MUSEO GIARDINO GEOLOGICO

Sandra Forni

THE OROGENESIS OF A GARDEN

RegioneEmilia-Romagna

THE OROGENESIS OF A GARDEN

So, if the soul is distracted from human things and turns to plants, animals and minerals, it is not a mistake at all, as sometimes you hear. Such an act can represent a pure effort of self-preservation, the desire to take part in a higher existence. If the fountains dry up, you go to the river. There, there is no need to believe: the miracle is plain to see. When everything is silent, things begin to speak: stones, animals and plants become brothers and sisters and communicate what is hidden.

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The Geological Garden Museum is dedicated to the memory of Sandra Forni,
a colleague and friend who died prematurely in 2005.

The Geological, Seismic and Soil Survey of Emilia-Romagna Region will be happy to correct any omissions or misattributions.

SUMMARY

PRESENTATION

After *Memorandom* and *Errandom*, which offer visitors a guide to the exhibition of minerals and fossils in the atrium of the Third Tower of the Emilia-Romagna regional government, and to the geological tour of the city of Bologna, I am pleased to present the ***Orogenesis of a Garden,*** the new guide to the "Sandra Forni" Geological Garden Museum. This publication aims to offer visitors an insight into the essence of the design and creation of the garden next to the Third Tower.

In this educational garden, established thanks to my predecessor Dr. Raffaele Pignone, the rocks and plants create a picture that represents the geological and vegetational variety found across our regional territory.

Through this guide, the garden is thus able to operate like an actual museum, a valuable resource that is accessible throughout the day and that naturally evolves over the course of the seasons. An open-air museum that enthrals visitors with stories of ancient times, mythological tales, scientific interpretations and current issues related to natural events, in a bid to enhance the culture of this territory.

The guide aims to add to the value of garden by providing texts and a glossary (to which the words highlighted in red in the text refer) with information on geology, botany, history and mythology, all connected to what visitors can see for themselves in the garden.

The experiment carried out in this tiny plot of land uses a scientific approach to attempt to foster genuine environmental awareness and to convey to future generations the value and fragility of our region's natural resources.

Gabriele Bartolini
Head of Geological Seismic and Soil Survey


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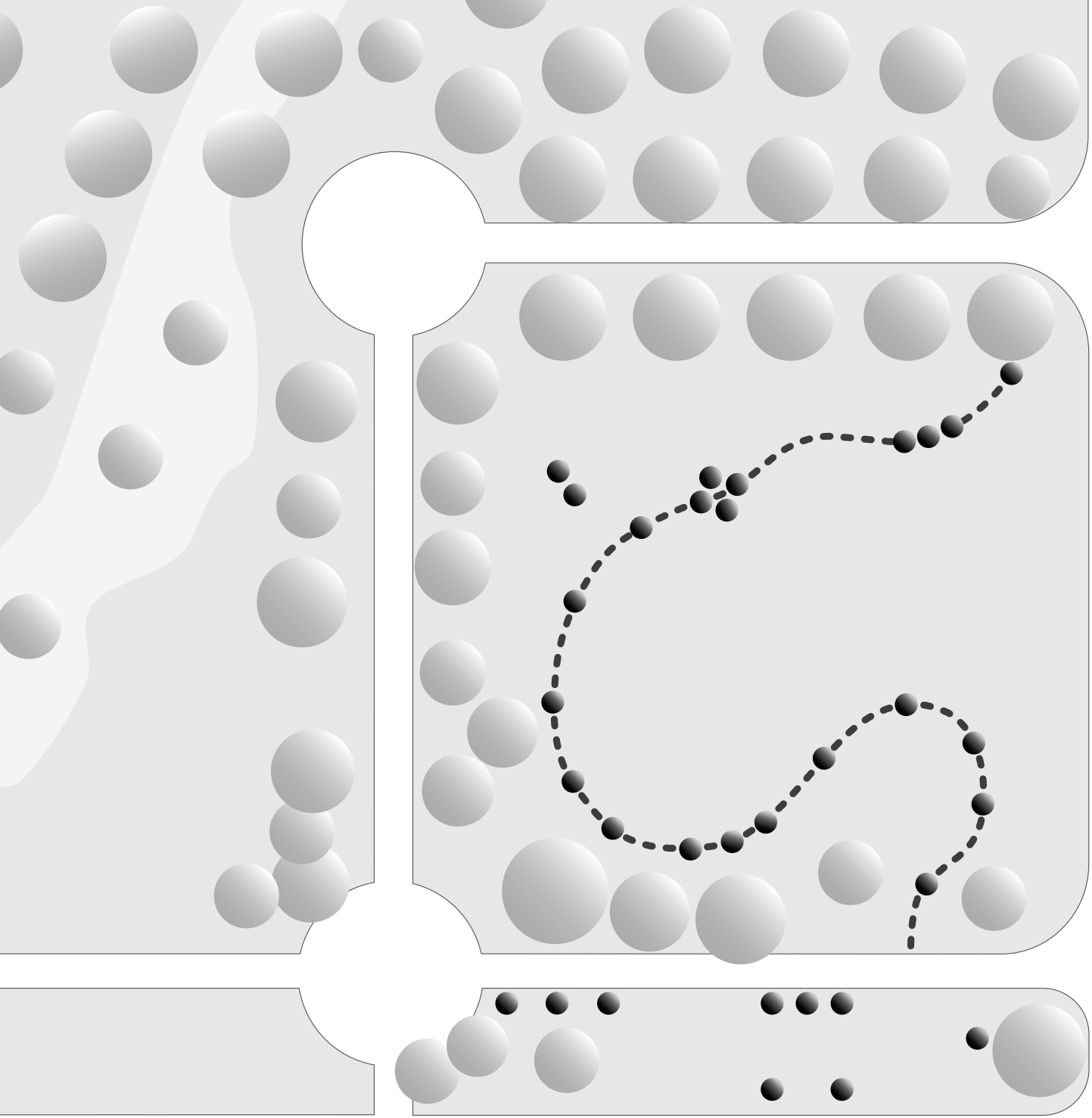


PROLOGUE

The geological garden is located in the green space that extends along the southern border of Bologna's Fiera District: seven tall buildings (the towers), designed by architect Kenzo Tange, arranged around a main square featuring a monumental sculpture by Isamu Noguchi.

Kenzo Tange's towers stand tall and proud like majestic concrete tree trunks surrounded by an aura of absolute silence which, especially when you look out over the monumental square, bring to mind certain works by De Chirico. The simple, uncompromising shape of the buildings with their cold minimalism conveys an almost military restraint. In this space, even voids are meaningful and the army of identical shielded windows creates a balance between built-up and open spaces.

The garden is a small island of greenery opposite one of the towers - the third, which soars to a height of 83 metres and is the workplace of some 600 people. Here time seems to stand still and the traffic along the main avenue bordering this green space is barely noticeable. This is precisely the space we are going to be talking about.

The 'Museo Giardino Geologico Sandra Forni' (MuGG) is an exhibition project launched in 2010 by the Geological, Seismic and Soil Survey of Emilia-Romagna Region (Department of Soil and Coast Protection, Civil Protection and Environmental and Mountain Policies - Directorate General for Land and Environmental Care).

The green area is owned by the Municipality of Bologna, which is responsible for the care and maintenance of green spaces and authorized the project to transform the space into a geological garden.

There are several examples around the world of geological gardens that are largely inspired by 1800s Anglo-Saxon culture. These are gardens that, like their botanical counterparts, display the rocks that form a given geographical area in order to create a sort of geological training ground for visitors.

The idea behind our installation is to condense the main geological formations of the regional territory in an urban park, thus offering visitors a comprehensive overview of the geodiversity of the Emilia-Romagna Apennines. The rocks displayed, located in such a limited area, form a miniature Apennine park. The garden is enriched by a number of boulders from other regions of Italy, separated from the regional rocks by a pathway. Here, visitors can directly compare the different rocks, note their lithological differences and, in the process, acquire new knowledge.

The added value of the trees and plants that frame the stone display is an excellent starting point for a closer look at the botanical attractions on offer. The garden as a whole thus becomes an open-air natural science laboratory designed to stimulate the curiosity and sensitivity of visitors and, we hope, to be used and enjoyed by people and schools.

For nearly 300 million years plants, just like animals, lived and died in the water without any species taking root on dry land: the blistering sun beat down on the naked continents without a single leaf to cast a shadow. Then, slowly, plants began to adapt to dry air, to intense light, and to the rapid changes in temperature. Towards the end of the Ordovician, 500 million years ago, oblate plants evolved to live on the muddy banks of estuaries and lagoons. The fossils of these ancient terrestrial plants, called *Foerstia* and *Parka,* are reminiscent in many aspects of the lichens that grow today on bare rocks, stone walls, on tree bark, and on the ground. For millennia, no plant had roots; the land had no soil. In the world we see today, plants have invaded all lands: in the humid tropics they tangle in a dense jungle; in the arid plains, one root after another, they extend to form endless steppes; in the Arctic and in Antarctica they endure harsh frost and punishing winds. Even in parched deserts, they find a little corner where they are able to germinate. Civilizations down through the ages interpreted plants and trees as symbolising the divine, weaving them into legends and myths that have come down to us. Plants as a form of theophany, a discernible manifestation of divinity, is the common thread that links the scientific descriptions that follow.


SU 54

THE PLANT GARDEN

P01 White poplar
Populus alba L.

P02 Black poplar
Populus nigra L.

P03 Common oak
Quercus robur L.

P04 Hackberry
Celtis australis L.

P05 Common ash
Fraxinus excelsior L.

P06 Broad-leaf privet
Ligustrum lucidum W.T.Aiton

P07 Himalayan Cedar
Cedrus deodara Loud.

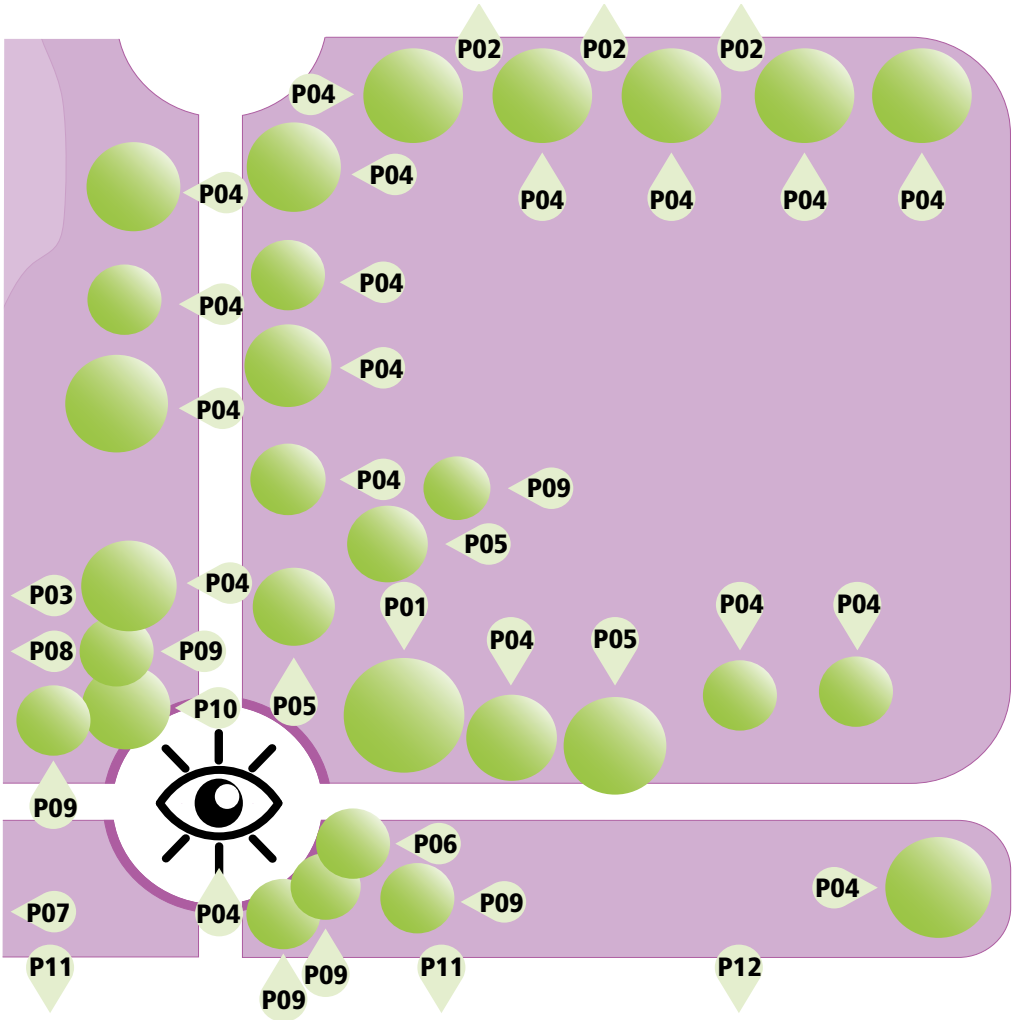
P08 Judas tree
Cercis siliquastrum L.

P09 Hawthorn
Crataegus monogyna Jacq.

P10 Scarlet firethorn
Pyracantha coccinea M.Roem.

P11 Cherry laurel
Prunus laurocerasus L.

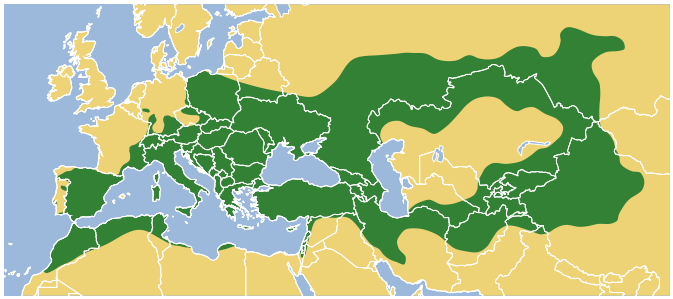
P12 Spanish broom
Spartium junceum L.



WHITE POPLAR - *Populus alba* L.

This is a **deciduous** tree with a whitish bark, which, with age, cracks into a characteristic pattern of darker diamonds. The plant displays alternate palmate-lobate leaves with 3-5 lobes and oval-elliptical leaves with coarsely toothed margins, white and downy on the underside and dark green above. Male and female inflorescences are found on separate specimens and are pendulous **catkins**. The fruits are capsules which, when ripe, release numerous cottony seeds. White poplars prefer cools soils and the banks of watercourses. They are common in riparian environments on the plain, but also in mixed woods found in the hills and low mountains.

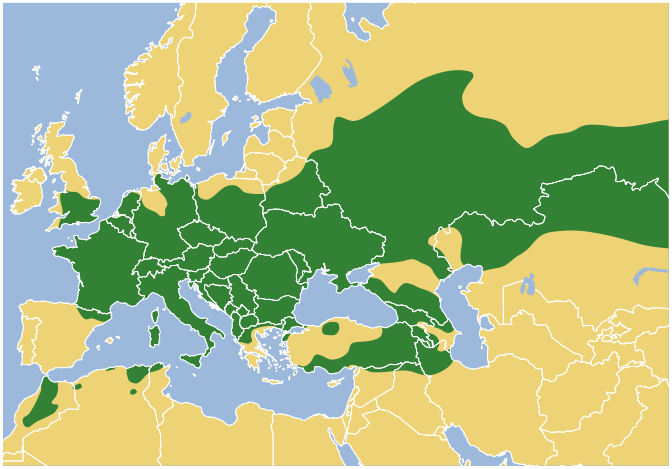
In ancient Greece this tree was called leúke, after the nymph of the same name who, in her bid to escape Hades, turned herself into a white poplar which was then planted by a god before one of the thresholds of the underworld. Heracles, leaving the kingdom of the dead after completing his twelfth labour, wore a crown woven from the branches of that same tree. The underside of the leaves, in contact with the hero's sweating brow, immediately lightened in colour. The white poplar symbolises rebirth, the triumph of life over death.



BLACK POPLAR - *Populus nigra* L.

This is a fast-growing tree with dark, grooved bark, deciduous triangular or rhomboid leaves toothed margins. The male and female inflorescences are pendulous catkins that develop on different plants, the fruits are capsules that release feathery seeds. The species, typical along waterways, represents an important element of **riparian** vegetation. It is also commonly found in woodlands and road embankments and grows vigorously in highly industrialised areas.

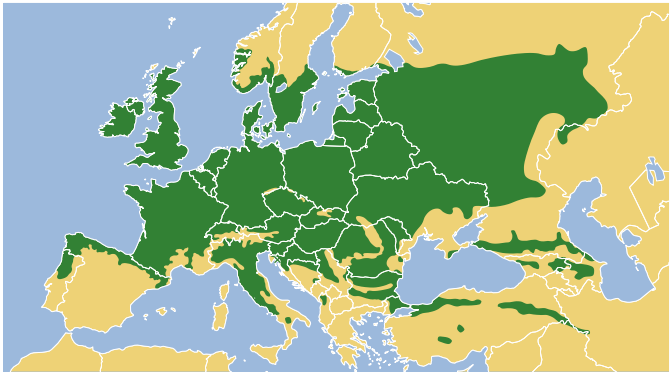
The black poplar has always been considered a funerary tree: according to Greek mythology, the Heliades, daughters of the Sun, inconsolable at the death of their brother Phaethon, were transformed into black poplars. Their tears, which continued to drip from the trunks, were set into amber by the sun.



COMMON OAK - *Quercus robur* L.

This long-lived, deciduous oak has strong branches and a massive crown. It can reach impressive dimensions. The bark is brown-grey and fissured, the leaves have a short petiole, are deeply lobed and feature two auricles at the sides of the petiole. The male inflorescences, long hanging catkins, and the female flowers, arranged in small groups at the tips of small branches, grow on the same plant. 2-3 acorns are carried on the one peduncle. Once upon a time the oak was widespread in the forests of the Po Valley, of which only a few strips remain. Today it is more sporadic, but it can be found in the hills and low mountains, in moist soils.

The oldest Greek oracle was located near an oak tree consecrated to Zeus. The oak was the tree of celestial and terrestrial sovereignty among the Greeks and Celts, a symbol of strength, endurance and longevity. Its very hard wood was used for the construction of ships, for this reason the Romans used the term robur for both the tree and physical and moral strength.



HACKBERRY - *Celtis australis* L.

This is a deciduous tree with smooth, grey bark. The oval-lanceolate leaves have a sharp apex and serrated margins; rough and dark green above, lighter and tomentose on the underside. The inconspicuous, yellow-green flowers are solitary or grouped in small clusters. The fruits are small roundish drupes, first yellow-greenish then black-purple when ripe, with little flesh that nonetheless attracts birds. It is a frugal species, resistant to air pollution, growing wild in the plain and hills and often used to line roadways.

The hackberry is commonly referred to as the stone crusher, a name that indicates its ability to thrive in stony soils and to cause cracks in rocks and walls through its strong, wide-spreading root system. It is also called the rosary tree because the stones of the drupes were used to make necklaces and rosary wreaths.

COMMON ASH - *Fraxinus excelsior* L.

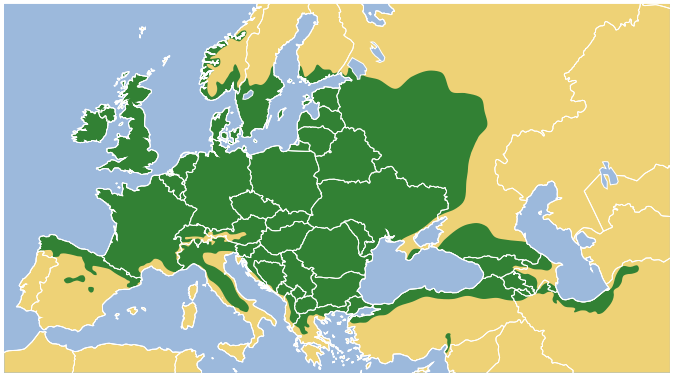
This is a deciduous tree with a slender trunk and bark that is initially greenish and smooth, then grey-brown and cracked. The leaves are **odd-pinnate**, formed by elliptical-lanceolate segments with toothed margins. The flowers, grouped in thick purple panicles, appear before the leaves and can be **hermaphrodite** or **unisexual** (male and female flowers are often found on the same specimen). The fruits are samaras, with the membranous wing carrying the seed at one end. It is a species that loves cool and humid environments, present from the plain to the mountain area.

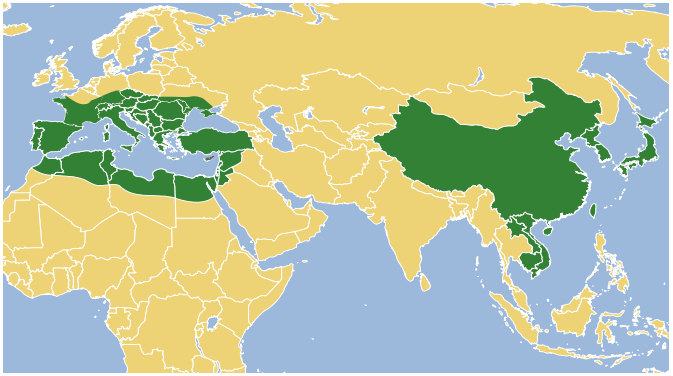
For the Germanic and Scandinavian peoples, the giant Yggdrasill ash was the cosmic tree that connected the subterranean and celestial worlds, as well as the tree of supreme knowledge and immortality. Among the Celts, the ash tree was considered a symbol of rebirth, with the capacity to perform miraculous healings. The deadly spear of Achilles was made of ash wood, renowned for being hard yet pliable.

BROAD-LEAF PRIVET - *Ligustrum lucidum* W. T. Aiton

This evergreen shrub or tree of far-eastern origin has grey bark that over time develops pronounced fissures and roughness. The leaves are oval, sharp, glossy on the upper side and dark green in colour. The two edges of the foliar lamina face upwards with respect to the marked central nervation. The small white flowers are grouped in large pyramidal panicles. The fruits, very numerous globular berries which are bluish when ripe, persist throughout the winter and are toxic to humans. This ornamental plant is not overly demanding and is utilised in parks and gardens and as street trees.

The name of the genus, Ligustrum, is thought to derive from the Latin verb ligare, in reference to the suppleness of its twigs used in the countryside as ties, or it might indicate the Ligurian origin of the genus.





HIMALAYAN CEDAR - *Cedrus deodara* Loud.

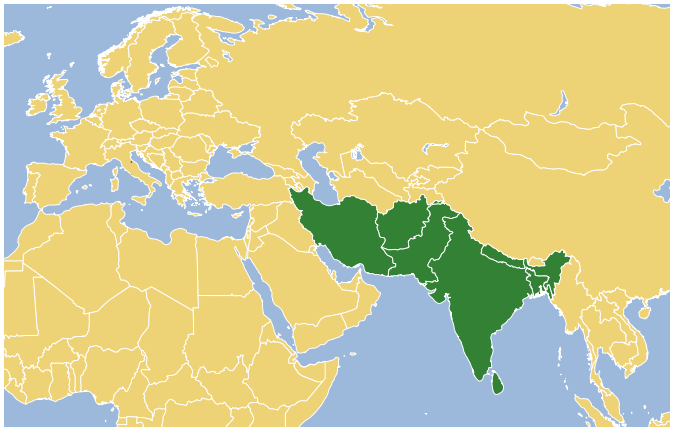
This is a dark green conifer with a pyramidal crown, and a pointed top already in young specimens. The branches are horizontal, with shoot tips pendulous, and the bark is dark grey and scaly. The soft needle-shaped leaves grow solitary on new branches, while the older needles appear in rosettes. The male reproductive structures are cones that release yellow pollen in autumn; the female ones, light green in colour, become brown oval cones when ripe. Both are found on the same specimen. The species, native to the mountains slopes, is frequently used in parks and gardens for its ornamental value.

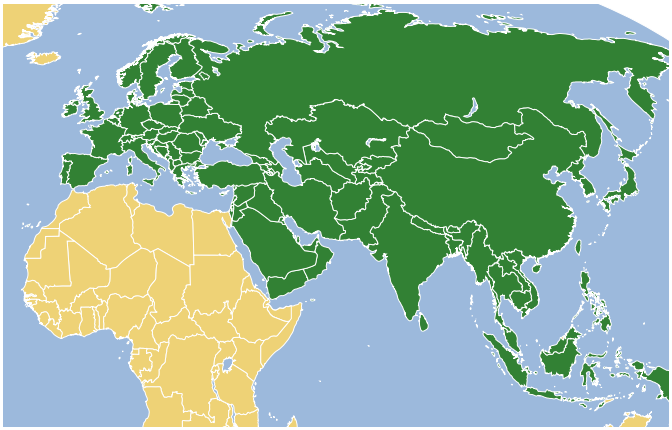
In its land of origin, the cedar is considered a sacred tree, known as the tree of the gods, a symbol of fertility and durability: its wood is used to build temples, palaces and sacred objects such as statues of gods.

JUDAS TREE - C*ercis siliquastrum* L.

Deciduous shrub or sapling with dark reddish-brown bark, smooth when young then finely fissured. The leaves are heart-shaped or kidney-shaped, shinier on top, palmately veined with margins entire. The violet-pink flowers sprout directly on the branches and trunk, in clusters, before the leaves appear. The fruits are legumes, initially purplish and then brown. The species, native to the eastern Mediterranean, is cultivated for embellishing avenues and gardens.

It is said that the apostle Judas hung himself from this tree after having betrayed Jesus, the tree's twisted trunk thus attributed precisely to that episode. The flowers are meant to represent the tears of Christ and their colour the shame of Judas's treachery.

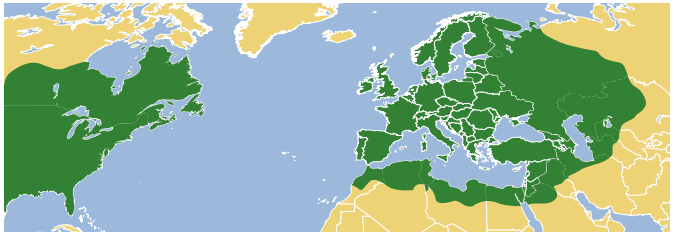




HAWTHORN - *Crataegus monogyna* Jacq.

This is a deciduous thorny shrub, or rarely a small tree, with grey-brown bark that peels off in sections in older specimens. The leaves have deep lobes with entire margins, with a few notches at the apex. The flowers, white or slightly pinkish, have 5 petals and form showy inflorescences that attract pollinating insects. The small fleshy fruits, red and shiny, are eaten by birds and mammals, which contribute to their dissemination. It is a common species, widespread from the plain to the low mountains, where it grows wild in the woods and helps form hedges and bushes.

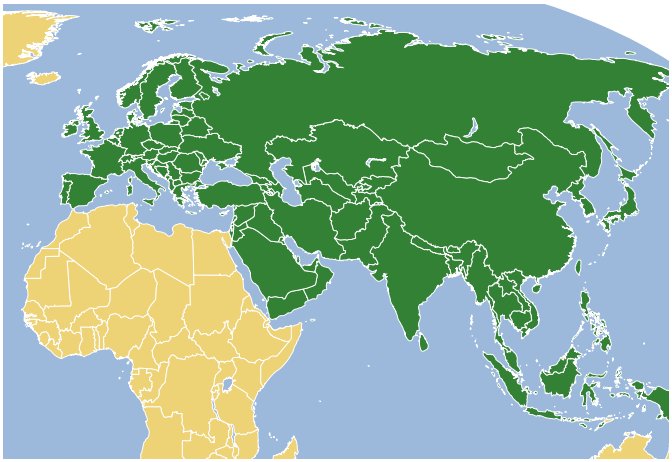
In ancient Greece, hawthorn plants symbolised fertility: during wedding ceremonies, altars were adorned with its flowering branches. An English legend has it that Joseph of Arimathea, an important member of the Sanhedrin who buried Jesus, having travelled to Great Britain to spread the word of Christ, thrust his staff into the ground at Glastonbury, where it miraculously took root and blossomed into a hawthorn tree. Next to it Joseph built the first church in England. From that moment on, the plant began to flower every year on Christmas Eve; the following day, one of its branches was taken to the King and Queen of England.



SCARLET FIRETHORN - *Pyracantha coccinea* M. Roem.

This is a thick and thorny evergreen shrub with yellowish bark that later turns brow. The leaves are oval-lanceolate, slightly leathery, glossy and dark green on the upper side, pale green on the underside, with a toothed margin towards the apex and drop when new leaves sprout in spring. The white flowers are grouped in dense inflorescences. The clusters of small, fleshy, orange-red fruits attract birds such as blackbirds and thrushes. The species, widely cultivated for its ornamental value, can grow wild in bright woodlands, holm-oak woods and hedges.

The scarlet firethorn is also known by the popular name of burning bush, in reference to the thorny branches and the flame-red colour of the fruits (in Greek pyros means fire and thorny acanthos).



CHERRY LAUREL - *Prunus laurocerasus* L.

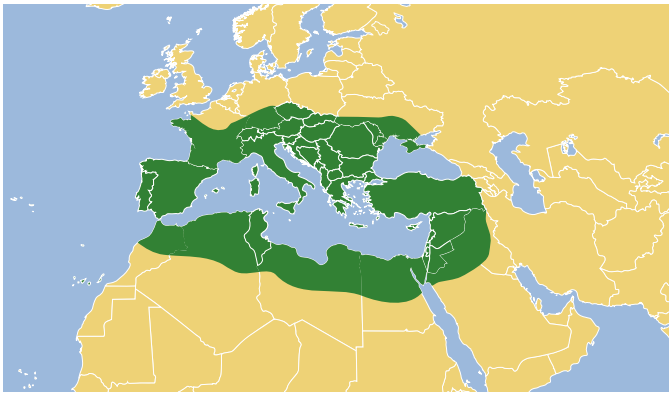
This shrub or small evergreen tree has a thick, compact crown. The grey and smooth bark becomes grey-brown, wrinkled, and takes on blackish shades with passing time. The coriaceous oval-lanceolate leaves, with entire or indented margins, are glossy and dark green above and paler on the underside. The erect inflorescences are composed of flowers with cream-white petals. The fruits are small roundish drupes, initially red and then blackish-purple. The species, native to Asia Minor and cultivated as an ornamental, tolerates shade and drought, and when it grows in the wild it forms dense shelters for many animals.

Its name refers to the similarity of the leaves to those of the laurel Laurus nobilis. Laurocerasum is toxic.

SPANISH BROOM - *Spartium junceum* L.

This thornless shrub has a compact appearance and numerous shoots at the base. The lance-shaped leaves have an entire margin and fall early from the green, cylindrical branches. The bright yellow flowers, gathered in clusters at the end of stems, are fragrant and produce nectar that bees find irresistible. The fruits are sickle-shaped legumes, dark brown when mature, at which point they burst open, releasing the poisonous seeds. It is a pioneer species that adapts to any type of soil and, thanks to its well-developed root system, is used to consolidate slopes and landslide areas. Its flexible branches were used in the countryside to manufacture brooms, baskets and to secure vines to braces.

The most famous broom in the history of literature is that of Leopardi's poem of the same name: the plant bears witness to the destructive power of Vesuvius and the annihilation of the city, an image of the power of nature and the impermanence of man.






HERBACEOUS PLANTS

Often neglected and forgotten, these so-called weeds are a demonstration of how nature is versatile and takes advantage of every opportunity, even in urban settings. Crevices, cracks and even well-trodden ground can all host wild herbaceous plants of every shape, colour and scent, some with valuable medicinal properties.

Gardens and city parks, seemingly uniform underfoot, are actually heterogeneous areas with different conditions in terms of temperature, water and soil, added to which is the continuous transformation brought about by human intervention.

In the cracks in walls and gaps between stones, spaces characterized by scarce availability of water and nutrients but protected from mechanical disturbances, we find rock species such as lichwort (Parietaria officinalis), known for its diuretic properties.

At the side of pavements and in well-trodden areas, it is common to find low-growing plants with leaves clustered in basal rosettes, such as the common daisy (Bellis perennis, used in cosmetics for its refreshing and lightening properties) and plantain (Plantago major, an expectorant which protects the airways).

In meadows, on uncultivated land and along roadsides, we find beautiful blooming mallow (Malva sylvestris, emollient and soothing), chicory (Cichorium intybus, aids digestion and has purifying properties), dandelion (Taraxacum officinale, purifying and diuretic) and wild carrot (Daucus carota, diuretic and decongestant of the digestive and intestinal tract).

These are just a few examples of the richness and diversity of an unflagging nature that we invite you to discover with a curious and sensitive gaze.




Seen from above, the geological garden resembles a string of pearls torn and scattered on a meadow. The apparently random arrangement that is, however, highly practical to visit. The rocks are the stages of a route that winds its way through space and time, leading visitors on a journey of learning through the geological history of the Emilia-Romagna Apennines. The starting point coincides with the oldest rocks and ends with the rocks that document the most recent part of this history. The time dimension is revealed in the space that separates the boulders: a few tens of centimetres represent millions of years.

Our challenge has been to condense all the geological history and the many changes in the geography of the Earth in a garden where millions of years and thousands of kilometres become simple boulders, silent witnesses to the geological cycles, an allegory of the processes of creation, conservation and destruction that have always governed the life of planet Earth. Visitors to the garden can not only take a dip in the deep time of geology but also immerse themselves in the landscape of Emilia-Romagna, where outcropping rocks help to define the environment together with the plants alongside which they naturally live.

THE STONES GARDEN

EMILIA-ROMAGNA

R01 Palaeozoic granite
R02 Triassic gypsum
R03 Ophiolites
R04 Palombini limestone
R05 Devil's jumps conglomerates
R06 Helmintoids flysch
R07 Groppo del Vescovo (Bishop's Knot) limestone
R08 Mount Modino sandstone
R09 Marnoso-Arenacea (Arenaceous marl)
R10 Bismantova and S. Leo sandstones
R11 Messinian gypsum
R12 Plio-Pleistocene sandstones
R14 Spungone formation

TUSCANY

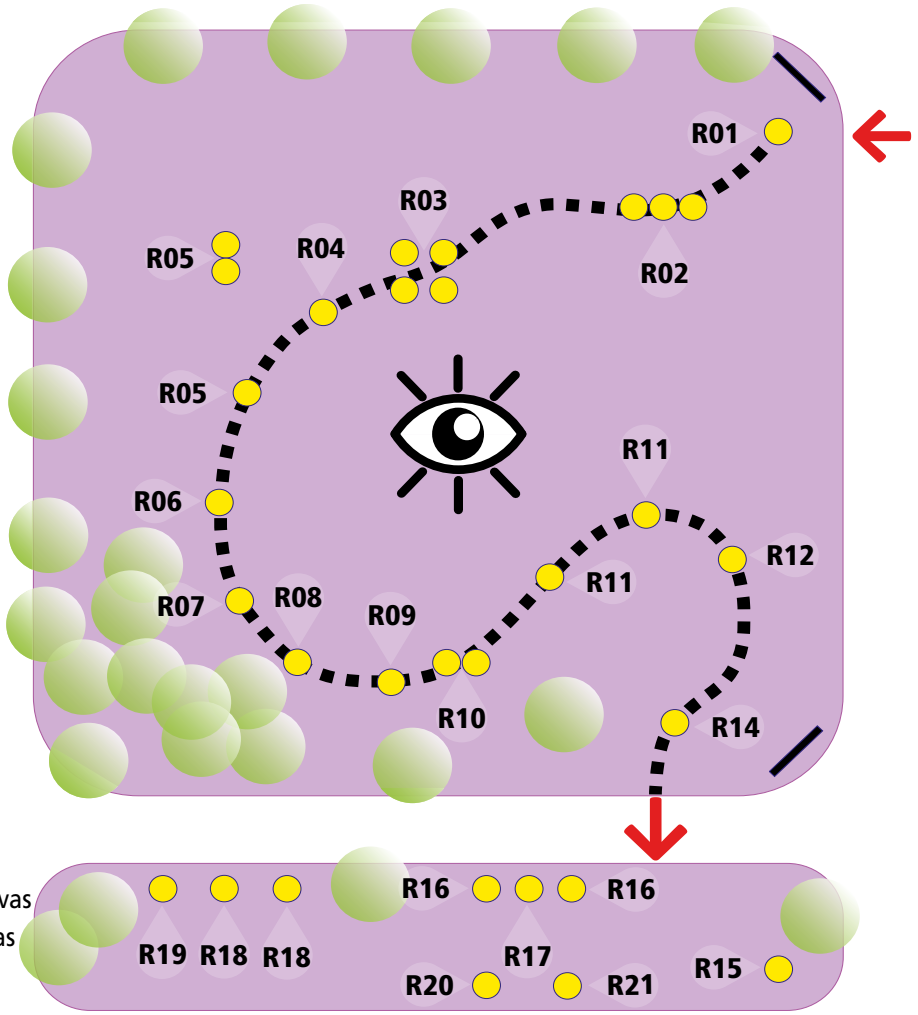
R15 Marble of the Apuan Alps

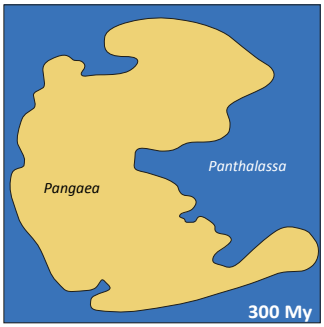
TRENTINO ALTO ADIGE

R16 Rotzo limestone formation
R17 Tonalite

CAMPANIA

R18 Somma Vesuvio volcanic complex lavas
R19 Roccamonfina volcanic complex lavas
R20 Roccarainola limestone
R21 Vitulano marble






Rombecco (Parma province)

R01 - Palaeozoic Granite

Granite is one of the most abundant rocks on the earth's surface and has always been used by man for artefacts and construction. It is an intrusive **magmatic** rock that was formed by the slow cooling, within the earth's crust, of silica-rich magma. Its name comes from the Latin granum (grains), with reference to its very compact structure, formed by crystals visible to the human eye as quartz, feldspar and mica.

In the Emilia-Romagna Apennines, granite is a very rare rock, found more frequently in isolated and small outcrops in the mountains of Parma and Piacenza provinces. It appears immersed in the Helmintoids Flysch formations and shaped as small plates or cliffs recognizable by the light colour and sparse plant coverage.

The largest granite outcrop in the region emerges at Rombecco, in the upper Baganza valley (Parma province Apennines). It is a geosite, a place of great significance for the geology of Emilia-Romagna. Absolute datings confirm these granites to be approximately 300 million years old and their formation dates back to the Hercynian orogenesis that produced the supercontinent Pangaea, which incorporated all of Earth's landmasses.

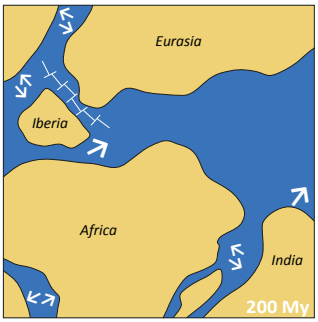
The granite landscape is characterized by predominantly sparse, low vegetation in intermittent patches, like juniper, snowy mespilus and several species belonging to the genus *Sedum* [1], *Sempervivum* [2] and *Saxifraga*, typical of rocky environments. The woodland covering the outcrop is dominated by beech.

[1]

[1]

[2]

[2]




Secchia river (Reggio Emilia province)

R02 - Triassic gypsum

This name refers to the group of rocks that includes Burano evaporites, Calcare Cavernoso (Cavernous limestone) and Arenarie Quarzitiche (Quartzitic sandstones). These rocks document the process of fragmentation of the supercontinent Pangaea and the formation of the two continents, Africa and Eurasia, separated by a sea basin. Quarzitic sandstone is the last continental sediment deposited on the edge of the Pangaea; Cavernous Limestone and Burano evaporites deposited in the expanding sea **basin** in shallow sea conditions amid an arid climate.

These rocks, which are the oldest sedimentary rocks of the Apennines (about 200 million years), characterise the landscape of the upper valley of the Secchia river (Reggio Emilia province Apennines), where they outcrop as imposing walls of white, pink and gray gypsum along the wide riverbed. A unique landscape in the Apennine context thanks to karst phenomena of extreme scientific interest, such as the deepest gypsum cave in the world (Abyss of Mount Caldina) and the highly mineralised spring of Poiano. Towards the Cerreto Pass, along the extended front of the Rivarossa quarry, the white-pink quartzites typical of this rock complex outcrop.

In these rocky outcrops we can identify different types of vegetation that have adapted to this specific habitat. The ledges dotted across the rocky walls are colonised by pioneer species equipped to endure environmental conditions with high temperatures, scarce water availability and thin soils. In these conditions there is a sparse and discontinuous vegetation characterised by *Sedum album* and *Sedum montanum*. Along the cliffs and subvertical faces is patchy vegetation dominated by *Saxifraga Callosa*, and by herbaceous species like *Carex humilis Sesleria Pichiana* and plants as *Amelianchier ovalis* [3] and *Cotoneaster integerrimus*. Bare rock faces are home to chasmophyte plant species whose roots grow in crevices; these plants, which have made physiological adaptations to compensate for the scant soil, include wormwood and round-leaved restharrow, *Ononis rotundifolia* [4].

[3]

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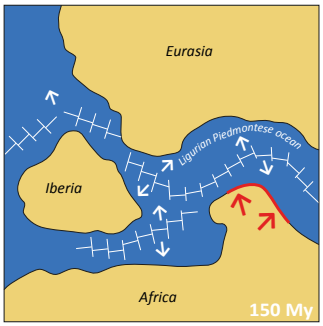

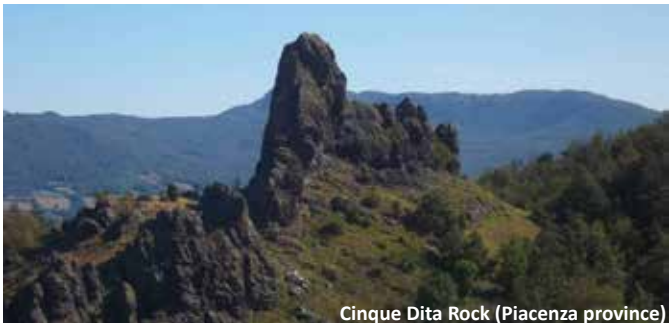
Cinque Dita Rock (Piacenza province)

R03 - Ophiolites

This is a group of magmatic and metamorphic rocks called ophiolites, named after the green-blue-black colouration which vaguely recalls snakeskin (from the Greek ophios, snake). They include basalts, gabbros, serpentine and serpentinised peridotites and, as a whole, they represent fragments of an oceanic crust: portions of an ancient oceanic seabed that has now disappeared. The ophiolites that outcrop in the Apennines were formed in the late Jurassic as a result of the opening of the Ligurian-Piedmont Ocean.

In Emilia-Romagna, ophiolites are located mainly near Eastern Liguria (Bracco pass area) and in the high valleys of Taro and Ceno (province of Parma), Nure, Trebbia and Aveto (province of Piacenza). Here these rocks outcrop as small blocks or as rock bodies extending for several miles and sometimes with thicknesses of hundreds of metres.

The ophiolites landscape is always visually striking and easily distinguishable in the territorial setting. The harsh profile of the reliefs, given by their greater resistance to erosion compared to surrounding rocks, consisting predominantly of clays, coupled with dark colours, extremely sparse and patchy vegetation and very little farming activity are the distinctive features of this landscape.

The ophiolitic rocks represent one of the most precious environmental treasures of the northern Apennines and, from a floristic point of view, they are islands of biodiversity. The ophiolitic substratum is home to a rare, specialised flora that has adapted to the very particular conditions, like the scarce availability of water and the presence of a nutrient-poor rocky substratum rich in heavy metals (nickel, chrome, zinc).

Some species are exclusive to the ophiolitic substratum such as Greek bladderpod *(Alyssoides utriculata*) and spiny spurge (*Euphorbia spinosa subsp. ligustica*) [5]; others, like the wild tulip (*Tulipa australis)*, are typical of higher altitudes but can also be observed at lower levels on ophiolites. In the province of Parma and Piacenza some species, which are found on other substrates elsewhere in the region, are exclusive to ophiolites, like rose daphne (Daphne cneorum), spring gentian *(Gentiana verna)*, candytuft *(Iberis sempervirens*), shrubby milkwort (*Polygala chamaebuxus) and* red alpine catchfly *(Silene suecica*). The ophiolites are also home to numerous species that survived the ice age, like Alpine aster *(Aster alpinus),* Alpine snowbell *(Soldanella alpina*), bird's-eye primrose (*primula farinosa)* [6] and mountain pine (*Pinus uncinata*).

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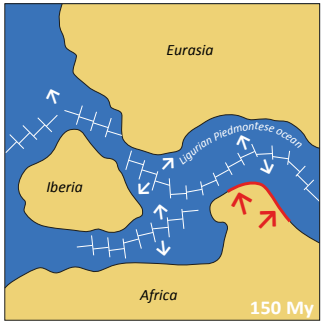


Outcrop (Bologna province)

R04 - Palombini limestone

The rock in the garden is a micritic limestone made up of crystals invisible to the human eye. It comes from the Palombini formation which, in addition to limestone, includes **claystone** and thin layers of sandstone. These are sediments that were deposited on the seabed 140 million years ago, in a very deep sea while the Ligurian-Piedmontese Ocean was in expansion.

The current chaotic aspect of these rocks, which present fragmented limestone layers immersed in a clay matrix, is a result of deformation that started in the middle-upper Eocene (about 40 million years ago), following the closure of the Ligurian-Piedmont ocean and the collision of the Eurasian and African plates.

This **geological formation**, extremely widespread in the Emilian mountains, combines with other lithological units to form a composite landscape. Gentle slopes, often cultivated, give way to badland gullies, some remarkably large and deep, characterised by small dark-coloured crags composed of ophiolites, and imposing rocky reliefs carpeted by thick woodland. A further distinguishing feature is the presence of numerous active and quiescent landslides, making the Emilian mountains one of the most landslide-prone areas of Italy.

The Palombini Clays give us the opportunity to describe the richness of vegetation found in one of the most characteristic features of the mountain landscape of Emilia: the badland gullies. The upper reaches of the badland gullies provide a habitat for species that form part of the native hill country vegetation, with small strips of thermophilic woods (species suited to warm environments) and shrubby grasslands with broom *(Genisteae)*, blackthorn (*Prunus spinosa)*, elm *(Ulmus)*, common hawthorn *(Crataegus monogyna)*, dog rose *(Rosa canina)*, downy oak *(Quercus pubescens)*, common juniper *(Juniperus communis)* [7] and common dogwood *(Cornus sanguinea)*. The steep gully walls predominantly feature herbaceous xerophilous species (numerous grasses) accustomed to warm and very dry climates. At the foot of the badland gullies, where debris accumulates and runoff water and landslide deposits are collected, we find hygrophilous species (which thrive in environments with water in abundance) like reed and tree species typical of riparian areas such as white willow *(Salix alba)* [8], silver poplar *(Populus alba)* and black poplar *(Populus nigra).*

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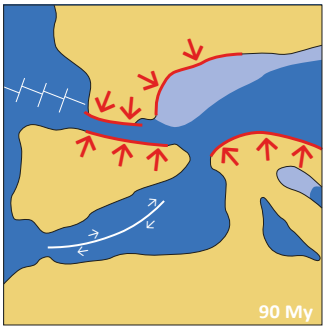

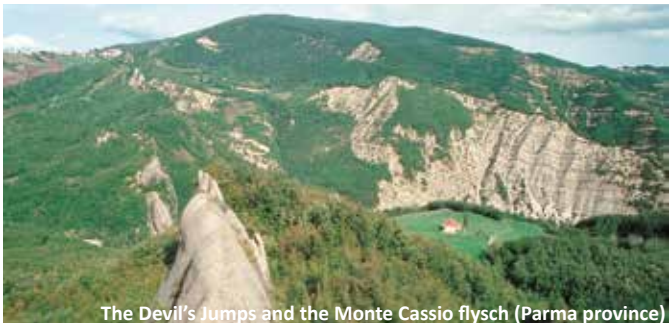
The Devil's Jumps and the Monte Cassio flysch (Parma province)

R05 - Devil's Jumps Conglomerates

This sedimentary rock is made up of rounded pebbles and well cemented sands produced by the disintegration of typical Alpine sector rocks (granite, porphyry, limestone, dolomite). These pebbles were first transported by ancient rivers, then deposited on the coast of the Ligurian-Piedmontese Ocean and finally crumbled en masse onto the seabed, covering an area of many tens of kilometres. Because of the tectonic thrusts that generated the Apennines, this rock formation has undergone a complex history of translation and dislocation and today it outcrops from Monferrato (Piedmont) to the Apennines of Modena province. In Emilia-Romagna, the most significant outcrop area is located in Val Baganza (Parma province) where a single layer, arranged vertically, emerges from the dense forest, soaring tens of metres high. Thanks to its greater resistance to erosion, the layer appears in relief compared to the surrounding clays and crosses the valley like a disjointed wall formed by a beguilingly beautiful series of spires and rock faces, in some parts resembling the backbone of a dragon.

The vegetation of the landscape is typical of rocky environments with lichens, mosses, small fleshy plants and some beautiful flowering herbaceous species like woodland pink *(Dianthus sylvestris)* [9], rock soapwort *(Saponaria ocymoides)* [10] and dwarf shrubs such as common juniper *(Juniperus communis)*. All around the vegetation is characterized by woods of turkey oak *(Quercus cerris)*, hornbeam *(Carpinus)* [11] and common beech *(Fagus sylvatica)* [12]. Today a tourist destination, the area can be reached via the hiking trail called 'La Via degli Scalpellini' (trail sign C.A.I. 771) which connects the opposite sides of the Val Baganza, Cassio and Chiastre, and traces the route taken, in the past, by stonemasons to reach the sites where the stone was quarried. The rather evocative etymology of the Salti del Diavolo (Devil's Jumps) can be traced back to a valley legend that identifies these steep rock spurs as the evidence left by the devil as he fled at the sight of a small crucifix worn by a local hermit saint.

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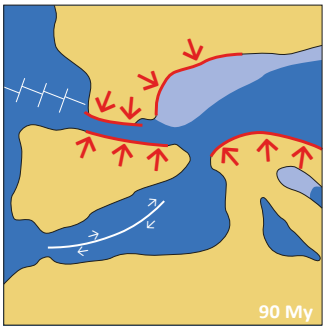

R06 - Helmintoid flysch

This is one of the most widespread rock types in the Emilia Apennines, characterised by a marked stratification given by the alternation of light-coloured calcareous-arenaceous levels and dark-coloured marl or clay levels. These are turbidite deposits, i.e. the product of the resettlement of sediments that had accumulated at the edge of a basin, courtesy of turbid currents. The basin in question is the Ligurian-Piedmontese Ocean, on the seabed of which, between the end of the Cretaceous and the middle Eocene, those sediments that today form a large part of the so-called Ligurian layer were deposited.

The name flysch, coined in the Alps, means slippery ground, while the helmintoids are the curious patterns, sometimes present on the surface of the sandstone layers, which have been interpreted as fossil tracks left by organisms that lived on the seabed.

The Helmintoid flyschs outcrop in the mid mountains and hills of Emilia, creating a composite landscape marked by strong contrasts. In these places, the rocky substratum is mainly formed by the so-called Argille Scagliose (scaly clays): a complex with a chaotic structure in which the clay matrix incorporates rocks of different ages and lithology. Due to their greater stability and resistance to erosion, the vast sections of Cretaceous-Eocene flysch often form the tops of slopes, characterized by wooded areas from which steep, densely stratified rock faces emerge.

In terms of flora, the flysch landscape is characterised by downy oak *(Quercus pubescens)*, turkey oak *(Quercus cerris)*, sessile oak *(Quercus petraea)* and hornbeam *(Carpinus)*, replaced at higher altitudes by common beech *(Fagus syslvatica)*, Scotch laburnum *(Laburnum alpinum*) [13] and rowan *(Sorbus aucuparia)* [14]. There are also limited reforested areas with Scots pine *(Pinus sylvestris)* and black poplar *(Pinus nigra)*. Above the tree line, are grasslands rich in wild orchids such as burnt orchid *(Neotinea Ustulata)*, many lilies like martagon lily *(Lilium martagon)*, tiger lily *(Lilium bulbiferum*) and numerous gentians. Other valuable plant species are globeflowers *(Trollius europaeus)* and wild tulips *(Tulipa australis*. The woods are home to a rich array of rare and protected flora.

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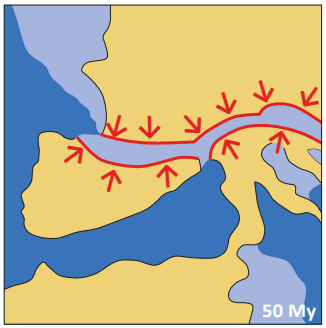


Upper Baganza valley (Parma province)

R07 - Calcare di Groppo del Vescovo (Bishop's Knot) Limestone

It is a formation composed of layers of grey microcrystalline limestone of the lower-middle Eocene (about 50 million years ago). It was formed by the sedimentation of turbid currents on the seabed of the Ligurian-Piedmontese Ocean during the closing phase. This rock is part of a complex of formations grouped in the Sub-ligurian unit, one of the rocky "**nappe**", hundreds or thousands of metres thick, whose overlapping led to the formation of the Apennines. This lithology, which outcrops in the high Emilian Apennines, owes its name to the locality of Groppo del Vescovo: a geosite, near the Cisa mountain pass in the province of Parma. This is one of the few limestone outcrops along the Parma mountain ridge. Its white rocks, clearly visible even from a considerable distance, emerge from the rolling green landscape of high meadows and pastures.

The vegetation here is characterized by beech woods that cover the slopes, dotted with grassy clearings and rocky outcrops that culminate in the large meadow that leads to the top of Bishop's Knot (1,248 m above sea level). The cool, humid climate and the age-old exploitation of beech forests (*Fagus sylvatica*) have favoured the almost exclusive development of this broadleaf species. However, the structural monotony of the beech forest is regularly interrupted by the presence of sycamore *(Acer pseudoplatanus*), common hazel *(Corylus avellana)*, hornbeam *(Carpinus)*, birth *(Betula),* common whitebeam *(Sorbus aria)* and Scotch laburnum *(Laburnum alpinum)*, often confined to the edges of the forest. Completing the rich, diverse mosaic is a series of rupicolous environments featuring rocks carpeted by lichens, mosses and tufts of small ferns inhabiting shady crevices. Only particularly robust species survive in these environments, as they need to be able to exploit the little soil found in the recesses of the rocks; these species include common houseleek *(Sempervivum tectorum)* and stonecrops *(Sedum)*. Finally, the typical blooms of the summit meadows include mountain arnica *(Arnica montana)* [15] and numerous species of orchids, dog's-tooth-violet *(Erythronium dens-canis)* [16], crocus [17] and gentian *(Gentiana)* [18].

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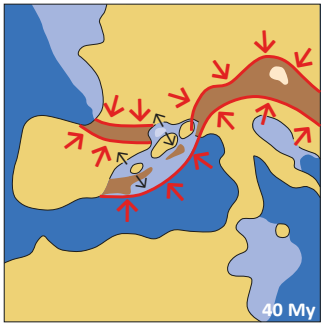


Mount Cimone (Modena province)

R08 - Monte Modino Sandstones

These are sedimentary rocks, mainly sandstone interspersed with marl, characterised by spectacular stratifications. This lithology documents the deposition of sediments, starting from about 24 million years ago, within one of the foredeep basins that developed during the Apennine orogenesis following the closure of the Ligurian-Piedmontese Ocean. Once deposited, these muddy sandstones were lifted and moved many kilometres, covering other similar formations deposited further north-east and then covered, in turn, by the oldest formations. Today, exposed by the erosion, the sandstones of Mount Modino form the highest peaks of the northern Apennines (Mount Cimone 2,165 m and Mount Cusna 2,120 m).

The landscape is dominated by imposing mountains, with steep slopes cloaked by forest where the stratification sometimes reveals the large **anticlinal folds** that gave rise to these reliefs. On the ridge we can observe glacial morphologies such as **glacial cirques** and, locally, **"roche moutonnee"** and striated rocks; **moraine** deposits downstream cover the areas reached by the tongues of ice.

In the ridge area, low temperatures and prolonged snow cover prevent the development of forest vegetation and the flora is mainly associated with environments such as cliffs, ledges, debris layers, grasslands and heaths. Along the cliffs we find species adapted to living in cracks and crevices, with very little soil, such as yellow whitlow-grass *(Draba aizoides)*, *Saxifraga* [19], Bertoloni's sandwort *(Arenaria bertolonii)* [20] and maidenhair spleenwort *(Asplenium trichomanes)*. Along the ledges that punctuate the rock faces, we can observe very striking blooms such as narcissus anemone *(Anemone narcissiflora)* [21], columbine *(Aquilegia)* and other species such as pasque flower and alpine knotweed *(Polygonum alpinum)*. In all these environments, at the highest altitudes, we also find the wild primrose *(Primula apennina)* [22], a very rare species at European level, native to the Tuscan-Emilian Apennines.

At the foot of the cliffs, the debris layers are colonised by ferns and to a lesser extent by saxifragaceae (from 'saxum' meaning stone and 'frangere', to break) which grows in cracks in the rock. The grasslands developed on arenaceous substratum can host clover *(Trifolium)*, fescue *(Festuca)* and matgrass *(Nardus)* if the substratum is marly-calcareous. Finally, shrubs dominate the moorland, which is mainly made up of bilberry *(Vaccinium myrtillus)* and bog bilberry *(Vaccinium uliginosum)*.

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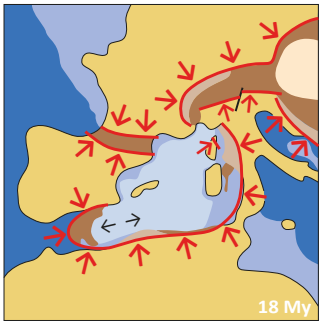


Savio Valley (Forlì-Cesena province)

R09 - Marnoso-Arenacea (Arenaceous Marl)

The name Marnoso-Arenacea encloses the two main lithological components of this rock formation comprised of an alternation of arenaceous strata of grey-beige-yellow and grey-coloured marl. This pair of strata records a single episode of sedimentation (layer), in other words the deposition of sediments transported by a **turbid current** on the bottom of the sea basin. Gradually losing energy, the current first deposited the coarsest and heaviest sediments, sands, and then the finest and lightest ones, namely the silt and then the clay. The base of the layer often shows, as in the case displayed in the garden, protuberances of various shapes produced by the vortices of the current or by the dragging of objects on the seabed, preserved thanks to rapid filling by sand.

The Marnoso-Arenacea documents the filling of the forefoot basins that developed in the Miocene (about 20 million years ago), along the front of the developing Apennine chain.

It outcrops in a vast swathe of the mountains of Romagna, from the valley of the river Sillaro to that of the river Savio, where it creates a highly distinctive landscape. Depending on the age and geographical position, we can distinguish between the inland Marnoso-Arenacea, which outcrops in the high Apennine sector and produces a landscape with steep slopes, straight valleys with recessed meanders and waterfalls, and the outer Marnoso-Arenacea, which characterizes the landscape of the middle and lower Apennines of Romagna.

The vegetation landscape is influenced by the asymmetry of the ridges caused by the layering of the strata: gentler slopes are covered with forests, meadows and pastures, while steeper slopes are often bare, covered with sparse forests or reforestation. The most eastern peaks are home to the only example of millenary forest in our region, found within the Sasso Fratino reserve in the Casentino Forest Park, recently declared a UNESCO World Heritage Site.

The flora typically found in this landscape is the same as that described for the Monte Modino sandstones (R8), which can be consulted for details.

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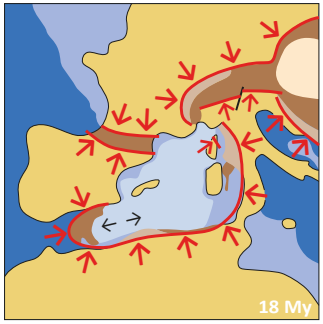


The fortress of San Leo (Rimini province)

R10 - Bismantova and San Leo Sandstones

The cliffs of Bismantova and San Leo, as well as that of S. Marino, are composed of biocalcarenite, a particular type of sandstone. This rock is comprised mainly of calcareous granules and fossil fragments of marine organisms. The latter were deposited on shallow sea beds where the sand was mixed, thanks to the currents, with the remains of marine organisms (fragments of sea urchins, shells of molluscs, shark teeth, etc..).

These sandstones are part of units referred to as Epiligurian since they were deposited, from the Middle Eocene (about 45 million years ago) onward, atop the oldest Ligurian units that represented the embryo of the newly-forming Apennines.

The Epiligurian units include rocks of different ages that form the substrate of a landscape marked by reliefs, frequently tabular in shape, bordered by steep slopes (cliffs) and rock faces (spurs), due to the greater mechanical resistance of this lithology compared to surrounding ones. The Pietra di Bismatova rock has a mesa profile with rock faces that exceed 100 metres in height. The crag of San Leo, together with San Marino, represents the most spectacular example of the geological landscape of the Marecchia valley: the rock faces, surrounded by clayey slopes, dotted with gullies and landslides, surround a large and in some points flat summit with an ancient hamlet and medieval castle.

From a floristic-vegetational point of view, the slopes present both rocky and woodland environments. Along the cliffs we find lichens, mosses and small crassulaceae plus herbaceous plants with beautiful blooms such as woodland pink *(Dianthus sylvestris),* rock soapwort *(Saponaria ocymoides)*, autumn squill *(Scilla autumnalis)* [23] and dwarf shrubs like helichrysum *(Helichrysum italicum)*. Dry wooded areas are home to xerophilous oak woods with downy oak *(Quercus pubescens)*, manna ash *(Fraxinus ornus)*, sorb tree *(Sorbus domestica)* and the rarer Montpellier maple *(Acer monspessulanum*). On the cool, damp slopes (mesophilic woods), the European hop-hornbeam *(Ostrya carpinifolia)* prevails, alongside turkey oak (*Quercus cerris)*, maple *(Acer)*, Cornelian cherry *(Cornus mas)* and common hazel *(Corylus avellana*) [24].

Ascending, this plant landscape often gives way to high, arid prairies dominated by grasses and punctuated by common jumper *(Juniperus communis),* broom *(Genisteae)* and sea buckthorn *(Hippophae rhamnoides).*

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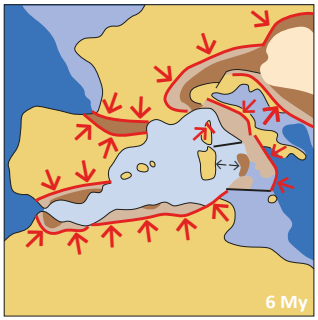


The Gypsum Vein of Romagna (Forlì Cesena province)

R11 - The messinian gypsum

This evaporitic sedimentary rock consists only of gypsum crystals, a salt (calcium sulphate dihydrate) that crystallizes by precipitation following the evaporation of seawater. The messinian gypsum of the Emilia-Romagna Apennines belongs to the gypsum-sulphur formation and documents a unique event in the history of the Mediterranean: the salinity crisis. In the Messinian age (between 7 and 6 million years ago), as a result of complex and still somewhat obscure reasons, the whole Mediterranean became isolated from the Atlantic, drying up several times and becoming a very deep white depression of salts (if it were isolated again today, it would dry up in just 1000 years!). The messinian gypsum is visible along a narrow strip that follows the Apennine margin in the areas of Reggio Emilia, Bologna, Imola and Faenza and in the Cesena hills, appearing as a ridge known as the Gypsum Vein. The landscape is characterized by cliffs, shaped by typical karst morphologies, with rare flora and fauna and evidence of ancient human settlements. Numerous gypsum quarries are located both Emilia and Romagna. The city of Bologna, too, has strong links with gypsum, which was used in the form of large square blocks for the construction of the first city walls in the third century AD. A well-known example of the use of gypsum as a building material is represented by the base section of the city's two most famous towers, the Garisenda and the Asinelli Tower. A decidedly warm, dry microclimate, with very scarce soil, characterises the top of the outcrop, which is populated by typical Mediterranean flora; the plants in question became established in our region during a warmer phase than the current one, and survived subsequent climate changes only in a few favourable locations.

We can easily spot oak woods of downy oak *(Quercus pubescens)* interspersed with broom *(Genisteae)* [25], French honeysuckle *(Sulla coronaria*) [26], Italian buckthorn *(Rhamnus alaternus)* and holly oak *(Quercus ilex*), which stand out in winter thanks to the dark colour of the evergreen foliage. These are flanked by other less showy species such as osyris *(Osyris alba*), cistus, heather *(Erica)* and evergreen rose *(Rosa sempervirens)*. The rock faces of the chalk cliffs are characterised by the colours of the lichens: crusty yellow patches of scrambled-egg lichen *(Fulgensia Fulgida)* and the green thalluses of cup lichen *(Cladonia convoluta)*. Alongside these we find compact cushions of mosses and the fern *Cheilanthes persica*, an exclusive relict species of Emilia-Romagna. At the base of the cliff, where soil accumulates by force of gravity, more developed plants grow, including helichrysum *(Helichrysum italicum)*, wild thyme *(Thymus serpyllum*) and white wormwood *(Artemisia alba*), plus numerous grasses and rare orchids.

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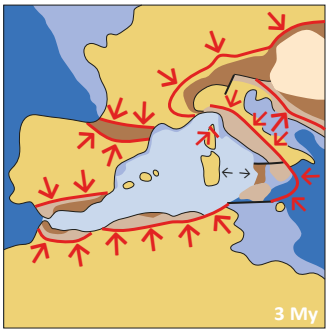
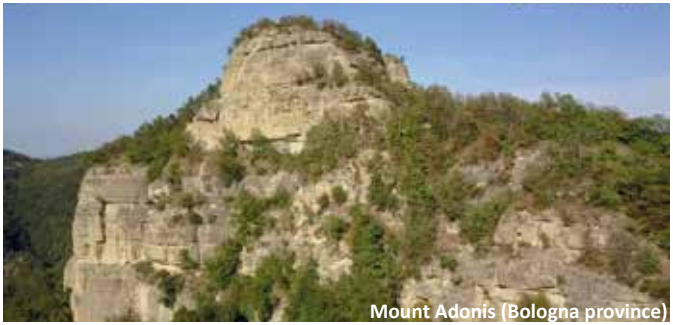




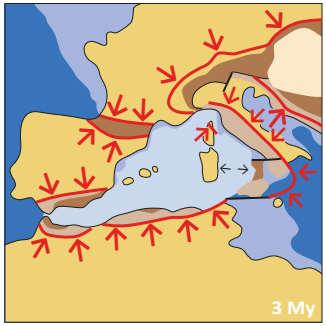
R12 - Mount Adonis sandstone

Mount Adonis, standing 654 meters tall, is the highest peak of the Pliocene Spur of the Bolognese Apennines. The term spur refers to the sequence of rock faces that cross the valleys of the Reno, Setta, Savena, Zena and Idice rivers, while Pliocene indicates the geological age of the sandstones that form these reliefs. These are cemented sedimentary rocks and sands characterized by a typical golden yellow colour, often containing marine fossils. These sandstones document the existence, in the Pliocene (between 4 and 2 million years ago), of a small marine gulf that snaked between the reliefs of the Apennine chain, which by then had largely emerged. After their sedimentation, these lithologies were later involved in the more recent lifting of the Apennines and today these sand deposits form part of the hills of Bologna. In addition to molluscs and other invertebrates, the Bolognese Pliocene Gulf was also the habitat of various species of cetaceans, whales and dolphins, the fossil remains of which are now preserved in the G. Capellini Paleontological Museum in Bologna. In terms of the landscape, the Bolognese Pliocene spur is marked by reliefs with the upper part frequently tabular, forming extensive summit plains, or cliff-shaped bordered by steep slopes and rocky escarpments.

Six forest habitats with European Community protection, including the most beautiful holm oak forests in the Apennine region, are evidence of valuable and varied, albeit quite young woodland environments. In dry wooded areas, xerophilous oak woods are home to downy oak *(Quercus pubescens)*, manna ash *(Fraxinus ornus)* [27], Sorb tree *(Sorbus domestica)* and the rarer Montpellier maple. On the cool, damp slopes (mesophilic woods) the European hop-hornbeam *(Ostrya carpinifolia)* prevails, and we find turkey oak *(Quercus cerris)*, maple *(Acer)*, Cornelian cherry *(Cornus mas)* and common hazel *(Corylus avellana)*. There is also a population of common beech *(Fagus sylvatica)*. The undergrowth reveals the most often localized presence of common herbaceous plants such as burning bush *(Dictamnus albus),* lily-of-the-valley *(Convallaria majalis,* butcher's-broom *(Ruscus aculeatus),* dog's-tooth-violet *(Erythronium dens-canis)* and spring snowflake *(Leucojum vernum)* [28]. It is estimated that the flora of the Bolognese Pliocene Spur numbers some 800-900 different species. Very well known and the subject of study is European feather grass *(Stipa pennata)*. EU protected species include some rare and endangered varieties of orchids, geophytes like the snowdrop *(Galanthus nivalis),* Alpine squill *(Scilla bifolia)*, and ferns *(Pteridophyta),* plus several leguminous plants linked to the clayey substratum.

[27]

[28]



R14 - Spungone formation

The term spungone refers to the spongy aspect of this rock that outcrops in the hills of Faenza and Forlì, between the Montone and Senio valleys. It is a biocalcarenite, namely a sedimentary rock that was formed by the accumulation of shells of marine organisms. The study of fossil associations has enabled us to attribute the unit to the mid-Pliocene and to characterise the environment in which these rocks were deposited. The warm sea that stretched from the edge of the Apennines to the Po basin had oxygen-rich, shallow seabeds. This marine area was quite diverse, with underwater ridges that in some cases reached the surface of the water, forming promontories and small islands, where environmental conditions favoured the growth of organogenic banks very similar to today's coral reefs.

The Spungone landscape is characterized by ridges, thin spurs and small light-coloured cliffs that stand out against the surrounding clayey slopes. There are many similarities, also in terms of vegetation, with what we described for the Bolognese Pliocene Spur and the cliffs of Bismantova and San Leo. The environments of the Spungone reveal a high level of biodiversity. The woods, almost exclusively coppiced, are dominated by downy oak *(Quercus pubescens)* and European hop-hornbeam *(Ostrya carpinifolia)*. The holly oak *(Quercus ilex*) appears in southern exposures (very rare), and turkey oak *(Quercus cerris)*, European hornbeam *(Carpinus betulus)* and small-leaved lime *(Tilia cordata*) in some especially cool areas. A gorge with markedly mesophilic flora is characterized by pteridophyte ferns *(Pteridophyta)* and the rare European bladdernut *(Staphylea pinnata)*. Typically Mediterranean shrubs include juniper *(Juniperus communis)*, tree heath *(Erica arborea)* and Phillyrea, also with monumental specimens, characteristic patches of cistus and an abundance of European spindle (*Euonymus europaeus*) and wild privet *(Ligustrum vulgare)*. Rocky gorges provide the ideal habitat for groups of ferns *(Pteridophyta*), typically Southern maidenhair *(Adiantum capillus-veneris)* and hart's-tongue *(Asplenium scolopendrium*), while in more open areas we find caper bushes (*Capparis spinosa*), rather unusually growing wild at these latitudes. Several protected species are present, such as the common snowdrop *(Galanthus nivalis)*, the tiger lily *(Lilium bulbiferum*) [29], the Carthusian Pink *(Dianthus carthusianorum)* and numerous members of the orchid family (*Orchidaceae)*. Finally, the very rare and somewhat bizarre-looking dragon lily *(Dracunculus vulgaris)* [30] has been documented about Cozzi creek.

[29]

[30]

After introducing us to some of the main rocks that make up the landscapes of Emilia-Romagna, the garden offers us the opportunity to broaden our horizons with a series of rocks from other regions of Italy. These are donations from institutions, parks and universities to the Seismic and Soil Geological Survey which, in addition to representing a sort of institutional twinning, allow us to enrich our experience and knowledge of geology without having to embark on an actual journey.

In this part of the garden, which we like to call exotic because it hosts rocks from other regions of Italy, there are: limestones from Trentino and Campania, sedimentary rocks that tell of ancient carbonate platforms, the famous marble of the Apuan Alps, a **metamorphic** rock unique in the Italian landscape, a series of magmatic rocks from intrusive Adamello tonalite to lava rock from Vesuvius and the complex of Roccamonfina. These rocks were formed in the same time interval that comprises the geological history of Emilia-Romagna and they provide an overview of the events that characterised the formation of the Italian territory.

Tuscany


R15


Apuan Alps (Massa Carrara province)

R15 - Marble of the Apuan Alps

The rock in the garden is an arabesque marble that comes from the quarries of the Apuan Alps (Provinces of Massa-Carrara and Lucca). Marble is a metamorphic rock that originated from the **recrystallisation** of organogenic limestones of the Upper Triassic period (between 228 and 199 million years ago) following processes linked to the formation of the Apennines. Starting with and from the Upper Oligocene (between 28 and 23 million years ago), the limestones were buried under the Apennine edifice being formed under conditions of high temperatures (350-450 °C) and high pressures (0.4-0.6 GPa) that determined its low-grade metamorphosis and transformation into the current marbles. The rising of the Apennine chain led to the emergence of the Apuan Alps characterized by a typically alpine landscape, characterized by deeply carved valleys.

Apuan marble has been extracted since Roman times and today there are over 140 quarries in this area with a total production of about 1,200,000 tons per year. Known as one of the most precious marbles in the world, it is used for the creation of prestigious coverings and important sculptural works which have left their mark on art history worldwide.

Trentino Alto Adige

R16 - Rotzo formation and Lithiotis facies

In the garden there are two boulders that represent the typical lithology of the Rotzo Formation: on the left, R16, is a marly limestone, clearly stratified, which characterises the base of the formation; on the right, R17, a bioclastic limestone, rich in fossils of the bivalve Lithiotis, is the lithotype that is found on the roof of R16. This rock outcrops extensively in Trentino and locally in Friuli Venezia-Giulia and Veneto. The environment in which these rocks are formed coincides with a large area of the **carbonate platform**, known as the Trento Platform, an underwater relief which in the lower Jurassic (about 200 million years ago), separated two deep sea basins located in correspondence with present-day Lombardy and the Belluno area. In particular, the rock is made up of carbonate sediments, rich in bivalves and foraminifera (plankton), which settled in a tropical environment characterized by isolated lagoons and tidal plains with shallow waters. In terms of environment and time of sedimentation this rock is almost homologous and contemporary to the limestone from which the Apuan marbles derive, but geologically involved in the **orogenesis** of the Alps.


R16


R17


Adamello (Trento province)

R17 - Tonalite

Tonalite takes its name from the Passo del Tonale (Tonale pass) where it was first documented. This is an intrusive magmatic rock that was formed by the solidification of magma inside the earth's crust during the Alpine orogenesis. Light grey in colour, it consists of feldspar, quartz, biotite and hornblende minerals. It constitutes the Adamello-Presanella Massif located in the heart of the Alps, between Trentino and Lombardy, and is widely used in the historic buildings of western Trentino.

The Alps are the result of the collision between the continental plates Europe and Apula (portion of the African plate), a process that began during the Middle Cretaceous (about 80 million years ago) and persists today. The collision caused the subduction of the oceanic crust that separated the two plates, determining the fusion of rocks deep below the crust and their rise, like magma, in correspondence with fractures in the continental crust. The slow cooling of the magma, just below the earth's surface, and pressure variations are the conditions that allowed the formation of the well-crystallized minerals that we observe in the tonalite in the garden.

Campania

R18 - Somma Vesuvio Volcanic Complex lavas

The volcanic complex of Mount Somma-Vesuvio consists of lava rich in potassium (leucitic tephrites and tephrites) with clearly recognisable leucite minerals, consisting of large crystals also of a greyish-white colour. The two rocks in the garden come from two different flows: one relating to the flow of the Caposicchi eruption of 1834 (municipality of Terzigno), the other dated to about 8000 years ago, comes from the town of Ottaviano. The Somma-Vesuvio complex is a medium sized somma-stratovolcano which became active around 400,000 years ago.

Mount Somma was the ancient volcano whose summit collapsed, generating a caldera. Vesuvius grew in this caldera 25,000 years ago. The eruption of Vesuvius in 79 AD, which destroyed Pompeii, Herculaneum and Stabia, is without a doubt the best known volcanic eruption of all. The event was described by Pliny the Younger in two famous letters sent to Tacitus that can be considered the first treatise on vulcanology. The last eruption of Vesuvius was in 1944.


R18


R19


Mount Somma-Vesuvio (Naples province)

R19 - Roccamonfina Volcanic Complex lavas

The rock is a lava rich in silica, sodium and potassium (leucitic tephrite) that comes from the village of Roccamonfina (Caserta province), located on the slope of the extinct crater from which it takes its name. The volcanic complex of Roccamonfina is a volcanic layer formed by the alternation of lava and pyroclastic deposits whose activity is documented until at least 50,000 years ago. This volcano, like all the others that characterize the Tyrrhenian area from Tuscany to Campania, documents the intense volcanic activity which, starting from the Pliocene (5 million years ago), characterised the final phase of the formation of the Apennines and is closely linked to the opening of the Tyrrhenian Sea.

Roccamonfina has become internationally renowned thanks to the discovery in this area of the oldest documented hominid footprints, called Ciampate del Diavolo, or Devil's Footprints. The footprints belong to at least three individuals of Homo heidelbergensis, early humans who lived in the area about 350 thousand years ago and were left in a hot pyroclastic flow whose rapid cooling and setting has allowed the footprints to be preserved to this day.

R20 - Roccarainola Limestone

This limestone comes from the southern slope of Mount Fellino, in the municipality of Roccarainola in the province of Naples. It belongs to a succession of limestones and dolomites, about 3000 metres thick, that formed during the Cretaceous.

The origin is due to the deposition, in a shallow sea, of hard parts of calcareous skeletal organisms and chemical processes resulting from biological activity. To understand the environment in which this rock was formed, it is suffice to imagine how during the Mesozoic period and into the Cenozoic period, the area between the current island of Capri and the Gargano in Apulia was characterized by a series of carbonate platforms (shallow areas) separated by deep sea basins. From the Miocene, the deposits of the carbonate platforms and adjacent sea basins were involved in the tectonic processes which led to the formation of the southern Apennines and now form their backbone.

The Roccarainola limestone was used by the ancient Romans for the construction of buildings and roads in Pompeii.


R20


R21


Mount Taburno (Benevento province)

R21 - Vitulano marble

The marble of Vitulano became famous in 1700 when the architect Luigi Vanvitelli used it to embellish the spectacular staircase of the Royal Palace of Caserta, the palace of King Charles III of Spain. The rock is made up of calcareous clasts in a bauxitic matrix of a predominantly grey-red-brown colour. The block on display comes from the Rosso Uria quarry known as Vanvitelli Quarry (Benevento province). The original limestone was formed from the deposits of the so-called Apennine Carbonate Platform, formed by powerfully thick limestone-dolomite rocks, deposited in a shallow sea environment between the Upper Triassic and the Upper Cretaceous. Following the tectonic phases linked to the orogenesis of the South Apennine chain, these deposits were dismembered into different tectonic units and raised to the surface. Exposed on the surface, they were affected by karstification, i.e. by the development of cavities that were subsequently filled with calcitic **cements** and **bauxitic** deposits. Vitulano marble is the most prized ornamental stone in all of Campania: its chromatic variability makes it particularly beautiful.

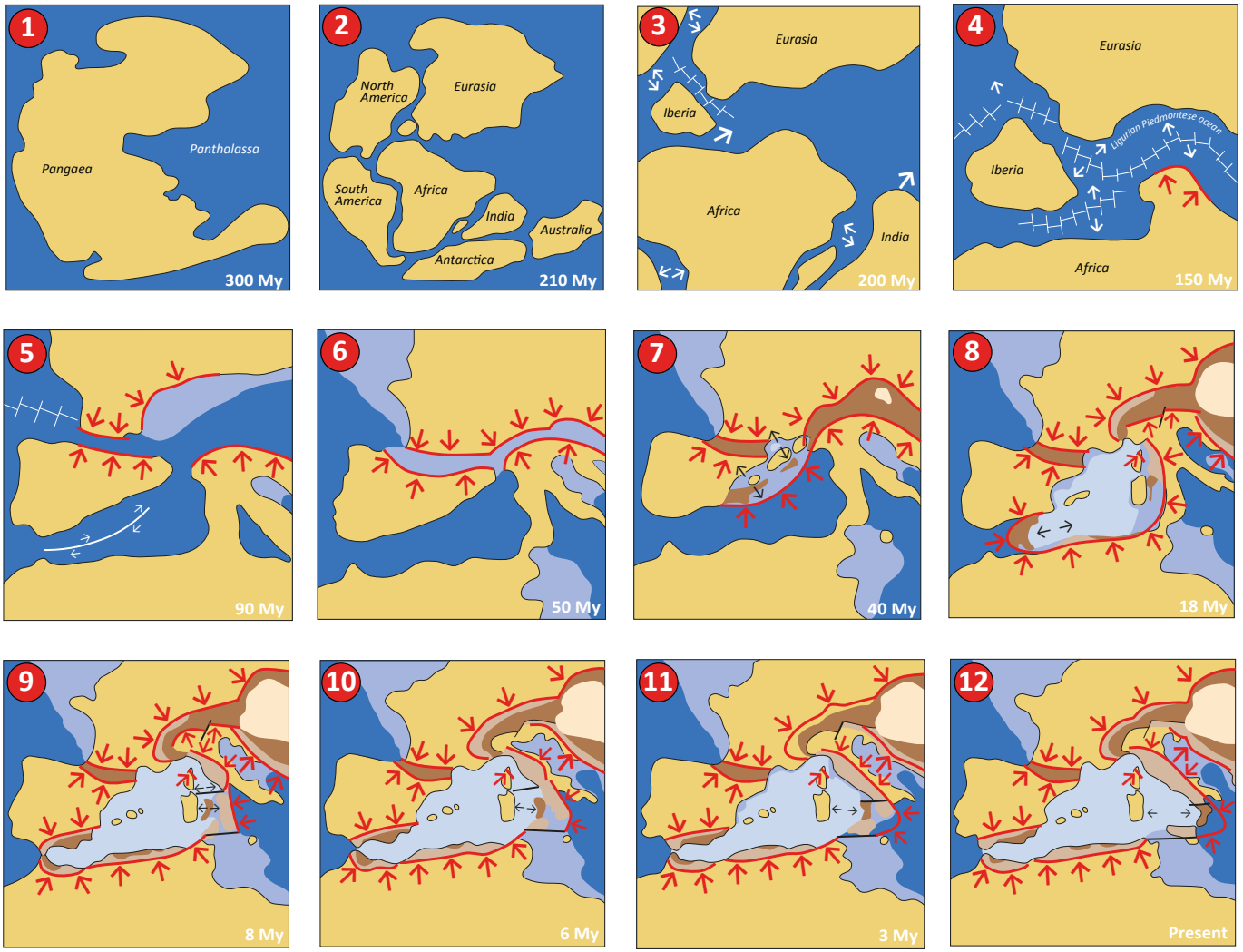
Now make yourself comfortable, close your eyes and let your perception run free. Even if you still don't feel anything, give yourself time, slowly you will reconnect with all your senses and, with them, the awareness of your body and breathing. You will suddenly feel serene. In this way, you can achieve the ideal state to project your mind into another dimension, another time.

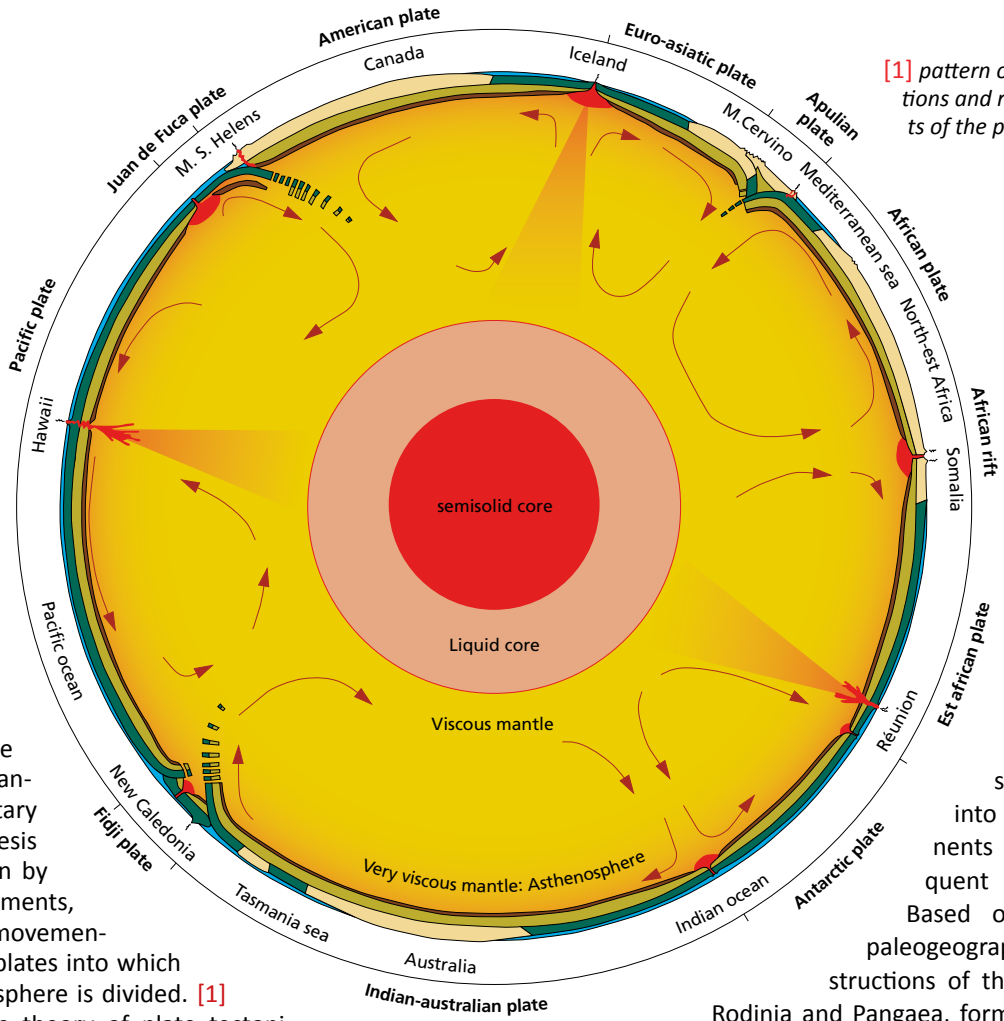
We want to lead you in the discovery of deep geological time, exploring how what today appears static and immutable, like rocks, is, on the contrary, subject to a whirling evolution.

Just as a starry sky has infinite charm but makes us suddenly feel small and alone, so geological time makes us grasp the profound meaning of life and reassess our feelings, making us aware that what surrounds us has never been and never will be the same. In this dimension rocks are formed, transformed, deformed, destroyed and regenerated in a continuous flux where beginning and end lose all formal value.

The garden captures a fragment of such a flux that coincides with the geological history of Emilia-Romagna. A story still unfolding that is a little chapter in the history of planet Earth!

GEOLOGICAL HISTORY



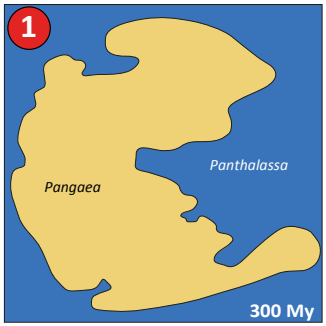


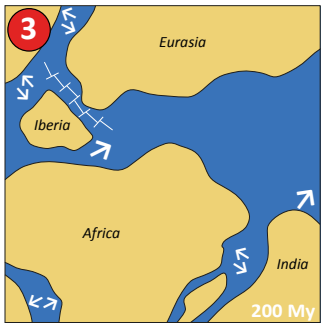
[1] *pattern of convective motions and relative movements of the plates*

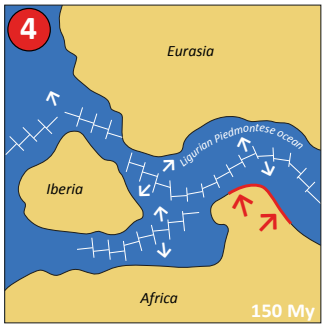
Whatever their origin - volcanic, **sedimentary** or metamorphic - rocks are subject to physical and chemical processes that, over geological time, determine continuous changes. On a planetary scale, the genesis of rocks is driven by tectonic movements, i.e. the relative movements between the plates into which the earth's lithosphere is divided. [1] According to the theory of plate tectonics, plates move over the asthenosphere and can collide (convergent boundary), sliding one next to another (transform plate boundary) or move away from each other (divergent boundary). For this reason, throughout the history of the Earth, the extent and shape of the continents and oceans have undergone major transformations. The most evident manifestation of this dynamic is orogenesis, that is to say the formation of the mountain chains that constitute the physical expression of the engagement of tectonic plates. Over the course of geological time, a long succession of orogenic events occurred, giving rise to the various supercontinents into which the landmasses periodically converged.

John Tuzo Wilson (1908-1993) was responsible for the theory describing the cyclical formation of a supercontinent, its subsequent dismemberment into plates/continents and its subsequent recomposition. Based on this theory, paleogeographic reconstructions of the continents of Rodinia and Pangaea, formed respectively 750 and 300 million years ago, have been completed, as well as scenarios on the future evolution of planet Earth that hypothesise the return of a new Pangaea in 250 million years.

In the geological history that we are going to recount, we return again to the rocks in the garden, retracing their formation stage by stage and their positioning in situ brought about by internal tectonic forces and phenomena acting on the Earth's surface. They will be the guiding elements that allow us to reconstruct the geological processes that led to the formation of the territory of Emilia-Romagna.





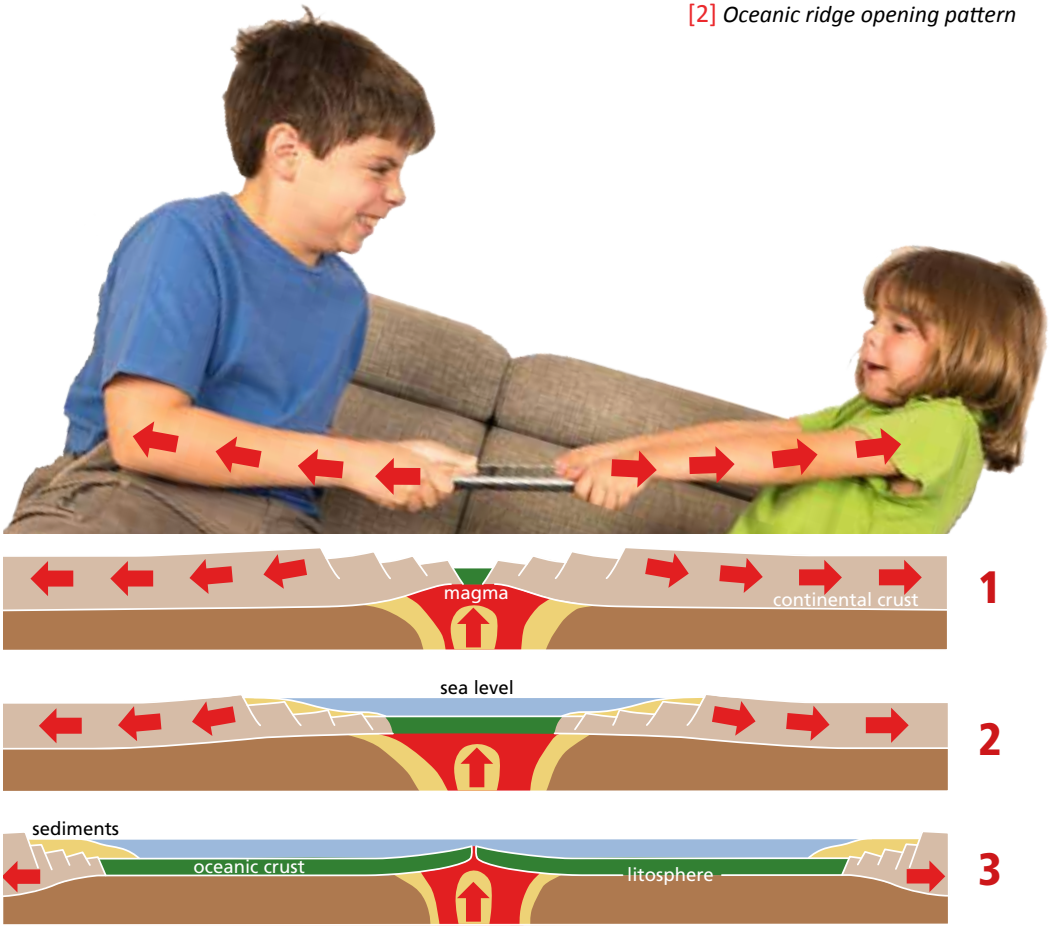


The story begins with the supercontinent of Pangaea, formed by all the Earth's landmasses joined together, represented by a fragment on display in the garden: the R01 Palaeozoic granite. These granites, from 300 million years ago, come from the heart of the mountains that were formed as a result of the Hercynian orogenesis, which occurred between the Carboniferous and Permian (350-250 million years ago). An orogenesis that occurred after the collision between the great continental masses resulting in the single continent of Pangaea (which in Greek means 'unic land'), surrounded by the vast ocean Panthalassa (meaning 'all seas'). 1

In the late Triassic period (about 210 million years ago), the supercontinent Pangaea began to fragment into large **plates** and new continents were formed, including Eurasia and Africa. 2

The break-up of Pangaea led to the formation, in between the new continents, of sea basins that were destined, many millions of years later, to become oceans.

[2] *Oceanic ridge opening pattern*



Triassic evaporites (rocks of group R02) document the fragmentation of Pangaea. In particular, Quartz sandstone is the last sediment deposited on Pangaea, while Cavernous Limestone and Evaporites of Burano record the deposition of sediment in a shallow sea or in the sea basin then forming.

During the entire Jurassic period, the progressive separation between Eurasia and Africa led to the deepening of the marine basin and the consequent deposition, on the evaporites, of thick sedimentary successions typical of deeper marine environments. These sediments today constitute the imposing rocky sequences of the Mesozoic age (250-65 million years old) that can be observed in Tuscany, Liguria and the central Apennines but that, except for a few sporadic strips, do not outcrop in Emilia-Romagna.

During the Jurassic period (about 200-150 million years ago), the Piedmontese Ligurian Ocean was formed between the African and Eurasian plates, an offshoot of the great Tethys ocean, so named because of its original position between the present-day Piedmont and the Ligurian Sea. 3 4 [2]

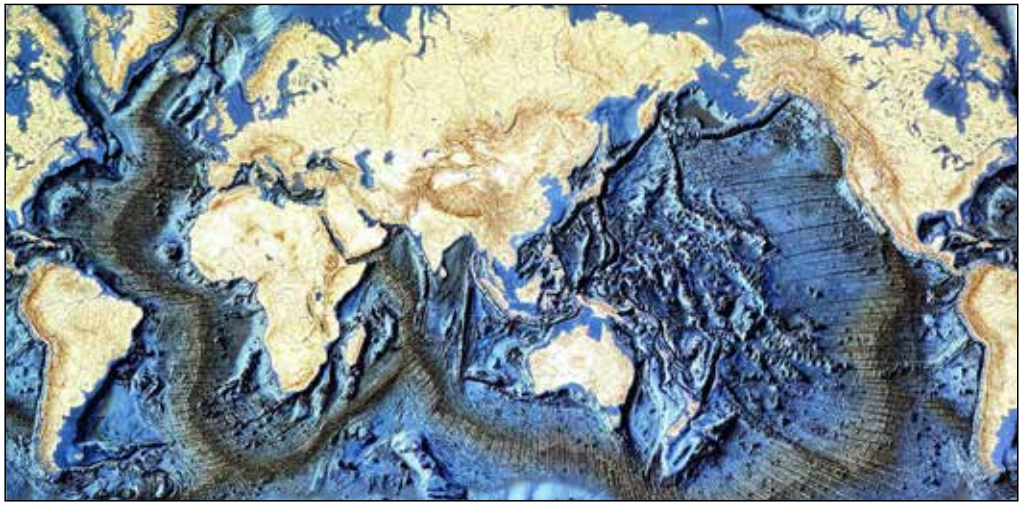
The existence of this ocean, which has now disappeared, is documented by the presence, even in our Apennines, of scraps of oceanic crust, i.e. remains of the ancient ocean floor, known as ophiolites (rocks of the R3 group). These are magmatic and metamorphic rocks formed in contexts like the current mid-oceanic ridges, the chains of submarine volcanoes that characterise the Earth's oceans. In these environments, oceanic crust forms continuously thanks to magma which rises from the mantle and solidifies quickly. [3]

Above the crust, fine sediments typical of a very deep-sea environment were deposited, such as those that gave rise to red jaspers (one of the rocks of the group R03) and marly limestone as the Palombini Limestone (rock R04).

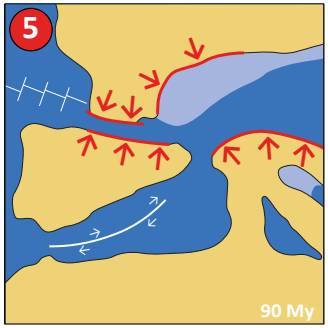
The Ligurian-Piedmontese Ocean continued to expand until it reached its maximum width (800-1000 km) in the mid-Cretaceous, about 90 million years ago. From this moment on, following the reversal of the direction of movement of the plates, the ocean slowly closed and Eurasia and Africa progressively moved closer together. 5

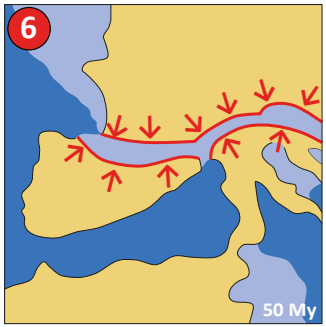
This triggered the start of **subduction**, i.e. the sinking of the oceanic crust of the Eurasian plate below the African continental plate. Subduction is a phenomenon that still occurs today in correspondence with oceanic trenches, that is to say, long, narrow depressions that border the edge of the plates (the most famous oceanic trench is that of the Mariana, which is almost 11,000 metres deep). [4]

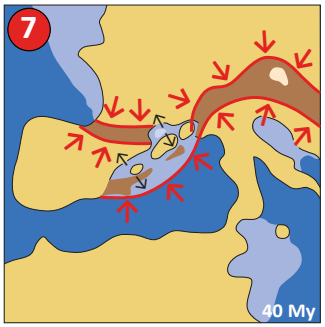
As if transported on a treadmill, the sediments deposited on the bottom of the ocean were gradually raked up, accumula-

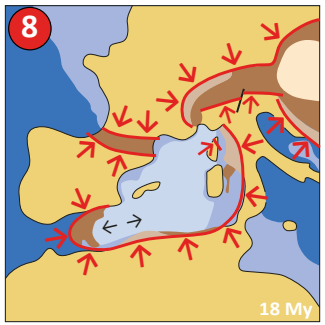


[3] *Map of medium oceanic ridges*









ting at the subduction zone (oceanic trench) formed along the edge of the African plate. A complex of geological units thus formed, superimposed one on top of another, known as Ligurian Units (because they formed in the Ligurian Ocean).

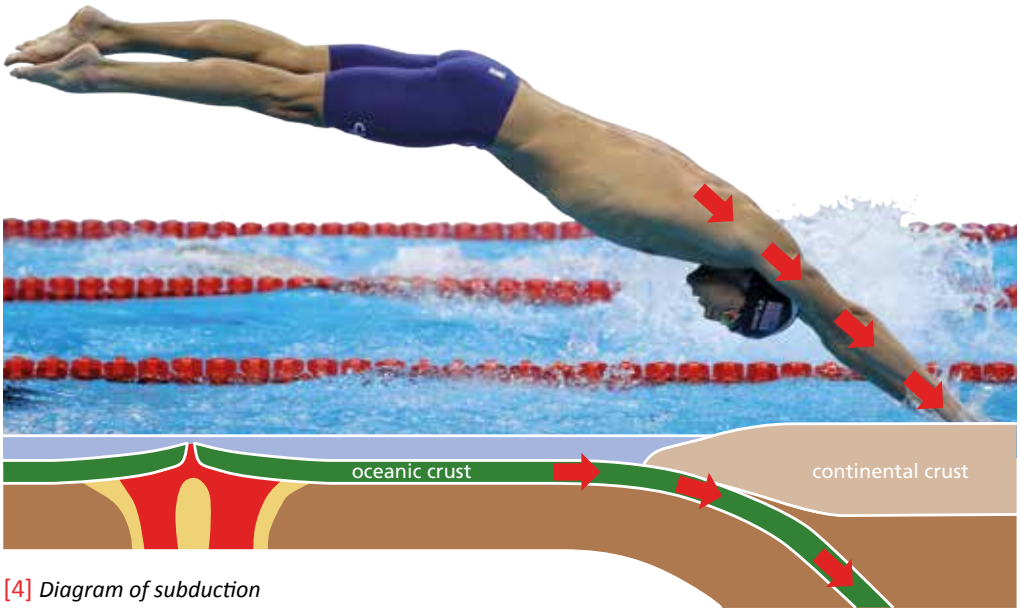
For millions of years, sedimentation in the Ligurian-Piedmont Ocean continued simultaneously with subduction in a context of tectonic instability due to the progressive rapprochement of the two plates. This led to the formation of mountain reliefs which, as they emerged, were subject to erosion. The eroded sediments were transported to the sea by watercourses and deposited on the ocean floor in thick successions of rocks called **turbidites**. The conglomerates of the Devil's Jumps, the Helmintoids flysch and the Bishop's Knots limestone (rocks R05, R06 and R07) document this troubled phase of formation of the Apennine edifice.

During these phases of strong compression, the Ligurian Units were pushed for several kilometres, subjecting them to intense deformations. 6

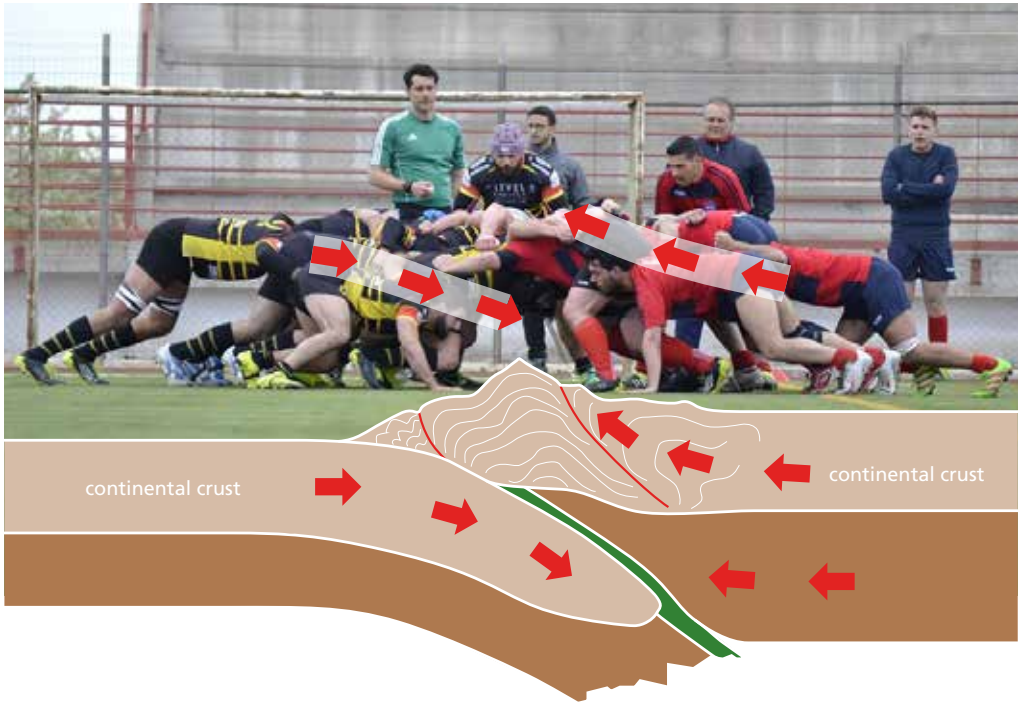
Only in the middle Eocene (about 45 million years ago) did the Ligurian-Piedmontese Ocean close definitively, and the continental collision between Africa and Eurasia begin. 7

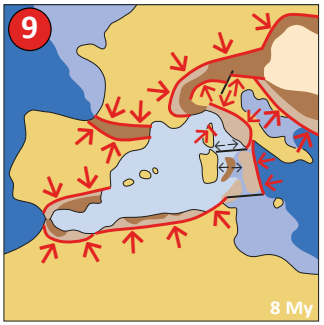
This moment marked the start of the Alpine-Himalayan orogenesis, that is to say, the event that gave our planet its present-day appearance. The collision of the margins of the two plates produced a complex system of mountain ranges stretching from the Mediterranean to Asia which includes, in addition to the Alps and the Apennines, the Pyrenees, the Dinarides, the Balkans, the Caucasus and the Himalayas.

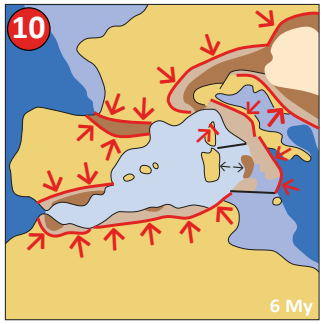
The orogenesis of the Apennines occurred just after that of the Alps and was determined by



[4] *Diagram of subduction*







[5] *Diagram of continental collision (orogenesis)*

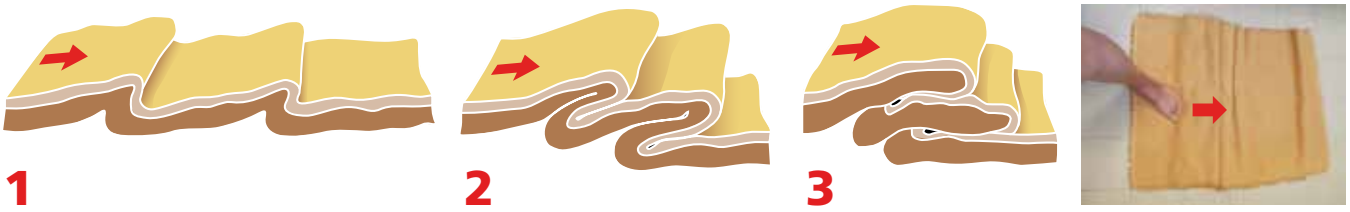
two tectonic events: the separation of Corsica and Sardinia from the European plate, with the opening of the Balearic basin, and the subsequent opening of the Tyrrhenian Sea. These processes acted simultaneously with the subduction of the African plate below the Eurasian one.

About 30 million years ago, Corsica and Sardinia began to move away from what is now the Franco-Spanish coast (to which they were attached) by turning counterclockwise. The rotation occurred as if the two islands were leaning against a door that began to inch open, a door whose hinges were in the centre of Liguria. This movement continued until about 16-18 million years ago when the two islands reached their present position. 8

The Corsica-Sardinia block rotation generated compressive thrusts which were responsible for the formation of the typical fold and thrust belt of the Apennines. This structure features juxtaposed levels, where the oldest strata are stacked on top of the most recent. In this manner, the developing Apennine chain gradually moved from south-west in a north-easterly direction, until it assumed its current position and configuration.

Let's try to visualize this process. Imagine taking an running jump onto a rug. The rug will bunch up into folds: the thickest fold will be close to your foot and will tend to fold over itself, while the smaller folds will be farther on. After folding, two things can be observed: the rug doubles its thickness and the upper side folds over the lower side. Similarly, in the northern Apennines, compressive pressures have led to the stacking of the rock strata one above the other, producing an increase in the thickness of the crust, from hundreds to thousands of metres, and the formation of inverted folds with younger rocks buried by older rocks. [6]

For many millions of years, sedimentation and orogenesis proceeded together and the Apennine chain continued to grow. The sedimentation occurred both in the developing chain (Epiligurian basins) and in deep basins developed in front of the



[6] *Simplified diagram of the evolutionary process of aquifers*

chain. In these basins, called foredeep basins, huge amounts of sediment from the erosion of the Alps (already emerged) and the developing Apennines were deposited by turbid currents. The foredeep basins were elongated in shape, trending from north-west to south-east, similar to the present Adriatic and its northern appendix, the Po Valley. With the continuation of the orogenesis, the first foredeeps (rock R08 - Monte Modino sandstone) were incorporated into the chain and other younger, more external ones were formed in an almost continuous process that is still ongoing. [7]

In the garden, rock R09 (Marnoso-Arenacea) represents the deposition of turbiditic sandstones in a **foredeep** that was incorporated by the front of the forming Apennine chain during the Miocene, about 7 million years ago. Rock R10 (Bismantova and San Leo sandstone), on the other hand, documents the deposition of turbidite sediments in the Epiligurian basins starting from the middle Eocene.

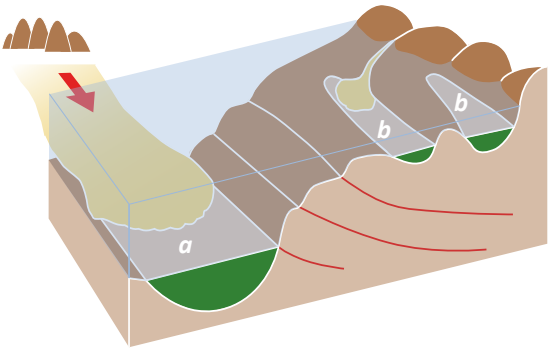
The emergence of the Apennines and their current structure is due to another important geodynamic event: the opening of the Tyrrhenian Sea about 7-8 million years ago, which started during the Upper Miocene and in still ongoing. 9

In the Messinian era (between 6.5 and 5.3 million years ago), when the newly formed Apennines were lapped by a large marine gulf, the whole Mediterranean area was upset by the so-called salinity crisis, an extraordinary event caused by the temporary closure of the Strait of Gibraltar. 10

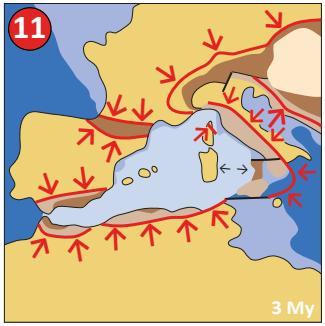
The sudden evaporation and the lack of new water supply quickly transformed the Mediterranean into a large salt-pan where powerful layers of salt and chalk (evaporated) were deposited. Today these layers outcrop along the Apennine margin from Reggio Emilia to the border with the Marche region (rock R11), forming the so-called chalk vein. [9]

When the link between the Atlantic and the Mediterranean was restored, the sea returned to occupy the seabed on which the evaporites lay.

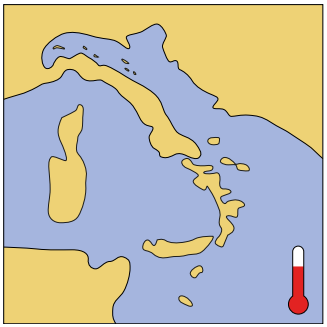
This takes us to the start of the Pliocene (about 5.3 million



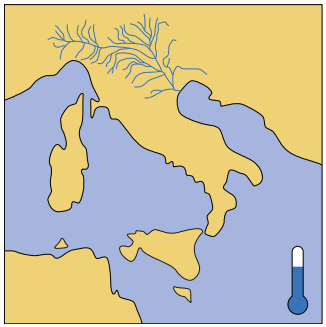
[7] *Deposition of turbidites in the foredeep (a) and in Epiligurian basins (b)*



[9] *Salinity crisis (6.5 My)*



[10] *Coastline in the Pliocene*



[11] *Coastline in the Pleistocene*

years ago), when the Emilia-Romagna landscape featured a hydrographic network similar today's, with waterways, running almost parallel, flowing across the chain and into the sea where they discharged copious sediments eroded along the way. 11

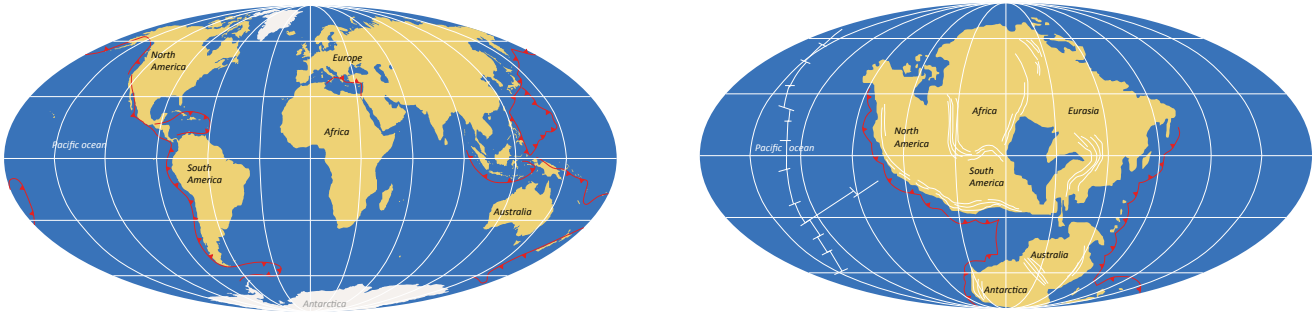
The sediments that now outcrop along the Apennine margin were deposited between the Pliocene and Pleistocene. This succession of fossil-rich sediments (rocks R12, R14 dated between 3 and 2 million years ago) document the progressive filling of the marine gulf by rivers moving from deep marine to coastal environments, all the way to river environment. [10]

Starting from 800,000 years ago, at least 4 important glaciations alternated with hot periods that caused fluctuations in sea level between -100 and +20 metres compared to the current level. Just think, about 18,000 years ago the Adriatic coastline and the Po delta were located where San Benedetto del Tronto stands today. [11]

These last, important events are documented by the sediments present in the subsoil of the plain, which have been studied in-depth over the last 20 years.

The orogenesis is still in progress and the Apennines continue their evolution, pushing towards the coasts of Dalmatia at a speed of 4-5 millimetres per year. The Po plan - Adriatic Sea system is in fact the last present-day foredeep basin whose evolution continues within the framework of the Apennine orogenesis. The seismicity of the Apennines and the Emilia-Romagna plain derives from this dynamic. The real front of the mountain range is buried underground, and does not coincide with the morphological hill-plan boundary but continues northwards as far as the river Po and beyond.

The Africa-Europe collision is not over. Currently the speed of movement is measured at about 3 cm per year and the Mediterranean basin is destined eventually to close, which gives us an idea of how the Earth might look in the future! [12]



[12] *The Earth of today and the Earth of the future (next 250 million years) according to the reconstruction by C.R. Scotese*

The Earth appears, from the pages we have read so far, as a living and extremely changeable creature continuously shaped by the weather, heat and frost, modelled by wind and running waters. Each stone experiences a childhood, a youth, a maturity and an old age before being reborn as a completely different rock. The underground phenomena that lead to the genesis of caves, hot and cold springs, metal deposits and volcanic eruptions are great phenomena that are truly awe-inspiring and remind us of the importance of the earth.

on which we live, as the very existence of humanity and other life forms depends on it.

Humanity unconsciously recognizes the importance of its intimate relationship with nature, which is expressed above all by its desire to dominate over creation through a process of crop and animal farming that has lasted millennia. The most striking expression of his hegemony is represented by the garden, a space whose natural appearance is wholly deceptive, as it was designed as an artefact and has accompanied evolution and history in its various forms since ancient times.

THE ORIGINS OF GARDENS

Between Heaven and Earth

In all traditions, gardens are a manifestation of the cosmos, of time and nature, as they represent a space that provides an instinctive connection between man and nature. In prehistoric times, there were no gardens and the cosmos, time and the divine were represented on earth with megaliths. Megaliths (from the Greek *mega* = large and *lithos* = stone) are very common stone artefacts in European prehistory. Essentially, megaliths can be of two types: erect stones (stelae or menhirs) and dolmens. Stelae and menhirs can be of any size (up to 20 metres high) and have been found arranged according to various alignments and plans (circular, rectangular, elliptical, oval, etc..). Dolmens are made up of multiple slabs embedded in the ground, supporting one or more roofing slabs. A wide variety of dolmens have been found, taking various forms, from a small house to a long tunnel.

In the past, thaumaturgical and talismanic powers were often attributed to stones. Man's instinct perceives a mystical significance in the enduring beauty of stones, be they monoliths or gems. This magical aura also translates into the belief that stones are the vehicle of the influence of the stars. Thus, in the imaginations of many peoples, the celestial and earthly worlds find a profound, though totally artificial, connection. So a small stone becomes an amulet, from the Latin *amuletum* (from amoliri, to move away) and therefore wearing it affords passive protection. If activated by an engraved symbol, or by a prayer, a ritual becomes a talisman (from the Greek *telesma*, consecrated thing), acting earnestly based on the qualities it is deemed to possess, which might also be medical-therapeutic.

Only with the appearance of the first civilizations was the idea of a garden born and stone evolved towards construction uses.

The etymology of Paradise

The term garden has Indo-Germanic origins (*Gart*, *Hart* or *Ghordho*), meaning fenced, surrounded. It indicates a non-natural landscape composed of objects and living beings that are part of the environment: it meets requirements dictated by man, but is not a man-made product in the same way as an artefact or a building. It represents the projection of human will on an apparently spontaneous environment, proposing an analogous relationship between man and divinity in which, in this case, it is man himself who stands as creator. Indeed, a garden is like a mirror that reflects the soul of its creator or owner, revealing his personality and culture and that of the civilization that produced it. The perfect garden is distant and unattainable, it remains in that ideal sphere where the desires, hopes and needs of man find refuge. The terms 'garden' and 'paradise' have a common linguistic root.

The term paradise comes from the ancient Persian *pairi-daéza* which means fenced park or private garden of kings. The late Babylonian term *paradisu* is nothing more than a linguistic variant of *pairi-daé-za* and can literally be translated as fence, circumscribed terrain. The Hebrew word *pardes* and the Greek *paradeisos* have the same meaning and also define the private gardens of the Persian kings. These gardens must have appeared as a place of delight to a population living in a desert territory. The fence and consequently the gardens' inaccessibility, made them even more coveted, which is how the gardens became paradise. Paradise exists somewhere and, in the popular imagination of the day, it resembled the private gardens of Persian kings.

This motif is taken up in the representation of heaven in the Old Testament, with a description that begins "And the Lord God planted a garden in Eden, in the east, and there he put the man whom he had formed" (Genesis 2:8). Man has the role of gardener-creator: Adam, the man of clay (from the Hebrew *adam*, meaning man made of red earth) is placed in the garden to take care of the divine creation.

In the book of Genesis, Eden is more precisely defined as the source of four rivers that irrigate the garden. The rivers are the Euphrates, the Tigris, the *Gihon* and the *Pishon*, although the last two appear on no map and efforts to locate them have failed, frustrating bids to identify this sublime place on Earth. It was believed that the two unknown rivers could be found in a land yet to be discovered: after all, God had created the Garden of Eden for men. Was it perhaps a continent, crossed by four rivers and then divided?

It is worth mentioning that the unknown rivers *Pishon* and *Gihon* were as long and mighty as the Euphrates and the Tigris; it was a divine continent and in fact the Babylonian kings of the third century B.C. called themselves the Kings of the Four Quarters, the latter referring to the four corners of the Earth, at the centre of which was the fountainhead of the spring of life, the source of the four rivers. This is where the basic plan outlining the garden with a fountain in the middle originates. The Persian garden is exemplified in the *Chahar Bagh* style, a quadrilateral garden layout divided into four parts arranged in a cross and bordered by irrigation channels. Persian rugs represent the *Pardes* with colourful and sublime images.

Carpet-like gardens and garden-like carpets imply a dialogue between the interior and exterior worlds. This ideal model of eastern garden and the private gardens of the Babylonian kings (a Persian cruciform garden model) was absorbed into Roman tradition through the Hellenistic culture of house and garden, the same culture that fuelled the creation of Arab-Saracen gardens. Islamic gardens, those of Alhambra and those of the Taj Mahal, descend from Persian paradises but reflect the passion for geometry, abstract forms and above all for the religious and philosophical symbology typical of Muslim art. All this was to influence the basic structure of western convent gardens.

Classical literature and gardens in antiquity

In the fourth song of Homer's Odyssey, the Elysian Fields, home of the blessed, are bordered by the sea and are located on an island in the western ocean, on the edge of the world. This island is not accessible to mortals, but only to heroes, who can live by the grace granted to them by the gods, such as Menelaus. In this case we cannot yet speak of a real garden, but rather of a paradise on Earth, where the deceased can spend their life in eternal joy. Even if Ulysses cannot enjoy it, as a living being, he can cross the threshold of the Garden of Alcinous, king of the Phaeacians and father of Nausicaa as told in the seventh canto of the Odyssey.

A wealth of information on vegetable gardens and gardens has been handed down to us by ancient Roman authors. Cato recommends plants to be planted in the garden just outside the walls (*sub urbe hortum*) and Seneca describes the urban villa garden (*rus in urbe*) as a place of rest and walking. The path (*ambulatio*) that runs between flowerbeds (*gestatio*) and bushes connecting the pavilions (*dietae*) becomes a fundamental architectural element. A noteable *rus in urbe* was that of Lucullo, who had a villa built on the Pincian hill: the hill of gardens (*collis hortulorum*). The Lucullan gardens (*Horti Luculliani*) lstretched between the current Spanish Steps and Villa Borghese, with a series of terraces and steps overcoming the different heights of the land.

In reference to gardens, Cicero uses the term *cultus*, endowed with dual meaning: cultivating one's own garden also enriches the spirit and soul.

Columella in the 2nd century after Christ, describes the state of mind required to tend to a garden: "As soon as the earth is ready, combed and smoothed, it will ask for seeds, then paint it with different colours, like stars on the ground, plant white stock, golden asters and then daffodils and snapdragons next to the white chalices of flowering lilies, also hyacinths, as white as snow or as blue as the sky. Plant violets - one will slide to the ground, the other will grow straight, pointing the sun. Lush in purple and gold - and don't forget the timid rose."

Quintus Curtius Rufus in the second century after Christ writes: "near the gardens of Babylon there are hanging gardens, a wonder celebrated in the tales of the Greeks [those of Ctesias ed]. They are located on the top of the citadel and made charming by the shade of lofty trees. Columns of stone were set up to sustain the whole work, and on these was laid a floor of squared blocks, strong enough to hold the earth which is thrown upon it to a great depth, as well as the water with which they irrigate the soil. And the structure supports trees of such great size that the thickness of their trunks equals a measure of eight cubits. They tower to a height of fifty feet, and then yield as much fruit as if they were growing in their native soil."

The garden of the dead

The idea of presenting cemeteries as tree-lined gardens dates back to ancient times. Archaeologists in Athens discovered that the *Kerameikos* cemetery was conceived as a sacred grove, a place where the dead could find peace. Plato in the twelfth book of his Laws (*Nomoi*) places the emphasis on the fact that a man who has committed himself to the welfare of the state must be granted the privilege of resting in a tomb surrounded by trees. These traditions were most likely grasped upon and developed in the Middle Ages, so much so that the cemetery adorned with trees can be considered a specific type of garden for convent use. The form and the concept of rest and serenity associated with burial resting in a sacred, sacrosanct garden still endures in Mediterranean style cemeteries.

Sacred woods and enchanted gardens

Nature is conditioned by the cycle of the seasons and therefore reflects in its form and progress a cosmic order that seems to us almost supernatural.

In ancient times, for example in Etruscan culture, woodlands were sacred and initiatory places within which clearings constituted secret areas that allowed a vision of the sky. Clearings were the *Lucus* (with the original meaning of "forest clearing where sunlight comes"), the sacredness of the Greek *alsos* (similar to *Lucus*) extended to the cult of trees (in shrines in Greece it was forbidden to cut cypresses). The sacred forest (*nemus* or *nemos*) became the fence, dwelling place of supernatural beings. In this mystical plan, the elements consisted not only of trees, but also of a hill, a cave, some stones and a spring. Architecture transformed the fence of plants into masonry, the cave became the apse and the ceiling interpreted the sky, with the aisle leading the faithful to salvation. The temple was a landscape in stone.

In the Middle Ages, with the return to the primitive image of nature, the sacred concept of the forest assumed antithetical meanings: either Earthly Paradise (*Hortus conclusus*) or Dark Forest. A place of spirituality or perdition, populated by monsters and fantastical beings who add to or replace or even re-propose, no longer in a pagan guise, the rural divinities of antiquity. The *Hortus conclusus* was the typical form of a medieval garden, characteristic of monasteries and convents: sacredness was transferred from the open place to a protected area surrounded by high walls where the monks essentially cultivated plants and trees for food and medicinal uses. It combined the Roman idea of *Hortus* or small plot of land where vegetables were grown, and the idea of a garden and/or *impluvium* of the Roman *domus*, namely that part of the house used for the cultivation of flowers and the worship of gods and ancestors. However, around 1200 Saint Albert the Great wrote: "there are certain places which are given over less to usefulness and a rich harvest than to pleasure."

In abbeys, cloisters are built around the four pathways that intersect perpendicularly and delimit the four flowerbeds. In the centre of the cross thus formed stands a fountain, a well or a tree. The number four symbolizes the four rivers of paradise, but also the four cardinal virtues (prudence, temperance, fortitude, justice) and the four evangelists. The Christian symbolism of the cross is fundamental, and the fountain evokes blessed water.

Labyrinths, statues, ruins

Through geometry, the garden becomes a vegetable garden, a pinewood, a wood, a garden of simples (where medicinal herbs were grown), a place of worship, a symbolic language

of traditions and myths. But the garden is an allegory and a metaphor for a pathway (labyrinths), an initiatory or spiritual itinerary or a sort of map (*imago mundi*) referring to an otherworldly world, a heavenly vault or a representation of a geographical reality, a sort of treasure map.

The formal garden, or Italian garden, is a garden style of late Renaissance origin characterised by a geometric division of spaces achieved through the use of rows of trees and hedges. Remarkable examples are the gardens of Villa D'Este in Tivoli and, in Florence, the gardens of Villa di Castello, Villa Corsini and Boboli Gardens. The Italian garden became popular throughout Europe, also assuming alchemical meaning.

Alchemy was an ancient esoteric philosophical system (*esoteric* = knowledge reserved for a few, opposite of *exoteric* = knowledge open to everyone) that is expressed through the language of various disciplines such as chemistry, physics, astrology, metallurgy and medicine. One of the many names for Alchemy was *Celestial Agriculture*, because with its laws and conditions, it was thought to show a very close relationship with terrestrial farming. The alchemist himself was, firstly, a ploughman and the terms used by many authors refer to agriculture: May dew, the vineyard of philosophers, the garden of the Hesperides, the tree of science. The so-called Porta Magica (Magic Door) in the garden of the Villa of Marquis Maximilian Palombara in Rome, the Park of the Monsters in the province of Viterbo, also known as the Sacred Grove or Villa delle Meraviglie (Villa of Wonders) of Bomarzo, designed by Roman gentleman Vicino Orsini, but also the allegorical elements of Villa Lante in Bagnaia, all have alchemical value.

Since 1500, gardens have been populated with additional elements, often with a strongly symbolic character: mythical sphinxes, keepers of secrets, monsters, giants, pyramids. A world rich in symbols which, rather than representing something, reiterate the profound questions raised by the Renaissance. In this sense, the labyrinth represents one of the clearest representations: both because on the one hand it recalls the legend of the Minotaur, and therefore from an iconographic point of view it is a clear allusion to classical culture, and also because it is the representation of life, of impenetrability, of mystery, of a journey without reference points. In the Middle Ages, the labyrinth had a mystical value: *"Hic quem creticus edit Dedalus est laberinthus de quo nullus vadere quivit qui fuit intus. Ni Theseus gratis Ariadne stamine iutus"* or This is the labyrinth built by Dedalus of Crete; all who entered therein were lost, save Theseus, thanks to Ariadne's thread. In appeared in many cathedrals (the inscription quoted refers to the Cathedral of Lucca but is also found in other cathedrals, the most famous being that of Chartres in France). It was a way of illustrating to the faithful the tiring and tortuous journey

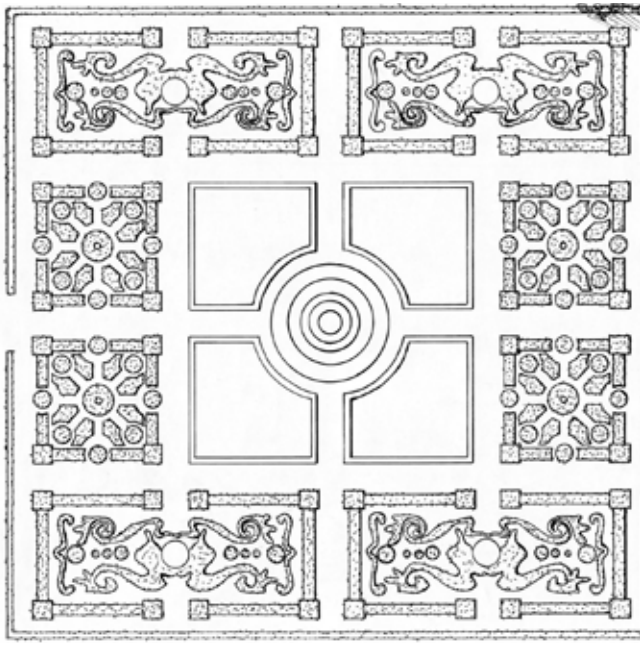
towards faith. The symbol remains the same, but the attributed meaning has changed over time.

The creation of the secret garden also dates back to the Renaissance. It consisted of a small area within a garden or park that provided privacy and shelter, and was usually placed directly next to the private apartments of the building or villa or extended to a place that offered spectacular views of the surroundings.

From Italy, Renaissance gardens spread first to France and then to Germany, Austria and England. In 1500, some prominent figures in the field of architecture worked on gardens: Desiderius Erasmus Roterodamus (1469-1536), Francesco Colonna (1433-1527) who wrote *Hypnerotomachia Poliphili* or Poliphilo's Strife of Love in a Dream of love which specifies in detail how to set up a garden, and Leon Battista Alberti (1404-1472) who wrote *De Re Aedificatoria*. But with passing time, gardens evolved. The style of the baroque garden originated in France between the sixteenth and seventeenth centuries. The principle behind a Baroque garden is attributed to Descartes' theories: infinite space can be divided into finite parts. The baroque garden, an expression of absolutism, denoted European culture at least until the middle of the century. The French typology was perfected in the second half of the seventeenth century by André Le Nôtre for Louis XIV, the Sun King, according to the principles of maximum grandeur and geometric rigor, symmetry and artificiality of form. In this sense, the garden of Versailles is exemplary.

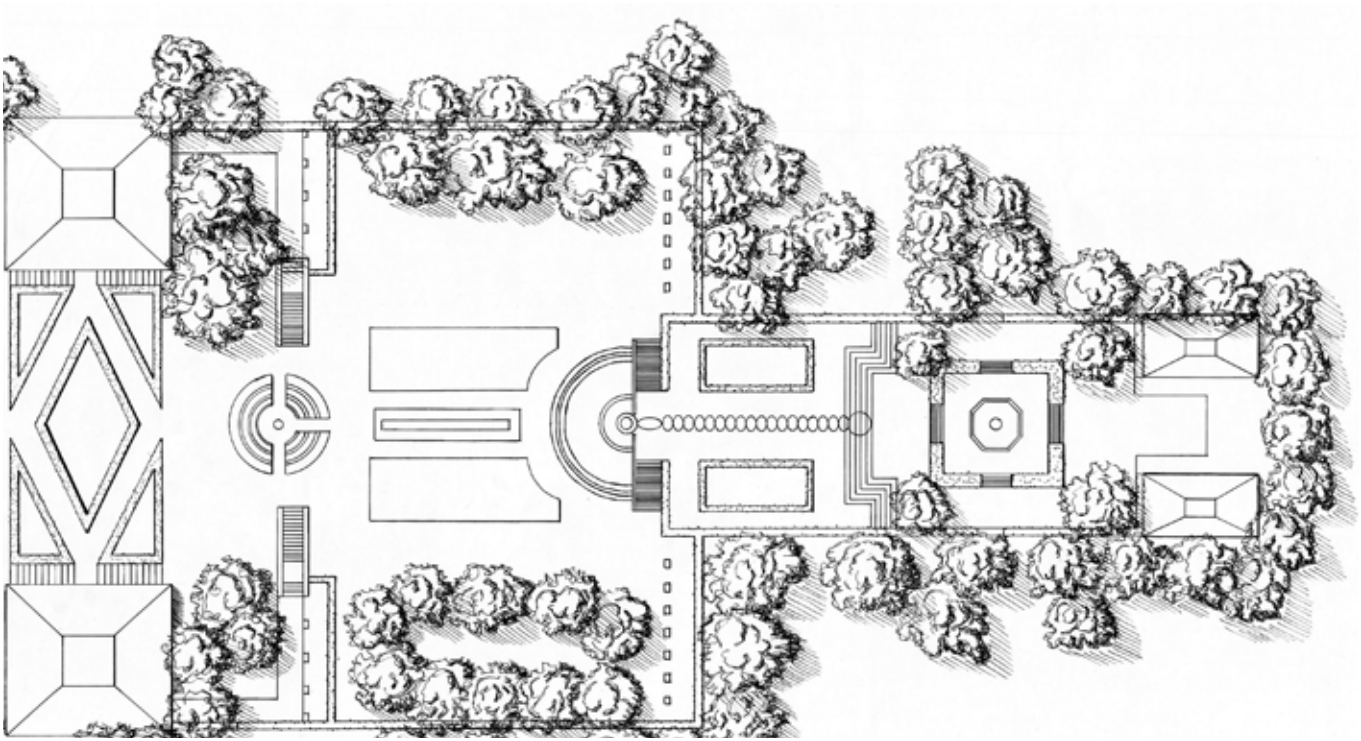
In the Italian Renaissance gardens, the emphasis was on curved lines, while the French preferred straight lines, squaring, symmetry which for them did not consist in the identical repetition of motifs, but in a balance of parts creating an impression of variety and harmony. The gardens of Versailles, in this way, are full of symbols: the four elements, the four seasons, the four temperaments (melancholic, choleric, phlegmatic, sanguine), the four poems (epic, pastoral, lyrical, satirical), the four hours of the day, the four great rivers (Garonne, Seine, Loire and Rhône) but also a labyrinth with 39 fountains, representing the fables of Aesop and avenues radiating outwards, like rays of sunlight.

At the end of the 1600s, a new element enriched the garden: ruins were rebuilt in order to compose a landscape through free combination of real or fantastic architectural elements. That same garden thus became a place of memory and emotions. With the dawn of the romantic era, the maze of gardens became an example of a labyrinth of love and feelings. Baroque gardens gave way to rococo gardens, which spread in popularity throughout Europe from Spain and Portugal to the Netherlands and Great Britain. The term rococo comes from the French word *Rocaille* (literally rubble), a word used to indicate a type of decoration made with stones, rocks and shells, used as embellishment for garden pavilions and grottoes. The *partèrre*, or the set of ornamental flowerbeds of grass or flowers arranged in designs of various shapes, characterized both of these gardens.



In the 18th century, Topiary art, or the art of shaping perennial plants, whether trees or shrubs, into anthropomorphic or imaginative geometric shapes in order to create a living sculpture, took hold in Holland. Topiary art, in actual fact, originated in ancient Rome and the word comes from a mixture of Latin and Greek, *topiarius*, which means creator of places.

The taste for the landscape garden, or English garden, developed in England from the early eighteenth century as a reaction to the French models. In the first phase, the guiding idea for their design was also political: freedom from the rules and constraints of absolutism. Some thinkers proposed an aesthetic based on the imitation of nature and its spontaneous forms, according to the motto 'as nature intended'. The English garden freed itself from symmetries by re-evaluating the natural component: woods, isolated trees and sinuous landscapes,



and in their paintings, English artists represented gardens as privileged places of the emotional sphere. The garden also became a landscape.

The close of the century in England heralded a new shift in taste: the aesthetic trend rejected the idealised models by landscape architect Brown (1716-1783) and turned towards the more irregular, wilder expressions of nature, according to the categories of the picturesque and the sublime. The nineteenth century collected the legacy of previous centuries which had developed and defined classical systems and landscapes; in the art of gardens, there was a mixture of styles. Garden and urban planning are closely linked to the birth of the urban public park, an element that is becoming increasingly important in European cities. The reasons that led to the birth of the urban park in cities such as London and Paris are many: attention to the so-called needs of the people, which requires a livable space within the city, the improvement of hygiene conditions, attention to design and urban architecture, the desire for spaces that enhance the prestige of the city itself.

We also find this style in Bologna in the Margherita gardens and in the monument to Carducci where some characteristic elements of this style of garden design are evident.

In the monument to Carducci we find a grand staircase, niches (set into the wall and used as a decorative-protective elements to accommodate statues and vases), and terraces that shape the reliefs, cutting them into long steps of flat land separated by vertical walls generally supported by dry stone walls. In the Margherita gardens we find a tree-lined avenue, a fountain and a theatre, an area of large, flat garden with a niche at the back serving as a scenic backdrop that recalls ancient Greek outdoor theatres.

The style of the nineteenth-century garden lasted until the 1950s, when the two world wars put the brakes on creativity. After the war, there was renewed interest in green areas, but the only real innovation was represented by the contamination by Land Art, a form of contemporary art born in the United States between 1967 and 1968, characterized by the direct intervention of artists in the natural territory. However, in large cities throughout the 20th and 21st century once again the gardens of Versailles became a reference point inspiring,

for example, the National Mall in Washington, the street plan of Chicago, the hanging gardens of the Rockfeller Center and the National September 11 Memorial in New York.

Flora and its meaning in gardens

Planting represents the common denominator of all gardens and must in any case be present, although the form, layout and setting of gardens can vary hugely. Many types of plant can be used, but it is precisely the carefully considered combination of different plants that expresses the meaning of the garden. The current organization of green spaces is above all based on functionality: hardy plants that are able to withstand the environment and pests, or sufficiently fast-growing plants, yet all this ignores the ideas that underpinned garden design in the past. Different plants present in a garden could have multiple meanings related to simple officinal use as well as to a specific aesthetic purpose or to the search for the exotic or even as an allusion to symbolic or mystical concepts. The bibliography is extensive and complex, complicated by the fact that, over the centuries, the same plant can take on different meanings. An overview of this symbolism can be seen in the visual and literary arts of virtually all the eras, often representing silently but eloquently expressing hidden and inescapable meanings. The culture of the reader is the key to knowledge. Often the hidden meaning is clearly the opposite of that manifested by the image or poetic verse. One such example is Botticelli's Divine Comedy and his illustration of Spring, upon which endless comments have been written and the most audacious hypotheses ventured.

The tree, the centre and axis of the world

Trees are one of the elements most traditionally present in the garden, followed by shrubs and wild herbs. We have therefore decided to devote an in-depth look at trees, also considering the key played by this natural element in the myths and folklore of ancient populations.

It is suffice to leaf through a book like *Florario ed Erbario* by Alfredo Cattabiani to grasp the vastness of the subject.

The tree assumes a great variety of functions but one more than any other highlights the importance it always had in ancient times: that of the centre and axis of the universe. The idea of centre (geometrically, the midpoint) has strong symbolic connotations. From an etymological point of view, the word symbol comes from the Greek *sumballein*, which means to bind together. A *sumbalon* was originally a sign of recognition, an object cut into two halves whose combination allowed the bearers of each of the two parts to recognize themselves as brothers and to welcome each other as such without ever having met before. The centre is the figurative symbolism of balance, of the connection between several entities and a point of reference between opposites, of invariant, of origin and of axis of reference.

In this regard, Benoist (1893-1980) in *Segni, simboli e miti*, argues that the most widespread variant of the axial centre is the tree worshipped by pre-Hellenic civilizations. In Gaul we find the oak, in Germany the lime tree, the ash tree (*Yggdrasil*) in Scandinavia, the birch tree in Siberia, the olive tree in the land of Islam, the banyan tree in India, the bamboo tree in Japan. Without forgetting, in the strictest sense, the Masonic acacia, the Jewish almond tree (remember the shape of the *Menorah*, the seven-branched candlestick), the Chinese willow, the laurel of Apollo and the mistletoe of the Druids. Planted in the middle of the universe or in the midpoint that it represents, the cosmic tree, like the sacrificial pole of India, connects earth and sky. The most important arboreal theme is that of the tree of life, which in Iranian art is often flanked by two peacocks facing one another, representing cosmic duality. A fountain, symbolising perpetual rejuvenation, sometimes wets the foot of the tree and overflows, dividing into four streams that flow in the four directions of space [the Earth's garden was furrowed by four rivers that irrigated it perpetually ed]. In the Bible, the two peacocks have been replaced by the trees of the science of good and evil that flank the tree of life, a triplicity that in the *Kabbalah* equates to the three branchs tree, *Sephirot*. When stone replaced wood in architecture, the carved stone column became also an axial symbol (*axis mundi*).

Totemic plants, the sacred trees of primitive worship, later took on a symbolic role in religions. The tree has always represented the image of life and at the same time the element of union and communication between the three levels of the Cosmos: the underground world (the roots), the terrestrial world (the trunk) and the celestial dimension (the foliage that extends upwards, towards the light).

The inverted tree

In Indian tradition, the cosmos is represented as a gigantic inverted tree (*Asvattha*) with its branches growing downwards and its roots upwards. The leaves are the Vedic texts, the shoots are the material objects, and at the bottom, are the actions of men. Cutting down the tree means detaching oneself from material goods and earthly sensations and going back to one's own celestial roots. Ascetics are those who undertake this path through meditation.

The upside-down tree is also proposed in the *Kabbalah*, the Jewish mystical teachings, where the Tree of Life, represented by 10 emanations or *Sephirot*, is an upside-down tree, whose roots are in the sky (*Keter*, the crown) with branches with foliage growing downwards (*Malkut*, the kingdom). In the philosophical sphere, in his *Timaeus* Plato compares man to a plant whose roots reach towards heaven and branches towards earth and finally, from a literary point of view, in the Divine Comedy in Purgatory (XXII *canto*) an upside-down tree similar to a fir tree stands in the middle of the road.

Perhaps the image that allows a better understanding of this upside-down conception is the hydrography of a river in which the basal part of the tree is represented by the estuary of the waterway, the trunk by the riverbed itself and the aerial part (branches, foliage, etc..) is the branching of the tributaries which, in differing degrees and order, bring the water to the main river. The direction of flow also recalls the idea of an upside-down tree.

In its verticality, both conventional and upside-down, the tree represents the means that allows ascent, spiritual elevation, even though this is a clear but difficult path to take. The same verticality describes growth, flux and diffusion according to a predetermined and mysterious order. Overall, however, it is an icon of continuous renewal, of cyclical transformation through the seasons (buds, flowers, fruits, leaves), of fecundity. The symbolism of the tree is also manifested in a temporal vision of the world: the family tree that is the symbol of life from one individual to another in the same family. It becomes a representation of social, military, working, computer and technological structures, or the taxonomic representation of animal and plant species. The success of the symbolism of the plant is linked to its structure as it is a great unifying symbol common to a tradition in which allegory, myth, tradition and ritual intertwine, overlap, feeding on archetypes and suggestions that, in the slow pace of human history, have pervaded the cultures of civilizations and peoples.

Plants and science

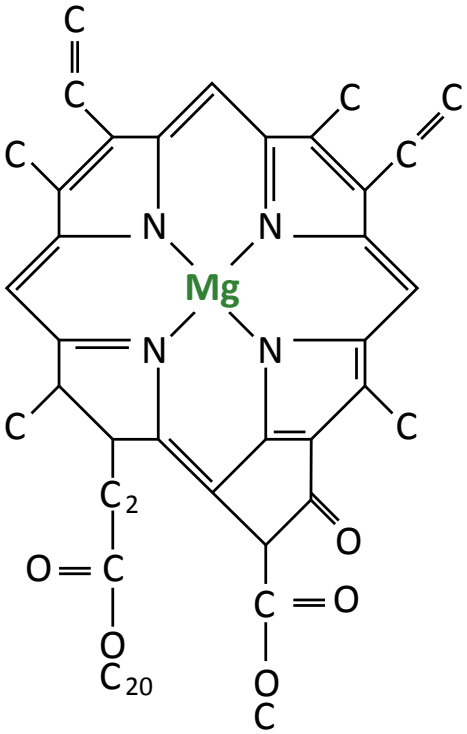
One of the oldest medical documents with numerous plant medicines is the Egyptian Ebers papyrus (1500 BC), now in the library of the University of Leipzig in Germany. The sacred books of Indian civilization (1000-800 B.C.), list more than 800 medicinal drugs; some cuneiform tablets of the Assyrian-Babylonian civilization, among which that of Assurbanipal, mention belladonna, cannabis indica, colocynth, opium, cassia, etc. The Bible itself teaches us of the use, by Jews, of certain plants, including hyssop and cedar, to cure diseases. In reality, all civilizations have used plant essences for pharmaceutical purposes. One of the oldest botanical gardens in the world was that of Alexandria in Egypt under the Ptolemian dynasty (from the fourth century BC) and that established in Athens, around 340 BC, at the behest of Aristotle for the purpose of study. Right from the first century AD, extensive officinal gardens were created in Rome for mass production and, from Roman times to the Middle Ages, the botanical works of Theophrastus and information on Hippocrates' studies on therapeutic remedies obtained from plants constituted the first reference materials for medicine. However, botany as an actual science only came into existence at the end of the 1400s, most likely as a result of great geographical discoveries. Corn, cocoa, tomato, tobacco, potato, vanilla were just some of the products brought to Europe in that period, representing new food resources that needed thorough study. This is how the first herbaria were created in the 16th century: Luca Ghini, Ulisse Aldrovandi and Andrea Cesalpino were the pioneers of systematic studies. In the 17th century, Pierre Magnol, director of the Montpellier botanical garden, introduced the idea of the family into botanical classification. Later, in the 1700s, the Swede Carl von Linnè, starting from the discovery at the end of 1600s by the German Joachim Camerarius, who identified the sexual organs of plants in flowers, taking into account the number of stamens in classes and orders, divided plants into genus and species, adopting a special two-word nomenclature that allowed the identification of every living species. The road to modern botany was mapped out. The use of medicinal plants remained unchanged until the end of the 1800s, when pharmaceutical chemistry gradually replaced the traditional pharmacopoeia, although it failed to eliminate it altogether.

Greetings

We have tried to give a harmonious picture of the different aspects of the Geological Garden. Urban greenery is of vital importance in the structure of a city. It is not just recreational areas and places where children can grow and play and elderly people can feel at ease. Urban green spaces are unique places where the spirit is regenerated, where we can find ourselves. Despite daily life that often dulls our attention and makes everything uniform, almost invisible, a small patch of green allows us to break those tautological mechanisms that wear out our existence; it gives us renewed vigour.

Have you ever tried to embrace a tree? Perhaps you did as a child. You will be struck by the sense of security, solidity and vitality it conveys to you.

Although the garden is an artificial, manmade structure, with plants that are not necessarily native to the area, nature still has the upper hand, briefly defining rules and balances in this microcosm. The same balances that will condition even a simple walk we might take. We would do well to remember that plants are much more similar to us than we think.



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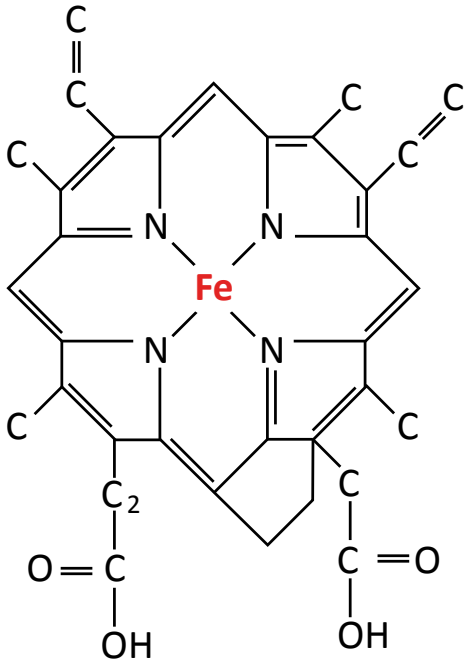

Hemoglobin

BRIEF GLOSSARY

Plants

CATKIN: elongated inflorescence, usually pendulous, which carries many unisexual flowers.

DECIDUOUS: not persistent, which stands out. Referred to the leaves that fall in cooler seasons, and trees and shrubs with deciduous leaves.

HERMAPHRODITE: Presence in the same individual of male and female sexual organs.

ODD-PINNATE: This is a leaf formed by a main axis that has several compound leaves with a lone terminal leaflet.

RIPARIAL: which is near the shores of streams and ponds. Of the vegetation of river banks.

UNISEXUAL: A unisexual or diclinous flower, is a flower that has only one of the two sexual apparatuses.

Geology

ANTICLINAL FOLD: folded rock strata with the convexity facing upwards, namely contrary to the Syncline; in it the oldest rocks are found at its centre.

BASIN: topographic depression in which water, snow, sediment or other materials accumulate.

BAUXITE: terrigenous sedimentary rock from which aluminium is obtained.

CARBONATIC PLATFORM: rocky structure of a tabular shape made up of carbonate rocks derived from the accumulation of hard parts of limestone shell organisms or from the precipitation of carbonate induced by the activity of living organisms.

CEMENT: mineral substance that binds together the minerals, granules or other constituent parts of rocks. It can be of mixed composition (calcite, silica, iron).

CLAYSTONE: sedimentary rock formed by clayey sediments.

FACIES: physically it is comprised of a bundle of layers characterized by homogeneity and singularity of physical characteristics (lithology, granulometry, sedimentary structures and accessory components), chemical or paleontological characteristics (presence of fossil organisms and/or plant remains) connected with the environment and the method of formation.

FOREDEEP BASIN: basin positioned at the front of a mountain range that receives the eroded materials from emerged mountain ranges, before being incorporated by the latter as the deformation migrates outwards (foreland).

GEOLOGICAL FORMATION: it consists of a certain number of rocky layers which have a comparable lithology or similar characteristics and which are recognisable and distinguishable from other adjacent layers present above, below and also laterally.

GLACIAL CIRQUES: relief forms modelled by the glacier excavation; glacial cirques correspond to depressions that originally contained a suspended glacier in the high mountains.

MAGMATIC (rock): rock that is generated by the cooling of magma, i.e. of a totally or partially molten and incandescent rock located deep in the lithosphere.

METHAMORPHICS (rock): originally sedimentary, magmatic or even metamorphic rock that, due to increase in pressure and/or temperature, changes its structure, chemistry and mineralogical composition.

MORAINE: (from moraine), heterogeneous and disorganized sediments transported by glaciers and then abandoned upon their withdrawal.

NAPPE (tectonics): set of rocky masses uprooted from their original sedimentation environment and transported to other areas that may originally have been very far away. These deformations are due to the endogenous forces of the earth.

OROGENESIS: a set of phenomena of deformation and lifting of the earth's crust that lead to the formation of a mountain range.

PLATE: portion of the Earth's lithosphere that moves on the underlying asthenosphere as a result of the convective motions of the mantle.

RECRYSTALLISATION: phenomenon of transformation of rocks due to physical and chemical processes as a result of which the existing minerals take on a new crystalline configuration, giving rise to minerals of neoformation.

ROCHE MOUTONNEE: with a rounded surface recalling the back of a ram, formed by the erosion of glaciers.

SEDIMENTARY (rock): rock formed by the accumulation of sediments of various origins, deriving largely from the degradation and erosion of pre-existing rocks (clastic rocks), from chemical processes (evaporitic and carbonate rocks) and from the accumulation of remains of living organisms (organic or biochemical).

SUBDUCTION: this term refers to the sliding of a lithospheric plate under another plate and its consequent dragging deep into the mantle.

TURBID CURRENT: high-density current comparable to an avalanche of sediment mixed with water. The current is triggered by submarine landslides, large river floods or seismic tremors that mobilise the sediments deposited in marine environments in front of river mouths. The mixture of water and sediment flows in contact with the seabed, often carving out canyons, until it reaches the abyssal plains. Here, due to the abrupt change in topographical gradient, the current slows down and progressively releases its load: first it deposits the coarsest and heaviest fraction (sandstone) and then the finest (pelite). The layers of turbiditic origin are often graded and formed by the typical association of sandstone pelite.

TURBIDITE: sedimentary rock formed by the deposition of sediments transported to the bottom of the basin by high density currents.

BIBLIOGRAPHIC REFERENCES

Benoist L. (1976) - *Segni, Simboli e miti*. Garzanti, 123 pp.

Bulleri G. (2001) - *Hortus Pompeianus: i segreti delle piante antiche, la cucina e la vita sociale a Pompei*. Spano, Pompei, 57 pp.

Cattabiani A. (1996) - *Florario – Miti, leggende e simboli di fiori e piante*. Mondadori, 747 pp.

Donini (2009) - *Breve storia delle religioni.* Newton Compton, 300 pp.

Kluckert E. (2005) - *Giardini d'Europa dall'antichità a oggi*. Ullmann, 496 pp.

Maresca P. (2004) - *Giardini incantati, boschi sacri e architetture magiche*. Angelo Pontecorboli, 234. pp.

Mussio M.G. (2012) - *L'albero e il sacro*. Effegi, 234 pp.

"Stroll freely through this book as you would through a park. Follow a path, maybe skip one, stop, retrace your steps, breathe in the scent of a metaphor or wander around a detour of a phrase in your own memory. Above all, cultivate your own garden, right in the ground, in pots, in dreams, or in words..."

Evelyne Bloch-Dano

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