

MOOC sobre Sierra Nevada

MODULE 1

1.1 SIERRA NEVADA: THE VERY CEILING OF IBERIA

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The formation of Sierra Nevada

Sierra Nevada is the third-highest mountain system in Europe after the Alps and the oft-forgotten Mount Elbrus, in the Caucasus (5,633m). Sierra Nevada sits within the boundaries of the European continent, and is almost 1,000m higher than Mont Blanc (4,810m). Its highest peak, Mulhacén, is 3,478.6m high. Back in the 19th Century, travellers dubbed Granada the “Andalusian Switzerland” and Sierra Nevada the “Andalusian Alps”, drawing a clear parallel between the Central European and Penibaetic mountain ranges.

In the recent Miocene, some 15 Ma (millions of years) ago, the Sierra Nevada that we know today was submerged at the bottom of the sea, where sediments (sandstone, conglomerates, marlstone, limestone ...) were deposited. Approximately 7–8 Ma ago, these sediments became continental, as the reliefs of the mountain range were forming. The eroded sediments were deposited in adjacent depressions (Granada, Lecrín, Guadix, Corredor de la Alpujarra), establishing their outer border, so today’s relief is young in geological terms. However, the rocks that form the highest peaks are much older and show signs of intense deformation due to orogenic folding, which characterises much of Europe—including the Alps, the Pyrenees, and Sierra Nevada.

The majority of Sierra Nevada’s rocks are ancient deposits accumulated in sedimentary basins that opened-up between the tectonic plates of Iberia (Europe) and Africa during the Paleozoic (550–50 Ma) and the Mesozoic (250–66 Ma). When, during the Cenozoic (post-66 Ma), the plates shifted closer, and then collided toward the end of the early Miocene, about 20–15 Ma ago, the previously-opened basins closed. Their sediments were folded, dragged, and stacked on top of each other, creating thrust surfaces. As these shifting sediments reached great depths, they underwent metamorphism due to the increase in pressure and temperature during subsidence. Subsequently, the stack of thrusts bulged outward, forming a fold whose core constitutes the high peaks of the Sierra Nevada, which were carved into the emerging relief as the eroded fragments came to settle in the surrounding basins. It is for this reason that, under the sediments of the recent Miocene, the rocks of the Sierra Nevada are organized concentrically, shaping a further two geological formations: the Alpujárride Complex (constituting the mid-level reliefs); and, beneath this, the Nevado-Filábride Complex, whose rocks constitute the highest peaks.



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By the end of the Cenozoic, at the turn of the Pleistocene, within the Quaternary period (last 2.6 Ma), the Sierra Nevada uplift process had carried rocks from the nucleus to very high elevations, despite the extremely rapid erosion to which they were subjected. At the same time, the Earth's climate was gradually evolving toward repeated surges of cooling: the global climate, which until then had been relatively warm, began to undergo extremely rapid cooling (glaciations); and ice dominated a large proportion of the continents, accounting for more than 42 million km² globally. The highest latitudes of the planet absorbed the greatest accumulations of snow that formed glaciers, which appeared in many mountain ranges, including Sierra Nevada.

The dragging of the frozen masses toward lower elevations caused the formation of U-shaped valleys through which the terminal moraines slid. There remain abundant signs of this entire process in Sierra Nevada: the retreat of the ice after the last glacial period, about 10,000 years ago, left exposed large cirques, basins, ridges, and needles around the summits. In the depressions produced by over-excavation or limited by moraines, these have led water from the thaw to be trapped, creating a series of glacial lakes, which have inspired many delightful legends. Antonio Castillo has identified up to 72 such lakes, tarns, and ponds located above 2,600m (other authors claim there are 74). The highest of these is Corral del Veleta, at 3,086m; and the largest are the Caldera (25,000m²) and the Larga (22,000m²).

The rivers of the Sierra Nevada massif cover some 2,000m², of which 65% pertain to the Mediterranean basin and the remaining 35% to the Atlantic basin. Three rivers that originate in the Sierra Nevada enter the Mediterranean: the Guadalfeo (Dúrcal, Torrente, Lanjarón, Chico, Poqueira, Trevélez and Cádiar); the Adra (Mecina, Válor, Nechite, Laroles, Bayárcal, and Alcolea); and the Andarax (Laujar and Nacimiento). And two rivers originating in the Sierra flow into the Atlantic: the Fardes, a tributary of the Guadiana Menor (and whose tributary is the River Guadix); and the Genil (San Juan, Maitena, Dílar, Monachil, and Aguas Blancas). The Genil River is the result of the confluence of the rivers Valdecasillas, Valdeinfierno, and Bacares, which, together, form the River Real; in turn, this forms a confluence with the River Vadillo, to become the Genil. Here, then, we have five principal rivers fed by a series of secondary rivers or tributaries that make up a 50-strong network. It is estimated that Sierra Nevada accounts for water resources of 750hm³/year, primarily from the thawing of snow accumulated on the summits.

The biological uniqueness of Sierra Nevada

Sierra Nevada's high altitude, combined with its close proximity to the warm Mediterranean, at a latitude of around 36°, means that temperatures there vary between -25 and +25 degrees Celsius. This has helped create a highly unusual botanical landscape, in which Arctic tundra on the highest peaks coexists with the tropical crops at sea level, over a distance of just a few kilometres, as the crow flies. From these peaks, the waters of the Mediterranean are perfectly visible (and, occasionally, even North Africa's Rif mountains or the Strait of Gibraltar can be seen). The summits have a desert-like



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appearance, but for botanists they are nothing less than a paradise for endemics—plants that exist nowhere else in the world (of which at least 77 have been identified in Sierra Nevada). Here there are also 25 other endemic species shared with nearby mountain ranges, 170 endemics from the Iberian Peninsula, and 200 shared with North Africa. According to the most recent research, conducted by Juan Lorite, overall there are 2,354 species inhabiting Sierra Nevada.

Among the most unique endemic botanical gems is the Sierra chamomile, *Artemisia granatensis*, which grows on dry, stony ground from 2,500m. Used for many years for medicinal purposes, it is now in danger of extinction despite valiant efforts to ward off its demise. We also find here the Sierra Nevada violet, *Viola crassiuscula*, one of the most beautiful endemic species of Sierra, and *Plantago nivalis*, known also as “the star of the snows”. This species prefers the lake-edge for its habitat, in more moist and generous soils. It forms beautiful, abundant blankets of white that stand out among the green vegetation of the mountain pastures.

The Sierra is also home to endemic fauna, including species such as the butterfly *Erebia Hispania*, observed exclusively here and in the Pyrenees. The *Pseudochazara hippolyte* butterfly and the *Rossomyrmex* ant are found in Sierra Nevada and certain other mountains in the centre and south of the Peninsula, and in Central Asia and the Urals, with no populations in between. Some of the endemic plants provide the core nutrition for a specific species of mountain goat, which—now the bears, wolves, and lynxes that used to populate the mountain range have disappeared—account for most of the ungulates on the Sierra, with a population of over 13,000. Other interesting specimens include the snow vole or *Chionomys nivalis*, the golden eagle, *Aquila chrysaetos*, the Alpine accentor, *Prunella collaris*, and the Iberian lizard, *Podarcis hispanica*, as well as countless species of insects, many of which are also endemic to Sierra Nevada. The almost-mythical *Parnassius apollo nevadensis* butterfly also resides here, known for the circular orange-brown spots on its hind wings, or yellowy-orange on adult specimens.

All of these flora and fauna are the result of a millennia-long process of adaptation to a hostile environment characterized by prolonged snow, low winter temperatures, high summer temperatures in sunny areas, strong solar radiation, low availability of water for long periods, frequent wind that dries out the soil and the plants, and shallow soils offering poor nutrients. This combination of factors has given rise to a process of specialisation, in which the life cycle is reduced to the minimum. In turn, this has led to the appearance of new species that have found no similar conditions anywhere else.

The peaks of Sierra Nevada

The approximate surface area of the massif is about 1,750km², extending across about 80km from east to west and 10–30km, north to south. The 3,000m contour covers an area of 23.71km² and features a series of summits above this altitude, between Picón de Jerez and Cerro del Caballo, of 24km and an average width of 895m. At a lower level, Sierra Nevada can be said to begin at the apex



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of the confluence between the Nacimiento and Andarax Rivers, in the Province of Almería, and end at Suspiro del Moro, just a few kilometres from Granada. In the Province of Almería, the highest peaks are Monte Negro (1,710m), Polarda (2,252m), Buitre (2,465m), Cerro del Almirez (2,519m) and Chullo (2,609m).

In the Province of Granada, we can follow La Integral (the Complete Sierra Nevada Route), which covers almost 25km above the 3,000m mark between the aforementioned Picón de Jérez (3,088m) and Cerro del Caballo (3,011m). The number of peaks counted at this level varies, depending on the measurement criteria used (height between col and summit, and distance between two summits). Juan Luis Ortega and José Manuel Peula recently proposed the figure of 29 three-thousanders for Sierra Nevada. The highest ones, with an altitude of over 3,200m, are the following eleven mountains: Mulhacén (3,479m), Veleta (3,396m), Alcazaba (3,369m), Cerro de los Machos (3,327m), Puntal de la Cornisa (3,318m), Peñón del Globo (3,389m), Puntal de Siete Lagunas (3,251m), Tajos de la Virgen (3,239m), Puntal de Loma Púa (3,224m), Puntal de la Caldera (3,222m), and Puntal del Goterón (3,204m). There are, of course, other intermediate peaks that are not considered summits in their own right. The three highest are among the five highest of the Iberian Peninsula.

In Sierra Nevada, there are no valleys to break the continuity of the peaks, hence the two faces are isolated from one another and markedly different. The north face, where the city of Granada sits, is the steepest, featuring huge gorges such as those of Alcazaba, Mulhacén, or Veleta. The south face, much gentler and closer to the sea, is such that small communities populate the Sierra up to an altitude of 1,500m.

Connection between the two faces was historically achieved by means of a series of passes—none of which is without its challenges and dangers: La Ragua (2,038m); Trevélez or Albardas (2,798m); Jérez or Rejones (2,873m); Mecina (2,621m); Lobo or Bérchules (2,412m); Bacares (3,002m); and the col of Capileira or Carigüela del Veleta, also a former natural pass (3,200m). The latter is famous because it is here, according to Christian tradition, that the Virgen de las Nieves (Our Lady of the Snows) appeared to the Beneficiado of Valor, Martín de Mérida, when he was making the journey from the Alpujarra to Granada, on 5 August 1717. The first few of the aforementioned passes linked the Alpujarra with the Marquesado del Zenete area, while the last two linked across to the city of Granada itself, although they could only be crossed for about four months of the year.

The names of Sierra Nevada

The first known written testimony about Sierra Nevada is attributed to the Greek geographer and historian Strabo. In the third book of his Geographica, referring to the Mediterranean coastline, he states: “From Calpe there extends a mountain range that crosses Bastetani and Oretani territory, and is covered with dense forests and large trees, and separates the coast from the inland area. There are



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many places in this mountain range that produce gold and other metals.” There is no reference to snow, but we must take into account the fact that this description was written more than two millennia ago. Strabo used the name Orospeida to refer to Sierra Nevada, although he was possibly alluding to all the mountain ranges stretching from Segura and Cazorla to the Serranía de Ronda.

In the 1st Century, Pliny the Elder provided a more precise denomination for what is now known as Sierra Nevada, Monte Solarius, and spoke of a river that flowed into the Betis that he named—with no explanation as to its origin—Singilius fluvius. This is the same terminology used by Julio Honorio and Rufo Festo Avieno in the 4th Century. The last recorded testimony from antiquity is that of Isidoro, Bishop of Seville, which dates back to the 7th Century. He, too, uses the same name for the Penibaetic system, Solorius or Solorio (“Solorius a singularitate dicitur, quod omnibus montibus solus altior videatur”: “It is called Solorio for its singularity, because, of all the mountains of Hispania, it alone appears to be taller”).

And this was inherited by Arabic literature, where we find that sometimes Jabal al-Taly (Mount of Snow) is used, but more often Jabal Sulayr (Mount Sulayr), or simply Sulayr. The first of these is an entirely descriptive Arabic place-name: Mount of Snow. The second is the phonetic transcription into Arabic of its old Latin name Solorius or Mons Solaris, which in Arabic would become Sulayr. And, from there, it would return to Castilian with the first known name: Sierra Solera, a title that appeared in the 16th Century and would be retained in some sources (primarily judicial) until the 18th Century. But soon after, it would have to compete with other denominations, such as Sierra de la Helada (Lafuente Alcántara and Antonio Ponz).

Thus, Orospeida, Solorio, Monte de la Nieve, Mount Sulayr, Sierra Solera, and Sierra de la Helada are just some of the names attached to this mountain prior to the second half of the 18th Century, when its current denomination took root: Sierra Nevada.



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