# SOS DEL REY CATOLICO*

## *OF KINGS AND SANDSTONES*

**Wes Gibbons 2020**

Sos del Rey Catolico is a town in the autonomous community of Aragon, Northern Spain, close to the border with Navarra and known for its exceptionally well preserved medieval character. It lies at around 650m above sea level, standing on a rocky ridge of Cenozoic sediments facing north towards the southern Pyrenees and backed by a sierra that rises to the peak of Peña 6km to the east. In this Holiday Geology excursion we describe a 15km (3.5-4hr) return walk that follows the historic GR1 long distance path northwest from Sos to the Torre de Añués at the border with Navarra. In good weather, and avoiding the hottest times of the year, the walk is easy, relaxing and enjoyable, affording great views north towards the Pyrenees accompanied by exposures of the local sandstone geology. Bring all food and water with you.

*Geology and landscape. View looking southeast from the vantage point at the church of San Esteban, which crowns the medieval village of Sos del Rey Católico. The serrated shape of the hills and ridges, and the commonly linear vegetation pattern defined by treelines running from southeast to northwest, reflect the shape of the underlying rock strata. Harder sandstone layers (or "beds") stand proud as ridges each with individual beds dipping steeply towards the right (southwest), producing a distinctive scenery best displayed in the ground beyond the town on the right side of this view. The study of how geographic landforms are influenced by the underlying geology is called "geomorphology".*

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http://barcelonatimetraveller.com/wp-content/uploads/2020/11/SOS.pdf

*View from the Parador (bar and restaurant terrace on the right) which stands at the northern edge of the town adjacent to the defensive walls. Although a recent structure (built in 1975), the hotel has been designed to blend in with its surroundings relatively unobtrusively, using the same grey-brown sandstones that characterise building materials throughout the town and which here are exposed below the town wall. In Sos the underlying geology not only shapes the landscape but also provides the raw material from which the medieval border town stronghold was constructed.*

From the Parador car park follow the road that runs beneath the village SSE for 250m to the Portal del Mudo where there are further exposures of the local sandstones that form the basement to the medieval defences. This town gate was built in the 13th century under the orders of King Alfonso III “The Liberal” of Aragon, one of a line of Aragonese kings whose roots lay in the lineage of the House of Barcelona. This line of medieval rulers ran “unbroken for nearly two and a half centuries as the fortunes of Catalonia and Aragon were inextricably tied to each other during the governance of Alfonso the Troubadour, Peter the Catholic, James the Conqueror, Peter the Great, Alfonso the Liberal, James the Just, Alfonso the Kind, Peter the Ceremonious, John the Hunter, and finally Martin the Humane who dies almost exactly seven centuries after the attack on Gibraltar by Tariq ibn Ziyad in 711.

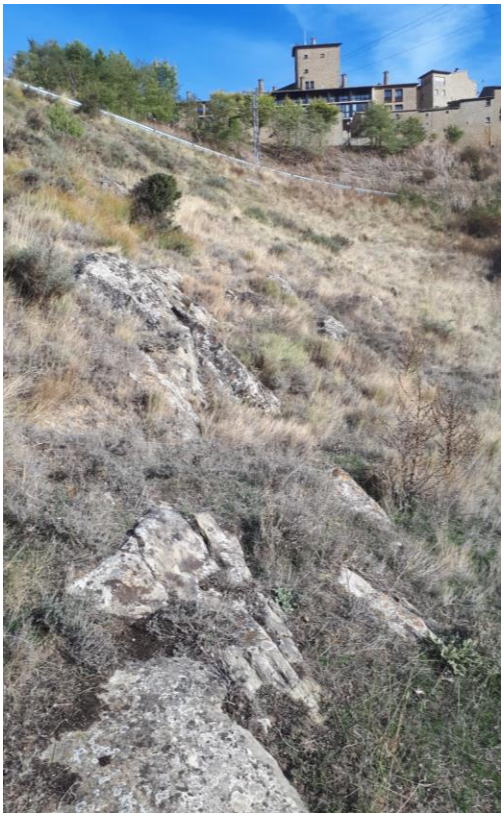
The story is all very interesting to The Traveller, with her singular and inexplicable fate to have been born a human, but she knows that from a geological perspective it is just a fleeting moment in Earth's history. After all, the oldest rocks in Spain have existed nearly one million times longer than these seven centuries of Iberian strife. But she is struck once again by the one great similarity between Human and Deep Time: there is always so much more missing than present on the record. In tales of nobilities striving for control, wealth, fame and glory, inflicting their vanishingly transient mark on the biosphere, there is little or no word from the rest of us.”

From Barcelona Time Traveller.

According to Wikipedia, the spirit of King Alfonso the Liberal makes an appearance in Dante's Divine Comedy, seated with other monarchs outside the gates of Purgatory inside which they would be punished for their role in creating political chaos in 13th century Europe.

*Portal del Mudo ("The Mute") on the western side of Sos del Rey Catolico, underlain by southwest-dipping beds of sandstones which provide a solid basement to the strong town defences. The name of the gateway refers to a legend about events here during the bloody Peninsular War of 1808-14 when French troops invaded Iberia but were defeated by Spain aided by troops advancing from Portugal under the command of Wellington. The story at Sos has it that a local man left the town to visit his girlfriend, only to be captured and tortured by the French troops who demanded inside knowledge on the defences. Rather than release any information under pressure, the hero bit his own tongue off, a courageous act of loyalty which so impressed the French commandant that the man was set free to return to the village where he collapsed and died in front of his townsfolk.*

On the other side of the road below the Portal del Mudo there is a house from which the GR1 footpath leads off southwards then curves right around the house to descend now northwards over exposed beds of sandstone underfoot as it runs beneath the Parador to cross the main road (A127).



*Exposures of sandstones running southeast from the GR1 beneath the Parador at Sos. The age of these rocks is around 23 million years (23Ma), a time which corresponds to the change from the older Oligocene Epoch (34-23Ma) to the younger Miocene Epoch (23-5Ma). They were deposited as sands in river channels draining wide fluvial lowlands lying in the foreland to the south of the Pyrenees, an area which would evolve through time to become the modern Ebro Basin.*

Continuing north the path descends further to reach another road (A1601) where you turn left to cross a small bridge and reach a T-junction with the A127. Here turn left to locate the signposted GR1 track 100m on the right. From here follow the GR1 which initially heads north then curves northwest past further rock exposures of the Oligocene-Miocene sandstones.

*The natural wall of rocks exposed on the GR1 track-side exposes the top side of a steeply dipping (nearly vertical) sandstone bed on the surface of which are fossilised ripple marks.*

*A close-up of the ripple mark pattern seems to reveal a complex pattern with two sets of ripples, one superimposed on the other ("interference ripples"). A sedimentologist colleague of mine writes: "the surface looks like it features a set of asymmetrical sinuous to linguoid ripples (oriented top left to bottom right in the picture), with the stoss-lee slopes indicating flow from top right towards the bottom left. Interestingly, there are also less-well-developed but still clearly visible symmetrical ripples in some of the sinuous ripple trough areas".*

Such sedimentary structures record the initial formation of ripples by currents, such as those in a sandy river channel or beach. This was followed by a second ripple-forming event such as the effect of wind-blown waves acting on shallow, slack water and superimposing a new set of ripples over those previously formed. Similar structures are commonly found on tidal beaches everyday across the world, but in the palaeogeographical context of Late Oligocene geology here at Sos they are more likely to have formed in a river system setting. One possibility is that river water currents produced one set of ripples which then were overprinted by the action of wind on the drying exposed surface of the river bed or adjacent flooded overbank area.

The main point here is the remarkable fact that bedforms produced in sediments such as these can be preserved for millions of years through geological time. Another relevant point is that these structures indicate that we are looking at the top of the sandstone bed so that this tells us which way the rocks become younger. The sandstone was deposited on a flat land surface but has since become involved in tectonic earth movements that have tilted it almost to vertical in response to the uplift and south-directed push of the Pyrenean mountain chain.

"The study of sedimentary rock layers is known as lithostratigraphy and…..it rests upon the fundamental premise that younger rocks are deposited upon older ones as horizontally and laterally continuous beds. The idea was expressed in the Dissertationis prodromus published in 1669 by the Danish scientist Nicolas Steno who is credited with being one of the first to elucidate several of the defining principles of the science of stratigraphy." From: Barcelona Time Traveller.

*View southeast along the GR1 with the ripple-marked sandstone outcrops on the left side of the track and Soc del Rey Catolico perched on the rocky ridge to the right. The sedimentary beds get younger to the right, so that the rocks exposed in the track here lie below, and are therefore older than, the sandstones exposed beneath Sos.*

Continue following the track to locate a small quarry exposing another bed of sandstone:

*View looking north from the GR1 trackside quarry in latest Oligocene sandstones (c. 25 million years old). In the foreground are broken flakes of the bedrock sandstone which is exposed behind as an upstanding vertical bed. In the distant background the Pre-Pyrenean hills of the Sierra de Leyre rise to a height of over 1,300m and expose sediments of Eocene age (over 35 million years old). Thus the rocks in this area become younger southwards, from Eocene (Leyre), to Oligocene (this quarry and the lower ground beyond to the north), to Miocene (south of Sos).*

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Continue walking west along the GR1, passing a cattle farm and haystacks. On a clear day there are views northeast to the distant snowy high Aragonese Pyrenean mountain peaks.

The Pyrenees is one of the many mountain belts that have come and gone due to the movement of tectonic plates through geological time. In this case the Iberian plate became locked between Africa and Europe around 60 million years ago. As Africa applied inexorable force, so northern Iberia was driven beneath what is now France “nosing into the Deep Earth to elevate the crust above it and produce more and higher land. This is how classical orogenic collision mountain belts form: two plates collide to create a linear zone of uplifted, faulted and deformed rocks called an “orogen". It is a gradual process that takes hundreds of thousands of centuries…..

The first Pyrenean hills arose in the east, at the Catalan end of the developing mountain belt. After the slow Palaeocene start the screws were tightened in Early Eocene time as Africa began to push harder against Iberia, squeezing, slicing and shortening the orogen to pile up mountains over one kilometre in height. By now the Pyrenean orogen exposed above sea level had grown to over two hundred kilometres long as it extended westward to disappear into the deep marine Basque Basin and the open Atlantic Ocean. The southern shelf of this oceanic margin initially ran eastward all the way to northeastern Catalonia, but by the end of Eocene times the seas had retreated so that land extended westward to Pamplona as the Pyrenees rise to dominate and define the collisional plate boundary. The basins lying south of the Pyrenees were thus denied a marine connection to the west and the inward-draining isolated Ebro Basin was born, receiving river sediment from the rising mountains immediately to the north.

From: Barcelona Time Traveller.

*Panaramic shot from the GR1 as the Torre de Añués at the Navarrese border comes into view.*


The GR1 follows an ancient east-west route south of the Pyrenean peaks, from the Catalan coast to Asturias and beyond. Its roots presumably go back at least to the days of Charlemagne King of the Franks who, in the final years of the eighth century progressively established and stabilized a buffer zone of various counties south of the Pyrenees in what later became the northern parts of Navarra, Aragon and Catalonia. This protective borderland strip, known as the “Marca Hispánica”, separated the Muslim Emirate in the south from the Christian Frankish Empire to the north, and was governed by counts, all of whom owed their allegiance to the Frankish King.

The tower at Añués, standing vigil exactly on the border between Navarra and Aragon, goes back at least to the late part of the 9th century, the rule of King García Iñiguez of Pamplona and the Monastery of Leyre. The simple fortification has a spiral staircase inside and lies alongside a ruined 12-13th century Romanesque church.
http://www.castillodeloarre.org/Zaragoza/990510-Anues1.htm

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*A few metres north of the ruined church and tower are low exposures of gravelly river terrace deposits of Quaternary age, covering the unexposed older Oligocene sediments that underlie this area. The northern flanks of the Sierra de Peña are largely covered by spreads of young sediments deposited on slopes draining into the River Aragon which lies just 4km northwest from here.*

*View looking south along the Aragon-Navarra border beyond Añués Tower and ruined church to the Sierra de Peña which rises to a peak of 1069m and exposes Miocene fluvial sediments dipping south into the Ebro Valley. The flat grassland immediately in the foreground is underlain by Quaternary sediments.*

Return by the same route.

Wes Gibbons 2020
http://barcelonatimetraveller.com/

# Background to Holiday Geology Guides

The author and geologist Wes Gibbons has always had an interest in writing short geoguides aimed at inquisitive tourists, offering them the opportunity to learn about the landscapes and rocks of scenically attractive places. His argument is that there is so much more to know about rocks and Earth history than the superficial descriptions offered by tourist guidebooks, which rarely even scratch the surface of Deep Time.

His first attempt in this direction produced *The Rocks of Sark* (1975), published jointly with John Renouf of Manche Technical Supplies in Jersey, a venture that taught a youthful Wes to always be the one responsible for the final proof reading. In 1976 Wes moved from Sark to begin a PhD supervised by Greg Power (Portsmouth University) and Tony Reedman (British Geological Survey). Living in a former Post Office in the village of Greatham on the Hampshire-West Sussex border, Wes decided to pass his spare time preparing a guide to the geology of the Weald in southeast England. He sold the idea to the publishers Allen and Unwin who commissioned other authors to develop a mini-series: *The Weald* (1981), *Snowdonia* (1981), *Lake District* (1982), and *Peak District* (1982).

His next field-based guidebook surfaced in 1985, fruit of several years research work in Corsica (*Corsican Geology: a field guidebook* by Gibbons and Horák). Two years later Wes launched the Holiday Geology series, using a simple, inexpensive format later described as "a single A3 laminated sheet …. folded into three and (with).. six portrait panels … filled with a lively mix of colour photos, maps, sections and text" (review by Nigel Woodcock in Geological Magazine, 2000). The first two Holiday Geology guides were *Scenery and Geology around Beer and Seaton* (1987) and *Rocks and Fossils around Lyme Regis* (1988). The Holiday Geology concept attracted the attention of the British Geological Survey who went on to expand the series to over 20 titles.

Following his retirement in 2004 to live in Barcelona with Teresa Moreno, Wes maintained his interest in publishing field guides by writing the text to *Field Excursion from Central Chile to the Atacama Desert* (Gibbons and Moreno 2007), *The Geology of Barcelona: an Urban Excursion Guide* (Gibbons and Moreno 2012), and *Field Geotraverse, Geoparks and Geomuseums* (in central and southwest Japan: Gibbons, Moreno and Kojima 2016). His most recent publishing project, the most ambitious so far aimed at a general readership, has produced the book *Barcelona Time Traveller: Twelve Tales* (2016, Spanish translation 2017: Bimón Press Barcelona) and the resurgence of the Holiday Geology concept, although this time in virtual format linked to the *Barcelona Time Traveller* webpage.