

**Teaching of Stratigraphy, geological heritage
and Geoethics**

Virtual tours through Earth history and paleoclimate: examples from the Piemonte (NW Italy) geoheritage (PROGEO-Piemonte project)

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The development of virtual tours on the geoheritage of Piemonte aims to disseminate geological knowledge among the general public. Two of the most crucial geological themes, geological time and climate and environmental change, are addressed. People will enhance their awareness on the geodiversity and on the potential of the Earth Sciences to improve our everyday life. The tours will be developed with special care to educational purposes and in lay language, and will finally contribute to preserve vulnerable geoheritage.

Keywords: geological heritage, Piemonte, geological time, climate and environmental change, virtual tour.

Magnetostratigraphic models as teaching models to learn Stratigraphy: examples of Portuguese 12th grade Geology Education

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The main goals of this study are: 1) to present the essential concept of a model; 2) to present the models of magnetostratigraphic records; 3) to show the possibility of developing models of magnetostratigraphic records of some Portuguese marl-limestone succession; and 4) to show the possibility of creating teaching and learning models for Geology Education. For example, in twelfth grade geology, students learn about magnetostratigraphy and the textbooks present some scientific models. One of the examples is the magnetostratigraphic record of the Aalenian–Bajocian limit in Cabo Mondego, Figueira da Foz, Portugal. A model may be understood in different ways. In this study, a model is considered a structured representation, including symbolic elements essentially of an idea, an object, a process, a sub system, or a system. Modelling means construction, assessment and/or revision of a model to answer a specific problem. We can write about magnetostratigraphic models, about the work involved in the production of research models and about the models which represent geologic objects and processes. The first ones are the result of knowledge and are constructed using specific data obtained in case studies. The models of magnetostratigraphic record, although incomplete, as are all scientific and consensual models, are the best ones to construct teaching models, creating simplifying models that could be understood by teachers and students. The teachers of Stratigraphy could also use these scientific and teaching models to teach magnetostratigraphy. In this study we developed 2 different teaching models: 1) a magnetostratigraphic record of the Aalenian–Bajocian limit in Cabo Mondego, Figueira da Foz, Portugal, using the model developed in our PhD Thesis and 2) a magnetostratigraphic record of the Toarcian marly-limestone succession, Maria Pares, Portugal. These teaching models were developed taking into consideration the recent models of stratigraphic and magnetostratigraphic time scales.

Keywords: Magnetostratigraphic records, teaching models, learning models, marl–limestone succession, time scales Lusitanian Basin, Portugal.

Geological and cultural routes of the Brecha da Arrábida: a contribution to the candidature of Arrábida for UNESCO's Mixed World Heritage List

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Summary: The Upper Oxfordian Brecha da Arrábida is a unique lithological type in Portugal and probably in the world because it was formed through several particular geological influences acting simultaneously. The rock is a conglomerate composed of carbonate pebbles of different colours, cemented by a red, ferruginous, clayey carbonate. It is the expression of fossilized a karst that marks one of the major unconformities of the Lusitanian Basin, which was associated with the early stages of the opening of the North Atlantic. One of the strengths of the candidature of Arrábida for UNESCO's Mixed World Heritage List is the intimate connection between the natural environment, particularly the landscape (Criterion VII) and the geology and geomorphology (Criterion VIII), and the history and culture of the region and country. The natural occurrences of Brecha da Arrábida, the exploration of which ended in 1975 with the creation of the Natural Park, are rare and sporadic. The geographical dispersion of outcrops will necessitate the creation of scientific and cultural routes to facilitate visits by the millions of tourists who travel to the Arrábida region each year. The creation of routes in the region is, therefore, one of the objectives of this candidature. In addition, the Brecha da Arrábida conglomerate has been used for ornamental purposes since the late fifteenth century, and was used for the first sculptural and decorative expressions of the so-called Portuguese Late Gothic and Manueline styles, and later in the Baroque because of its colourful varieties. This artistic use of the Brecha da Arrábida, as well as other uses of the material, extends far beyond the actual geographical area of Arrábida. This wider significance provides part of the justification for building a website where users can add information regarding the uses of Brecha da Arrábida in both Portugal and other countries, thereby updating the existing features of Arrábida, and is viewed as a vital component for disseminating knowledge about geology to the public.

Keywords: Brecha da Arrábida, Portugal, UNESCO's World Heritage List, Geological and cultural routes, Dissemination

ABC heritage project – a tool for geo-education

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The geological tourism and business opportunities regarding to that are growing in the Barents area. To be able to develop this sector of tourism in sustainable way, a cooperation project ABC heritage – Arctic Biological, Cultural and Geological Heritage has been created. Project is partly financed by EU Kolarctic ENPI program. In the geological heritage part of the project the three main participants are the Geological Survey of Finland, Northern Finland Office, the Geological Institute of the Kola Science Centre of the Russian Academy of Sciences and Bioforsk Soil and Environment from northeastern Norway. The duration of the project is 2012-2014.

Main method for cherishing the geological heritage is to raise the awareness of the actors in the nature tourism sector about geology. On the other hand it is also important to engage the youth of the area to support the sustainable use of geological recreation areas. This can be achieved by educating those target groups of the project. Other example of ways to protect the geological recreation sites is a geological outdoor map. When that kind of map of the area is created, it guides the tourists to go along the safe and environment-friendly routes. In this project geological outdoor map will be prepared from the Khibiny Tundra area locating in the middle of the Kola Peninsula. Geological heritage trails with information panels will also be produced to some key areas. Totally there are ten different activities in the geological part of the project. The primary outputs of the project's geological heritage part are the geological outdoor map of Khibiny Tundra, the geological nature trails on the field, geological demonstration sites with uniform signing and educational packages of geological heritage targeted for pupils of the schools, teachers and personnel working in nature tourism.

Keywords: Geological heritage, nature tourism, Quaternary geology.

Stratigraphy and conservation of cultural heritage: the example of rupestrian churches of Cappadocia (Turkey)

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The conservation of cultural heritage needs a multidisciplinary approach to identify the most suitable and durable methods of intervention regarding physical and chemical decay of materials. In particular this approach is essential to preserve outdoor heritage affected by climatic and environmental changes; in regard to it, Cappadocian region is a unique ignimbrite landscape created by neogenic volcanic activity shaped by phenomena as erosion and freeze-thaw cycles.

The tabular stratigraphic trend of the ignimbritic sequence influenced the geomorphological evolution, promoting typical earth pyramids called “fairy chimneys”. These structures were carved and transformed during the centuries, especially by Byzantine population, into urban centres and churches with precious frescoes; for this reason some Cappadocia sites have been in World Heritage List since 1985.

The present work belongs to a greater research project about cave churches conservation coordinated by Prof.ssa Andaloro from Tuscia University (Italy). The aim is to focus the relationships between geological features and the conservation in Şahinefendi village, already known for the site of Sobesos, a city dating to the late Roman and early Christian period (mid-4th century to 5th century A.D.).

Keywords: Cappadocia, degradation, earth pyramids, rock hewn churches.