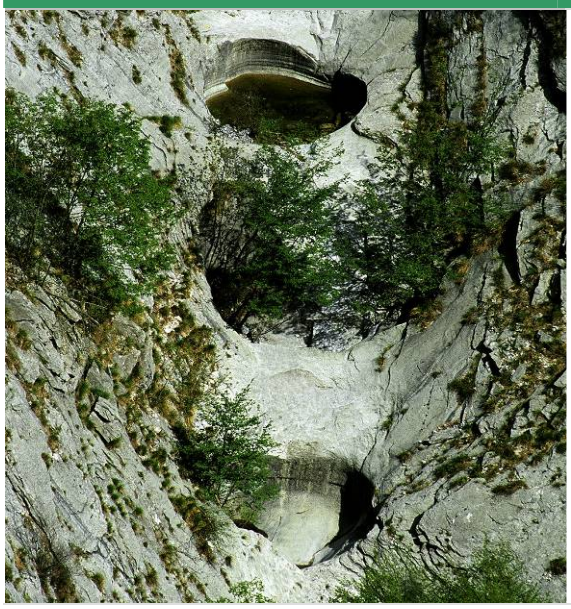
geological and environmental description

Piano di Gorfigliano is a large thalweg, 1.5 km long and 500 m wide, where the Torrent Acqua Bianca, right tributary of Serchio di Gramolazzo river, runs through.

During Würm, a glacier, descending from Pisanino-Cavallo-Tambura-Roccandagia high sides, enlarged the valley rift in an unusual way for the Apuan Alps and created a U-shape profile. Upon the ablation zone retreat, a small morainic barrier lake formed, as meltwater was stopped from flowing to the valley by some glacial ridges. Piano di Gorfigliano original glacial morphology was partly modified by fluvial and gravitative processes in the Post-Glacial. Its hydrography too was strongly affected by morpho-climatic vicissitudes occurred between the Late Pleistocene and Olocene.

Piano di Gorfigliano is an almost unique geosite within the Apuan Alps and Tuscan context.

69-70 Pot-holes of Anguillaja and Fatonero's ditches



geological and environmental description

Anguillaja and Fatonero's pot-holes have been moulded directly into the rock and their dimensions may vary from a few centimetres until reaching a diameter of 6.6 m and a deepness of 1.6 m. Quantifying them is not easy, not least because sometimes smaller pot-holes are contained in larger ones. Considering only the latter, thirty is probably the total number in both streams.

Anguillaja and Fatonero's pot-holes are often formed as a consequence of the abrasive action of rotating pebbles. In certain cases, their formation might have been favoured at first by chemical leaching (superficial karst phenomena), but then the hydrodynamic action was either prevalent or exclusive.

However, other Authors hypothesised that the pot-holes formed as a consequence of water forcedly flowing through subglacial tunnels, which were probably found under the glaciers formed during the last Glaciation.

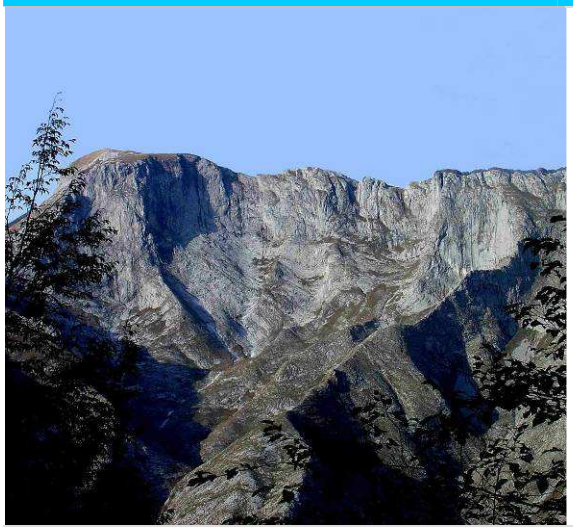
Despite the diffusion of these erosion products in the Apuan Alps' gorges, especially on a outcropping carbonate substrate, the Anguillaja and Fatonero's geosite stands out for the unique density, regular form and dimensions of the pot-holes, not found elsewhere at regional level.

71, 101-102 Orto di Donna-Serenaia's glacial valley

geological and environmental description

Serchio di Gramolazzo's upper valley is surrounded, to its southern head, by the Apuan Alps highest ridges arranged in a horseshoe-shape. During Würm, the longest and widest Apuan glacier originated from here; it covered an area of almost 12 km^2 and its major stream was slightly longer than 6 km.
The wide and flat thalweg, almost 1 km long, between Serenaia and Orto di Donna (1000-1100 m of altitude), is of particular geomorphological importance, not least for its dimensions. In this part, a rare example of glacial valley in the Apuan Alps may be seen; it is characterised by a typical U-shaped cross section and a number of modest steps. Near Tecchiarella (1031 m), the Post-Glacial river erosion has progressively isolated a relict of roof glacial valley, where there are roches moutonnées.
In Orto di Donna-Serenaia's valley, detrital filling and deposits prevail, today fed by small alluvial fans and cryonival processes (snow avalanches) especially on the hydrographic right and on the eastern side.

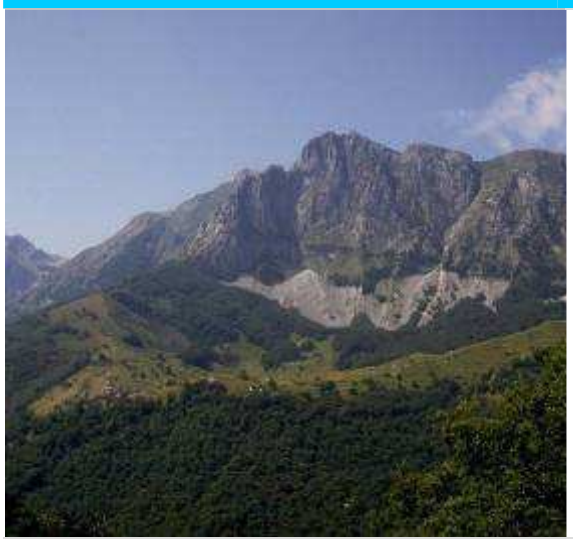
79, 188 Sumbra's glacial cirques and karst landforms



geological and environmental description

Mt. Sumbra (1765 m) rises in the centre of the Apuan Alps, along a secondary watershed running from west to east. Its morphology is characterised by four differently coalescent glacial cirques, located on the southern slope, which open up below the ridge as sub-circular amphitheatres, forming impressive vertical slopes, more than 250 m high.
The sharp southward-looking slopes are characterized by rounded grooves originated by cryonival processes, confirming the presence of perpetual snowfields or small ephemeral ice masses toward the same ridge during the Late-Glacial. Furthermore, glacial karst phenomena shaped both slopes, with deeply carved grikes and marvellous pot-holes along the southern face. The northern mountainsides, on the other hand, are characterised by epigean karst formations, such as large flat bottomed or funnel-shaped dolines, well developed above structural morphological plateaus.
The geomorphosite of Mt. Sumbra is extremely remarkable for both the Apuan Alps and Tuscany, even in relation with similar formations present in Apennines sites within the same Region.

92, 110-112 Campocatino's moraine ridges and glacial hollow

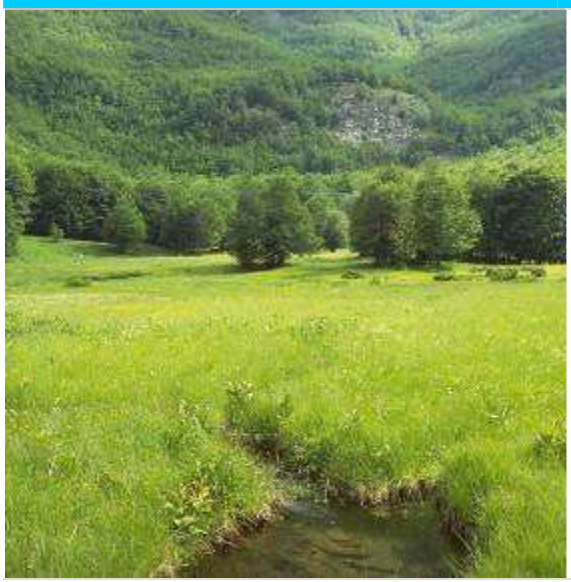


geological and environmental description

The erosion and glacial deposit forms on the eastern slope of Mt. Roccandagia, along with Campocatino's overdeepened basin and morainic ridges, are the most significant and best preserved example of glacialism in the Apuan Alps and of its fluctuations. The area is located in the north-eastern part of the Apuan massif, where the Würm glacial moulding had its major effects.
Campocatino's hollow is limited by an articulated and well defined morainic amphitheatre, typically arched in the front part, made of several evident concentric rings and numerous isolated morainic outliers. The threshold, slightly reverse, is situated at the convergence point of the ridges, at an altitude of around one thousand metres, where the glacial deposit is partially gutted due to the erosive action of channelled water.
The hollow (about 500 m long and 250 m wide) is situated at the foot of Roccandagia's vertical walls, where scree accumulates in large quantity resembling many coalescent cryoclastic cones, at different levels of activity.

93, 251 Fociomboli's glacial hollow and bog

geological and environmental description



The geosite/biotope of Fociomboli, characterized by a high level of geo-biodiversity, is the largest bog in the Apuan Alps and one of the most important in Tuscany. Its morphology and flora recall the progressive evolution, from lake to swamp, of a typical wetland, formed – following glacier retreat – in an overdeepened basin, well moulded in the porphyritic Schists of the Paleozoic basement.
During Würm, the northern slope of Mt. Corchia (1678 m) was characterised by several ice tongues, originated from the large glacial cirque near the mountain ridge.
At the external edge of the geosite there is a small threshold of *Orthoceras*-bearing schistose Dolomites which, thanks to their greater resistance to exaration, created a counterslope during glacial retreat. Behind the threshold, a small periglacial lake formed on an area of about a hectare, but it was progressively filled in by fine detritus and is now a swampy plateau.
The loamy and bog sediments of the hollow's most depressed part are 4 m deep and contain, almost all along the sequence, fossil pollens from a large period of the Post-Glacial.

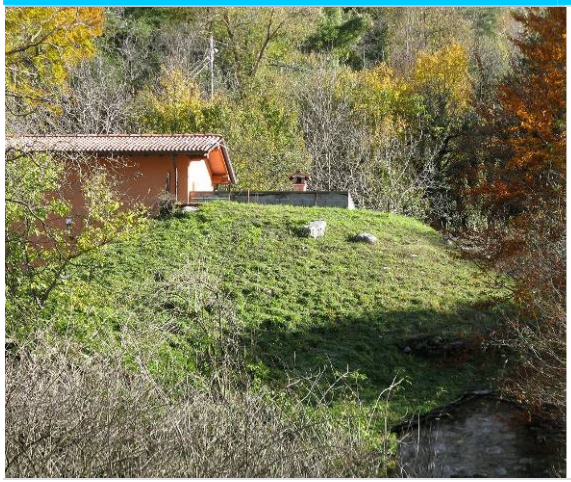
98, 150 Passo Sella's glacial saddle and dolines

geological and environmental description

Sella Pass is a regionally emblematic and representative geosite for what concerns the complex combination of morphogenetic, glacial and karst processes on carbonate outcrops, situated on not very steep internal slopes at rather high altitudes.
The geosite is mainly a glacial transfluence saddle between Arnetola and Arni's valley. Furthermore, dolines line up coherently with structural elements and, in particular, with the axial-plane schistosity. Along the Apuan ridge, the presence of dolines in ridge areas or near saddlebacks is not extremely rare. Their unusual morphological collocation renders their genesis and evolution hard to explain under current conditions. These epigean karst forms are probably signs of a now changed landscape, whose steepness was probably less pronounced.
Karst processes affected the area both superficially and in depth. On the western slope of Mt. Sella, there are relicts of cavities with a pronounced high-altitude palaeo-phreatic morphology. These caves may be linked to a large endorheic basin, which spread out in the central part of the Apuan complex during late and early Pleistocene.

115 Stoppani's "moraine" in Campagrina

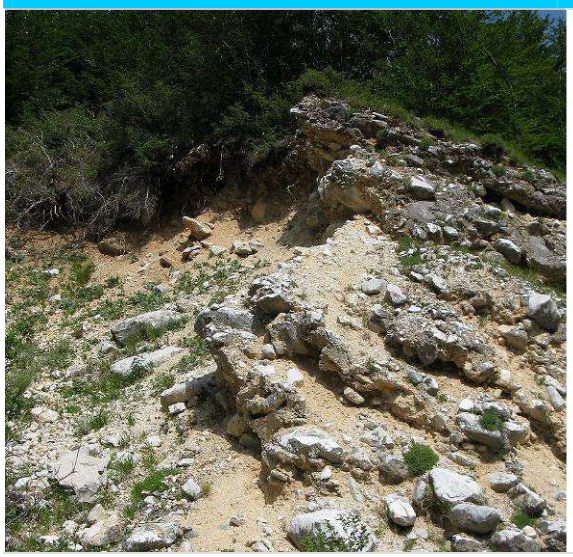
geological and environmental description



Beside the general scientific interest toward this glacial geomorphosite, its fame is linked to the history of geology. It was here that, on 13th June 1872, the famous geologist Antonio Stoppani (1824-1891) detected the first signs of the Quaternary Glaciation outside the Alps. Until that moment, no evidence had been found along the whole Apennines ridge.
Near the town of Arni di Stazzema (Campagrina), there are visible signs of the extreme expansion of a medium-sized glacier which, during Würm glacial stage, was probably spread over the whole Canale delle Gobbie's valley, to the north of Mt. Altissimo. After it merges into Tùrrite Secca, beyond the river banks, well-visible and wide glacial deposits crop out, even to the side of the main riverbed. They are partly carved and have been partly removed by watercourses. The glacial deposit consists of a chaotic mass of heterogeneous clasts, especially Marble *s.s.* and secondarily "Grezzoni" Dolomite and porphyritic Schists.

119 Gobbie pre-würmian “moraine”

geological and environmental description

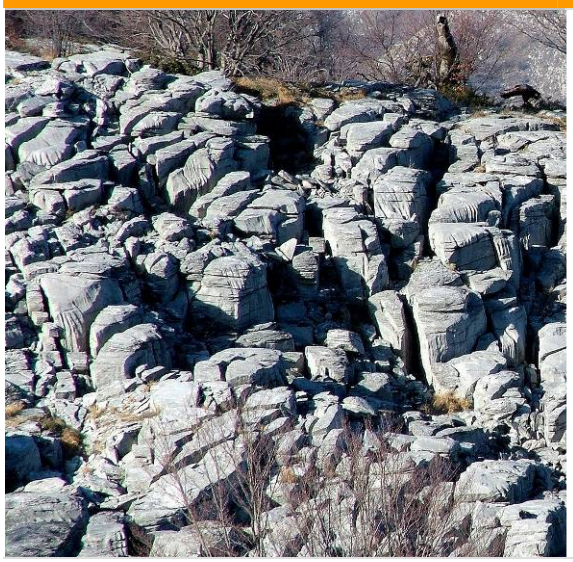


Small outliers of glacial and fluvioglacial deposits outcrop in Retroaltissimo, where Canale delle Gobbie (Gobbie’s Channel) flows though. Most of these sediments were produced by a glacier which occupied the whole valley during the maximum würmian expansion and retreated to the valley head of Grotta Giuncona cirque in the Late-Glacial. The glacial deposit here has two different and separated aspects, without gradual transitions. Typical loose deposits coexist with cemented, conglomerate deposits. The first have been attributed to the Würm, whereas the latter are thought to belong to a previous glacial expansion. The signs of a pre-würmian glaciation in the Apuan Alps, probably the Riss of the Alps, is in line with what was discovered in some areas of the Apennines.

A stalactite and stalagmite concretion, formed within a “pocket” of Gobbie cemented glacial deposit, enabled the first conglomerate radiometric dating (U/Th). Despite contaminations, the result (not published yet) seems to suggest a pre-würmian formation of the moraine, thus attributable to Riss with a certain reliability margin.

130 Vetricia’s karren field

geological and environmental description



Vetricia (1300-1500 m of altitude) is a karst plateau situated between Pizzo delle Saette massif (1720 m) and Pania della Croce-Pania Secca ridge. The area is characterised by large superficial and deep karst phenomena, caused by heavy rain and snowfalls and especially by the rock substrate’s carbonate nature and intense fracturing. The various karst phenomena and their evolution level suggest that the karstification process probably started during the Quaternary Glaciation and then developed through the widening by dissolution of the rock substrate’s discontinuities and fractures.

Epigean macroforms of this karren field include dolines, although not in a significant number. Almost all of them are typically bowl-shaped, with a round opening. Microforms include gouges and linear and/or meandering grikes, excavated in smooth and slightly sloped bedrocks. There are also deep parallel grikes, solution runnels and rock tanks (“kamenitze”). Furthermore, here there is the entrance to several hypogean cavities, mainly vertically developed (Abisso Revel, Buca Larga, etc.).

135 Carcaraia’s doline field

geological and environmental description

Carcaraia is situated on Mt. Tambura’s (1895 m) northern slope and is limited to the west by Cavallo’s mountainsides and to the east by Roccandagia-Tombaccio’s secondary ridge.

Considering only superficial formations, the distinctive feature of Carcaraia is the large extension of its doline field, situated on its rather steep slope and covering about 1,2 km^2. Dolines are depressions formed by dissolution, whose dimensions may vary from metres to decametres and whose depth is remarkable in comparison to the diameter. Their forms are very heterogeneous; they may be dish-, bowl-, funnel- and even well-shaped.

Carcaraia is, therefore, the place in the Apuan Alps with the highest concentration of superficial karst forms. Dolines are the distinctive elements of the landscape, with an average density of 320 elements per km^2. It is an extremely unusual value in comparison with the average density of the entire Apuan massif (about 0.5 dolines/km^2) or of other Italian karst areas (between 50 and 100 dolines/km^2).

147-148, 160-161 — Dolines on Garfagnana plateaux

geological and environmental description

The dolines on the Apuan inland side plateaux are of regional interest for their quality and quantity, compared to the dimension of the territory. It is noteworthy to recall that 44 karst areas have been registered in Tuscany. They spread over a surface totalling 1,100 km^2, that is to say 5% of the entire Region. These areas are not very large considering that almost 1/3 of karstifiable lands, 350 km^2, are located in the Apuan Alps, especially on their inland side of the Garfagnana.

The Garfagnana mountainside is, therefore, characterized by the alignment of structural highs, levelled towards the crest, which are far from the main ridge. These landforms are to be interpreted as horsts of the Serchio' tectonic ditch (graben), into which they suddenly sink, along the valley Apuan margin. These plateaux create favourable conditions for medium scale epigean karst phenomena, especially where Tuscan Nappe carbonate formations outcrop. Dolines of remarkable dimensions, mainly flat dish-shaped, may be found on non-metamorphic limestones and dolomites.

162 — Buca e Tecchia d'Equi's karst complex

geological and environmental description

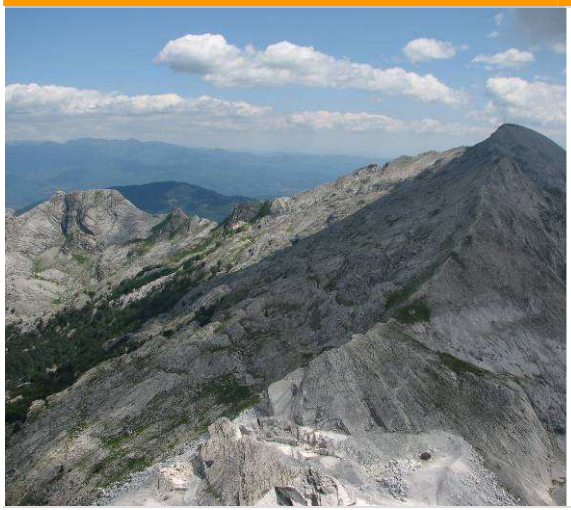
The karst complex of Equi Terme's caves comprises two different elements: "Buca" and "Tecchia", situated not very far one from the other, where Fagli valley to flow into Lucido's valley.

"Buca" di Equi opens up at 258 m a.s.l., to the hydrographic left of Fagli stream, almost at the same altitude. The karst cavity is about 850 m long, parallel to a fault running in north (north-west)-south (south-east) direction, and it spreads into the cataclasites formed by friction between cherty Limestones and dolomite Marbles. "Buca" is a perpetual karst spring of underground water, whose average flow rate is estimated around 250 l/s. During floods, spectacular and violent water outflows occur, reaching a maximum of 15 m^3/s.

Finally, Equi Terme's Tecchia is a neutral cavity which opens up at 305 m a.s.l., to the left of Fagli stream. The cave resembles a rock shelter and is home to significant deposits of palaeontological and archaeological interest. Excavations, started in the 19th cent., brought to light stone tools from the Mousterian to the Neolithic, together with Würm and Post-Glacial faunas (bear, wolf, dhole, jackal, leopard, lynx, ermine, marmot, beaver, ibex, chamois, etc.).

175 — Abisso Roversi's cave

geological and environmental description



Abisso Roversi outer opening is situated at 1710 m a.s.l., near the mountain range main watershed, in the stretch between Mt. Tambura peak and Passo della Focolaccia. This cave has a linear extension of 4200 metres, but its main feature is the remarkable height differences, amounting to 1350 m a.s.l. Abisso Roversi is the deepest cave in Italy and ranks twentieth in the world list.

Most of the cavity has a vadose origin, with wells following vertical fractures inside the dolomite Marble formation. These descending elements are also characterized by a single vertical 310-m deep environment (black hole or Mandini well), which is one of the largest in the world. The cave has also elements with a horizontal course allegedly evolved from ancient tunnels of phreatic origins.

The colours of the torrent flowing inside Abisso Roversi testify to the link between the cave and the source of the river Frigido in Forno di Massa. In other words, Mt. Tambura underground water emerges after flowing underground for about 4.5 km (beeline distance).

194 Antro Corchia's karst Complex

geological and environmental description

Antro del Corchia is the first karst Complex of the Apuan Alps, for the absolute value of its dimensions, measured both in length (about 53 km) and deepness (1187 m). The karst Complex consists of four different levels of large galleries.

The geosite morphology and pre-Quaternary origin, enable a deep study on the Apuan Alps' post-orogenetic vicissitudes and morphotectonic history. Furthermore, recent studies on the Antro's speleothems radiometric dating showed the presence of one of the longest and most continuous Earth climate archives, which has been able to record climate variations in the Mediterranean area in the past million years.

The exploration history of the karst complex has ancient origins, since it dates back to 1840. Since then, thousands of Italian and foreign speleologists have explored the numerous underground ramifications of Antro del Corchia. It is thanks to them that the different explored parts are now joint, starting from the 14 natural entrances known so far.

198 Tana che Urla ("Vallisneri's cave")

geological and environmental description

Tana che Urla (Screaming Den) is a 400 m long karst cavity with a height difference of 48 m. It opens up in the eastern slope of the tract comprised between Pania della Croce (1858 m) and Mt. Forato (1230 m), to the hydrographic left of the Tùrrite di Gallicano at 615 m of altitude. The cave consists of a single gallery with a basically horizontal course, carved in "Grezzone" Dolomite, almost touching the impermeable lower Phyllites. Its morphology is typically phreatic and is characterised by a wide entrance, from which a stream flows out (average flow rate: 30 l/s).

The most inner tract of the gallery has a long active siphon (220 m). During waterfloods, water pours out violently from the cavity's entrance and flows into the stream below with an impressive waterfall, which may reach a maximum of 3 m^3/s.

The prevailing scientific interest, beside that linked to the hypogean karst phenomena, is mainly of geohistorical nature, since the cave suggested to Antonio Vallisneri *senior* (1661-1730) the perpetual water cycle. The observations made here in 1704 inspired him his famous *Academic Lecture on the origin of springs* (1715).

199 Grotta all'Onda's karst cave

geological and environmental description

Grotta all'Onda is located at the bottom of a morphological crag at 708 m a.s.l., in an area particularly rich in karst springs, fed by the overlooking carbonate formations of Mt. Matanna southern side (1318 m).

The cave entrance is characterized by a wide ogival cleft, 30 m. wide and 2-3 m high. The upper edge of the outer vault resembles a large sea wave. The deposits of cavity testify to remarkable sedimentologic and paleoclimatic vicissitudes occurred since 0.17 Ma. This site testifies human presence until recent times. Its most ancient Mousterian stone tools date back to 40,000 years ago, as shown by a recent speleothems radiometric dating.

Another cave of palaeoetnhological and palaeontological interest, Buca del Tasso (the Badger's Hole), is situated near Grotta all'Onda. The small cavit has also preserved an exceptional anthropological find, very rare in Italy: a femur of a child of *Homo neanderthalensis* King.

208 Frigido's karst spring

geological and environmental description

Frigido's spring flows out from a cavity in the rock, at 235 m a.s.l., on the western slope of Mt. Castagnolo (1003 m). It is a karst spring of underground water, situated where two formations with different permeability levels touch.

Frigido's spring is the largest in the Apuan Alps, with an average flow rate of 1550 l/s and peaks of 8 m^3/s. The spring catchment area allegedly comprises most of the Apuan massif northern sector, including wide areas beyond the main watershed. Indeed, the hydrogeological basin (34,5 km^2) is significantly different from the superficial hydrographic basin (20,0 km^2), since it affects the high north-eastern slopes of Grondilice, Pisanino, Cavallo, Tambura, Sella e Macina, including most of Carcaraia and Arnetola's valley.

Frigido's spring is the best example in the Apuan Alps (and beyond) of underground water capture by coastal basins to the detriment of internal ones, as evolutionary consequence of the progressive erosion of impermeable thresholds in sea slope.

236 Levigliani's Mine (Hg)

geological and environmental description

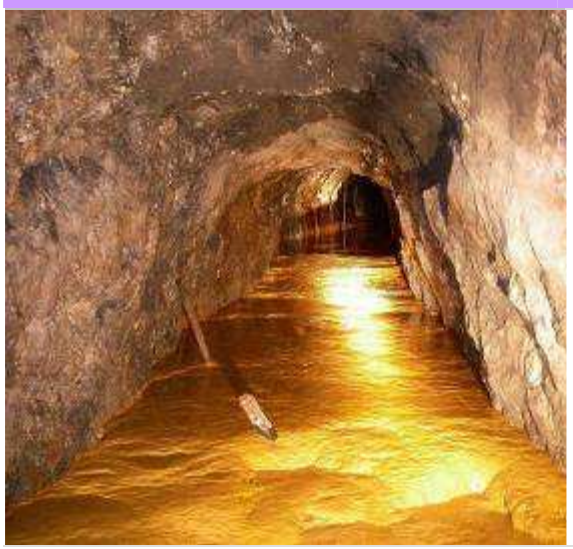
Levignani's mineral resources are encased in the Paleozoic basement of the Apuan Alps, where they are disseminated or incorporated in quartz-carbonate veins. There is an interesting and rare paragenesis of mercury sulphides, zinc, iron and bismuth. Mercuriferous minerals (cinnabar, metacinnabar, sphalerite, etc.) are completely incorporated in Ordovician volcano-sedimentary rocks, metamorphised during the Hercynian and Alpine orogenesis. The diffusion in the deposit of native mercury, easily findable in metallic drops along quartz veins, is particularly significant.

Furthermore, other rare, if not unique, minerals are found here; e.g. leviglianite (a zinciferous variety of messelite) and especially calomel (a mercury chloride, which rendered the mine famous). A new mineral species was recently discovered: grumiplucite, a mercury and bismuth sulfosalt mineral, found in the form of metallic grey coloured and longitudinally striped prismatic acicular crystals.

The date when mining activity started in Levigliani is uncertain, though it probably occurred in the Middle Ages.

238 Buca della Vena's Mine (Fe-Ba)

geological and environmental description



Buca della Vena's mine belongs to the metalliferous area in the Apuan Alps central-southern sector. Mineralisation is found between Paleozoic basement's tourmalinized phyllites and the triassic carbonate cover of the Apuan Alps Metamorphic Complex.

In the past decades, more than 80 mineral species were identified in Buca della Vena, 10 of which completely new [allanite-(La), apuanite, dessauite, marruciite, pellouxite, pillaite, rouxelite, scainiite, stibivanite-2O and versiliaite]. Most of them have not yet been found in other parts of the world.

Buca della Vena's mine is the most important mineral geosite in the Apuan Alps, since it hosts numerous rare and unique species. The place also stands out for the presence of complex mineral phases with an unusual chemical composition generated under particular chemico-physical crystallization conditions, rarely found in nature. Thanks to these unique characteristics, the geosite is interesting at international level and recognised by the world scientific community.

242-244 Valle Buona's Mines (Pb-Zn-Ag)

geological and environmental description

"Valle Buona" (Good Valley) comprises the mines of Buca dell'Angina, Monte Arsiccio and Pollone.
The three mines, which host deposits of baryte, pyrite and lead, silver and zinc sulphides, are all located within the small Sant'Anna's tectonic window and have the same relations between mineralization and enclosing rocks.
The mining tunnels exploited lenticular deposits, situated where paleozoic Phyllites and quartzite touch the overlaying "Grezzone" Dolomite. Usually, the mineralization zoning, going from top to bottom, is as follows: "Grezzone" (top) - hematite and compact magnetite, iron oxides mixed with finely crystallized baryte, massive baryte, baryte mixed with pyrite; pyrite - Phyllites (bottom).
Angina, Arsiccio and Pollone's mineralogical and mineral geosites are important at national level for the historical continuity in extraction activities and for their relatively well-preserved mineral sites and goods.

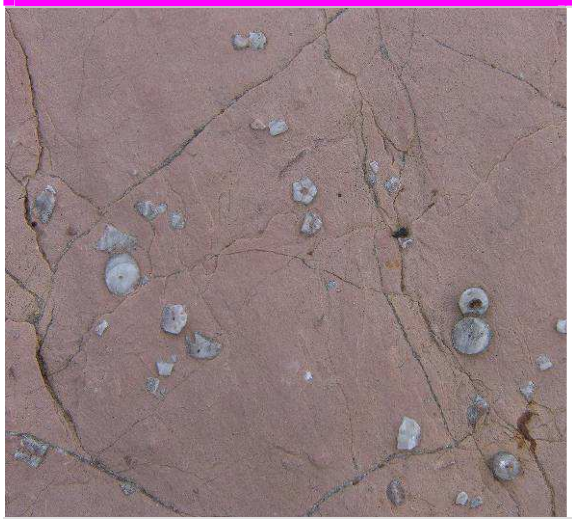
247 Fossils in marble banks in Foce di Pianza

geological and environmental description

Foce di Pianza's marble banks are among the rare places within the Apuan tectonic window still conserving visible palaeontological signs, despite the effects of metamorphism. The geosite is found at about 1300 m of altitude, toward Mt. Borla (1465 m). It was discovered in 1945 by Enzo Beneo (1903-1988), who described a level of gastropods, with the same structure as marble, which called "*lumachelle*" (small snail) owing to their richness in tower-like formations. Subsequent studies identified ammonites, crinoids and fossilised algae.
Notoriously, Apuan Alps' metalimestones were subject to high temperature and pressure, which almost completely destroyed sedimentation levels and fossils in all known outcrops. Therefore, fossiliferous areas are rather rare in the Apuan Alps Metamorphic Complex and even rarer in Marbles *s.s.* of Autochthon *Auct.* Its attribution to the Hettangian, based on the few reliable and recognizable fossils, generated a period of confusion, uncertainty and discussions in geological literature.

253 Alto Matanna's "red ammonitiferous Limestone"

geological and environmental description



The outcrops of Mt. Matanna's (1318 m) "red ammoniteferous Limestone" are apparently larger than elsewhere, because landform morphology follows the rock line. They are characterised by a modest thickness, which, in the entire Apuan complex, never measures more than 50 m between the massif base level and the stratified facies above.
In general, the yellow, pink and red nodular limestones of the non-Metamorphic Succession of the Tuscan Domain (Tuscan Nappe) have fossiliferous levels containing ammonites, which won them the ancient denomination of "*Arietites* Limestones". A typical Sinemurian cephalopod of this area is *Plesechioceras doricum* (Savi & Meneghini), often associated to other species of ammonites and crinoids. The presence of fossilised fauna in Alto Matanna's "red ammonitiferous Limestone" was first reported in 1864. The geohistorical evaluations and annotations confer an interest of regional level to Mt. Matanna's palaeontological site.

Main geosites in the Apuan Alps Regional Park: interest and conservation status

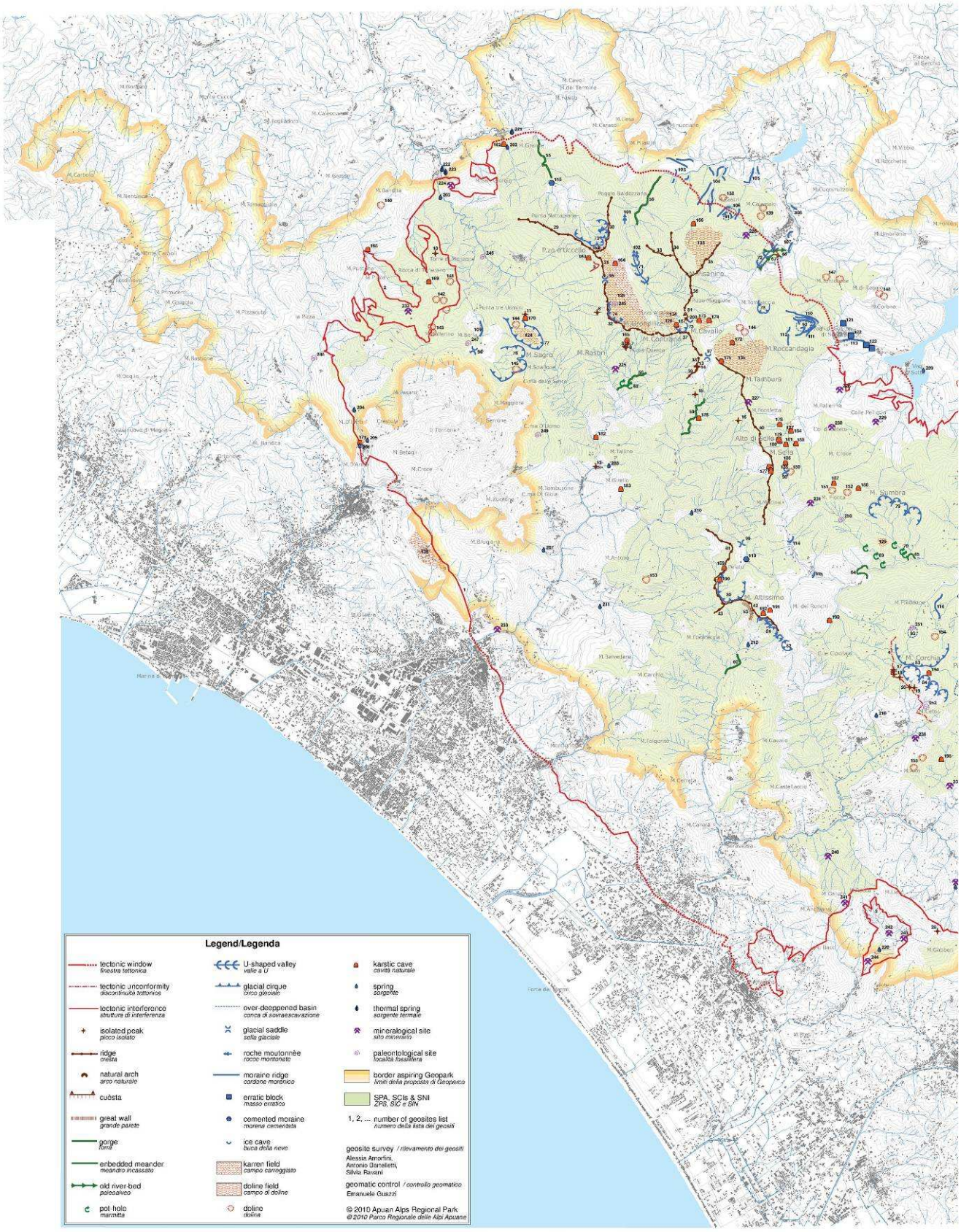
geosites	park sector	interest				conservation status		
		scientific	contextual	evaluation	level	condition	risk of deterioration natural	risk of deterioration anthrop.
Apuan tectonic window	1-16	structural geology, geohistory	landscape, historical, botanical, faunal, etc.	representative	international	good	non-existent	medium
Corchia Hercynian unconformity	11	stratigraphy geology	landscape, hiking	representative	international	good	non-existent	non-existent
Procinto's crags and aiguilles	14	geomorphology	landscape, hiking, botanical	representative	regional	good	non-existent	non-existent
Pisanino's ridges	4	geomorphology	landscape, hiking	representative	regional	good	non-existent	non-existent
Forato's natural arch	12	geomorphology	landscape, hiking	representative	national	good	non-existent	non-existent
Pizzo d'Uccello northern side	3	geomorphology	landscape, hiking	representative	regional	good	non-existent	non-existent
Solco d'Equi fluvio-glacial fissure	3	geomorphology	landscape	illustrative	regional	fair	non-existent	medium
Gorfigliano fluvio-glacial plane	4/5	geomorphology	landscape, botanical	illustrative	regional	fair	non-existent	medium
Pot-holes of Anguillaja and Fatonero's ditches	8	geomorphology, epigean karst phenomena	landscape, hiking, botanical	representative	regional	good	non-existent	non-existent
Orto di Donna-Serenaia's glacial valley	3/4	geomorphology	landscape, hiking	representative	regional	fair	non-existent	medium
Sumbra's glacial cirques and karst landformes	8	geomorphology, hypogean karst phenomena	landscape, hiking	representative	regional	good	non-existent	non-existent
Campocatino's moraine ridges and glacial hollow	7	geomorphology	landscape, hiking, didactic, architectural	representative	regional	good	non-existent	medium
Fociomboli's glacial hollow and bog	11	geomorphology	botanical, hiking	representative	regional	good	non-existent	medium
Passo Sella's glacial saddle and dolines	7/8	geomorphology, epigean karst phenomena	landscape, hiking	representative	regional	good	non-existent	non-existent
Stoppani's "moraine" in Campagrina	8/10	geomorphology, geohistory	cultural	illustrative	national	precarius	non-existent	medium
Gobbie pre-würmian "moraine"	10	geomorphology	cultural, didactic	rare	regional	fair	medium	medium
Vetricia's karren field	12	epigean karst phenomena	hiking, archaeological	representative	regional	good	non-existent	non-existent
Carcaraia's doline field	7	epigean karst phenomena	hiking, didactic	representative	national	good	non-existent	non-existent
Dolines on Garfagnana plateaux	5/15	epigean karst phenomena	botanical, didactic	illustrative	regional	good	non-existent	medium
Buca e Tecchia d'Equi's karst complex	3	hypogean karst phenomena, hydrogeology, palaeontology	hiking, archaeological, cultural	representative	national	fair	non-existent	medium
Abisso Roversi's cave	7	hypogean karst phenomena, hydrogeology	hiking	representative	international	good	non-existent	non-existent
Antro Corchia's karst complex	11	hypogean karst phenomena	hiking, didactic	representative	international	good	non-existent	medium
Tana che Urla ("Vallisneri's cave")	12	hypogean karst phenomena, hydrogeology, geohistory	hiking, didactic	representative	national	good	non-existent	medium
Grotta all'Onda's karst cave	14	hypogean karst phenomena, hydrogeology	hiking, archaeological, cultural	rare	national	fair	non-existent	medium
Frigido karst spring	6	hydrogeology	historical	representative	national	good	non-existent	non-existent
Levigliani's Mine (Hg)	11	mineralogy	historical, cultural	representative	national	good	non-existent	medium
Buca della Vena's Mine (Fe-Ba)	14	mineralogy	historical, cultural	representative	international	fair	non-existent	medium
Valle Buona's Mine (Pb-Zn-Ag)	13	mineralogy	historical, cultural, architectural	representative	national	good	non-existent	medium
Fossil in marble banks in Foce di Pianza	2	palaeontolology	cultural, didactic	rare	regional	fair	non-existent	medium
Alto Matanna's "red ammonitiferous" Limestone"	14	palaeontolology	historical, didactic	representative	regional	good	non-existent	medium

In the following pages: Geosite Map of the Apuan Alps Regional Park (West and East sheets)

Geosite Map of the Apuan Alps Regional Park

West sheet

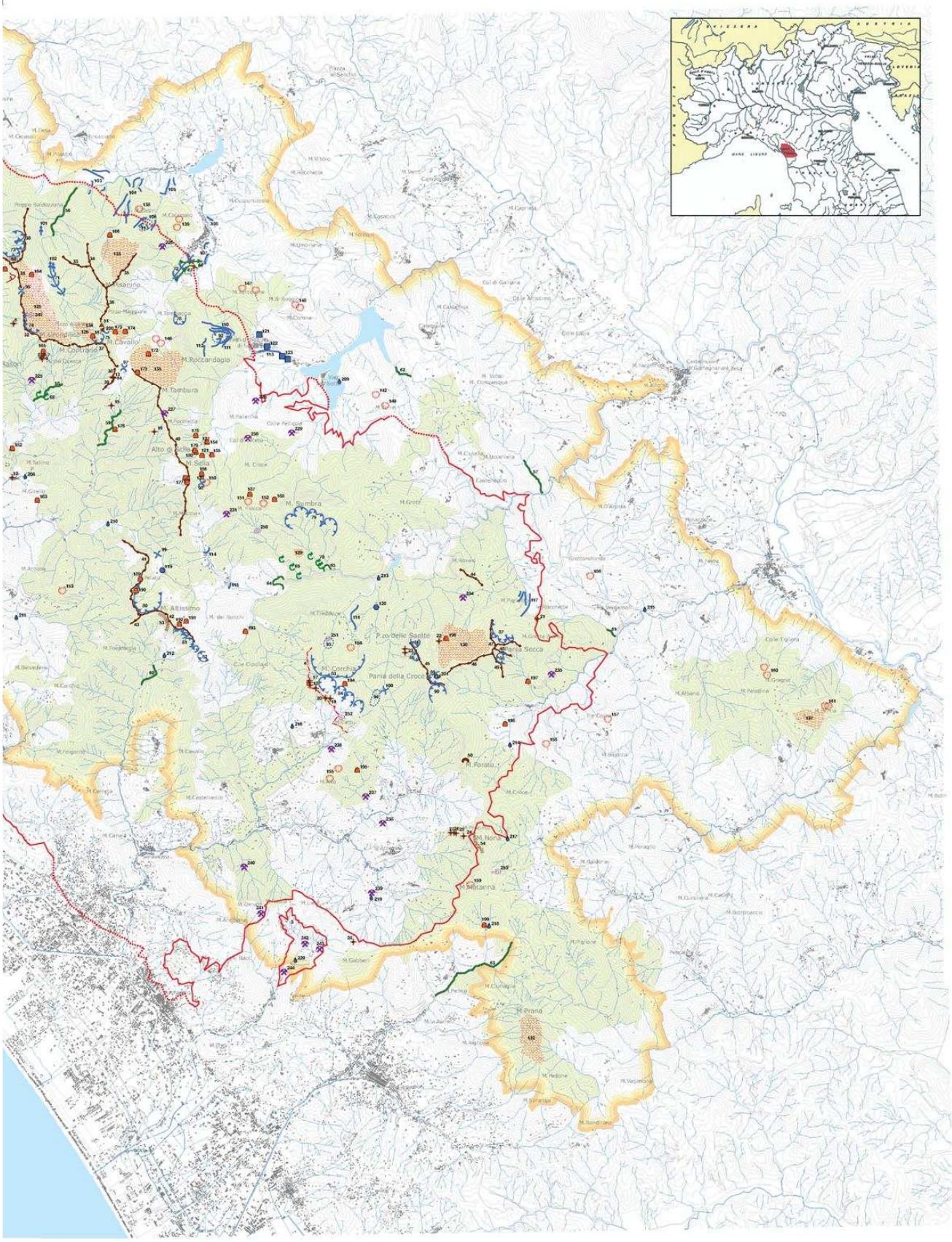
0 2.500 5.000 Meters



Geosite Map of the Apuan Alps Regional Park

East sheet

0 2.500 5.000 Meters



B.4 – DETAILS ON THE INTEREST OF THESE SITES (SCIENTIFIC, EDUCATIONAL, ETC.)

The first list of European geosites, drawn up by Wimbledon *et alii* (1996) for ProGEO (the *European Association for the Conservation of the Geological Heritage*), already contained numerous sites of the Apuan Alps. The list takes stock of remarkable elements of the European geological heritage and includes Apuan geological sites, both exclusive to the territory and present outside its borders. The following elements belong to the first category: the Apuan tectonic window, the Hercynian discontinuity of Mt. Corchia, the Apuan "Cipollino" marble. The second group comprises würmian moraines of the Alps and Apennines and the Tuscan Mezocenozoic (pyrite, mercury, cinnabar and antimony). After this first important acknowledgement, the Park Authority started a detailed review of the values of its geosites as explained in the paragraph on census and filing. A careful and detailed territorial analysis showed that Apuan geological sites arise all different levels of scientific interest, from global to local, according to the following grid of criteria and considerations.

Among geosites of global scientific interest attention needs to be drawn to the Antro del Corchia karst Complex (Stazzema) because of different reasons. On the one hand, it is a geological and climatic archive preserved in its complex network of tunnels and wells. Moreover, its development, both extension (estimated at 53 km) and height (1187 m deep) and its historic contribution to the progress of speleological exploration have an undeniable value. The Antro del Corchia Complex is an important investigation field especially with regards to its complex morphology and its pre-Quaternary origins which enable a research on the post-orogenic events and the morphotectonic history of the Apuan Alps. Moreover, recent radiometric dating studies on Antro del Corchia's speleothems have shown that the complex keeps one of the longest and most continuous log of the Earth climate which has been able to record climate variations in the Mediterranean area in the past million years. Another geosite of global interest is the Buca della Vena's Mine (Stazzema) thanks to its very rare mineral paragenesis. In the past twenty years eighty mineral species have been identified, ten of which happened to be new [allanite-(La), apuanite, dessauite, marruciite, pellouxite, pillaite, rouxelite, scainiite, stibivanite-20, versiliaite] and have not yet been found in other places of the world.

With regards to geosites of European interest, a remarkable number of karst cavities in the Apuan Alps ought to be pointed out, especially when they form significant underground networks or steep drops. Apart from the Antro del Corchia Complex, which has already been discussed, the area boasts other impressive karst complexes as far as the overall extension of tunnels and wells is concerned. These include Saragato-Aria Ghiaccia in Carcaraia (35 km), Milazzo on Monte dei Ronchi (10 km) and Pelato to the north of Mt. Altissimo (7 km). With regards to depth, several Apuan caves cross the remarkable threshold of a thousand metre in height difference: Abisso Paolo Roversi, Carcaraia, - 1350 m; Abisso Olivifer, Forno, - 1215 m; Antro del Corchia, Levigliani, - 1187 m; Saragato-Aria Ghiaccia, Carcaraia, - 1125 m; Abisso Mani Pulite, Carcaraia, - 1060 m; Buca Go Fredo, Mt. Sumbra-Fiocca, - 1015 m; Pianone-Pinelli-Paleri, Resceto complex, - 1008 m.

Now for geosites of national interest, their number in the Apuan Alps is considerably higher compared to the previous groups. They mainly include hypogean karst landforms sligthly smaller than those mentioned above as far as extension (1 to 5 km) and height difference (500 to 1000 m). Within the category of "springs", often of karst origin, that of Forno di Massa, from which River Frigido originates, needs to be recalled as it is the only spring exceeding the average flowrate of 1 m^3/s (and more precisely it reaches 1550 l/s). Statistics aside, Forno spring is important for another reason, since 40% of the hydrological basin is located beyond the main watershed of the mountain range and consequently beyond the superficial hydrographic limit. Therefore, the spring is the best example of a widespread phenomenon in the Apuan Alps: the underground catch of water by coastal basins to the detriment of inland basins as a result of the progressive incision of impermeable watersheds by the coastal side.

Thanks to their rarity and/or their scenic value several other Apuan geosites with geomorphological features are also of national interest. One of them is the natural arch of Mt. Forato (Stazzema), whose 32 metre span and 25 metre maximum height make it one of the largest in Italy. Yet, this peculiar landform is not the only site of interest. There are also some elements typical of the Dolomite-like landscape of the Apuan Alps, often characterized by aiguilles and pinnacles, especially on carbonate lithotypes and under favourable structural conditions. The value of the geosite is higher where the dimensions and/or the concentration of isolated peaks are more evident. The most striking examples are Mt. Procinto's Group, with the "Bimbi" (Stazzema) and Punta Carina with Focolaccia's aiguilles (Massa), together with other landforms of no less scenic impact and geomorphological significance (Torre dei Campaniletti of Mt. Tambura, Pizzo di Forno, Punta Quésta of Mt. Grondilice, etc.).

Elements of glacial morphology classifiable as geosites of national interest are quite rare and perhaps limited to melted würmian moraine deposits with cemented parts, probably deriving from the previous Riss glaciation. They may be seen in Solco d'Equi in Lunigiana, from Arni to Campo delle Gobbie and in Val Terreno in the basin of the stream Tùrrite Secca. The Apuan Alps also preserve other widespread forms of erosion and glacial deposit, such as overdeepened basin, U-shaped valleys, valley steps, transfluence and diffluence saddles, roches moutonnées, moraine ridges and erratic blocks. They are potential geosites of regional interest, since würmian glaciers in Tuscany limited their action to the highest areas of Apuan and Apennines with a less powerful result compared to the Alpine territory. Other sites of national interest for their remarkable dimensions and concentration are the pot-holes of the ditches Fatonero and Anguillaja.

Scientific interest is coupled with educational interest in geological sites registered by the Park Authority. The Apuan territory has always been a fruitful investigation field and a special open-air educational laboratory constantly visited by university departments, research institutes, primary and secondary schools, national and local environmental associations, as it is characterized by natural phenomena of extraordinary illustrative value, the most remarkable being geological. Some of the

most noteworthy elements include ductile and brittle tectonic structures especially found in the highest and central part of the range, which is almost devoid of vegetation cover. Here, bedrock outcrops are widespread and expose a great variety of lithologies, which are thought to be the reason for the peculiar diffusion of mineral species and numerous ornamental stones which have been subject to quarrying activities, especially in the past. A special educational and didactic value lies in the existence of ancient and modern traces left by the quarrying and mining industries. It may be food for thought on the long-lasting use of non renewable geo-resources.

Numerous geomorphosites of different origins and easy to identify are scattered throughout the territory of the future Geopark. They are often found in their more typical and regular forms, even underground. There are also more complex landforms deriving from combined geomorphological processes (glacial, karst and/or fluvial), and unusual geological phenomena, such as thermal springs, karst springs and the frequent mismatch between hydrographic and hydrogeological basins. Opportunities for the development of educational and naturalistic initiatives are plentiful thanks to the Park extreme geodiversity and its illustrative and sometimes highly evocative value.

Last but not least, geosites of paleontological interest are rarer in the Apuan Alps than elsewhere. Fossiliferous areas are rare in the tectonic window because metamorphism has generally deleted any sign or trace of life in the rocks of the Autochthonous *Auct*. and Massa Unit. Yet, where temperature and pressure had a lower influence (especially on the north-eastern side of the range) remains of animal may have preserved (in particular Brachiopods, Gastropods, Bivalvias, Cephalopods and Crinoids), though they are not always recognizable and/or are limited to certain levels of certain geological formations. Clearly, these rare fossiliferous areas are very interesting from a scientific and educational point of view. Some of them are: Fociomboli for its Silurian *Orthoceras*; Orto di Donna for its *Megalodont*-bearing Marbles (Rhaetian); Poggio Troncone and Foce di Pianza for their Ammonites and Crinoids from the Hettangian formation of Marble *s.s.*

B.5 – CURRENT OR POTENTIAL PRESSURE ON THE TERRITORY AND THESE SITES

The Apuan Alps area is a subregion with an average population density slightly higher than 100 inhabitants per km^2, the coastal side being more populated than the inland. Population density is higher in the many concentrated settlements distributed on hilly and low-mountain terrains (0 to 600 m), whereas only 2% of inhabitants live above 800 m of altitude.

The area defined as Geopark spreads over the highest and most central part of the mountain range. It is, therefore, widely unsettled and its density is always lower than 50 inhabitants/km^2. This data explains the scarce anthropic pressure exerted by the resident population on the territory. Moreover, a demographic decrease has taken place and agro-silvo-pastoral activities, once carried out on high-altitude areas, have almost completely been abandoned. The inhabitants of the Apuan Alps do not pose a threat to the integrity of geological sites either for their distribution or the number and the kind of activities carried out, as they do not significantly change the territory.

Mountain peaks and slopes with high levels of geodiversity and naturality are tourist destinations too, irrespectively of the forms of tourism (traditional or more recent ones). There is a remarkable presence of tourists along high altitude paths and climbing trails during spring and summer but tourism remains sustainable. Even though practised on vulnerable areas, environmental tourism involves mature and aware visitors who have always been sensible to issues such as nature safeguarding and conservation. Moreover, the dense network of mountain paths favours the channelling and the control of tourist flows. Limited concentrations are to be found in alpine huts and negative impacts on sites of geological interest have never been registered. In winter, the limited and variable snow cover of the Apuan Alps has not favoured the construction of resorts for winter sports and ski-lift facilities. The only exception is found in Careggine, where five small ski slopes have been built on a 5-ha surface and do not affect sites of geological interest.

A large number of visitors are attracted by the opportunity of exploring the numerous Apuan karst caves, which are elements of great geological value and environmental fragility. Speleological groups from Tuscany or other Italian regions and also from European countries regularly visit the Apuan Alps to develop new scientific knowledge, carry out sports activities or educational and didactic projects. It is again a niche tourism, characterized by high environmental and cultural sensitivity, knowledge of the limits of exploitation and respect for the threshold levels of tolerability of the visited hypogean areas. The average number of visitors of the three Apuan tourist caves is largely eco-sustainable (Grotta del Vento: 65,000; Antro del Corchia: 16, 000; Buca di Equi: 8,000) and has little consequences on the physical and chemical balance of the karst landscape, even during daily peaks. They are medium to high energy karst systems and therefore involve rapid flows of air circulation and air exchange with the outside. Moreover, the instrumental monitoring reassured the experts on the potential risk of high CO_2 concentration levels owing to the presence of tourists. As a matter of fact, hypogean $CaCO_3$ deposition does not entail negative impacts.

Furthermore, geosites do not risk being destroyed or degraded because of the construction of roads and buildings. Building is forbidden in the protected area, with the only exception for functional adaptations of already existing building. With regard to the construction of new roads, the Plan for the Park only allows works for the rationalization of already existing roads and absolutely rules out any hypothesis of superficial connection between the two main sides of the Apuan Alps.

The only economic activity, which in theory could exert pressure on the area and affect geosites, is marble quarrying. Before the foundation of the Park Authority, quarrying activity had irreversibly transformed the natural morphology of main and secondary ridges, saddles and high mountain slopes cutting and breaking down mountain skyline, whose damage is visible from afar (Focolaccia, Alto di Sella, Carchio, Cervaiole, Corchia). During that far away period the expansion of

quarries brought about the destruction of some small and medium sized geosites such as one of the roches moutonnées in Orto di Donna and two of the potholes in the Anguillaja ditch.

Since the Park Authority is fully responsible for planning and authorization with regards to quarrying activities, these negative episodes have ceased, not least because every exploitation plan is now subject to Environmental Impact and Incidence Assessments, which are going to be better explained in the following paragraph. The strategy implemented by the Park Authority has been entailing the progressive transfer of marble quarries for years. Where morphology allows it, there will be a shift from open air quarries to underground quarries, with the purpose of mitigating the impact on the landscape and safeguarding hypogean geomorphosites. In case of quarrying development in areas where karst caves may be present, a preventive survey by georadars might sometimes be necessary, whereas quarrying activities are forbidden in the unlikely cases of accidental discovery of minor hypogean waterways.

Finally, the authorization for a new exploitation plan has sometimes been an opportunity to improve the practicability of those geosites which had been covered with debris by former quarrying activites. For example, at present the large Carcaraia doline is being cleaned from waste material ("ravaneto") which had almost filled it up in the past.

B.6 – CURRENT STATUS IN TERMS OF PROTECTION OF THE SITES

Article 11 of the Tuscany Regional Law no. 56 of 6th April 2000 safeguards the diversity of wild animal species, non-cultivated plants, habitats of Community interest as well as the geodiversity of certain natural forms of the territory defined "Geotopes of Regional Importance" under the article itself. Tuscan planning actions, carried out at various levels – from regional to local – consider geological sites "structural invariants", that is to say elements of physical and structural value characterized by their invariance or by a restriction on their use by tourists. Going into technical details, they are territorial components or landscape elements, whose typical features of stable configuration or slow alteration ought to be protected, preserved and enhanced.

The Plan for the Park, which is the planning instrument adopted in 2007, contains a long list of geosites/geotopes almost identical to the list used in this dossier, thus acknowledging their status of "structural invariants". The Plan's *map of the geological survey* pinpoints all geological sites in the Park and its adjacent areas. Technical implementation rules aims to safeguard them as they do not allow actions risking of jeopardising the value or the possible use of the geosites/geotopes. The protection of the geological heritage in adjacent areas is regulated by protection rules included in the *Piani Territoriali di Coordinamento delle Province* (Provinces' Territorial Coordination Plan), in which these geosites are considered "structural invariants" like those within the Park. The choice stems from the existence of similar or almost identical protection rules and the directives on the environmental and geological heritage agreed upon by territorial bodies and inserted in a special section of the Plan for the Park.

Further rules on the protection and preservation of geosites are set out in the Park Regulations which is under approval. However, provisional measures for the safeguarding of geosites are already in force under art. 31 of Tuscany Regional Law no. 65 of 11 August 1997, as are legally binding restrictions established by art. 11 of national framework Law no. 394/91 on protected areas. Focusing on the safeguarding of the geological heritage only, opening and using quarries, mines and dumps as well as extracting minerals, changing watercourses' regimes, introducing and using any means of destruction or alteration of biogeochemical cycles are forbidden in the area of the Park. Finally, the Park Authority has drown up a Road Map concerning the authorisation of actions and works on the territories under its jurisdiction. The road map foreshadows those rules on protection and conservation of geosites already laid down in the Park Regulations.

In the view of the potential threats posed on the geological heritage by mining activities, an aspect requiring in-depth examination concerns the planning and authorization of extractives activities, as they characterize the landscape of small, but representative, areas of the territory. Regional law forbids the extraction of industrial and technological materials (aggregates, sands, gravel, etc.) in the entire territory proposed as Geopark. The Park Authority has extended the ban to the quarrying of dolostones (Frigido Valley) which were used in the steel and glass production. Hence those open-air quarries already existing before the creation of the Park have been abandoned. Nowadays traditional quarrying activities are only allowed inside the boundaries of the "adjacent quarry areas" and limited to ornamental stones, which in the past were extracted in this area and are almost exclusive to the Apuan Alps (marbles, breccias, "Cipollino", Pietra del Cardoso).

These quarries of limited extension are subject to the planning jurisdiction of the Park Authority, which in the Plan for the Park establishes the size of the quarries and the technical and management rules for the extraction of this geo-resource. Quarrying activities planning, undertaken under the supervision of the Tuscan Regional Administration, always draws inspiration from the principles of sustainable development and the long-term use of natural resources, as well as from the Park's institutional aims with particular emphasis on the *"creation of a balanced relation between economic activities and the ecosystem"*. In the section regarding quarrying activities the Plan for the Park is more binding than any other generic or sector planning instrument, thus becoming the transition law for the PRAER (Regional Plan for Extractive Activities for the reclamation of excavated areas and for the reuse of recoverable residuals).

The Park Authority is also the main institution responsible for the authorization of each and every extractive project and any of its change. Quarrying project are subject to the Environmental Impact Assessment, the hydrogeological and the special Park authorization. When quarries are situated at the borders of or near SPAs and/or SCIs (or SACs) they also need to undergo the 'Incidence Evaluation'. The competent technical offices of the Park Authority ["Territorial Planning", "Soil Conservation",

"Research and Conservation", "Park Rangers"(surveillance and monitoring)] are responsible for authorizing and supervising quarrying activities. It is necessary to underline that the Park Authority does not owe quarrying areas and does not receive any contribution or funding by quarry managers and owners, who are not represented in the Park Authority governing bodies.

B.7 – DATA ON THE MANAGEMENT OF THESE SITES

The main, but not the sole, institution responsible for the management of the Apuan Alps geosites is the Park Authority, which, according to the location and territorial implication of each geosite, is going to involve local authorities (municipalities, provinces and consortia of mountain municipalities) and/or firms, tourist centres (APT Tourist Office, Tourist Information Center IAT) and/or environmental and trade associations, and/ or local communities, mountain family associations, citizens and groups of citizens. The model to be used and already widely applied is based on raising the awareness of local institutions and populations, which ought to be in charge of their own sustainable development and play the innovative role of "community keepers" of geodiversity. The management activity and the technical-administrative monitoring will be carried out by the Park Authority, which already counts on Offices and effective services, suitable for the above-mentioned objectives. The organizational structure, underlying the Direction of the Park consists of Units or operative staff specializing in the technical-scientific sector ("Soil Protection", "Territorial Planning", "Research and Conservation"), the educational-promotional sector ("Territorial Enhancement"), the economic-administrative sector ("Director's Staff" and "Budget and Human Resources") and the territorial patrolling sector ("Park Rangers").

The Park Authority staff comprises 23 employees with open-end contracts, more than half of whom possess a university degree while the rest of them have a higher education qualification. More than 10% of the employees graduated in geology and another 10% in natural sciences. The professional expertise is constantly updated and applied thanks to the participation in training courses, seminars, workshops, internships, etc.The permanent team of the Park Rangers has the duty of monitoring the territory and providing assistance to visitors along paths and roads within the park and its surroundings. It is helped in its tasks by two provincial groups of Voluntary Environmental Wardens for a total of 21 people. It is possible to become part of the Voluntary Environmental Wardens service after completing specific training courses and passing the final exam on environment and territory protection. Moreover, in the area which has been proposed as Geopark there are already 37 Park Guides, authorized by the Tuscany Regional Administration upon the successful completion of the relevant training courses. The Park Guides organize educational and didactic meetings in primary and secondary schools, and take care of visitors during their trips to the most interesting natural areas of the Apuan Alps, where the physical landscape is characterized by numerous geosites. A group of Guides, specializing in speleology, is qualified to accompany visitors through non-equipped hiking trails in the over thousands Apuan karst caves.

At present, there are three geosites that are currently and regularly managed, namely the three Apuan Alps tourist caves, where the karst caves *vie ferrate* (Iron ways) require a high level of organization, as the entrance is subject to the payment of an entry fee. The Grotta del Vento (the Wind Cave) in Garfagnana is a clear example, in Italy, of a family-run business which has steady profits and offers stable employment to a fair number of local residents. The enhancement of this hypogean geosite is to be attributed to a speleology lover, who was able to organize tourist flows whilst respecting the integrity of the karst environment, thus serving as an interesting model for sustainable management. The Buca di Equi Terme (Equi Terme Hollow) in Lunigiana, owned by Fivizzano Municipality, is another Apuan hypogean karst itinerary which is currently managed by an environmental association (Legambiente) through local cooperatives providing excursion guides and education workers. For ten years the Park Authority has been supporting and promoting the activity of the "Buca" within 'Karst-Palaeontological Park of the "Grotte" (Caves)' in Equi Terme, which provides visitors with educational activities on the geological-palaeontological-natural and the archaeological-palaeoethnological heritage. Finally, the Antro del Corchia (Corchia Cave) in Alta Versilia (Upper Versilia) is the most advanced example of underground karst itinerary, very well integrated into the network of tours to former mercury mines (Quicksilver Mines) and underground marble quarries. These equipped geosites are grouped together in an interesting tourist project called Corchia Underground, whose cultural task is also supported by the Museum of the "Pietra Piegata" (Bended Stone) and the Museum of community and enterprise "Lavorare Liberi" (Working in freedom). The Park together with the Municipalities of Stazzema and Forte dei Marmi, set up a public company LLC (Antro del Corchia Srl) in order to manage the cave. The services are carried out by a cooperative voicing the interests of the local community which, in turn, let the *Corchia Underground project* use former quarrying sites and one of the two above-mentioned museums, after local associations and firms financed their restoration and recovery. It is a rare example of synergic cooperation between public and private local institutions sharing the aim of preserving enhanced geosites through their proactive management.

B.8 – LISTING AND DESCRIPTION OF NON-GEOLOGICAL SITES PRESENT IN THE TERRITORY THAT MAY BE LINKED TO THE SITES OF GEOLOGICAL INTEREST

Vegetation and animal population in the Apuan Alps have an undoubted environmental and naturalistic value both for their high levels of biodiversity and for the number and the diffusion of endemic and relict species testifying to complex evolution linked to changes in climate and paleographic situations. Briefly, the biological richness of the Apuan Alps depends upon two elements:

a) their relative isolation from the Apennines;
b) their location on a transit area between the middle-European and Mediterranean biogeographic regions.

It is enough to recall that almost half of the seven thousands Italian vegetal species (phanerogames) live in the Apuan territory, where, within less than 2000 m of height, groups of vegetation almost continuously follow one another, from the xero-thermophilous Mesomediterranean basal area to the uppermost microtherm subalpine area.

Describing the quality and quantity of flora and fauna in the Apuan Alps in a few lines is difficult and would risk trivializing an otherwise rich and diversified situation. Nor the description of sample areas or significant sites is feasible, as the contexts are so complex, diversified and often intertwined that a selection of places is not possible. Hence the decision of describing those typologies of habitats which better illustrate the biological and landscape diversity of the Apuan territory. It cannot be ignored that the majority of the Apuan habitats greatly depend on the features of the substrate both in terms of rock and soil chemism and existing morphostructures and morphoscultpures. The most valuable sites are the rarest, most residual and often most vulnerable, providing the Apuan Alps with precious elements of environmental biodiversity, here expressed in terms of differentiation of both ecosystems and living organisms.

The following elements are noteworthy:

- Periglacial bogs or limited humid areas of a carbonate and inaccessible mountain range which does not allow water stagnation and groundwater table surfacing. These extremely rare biotopes are important not only from a floristic-vegetational point of view, but also from a faunal, geomorphological and palynological standpoint [Bogs of Fociomboli, Puntato, Mosceta, Mt. Tontorone, Piano di Gorfigliano];
- *Vaccinium* formations, limited to residual outliers of some siliceous peaks and testifying to the survival of a boreal vegetation strip with relict elements of cranberry heaths and some typical species, despite clear signals of "floristic loss" identifiable in this part of the Apennines range too [Mt. Pisanino, Zucchi di Cardeto, Mt. Contrario-Cavallo, Mt. Fiocca-Sumbra];
- Humid thalwegs on Paleozoic schists ("Verrucano" s.l.) with sometimes very humid and cool microclimatic conditions contributing to the presence of "Atlantic" relicts of high geobotanical significance (such as *Hymenophyllum tunbrigense* and *Vandenboschia speciosa* ferns). They are often punctiform and develop under a condition of extreme vulnerability because of the existence of inhabited settlements, roads and various working activities [Valle del Frigido, Canale di Renara, Valle del Serra, Canale del Giardino, Valle del Vezza, etc.];
- Limited extension of *Oleo-Lentiscetum* which is an interesting xeric trace with typical flower specimens, quite limited here but common in coastal areas of southern Italy [Castello Aghinolfi-Rupi di Porta].

High-Altitude Habitats (Dir. 92/43/EEC with regional amendments and additions)	**Natura 2000 Code**
Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	6110
Alpine and subalpine calcareous grasslands	6170
Calcareous ridges and scope with discontinue alpine and subalpine vegetation	6173
Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)	6210
Siliceous scree of the montane to snow levels (*Androsacetalia alpinae* and *Galeopsietalia ladani*)	8110
Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*)	8120
Western Mediterranean and thermophilous scree	8130
Medio-European calcareous scree of hill and montane levels	8160
Calcareous rocky slopes with chasmophytic vegetation	8210
Calcareous rocky slopes with chasmophytic vegetation	8213
Siliceous rocky slopes with chasmophytic vegetation	8220
Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*	8230
Limestone pavements	8240

An outline of the most widespread and typical elements of the Apuan natural landscape requires the descriptive categories of habitats identified by Community Directive 92/43/EEC of 21 May 1992 which follows and integrates Directive 79/409/EEC of 2 April 1979. The territory of the Apuan Alps is characterized by the main natural habitats of community interest, listed in the tables here enclosed. First of all, there is a number of typical elements of high-altitude landscapes which are linked to chasmophytic and gravel environments exclusive to this unusual carbonate part of the

northern Apennines. They are habitats which are widespread on Apuan rock mountainsides and scree and are characterized by endemic, relictual or relevant species of biological interest. Their aspect and structure are greatly affected by geological and geomorphological elements. This is even more evident on often steep areas with detrital lithosols and taluses.

They are extensive landscapes with sometimes blurred borders and mosaic-like features which are found in a number of geographic locations highlighted below for their representativeness:

- chasmophytic and calcicole phytocoenosis on Cresta Garnerone, Mt. Tambura, Pania della Croce;
- gravel and calcicole phytocoenosis in Borra Canala;
- litophile phytocoenosis of calcareous plateaux in Passo Fiocca and Vetricia;
- chasmophytic *Juniper* thickets of *Juniperus phoenicea* in Valle della Tùrrite.

Montane and hilly habitats, excluded from the previous list, are added below. They especially comprise formations with trees, shrubs and subshrubs:

montane habitats (dir. 92/43/EEC with regional amendments and additions)	**natura 2000 code**
European dry heaths	4030
Alpine and Boreal heaths with Ericacee (*Loiseleurio-Vaccinietalia*)	4060
Species-rich *Nardus* grasslands, on silicious substrates in mountain and submontaion areas	6230
Transition mires and quaking bogs (*Scheusczeretalia palustris; Caricetalia fuscae*)	7140
Apennine beech forests with *Taxus* and *Ilex*	9210
Apennine beech forests with *Abies alba* and beech forests with *Abies nebrodensis*	9220
Castanea sativa woods	9260
Quercus suber forests	9330

The various natural habitats as defined in Community Directive 92/43/EEC have a different significance in the Apuan Alps, not only with regards to quality and quantity of animal and vegetable species, but also for their territorial extension. The table below shows that the territory is dominated by rocky and high-altitude habitats with chasmophytic vegetation and/or bushes, as high-altitude places with outcropping carbonate substrates prevail along the main ridge. These elements of high naturalistic interest, here grouped together because often found in natural mosaics, amount to as much as 77.8 % (2,335.8 ha) out of the overall surface of the Apuan Alps covered by natural habitats of community interest. A further 6.9 % (206.9 ha) of screes with a carbonate matrix completes the picture of a vegetal montane landscape almost devoid of forest vegetation, dependent on the rocky substrate and different from similar situations at the same altitudes in the northern Apennines. Differently, the contribution of meadows of community interest (1.0% only), humid mountainous areas (0.2%) and beech forests with autochthonous conifers worthy of conservation (2.2% *Taxus baccata*; 2.6% *Abies alba*) is modest.

habitats (dir. 92/43/EEC)	**park area**		**adjacent area**		**other areas**	
	surf. (ha)	**%**	**surf. (ha)**	**%**	**surf. (ha)**	**%**
Siliceous rocky slopes with chasmophytic vegetation from alpine to basal level of the Eurosiberian and Mediterranean areas	94.6	***3.2***	0.0	***0.0***	0.0	***0.0***
Calcareous rocky slopes with chasmophytic vegetation (*Saxifragion lingulatae*); limestone pavements; subshrubs, alpine and subalpine calcareous creeping shrubs and perennial grasses (*Seslerietea albicantis*)	2,075.7	***69.1***	74.2	***2.5***	185.9	***6.2***
Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*) with perennial grasses and/or fern	205.1	***6.8***	1.7	***0.1***	0.1	***0.0***
Semi-natural dry grasslands on calcareous substrates (*Festuco-Brometalia*)	9.2	***0.3***	0.0	***0.0***	0.0	***0.0***
Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe) (*Nardion strictae; Violo-Nardion*)	22.2	***0.7***	0.0	***0.0***	0.0	***0.0***
Subalpine heaths with *Rhododendron ferrugineum* and Apennine *Vaccinium vitis-idaea*	26.6	***0.9***	0.0	***0.0***	0.0	***0.0***
European dry heaths	152.0	***5.1***	0.0	***0.0***	4.4	***0.1***
Transition mires and quaking bogs	7.0	***0.2***	0.6	***0.0***	0.0	***0.0***
Apeninne beech forests with *Taxus* and *Ilex*	66.6	***2.2***	0.0	***0.0***	0.0	***0.0***
Apennine beech forests with *Abies alba*	77.2	***2.6***	0.0	***0.0***	0.0	***0.0***
Total (out of 3003.1 ha)	2,736.2	***91.1***	76.5	***2.6***	190.4	***6.3***

figure 8* – Galium palaeoitalicum *Ehrend. typical endemic specie on limestone pavement of the Apuan Alps

site ord. n.°	name and bioitaly code	total (ha) surface	main environmental type	other relevant environmental types
SCI 6	M. Sagro – IT5110006	1,223.28	Mountain area with steep rocky slopes, with vertical walls and grassy ledges, secondary grasslands and broad-leaved forests (beech and chestnut)	heaths, abandoned mining areas
SCI 7	M. Castagnolo – IT5110007	116.10	Steep rocky slopes with vertical walls and grassy ledges, secondary grasslands and shrublands (*Erica sp. pl., Ulex* formations), pasture-meadows being abandoned	sparse broad-leaved heliophilous forests, conifer afforestation
SCI 8	M. Borla-Rocca di Tenerano – IT5110008	1,081.30	High mountain area characterized by mainly calcareous landforms with broad-leaved forests (beeches, ostryeta, chestnuts), rocky slopes and grasslands	Dolines with heathers, montane *Vaccinium* formations, small groups of coniferous afforestation, abandoned mining areas
SCI 16	Valli glaciali di Orto di Donna e Solco d'Equi – IT5120008	2,832.62	Mountain valleys of glacial origin, with broad-leaved forests (beeches, ostryeta, chestnuts), siliceous and calcareous rocky slopes with vertical walls and grassy ledges, primary and secondary meadows	montane and subalpine heaths, shrubs, active and abandoned mining areas, upper course river ecosystems
SCI 17	M. Sumbra – IT5120009	1,862.57	Broad-leaved forests (beeches, ostryeta), siliceous and calcareous rock landforms with vertical walls, glacial cirques, limestone floors, primary and secondary meadows, shrublands (mainly Ulex formations)	*Vaccinium* formations, heaths, active and abandoned mining areas
SCI 18	Valle del Serra-M. Altissimo – IT5120010	1,857.08	Area largely located around the upper course of Torrente Serra, characterized by broad-leaved forests (chestnuts, beeches, ostryeta), shrubs-degradation formations (*Erica sp. pl., Ulex* formations), ridges and rocky slopes, with mainly secondary meadows	abandoned mining areas, river ecosystems
SCI 19	Valle del Giardino – IT5120011	783.17	Wooded slopes with prevalence of mesophile broad-leaved trees (sweet and horse chestnuts, European hornbeams, Turkey oaks)	Degradation shrubs, river ecosystems,
SCI 20	M. Croce-M. Matanna – IT5120012	1,246.48	Wooded slopes with prevalence of broad-leaved trees (chestnuts, beeches, ostryeta, Turkey oaks), peaks with calcareous vertical walls and scree on western sides, pasture-meadows on eastern sides.	degradation shrubs of the broad-leaved forests and recolonization of abandoned pastures
SCI 21	M. Tambura-M. Sella – IT5120013	2,009.88	Alpine landforms characterized by calcareous rocky slopes, large glacial cirques with scree, primary and secondary meadows, main ridges of the Apuan watershed	Broad-leaved forests (mainly beeches and hornbeams), degradation shrubs (Ulex formations, heaths), abandoned mining areas
SCI 22	M. Corchia-Le Panie – IT5120014	3,962.87	predominantly calcareous landforms with a typical alternation of vertical walls, grassy slopes, rock outcrops and scree. Broad-leaved forests with predominance of beeches, ostryeta and chestnuts are found at the bottom of the mountains and on northern sides	degradation shrubs, montane heaths, bogs and wet meadows, hay meadows, active and abandoned mining areas
SPA 23	Apuan primary and secondary meadows (SPA) – IT5120015	17,320.84	Upland areas of the Apuan Alps with calcareous and siliceous walls and rock outcrops, primary and secondary meadows	heaths, shrubs, broad-leaved forests, sweet chestnuts groves, active and abandoned mining areas
SNI B06	M. Palodina – IT5120105	1,091.38	Continuous forest matrix with prevalence of chestnuts, beeches and mixed forests with valuable broad-leaved trees	rocky slopes, wet meadows, shrubs

C – ARGUMENTS FOR NOMINATING THE TERRITORY AS A EUROPEAN GEOPARK

The area proposed as "Apuane Geopark" is a mountainous territory of undoubted interest and geo-environmental value. There are very few places in Italy and Europe which can boast such a natural heritage rich in landscapes, environments and naturalistic elements. This holds true not only for flora and fauna, which are rich in endemic species, but also for rocks, minerals, fossils, tectonic structures, superficial and hypogean morphologies, which provide unusual, varied and widespread elements of environmental value.

The proposed territory is a highly suggestive orographic complex, both for the imposing feature of the main range and the high relief energy, accompanied by a harsh morphology of carbonate crests, towers and walls, with deep valleys abounding with water. The rough and harsh physical landscape of the main ridge is very different from the gentle slopes of the nearby Northern Apennines.

The Apuan Alps are famous thanks to their beautiful marbles, deep abysses and large karst underground cavities. Their geographical location and vertical development, exposure and the different nature of rocks have created diversified and contrasting environments rich in animal and vegetal populations. The whole territory is characterized by a high biodiversity as a result of a complex biological evolution occurred in the context of a large territorial biodiversity deriving from a complex geological history. Habitats and vegetal and animal species of Community interest enabled the identification of a large SPA and ten SCIs directly linked with the physical landscape and the geological substrate with crests, cliffs, carbonate or siliceous ridges and screes, limestone pavements and lithosols.

The geological heritage of the Apuan Alps is particularly valuable and arouses all types of interests, from global to local (according to the cases), as the territory preserves remarkable numerous and widespread traces of the geological and evolutionary history of the continent and the Mediterranean region. Moreover, the use of geological resources here has a universal scope and value.

The importance of the geological heritage is particularly evident:

a) in the structural geological context with the peculiar tectonic window at the centre of the Apuan ellipsoid;
b) in the occurrence of the oldest geological formations of the whole Apenninic range;
c) in the great variety of mineralogical attitudes and mineral species, a significant number of which has been discovered in the Apuan region;
d) in the karst phenomena, especially hypogean, which render Mt. Corchia a karst system of global value;
e) in the traces of the great climate change which brought about glaciations and associated prehistoric settlements;
f) in the ecological importance of a large number of geosites which are rich in endemic species of plants and animals and are often natural habitats of Community interest and in some cases also of conservation priorities;
g) in the archaeological and historical-cultural remains and finds linked to mining and quarrying activities.

C.1 – COMPREHENSIVE ANALYSIS OF THE TERRITORY'S POTENTIAL FOR THE DEVELOPMENT OF GEOTOURISM

C.1.1 – The Apuan Geotourism and its Renaissance origins

The morphological rarity of the Apuan Alps has always been an attraction for naturalists-travellers, or at least, it has been so since the 16th century, when a scientific investigation on the mountain range was carried out to understand its nature and find natural products useful for economy. In the modern age famous geologists and botanists used to match excursions with the pleasure of naturalistic knowledge. Herborists were the first to climb peaks in search for rare medicinal plants. The travel of Luigi Anguillara (1512-1570) and Luca Ghini (1490-1556) dates back to 1543-44 and was followed by the excursion by Andrea Cesalpino (1525-1603) who focused on a firestone, described as "invincible to fire", found in Cardoso di Stazzema. In the 17th century the Dutch Jan Jansson (1588-1664) visited the area and drew the valley of Seravezza (around 1657) pinpointing the sites for marble excavation and silver extraction.

The Apuan Alps, visible from western Florence, were particularly fascinating for its citizens, who grew up surrounded by Renaissance culture and, therefore, naturally inclined to discover nature from an aesthetic and scientific point of view. The visits were already numerous in the 18th century. In particular, in 1704 Pier Antonio Micheli (1679-1737) and Bruno Tozzi (1656-1743) were among the first to go, often on foot, from the Tuscan city to the Mountain Group of Panie. The description of the naturalistic voyage of Giovanni Targioni Tozzetti (1712-1783) in 1743 is rich in content as he described not only Apuan rocks and minerals, but also physical landforms and morphogenetic agents.

C.1.2 – Mountain climbing and hiking: core attractions of the Apuan Mountains

These "Tuscan Alps" started attracting tourists' attention in the second half of the nineteenth century, the age which pioneered the conquest of the Apuan peaks, driving numerous explorers to scramble up inaccessible mountain paths and steep rock faces. From 1865 onwards, in concurrence with Italy's capital Florence, the climbing enterprises turned to the Apuan mountains for a number of reasons, namely: the difficulty of the ascents, the area's accessibility, the allure of their unique landscape, but also the scientific curiosity and the industrial interest for their underground geo-resources. The Italian Alpine Club's Florence branch, the second body of its kind to be founded in Italy (1868),

has always focused on the Apuan mountains as the main centre for its activities. Its first members included not only mountaineers of great renown (Giordano, Corona, Rimini, etc.), but also famous geologists (Cocchi, De Stefani, Marinelli, etc.) and great marble entrepreneurs (Del Medico, Fabbricotti, Dalgas, Simi, etc.). Anglo-Saxon travellers/explorers/mountain climbers such as Budden, Freshfield and Tuckett also played an important role in promoting the Apuan mountains which became their second homeland. They helped spread the word about these mountains beyond their national borders, as they constituted a compulsory part of the Tuscan leg of the *Grand Tour*.

Since the early 1900s, the noble and upper middle class families not just from Tuscany but from other regions as well, have got to know the Apuan Alps by following a persistent and seductive echo which accompanied them through the valleys, up to the most exposed paths of the mountain range. The flow of visitors with an interest in mountain climbing has been consistent up until today for the high grades of difficulty of the Apuan peaks despite their relative elevations. Over the last few decades the excursions sector has registered the highest increase in terms of people taking part, especially in numbers joining organised groups which include individuals of all ages and social backgrounds. The greatest appeal of the Apuan Alps is the harsh landscape of its peaks, composed of carbonate rocks, which provided and may again provide incentives for further growth of ecotourism and geotourism.

The hystorical presence of hikers along the high altitude routes – the so-called "high paths" – has ensured the conservation of an intricate network of footpaths – referring specifically here to pathways which are signposted and maintained – which cover a distance of 611.3 km. The various branches of the Italian Alpine Club which, in collaboration with the Park Authority, guarantee the routine upkeep of mule tracks and mountain paths. This network of routes connects and brings visitors closer to areas of outstanding natural beauty along the Apuan ridge, allowing them to appreciate these areas which are home to many important geological sites.

Geotourism has always been an innate feature of the exploration of the "high paths" and climbing itineraries, as it brings the visitor, who may initially have been drawn to the area for sporting and recreational reasons, closer to the geological heritage with its breathtaking scenery and above all its unique landscape. The Geopark's managers should play on these emotions in order to stimulate interest and promote popular (but in-depth) knowledge of the perceivable natural elements, to educate and raise awareness on the utmost importance of protecting and preserving geodiversity. The entire Apuan network of footpaths is served by 16 mountain huts, offering visitors the chance to refreshen and spend the night, especially during the summer months and on weekends during other seasons. These facilities, which are sometimes located quite far away from main roads, ensure that people continue visiting the Park geological sites, offering technical assistance and tourist information to visitors. The huts and the orientation and hospitality structures that exist throughout the area are well supplied with information materials, mainly in the form of guide books and hiking maps.

The territory boasts an old and long tradition of pocket size publications of a general nature which aim to increase the numbers of visitors on the mountain paths and spread the word about the geography of the highest areas of the mountain range. The first guide to the Apuan Alps – *Guida alle Alpi Apuane* – by Zolfanelli and Santini was published as early as 1874, followed in 1905 by the most famous publication of the Italian Alpine Club's Liguria branch, written by Bozzano, Questa and Rovereto, whose rich descriptions of alpine environments are testament to a profound geological culture. A more recent and updated work is the book entitled *Alpi Apuane* (*Apuan Alps*) by Nerli and Sabbadini (1958), an Italian Alpine Club and Touring Club publication which precedes a long series of more recent tourist guides. Amongst these, various publications which stand out, have been promoted and/or published by the Park Authority: *I Paesaggi delle Alpi Apuane* (*The landscapes of the Apuan Alps*) by Pizziolo *et al.* (1994); *Apuane segrete* (*Secret Apuan Alps*) (1995) by Lapi and Ramacciotti; *L'Alta Via* (*The High Path*) by Nerli (2005) and *Guida al Parco delle Alpi Apuane* (*Guide to the Apuan Alps Park*) by Valdes (2005).

In addition to the various tourist guides there are also hiking maps for the Apuan Alps, issued by various publishing houses specialising in cartography. These are reproduced on scales of 1:50.000 and 1:25.000 and depict the extensive and intricate network of mountain paths, all of which are nevertheless marked and numbered along their entire length.

C.1.3 – Speleological exploration, the last uncrossed frontier

A long-standing scientific and cultural interest lies not only in the Apuan mountain ridge that explorers and tourists have been visiting since the second half of the nineteenth century, if not before, but also in the caves of the Apuan Alps. This early form of geotourism is already apparent throughout the course of the Eighteenth Century, in those access-friendly karst cavities which fuelled the fantasy of a culturally evolved public. In 1704, Antonio Vallisneri senior (1661-1730) visited La Tana che Urla (The Screaming Den) in Garfagnana and La Grotta di Equi Terme (The Cave of Equi Terme) in Lunigiana, to understand the pluvial origin of the springs. This led to the first explanation of the water cycle, between 1704 and 1715. In 1783 Lazzaro Spallanzani (1729-1799) undertook a similar scientific tour which included a visit to Tanone di Torano or "Grotta del Forolio" (The Great Den of Torano or Cave of Forolio) as it was then called, a cave near the town of Carrara which aroused great interest amongst visitors of the time, because its floor was believed made by marine sand. The magic of this rare phenomenon, shrouded in the mystery of a dark place, but extraordinarily rich in concretions, drove Spallanzani (and others who followed) along the paths of the Apuan mountains where the caves are teeming.

However, the birth of modern speleology is far more recent. 1840 – the year in which the first entrance into Antro del Corchia or "Buca d'Eolo" (Corchia Cave or Aeolus' Hollow) was discovered – started an uninterrupted season of explorations, with new entrances and branches constantly being discovered. This was thanks to Angelo Simi's family from Levigliani di Stazzema, whose son Emilio – a geologist and botanist – was able to spread the word beyond the nation's

borders. The signatures of many illustrious visitors – who throughout the course of the nineteenth and twentieth centuries left written evidence of their presence – can still be seen in the first part of the cave. Many individuals, such as Leopoldo Pilla, Paolo Savi, Igino Cocchi etc., visited the cave attracted by celebratory descriptions of "Buca d'Eolo".

In the second half of the nineteenth century and the early twentieth century, the scientific community turned its attention to the Apuan caves for their palaeoethnological and palaeontological interest, following Carlo Regnoli's (1838-1873) work. It was during the first explorations of the Grotta all'Onda (Cave by the wave) on Mt. Matanna and Tecchia d'Equi in Lunigiana, which took place during this period, that numerous discoveries of finds of lithic industry from the Mousterian to the Neolithic as well as many remains of Würm extinct fauna (cave bear, lion, leopard, hyena, jackal, snow hare, etc.) were made. The first census of the 174 caverns and caves of the Apuan mountains (*Caverne e Grotte delle Apuane*) was made in 1913 by Alessandro Brian (1873-1969), a Genoese bio-speleologist, in collaboration with Cesare Mancini. The first speleological groups were formed after World War I, introducing a new season of collective explorations and systematic expeditions which took place far more frequently that any research which had previously been carried out by individuals. The Gruppo Speleologico Fiorentino (Florentine Speleological Group) was founded in 1927, providing a strong incentive for research as well as triggering frequent visits to the Apuan caves. Soon after, explorations began in other important cavities of the systems of Panie and Corchia, such as La Tana dell'Omo selvatico (The Wild Man's Den) and L'Abisso Revel (Revel's Abyss). Also the Antro del Corchia (Corchia Cave) has been subject of constant visits, with the "Florentines" that in 1934 reached the depth of - 540 m, believing to have reached the bottom of the cave. Following the Second World War, the speleological explorations slowly resumed and continued to take place throughout the reconstruction period, with increasing numbers of groups of foreigners and Italians from North-Central Italy now taking part. In the Sixties Antro del Corchia (Corchia Cave), more than any other cave, attracted speleologists from all regions of Italy and European countries, especially Britain and France. The high number of new karst cavities and other unexplored branches that have been discovered over recent decades as well as the frequency of these discoveries, have now made the task of keeping updated a historical report impossible.

The caves of the Apuan Alps attract visitors not only because of their scientific and sporting interest but also because of their recently discovered educational and recreational dimension. Credit goes to the speleological societies, federations and groups for their broad diffusion of geological and chemico-physical knowledge relating to these underground environments as well as for progress in speleogenesis research. This type of geotourism, which already existed before the creation of the Geopark, could develop further thanks to the Park itself. There is room for improvement with regard to the diffusion and increase in importance of the more than one thousand existing karst cavities, given the high level of promotion and enhancement these have been subject to. The presence of speleologists in the Apuan mountains throughout the year is now a fact and is unique in Italy.

Visits to the karst cavities are not only available to speleologists, that is to say expert visitors with equipments. The Apuan Alps also offer possibilities for the wider public to access three tourist caves, each located in the three areas into which the territory is divided: Lunigiana, Garfagnana and Versilia. The first attempt to make an Apuan cave accessible to tourists took place in 1964 with Buca di Equi Terme (Equi Terme Hollow) in the town of Fivizzano, followed by the Grotta del Vento (Wind Cave) in the town of Vergemoli in 1967 and finally the Antro del Corchia (Corchia Cave in Stazzema) in 2001. This tourism welcomes approximately 90,000 paying visitors every year, producing a turnover of over one million Euros in twelve months (including capital generated from merchandising and catering).

C.1.4 – The Park and environmental and geological tourism

With the foundation of the Park in 1985, another form of tourism emerged, adding to the deep-rooted "traditional" types. It established itself with such continuity and contiguity, that it led these typologies to overlap. Undoubtedly, the Park has been an important propellant for environmental tourism in the whole mountain range of the Apuan Alps, whose environment and landscape conservation is guaranteed by the Authority of the protected area. The Park has organised the surrounding territory so that informational excursions can take place, explaining naturalistic, cultural and historical emergencies. No hunting takes place here and animals are free to roam around in an environment where human pressure is kept to a minimum and is controlled. Today, there are facilities in place for welcoming tourist in all protected areas (Massa-Carrara, Garfagnana, Versilia and Lunigiana). These include three Visitors' Centres (Massa, Castelnuovo Garfagnana and Seravezza) and two Tourist Information Points (Equi Terme and Marina di Massa) which the Park manages directly or in agreement with local authorities, other public figures and tourist promotion agencies.

It is difficult to measure the Park's influence on the number of tourists visiting the Apuan Alps because entrances to the protected areas are so numerous that it is impossible to determine exact numbers (and even more so to split tourists into categories such as: mountain climbers, hikers, etc.). Tourist numbers in mountain huts and other tourist structures constitute a very approximate estimate of total tourist numbers as this method does not take into account the daily presences of tourists and occasional visits. During the elaboration of various studies relating to the Plan for the Park, it was estimated that approximately half a million environmentally aware tourists visits the protected area of the Apuan Alps each year. These types of tourists could be ideal targets for the promotion of "geotourism".

A definite and statistically reliable fact is that representing the number of individuals visiting the three Apuan tourist caves, for a total of between 70,000 and 90,000 paying visitors each year. This data is especially valuable and is of particular economic and cultural interest as it reflects the usage of a particular aspect of the geological heritage. However, numbers in this particular type of tourist group are susceptible to medium and long term increases, even leaving aside

potential developments in the numbers of tourist caves and/or an increase in equipped routes available to the wider public. Given that tourism in Grotta del Vento (Wind Cave) has a long, well-established tradition, the already remarkable number of visitors will probably remain constant or experience a slight increase only. However, there is still room for increasing the number of visitors of Antro del Corchia (Corchia Cave) which has not been used at the maximum of its capacity as a result of the early uncertainty with regards to its management. The cave, as a matter of fact, could be attracting over 100,000 visitors a year according to an estimation made prior to its opening by the economist Paolo Leon (1995). The number of visitors of Buca di Equi Terme (Equi Terme Hollow), as well, is expected to increase, though to a lesser extent owing to the same above-mentioned reasons and the impact of recent changes in the management staff.

In any case, both Antro del Corchia and Buca di Equi Terme will soon be able to benefit from full integration into other structures, routes and activities which are being developed in the surrounding area and which are expected to provide further impetus for the long term use of these geological assets. More will be said further on about the 'Corchia Underground' System near Levigliani and the 'Karst-Palaeontological Park of the "Grotte" (Caves)' in Equi Terme and about how more tourism initiatives in the same area could generate enough critical mass to allow a economic self-management.

Finally, an assessment needs to be carried out regarding the territory's potential for the development of other geotourism initiatives aimed at promoting enhancement of new aspects of the Apuan Alps geological heritage. The numerous geosites and geological assets are prerequisites for the planning of new tourist routes, starting from some unique geomorphological features which have already been identified and recognised (eg: the "Marmitte dei Giganti", pot-holes on the southern side of Mt. Sumbra).

C.2 – OVERVIEW OF THE EXISTING GEO-INSTITUTION AND GEO-ACTIVITIES

As already mentioned, the Apuan Alps are an area of high geological interest both for basic and applied researches, especially with regards to quarrying activities for ornamental stones. Tuscan (and other) universities attach great importance to and are interested in the Apuan Alps. Witness numerous studies, dissertations and educational excursions aiming at deepening and spreading geological and geomorphological knowledge. The geology of the Apuan Alps has always been an appealing and culturally interesting topic for relevant literature. Despite the huge number of scientific contributions published in books, journals and congress proceedings since the first half of the 19th century, investigations are still constantly carried out on old and new branches of research and lead to the acquisition of new knowledge.

In particular, the University of Siena, with the contribution of the joint-stock company Henraux SpA and the patronage of the Park Authority, has recently set up the "Gaetano Giglia" university educational Centre in Cervaiole, on the group of Mt. Altissimo. It aims at developing and supporting geological studies in the Apuan Alps and applied research for the enhancement of geo-resources (with regards to environment and ornamental stones). It also contributes to the training of university students and new graduates through workshops, refresher trainings, field and educational excursions for various curricula. The "Giglia" Centre acts as a residential educational centre, offering hospitality facilities together with an educational laboratory and the necessary equipment for scientific research and training activities. These facilities are also available for other Earth Science departments and research institutes and for teachers/students/researchers of natural sciences, biology, environmental sciences, engineering, etc.

Ongoing initiatives and cooperation with geo-institutes external to the Park Authority emerging for their technical and scientific contribution are listed below together with their achievements and/or the aims established in each report. The analysis is limited to non-material activities – which are the main purpose of cooperations – as tangible assets are discussed in a following paragraph. In February 2010 the Park Authority signed a *Memorandum of Understanding on the development of geological knowledge and the protection and enhancement of the geodiversity of the Apuan Alps* with the Institute of Geosciences and Earth Resources (IGG) of the National Research Council of Italy (CNR). It is a framework agreement for actions contributing to the protection and preservation of environmental and landscape values of the protected territory as well as their promotion and enhancement through cultural initiatives increasing scientific knowledge. The memorandum of understanding envisages various initiatives enabling a long-lasting eco-friendly, sustainable use of geological resources taking into consideration their non-renewability. The Park Authority turned to IGG for its research activity aimed at understanding geological processes of the Earth system and for its knowledge of geodynamics, geochemistry, geochronology, geothermal energy and environmental geology.

A similar memorandum on the protection and enhancement of geodiversity was signed in August 2010 with the Centre for Geo-technologies of the University of Siena and in November 2010 with the Earth Science Department of the University of Pisa. Moreover, the Park Authority cooperates with the Italian Higher Institute for Environmental Protection and Research (I.S.P.R.A.), *Protected Areas and Territorial Planning* Division, Department for the *Protection of the Geological Heritage* (former National Geological Survey) to optimize the filing of geosites and make it compliant with Italian survey standards. Information on elements of geological interest found in the Apuan Alps has been entered into the ISPRA database in Rome.

C.3 – POLICIES FOR THE PROTECTION, ENHANCEMENT AND ECONOMIC DEVELOPMENT OF THE GEOLOGICAL HERITAGE

Ever since its early years, the Park Authority has always put in place integrated strategies and dynamic policies for the protection of the Park and the promotion of its environmental, landscape and cultural assets which have often been treated according to their value as a whole without ever favouring just one category or aspect of the territory heritage in particular. It was mainly the Plan for the Park, which from 1995 onwards, imposed a holistic vision and a structuralist and multidisciplinary approach to the planning of actions relating to the conservation, maintenance, restoration and requalification of the various sites. Thus, a clear orientation in the protection and enhancement of the distinctive features of the Park and its adjacent area has emerged over time. The historical and naturalistic heritage of the Apuan Alps was thus conceived and treated as a complex whole, comprising elements of different origin and content, which link together the added value and the development of an extraordinarily multiform and varied territorial system. As such, geodiversity is but one of the possible manifestations of the environmental and cultural diversity in a given geographical area. Geodiversity along with biodiversity are fundamental components of the landscape ecology; They are interlinked and have the same value-level.

In the context of the Italian protected areas, the level of attention paid by the Park Authority to the geological, geomorphological, hydrological and pedological features of its territory is not common. The geodiversity of the Apuan Alps has always been protected and promoted with awareness, even before the Geopark was conceived. Unlike the managing bodies of other Parks and Reserves, this Park Authority has not made the Earth sciences dependant upon the biological sciences; geology has not been overshadowed by botany, or zoology, ecology etc. Witness, the organizational structure of the Park Authority, the scientific and cultural skills of the technical staff as well as the works and activities carried out in the protected area.

In the future, the Geopark's strategy will place more emphasis on specific elements of the geological heritage, always within the framework of protection, conservation and enhancement of its environmental, landscape and cultural assets. For these objectives to be reached, agreements, conventions and protocols of intention have already been signed with associations, federations and agencies, for the protection, enhancement and/or economic development of assets or infrastructures linked to the Park's geological heritage.

In 1998, the Park Authority in conjunction with the Tuscan Speleological Federation – which brings together the numerous speleological groups in the region – reached and signed an agreement identifying and promoting initiatives for the protection, enhancement and scientific and cultural usage of the Apuan Alps' hypogean and epigean karst environments. Thanks to its scientific knowledge of and technical-exploratory expertise in the Apuan caves, the Tuscan Speleological Federation reported to the Park Authority the presence of litter, taking steps to eliminate the states of degradation.

The preservation of the integrity of karst environments visited by humans is the subject of a convention with the Regional Environmental Protection Agency of Tuscany (ARPAT) through the creation and management of a permanent monitoring system in Corchia's underground complex. The system, which has been in use since 2001, was intended as a means of gathering combined environmental data on air, water and soil, with the aim of analysing, studying and preventing potential alterations of the natural and particularly delicate conditions of the karst Complex.

In 1999, the Park Authority and the Italian Alpine Club (Regional Delegation of Tuscany) signed a protocol of intention with the purpose of raising awareness and contributing to the protection and enhancement of the natural resources in the territory of the Apuan Alps. In this protocol, both parties committed to providing regular updates and consultations on problems of greatest importance posed by tourism and sport activities in the mountain range. Over the past few years the Park-Italian Alpine Club Commission, responsible for implementing the protocol, guarantees the maintenance of the footpath network and signpost, the upkeep of the mountain huts and related works, as well as the promotion of activities connected to mountain climbing, off track skiing and hiking. All collaboratives actions are carried out with the specific aim of protecting the mountain environement and the science of speleology.

The protocol of intentions with the Municipality of Fivizzano, in force since 2001, set the goal – achieved in full – of making the caves at Equi Terme accessible to tourists and carrying out any work that was required to guarantee the safety of the karst cavity, as well establishing policies for its enhancement and management. The following year, the Park Authority and the Municipality of Stazzema set up a public limited company named "Antro del Corchia" S.r.l., the aim of which was to boost the use of this cave for tourism and cultural purposes, once an equipped pathway was created in its interior, thus making an important stretch of Italy's huge karst system available to a vast public.

Since 2009, the Park Authority has been planning an ambitious project – with few existing examples to be used for reference – aimed at promoting unique geological resources (ornamental stones) through good practices of environmental and economic sustainability, counting on the proactive and vital contributions of the inhabitants, authorities, trade associations and handcraft businesses. The primary objective is to establish an experimental "geocultural district" in Cardoso Valley, Pruno and Volegno di Stazzema, where "Cipollino" marble can be enhanced. These marble outcrops are of niche interest and have been considered a geosite by Wimbledon *et al.* (1996), in a pubblication for ProGEO. The *Being Green* projet aims to apply the model of an "integrated sustainable local production-chain", within a defined geographical area, through the formation of a production system developed on a local scale (but still sensitive to environmental fragility and aimed at preserving local identity and knowledge). The extraction of ornamental stone (exclusively of this kind and limited by a set quota) for a niche market is only permitted for on-spot production of durable high-quality pieces, which ought to be integrated into a tourist offer based on environmental features, landscape sights, historical settlements and local products. The viability of the project is linked to the existence of a geo-resource – "Cipollino" marble – a remarkable, fascinating stone of great aesthetic beauty, and

to the rich socio-cultural and environmental fabric. These elements offer a good starting point for the promotion of local identity and the improvement of the economic and overall living conditions within the district.

C.4 – THE TERRITORY'S INTEREST IN JOINING THE EUROPEAN GEOPARK NETWORK

The area's interest in becoming part of the European and Global Geoparks Network was for the first time presented and unanimously ratified during the conference in Marina di Carrara on 11th October 2001, on the day of the opening of the meeting entitled: *Geositi tra valorizzazione e conservazione della natura* (*Geosites between nature enhancement and conservation*). The document, which was approved during the conference and published on the title page of the scientific Proceedings of the meeting, acts as a reminder of the area's geological heritage, deeming it a worthy candidate for becoming a European Geopark. Among the participants and promoters of the 2001 motion – otherwise known as *Carta di Carrara* ("The Carrara Charter") – are many representatives from the Park Authority and the local administration bodies and communities, environmental, cultural and trade associations, as well as nationally and regionally recognised experts on the subjects of geology and geomorphology. The motion was a starting point for the following phase of further sharing of principles and ideas between locals, to support the area's membership in the network. Above all, this strategy has sought to stimulate a strong appreciation for and the proactive participation on the part of all resident populations in all actions and services aimed at protecting and fostering the enhancement of the area's geological heritage, allowing people to experience directly the importance of a Geopark. The testing out of a management model based on the shared use of geological assets, which is able to anticipate the effects of the future Geopark, has been especially fruitful in the area of Mt. Corchia. Following the creation of a scientific and cultural route through the karst cavities of Antro del Corchia (Corchia Cave), in 2001, the Park Authority started a close cooperation with the Municipality of Stazzema and the native Community of Levigliani, in order to create a local network of enhanced geological sites and documentation services, aimed at helping visitors get the most out of their stay. Between 2008 and 2009, two mining routes and two museums were created, whereas the visit to the marble underground quarries has been completely reorganised. The local population has invested most of the economic resources required for the project and currently manages tour visits and documentation centres directly, upholding the principles of geoconservation. The system of managment of this part of the Park – which groups together karst cavities, underground quarries and museums – has been called *Corchia Underground* and aims to enhance underground experiences, in contact with the geological background. Though on a smaller scale, the model was inspired by a project for tourism promotion purposes called *Toscana Underground* which the Park Authority coordinated across the entire region between 2005 and 2008, networking karst caves, disused mining sites and archaeological underground sites.

The concrete actions taken by the Park in relation to the local communities have always been the only means of increasing the consensus on the Park Authority and of raising civic awareness on the importance of sharing strategies for the protection and enhancement of the protected territory. In order to eliminate the initial distrust towards the creation of the Park, deemed an obstacle to the development of marginal areas, the Park Authority has always sought to actively involve local residents and territorial bodies. The aim of these actions was to promote and increase inhabitants' interest in taking part in the Global and European Geoparks Network, as in the previously described case of the construction of the *Corchia Underground* system in the village of Levigliani di Stazzema.

A similar participatory strategy was followed in the *Being Green* project, linked to the promotion of the soustainable use of "Cipollino" marble in the "geocultural district" of Valley of Cardoso, Pruno and Volegno di Stazzema. Whenever the Park Authority promotes initiatives relating to geo-conservation and/or sustainable enhancement of non renewable geo-resources, it explains to stakeholders that the project could form part of a more general strategy for the future Geopark, thus stimulating their interest in becoming part of the Network. Therefore, the Park Authority aims to involve local inhabitants, associations, public authorities and organisations in the decision-making process, including decisions regarding sites of geological interest. The participation of local public and private figures in the decision-making process, so that they no longer play passive and marginal roles, is a fundamental prerequisite generating support, cooperation and a widespread sense of responsibility for upholding the area's geological heritage. The Park Authority has put this policy into practice by conducting public inquiries opened to individual citizens and associates. A case in point was that regarding the authorisation of extraction plans of the quarries (Renara, 2003; Cervaiole-Buca-Piastrone, 2005; Macchietta, 2010) towards which residents had expressed doubts or submitted requests for mitigation and/or compensation.

Finally, among the formal acts supporting the membership of the Apuan Alps in the European and Global Geoparks Network, it is worth mentioning one document, approved on 27th April 2010 by the Park Community, in other words the body responsible for bringing together the legal representatives of all municipalities, provinces and mountain communities belonging to the protected area. The unanimous vote in favour of the project was motivated by the need to achieve an internationally recognised certification of quality for a complex system of promotional and enhancement initiatives to be sustained and implemented, where assets and sites of geological interest constitute a valuable aspect of the Apuan Alps' environment and landscape. Furthermore – according to the representatives of local bodies – the future use of the Park's geological heritage, including its stone georesources, must be better integrated into tourism in geological sites and promote the advancement of studies and scientific researches on geology. Some town councils (Careggine, Fabbriche di Vallico, Fivizzano) – that were not present at the meeting held on 27th April 2010 – supported the Park's application with the aim of ensuring a unanimous consensus by the local communities, on joining the European and Global Geoparks Network.

D – GENERAL INFORMATION ON THE TERRITORY

D.1 – ECONOMIC ACTIVITY

The traditional economic activities of the Apuan Alps are currently undergoing one last transformation and in some cases marginal deviation, as a consequence of the combined effects of the recent globalization and the historic trend of slow abandonment and demographic decline of the entire mountain area. The most marginal areas of the Apuan Alps, where quarrying activities are not carried out, have managed to preserve the original features of subsistence mountain economies based on sylvo-pastoral agroforestry activities, typical to the entire Apennines area. They have been able to do so for a longer period and in some cases they have been the only areas where it was possible. Sheep farming and chestnut cultivation were the main occupations in areas where cereal and vegetable production was limited to the gardens surrounding the villages, whilst coppicing of spontaneous trees aimed at supplying firewood and not timber. This rural world has remained practically unchanged for centuries, from the Middle Ages right up until the modern era. It was characterized by seasonal transhumance towards the coastal plains of the Tuscan Maremma and the use of seasonal settlements: villages in winters and Alpine pastures in summers.

Change came quickly however, from the Second post-war period onwards, thus the old system of production has endured as a relic, in the form of individual activities that locals carry out to supplement their income. If said activities are carried out as part of a business, these are limited to the most profitable aspects. This form of mountainous agriculture is limited in terms of land space, but is constantly growing in terms of quality. It has survived thanks to the support of policies for the conservation and enhancement of traditional farming and rearing methods (mostly organic), which make use of old and local cultivars as well as local breeds of livestock. Short production chains have been most effective on the inland mountainside of the Apuan Alps, in Garfagnana, one of the reasons being that morphological conditions here are more favourable than in any other part of the mountain range. The cultivation of quality cereals, such as *Farro della Garfagnana* (emmer wheat of Garfagnana), has been labelled as PGI, whereas Garfagnana's chestnut flour *Farina di neccio della Garfagnana* has qualified as a PDO product, as has Lunigiana's equivalent *Farina di Castagne della Lunigiana.*

Conditions on the coastal mountainside of the Apuan Alps were different from the outset, as the transformation of the original production system, based on sylvo-pastoral agroforestry activities, was more radical. The industrial development in the marble sector – which began in the mid nineteenth century and continues today albeit with economic fluctuations – has had a profound impact on the economy, on the occupational typologies and on the social relations of those communities which were impacted the most by the phenomenon. Apart from the last phase – involving the mechanisation of the processes of stone extraction and processing – the previous century and a half of history was characterised by the employment in vast numbers, of manual labourers who had previously been occupied in traditional agricultural activities.

In the area of Alta Versilia (higher Versilia) in particular, activities such as the cultivation of fields and chestnut trees around the mountain villages, as well as regular wood chopping and livestock rearing on high pastures, have been slowly but surely pushed to the sidelines by the marble industry. The economic transformations that took part during the Second post-war period further favoured the exodus from the mountain areas towards the industrial and commercial centres on the plains, leading to an increase in tourism on the Apuan/Versilia coast. Today, many villages on the coastal mountainside of the Apuan Alps have long since done away with agricultural activities and are fast losing interest in the marble industry as a source of employment. Sources of income are mostly guaranteed outside the community, thanks to the job opportunities available in the largest inhabited centres on the plains. Hence, policies for the promotion of agri-food produce are less effective in coastal mountainside areas. As previously mentioned, the reason for this is linked mainly to the fact that the area has done less to preserve traditional industries. Nevertheless, even these areas have continued the production of first-class niche products which have received recognition and labels testifying to their quality. Such is the case of the quality assurance italian label DOC (equivalent to Protected Designation of Origin, PDO) given to two wines which are produced on siliceous terrain at the foothills of the Apuan Alps, in the provinces of Massa Carrara and La Spezia. These wines have been named *Candia dei Colli apuani*, *Colli di Luni* and *Miele della Lunigiana*, the first of its type in Italy to qualify as a PDO product.

Then there is also the extremely unique case of the famous lard, *Lardo di Colonnata*, which qualified as a PGI product. Colonnata is a village on the edge of the Geopark, occupying a small section of the municipality of Carrara. What makes this product so special is not the breed of pig from which it is made, but its unique production and maturation method. The organoleptic qualities of *Lardo di Colonnata* (which boasts equivalents in other parts of the Apuan Alps) derive mainly from mineral petrographic elements of the tub in which the pig's meat is left to mature, as well as from the microclimate conditions in the place where it is produced. It is these tubs (known as *conche*) carved in small, fine grain blocks of white marble, that make this meat such a high quality and energy rich food, which in the past used to be the quarrymen's favourite type of food.

When the Apuan Alps Park was set up in 1985, it faced an economic situation that was still characterised by remarkable rates of production and employment thanks to the natural stone sector, both inside and outside the protected area. The need to promote a parallel park economy, based on activities that promoted sustainable traditional agriculture and tourism, was opposed by public opinion which tended to compare macroeconomic data on the number of employees and the wealth produced. Such unfair and unsustainable comparisons were always contested by the Park Authority, which tried to highlight the value of the quality of the products and the quality of life enjoyed by those living in production areas.

25 years after the establishment of the Park the socio-economic situation has changed, mostly due to the marble sector showing slow but significant signs of decline. Statistics show a progressive fall in the number of employees in this sector, particularly in the decorative stone manufacturing section. There has, however, been an encouraging increase in agritourism-related activities, which include opportunities for visitors to taste quality agri-food products from local areas, during their visit to the Apuan Alps.

In 2006, the Park Authority promoted and defined the project named *Agenda 21 locale*, aimed at a sustainable development of the park and the surrounding area, through a joint programme by institutional authorities and local stakeholders. Thus, a shared and conscious path was set towards identifying a number of economic, social and cultural objectives, which were to be met through the active and voluntary involvement of local residents, in order to contribute to the projects put forward by institutional bodies, starting with the Park Authority.

Agenda 21 locale was developed through five thematic forums (marble; tourism and mobility; school; history and culture; nature and biodiversity), which provided in-depth information and offered useful suggestions for territorial planning. Other than the initiatives for life-long learning and training, a number of concrete objectives were also met, such as the concession of the Park's logo to tourist structures of merit (for energy saving, rational use of resources, improvement of the uniqueness of tourist offers). A total of fourteen facilities, including hotels, hostels, shelters, bed and breakfasts, agritourism establishments and landlords in the protected area and its surroundings may display the Park's logo with the inscription "this establishment has been recommended for its eco-friendly choices", in English and Italian. Facilities displaying this logo, comply with environmental standards and have received high customer ratings. The criteria have been enshrined in a specific disciplinary approved by the Park Authority.

Another goal for the future, which has already been set out as a strategy, will involve the concession of this logo representing the protected area, to the decorative stones, unique to the Apuan mountains, in presence of the quality of their craftsmanship, special environmental protection and enhancement of this georesource, in compliance with article 18 of the Park Authority's constitutive act.

D.2 – THE PROVISIONS FOR THE PROTECTION OF THE TERRITORY

The territory under the Apuan Park Authority's jurisdiction already enjoys high levels of protection and has been subject to efficient conservation strategies for years. Consequently, no further normative, planning or regulatory measures are necessary to tighten regulations already in place or to broaden restrictions. National and regional laws, European Union directives, territorial and sector planning, together with the authority competences regarding projects and activities (often through E.I.A. procedures) are the numerous existing instruments, which are more than sufficient to enable the Park Authority and other public entities (Region, Provinces and Municipalities) to establish direct and secure monitoring of potential threats to the integrity of the environment and natural landscape, including the protection of the area's geological heritage.

Nevertheless, the eventual recognition of the Apuan Alps as a Geopark could increase the local inhabitants' awareness that they belong to a tight circle of European protected areas, each of which is living evidence of the geological and evolutionary history of the continent and the Mediterranean region. The resident population's conscious appreciation towards the area's georesources is the most efficient means of preventing the development of non sustainable ideas and plans. The global experience of protected areas has shown how the highest level of protection is only achieved through the consensus of the local community.

In the Apuan Alps, environmental awareness has improved slightly since the establishment of the Park Authority; the Park's recognition as a Geopark would be another positive step forward.

figures: 9a (left) Features of mountain economy based on sylvo-pastoral agrforestry activities, typical to the Apuans Alps
9b (right) The "Apuan's breads way": a Park project for the valorization of the typical local productions

D.3 – BRIEF ANALYSIS OF THE PRESENT STATUS OF PROTECTION FOR THE TERRITORY

The area proposed for the Geopark is subject mainly to the standards of protection and enhancement under Tuscan Regional Law no. 65/1997, which has transformed the protected area's administrative body from a local authorities' association to a regional body governed by public law. The protection and safeguard of environmental, landscape and cultural heritage in the area of the park has been put into practice both with the Plan for the Park and the Regulation. The first implementation tool splits the area into zones of different protection levels; it specifies types of usage and activities that are compatible with the Park's objectives; it sets out admissible recovery, conservation, redevelopment and transformation operations. The second tool ensures the detailed regulation of the usage and activities which are permitted within the protected area, dedicating a special chapter to the regulation of excavation and environmental reorganization methods, to be enforced in the adjacent mining areas under the jurisdiction of the protected area's administrative body. The third implementation tool – the long-term economic and social Plan – promotes initiatives coordinated together with the area's territorial bodies, to boost the economic, social and cultural growth of the resident population of the park and its surrounding area.

As regards the implementation tools of the management policies, the Plan for the Park corresponds predominantly with its Anglo-Saxon equivalent – the Master plan. Thus, on the one hand this instrument has the task of protecting the significant value of the natural resources, the ecosystems and the landscapes of a particular environment and on the other, it manages its use. Furthermore, the Plan for the Park sets out a strategic plan, outlining objectives and actions to be implemented. Consequently, the long-term economic and social Plan is the executive part of the Action plan. Starting from a survey on existing problems and programmes carried out through a series of discussions with local authorities and residents, it selects projects to be implemented according to the Park's strategic objectives and the available and obtainable resources.

Following an agreement reached with the Provinces, the Plan for the Park implement a number of protection and conservation directives regarding the park's adjacent area (excluding mining areas), which Municipalities in the area must comply with in their regulations. Furthermore, the *P.T.C.* (Territorial Coordination Plans) of the Provinces must include the findings of the Plan for the Park and in particular those elements and territorial components referred to as 'structural invariants', in order to guarantee the protection of the environment and landscape. Since the Plan for the Park defines geosites and other single components of the physical landscape and the geological heritage 'structural invariants', these same elements are automatically recognised by the provincial planning for the surrounding area and are thus subject to territorial protection.

Until all the Park's implementation tools have not been approved, the protected area and its adjacent area remain subject to the protection measures of Tuscan Regional Laws no. 65/1997 and no. 1/2005, which recall and apply the restrictions imposed by the Italian framework law on protected areas and town planning. Thus, any potential change to the area's land use (particularly building works), that may clash with Park planning are suspended, since this plan became binding following the adoption of this town planning instrument as a preventive measure. In addition to this, precise guidelines on authorisation, Environmental Impact Assessment and hydrogeological regulation, contribute to the efficient planning of building and mining activities and prompt controls by the Park Authority's technical structures, guaranteeing compatibility between projects and the protected area's aims and objectives. In the authorisation phase, rather than in the planning phase, what is at stake is the problems linked to conservation, maintenance, requalification and redevelopment of places subject to projects and actions carried out by public or private figures.

Finally, there are 10 Sites of Community Importance (SCIs) and one Site of National Interest in the Apuan Alps stretching over 18,066.9 ha, 99.2% of which overlaps with the Geopark (80.0% with the park area; 19.2% with the park's surrounding area). There is also a Special Protection Area (SPA), which extends across 17,320.8 ha and overlaps the Geopark by 98.7% (87.9% of the park area; 10.8% of the park's surrounding area). Consequently, a significant proportion of land proposed as European Geopark is also subject to measures of environmental protection and nature conservation that form part of national transposition decrees and regional laws and regulations enforcing European Union directives 79/409/EEC "wild birds" and 92/43/EEC "habitat".

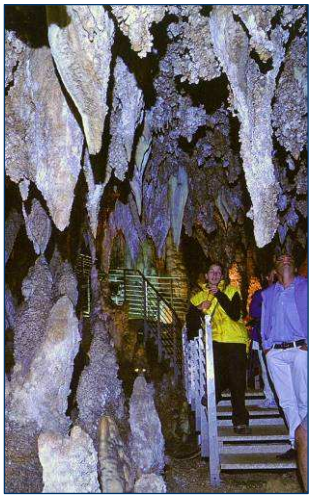
D.4 – EXISTING FACILITIES

The Park Authority has always engaged in tourism activities in parallel with the promotion of environmental and naturalistic education within a large framework of topics covering the complex reality of the territory in all its natural and anthropic elements. Whenever an initiative was about to be defined or an action to be carried out, the Park Authority has tried to avoid relegating the project to a single subject, without any relation with other surrounding or relevant disciplines. For example, the description of a geological phenomenon has always been linked to the biological environment in which it occurs without ignoring the cultural and socio-economic relations developed by the local community or the scientific community. Which is why existing facilities as well as promotional material cannot be limited to the description/interpretation of the single element of the geological heritage which originally was the pretext for the action. This also holds true for projects or initiatives conceived within other disciplines but involving aspects of geodiversity.

After this necessary preliminary remark, a detailed description follows on existing facilities in which the geological element and/or the historical use of geo-resources prevail. The creation and/or management of these projects have seen the participation of the Park Authority as the main actor or sponsor of the initiatives. For clarity purposes, material activities are described before non-material initiatives.

D.4.1 – **Existing Material Activities**

Antro del Corchia show cave - The project for the scientific and cultural enjoyment of a part of the Italian largest karst Complex – developing inside Mt. Corchia (Stazzema) – is the main initiative of the Park Authority for the enhancement of its geosites.



The project started in 1999 and was completed after two years. It provides tourists and speleologists with 1024 m long natural tunnels equipped with 646 m long stainless steel trails, without using concrete in order to preserve the integrity of the hypogean environment as much as possible.

The visit starts with a 168 m artificial tunnel enabling a quick penetration right into the heart of the karst System. There are three doors in succession in order to control the flows of air currents inside and outside the cave. It is a two-way path with a final small circle and it stretches over 1978 m for a maximum difference of heights of 43 m (860-903 m a.s.l.). A two-hour tour with guides informing visitors on the Antro del Corchia's speleogenesis shows various hypogean karst macro and microforms, such as vadose tunnels, pressure conduits, scallops and different types of stalactitic and stalagmitic concretions (curtains, lace-like formations, coralloids etc.). Three monitoring station constantly check the chemical and physical parameters of the karst environment with particular attention to CO_2 levels and wind speed to avoid saturation which may affect the integrity of calcareous deposits. Internal temperature is constant at 7.6 °C throughout the year.

Bardiglio Cappella's Archaeomineralogical area - In 2005 the Park Authority bought, restored and opened to tourists an old mining area which was probably already used in the Middle Ages. It is located near the Romanic parish church of S. Martino alla Cappella in the municipality of Seravezza. A short tour enables visitors to enjoy the main traditional techniques used in mining activities within a basin rich in a precious type of marble, appreciated for its deep dark colour.

Those caves were famous for *Bardiglio Cappella* marble, named after the Spanish word *pardillo*, diminutive of *pardo*, meaning "grey". The colour of the rock depends on the widespread presence of microcrystalline pyrite, also responsible for a typical short-term sulphureous smell when crashed.

The tour of the archaeomineralogical area comprises the old mule track which links it to Seravezza bottom valley. In its first part, the path runs parallel to huge containment walls and near old test pits whose dump ("*ravaneti*") are being renaturated.

Two small caves have been turned into museums reconstructing the main phases of mining activities: the advance and detachment of material from the faces by blasting or tools and the squaring of small and medium-sized marble blocks in the yard. The tour also shows techniques used to move processed marble blocks to the valley. They were slowly transported over large beechwood sledges (called "lizze") along steep and paved streets (called "vie di lizza").

Museum of the "Pietra piegata" (bended stone) in Levigliani di Stazzema - It is a cultural institute of the Park Authority which was created from the idea of gathering in the same place the best and most important heritage left, over the centuries, in the territory and beyond by the Apuan marble culture.

The aim is the preservation and the documentation of the most typical products made of Apuan marble, beginning with serial productions, in order to develop specialized archaeological knowledge and keep alive artesanal and artistic traditions which unfortunately are being forgotten. The exhibition is distributed over four floors and comprises of five rooms, each of which is dedicated to sacred art, domestic sciences, civil and military architecture. One of the most remarkable features is the window showing coloured ornamental Apuan marble and preserving samples of metalimestones and metabreccias, which, though not extracted anymore, have been particularly famous in some moments of the past. The Museum is also a centre for applied research, especially on the archaeometry of decorative stonework. In the past few years, petrographic and microstructural analyses have been carried out on samples of Apuan marbles to identify their origins, especially when used in architectonic monuments or artwork. The Museum of the "*Pietra piegata*" was opened to the public in 2008. It is located in a late 18th-century building of historic-environmental value which was completely restored and enlarged in 1910.

Mines of the "Argento vivo" (Quicksilver) in Levigliani di Stazzema - They are two tourist itineraries enabling the cultural enjoyment of an abandoned mine. They were set up in 2008-2009 by local private citizens and a community in order to develop the existing geotourist offer. The Park Authority proposed and supported the initiative partly contributing with economic and human resources. The project managed to enhance one of the most ancient mining areas in the Apuan Alps.

The area was already mentioned in Pisa Town Hall's documents in 1153 and then occasionally exploited for the extraction of mercurial minerals. In particular, it is one of the rarest sites in the world where mercury is found in its native state, in the shape of metal drops in quartz veins (*Hydrargirium* or "*Quicksilver*"). Here, mineralogical research has recently discovered a new mineral species: grumiplucite (mercury and bismuth sulfosalt mineral).

The two paths, measuring 30 and 130 m respectively, involve two mining assets: Cava Romana and Cavetta. Excavation galleries have been renovated: vaults have been secured, Decauville railway tracks and tubs restored, new lights have been set up. The restoration was carried out in outer spaces as well, with a partial recovery of rare machinery used to crash excavated material and separate mercury.

Thematic visitor centre in Massa on the geological evolution of the Apuan Alps - The Documentation and Information Centre *(Centro di documentazione e accoglienza visitatori)* is situated in the Park Authority's technical and scientific offices, recently moved to the centre of the city of Massa. It provides a quality information service, not limited to general tourist information, but able to gives visitors a detailed knowledge on the environments and landscapes of the Park. In particular, the centre in Massa is responsible for disseminating information on *the geological evolution of the Apuan Alps* which is why the exhibition explains physical phenomena first, and then accompanies visitors along various geological tours in search for geosites illustrative of the topic.

The visitor centre also houses the Park Authority's scientific library, rich in books and audiovisuals.

Karst-Palaeontological Park of the "Grotte" (caves) in Equi Terme di Fivizzano - It comprises facilities and tourist tours of a number of geosites and archaeosites, situated one near the other, where cultural, naturalistic and geological elements are enhanced.

It is formed by a perpetual karst spring [Buca di Equi Terme], some caves of palaeoetnhological and palaeontological interest [Tecchia di Equi Terme and Tana della Volpe (the fox's den)], various thermal springs (radioactive thermo-sulphurous springs in Equi Terme) and paths along a deeply and vertically carved river stretch (Solco di Equi).

The Buca di Equi Terme (Equi Terme's Hollows), whose discovery dates back to centuries ago, is a special karst geomorphosite. It was already described in 1726 and the first tourist activities started in 1964. It was reopened in 2001.

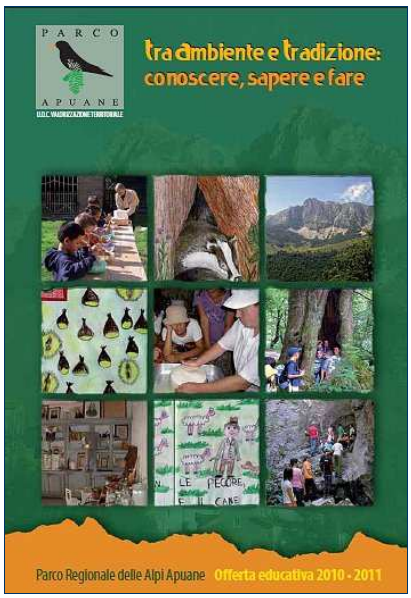
The cave stretches over a total of 1,500 m and is characterized by a single itinerary of 320 m. Internal adjustment and lighting works have been carried out by the Municipality of Fivizzano and the Park Authority. The cave is situated in a small area which also includes the prehistoric site of Tecchia.

The Museum of the "Grotte" (Caves) has been set up for tourists and schools. It is an educational exhibition on the physical landscape of surrounding areas and it reconstructs the palaeoenvironment in which Neanderthal men coexisted with cave bears.

Other facilities - the Park Authority has recovered and restructured various hiking trails in the protected areas [Via Vandelli, Treno nei Parchi (Train in the Parks), Anello di M. Ballerino (Mt. Ballerino ring), paths for disabled visitors in Val Serenaia, Sentiero del muflone (the muflon's path), etc.] which are equipped with information and explanations in Italian and English. They also deal with geological topics and show geomorphological formations. Moreover, as already mentioned earlier, the area of Garfagnana is characterized by the Grotta del Vento (the Wind Cave), discovered in 1898, explored in 1932 and opened to visitors in 1967. It is a fossil spring which has created a 4,570 m long karst System in which three equipped trails have been set up for a total of 1,250 m. Finally, the Park works in the management of the Botanical Garden "Pietro Pellegrini", located in Pian della Fioba (Massa).

D.4.2 – **Existing Non-Material Activities**

Teaching Service and Environmental Education - every year the Park Authority offers courses entitled *Tra ambiente e tradizione: conoscere, sapere e fare* (*Between Environment and Tradition: Knowledge, Skills and Actions*) for primary and secondary schools located both inside and outside the protected area. It provides introductory classes in schools and excursions in the Apuan Alps with the help of the Park's Tour Guides. The programme envisages initiatives on the tradition and culture of the Apuan territory as well as activities promoting the understanding and knowledge of landscapes and environments in the protected area. With regards to bio and geodiversity, the offer for 2010-2011 includes educational paths entitled *Alla scoperta dei geositi apuani* (*Discovering Apuan Geosites*) and *Vivere il Parco* (*Living the Park*) with the aim of raising students' awareness on the preservation of the environmental heritage through its rational use. The initiative is coupled with a competition, *Il Parco nel quaderno* (*The Park in the exercise-book*) requiring schools to create stories, tales, interviews, recipes, drawings, pieces of poetry or itineraries regarding elements of the naturalistic, geological and cultural heritage of the Park.

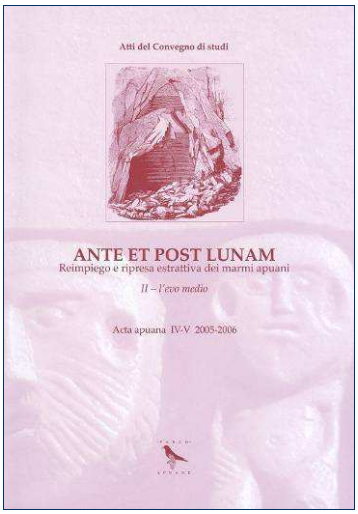


Acta Apuana - it is the yearly scientific journal of the Park Authority. It draws from the daily technical and administrative experience of the Park for reflections and discussions of documentary and methodological value which are published in memoirs and written communications.

The Park's activities and initiatives are always preceded by studies and research which, in certain cases, are published in scientific reviews.

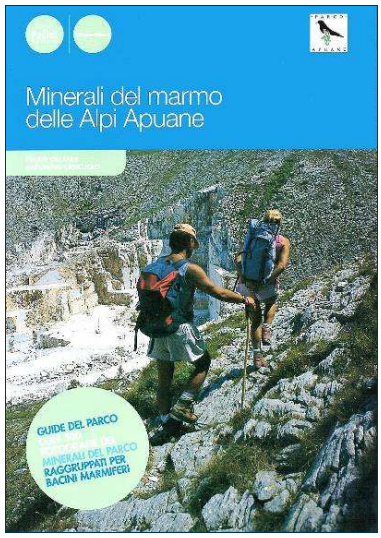
Moreover, the Review contains articles of experts who cooperate on the Park's initiatives, have carried out research in the protected area or its surroundings or intend to do so. Clearly, research focuses on the territory which needs to be discovered in every single physical phenomenon and cultural element, from naturalistic and geographical features to archaeological, architectonic, urban characteristics, etc. The scientific Review deals with a vast array of subjects but has always given priority to studies, research and considerations on geology because of its relevance for the Apuan Alps. Every miscellaneous issue contains articles on geology and geomorphology with a particular emphasis on the history of the geological research in the area.

Acta Apuana also comprises of two supplements based on the proceedings of the 2001 workshops on the subject of *Geositi, tra valorizzazione e conservazione della natura* (Geosites, between nature enhancement and preservation).

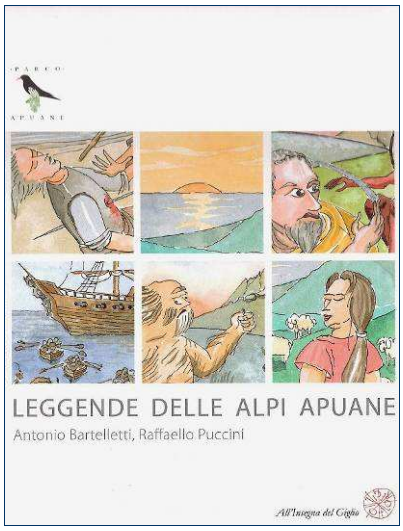


The first volume is more general and is entitled *Dalla conoscenza alla gestione dei beni geologici* (From knowledge to the management of the geological heritage), whereas the second, entitled *La geodiversità delle Alpi Apuane* (The Geodiversity of the Apuan Alps) is more focused on the territory and illustrates its typical features.
Finally, other two monographs of the scientific journal have been dedicated to archaeological and archaeometric studies on the excavation and use of Apuan metalimestones during the pre-Roman, Roman and medieval periods. The monographs gather scientific contributions presented on the occasion of two different meetings (2003 and 2005) entitled *Ante et post Lunam: I, splendore e ricchezza dei marmi apuani* (l'evo antico); II, reimpiego e ripresa estrattiva dei marmi apuani (l'evo medio) [*Ante et post Lunam: I, splendour and richness of the Apuan marble (ancient times); II, Apuan marble reutilization and mining activities recovery (Middle Ages)*].

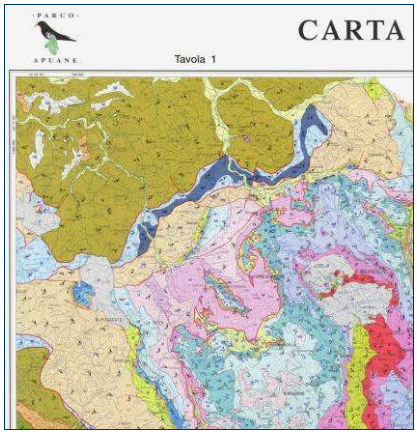
"Le Guide del Parco" (The guides of the Park) Publishing Series - The Park Authority's journalistic and information activities have also produced several naturalistic guidebooks illustrating categories of biological and abiological phenomena widespread in the Apuan Alps. In its first period, the publishing series focused especially on botanical subjects, with single volumes on the flowers, mushrooms, orchids and officinal plants of the Apuan territory.
2009 saw the publication of the first geological guide, entitled *Minerali del marmo delle Alpi Apuane* (*Marble minerals of the Apuan Alps*), written by Paolo Orlandi (University of Pisa) and Antonino Criscuolo (geologist of Carrara's marble Office). It provides an exact and complete picture of the mineralogical heritage preserved in metalimestones and metabreccias, traditionally subject to mining activity. The book thoroughly and accurately describes 117 mineral species with more than 300 coloured images, grouping them according to the location of marble fields.
Another guide on fauna with the title of *Rapaci delle Alpi Apuane* (Birds of prey of the Apuan Alps) was published in 2010.



Leggende delle Alpi Apuane (Apuan Alps' Legends) - it is a book in three languages (Italian, English and German) with six Apuan legends on six peaks and important places of the mountain range: *I bimbi del Monte Procinto* (*The Kids of Mt. Procinto*); *l'Omo selvatico del Monte Corchia* (*The Wild Man of Mt. Corchia*); *San Pellegrino, il Diavolo e il Monte Forato* (*St. Peregrin, the Devil and Mt Forato*); *le giunchiglie del Monte Croce* (*Mt. Croce's Daffodils*); *il Principe del Monte Pisanino* (*The Prince of Mt. Pisanino*); *l'Omo morto del Monte Pania* (*The Dead Man of Mt. Pania*).
The aim is to show how popular tradition has tried to understand and pass on, through legends, the suggestive and evocative morphologies, the naturalistic elements and names of some Apuan mountains.
It is a short treatise on the "ethnology of geosites" enhancing the culture and the traditions of local inhabitants in their ancestral relation with the sacred nature of the profiles of the most important peaks. The book, supplied with drawings for each legends, comes with an audio CD entitled *Siam venuti a canta' storie* (*We came here to sing stories*) where the reading of legends is alternated with folkloric songs on the same topic.



Geological Map of the Park - In 2000 the Park Authority financed the printing and circulation of two 100x70 cm pieces of paper. The first is the *Geological Map of the Park of the Apuan Alps* with a scale ratio of 1:50,000 and the second focuses on the geological cross-sections and structures of the Apuan Alps. The publication was edited by the Department of Earth Sciences of the University of Siena and saw the contribution of famous scientists and researchers – Luigi Carmignani, Gaetano Giglia and Marco Meccheri just to name a few – who have been working for years on the surveys and structural interpretation of the Apuan Alps. The Geological Map of the Apuan Park follows the geological mapping tradition which, since the second half of the 19th century, has been focused on the Apuan territory reaching a level of details and precision not found elsewhere. Technical importance aside, the language used and the information provided are really valuable.



Scientific studies and teaching materials on the 1996 flood - The central-southern part of the Park of the Apuan Alps, situated between the municipalities of Stazzema and Vergemoli, was stricken by an unprecedented natural catastrophe which caused about 300 debris flows and overflows of watercourses within few square kilometres. On 19th June 1996 an extraordinary rainfall - amounting to more than 500 mm throughout the day, with peaks of 176 mm/per hour - destroyed a large number of buildings and killed local residents, especially in the town of Cardoso of Stazzema. The following day the Park Authority was encharged with carrying out a detailed study on the scope of the flood and its different impacts on mountainsides with regards to slopes stability.

The research results, published in various scientific journals, managed to explain the complex relations among vegetation, soil and geological substrate and, consequently, the different levels of hydrogeological instability in the valleys stricken by the natural disaster. These studies and the safety implementation plan have been gathered in a user-friendly intelligible teaching aid. The CD entitled *Il Parco per l'alluvione: documenti e testimonianze su eventi ed interventi a cinque anni dal diluvio in Versilia e Garfagnana* (*The Park for the flood: documents and accounts on events and actions five years after the flood in Versilia and Garfagnana*) was produced and distributed in 2001. It contains videos, pictures and thematic maps as well as written texts and oral narrations on the 1996 flood. Not only was it an useful activity to recall the vicissitudes of that period, but it was also a cultural initiative aiming at the creation of a multi-media essay containing news excerpts on those terrible days as well as scientific explanations in a more accessible language.

Other initiatives - The Park Authority regularly organizes meetings, conferences, round tables and presentations of books on naturalistic and historical-cultural topics, among which geology and history of mining activities (stones and minerals) in the Apuan Alps have the lion's share. The program was exceptionally rich in content between 2005 and 2010, on the occasions of the twentieth and the twenty-fifth anniversaries of the Park Authority. In particular, the events organized for the current year to celebrate a quarter of a century of the Apuan protected area revolves around a main theme, *Il valore della Terra* (*The Value of the Earth*) which focuses on the geological heritage. Initiatives include the photographic context *Geositi delle Alpi Apuane* (*Geosites of the Apuan*), in which numerous hiking lovers participated and which provided the pictures for this dossier.

D.5 – FUTURE FACILITIES PLANNED

D.5.1 – **Future Material Activities**

***Equi Terme's Apuan*GeoLab** - It is a museum aimed at the dissemination of knowledge of the Earth Sciences. It was conceived as a laboratory, where mechanic, rather than electronic, interactive "machines" accompany visitors in an ideal voyage, through observation and research, from global to local, from the planet to the region, from "Gaia" to "Apua". The Apuan*GeoLab* is an educational window to the Earth. It observes its continuous changes during different geological eras, aiming to explain why earthquakes occur and mountains form, why the Mediterranean formed and the Apennines were moulded, how water carved the carbonate body of the Apuan Alps or how water formed entangled tunnels and deep wells as well as the karst siphon and Buca d'Equi's concretions or, finally, how near-by hypothermal springs became rich in mineral salt and saline-sulphate-alkaline substances. The guided tour of the Apuan*GeoLab* starts with the explanation of physical-chemical mechanisms which slowly change the Earth and make it alive. In a few room the museum manages to describe what happens inside the Earth. It coherently and scientifically explains the different phases, from convection cells through plate tectonics to the formation of the Apuan Alps and its complex structure, characterized by indelible marks left by different geological climates and landscapes on its rocks, deposits and soils. Another facility is an equipped laboratory aimed at providing educational experience in the Earth Sciences. Apuan*GeoLab* will be housed in a restored building, in the former elementary schools of Equi Terme (Fivizzano), where the first exhibition will be displayed by the end of 2010 together with the Park's visitor centre of the Lunigiana area.

Small museum of yesterday's and today's fauna - The Bósa di Careggine's rural-natural centre will soon become the most important and complete facility for the ex-situ conservation of the Park's biodiversity as well as a modern laboratory for environmental education and teaching. The centre will house a small exhibition on Apuan Alps' animals, from late Pleistocene until today. Non-exctinct animals are displayed alongside with high-quality findings and drawings of Würm and post-glacial animals which abounded in the territory.

"Marmitte dei Giganti" (Pot holes') Itinerary on Mt. Sumbra - The Park Authority wishes to equip the pathway leading to the pot holes, making it more accessible to tourists. These circular cavities of fluvio-glacial origin are typical of the rocky river bed of the torrent Angullaja which flows downwards to the southern mountainside of Mt. Sumbra. A fair number of tourists already visit the area using the existing path, situated next to the provincial road of Valle d'Arni, two of the reasons being the aesthetic charm of the potholes and the brevity of the itinerary. The project provides for the complete signposting of the path with illustrative material on geological phenomena including the karst underflow of Turrite Secca (hence the name Dried Turrite), a fluvial channel with an embedded meander, glacial cirques on the Sumbra ridge and various karrens along the sides of the same mountain. Metal staircases will also be put in place to overcome the obstacle posed by the edges of the potholes along the Anguillaja ditch.

D.5.2 – **Future Non-Material Activities**

Geomorphological and Neotectonic Map - Despite numerous studies and research on the territory of the Apuan Alps, a thematic map on a proper scale ratio has not yet been published. It should summarize the main morphostructures and morphosculptures produced by various morphogenetic elements as well as their relations with recent deformations. Nevertheless, surveys on a small scale ratio, limited to small areas [for ex. Alta Valle del Serchio (Serchio's High Valley)] or certain categories (for ex. the landslide predisposition map of the basin of the river Serchio) are available. Yet, not all of them have been published.
The Park Authority tries to stimulate the interest of universities and National and Regional Geological Surveys in carrying out a scientific and planned survey of the Apuan Alps's geomorphology. Such a project is in the pipeline.

Structural geosites - the filing and the census of the Apuan Alps's geosites have focused, as usual, on geomorphological categories and typologies, starting with a particular emphasis on geomorphosites. Structural geosites require a more complex analysis and interpretation, despite their importance within the geological heritage of the Apuan Alps. Therefore, these valuable unique elements will need to be surveyed in a second and more complex territorial analysis.

Hiking and Geotourist Map - The Park Authority will publish a thematic map with a 1:20,000 scale ratio pinpointing the paths' network in the park and in its adjacent area as well as mountain huts and other facilities for hiking activities. The map will also include linear and areal indications of the geosites included in the census (karst cavities, glacial cirques, crests, etc.), the main landforms and those elements testifying to the natural value of the Apuan Alps [Special Protection Areas (SPA), Sites of Community Interest (SCIs)]. This information will be matched with user-friendly geological data in order to contribute to an aware usage of geodiversity. The map will be possible thanks to the cooperation between the Park Authority and the Italian Alpine Club (CAI).

Rock Shelters and Buildings - In the Regional Park of the Apuan Alps there are numerous and interesting artifacts made in a close relation with outcropping rock masses, erratics or fallen blocks. In particular, the three "*abri*" shrines (hermitages built inside rock shelters) saw a shift in their function: from prehistoric rock shelters to places of pagan and then Christian worship. Abri shrines are often linked to legendary hermits and popular traditions associating the cult of a spring, at times miraculous, with that of a sacred plant. There are also widespread examples of shepherds huts built under rocky walls or cyclopean blocks which are found in the area of Alpine pastures. An illustrative case in point is the scattered settlement of Orto di Donna-Serenaia which exploited glacial erratics, detached blocks and the gravitational collapse of masses during the post-glacial era. The Park Authority whishes to carry out enhancement activities, once all the above-mentioned elements have been studied and surveyed. These activities include the publication of information material, the establishment of permanent exhibitions, the creation and improvement of tourist paths equipped with illustrative posters with images.

Publication of the Application Dossier - The different revises of the application dossier for the Park's membership in the European and Global Geoparks Network have been uploaded to the geosite website (http://www.apuaneweb.it). Preventive information for citizens and local institutions has thus been put in place and there is room for suggesting integrations and changes to the text. Information will be disseminated with the publication of the entire dossier and its annexes (with the exception of the self-assessment form) in a special monograph of the Park's scientific review – *Acta Apuana* – in the issue no. IX of 2010.

Apuanegeopark.it website - The layout and the pages of the website on the geodiversity of the Apuan Alps are being improved with a direct access (www.apuanegeopark.it) or an access through the portal of the Park Authority (www.parcapuane.it or www.apuaneweb.it). The website will be further improved with the translation into English of existing and future pages.

TABLE OF CONTENTS

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