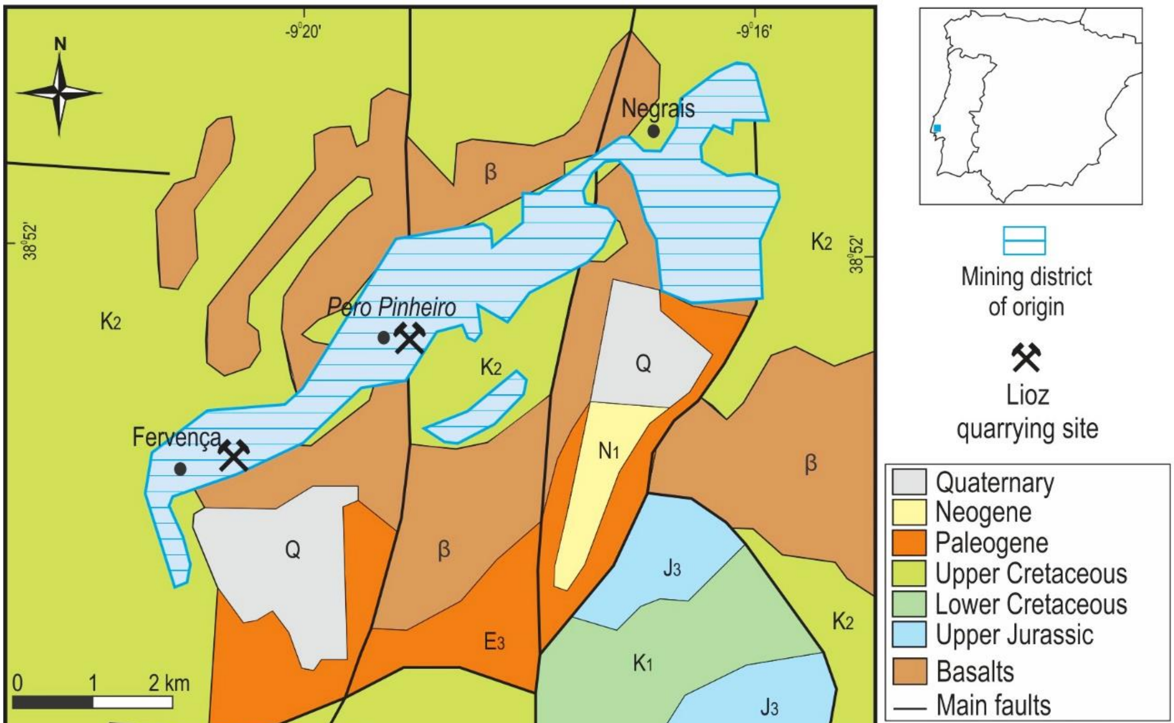
Lioz

Lioz de Pero Pinheiro

Short description:
Light beige to white coloured limestone with large fossils of rudists and bivalves.

Commodity	Lithology	Typical colour	Place of origin			
			Country	District	Municipality	Place
Commercial Limestone	Limestone	Beige	Portugal	Lisboa	Sintra	Pero Pinheiro

Geological setting



Adapted from sheet 34-A; Geol. Map Portugal, 1/50000, LNEG

Geology:
During the mid-Cretaceous (Albian - Turonian), a rim-shelf carbonate platform set up over larger areas of the in the Western Iberian margin. Reef and lagoonal limestones with coral and rudist units of middle Turonian age occur in the region of Lisbon and are overlain by basaltic rocks. The outcropping area of these reef units (Bica Formation), and part of the basaltic tuffs that overlap them, corresponds to a mining district of provenance for some ornamental stone varieties widely used in Portugal and, particularly, in the Lisbon region.
The best-known ornamental variety is called Lioz, which is an ivory coloured micritic fossiliferous limestone typified by the presence of large rudist fossils. Colour variations give place to other commercial varieties (Amarelo de Negrais, Chainette, Encarnadão, and others).

Production:
Lioz and similar varieties have been exploited in the Lisbon region since its occupation by the Romans and were intensively used in its reconstruction after the 1755 earthquake.
Modern exploitation reached its peak during the 60s and 70s of the last century in the Pero Pinheiro region, near Sintra. Currently only a few quarries are operating, greatly constrained by urban expansion.
The sedimentary beds are not very thick and fracturing is relatively intense, so the extracted blocks are small and medium in size. The final cut is made parallel or perpendicularly to the bedding plane. When cut perpendicularly, the aesthetics of the stone changes dramatically due to the presence of abundant closed stylolites.

Geological age: Cretaceous / Turonian
Geological unit: Bica Formation

Application, use and heritage

Because of its remarkable aesthetical and technical characteristics, Lioz is a much-appreciated building construction material. It was widely used for the construction of buildings and churches in the region of Lisbon, particularly for its reconstruction after the 1755 earthquake, but its use is widespread in Portugal. Lioz and similar varieties were also used for the construction of several monuments in Brazil, as they were also used as ballast of freight boats during the seventeenth and eighteenth centuries.

By Alvesgaspar - Own work, CC BY-SA 3.0; https://commons.wikimedia.org/w/index.php?curid=6580719

The Portuguese Belém Tower is a 16th-century fortification located in Lisbon, built from Lioz ornamental stone. It is a notable example of the Portuguese Manueline architectural style. Since 1983, the tower has been part of the UNESCO World Heritage, together with the Jerónimos Monastery, in which Lioz was also used.

https://en.wikipedia.org/wiki/Bel%C3%A9m_Tower

By Deensel - Lisbon main square, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=62192653

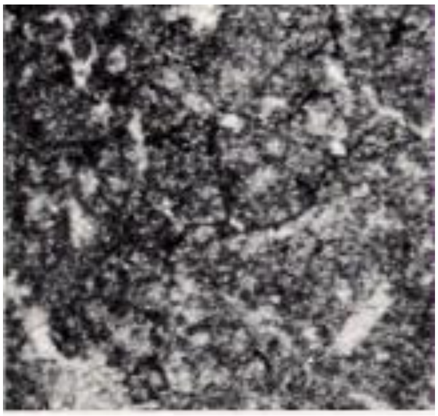
The Lisbon downtown (*Baixa Pombalina*) is a district constructed with Lioz after the 1755 Lisbon earthquake. It is one of the first examples of earthquake-resistant construction. Notable features of Pombaline structures include the Pombaline cage, a symmetrical wood-lattice framework aimed at distributing earthquake stresses, and inter-terrace walls that are built higher than roof timbers to reduce fire propagation.

https://en.wikipedia.org/wiki/Lisbon_Baixa

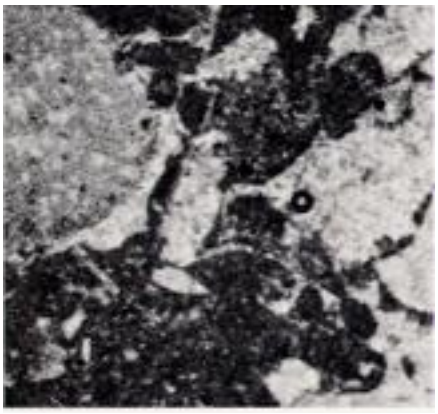
By Therese C - Flickr: DSCN5750, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=16119126

Centro Cultural de Belém, built in 1992, is a complex of artistic spaces located in Lisbon and a flagship example of the modern use of Lioz.

Petrography



Thin section parallel to the preferred orientation plane, when applied.



Thin section perpendicular to the preferred orientation plane, when applied.

Description:
Very spathized intrabioclastic limestone (Biosparite-microsparite
Obs.: not representative of the framestone texture as seen by the naked-eye).

Source of information:
Geological Survey of Portugal (LNEG - Laboratório Nacional de Energia e Geologia, IP).

Mineral composition

Calcite (%)					
~100					

Source of information:
Geological survey of Portugal (Laboratório Nacional de Energia e Geologia, IP)

Physical properties

Apparent density (EN 1936) kg/m3	Open porosity (EN 1936) % vol	Water absorption at atmospheric pressure (EN 13755) % wt	Uniaxial Compressive strength (EN 1926) MPa	Flexural strength under concentrated load (EN 12372) MPa
2690	0.5	0.2	103	11.0

Real density (EN 1936) kg/m3	Total porosity (EN 1936) % vol	Water absorption coefficient by capillary (EN 1925) (g/m2 x s0,5)	Flexural strength under constant moment (EN 13161) MPa
—	—	—	—

Frost resistance (EN 12371)				
Technological Test (Test A)				Identification Test (Test B): Number of cycles completed prior to stone failure
Flexural strength (EN 12372) after freeze-thaw cycling, MPa	Number of cycles	Uniaxial compressive strength (EN 1926) after freeze-thaw cycling, MPa	Number of cycles	
—	—	135	25	—

Resistance to ageing by thermal shock (EN 14066)			
Change in dynamic modulus of elasticity (increase: +; decrease: -) %	Change in open porosity (increase: +; decrease: -) %	Change in ultrasound pulse velocity (increase: +; decrease: -) %	Change in flexural strength under conc. load (increase: +; decrease: -) %
—	—	—	—

Abrasion resistance (EN 14157)			Resistance to salt crystallisation (EN 12370)	Breaking load at dowel hole (EN 13364)	
Method A - Wide Wheel Abrasion Test, mm	Method B - Böhme Abrasion Test, mm^3	Method C - Amsler Abrasion Test, mm	Change in mass (increase: +; decrease: -), %	Breaking load, N	Thickness of the test specimens, mm
21.7	—	2.2	—	—	—

Slip resistance by means of the pendulum tester (EN 14231 / CEN/TS 16165)			Rupture energy (EN 14158), Joule	Thermal Conductivity (EN 1745), W/m·K
Tested surface finish	Slip Resistance Value — SRV			
	Dry test condition	Wet test condition		
—	—	—	4	—

Source of information:
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Chemical properties

Main elements (%)

SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	TiO_2	SO_3	LOI
0.20	0.41	0.02	0.00	0.39	55.54	0.04	0.05	—	vest.	—	43.34

Trace elements (ppm)

V	Cr	Mn	Co	Ni	Cu	Zn	As
Sr	**Cd**	**Ba**	**Pb**	**Be**	**Rb**	**Bi**	**U**
Sc	**Y**	**Th**	**Sb**	**Ta**	**Nb**	**Zr**	**Sn**
Ag	**B**	**Mo**	**W**	**Ga**	**Ge**	**Se**	**Cs**
Tl							

REE (ppm)

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb
Dy	**Ho**	**Er**	**Tm**	**Yb**	**Lu**		

Methods applied:
Determination of the main elements trace elements and REE: X-Ray Fluorescence.

Source of information:
Geological survey of Portugal (Laboratório Nacional de Energia e Geologia, IP)

Sources of more information

Type of information	Name of provider	URL
This data sheet:	Geological survey of Portugal (Laboratório Nacional de Energia e Geologia, IP	www.lneg.pt https://rop.lneg.pt/rop/index_en.php
Non-commercial directory:	Primeira Pedra	http://www.primeirapedra.com/en/stones/lioz/
	Stone by Portugal	https://stonebyportugal.com/stone/lioz/?lang=en
Commercial directory:		
Scientific publication:	Geoheritage	https://doi.org/10.1007/s12371-017-0267-7
Other publication:		

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