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The Beja Public Geological Trail – Geology in the garden

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ABSTRACT: A Geological Time trail is being developed by LNEG in the Beja Public Garden. Along a 200 m linear path, 1000 Ma are considered, from Precambrian to Quaternary. Fourteen rock samples from South Portugal geological units show igneous, sedimentary and metamorphic rocks, ores and fossils from the South Portuguese and Ossa Morena Zones, Santiago Cacém Mesozoic and Alvalade Neogenic basins. A special jump through time is dedicated to children (1 m = 5 Ma, the time scale). With this project, LNEG and the Beja Municipality aim at promoting the visit of the city and improving culture in geosciences.

KEYWORDS: Geological time trails, Beja Garden, geological and mining heritage.

1. INTRODUCTION TO THE GEOLOGICAL TIME TRAIL

Time in geosciences is a basic principle commonly used by geologists to understand the Earth History and the evolution of life. Each rock class (sedimentary, igneous, metamorphic), each crust process, each tectonic event, each deformation phase, each ore deposit present different time scales, intensely investigated in geosciences. By nature, the geological time is complex and continuous, considering the different aspects of stability and evolution process of each rock. Detailed research allows a better understanding of each geological formation. Academic discussions help to understand the origin and evolution of each geological unit, and their stratigraphic correlation. Geological time however is a very complex theme for the general public. The lay person has difficulties understanding the fourth dimension concept and complex models, like discordances, faults, intrusions, marine transgressive/regressive sequences, complex folding phases, etc. The valorisation and promotion of geological heritage to the public is an important work; recently developed by Geological Surveys, Universities and geologists using and applying the same synergies in a didactic approach. The main goal is to develop a new generation of geoscience exhibits, serving as dynamic learning laboratories, where visitors can explore the geological materials, allowing an accurate content, an active inquiry and interpretation that promote a cultural integration (Karlstrom *et al.*, 2008).

Portugal is characterised by a rich geodiversity illustrated in the Palaeozoic Variscan basement, in the Mesozoic basins and massifs and in the Neogenic basins (see 1/1000000 Portugal geological map, LNEG 2010 and 1/500000 South Portugal map, SGP 1992). From the Precambrian (the most ancient rock record) to the present time, the Portuguese territory shows a complex geological history, characterised by the orogenic cycles, continental drift, ocean openings and closures. The Beja Garden Geological Time Trail is a project developed by LNEG and the Beja Municipality, focussing on the geological formations of South Portugal and dedicated to the Earth crust evolution through time in the Baixo Alentejo district; the Portuguese southern region where Beja City is the capital and main urban area. The Beja Public Garden Geological Trail is one the first of its kind ever prepared in Portugal.

2. GEOLOGY IN THE BEJA PUBLIC GARDEN, THE PROJECT CONCEPT

Considering best practice examples of the European Atlántica/Green Mines Space Atlantic Area Project, LNEG and the Beja Municipality planned a geological time trail for the city main Public Garden. The Geological Survey of Ireland and the Copper Coast Geopark are collaborating with the Portuguese team considering their experience in developing a Geological Time Trail in the Irish village of Bunmahon, where a geological garden was constructed (see Copper Coast Geopark 2011 web site <http://homepage.eircom.net/~ccgeopark/Everyone.htm>).

The Beja Public Garden was built in 1900s by the municipality in the downtown area, near the historic city centre. The Beja Public Garden Geological Trail and other recent educational projects developed in the garden aim at increasing the number of visitors to the city centre and promoting geosciences to the general public, schools and residents.

The Beja Geological Trail will consist of a linear 200 m path, corresponding to a time interval of 1000Ma. The journey goes back in time to the formation of the Earth (4500 Ma in age), and it is materialised by an outside known urban area, located more than 1km from the garden (i.e. Beja Hospital). This option allows a better management of the interpretation points, focused in the most recent periods of the planet Earth history. Fourteen stops are considered (see Table 1) along the geological timeline and allow valorising the main geological units of the Ossa Morena and South Portuguese Zones, the Sines Massif, the Santiago do Cacém Mesozoic Basin, and the Alvalade Neogenic Basin. Each sample is correlated with a clear geographic reference and, when possible, related with a Baixo Alentejo extractive activity, e.g. the massive sulphide ore of the Neves Corvo mine (Cu, Zn, Sn), the Barrancos shales and Trigaches marbles used as ornamental rock and house construction; the Beja gabbros used in road pavement and the Alvalade Basin sandstones used as aggregates. The trail is mainly an interpretative trail that will be marked with several Trigaches marble cubes, 28 cm x 28 cm in dimension, which will mark the position of the selected samples (See table 1). Each cube presents the age of the sample in million years and a short descriptive text label of the sample. The selected samples have ~1m dimensions, in order to be geologically representative of the events, units and paleontological contents. Samples include fossils of the Silurian graptolites of Barrancos (Piçarra, 2000), the Famennian miospores and acritarchs (microfossils) black shales of the Phyllite-Quartzite Group, the Upper Visean bivalves of the Mértola Formation (Oliveira *et al.*, 2006; Pereira *et al.*, 2008), the Upper Jurassic marine shells of the Santiago Cacém limestones, the Miocene ostrae of Alfundão and the calcretes of Beringel. The presence of volcanoes and igneous massifs is recorded by the Famennian (Upper Devonian) felsic volcanism of the Iberian Pyrite Belt and the Carboniferous Beja Igneous Complex gabbros. Deformation and orogenic events are shown by the Precambrian gneisses and the Lower Cambrian marbles of Trigaches. These marbles present a coarse granoblastic texture and grey colour. They are the main rocks used in construction of modern and ancient monuments in Beja City, like the Beja Castle (12th century), museum, city hall, court, library and main schools.

The selected presented samples, some of which are approximately 1 ton in weight, were collected in the best outcrops: some in quarries and galleries. The LNEG team very much appreciated the precious help in transport and logistics provided by the Baixo Alentejo extractive companies and some municipalities.

The location of each stop, marked with the cubes, is planned along the timeline trail which sets a project scale of 1 m per 5 Ma. A special feature: the “jump through time”, illustrating an important gap through geological time, is being considered mainly for children and students.

A series of rocks and exhibits that will include interpretation panels, brochures and a website will serve to promote the project and explain how South Portugal rocks were formed. Schools guides can also be considered.

Table I. Beja Public Garden Geological Trail – stops and samples:

Ma	Geological unit	Period	Geographical reference	Fossils
1000	Micaschist	Precambrian	Vidigueira	-
520	Marbles of Trigaches	Cambrian	Trigaches (Beja)	-
470	Shales of Barrancos	Ordovician	Barrancos	Ichnofossils
443	Quartzites of Colorada	Ordovician/Silurian	Barrancos	Ichnofossils
428	Nodules Shales	Silurian	Barrancos	Graptolites
360	Volcano-Sedimentary Comp.	Devonian	Cercal, Neves Corvo	Palynomorphs
330	Flysch of Mértola	Carboniferous	Mértola	Bivalves
310	Beja Igneous Complex	Carboniferous	Beja	-
300	Pedrogão Granite	Carboniferous	Pedrogão	-
230	Silves Sandstone	Triassic	Santiago do Cacém	-
180	Bioclastic Limestone	Jurassic	Santiago do Cacém	Ammonoids
7	Carbonate sandstones	Miocene	Alfundão	Oysters
5	Sandstones	Pliocene	Melides	-
0	Alluvium and Dunes	Quaternary	Guadiana, S. Torpes	-

3. CONCLUSIONS AND PROJECT SUSTAINABLE DEVELOPMENT

The Beja Public Garden Geological Trail prepared for the Beja Garden is one of the first of its kind ever prepared in Portugal. This is a singular project that allows the presentation and valorisation of the significant geodiversity of the South Portugal Geological Units.

This Geological Trail project is dedicated to the Beja citizens and general public. The trail will be a valid opportunity to promote Geoscience contents in a didactic way, mainly for local schools. The design and research results will be developed and applied to cultural exhibits and programs that will be integrated in the regional network partners dedicated to the geological and mining heritage (Matos *et al.*, 2008), which involves the Lousal (Relvas *et al.*, 2005) and the Estremoz Life Science Centres and the Noudar Nature Park (Barrancos) Piçarra, 2009. Exhibitions will be prepared, based on small collection samples, to promote the concept. As partner of the Atlanterra project, LNEG team work will discuss the project methodology with European partners. Other networks can be considered like ProGeo, Iberoamerican networks and National Forum of Geoparks.

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