

Visit to the Languedoc-Roussillon Region of South-west France - May 2006

Geographical Setting

This region is bounded to the south by its border with Northern Spain and to the east by the Mediterranean Sea west of the Rhone Delta. To the north is the Massif Central, the large volcanic area visited by the Society in 1990, which has its southernmost part in the Montagne Noire mountain belt of the Languedoc. From east to west it is less than 100 miles; a further 250 miles to the west is the Atlantic coast. Later in this article reference is made to the Canal du Midi which, linking up to river systems, provides a water passage from the Mediterranean to the Atlantic.

Outline of the 14-day visit

Dr Roger Suthren of Derby University led the tour of this complex geological region. He has gained his knowledge both of the geology and the extensive wine growing over a period of 25 years. The Languedoc is the largest wine producing region in the world and Roger was able to tell us how its varied geology contributes to a great range of terroirs – the totality of the elements of a vineyard habitat – for vine growing.

He planned the tour using two bases, one in the south-west near Carcassonne at Alet-les-Bains, and the other in the north-east at Lodeve. From these two bases the group of 21 covered visits to 67 locations using a coach provided from Montpellier with 3 drivers, including an excellent young lady, to cover separate sections.

Geologically the Languedoc comprises 4 sub regions; the foot hills of the Pyrenees mountain chain; the Languedoc Basin; and the Montagne Noire mountain chain which is bounded to its east and north by a large high limestone plateau called Les Causses. These 4 sub regions will be covered separately in this write-up although our days' visits did not necessarily follow this sequence

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1. The Pyrenees and their northern foothills

Looking south from many places in the Languedoc one can see the distant mountain range of the Pyrenees which forms the border between France and Spain for much of its length. The Pyrenees are an early Tertiary mountain belt superimposed on an older structure. The event leading to the creation of the Pyrenees can be simply described as the collision between the Iberian Peninsular and France but its effect in terms of folding, faulting and crustal shortening were dramatic. A separate article devoted to

this orogenic event will appear in the next newsletter because our two days visiting 12 locations in the foothills could only scratch the surface of the subject. One of the most notable features is the North Pyrenean fault which is a major break in the earth's crust to the south of the Massif d'Agly, the 'metamorphic mountain' created during the Variscan Orogeny. To the north of this is the Massif de Mouthoumet which borders the Languedoc Basin and to its south another range of hills, the Fenouilledes, with a gorge defined by limestone ridges to north and south of the valley. In the gorge there are thermal springs and many rivers flow eastwards to the Mediterranean.



At the various locations visited we saw a variety of rocks of various ages, including many metamorphic Ordovician exposures, gneisses, granites right through to Quaternary deposits. There were vineyards every where and some of the best Cotes de Roussillon vines were growing in almost solid rock. We saw a remarkable exposure in the valley of the river Tet called Les Orgues (Organ Pipes). [See photo](#) These are earth pillars eroded from soft Pliocene sediments which are in turn products of rotted granites located up the nearby hill. They

are protected from erosion by cappings of coarse breccias. Further to the south is the Roussillon Basin which is filled with Tertiary and Quaternary deposits derived largely from erosion of the Pyrenees by major river systems.

2 The Languedoc Foreland Basin

This is an elongate sedimentary basin lying between the Pyrenean foothills to the south and the Montagne Noire to the north. It is called a "foreland" basin because its development was linked to the uplift of the Pyrenees thrusting against the continental plate. Most of the sediments in the basin are of late Cretaceous and Tertiary age and are derived from both marine and continental sources. In the west of the Basin are the Corbiere Hills, an important wine growing area, which we visited on two days. Our introduction to this area was a beautiful scenic drive through the High Corbieres which crosses a major fault separating the older Paleozoic rocks of the Massif de Mouthamet from the Tertiary sedimentary rocks of the Basin. There are many such unconformities around the Basin where its younger rocks rest against the Paleozoic sediments. It was at Ribaute north of the lovely medieval village of Lagrasse where Roger explained that the sedimentary rocks of the Basin were a mixture of river, lake and flood plain deposits grading into thick fossiliferous shallow marine sediments of Eocene age when the sea broke through into the Basin. In modern times flooding is a major hazard in many settlements along the river valleys and in Ribaute there was massive destruction in 1999 from the River Orbieu.

On the following day we visited locations round our base at Alet-les-Bains. At Argues in a road cutting there were examples of river channels, flood plain deposits and lake sediments. In nearby Rennes-les-Bains we saw how rainwater falling on the Palaeozoic and Triassic rocks of the Massif de Mouthamet emerged as warm waters rich in sulphate, calcium and chloride; this is similar to the warm water of Bath where “Roman Rain” falling on the Mendips has been heated at depth. To complete this day we paid a visit to a site of late Cretaceous dinosaur-bearing deposits in the Upper Aude valley. Here at Bellevue a skeleton of *Ampelosaurus* – known as Eva – has been found. On the climb up to the site there is a whole cutting where thousands of dinosaur eggs are exposed. A museum at nearby Esperaza contains displays and reconstructions relating to these late Cretaceous finds



Before moving to the eastern end of the Languedoc Basin we visited the superb city of Carcassonne, a much reconstructed fortified place where extensive use is made of the local sandstone known as the Molasse de Carcassonne. We had earlier in the day seen this rock at Moulin de St Jean in a section of the Canal du Midi where it cuts through these near horizontal beds of sandstone. [See photo](#) The construction of this canal by Paul Riquet between 1667 and 1687 was a fantastic achievement in those days using up

to 12,000 men with picks and shovels. It was built to avoid ships having to sail round Spain; water for the canal was provided via a network of reservoirs and channels from the Montagne Noire to the north.

The eastern end of the Languedoc Basin runs into the Mediterranean and we visited two areas, one to the south of Narbonne and one around Beziers. Around Portel-des-Corbieres there was a gypsum mining activity until 1992 and this mine complex is now used for maturing wine. We visited this tourist attraction and sampled their wines. In a number of places around the Etang de Bages modern evaporites are being produced in evaporating pans and salt is an important industry. A road cutting at Durban-Corbieres showed striking striped and folded rocks of Triassic age. These sediments consist of gypsum interbedded with siltstone, the gypsum acting as a lubricant in the folding process. Around Narbonne there was a lot of earth movement in late Eocene times and the geological structures are probably the result of the



collapse of the eastern Pyrenees which caused a series of great faults and was instrumental in the creation of the Mediterranean.

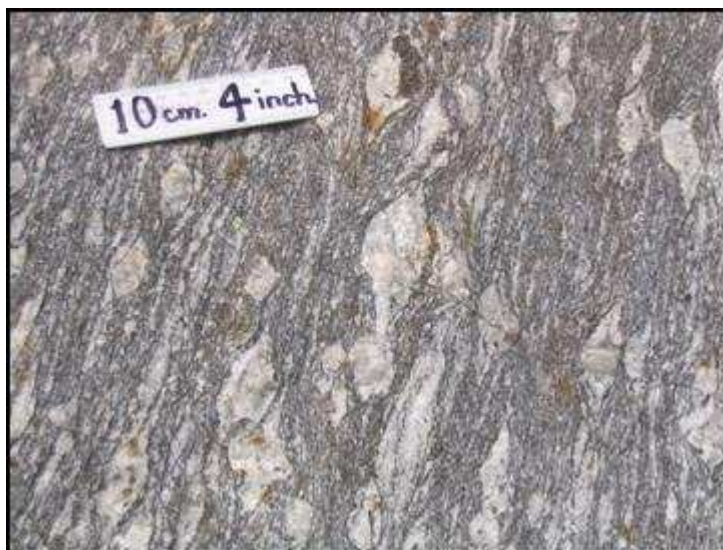
3 The Montagne Noire

This Palaeozoic mountain belt was formed in the Variscan Orogeny in late Carboniferous times. It rises to a maximum height of 4000 feet and is cored by granites and gneisses. Our visits to the various parts of the Montagne Noire were made over 4 days, the western end being from our base at Alet-les-Bains and the east and northern sections in our second week at Lodeve. As in the Pyrenean foothills there is a wide range of rocks from Cambrian through to Tertiary. On our first day in the Caunes-Minervois locality we encountered Middle Devonian limestones with a red and white marbled appearance and quarried for use all over the world in famous buildings such as the Grand Trianon palace at Versailles. [See photo](#) Roger pointed out in one quarry the different methods that had been used for cutting the marble.

Nearby is the Gouffre Geant de Cabrespine which is a massive cave system formed by one pothole collapsing into a second one in the Devonian limestone. It is 250 metres deep and, although clearly a tourist attraction, there was much geology to admire such as spectacular aragonite and calcite heliotes with different crystal structures – orthorhombic and rhombic respectively.

Some 20 miles to the east of these sites is the superb fortified mediaeval village of Minerve which was once a refuge of the Cathars who were a powerful group of religious dissidents which was, over time, exterminated by Papal Forces leaving many castle ruins on the tops of hills over a wide area. A feature of particular geological interest is a major unconformity to be seen in the gorge of the River Briant north of its confluence with the river Cesse where Cambrian limestone steeply dipping rests alongside Tertiary limestone, a gap of 500 m.a. Also in this area of gorges there is a cave where the bones of 10,000 bears have been found

dissolved in phosphate forming a substance called Minervite - (b)earely believable)



After transferring to our north-east base at Lodeve we began a series of visits to the east and northern sections of the Montagne Noire. What better way to start than making a north-south traverse through the mountains to reveal the core of granites and gneisses. In order to access a gorge created by the River Heric we had first of all to head west from Lodeve along a fault line in which there was

a watershed where rivers such as the Orb flow east into the Mediterranean and the River Agouté flows west into the Atlantic. The Gorges d'Heric is one of a number of deep river valleys cutting into the Caroux Massif. As we climbed up the access track beside the Heric we began to notice schists, augen gneisses and pegmatites in the steeply dipping strata. Some of the large feldspar crystals and augen gneisses were over 10 cm long. [See photo](#) The reason for this stunning scenery was the late Alpine uplift of up to 1000 metres which exposed the granites formed some 440 m.a., the metamorphics some 330 m.a., and the pegmatites and aplites some 300 m.a.

After lunch taken high up in the gorge we went to St.Pons de Thomieres where marble of Devonian age had been quarried for the town buildings. Crossing the folded and faulted Paleozoic tocks of the Montagne Noire to Pierrue, we studied the dolomitic limestone of the Lower Jurassic in a complex contact zone of palaeokarstic bedrock with a mottled red and grey colour. This turned out to be bauxite representing tropical soils developed in the Cretaceous period when continental conditions existed. Further south in this very complex sequence of exposures we saw sandstone and conglomerate river deposits called the *Gres a Reptiles*.



The following day and at the northern edge of the Languedoc Basin in the Paleozoic rocks of the Montagne Noire, grapevines grew in orderly rows on the rolling landscape of the St Chinian appellation. Underlying this famous wine growing area are mudstones and sandstones deposited during Ordovician times in deep water. The vines thrive in the poor sandstone and shale soils which stress them into producing larger and sweeter grapes. Our intrepid group walked along an excellent botanical trail created by the local school

and observed the typical flora of these acid soils. We then visited the premises of the Berlou Cave Co-operative where, apart from wine tasting we were treated to a superb display of fossils found by the owner in the local area over many years from Ordovician, Cambrian and Carboniferous. The trilobite collection was the most stunning and varied. [See photo](#) Our return route took us through acre upon acre of vineyards, stopping at the picturesque village of Roquebrun perched above the River Orb where it has eroded its valley through Devonian limestones and Ordovician shales on its way to the Mediterranean. We visited an old marble quarry where a type of nodular red stone was extracted, having the local name of Griotte.

On the following day we left our hotel at Lodeve to make a series of visits around the Lodevois and Cabrieres hills. In a former opencast uranium mine at Mas-d'Alary, 5 km from Lodeve the quarry showed southward-dipping Permian red beds, mainly sandstones and conglomerates of continental origin. The disseminated uranium in these rocks has migrated from grey beds lower in the Permian succession. We examined beautiful examples of normal faults, and looked at mud cracks and cross bedding.

At Lac du Salagou an artificial lake around which the weathering of the Permian sediments has given rise to a 'badlands' topography with sparse vegetation. Near the village of La Lieude we stopped at a site where many reptile footprints are preserved on a bedding plane which represents the floor of a Permian lake. These footprints of Therapsid and other mammal-like reptiles, pre-date the appearance of the dinosaurs. The well-exposed alternation of red and green sediments with some ripple marks gave a striking appearance to the landscape. Nearby Jurassic dolomites showed deep karstic weathering.

In old copper and barite mines in the Devonian limestones near Cabriere, barite as white platy crystals were plentiful, but only specks of copper minerals were found. At another roadside

locality we looked at Devonian nodular limestones (“griotte”) containing ferromanganese nodules, an indication of deep-sea deposition.

From a hillside viewpoint near Neffies we could see for about 30 km and Roger pointed out the main geological features. Small hills marked the positions of Quaternary volcanoes rising from the Tertiary plain to the south and we could also see the Causse du Larzac limestone plateau to the east and the Montagne Noire to the west. In the hilltop village of Carlenças we walked through bauxited Jurassic limestones and Quaternary basalts. Near the summit a belvedere laid out by local conservationists explained the view with the help of large blocks of gneiss, sandstone, limestone, dolomites, bauxite and basalt and how they were distributed in the surrounding landscape

4 Les Causses



On our excursion to the Causses the great limestone plateaux to the north of Lodeve, we were able to see the Millau viaduct from many angles and to drive over this highest bridge in the world. Opened just over a year ago, it carries the A75 autoroute across the Tarn gorges by a cable-stay bridge 2.5 km long and 280 metres high. In Roquefort-sur-Soulzon we visited the caves – resulting from a partial landslip of the Jurassic limestone cliff – where Roquefort cheese is matured. Airflow from fissures in the rock is regulated to provide the steady, low temperature that

favours the growth of different strains of *Penicillium roqueforti* in the cheese. At Montpellier-le-Vieux we wandered round a striking assembly of karstic pinnacles. [See photo](#)

Our last visit was to La Couvertoirade, a fortified medieval town which still evokes the power of the Templars. It also provided a chance to examine a lavogne, one of the man-made dew ponds characteristic of the Causses. Despite all we learned during the day one mystery persisted – if so much Roquefort cheese is produced, where are all those famous flop-eared sheep whose milk is supposed to go into it?

Our Final Day

This was spent back in the eastern end of the Languedoc Basin where shallow marine sediments can be seen. Later in the Miocene the sea disappeared leaving the

Mediterranean Basin dried out. Not until the Pliocene age was the Mediterranean re-connected to the Atlantic where the waterfall around Gibraltar must have been an astonishing sight.

The highlight of this day's visits was to the Oppidum d'Enserune, a fortified hill-top site occupied from about 600 BC with underground food storage silos dug into the bedrock. In Roman times the Via Domitia, an important road connecting Rome to its provinces in southern France, ran past this site. From the hilltop can be seen a remarkable pattern of fields running down to the valley. This is the site of a huge 400 hectares drained lake at the foot of which 13th century farmers dug drainage channels. We visited a site at the foot of this hill where today three tunnels have been cut through the Miocene rocks: one to carry the Canal du Midi, an upper one carries the railway and the third the drainage channel..

Returning to Lodeve to pack for the next day's flight from Montpellier to Gatwick we visited the village of St Thibery which is built on an eroded Quaternary volcano. Around the village there are many volcanic features such as columnar jointed basalt lavas, spatter cones and volcanic mudflow deposits.

Various members of the Society