Museum of Geology

Apt, Vaucluse

Welcome to the museum of geology. This floor is dedicated to the discovery of the Luberon territory and the presentation of its rich geological heritage.

Luberon: Earth's Memory, a Heritage to Preserve

The Luberon is known worldwide as a region of significant importance for palaeontology since the nineteenth century. The Regional Nature Park of Luberon protects this irreplaceable heritage through the management of its Geological Nature Reserve.

What is the Geological Nature reserve of Luberon?

- One of the 169 National Reserves in France
- Comprises 28 fossil sites and a protection perimeter
- Encompasses 31 municipalities within its protected area
- Operates under an adapted regulation
- And its mission is to protect the fossil sites, conduct scientific studies and engage in public outreach

The Luberon Regional Nature Park is recognized as a UNESCO Global Geopark due to its rich geological, historical and cultural heritage.

Discovering the geology of Luberon

The Luberon territory has an exceptional geological heritage showcasing a wide range of fossils and fascinating landscapes that relate the geological history of southeastern France, including the uplift of the Pyrenees and the Alps.

Land of flaming colors, the ochre cliffs form one of the most amazing landscapes of Luberon.

The Calavon river passes through the Oppedette canyon and the Apt Basin. Its name comes from the combination of the Indo-European root ‘cal’ meaning ‘stone’, and the Celtic term "von" meaning river.

The grey marl outcrops surrounding Apt hold significant geological importance as they correspond to the historical stratotype of the Aptian stage, which dates back approximately 120 million years.

The different landscapes are the result of:

- The nature of the rock
- The tectonic movements that cause them to tilt, break, and fold over time
- The processes of erosion that sculpts and reshapes the earth's surface
- Lastly, but certainly not least, human activities through agriculture, urbanization, infrastructure development…

Luberon fossils

The area's exceptional geological character lies in its rich fossil deposits, which have yielded a diverse range of vertebrates, including fish, frogs, birds and mammals with preserved skin outlines. Perfectly preserved insects, such as beetles and flies, as well as various plant fossils, including leaves, wood and flowers, have also been found. The area has also yielded ammonites and even a remarkably well-preserved sirenian (sea cow) skeleton.

Let's go downstairs to learn more about the geological history of Luberon.

Luberon: a simple geological structure

The Luberon-Lure territory extends from basse Provence to the borders of Pre-Alps. The Mediterranean plains and hills are surrounded by the Provencal Mountain ranges of Luberon (1,125 m), the Monts de Vaucluse (1,256 m) and the Lure Mountain (1,825 m).

The forms of the relief correspond to its geological structure which is characterized by a folded structure comprising both synclines (downward arcs) and anticlines (arch-like folds). The mountains of Luberon and Lure are formed by prominent anticlines, while the bassin of Apt, Céreste, and Forcalquier correspond to a large synclinal structure.

Sedimentary column

Here is a succession of sedimentary rocks you can find in Luberon.

Typically, in a sedimentary pile, each layer above is more recent than the one below, representing a chronological sequence of deposition. However tectonic forces, such as folding and faulting, can disrupt the original order of the layers, leading to an inversion of their positions.

Luberon rocks… sedimentary rocks

Most sedimentary rocks, such as clay, sand and sandstone, are formed by the deposition and consolidation of the weathered remains of other rocks from the continents. Others, such as limestone, result from the activity of living organisms. Some sedimentary rocks, such as gypsum and rock salt, are formed by chemical precipitation.

Sedimentary rocks can be regarded as archives, like pages in a book, recording the history of the Earth.

However, sometimes a page can be missing! Why?

- The page has not been written: in areas where no deposition has occurred
- The page has been erased or torn off: erosion can remove or erode previously deposited rocks.
- The pages are wrinkled due to tectonic deformation and disturbance of the original layers.

Erosion, transport and deposition

Erosion breaks down rocks and forms large quantities of materials, such as rocks, blocks, gravel, grains, particles, and dissolved substances. These materials are then transported by rivers, and occasionally by winds and glaciers. The transported sediments are eventually deposited in various locations, including lakes, beaches, deltas, and the seafloor. Over time, the deposited sediments undergo diagenesis, which involves processes like consolidation, reworking, and compaction. These processes contribute to the transformation of the sediments into sedimentary rocks.

It is estimated that approximately two centimetres of material are eroded from the surface of the continents every 1000 years in lowland areas, while mountainous areas experience erosion rates about 10 times higher. As a result, billions of tons of material are washed into the seas and oceans annually.

Between land and sea

The geological history of Luberon:

Over geological times, the global sea level has fluctuated as the result of climate changes and tectonic plate movements that affected the formation or the melting of ice sheets and modify the number, size, and shape of ocean basins.

In the context of the Luberon region, the oldest rocks date back to the end of the Jurassic period, approximately 150 million years ago. At that time, the Alpine Tethys, a vast warm and shallow sea, which no longer exists today, covered what is now Provence. This sea was bounded to the northwest by the Massif Central and to the south by Corsica and Sardinia, which were not in their present position.

Between 150 and 100 million years ago, the Luberon region was covered by the sea.

Like other parts of France, the Luberon was situated near the northern tropic at that time. The climate was warm, and ocean temperatures reached approximately 22°C. The sea was inhabited by various species of ammonites, belemnites, fish, and large predators such as plesiosaurs.

Between 145 and 130 million years ago

During the Early Cretaceous, marly and marly limestone sediments were deposited in a deep marine environment. These rocks can be seen in the heart of the Luberon massif.

Between 130 and 120 million years ago

Massive limestones (Urgonian limestones) were deposited in a shallow sea. Today these limestones outcrop in the Petit Luberon and the Monts de Vaucluse.

Between 120 and 112 million years ago

The Aptian grey marls are marine deposits that are approximately a hundred meters thick. They crop out in the agricultural plains to the north of Apt. The Aptian historical stratotype is located in the region of Gargas.

Between 112 and 100 million years ago

Several tens of metres of marine green sands were deposited in a shallow sea.

Around 100 million years ago

As the sea level dropped, the Luberon region emerged from beneath the water.

The Luberon became continental. It transitioned from a marine to a continental environment. The green sands present in the area underwent a process of weathering and transformation, becoming ochre sands. These sands now form the landscapes of the Colorado Provençal, Gargas, Villars and Roussillon.

Between 45 and 28 million years ago, large lakes covered the Luberon

The geological history of the Luberon includes a 40-million-year hiatus between the end of the Mesozoic and the beginning of the Cenozoic Era. During this hiatus, catastrophic events occurred around 66 million years ago, leading to the extinction of dinosaurs and the subsequent rise of mammals.

Around 40 million years ago, north-south compression and the opening of the Gulf of Gascogne resulted in the uplifting of the Pyrenees and the Provençal massifs, including the Luberon, Sainte-Victoire, Sainte-Baume, Alpilles, Lure and Ventoux mountains.

Between 45 and 34 million years

The Luberon region had a warm, tropical climate. This climate has led to the formation of rivers, lakes and marshes, resulting in a diverse range of deposits in the area. These included sands, marl, limestone, lignite and gypsum.

Between 34 and 23 million years ago

During this period, the Luberon was covered by large lakes. Laminated limestones, renowned for their remarkable preservation of fossils, were deposited in these lakes. These include vertebrates such as mammals, birds, reptiles, amphibians and fish, as well as insects such as dragonflies and butterflies, and plants such as leaves, seeds and flowers. Additionally, the shores of these lakes bear the footprints of animals that can still be observed today.

A subcomplete skeleton of the Oligocene ruminant Bachitherium cf. insigne *exceptionally preserved from Vachères.* Bachitherium *was a primitive ruminant that lived in the Oligocene epoch (~30millions years ago).*

Between 20 and 7 million years ago, the sea returned, the Alps rose, the sea retreated...

In the Miocene, 20 million years ago

During the Miocene period, 20 million years ago, the sea gradually advanced as far north as Switzerland and Bresse.

The waters of the Luberon region were home to sirenians, sharks and scallops during this time. Some islands persisted in the area. At the end of the Miocene, the sea retreated again. Relatives of elephants, tigers and gazelles lived in the Luberon region at that time.

Between 20 and 10 million years ago

The sea covered the region, resulting in the accumulation of extensive deposits of marine sediments, including sandstones and calcareous sandstones.

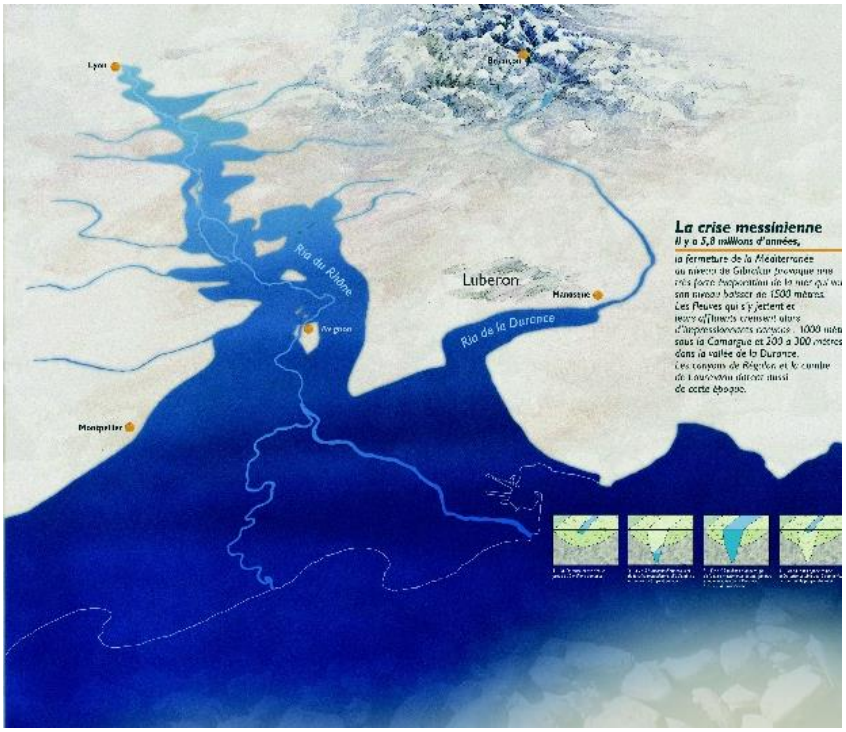
Around 8 million years ago

Around 10 million years ago, the alpine uplift played a significant role in renewing the landscape of the Provençal massifs, including the Luberon. This uplift resulted in the formation of these massifs' current dimensions.

As the sea slowly retreated, it gradually gave way to a savannah landscape populated by herbivores and carnivores.

Since 6 million years ago, the geological history of Luberon is linked to the Durance River

The geological history of the Luberon region has been closely linked to the Durance River since approximately 6 million years ago. The area's geography has resembled its current form throughout this period. The southern and eastern parts of the Luberon are covered by an alluvial plain.



The Messinian crisis

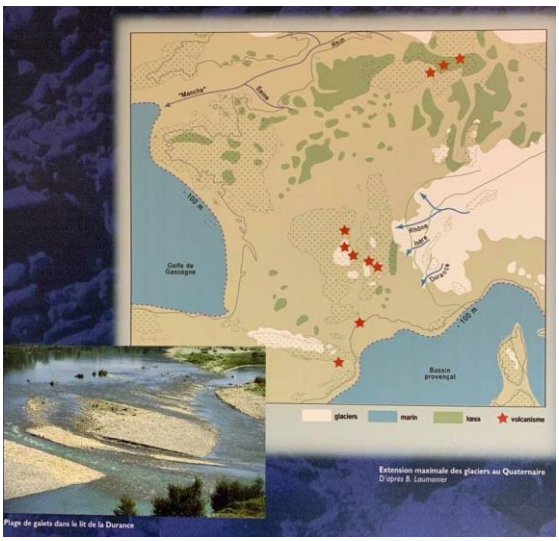
5.8 million years ago

Around five million years ago, the Strait of Gibraltar closed, causing the Mediterranean Sea to dry up. This led to a drastic decrease in sea level of approximately 1,500 metres. Consequently, the rivers that once flowed into the Mediterranean began to cut deeper channels, forming impressive canyons. The Régalon and Combe de Lourmarin canyons date back to this period.

5.3 million years ago

The Strait of Gibraltar reopened, restoring the connection between the Mediterranean Sea and the Atlantic Ocean. As a result, the sea level began to rise. Sea channels formed and flowed into river valleys, including the Durance, reaching as far as Manosque. Over time, these valleys gradually filled with alluvial deposits as the sea receded.

The time of the ice ages



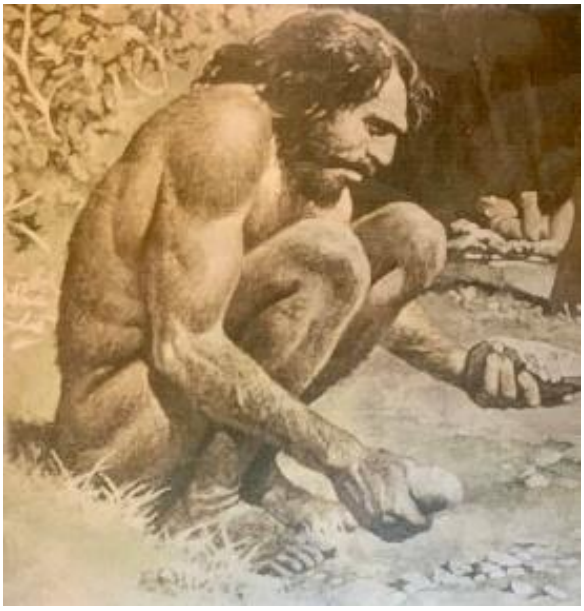
Over the past 2 million years, the Earth has experienced cycles of glacial and interglacial periods, known as ice ages. During these periods, temperatures dropped and glaciers expanded, covering mountain ranges such as the Alps, the Pyrenees, the Massif Central and the Vosges. In Provence, the region experienced a cold and harsh climate, resulting in significant erosion which played a key role in shaping the landscape.

During glacial outburst floods, the Durance River carried large quantities of material, including pebbles, gravel and sand, which had been eroded from the surrounding landscape. These materials were carried by the force of the floodwaters and were eventually deposited in the riverbed. Today, these materials constitute the majority of the alluvium found in the Durance River.

The last glacial maximum occurred around 18,000 years ago.

Human appeared in Luberon

The oldest evidence of human presence in the Luberon dates back to the Paleolithic period: - 100,000 years ago in Murs and 57,000 years ago in Bonnieux.



Reading the landscapes

The cliff of Lioux highlights a fault, representing the fracture surface of a normal fault. The northern part of the fault, the hanging wall, moved downward and is dominated by limestone.

The abbey of Sénanque is located within a small graben, which is defined by two normal faults. The graben is bordered by limestone formations and filled with more recent sediments.

The hill of Mirabeau, on the edge of the Durance, corresponds to an anticlinal fold... On its eastern flank, the limestone strata have been tilted vertically.

An earthquake reveals Earth's tectonic forces

An earthquake is caused by a sudden movement along faults within the Earth's crust. This releases stored-up energy in the form of seismic waves that travel through the Earth, causing the ground to shake.

Earthquakes in Provence

In 1909, the region was hit by a severe earthquake, causing significant destruction. The towns of Lambesc, Vernègues, Salon-de-Provence and Rognes were badly affected, with 46 lives lost.

The Durance fault, which runs along the eastern edge of the Luberon mountain range, is a large active fault. It exhibits moderate activity and has been linked to earthquakes measuring approximately between 5.0 and 5.3 in magnitude every 100 years or so since 1509. Currently, this fault is being monitored in order to evaluate the regional seismic risk.