
HIDDEN SURPRISES AMONG THE PYRENEAN TURBULENCE

Roger Lawley

We first toured Northern Spain in the Spring of 2004. High on our list of priorities was to visit the Archaeological Centre at Altamira, the location of wonderful Cro-Magnon Rock Paintings, and now an important exhibition centre for evidence of Early Man. It proved to be a very informative and stimulating visit. I had become interested in the subject matter of the redistribution of *Homo sapiens* following the last Ice Age. Maps indicated that there are numerous cave painting sites to the North and West of the Pyrenees, but apparently none of significance immediately to the South. On the face of it, conditions appear to be fairly similar. I was later to conclude that not much archaeological investigation has, as yet, been carried out in this fairly remote section of the Province of Aragon. It is located between Basque country to the West and Catalonia to the East. It was ravaged by civil war in the 30s and 40s and until quite recently, it has been a bit of a 'no go' area for foreigners, because of the activities of Separatist Groups.

Our Guide Book was rather light on detail as to what we could expect to find there. However, the distributors of EEC funds appeared to have identified the 'needs for development' in this remote area of Spain, and good roads have more recently been imposed on the turbulent terrain. Wild flowers of great variety and colour had clearly ventured into the area at some earlier stage, presumably with the easing of the last Ice Age, some fifteen thousand years ago. This was approximately the time of the cave paintings at Altamira, and at many sites on the northern side of the Pyrenees such as those near Foix.

Driving into the area, for us, was like stumbling on Shangri La. The area was bathed in warm sunshine and the line of snow-capped peaks stretched as far as the eye could see. We were to find, however, that not all was what it initially appeared to be. On that first trip, we identified but did not stay at an attractive looking hotel in the town of Torla, fronting on to the beautiful mountains of the Ordesa National Park (*photograph 1*). We spoke to and obtained a hotel brochure from its owner Miguel, and assured him that we would be back.

We did in fact return the next year, and the production of a crumpled brochure, with his name written on it, resulted in a warm welcome from Miguel. He proved to be a man of great interest. Trained as an Archaeologist, he said that his pursuit of early human activities was largely confined to the winter months, when visitors to his hotel were scarce. In recent years he had concentrated his investigations on a nearby ruined medieval monastery. He was a fund of knowledge and intelligent comment. However, he could shed little light on the possibility of Cro-Magnon paintings in the area, though he did direct us to some rather more recent rock paintings to the South.



*Photograph 1: View of the Mountains in Ordesa Park
from the Town of Torla*

On our visit to the area in 2006, we were perhaps a little more penetrating in our observations. On one particular day, we climbed up to the spectacular castle site at Boltana. It was sign-posted as 11th Century, so we anticipated that it would be Moorish in origin. The brickwork construction was indicative of Arab workmanship. On our return to the Town Information Office, we sought confirmation from the Spanish lady that it was indeed Moorish. She looked rather shocked at the suggestion and appeared to be of the school which doubted that the 'infidel' had ever been in the area. We asked the same question of the helpful lady at the main centre in Ainsa, whom we had thought might be of Moroccan origin. She was very interested in our views, though we subsequently worried that she might get into trouble if she passed them on to her superiors within the Tourist Office. Miguel's response, on the other hand, when we questioned him in the evening, was that 'of course it was Moorish.'

We also asked him about some abandoned villages we had observed further down the valley, and which appeared to be related to a partly constructed dam. He told us that the project had been stopped during the Civil War. It was his view that work at the site had not subsequently been resumed, on the basis that it was against the will of the country folk, who by that time had had enough of 'exploitation by power-hungry bureaucrats from Barcelona'. The dam site itself was a spectacular one, with twisted rock bands largely spanning the gorge area, and providing what appeared to be a very economic construction site (*Photograph 2*). However, I was a bit suspicious of its suitability because of the presence of extensive limestone, which, if Karstic, would pose severe risks to water tightness. During the course of the trip, I was to get sight of geological mapping of the area, which



Photograph 2: Location of an abandoned dam site on the River Ara

indicated that a major fault crossed the potential dam reservoir basin and, in all probability, connected with adjacent river valleys. I then had serious doubts about the water tightness features of the site and suspected that with increased geological understanding, which had become possible in the second half of twentieth century, the investors had considered it unwise to proceed with construction of a dam in that location. I did not convey my views on the subject to Miguel.

Limestone was very prevalent in the area of the Ordesa Park, presumably coming from the coastal basins, which had become elevated with the relentless push from the South. We were to see some very impressive exposures of folded and displaced strata which I had assumed were associated with the Alpine Orogeny some 25 Ma, (*Photograph 3*)



Photograph 3: Rock exposure in the Canyon area of Ordesa Park

However, I was to learn that mountain building in the Pyrenees goes back to the Variscan Orogeny, perhaps some 290 Ma. Our enquiries in the Ordesa Park had confirmed that the relatively horizontal strata to be seen at a high elevation in the centre of the Park, (*Photograph 1*), was indeed limestone, but we were not able to gain a detailed understanding of the mechanics for what must have been complex processes of folding and thrust.

In the latter part of the holiday, we moved further East to the area of the Aiguestortes National Park, which is in the province of Catalonia. We had sought a modest hotel in the village of Espot, which is located on a direct access route to the Park. We debated for some time about the apparent merits of two quite adjacent hotels. Having entered the one of our choice, I was surprised that the lady at the desk in fact went across the road to the other hotel to summon Eduardo, the owner, who dealt with us thereafter. When we made enquiries about an attractive restaurant, which we had observed in the vicinity, we were to learn that Eduardo was again the owner.

The next day, we set off for the Aiguestortes Park. As for Ordesa, it was only permitted to drive to an adjacent car park, and thereafter it was necessary to walk. Initially, we seemed to be alone in the world and the scenery was magnificent (*Photograph 4*). Jagged peaks of what I took to be limestone outcrops, surrounded the valley.



Photograph 4: Mountain scenery in Aiguestores Park

At one point, we chatted with an elderly English couple, who were on their way back down the valley. It would not have been any good asking their views about the Geology of the area, as their gazes were firmly directed below the horizontal. They were identifying the wild flowers and announced that they had just spotted Gentians, for the first time that day. On parting, they told us to look out for Azaleas further up the valley. This did not seem right to me, as every 'gardener' knows that that type of plant will not thrive in limestone conditions. This made me look more carefully at the surrounding rocks and I noticed that the boulders near the path were in fact granite. I then wondered if the spectacular peaks around us were in fact

composed of igneous and metamorphic rocks, much older than those we had been seeing at Ordessa.

Back in the hotel that evening, I noticed for the first time the fabulous orange-coloured marble staircase, which might have graced a stately home in UK, rather than a modest hotel in the back of beyond. We then started to become aware of marble everywhere, with attractive slabs even serving as paving stones.

A walk around the village produced no more surprises, until we were nearing the hotel on our return. We spotted a Spanish geological book among the post cards and tourist bric-a-brac on display in a shop window. A notice said that you should ring the bell if you wanted attention. It came as no surprise to us, to find that it was the nice Eduardo who came to open the door. When we looked carefully at the surrounding area of human habitation, it was quite clear that we were in deed within a single strata (perhaps Eduardozite?), in that corner of the town of Espot!

We resolved to brush up our technical Spanish and study our newly-acquired geological book, with the object of returning another year to seek more answers to the riddles of the Pyrenees.

GEOLOGY OF SPAIN

Elizabeth Devon

Roger and Joy Lawley, members of Bath Geological Society, are planning to lead a visit for the Society to the Spanish Pyrenees in May 2007. We shall be visiting sites mostly in the Ordessa and Mount Perdido National Park.

We shall be travelling from Barcelona to the south-west of the Catalonian Coastal Ranges, through the Ebro Basin north to the Pyrenees. The Catalonia Coastal Ranges are formed from Palaeozoic (Variscan) inliers and Palaeozoic and Precambrian rocks of the Iberian Massif. The Ebro Basin contains Cainozoic sediments with little or no Alpine deformation. Once we reach the Pyrenees we shall be travelling over Mesozoic and Cainozoic sediments deformed by the Alpine orogeny.

The geology of Spain is remarkably diverse and includes one of the most complete Palaeozoic sedimentary successions in Europe and an excellent record of the effects of the Variscan orogeny on the margins of the super-continent, Gondwanaland. Post Variscan Mesozoic and Cainozoic strata are widely exposed across the eastern half of Spain from the Pyrenees to the Balearic Islands. These successions and their fauna reveal a unique Iberian palaeogeography influenced both by the widening of the Atlantic to the west and by the events in the Tethys Ocean and Alpine-Himalayan orogen (mountain belt) to the east. Alpine collisions in Cainozoic times have created spectacular mountain belts in which the effects of both collisional and extensional processes can be observed.

Neogene and Quaternary volcanism has occurred in southern, south-central and eastern mainland Spain and the magnificent Canarian volcanoes expose one of the world's classic hot spots related to ocean island chains, similar to Hawaii.

The Alpine structures in Spain are rather complex compared to other European foreland areas. This is a consequence of the Iberian peninsula being a small continental plate, which, after the Variscan orogeny, moved relatively independently of its two great neighbours, the European and African plates. The most important Alpine range, the Pyrenees, was formed along the northern limit of the Iberian plate with a north-south shortening direction.

The Pyrenees is a mountain range produced by tectonic inversion of Mesozoic rift systems. This rifting was associated with the fragmentation of southern Variscan Europe and western Tethys as a result of the break-up of Pangaea, as well as with the opening of the central Atlantic Ocean and the Bay of Biscay, and the resulting rotation of Iberia. The Pyrenees form a doubly convergent collisional mountain belt which resulted from Mesozoic-Cainozoic interaction between the Afro-Iberian and European plates. Convergence occurred from Late Cretaceous (Santonian) to Middle Miocene times. As a result the earlier extensional structures were firstly inverted, then incorporated into the thrust system.

The area is part of a larger mountain belt extending for some 1500km from the eastern Alps along the Mediterranean coast to the Atlantic Ocean NW of the Iberian peninsula. The Pyrenean mountains are flanked by two main foreland basins, the Aquitanian basin in the north and the Ebro basin in the south, and they display different characteristics along strike. In the east, the Pyrenean mountains have been overprinted by Neogene extensional features related to the opening of the Gulf of Lyon and the drift of the Corso-Sardinian block. In contrast, the main part of the mountain range between France and Spain forms a continental collision zone without this late extensional overprint. Here the mountain belt developed over a previously thinned continental crust but without intervening oceanic crust between the two plates.

The size of this linear range of mountains, the quality of exposures and the unusually good preservation of the strata and its structures make the Pyrenees an excellent natural laboratory for investigating mountain-building processes and foreland basin formation mechanisms.

The Pyrenean range can be divided into two main parts: the Aragonese-Catalan Pyrenees (subdivided into eastern, central and west central) and the Basque-Cantabrian or western Pyrenees. The boundary between the two parts corresponds to an inverted Early Cretaceous transfer zone known as the Pamplona Fault.

We shall be visiting an area within the Aragonese-Catalan Pyrenees which forms the main part of the mountain belt and defines the Spanish/French border.

It is characterised by a thrust system that displays an asymmetric double wedge of upper crustal rocks. This

double wedge divides the mountains into the northern and southern Pyrenees. The southern wedge, where we shall be, is formed by a southward-directed imbricate stack involving cover rocks (south Pyrenean thrust system) and basement rocks (known as the 'axial' zone).

The geology and landscapes we shall see are spectacular. I hope we shall be able to work it all out when we are there!