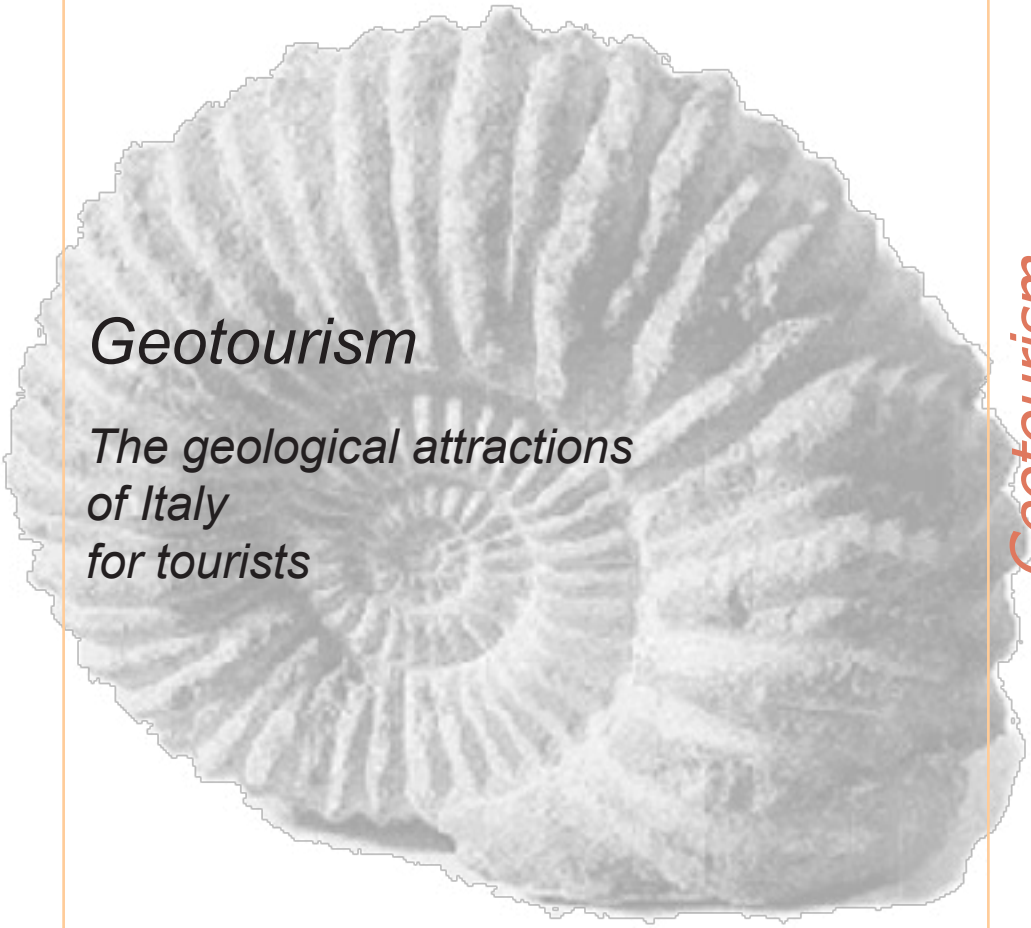
Matteo Garofano

Geotourism

The geological attractions of Italy for tourists

Translated from the Italian 3rd edition
Contains more than 80 geotouristic locations in Italy



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The geological attractions of Italy for tourists

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“The real voyage of discovery
consists not in seeking new landscapes
but in having new eyes

Marcel Proust

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PART 1

Geotourism introduction

In every place there are wonderful forms of landscape and amazing phenomena. Geotourism means travelling to discover the most beautiful scenery of our planet.

Erosion on layered rocks, Morocco

Waterfalls, deserts, volcanoes, caves are more than only fascinating, they have a story to tell: the history of the Earth.

The explanation of how the earth is made up comes to us from the geology. This science is known for the role it plays in the field of civil engineering, in practical terms in all those activities for which you need to know the underground: digging of tunnels, exploitation of mineral resources, construction of buildings.

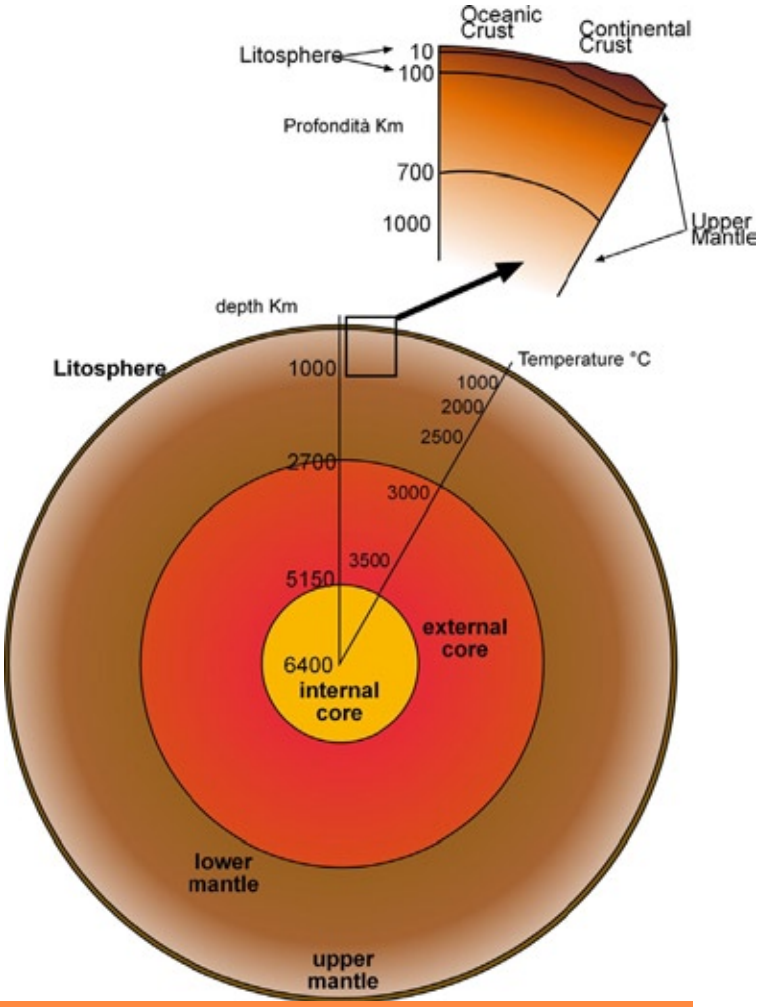
In fact, one of the main purposes of geology is to reconstruct the events that have occurred to our planet since it was formed.

Understanding how beautiful landscapes originated could become a subject of interest even for those not active in research as "the understanding of the

earth" may be a valid reason to take a fascinating journey.
Hence the idea (not new) of Geotourism, is "the discovery and understanding of the geological beauties visited directly where they are located."
In this book the aspects relating to the organization of a geotouristic trip or excursion will be addressed.

Geology

To organize or participate in a geotouristic journey you should have a basic geological knowledge. This knowledge is needed to put to a broader



Internal Earth's structure

framework of geology individual phenomena observed during the excursions. It often happens that the scale with which the observations take place, that is the size of the objects observed, is too small to understand the geological evolution of an entire region.

The basics for understanding

Some basics concepts of geology are relatively recent discoveries: such discoveries are the basis that link geological phenomena that seemingly appears to be independent from each other. One of the most important discoveries is the plate tectonics.

Plate tectonics: structure of the earth and large scale geological processes.

The Earth is a planet almost spherical in shape. On its surface you can directly analyze the composition and the characteristics of the rocks. What escapes the possibility of direct analysis is what resides in the depths. The study of earthquakes has made it possible to understand the composition and structure of the earth. Put simply, the land consists of a series of concentric "shells" with different characteristics.

Lithosperic plates

The **crust** is the solid and most external part of the planet and is divided into oceanic and continental, as indicated by the names. The oceanic crust is present in ocean depths, while the continental crust in the continents. They differ in their composition and their genesis. Minerals prevailing in the crust are silicates.

The **mantle** is the part below the crust and constitutes most of the Earth's mass. It differs from the crust by its chemical composition and physical characteristics. Generally abundant iron ore and magnesium combined with oxygen and silicon are present.

The **core** is the inner part of the earth and has high density and is composed primarily of iron and nickel. The inner part of the core is solid, while the outer is liquid.

The outer part of the land can be subdivided according to its physical characteristics into lithosphere and asthenosphere. The lithosphere (from the greek Lithos stone and sphaira: sphere) is the outer crust and the upper mantle with rigid characteristics. The asthenosphere (from the greek asthenos: without force) is the part of the mantle that has plastic characteristics and can flow like a liquid on geological time scales

The description of the Earth's structure is useful to introduce a fundamental concept: Plate tectonics.

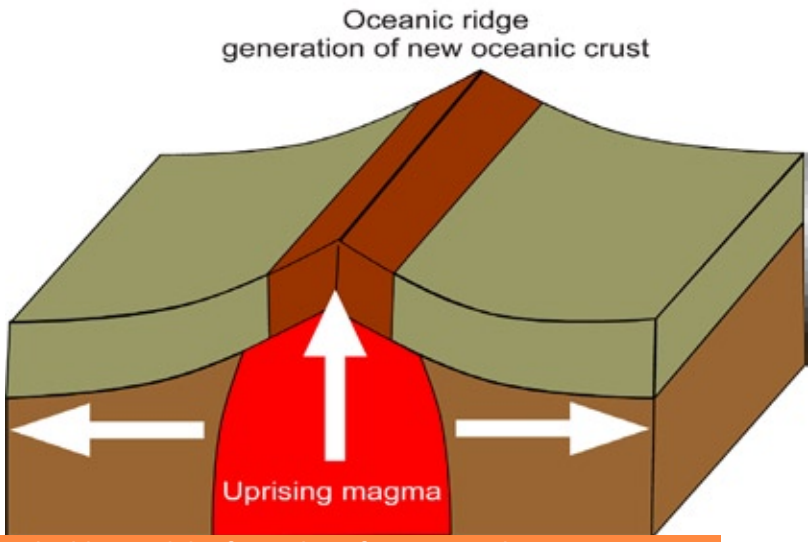
In daily life, althought it is rarely possible to realize it, our planet is continually evolving. The Earth is a dynamic system: the hard surface (lithosphere) is fragmented into plates, called lithospheric plates, that move over a plastic layer (asthenosphere).

Depending on the type of movement going on between one plate and anothers, different geological occurencies can take place. It also depends on the type of plates, oceanic or continental, involved in the movement. Most geological activities happen on the margins of the plates.

Diverging plates and oceanic ridges

When two plates move apart from each other and the distance between them increases, the space that is created is filled with new material arising from molten magma that forms below. These conditions lead to the formation of new oceanic crust.

The border between two diverging plates is called ocean ridge. Intense volcanic activity takes places there which in most cases occurs underwater; in these geological settings basaltic magmas are poured out. A particular place on the planet is Iceland where the oceanic ridge barely touches the sea's surface and has spectacular volcanic activity.



Oceanic ridge and the formation of new oceanic crust

Converging plates and subduction

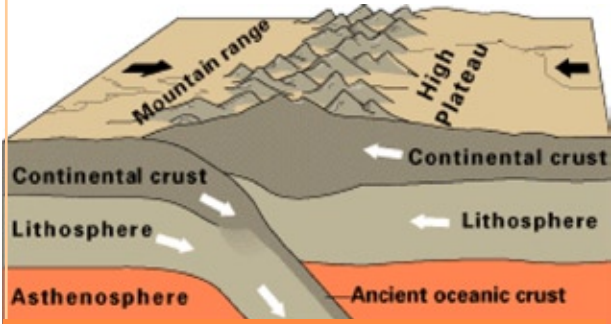
When two lithosphere plates approach each other we speak of converging plates. In these conditions a phenomenon occurs called "subduction": one of the two plates is wedged under the other. The effect that the subduction produces is different depending on the type of plates involved.

A portion of oceanic lithosphere, which is wedged under the continental lithosphere leads to the uplift and the creation of a new mountain ridge: this is called orogenesis and is the formation of a mountain. An example of this phenomenon are the Andes in South America and the Alps in Europe.

Associated with this event there is magmatic production and metamorphism: the portion of oceanic lithosphere pushed in profondity, as a result of high pressure and the increase in temperature, is transformed, sometimes to the extent that the melting occurs. The melted materials tend to go up and reach the surface: this is the origin of many volcanoes.

The movement of the two plates is also an important mechanism that

produces the earthquakes. The plaques, in fact, are subject to enormous stress for a prolonged time. These forces working for long periods mean that large amounts of mechanical energy are accumulated and then released suddenly during earthquakes. The energy released reaches the surface in the form of ground movement or seismic waves and in most cases produces destructive phenomena.



Convergent plates and subduction

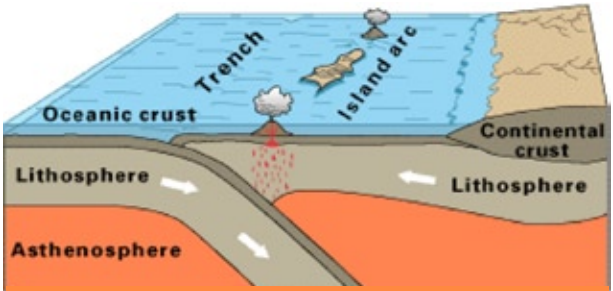
Subduction may also occur between two slabs of oceanic lithosphere (intraoceanic subduction). In this scenario magmatic phenomena can also take place and magma can reach the surface and generate submarine volcanoes on the seabed. These volcanic chains are called island arcs. Many of the islands in the Indian Ocean have (Indonesia and Malaysia) this origin. The subductive process, as seen earlier, can cause the occurrence of earthquakes. In this case the energy released in the earth is transferred to the water when it reaches the ocean bottom and can generate huge waves called "tsunamis".

Transcurrent strike-slip Plates

Two plates sliding against one another are called strike-slip; the cut that separates the two plates is a fault (a famous example is the San Andreas fault in California). In these situations the melting of rocks does not take place but there is often the occurrence of earthquakes due to the friction between the two plates.

The rock formation processes

The interpretation of the landscape begins from the rocks. Each rock carries with it its own



Intraoceanic subduction

history. Geologists have translated these stories into a language which is understandable to everybody. With a minimum knowledge of rocks and their names, you can find a fragment along a path and "expand" it into an entire landscape which had existed in the past, or into the succession of events that formed it.

The rocks are a combination of natural minerals and are the most basic components of the landscape. The composition and disposition of minerals in the rock reveals information about how it was formed and where it comes from. The great variety of existing rocks has required a rational classification system that is mainly based on the genesis process. All the processes of the formation of rocks occur within the Earth's dynamics.

There are three main genetic processes:

Sedimentary

Magmatic or igneous

Metamorphic

From these processes three main categories of rocks derive, respectively sedimentary rocks, magmaic or igneous rocks and metamorphic rocks.

The sedimentary rocks

The rocks, when exposed to the atmospheric elements, are altered and the materials that are produced will then form sedimentary rocks. The process of formation of sedimentary rocks can be summarized in the sequence **erosion-transport-deposition-diagenesis**.

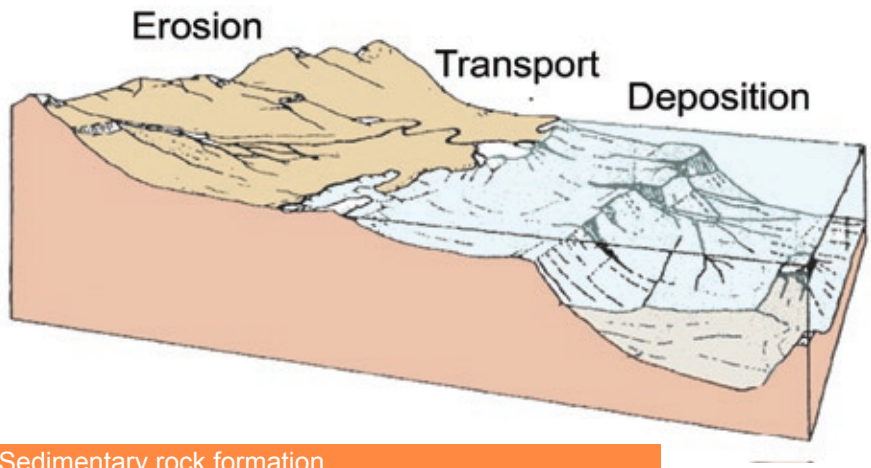
The main stages of formation of sedimentary rocks will be explained briefly to understand the characteristics of those rocks better. Some stages of this process can easily be understood observing the environment around us.

Erosion. We can observe that the Earth's surface is continually subjected to the athmospheric agents every day which tend to alter, breake-up and modify the rocks.

Erosion takes place in several different ways but mainly by physical and chemical actions. An example of a physical action is the effect of temperature variation. The temperature in most environments increases and decreases periodically mostly due to sunlight and this variation tends to break up the rocky masses.

Other physical phenomena that produce erosion are related to the mechanical action of ice, wind and water.
There are also chemical actions which tend to transform minerals through chemical reactions, in particular by the presence of water.
The different climates existing on the planet tend to establish characteristic erosive pattern, for example in hot and humid equatorial climates (equatorial areas are places on the planet where average temperatures are greater than 25 degrees and rain around 2000 mm per year) give rise to a prevailing degradation caused by chemical reactions, also called weathering. Examples of equatorial climate areas are the basin of the Amazon, the Congo, the Sonda archipelago.
On the contrary, desert or arid climates, both cold and hot, make the mechanical action in the erosion process predominant. Typical desert areas of our planet are the Sahara and the Kalahari which are hot deserts, while the Gobi desert, the area of Tibet and Patagonia have typical cold desert climates.

Transport. The materials generated by erosion are takes away from the place where they were produced. Typically, the "engine" of the transport is the gravity force, but there are also other forces that work like the wind. Some agents like rivers, glaciers, winds operate as carriers.



Sedimentary rock formation

Sedimentation. It occurs when the materials transported are deposited within a basin, usually in the sea or in lakes, but also waterless areas such as deserts should not be excluded. The solid material transported by the water, loses its speed and tends to settle when it reaches the sea. The first deposited is the coarse materials then, farther away from the mouth of the river, the finer materials. Chemical deposition occurs when chemical salts are dissolved in water and reach a concentration which is too high and induces the crystallisation and precipitation. Such a situation occurs in closed basins where strong evaporation takes place. The salt concentration increases and the salts precipitate forming deposits which then become evaporitic rocks. This category includes gypsum (Chalk) and rock salt. A good example of this are evaporitic rocks near Imola (North Italy) in the Chalk formation of rocks called "the vein of chalk."

The special characteristic of sedimentary rocks is stratification, division into planes. This reflects their origin, because the layers roughly represent the horizon over which they had deposited the debris during sedimentation.

The sedimentary environments, the most important of which is the sea, can be occupied by living organisms, which, at the time of their death, tend to settle on the bottom. In particular conditions the organism can be covered with sediment and is preserved from decomposition, in which case the hard parts of their bodies, such as bones, shells and teeth are better preserved. For this reason, the most common rocks that contain fossils are those of sedimentary origin.

Sedimentary rocks, conglomerate and sandstone

Diagenesis. This term means (from the greek dia "pass through", genesis: origin, creating) a series of transformations that cause loosely deposited sediments to become a rock.

The loose material accumulates and is pressed by the weight (pressure) of sediment placed above. It also tends to expel the liquid contained in the spaces between the grains. In addition to compacting, the movement of fluids can lead to the crystallization of new minerals into voids. These crystals work like glue and keep the grains together.

The rocks formed from big coarse and not rouded fragments are called breccias, the ones formed by rounded fragments are called conglomerates. The fragments are also called clasts.

When deposits of sand occur, the rocks that are formed are sandstone (from the latin arena: sand), if the sediments are formed by clay, the rocks are mudstone. The rocks formed by chemical deposits are also sedimentary, the most common is limestone, formed by a deposition of calcium carbonate. If the carbonate deposits together with a percentage of clay the rocks formed are called marl.

Classification of sedimentary rocks

There are various classification systems for assigning names to sedimentary rocks. These classifications are broadly based on the characteristics and origin of the material that forms the sediment. A major breakdown is as follows.

Clastic rocks: formed by fragments of other cemented rocks: conglomerates, breccias, sandstone.

Chemical rocks: formed by minerals produced by chemical processes: limestone, dolomite, gypsum/chalk, cherts.

Organogenic rocks: comprising mostly of fragments of dead bodies: fossiliferous limestone, dolomite.

Fossils

This topic is of great interest to the public because it give rise to curiosity and imagination. The fossils bring back the history of our planet Earth and in particular living forms which lived in the past.

The organisms, after their death, may be buried into the sediments, then the sediments are transformed into rock by diagenesis, while the organic parts are fossilized. The fossils come to the surface again when the rocks containing them are involved in orogenies process and brings to the surface by the erosion.

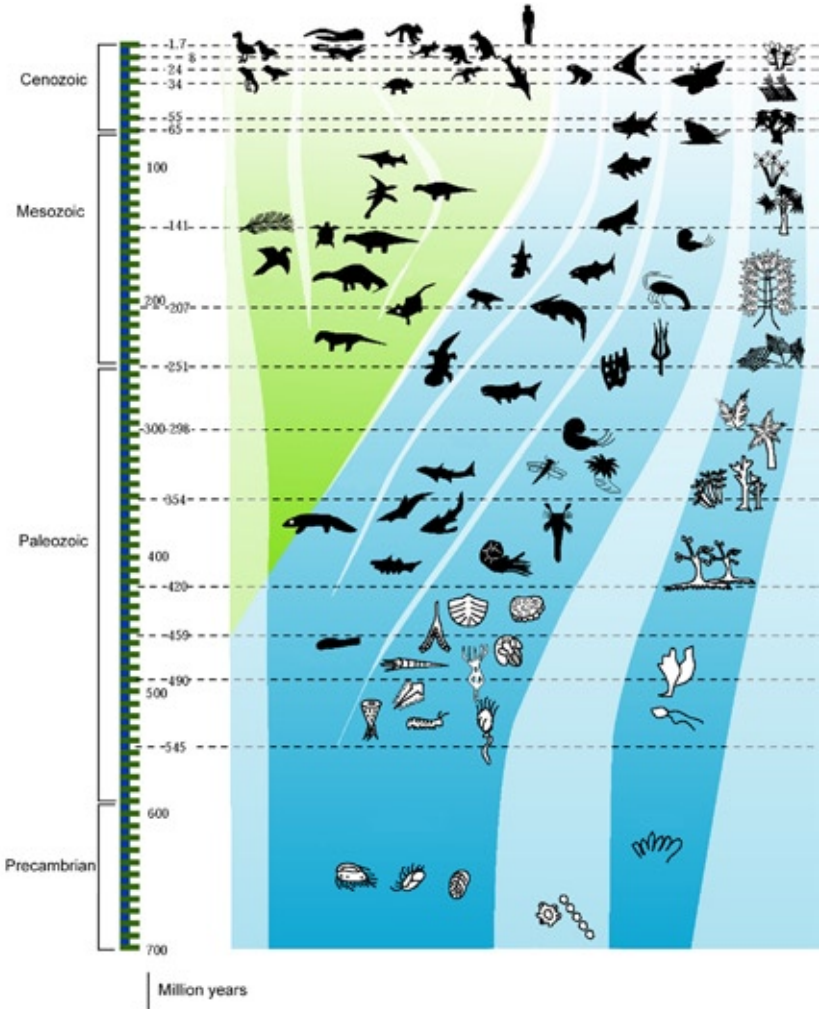
It is useful to know that species of animals and plants currently found in our planet are only a small fraction of those which have lived on Earth, many species have existed and then disappeared (extinct), while new ones originated from a process called speciation. Most fossils discovered rappresent organisms no longer existing.

Paleontology (from the greek palaios: old; Ontos: being, organism, logos: word, speech) studies species which existed and from which they have evolved.

In paleontology particular attention is given to "time" trying to determine in which order the extinctions and the rise of new species occurred. This is done to organize the events in a chronological order. This sequence of mutations of life forms is then associated with geological eras. Geological

Fossil fish

eras are the most significant time units in the history of the Earth and are defined on the basis of the great changes of living organisms on earth. This definition is useful for geologist who can estimate the age of a rock by recognizing the fossils it contains. This is an effective system that is used for the dating of rocks.



Life evolutions through the geological time

Duringthe geological excursions it is not difficult to find a fossil, in this case it is very interesting to try to understand what kind of organism it was and possibly to find out its age.

Some fossils in particular are called "index fossils" because they lived and were widely disseminated at a given time span. If you find these fossils you can certainly identify the geological era of the rock formation in which they are located. You can find fossils preserved in different ways and in different rocks, for example shellfish shells in sandstone or limestone are common, but also sharks teeth, corals, ammonites, brachiopods, trilobites are frequent.
The fossils may retain their original composition or they may have been replaced by new minerals (dissolution and precipitation), such as calcite, pyrite or quartz.

The igneous or magmatic rocks

An erupting volcano is the most tangible thing which can be seen to understand the formation processes of igneous rocks. In this situation we can see how a molten material, the lava, leaves the volcanic crater and then cools and solidifies leading finally to the formation of new rocks.
The simple observation of molten material coming from inside the Earth should not lead to any misunderstanding. In the past it was believed that underground there was a "sea of fire", which is wrong. Most of the subsoil is in a solid state. The magmas that emerge from the volcanoes are contained within magma chambers. The rocks that are formed from magmas are different for two main factors: the chemical composition and the way of cooling and solidification.
The magma composition may vary but the major components, usually always present, are the silicates. The chemical elements that form the silicates are oxygen (chemical symbol: O) and silicon (Si): the latter, in fact, is among the most common element on our planet. These two common elements are usually combined with other less abundant elements like potassium (K), sodium (Na), calcium (Ca), iron (Fe) and magnesium (Mg), many other elements may still be present in smaller quantities. In addition to solid constituents, dissolved in magma gases are present in various quantities, these influence the magma when it reaches the surface.
The magma is formed in depth from the melting, often only partial, of other existing rocks. Due to its liquid state and its relatively low density, the magma tends to move up to the surface. During this process it will meet two destinies; either reach the surface or remain trapped below the surface.

When the magma reaches the surface volcanism take place and the rocks produced are known as "effusive". In these conditions, the molten material tends to cool quickly and form a large number of very small crystals of different minerals. Volcanic rocks have a very fine texture, in some cases large crystals are contained, such phenocrysts, which were formed in the magmatic chamber before reaching the surface. During a volcanic eruption rapid expansion of gases contained in the magma also happens, in some cases the rapid expansion may lead to explosive activity.

This phenomenon also explains a characteristic that is found in many volcanic rocks, the porosity. The gas bubbles that expand, while the magma solidifies, remain trapped in the rock, making it porous.

Usually in the presence of magmas rich in fluids and gases, the outpouring is violent, with intense and frequent explosions.

On the contrary in magmas with few gases, the effusions are quiet and only few explosions take place. Most of the material comes out through lava flows, a good example of which is the volcano activity of Mount Etna in Sicily.

If the magma fails to reach the surface during its ascent, it will become solid underground forming rocks called "intrusive".

In this type of rock the peculiarity lies in the fact that minerals are formed and can develop into crystal of a size observable with the naked eye. This peculiarity is due to the slow cooling of the magma that allows crystals to

Porous volcanic rock

Intrusive magmatic rock, granite

form. The solidification temperature is different for the various minerals and for this reason they do not crystallize all at once: this phenomenon is known as fractional crystallization.

Included in this category of rocks are the granite that usually have big crystals of quartz, feldspar and plagioclase beside some mica.

Metamorphic rocks

The sedimentary rocks and the igneous rocks may have the geological processes mentioned above. For instance the process of subduction leads to large portions of the Earth's crust in depth, in this way they undergo a substantial increase in temperature and pressure.

Due to the variation of these parameters, the minerals that make up the rocks become unstable and are transformed by chemical reactions, in other minerals, this transformation is called metamorphism. The reactions occurs in a solid state and takes an extremely long time.

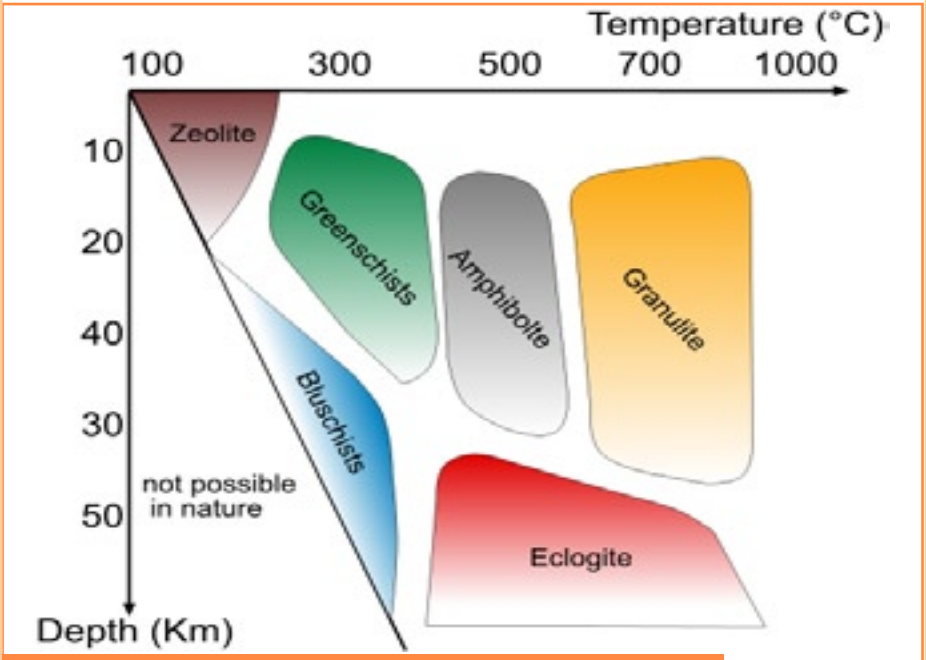
There are other mechanisms, in addition to subduction, which ca cause the metamorphism. The intrusion of magma at a high temperature inside cooler rocks is an example. The rocks that host the magma tend to recrystallize its minerals because of the heat. This phenomenon, known contact metamorphism, form an aureole of metamorphic rocks around the intrusive

body. The metamorphic rocks formed are often of mineralogical interest because rare minerals can be found.

The metamorphic rocks are classified according to the condition of pressure and temperature in which their minerals are recrystallised in this regard some areas in a Pressure and Temperature diagram have been defined on the basis of minerals that are formed in those conditions. These fields are called metamorphic facies and the metamorphic rocks are called according to the names of those areas.

Typical examples of metamorphic rocks are marble, such as those well known from the quarries in Carrara. They come from a metamorphism of sedimentary rocks, limestone in particular. The originale calcium carbonate of the sedimentary rock is recrystallised again in big crystals of calcium carbonate.

At great depth the high pressure leads to the deformation of rocks and the reorganization of the crystals. A characteristic often present in the metamorphic rock is schistosity that is the preferential orientation of minerals on plains known as "foliation". The schistosity must not be confused with the stratification that can be seen in sedimentary rocks.



Pressure-Temperature relation with metamorphic rocks

Another example of metamorphic rock is represented by gneiss, which is derived from metamorphism of granite from which many features are preserved, but differ for the mineralogical composition and in a clearly recognizable foliation (schistosity).

Minerals

As seen before, the rocks are composed of aggregates of minerals. To understand what a mineral is, we need to know that the atoms and molecules forming solid materials tend to organize themselves on the basis of precise geometric rules. A particular solid state chemical compound with crystal lattice is a mineral.

The geometric order of atoms or molecules inside the crystal, called crystalline lattice, is reflected in the external shape in particular conditions: this is one of the unique characteristics that attract mineral collectors.

If minerals find the ideal conditions during their formation may increase their volume according to what is called the crystal habit. One of the conditions necessary for this to happen is that the crystal has the necessary space, otherwise the mineral will grow and take the form of the available space.

The geometry that governs the arrangement of atoms of a mineral has been studied and described. From it seven crystal systems (cubic, hexagonal, tetragonale, us, Rhombic, monoclino, triclinium) and 32 classes of symmetry have been identified.

The chemical composition is based on the division in the main categories of the minerals. Native elements, silicates, sulfides, oxides, hydroxides, halides, carbonates, phosphates, arsenites, vanadates, chromates and others. The majority of minerals on Earth belongs the category of silicates.

It is interesting to note that certain chemical compounds can crystallize into different forms: in this case we speak of polymorphism (from the greek Polys very , morphé shape). For example, calcium carbonate can crystallize into the form of calcite or aragonite.

There are other aspects that characterize minerals such as hardness, toughness, luster, color, luminescence and others.

The number of known minerals is huge, but most rocks are formed by a small number of them.

It is possible to summarize the main minerals present in rocks as follows:

Magmatic or igneous rocks (granite, rhyolite, gabbro, basalt): quartz, feldspar, plagioclase, pyroxene.
Sedimentary rock (limestone, dolomite, sandstone): calcite, dolomite, quartz, feldspar.
Metamorphic rocks (gneiss, marble, metabasites): quartz, feldspar, plagioclase, epidote, amphibole, pyroxene, calcite, dolomite.
The field mineral recognition is useful to the collector, the professional geologist and the naturalist and is based on the observation of several aspects; some minerals are easily recognizable on the basis of evident characteristics.


Fluorite minerals

- habit
The external shape of the mineral is characteristic of each system and crystal class, to be able to recognize it is therefore of fundamental importance in recognition of a mineral.
A small manual of mineralogy will help beginnners to recognize minerals during their field activity.
Example. Pyrite: cubic crystals, octahedral crystals

- luster

One of the distinctive characters of minerals is presented by their luster. Luster is the quality of the shine of a mineral surface. It can be seen with the naked eye or with the aid of a magnifying glass. Some very common types of lusters are the vitreous, opal, milky, metallic, resinous and less common the adamantine.

Luster	Description	Example
Adamantine	The most vivid, similar to a diamond	Diamond, cassiterite, zircon
Metallic	Similar to the metal	Piroxenes
Glassy, vitreous	Similar to glass	Quartz
Greasy	Less lucent in comparison to the glassy one but similar to glass	
Pearly	Irid like luster due to the dispersion of light on the fractures of the mineral	Micas, Talc
Fibrous	Typical of fibrous minerals	Gypsum, asbestos
Wet	Minerals with a wet luster, if submerged in water disappear	Criolite, fluorite
Waxy	The look of wax, doesn't reflect very much, like the previous one	Calcedonio
Resinous	Like resin or sap from a tree	Sphalerite, sulfur
Earthy	Doesn't reflect because of a very rough surface, the look of dirt or dried mud	Bauxite

- Color

The color is not only a valuable aesthetic feature. It may be helpful for the recognition of a mineral. The color can be "its own" or due to the inclusion of colored particles. In the first case rubbing the mineral against an abrasive surface, the dust created is the same color as the mineral itself. In the case

of a color due to inclusions, the powder produced has a different color than the one of the mineral.
The color can be helpful for the recognition of a mineral but unfortunately small changes in chemical composition or the presence of inclusions may lead to a substantial variation of the mineral color. On the other hand, this increases the variety and richness of the fascinating world of minerals.
An example of a colored mineral is amethyst, a violet variety of quartz which owes its color to small inclusions of iron or manganese.

- Hardness
A mineral characteristic that can be easily evaluated and measured is the hardness.
A scale of hardness, called Mohs scale, was made where a hardness degree for each mineral is assign so that it can be scratched by minerals with a higher grade, but not by those with a lower grade.

Mohs hardness scale - mineral	
Durezza	**Minerale**
1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz
9	Corundum
10	Diamond

It is useful to bring a steel puncted tool in the field, which, although it is not a mineral, has a hardness of about 5-5,5 grade on the Mohs scale. In this way it possible to make a comparison and to distinguish the minerals according to their hardness, for example quartz has a hardness of 7 and is not scratched by a steel point, calcite has hardness of 3 and is scratched a steel point.

- Presence of cleavage
Some minerals show a cleavage that are observed as lines on the faces of the mineral, those lines reflect the presence, within the crystal, of parallel plans along which the atoms are arranged. There can be one or two families of parallel planes materializing into a single or double cleavage.
Observation of the cleavage can be done through a magnifying glass, although sometimes in the presence of minerals of a certain size, this characteristic is visible to the naked eye. Minerals showing a typically double cleavage are pyroxene and amphibole.

- Fracture
describes how a mineral breaks when broken, contrary to its natural cleavage planes. It can be described as follow.
- chonchoidal, which is a smooth curved fracture with concentric ridges of the type shown by glass. (eg dolomite, quartz, topaz)
- Terrosi (eg bauxite)
- Fibrous, (eg asbestos)
- Hackley is jagged fracture with sharp edges. (eg copper)
- Scaglioso (eg graphite)

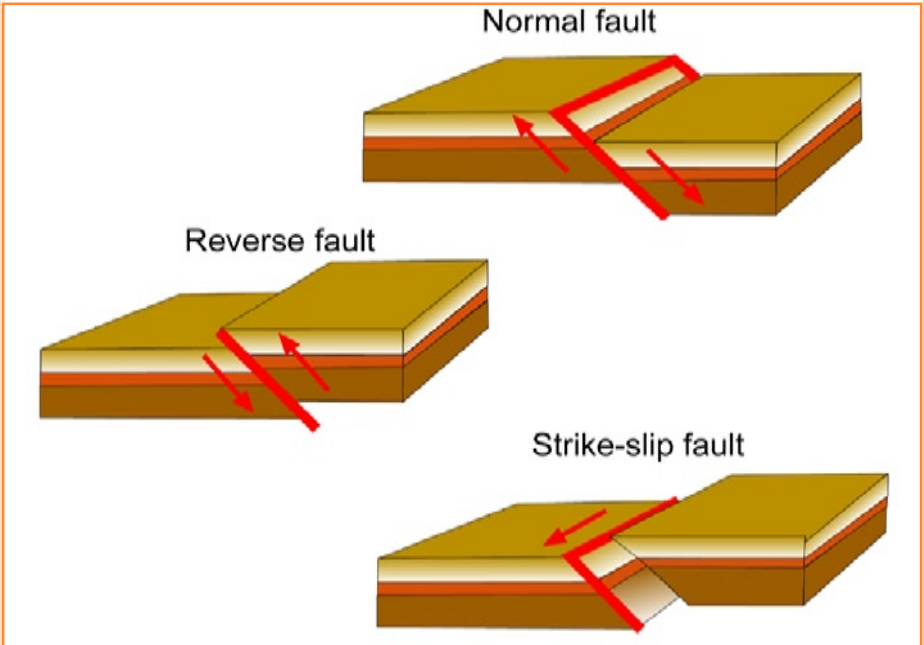
The structures of the planet
The Earth, in our daily observation may seem like a "static" planet, but it is not. There is a dynamism of lithospheric plates related to the processes of formation and destruction of rocks.
The movement of the plates is driven by huge forces that are generated in the subsoil. Those forces work for a long time and submit huge portions of the lithosphere to great pressure. Due to this pressure the rocks are deformed. The deformations of the rocks are the subject of structural geology.
It is possible to distinguish between brittle deformation and ductile deformation: in the case of brittle deformation, the rocks that are under pressure break along planes. Those structures are called faults.
Faults are divided according to the relative movement of the blocks that have separated. Normal faults occur when the blocks separate from each other. In reverse faults or "thrust faults" the blocks converge, while with strike-slip faults the blocks slide next to each other.

Although faults are structures that affect the subsurface they can also be observed on the surface, they are widespread and, in some cases, are recognizable as they cut other structures, such as the layering of sedimentary rock.

Among the various types of faults, there is a type called "thrust". It is a reverse fault in which the dip angle of the fault plane is relatively low (15 degrees or less) or horizontal. In this type of structures there is a stack of portions of crust, called "nappe", one above the other. The thrust faults are very common structures that have a key role in the formation of mountain ranges.

Nappe is a slab of rock that has moved over a large horizontal distance by thrust faulting, recumbent folding, or both, so that it lies on rocks of a markedly different age or lithologic character. Nappe are also considered "structural units", a term that clearly explains their origin.

The erosion, sometimes acting on a structural unit, expose the underlying terrains, in this case we have a so-called "tectonic window". Other times the erosion leave isolated limbs of the overhanging nappe that are called "Klippen."



Faults normal, reverse, strike-slip

The rocks placed at depth are subject to continuous and sustained stress that deform them in a ductile way. The structures that are formed more often in these conditions are the folds. They may be visible on the surface in rocky forms, varying in size from a few centimeters up to tens of meters.
In fact those structures may stretch for many kilometres but in this case they are not easily visible because they are too wide to be seen, moreover, most of the time the rocks are not completely exposed.

Regional geological understanding of an area is important to understand how the different rocks come into contact with each other. Contacts can be of different types, the stratigraphic contacts occurs when different rocks are overlaid by sedimentary processes that have formed them.
Contacts can also take place as a result of magmatic processes, when a magma body intrude into an already existing body rock. Such contact may occur even in the case of effusive rocks, where there is usually a sort of stratification of magmatic materials spread above a solid substrate.
The tectonic contacts takes place when a fault, moving two volumes of Earth's crust, put in contact rocks of different types.

Geomorphology: the shapes of the earth

The environment around us has many aspects, one of the most important is the shape. The Earth's surface, on which we live, has a great variety of forms, these are studied by geomorphology (from the greek ghé: land, Earth; morphé shape; logos: word, speech).
The factors that determine the development of particular forms of the earth's surface are many and can be grouped into two sets: morphogenetic processes and geological structure.
Morphogenetic processes are all processes that tend to disrupt, erode and remove the superficial rocks, are the active part of the "creation" of the forms, in other words the processes that shape the forms. To make an analogy, the morphogenetic processes behave as a sculptor that eliminates unnecessary material from a block of stone to "bring out" the form he desired.
The geological structures are differences between a point and the other within the rock: these differences affect the erosive process promoting or slowing down them in some parts of the rocky masses.

Morphogenetic processes and land forms

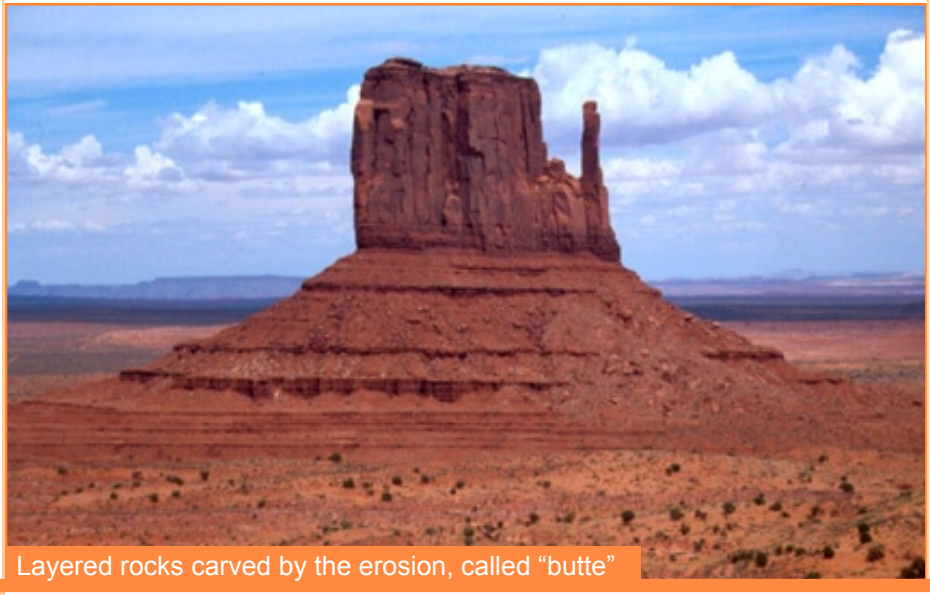
Morphogenetic processes are different, distinguished mainly according to the weather conditions dominant an area so the action may be predominantly mechanical or chemical.

The mechanical action consist in the break into fragments of rock, is typical of dry, hot or cold climates. The chemical action lead to the dissolution of minerals, is favoured by warm and humid climates.

The geological structure and forms of land

The erosive processes alone are not sufficient to explain the variety of existing land forms. Is relevant, in fact, the geological structure. Geological structure is the difference of property between one point and another existent within the rock masses. The lithological characteristics (ie rocks, from the greek: lithos stone; logos word, speech) are passive factors in the development of forms. They can only slow down, more or less, the erosive action on the basis of the resistance they oppose. The land surface can be considered a set of slopes of different inclinations, as there is a wide variety of rocks at different erodibility, less erodible rocks are capable of producing more inclined slopes meanwhile more erodible lead to less steep slopes.

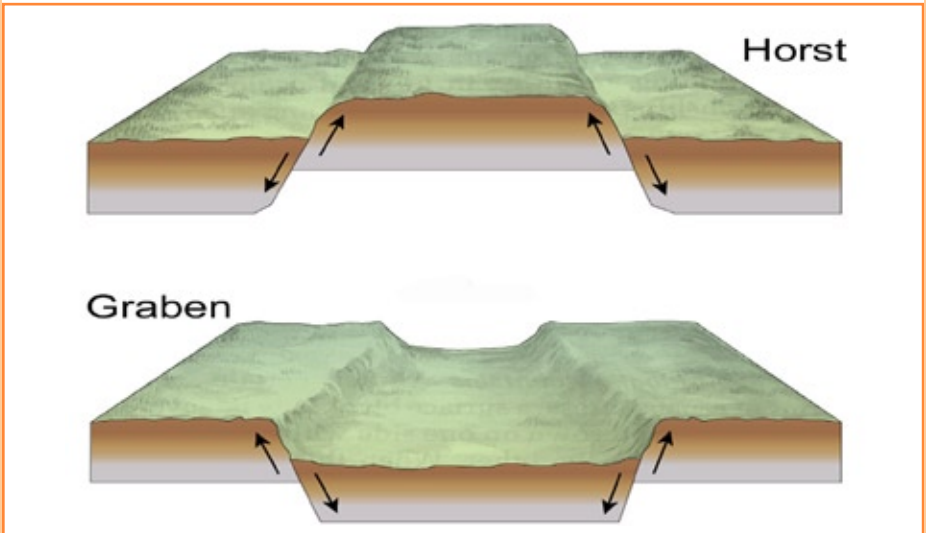
This difference is emphasized in the presence of rocks with volumes of different strength, as happens, for example, in sedimentary rocks, where most erodible layers alternate with layers more resistant.



Layered rocks carved by the erosion, called “butte”

Some of the most common geological structures are the following.
- Tabular structures: the presence of stratified rocks with horizontal layers results in tabular structures.
The characteristic morphology in the presence of tabular structures is that of a summit plateau and very inclined slopes at the margins of the plateau. Alternating layers with different erodibility may lead to a side steps. The most visible steps are called in some places, "ledges". Insulated portions of tabular structures are called "butte"

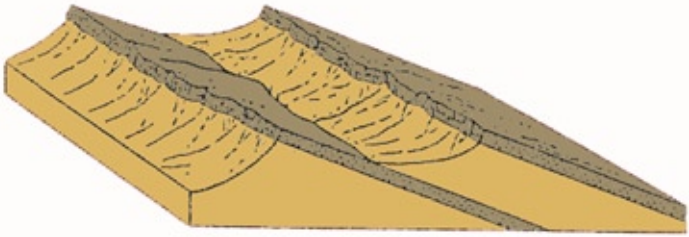
- Monoclinal structures in layered rocks can show layering tilted in various types of slopes. The slope at the same franapoggio degrades to where the layers dip is often the pattern is regular since the Lying of the layers coincides with the same side.
A reggipoggio is the side opposite the franapoggio in which the layers dip against the slope. These slopes can become very acclivi because the plans do not favor the layer separation of fragments. The slopes at traverpoggio are arranged transversely to the layers.
- Fault structures: the faults are structural elements that can greatly affect the landscape. One of the effect produced, therefore faulting should be considered active process, is the real displacement of large volumes of rock, in general, for normal and reverse faults one part is raised above the other.



Tectonic morphologies "horst" and "graben"

The gap that is formed as a result of the movement of the fault is called fault scarp and is usually well recognizable on the ground. The surface of the fault is called fault mirror and is generally seen as a clear and polished surface.
A volume of rock lowered between two faults generate a structure called "graben", on the contrary, if the faults limit a volume of rock raised, the structure is an "horst".

- Folded structures: as we have seen, there are structures generated by ductile deformation. These structures have sinusoidal shape and may occur in different sizes, when the size is of hundreds or thousands of meters they can affect the morphology of the landscape.
A landscape that is typical for the presence of large folds is a synclinal



Layered rocks and monoclinal strucures

valleys and anticlinal ridges: synclinal valleys sets in the concave bend of the fold (called syncline), while the anticlinal ridges are placed on the convex anticline of the fold (called anticline).
The two sides of the fold when exposed can are identified as two monocline structures.

Rocks and erosion
The peculiarities of some rocks allow, under certain weather conditions, the development of particular morphologies. Below will be presented some rocks and the morphologies that commonly they can show.

Granitic rocks

The granite rocks, on the basis of their mineralogical composition and homogeneous distribution of the minerals within the rock mass, tend to be eroded uniformly on all sides and therefore the forms that occur are mostly rounded and regular. When factors that facilitates the erosion are operating the forms may be more complex: in the case of granite masses, the portion in contact with the ground may receive input of water that facilitates the alteration chemical reactions of the granite, in this way it can be developed typical forms "mushroom-shaped".

Fault cutting layered rocks

Limestone rocks, the karst

The chemical composition of limestone, consisting primarily of calcium carbonate, makes these rocks particularly prone to the dissolution operated by the water. The dissolution of carbonate produces peculiar morphologies, both on the surface, these forms epigean (from the greek epi: above, ghé: earth) and in the subsoil, these hypogean (from the greek hypo: under, ghé: earth).

The limestones are in fact the most widespread rocks where the erosive phenomenon can occur not only on the surface but even in depth: the areas where this erosion occurs are called karst. Similar phenomena are developed in the more rare evaporitic rocks as in chalk.

The superficial dissolution of limestones often produces a few centimeters wide grooves on the rocks: these patterns are called karren, from German,

or "lapiés" from French. Where the slope is not very high, it can also be formed some small bowls-shaped holes "pans".

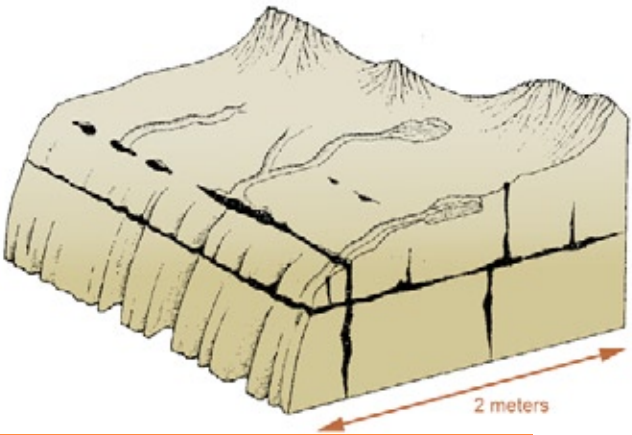
The effect of dissolution is even more evident with larger forms, an example are the sinkholes that are generated as a result of dissolution and collapse a cavern roof.

The sinkholes are funnel-shape forms that are closed basins with a large and permeable bottom with a subterranean passage, the sinkhole size ranges from several meters to tens of meters. When the dissolution takes place in depth, are formed of all karst cavity known as caves. The caves can achieve substantial extensions, from several meters to several kilometers, and are created by dissolution of limestone.

It is interesting to note that the creation of a cave starts with the development of a first cavity whose dimensions increase due to the water erosion: for this reason this first cave is called "active cave". Subsequently, the placement of the underground river tends to lower so in the previously formed cavity, no more subdue to erosional processes, occur a depositional phenomenon. On the walls of the cave, the water deposit calcium carbonate, this part of the cave is called "fossil cave". Slowly the structures develop from top to bottom (stalactites) and from the bottom up (stalagmites), sometimes they merge and produces spectacular columns.

Erodible rocks: gullies and pinnacles

The soft soils such as those made up by clays, are usually easily erodible, so when they undergo to pluvial water, often develop, on steep slopes, many deep SOLCHI called "badlands".

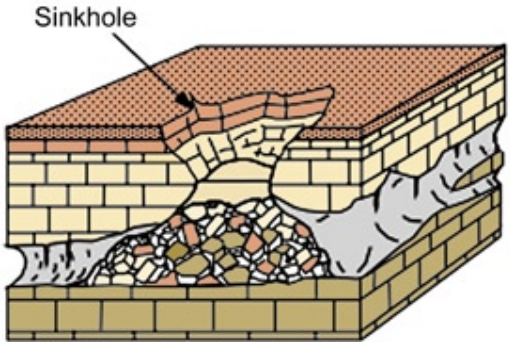


superficial karst forms

This process can extend to entire slopes to obtain a network of tiny and deep valley separated by narrow ridges. more resistant material Bodies within the clay can preserve

from the erosion the materials placed below them, in this way may take place picturesque colorful pinnacles- shaped residual forms.

in Italy the lands where badland erosion thake place are called "calanchi", you can see examples of it in Tuscany and Emilia Romagna, in Trentino are famous the Segonzano's pyramids.



Formation of a sinkholes

In some setups, rather than erosive factors, the landscape is influenced predominantly by the lithological factors. An example is in glacial morphologies, where the erosive action of ice model the landscape in typical ways. These forms are present in Italy in many places with often interesting and beautiful evidences.

Glacial morphologies

When areas undergo for a certain period the ice action develop particular morphologies. The glaciers in their movements from upstream to downstream, bear erosive action on the rocks surfaces.

Common manifestations of the glacial erosion on the rocks are the signs of abrasion, smooth and rounded surfaces, "glacial LISCIONI", striae, glacial


Karren

grooves and ruts with orientation equal to that of the movement of the ice. The Montonate rocks show as rocky humps, smooth and rounded according to the direction of glacier movement.

With a different dimensional scale, but of glacial origin, are the U-shaped valleys, the glaciers may excavate the bottom of the valleys in which they move and carve the typical U-shaped profile, unlike the river valleys profile that typically have a form of V. Also glacial is the origin of glacial cirques, they are niches in mountain flanks.

If the glacial valleys reach the sea, can be formed deep and beautiful bays called "fjords", which often have high and steep walls, the sea bottom can can be very deep and the fjords are often navigable. The storage of materials originated from the erosion and transport of glaciers gives rise to particular forms. Moraines are significant, accumulations of debris of various sizes, placed at the sides and in front of the glacier (respectively frontal and lateral moraines). The frontal moraines may have arched shape while the lateral moraines are generally elongated.

Pinnacles formations made by the erosion

The Geosites

In recent years is growing the awareness of the particular aesthetic, naturalistic and scientific value of many places, and also the awareness of the fragility of some sites. For these reasons, recently, UNESCO has suggested some guidelines regarding the "preservation of the geological

world heritage". Following this initiative, the most sensible nations are working to identify most geological valuable areas, meaning for "geological valuable" the scientific but also the scenic value: these areas are known as"geosites". Also Italy is working to satisfy the need to identify geosites that deserve to be protected and preserved, in particular, the law on protected areas (394/1991) states, in its Article 1, the purpose of the protection and management of the "... preservation of geological singularity, paleontological formations, landscapes and scenic values, natural processes, hydraulic and hydrogeological equilibria...."

Under this stimulus, in Italy and in many other countries, have been identified many geosites of great value that can be transformed, for their protection in protected areas. Therefore it will be available in the next years an increasing number of areas dedicated to conservation but also to the promotion of geological heritage, it will possible to access to an extensive documentation suitable for the preparation of geotourism and will spread geological thematic itineraries which will make it easier and enjoyable the geotourism activity.

U-shaped valley

Tourism: a resource for the future

Historically the term "geological resources" means the mineral deposits and the materials with economic value. Only recently have been acknoledged a touristic, scientific and scenic value to areas of special geological interest. Both in Italy and abroad, are frequent the cases of transformation of inactive mines into parks accessible through guided tours. Only now geological parks are been created where you can see the real dinosaur footprints on the rocks instead of in dark and dusty museums. We already appreciate natural beauty such as waterfalls, mountain peaks, islands, volcanoes, lakes, which owe their origin to geological phenomena, but often without taking into account the geological aspects. It becomes clear that placing into a new perspective the existing natural heritage will lead us to better appreciate it.

The Landscapes

There is a huge variety of landscapes on the Earth, whose diversity depends on several factors. Although not well known, one of the most important factors that influence the landscapes diversity is geology.

Many fascinating and colorful shapes that exist on our planet, such as dunes, high waterfalls, vertical cliffs, impressive volcanoes, mountains and the plains could be explained by geology.

From the point of view of a geotourist, it will be convenient to distinguish between some main categories, that will be called geological landscapes, although this division is only an artifice to facilitate the description of the peculiarities of the different environments. The criterion for division is mainly based on the type of rocks and rock associations, which in turn depend on the processes that have generated them.

It to stress that geotouristic travels are not tied to purely geological aspects of a landscape but, as we have seen, will involve all aspects of tourism including botany, biology, zoology. Nevertheless it will be also fascinating to understand the historical and cultural aspects of the sites visited: this broad scope of integration between the earth sciences and other disciplines is an excellent opportunity to organize and take a nice "geotouristic" trip.

Mountain landscapes, Alps and Appennine

The alpine mountain landscape is representative of all geological active areas where orogenesis is in process. In this landscape there are mountains that, compared to the geological time scale, may be considered "young"; they are most of the time still developing.

This type of landscape is widespread all over the planet: from the Andes to the Pyrenees, from the Alps to Himalayas up to New Zealand.

The nature of the mountain ranges is highly varied but linked by structures developed during the formation of the chain.

We can summarize the process that forms a mountain range in the following three stages

- convergence between plates
- collision of plates
- uplifting of plates

The mountain landscapes presents a rather complex but very interesting geology, the effects of plate tectonics are often stunning and can be detected by observing the wonderful deformation structures in outcropping rocks in many places. The presence of huge folds is the most obvious clue of the forces acting between the lithospheric plates. The schistosity, often present in rocks, is developed as the result of deformation phenomena suffered by rocks when they undergo tectonic forces.

Badlands shapes in volcanic rocks

The geological principles useful to undertake a trip to a mountain chain, for instance the Apennines or the Alps, are those of the structural geology of the "tectonic units". The tectonic units are large portions of Earth's crust that are subject to the pressures generated by the plates movement, some of these units are first pushed deep (subduction) and then come back to the surface. When the plates collide, some units are on top of the other, forming a stack.

A tectonic unit is also characterized by its place of origin; there are units from the ocean bottom, units from the continental margin and "continental unity", from the furthest interior of a continental plate. Recognizing the type of a unit allows you to understand the overlap and deformation relations between them and to understand the complex structure of the chain.

The reconstruction of the history of a mountain aims to go back to conditions existing before the continental collision.

These relationship between the structural units can be the subject of a geological trip. Looking at the geological maps, it is possible to distinguish the different rock formations grouped into tectonic units and you can decide the itinerary of the trip so that it passes through the different units.

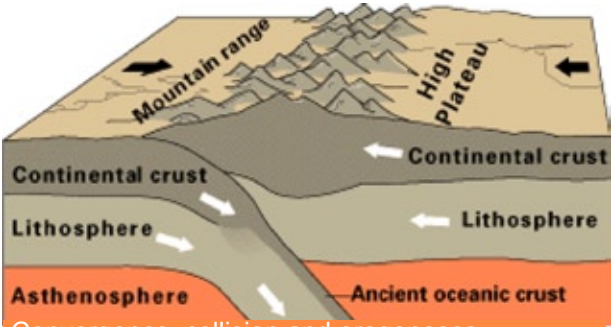
In Italy is important to distinguish the genesis of the Alps and the Apennines. The Alps have developed in consequence of a series of movements involving a large part of the surface of the Earth. The chain that has developed from these movements is well largest than the Alps as defined by geographers.

Folded rocks in Alps

Actually, this mountain range stretches from the Iberian Peninsula through the Himalayas all the way to New Zealand. The tectonic units involved have undertaken major deformations and metamorphic processes, so that the recognizable characteristics in alpine rocks are the result of changes on oldest rocks.

The Apennines chain is more recent than the alpine one and it is less extended, the rock formations underwent less intense metamorphic transformations and therefore keep many of their original characters (stratification, mineralogical composition, fossils). Also the deformations occurred are "less intense" and you may often observe very large folds instead of those very tight in alpine rocks.

The above discussion explains the fact that many common rocks in alpine environment, are metamorphic, even if they are not lacking intrusive and effusive magmatic rocks. The Apennines, on the other hand, are mostly made up by sedimentary rocks.



Convergence, collision and orogeneses

The size of the mountain ranges is the result of the intensity and duration of tectonic forces that have acted on the lithospheric plates. The phenomenon of lifting may also be in process or completed since a while, in the latter case it is possible that the mountains have already suffered significant erosion that has reduced their size.

The morphologies often present, especially in the Apennines, are typical of monoclinal structures (with a uniform stratification) or folded structures.

At the highest altitudes mechanical erosion phenomena prevail, due to the low level of water in liquid state (almost compulsory for chemical reactions) and the low temperature (low temperature heavily slow down chemical reactions). The physical phenomena due to changes of temperature, are pronounced with high altitudes.

The steep slopes help the movement of material, including large sized one,

while the lack of vegetation allows abundance of outcropping rocks, making the landscape barren but fascinating at the same time.
In the mountains it can be easily observed morphologies due to erosional processes like landslides, slips, and accumulation of material like debris and conoids.
The vegetation suffer like the one in cold climate with little presence of water and soil. In alpine landscapes glacial phenomena are widespread; in very cold weather, with temperatures below zero for long time, the presence of ice gives rise to glacial forms.
The mountain areas in high altitude often show very evident morphologies such as U-shaped valleys, glacial cirques, glacial moraines. rocks, sheep and striate.

Attractions in Alpine landscapes:
Tectonic units, large and small deformation structures, metamorphic rocks, U-shaped valleys, rocks, sheep and striate, glacial cirques, lateral and frontal glacial moraines.

Volcanic landscapes
Some of the most interesting and spectacular geological manifestations of the activity of our planet certainly are the volcanic phenomena. The volcanic activity, in fact, shows the enormous amount of energy involved during an eruption. The eruptions occur as the result of magma rising from a magma chamber to the surface. Magma is formed in depth by fusion processes of pre-existing rocks. The melting of the rocks is caused by the rising of the temperature over the melting point which may occur when large portions of the lithosphere are carried in depth by a process of subduction. The conditions for the melting of rocks also occur when materials from the mantle are rising up; this case usually happens below the oceanic ridges.
The molten material reaches the magma chamber, where it can stagnate before reaching the surface. The magma chamber is an emptiness placed below the volcanic crater, whose shape can be extremely varied.
The volcanic crater is a building created by the accumulation of erupted volcanic materials, whose shape and size depend on the type of materials that constitute it and also on the type of eruption occurred.

Acidic magmas, rich in silica (SiO2), tend to be very viscous and therefore difficult to flow, in which case the volcanic activity will usually be explosive. On the other hand, basic magmas are less viscous and can flow more easily with a less explosive activity. The buildings produced by acids magmas, which have little ability to flow and therefore to go far from the emission spot, develop vertical forms; the buildings made from basic magmas will develop flat forms due to the ease of movement of these magmas.
The volcanoes may be classified according to their morphology.

Basaltic plateaux
Some parts of our planet are covered by wide spread of basalt that are generated by the spread of very fluid magmas that find a way out through cracks of the earth's crust: there are examples in Deccam, in Siberia, Mongolia, Arabia, Ethiopia and in Patagonia. These long cracks develop when the Earth's crust is subjected to "stretching" and thinning that leads to fracturing.

Shield volcanoes
Shield volcanoes are generated by the emission of very fluid basaltic magmas and they take the name from their flat shape. The slope of their sides is gentle, only a few degrees. Many examples of such volcanoes are present in Iceland.

Stratovolcanoes
These type of volcanoes are formed from an alternance of lava flows and ejection of pyroclastic materials. The structures have conical and symmetrical shape with concave and steep sides. Well-known stratovolcano in Italy are Etna, Vesuvius and Stromboli.

Calderas
Calderas are created from the collapse of a previously formed volcanic structure: the already formed cone sinks due to the empty magma chamber below and the overload produced by the accumulation of materials on the surface. Often the depression created by the subsidence is occupied by water, resulting in the formation of one ore more lakes of round shape.

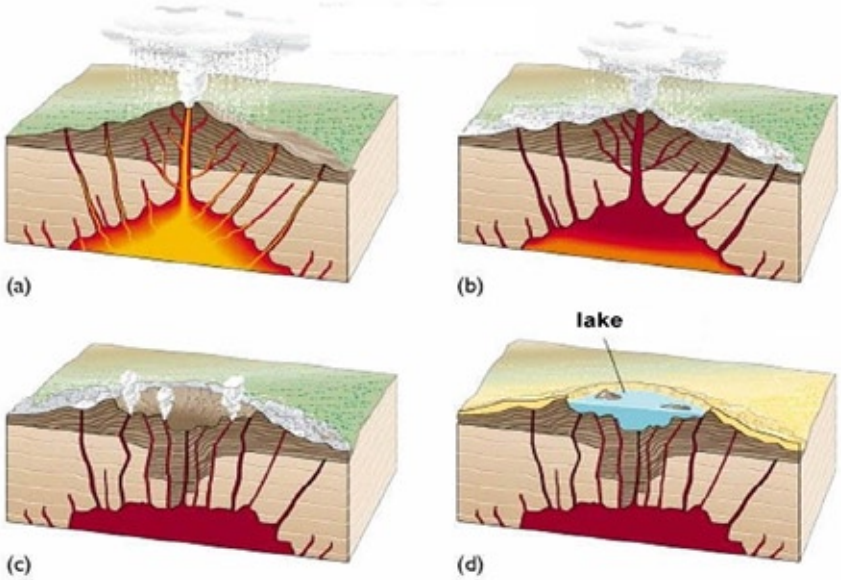
Italy's calderas are placed in the region of Lazio, where the craters are currently occupied by the lakes of Bolsena, Vico, Bracciano and Nemi.
If the collapsed crater is located in the marine environment, the subsidence can result in islands of the strange circular form: some examples are Santorini and Milos islands in the Aegean sea in Greece; indeed they are called Ciclades from the greek word kiklos that means circle.

Volcanic eruptions

The types of eruption are defined on the basis of the explosive intensity associated with the volcanic phenomenon and the type of material ejected: the two factors are closely related. Knowing the various types of eruption may give the idea of the phenomena that generated the different volcanic landscapes.

Peléeiane Eruptions

The peléeian eruption are the most explosive, this type of eruption is defined from the mountain Pelée in small Antilles (Caribbean Sea), where, in 1902, was recognized for the first time.



Caldera developement fases a) eruption b) stasis, c) collapse, d) filling

Plinian eruptions or Vulcans

Plinian eruptions or vulcanian eruptions are highly explosive and dangerous, they form an eruption column high a few dozen kilometers, made up of gas and solid particles of pumice, ash and rock fragments.

These eruptions named after Plinio "the young" who described for the first time the phenomenon, observing it during the famous eruption of Vesuvius in 79 AD in Italy.

These eruptions are also called "Vulcanian", the name comes from Vulcano, a small island in the middle of the Tirrenian sea where there is a volcano with a typical vulcanian eruptive activity. These eruptions leads to the formation of deposits on fall, characterized by high distribution area.

Hawaiian eruptions

Many volcanoes in Central America and in Indies are made by this type of eruption that are characterized by the emission of large quantities of basaltic lava that flows swiftly along "lava rivers". This type of eruption take the name from the well-known Hawaii islands located in the Pacific Ocean.

Erupting volcano

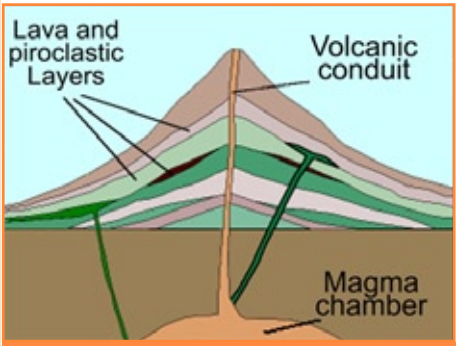
Icelandic eruptions

These eruptions are similar to the Hawaiian-type eruptions, but, unlike them, the lava flows originate tabular structures made up by several almost horizontal superimposed (overlapping) layers. The lava generally comes out through long fracture.

Strombolian eruptions

The Strombolian activity is characterized by a series of small explosions and fountains of basaltic lava. Each episode is caused by rising bubbles of volcanic gas and it is separated from the preceding episode by an interval lasting several minutes, rarely regular, more often irregular. These eruptions take their name from Stromboli's island in Tirrenian sea (Italy).

Activities related to the magma phenomena



Strato volcano

There are many natural phenomena related to magmatic activity, which are often of great natural beauty and scientific interest, and sometimes they produce spectacular effects. Around these special geological occurrences are born legends that are still known today and that deserve to be remembered, if not for their scientific accuracy, for their great charm.

Gas emission (Sulphated)

The emission of gases from the magma body lying at depth can occur during non-eruptive phase, when the volcano, although active, is not being erupting. In this situation we can assist, in areas affected by magmatic phenomena, to the emission from the soil of gas puffs rich in hydrogen sulphide: the latter, in contact with air, is oxidizes, leaving a deposit of crystals of sulphur. The smell nearby the emission points of the gases is most of the time typical of sulphur. Besides the release of steam, hot water from the magma body may bring salts of economic interest to the surface, such as the "Soffioni boraciferi" of Larderello, Tuscany, which are formed by boric acid, hydrogen sulphide, ammonia, methane as well as other gas.

Fumaroles, hot springs and gayser

The fumaroles are generated by movements of water, often of meteoric origin, penetrating the soil and reaching the lava, which is at depth and at high temperatures. This circulation produces the steam, which in some cases violently escapes during small explosions whereas in other cases it quietly escapes through the porosity of the soil. Examples of this phenomenon in Italy can be seen at Sasso Pisano (Toscana), near Vesuvius and Ischia (Campania) and in the Aeolian islands (Sicily).

A similar origin is that of gayser, powerful spray of hot water which is pushed strongly upwards. The gaysers power have their origin in the magma body that functions as a source of heat and bring the circulating water to turn into steam when it reaches the surface.

Some famous gaysers are located at Geysir (Iceland), which is the place from which the phenomenon took its name, the Valley of the Geyser (Kamchatka Peninsula, Siberia), in North Island (New Zealand), in El Tatio (Chile), in Yellowstone National Park (Wyoming, USA), in the Beowawe Geyser Field (Nevada, USA), a Steamboat Springs (Nevada, USA), in Umnak Island (Alaska, USA).

Thermal waters are also produced by the movement of water in the vicinity of hot magma bodies. The hot waters reaching the surface are often enriched in minerals collected from the rocks they passed through, when the

Caldera and volcano in background

waters escape to the surface the salts crystallize bearing to the formation of beautiful forms. An example of rocks formed by deposition of minerals found in geothermal waters are the famous travertine from Lazio. These carbonate rocks are used as construction material in buildings, indeed many part of ancient Rome have been built using travertino marble.

The thermal waters springs have been, since ancient times, used for the welfare of the body and around it were built beautiful and ingenious architectural works, particularly in the Greek and Roman influence area. An example is the Roman building of Hierapolis, located near the beautiful white limestone terraces of Pamukkale in Turkey.

Some of the most famous thermal complex of the past are still active and can be visited.

Men and volcanoes

The volcanic areas not only present a very distinctive landscape, they often have a human history closely linked to the life of the volcano. The great fertility of the areas surrounding the volcanoes, opposes the threat and the danger of sudden eruptions. The life of a volcano is a succession of short periods of eruptive activity and long quiet periods. This behaviour has often surprised populations located on the slopes of craters and often totally unaware of the threat. A tragic example of how the occurence of this

Hydrothermal emissions of water and mud

cyclicity can have catastrophic effects can be seen in Pompei (Italy), where, in 79 BC, an entire town was wiped out by a violent eruption of Vesuvius. The history takes into account the geological events: it is supposed, in fact, that the Minoan civilization was destroyed in 1400 BC, by the explosive volcano located on the Santorini island, in the Aegean sea (Greece), and by the resulting tsunami produced by the collapse of the crater.

To see in volcanic areas

During an excursion to a volcanic area, you can make several observations. Generally the most prominent element that can be noted is the volcano itself and its typical cone-shape, or, if the building is collapsed, you can see the caldera. It will be interesting to understand the volcano building processes occurred, the extent of lava flows, their layering, forms and overlapping.

It will be possible to examine the rocks that make up the lava deposits and the ejected materials, the mineralization of sulfur, the hot waters and gas emissions.

Sedimentary landscapes, karst and mountain

Sedimentary rocks tell us what happened in the seas of hundreds of millions of years ago. On the seabed, now as in the past, materials from the land are settling and from those sediments the sedimentary rocks take place.

The presence in the sedimentary rocks of more coarse fragments, like sand

Calcareous deposit inside a cave

and gravel suggests us that the sediments were deposited near the coastline. The type of deposited material gives clues about how the continental area that produced the sediments was made. For example a sandstone rich in quartz grains can be originated from the dismantling of granitic rocks.

Among the most interesting elements that can be found within the sedimentary rocks there are undoubtedly the fossils. The fossils tell us in which geological era the rock was formed, under what conditions and in some cases it helps us to understand the original setting of the rock. For example, a coral may be useful to understand whether the rock layers are rights or overturned; it should be remembered, in fact, that the rocks, as we observe them, may have a very different position from what they had in their original environment, in some circumstances they may be even inverted.

Sometimes within the layers themselves are visible traces of the presence of ancient underwater currents or underwater landslides and slips and the presence of undulations of the seabed occurred millions of years ago.

Geologists assume that during the sedimentation, the oldest sediments are placed below in comparison to the younger that are found above. To reconstruct the right order of the sedimentary sequence means to make a scale with the most ancient rocks at the bottom and the younger at the top. These simple rules are the base of the stratigraphy, a discipline that deals with the reconstruction of the relation between the various layers in the rocks.

The karst landscapes are characterized by the presence of a typical sedimentary rock, the limestone. Limestone has chemical characteristics that easily allow the erosion by dissolution.

The reef is a sedimentary environment where limestone and dolomite can be formed. Even today, in a shallow sea, near the land, on what is called the continental shelf the limestone develops. The continental shelf is a large "step" that exists around the continents, which descends abruptly into the depths of the ocean. On the continental shelves the limestone produced by the chemical reaction of water coming from the continents is deposited. The accumulation of calcium carbonate can take place via the deposition of fragments of dead bodies formed from parts such as corals. The most populous the sea is the easily it produces this kind of sediment.

Once on the surface, the limestone can tell its history "lived in the sea".

The layered appearance denote the sedimentary origin, the thickness of the blocks may range from a few centimeters to several meters, indicating a more or less significant sedimentation. A wonderful example of a landscape formed by ancient rocks formed into the sea is represented by the Italian Dolomites.

What to see in sedimentary landscapes, karst and mountain.
Rock layering, alternating layers, internal structures. Sedimentary rocks, chemical and organic. Erosional processes, badland and pinnacles, influence of stratification of the rocks on landscape. Karstic surface and caves. Fossils and fossil-rich formations.

Granite landscapes
Intrusive magmatic rocks are wide spread on Earth. Their composition has a wide range but with common characteristics.

- The presence of crystals of a size visible to the naked eye, they have granular texture (the texture is the internal organization of the rock);
- predominantly "acid", i.e. with abundance of quartz;
- general lack of layering acquired during the original magma genesis (e.g. differently from the rocks that are formed by sedimentary deposition).

The magmatic rocks of this type are formed in a geologically active environment, often in close proximity to mountain ranges in its formative stages.
The erosion of these rocks frequently produce fascinating and imaginative forms known as "tafoni". In some places the similarity of these forms with certain animals or objects lead to naming like "the bear" or "the mushroom".

Attractions in granite landscapes
The texture of the rocks, their composition, the fine granular minerals (quartz, feldspar, plagioclase, biotite) and their order of growth (crystallization), veins and sills, and morphologies: the tafoni.

Ophiolitics landscapes and the ocean floor

Even without reaching the depths of the abyss, you can see how a ocean bottom is formed because in some areas the outcropping rocks that originally formed the sea bottom are present. If you go to these places you can "see the bottom of an ancient ocean."

The formation process of the ocean depths is explained by the tectonic plate theory, two plates diverging, that move away from one another, are separated by an ocean ridge. The ocean ridges are long "cracks" that can cross an entire ocean and the magmas that comes out from it solidify, creating new oceanic crust.

The sequence of rocks formed by the oceanic ridges is similar in all oceans and can be sketched as follows. The substrate of the sequence is made-up by serpentine (so called for its bright green and black colour), a rocks derived from great depths of our planet, from the mantle.

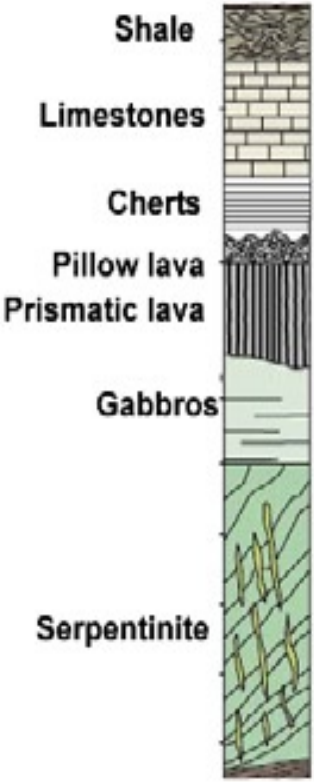
The magmas from the mantle, solidified within the serpentine, form large intrusive magmatic rocks bodies: the gabbros. The magmas that is solidified on top of the serpentine form thick layers of columnar basalt, so called because, when observed on the surface, they are divided into very regular prismatic columns.

There are famous examples of columnar basalt along the Irish coast in a place called the Giant's Causeway, in Iceland, in the Nikko National Park in Japan, in Hoggar Algeria, in Canary Islands, n the United States of America is also

Erosion over granite rock

famous the Devil's Tower, in the French Massif Central at the Regional Park of Auvergne. In Italy some cases can be seen in Sardinia within the Iglesiente area, in Sicily in the Alcantara gorges and in Acitrezza and Acicastello.
The same magmas, when it comes in contact with water, solidified very quickly producing pillow lava basalt.
Above the pillow lava basalts often are placed sediments typical of oceanic areas: cherts (chemical and biological deposits of quartz), limestone (mainly produced by chemical deposition), mudstone (sedimentary deposits of clay).
The association of the rocks described above is called ophiolites (from the greek Ophis: snake, and lithos: stone).

What to see in ophiolitics landscapes
The Serpentines and gabbos rocks, columnar basalt, pillow lava basalts, cherts, limestone, mudstone.



Sketch of the ocean floor


Prismatic columnar basalts

Routes

After having "studied" the geology, it is now time to understand how to organize a geotouristic trip.

If some aspects of a geotouristic trip correspond to the one of the traditional tourism, in other areas it differs, both during the preparation prior to departure and during the trip itself.

During the organization of the route it is better to remember that, although the rocks are very common, there are some places where they are suitable in order to understand the geology with ease.

In a good geotouristic route is foundamental to select some "key locations". In many cases the distance between these locations will require the help of an appropriate means of transport to move from one location the other. Outlining the routes is better, depending on the time available, not to take into account many different geological issues, otherwise there is the risk of confusion between places and "objects". Many rocks are similar but each one has its own history.

Geological information

How to gather the informations needed to prepare a geotouristic trip.

Road maps and travel guides are well known in traditional tourism, less known is that there exist geological maps and geological guides. Geological maps are produced by the geological survey officies of many countries for the purposes of planning, for the knowledge of the geological resources and for scientific purposes, although they can also be used as a useful aid in the planning of a journey. Ggeological maps are very rich in information showing the topography by means of the contour lines i.e. lines on a map that joins points of equal elevation, they defines the shapes of the land that represent.

In addition to isoipse, geographical common features are shown as roads, houses, rivers, lakes, boundaries and more. Do not forget to take into account the scale adopted by the map: it gives the correlation between real objects size and the shown actual size on the map (example: scale 1:100.000 means that one centimeter represented on the map is equals to 100.000 centimeters the real object, or also 1000 meters). The Italian official geological maps use a 1:100.000 scale; in the future will be available maps

with 1:50.000 scale, there are also more detailed maps (scale 1:25.000, 1:10.000 scale) for some regions. The peculiarity of these maps is that the existing geological formations are represented in different colours. The colours represents the rocks found below the surface even if they are not directly observable, this information are deduced from the interpretation of geological data collected in the area. In one side of the map is also present the legend that allows to understand what kind of rock symbolize each colour, which features presents, what age, which fossils and minerals contains and much more. The geological maps also show, as symbols, information about the structures of rocks and their arrangement in space. For example, a place with layered rock on the map will be described with a symbol that indicates the presence of stratification and its orientation and inclination.

Geological cross sections, usually present on these maps, are a sketch of what could be ideally seen cutting the Earth's surface along a vertical line. Looking at a geological section, we can imagine the arrangement of the rocks underneath.

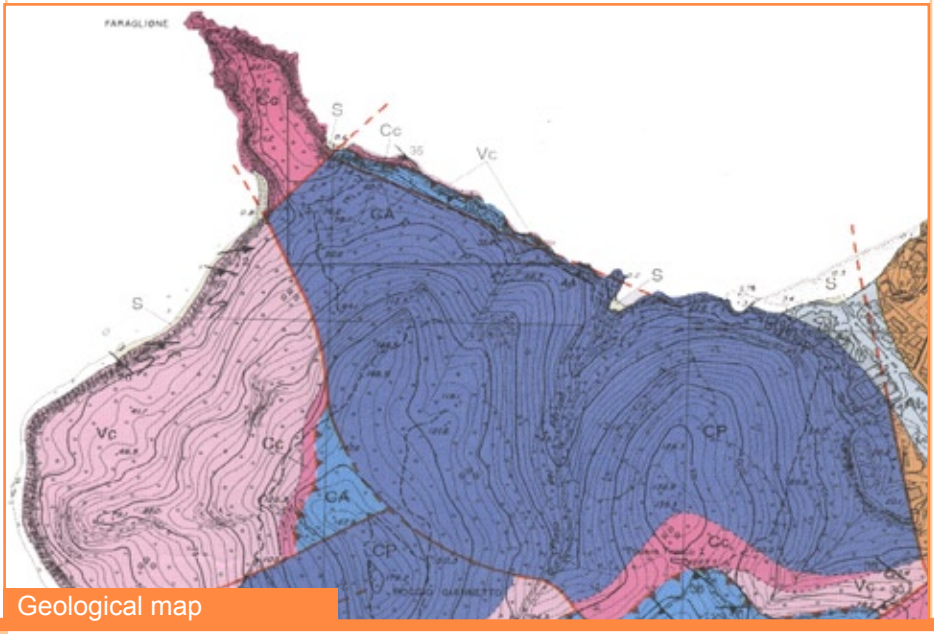
Geological maps are a valuable tool to understand where certain types of rock are placed. These maps, however, does not indicate where the rocks are actually visible on the surface neither indicate the sites of major scientific and educational interest and where to find them. For those reasons, the geological maps should be used together with other documentation. It should be noted that it is not easy to find this kind of maps, indeed geological maps can be found on sale in specialized libraries, in consultation in university departments and cultural centers. It is useful to know that while in Italy and in some other countries there is good geological cartography continuously updated, in other countries this thematic cartography may not exist.

Other valuable sources of information to organize a geotouristic trip are geological guidebooks. These books can be found in specialized libraries.

Usually they have a comprehensive introduction about the concerned area, where it is described the reconstruction of geological events that led to the current situation according to the most accredited theories. Then some routes or places of geological interest are presented, with a road map showing the routes that drive to the places to be visited (also called "stop" or geosites). The stops most of the time are selected for their high scientific value and are described and represented with diagrams and drawings.

Typically, a route can be completed in one day but nothing prevents you from taking the information from different itineraries and to assemble new interesting itineraries.
If there is a need for more in-depth information, you can find a huge number of scientific publications on journals issued for geologists. These can be found in consultation in the universities or in libraries.
For those who wish to have the support of an expert for their trip or excursion, there are in each region entitled naturalistic guides. They are often graduates in science and may organize a trip for the tourists who wish to visit areas of natural interest.

In order to contact a geological guide may be helpful to ask information to the local tourism agencies or park working on the promotion of the place you want to visit.
It is also a good idea to ask wheather there are of museums, near the area you wish to visit, especially asking about the presence of a section about the local geology. There are often valuable minerals and fossils collections, although most of the time modest in terms of number of samples.



Geological map

The path (the "stop")

A geotouristic journey or hike is usually organized in a sequence of "stops" selected on the basis of the available documentation. Stops are made in the salient points of the route, where the superficial rocks are well exposed and accessible. The focus will be placed on the outcrops that are most representative of the local geology, well observable and understandable; for example, a sedimentary sequence can be better understood where the layering can be easily identified.

Some of the most suitable places to make rocks outcrops observations are the road cuts where the rocks are easily accessible and because the rocks are well exposed, however the stop can be made anywhere for any observation.

It is also possible to stop to make panoramic observations, in some cases, you may recognize the rock formations in the distance due to the difference in color or type of fracture and erosion; this often happens in high mountains where cliffs are well exposed but most of the time inaccessible; in these cases it is interesting to make observations on the structures developed at wide, such as layers, folds, faults, intrusive bodies.

In some cases, when we are in elevated position, there is a wide visibility field: this is a suitable condition for geomorphological observations because many beautiful forms of relief are often very big in size.

The time spent at a stop can vary depending on the amount of things to be observed and the level of detail you want to achieve. During a stop is very useful to make a diagram or a sketch on a notebook registering the significant elements that are observed. This effort allows you to check if the geological occurrences are really understood.

Gological cross-section

In one stop, we can realize more than one sketch showing objects of different sizes, for example, the layering of the outcrop and the fossils contained in one layer. Making a representation of outcrops can serve as information storing of the geology of an area, this archive also allow to make relationships between geological occurrences made in different places. For example, in order to construct a stratigraphic sequence, outcrops placed in an area can be put in relation. It is useful to register the scale of the sketch (meter, centimeter, mile), and it is also necessary to indicate the type of view, from high (plan) or lateral (section) and possibly the cardinal points of the our scheme. This information become very important when the sketch is consulted after its completion.

Equipment

The equipment for geotourism consists of few and simple objecs. First of all you must wear a suitable dress, generally the one used for normal hiking is fine. Particularly important are the shoes, which must be suitable for walking on rough terrains , a pair of boots are therefore the most suitable. The rest of the clothing should be chosen according to the climatic conditions of the place that will be visited and the season when the visit will take place. For this purpose the usual informations available for travellers can be useful. A tip for geotourists is to keep in mind that very often, during an hike, the eyes will be turned down, perhaps in looking for fossils or only observing the rocks on which we are walking, so in sunny places it is advisable to cover neck from exposure to sunlight.

One of the typical tools of the geologist is the hammer, which is used to detach pieces of rocks from the outcrop. This can be useful, especially by professional staff, to take samples that will be brought into laboratories for later analysis. Breaking a piece of rock is also useful to let us see a new surface of the rock, also called "fresh surface" so that we can better observe the minerals that form it. An already existing surface, in fact, can be altered by weathering or covered by lichen or moss or other minerals (eg clay from soil). The choice of the hammer can be made between the existing tools made for the specific purpose, but will be also fine a normal hammer with a weight of 1-2 kg, a good grip and possibly with a pointed end to extract, and a flat one, to break. When using the hammer, it is advisable to wear a pair of

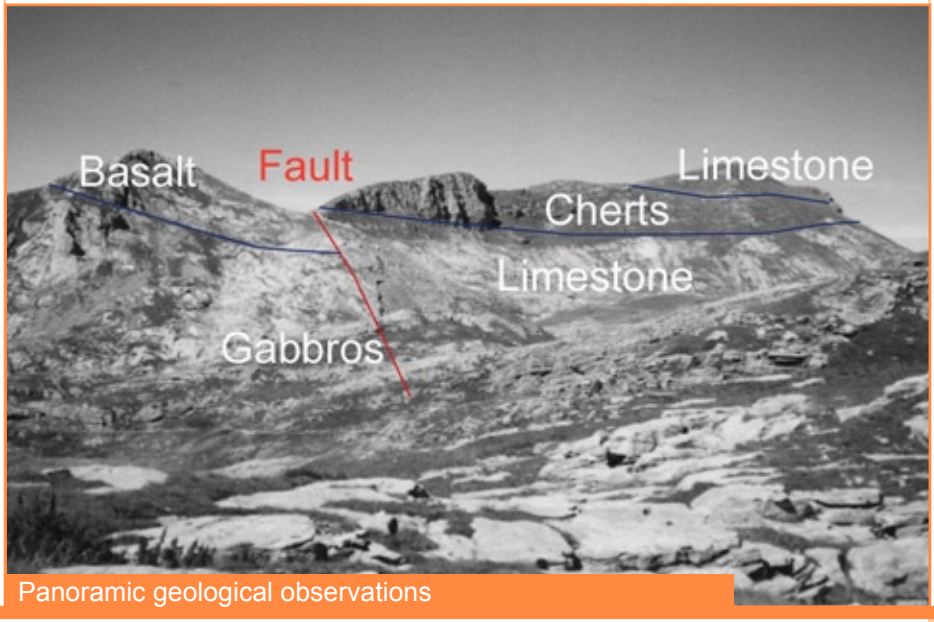
goggles to protect the eyes from possible splinters.

Another useful tool during a geotouristic journey or excursion is the magnifying glass, it may serve to view more detail of the minerals that make up a rock and in particular some of their characteristics (cleavage, habit, fracture), but can also be used to observe small fossils. Indicatively, the most appropriate magnification ratio is between 8 and 10 times (designated as 8X and 10X). There are specific magnifying lenses for geology, but are rather difficult to find, and in any case normal lenses with the magnification ratio indicated above are good tools.

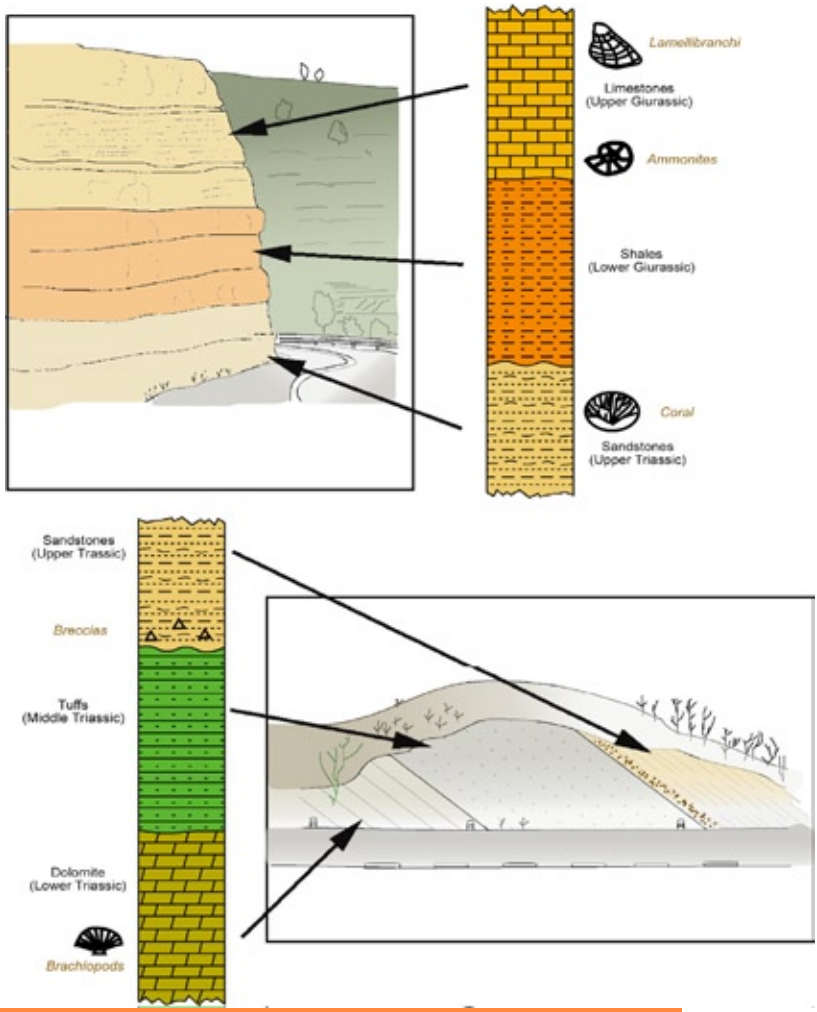
While this may seem a simple tool, it is very useful a bit of steel (just a simple nail of 6-10 cm), this peak, as discussed in the chapter about minerals, is used to evaluate the hardness of a mineral, if a mineral is scratched by the steel nail then it has a value 5,5 in the Mohs scale, on the contrary, if the mineral is not scratched it is less hard. The evaluation of the hardness of a mineral is often used to facilitate the recognition of the ore itself.

Among the tools suitable for recognition of rocks and minerals we can include the hydrochloric acid (HCl). This chemical compound can be used to recognize the presence of calcium carbonate (CaCO3).

hammer from geology, the tip of steel, magnifying glass, hydrochloric acid.



Panoramic geological observations



Stratigraphic sequence and two observation “stops”

By dropping a few drops of this acid on calcium carbonate, a chemical compound that as mineral is, most of the time, in a form called calcite, the reaction will release carbon dioxide (CO_2) in the form of gas that will produce visible effervescence. With this test we can dispel the doubts about the presence or absence of calcite.

We recommend to use a small bottle with dispenser, with a good plug. the acid is sold with a concentration of approximately 37% so it has to be diluted to approximately 50% with water. To avoid security problems, it is

necessary to place on the bottle a label indicating the presence of corrosive and hazardous substance. Remember also to keep out of reach of children.
In order to write down comments, to make diagrams, drawings and sketches, it is useful to carry a pencil and a notebook, the latter preferably of small size and with hardcover. As it is used in various places and climatic conditions is better to protect it with a cover, the geologists call it "field notebook"

A good way to bring home memories of a geotouristic trip is using a camera. This instrument offers significant benefits:
• the representations is faithful to reality, much more than a drawing,
• you can "take home" items of all sizes, from entire landscapes to small fossils and minerals,
• it does not impoverish the countryside by subtracting items, sometimes rare, which may be of interest, in particular minerals and fossils,
• with a few grams of weight carried it is possible to made dozens of pictures, while a fragment of rock can weigh several kilograms.
The only "photographic advice" is to bring also wide angle camera lens to let you photograph landscapes and macro lenses to take pictures of small objects at close distance. It may be useful, as well, to have a tripod to take pictures in a poorly enlightened environment.

Useful tools for geological hikes

The topographic and geologic maps used during the organization of the trip will also be useful during the trip itself. Often these maps are bulky and therefore not suitable for use in the presence of wind. For this reason it can be handy to make small sized copies of the interesting area; that can be handled even during outdoor excursions. Doing the excursion it is also possible to write on the copies without "ruining" the original maps.
In some cases, for better orientation, you will need to use a compass. If the compass is used only to identify the North (magnetic) it does not suite specific technical characteristics. There are, in fact, rather expensive models used during operation of geological measurements, such as stratification layering, orientation of faults, orientation of schistosity plane.

Transport and journey times

The means of transport that can be used in a geotouristic journey are various, what have to be considered is to take into account, during the design phase, the distance between the geological stops, the terrain type, the weather conditions and the number and physical conditions of the travellers.
The best observations on geological phenomena are made at the outcrop scale (a few meters or tens of meters) and moving from one to the other on foot. If the distance between a stop and another is significant, it may be necessary to use other transport means.

Besides geology

Practising Geotourism should be considered an opportunity to travel and observe the geological beauties, but it will be even more interesting when also the botanical, wildlife, historical and cultural aspects of the places visited are taken into account.
Geology affects many aspects of nature and men, if the right key to understand and observe these interactions is used, than significant considerations will take place. Sometimes the reading of the story and the relationships with natural processes are neglected by "traditional tourism".

Botanical aspects

There is a close relationship between the geological conditions and the vegetation that develops in an area. The most important geological factors

are the mineralogical composition of the rocks in the subsurface, which determines the composition of the soil. Different plant species may be more or less favorable to their development on some soils than others. The type of vegetation is also influenced by climatic conditions that determine the availability of resources needed by the plants, especially the light and water. The type of bedrock and the erosional evolution influence on the morphology of the territory and the forms of the land, which in turn will be more favourable to the development of certain plant species. It will be useful to dedicate one or more stops to the observation of the flora and its relationships to the geology, in order to better understand a certain environment.

Fauna aspects

As previously seen, the geological conditions influence the vegetation of an area. The plants, being the base of the food chain, affect the fauna. Taking into account the interaction between living beings and their environment will undoubtedly enrich the value of the observations during a geotouristic travel.

GEOWATCHING!

Among nature lovers it is increasing sensitivity towards the preservation of the environment and there are more and more people who tend to observe and photograph instead of capturing and carrying away items and animals. In this way they keep their emotions and not the objects themselves. We must also take into account that some animals and objects reveal their full value only in their natural home, where they are born and live or are placed by natural processes. Moreover, the removal of fossils, minerals or plants and the killing of animals eliminate forever these wonders of nature from the possibility of observation by others. At this wavelength are the birdwatching (bird observation), the whalewatching (observation of whales) and other activities practised outdoors.

Here, therefore, it is made the invitation to all who love nature, to practice geowatching! Observe the geological beauty but not remove them from where they are, being especially careful to preserve fossils and minerals which are often rare.

Historical aspects

Man, during their evolution, have always interacted with the territory in which they lived: since prehistorical age they have learned to use and modify objects existing in the environment in order to improve their living conditions.

In this process men have learned to discover, recognize, transform and use the materials existing in nature, leaving along the course of time traces of their activities. From these traces it is possible to discover the techniques used by the people and their ability to manipulate natural materials to make them useful to their lives. These objects are charged with meaning and thus become the true witnesses of the human past.

For the geotourism is fascinating to understand what objects were made by the men of a certain time and place, for what functions, which techniques and arts they used, by who they were influenced and whether they influenced other populations. In this way, is it possibly to understand the concept our ancestor had about the Earth and how they lived on it.

To study the story of our planet without taking into account human history would mean neglecting one of its most beautiful aspects.

Traditions and legends

Many places are linked to myths and legends, sometimes known only by local populations. A legend, often, is developed as a result of a singularity that can be explained by geology. Location names are an example of how a legend is related to the territory in fact toponymy often describe the place; in Italy they are sometimes expressed in local dialect. This is a cultural aspect that can produce interest and give charm and historical depth to the visitors of a place.

Cultural aspects

The trip may surely become an opportunity for meeting other people, their customs and their folklore, religions, languages. Often the best memories and happiest moments of a trip are those that arise from the exchange of ideas and views between people. It is appropriate, when travelling, to remember to respect cultural differences and to understand the diversity.

Geology and sport

Some sports can be enjoyed only in places where geological processes have produced a peculiarity, some examples of those sports are caving, climbing and canyoning.

The vertiginous granite walls and the cliffs are loved by the climbers, the huge structures in complex karst limestone massifs are the "playground" for cavers, the deep gorges carved by impetuous streams are the joy for people doing canyoning and kayak. For those who practice those sports could be important to understand how the environment they explore were formed. The solidity of a rocky massif may, for example, influence the choice of the materials used by rock climbers. This is why many outdoor athletes may be considered "geotourists" because they explore places of geological beauty and scientific value. They also consider geology and geological knowledge as a way to improve the performance of their favourite sport.

Other aspects beyond geology. Food, wine, and...

Maybe is not necessary to remind that often, during a geotouristic trip, is it possible to find ourself outside of the traditional routes of the tourism in not well known countries and villages. In these places you can discover a non-publicized cultural heritage. For example in Italy there is a great culinary tradition and it is easy to find local specialties served according to ancient customs and accompanied by fine wines albeit little known and widespread. Our advice is to take the opportunity to discover these values that, even though have little to share with geology, have much to offer on other respects.

General information

To enrich a geotouristic trip of non-geological aspects and to achieve optimal scheduling, it is useful to use documentation related to "traditional" tourism. This type of documentation is easily available in specialized libraries and now cover most of the world.

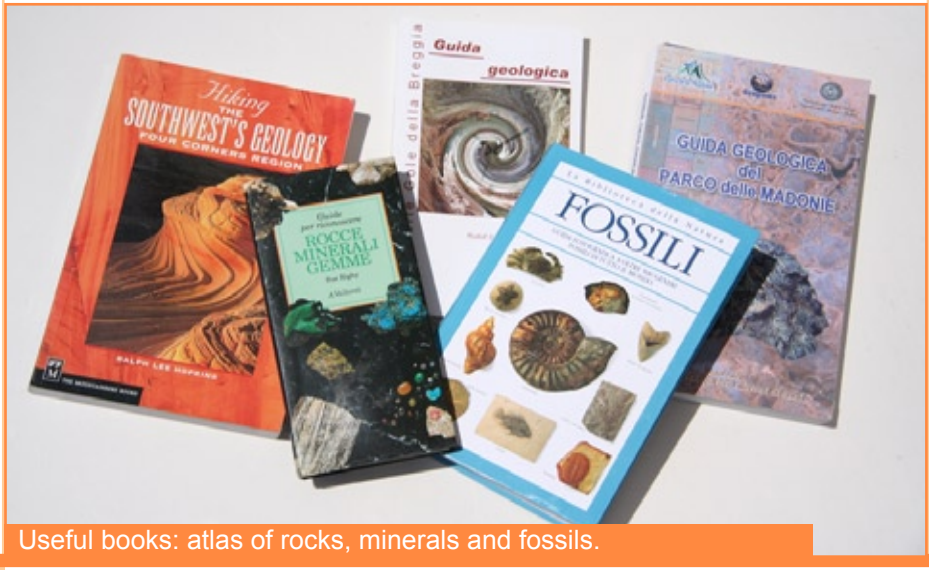
The road maps are essential to understand which paths will be followed and to reach the area we are interested to visit. It also helps to move from one place to another, to estimate distances and to calculate journey times.

It will be useful to have detailed topographic maps of the area where the

geological hikes will take place. This is, in some cases, necessary as some interesting places can be reached only on foot and by trains. When the connection from one stop to another is made on foot, a geotouristic trip becomes an enjoyable outdoor activity. Maps of the paths must, in general, have an appropriate scale in order to let us view in detail the places that we want to observe and the paths and roads that we will follow. In Italy tourist map suited for hiking are widely used, the scale is 1:25.000 and 1:50.000. The maps shows the locations of shelters and huts, useful for trips where overnight stays are scheduled.

Some recent maps are enriched with information concerning the presence and location of minerals and fossils as well as caves, sources, viewpoints, areas of archaeological and architectural interest.

For more information about the countries that will be visited it is possible to refer to the wide availability of tour guides. From that books informations can be retrieved about accommodations in hotels, guesthouses, hostels and other forms of touristic accommodation. It is useful to note that there are travel guidebooks designed to provide informations useful to the organization of a trip, while others more oriented in providing historical, artistic, architectural and cultural informations, it is therefore useful to integrate information from different sources in order to find what is needed to organize the best geotoruistic trip.



Useful books: atlas of rocks, minerals and fossils.

Geology provides a wide variety of items that can be observed but it is often impossible to remember all of them, threfore, in addition to travel guidebooks, atlases of rocks, fossils and minerals may be useful. The latter report information relating to a large number of minerals, often sorted according to their chemical composition (metals, oxides, sulphides, silicates, etc..) and the geometric characteristics of the crystal lattice (system class). The descriptions of the minerals are made through cards accompanied by photos to facilitate their recognition. Same organization is presented by atlases of rocks which are grouped according to their origin (sedimentary, metamorphic, magmatic). The most common rocks are described through cards supported, in general, by beautiful photos.

The atlas of fossils, in most cases, have a systematic (class, order, family, genus, species) and chronological organization according to the geological age in which organisms lived. Other interesting information about the living environment of them are also reported and these atlases are often enriched by pictures.

Fossil, Reserve Geologique Haute Provance, France

Gunung Bromo, Indonesia

Calcareous terraces, Pamukkale, Turkey

Erosion morphologies on glacial deposits, Zone, Italy

Alternated colours in layered rocks, USA

Krafla crater, Iceland

Running over lapilli, Fogo, Capo Verde

Prismatic basalts, Porto Santo, Portugal

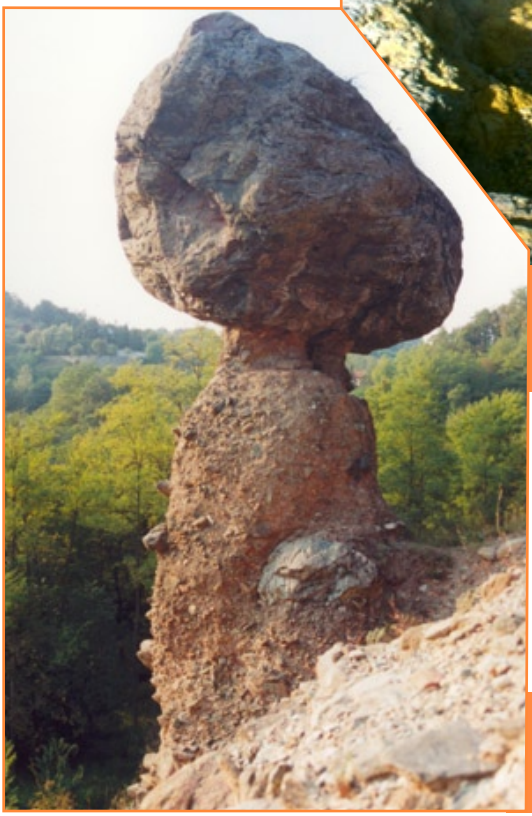
Incandescent lava flowing from Etna volcano, Sicilia, Italy

Sahara desert, Morocco

Layered folded rocks, Val Graveglia, Liguria, Italy

Sulfur cristals, mount Vulcano, Sicilia, Italy

Volcanic emissions, mount Vulcano, Sicilia, Italy



Mushroom-like shape, Piana Crixia, Liguria, Italy

Volcanic cave, Madeira, Portugal

Variegated volcanic rocks Landamannalaugar, Iceland

Limestone natural tower called “Goloritzé”, Sardegna, Italy

Neptune’s cave, Sardegna, Italy

Maps of the italian geological attractions

PART 2

Italian geoturistic locations

The areas of geotouristic interest in Italy are uncountable. It would be impossible to list them all.
In this chapter will be described some geoturistic places that can be helpful for those who wish to approach this exciting sort of natural tourism, it also serve as a basis for developing new and personal itineraries. All the places listed are suitable for easy excursions and are suitable for people with only a minimum of geological knowledge.

LEGEND OF THE SIMBOLS


MUSEUM & EXPOSITIONS

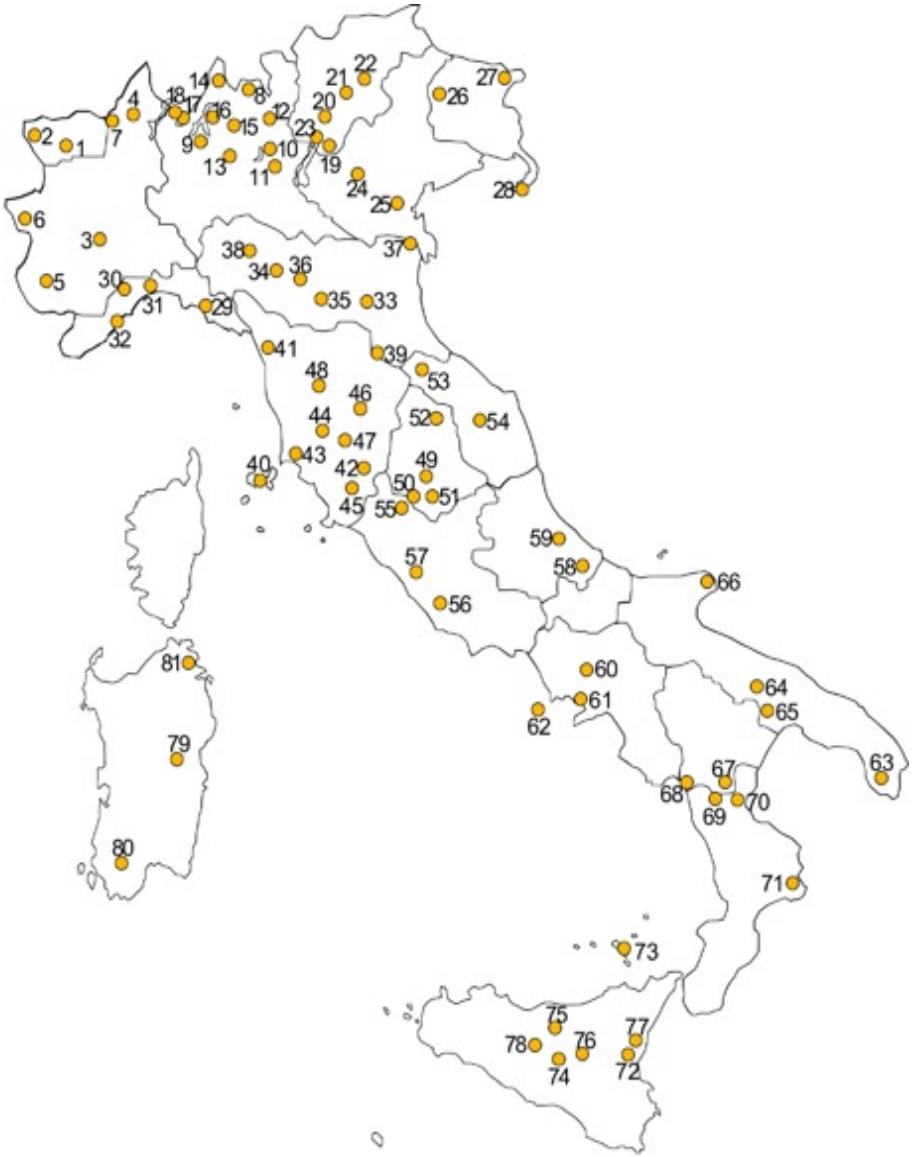

MINERALS & ROCKS


FOSSILS


LANDFORMS


VOLCANOES


CAVES & MINES



Map of the itineraries described in the guide.

Valle D'Aosta

1. The Grand-Place rock garden

Getting there	Region: Valle D'Aosta
From the motorway exit "Aosta Est", follow the direction Aosta, turn left onto the main road SR34, turn right. Cross the Dora Baltea river, and find on your right the Grand-Place area.	
 	

Park Grand-Place, with his "rock garden", allows the visitor to admire the view and understand, through panels the main elements of geography, geology and geomorphology of the landscape. This is an example of effective educational and touristic "path" with good scientific level, and perfect architectural location.

The place, easily reachable in few minutes by car from Aosta, is located in a quiet area. It is a ring tour that illustrates, through samples of rocks, the long and complex geological history of the surrounding area. The choice and arrangement of the samples follow a geographical logic representation of the order in which the rocks are present inside the Aosta valley.

2. I calanchi di Saint-Nicolas

Getting there	Region: Valle D'Aosta
From Aosta, going in direction Courmayeur, reach St. Pierre, turn for St. Nicolas and climb for about 8 km. After you arrive in St. Nicolas continue for about 1 km following the signs to Avise.	
	

The Valle d'Aosta is a valley full of interesting geoturistic aspects some of which fall within the field of geomorphology. The phenomena of earth pyramids are clearly visible along the sides of the river Gabo and in the area behind the main town of Saint-Nicolas.

The steeples are steep and small valley with steep slopes without vegetation, resulting from water erosion on low cohesion soil. Here the forms have evolved on detrital deposits of glacial origin as a result of leaching processes,

particularly the erosive impact of rainfall and stream flows. This processes tend to deepen the notches along a slope creating striking badlands. Near the notches, you can see a dozen high pinnacles soaring up to 40 meters with a different degree of erosion occurring in their top. Indeed, the erosion is tabular in recently formed towers, which are closer to the edge of the escarpment, and more pointed in the older towers, nearer to the bed of the river.

Piemonte

3. Special Natural Reserve of Valleandona and Valle Botto.

Getting there	Region: Piemonte
From Asti, take the SS10 connecting Asti to Torino, take the to Valleandona and drive for about 1.5 km	
 	

The special natural reserve Baldichieri d'Asti is a paleontological reserve where you can find fossils of scientific interest. The reserve, founded in 1985 with the aim to protect and enhance the existing paleontological material present in the area, consists of two distinct adjacent hill-areas in the west of Asti. It is one of the rare concrete cases of national sites for the protection of this particular scientific and cultural heritage.

The reserve is nestled in the typical environment of the countryside, where there has been a clear river erosion phenomenon called "Tanaro's capture". This phenomenon occurred during the Riss-Wurm interglacial period, around 100,000 years ago. In the Valleandona area some self guided pedestrian paths are present, with starting and ending point in the square of the town. These paths are free, while the access to the paleontological path in Valle Botto is allowed only with a guided tour, by reservation.

The fossil emerging in the sandy layers of the reserve are the remains of organisms buried in the sediments of the sea that occupied the Pianura Padana plane up to the Alps during the Pliocene period (5-1,8 million years ago).

The fossils are concentrated in specific layers that can be observed along the walls of the valley notches. Many paleontological finds, from shell remains to

marine and terrestrial vertebrates, have drawn since the eighteenth century the attention of many scholars and researchers, who have helped to spread the curiosity and interest in paleontology. These findings consist of hundreds of species of marine molluscs, gastropods, bivalves and scafopods, whose shells have been preserved in an excellent condition. Besides shellfish, there are arthropods, bryozoans, brachiopods, corals, echinoderms and rare vertebrate remains.

4. Uriezzo ravines, and Giant's "marmitte"

Getting there	Region: Piemonte
Using the highway A26 northbound, after the and go further along the SS33 road toward Verbania. After the famous Crodo village go to Baceno until Premia.	
	

Placed close to a famous mineral water plant, the Uriezzo ravine is a place of great natural beauty where nature has created striking forms. It is an imposing and impressive canyon carved from the action of ice and water in the Alps crystalline rocks.

You can visit the Uriezzo ravines along itineraries allowing you to walk across and admire the deep and spectacular natural structures crossed by the impetuous Toce river. There are three spots that can be visited with many pleasant excursions. The south ravine is the most spectacular and spread with a length of about 200 meters and a depth up to 30 meters. The North-East Ravine is about 100 meters long and very narrow at some points. Eventually, you can visit the more modest West ravine. The entire route requires about three hours hiking without any particular problem, and also offers along the route many alternative paths.

The route that departs from the Church of Baceno allows to observe the effects of erosive geological processes in deep ravines, narrow, almost mazing passages, overhangs of tens of meters, basins and natural pools, waterfalls and bubbling water games.

Along the route, at Maiesso, from a bridge on the river Toce you can admire the so called "Giant's marmitte". The rocky shores were carved in

semicircular shapes, sinuous, smooth and enveloping, beautiful bays where the current relaxes and the river widens glittering in the green-blue waters that call you for a dive.

5. Special Nature Reserve of Ciciu del Villar

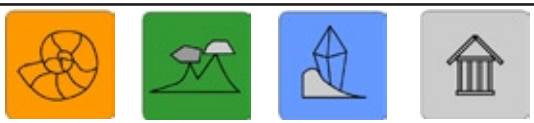
Getting there	Region: Piemonte
From Turin overcome Saluzzo, continue along the SS589, pass the town of Busca and continue towards Dronero on SP24, after about 8 km you reach the junction for Villar S. Costanzo from which, following the specific directions, you get to the reserve. From Cuneo take the SS22 towards Dronero. Arrived in the country to continue for about 3 km in direction to the junction Busca for Villar San Costanzo.	
	

The special nature of the Villar Ciciu is located in foothills, and between Dronero Busca, and protects a geological phenomenon of great scientific and aesthetic value. This is beautiful columns of erosion also called "stony mushrooms". These original e scenic forms are the result of a selective erosion of slopes covered with accumulations of detrital material composed of fragments of various sizes. The accumulations were washed away by rain water: in presence of a big boulder, usually flattened, debris beneath it has been preserved by the erosive phenomenon resulting in a column. While some columns, with the passage of time, have collapsed, others were formed to renew the landscape and this curious phenomenon that takes place since 12,000 years. These bizarre forms were called "Ciciu", a name which comes from the Piedmont dialect that means "puppets". These oddities of nature have stimulated the imagination in the past, as the legend of St. Costanzo.
The popular legend tells that San Costanzo, one of the first martyrs evangelizers of Christian doctrine in the Cuneo valleys, while fleeing through the woods pursued by Roman soldiers, came to Costa Pragamonti turned toward them shouting: "O wicked incorrigible, or sad with the heart of stone! In the name of the true God curse you. Be you stones .With this invocation 100 soldiers were instantly turned into stone. Currently there are over 400 Ciciu of varying heights and spread over an area of 0.25 km square.

You can follow two routes that allow you to visit this "rocky garden": a self-teaching and a longer loop hiking. At the entrance of the reserve is placed a tiny visitor center that allows you to get information about the reserve and the geological phenomena. Outside the visitor center is equipped an athletics track and two walking paths. An educational trail called "Ciciuvagando" leads to the discovery of the peculiarities of the protected area.

6. Routes between corals, ocean bottoms and green marble in the Dora valley

Getting there	Region: Piemonte
By the motorway A32 Torino-Bardonecchia-Frejus, exit at Oulx and continue to Cesana Torinese. Alternatively you can drive along the Monginevro SS 24.	



Nearby the town of Cesana Torinese are many interesting geological phenomena located the impressive mountain landscape.

The dorsal Monginevro, with the mass of Chenaillet, the Mountains of the Moon and Mount Chaberton, is the scenic testimony of an environment no longer existing but still largely recognizable in rocks. Those Alpine mountains represent a fragment of an ancient ocean, a strip of a "fossil" seabed that keeps rocks rare in the Alps: from basaltic lavas originate in the ocean depths, to coral reefs dating back some 200 million years ago.

According to the phenomenon, have been identified seven geological thematic itineraries to allow people to come in contact with interesting aspects of earth science through hiking. The subjects are touched by various paths, they start from fossil rich sites where corals are directly observable and belonged to an ancient coral reef, to paths that reach sites where you can see and touch the pillow lava basalt coming from an ancient ocean seabed .

The quarries of marble called "Green Alps" are reached by a scenic path that allows you to observe the extraction techniques and the particularities of these rocks that are geologically called "ophicalcites".

To complete the great geological interest of the valley contributes also the

"rocks garden" in Cesana Torinese, located along the main road that connects Cesana to Claviere. The garden is a space, organized with panels, which allows you to understand, through diagrams and real rocks, the formation of the Alps. are also present buildings that allow, through play, to get closer to the geology of the valley.

7. The Guia gold mine in the Anzasca Valley

Getting there	Region: Piemonte
With the Milano-Domodossola, exit at Valley Piedimulera-Anzasca-Macugnaga.	

In front of the majestic Monte Rosa, Macugnaga is the starting point for many excursions and alpine ascents. An activity of particular interest is the visit to the Guia gold mine. It is situated in a valley where the beautiful architecture of the houses bears the imprint of the culture of a the Walser, a groups which in past centuries colonized mainly the highest parts of the valley. The area surrounding the Monte Rosa in the past was one of the richest in Italy for the gold mining, today the mines are all closed, but marked a chapter in the history of the country. The Guia mine is the only gold mine that can be visited in Italy, from which in the past was extracted the noble metal, the most loved and even adored by almost all the peoples for durability, its beauty and workability, making it perfect for fine works of jewelry. For those coming from the low valley, the mine is located just before the town of Macugnaga in a place surely suggestive, where the stream, which served also for the selection and cleaning of minerals, makes a great jump on the rock and form a beautiful waterfall. The mine was active for more than 3 centuries and was closed around 1945, not because it was exhausted - it is considered that the richest vein has not yet been reached - but because the costs of extraction have become too high and not competitive compared to other producer in the market price of gold. Tunnels in the Guia mine have a development of about 12 km and form a labyrinth of various levels. It can be visited along a itinerary about 1,600 meters long, all on a single level, then the visit is also accessible to people with limited mobility.

Lombardia

8. Val Malenco Geological Park

Getting there	Region: Lombardia
From Sondrio follow the Valmalenco road for about 15 km to the Chiesa di Valmalenco village, from there, towards Chiareggio, then you arrive after about 12 Km.	
 	

The Valmalenco Geological Park is located in Chiareggio, the area is of great interest in relation to the diverse geological topics about the Alps extending from petrology to structural geology and from mineralogy to glaciology.

Besides the park, the valley offers many suggestions of geological, natural and historical interest.

Val Malenco is one of the mineralogical most important areas of the Alps and destination for over a century of collectors looking for items on Mount Motta, on Crestun, in the crystals cave or in old mines. The great diversity of mineralogical species present in the area (almost 300 different) is mainly due to geological complexity. vesuvianite, titanite, diopside are just some of the minerals that can be found.

The ethnographic historical museum nature of Chiesa holds the mineral collection of Pietro Sigismund, a true pioneer in this field, in the collection can be found fine quartz and garnet crystals.

In the valley for a long time has been extracted "soapstone" or steatite, a rock that has a color between gray and green, is composed in equal proportions of magnesite and talc with about a 5% chlorite, and itself is easily modeled. Thanks to its high qualities of thermal conduction, is particularly suitable for the construction of stoves and also of the "lavecc" the traditional pots circled with bands of copper.

To the soapstone are related to some of the traditional jobs of the valley now almost disappeared and their names for example gthe giuelé h, was one who extracted and crafted flat blocks from quarries, sometimes even becoming gteciàt h, using precise techniques, often secret, to cover the roofs, the "lavegiat" was the craftsman who worked the soapstone with a lathe to obtain items such as dishes, vases, also called "pignatte" or

casserole. Currently, are still produced the "piode" plates on which meat is cooked, household and decorative items such as pots, ashtrays and ornaments of various shape.

9. Sasso Malascarpa Natural Reserve

Getting there	Region: Lombardia
From Lecco or Como take the SS639 road and turn to Canzo. Continue onwards to the Gajum village.	


Natural Sasso Malascarpa reserve is one geological, geomorphological and paleontological interesting area in Lombardy. In fact, can be observed karstic phenomenon and fossiliferous spots. The rock formations are of marine sedimentary origin and, in particular in the area of Valmadrera, one can observe a tectonic fold of dolomite and limestone, containing rich levels of fossil as madrepores, corals appearing as small branches.

On the surface there are sources that indicate the movement of water in the substrate: the meteoric infiltrates along the fractures and falls until it reach impervious levels, along which tends to be channeled to the surface.

The nature of the fractured layers, mainly carbonates, promotes the development of karst phenomenon, which on the surface is highlighted by the characteristic "karren", located below the mountain Prasanto, these vertical grooves in the rock, deep and narrow, were made by erosive action of rainwater. At the top can be seen the white slabs of limestone, called altogether Sasso Malascarpa. The slabs are cut into cubes regularly arranged and produced by horizontal and vertical fractures that intersect at right angles. On the surface there is a considerable amount of Conchodon fossils, shells of marine molluscs made by double curved valves. In "Colma Val di Ravello", is placed the Rosso Ammonitico Lombardo formation rich in ammonites fossils.

10. The Zone pyramids

Getting there	Region: Lombardia
With the A4 road Turin-Venice reach Brescia, then proceed along the SS510 to the North. The locality of Zone is reached turning right along the highway just after the village of Marone.	
	

The area is amazing and allows you to observe and understand the particular erosive forms and their origin. These forms owe their origin to the Camuno glacier, which reached up to the limits of the plain. moraine deposits formed by glaciers, mainly composed of gravel, sand and large boulders were shaped by rainwater. They have generated so rare and spectacular shapes called earth pyramids, they are majestic and vertical structures that seem to defy gravity. Some of the subtle structures reach a height of 30 meters, their lean form may remind the Gothic style of some human buildings. In some cases the head of the structure is a large boulder resting on a small base, reflecting the effect of selective erosional processes. In other cases, the stone is no longer present showing that the erosive phenomenon is still taking place.

Not only offering a truly impressive view, the pyramids can let us understand many of the geological processes that have so heavily influenced landscape. Around the most spectacular area there is a path that can be accomplished on foot and allows the close observation of the numerous and spectacular pyramids.

The trail is accompanied by explanatory placards that allow peoples to understand the observed phenomena. The view, in good weather conditions, including the lake D'Iseo, which is further evidence of glacial phenomena occurred in the past.

11. Val Trompia Mineral Park

Getting there	Region: Lombardia
The Val Trompia can be reached from Brescia with SS345. From the A4 Milan-Venice take the junction for SP19, which allows access to the valley	


The high Val Trompia, was a rich geological mining place, and currently, for commercial reasons, the mines of Val Trompia are closed. There are many remainings of the past, among many others objects, is still present the ancient furnaces and the workshops with hammers moved by water.

In the valley is well represented by the "industrial archeology", with a number of buildings posed on the steep slopes of the mountains which were used to the processes of extraction and processing of minerals.

The recent past is represented not only by building on the slopes of the mountains, but also by stories, by paths of coal miners and by their songs.

The structures that testify the ancient mining art and processing of minerals have been renovated. Workshops for students have been opened, conducted historical research and prepared documentation, and museum path. Recommended activities include a visit to the Marzoli di Pezzaze mine, the visit to the extraordinary complex of the furnace of Tavernole and the ancient Fucie of Sarezzo.

The Val Trompia is the witness of the mining art and of minerals processing provided from the surrounding mountains.

Many routes are present in the valley and extend between mines, worship places and ancient villages. One route starts from the square of Marzoli di Pezzate mine from which you can start with a guided tour inside the mine. Then you can go to Pezzazole and then along the path that leads to the Croce of Savenone to visit the sanctuary of Madonna della Misericordia.

A possible alternative route, after the visit to the mine, lead to the Cavallina valley passing through the village of Mondaro: here you can follow the "sentiero dei carbonai" which comes to the Malga Vivazzo.

12. The Valley of Scalve

Getting there	Region: Lombardia
From Bergamo, along the SS671 going to the Valley Seriana, ascend to the Giogo of Presolana at altitude of 1297 meters on sea level and then declined to Dezzo di Scalve.	



Scalve Valley, located in the Orobics prealps, was previously one of the main mineral areas of Lombardy for the presence of important deposits of siderite (iron carbonate). Were also extracted the galena, the blende, the calamine and the fluorite.

Now are currently possible excursions outside the mines and, on request, is it possible to make a visit to a stretch of 1300 meters inside the Gaffione mine, the travel to go inside is made aboard a miners train.

In the valley has been set a geomorphologic path allowing a detailed view of some aspects of the surrounding geology. The main topics concern "lithology", or the types of rocks present and the processes of their genesis, and the geomorphology, the forms of the relief and their development.

The route has been set up with descriptive signs and is dedicated to those who want to combine the exercise of walking and also is pleased to learn. The geological trail extends along the road the road that connect the Azzone village to the Natural Reserve of the gBoschi del Giovetti h.

13. The palaeontological Park of Cene

Getting there	Region: Lombardia
From Bergamo along the SP 35 northbound, after the Nembro village go toward Albino until Cene.	


In the Seriana valley there are many fossils-rich outcrops that has allowed the creation of a paleontological park, opened in June 2002.

In February 1965, in the paleontological park area, a large landslide revealed one of the most interesting paleontological sites worldwide.

The discovery of the first fossil was followed by searches conducted by the Natural Science Museum "E. Caffi" of Bergamo, who startd, in the'70s, a series of successful campaigns of excavation, the 1973 is the sensational discovery of a perfectly preserved skeleton of Eudimorphodon Ranzi, the oldest pterosaurus in the world.

Inside the park is present a nature trail that allows direct observation of many geological peculiarities. Through this scenario and the direct contact is possible to know the context and methods of research, the rocks, the nature and the geological landscape of the valley.

In the park are carried on educational activities and hiking trails in the Vertova valley and in the naturalistic area of Prato Alto.

The fossil findings extracted in Cene are stored in the palaeontological collections of the Science Museum "E. Caffi" (Museo Civico di Scienze Naturali) in Bergamo. The experience of visitors of the park can be completed in the halls of the Museum, the great hall in palaeoenvironmental reconstruction "Bergamo ... 220 million years ago "is dedicated to the character of the territory and its inhabitants during the Triassic.

14. Marmitte Dei Giganti Park, Val Chiavenna

Getting there	Region: Lombardia
Take the highway Milano-Lecco-Colico and take the "Passo dello Spluga" road SS36, which leads to Chiavenna.	
	

On the outskirts of Switzerland there are wonderful natural monuments, the rocky wells, also called, "marmitte dei giganti" and the Acquafraggia waterfalls. The exhaust "marmitte dei giganti" are big circular or elliptical cylindrical holes vertically dug into the rock. Their size start from few centimeters in diameter and depth up to 4-5 meters in diameter and 10-12 m deep.

The "marmitte dei giganti" of Val Chiavenna are numerous in the the region, so it has been constituted a protected park that covers the territories of the municipalities of Chiavenna, Piuro and Prata Camportaccio.

Their origin can be reconnected to the glaciers that have covered various

times in the Alps. During the summer, the water of these melting glaciers, gave birth to numerous streams. The movement of water downstream, carrying sand, pebbles and gravel, and having sudden jumps, precipitated as a cascade on the rock. The erosive action of the debris spinning trapped inside the rocks and the force of falling gave rise to many glacial wells. In addition to the "marmitte", the park has other signs of glacial activity, polished and scratched rocks, erosional channels and striae. For the protection of these spectacular natural forms in 1984 was established the Natural Reserve "Marmitte dei Giganti". Several trails that cross the area allow a direct observation of the erosion that generated a varied and colorful landscape.

15. Geological path to Rifugio Benigni

Getting there	Region: Lombardia
From Bergamo take the SS470 road and follow the signs for Val Brembana up to Cusio.	
 	

Within the Orobie mountains, in a typically Alpine environment, is located the "Geologica path to the Benigni refuge" which, besides having an interesting landscape and scenic value, allows the observation of ancient geological formations dating back to the Paleozoic Era, over 240 million years ago.
Along the path you can get in touch with many rocky outcrops and observe their nature, these observations let understand the series of events that led to the genesis of the mountain chain.
The trail begins at Sciocc in the municipality of Cusio, on the road that goes to "Piani dell'Avaro", and follow the marker until the Salmurano pass.
The rocks of this part of the chain that can be observed along the trail are sandstones and silt, rocks of sedimentary origin derived from the dismantling of schists and gneiss and effusive rocks produced by ancient volcanoes during their activity. Near the "Casera di Valletta" is present the "Verrucano" rock formation, a rock type conglomerate apparent reddish colored.
Along the trail there is a panoramic view of the amphitheater formed by glacial origin from the tops of ridges Torrione Giacomo, Piazzotti, Valletta

dorsal. In this place you can see the effect of erosion on different rocks with different resistance: the less steep slopes and sides are set in metamorphic rocks, micaschists and gneiss, while the steep slopes visible to the west are formed by conglomerates.

16. The Bellano gorge

Getting there	Region: Lombardia
Reach Bellano using the road SS36 from Milan. Alternatively travelling on the road SP72 along the Como lake or using the road SP62 crossing Valsassina.	
	

The Bellano gorge is an impressive spectacle of the nature that could be visited thanks by means of suspended walkways. The river Pioverna in its final stretch cross a narrow passage between high cliffs and form a deep and narrow incision.

The ravine was formed after the retreat of ice and the consequent change of erosional regime has established the process of engraving.

Beginning from the sixteenth century structures were built to allowed the access to the gorge and at the same time it promoted the knowledge of the area so that the gorge, called gorrido h, became famous in Europe and attracted a nobles and artists who contributed to make the place a tourist locality.

The place, for its peculiarity, gave rise to fascinating and curious legends, like the one of the Taino warrior: he would have been buried in the bed of the river with its immense treasure obtained during his robbery, to make the burial is said that the river was diverted, the body placed on the river bed and covered with a huge boulder.

It is said that the tower entrance of the gorge, called "Ca del Diavolo" meaning house of the Devil, was in the past where satanic rituals were performed.

Currently it is possible for everyone to visit the gorge using exciting aerial walkways that go along the deep passage, in thunder and whirlwind of sparkling waterfalls.

17. The Breggia Gorges Geopark

Getting there	Region: Lombardia - Svizzera
The park is located in the heart of Europe, easily accesible, less than 1 km from the highway A2 that cross Switzerland, exit Balerna / Chiasso.	



The park of the Gorge of Breggia allows you to cross a long piece of rocky outcrops that take us back in time and allow us to reconstruct a very long geological past of our planet.

Since the visit to the main attraction of the park is more successful if carried out in the chronological order of the rocks (from oldest to most recent), which is also the natural sequence of events that have generated, we must start from the top of Park.

Besides an interesting history that allows you to see a mill, a nice pond and a number of mills dating back to a period running from 1600 to today, you can take a journey of great geological interest, which leaves from gMulin da Canaa h.

The route passes through the stratified rocks visible in the bed of the river, limestone dating back 190 million years ago. Along the river the same rocks are rich in clay and ammonites fossils and as we continue the descent, are clearly visible the beautiful layers red colored of the "Rosso ammonitico" formation, where over 800 different species of the ammonites were found.

Near the narrow and deep gorge called "Buzun dal Diavul" appear the Radiolarian formation followed by the colorful formations and known as "Rosso ad Aptici h. The name of the latter derives from the presence of a fossil that had long puzzled paleontologists that only after a long time realized that the "aptic" were an anatomical part of some ammonites. The park is also visible the "Maiolica" formation consisting of nearly pure limestone gray coloured and contrasting with the previous red layers. The trail traverses along a high step, the gscaglia h. This rock takes its name from its way of breaking into sharp fragments (scaglia in italian) and for the composition rich in impurities, responsible for sudden changes in color. Where the impurities are less abundant outcrops show the formations of the "scaglia bianca". Of great visual effect is the youngest layers of "scaglia rossa" that has earned

its name because of its striking color (rosso). Along the trail you can easily observe the effect of tectonic forces that led to the orogenesis, the stratified rocks are deformed and folded in several points.
At the end of the trail you pass near a flysch deposits, rocks born in great depths by the accumulation of sediment transported by submarine currents.

18. Mount St. George and the large fossil ittiosauri

Getting there	Region: Lombardia
From the A2, at Mendrisio, follow the direction for Stabio-Varese. At the Rancate exit follow the signs for Besazio then Arzo and then go on for Meride.	
 	

The mountain of Monte San Giorgio, with its pyramidal shape and high of 1096 meters, maintains a rich variety of marine rocks and fossils dating back to Triassic, some 230 million years ago. Of particular importance are some rocky levels called "scisti bituminosi" or "oil shale" which owe their name in the high oil content. These levels in the past have been extracted to produce the so-called "shale oil", oil from which were produced the "ittiolo" a compound used for medicinal purposes. The scisti bituminosi became known, more than 100 years ago for their significant levels where were found fossils of marine vertebrates. These animals are known as "ittiosauri" (a swimming animal), the first to be discovered was the gMacrocnemus h. In addition to large Sauri, like Besanosaurus (6 meters in length), were found fossils of many other animals such as Nauticosaurus and numerous species of fish and insects. The findings were placed in the Museum of Natural History in Milan where, during the World War II , because of the bombing, several samples were lost and damaged.
In the San Giorgio Mount are present galena, barite and fluorite minerals. Some of them were exploited digging mines that now are no longer active.
Currently is it possible to do hiking along the trails and through the woods and the other beauty that lead in 2003 to the inclusion of the park in the UNESCO world heritage list.
Among the most interesting tours are suggested those that offer the

opportunity to visit the cultivation of the "scisti bituminosi" and the paleontological excavations, the mining of barite and fluorite, the quarries of the Viggiù stone.

Trentino Alto Adige

19. Dinosaur tracks in Lavini di Marco.

Getting there	Region: Trentino Alto Adige
By the A22 motorway, exit at Rovereto Sud highway exit, follow the signs for the Rovereto center, "ossario di Casteldante" or "Piste dei Dinosauri"	
	

In the south of Rovereto, in Lavini di Marco locality, have been discovered tracks and footprints of hundreds of carnivorous and herbivores dinosaurs. The fossil footprints, well preserved and clearly visible, are engraved on six stratigraphic levels included in a package of layers of gray limestone dating to the Jurassic. Surfaces are tilted layers and cover an area of about 1200 square meters.

The dinosaurs who have left these traces are ornithischian and theropod among these have been recognized: Camptosaurus, a herbivore of the Jurassic (3-4 m height, length 6-7 m, weight 500-700 kg) and Dilophosaurus (Jurassic carnivore, height 2-3 m, 4-6 m length, weight 300-400 kg).

To protect this important area, was made a protected area and now it is possible to travel the the routes in the paleontological park. Following the signs it is possible to better understand the great scientific value that these footprints can provide, you are also fantastically conveyed back in time of millions of years in the era dominated by dinosaurs.

20. The glacial Vezzano park

Getting there	Region: Trentino Alto Adige
From Trento cross the gorge of the "Bus de Vela" from which the road SS45 bis "Gardesana Occidentale" depart, it is the main communication route between Trento and the western Trentino.	


The glacial Vezzano park has been called "Stoppani Park" in honor of the lombard naturalist scientist, abbot Antonio Stoppani (1824-1891), who first dealt with glacial phenomena of the area of Vezzano, pointing and describing their morphological effects and presenting them in his book "Il Bel Paese" (gThe Beautiful Country h). The "Stoppani Park" extends on the lower slopes of the north-west of Monte Bondone, which makes up the eastern side of the "Valle dei Laghi" ("Valley of Lakes"), near the town of Vezzano. Lies at an altitude around 450 m s.l.m. In the zone, up to an altitude of about 500 m from the bottom of the valley are clear traces of the erosive action and deposition occurred during the last glaciation: smooth rock, ram, striate and morainic deposits. Are also very evident and widespread karst phenomena, developed on limestone rocks of the Lower and Middle Jurassic. Traces of surface karst are found all over rocky outcrops in the form of grooves, wells and small fields roadways.

21.Segonzano pyramids

Getting there	Region: Trentino Alto Adige
From the South and North, with the A22 Brenner motorway exit at Trento center, (distance from exit 25 km), or coming with the Brennero road SS12, take the SS47 Valsugana Pergine-Valsugana up to the junction of Mocheni from here continue on the road SP71 Fersina-Avisio that leads to the location.	
	

The wonderful pyramids of Segonzano are elegant columns, sometimes high up to 20 m, some of which are covered by a large boulder. During the Quaternary period the Alvisio glaciers left in the valley of river Regnana a considerable amount of material, which formed huge morainic deposits consisting of a mixture of fine material with pebbles and large boulders. These accumulations are due to the disruption and the disintegration of the crests and flanks of the mountain, by the movement of the ice. Over the

millennia, the action of meteoric water has given rise to the formation of the pyramids: the drops hit the ground, causing the displacement of particles and erosive activity levels that increase with the slope. Small fragments are found together with numerous rounded blocks deposited in a chaotic glacier, the blocks are a protection against mechanical and erosive action of water and protect the material underneath that is not removed completely.
The shape of the earth pyramids is that of a truncated cone surmounted by a stone. You may also find thin pyramid with conic stalk and without the protection block. Another typical form is that like "crest" consisting of a blade ground ridge, sharpened and formed for the thinning of the watershed between two gullies. Sometimes the pyramids are grouped and called "organ pipes".
The summital block, also called "hat", and its shape influence the existence and duration of the underneath pyramid. The most appropriate structure is that of a rather squared slab slightly tilted down, forming a natural roof of the pyramid. If the stone falls, the pyramid has a pointed shape, easily attacked by water, in that case its fate is marked, unless along its stem is not found another boulder, the future new "hat." A pyramid in the area has a really great hat, the weight estimated is about 100 kilos. At certain times of day, the soft light of the sun turns the pyramids similar to an unreal fairy castle and a legend tells that the elves who frequented the forests of the valley, one day were petrified into earth columns as punishment for their carelessness.

22. The Geological Doss Capèl trail and Geological Malgola trail

Getting there	Region: Trentino Alto Adige
Using the Brennero highway A22, exit at Egna-Ora, then on the highway SS 48 of the Dolomites: 24 Km to reach Cavalese and 36 Km for Predazzo	
 	

An enormous variety of landscapes and geological phenomena is kept in the Dolomites, from the ancient deserts to tropical islands and deep sea volcanoes. In dolomite rocks are saved the stories of these ancient landscapes, aspects that in the nineteenth century led many Italian and

European researchers to analyze the composition and formation the rocks present in the valley.

The "geological Doss Capel" trail, recently completely renovated and equipped, winds at an altitude of between 2,000 and 2,200 meters, between Passo Feudo and gAlpe di Pampeago h. In 32 stop areas are placed illustrative and educational signs explaining in detail the observable phenomena and allowing everyone to "read" the rocks. Along the path can be found the remains of beaches and seabed, shells and starfishes that lived millions of years ago. The route is particularly scenic and charming and gives an overview of the geology of the western Dolomites. You can walk on lava, ash and lapilli of the ancient Predazzo volcano. The access roads to the trail are three and start from Pampeago,from the Zischgalm refuge and from the chairlift Latemar station.

The Malgolo geological trail is an interesting geological excursion, the route starts from Predazzo and allows you to walk on eruptive and metamorphic rocks. It also let us come in contact with the sedimentary rocks dating back to a period lasting from the Permian to the Triassic (from 280 to 240 million years ago).

Very nice is also a visit to the Bedovina mines always around Predazzo, they are deposits rich in copper and tungsten where can be found many interesting minerals.

23. Arco di Trento Geological reserves

Getting there	Region: Trentino Alto Adige
With the A22 Brenner motorway, exit at Rovereto Sud, follow the signs to Garda Lake, at the town of Nago follow the signs to Arco.	
	

The area surrounding the town of Arco di Trento has long been known for geological forms that made it possible to practice sports such as climbing and alpinism. This lead to become a frequented place by athletes in last decades. The geologists also known since a long time the richness of natural phenomena in the area and have helped to disseminate this knowledge to the general public. Have been identified many interesting routes that have

a great range of beautiful geological objects, each of which represents a piece of the history of this alpine area. The observations it is possible to do along the trail range from the study of forms (geomorphology), fossils (palaeontology) and structures.

The first route will depart from Arco and crosses sedimentary rocks with coarse layers (conglomerates) and finest leyers. In some places you can see Nummulite fossils, unicellular organisms with calcareous shell disc-shaped that can reach the size of 2-3 cm in diameter, these organisms lived about 50 million years ago.

Fragments of volcanic rocks provide evidence of eruptive events dating back to the formation of these rocks, particularly ialoclastiti similar to glass fragments, which are the result of emission of lavas in aquatic environments. Part of the tilted layers of rocks are called "scaglia rossa" ("red scale") and are formed by the deposition of fragments of shells. Along the route, the rocks are crossed by numerous visible faults.

A second route depart from the sanctuary of Làghel and allows to observe many geological and botanical wonders along with some evidence of prehistoric human activity. The trail crosses a reddish limestone formation that, due to the presence of fossils of ammonites, has obtained the name of "rosso ammonitico" ("Ammonitic Red"). In addition to ammonites are preserved in these layers also Belemnites fossils of ancient molluscs dating back to the Jurassic.

A third route has an absolute originality: it develops along a via ferrata and can therefore only be run using the necessary equipment and by trained people. This is the Colodri equiped alpine route ("via ferrata") that, from a geological point of view, allows the observation of oolitic limestone, a deposit made up of spheric grains of limestone, in which there are sponges, corals, calcareous algae as well as bivalves and gastropods.

Veneto

24. Regional Natural Park of Lessinia and fish fossils of Bolca

Getting there	Region: Veneto
From Verona take the SS11 road to Vicenza for about 15km and then turn left towards Tregnago. After another 18 km, at Badia Calavena, turn right to Bolca.	
	

The Regional Natural Lessinia Park covers a vast territory which mainly correspond to the Lessinia plateau, which extends north of Verona to the border with the province of Trento, the park extends also to some deep valley, called "vaj" descending from the plateau.

In these places there is a series of sites of special natural and paleontological interest like the Molina waterfalls, Covolo of Camposilvano, Covoli and Purga di Velo, the "Pesciara di Bolca", the Roncà layers, the columnar basalt of San Giovanni Ilarione.

The area is also characterized by many karst occurence as evidenced by the presence of numerous dolines, caves and natural cavities such as the famous Spluga della Preta, spectacular structures carved by nature in limestone, such as Ponte di Veja and Valle delle Sfingi ("Sphinxes valley"), by valleys and vaj deeply cut into the rocks and by the lack of surface water.

Another Lessinia peculiarity is the presence of important fossil deposits, spread in various sites of the plateau and valleys below, which are subject to visit and study the enthusiast, the most famous spot, among all, is Bolca.

Bolca is one of the most important Italian and world wide fossil deposit. Known since 1555, has provided thousands of fossils, with over 240 species of fish in a perfect state of preservation. In particular, a limestone outcrop extremely rich in fish fossils has been called "la pesciaia" ("the fishery").

The proof of the relevance of Bolca is that most of the main Natural History museums of the world have exposed some findings from Bolca. Some of the famous fossil found are the Eoplatax, Blochius, Cyclopoma, Sphyraena, Seriola, Serranus, Exelia, Sparnodus, Mene. The latter (Mene rhombea) or turbot Indian (Scomber) is often referred as the symbol of the fossil deposit of Bolca. Were also found plants and, to a lesser extent, worms, crustaceans,

insects, jellyfish, lamellibranch, cephalopods, reptiles and bird feathers.
The fossils date back to the Eocene era, about 48 million years ago, and come from a protected environment of shallow sea like a lagoon. In Bolca there is also a museum dedicated to this important fossil site. The visit to the museum may be followed by a paleontological hike, a journey that leads form the Bolca village to the hill of "the Pesciaia" by a pedestrian a path.

25. Colli Euganei

Getting there	Region: Veneto
By the motorway A13 Bologna-Padova, exit at Terme Eugane - Monselice. Using the A4 Milan-Venice, exit Padova.	
 	

The Colli Euganei ("Euganean Hills"), renowned for the gentle rolling hills, hidden between the layers of sedimentary rocks, fossils of several organisms such as algae and molluscs. In the area of the Colli Euganei are also found evidence of large marine mammals lived in the past. Were also found fossils of whales that pushed by the currents, died in this area and were eventually buried by mud and clay and left a unique geological heritage. To realize the value of these findings, could not be other then a genius, the first person to be interested in fossils of the area was Leonardo Da Vinci in the distant 1482. Among the various paleontological discoveries occurred in the area, the cetaceans are some of the most relevant that marked the history of these valleys. The Mount Padova was the scene of findings already during eighteenth century, the first core of the Geological Museum of Castell'Arquato born here.
Through numerous hiking trails you can get in touch with the geological heritage, in particular, four major pathways dedicated to the discovery of whales in the territory of Lugnano, the badlands of Rio Carbonaro, the abyss of Montezago the Rio Stramonte and Mount Giogo, a true book of stone, where in 1834, was found even the skeleton of a rhinoceros.

Friuli Venezia Giulia

26. Regional Natural Park of the Friulans Dolomites

Getting there	Region: Friuli Venezia Giulia
Highway A27 Venezia-Belluno, exit Belluno, highway SS51 to Cortina to Longarone, SS251 for Valcellina. Highway A23 Udine-Tolmezzo, exit Tolmezzo, SS52 to Passo Mauri, Val and Val Tramontina Colvera.	
	

In the park are present teropod dinosaur footprints fossils, stamped on a block of Dolomite, a rock formation deposited in the upper Triassic, more than 200 million years ago. The footprints of dinosaurs in the Dolomite testify unequivocally that in the Italian peninsula, there was the presence of such forms of life.

In the area are located different sites where the fossil footprints show up, but those of Casera Casavento observed on a boulder in the nearby creek called Ciol de Ciasavent, are the most visited and appreciated.

The path is set up with signs and information boards usfull to find and make the best use of the site. At the visitor centers and information offices on the premises of Claut village are available supplementary leaflets.

27. Regional Natural Park of the Julian Alps

Getting there	Region: Friuli Venezia Giulia
Highway A23 Venezia-Tarvisio exit Gemona or Carnia and continue on the SS13 Pontebbana Udine-Tarvisio.	
	

The karst plateau of the "Foran dal Muss" is located north of the mountains Canin and Sart, it is very interesting from a geological point of view because is located in an environment with no vegetation, almost lunar, where you can watch both the superficial and the deep karstic phenomena. The lack of vegetation is explained by the presence, in recent times, of a glacial coverage. Close to the "Col delle Erbe" is located large cavities, including

the Gortani abyss, over 900 meters deep, it is one of the most important element.

The plateau is a unique environment of great importance for the study of geological phenomena, where the tectonic events are perfectly observable because well exposed. The entire area, therefore, is particularly popular with geologists and speleologist.

The Barman fountain is a source of considerable flow Karstic located at 772 m in the northern side of Musi mountains where, within a gorge with difficult access, it produces a beautiful waterfall.

Resartico mine, in the upper valley of Resartico, about at a thousand meters of altitude, on the slopes of Mount Plauris, shows the remains of a small mining activities aimed at the exploitation of certain lenses of bituminous dolomite. The mine worked several times in the first decades of 1900. For the transport of the ore, which was worked at Resiutta, the mine has a cable whose remains are still visible in the ruins of buildings used in the past by workers. From the ore was obtained various oils including the gittiolo h.

The upper Lavaruzza valley is a glacial cirque describes very well, from the morphological, lithological and tectonic, some glaciation effects, as well as those due to the enormous forces created by the collision between the European and the African plates. At Cjariguart, this circushas a glacial moraine, probably accumulated in several stages. Near Pares, there are two temporary waterfalls that flow within a deep incision. Between Plauris and the top of Clapadorie outcrop the inner part of a folded structure upon which you can see the effect of deformation of the layers. There are also some evident faults that cut the slabs of rock. Also can be seen the effects of karst with large areas presenting karren. Morainic arcs of "Santa Anna di Carnizza" are evident and are due to the deposits front of a small glacier, coming down from the north side of Mount Zaiavor during the late stages of glaciation. The internal arc, remained perfectly intact, is a significant didactical example.

28. The Trieste's karst

Getting there	Region: Friuli Venezia Giulia
From Udine with the A23 motorway and the A4 Venice-Trieste reach. Follow Basovizza direction, then to S. therefore to Cattinara then for Dorligo and for the Val Rosandra.	


The Trieste Carso give the name to karst and is one of the most important examples of karst massif in Italy. The limestone rock is sculpt by rainwater and it shows erosive forms on the surface and underground.

There are numerous routes that can be run to discover these wonderful landscapes, with clear and bright rocks and a particular vegetation adapted to calcareous soil.

The Rosandra valley offers a spectacular landscape of cliffs, scree, sheer cliffs on the gorge of the river that crosses it. The wild and rugged valley favored the creation of evocative folk legends devoted to the mysterious princess Rosandra and Charlemagne.

Some interesting hiking trails, suitable for most part of the year, departing from the nearby refuge Premuda.

The Grotta Gigante, near "Borgo Grotta" village North-East of Prosecco is exceptional case within the karst phenomena, as the central cave, entirely viable, has significant dimensions: 380 meters long, 65 meters wide and 107 meters in height. Was explored as early as 1840 and open to the public only in 1908.

Visiting the Dolina of Percedol, located along the road that leads from Opicina to Monrupino, allows to observe one of the largest and deepest doline of the Carso area. Because of its shape - has a depth of 34 meters - will form a particular environment and microclimate, the temperature lower by about one degree every 10 meters of depth.

It is desirable a visit to the botanical garden of Carsiana which, through a guided tour, let to know the principal and characteristic flora of the Carso. The garden is a sample of karst environment consisting of a wide doline, as natural wells and the surface karst phenomena, there are also over 600 plant typical species.

One of the most significant examples of mixing of Mediterranean sweet climate and the asperities of the karst plateau is offered by the Rilke path. Stretched in front of the sea from Sistiana to the Duino Castle is a pleasant walk during which you can find typical Mediterranean plants. From the panoramic view points the sight go on the rocks, with their spectacular forms, to the sea with its rich colors and the plants and their blooms.

Liguria

29. Val Graveglia between rocks, mines and minerals

Getting there	Region: Liguria
With the highway A12 Genova-Livorno take the exit Lavagna, go to the inland following the signs for Val Graveglia. From the exit it is about 15 km far.	
	

Val Graveglia, located in Liguria, from a geological point of view, may be considered a treasure. In the valley there is present a wide variety of rocks and minerals, along with many special geomorphologic features. Can be seen rocks that were formed during the Jurassic (about 200 million years ago) on the bottom of an ocean now disappeared.

The whole process of formation of these rocks involved the opening of a new "ocean" (rifting) and the generation of oceanic crust, followed by the convergence and collision of continents that allowed the formation of the Apennine mountains. Under these conditions, were formed a very characteristic association of rocks called "ofioliti".

Val Graveglia is also a place of great mineralogical interest because it hosts a small number of mines. It is possible to visit a manganese mine that is developed in red cherts, it is called the Gambatesa mine.

The mine, the largest of the 13 present in the valley and the only still active, is now dedicated to geotourism because it was equipped to carry out guided tours.

It is possible to enter and observe the mineralization, the type of cultivation, the methods of mining and excavation, the extensive network of tunnels, the ventilation shafts, will descend to the stove and back.

Access to the mine, after having worn the helmet, is possible thanks to a characteristic train that will take visitors into the heart of the mountain. A special feature of the visit lies in the fact that the mine is still active even though the extraction is low. For fans of mineralogy and mining environments, is it possible to perform a dedicated visit on demand with access to every part of the mine.

Technical data about the mine.
Type of cultivation: lens and layers.
Number of different minerals species found: around 250 identified some for the first time in this place.
Year opened: 1887.
Development: on many levels and has a total length of tunnels (year 2003) of 30 Km.
Temperature: 18 °C
Rock: chert.
Principal mineral extracted: Braunite (Manganese oxide)
Minerals of interest: Tinzenite, Rodonite, Rodocrosite, Conicalcite, Kuthnaorite.

30. Regional Natural Park of Piana Crixia

Getting there	Region: Liguria
From Savona, with the road SS29 or the A6 go to Carcare. Then proceed along the SS29 towards Acqui Terme then to Crixia Piana.	
	

The area has fascinating forms that have been originated from the interaction between erosion and accumulation. The most interesting forms include ravines, alluvial plains and slumps.

The gullies, because of their gray coloration and their morphology without vegetation, characterize the landscape of the Langhe that is curious and ghostly in autumn and winter meanwhile during springand summer it is sunny and welcoming. Remarkable is the presence of a "mushroom" shape that is located near the village of Borgo, on the banks of a meander of the Bormida di Spigno river. This is a form of erosion, fifteen meters high, due to the presence of a large boulder that has preserved the leaching of the underlying coarse sediments that support it. In the area are present explanatory signs that help the visitors trips.

31. Beigua Geopark

Getting there	Region: Liguria
Numerous access points. By the highway A12 Genoa-Ventimiglia exit Pegli, Arenzano, Celle, Varazze, Savona. By the A26 (Milan – Genoa) exits Masone.	

Beigua Park is located half way between the provinces of Genoa and Savona, and was recognized Geopark in 2005 by the UNESCO. The most widespread rocks of the park are called by geologists "ophiolites" and come from the bottom of an ancient ocean. Due to the chemical peculiarity of these rocks the vegetation is not developed and only some species are adapted to the soils, for those reasons within the park are present rare flora varieties.

Among the major geotouristic attractions there are many fossil sites which allowed the reconstruction of climatic and biological conditions of the sea dating back to the Oligocene period (about 30 million years ago). It is possible to visit sites where fossils leaves are exceptionally preserved leaves and plants parts from a lagoon now disappeared. Even a well-preserved coral reef outcrops with many fossils of corals to witness the tropical climatic conditions. Not only paleontology is interesting in the park but also the erosive forms are developed and allow interesting visits. The Gargassa Valley ring path, not far outside of Rossiglione, pass through a scenic canyon carved in the conglomerates. These sedimentary rocks subjected to erosion have resulted in forms with predominantly vertical development, there is also a natural arch, a rare and fragile geological phenomenon.

Even for those who love minerals the park offers many ideas, in fact within its boundaries there are many interesting sites in particular near the Orba and Gava valleys and also near Passo del Faiallo. Among the ophiolites rocks outcrops some metamorphic rocks, called Rodingite, which in some points, including fractures and voids, with pockets which have developed wonderful garnet crystals. The crystals often have their crystal habit and reach considerable size, they are mainly garnets of the Grossularia and Andradide variety with the characteristic red-brown color. In addition to the garnets are also found beautiful Epidoto, Vesuviana, Titanite, Chlorite crystals.

32. Regional Natural Reserve of Rio Torsero

Getting there	Region: Liguria
By the motorway A10 Genoa-Ventimiglia exit Borghetto S. Spirit and drive to the village of Ceriale. From here follow towards the inland direction Peagna.	


A few kilometers from the sea, near the town of Ceriale, is present a small canyon carved in clear sandstone rocks. The site, not particularly significant from the landscape point of view, however, a considerable paleontological interest since it has an extremely rich source of fossils of the Pliocene period (from 5.2 to 1.8 million years ago), known worldwide for their exceptional state of preservation and the abundance and variety of specimens.

Carved by the Rio Torsero, the incision through the sedimentary rock layers are containing numerous fossils of molluscs. In particular, are represented lamellibranch and gastropods are often exceptionally preserved and still show the external ornamentation of the shell.

In the past, the site has been a destination for collectors and scientists who have collected numerous specimens of fossils greatly depleting the site, sometimes even doing excavations. For this reason, to prevent further improper removal in 1985 was established the Regional Natural Reserve of Rio Torsero which aims to protect and preserve the site.

With some of the fossils taken from the reserve is also built a collection hosted in the paleontological museum "Silvio Lai" in Peagna, fraction of Ceriale, located a few hundred meters from the natural reserve.

The reserve and museum are open to all with the accompaniment of authorized personnel that provides the correct scientific and historical information.

Emilia Romagna

33. Regional Park "Vena del Gesso"

Getting there	Region: Emilia Romagna
From Bologna to the A14 motorway, proceed to Faenza, with the SS302 up to Brisighella, Imola or take the SS610 up to the Village Tossignano.	
  	

Between the provinces of Bologna and Ravenna, is placed the "Vena del Gesso". This is a large outcrop of gypsum rocks formations dating back to the Miocene of relevant geological and naturalistic interest.

The exposure of layers of gypsum stretches across the valley for about 20 Km, the beautiful rocks in this area testify the closure and drainage of the Mediterranean Sea occurred about 6 million years ago. These evaporitic rocks that, as the name suggests, were formed by the evaporation of salt sea water. The salts dissolved in the sea, depleted of the water, crystallize and form large deposits.

In the area are wide spread karstic dolines, blind valleys and caves also very large populated by an interesting underground fauna. The flora is very diverse and there is a small fern (Cheilanthes persica) that here has the only station in Italy.

Parallel to the Santerno valley lie the Sillaro Valley, where there are interesting geomorphological aspects, such as gullies that have developed in easily erodible formations of blue clays dating to the plio-Pleistocene period.

34. Natural Geological Piacenzian Reserve

Getting there	Region: Emilia Romagna
The area allows many points of access. Leave the A1 at Fiorenzuola or Fidenza. The areas visited are Gropparello, Badagnano, Chiavenna Rocchetta, Val d'Arda, Valle dell'Ongina.	
 	

The Natural Geological Reserve of Piacenza uncommonly is a regional protected areas established for the protection of important sedimentary

rocks outcrops well known by the international scientific community. They represent the geological period called "Piacentian" by the geologist and corresponding to the time between 3.5 and 1.8 million years ago. In the reserve are also present outcrops of stratigraphic and palaeontological interest with cliffs, chasms, ravines and shadowy valley of great landscape value and natural beauty.

Among the rocky outcrops, consisting of steep walls of gullies form, with colors ranging from gray-blue to yellow, remained imprisoned fossil of many organisms of the Pliocene period, from the common different shellfish species to the whale skeleton found near Castell'Arquato in 1934. The Reserve was established in 1995 and has an area of 345 hectares divided into two areas, the A and B areas, in both areas is prohibited to collect paleontological material and some places the access is allowed only through guided tours. The scientific management of the reserve is made by the Geological Museum of Castell'Arquato, which also displayed numerous finding coming from the reserve.

A short distance separate the reserve from the Regional Park Stirone that is also of great paleontological and stratigraphic interest.

35. Natural Reserve of the Rupe Campotrera

Getting there	Region: Emilia Romagna
From Parma procede southward using the road SS513 to Ciano d'Enza than turn to Canossa. From Reggio Emilia using the road SS63, reaching Casina and turning to Canossa. La Spezia follow to Aulla, than take the SS63 to Casina and then to Canossa.	
 	

The Natural Reserve of the Rupe Campotrera is located in Canossa village and was established in 1999 by the Emilia Romagna Region in order to protect one of the most interesting geology, flora, history and landscape of the province. For the presence of some large outcrops of basaltic volcanic rocks, precious and rare minerals and plant and animal species found nowhere else, the area is particularly suitable for educational activities on issues related to

the geological, geomorphological and environmental fields. Is it possible to visit a particular environment made of ophiolitics rocks that come from an ancient ocean floor. This is rather rare rocks formation which, due to their peculiarities, lead to the creation of an original and unusual landscape.
Hiking trails in the reserve makes possible to know the different types of rocks and their influence on living organisms. The area offers some biotopes that can be considered valuable islands of biodiversity. Are also interesting, from a geological point of view, gullies, plio-Pleistocene fossiliferous sediments.

36. The mud Volcanoes of the natural reserve of "Salse di Nirano"

Getting there	Region: Emilia Romagna
With the A1 motorway reach Modena, then proceed along the road SS486 southward, then from Casinalbo turn to Fiorano Modenese.	
 	

The notes of the great naturalist Lazzaro Spallanzani describes with great effect the phenomenon of the "Salse", literally "sauces", spread along the Emilian Apennines hills: "some unique and constant phenomena in small awaken in us the idea of volcanoes. Those are some land masses that comes out from the floor, with a cone shape outside and of reversed funnel shape on the top, from which a spray jets and is expelled out a semiliquid mud ..."
The "Salse di Nirano" are curious muddy "volcanoes" shapes created by the emissions of salty mud fluid accompanying the rise of hydrocarbon gas from the subsoil. Nirano emission vents, for their number and the constant activity, are among the most spectacular examples of this phenomenon in Italy. Small babbling cones, from which mud flows down, impress a surreal atmosphere to the landscape enclosed in an amphitheater of hills.
These "mud volcanoes" that emit cold mud, salt and gases (a flammable mixture of methane with varying percentages of carbon dioxide and hydrogen sulfide) and small amounts of oil, are the surface expression of the presence, in depth, of deposits of hydrocarbons. The accumulation of methane and oil, that arise from the anaerobic decomposition of organic remains of animals and plants, are always accompanied by salt water that often, as in the case

of Nirano, show the geochemical characters of fossil marine waters. The spontaneous rise of these materials occurs under the impetus given by the pressure of the gas along deep fractures that cross the deposit. Many hills in Emilia are effected by emissions affecting mainly clay rocks belonging to the so-called "Argille scagliose" or, as in the case of Nirano, the blue-gray Pliocenian clays.

At the emission points are generated curious form similar to the one of volcanic cones, they rise to different heights in relation to the density of the mud; from emissions of very fluid materials stem flat cones meanwhile while more dense sludge form cones that can reach a couple of meters height.

The cones, overflowing from the crater and filled with mud, mutters continuously, hence the dialect name of "barboj", with some frequently emitting mud flowing down in typical channels, others erupt occasionally, intermittently, abundant amounts of dense sludge that form distinct recognizable deposits along the sides of the cones. Collected along the circumference of small craters and floating on the mud, can be observed oil patinas, brown and iridescent. The "Salse di Nirano" also features two pools from which muddy water comes out and are particularly evident gurgling gas emissions.

The protected area of Nirano, in addition to the cones erupting mud, show also badlands hills that give to the area a unique "lunar" effect.

Four paths are of particular interest.

The Salse tour from Castello di Spezzano is without doubt the most significant for the observation of the phenomenon of "sauces".

A pleasant stroll to the lakes along the little Rio Serra stream, right tributary of the Rio delle Salse.

The route that proceeds from the basin of the Salse valley to the one of Chianca, starts from the "Salse" road and rise to a panoramic position from which you see the basin, the gullies in the valley of the Chianca river and the Rocca Santa Maria cliff.

The Calanchi round starts from the sports facilities of Spezzano and go upward to the valley of the Chianca river until the confluence with the Rio del Petrolio ("River of the oil").

37. Fossil Dunes Natural Reserve of Massenzatica

Getting there	Region: Emilia Romagna
To reach the reserve from the Romea road SS309, north of Pomposa, take the direction to Italba, arrived in this town follow Northward the signs for Massenzatica, after a few hundred meters is placed the protected area.	
	

The Fossil Dunes Natural Reserve of Massenzatica holds the last relic of fossil coastal dunes of the Bronze age that can be seen in the region.

The dunes, which until the'50s were much more extensive, are among the most important evidence of the evolutionary history of the Po delta in the last thousand years. Undulations covered with low meadows alternate with depressions occupied by shrubs and forest edges: a landscape unique and unexpected, in sharp contrast with the boundless countryside. In the reserve are also present plants and animals typical of coastal environments, including some rare species, but the area is a refuge for flora and fauna typical of the plain. Back in time 50,000 years, where today lies the delta, are located the valleys carved by the progenitor of the Po and its tributaries.

During the last glacial period that took place during the Quaternary, the Würm (between 75,000 and 10,000 years ago), due to the huge amount of water imprisoned in the ice caps that covered the northern Europe, the sea level dropped by more than 100 m compared to today. When the ice age was over the waters invading the lands, the sea level raised and about 5000 years ago the coastline was very stabilized inside, describing a bay that was 20-30 km inward compared to the today coastline, along Ravenna, Alfonsine, Massa Fiscaglia and Adria. Under these conditions of relative stability of sea level began the construction of today's Po delta. The sea regressed and the old beaches stayed behind the new coastlines.

Many studies have allowed the reconstruction of the shape of the ancient delta systems, revealing that in the past, the Po delta was very different from now.

38. Fluvial Stirone Park

Getting there	Region: Emilia Romagna
From Parma or from Piacenza with A1 go to Fidenza.	
 	

Along the Stirone river for a stretch of about 14 Km is placed the Fluvial Stirone Regional Park. The landscape offers to the enthusiasts the opportunity to do hiking and practice their favorite activities and also to visit a rich fossil site. The area represents a geologically ancient marine gulf dating back to the Pliocene and retains an overwhelming amount and variety of fossil formations well known to paleontology researchers for the spectacular founds of the Tertiary and Quaternary emerging along the stream.

The bed of the river is cut in sandstone rocks and mudstone born from a marine regression. Currently, the stratified rocks containing fossils lie tilted towards the North-East.

The fossils are especially numerous at "Ponte di Scipione", along the escarpment that band a broad bow of the stream. The first fossil outcrop going downstream are a level of sandstone composed predominantly of fragments of fossil organisms, which are followed by fine grained levels of sandstone and gray clay, which deposited in marine environments during the upper Miocene, around 10 million years ago. Downstream of S. Nicomede is placed the open-air museum, the rocks are gray clays of the Pliocene rich in fossils.

39. Geological and environmental tours in the Park of the "Foreste Casentinesi"

Getting there	Region: Emilia Romagna
The Park can be reached fro south by the A1 road, the exits is Barberino del Mugello, Florence or Arezzo. From Barberino with the road SS67, from Florence, through SS70; from Arezzo with the SS71. The park is also accessible from the A14 by the exit of Faenza, Forlì or Cesena. From Forlì with SS9 and SS67 or SS310. From Cesena, going up the Savio valley with the road E45.	


The Tuscan side of the Park "Foreste Casentinesi" has dense forests, while on the Romagna side shows rocky outcrops that reveal the geological history of a stretch of mountains.

The stratified rocks, mainly mudstones, incorporate fragments of different age and composition, as blocks of limestone of light color, dark red cherts, brown sandstone and sometimes dark and heavy ophiolite rocks.

To enhance the geological aspects of the park have been identified some thematic itineraries that can be easily discovered through excursions.

Along a ring path departing from Case Gualco can be made observations on rocks formed by turbidity current, their structures demonstrate the various stages of hydrodynamic turbulent process of transport and sedimentation. In these formations may also be observed delicate fossil traces, similar to small umbrellas-shaped curved spiral, called "Zoophycos" left by ancient organisms who lived on the seabed.

Among the main points of interest of the park there is the Acquacheta waterfall, over 70 meters high and placed on a stair of layerded rocks of great scenic effect. Along the Rabbi river at the arcuated bridge, at the village of Ponte Nuovo, you can follow the river and observe the shapes carved by erosion called "marmitte dei giganti" ("mufflers of giants"), even further south , near Monte Fatucchio, is a spectacular form of the same type. In the area, particularly near the town of Fiumicello, faults that that interrupts the layered rock formations can be clearly observed. Near Mount Falterona emerge from the vegetation the scenic "Balze delle Rondinaie" that are stratified sandstone formations.

Between the towns of Giampereta and Montesilvestre is a landscape embellished with spectacular badlands set of alternating layers of marl and limestone.

In the southern part of the park dominate limestone and karst phenomena of which one example is the "scogliera della Stimmate" a wall of calcarenite about 30 meters high on which is perched a sanctuary and the surrounding area is rich in caves and superficial karst forms. The area of the park, has also a rich botanical and natural landscape.

Toscana

40. Elba island

Getting there	Region: Toscana
How to get there. From Livorno to the port of Piombino from which, by ferry, arrive on the Elba island landing in Portoferraio.	
	

The Elba Island, within the Tuscan archipelago, may be considered an open-air geological laboratory island. Gathered in a small area it shows sedimentary, magmatic and metamorphic rocks, this variety is also accompanied by a good quality of exposure. In addition to a wonderful variety of rocks there is an extreme wealth of minerals of interest for collectors and also for scientists, these minerals made the island well known worldwide. These peculiarities could be alone sufficient to justify the transformation of the island in a national geological park.

If we add to this a wonderful and hospitable place, where the sea has always been a major actor, a rich history of mines and miners a good tourist organization, then we can understand the value of this place.

The geology of the island is the witness of the orogenesis of the Apennines with the phenomena of superposition of nappes, typical structures in the formation of mountain ranges. The formation of the Apennines events can be traced back to the upper Cretaceous (about 100 million years ago) when the sea (called the Ligurian-Piedmont Ocean) begins to close. Thick deposits of sediment accumulated that will transform into sedimentary rocks. During the lower Oligocene (about 30 million years ago) an entire block of continental crust, the current Sardinia and Corsica, migrated by turning toward the east. This migration, which still continues, produce the stacking of nappse constituting the Apennines. In the late stages of this movement, in the upper Miocene (about 8-10 million years ago), occurred magmatic processes (accumulation of magma in depth) that produced a pluton, and the dike complex of the island. The Elba island is mostly made up, to the west by magmatic rocks and to the east by metamorphic and sedimentary rocks.

Metamorphic phenomena due to Monte Capanne Pluton.
Around Procchio along the beach between Punta Agnone and the promontory of Spartaia, there are "contact" metamorphic rocks, transformed due to the heat of a magma body intruded underground.
Very interesting mineralogical and petrographic phenomena can be observed, there are garnets marbles derived from limestone-marl clay. The marble present the granoblastic structure, ie with large crystals, the crystals are calcite and garnet.
Along the road to Chiessi, at Punta della Zanca and Punta della Fornace can be seen a beautiful display of granodiorite, an intrusive magmatic rocks, with large crystals of plagioclase. Given the size of the crystals, it is easy to recognize the mineralogical composition. Quartz is present with its typical luster; biotite with its thin sheets, hexagonal and black colored, also is present plagioclase and the rose colored potassium feldspar. The latter is in large elongated crystals (phenocryst) of dimensions greater than 10 cm in length. For the mineralogy fans, it should be noted that the feldspar crystals are geminated (particular phenomenon of symmetrical growth) if, the illuminated crystals are observed, can be seen, on some faces, a different reflection of the light on two halves forming the crystal.

The magmatic dikes
At Punta Nerasi can be observed a set of rocks that formed the ocean floor, particularly serpentine and mudstones. These rocks have been affected by the phenomenon of magma intrusion that has thus formed many dikes.
The serpentine is black-green in color and shiny, the mudstone is gray-brown looking and laminated. The dikes are composed by porphyry, the cooling of magma took place rather quickly, so the developed crystals are not very large, the predominant minerals are quartz and plagioclase. The appearance of the dikes is that of a band of lighter color in the dark serpentine, in proximity of them may be observed contact metamorphism phenomenon. This is recrystallization of the host rocks due to the high temperature of the intruding magma.

Sedimentary rocks
Among the Punta Tombe and Punta Fetovaia the great variety of rocks of

the island is brought up. Within a few hundred meters, an ophiolites rocks sequence (serpentine, gabbro, cherts, limestone), and a type of rock called "flysch" (they are formed in the ocean depths for intense sedimentation of materials obtained from the areas closest to the coast). The promontory of Punta Fetovaia consists of gabbros, while just a little north-west over are well recognizable the serpentine by their typical shiny green-black appearance.

Mineral beaches, acid lakes and aplitic dikes.

Close to Porto Azzurro, from the Barbarossa beach, can reached the Spiaggia di Realewhere could be observed natural phenomena of great geological interest. One in particular gave rise to the name: "Spiagge nere" ("black beaches"). First, watching the beach, it is possible to notice the deep black color of the sand. If we approach and then we take a handful of that black sand, we see that its weight is much higher than the sand we are used to find along the sea coasts. We are facing a phenomenon of erosion of iron rich rocks. The ore is eroded and transported to the beach where it is deposited early and removed with difficulty from the waves because of its high specific weight. This effect of concentration for natural agents and the singularity of the material involved (high specific density) may, in some cases, lead to the formation of an ore deposit of economic relevance. In some places on the planet, in fact, some minerals are extracted directly from the marine sands, because these are heavily concentrated, the high concentration is often for reasons similar to those described above. A few meters from the beach lies a small lake with a nice green color. In addition to the color there are also some chemical oddity, its waters, due to chemical reactions of transformation of the iron ore, are highly acidic. Entirely natural phenomena have led to "pollute" the water of the lake, therefore is not advisable to swim in the waters of this beautiful lake.

The rocks in the vicinity can be observed aplitic dikes (mineralogical composition rich in quartz, feldspar and plagioclase). They appear as bands of light color (due to the color of the minerals) within darker rock massifs. Often, these bands are interrupted by fractures of the rock.

Elban Mines

Elban mines have many mineralogical interesting aspects.

Currently, the mines are inactive and there are plans to develop a mining park, which should facilitate the public access. The iron mines of the island have been exploited since the time of the Etruscans until a few decades ago. Even if they are not active the mines still remain very interesting for scientific, historical, natural and tourism reasons. The main mineralization of the island are of iron ore and their high concentrations are attributable to physical-chemical processes related to the intrusion of magmas of the pluton body called "Plutone di Porto Azzurro. The intrusion of the magma happened about 5 million years ago.

Not far from Rio Marina, is situated the Valle Giove mine that is part of a mining area, it is necessary to contact the local guides to access.

In the mine can be observed hematite mineralizations, which are often associated with beautiful crystals of pyrite (iron sulfide). From this island come of the most beautiful in the world pyrite samples.

Some of the many minerals that can be found here are ilvaite, hedembergite, diopside, epidote.

For the richness, the beauty and variety of mineralogical samples discovered and still present in this place, it will be like being in a real museum for fans of minerals collection.

41. Regional Park of the Apuan Alps

Getting there	Region: Toscana
By the highway A11, after the Lucca exit follow to Garfagnana, Castelnuovo visitor center, Grotta del Vento. From the A12, exit Versilia direction southern Apuane, Seravezza visitor center, the Antro del Corchia or Massa northern Apuane; visitor center Filanda di Forno or Carrara northern Apuane Campocecina. By the higtway A15, exit Aulla.	

In this park you can see various aspects of geological interest. At Stazzema are present the "Marmitte dei Giganti" that are a phenomenon of geomorphological significance, they are semi-spheric hollows, sometimes quite smooth, carved in limestone rock. They are in some canyons that descend the slopes of M. Sumbra, from M. Tambura and at the Valle degli

Alberghi. Their formation is caused by the slow erosion due to the abrasion of pebbles at the water whirls.

Mount Forato presents a magnificent arch visible from many miles away, whose origin is probably due to mutual interaction between surface and underground karstic effects. Interesting phenomenon is the visitable entrance of the Corchia cave, that is of one of the most important and large Italians karst complex.

At Equi Terme Fivizzano area, are located the caves and the spa, the Canyon of d'Equi and the Vinca valley.

Among the Apuane attractions appear on top of the marble quarries, where the mining operation gave to the landscape a peculiar character . Are stunning the cuts and fractures made by men that reach the highest point of the relief, the cascades of debris, known as "ravaneti" along the sides and the typical "vie di lizza" (used in the past for the transportation of materials, but now abandoned and in renaturalisation). This has created a unique mining landscape that contains profound reasons of interest. The highest concentration of marble quarries are located in the hills behind the town of Carrara. The geomineralogical richness of the Apuane includes metalliferous veins with abundant iron ore, lead and silver, copper and other metals, as well as places of mineralogical value, mineral springs and thermal water.

42. Faunistic Park of Monte Amiata

Getting there	Region: Toscana
From Pisa passing by Grosseto using the road SS1 Aurelia and then the SS322 and 323. From Siena with the SS2 and then the 323. From Rome and Pisa with the SS1 Aurelia and then following the SS323.	
  	

Monte Amiata is a volcano, the first you meet coming down the Italian peninsula from north to south and, unlike those volcanoes with a simple cone-shape and regular slopes (like Mount Vesuvius and Mount Etna), Amiata seems like a set of hills. The origin of the volcano began in the Pleistocene, about one million and a half years ago, ending 290,000 - 180,000 years ago. Today the site is rich of quicksilver mineralization in the

form of sulfide red colored, called cinnabar, often associated with gypsum, pyrite and sometimes arsenic sulfides: realgar and orpimento. There are also geothermal fields, sulfur baths, colorful land (the famous "terra di Siena" or "Ocra"). Worth visiting the villages of Bagno Vignoni and Bagni San Filippo in Orcia valley where thermal spring water are over 50 ° C.

43. Archeominepark of San Silvestro

Getting there	Region: Toscana
The park entrance is located in Madonna di Fucinaia that can be reached using the road SS1 Aurelia to Campiglia Marittima and then following the SP20 where are placed indications.	
 	

The park is rich of natural and historic elements where humans have strongly interacted with the environment. Out-stand the Temperino mine which preserves the signs of the mining hard work of men and the medieval castle of Rocca San Silvestro.

The Park of San Silvestro, with its 450 acres, affects only part of the Campiglia mining district, but constitutes the most important historic core.

What characterizes the Park more are the signs of mining activity that extracted the lead ore, copper and silver, an activity already started in the seventh century BC with ups and downs and lasted until the present day.

At Temperino, at the entrance of the park, a series of buildings constructed between the mid-nineteenth century and the beginning of this century for the mining industry, have been restored and host the visitor center, the museums of the park and the point of refreshment. Here is also the entrance of the mine and from here begins a series of archeological and mining paths that lead the visitor to discover the park. Along these paths is it possible to walk to the medieval village of Rocca San Silvestro, or the old town of Campiglia Marittima where is placed the Praetorian Palace Museum.

44. The geothermal area of Val di Cecina

Getting there	Region: Toscana
From the Aurelia road (Livorno-Grosseto), exit Donaratico-Castagneto Carducci, follow the SS29 to Larderello. From Saline di Volterra Volterra, follow the SS439 to Larderello. Using the highway A12, exit Rosignano then follow signs for Cecina Volterra, Pomarance Larderello.	



Also called the Valle del Diavolo ("Devil Valley"), the high Val di Cecina geothermal shows interesting geothermal phenomena that occur in the form of fumaroles and puffs of steam coming out from the ground. Already exploited by the time of the Etruscans, then Romans until now, the emissions were used both as a geothermal baths and to produce sulfur, alum, drugs, salts of boron and coating. Today, as a result of the first studies of the French Francesco De Larderel, who in the early nineteenth century began to exploit the geothermal heat to produce energy, the location has reached a modern way to product huge amounts of electricity of geothermal origin. Currently the area can be visited to see the picturesque geothermal manifestations.

One of the most picturesque spot is near the village of Sasso Pisano from which depart a circular route that allows to closely observe the "putizze", steam emissions and odorous gases. The water that flows outside from cracks can reach temperatures well above 100 ° C therefore should be paid attention. Along the way you could be observed small holes around which crystallize beautiful crystals of sulfur with the typical yellow color . The landscape have the characteristics described by the ancient poet Dante in his chapter titled "hell" of the famous "Divina Commedia". In the place it is possible to hear the hiss of steam escaping from the underground, the bubbling pools of water, observe the land yellow tinted and ocher due to the mineralization found in geothermal fluids.

Do not miss the visit to the Museum of geothermy of Larderello which describe the history of the exploitation of the heat from the beginning until today.

45. Saturnia's thermae

Getting there	Region: Toscana
From the South with the A12 to Civitavecchia, go on along the SS1 towards Grosseto, exit at Km 111 Marciano. From the north by the highway A1 exit Firenze Certosa, connection Firenze-Siena. Once in Siena take the highway for Grosseto, Roselle exit, following signs for Roselle and after Saturnia.	
	

Le Saturnia therme are an example of how a phenomenon of geological origin, the hot mineral water, have altered the landscape and the human behavior.

Saturnia is a small hamlet of Manciano in the Grosseto area, was described as "the oldest city of the Italic civilization" and carries a strong touristic appeal today. In the past centuries has hosted many civilizations, from the Etruscan to the Romans and after the barbarian invasions. As evidence of its past remain the "Porta Romana" ("the roman door"), the "cinta muraria" ("the walls"), the "necropoli di Puntone" ("Puntone's necropolis") and the remains of the "bagno secco" ("dry bath"), an ancient spa complex.

Saturnia's fame is due to the source of sulphurous water (Saturnia's thermae) that with a flux of about 800 liters of hot water (37.5 ° C) every second guarantees the purity and therapeutic properties. The thermal waters were already being used by the Etruscans and Romans thousands of years ago to cure "the disease of men and those of livestock". In the '30s was built on private spa that since then exploits the beneficial properties of the hot water. Le Saturnia's thermae are known at international level thanks to the particular shape of the "public" spa, the "cascata del Mulino" ("Mulino's waterfalls") which are defined by many as a magic and romantic place.

Located a few hundred meters from the private spa, the charming cascades of water are fed by a sulphurous thermal stream called "Gorello" who, by jumping down and reaching the river Stellata, created over time natural limestone pools where is it possible to dive even in winter, to benefit from the valuable therapeutic properties of the water.

46. The Tuscan "balze"

Getting there	Region: Toscana
With the A1 highway which connects Florence to Arezzo, exit at Valdarno and follow the signs to Terranuova Bracciolini.	
	

The term "balze" mean "big steps", they constitute one of the most typical landscape of the territory of Terranuova Bracciolini. Their origin dates back to fairly recent geological times, when in the upper Pleistocene, less than 100,000 years ago, there was the engraving of the doposits that closed the north-western part of the fluvio-lacustrine basin. Near Incisa Valdarno ("incisa" mean "cut"), the Arno joined the Sieve and continued its course until it reaches the plain of Florence, simultaneously lowering its basic level. This reduction caused the river and its tributaries to erode the sediments previously deposited with different morphological results depending on the lithology. Where, in fact, there was a prevalence of silty-clayey soils, as in the central part of the basin, has generated a gently undulating landscape, characterized by low inclination and wide valleys. In the more internal part of the basin, the lithology is predominantly sandy and pebbly, the effects of water has resulted in rough morphologies, with steep slopes and deep narrow valleys, often separated by thin ridges, this is the "Balze" landscape that the dense and luxuriant vegetation and the low presence of human settlements make it even more impressive. A hike in these beautiful places can let see and understand the evolution of a landscape under the effects of the erosion.

47. The "Calanchi of Montieri"

Getting there	Region: Toscana
To reach San Galgano take the higway "del Sole" A1 exit at Certosa, then the motorway Firenze-Siena and exit at Colle Val d'Elsa Nord, then follow the signs to Follonica.	


Along the road that connects Montieri and Boccheggiano is placed an interesting area in terms of geomorphologic, mining and historical occurences. In this area are located badlands, here called "calanchi", that characterize the landscape but also the Metalliferous Hills that have been exploited for the extraction of silver ore. The mining activities is highly developed starting from the year 1000, so attracting the interests of Siena that in 1205 acquires ownership of the village of Montieri.

Located around the village of Montieri are the Metalliferous hills, once famous for there to be extracted silver, not pure, but in combination with other minerals such as galena, blende, pyrite and chalcopyrite, the silver was then separated by complex processes. It was also extracted lignite, borax, pyrite, sulfur and copper lead, zinc and antimony. There are many interesting traces of ancient work and truly beautiful, for example, are the reddish slag eroded by rainwater, so-called "calanchi rossi" "red badlands", which are seen along the road leading from San Galgano to Massa Marittima before turning for Montieri and Boccheggiano.

An interesting route is the one that let see from the road these hills that are nothing more than the rock extracted from the mines and that the weather has changed and eroded, over time, in its present form. Crossing the river Merse the "calanchi" are reached, hills, red and yellow pinnacles and guile that nature has shaped. Countless are the minerals that can be found here, especially for those people who is used to search them, but even minerals non-experts can certainly make a visit to the gullies forming a pleasant chromatic spectacle.

48. The geological trail of "Colle di Monsummano"

Getting there	Region: Toscana
With the A11 motorway exit at Montecatini Terme and follow the SP14 to the village of Monsummano Terme, the trail starts from the SPA establishment of the Grotta Giusti.	
 	

The hill of Monsummano Alto is a place of great natural and hiking value since it has many geological peculiarities that make it fascinating.

Due to the high scientific and landscape value, in 1998 have been realized two geological paths called of "Colle Monsummano".

Along a geological route, you will find some of the few famous thermal caves or caves with a temperature higher than the norm for the influence of geothermal phenomena in the subsurface. The morphology of the area is particularly rich because of karstic surface erosion related to the phenomena that develop in depth. In addition to the special shape of the hill you can see unique flora and characteristics vegetation, such as the presence of numerous orchids of which have been reported over 24 different species.

Both geological trails start from the thermal establishment of Grotta Giusti. The path that departs from the right pass through formations of limestone and silica-limestone locally crossed by thick veins of calcite. The path also let observe chert formations red-violet colored on which the tectonic effects are visible, in fact here faults have cut and displaced large portions of rock masses.

The path that from the thermal building bend to the left allows the observation of limestones cave where the walls have very red colors. The cutting slots can also allow to see in detail the stratigraphic sections of several formations.

Umbria

49. The volcanology park of San Venanzo

Getting there	Region: Umbria
From Terni, Perugia and Rome with the E45, exit Marciano. From Florence and Rome with the motorway A1, exit Orvieto.	

Around three volcanoes that were active up to 265,000 years ago was born the structure of the San Venanzo park. It is a maar, a flat-bottomed, roughly circular volcanic crater of explosive origin, to the north, the tuff ring of Pian di Celle, about one kilometer to the south of the former and then the lapilli ring 500 meters to the east. They are small volcanic craters that reach an altitude of maximum 30 meters. Compared to humans those volcanoes are very old but, from a geological point of view, they can be considered recent. For this reason, the craters are well preserved and the morphologies are easily recognizable. In addition to the crater there are many volcanic structures that can be observed to understand how a volcano is formed and what phenomena occur during an eruption. In addition, we appreciate rare minerals including the "Venanzite". Around the Pian di Celle volcano an interesting volcanological path outline a pleasant journey of about 2 km long that let to comprehend the history of the volcano, which has a large crater located at the summit of a cone of lapilli and scoriae. There are located two large lava flows formed by Venanzite, the famous and rare mineral that characterizes the area. Near the northern lava flow there are the remains of an ancient quarry of grinders stone that testifies the ancient mining activity. Housed in a historic building in the San Venanzo center is a volcanological museum, consisting of a video room dedicated to volcanology, a room addressed to geology and paleontology and one to the mineralogy and volcanology. The visit to the museum help, in particular, to clarify the phenomenon of volcanic activity and the volcanoes of San Venanzo. In the museum is also possible to observe the rare mineral of volcanic origin, known as "Venanzite".

50. The Forello gorge

Getting there	Region: Umbria
With the highway A1 reach the exit of Orvieto, with SS79BIS reach Corbara village.	
 	

During the Pliocene and Pleistocene, the great Umbrian depressions have been occupied by a large lake called Tiberino. The lake stretched from Sansepolcro to Ponte S. Giovanni, then divided into two arms, respectively elongated to Spoleto and Terni. The lake was subsequently drained and significant erosion has contributed to the genesis of the Forello gorge, along with two other deep rifts of "Gola del Fosso Grande" at Amelia and the "Gola del Nera" at Narni. The phenomenon of the lake drainage has led to the formation of marsh environments that are witnessed by the nearby site of the Fossil Forest of Dunarobba.

Currently, in addition to the sedimentary rocks of the Pliocene, are present much older rocks dating back to the Jurassic, containing numerous ammonites fossils.

The landscape of the Forello gorge, of great scenic effect, is characterized by high rock walls of travertine, which are often affected by cavities and caves, descending to the Tevere river along the narrow valley. The place offer pleasant hikes through an area of varied shapes and colors.

Near the Forello gorges, in "Roccaccia di Titignano", there are the interesting "Grotte della Piana" caves where there are networks of tunnels dug by the waters and the vast rooms made by karst activity.

51. Fossil Forest of Dunarobba

Getting there	Region: Umbria
From Terni with the road SS3BIS/E45 heading towards Montecastrilli, after continue to Dunarobba. From Todi, with the road SP379 southward along the SP39 and then along the SP37 to Dunarobba.	


The palaeontological site of the Fossil Forest of Dunarobba, for its content, is very relevant. Since 1600, by Prince Federico Cesi and Stellutti, was knonw the presence of fossil wood in the countryside of Avigliano Umbro, Montecastrilli, Sismano and Rosaro.

In this site there is a fossil forest whose trunks are formed from their original wood, this has allowed, through histological studies, and by the analysis of of pollen, fruits and leaves, to state with certainty that this is a conifers forest of Taxodion specie, probably an extinct form of sequoia very similar to redwood Sequoia Sempervirens.

All the trunks of this forest are still erect, they maintain their position in life, it has allowed scientists to study the material that is located at the base of the logs (about 30 meters below the today ground level) which was the soil where the plants lived. The Fossil Forest of Dunarobba lived in the Pliocene, 3 million years ago, between the Amerini and Martani mountains where was placed a large lake named Tiberino. Together with the fossil tree trunks were also found fossils of large and small mammals living near the lake and the forest itself, as evidenced by the discovery in an alluvial deposit near Todi, the remains of rhinoceros, deer and rodents.

Between the '70s and '80s the Fossil Forest of Dunarobba was discovered during the process of extraction of a clay quarry. In November 1987 the Archaeological Superintendence of Umbria began its protection activities, including the photographic and topographic survey of the area.

Currently the forest can be visited with a guided tour that should be booked at the Center for Plant Paleontology Fossil of the Dunarobba Forest, located in the municipality of Avigliano Umbro.

52. The Bottaccione Gorge

Getting there	Region: Umbria
With the road SS 3BIS/E45 or SS76 or S3 reached Gubbio, from Piazza Martiri 40 departs the route, along the SS298 are placed some signs.	
  	

The Bottaccione gorge pass through the mountains chain of Gubbio and was carved, in the last 2-3 million years, by the erosive action of the Camignano stream that still flows in the valley.

In the recent decades, the Bottaccione Gorge has assumed a role of great importance from a geological point of view for the many relevant researches that were conducted there.

The rocks that emerge along the gorge are of sedimentary origin and were laid on the bottom of an ancient sea 140 to 30 million years ago, when the configuration of the land was very different from now.

The rocks that make up this gorge are composed of calcium carbonate and a part of silica and clay minerals. Some layers of these rocks are rich in remains of microscopic shells of organisms that lived in the ocean. The rocks richest in these shells are those of the formation of the "Scaglia", divided into Scaglia Bianca (white), Rossa (red) and Cinerea (gray) by its color.

The period of formation of rocks in the Gorge Bottaccione include a timespan that geologists have identified as the threshold between Secondary and Tertiary era, dated 65 million years ago. This is a conventional limit in which big events happened that were probably brought enormous consequences for the history of the life on the Earth.

In a relatively short time disappeared many species of living beings, the most famous of these are definitely the dinosaurs. According to some scientists, in the Bottaccione Gorge we have scientific evidence that this event happened because one or more meteorites hit the Earth.

The effect of this impact on the earth's surface would have catastrophic consequences, putting the photosynthetic organisms, like the plants, in crisis. The food chains based on these organisms went into crisis and many organisms extinguished.

Some minerals containing elements such as Iridium are very rare on Earth's

surface and are produced almost exclusively by the continuous bombardment of meteorites. By measuring the concentration of these minerals in the Scaglia rock formation of Gubbio was found abnormal amounts of Iridium on the boundary between the Cretaceous and Tertiary. This fact has allowed to formulate the hypothesis of an ecological catastrophe caused by the asteroid that would have drastically changed the climate.
Moreover having a scientific value, the Bottaccione Gorge is also a pleasant place for excursions with the chance to see the highly visible and well preserved sedimentary rock. The landscape is that of the pleasant and romantic hills of Umbria.

Marche

53. Sasso Simone and Simoncello Park

Getting there	Region: Marche
From the North and the East with the A14 highway exit at Rimini Nord, then SS9 until Santarcangelo R., SS258 of Marecchia, Pennabilli. From South-West with the highway E45, exit at S. Justin, then up to a SS73 S. Angelo in Vado, then road for Pian di Meleto. From the North-West with the E45 exit San Sepolcro with SS258 of Marecchia Ponte Messa then to Pennabilli.	
 	

The unique morphology of this area is due to its complex geological history, characterized first by the formation of the Apennine then by the evolution of these rocks formed mainly in the Tyrrhenian Sea.
Due to the orogenetic forces and thanks to submarine slumps phenomena, the Coltre della Val Marecchia rock formation, of which is made most of the park, came to occupy the present position, with most movements occurred between the Tortonian and Pliocene among between 8 and 5 million years ago. The area represents an excellent training ground for improving the geological knowledge.
The most significant morphology of the area is the marked contrast between the calcareous and clay rock formations. The morphology is influenced by the outcrops showing very different nature and mechanical resistance. The

most reluctant to the erosion are the limestone and mudstone formations, sometime occurring in very thick layers, which constitute the entire relief of the Mount Carpegna and Sassi Simone e Simoncello.

In more rocks resistant it creates a fairly steep morphology with slopes almost near to vertical, those slopes are mainly resulting from faults that lead to abrupt changes in altitude and along them is it possible to easily distinguish the rock layers that make up the rock formation itself (Costa dei Salti, Sassi Simone e Simoncello). Erodible rocks, however, leads to a gradual slopes affected by erosion, which frequently produce morphologies like gullies and badlands of considerable extent, as in the south of the Sassi, around Villagrande of Montecopiolo and around Peschio. In this areas of the Park is impossible not to be fascinated by the various colors that clays assume like vivid red alternating with green and shades ranging from light gray to black. These colors are due to the presence of minerals that, as natural pigments, color the clays, iron oxides gives the red color, while the organic matter in the clays produces various shades of black.

Walking through the badlands, is also possible to note brighting fragments in the clay minerals: it is shiny pyrite, yellow gold coloured, there is also calcite which is found in fragmented layers of even thickness of 10 cm, is also found heavy spherical barytes, sulfur in small grains with its unmistakable odor. Their presence is due to the passage, within these ancient soils, of mineralized fluids that have resulted in the crystallization.

The two Sassi, as well as the peaks of Pennabilli and those of Montecopiolo are made of limestone rich in fossils and fragments of oysters, scallops, echinoid or sea urchins and coralline algae, fossil association that testifies the sedimentation in a marine environment, with depths ranging from 0 to 200 m, these rocks in fact date back to the Miocene, or about 18 million years ago.

Blocks of limestone of the Formation of San Marino is also found scattered over almost the entire area of the park to witness an initial rock formation much bigger than the current, even the two Sassi were once probably united to form a single massive now divided by the rock fracturing and erosive action occurred in the underlying clay.

54. Rossa Gorge and Frasassi Natural Regional Park

Getting there	Region: Marche
Using the highway A14 (Bologna-Canosa) exit Ancona North. With the road SS Ancona-Roma, exit at Genga-Sassoferrato.	



The scenario is that of the complex and rough morphology of the Appennine section from Umbria to Marche, it is an area where the speleology is one of the most interesting in Europe with a powerful development of the karst phenomena and with austere and pristine nature that preserves intact the signs of a millennial past.

In Frasassi di Genga near Ancona, between the mountains cut by a wild gorge impetuous flows the Sentino river.

The "Foro degli Occhialini" (that means "the hole of goggle"), is an evocative "window" on the Frasassi Gorge, known in the thirteenth century as Grotta Traforata ("pierced cave"), is the remnant of an ancient cave once certainly much larger, progressively dismantled by the disintegration of the cliffs. A higher entrance let access to the tunnel that open of great natural arch, and behind this are many tunnels branching off, fragments of an underground maze now almost completely revealed by the light of the sun. Lower down, on the cliffs that run in the Frasassi Gorge, are overlooking the accesses of many other cavity. To understand the conditions that led to the formation of the "Foro degli Occhialoni", is necessary to turn back the geological clock, at a time when the river flowed in small valley, it was also different the appearance of the relief of the surroundings and the shape of the caves.

This chalky sediment, show a cristalline structure with white tiny cristals and itself is covered by geminated cristal.

Scappuccia Valley is a small valley north of the country of Genga, bounded by mountains Picco, and Termine and Piano, which are made up of different types of limestones. The valley, crossed by the Scappuccia river, forms a rather narrow winding gorge, is characterized by a wide variety of environments and vegetation, affected by the substrate, exposure, height and by the presence of water.

The "Grotta della Beata Vergine di Frasassi" (Blessed Virgin cave of Frasassi)

is a major natural cavities in the Park. Because of its great hall of access has been visited by man since prehistoric times. The cave, which has another entrance in the walls above S. Vittore (Grotta di Mezzogiorno), grows in the mountain for about 4.5 Km currently hosts one of the largest colonies of bats in the area.

La "Grotta del Vento" (that means "wind cave") is a great cavity where the peculiarities of karst has produced a scene of incomparable beauty. Key element is the presence of large and important deposits of gypsum that fill the cavities of limestone. This gypsum sediment, deposited on cooling, shows a grained structure with white micro crystals and is coated on the surface by twin crystals.

Lazio

55. Civita di Bagnoregio and the Valley of Calanchi

Getting there	Region: Lazio
With the highway "del sole" A1 towards Rome, exit at Orvieto, continue to Montefiascone turning, after a few kilometers, for Bagnoregio. After the village continue towards Cantagallo.	
	

Civita di Bagnoregio stand on top of a hill between the valleys of the Chiaro river and the Torbido river. The rocks upon which it flows are relatively recent and are of volcanic origin.

Underlying volcanic rocks are sand and clay sediments rich in marine fossils that testify the marine life of the past of this area.

The rocks that form these hills have the particularity of being easily erodible by the weather action and facilitate the development of a unique landscape. Here are placed the particular erosive morphologies produced by rainwater. These are the badlands, canyon and small and deep valleys that denudate the underlying rocks and soils. The landscape is bare and moved by forms and expresses its charm thanks to the colors of the rocks.

Already the Etruscans, even before the Romans, had to take into account the erosion when building their construction realizing drainage channels to

capture and control the rainwaters.
The trail that runs through the Valle dei Calanchi ("Badland Valley") allows to closely observe the phenomena of white rocks. The trail passes through the most famous and highest of the gullies, known by local people as the "Cattedrale" ("Cathedral"). From the heights of the surrounding hills can be seen a panoramic view of the landscape of the badlands.

56. Natural Monument of Campo Soriano

Getting there	Region: Lazio
With the highway A1 Rome-Naples, exit Frosinone or the SS7 Via Appia and Pontina SS148 to Terracina.	
	

The natural monument protect one of the most significant examples of the karst area of the Mediterranean basin, inserted into the mountains of Monti Ausoni. The area is a closed valley surrounded by mountains. The valley floor is occupied by a bed of red soil, chemical residue from the dissolution of limestone by water circulating in the carbonate rocks during the physical-chemical process that goes under the name "karst." The red soil is affected by its fertility from trees and grappes cultivation, mainly vineyards.
The most significant morphological features are the "towers" and other emerging karst forms like pinnacles several meters high as the "Cathedral", the rocky peak 15 meters high, a symbol of the protected area. The Campo Soriano karstic basin, despite his almost absolute dryness surface, even in the event of rain, is a major recharge area of springs placed at the feet of the ground Ausoni, at the level of Piana Pontina. Although the geomorphological features are the reason for increased interest in the area, should not forgotten that it retains significant aspects of the vegetation of the Ausoni massif and, more generally, the appenninic ridge of southern Lazio.

57. Natural Monument of Caldara Manziana

Getting there	Region: Lazio
With the road SS1 Aurelia go to the junction for Manziana, Oriolo Romano or the road SS493 Via Braccianense.	


The Natural Monument Caldara di Manziana is placed in a small crater that extends into the municipality of Manziana, in the area between Lake Bracciano and the Ceriti mountains, it is a remaining of the Sabatino Volcano. The protected area is 90 hectares. This is a wonderful environment created by the ferment of infinite pools of sulphurous water, pushed to the surface by the pressure of a huge boiling underground cauldron, testifying that the volcanic phenomena in the area are still active.

The name probably derives from "Caldara" popular dialect that makes this environment characteristic of a cauldron of boiling water. The sulphurous water gurgles at 20 degrees in a special pond. In the middle of Caldara is a pool which is a fascinating and unique post volcanic phenomenon. The bottom of the depression consists of a thick layer of white mud and sulfur not permeable. Walking through the center of the depression, can be realized that the soft ground under our feet sound as if it were empty. In fact there is no underground hard rock, but an accumulation of organic matter that eventually were compacted, forming a kind of bog. Caldara, with its bowl shape, tends to retain the rainwater into a marsh environment.

Abruzzo

58. Oasis of Sagittarius gorges

Getting there	Region: Abruzzo
The Oasis can be reached by car with the A25 Roma-Pescara, from Rome take the exit Cocullo, continue on the road to Anversa degli Abruzzi. From Pescara, exit Pratola Peligna and continue on the SS17 for Sulmona. Starting from L'Aquila, take the SS17.	
 	

The gorges have been carved and shaped by the powerful and continuous action of erosive river Sagittario the profound valley incision has a typical transverse V-shaped profile. The cut rocks are sedimentary of marine origin and consist of limestone deposited in a time interval ranging from 200 to 20 million years ago. The carbonate rocks were formed in a marine reef by aquatic organisms such as corals and foraminifera. This origin is testified by the many marine fossil shells which may occur in rocks of the area. It is possible to walk hiking trails that allow to observe the layered formations and the fossils.

59. Natural Regional reserve of Calanchi di Atri ("Atri's badland")

Getting there	Region: Abruzzo
With the highway A14 exit Atri-Pineto. Highway A24 exit Villa Vomano - Roseto degli Abruzzi, SS16 Adriatica. Follow the signs for "Natural Reserve Calanchi Atri", leading to the Colle della Giustizia.	
	

The "Calanchi di Atri" is a geomorphological peculiarity of the relief and for this, since 1995, was established a reserve for their protection. They are much more known abroad than locally, and they can even be found on several magazines and books in many parts of the world. The erosion, unlike generally viewed as agents of land degradation, here are the generating force of the badlands area of Atri, and the Castilenti and Mutignano area assume,

for beauty and size, characters of "natural monuments". It is interesting to note that these monuments were carved by rainwater. The Natural Reserve of Calanchi Atri was recently established and managed by the WWF, which has transformed it into the Natural Oasis dell'Istrice, a natural pearl, the most interesting area of clay hills of the Abruzzo region, for the extension and the spectacular geomorphological phenomenon, a unique microcosm of geology, fauna and flora suitable to be visited and explored through hiking.

Campania

60. Geopaleontological Park of Pietraroia

Getting there	Region: Campania
From the A1 exit at Caserta Nord or Caianello follow the SS372 Telesina. With the SS87 Sannitica from Campobasso Caserta and follow the signs to Pietraroia.	
	

It is a site of palaeontological interest that preserves a bedrock of limestone rich in fossils of fish called "calcare ittiolitico". The limestones form the top layer of the geological series of Pietraroia and were formed in calm water environment during the Cretaceous. In the site ware recognized more than 20 species of marine and freshwater fish. Besides the fish were found fossils of reptiles, including two specimens of crocodiles. The most important finding, from a scientific perspective, however, was that of a small and young dinosaur dating back to about 113 million years, now it is famous and called "Ciro".

61. Vesuvio National Park

Getting there	Region: Campania
Take the A3 Napoli - Salerno until exit Ercolano or Torre del Greco, then follow the signs.	

A geological rich area in Italy is that of the Vesuvius, now transformed into a national park. In this area you can see the main and famous Vesuvio crater and smaller volcanic craters, in addition, are of great interest the Campi Flegrei and Solfatara all of those places are on a still active volcanic area. Can be visited the famous ruins of the cities of Pompeii (Pompeii) and Ercolano (Herculaneum), where they are visible even today the effects of catastrophic eruptions occurred in 79 AD.

Vesuvius in the past has erupted manifesting unique characteristics, this king of eruptions have been named or plinian or Vulcanian eruptions. Those are highly explosive eruptions that form a a few dozen kilometers high eruption column and consist of gas and solid particles (pumice, ash and rock fragments). These eruptions take their name from "Plinio il Giovane", who described for the first time the phenomenon that he observed during the famous eruption in 79 AD These eruptions led to the formation of deposits on fall, characterized by high distribution area. The whole area of Vesuvius, though strongly inhabited, has many suitable points for geological observations of the volcanic landscapes and of the pleasant Mediterranean landscape, the views over the Gulf of Naples and a sweet climate offer good conditions for a visit during most of the year.

62. The thermal manifestations and volcanoes of the Ischia island

Getting there	Region: Campania
From Naples you can reach the island of Ischia and Procida, with frequent ferries.	

The Ischia island, located in the Gulf of Naples, is of volcanic origin and has

a large and interesting variety of shapes and rocks that can give the impetus for the visit.

The Ischia island has a central mountain range formed by the Monte Epomeo, 785 m high, around which are arranged a number of other small reliefs all of volcanic origin and a flat, triangular, called Ischia Graben, which extends between Casamicciola, Barano and Ischia Ponte.

During the last 150,000 years of volcanic activity the explosive phases were alternated with effusive phases, sometimes suspend by long quiet periods.

The current port of Ischia was originally a lake, called Lago del Bagno ("Bath's Lake"), separated from the sea by a narrow isthmus that was cut in 1853-54. The circular structure consisting of scoriae and black scoriaceous lava, has a diameter of about 400 m and represents the remains of the crater of a volcano formed around the third century BC.

From the village of San Alessandro, you can reach the Cafiero beach from which is visible a cliff and a old lava conduit that the marine erosion has revealed.

Layers visible in some places near Cafiero are of sedimentary origin and contain fossils of marine gastropods, bivalves and lamellibranch. The sedimentary layers are green colored and are composed predominantly of reworked ash. At the top of the cliff, in a layer of beach fossils were found pebbles and artefacts of the Bronze Age covered by volcanic deposits. It is likely that the prehistoric village has been destroyed by an eruption.

Near the Castiglione thermal building is the football playing field in Casamicciola, from this position, looking up the hill, it is possible to recognize the Rotaro crater from which was emitted a big lava flow, now covered with a thick pine forest. Recent analysis date this volcanic episode in the third century AD. The lava flow is about 650 meters long and ends in the sea forming Punta Scrofa. The volcanic complex of Monte Rotaro is a series of craters aligned along a fracture. The oldest eruptive center is "Bosco della Maddalena", a regular cone on top of which is the crater of "Fondo d'Oglio". The north side of the cone was destroyed by the eruption that formed the lava dome of Mount Rotaro. In Lacco Ameno, there is a particular shape called "il fungo" ("the mushroom"), it is a structure produced by marine erosion in volcanic tuffs. From this location you can enjoy a wide view on the coastline from Monte di Procida to the Circeo, with the islet of San Martino

and the fortress of Cuma well visible.
On the coast in front of the church of Lacco Ameno are the hot springs called "Isabella", the Roman and Greek. The flux of these springs is 74 cubic meters per day and water temperatures are between 50 and 70 ° C.
Along the road leading to Forio, at the crossing for Punta Caruso, can be observed a lava dome which produced the lava flow of Zaro. In Punta Caruso is situated a point that generated the pumice volcanic deposit and some lava domes dating back 10,000 years ago.
Along the stretch of road in the direction of Forio can be seen the elevation of Mount Epomeo, the an area crossed is affected by an intense and spectacular hydrothermal activity witnessed by the "Bagni di Poseidone" ("Baths of Poseidon") and of Afrodite.
Near the village of Panza in the Sorgeto bay are fumaroles and hydrothermal springs that warm the seawater, it can also be observed interesting pumice rock formations, bombs and blocks.
Along the peninsula of St. Angelo until Serrara Fontana you can enjoy the panorama of the coast of the island below and to the Pontine islands (Ponza and Ventotene). At the village of Buonopane are the Baths of Nitrodi known since the first century BC.
From Testaccio can be reached the largest beach of the island, called Maronti, it is affected by geothermal activity with sources that exceed 70 ° C temperature and fumaroles.
From the town square of Vatoliero can be seen the crater of the "Fondo del Vatoliere", a volcano dated around 2000 years ago. The nearby Barano mountain, of great beauty, allow to observe a lot of volcanic products, including layers of pumice fallout, interlayered breccias with levels of welded scoriae.
Fiaiano is located above the Arso lava flow that witness the last eruption occurred at Ischia in 1302, during which the medieval Geronda town was destroyed.
From the center of Fiaiano can be reached Cretaio village and the crater of Fondo Ferraro, the volcanic building of Posta Lubrano and the one of Bosco della Maddalena, of Moschiata, and the peak of Montangone.

Puglia

63. fossils Park of the Lustrelle Quarry

Getting there	Region: Puglia
From Lecce, the SS476 proceed south to the junction with the SS497 and then to Cutrofiano The park is located at Sogliano for Cavour.	

The park is located in the Lecce province, in the heart of Salento, along the highway Aradeo-Cutrofiano at the intersection for Sogliano Cavour. It is situated in a former clay quarry, in Lustrelle locality, dismissed in the late 70s. In this open-air reservoir, which covers approximately 12 hectares, are exposed strata of marine origin, some extraordinarily rich in fossils.

The quarry is well known in the Italian and foreign scientific community for the abundance and state of preservation of the founds, but it crossed a period of neglect and almost got lost during the'80s, when it became an illegal waste dump. In the 90s the new company owner, managed his recovery and also planted trees along the edges to gentle slopes. Some local organizations in the country of Cutrofiano then decided to keep the fossil-rich layers exposed and draw paths for visitors, with the intention of turning the place into a real tourist science park. The site allows the observation of fossils of gastropods, bivalves and scaphopods. In the park can be also seen how the Salento is built on a disappeared ancient sea.

64. The footprints of dinosaurs of Altamura

Getting there	Region: Puglia
From Bari, using the road SS96 reach Altamura. With the SS171 to Santeramo after 5 km arrive at locality Pontrelli where is placed the paleontological site.	

The site of considerable scientific interest, show numerous dinosaur footprints, mostly ornitischi and saurischi identified on the plane of a limestone quarry. The palaeontological site is located in the quarry known

as "De Lucia" in Pontrelli, about five km far from Altamura, on the road that connects to Altamura Santeramo. The quarry is set to a single layer of "Altamura Limestone" dating from the upper Cretaceous. At the quarry, which covers about 120,000 square meters, are impressed on a single surface layer, thousands of footprints that let us imagine the life of these ancient beings who lived and walked on littoral made of mud not yet solidified. The visit to this site offers the opportunity to make a leap back in time and immerse themselves in a lost world that fascinates children but also adults.

65. Gravine of Laterza Park

Getting there	Region: Puglia
From Taranto with the road SS7, which crosses the Massafra, Palagiano and Castellaneta centers, passed the latter, after about 8 km turn left following signs to Laterza and reach the park.	
	

The "Gravina" is a deep gorge cut in the limestone, also known as the "Grande Canyon" ("Great Canyon", which originated by the erosion of rocks over old fractures.

The "gravine" are the most impressive expression of a particular territory known as Gravine dell'Arco Jonico (which extends from a Ginosa to Grottaglie) and are arranged in a fan-shaped area around the Gulf of Taranto, each one is different in size and morphology.

In these exceptional places has developed, during thousands of years, a civilization which has left clear traces in the culture, history, art and the relationship of human life in close contact with nature.

The Gravina di Laterza is one of the largest canyons in Europe and has a meandering course that stretches for 12 km and 400 meters wide, between walls of rock shaped by erosion and smooth white limestone walls over 200 meters high, dotted with countless caves and suspended steps hanging over the gorge.

Due to their shape and to the composition of the rocks, the Gravine may be considered as naturalistic "islands" where various botanic and animal species of great interest have been long isolated from the surrounding environmental

context that has changed radically in recent centuries. Have survived in those inhospitable environment, forests of Quercus trojana (found in Italy only on the Murge of Puglia and Materana) and the endemic Campanula Versicolor, from beautiful pale purple flowers that blooms from June to October and cover the walls of the Gravina. The less steep walls are green, due to the by vegetation of Leccio and Euphorbia tree, the Cisto, the Terebinth, Lentisk and Juniper. In the spring along the paths of the Gravina you can admire the colorful blooms of orchids.

Recently the Gravina di Laterza has been declared Oasis, it extended over an area of 800 hectares and can be visited on foot by following pathways that departs from the visitor center and run along the edge of the natural Gravina offering a breathtaking spectacle.

Inside the visitor center there is a photographs exhibition, a diorama of the Gravina and an educational workshop and a hall for lectures and conferences.

66. Karst forms of Gargano

Getting there	Region: Puglia
Driving along the A14 highway exit at Poggio Imperiale, and follow the signs to Vieste.	
 	

The Gargano promontory is well known for its spectacular scenery and fascinating light, so it deserves to become a National Park. The origin of the limestone that forms the area tells us an interesting sequence of geological events that can be observed today in many testimonies and natural phenomena.

The cape goes for about 40 km towards the sea and consists of limestone, which gave rise to significant karst processes both deep and superficial, with the development of caves, arches, dolines and vertical cliffs overhanging the sea.

At the foot of the town of Vieste, on the Castello beach, stands the imposing white and tall rock of "Pizzomunno", which shows a clear stratification. This is a real natural sculpture that has generated many legends in the past.

The most beautiful story tell that Pizzomunno was a very tall and handsome young man and a mermaid, named Cristalda, fell in love with him. It was a so much crystal clear love that the two sisters of Cristalda envying her, turned Pizzomunno into what today is: a big rock. It is said that every one hundred years, at midnight of the 15th of August, Pizzomunno returns to be a man to spend one more night with his sweet beloved Cristalda.

In the Bay of San Felice is the "Architello di San Felice" a natural arc created by marine erosion, and the challenge of these structures to gravity is a great scenic effect.

In the most elevated municipality of Gargano, Monte S. Angelo, there is a cave which, according to tradition, was the place of apparition angel Michele, for this reason in the place a sanctuary was built.

Carbonara valley offers an opportunity to observe an impressing fault that develops a deep incision. The evident fault cut in two the promontory and is called by geologists in different ways, the Carbonara Valley fault, the Mattinata fault or the Mattinata–Gondola fault.

The effects of the fault manifest itself through the development of depressions like that of the "Sant'Egidio" swamp. Located at the foot of Mount Calvo, the depression was previously occupied by a lake about 5 km long and now almost completely dried up.

The diffuse karst phenomena of the Gargano are the dolines, worthy of a visit is the Pozzatina doline that has exceptional size and is considered the largest in the region. The shape is "bowl-like" and the size is of about 600 m in diameter and more than 100 m in depth. This type of spectacular karst structures is known in Puglia region as "puli".

Basilicata

67. National Pollino Park

Getting there	Region: Basilicata
With the A3, any exit between Lauria Nord, within the Basilicata region, and Spezzano Terme within the Calabria region, the parck can be reached from many towns by the road SS19.	
 	

In the countryside there are several geological environment, from ophiolitic to those of glacial morphologies. From Casa del Conte departs many roads and some paths that let discover the area. Not far from there, at Timpa delle Murge, can be observed an oceanic pillow lava. Also from Casa del Conte can be traced back through vast woods of FAGGI e ABETI to the edge of the slopes of the limestone rock formations of the Pollino. In the park can admired the bimillenary Pino Lorico, a symbol of the Pollino National Park, and residual plant of the Wurm glacial time. Suggestive and spectacular is the Garavini gorge that demonstrates the thrust (rock formations piled up) phenomenon occurred in the limestone.

Timpa Falconara is a fierce mountain that dominates the landscape of the Val Sarmento, along the eastern borders of the park. Although not particularly high, Timpa Falconara is however one of the most interesting place to be visited of the park. The southern wall of this mountain shows clear signs of large tectonic forces that shape the surface of our planet, the bare rock wall is incised by deep fractures and faults. In correspondence of these cracks, immense rock masses were split away from each other.

Among the other possibilities for geotouristic observation inside the park include the palaeontological site of Valle del Mercure and the badland and gullies forms along the Sinni Fardella river.

68. Caves of the Basilicata region

Getting there	Region: Basilicata
Coming from the North take the Lagonegro Nord exit or, coming from the South the Lauria Nord. Reach Fondovalle Del Noce and from here, at the junction to Trecchina proceed towards this small town along the main road. After about 10 Km outside of Trecchina will be reached Maratea.	
	

The Maratea cave is small (it is a single room for an extension of only 90 meters) but is of great beauty. Just passed a artificially excavated part of the cave, one will be immediately immersed in the majesty of concretions. Columns and stalagmites are the framework to the view of the only room in the "Grotta delle Meraviglie" ("Cave of Wonders").

Other caves in the area are interesting, many of them show signs of human life in the prehistoric age. At Marina you can be visited several caves, including the Grotta dei Monacelli, characteristic for the blue coloration due to the refraction of light and reachable only by boat.
Suggestive is the "Grotta dei Pipistrelli" ("Cave of the Bats") which can be accessed only by boat, while the Grotta di Judia is characterized by pools of fresh water can be reached by boat or through a path along the beach. Very spectacular is the "Grotta del Sogno" ("Cave of the Dream"), with a large entrance on the sea. On the northern side of Punta Caina is the fascinating cave of Cetroselle. The visit of the caves could be done cautiously and with the help of a guide.

Calabria

69. Caves and glacial forms in the Parco Nazionale del Pollino

Getting there	Region: Calabria
With the A3, the section between the exit Lauria Nord, in Basilicata, and Spezzano Terme, Calabria, can reached the villages of the park, linked by the SS19 through the protected area.	
 	

The morphology of the territory of the Park is characterized by the erosive effects of water on limestone, which gave rise to karst phenomena, both superficial as planes and dolines, and hypogeous consisting of many tunnels and deep chasms that insinuate for kilometers in the depth of the mountain.
A wealth of underground caves and cavity is represented by the cave "Piezze 'i trende" near Rotonda, the Grotta del Romito, by the "del Romito" and by the "Grotta di S. Paolo" in the territory of Morano Calabro and by the pit of Bifurto at Cerchiara di Calabria, renowned for its depth of 683 meters.
Many glacial forms witness the transformation of the territory, the accumulation of huge masses of ice gave rise to the observed glacial cirques in the northern slope of Mount Pollino, Serra del Prete or Serra Dolcedorme, in the basin of the Fossa del Lupo and the southern side of Mula, where can be seen the moraine deposits due to the transport of stones and debris

that the slow process of retreat of glaciers has resulted. In some cases, the accumulation of material formed the moraine hills, in other cases the retreat of glaciers left large isolated boulders, so-called erratic, beautiful examples can be seen in the plan "Piano di Acquafredda" and "Piani di Pollino".
Important paleontological evidence are found in the territory of the park and in the limestone rocks are present huge fossils of Rudiste, large molluscs lived on the bottom of the Tethys ancient sea and disappeared 65 million years ago.

70. The canyons and the Natural Reserve of the Raganello Gorges

Getting there	Region: Calabria
From the highway A3 Napoli-Reggio Calabria take the exit Castrovillari-Frascineto, then the SS 105 until the junction for San Lorenzo Bellizzi, from which you reach the Raganello Gorge Reserve.	
	

In the south of Italy, almost unknown, is placedone of the most majestic canyon of Europe, a 13 km gorge with cliffs high up to 700 meters, crossed the river Raganello. Along this incision can be make a uneasy hike down about 10 km long, from Pietramonte up to Ponte del Diavolo ("Devil's Bridge"), where nature let us see fantastic shapes made by the river erosion, carved rocks of incredible beauty.
The canyon is located in the scenario of the Pollino National Park, located in the mountainous area between the Calabria and Basilicata regions. The river is set among masses of bright limestone that locally are called "Timpe". Even the tributaries of Raganello gave birth, due to the presence of easily erodible rocks, gorges of exceptional beauty.
The valley near the Raganello river showing a scenario of deep cuts is spectacular, the Lao river has generated impressive gorges in the limestone rocks. Noteworthy are also the gorges and canyons of Garavina and Barile.
The Caldanello Gorge, located on the eastern side of Mount Sellaro, presents again the majestic phenomenon of deep canyons cut in the earth's surface and, for grandeur and beauty, has nothing to envy to Raganello.
The variety of forms of the Pollino Park does not end with the three major

canyons described, but has smaller but no less interesting phenomena. In the eastern sector of the park a few throats that deserve a visit are the Canale del Forno, Canale Zagaria, Canale Margherita, the Gola del Saraceno and Canale Franciardi. In the southern part of the Pollino Park, more particularly on the eastern slope of Mount Caramolo and Cozzo del Pellegrino, is the impressive Gàlatro Gorge .

71. Vrica geosite

Getting there	Region: Calabria
With the highway A3 reach Cosenza, then cross the Sila using the SS107 with which you reach Crotone.	
 	

The Vrica Geosite is located in the Province of Crotone in the peninsula known as the Marchesato.

The hilly landscape is characterized by large flat surfaces, separated by slopes that are connected to a side formed with typical forms of a badlands. The outcropping sediments consist of gray-blue clays rich in fossils, including fish, foraminifera, ostracods, deposited during the Pliocene at 400-800 m deep. In the higher parts of the rock formations there are biocalcareniti containing algae, fragments of molluscs and small fragments of coral reef dating back to the Pleistocene.

The place is also an important site of scientific importance, because the rocks in this place were deposited during the transition between two geological eras. This transition, from a geological point of view, means that many species of living things are missing and therefore it is a phenomenon of great interest to paleontologists and biologists who are trying to understand the causes of these biological changes of the past.

At Zinga locality are present important gypsum outcrops, called "diapirs", where are developed the rare karst phenomena forming cavities and caves, as well as surface shapes.

Interesting from the point of view is the historic site of Capo Colonna, a fascinating place full of mysteries, destination of ancient and modern pilgrimages, that gives the opportunity for a pleasant trip.

Sicilia

72. Regional Natural Park Etna

Getting there	Region: Sicilia
There are several entrances to the area. From Catania Nicolosi to climb and you can, if conditions permit, go back to the slopes of the crater.	
  	

It is impossible to forget one of the greatest Italian beauty and geological interest turned into the Regional Natural Park: Mount Etna. Etna, the highest active volcano in Europe, is a very special place in fact, visiting an active volcano, can be visualized the incredible forces that act on our planet. The landscape is constantly changing and is characterized by the slopes and shapes modeled in basaltic rocks. Can be observed a wide range of "volcanic products" and eruptive shapes. Ash, lapilli, lava flows "string", "volcanic bombs". There are also beautiful examples of volcanic morphologies, including the lava tunnels. If the visit takes place during a period of volcanic activity, it will be an opportunity to observe, stunning eruptive processes.

The climb to the mountain also allows to appreciate the different vegetation, from the beautiful citrus groves to vineyards, fruit trees, forests of chestnut, beech, pine, up to the almost desert highest areas, covered by lava and juniper bushes and Astragals. The peak, about 3300 meters high, can be reached coming from different points. Once at the top, the view is amazing and vast and somehow similar to the inferno, along the slopes can be seen hundreds of smaller craters.

In the area there are roads, trails, shelters, hotels that can be used during the excursions. In particular, around the volcano, there is a railway and roads linking different villages of great historical interest, especially medieval and baroque. Among these Acireale, Bronte, Randazzo, Linguaglossa, Giarre, Paternò, Misterbianco, Biancavilla, Adrano.

73. Aeolian Islands

Getting there	Region: Sicilia
The Aeolian Islands can be reached by ferry from Milazzo or, less frequently, from Naples. The most important stop is the island of Lipari.	



The Aeolian Islands have been declared World Heritage by UNESCO in 2000, because they are one of the most beautiful volcanic scenery in the world. It is a small archipelago of seven islands of volcanic origin in the north of Sicily. From a geological point of view, they are very young, the subaerial part is half a million years old, while the submerged, the oldest, date back to little more than a million years. The volcanic phenomena are still active and this is a place of great scenic effect. The seven islands that form the Aeolian archipelago (Vulcano, Lipari, Salina, Alicudi, Filicudi, Panarea and Stromboli) are arranged in three directions from a center, as the bisectors of an equilateral triangle, which correspond to fractures from which spill out the magma that formed the volcanoes.

The Aeolian Islands are all typical forms of volcanic activity. You can admire the Stromboli with its eruptions taking place at regular intervals. In the island of Vulcano, on the edge of the Fossa crater can be seen the extensive fumarole typical of an active volcano and hydrothermal occurences in the eastern area. Almost anywhere on the various islands can be seen the volcanic centers which produced a great variety of materials, from lavas to completely glassy obsidian, materials typical of the explosive eruptions, the pumice, "bread crust" bombs. All this huge variety of volcanic products is due to the difference in chemical composition of Aeolians magmas.

The Aeolian Islands are the place where was born a part of the Classical Western mythology. In Greek mythology Hephaestus was the god of fire, in the Roman Hephaestus was identified with Vulcan, the god of fire and volcanic eruptions. Vulcan was also the blacksmith of the gods, he molded the arrows for Apollo and Diana, the shield of Achilles and the invincible Hercules's armor.

In antiquity, the laboratory of the god of fire was, from time to time, identified by different active volcanoes. Frequently many ancient writers believed that

the forge of the god Vulcan was located on the island of Vulcano, one of the Aeolian Islands. For this association all the mountains that produce fire and smoke in the world are called "volcano".

74. Floristella-Grottacalda Mining Park

Getting there	Region: Sicilia
The park is reached from the A19 Palermo-Catania, exit Enna and Mulinello, from here follow the signs for Valguarnera.	



The old sulfur mines in the province of Enna constituted an important source of wealth for nearly two centuries, from 1700 to 1980, the Sicilian sulfur market became, during the Kingdom of the Two Sicilies ('800), reason for discord between France and England . Sicily for a time became the world's leading sulfur exporter , which was used in wartime.

The cultivation of the mines was carried out by workers who worked in difficult conditions, even children, called "carusi", worked in these environments. The children represent the last link in a chain of exploitation of the work consisting in profession like the "picconieri" and "gabellotti", tenants of the mines that paid the owners for the exploitation rights. Pirandello, an italian writer, was inspired by that people and wrote stories set in those environment, first of all "Ciaula la luna" ("Ciaula discovers the moon"), set in one of the oldest parts of the mining area. In the last years of mining activity the methods were modified and the prevalence of manual work took over the by the use of explosives and machinery.

At the end of the mining activity, in the'80s, it was obvious that it should not miss this historical and cultural heritage, and for this purpose was established the Floristella-Grottacalda mining Park.

The three mining sites of Floristella, Grottacalda and Gallizzi are surrounded by a suggestive scenery that extends for 400 hectares immersed in the woods that now colonize the area made sterile by sulfur dioxide released from the burned sulfur.

In Floristella is located the Park and the Palazzo Pennisi, the residence of the park owners and the business offices of the old mine. From the

nineteenth-building can enjoyed a wide view and can be noted that now the nature and mine, can live together, after having been for hundreds of years incompatible. Can also be seen the pits, the huge piles of ore and scrap and the old buildings used during the mining operation.
The site has also two large and four smaller holes, these are the "calcheroni" or kilns where the sulfur were melt then the liquid poured into the collection points, "the death mouths", into special types of wood molds called "gavite". From this process were obtained the "panetti", who were then transported to the ports of Catania, Licata and Porto Empedocle for export.

75. The Madonie Geopark

Getting there	Region: Sicilia
The Geopark has many accesses: from Palermo by the motorway A20 then proceed to the east take the A19 towards Enna, Tremonzelli exit and follow the SS120 to Petralia Sottana.	



Madonie Park, for his great wealth of geological phenomena is a Geopark recognized by the UNESCO European Geopark Network. The area is part of a section of mountain range placed along the northern coast of the island.
The whole area is characterized by sedimentary rocks of marine origin dating back to a period ranging from Triassic to lower Pleistocene (a period of more than 200 million years).
The sedimentary rocks are rich in fossils that are evidence of the marine life of the past. Fossil of organisms that formed ancient coral reefs can be seen in rock formations lying at rather high altitude. Currently the location of these rocks is due to the action of tectonic forces that during the Miocene, have pushed them up. Among the fossils are widespread impressive lamellibranch called Megalodon, large bivalve that can reach the size of more than 10 cm. Well known in the park are also the wonderful ammonites who lived during the Mesozoic Era. In several rocky outcrops of the park there are beautiful coral, large "rudist", gastropods and shells of unicellular organisms such as foraminifera.
The current Madonie mountain is largely composed of limestone and

dolomite and has interesting and well observable karst phenomena. Among these phenomena is to be noted the Battaglietta sinkhole, which is the entrance of a small cavity. The polje of Piano Battaglia and polje of Battaglietta are a manifestation of karst phenomena that have developed in the area, they are large depressions originated from the dissolution of the underlying limestone.

The area where the rocks are limestone allows also the observation of surface karst phenomena, such as karren and kamenitze: the former are small furrows, and the latter are small holes made by corrosion few inches deep with a flat bottom, they often develop on slightly inclined surfaces.

The karst has led to the formation of many caves among them the largest is the "Abisso del Vento" ("Abyss of the Wind") that is extended for over 4 km and deeper than 300 m.

In the Park, to witness the special richness of phenomena, there are also gypsum rock formations that point to the event, about 5 million years ago, of the evaporation occurred during the Messinian geological time that allowed the deposition of marine salts. In these formations of "chalk and sulfur" are present large crystals of gypsum so-called "a ferro di lancia" ("iron lance shaped") for their shape. At the base of the formations are present high concentrations of sulfur that in ancient times were extracted. The place Tufo Gipsi, in the town of Castellana Sicula, is the place where can be observed, through a marked trail (trail "Tuff Gipsi"), the ancient quarries of gipsum and ancient settlements and the Roman baths. Other tracks are "Mulino Petrolio" ("Oil Mill") which starts outside of Nociazzi. Another path is the the one named "San Brancato - Sant'Otiero" located along the road leading to the Piano Battaglia.

The park has equipped paths for geotourism leading the hiker through rock formations, where can be observed fossils of sponges and corals, karstic phenomenon and gypsum rich rocks. To make even more interesting the area contribute many other interesting geological values, which are worthy to be known such as the "Gole di Tiberio", in Borrello locality (they are a spectacular river incision in limestone), the Carbonara plateau (nice example of karstic erosion surface), the badlands of Contrada Ottosalme, although outside the boundaries of the park (a nice and beautiful landscape made up by erosion).

76. Rocca di Cerere Cultural Reserve

Getting there	Region: Sicilia
Several points allow the access to the reserve, through the highway A19 connecting Palermo to Catania can be used the Enna exit.	
 	

The cultural park "Rocca di Cerere" is located in the heart of Sicily. Extends over an area of about 1200 square km through the chain of Erei mountains. At the summit of the mountain chain is placed the town of Enna, one of the oldest cities in Sicily, famous throughout the centuries for its worship of Ceres, the goddess of crops and the mother of civilization.

The area, for its geological richness the Geological park was established and it present aspects similar to the nearby Madonie geopark . It is an area where the prevailing rocks of sedimentary origin give rise to the typical "sedimentary" landscape. There are found limestone and gypsum formations dating back to the Messinian, the landscape is characterized by white hills. Below these formations are present sulfur rich levels that even here, as in other areas of Sicily, in the past have allowed the development of an economy tied to mining of the mineral.

Through various paths can be visited the area to observe and understand the many natural and geological phenomena.

77. The Alcantara Gorges

Getting there	Region: Sicilia
From Messina or Catania along the A18, exit at Giardini-Naxos and take the SS185 in the direction of "Francavilla di Sicilia", following the signs "Gole Alcantara" for about 13 Km	
  	

The foot of the Etna volcanic cone, between the blacks basalts generated by the volcano, has developed a natural beauty of considerable interest, the river cut the Alcantara gorges, a deep incision that show impressive walls of columnar and prismatic basalt. The turbulent waters of the river Alcantara,

who was born at an altitude of over 1200 m and is about 52 km long, has cut a large lava plateaus that originated from the lateral crater called "Mojo Alcantara".

The significant development in height of the rock contrasts with the width of a few meters of the gorge, giving a striking and unique appearance. Between the high and black lava walls are found clear lakes, sparkling waterfalls and small beaches formed by erosion. Here is possible to stop and admire the imposing basaltic prisms as ancient columns that surround the area.

Proceeding along the gorge downstream from the source to the gorges, the landscape is constantly changing. From the forest near the source to the typical Mediterranean scrub, with the leaves of Indian figs and large euphorbia bushes stuck tenaciously to the rocks. Immersed in the lush vegetation, reached the area of canyons, are discovered caves and gorges overlooking the water.

In about an hour and a half can be made the excursion of about 500 meters along that gorge, the route is challenging and recommended for experienced hikers. The hikers sometimes must walk in cold water and some parts of the path is necessary to swim. Take the full Gorge exploration should be considered only by people who practice canyoning while conducting normal walking is possible to see a part of the gorges.

78. Geological reserves Contrada Scaleri

Getting there	Region: Sicilia
Through the A19 highway that connects Palermo to Catania can be used the exit to Nicosia and continue along the SS121 to Santa Caterina Villarmosa.	
 	

The Contrada Scaleri is located a few kilometers outside of Santa Caterina Villarmosa along the hillside sloping gently to the stream Vaccarizzo. Its geological and nature significance is due to the presence of "karst microforms" set over gypsum rocks variously carved.

These forms are rather widespread on Sicilian chalks but here are they are rather peculiar and show characteristics due to the rapid of erosion.

The geologically most interesting part is the rocky ridge amphitheater shaped that from Contrada Piraino gently slopes to the stream, the outcrops show a thick layer of the gypsum called "gesso Balatino" and are subject to frequent landslides. The slope is then populated by numerous landslides slabs of rocks of various sizes, which have highlighted the erosion caused by run-off water.
The reserve is set to protect these microforms, but also the flora, which consists of a Mediterranean vegetation where also grow valuable orchids like Anacamptis pyramidalis and Barlia.
The park plan provides for Contrada Scalera Parks a full protection scheme which allow a visit only to scientific purposes.

Sardegna

79. Petrified Forest of Zuri-Soddì

Getting there	Region: Sardegna
Soddì can be reached from Nuoro going southward with the SS131. From ì exit a road lead to the Lake Omodeo, only 2.6 km far is placed Sa Manenzia.	
	

During the Miocene, about 20-25 million years ago, the eruptive phenomena have covered with ash and lapilli the whole forests that have been well preserved until today. The fossilized forest of Zuri-ì is near the Omodeo lake, in the Nuoro province. Largely submerged by the waters of Lake Omodeo, the Petrified Forest is mainly visible in summer when the lake is dry or when the water is only few meters high, a part is visible in the area
closer to Soddì village. Also near the new church, you be admired a petrified tree, in perfect condition. The fossilization made by silica must be accomplished very slowly, this is an optimal way to preserve most of the components of plants.
Raises an interesting curiosity the theory formulated during the 1929 by Chiarugi who speculated that the plants in Sardinia were only a part of a larger forest extended between the island and Africa. Some Sardinian specimens studied are in fact very similar to those found in mines in Africa.

80. Geo-mineral Park Iglesias, mines, minerals and fossil Paleozoic

Getting there	Region: Sardegna
The area dell'Iglesiente can be reached from Cagliari along for about 56 km from the SS130	

Geo-mineral Park was established by UNESCO and declared as an example of the new worldwide Geosites and Geoparks network.

Iglesiente area is unique because in one day can be crossed the whole series of geological terrain, from the first appearance of life forms on Earth, over 500 million years ago, until the present day. It is a long series of different rocks, from sandstone to limestone, from granite to basalt, from schist to trachyte, each one representing a landscape.

Travelling across the Iglesiente is like a back in time journey to the deepest roots of the history of Earth, when most of Europe did not exist and Sardinia was a small part of a vast continent which broke away to start his journey to the center of the Mediterranean.

In the Iglesiente were discovered some of the oldest fossils in the world. The most interesting for scientists are trilobites dating back to the lower Cambria (500 million years ago). The fossils deposits of Canalgrande (the coast between Cala Domestica and Fontanamare), those surveyed in the north of Nebida and those found in Cabitza (south of Iglesias) were the subject of scientific investigation by many international researchers. Specimens of Iglesiente fossils are included in the collections of many museums all over the world.

The mining activity that took place in the past has great importance and it has left important traces in the territory. For this reason, the UNESCO conference in Paris in 1998 decided to create a Geo-mineral Park. This act represents the first example of a new network of worldwide Geosites and Geoparks established to protect the geological heritage. The larger and more important mining area is Sulcis-Iglesiente-Guspinese that is relevant for the extraction of lead, silver, iron, coal but also in the geological aspect, economic, scientific, scenic, environmental and historic can be mention: the Monte Arci (where is placed the first mine with extraction and use of obsidian

that dates back almost 6000 years ago), the Orani area (important for the presence of talcosteatite and feldspars and quarries of marble and granite), the area of Raminosa, between Gadoni and Seulo (where was placed a copper mine, one of the largest in the Mediterranean), Sarrabus-Gerrei are ancient mines of lead, zinc, silver, copper, tin and iron, used since the time of the Phoenician-Punic invasions.

Almost half of the Iglesiente territory is formed by limestone and dolomite that the chisel of time has molded into unusual and bizarre shapes. The long exposure of these rocks to the erosive weathering has led to the formation of complex karst phenomena, both over the surface and underground, producing caves of great beauty and fascinating landscapes. The cave of S. Barbara, at the mine in S. , in addition to the beauty of its concretions, contains a special unique barite crystals which adorn the ceiling and walls. Under the limestone fortifications of Mount Marganai, a few km from Iglesias, the grotto of St. Giovanni di Domusnovas can be crossed by car for its entire length (850 m). To the north of Iglesias, near Fluminimaggiore, the cave of Su Mannau is a huge underground karst system.

In the area are other interesting issues, including archeology, with nuraghe Mustatzu, Medau Mannu, and architecture, with the fortified walls and the Salvaterra Castle. Valuable naturalistic aspects are the waterfalls, the "Pan di Zucchero", one of the biggest rocky natural stacks of Europe, 133 meters high.

81. The granite sculpture of Gallura

Getting there	Region: Sardegna
Is reached using Olbia ferry from Civitavecchia, Genoa and Livorno.	
 	

Sardinia, for its many areas made up by granitic rocks, is a region which has a large amount of valuable natural sculptures that make beautiful the landscape.

Can be found magmatic rocks more ancient over 300 million years, ranging from leucogranites, very rich in quartz and thus particularly bright in color, with the granodiorite, more rich in black biotite, which gives to the rock a

particular "pepper and salt" aspect.
The area present the largest Italian variety of macro and micro typical shapes over granitic rocks.
These geomorphological phenomena could be observed through easy routes that can be traveled by car in the north-east of the Sardinia island. The recommended route is developed through the beautiful landscape of Gallura, from Olbia to Capo Testa.
San Pantaleo is a small village about 21 km far from the Olbia-Arzachena junction, it is set within an amphitheater of granite towers and surrounded by jagged ridges and pinnacles that stand out on the horizon, creating a landscape of great charm.
In Arzachena, walking five minutes from the center of the village, is a famous "tafone", a granite shape made by the erosion. It represents a magnificent example of a "mushroom-shaped" rock that was shaped over granite by selective alteration with a cylindrical stalk and a rounded hat on it.
A significant example of how the shapes of the landscape can influence the thinking of men there is the famous "Capo d'Orso" ("Bear's Head"). The village takes its name from the sculpture known as the "Palau's Bear" which, for its zoomorphic similarities, has stimulated the fantasy of people that gave this evocative name of a granite structure molded by erosion. It is reachable depating from "Capo d'Orso" through an equipped path that winds among the harsh landscape, where can be observed the phenomena of chemical and physical alteration and exfoliation that produce the "tafoni" and typical rounded convex rocks.
Along the road between the Tempio and Luogosanto stands a characteristic form due to the erosion of the granite. The visible dome-shaped structure, above a hundred meters high, is called "inselberg" or form "Pan di Zucchero" ("sugarloaf mountain") and originated in periods when the climate was hot and humid. The landscape around the inselberg is flat and formed by a stretch of sand originated from erosion of adjacent rocks. Surrounding forms are called "serre" from the dialect word that means the blade of the saw, to indicate the shape of the jagged profiles of the relief of the landscape of Gallura.
Not far away lies the picturesque "Valle della Luna" ("Valley of the Moon") where can be seen another "inselberg" and many "Thor" that are, granite

blocks in stacks, sometimes in a precarious balance (sometimes called "balanced rocks").
Some of the blocks of granite in the valley are crossed by lines of fracture oriented in various ways and have surfaces covered with numerous holes that geologists call "cellular structure" and the locals in the local dialect call "Cuncheddi".

Geohobby

Fossils and minerals give off a particularly strong fascination for the aesthetic value and for their originality and rarity. For this, one of the recreational activities related to geology, is their research. To perform this work, however, is required at least a basic scientific knowledge. Fossils and minerals, in fact, can be found only in specific geological settings and not in others.
Consistently with their formation process, fossils can be found almost exclusively in rocks of sedimentary origin, especially those fine-grained, for this reason are very suitable sandstones, limestones and mudstones.
As for minerals, the environment where can be found are different, moreover to got a "beautiful" mineral it must have its own crystal habit (shape). This condition occurs when the crystal, during its formation, has the space needed to grow. Fractures (elongated) and cavity (spheroidal) can let fluids to move trough the hole allowing the deposition and the formation of the crystals. If this happens, the fractures and the cavities are called respectively "druse" and "geode".
One of the more folkloristic and fascinating minerals research is the gold search. This is still practiced by some enthusiasts with simple and ancient techniques. Sieving the river sand, flakes and nuggets are extracted with dishes and other types of separators. The gold presents a high specific weight and this feature is used to separate it from the sand. In Italy and other countries real prospecting races are organized. Also note that many Italian rivers, particularly those of the Po basin are rich in this noble metal. The Dora Baltea and Dora Riparia rivers take their names to the presence of gold (Dora, from "d'oro" that means "made of gold").
Another type of "research" is the rocks collection. Some fans try to get their samples in order to find one or more specimens for each type of rock, it can be considered a scientific-like research.

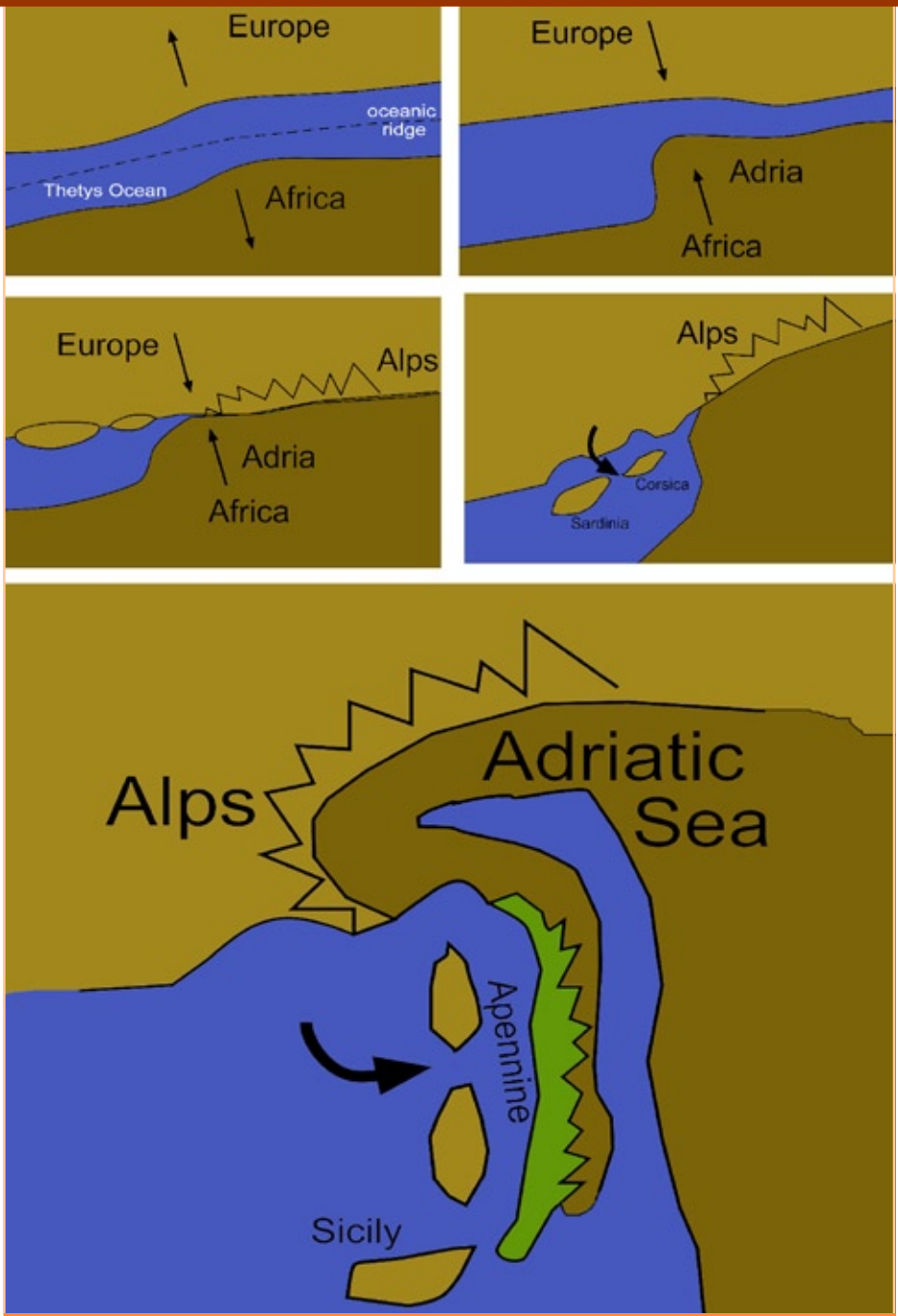
Others do not care about the geological meaning of the rocks, but only of their appearance, in this case may be relevant colors, associations of colors, patterns of lines and veins, shape and many other aspects that may make it a "beautiful" sample, there are many collectors of sea pebbles that have attractive pieces in their collection. Geotourism leaves the choice of the preferred type of "hunting" but, as stated above, to respect the existing natural heritage is preferably to prevent from taking minerals and fossils, ibetter to do it using photographs (geowatching!). IMPORTANT: please note that in many countries, including Italy, there is a law that prohibits the removal of a valuable nature samples including fossils and minerals.

Geological of Italy

Geologically speaking the Italian peninsula is an area of great interest.
It all began in the Cretaceous (about 130-100 million years ago), when it began closing the great gulf called Tethys (a sea goddess from the Greek mythology) due to convergence of the Eurasian and African plates.
The backbone of nowadays Italy is represented by the Alps and the Apennines, mountain ranges of the Tertiary or Cenozoic age. The rocks that characterize Italy are relatively young. The oldest rocks, dating back to the Primary or Palaeozoic Era, are present only in some parts of the Italian territory, in Sardinia and in the Carnia, they are the remaining of a previous orogeny called Hercynian.
In short, Italy is the result of events mainly occurring during the last 230 million years of Earth's history, a period that may seem long but that represents only a short time compared to th overall age of our planet.

The italian formation

At the end of the Paleozoic Era (235 million years ago), Italy did not exist. Inside the supercontinent called Pangea, which in that time made the whole land, the area where today is Italy was occupied by a large gulf which affects Pangea in Eastern Europe, more or less located along the Equator, this gulf is called Paleotethys. Into this depression have poured large amounts of sediment that subsequently give rise to mountain ranges including the Alps and the Apennines. The geological history of Italy can be described by four steps.



The main phases of the gological formation of the italian peninsula

- Phase of crustal extension characterized by the formation of the Tethys;
- Stage of compression, with disappearance of the Tethys and the origin of mountain chains;
- separation of Sardinia and Corsica from Europe and formation of the Apennine;
- Further phase of crustal extension with opening of the Tyrrhenian and complete development of the Apennine Mountains.

Stage 1: from the gulf of an ancient ocean (tethys)
Early Mesozoic (235 million years ago), Pangea began to break down, causing the extension and producing a series of crustal continental blocks that move away from each other. Waters invaded the coastal territory. In the middle Mesozoic (Jurassic 192-135 MA), the continental crust below the Paleotethys is progressively thinned, and formed a band of deep fissures from which overflowed basaltic lava that gave rise to the oceanic ridge starting from NE to SW, which in turn feeded the formation of oceanic crust of a new ocean: the Tethys.
Two masses were formed, Paleoeurope plate to the the north and Paleoafrican plate to the south. Between these Large blocks there was a small autonomous plaque, perhaps a promontory connected to Africa, named Adria (or Apulia, or Insubria).
To the west of that promontory laid a wide sea called Tethys Ocean, the Ligure-Piemontese basin, and to the east of the Dinars basin. Along the margins of these continents, from the coasts to open ocean, accumulates gradually enormous sedimentary deposits. On existing coastal sandstones (generated from the dismantling of previous reliefs of the Pangea), now submerged, were deposited marine sediments typical of a warm sea. It is in this tropical sea that formed huge reefs and carbonate platforms by algae and corals, found today in the Dolomites and Apennines.
In the deepest parts were formed sedimentary rocks containing clay and cherts, and also fossils of pelagic organisms (Ammonites). These rocks can be found today in both the Prealpi (foothills of the Alps) and along the Apennines.

Stage 2: the disappearance of tethys and the alps formation (compression)
Between the late Jurassic and early Cretaceous (from 135 to 65 million years ago) ended the long phase of expansion of the Tethys ocean.
During the Cretaceous the African plate begins to rotate counterclockwise to the north. Therefore the opening of the ocean South Atlantic begins closing the Ligure – Piemontese basin.
The closure is achieved by sinking (subduction) of the oceanic crust beneath the continental crust Adria - Africa.
The huge pressures involved caused the slow, relentless compression of the sedimentary rocks and those of the oceanic crust. Those who were at greater depths underwent major transformation for the high temperatures and pressures generating the ophiolites, they are fragments of the oceanic crust that testify of the now lost Tethys ocean.
The same period reveal the first uplifting stages of the Alps chain. During the Eocene (40 million years ago) the subduction of oceanic crust proceeds until the closure of the Ligure-Piemontese basin and the collision of Europe with Adria. The scar that marks this clash is made by a series of fractures now called "Insubrian line" (or "Periadriatica"). It, starting from the east, follows the Pusteria Valley crossing the Giudicarie, down to the Tonale Pass, continue along the Valtellina locality and beyond to the west of Lake Maggiore before reaching the Canavese, north of Turin. Later, the sediments that make up the Po Valley cover the continuation of this boundary between Europe and Adria, but again it becomes evident north of Genoa, where is placed the boundary between the Alps and Apennines.
The clash between the continents produced the thickening of the crust along the collision zone resulting in an uplift process. Large strata of sediment accumulated in marine waters rise and buckled northward and westward into giant coatings that overlapped the pre-existing rocks of Europe.
During the Oligocene (30 million years ago) the newly formed Alps went to meet to intense erosion with accumulation of huge masses of debris in a depression running at the foot of the northern side of the Alps, the Molasse basin.
From the lower Aosta Valley, to the border with Austria, along the fractures of the Insubrian line, this generated a set of magmatic emission phenomena. This generates the Traversella plutonium at Ivrea, "Valle del Cervo" near

Biella, the Adamello, the Masino-Bregaglia, the "Vedrette di Ries" and Pohorje massifs.
Since the late Oligocene the Alpine chain continued to slowly move northward generating new mountain ranges systems that covered the Molassa basin.
South of the Insubrian Line occurred a movement of the nappes that determine the development of the Southern Alps and Apennines.
This uplift is still ongoing, and compressive seismicity of Friuli and other areas of the Alps Southern is its direct consequence.

Stage 3: the origin of Sardinia and Corsica
Since 20 million years ago a fragment of the European margin, constituting currently Corsica and Sardinia, separated from the mainland and made a counterclockwise rotating movement. This phenomenon led to the opening of the western Mediterranean (the Algerian-Provençal basin).
This move eastward movement of sardinian-corse block produced two important consequences.
The first is an intense volcanic activity, and the second the compression the east of the materials to form the Apennine Mountains.

Stage 4: the Tyrrhenian Sea formation
About 8 million years ago, East of Corsica and Sardinia, the continental crust began to thin forming the Tyrrhenian Sea that is still expanding.
This new process of crustal distension, as well as generating the opening the Tyrrhenian Sea, involved also the Peloritan-Calabrian massif, whose origin is similar to the Corsican-Sardinian block. This massive was displaced of a substantial dislocation eastward and brought in continuity with the southern Apennines. For a period of about two million years the Mediterranean was drained due to the closure of the Strait of Gibraltar. Over the last four million years, the Italian territory became as nowadays. The formation of the Apennines wat completed and the coastal plains were formed, including the Po Plain, for the accumulation of debris eroded from the young mountain ranges. Also the glaciation that occurred during the Quaternary played a relevant role in the delineation of the Italian territory. Intense volcanic activity throughout the coast of the Tyrrhenian Sea has accompanied the continued expansion of this basin.

Geological time scale		
Million years	**Era**	**Period**
1,8	Neozoic or Quaternary	Holocene
		Pleistocene
65	Cenozoic or Tertiary	Pliocene
		Miocene
		Oligocene
		Eocene
		Paleocene
230	Mesozoic	Cretaceous
		Giurassic
		Triassic
700	Paleozoic	Permian
		Carboniferous
		Devonian
		Silurian
		Ordovician
		Cambrian
3.800	Precambrian	

From Internet

Internet is an excellent source of tourist information, this is true even within the geotouristic argument. Here are some interesting web sites. Many other web site and information can be found independently using search engines. In the world wide web there are many virtual travels and hiking trails built over the geological theme and intended for any kind of traveler and hiker. The links on this page are only some examples, given the speed of the changes on the Web, some links might not be functioning.

Resources

http://www.geoturismo.it	Geoturism in Italy and abroad
http://www.geoparks.it	Geoparks
http://www.e-geo.unisi.it	Geological maps of Italy
http://www.parks.it	Italian Parks
http://www.museionline.it	Museums
http://www.geologi.it	Geology
http://www.geologia.com	Geology
http://www.bema.it/OpGuide1.html	Italian geological guidebooks
http://www.unesco.org	International organization world heritage
http://www.geoenv.it	Geology and environment
http://www.minerali.it/itinerarimineralogici.htm	Minerals
http://www.viaggiaresicuri.mae.aci.it	Travel informations
http://geoinfo.nmt.edu/tour/home.html	Messico
http://vishnu.glg.nau.edu/people/jhw/Tibet/Tibet.html	Tibet
http://www.kaibab.org/geology/gc_geol.htm	Grand Canyon
http://www.casdn.neu.edu/~geology/department/staff/colgan/iceland/welcome.htm	Iceland
http://online.redwoods.cc.ca.us/depts/science/earth/smith/smith.htm	USA
http://www.lib.utexas.edu/geo/onlineguides.html	USA Canada Alaska
http://www.soton.ac.uk/~imw	England
http://www.resgeol04.org	Réserve Géologique de Haute Provence, France
http://www.geyserstudy.org	Gayser of the world
http://europeangeoparks.maestrazgo.org	European Geopaks
http://www.geotoursafrica.com	Africa

About Italy

http://www.regione.vda.it/territorio/geositi	Valle D'Aosta
http://www.naturaosta.it/geoturismo	Valle D'Aosta
http://digilander.libero.it/mineralweb/brosso.htm	Piemonte
http://gmv.fmal.com	Piemonte
http://www.provincia.torino.it/territorio/geositi/home.htm	Piemonte
http://www.provincia.torino.it/cultura/ecomusei	Piemonte
http://www.scopriminiera.it	Piemonte
http://www.parchiastigiani.it/valleandona.htm	Piemonte
http://www.valmalencofree.com/geologia	Piemonte
http://www.minieradoro.it	Piemonte
http://www.scalve.it	Lombardia
http://www.valtrompiaturismo.it	Lombardia
http://www.miniereinvaltrompia.it/viadelferro.html	Lombardia
http://www.triassico.it/parcocene	Lombardia
http://www.parcobreggia.ch	Lombardia
http://www.montesangiorgio.ch	Lombardia
http://www.valledeilaghi.it	Trentino-Alto Adige
http://www.pnab.it	Trentino-Alto Adige (*)
http://www.itinerarigeologici.it	Trentino-Alto Adige
http://www.bletterbach.info	Trentino-Alto Adige
http://www.lessiniamusei.it/musei/bolca/museo.htm	Veneto
http://www.interware.it/tsr/Ambiente/carso/index.html	Friuli-Venezia Giulia
http://www.grottagigante.it	Friuli-Venezia Giulia
http://www.minieragambatesa.it	Liguria
http://www.parcobeigua.it	Liguria (*)
http://www.regione.emilia-romagna.it/Geologia/itiner.htm	Emilia-romagna
http://www.regione.emilia-romagna.it/parchi/stirone/	Emilia-romagna
http://www.venadelgesso.it	Emilia-romagna
http://www.amiata.net/home2.htm	Toscana
http://www.parchivaldicornia.it	Toscana
http://www.parcapuane.toscana.it	Toscana
http://www.etruscan.li.it/parcoss/italiano/parcoss.htm	Toscana
http://www.grottadelvento.com	Toscana

http://www.parcofaunistico.it	Toscana
http://www.peglia.com/didattico/sanvenanzo.htm	Umbria
http://www.forestafossile.it	Umbria
http://www.minieracabernardi.it	Marche
http://www.parcosimone.org	Marche
http://www.parcogolarossa.it	Marche
http://www.frasassi.com	Marche
http://www.lalumiera.it	Lazio
http://www.sabina.it/itinerari/geo.htm	Lazio
http://www.agri-net.org	Lazio
http://www.parchi.lazio.it/mn.campo.soriano	Lazio
http://www.hatria.net/itinerari/itinerario1.htm	Abruzzo
http://www.riservacalanchidiatri.it	Abruzzo
http://www.minieracabernardi.it	Marche
http://www.eurogeopark.com	Campania
http://www.vesuviopark.it/pnv/home/index.asp	Campania
http://www.geologi.it/pietraroja	Campania
http://www.japigia.com/parcodeifossili	Puglia
http://www.parcodeifossili.it	Puglia
http://www.parcopollino.it	Calabria e Basilicata
http://www.vulcanoconsult.it/geo.htm	Sicilia
http://www.roccadicerere.it	Sicilia (*)
http://www.parcodellemadonie.it	Sicilia (*)
http://www.k2net.it/aceenna/floristella	Sicilia
http://www.parcoetna.ct.it	Sicilia
http://www.isoleeolie.com	Sicilia
http://www.geomine.it	Sardegna
http://www.parcogeominerario.eu	Sardegna (*)
http://www.grottedinettuno.it	Sardegna

(*) UNESCO Geoparks in 2010

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Contents

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