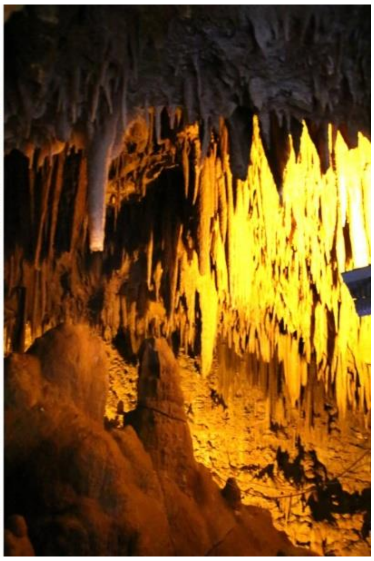
EUROLITHOS European Ornamental Stone Resources

Eurolithos case study

Sustainable exploitation of ornamental limestones in Maciço Calcário Estremenho, Portugal





Thematic focus: Sustainable ornamental stone production

Responsible partner: LNEG

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GeoERA RAW MATERIALS

Foreword

A fact well known to the geological community is that the places where mineral deposits occur are not set by Man. Hence, extraction of essential mineral resources for society can only take place where these deposits occur and, therefore, their sustainable supply depends, largely, on the conditions of access to these places by the extractive industry.

Nevertheless, people in general do not know this fact and, currently, there is a widespread negative opinion about the exploitation of mineral resources, especially when it occurs in quarries, because of the visual impact they cause on the landscape. Even if mineral resources are essential for society, the negative opinion is worse when extraction takes place in areas subject to nature conservation measures, such as natural parks.

In reality, the basis for the implementation of many natural parks, rests on the existing knowledge about the wild life and flora values of the areas considered for protection, frequently forgetting the geology that supports these biological values. Worse, the value of mineral deposits that exist or may exist in the considered areas is also forgotten, which in most cases leads to their sterilization, because there is a generalized idea that quarrying is incompatible with environmentally protected areas, such as natural parks and Natura 2000 sites. Therefore, in order to ensure access to these mineral resources, it is necessary to find ways to reconcile the mining activity with the protection of relevant environmental values.

Executive summary

The Maciço Calcário Estremenho, in Portugal, is a limestones massif where an intense extraction activity of limestones for ornamental purposes takes place in five main quarry clusters. A large extent of this massif, including the exploitation centres, is covered by the Natura 2000 Network PTCON0015 site, which, simultaneously, corresponds to the Portuguese Natural Park of *Serras de Aire e Candeeiros.*

As a result of the restrictive measures imposed by the regulations for the protection of nature, a large number of conflicts with the extractive industry, have persisted for decades.

In this case-study we demonstrate that through the dialogue between the industry and the public entities responsible for nature conservation and spatial planning, it is possible to find compatibility solutions that consider the territory's aptitude for the production of mineral resources and the need to preserve relevant environmental values.

For that purpose, an unprecedented partnership between the environmental authority and an association representative of the extractive sector carried out detailed geological and environmental studies that resulted in a land-use planning proposal for each of the exploitation clusters. These proposals make it possible to reconcile extraction with the protection of outstanding biological values and geological heritage.

Keywords: Limestone, Ornamental Stone, Mining, Environment, Compatibility

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Description of case study

This case study is about the sustainable production of blocks of ornamental limestones in a Natura2000 site located in Portugal. It reports the methodology applied by a project aimed at ensuring the integration of extraction areas in land use planning and their management taking into account the nature conservation needs inherent to the Natura2000 Network site.

This Natura2000 Network site corresponds to a Portuguese natural park (PNSAC – *Parque Natural das Serras de Aire e Candeeiros*[1]), located in the *Maciço Calcário Estremenho* (MCE), which is a Jurassic limestone massif, about 150 km north of the capital city, Lisbon (Figure 1). It is one of the most important world centres for the production of ornamental limestones. Recent data from the Portuguese mining authority point to a production of 1 million tons, corresponding to an income of around 60 million euros.

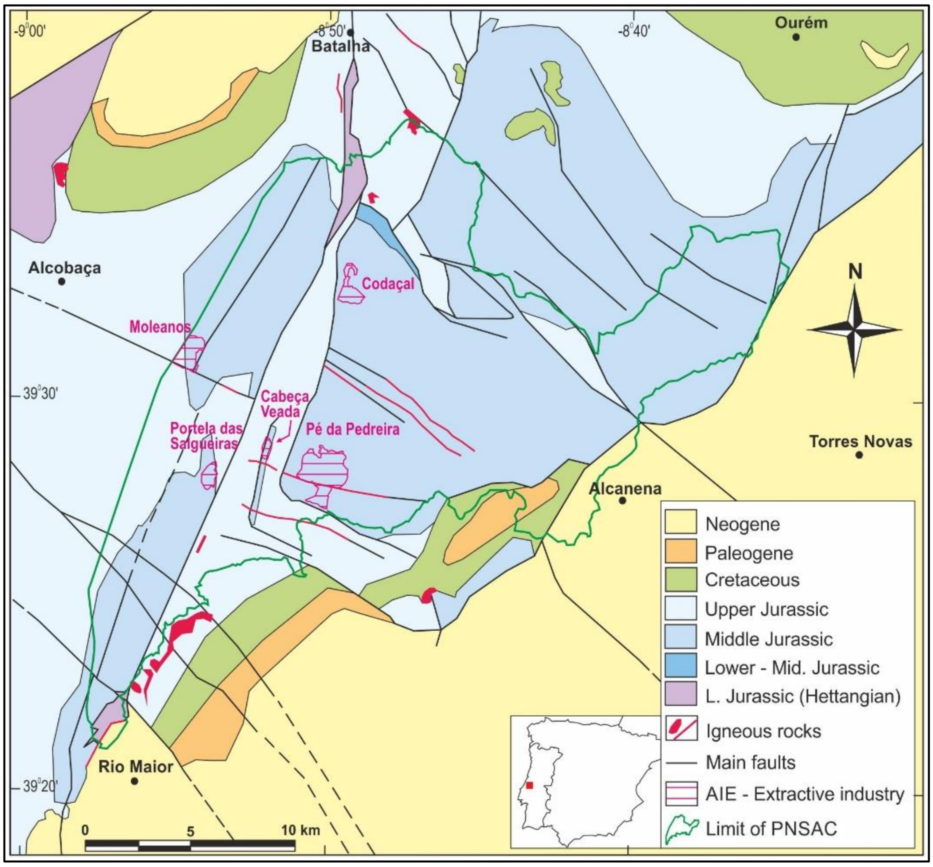

Figure 1 - Simplified geological map of MCE with location of the Natural Park of Serras de Aire and Candeeiros and its quarrying areas.

[1] Serras de Aire e Candeeiros Nature Park - Natural.pt

Background

The limestone's potential in the MCE as a resource for construction and ornamental stone production has been known for a long time, and these limestones, although intermittently, have been exploited for centuries, namely for monuments that are now World Heritage sites (monasteries of Alcobaça and Batalha, Figure 2). However, the extraction activity from an industrialized and intensive view point is relatively recent, having settled since the 1970s. In the middle of the following decade, the activity went into full development, particularly in what regards the exploitation of ornamental limestone, due to the combination of a period of economic expansion with technological advances in the extractive sector (Figure 3).

Figure 2 - The monasteries of Batalha[2] (left) and Alcobaça[3] (right). The Monastery of Batalha, was erected in commemoration of the 1385 Battle of Aljubarrota and took over a century to build (1386-1517). The Monastery of Alcobaça, is a Roman Catholic monastic complex established in 1153 by the first Portuguese king, Afonso Henriques. It is one of the first buildings associated with the Cistercian Order in Portugal and was built between 1178 and 1223. Both monasteries are UNESCO World Heritage sites.

At that time, in 1979, the PNSAC was implemented, partially covering the MCE and most of the quarrying sites. Its main objective was to protect the natural characteristics related to the karst morphology and associated flora, the groundwater drainage network and the fauna, of which cave-dwelling fauna stands out. The existence of specific habitats later led, in 2008, to its integration into the Natura2000 Network (Site PTCON0015 - Serras de Aire e Candeeiros).

The PNSAC's first land use plan and respective regulation (Ordinance No. 21/1988) did not properly consider the use of land for other activities already settled there, namely the extraction of ornamental stones. Consequently, several conflicts arose between the extractive sector and the environmental authorities: on one hand, the growing market demand for ornamental stones from MCE (Figure 4) and the natural desire for economic growth in the industry, on the other, the need to enforce the objectives of nature conservation according to the PNSAC's regulation (Figure 5).

[2] Batalha Monastery - Wikipedia
[3] Alcobaça Monastery - Wikipedia

Figure 3 - Large limestone blocks produced in Pé da Pedreira. These quarries are equipped with the most modern technological equipment and skilled workers, giving them the hability to produce large quantities of blocks.

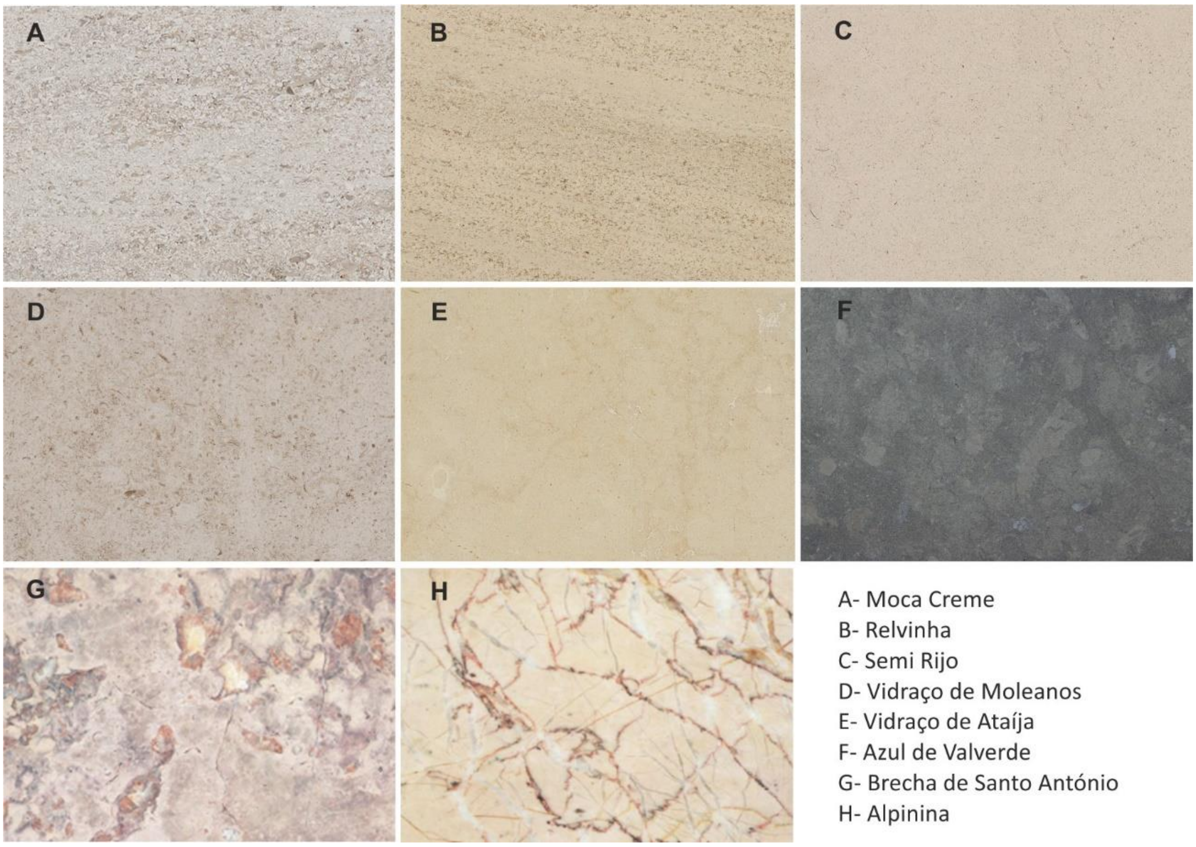

Figure 4 - Main ornamental varieties produced in MCE. These are mainly exported to the Chinese market, where they are highly appreciated for building cladding. Since the beginning of the century, the Chinese market has been responsible for purchasing about 90% of production.

These conflicts have lasted for more than ten years. They only began to decline when a new PNSAC land use plan was approved in 2010 specifying areas for the development of the extractive activity covering the five main quarrying sites (Figure 1), namely, the Cabeça Veada, Codaçal, Moleanos, Pé da Pedreira and Portela das Salgueiras areas (Council of Ministers Resolution no. 57/2010). According to this new plan, these five areas designated for quarrying, formally named Areas for Specific Interventions (AIE), should be subjected to detailed municipal land use plans aiming to implement compliance measures between the rational management of the resources and the protection of environmental values. It also states that these areas should be covered by integrated exploitation projects, that is, a single mining project covering all quarries in each AIE.

Figure 5 - Examples of PNSAC's natural heritage subjected to protection measures.

In order to meet these demands, a project called Sustainable Exploitation of Resources in the *Maciço Calcário Estremenho* was implemented. It was carried out in the period 2011 - 2014 through an unprecedented partnership between the industry association of mining and quarrying (ASSIMAGRA[4]) and the Portuguese Nature Conservation Authority (ICNF[5]). This partnership involved the close cooperation of the Portuguese Mining Authority (DGEG[6]), the Geological Survey (LNEG[7]), municipalities

[4] Assimagra | Recursos Minerais
[5] www.icnf.pt
[6] Home (dgeg.gov.pt)
[7] LNEG – Laboratório Nacional de Energia e Geologia

(Alcobaça, Porto de Mós, Rio Maior, and Santarém), a technological center (CEVALOR), and private consulting companies for engineering and environmental studies (Visa Consultores, Lda.[8] and Biodesign, Lda.[9]). The project had a financing support of 30% by the quarrying companies operating in the MCE.

A comprehensive methodological approach

This project had as assumptions that the use and valorization of the ornamental stone resources, along with other factors, in particular the MCE's natural heritage, can be an important element of economic improvement for the region, contributing to a better acceptance (and not the mere tolerance) of the extractive industry. This way, the industry arises not only as a factor of economic development but, corresponding to the current expectations of environmental and social welfare preservation, it also emerges as a factor of identity and self-esteem for the local population. Aiming to foster the environmental performance of the quarrying activity through the increase of its efficiency and reduction of its impacts, key aspects that were taken into account were:

- The definition of strategies for the mining sector's sustainable development;
- The creation of geological and environmental background information regarding the integrated planning of the quarrying areas;
- The qualitative and quantitative characterization of the hydrogeological conditions of the MCE aquifer and its monitoring, aiming at assessing its vulnerability regarding the extractive industry;
- The inventory, characterization, and a management proposal of the vast geological and mining heritage encompassing the ornamental stones, aiming at their joint valorization as identity marks of the region;
- A Communication and Awareness Program to enhance the extractive activity alongside the conservation of the natural heritage;
- The definition and implementation of a panel of sustainability indicators for the quantification and monitoring of the environmental, economic and social performance of the extractive activity in MCE.

Most of these key aspects were considered in the main outputs of the project, which, given the requirements of the new PNSAC land use plan, consisted of: a proposal for land use and environmental planning for each of the quarrying areas, accompanied by integrated quarrying projects and respective Environmental Impact Assessment studies, also for each area, and a general plan for waste management.

In Portugal, detailed land use and environmental planning at municipal level in rural areas takes the formal name of Intervention Plans in Rural Areas (PIER). The PIER for each quarrying area resulted from a comprehensive approach that followed the various steps depicted in Figure 6. It was a transparent process, regularly monitored by all the entities involved.

[8] VISA Consultores
[9] biodesign

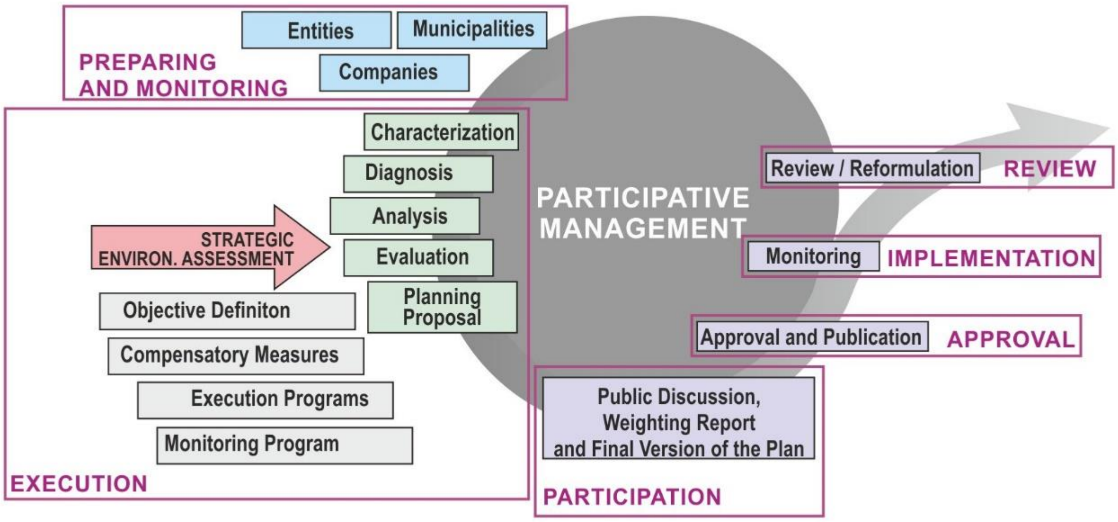

Figure 6 - The various steps considered for the preparation of the PIER proposal for each of the considered areas.

To achieve a land-use planning proposal for each one of the five AIE, the methodological scheme presented in Figure 7 was followed. Two main stages stand out: one of characterization and diagnosis and the other corresponding to the preparation of the planning proposal itself. Characterization and diagnosis studies were carried out at three levels:

• Analysis of the land use planning tools in force for each AIE, in order to guarantee compatibility and compliance with the tools of higher level (e.g. the Sectoral Plan for Natura 2000 Network) and support a proposal for changes to the current environmental protection regime;

• Public easements and restrictions, in order to identify their consequences and the necessary administrative procedures;

• Biophysical characterization aiming to create a zoning, which enlightens the compromise between the exploitation of resources, ecological values and environmental sensitivity.

The characterization and diagnosis studies, particularly the geological and environmental ones, were the basis for all subsequent evaluation and decision-making steps.

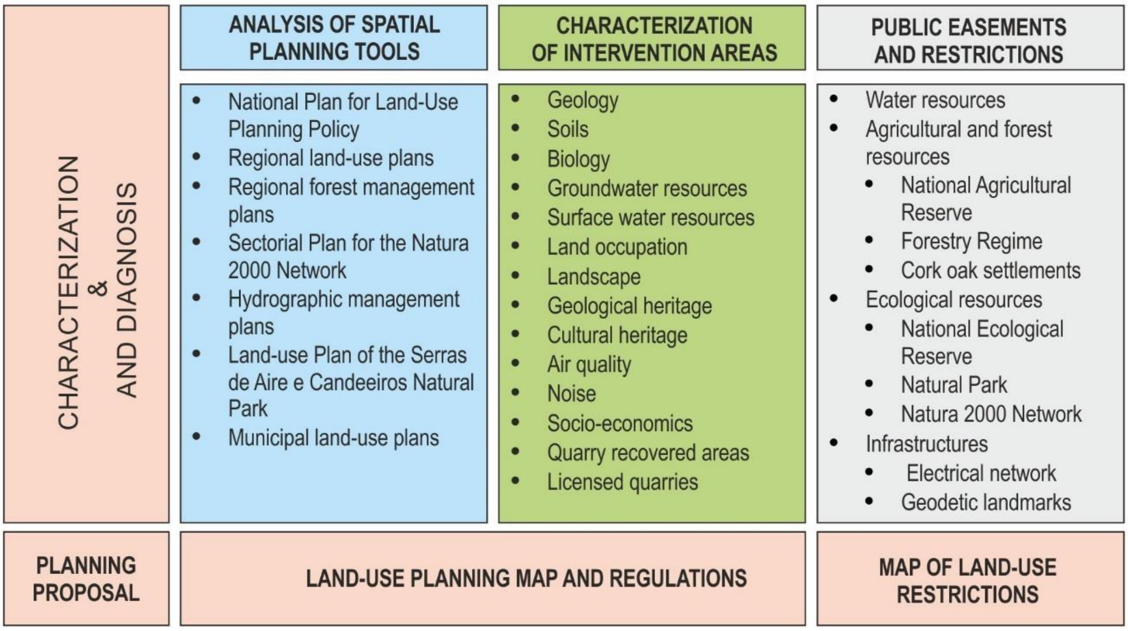

Figure 7 - Information components obtained for the preparation of a rural land use planning proposal for the each AIE.

Evaluation methodology and results

After all the data had been acquired and analyzed, the evaluation process started. It is on the process itself and its results, that we focus our attention from now on, namely those concerning geological, environmental (particularly those of a biological nature), and geological heritage data. For the case of the studied AIE, these are the most relevant.

Geological evaluation

The geological studies involved the characterization of the outcropping rocks and its geological mapping at 1: 2000 scale (the scale legally required for the elaboration of the PIER), drilling with continuous core recovery (validating and complementing the geological interpretations), and a general fracturing survey. These studies allowed the mapping of the most favorable areas for the extraction of large blocks of limestone within each AIE (Figure 8).

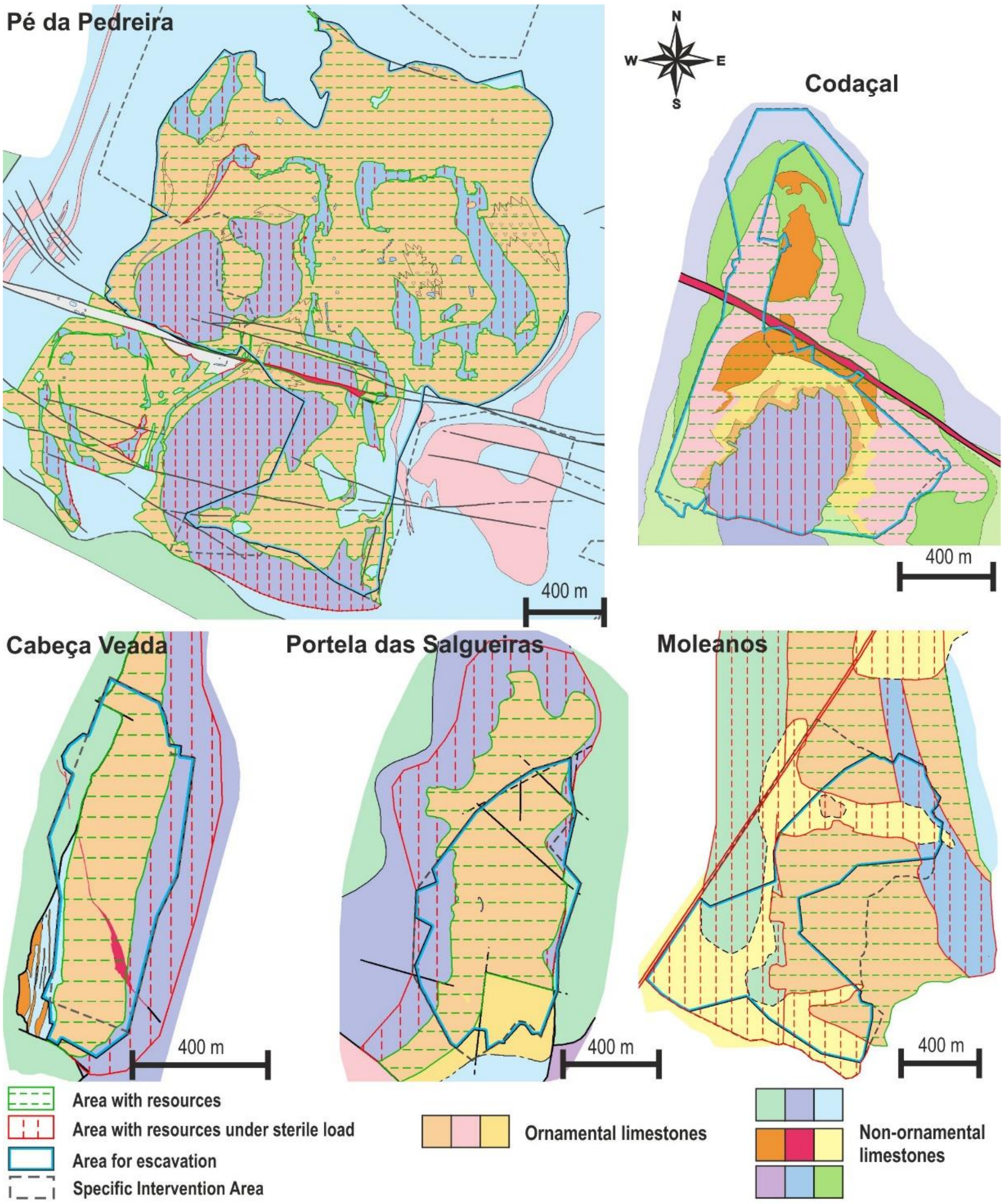

Figure 8 - Simplified geological maps showing the areas suitable for the production of ornamental stones.

Environmental evaluation

The environmental studies included the characterization of soils, biology, climate, surface and groundwater resources, landscape, air quality and noise. However, the greatest emphasis was on biological characterization and mapping of the following ecological components:

- Flora species, with relevance to those holding conservation value;
- Habitats, recognized from the vegetation and flora species units;
- Species of wildlife, particularly those most relevant to the local ecological context;

- Biotopes and associated wildlife communities, recognized from the mapping of habitats and land use, namely from important places for species of greater ecological relevance.

The areas corresponding to these ecological components were then subjected to distinct valorization processes: one for the valorization of the habitats / flora components, and other for the biotopes / wildlife components. This allowed obtaining distinct valorization zoning maps of flora and wildlife values. Finally, their aggregation led to a biological rating map for each AIE (Figure 9), in which the value of the natural heritage is reflected in an ecological relevance variable ranging between Outstanding and Low, yielding the following results:

	habitats / flora	biotopes / wildlife
Class of outstanding ecological relevance	Areas of Limestone Slabs and Limestone Slopes habitats and the areas occupied by relevant flora species	Priority places for the shelter and nesting of species with great conservation concern in the context of the PNSAC (mostly, punctual rock cavities, so it was considered a protection buffer with 200 m in diameter)
Class of high ecological relevance	Areas occupied by the most frequent natural habitats in the AIE, provided that they have a high spatial expression and include priority habitats of the Natura 2000 network	Areas occupied by the most valued biotopes, i.e. the Meadows, shrub-thickets, and rocky environments biotopes
Class of medium ecological relevance	Areas with median coverage percentages of natural habitats that have wide expression in the PNSAC	The remaining biotopes or the previous ones, when they present a very small spatial expression
Class of low ecological relevance	Artificial areas (quarrying-related landforms).	

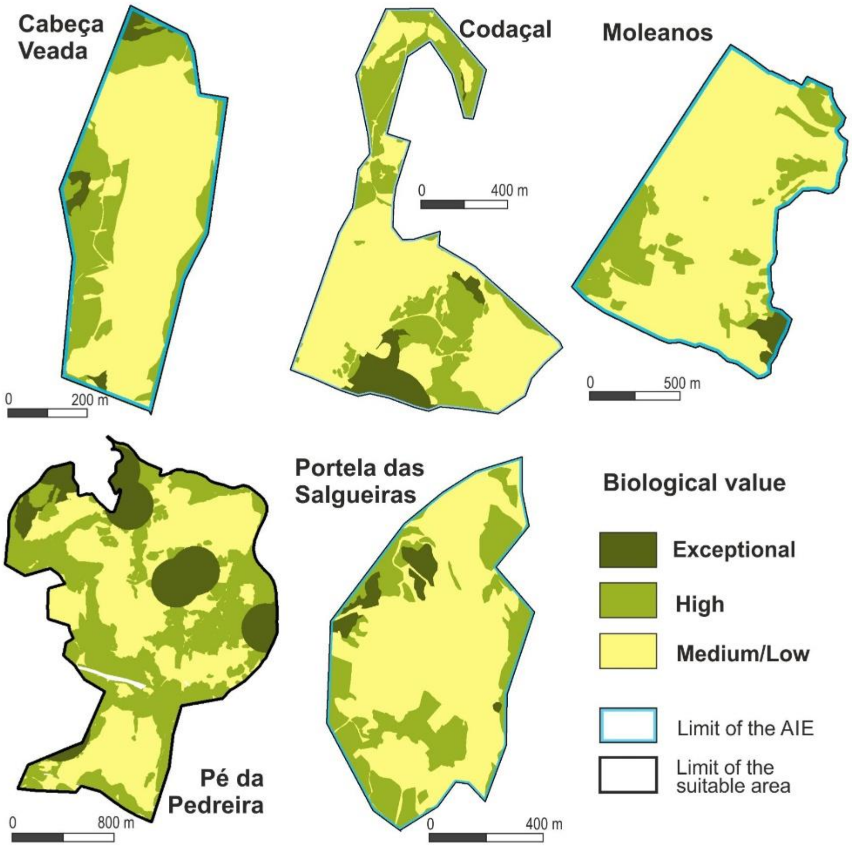

Figure 9 –Biological classification maps fore ach AIE.

Geological heritage evaluation

Geological heritage at MCE encompasses geological, mining and geomorphological sites of interest. Their inventory was not restricted to each AIE because the relevance of each site cannot be taken individually, but in the context of the entire MCE. As an example, the occurrence of a particularly interesting outcrop within a AIE is not relevant if that type of outcrop is very common in the MCE.

The characterization and evaluation of heritage sites was based on templates specifically developed for the PNSAC, according to a geoconservation methodology developed by Brilha (2005, 2006) and Brilha *et al.* (2010).

Each site was ranked quantitatively taking into account its scientific value, vulnerability and potential use, enabling the establishment of geoconservation priorities. Moreover, in order to reconcile the extraction of ornamental stones with the conservation of these geosites, they were systematized in three classes of qualitative value: outstanding value, high, and medium/low.

Relevant geosites only were found in two of the studied AIE, namely in Codaçal and Pé da Pedreira. They correspond to geomorphological values, such as karstic cavities (caves and shafts), dolines and well developed limestone pavements.

Case study results - A land use planning proposal

The land use planning strategy was to make land use compatible with the conditions and adequacies of each AIE, in a sustainable perspective of anthropic activities and their relationship with natural values.

The characterization study and the geological evaluation of each AIE showed, as expected, their suitability for the extraction of ornamental limestone blocks. On the other hand, studies on the characterization and evaluation of natural (biological) values showed the presence of ecologically relevant areas, sometimes with an outstanding character. In addition, there are geological heritage occurrences that are interesting for the PNSAC's conservation objectives.

These three factors were considered critical decision factors for the land use planning proposal, but a fourth factor must also be considered: Recovered Areas, that is, old quarries that were the object of environmental recovery actions, and for which the regulation of POPNSAC provides for their preservation. It is important to note that some of the areas still have ornamental resources.

The systematization and management of data was carried out in a geographic information system, which allowed the establishment of a dynamic interaction between the different subjects through the intersection of the different levels of information.

Given this set of determining factors for the planning model of each AIE, the fundamental question arises of deciding how to weight each of them. To answer this question, three different scenarios were considered:

- Give priority to the valorization of the territory due to its geological suitability for the production of ornamental limestone, that is, a scenario aimed at maximizing the extraction activity;
- Give priority to the valorization of the territory by the existing natural resources, i.e., where the outstanding and high ecological relevance values outweigh the benefits of the quarrying activity;
- Consider the compatibility between the quarrying activity with the results of the biological resources valuation, which should be achieved with the establishment of compensatory measures.

In the POPNSAC context, the decision clearly fell on the third scenario, as it advocates for a land use model that imposes the valorization of the AIEs by granting their use to an activity that generates significant impacts, but also imposes the need to minimize and compensate these impacts through corrective or balancing measures.

With these assumptions, the land use assignment in each AIE followed the methodology presented in the diagram shown in Figure 10, resulting in maps of land use planning proposals (Figure 11). In order for these maps to be formally considered in the municipal spatial planning procedure, as PIER, there is still a need to overlap the areas corresponding to easements and restrictions of public utility.

In each one of the maps, the areas indicated for nature and geological heritage conservation correspond to those where there are no ornamental stone resources. Exceptions are geosites with an outstanding value, which should be preserved, regardless of the existence of ornamental stone resources.

With regard to areas where resources were identified, but coinciding with the occurrence of ecological values of outstanding or high relevance, geosites without exceptional relevance, and recovered areas, those areas were classified as compatible with the extractive industry, provided that this activity was subject to compensatory measures. These are to be decided on a case-by-case basis, according to proposals to be submitted by the quarry owners to PNSAC or vice versa.

As for the areas indicated as compatible with the extractive industry, they match to areas whose ecological relevance is medium or low, and to the areas previously licensed for exploration.

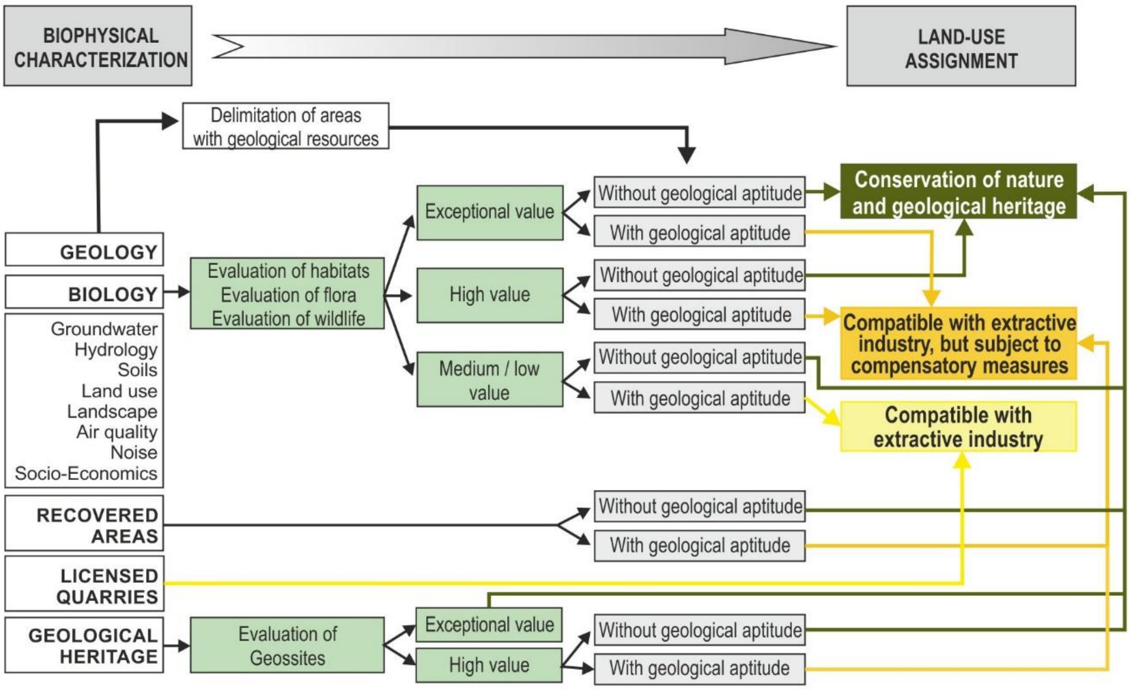

Figure 10 - Methodological diagram used for the land use planning of the Specific Intervention Areas.

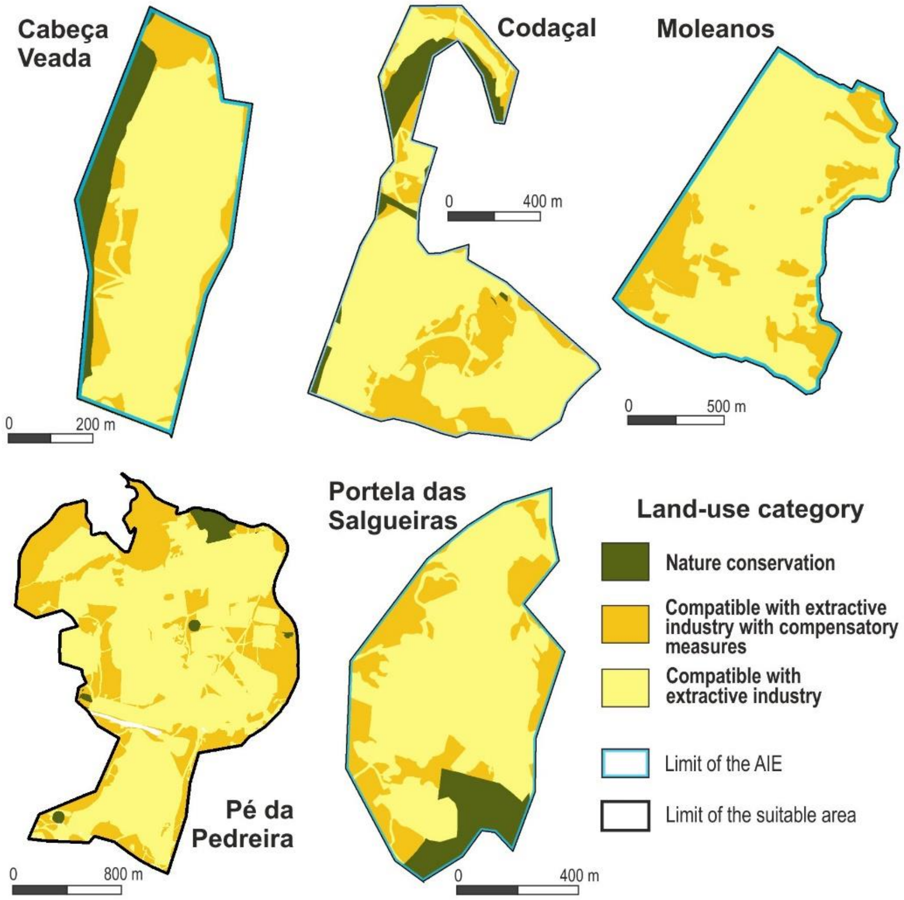

Figure 11 – Land-use planning proposal for each Specific Intervention Area.

Case study conclusions

The actions undertaken had the main objective of contributing to increase the competitiveness of the ornamental stone industry in a context of valorization of both the raw material and the environmental values specific to MCE. For this purpose, the project was developed according to a methodological process based on a strategy of making the rational exploitation of resources compatible with the conservation of natural values.

A fundamental component of that process was the development of a land use planning model to be applied to each of the AIEs, which was based on the identification of the critical decision factors, namely the existence of ornamental stone resources, outstanding and high biological values, relevant geological heritage and recovered quarry areas. In essence, this model advocates the allocation to nature conservation all the areas without interesting mineral resources. The remaining are compatible with the quarrying activity, but if outstanding or high relevance ecological values occur, environmental compensatory measures should be implemented. The spatial translation of this model consisted on the elaboration of a planning proposal for each of the areas.

The key to the success of this case study was the development of a partnership between the association representing the extractive industry and the Portuguese environmental authority.

Protocols for direct collaboration with national and local authorities responsible for the management of geological resources and spatial planning were implemented, as well as with quarry owners, in order to guarantee part of the financial contribution.

It is expected that this operating model can be replicated in other regions, namely those where there is a need to value mineral resources and increase the competitiveness of the mining industry in a sustainable way, both from a social and environmental point of view. In particular, the present planning methodology can be a reference for other situations, with the necessary adaptations. Effectively, it shows a way to make the mining activity and the conservation of natural assets compatible in the context of land use planning, even when the areas are subjected to environmental protection regimes, such as natural parks and the Natura 2000 Network.

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