

Urban geotopes and local museistics as key instruments for Geodidactics: The role of exomuseums in Geoscience teaching.

Los geotopos urbanos y la museística local como instrumentos clave en la didáctica de la Geología: Papel de los exomuseos en la enseñanza de las Ciencias de la Tierra.

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Abstract: Earth Science teaching in secondary schools and to a wider, non academic population requires making Geology an attractive and familiar topic. For this purpose, geodidactical strategies should focus in presenting clean cut cases of geological elements, processes and topics in an accessible, easy way. Those particular points displaying such features and holding a specially high didactical potential are geotopes. Urban geotopes, present in the cities, are points holding especially useful geodidactic and geotouristic potential, due to their proximity and accessibility and to their capacity to "melt" scientific and common knowledge. On the other hand, local museistics, which includes exhibition centres in small villages and towns and restored outcrops and sites prepared for visitors (exomuseums) can also be a prime instrument to present geosciences to students and wide public.

Key words: Geodidactics, geological heritage, geotopes, secondary schools, geotourism.

Resumen: La enseñanza de la Geología en la escuela secundaria y al público en general requiere presentar esta disciplina como algo atractivo y familiar. Las estrategias didácticas deben centrarse en casos y ejemplos claros que permitan comprender fácilmente y hacer accesibles problemas complejos. Los puntos que muestran claramente estos caracteres, con un alto interés didáctico, se denominan geotopos. Los geotops urbanos, situados en las ciudades presentan un interés especial tanto didáctico como geoturístico, por su proximidad, accesibilidad y capacidad de "fundir" el conocimiento científico con el común. La museística local, integrada por las pequeñas salas de exhibición que frecuentemente se encuentran en poblaciones pequeñas, rurales, y los yacimientos y afloramientos acondicionados para las visitas (exomuseos) pueden igualmente ser instrumentos de primera magnitud para difundir la geología entre los estudiantes y el público en general.

Palabras clave: Geodidáctica, patrimonio geológico, geotopos, enseñanza secundaria, geoturismo.

INTRODUCTION

The role of geotopes (particular points holding a particular educatinal potential for showing as prime geodidactical instruments) has been underlined in recent years by many authors and has received special attention from researchers in the frame of the EU funded educational programs (Fermeli et al., 2011). As relevant points displaying clear geological features geotopes are often the subject of publication and use as educational tools by Earth science teachers. The organization and publication of "Geotope Routes" as basic educational instruments for an active teaching of geology has undergone an important development in recent years, in the frame of a more participative learning programs (Calonge et al. 2013).

As a particular case of geotope routes, urban geotopes hold a special interest, as they are relevant points located in the cities and holding a geological

interest as they can show geological problems in an accessible way within the urban environment (Meléndez et al., 2011).

As a supplementary aspect of geodidactics, local museistics, in most of the cases small palaontological, local museums, is taking place as an emergent activity with a strong educational potential. Unlike the traditional use to take the fossil material resulting from palaeontological excavations to research centres, small localities holding important fossil sites, are more and more interested in creating small exhibition halls and museums (*in situ* museums: Meléndez and Rodrigues, 2008; Meléndez et al., 2008b,c). This sort of small, local museums certainly constitute an attraction for visitors and can contribute to foster the interest of both teachers and student groups, and groups of tourists (Moreira et al., 2008). Such local museums can hold either the original pieces (when being exhibition centres of a certain importance) or, more often, good reproductions

of valuable specimens. As a particular case of local museistics, open air museums, or *Exomuseums*, i.e. outcrops being arranged for visitors, are developing as efficient educational and geoturistic elements. When properly arranged and preserved, and supplemented with a good supporting explanatory pannels, exomuseums can certainly contribute to disseminate the scientific (earth science) knowledge among the population and become a valuable tool in the teaching-learning process (Meléndez et al., *loc cit.*) Although, exomuseums are usually associated with fossil sites showing exceptional fossil concentrations and rare remains (dinosaur tracks, large trace fossils, big trilobites, ammonites...) any outcrop properly arranged, showing relevant geological features, can actually constitute an exomuseum. In fact, many outcrops located in geoparks and showing clear geological features can be categorized as exomuseums.

GEOTOPE ROUTES

As educational geological itineraries geotope routes, hold the highest interest and educational potential as they may include different conceptually linked outcrops described by specialists and published in the geological literature. Being integrated by relevant points showing clear geological features they may contribute encourage and motivate attending people to solve many kinds of questions and geological problems, which may appear along their route and fix previously acquired concepts. Geotope routes have been the subject of numerous publications in the recent years, as basic elements for geological fieldtrips and valuable educational instruments (Fig. 1; Calonge et al. 2013).



FIGURE 1: Some geotopes holding good educational potential: a) The recumbent syncline of La Hoz de la Vieja, (province of Teruel, Iberian Range Spain) affecting the Middle-Upper Triassic sequence. b-c; Erosional landforms on the lower Triassic (Buntsandstein) conglomerates and sandstones

As a particular case, *urban geotopes* are geological features appearing in cities or villages play an important role in a double sense. On one side they can provide geological cases and problems in close areas to schools or public places. On the other, in some villages and old towns they can be a good example of harmony between nature (rock formations) and human development (architecture). This is the case of many middle age castles and villages, built on rocky cliffs, in which buildings adapt to the relief of the rocks and beds below (Fig.2).



2a



2b

FIGURE 2: Two cases of urban (rural) geotopes in which human constructions set on rock formations, offering a harmonic melting of geology and architecture. a) The village of Moscardón, in Sierra de Albarracín (Iberian Range) built on the middle Jurassic (Bajocian) limestones. b) The castle of Peracense, in Sierra Menera (Iberian Range) built on the red sandstones and conglomerates of the lower Triassic (Buntsandstein). In both cases, the construction materials are formed by the same rocks they set on.

According to Fermeli & Diacantoni-Marcopoulou, (2004), geotopes defined in urban environments are grouped in three main categories that can coexist in a city, either independently or as a combination of two.



3a



3b

FIGURE 3: a) Outcrop in the hill of Philopappou in Athens. b) Areios Pagos under the hill of Acropolis of Athens. (Athinai Schist Upper Cretaceous age).

In type 1, impressive or simply obvious natural geological features constitute the main attraction (Fig. 1). In type 2, the appearance of geological natural features is very limited, but it exists anyway, as in the case of the archaeological site of Kerameikos in Athens (Fig. 2). In these two types of features, we are looking for “typical geological natural resources in the urban environment geotopes” and there is the opportunity to promote and indicate their relationship with historical, social and cultural development of the city.



FIGURE 4: Archaeological site of Kerameikos, Athens (Athinai Schist Upper Cretaceous age).

From an educational point of view, these “non typical geotopes” are a challenge to discover the local geological history and the geographical and geological origin of building materials and rocks (Fig.5a). As a *non typical* geotope in Athens it is proposed the pedestrian zone of Pikionis under the hill of Acropolis. (Fig. 5b 5a) and the Iridanos River in the Underground Station of Monastiraki (Fig. 5c).



5a



5b



5c

FIGURE 5: a) Pedestrian zone in Acropolis and Philopappou hill, designed by the architect Pikionis in late fifties. b) A part of the external wall of the small church of Ag. Giannis Loubardiaris Lounardaieis. c) Iridanos river in the Underground Station of Monastiraki (Athens).

LOCAL MUSEUMS

Local museistics has steadily emerged in the last 20 years in many european countries. It includes a wide array of modalities, from *solid*, good geological or palaeontological museums in small towns, villages geoparks, etc, often created and leaded by the researchers themselves in collaboration with the Townhall authorities, to small exhibition halls in small villages holding private fossil collections. Main reasons for this increasing growth can be the academic development of Earth Sciences, the social interest of palaeontological studies, dinosaurs and human evolution playing a leading role, and the slow progress of social concern about Nature. Other, more local, factors that have contributed triggering the creation of local museums in some countries are the legal national regulations on geological heritage protection and, at a more local scale, the local and regional natural heritage regulations and the interest of political authorities seeing local museums as potential factors of economic development.

A typical feature that should characterise the local museums, unlike big geological and paleontological museums in cities or university departments, is their close connection to regional geology and paleontology. When properly leaded and mastered by specialists local geological and palaeontological museums provide good information and possibilities for visitors to learn about the local geology and fossil heritage of surrounding areas. This is usually the case of information centres in geoparks and small museums created in towns near important fossil sites. In such cases, a solution should be found for the destination of valuable specimens, as fossil collections should always fulfil the basic requirements of safety, accesibility for researchers and scientific catalogation of specimens. For such reasons, it may be more advisable for small local museums to focus on didactical aspects and educational resources (explanatory pannels, environmental reconstructions, life recreations of fossils etc) and keep good replicas for exhibition instead the original specimens, which should be better kept in research laboratories, in the hands of specialists.



FIGURE 6: a) The building of the local "Museum of the Paleozoic seas", in the village of Sta Cruz de Nogueras (S of Zaragoza, Iberian Range). b) A reconstruction of the life in the Silurian seas with Ostracoderm fish feeding on orthocone nautiloids. Original drawing by Antonio López Alcántara.

As a good case of the first, the *Paleozoic seas* museum in the small town of Sta Cruz de Nogueras, South of Zaragoza (Spain) mastered by specialists from University of Zaragoza holds, in a small building, a very good, representative collection of Palaeozoic marine invertebrates and fish including replicas and original specimens, from near fossil sites around the village. It also includes nice recreations of marine palaeozoic sea environments and a small laboratory offering the possibility for scientific work and to make replicas of key specimens. A nice guidebook supplements the information, hence constituting the best example of what a local museum should be. The museum, recently inaugurated, receives a fairly high amount of visitors, despite its location in a rather remote small village. They include from student groups to families and tourists, hence contributing actively to economic local development (Fig. 6a-b).

Local museums holding private collections often face problems derived from different reasons, among them, the lack of knowledge and poor scientific background of the owners, treating the fossils as curios or precious objects but having little knowledge of paleontology, the shortage of economic resources and possibilities for restoration and the complete ignorance of scientific literature. All these facts often lead to bad storage and cataloguing conditions, inadequate conservation and restoration and bad systematics, which make private collections and museums nice places holding beautiful specimens but often very misleading on what concerns their scientific content. The case of the paleontological museum of Galve, a small locality near Teruel and long known for the important dinosaur sites, holding the private, mainly vertebrate, collection of Mr. José María Herrero is a clean cut case of a good and valuable paleontological collection but exhibited and stored in poor conditions, as a consequence of long misunderstanding with the townhall authorities, the regional government of Aragón and, partly, the scientific community (Fig 7a-b). However, despite all these problems, the fossil collection is well catalogued and the material has been the subject of numerous scientific works, as collaboration with specialists, from time to time, has led to good results. These facts should make the collection housed there deserve a better

treatment by the local and regional Administration, to provide this valuable collection with a better building and facilities, as well as better storage and catalogue conditions, as it certainly represents the best Lower Cretaceous vertebrate remain collection in the region.



FIGURE 7: a) Exterior view of the paleontological museum of Galve (Teruel Province, Iberian Range). b) Interior view of the exhibition hall showing) the interesting vertebrate (mainly dinosaur) remains stored in rather precarious conditions.

Not uncommonly, private collections housed in local museums in small localities, and resulting from long fossil trade by the owners, include beautiful (expensive) specimens acquired in fossil markets but holding no relation at all with local fossil record. Such collections, despite the undoubted value as paleontological pieces, usually face the same problems, i.e. lack of good systematics, as fossil traders are not always good paleontologists and, most of all, a certain disconnection with the fossil wealth of the region, giving a wrong idea of what paleontology and the fossil record is. In certain cases, such collections can play a good role as educational instruments, as good specimens are always useful to learn paleontology, but they hold the serious problem of not being representative of local paleontology, which makes them of limited validity as local museums. The big paleontology-based recreational centre Dinopolis, in Teruel, which includes a museum with big reproductions of vertebrates and some rare (traded) specimens of exotic fossils is a fairly good example of this. Similarly the fossil collections of the local museums of Orihuela del Tremedal or Josa, in the province of Teruel, and Ricla, in the province of Zaragoza. The museum and cultural centre of Molina de Aragón, in the Natural Park of high river Tagus (Guadalara) which holds excellent natural history collections and organizes valuable temporary exhibitions, includes as well some good fossil specimens resulting from trade but holding little relation with local paleontological wealth.

EXOMUSEUMS

As a special case of local museistics, exomuseums are open air outcrops or fossil sites in which prominent geological features or a special fossil content might advise their arrangement *in situ* by the setting of facilities such as explanatory pannels, protective fences or roofs; even signalled trails, making them real open air museums suitable to be visited by groups of very different scientific level, from specialists, university or school students and teachers to a wider audience of visitors, families, and tourists (Fig. 8).



8a



8b

FIGURE 8: a) The exomuseum (arranged fossil site) of Cinctorres, (province of Castellón, Iberian Range-Maestrazgo). The obvious risk of destruction and expropriation made it advisable to substitute the original fossil bones by replicas. b) The exomuseum of Bueña (Truel Province, Iberian Range) holding the giant trace fossil: *Megaplanolites ibericus* Meléndez.

Prominent outcrops notorious by special geological features and being arranged for visitors in geoparks or natural park areas can be categorized as exomuseums, as it is the case in the geopark of Aliaga (Teruel) where some selected outcrops showing spectacular tectonic or stratigraphic features are arranged with detail explanatory pannels and legends, and in the Natural park of High Tagus (Guadalajara) where beautiful erosional features and forms are the subject of special arrangements and good explanations, hence making them easily accessible for all ranges of groups of visitors. However, in most cases, arranged exomuseums are more frequently, fossil sites holding some particular or exceptional remains, such as dinosaur tracks, large trace fossils or other fossil concentrations making them worth arranging and preparing for visitors, a sit is the case, e.g. in the fossil site of Cinctorres (Fig. 8a). When properly arranged, exomuseums can hold higher interest than local museums exhibiting private collections. The reason is that they show the fossil site or the geological feature *itself* and, being sustained by good arrangement and explanatory pannels, they set an immediate, clear connection with the surrounding geology, hence establishing a clear conceptual link with geology and past life (Fig. 8a). They can be either isolated points holding a clear attraction issue, as it is the case of, e.g. the giant trace fossils of *Megaplanolites ibericus* in the

small village of Bueña (Teruel Fig. 8b) or else be a part of a geotouristic route, such as the *Dinosaur routes*, which in different areas in Spain and Portugal follow important series of outcrops of dinosaur tracks as it is the case in the small village of Galve, of the outcrop known as: *Las Cerradicas* (Fig. 9). Also in such areas as Soria, Asturias, and different points in Portugal, perfectly arranged and prepared for visitors, and having been promoted joint candidate for their nomination as *Human Heritage*. Other important paleontological exomuseums in Spain are the Cambrian trilobite site of Murero in the surroundings of the historical town of Daroca, South of Zaragoza; the numerous mammal sites in the Mio-Pliocene sequences of Iberian basins, holding a detail fossil record of evolution of life during Tertiary times and the important site of human fossil remains of Atapuerca in the province of Burgos, which receives hundreds of thousand visitors every year.



9a

9b

Fig 9: General view of the dinosaur ichnite exomuseum of “Las Cerradicas” in Galve (Teruel, Iberian Range) showing the big protective structure and stairs and corridors for visitors. b) Detail of the restoration works and the dinosaur track trails.

Positive points and advantages of exomuseums are their high educational potential, both if groups are led by a guide (guided visits) and if visitors simply follow the explanation pannels. In other cases, as in Atapuerca, Asturias and, partly, Galve, the exomuseum and the routes are supported by a local Museum, which can be a relatively important centre, as in the case of the *Jurassic Museum of Asturias* (MUJA) where visitors can supplement the observations made in the outcrops, find information, learn more about it, buy souvenirs, etc.

Among the potential drawbacks, or problems, of exomuseums are their obvious vulnerability and risk of erosion, destruction, vandalic actions or expropriation by fossil collectors and traders, as a consequence of having been excavated, restored, and, in most cases, left in the open air. This makes them subject of potentially easy and rapid degradation and destruction, requiring a permanent work of maintenance and conservation. Protective fences and roofs to prevent vandalism and erosion are good, yet expensive, protection measures, which are not always easy to face by local authorities or by researchers. Surely, integrating exomuseums within a wider general development programme of e.g. natural protected areas should make these necessary measures easier to face. In any case, it seems clear that, beyond the budgetary and logistic problems they might face,

exomuseums stand as a real, powerful educational tool in geosciences, and as a solid, relevant component of geotourism strategies. For these reasons, they should be the subject of preferent attention by both scientists (geologists) local and regional political authorities and by the local populations as well since, properly promoted, they can contribute to local economic development. Similarly, they can become a powerful instrument towards an active learning of Earth Sciences for school and university teachers.

CONCLUSIONS

In the effort of building an active and participative teaching and learning of Earth Sciences both in schools and society, geotopes and geotope routes (*geo-trails*) play an important role as they can be created to connect related problems along successive points, hence making geology and geological cases appear as something coherent, interesting and accessible. In close relation with geological routes, local museistics, in its multiple possibilities, constitutes undoubtedly a powerful educational tool, as it really makes appear geological problems and fossil record as something real, close to the local population and to the land itself, which can also stand as potential factors of local economic development. Yet, those problems derived of museum and site and facilities conservation and maintenance should not be left aside, and be given the attention and budgetary attention they require to be effectively useful as educational and geotouristic elements.

ACKNOWLEDGEMENTS

This paper is a part of the EU project: GeoSchools (*Lifelong Learning Programme*: EACEA-LLP). It also benefitted from financial support from research projects: CGL 2011-23947/BTE MICINN (Spanish Ministry of research) and E-17 from Government of Aragón (DGA) Spain.

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Abstract Book

3rd International GEOschools Conference: “TEACHING GEOSCIENCES IN EUROPE from Primary to Secondary School”



**Publicaciones del Seminario de Paleontología
de Zaragoza (SEPAZ), Vol.11, 2013**

Dpto. Ciencias de la Tierra
Área de Paleontología, Universidad de Zaragoza
C/ Pedro Cerbuna, 12, E-50009 ZARAGOZA
Tel.:976 76 10 76/ Fax: 976 77 61 06

Editor de la Serie:
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Editores del Volumen:
Georgia Fermeli
Michael Dermitzakis
Guillermo Meléndez Hevia

Portada:
M^a Dolores López Carrillo
Georgia Fermeli

Fotos:
Georgia Fermeli & Anastasia Koutsouveli

Impresión:
Servicio de Publicaciones, Universidad de Zaragoza
C/ Pedro Cerbuna, 12, E-50009 ZARAGOZA
PRINTED IN SPAIN
&
Servicio de Publicaciones, Universidad de Athenas
PRINTED IN GREECE

Depósito Legal: Z 1435-2013

ISBN: 978-84-92522-71-2



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"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein."