

ROMAN GOLD MINING AT LAS MÉDULAS*

From Environmental Disaster to Tourist Attraction

Wes Gibbons 2018

This Holiday Geology Guide takes the traveller 900 kilometres west from Barcelona to offer an illuminating one-day route through one of the most important gold mining areas in the Roman world. The location is easily accessible by car and lies on the southwestern border of the El Bierzo basin in León province, in the Sil Valley 30 minutes' drive from the Camino de Santiago town of Villafranca del Bierzo. In Roman times this area would have been an environmental disaster zone. Now however, 1,800 years later, nature has largely reclaimed, softened and beautified the destructive work of humans, producing a scenic attraction visited annually by around 100,000 tourists.

Why is the gold there?

Las Médulas is one of more than five hundred Roman gold mines in northwest Spain, an area that has been calculated to have yielded around 200,000 kg of gold in the first and second centuries AD. The relative abundance of gold in this area is due to a long geological history of reworking that led to the concentration of the metal into quartz veins, then lateritic soils, and later into Miocene sediments such as those exposed at Las Médulas.

The oldest rocks containing gold in northwest Spain are Cambrian and Ordovician metasediments that form an ancient hard basement exposed today in the mountains surrounding El Bierzo. During the Variscan Orogeny around 300 million years ago some of this gold became concentrated into quartz veins, mainly as a result of igneous activity that drove hot fluids through these basement rocks. Some of the gold in these quartz veins is found as tiny crystals within the iron sulphide mineral known as pyrite.

In post-Variscan times the surface of much of western Iberia was a land area covered with lateritic soils produced by weathering under a tropical climate. Where this weathering affected auriferous pyritic quartz veins, the oxidation of pyrite by meteoric waters circulating through the soils liberated the fine gold which was carried away in the fluids and precipitated elsewhere as nuggets. This process of weathering and redistribution of ore metals by shallow, circulating waters is known as "supergene enrichment". Parts of western Iberia were exposed to an extraordinarily long history of supergene weathering (spanning around 200 million years of earth history during Mesozoic and early Cenozoic times), producing thick auriferous soils ripe for harvesting during the new orogenic shock to come.

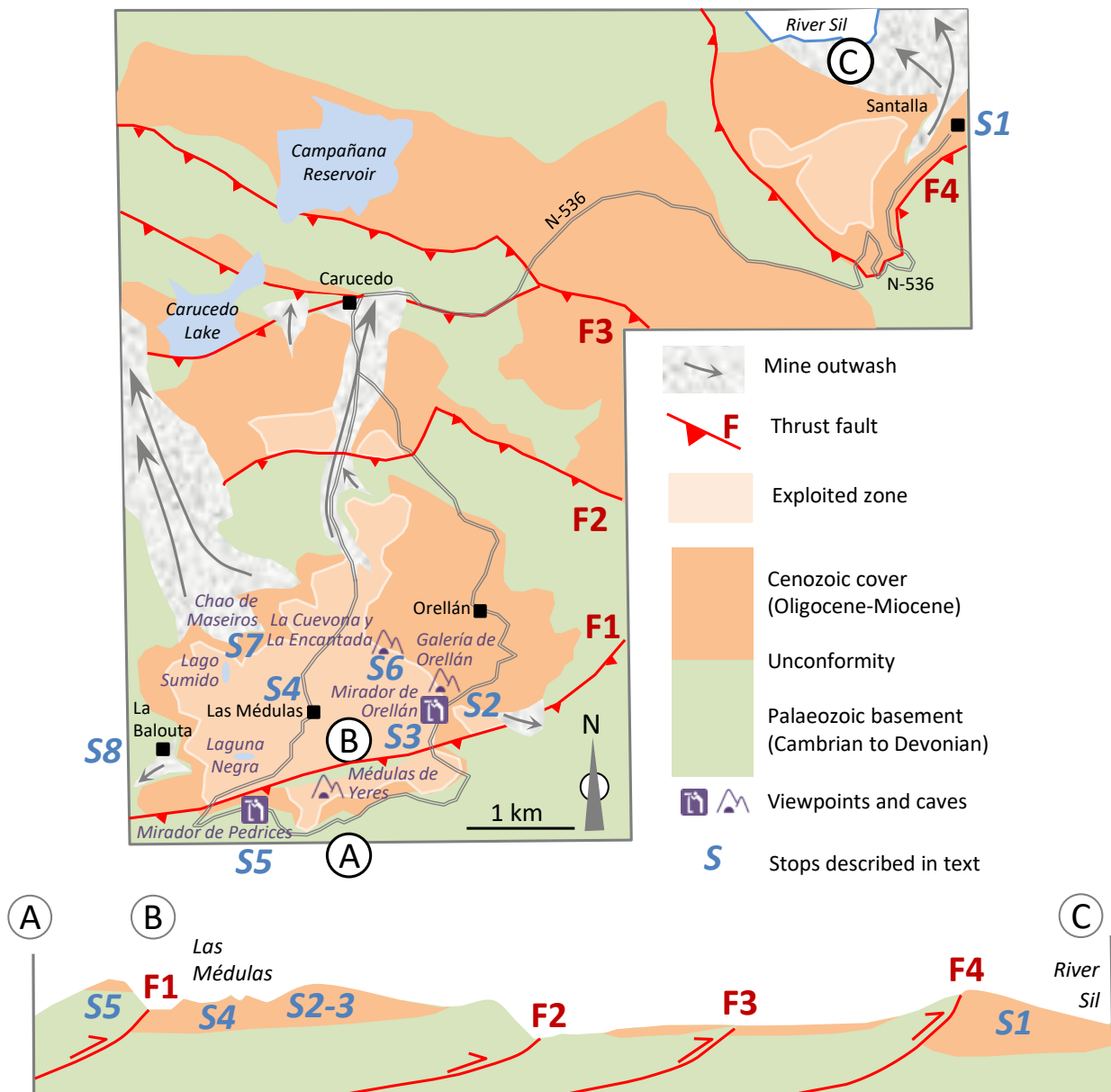
The long history of tropical weathering was finally interrupted around 30 million years ago by the "Alpine" compression of Iberia, caught between Africa and Europe. This renewal of orogenic forces (basically a push from Africa) induced the uplift of new mountains carried on piggy-backing thrust faults, and so rejuvenated the landscape in northwest Spain. Rivers incised deep valleys into the uplifting ground, with torrential rainstorms eroding the gold-bearing soils and washing the heavy metal particles to lower ground. The supergene-enriched gold thus found a new home in layers of conglomerate and sandstone building out to form great alluvial fans where the floodwaters lost energy as they entered intermontane basins such as El Bierzo.

*Cite as: Gibbons, W. 2018. Holiday Geology Guide to Las Médulas.
<http://barcelonatimetraveller.com/wp-content/uploads/2018/10/Médulas-Holiday-Geology.pdf>



Gold deposits at Las Médulas.

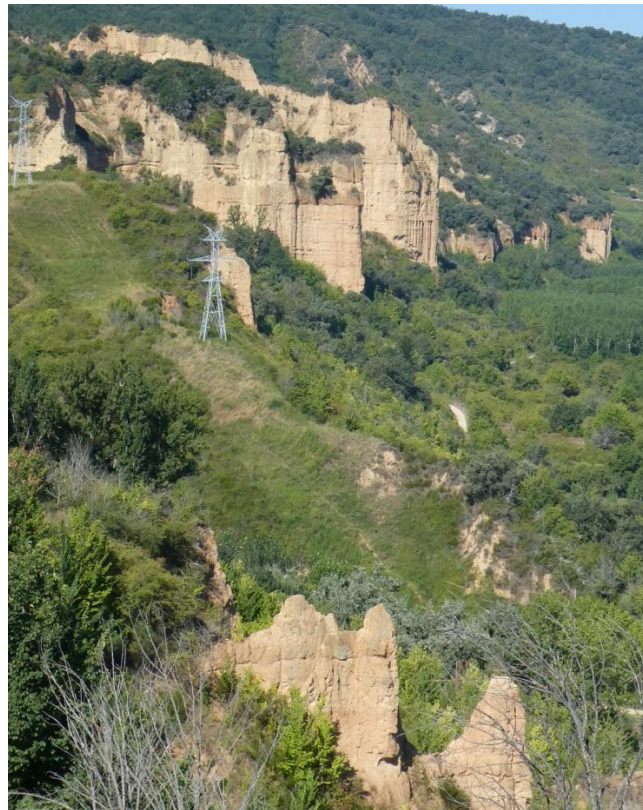
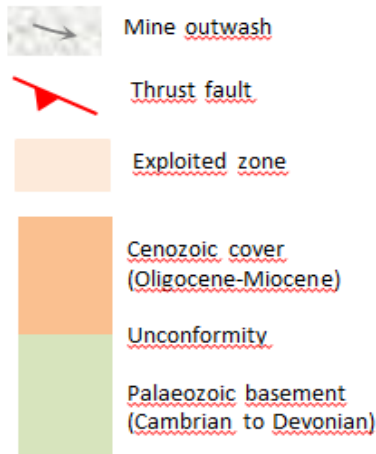
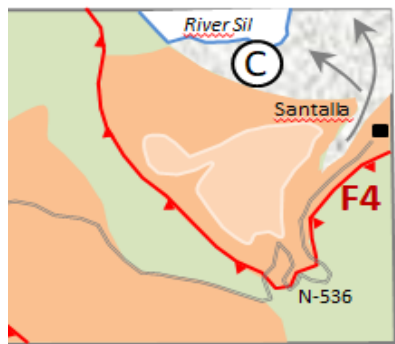
Most of the gold in this area lies in the lower part of the Miocene alluvial fan sediments deposited close to the southern side of El Bierzo Basin. The site lies at the foot of the Galaico-Leoneses Mountains produced by the uplift of basement rocks pushed northwards on south-dipping thrust faults. Some of these thrusts were active during and after Miocene alluvial fan sedimentation so that the gold-bearing sediments have become stacked up in successively higher ground which rises to the south. This produces a repetitive outcrop pattern on a geological map and cross section, as can be seen below.



Geological map and cross section of the Las Médulas area, simplified from the work of Nemesio Heredia and colleagues (2015), showing the series of south-dipping thrust faults (in red) that have broken through the old basement rocks (green) capped by young (mostly Miocene) alluvial sediments (orange). The itinerary described below begins at Santalla (top right of map) then moves southwest to Orellán (Mirador and Galería), then descends to Las Médulas village before climbing to the Mirador de Pedrices (southwest corner of map), descending again to the caves of La Cueva y La Encantada. Finally, the route ends with a visit to the Lago Sumido and the nearby Mirador de Chao de Maseiros.

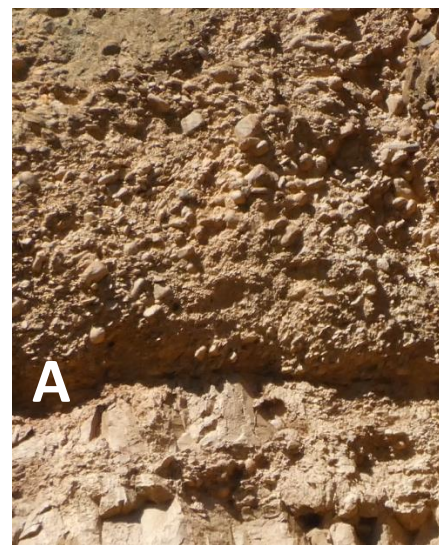


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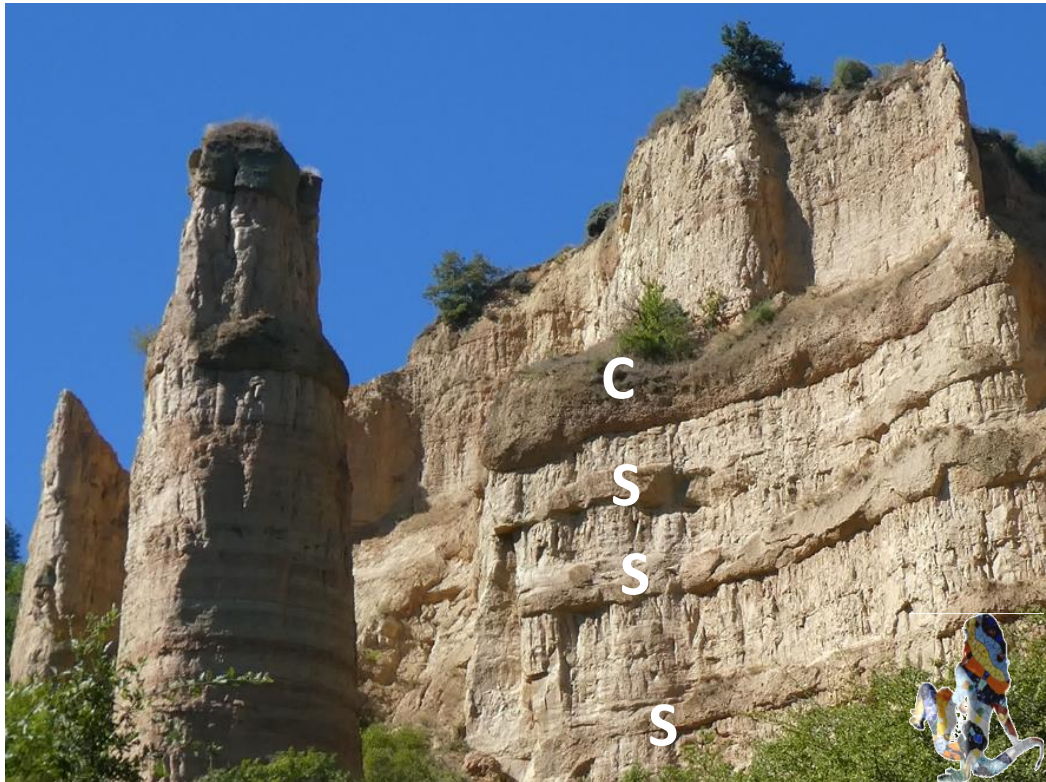


The photo (right), also taken from the Mirador de Santalla, zooms in on the pale cliff chimneys exposing Miocene sediment on either side of the Ferradilla stream gully. The thrust basement ridge forms the high ground behind (top right).

A closer view of the Miocene sediments can be made by walking (or driving: narrow, steep and not recommended, but possible) west down the lanes from the parking area into the Ferradilla gully and crossing the stream by a bridge from where a track leads west to the base of the exposures shown in the photos below.



Conglomerate layers within the Santalla sediments contain pebbles of basement rocks such as quartzite and slate (close up = A). These conglomerates record sediment deposition during storm-generated flash floods pouring from canyons and spreading their sedimentary load across an alluvial fan in Miocene times (the Miocene epoch lasted from 23 to 5 million years ago).



The layers of sediment exposed in the cliffs are mainly soft pale mudstones which erode easily, leaving the harder layers of sandstone and especially conglomerate standing proud from the cliff face. In the image above one can identify three sandstone layers (S) interbedded with mudstone, all overlain by a prominent conglomerate (C).

The different sediments preserved in the Miocene sequence here record contrasting types of sedimentary processes and environments. The materials forming the coarser beds (conglomerates and sandstones) were brought down by high-energy waters pouring across the alluvial fan surface, commonly at least partially confined within shallow channels. Some of these beds represent the infill to such channels, whereas others define delta-like lobes of sediment deposited in front and to the sides of the channels. In contrast, the fine mudstones record much quieter sedimentary conditions on a muddy alluvial plain. These areas away from the channel banks would likely be underwater during and after flood events, but often exposed to the air long enough to generate soils supporting plant growth. At any given time an aerial view of this area would have shown a complex, constantly changing dynamic mosaic of weaving channels and lobes separated by muddy areas as the alluvial fan evolved to leave its mark on Earth history:

“Rocks such as conglomerates, sandstones and mudstones all have one thing clearly in common: they are formed of pieces (clasts) of older rocks and minerals eroded from pre-existing formations and deposited as layers on lower ground. They are “clastic sedimentary rocks”. The size of the clasts decreases from boulders to pebbles in the conglomerate, through sand-sized grains in the sandstone, to tiny mud flakes in the mudstone, as the energy of the water carrying them declines from fast flowing (conglomerate), to slower flowing (sandstone) to gently drifting or stagnant (mudstone). Thus, in terms of reconstructing an ancient sedimentary environment....conglomerates record fluvial events such as fast-flowing rainstorm-induced flash floods which carry large pebbles down a mountainside over a steep alluvial fan.

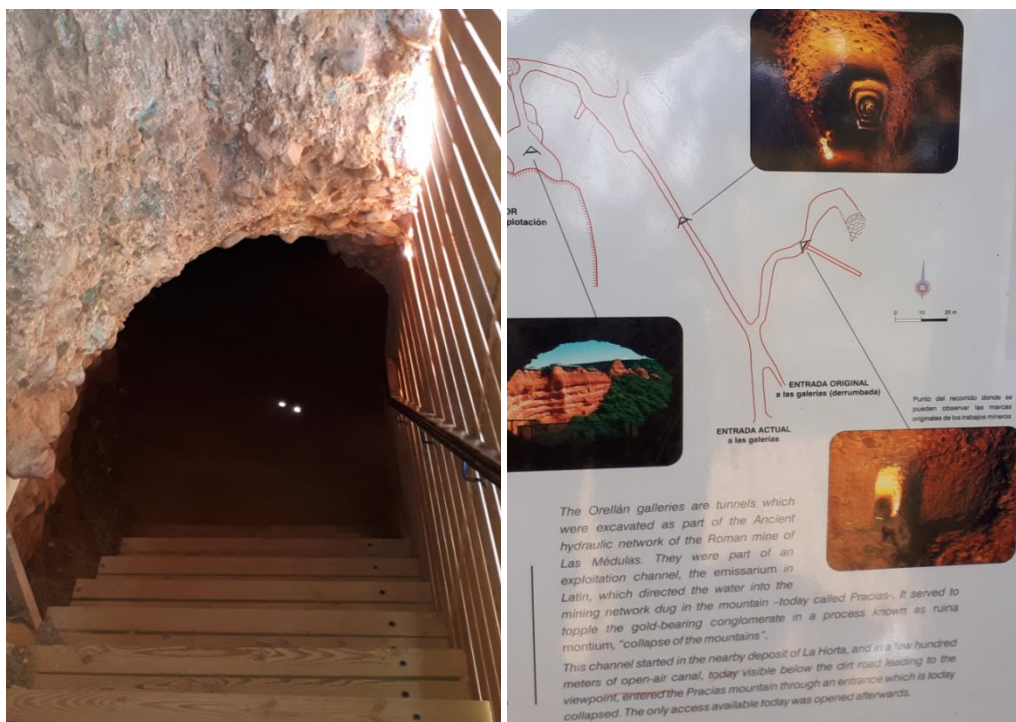
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The spread of conglomeratic clasts diminishes away from the mountainous source, and so the conglomerate typically grades laterally into finer, sandy sediment deposited under more gentle flow conditions in valley river channels. Further down the valley, on the flat muddy floodplain bordering the river, the finest grained sediments will be deposited in quiet “overbank” areas away from the channels. If the valley subsides enough to accommodate these sediments so that they pile up layer upon layer, and the surrounding mountains and climate keep up the clastic supply of eroded detritus, then a stratigraphic record will be born. The sedimentary sequence of fluvial conglomerates, gravels, sands and muds will be preserved in Deep Time, hardening into stone as they dry out and their clasts become fixed in precipitated cement. If raised back to the Earth’s surface to form mountains of their own, they will suffer the same erosive fate as their parental source rocks, passing on the record of their existence to fresh young sedimentary offspring which will be left in turn to take their chances with the lottery of geological preservation.”

From: *Montserrat*, Chapter 9 in *Barcelona Time Traveller*
<http://barcelonatimetraveller.com/>

Stop 2: Galería de Orellán

Drive 15km SW from Santalla through the village of Orellán to the car park below the Mirador de Orellán (leave nothing valuable visible in the car). From here walk 400m further SW on the track to the steps (left) leading down to the entrance to the *Galerías de Orellán* (closed 13.45-16.00 and some Tuesdays). For a small fee you will be given a hair net, hard hat, and access to the cave network excavated into Miocene sediments during Roman times.



Entrance to the Orellán Galleries is made via a series of wooden steps leading into the poorly lit tunnel network. The primary objective of such tunnels was to burrow through and destabilise the hillside and produce progressive collapse of the sediments. The debris beneath newly exposed cliff faces after each collapse was then washed and sorted for gold. This destructive method, which involved bringing water over long distances via canals, was referred to as “ruina montium” (mountain wrecking).

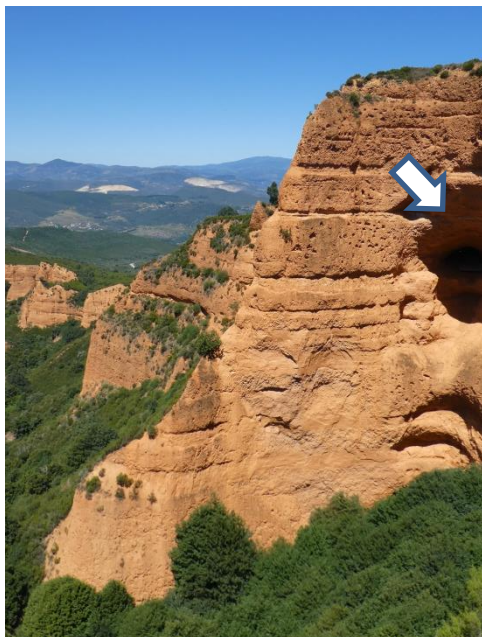




The main access tunnel (right) passes smaller tunnels (left) excavated within the underground network before curving sharply left (watch your head!) to emerge into daylight where the excavations are exposed at a vertical cliff face.



Left: Coarse conglomerates exposed in the perched cave at the end of the main tunnel in the Orellán Galleries. These high-energy sediments were deposited by debris flows which dumped their pebbly detritus within, on either side and in front of the channels emerging from the mountain front during catastrophic flood events on the Miocene alluvial fan. Right: The view looking out from the perched cave shows these coarser deposits alternating with thinner sandstones and (more rarely) mudstones.



The perched cave exit to the Orellán Galleries is shown on the right side of the photo (arrow). The weathered cliff face running northwest from the cave marks the collapse-front of Roman excavation using the “ruina montium” method. The well-exposed Miocene alluvial fan sequence, which here is over 150m thick, again shows the dominance of thick conglomeratic layers.

Return through the tunnels and, emerging back into daylight, turn right and follow the path to the Mirador de Orellán.



Stop 3: Mirador de Orellán

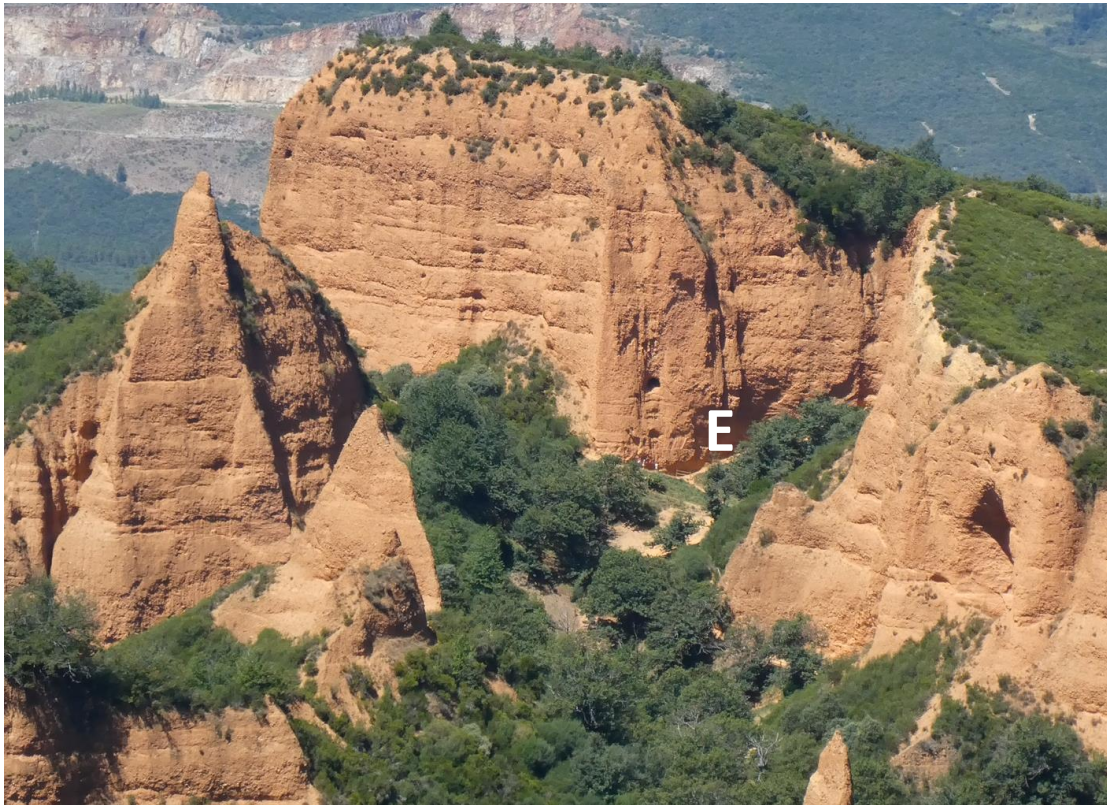


View west from the Mirador de Orellán across the area exploited by the Roman mountain wrecking mining method. In the foreground the excavation of the Miocene sediments has been only partial, leaving behind weathered pinnacles rising from the reforested valleys (known locally as Las Valiñas) and forming what is now the main scenic attraction of Las Médulas. The perched cave of the Orellán Galleries is seen to the right. The ridge on the extreme left of the photo is capped by Miocene sediment brought to higher ground by a thrust (F1 on the geological cross section) which has piggy-backed basement rocks (covered by forest) and their cover southwards over the Miocene of Las Valiñas.



Closer view of the pinnacles rising from Las Valiñas. The Miocene sediments comprise beds of conglomerates and sandstones stacked up as a succession of filled river channels once flowing across the alluvial fan. In the distance behind is the modern limestone quarry of Peña del Rego, recently immersed in legal controversy and bankruptcy for reputedly damaging the UNESCO World Heritage Site of Las Médulas, once itself a catastrophic blot on the landscape. Pliny the Elder, who was a procurator responsible for mining administration and wrote extensively about gold mining in Spain, would likely have appreciated the irony.





Zoom view of Las Médulas pinnacles in the area of the much-visited La Encantada cave (E: note the tiny tourists just to the left, standing beneath another perched tunnel opening in the cliff face). The Peña del Rego quarry lies behind.



Prominent layer of conglomerate resting on finer sediment exposed just south of the Mirador de Orellán. Observe how the conglomerate pebbles become smaller upwards from the base (“fining upward”). As the floodwaters subsided and lost energy, so they were progressively less capable of carrying big clasts and so deposited finer and finer particles. Near the top of the exposure another conglomerate records another time break and a renewed sedimentation event:

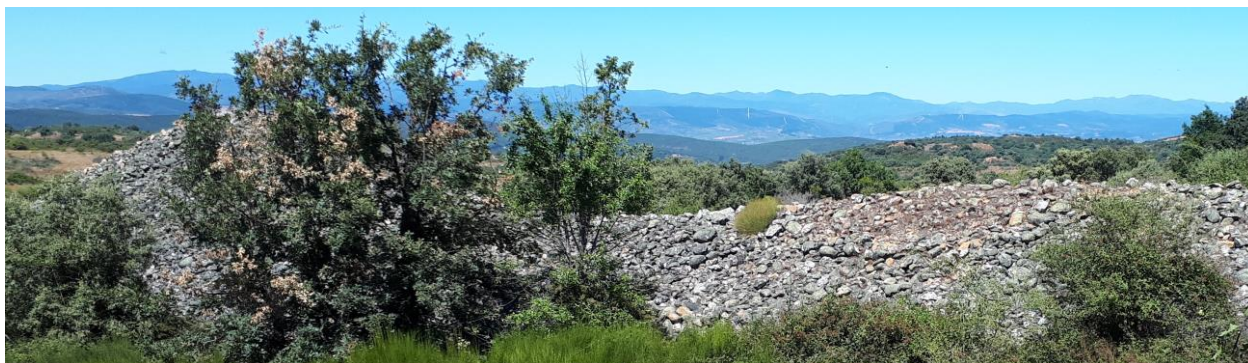
*“The Traveller is reminded of the words of the quantitative stratigrapher Peter Sadler who, working in California three hundred and thirty years after the *Dissertationis prodromus* of Nicolas Steno, wrote *Hiatuses pervade the stratigraphic record at all scales.....Each sediment layer represents one small and short-lived patch in the dynamic mosaic of Earth surface environments.*”*

From: Montserrat, Chapter 9 in *Barcelona Time Traveller*



Stop 4: Las Médulas Village

Return to the car park and drive for 5km back through Orellán village down almost to Carucedo before turning south to arrive at the parking area on the right just before entering the village of Las Médulas, where restaurants and bars offer a comfort stop. Continue on foot south through the village, passing on the right a picnic area with information boards about the Camino Real, a key route between Castile and Galicia before the modern road network. Follow the Camino de Santiago conch shell signs on the track out of the village south then southwest. To the right are views over the piles of conglomeratic cobbles left by the Roman mining operations and known locally as *urias*.



Rock clasts washed from the Miocene conglomerates were piled into “urias” by the mine workers and these piles were left strewn across the pervasively exploited ground west of Las Médulas village. It is impressive how, even after 1,800 years since the mining operations ceased, the barren heaps of muria stones are still there, often largely unreclaimed by vegetation, a testimony to the thoroughness of Roman environmental destruction in this part of their Iberian colonies. View looking north towards the Sierra de Ancares in the Cantabrian Cordillera north of El Bierzo basin.

As previously stated, most of the gold in the Las Médulas area is found in the lower part of the Miocene succession close to where the alluvial fans emerged from the mountain front. This is presumably because the gold sourced mainly from the deeply weathered lateritic tropical soils covering the basement. These soils were the first to be eroded as the mountain-building process started and so were the first to be deposited in the alluvial fan system. Similarly, being so heavy, the gold grains were amongst the first to be deposited by the flash floods, and so are found close to the mountain front rather than further out into El Bierzo basin.

The presence of gold low in the sedimentary succession would have meant that the miners progressively had to remove many metres of relatively barren Miocene conglomeratic sediment lying above the auriferous zones to get at their pay dirt, which according to some reports typically contained metal concentrations of just 10 to 150mg/m³. Thus the *ruina montium* method resulted in the production of a massive amount of waste material which included not only coarse pebbles and cobbles derived from the conglomerates (the *urias* seen here) but also finer tailings left after extensive washing of the gold-bearing sediment.

The Camino Real climbs southwest, beneath thrust fault F1 (see geological map) before curving left to a track junction, 1.5km from Las Médulas. Here turn left and climb towards the Mirador de Las Pedrices which lies 500m east. We have by now climbed above the thrust fault F1 which brings basement rocks over the Miocene sediments of Las Médulas (see geological map and cross section). These hard basement rocks can be seen exposed on the floor of the track.





Track leading up and eastwards to the Mirador de las Pedrices (the view is down and to the west). Poorly exposed hard basement rocks of Ordovician age are exposed in the road surface and adjacent low bank. Note the round cobbles of basement rocks (e.g. extreme right) resting on the basement: presumably muria deposits left from the excavated Miocene conglomerates.

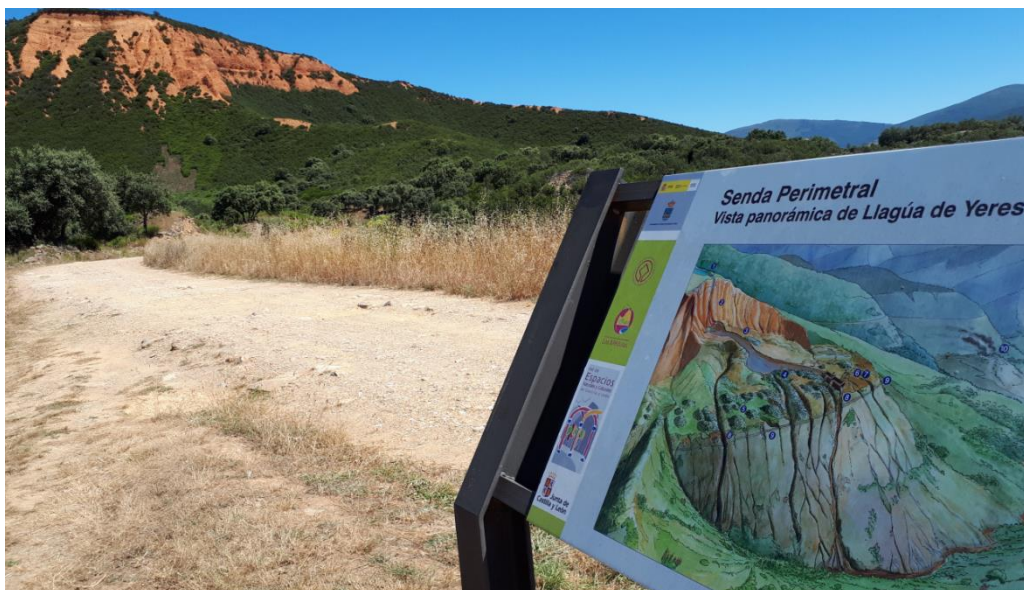
Stop 5: Mirador de las Pedrices



The splendid view from the Mirador de las Pedrices looks north across the village of Las Médulas, with the semi-exploited ground pinnacles of Las Valiñas and the Mirador de Orellán to the right, and the more thoroughly exploited mining zones forming the lower ground to the left.

The ground east of the Mirador de Las Pedrices rises to expose the exploitation front of thick Miocene sediments that were another important target for the Roman mining operations. In this area, known as the Llaguá de Yeres, water falling from the cliff was channelled into washing sluices where the gold was separated.





Information board providing a graphic representation of the challenging working environment where gold was won at the Llagúa de Yeres.

Continue walking east from the Mirador for a few minutes to locate a signpost marking a path to the left (the Senda de Reirigo: 1.2km to Las Valiñas). The path initially can be rather overgrown but then runs beneath the red conglomeratic cliffs of Miocene sediment (right), before plunging into the beautiful forests of Las Valiñas, descending through oak and beech into chestnut groves.



Stop 6: Las Valiñas and its artificial caves

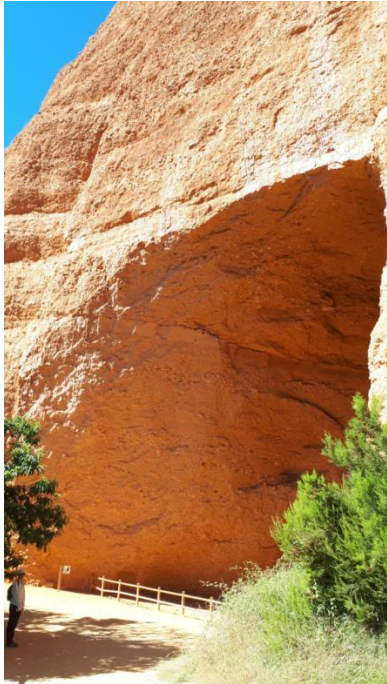
During the descent of this attractive forest path the observant walker will notice more exposures of the Ordovician rocks underfoot, these lying above the thrust fault F1.

Poor exposures of the Ordovician basement rocks in the Senda de Reirigo which descends through the forest to connect with the Senda de las Valiñas. These basement rocks lie just above the thrust fault F1 (the green area below "B" on the geological map).



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Upon reaching the valley floor turn right (La Cueva 1.4km) and follow the popular route (Senda de las Valiñas), passing the Fuente de la Tia Viviana (where a path leads right for a steep climb to the Mirador de Orellán) to reach firstly La Cueva then La Encantada, with various other cave and tunnel excavations exposed at higher levels (be aware of falling rock hazard here: unlike the majority of visitors). At La Encantada, locate the narrow path that leads northwest to the left of the small wooden barrier below the round perched tunnel. This is an attractive backroute to Las Médulas village, passing through the pinnacles and out to the more thoroughly exploited ground.



Left: The entrance to La Cueva. Right: the perched tunnel in the cliffs to the left of La Encantada. The backroute to Las Médulas passes below and to the left of the circular perched tunnel.



Surviving remnants of the Miocene sediments rise as pinnacles above the extensively exploited ground strewn with muria conglomeratic stone piles on the return to Las Médulas village.

LAS MÉDULAS

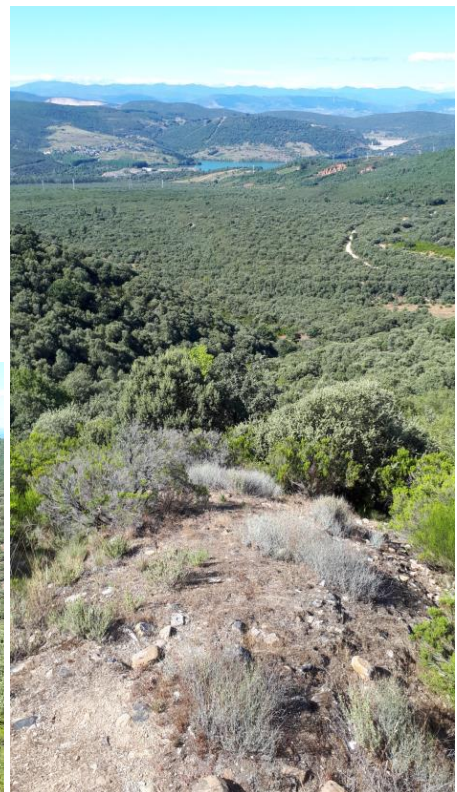
Stop 7: Lago Sumido and the Mirador de Chao de Maseiros

The backroute path from La Encantada joins the main road in the village centre at the picnic site with information boards passed earlier. Here turn left and, after a short distance, bear right away from the Camino Real on a track signed to Lago Sumido. This route crosses the flat, exploited ground west of the village, passing more examples of *murias* and lakes left behind as evidence of the mining operations.



Low mura in fields passed on the track to Lago Sumido.

Passing Lago Sumido, continue north for 5 minutes to locate the viewpoint overlooking the Chao de Maseiros. The wooden lookout is built on another *mura* stone pile.



Viewpoint overlooking the Chao de Maseiros, a former valley largely infilled with outwash from the Roman mining operations. The huge amount of material dumped into this valley, especially once the mountain wrecking method got into full swing, was enough to block the drainage system downstream and give rise to the artificial Carucedo Lake (centre background).



Stop 8: La Balouta

Return to Las Médulas village either by the same way or via a diversion to the abandoned (and rather spooky) hamlet of La Balouta which can be reached along a track that runs south just after returning past Lago Sumido. Although interesting, however, a visit to La Balouta will not be for everyone. The site is overgrown, there is not a lot to see that is easily accessible, and the buildings are in various stages of potentially dangerous collapse. Furthermore, the visit is hard, sweaty work in hot weather, and it is difficult to locate the challenging path that leads from behind the buildings to climb steeply eastwards up to Laguna Negra and so back to Las Médulas.



The track leading south from Lago Sumido passes murias as it descends the valley hiding the hamlet of La Balouta, abandoned in the 1970's: "Given that thousands of people visit Las Médulas every year and given the valley's triple status as a National Monument, Archaeological Site, and World Heritage Site, it is surprising that this valley has not been examined until now" (Redondo-Vega et al., 2015). The valley cuts down through hills of basement rocks (Ordovician limestones and slates) and there is evidence for mining activity within what is an ancient, pre-Miocene karstic landscape (see the paper by Redondo-Vega and colleagues, in reference list at the end).

There is indeed a striking contrast between the tourist crowds of Las Médulas and the atmosphere of isolated, ruined La Balouta and the sense of its lost people. During our visit in the evening of an oppressively hot summer, the ambience of the enclosed, secretive valley and the abandoned old path leading up to Laguna Negra (think: Lord of the Rings), all combined with an inexplicable pervading smell of rotting seafood to give us the willies. You are utterly alone: or are you? The place would make a perfect setting for a horror film: *La Balouta*.

A more romantic view of the ambience of La Balouta is captured by the (Spanish) blog "In between forests and stones" by Rosa Cruz, who quotes García Márquez: (<http://entrebosquesypiedras.blogspot.com/2018/01/de-las-medulas-la-balouta-el-bierzo-leon.html>).





No olvides cuidarla..... por si mañana, en vez de verla, te toca imaginarla

Never forget to look after her...in case tomorrow, instead of seeing her, you will have to imagine her.

Gabriel García Márquez



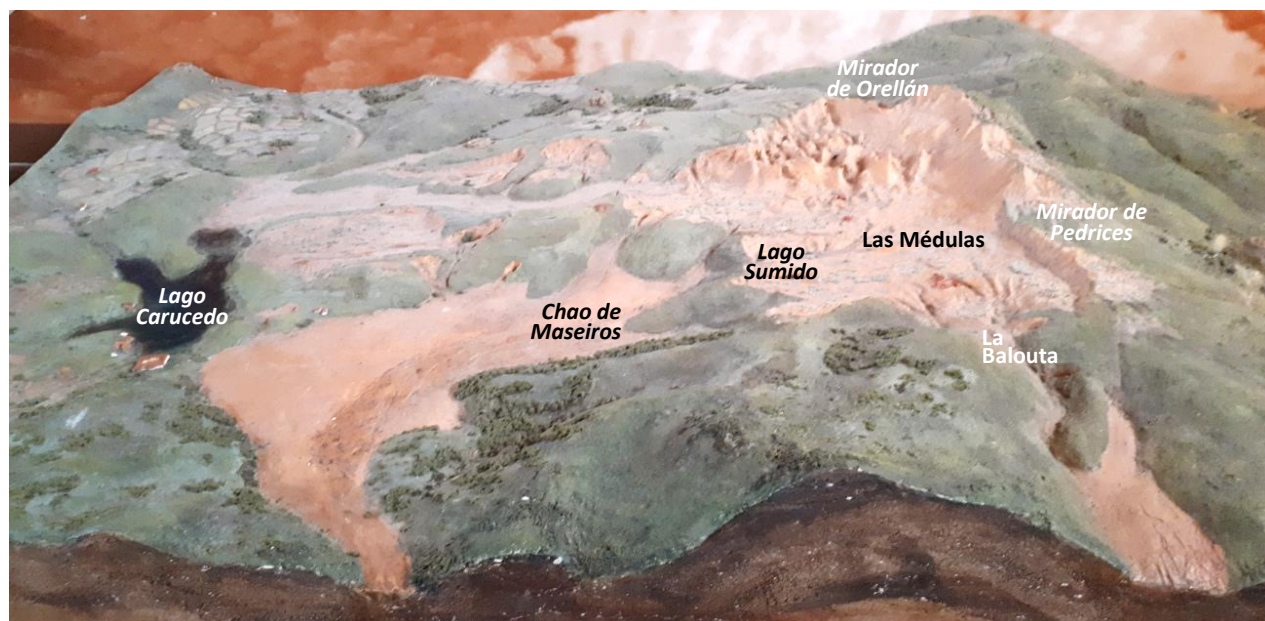
An overgrown track leads from La Balouta to Laguna Negra: to find this you need to clamber beneath the still-remaining balcony of a ruined house. The path runs from behind the house, crossing once-cultivated land and climbing through old chestnut forest, with exposures of reddened, karst-weathered basement limestone on the higher ground. "Many of those trees were my friends, creatures I had known from nut and acorn; many had voices of their own that are lost for ever now." Treebeard in The Lord of the Rings.





Laguna Negra, with views east to the Roman mining excavation front at Orellán. To the right rise the hills above thrust fault F1 visited earlier in the excursion.

Arriving back in Las Médulas, we recommend a visit to the *Aula Arqueológica* interpretation centre where, for a small fee, you can consolidate your understanding of what you have seen during the excursion.



Model of Las Médulas in the Aula Arqueológica de Las Médulas (near the car park). The view looks east and graphically portrays the devastating effects of the Roman “ruina montium” method, with the exploited ground lying beneath the cliffs excavated into the Miocene outcrop. Note also the spreads of barren waste washed into the valley drainage systems to the northwest (left: the Chao de Maseiros) and southwest (lower right: Balouta valley). The abandoned village of La Balouta lies in the narrow, curved valley which opens out southwest into a much broader fan of mine tailings.

Wes Gibbons 2018

<http://barcelonatimetraveller.com/>



Further Reading

The following publications are in English and freely available online:

1. Jesus Aller et al., 2014. The Roman Gold Mine of Las Médulas:
https://www.researchgate.net/publication/259930129_The_Roman_gold_mine_of_Las_Medulas
2. Nemesio Heredia et al., 2015. Depositional style and tectonostratigraphic evolution of El Bierzo Tertiary sub-basin (Pyrenean Orogen, NW Spain):
<http://revistes.ub.edu/index.php/GEOACTA/article/view/10502/14843>
3. José Redondo-Vega et al., 2015. La Balouta exhumed karst: a Roman gold-mine-derived landscape within Las Médulas UNESCO World Heritage Site (Spain):
https://www.researchgate.net/publication/279537136_La_Balouta_exhumed_karst_a_Roman_gold-mine-derived_landscape_within_the_Las_Medulas_UNESCO_World_Heritage_Site_Spain

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.