HISPANIAE GEOLOGICA CHARTOGRAPHIA
The geological representation of Spain through History

Produced by Instituto Geológico y Minero de España
(Spanish Geological Survey)

With the collaboration of the Board of Alcázar de Segovia
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PRESENTATION

This exhibition gathers together a selection of maps showing the evolution of geological mapping in Spain as it responds to scientific and cultural advances in the country, as well as to the concerns and needs of society. From the first graphic representations dating back over 3,000 years, up to modern maps, geological mapping has always been an indispensable tool for mankind. Thus, the exhibition contains maps used to locate mineral resources; to prevent geological hazards or to quantify their damage and effects; to promote agriculture; to supply water to cities with increasingly dense populations; to interpret the origin of landscapes, and even to design military strategy. These maps were important in advancing knowledge of the country's geology and are thus essential elements in the history of science in Spain.

Each of the 40 maps chosen represents an important milestone at the time of its making, due to the techniques involved, the subject matter, or the way in which the information was obtained. Ultimately, they are a graphic representation of the observations and knowledge acquired in the field. There are also exhibits of the instruments used by geologists to draw their maps, such as compasses and altimeters, which makes it the most complete exhibition of geological mapping ever to be held in Spain.

THE GEOLOGICAL MAP OF SPAIN
Under the direction of Manuel Fernández de Castro (1889-1893)
Reproduction of the original held by the Geomining Museum of the Geological and Mining Institute of Spain in Madrid.

The Commission for the Geological Map of Spain was created in 1849 to promote knowledge of the geology of Spanish territory by drawing geological maps of the provinces. It took forty years to complete this huge project. The hard work of mining engineers and geologists was condensed into 64 sheets on a scale of 1:400,000 to provide, for the first time, a complete geological map of Spain at the end of the 19th century.
1. THE FIRST GEOLOGICAL REPRESENTATIONS

Maps were being drawn before writing came into being. In Ancient Egypt cartography was developed due to the need to redefine the boundaries of properties that were regularly flooded. One of the few Egyptian maps still preserved is the famous Turin Papyrus, which shows rock types in different colours. Although geology was not recognised as a science until the beginning of the 19th century, the intellectuals of ancient times were fascinated by these issues. Thanks to this interest, graphic documents that expressed their ideas have been preserved to this day.

The first scientific expeditions to South America did not take artists, so books on the early discoveries mostly lack illustrations. However, there are some exceptions depicting how the Spanish explorers viewed the lands. On the other hand, exploiting the minerals there was one of the main objectives for colonising South America. This was the backdrop for the advances in technology reflected by geological mapping. Maps were also a great help in managing natural disasters. Volcanic eruptions and earthquakes were a cause of worry to the administrations of the past, as they are today, and so these were the first geological elements to be mapped.

In order to modernise the country, during the second half of the 18th century the Bourbon government strove to bring to Spain the most up-to-date science and technology from Europe. Scientific institutions were created, foreign specialists were employed and students given grants to study abroad. Despite all this, science in Spain underwent a severe crisis in the first half of the 19th century. The few institutions that succeeded those established in the previous century were bereft of any official aid. The situation improved around 1825 when a law on mining was introduced to encourage the industry. Consequently, the first partial geological maps of the country, all made by foreigners, appeared almost simultaneously in about 1834 and this brought to a close the first stage of geological mapping in Spain.

Between 1730 and 1736 the Timanfaya volcano on the island of Lanzarote registered a period of intense activity. The Royal Court of the Canary Islands ordered the authorities on the island to prepare a series of reports on the evolution of the eruption and its effects. This map is one of the documents prepared and it shows the destruction the eruption caused to the adjacent farmland. It is one of the first known maps of the effects of a volcanic eruption.
At the beginning of the 19th century two seminal works were published that laid the foundation of modern geological mapping: the geological map of England and Wales by William Smith (1769-1839) and the map of the Tertiary period in the sedimentary basin of Paris by Georges Cuvier (1769-1832) and Alexandre Brongniart (1770-1847). These authors realized that the distinct successive formations contained different fossils, and that the older the formation, the greater the difference when compared to more recent fossils. One of the fundamental principles of geology and geological mapping was based on this observation.

This map of the Duero basin shows three types of sedimentary material: the secondary (in green), the fresh-water tertiary terrain (in yellow) and the fluvial deposits of smooth stones (in pink). The mountain areas surrounding the basin are uncoloured. Ezquerra’s main interest was to demonstrate that the sediments in the Duero basin were lacustrine in origin. For this reason, he named the mountainous areas “dykes”, as he thought these were the barriers that contained the water from an ancient lake.

In 1832, the German mining engineer Wilhelm (Guillermo) Schulz (1805-1877) was asked by the Directorate General of Mines to make a geological map of Galicia. The map contained a legend with twenty-one different lithologies and is the first modern map of the region.
This is the first geological map of Spain produced by a Spaniard. The soils are identified by fossils and the three main geological features of the province are defined: the Palaeozoic material from the Sierra de la Demanda, which he calls Carboniferous soil; the Mesozoic material from the western part of the province, classified as Cretaceous soil; and, lastly, Tertiary material from the Duero and Ebro basins, which are fresh-water limestones.

This was the first geological sketch of Spain produced by a Spaniard. Although it was an incomplete synthesis, the author’s aim may have been to show the international scientific community that Spain was starting to gain some knowledge of its geology. Drawn on a scale of approximately 1:5,000,000, it was published in Stuttgart (Germany).

War and Geology, an analysis of the influence of land formations on military strategy, is among the best works of the military engineer Ángel Rodríguez de Quijano (1820-1893). Basing his study on the geological work of another famous soldier, Francisco de Luxán y Miguel-Romero (1799-1867), he wrote geological summaries of the Iberian Peninsula and the other European countries, while adding geological and military surveys to describe the features of the terrains and the difficulties presented for troop movement.
On 26th July 1529 the Governor of Cartagena, Gonzalo Fernández de Oviedo, climbed the Masaya volcano in Nicaragua, which was erupting at the time. He observed the lake of lava inside, took several notes and drew sketches of the geology. He also collected the information provided by the indigenous people on eruptions, as well as their mythology, and he visited other active and erupting volcanoes. He sent a report to the king of Spain and, years later wrote his General and Natural History of the Indies, which included sketches and maps. Oviedo became the first eye witness to bring pictures of South American volcanoes to Europe. He was a pioneer of vulcanology in the field, as he made notes in situ and (somewhat distorted) sketches of the geology.

In his Chronicle of Peru this conqueror, chronicler and historian dedicated a chapter to providing a detailed description of the discovery of a deposit of silver in the Cerro Rico de Potosí, in what is now Bolivia. It includes a drawing of his interpretation of the deposit showing the layout of seams of silver near the top. This is one of the first graphic representations of a mineral deposit.

The policy of encouraging studies abroad enabled Spanish students, like Carlos de Gimbernat (Barcelona, 1768-Bagneres de Bigorre 1834), to study in the most prestigious centres of science in Europe. Gimbernat carried out several scientific expeditions to the Alps, financed by Charles IV, to gain knowledge of the geology and apply the theories of Werner, the great German geologist who founded modern mineralogy. The resulting geological maps and cross sections are said to be the first of the Alps.
GEOLOGICAL SKETCH OF THE BALEARIC ISLANDS: MALLORCA AND MENORCA
Alberto Ferrero della Marmora (1834)

Lieutenant colonel della Marmora (1789-1863), who conducted the geological mapping of Sardinia, visited Mallorca in 1833 and published in Turin a study on the geology of the islands, illustrated by this geological map on a scale of 1:500,000. He added several geological cross-sections and a stratigraphic column, as well as a scientific report.

ESSAY TO MAKE A GEOLOGICAL MAP OF EXTREMADURA AND SEVERAL DISTRICTS OF ADJOINING PROVINCES. EXTREMADURA AND NORTH ANDALUSIA
Frédéric Le Play (1834)

This is the first geological map of a region in Spain. It must be seen as a true geological map, in the modern meaning of the term, since it establishes a chronological succession of the mapped terrain using a stratigraphic column and shows the structure of the subsoil through geological cross-sections. The map was made to conduct an exploration of the minerals of the region. The main geological features of south-eastern Spain are depicted for the first time in this map.

ROCKS OF GALICIA BY WILHELM (GUILLERMO) SCHULZ
Rocks collected by the German mining engineer, Wilhelm Schulz, between 1832 and 1834, during work to make the petrographic map of Galicia.

The regional council of Vizcaya, eager to find out its mineral potential, asked the Belgian engineer, Charles Collette, for a study on the geology of its territory. Collette prepared a long report together with this map. Its main contribution was to distinguish between ten different lithologies and to recognize volcanic material from the Cretaceous period.
2. COMMISSION FOR THE GEOLOGICAL MAP OF SPAIN

In the mid-19th century, a moderate government under Isabel II wished to make a study on the natural history of the country. On 20 July 1849, the Royal Decree of 12 July was published in the Madrid Gazette, signed by Queen Isabel II in the Real Sitio de San Ildefonso, thus creating "a commission to draw up the geological map of the territory of Madrid and to gather and coordinate data for a general map of the kingdom". In spite of its title, it was not to be simply a geological map, but also had to collect data on the geography and topography to support making the map, as well as zoological and botanical data that would be published in illustrated catalogues of the country’s natural resources. It was an innovative project for the time, in which engineers and naturalists working side by side had to provide the nation with valuable tools to improve its quality of life. Alternating moderate and progressive governments and other events of the period were clearly visible in the chaotic advance of the undertaking, which was halted at the end of 1859. At that point the zoological and botanical research was separated from the geological map. It went on to form part of a larger project at the General Board of Statistics, which took on the production of all thematic maps in a move toward greater efficiency.

A new Commission to draw up a national geological map was not created until 1870, but this time it was only made up of engineers. So that political circumstances did not affect such an important project for the country, deciphering the geological nature of its land, the map was freed from political control and given to the Commission for the Geological Map of Spain, as it was now called formally, and was the direct responsibility of the association of mining engineers. In 1889, forty years after it started, the geological map of the country finally came into being in the form of the Geological Map of Spain on a scale of 1:400,000. The change in paradigm caused by the loss of overseas possessions and the need to find new sources of wealth and to exploit underground resources led to significant changes in the purposes of the Commission, which was remodelled in 1910. The institution was modernised and became the new Geological Institute of Spain and later, in 1927, the Geological and Mining Institute of Spain.

GEOLOGICAL AND TOPOGRAPHICAL MAP OF THE PROVINCE OF HUELVA (on a scale of 1:400,000)
Joaquín Gonzalo y Tarín (1887)

Map of the geology and topography of the province of Huelva, an area of great interest for mining, where large sulphur mines would be opened later, and which is notable for the amount of detail.
The members of the Commission for the Geological Map of Spain belonged to the association of mining engineers or were teachers of geology, palaeontology and chemistry. They worked mainly on mapping, especially the synthesis of the whole of Spain and mapping of the provinces. The map of Valencia is a good example of this series on a scale of 1:400,000, whose end purpose was to draw up the national geological map.

While making the geological map of Madrid, Prado also travelled round other Spanish regions, in particular the adjacent provinces such as Toledo, Guadalajara, Soria and Segovia. He drew up an outline of a geological map of Segovia the same year that he was working on the one for Madrid, using similar denominations for the 'lands'. Eager to disseminate his findings, he published them in 1854 in the Mining Journal and the journal of the Geological Society of France.

One of the first provincial geological maps made by the Commission was, logically, the one for Madrid, since it was called the "Commission to draw up a geological map of the territory of Madrid and gather and coordinate data for the general map of the Kingdom". Although scheduled for 1853, Casiano de Prado finished it in 1852 when he published a first sketch on a scale of 1:400,000 in the Commission's annual report, with a description of the geological features of the province.

Ramón Adán de Yarza (1900)
This map is a notable example from the series of maps of the provinces made during the 19th century by the Vizcaya regional council. The topographical base with orographical shading, not often seen in the contemporary Spanish maps, provides a strong sense of relief and modernity in the outlining of the geological formations.
During the second half of the 19th century, the Renaixença, or the re-birth of Catalan culture, spread to all fields of culture and science. In this context, the canon and geologist Jaume Almera (1845-1919), supported by the regional council of Barcelona, published this map on a scale of 1:40,000. It is a fine work, incorporating a detailed description of all the geological units shown in the margin of each map.

At the turn of the 19th century, knowledge of the different islands in the Canary archipelago was inconsistent, both from a tourist and scientific point of view. The smaller islands and those not on ocean routes were the least visited, especially Lanzarote and Fuerteventura. Concerned with this lack of scientific knowledge, in 1907 the Spanish Royal Society for Natural History appointed Eduardo Hernández-Pacheco (1872-1965) to accompany Salvador Calderón (1853-1911) on an expedition to the eastern Canary Islands. For health reasons, Calderón did not travel and it was left to Hernández Pacheco to discover and survey the vulcanology of Lanzarote and its islets. It was all recorded in his writings on the expedition and on a geological map.

Made by a French geologist and mineralogist, teacher of agriculture and inspector general of mines, he was particularly interested in the sediments accumulated under the sea. The sheet on display was taken from his work *Lithologie des mers de France et des mers du globe* (1871) and is the first geological map of the seas of the Iberian Peninsula. The data required to make it had to be compiled from information about the coast provided by staff at ports and sailors in general.
Lithography of the view of the left bank of the Jalón River, between Alhama de Aragón (on the left of the drawing) and Valdeloso ravine. It accompanied the graphic information from the geological report on the province of Zaragoza by Felipe Martín Donayre (1873).

GEOLOGICAL MAP OF THE REGION OF ANDALUSIA AFFECTED BY THE EARTHQUAKE OF 25 DECEMBER 1884
Michel-Leví, Bertrand, Barrois, Offret, Kilian and Bergeron (1890)
On Christmas Day 1884, the ground in Andalusia shook as never before. The districts to the north and south of the Sierra Tejada, astride the borders separating the provinces of Granada and Malaga, were devastated by an earthquake with a magnitude of X at the epicentre between the towns of Ventas de Zafarraya and Arenas del Rey. Almost immediately, a number of geological missions (Spanish, Italian and French) went to the zone to gather data on the effects of the earthquake and study the geology. Some highly detailed maps were produced, such as the one by the French mission, which led to significant advances in the knowledge of the geology of a region as complex as the Cordillera Bética.

In the autumn of 1848, a series of earthquakes was recorded in the Sierra de Albarracín. Santiago Rodríguez (1824-1876), a mining engineer, visited the region to assess the damage. He made a study of the area and wrote a long report, which included this map. The map was highly accurate and detailed and was done on an unusual scale for maps at the time. It can be seen as a precursor to mapping geological hazards.

GEOGNOSTIC MAP OF PART OF THE PROVINCES OF TERUEL AND GUADALAJARA
Santiago Rodríguez (1849)
In 1878, the mining engineer Enrique Abella y Casariego was commissioned by the Directorate General of Civil Administration in the Philippines to carry out a geological survey of the island of Cebú, where there were mining operations. The main interest of the work was coal, with the study debating over the quality of the coal found, which may not have been bituminous coal but lignite, and whether it belonged to the Tertiary period.

In the second half of the 19th century, the geological map also reached the remaining Spanish colonies in Asia and South America - the Philippines, Puerto Rico and Cuba. On request from the capital, the respective mining inspections drew up maps focusing on assessing potential mines and the condition of those in operation, with a view to their direct development.
THE ARTESIAN WELL IN VITORIA (1877-1881)

The French engineer, Alphonse Richard, persuaded the Vitoria city council that it would be useful to build an artesian well for its water supply. Drilling began in the heart of the city in November 1877. After four years a mechanical problem caused the work to be abandoned after 1,021 metres had been drilled, a world record for many years. The works supervisors asked for help from the Commission for the Geological Map, whose report, based on a detailed geological survey by Ramón Adán de Yarza, concluded that the water would be found at a depth below 4,000 metres, and if the Commission council had been approached before, the money need not have been squandered.

2. Drilling for the artesian well in Plaza Vieja square in Vitoria. La Ilustración Española y Americana (15 July, 1877).

[SHOWCASES]

GEOLOGICAL MAP OF THE PROVINCE OF OVIEDO (on a scale of 1:400,000)
Guillermo Schulz (1857)

At the end of his presidency of the Geological Map Commission, the German mining engineer, Wilhelm (Guillermo) Schulz (1854-1857) published his geological map of the province of Oviedo in Asturias. As soon as he started working for the Spanish government in 1830, he immediately took on administrative responsibilities in especially complex geographical areas. Not only was he diligent in inspecting mines, but he also accepted significant challenges when he was asked to draw up the geological maps of Galicia (1834) and Asturias, for which he first had to make a map of the topography.

AGRONOMIC MAP OF THE MUNICIPAL AREA OF MADRID
Juan Vilanova y Piera (1879)

Concern with modernising agriculture became evident with the introduction of agricultural studies in pre-university teachings due to the Moyano law of 1857. The Valencian, Juan Vilanova y Piera (1821-1893), professor of Geology and Palaeontology at the University of Madrid, included aspects relating to soils in his geological reports on the provinces, reflecting the interest in agronomic aspects shown by the authorities who wished to improve crops.
GEOLOGICAL MAP OF THE BASQUE COUNTRY (on a scale of 1:400,000)

Ramón Adán de Yarza (1905)

Geological units spread over political borders and this led Ramón Adán de Yarza to compile the Geological Map of the Basque Country. The map, published as an addition to an article in the Commission for the Geological Map of Spain gazette, shows the geological configuration of the communities where the Basque culture and traditions are deeply rooted on both sides of the border between France and Spain.

3. MODERN GEOLOGICAL MAPPING

The beginning of modern geological mapping in Spain coincided with the celebration of the International Geological Congress in Madrid in 1926. This was a hugely important milestone, as it meant a change in the focus of mapping by what was now the Geological and Mining Institute of Spain (IGME). It marked the start of geological mapping on a scale of 1:50,000, with the first sheet, showing Alcalá de Henares, published in 1928. This was the launch of the National Geological Map series on a scale of 1:50,000, whose last sheet was printed in 1971.

Mapping as a prime tool in geological research is the first and most fruitful stage in exploring natural resources underground. Both the Second Republic of Spain in 1931 and the Civil War influenced the development of mapping. The former because of its rationalist approach and desire to find natural resources that would enable economic growth in the country; and the latter because plans to draw up maps were stopped, even though their strategic importance was recognised.

During the first half of the 20th century, before and after the Civil War, African colonies under the protectorate or rule of Spain (Morocco, Sahara and Guinea) enjoyed huge strategic interest. The government, through commissions, organisations or special institutions, encouraged all types of work to be carried out in these territories. From the geological point of view, their results were different versions of the geological outlines and maps of the Spanish Protectorate of Morocco, the Rif Mountains, the Spanish Sahara and Spanish continental Guinea.

Geological mapping was very important to Franco's plans for development. The three social and economic development plans promoted between 1964 and 1975 caused the country's economy to surge and gave strong impetus to geological mapping through programmes of mining research and exploration. More specifically, the National Programme for Mining Research (PNIM), started in 1972 and managed by the IGME, implemented several thematic mapping programmes, with one of the most important being the MAGNA Plan (National Geological Map on a scale of 1:50,000).

The new century brought modernisation of geological mapping, as well as new techniques for obtaining data, observation, organisation and representation, such as remote detection, geographic information systems and other IT applications, which
gave rise to the development of the Continuous Digital Geological Map (GEODE) and the plan to update the Geological Map.

14th INTERNATIONAL GEOLOGICAL CONGRESS (MADRID, 1926)
In May and June 1926 the only international geological congress to be held in Spain took place. The scientific sessions were held in Madrid between the 23 and 31 May. It was inaugurated by H.M. King Alfonso XIII in the plenary hall, at present the premises of the Geomining Museum of the Geological and Mining Institute of Spain. 722 accredited participants attended from 52 countries. The congress organised 16 field trips and published excellent guides in English, French, German and Spanish.

On 14 April, 1931 Spain underwent a momentous political change after the proclamation of the Second Republic. The new governments tried to promote geological knowledge as a base for the country’s economic development by surveying and exploiting mineral resources. Republican ideas are clearly seen in this geological map from 1936, not only in the legend on mines and the attempt to make a rational estimate of the surface area of various geological materials, but also in a much more expressive and obvious way by using the colours of the republican flag chosen to represent the geological terrain.

The 14th International Geological Congress marked a milestone in the development of knowledge of the country’s geology by launching a systematic geological mapping programme based on a topographical grid. This was the beginning of the First Series of the Geological Map of Spain on a scale of 1:50,000. In 1928, the first sheet of the series was published, sheet 560 (Alcalá de Henares). The series was in production until 1972, when it was substituted by the new Geological Map of Spain on a scale of 1:50,000, 2nd Series (MAGNA). 450 sheets were completed, 40% of the total, during a period when Spain went through very difficult times, such as the Civil War.

The report for the Alcalá de Henares sheet includes information collected from a borehole made at the time. It was reproduced in a large stained glass window in the IGME building, which was under construction at the time.
Juan Gavala (1927)

This curious map shows the Bay of Cadiz as it was 6,500 years ago, after the Flandrian transgression and before being filled by the Guadalete River. This map is included in a monograph on the Bay of Cadiz, published in 1927 together with a geological map. For this historical reconstruction, in addition to using archaeological data, the poem *Ora Maritima* was reviewed and translated from the Latin to extract interesting historical data.

J. de la Viña, C. Muñoz Cabezón and A. de Alvarado (1958)

This map is based on the Geological Outline of the Spanish Sahara drawn also ten years earlier by Manuel Alía Medina. This geologist, born in Toledo, was behind initiatives to improve geological knowledge in the former Spanish Sahara and also discovered phosphates and other minerals there. His work in Africa led him to conduct surveys in Equatorial Guinea, too.

Alfonso del Valle Lersundi and Pablo Fernández Iruegas (1917)

Like the geological map of Ceuta, the first map for Melilla dates from the first half of the 20th century. Years later, in 1947, sheet nº 6 on a scale of 1:50,000 was published at the headquarters of the Geological Map of the Spanish Protectorate of Morocco, with the name of Hidum-Melilla.
During the first half of the 20th century, geographical, historical, biological and geological surveys in African territories under the protectorate or rule of Spain (Morocco, Sahara and Guinea) enjoyed special attention from scientists and technicians. The government took an interest in them and several commissions, organisations and special institutions were created and logistic and administrative facilities provided, since the information gathered from these enabled better control and settlement. From the geological point of view, the results from that time were geological outlines and maps of the Spanish Protectorate of Morocco, the Rif Mountains, the Spanish Sahara and Spanish continental Guinea.

The Spanish cities in North Africa benefited from such activities. This led to various mapping initiatives for each city and the surrounding areas. One of these is for the city of Ceuta, with the first work published in 1917.

At the beginning of 1970, the foundations of the plan were established, including a common format and unified standards. Programming was carried out in accordance with the priorities of the sectors requiring good geological mapping: mining, public works, agriculture, etc. The aim was to provide the country with a uniform and quality geological infrastructure, and the plan was to draw up the sheets covering Spanish territory (1,180) over a period of 16 years, although this was extended to 2003. The sheet and report on display are an example of this mapping and its content.
Guide book for field trip B-2 during the 14th International Geological Congress (Madrid, 1926). Led by Hugo Obermaier and Juan Carandell, the field trip covered the Sierra de Guadarrama. The guide book contains interesting maps and drawings of quaternary glaciation in the Peñalara massif.

Reconnaissance of the geological layout and its strategic value was something the armed forces understood during the Spanish Civil War. A good example can be found in the Geographical and Military Survey of the Pyrenees, made by Major Gonzalo R. Gamarra and published by the national sub-committee of the National Confederation of Labour (CNT). The book includes this curious geological map in which the geological units are shown in strange colours, completely unlike the international stratigraphical conventions at the time.

Aerial photographs provide geologists with very valuable information on the layout of geological structures and are a basic tool in mapping. They are especially useful for observing an image in three dimensions. Stereoscopic imaging, a method developed in the early days of photography, is used. This technique is based on taking a pair of photos from two nearby points. When looking at both photos, keeping one eye on each separately, the observer’s brain generates a three-dimensional image that gives a clear idea of the depth.

The stereoscope is simply an optical instrument with a lens or mirror system, or a combination of both, that enables each eye to see only one of the pair of photos taken by the camera. When aerial photographs are viewed in this way, geologists can see the relief as if they were actually flying over the landscape, and can thus interpret and draw the geological features very precisely.
THE PIONEERS' TOOLS

“BELLOTA” GEOLOGIST'S HAMMER
The hammer, the simplest of instruments, enables geologists to take rock and mineral samples, check their hardness and friability, and analyse the way in which the material fractures. The hammers are specially shaped, with one flat and one pointed or chisel end, and made in hard alloy that does not cause sparks when breaking the material. The information on most of the maps in this exhibition started with a hammer blow on rock.

GEOLOGIST'S BACKPACK
The main feature of a geologist's backpack is its simplicity and durability. As it has to carry heavy loads under extreme conditions during long days in the field, they are usually designed without frames and other extras found on other backpacks, as these only add weight to an already heavy load.

MICROSCOPE
Optical microscopes enlarge images and distinguish much finer details than is possible with the naked eye.
To differentiate the minerals composing a rock, a slice is cut and polished so thin that many minerals become transparent. The slices are mounted between two glass sheets and analysed in a petrographic microscope, which casts polarised light on the specimens. An expert can distinguish different minerals by their colour and their behaviour under this type of light. The box contains several rock samples, thinly sliced and ready for analysis.

COLLECTION OF PHOTOGRAPHS taken by Luis Mariano Vidal to make the geological map of Lérida. The author dedicated the atlas to the president of the Commission for the Geological Map on 10 May, 1890.
Mountains to the north of Abella. Views from the top of mount San Cornelio. 1. Senonense marls. 2. Turonense marls. 3 Sierra de Pesonada; 4. North slope of the Aylamunt valley; Danian marls. 5. Sierra de Boumort.

CONTESSA-NETTEL BELLOWS CAMERA
The Contessa-Nettel company manufactured cameras in Stuttgart, in Germany, between 1919 and 1926. Although the brand is little known now, at the time they were much appreciated, and the company also produced very high quality stereoscopic cameras.
MAGNIFIERS
The hand lens magnifier helps to observe the texture of rock and sediment or the tiny particles of minerals forming these; it is more often used to see micro-fossils that are so small they cannot be seen with the naked eye. Magnifiers generally have high magnification of between 10X and 15X, with good quality achromatic lenses.

ALTIMETER
The barometric altimeter gives the height of a point above sea level, depending on the barometric pressure. It is a mechanical device and the more sophisticated models are highly accurate, but require frequent calibration. These days, many of its uses have been taken over by the GPS.

THE FIELD LOGS OF LUIS MARIANO VIDAL (1889-1890)
The observations and measurements a geologist makes in the field are recorded in a log or journal, to be interpreted later and used for mapping or in scientific articles. The log also contains objective data, ideas and observations crucial to interpreting the numerical data. Nowadays, there are logs that are very “sophisticated”. They float in water, it is almost impossible to tear the pages and it is very difficult to erase the writing - all very necessary, since a whole day's work can be contained in a few lines in the log.

COMPASSES
A compass is another of the geologist’s basic instruments. It generally incorporates a clinometer, which not shows orientation, but also the dip (incline) of the geological strata, an essential piece of information for determining the three-dimensional structure of the formations.

ILLUSTRIOUS SPANISH GEOLOGISTS

EDUARDO HERNÁNDEZ-PACHECO
He was born in Madrid, although he spent his childhood in Alcuéscar (Cáceres), where he also ended his days. He studied for his degree in Madrid became a Ph.D. in 1896 with a dissertation on the Sierra de Montánchez, which was supervised by José Macpherson. He started out in secondary education in Cordoba, where he
began to study geology in earnest in the Sierra Morena and the Guadalquivir basin. He published a great deal of works throughout his life on many subjects of natural history, although most dealt with geology in Spain, pre-history and palaeontology. His most important recognition came in 1938, when he was appointed an academy member of the Institute of Spain, and in 1952 Doctor Honoris Causa by the University of Toulouse in France.

In 1907, the Spanish Royal Society of Natural History sent him on an expedition to the eastern Canary Islands, supervised by Salvador Calderón. His studies focused on the vulcanology of Lanzarote and its islets, where he was the first Spaniard to make a geological map. In 1910, he became professor of geology at the University of Madrid, a post he combined with his position as head of the Geology and Stratigraphic Palaeontology Department at the Museum of Natural Science.

Hernández Pacheco is one of the pioneers of conservation policy in Spain. In 1917 he created the National Parks Central Board, of which he was appointed a member. In 1927, he took part in conservation activities by proposing two new figures or classifications for protecting nature: Nature Site of National Interest and Natural Monument of National Interest.

![Euardo Hernández-Pacheco in Montánchez (Cáceres), with a geological map on his lap.](image)

**LUCAS MALLADA Y PUEYO**

Born in Huesca, he studied mining engineering at the Madrid school. He joined the Commission for the Geological Map in 1870, and remained there until his retirement in 1911. Between 1879 and 1882, he was professor of Palaeontology at the mining school, combining teaching with geological and mining research. He worked hard in surveying the geology of the provinces to draw up the geological map of Spain, and wrote reports and descriptions of the geology of Cáceres, Cordoba, Huesca, Jaén, Tarragona, Navarre, Teruel and Toledo. At the request of the Commission for the Geological Map he wrote the monumental work *Explanation of the Geological Map of Spain*, once the map was finished in 1889, and the seven volumes appeared between 1895 and 1911.

Concerned about the extreme poverty prevailing in the country at the end of the 19th century, and considering the political reforms he believed would help relieve the problems, he became active in the Regenerationist movement. He published important papers of social issues, such as the *Physical and Geological Causes of the Poverty of our Land, a Proposal for a New Division of Territory in Spain*, and the *Woes of the Motherland*, his best known work which has become one of the cornerstones of Regenerationism.
CASIANO DE PRADO Y VALLO

An exceptional mining engineer and geologist, he did such significant work throughout his career that he is considered the most important figure in geology in Spain in the first half of the 19th century. He is also seen as the pioneer of Palaeontology and prehistoric studies in Spain.

Between 1841 and 1843, he was the manager of the mercury mines at Almadén, at a time when Spain was a world leader in mining and the main producer of the metal, and its strategic value was maintained due to the decline of the mercury mines in Peru. In 1849, he was appointed a member of the Commission for the Geological Map of Spain. In 1853, he had finished the sketches of the geological maps of the provinces of Madrid and Segovia. However, he did not publish what he deemed to be the final version of the geological map of Madrid until 1854, and this accompanied his seminal work on the geology of Madrid, the *Physical and Geological Description of the Province of Madrid*.

Prado was not a tall man (about 1.60 m), certainly short-sighted and deaf, but in excellent physical form. When talking about his mountaineering experiences, he always recalled that in 1859, when he was 59 years old, he was the first to climb the second highest peak in the Picos de Europa, Torre Llambrión (2,642 m).

JOAQUÍN EZQUERRA DEL BAYO

An eminent engineer and geologist, he was one of the most important figures in mining and geology in Spain in the first half of the 19th century. Born in Ferrol, his liberal ideology sent him into exile in France in 1810. On returning to Spain, he entered the School of Civil Engineering, but was once again exiled from Madrid in 1823 for a year when the French army intervened to support Fernando VII. In 1830 he was commissioned by the Director General of Mines, Fausto Elhúyar, for advanced studies at the Freiburg Mining Academy, where he trained as a mining engineer. On joining the mining engineers association in 1835, he started a stage of intense study and geological work.

His descriptions of large mineral deposits and his contributions to knowledge of the geology of Spain, which was still at an early stage, are of great interest. In 1851, he drew up the first geological sketch of Spain. Some of his important works include the *Elements of Mining Work*, a subject he taught in the mining school, the *Essay on a General Description of the Geological Structure of Spanish Terrain in the peninsula*, and the translation into Spanish of Charles Lyell's book, *Elements of Geology*.

Joaquín Ezquerra del Bayo's field pack. It contains items for collecting rock and mineral samples and to perform tests to identify minerals.