

EARTH SCIENCES HISTORY AND HISTORICAL COLLECTIONS AS A WAY TO REVEAL GEOLOGICAL HERITAGE: A CASE STUDY FROM THE UPPER CRETACEOUS OF PORTUGAL

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EARTH SCIENCES HISTORY, HISTORICAL COLLECTIONS AND GEOLOGICAL HERITAGE

Earth Sciences have more than two centuries as a major branch of modern scientific knowledge. Except from a few ancient roots arisen from the Classical Antiquity and Renaissance, the *corpus* of its epistemological frame is contemporaneous to the Enlightenment and to the subsequent phases of the European Industrial Revolution.

During these periods of substantial technological advances much scientific work has been done for that, improving our knowledge and exploring new perspectives and theories to explain the morphology, structure and age of the Earth (fig. 1). This dynamics was enhanced by the creation of several geological surveys, Natural History museums and university colleges, with repositories and laboratories extensively supplied by the addition of geocollections sampled from the main stratigraphic units and mining activities.

The history of Earth Sciences has for mission to investigate the records of these researches and their products, but also the related ideas and concepts of that time, and their socioeconomic and cultural impacts. From a descriptive point of view, its historiography can be looked as the testimony of an unbroken chain of failures and advances in the scientific process, where the role of many important contributors has deserved accurate biographic investigations (*The founders of Geology* in the sense of Geikie, 1897).

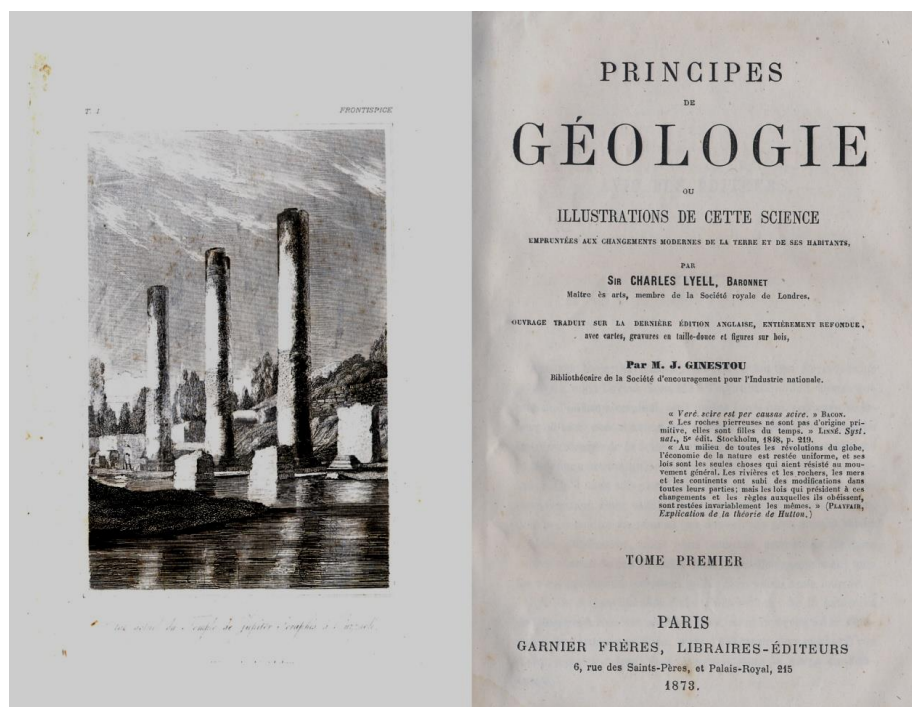


Figure 1: *The Principles of Geology* by Charles Lyell (1797-1875) have been repeatedly published since 1830-1833. They are a mark in Earth-Sciences history, as well the best example of a manual that influenced generations of worldwide geologists, and their scientific fieldwork. Its French translations have been widely used in Portugal since the second half of nineteenth century.

The study of these subjects has an obvious interest for modern and contemporaneous History of Science and its relationship with our society. Many topics on the history of Earth Sciences also have an additional interest for geological heritage and its relationship with teaching and pedagogic activities, because many concepts in

Geology contain a significant degree of abstraction and their comprehension can only be fully achieved if an historical approach is made, both in formal and non-formal environments. It is known that many European “classical” sites have been revisited thousands of times by successive generations of collectors, scientific geologists and school groups since their discovery in the eighteenth and nineteenth centuries. Their geological materials and contexts have been fully described and its samples housed in museums, part of them as scientific reference collections, but also disseminated as didactic materials for teaching purposes, or personal collectibles. In all these situations, there is a close and obvious relationship between the importance of these “classical” contexts for geological heritage, and their historical of contributes for the development and epistemology of Earth Sciences.

There is a variety of subjects from History of Science that can be used as contributions to reveal ‘points of geological interest’ (POGI’s). These subjects complement physical attributes already used by many, since the advent of geological heritage *in situ* as an attempt to preserve treasures of Earth legacy: rocks, minerals, fossils, structures, and landscapes from present and past. From them stand out: (1) The historical scientific researches concerning the site area, and their importance for the local and regional socioeconomic development (economy, tourism, environment, education, science); (2) The biography of pioneers and other contributors with emphasis on their importance to science and to knowledge advances about the geological setting; (3) The importance of Earth-Sciences evolution for the development of new ideas and models on local and regional geology; (4) The relevance of the local geology for the development of new theories and new methodological approaches; (5) The contributions for scientific and cultural enhancement of geological historical collections.

A CASE STUDY FROM THE CRETACEOUS OF PORTUGAL

The understanding of the link between the history of Earth sciences, geocollections and geological heritage as a methodological approach to reveal natural contexts and sites related to the geology of Portugal, is as necessary as structuring of future activities (Brandão, 2008). This is due, not only to the great diversity of the available outcrops and landscapes, but to the reason that the historical of researches is very rich and, sometimes, remaining more than two centuries ago.

On the explicit case of the Meso-Cenozoic sedimentary units that outcrop in the western border of the Portuguese territory, there are several noteworthy examples with singular relevance for geological heritage and, at the same time, suitable for didactic approaches with historical concepts based on “classical” sites. Among them, stand out the Upper Cretaceous formations of West Central Portugal, which have long been known since early researches made by Daniel Sharpe (1806-1856), during the first half of XIX century. This English pioneer on invertebrate Palaeontology and president of the Geological Society of London spent long periods in Portugal, travelling and studying its Cretaceous units and fossil faunas (fig. 2).

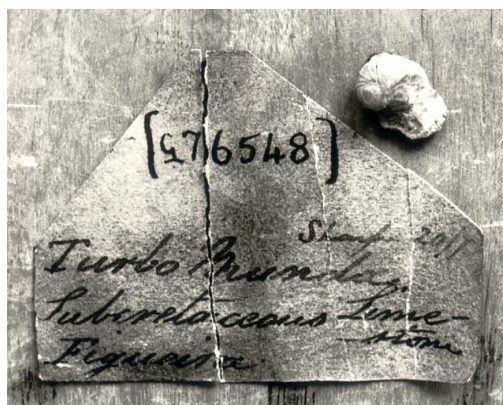
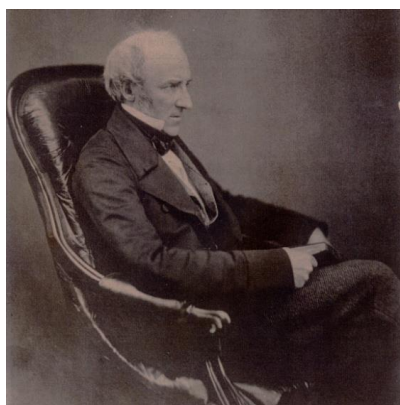


Figure 2: a) Daniel Sharpe (1806-1856) pioneer of the Portuguese geology (photo: courtesy of the Geological Society of London); (b) The type and original label of *Otostoma mundae* (Sharpe, 1849) from the Lower Turonian limestones of Figueira da Foz, Portugal (collection of the British Museum (Natural History); photo: P. Callapez, 1992).

The Cenomanian-Turonian platform carbonates from the Baixo Mondego region of Western Central Portugal are one of the best examples of these historical units known since the Earth-Sciences gold age. Here, the fossiliferous limestone and marly beds of the Costa d’Arnes Formation (Rocha *et al.*, 1981) are recorded by a

set of large outcrops situated in the “classic” localities of Salmanha (Figueira da Foz), Fontela, Vila Verde and Lares, near the local railway to Coimbra (fig. 3).



Figure 3: The main quarry of Salmanha, Figueira da Foz, showing the Cenomanian fossiliferous beds that have been studied since the nineteenth century (Photo: P. Callapez, 2003).

These exposures have been studied since 1849 for geological purposes. They reveal a 65 meters thick stratigraphic succession with ammonites and abundant benthic invertebrates. The local sequences of shallow marine carbonated facies were fully studied by the Swiss geologist Paul Choffat (1849-1919) of the Portuguese Geological Survey, and used to compare and correlate faunal associations of the Tethyan and Temperate domains, during the Cenomanian-Turonian transition in Western Europe (fig. 4).



Figure 4: Paul Choffat in mid 1919. (Photo: AHGM, LNEG).

This significant palaeontological evidence was fully recorded in several historical geocollections assembled since the 1840s. They have been housed in Lisbon, at the *Museu Geológico* (the museum of the former Geological Survey of Portugal; collection Paul Choffat) and also in the *Museu Nacional de História Natural e da Ciência* (University of Lisbon; nineteenth century specimens from the Geological Commission, and collection Pierre-Yves Berthou recently transferred from the University of Paris VI). Other additional collections have been held at the University of Coimbra (collection A. Ferreira Soares) and several other specimens conserved at the British Museum (Natural History) (collection Daniel Sharpe).

At the same time, the contemporary scientific work has resulted in a substantial list of monographs that described aspects of the Cretaceous stratigraphy and palaeontology of Figueira da Foz and related sections from the Baixo Mondego region. The works of Daniel Sharpe (1849a, 1849b, 1849c), Paul Choffat (1886, 1898, 1900, 1901-02, 1927), Perceval de Loriol (1887-88), Gaston de Saporta (1894) and Henri Sauvage (1897-98), among others, are excellent examples of this rich bibliographic background and historical setting that allow us to reveal the importance of the area for geological heritage purposes (fig. 5).

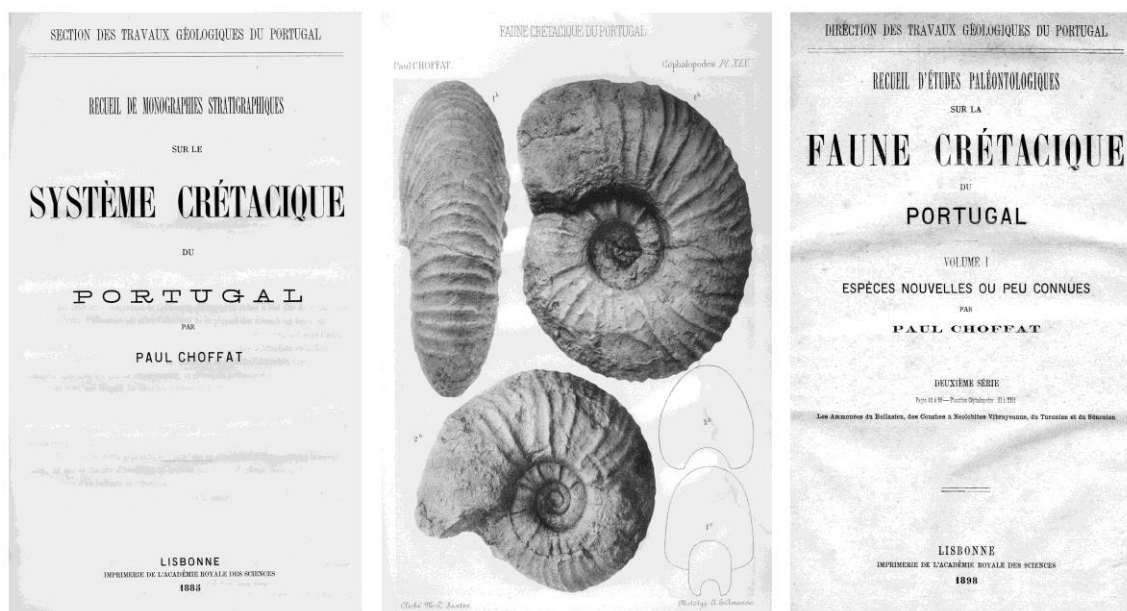


Figure 5: Front pages and plate of monographs published by Paul Choffat after 1885. They provide detailed descriptions of the Portuguese Upper Cretaceous stratigraphy and invertebrate faunas, including those from Figueira da Foz focused on this study.

Side to side with this rich historical of scientific studies, samples and publications, the classical outcrops of Figueira da Foz have been visited by large number of field excursions, many of them scholar groups of Geology and Biology interested in practical concepts and *in situ* observations of sedimentary rocks, stratigraphic principles and fossil record. These didactic field activities have been frequently extended to the geocollections, during visits to the museums.

Aspects of Earth Sciences history, with emphasis on the historical of the area, have been currently used as a complementary methodology for these non-formal teaching procedures. These approaches include, for instance: (1) The principles of historical geology and its overview in the local stratigraphic sections; (2) The historical course of the Portuguese geology and its response to the introduction to new concepts and ideas; (3) Daniel Sharpe, Paul Choffat and the studies of Mesozoic in Portugal; (4) The importance of stratigraphic reference collections for scientific knowledge, with emphasis on the Upper Cretaceous ones; (5) The relevance of geocollections as part of geological heritage and as an important tool for geoconservation.

CONCLUSIONS

The epistemology of Earth Sciences (history, methods and evolution of knowledge) is a valuable issue that can be used for the selection and characterization of geological sites. This interdisciplinary view based on history of geology and palaeontology has a special significance when it comes to "classical" sites with a long and rich background of scientific studies, museum collections and publications.

From this point of view, its developments are congruent with the purposes and the specific conceptual system of geological heritage. At the same time, this methodology could be well succeed reducing the traditional gap between the 'cult' of museum collections as absolute testimony of geodiversity, and 'worship' of geological heritage preserved *in situ*, after all, two sides of the same coin. Thus, for the apparent antagonism opposes

complementarity, mingling knowledge and efforts within the understanding of the history of Earth and Life, and conservation of the natural heritage.

The same approaches of historical sense can also be useful both for geological heritage and teaching of natural sciences, using the geological sites and their contexts as valuable didactic materials for interdisciplinary strategies. They have a wide field of application in the Geology of Portugal, as can be seen for the example of the Upper Cretaceous of Figueira da Foz.

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