Portuguese Ornamental Stones

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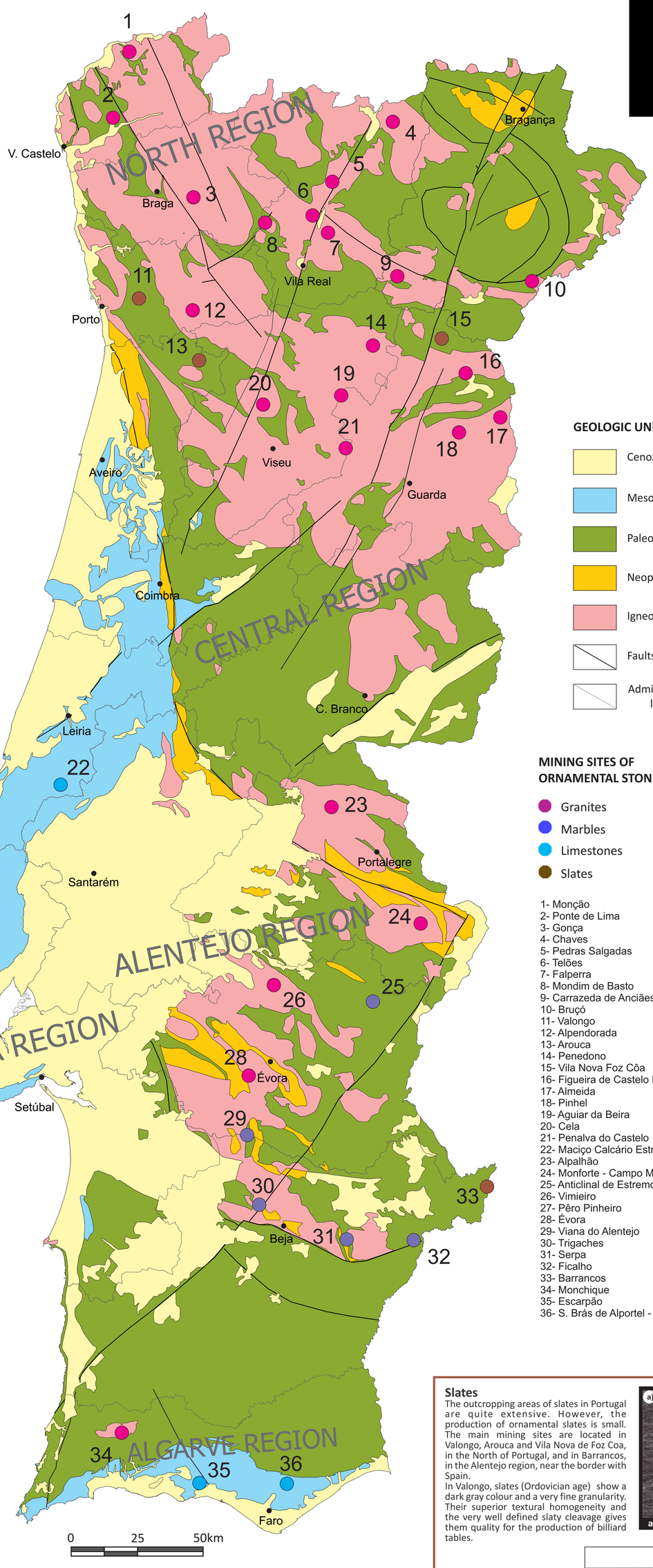
The inventory and characterization of the Portuguese ornamental stones is one of the goals pursued by the Portuguese Geological Survey (LNEG – Portuguese Energy and Geology Laboratory). This systematic work resulted in the preparation of the Portuguese Catalogue of Ornamental Stones, which is continuously updated and is available for online consultation through the Geological Survey Geoportal (http://geoportal.lneg.pt/).



GEOLOGIC UNITS

- Cenozoic
- Mesozoic
- Paleozoic
- Neoproterozoic
- Igneous intrusives
- Faults
- Administrative limits

MINING SITES OF ORNAMENTAL STONES

- Granites
- Marbles
- Limestones
- Slates

1- Monção
2- Ponte de Lima
3- Gonça
4- Chaves
5- Pedras Salgadas
6- Telões
7- Falperra
8- Mondim de Basto
9- Carrazeda de Anciães
10- Bruçó
11- Valongo
12- Alpendorada
13- Arouca
14- Penedono
15- Vila Nova Foz Côa
16- Figueira de Castelo Rodrigo
17- Almeida
18- Pinhel
19- Aguiar da Beira
20- Cela
21- Penalva do Castelo
22- Maciço Calcário Estremenho
23- Alpalhão
24- Monforte - Campo Maior
25- Anticlinal de Estremoz
26- Vimieiro
27- Pêro Pinheiro
28- Évora
29- Viana do Alentejo
30- Trigaches
31- Serpa
32- Ficalho
33- Barrancos
34- Monchique
35- Escarpão
36- S. Brás de Alportel - Tavira

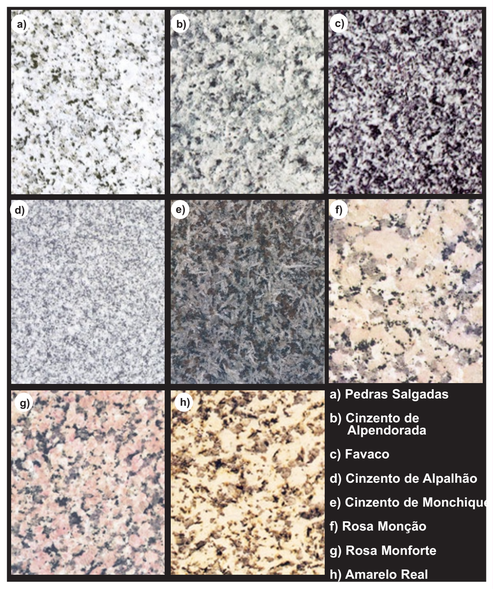
Online Portuguese Ornamental Stones Catalog

Site: http://rop.ineti.pt/rop/

Granites

The North and Centre of the Portuguese territory are characterized by extensive areas of granitic outcrops of Paleozoic age, to which are associated several mining districts of ornamental stones. However, in the Alentejo and Algarve regions the mining of these resources for ornamental purposes also takes place. The potentialities are mainly associated to post-Variscan granites.

Portuguese granites show a wide variety of colours and textures. Nevertheless, the vast majority have grey to bluish grey colours and fine to coarse granular textures, sometimes porphyritic [1]. These varieties of granites are exploited in most of the mining sites marked on the map.



		Mean Values - Variation range
	Yellow Granites	White, Grey, Dark and Pink Granites and other silicate stones *
Compressive strength [MPa]	79 - 246	131 - 262
Flexural strength under concentrated load [MPa]	3.1 - 20.1	9.4 - 29.4
Apparent density [kg/m^3]	2530 - 2660	2610 - 2870
Open porosity [%]	0.7 - 4.2	0.1 - 1.2
Water absorption at atmospheric pressure [%]	0.3 - 1.7	0.1 - 0.4
Linear thermal expansion coefficient [× 10^{-6}/ºC]	5.9 - 9.2	6.5 -10.7
Rupture energy [Joules]	6 - 11	4 - 11
Abrasion resistance - Wide Wheel Abrasion Test [mm]	13.0 - 20.5	11.5 - 20.5

* Sienite, serpentinite, gabrodiorite, etc.

Limestones

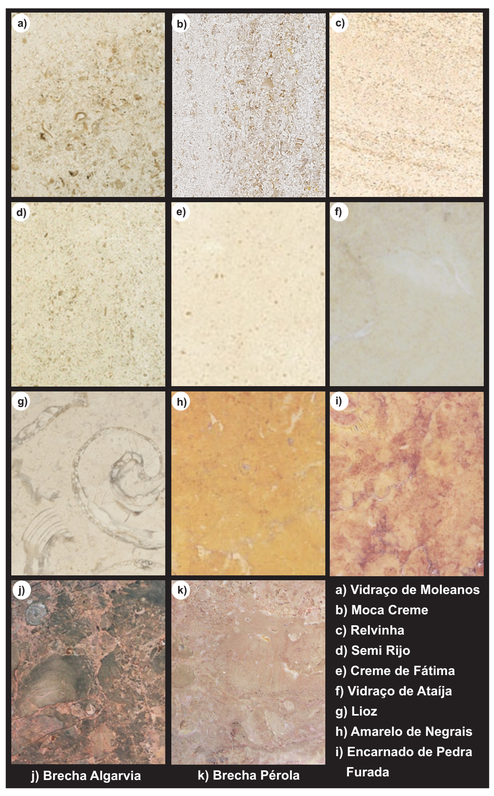
In Portugal they occur mainly near the shore, to the north of Lisbon and in the Algarve region, in the south. The main mining district of ornamental limestones is the Maciço Calcário Estremenho (MCE), located north of Lisbon. It is a limestone massif with a well-known lithostratigraphy that is made up of a thick sequence of Mesozoic carbonated rocks tectonically elevated [2,3]. The productive lithostratigraphic units of the main ornamental varieties date from Middle-Jurassic.

Mining is carried out by more than 50 quarries in 6 mining districts. The limestone's exploitation in MCE is relatively recent, having started in the early eighties of the last century. However, approximately since 10 years ago, these rocks are the most requested Portuguese ornamental stone, especially by the Chinese market.

Most of the MCE limestones are fine to coarse-grained calciclastic sparitic rocks (rudstones and grainstones); the grains correspond to skeletal fossil fragments of marine organisms and to other carbonate particles (intraclasts, oncholiths and ooliths). They are cream coloured with a texture marked by thin laminations, which are visible or not, depending on the way the blocks are cut.

The region of Pêro Pinheiro, just North of Lisbon, is one of the most traditional production centres of ornamental stones of Portugal. Quarrying in this region should have been started in Roman times. However, their intensive exploitation has only begun in the 18th century, for the reconstruction of Lisbon, after the big earthquake of 1755. Because of nowadays major urban spread in the region, the availability of the resource is threatened and most of the quarries are currently inactive. From one hundred quarries registered, only 27 remain occasionally active.

In the Algarve region ornamental stones are exploited near the localities of Escarpão (municipality of Albufeira), Mesquita (municipality of S. Brás de Alportel) and Santo Estêvão (municipality of Tavira).

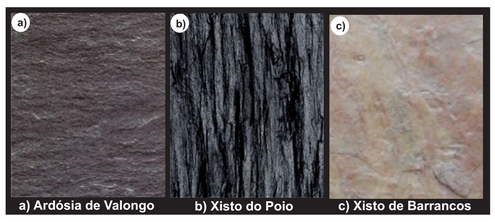


	Mean Values - Variation range
Compressive strength [MPa]	52 - 141
Flexural strength under concentrated load [MPa]	4.9 - 19.3
Apparent density [kg/m^3]	2710 - 2790
Open porosity [%]	0.2 - 0.5
Water absorption at atmospheric pressure [%]	0.0 - 0.2
Linear thermal expansion coefficient [× 10^{-6}/ºC]	4.1 - 14.0
Rupture energy [Joules]	5 - 11
Abrasion resistance - Wide Wheel Abrasion Test [mm]	15.5 - 26.5

Slates

The outcropping areas of slates in Portugal are quite extensive. However, the production of ornamental slates is small. The main mining sites are located in Valongo, Arouca and Vila Nova de Foz Coa, in the North of Portugal, and in Barrancos, in the Alentejo region, near the border with Spain.

In Valongo, slates (Ordovician age) show a dark gray colour and a very fine granularity. Their superior textural homogeneity and the very well defined slaty cleavage gives them quality for the production of billiard tables.

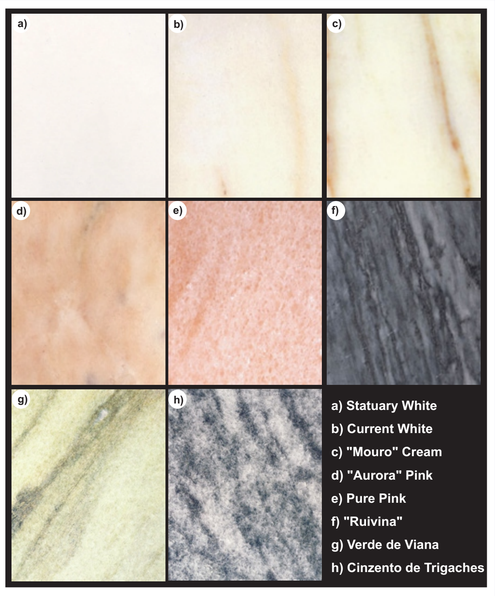


	Mean Values - Variation range
Compressive strength [MPa]	114 - 217
Flexural strength under concentrated load [MPa]	29.5 - 69.6
Apparent density [kg/m^3]	2700 - 2830
Open porosity [%]	0.4 - 1.2
Water absorption at atmospheric pressure [%]	0.2 - 0.5
Linear thermal expansion coefficient [× 10^{-6}/ºC]	7.1 - 8.1
Rupture energy [Joules]	9 - 10
Abrasion resistance - Wide Wheel Abrasion Test [mm]	20.0 - 36.0

Marbles

Although there are some known marble occurrences in the northern Portuguese territory, whose economic interest is very low, these ornamental stones occur mainly in the Alentejo region, being the Anticlinal de Estremoz the main production centre. The earliest evidence for exploitation of this resource in this region dates back to the year of 370 BC [4]. Later, in the Roman Period, it has been widely used for structural and decorative purposes. Because of this historical relevance and because some of the present day open-pits are very deep, reaching 150 m depth, they are considered in the context of the Portuguese geological heritage [5].

The marbles are characterized by a fine to medium-grained texture and they present a wide range of colours, from white to dark grey [6]. Although, the most common are the white and light cream varieties with more or less abundant greyish to reddish stripes, and they are known by different commercial names, according to the quarry owner. The most valuable are the pure white and the pinkish varieties.



	Mean Values - Variation range
Compressive strength [MPa]	44 - 246
Flexural strength under concentrated load [MPa]	4.4 - 23.4
Apparent density [kg/m^3]	2190 - 2710
Open porosity [%]	0.1 - 16.5
Water absorption at atmospheric pressure [%]	0.1 - 8.9
Linear thermal expansion coefficient [× 10^{-6}/ºC]	2.7 - 5.1
Rupture energy [Joules]	2 - 5
Abrasion resistance - Wide Wheel Abrasion Test [mm]	17.5 - 28.0

Conclusions

As a result of the geological diversity that characterizes its territory, Portugal produces a large chromatic and textural variety of granites and marbles for ornamental purposes. However, with regard to granites, the most abundant varieties are the greyish coloured whose present day economic value is relatively low due to the strong competition existing for this kind of stones in the global market. The most common varieties of marble are the light cream coloured with more or less abundant dark stripes.

Regarding limestones, does not exist such a great diversity of ornamental varieties, being the market dominated by the cream coloured rocks form MCE. Finally, with respect to slates, the Portuguese production is very low.

From the physical-mechanical point of view, Portuguese ornamental stones can be used in a wide range of applications. Stone suitability should be evaluated both on the stone properties and on the technical specifications for each application.

References

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