Moveable mineralogical and petrological heritage: the example of the Geominero Museum (Spanish Geological Survey, IGME, Madrid)

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Abstract

The Geominero Museum (Spanish Geological Survey, IGME, Madrid) preserves an extensive and varied movable heritage of minerals and rock, consisting of 14,600 specimens from Spain and other countries. Besides the purely natural materials, the collections include manufactured items such as petrographic thin section and gemstones. This museum also preserves other movable elements related to mineralogy and petrology, such as replicas of minerals and meteorites, and glass photographic plates. The movable mineralogical heritage is based on 5 different collections: systematic (organised according to the classification by H. Strunz), Autonomous Communities and Cities (sorted geographically), gems, didactic/thematic and itinerant (systematically organised). The moveable heritage of rocks has been divided into three collections: systematic (of a didactic nature), historical (Krantz collection, rocks from the Philippines, Schulz collection and rocks from the Commission for the Geological Map of Spain) and special rocks (meteorites, impact rocks and glass, fulgurites). The work carried out in recent years by the team at the Geominero Museum has enhanced strategic parts of each collection, substantially increasing the number and quality of the items, preparing collection catalogues and researching the most interesting aspects from a mineralogical and petrological point of view.

Resumen

El Museo Geominero (Instituto Geológico y Minero de España, IGME) conserva un extenso y variado patrimonio mineralógico y petrológico mueble, compuesto por 14.600 ejemplares de minerales y rocas, tanto españoles como extranjeros. Además del material puramente natural, las colecciones incluyen elementos manufacturados, como láminas delgadas o piedras preciosas. También se conservan en este museo otros elementos mueble relacionados con la mineralogía y la petrología, como réplicas de minerales y meteoritos, así como placas fotográficas de vidrio. El patrimonio mineralógico mueble se articula en 5 colecciones diferentes: sistemática (ordenada siguiendo la clasificación de H. Strunz), Comunidades y Ciudades Autónomas (ordenada geográficamente), gemas, didáctica/temática e itinerante (ordenada sistemáticamente). El patrimonio petrológico mueble se subdivide en tres colecciones: sistemática (de carácter didáctico), histórica (colección Krantz, rocas de Filipinas, colección Schulz y rocas de la Comisión del Mapa Geológico de España) y rocas especiales (meteoritos, rocas y vidrios de impacto y fulguritas). Los trabajos realizados en los últimos años por el equipo del Museo Geominero han puesto en valor sectores estratégicos de cada colección, aumentando sustancialmente el número y la calidad de los ejemplares, realizando catálogos de las colecciones e investigando los temas más interesantes desde el punto de vista mineralógico y petrológico.

Key-words: *collections of minerals and rocks, Spanish minerals, historical rocks, meteorites, impactites, fulgurites, photographic plates.*

1. Introduction

According to the Royal Academy of Spanish Language, one of the meanings of patrimonio (heritage) is: property acquired under any title. The items we are dealing with, always referring to public property, are valuable elements that offer some type of benefit or are of some interest to society. As the term patrimonio (heritage) has such a broad meaning, it can be understood as a set of ideas, buildings, lands or groups of natural or manufactured objects.

Geological heritage consists of two distinct parts: immovable items and movable items *(Carcavilla et al., 2007)*. The former comprises all natural elements directly or indirectly related to geology, framed within this discipline and that remain in their original natural environment *(Cendrero, 1996; Gallego & García Cortés, 1996, Lago et al., 2001)*.

There is no current consensus regarding a definition that includes all the elements that belong to the so-called movable geological heritage. *Durán (1999)* was the first author to consider the contents of museums related to Earth Sciences and, in general, geological collections gathered in accordance with scientific criteria, as being part of a movable geological heritage. *Rocha et al. (2007)* define this heritage as museum collections of rocks, minerals and fossils, and Díaz-*Martínez et al. (2010)* complete the definition by adding collections of meteorites. Finally, *Díaz Martínez et al. (2012)* define moveable geological heritage as "the set of non-renewable geological elements, extracted from their context and that have a certain value (scientific, educational, aesthetic, historical, etc.), which makes them a collective heritage asset".

Although it has been well established that the main bulk of this heritage are collections of rocks, minerals and fossils, there are many other types of items that can be included in this concept. Therefore, we cannot overlook geological materials manufactured by man or purely anthropogenic products directly related to geology.

The former group includes prepared items used in geological studies (petrographic thin section, polished rock-cylinders, peels, etc.), available for review and reinterpretations. It also includes drill core logs, of undoubted scientific and technical value as they store information from areas of the earth's crust that are difficult to access. Finally, carved geological products are modifications of natural material made for practical purposes (e.g. ancient miners' mallets carved from stone), teaching purposes (e.g. polished rock plates) and ornamental purposes (e.g. gems).

Purely anthropogenic products related to geology are particularly relevant in relation to movable geological heritage. Perhaps the most significant are books, documents, maps and photographs, as they are an invaluable source of geological knowledge. Although these elements have already been mentioned as elements of moveable palaeontological heritage *(Meléndez & Soria-Llop, 1999; Romero, 2004)*, they are generally considered at a secondary level. Geology-related scientific devices form another group in their own right as they include all those artefacts that have contributed to the progress of geology. Petrographic microscopes from different periods are a good example of moveable geological heritage because they illustrate the progress in the textural knowledge of minerals, rocks and fossils. Finally, replicas of fossils, minerals and meteorites are anthropic elements that can be included in this heritage, as they contain valuable morphological information.

The importance of collections in the advancement of geology is undeniable. All that is required is to review the progress in the study of the history of life, based on the information provided by fossils. If palaeontological remains are not preserved in public institutions, it would not be possible to compare and study fossils and it would be very difficult to advance the knowledge of this branch of geology. However, information does not only come from palaeontological material: minerals and rocks preserved in public institutions are very useful for petrological and mineralogical studies of different kinds. For example, when a mining district is closed, it is no longer possible to obtain samples of rocks and minerals. If material has been preserved in

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museums, it is possible to obtain samples of materials for petrographic and geochemical analyses. Another example are the studies of certain mineral species from different locations. If collections are not large enough, sampling can be conducted at the museum or institution, thus avoiding the need to travel to the respective sites.

The aim of this paper is to outline the main features of the movable mineralogical and petrological heritage of the Geominero Museum, highlighting the tasks, performed by museum staff and collaborators in recent years to enhance the collections.

2. The Geominero Museum

The Geominero Museum is a branch of the Spanish Geological Survey (IGME) and retains a varied and extensive moveable geological heritage. This is a museum with a long tradition. Its halls were inaugurated in 1926 by King Alfonso XIII during the Fourteenth International Geological Congress and launched by its first director, mining engineer Primitivo Hernández Sampelayo (1880-1959). However, the collections are older, as is the institution, which was created in 1849 as the Commission for the Geological Map of Spain by a royal decree issued by Queen Isabel II *(Rábano, 2002)*. This first Spanish geological survey institution was primarily dedicated to the geological mapping of Spain. Thanks to the fieldwork undertaken, the Commission accumulated many collections of minerals, rocks and fossils and, in the early twentieth century, this material became the initial core of the Geominero Museum.

From an architectural point of view, the main hall is spectacular. Of a distinctly eclectic nature, the hall has three balconies with wrought iron fittings and the same wood and glass showcases installed when it opened *(Fig. 1)*. The ceiling of the hall is a magnificent polychrome glazed ensemble manufactured by the company, Maumejean, featuring the royal crest in the centre and the coats of arms of the ancient mining districts arranged around the perimeter *(Rivas & Rañe, 2006)*.

3. Moveable mineralogical heritage

The moveable mineralogical heritage of the Geominero Museum (12,762 items), is divided into collections based on different criteria *(Fig. 2)*. Most minerals, whether Spanish

Fig. 1. A: Panoramic view of the Geominero Museum (IGME) from the first balcony. B: Systematic mineral collection. C: Collection of minerals by Autonomous Communities and Cities.

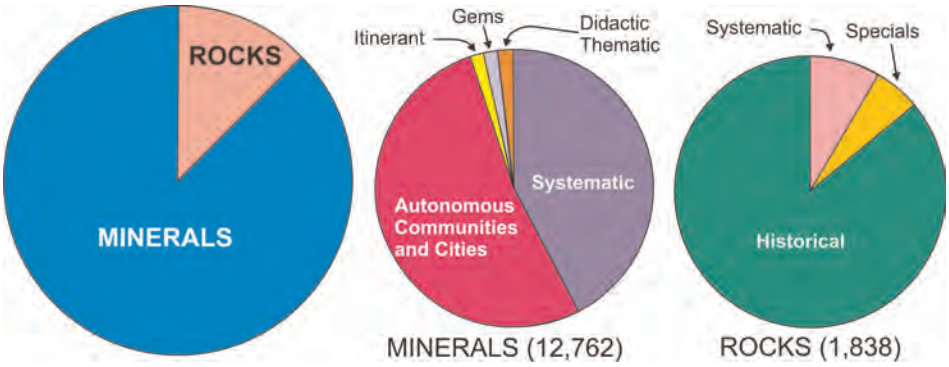

Fig. 2. Distribution of moveable mineralogical and petrological heritage from the Geominero Museum based on number of specimens.

or foreign, are distributed in 5 collections: systematic, Autonomous Communities and Cities, gems, didactic/thematic and itinerant.

3.1. Systematic collection

Most of the systematic collection is located on the ground floor of the museum, occupying 21 showcases *(Fig. 1B)*. It consists of foreign and Spanish mineral specimens selected for their aesthetic features, also taking into account other criteria, such as the rarity or representativeness of mineral deposits. With few exceptions, they are arranged systematically based on their chemical and structural affinities, following the classification by H. Strunz *(Rábano & Paradas, 2006)*. Completing the systematic ensemble, the collection also includes two monographic showcases, one with radioactive minerals and the other with natural materials of organic origin. Some emblematic specimens are on exhibition, such as the rutile cyclic twin from Georgia (USA), the largest known vivianite crystal from Spain (Cartagena, Murcia) or large gold nuggets from Spain *(Fig. 3)*. With 2,218 items on exhibition, the systematic collection is an excellent national benchmark regarding mineral classification. In addition to the material on exhibition, there are another 3,058 items preserved on the third floor.

Fig. 3. Large gold nuggets from Spain in the systematic mineral collection of the Geominero Museum

3.2. Collection by Autonomous Communities and Cities

The minerals in this collection are exhibited in 30 showcases on the second floor of the museum following a strictly geographical order *(Fig. 1C)*. A summary of the history of the collection can be found in *Lozano et al. (2011)*. This collection was formed with a view to representing, as closely as possible, the minerals that exist in each Spanish Autonomous Community and City. The 2,399 items on exhibition (plus 4,224 items preserved) illustrate many of Spain's classical mineral deposits.

However, the collection is currently under review due to the detection of deficiencies and the quality of the specimens is being assessed. The sub-collections for Madrid and Castilla-La Mancha have already been restructured, with a dramatic increase in the number of items and the addition of minerals from many deposits that had not been represented to date *(Jiménez Martínez et al., 2010a; González Laguna et al., 2010)*. In addition, informative catalogues have been published of the two sub-collections *(Jiménez Martínez et al., 2011a; Jiménez Martínez et al., 2012a)*.

During the cataloguing tasks of these minerals from autonomous communities, the museum

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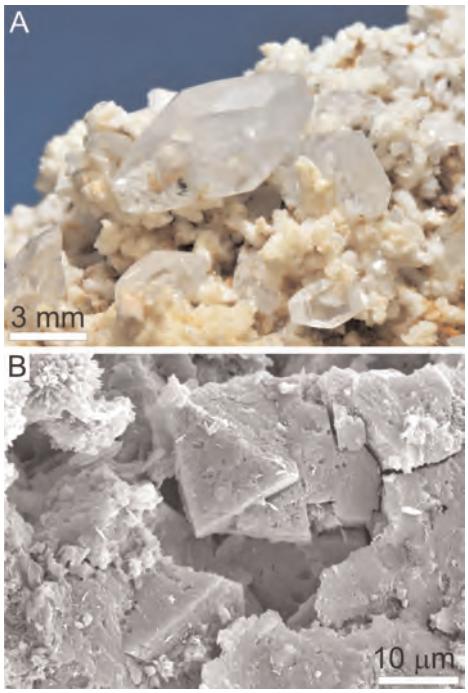

Fig. 4. A: Stokesite from Valdemanco (Madrid). B: Zaccagnaite-3R from El Soplao cave. Specimens from the collection of minerals by Autonomous Communities and Cities.

staff and collaborators conducted several studies that have greatly increased the value of this moveable mineralogical heritage. Some of them focus on iconic sites in the Community of Madrid, such as the pegmatites from the La Cabrera granitic pluton *(González del Tánago et al., 2008),* where the best crystals of stokesite in the world have been recovered *(Fig. 4A)*, an extremely rare Sn calcium silicate, not known to date in Spain *(González del Tánago et al., 2012)*. Furthermore, in an effort to incorporate specimens from as many locations as possible, *Jiménez Martínez & Prado (2008)* found new sites of rutile in the north of the Community of Madrid. Fieldwork has also led to the establishing of mineralogical routes in the work areas *(Jiménez Martínez et al., 2010b; Jiménez Martínez et al., 2011b).* In Castilla-La Mancha, *Jiménez Martínez (2010)* has taken samples of aragonite from new Keuper mineral deposits and, together with other collaborators, has incorporated garnets from Fuente de los Jacintos to the collection *(Jiménez Martínez et al., 2012b)* and magnetites from San Pablo de los Montes *(López Jerez & Jiménez Martínez, 2011)*, both sites in the province of Toledo.

As in the field of palaeontology, typical specimens of Spanish minerals (holotypes) are a heritage treasure trove. They are small numbers of samples, originally used to define new mineral species. The work of the museum is to preserve them in anticipation of future mineralogical studies, since there are relatively few new species

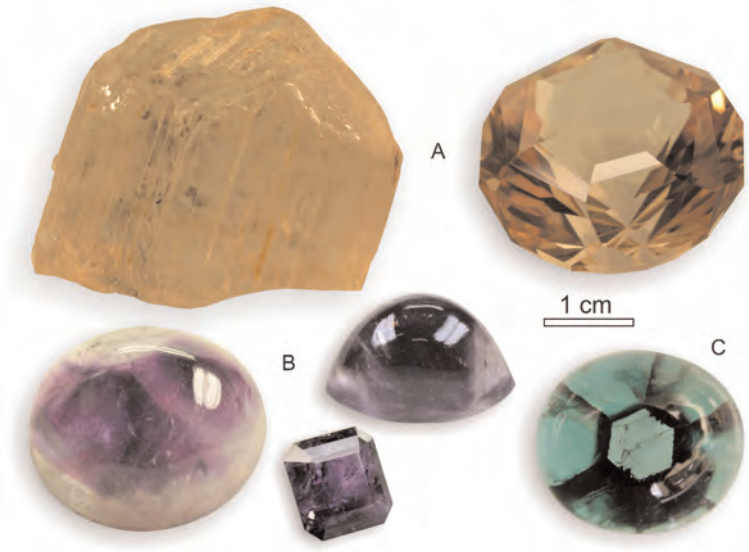

Fig. 5. Specimens from the Geominero Museum's collection of gems. A: Raw crystal and faceted scapolite from Nampula, Mozambique. B: Three polished samples of amethyst quartz from Cervera de Buitrago (Madrid). C: "Trapiche" esmerald from Muzo (Colombia).

Fig. 6. A: Crystallographic forms in the didactic collection. B: Physical properties in the didactic collection. C: Central showcase with spectacular minerals on the ground floor of the Geominero Museum. D: Great turquoise node from Hubei (China).

described in our country (*La Iglesia, 2004*). The Geominero Museum conserves 3 holotypes: a) barquillite ($Cu_2[Cd,Fe]GeS_4$), original from Barquilla (Salamanca) (*Murciego et al., 1999)*, b) calderonite ($Pb_2Fe[VO_4]_2[OH]$), found for the first time in Santa Marta and in Azuaga (Badajoz) *(González del Tánago et al., 2003)* and c) zaccagnaite-*3R* ($[Zn_{0.6}Al_{0.4}]\ [OH]_2[CO_3]_{0.2}{\cdot}0.5H_2O$), new hydrotalcite polytype recently discovered in El Soplao Cave (Cantabria) *(Lozano et al., 2012) (Fig. 4B)*.

3.3. Collection of gems

Gems are part of our moveable geological heritage within the group of geological materials modified by man. Cutting natural minerals to obtain gems enhances the beauty and substantially increases the value of these materials. The collection of gems at the Geominero Museum is very recent and consists of 292 items, acquired from different lapidaries and gemstone dealers in recent years. In the near future, the exhibition will open on the ground floor of the museum and the gems will be housed in some specially designed and illuminated display showcases. It has magnificent faceted and cabochon cut specimens (from Spain and abroad), plus several sets of transparent faceted minerals that exemplify the different cuts of the diamonds.

Many of the gems are exhibited with their corresponding minerals in order to compare the natural material with the manufactured gem. This is the case of a scapolite from Nampula, Mozambique, which is one of the largest known gems in the world *(Fig. 5A)*. *Fig. 5B* displays amethyst quartz from Cervera de Buitrago (Madrid), collected in 2012 by the author of this paper. Another notable example is the magnificent cabochon cut "trapiche" emerald from Muzo (Colombia) *(Fig. 5C)*.

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3.4. Didactic/thematic collection

Within this group, there are clearly didactic collections as well as theme-based collections and exceptional items. The 321 minerals that form this collection can be found on the ground floor. Almost half (138) form the mineral resources sub-collection, which occupies 6 showcases and illustrates the key metallic ores and major industrial minerals. Some museum resources, such as daily objects manufactured in metal or pyramid panels with production and reserves data, complete and enhance this exhibition. In addition, of a clear didactic nature, we have two showcases holding the sub-collections on physical properties *(Fig 6A)* and crystal morphology *(Fig. 6B)*. A very spectacular selection of minerals is on display in two central showcases, including exceptional items, such as beryl (aquamarine) from Gilgit (Pakistan) *(Fig. 6C)*. The remaining minerals are large pieces placed in independent urns *(Fig. 6D)* or on the radiators.

3.5. Itinerant collection

The "Rock treasure" exhibition comprises minerals and fossils and has visited dozens of towns in Spain since 1998 *(Menéndez & Rábano, 2004)*. The 250 minerals in this collection, whether from Spain or other countries, have been arranged in the same way as in the systematic collection. The items were selected for their spectacular nature, representing each systematic group. There are also two large samples: a fluorite from La Collada (Asturias) and a large specimen of amethyst from Brazil.

Another exhibition in the Geominero Museum houses a very particular type of moveable mineralogical heritage, one of purely anthropogenic nature. This is "Original or replica", comprising spectacular replicas of minerals. The original cast system, patented by the IGME, makes it possible to obtain items that are difficult to distinguish from the natural ones. In this line, there is a recreation of a granite block with a large miarolitic cavity layered with crystals *(Baeza Chico et al., 2006)*.

4. Moveable petrological heritage

The moveable petrological heritage at the Geominero Museum consists of collections of rocks and photographic plates with micropetrographic images. The rocks (1,838 specimens) have been divided into three extremely different collections: systematic, historical and special.

4.1. Systematic collection

This collection, comprising 108 specimens on display in three showcases on the second floor of the museum *(Fig. 7A)*, has been classified by origin: igneous (volcanic and plutonic), sedimentary (clastic and chemical) and metamorphic (regional and contact). There are another 50 items stored away. The collection has a definite didactic character and the display is very useful for students studying subjects related to petrology.

Fig. 7. A: Systematic collection of rocks on the second floor of the Geominero Museum. B: Funds belonging to the historical collection of rocks.

4.2. Historical collection

The historical collection of rocks, comprising 1,580 items, is an extremely valuable part of the moveable petrological heritage of the

Fig. 8. A: Rock specimens from the Schulz collection. B: Detail of one of the labels attached

Geominero Museum. The specimens are both from Spain and abroad and are kept on the third floor of the museum (*Fig. 7B).* These items are rectangular and have different sizes, hand carved using metallic tools. Among those from abroad, we have the Krantz collection and the Philippine rock collection. Rocks from Spain include the Schulz collection and the rocks from the Commission for the Geological Map of Spain.

There is very little information on the Krantz collection. All we know is that the rocks were acquired in Bonn (Germany) from F. Krantz, although there are no records of the period when the collection was added to those in the museum. The Commission for the Geological Map of Spain probably obtained the collection in the late nineteenth century or the early twentieth century, as the Museum of Natural Science in Madrid acquired a similar collection in 1882 *(Montero, 2003)* and the School of Mining Engineers of Madrid bought another in 1904 *(Puche & Mata, 1992).*

There are no records for the Philippine collection, either. Even so, each rock features a label with the emblem of the General Inspectorate of Mines of the Philippines, which indicates that the Commission for the Geological Map of Spain received the rocks between 1838, the year when the Inspectorate was established *(Moyano, 2007)* and 1898, the year Spain lost its overseas colonies, including the Philippines.

Guillermo Schulz (1800-1877) was a famous German mining engineer who developed extensive geological work in Spain. His work in Spain began in 1825, although it was not until 1831 that he joined the General Directorate of Mines and started what would become his first and perhaps most important mapping project: the geological map of Galicia (northwest of Spain), published in 1835. The work included a 52 page report, a petrographic map of Galicia, a table with geognostic terms in three languages (Spanish, French and German) and three similar collections of rocks, of which only the one in the Geominero Museum remains. The Schulz collection is in relatively good condition and consists of 173 items from Galicia with handwritten labels attached *(Lozano et al., 2005)* (*Fig. 8)*. Some rocks include the first fossils found in Galicia *(Rábano et al., 1989)*.

The collections of rocks belonging to the Commission of the Geolgical Map of Spain (915 items) constitute a valuable moveable heritage, directly linked to the geological history of Spain. The rocks were collected during the fieldwork that led to the preparation of the geological reports related to the first geological maps of Spanish provinces. They are, therefore, of a geographic nature but they also have their own nature, as the people who compiled them were eminent pioneers of Spanish geology. These are rectangular rocks, carved by percussion, with several types of labels attached and adhered. As in the Schulz collection, some rocks contain fossils *(Lozano et al., 1999a, 1999b)*. The collections that correspond to the geological reports for the provinces of Barcelona, Zaragoza and Huesca have been catalogued, but those for Gerona, Lérida, Tarragona, Baleares, Andorra, Toledo, Badajoz and Jaen have not been studied yet *(Lozano et al., 2008)*.

The history of the collection of rocks from Barcelona began towards the middle of the

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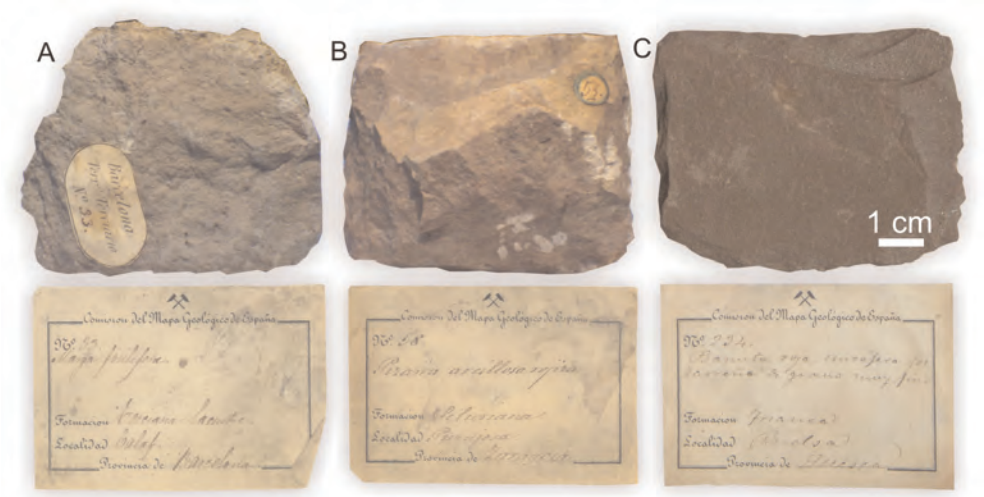

Fig. 9. A: Rocks and labels from the Commission for the Geological Map of Spain. Specimens from the A: Barcelona, B: Zaragoza and C: Huesca collections.

nineteenth century in connection with the geological work of Felipe Bauzá and Rávara (1802-1875), who was Inspector General First Class of Mining Engineers and director of the Commission for the Geological Map of Spain. Due to different circumstances, Bauzá did not publish the geological report on Barcelona and he commissioned its review to the engineers, José Maureta and Silvino Thos y Codina, who finished the task in 1881. The collection consists of 168 specimens and a complicated labelling system (*Fig. 9A)* derived from the different collecting stages and also from the corrections to the report and, consequently, to the rock collection *(Lozano & Rábano, 2001)*.

Felipe Martín Donayre (1825-1890), a member of the Commission for the Geological Map of Spain, began the first geological studies in the province of Zaragoza in 1863, although the final report was published in 1873, after several revisions and corrections. As in the case of the Barcelona collection, these corrections are reflected in the variety of labels present on the 114 items that form the collection *(Lozano & Rábano, 2004) (Fig. 9B)*.

The Huesca rock collection is related to the geological work performed by Lucas Mallada (1841-1921), an important member of the Commission for the Geological Map of Spain. Mallada and other collaborators began the geological work in Huesca in 1871, but the final report was not released until 1878. The 134 rocks that comprise the collection are similar to those in the previous collections *(Fig. 9C)* both in appearance and in the variety of attached and adhered labels *(González Laguna et al., 2007)*.

Finally, the Orueta collection of photographic plates is especially relevant. This heritage consists of 78 glass plates (autochrome), made by another famous director of the Commission for the Geological Map of Spain, Domingo de Orueta y Duarte (1862-1926). Made in the early twentieth century, the plates are the "negatives" used to publish the first full-colour micropetrographic images in Spain in 1917 (rocks from *Sierra of Ronda, Malaga, Rábano et al., 2007; Fig 10)*.

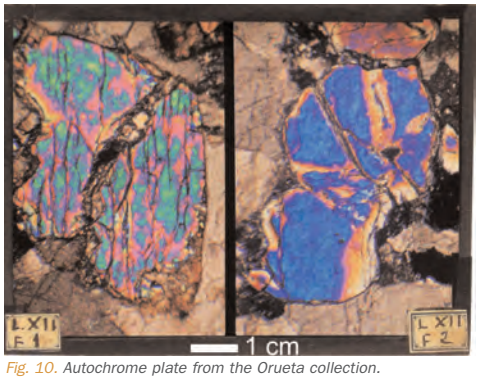

Fig. 10. Autochrome plate from the Orueta collection.

4.3. Special rocks collection

This collection includes some rocks with very special characteristics, which are difficult to include in conventional classifications. This is a heterogeneous group (100 items) comprising meteorites, impact rocks and glass and fulgurites.

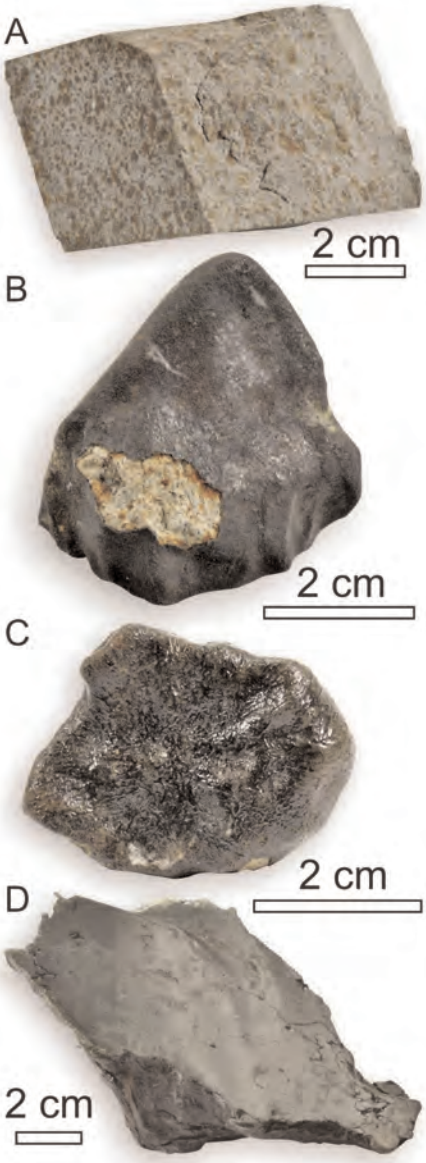

Fig. 11. Spanish meteorites from the Geominero Museum. A: Reliegos (León). B: Villalbeto de la Peña (Palencia). C: Puerto Lápice (Ciudad Real). D: Retuerta del Bullaque (Ciudad Real).

The meteorite collection consists of 28 specimens, including irons, stony-irons and stony meteorites. It is on display in a souwcase on the ground floor of the museum. From the point of view of Spanish petrological heritage, the most interesting specimens are those that have fallen most recently and those found in Spain. The collection includes specimens from the three latest falls: Reliegos, León (1947) *(Fig. 11A)*, Villalbeto de la Peña, Palencia (2004) *(Fig. 11B)* y Puerto Lápice, Ciudad Real (2007) *(Fig. 11C)*. While the collection was being catalogued, some peculiar chondrules in the meteorite from Reliegos were studied *(Lozano & Martin Crespo, 2004)* and the true terrestrial nature of a supposed Spanish meteorite was acknowledged: Los Blázquez (Córdoba) *(Martín Crespo & Lozano, 2005)*. The textural and chemical nature of the Villalbeto de la Peña meteorite was also studied *(Martín Crespo et al., 2007)*.

The latest Spanish specimens to join the museum's collection are fragments of the recently classified Retuerta del Bullaque (Ciudad Real) meteorite (iron: IAB complex, main group). This is the type material (holotype + cotypes) used in the study *(Fig. 11D)*. In addition, as part of the fully anthropic movable heritage, there are two casts of the complete specimen, of inestimable value considering that the main mass of the meteorite remains in private hands *(Lozano et al., 2013)*.

Regarding the materials formed by meteorite impacts, the museum displays a collection of 17 items in another case on the ground floor and also stores another 55 items. The most relevant impactites are fragments of deep surveys carried out in the Cretaceous crater in Yucatan (Mexico) *(Fig. 12)*, which gave rise to the well-known hypothesis of the extinction of the dinosaurs *(Sharpton et al., 1992)*. In addition, the collection contains several types of tektites, including gemstone quality varieties such as moldavite *(Lozano, 2005)*.

The collection consists of spectacular cylindrical fragments of the Torre de Moncorvo (Portugal) fulgurite, a rock formed by a lightning strike on arable land *(González Laguna et al., 2011)*. This is one of the largest fulgurites found worldwide and presents a peculiar bran-

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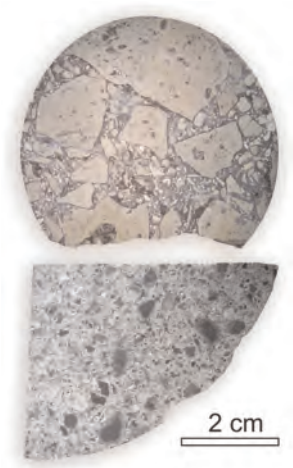

Fig. 12. Drill core logs from the Cretaceous impact crater in Yucatan (Mexico).

ched structure "in situ" *(Fig. 13A)* and a large centre hole *(Fig. 13B) (Lozano et al., 2007)*. The largest specimen, over 40 kg in weight, is on display in a glass urn on the ground floor of the museum *(Fig. 13C)* along with cylindrical samples of branched distal facies *(Fig. 13D)*. It comprises partially melted glass and mineral remains, with large cristobalite crystals formed by restructuring of quartz at high temperatures *(Martín Crespo et al., 2009)*. Its study has also been raised for the conservation of architectural heritage *(González Laguna et al., 2009)*.

Finally, this collection includes petrographic thin sections used in the study of Spanish meteorites and Portuguese fulgurite, which can be used in future reviews or for new studies of the material.

5. Conclusions

The moveable mineralogical and petrological heritage of the Geominero Museum is an excellent example of this type of public property, given both the extent and quality of the collections and the methods used to enhance their value. Indeed, these collections are valuable in themselves, but the publication of the documentation, the expansion, cataloguing and the research papers substantially enhance them and also provide the general public and specialists with an excellent overview of the mineralogical and petrological content.

Generally, when a museum collection is extended and/or documented with a view to cataloguing it, problems arise that open the door to mineralogical research. This is the case with the Spanish mineral collections (collection by Autonomous Communities and Cities) currently being restructured. During the museological tasks, minerals that were unknown in Spain, such as stokesite (Valdemanco, Madrid), and others that had been investigated to a limited degree, such as the garnets from Fuente de los Jacintos (Toledo), have been researched. In other cases, the study of new deposits led to the characterization of previously unknown minerals, such as zaccagnaite-*3R* from El Soplao Cave (Cantabria).

The same applies to the rock collections, where meteorites cataloguing led to the petrological research of Spanish specimens, such as Reliegos (León), Villalbeto de la peña (Palencia) and Retuerta del Bullaque (Ciudad Real). Once again, the acknowledgement of sites not only enriched the collections but allowed us to investigate the nature of the materials, as in the case of the fulgurite from Torre de Moncorvo (Portugal). Furthermore, in the field of rocks, a historical line of research has been developed linked to the first geological studies in Spain. Indeed, the study of the labels and available historical information has allowed us to catalogue and establish the time-line for the Galicia, Barcelona, Zaragoza and Huesca collections. In addition, and within the historical context, the complete cataloguing and study of the Orueta micropetrographic plates are intended as a model for future studies of this unique moveable petrological heritage of anthropogenic origins.

The criteria governing the organisation of the museum's collections are diverse and distinct for each one. In the case of minerals, the criteria used are aesthetic, linked to the beauty of the specimens in the exhibition (systematic collection of gems); rarity, assuming the value of rare minerals (systematic collection) and geographical, representing specimens from specific areas (collection by Autonomous Communities and Cities). We have not overlooked the educational criteria, used to transmit content related to the

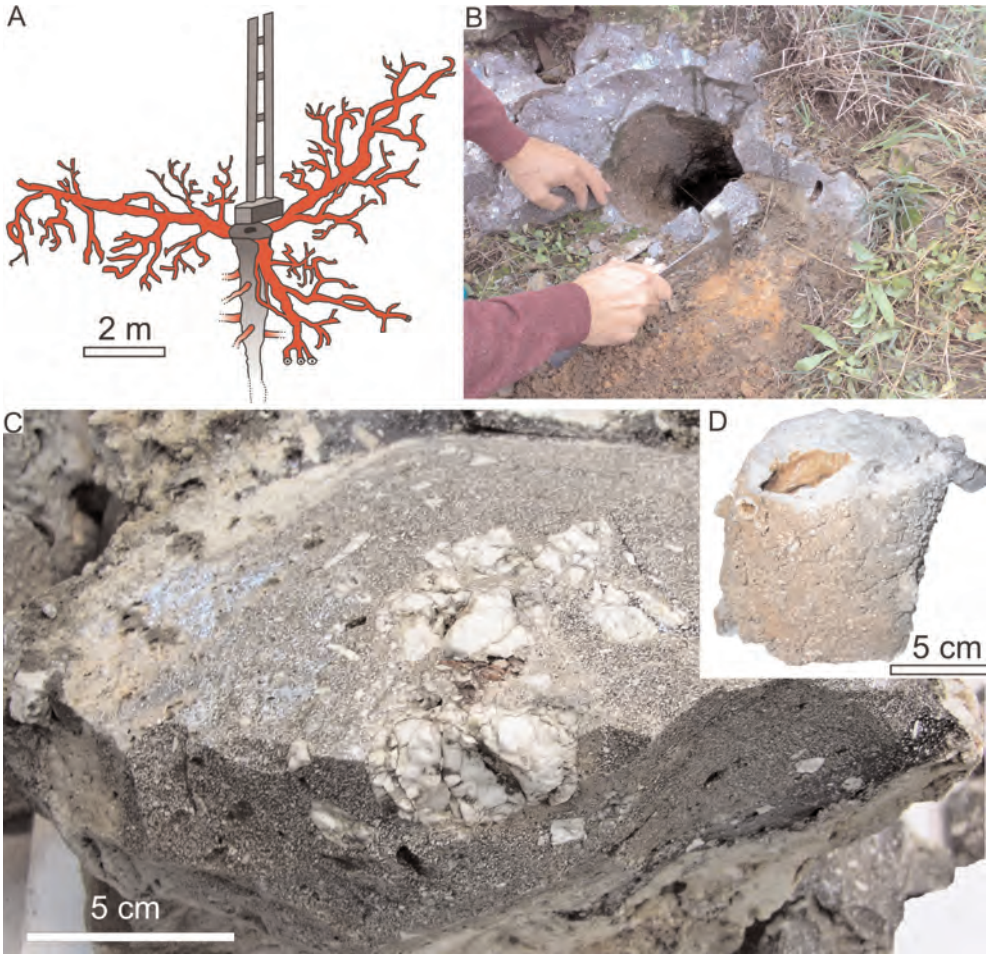

Fig. 13. A: Idealized structure of the fulgurite from Torre de Moncorvo (Portugal). B: Central hole of the fulgurite. C: Fragment of a thick branch, broken near its central insertion point. D: Fragment of a distal branch

genesis, classification and physical properties of minerals (itinerant collection and didactic/thematic collection).

Some of these criteria, such as the educational aspect, are also used in the rock collections (systematic collection). However, the very features of these stone materials affect the application of new criteria, such as historical criteria (historical collection) or the unusual genesis of certain materials (special rock collection).

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