

Pohorski marmor

Pohorje marble

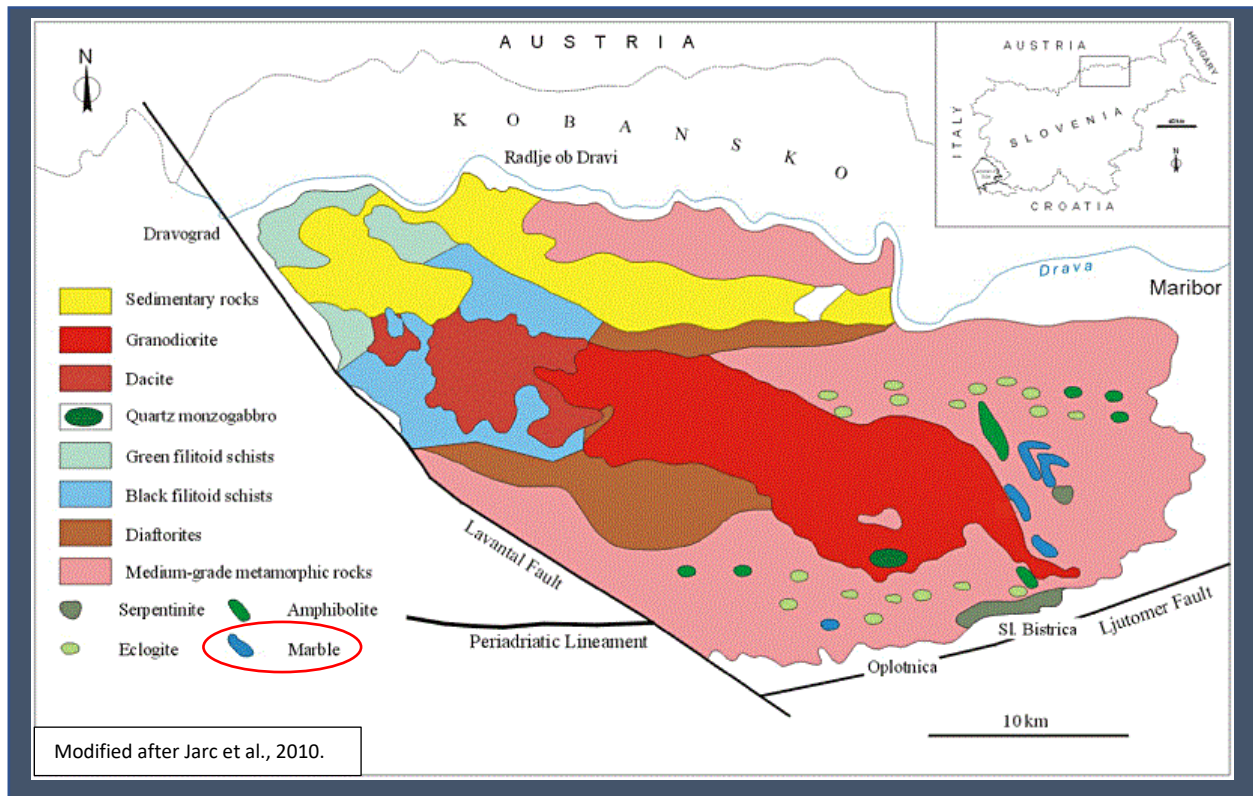


4 cm

Short description: Banded heterogenous fine- to coarse grained grey to light yellow calcite and dolomite marble, massive or stratified. Sampled by: Andreja Senegačnik

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
marble	marble	white	Slovenia	Štajerska (traditional province)	Slovenska Bistrica	Slovenska Bistrica

Geological setting



Geology: A geological map of the Pohorje area (modified after Jarc et al., 2010). The Pohorje Mountains are the only source of marble (darker blue) in Slovenia. Some quarries and outcrops are placed in regional metamorphic mica schists and gneisses (Jarc et al., 2010). The Pohorje metamorphic complex, located in the NE Slovenia, is the SE margin of the Eastern Alps. The Pohorje massif is build up of three Eoalpine nappes of Cretaceous age. The entire nappe stack is overlain by early Miocene sediments of the syn-rift Pannonian basin fill (Jarc & Zupančič, 2009).

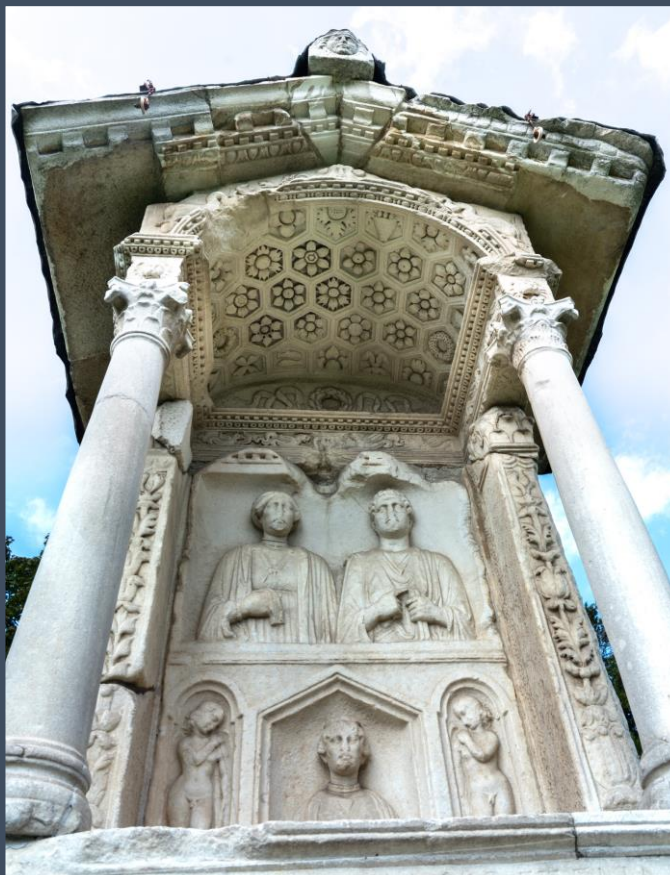
Production: No (abandoned quarries in the valley of the Bistrica River known from Roman times). Small marble quarrying is were recently active on the Pohorje Mountains. Excavation sites can be seen in the area of the village of Loška Gora near Zreče. Crushed marble is most often used for decorative graveling, in graveyards for example.

Geological age: Cretaceous

Geological unit: Pohorje series of Austroalpine nappe, Eastern Alps

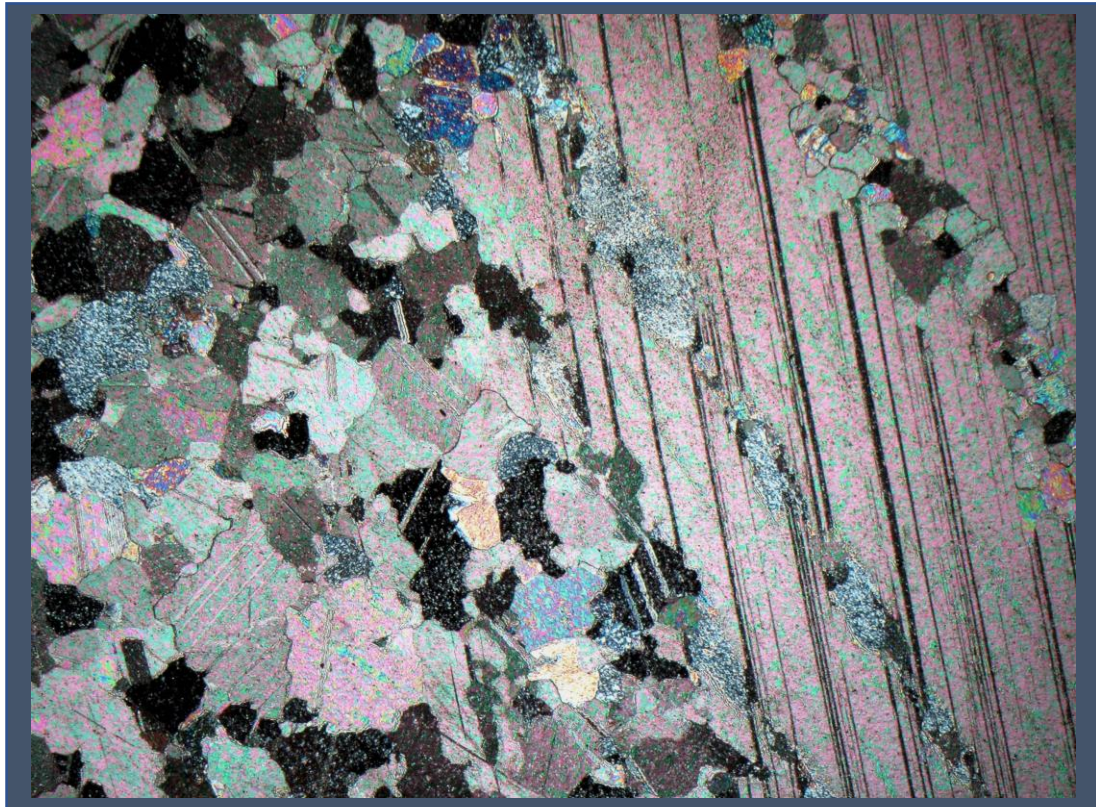
Application, use and heritage

Description: Pohorje marble is used from Roman times mainly as ornamental stone for tombstones and monuments.

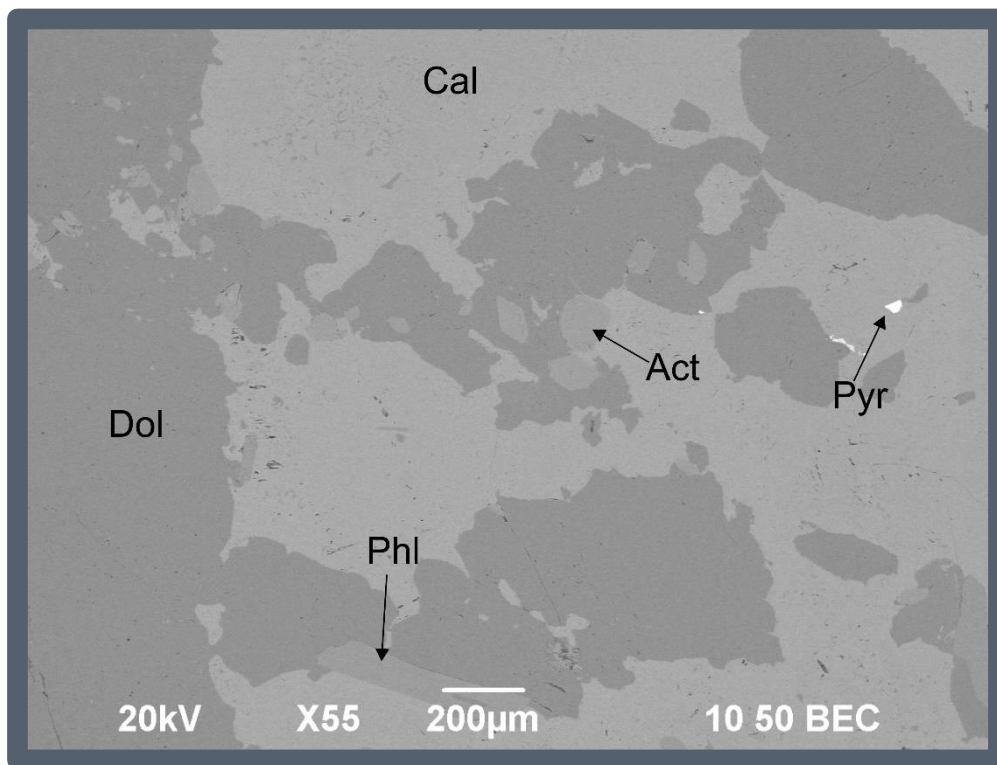


Tombs of Roman Necropolis (1st-3rd century AC) in Šempeter are most probably carved in Pohorje marble. Photo library of Regional Museum of Celje, photo: Ortolf Harl.

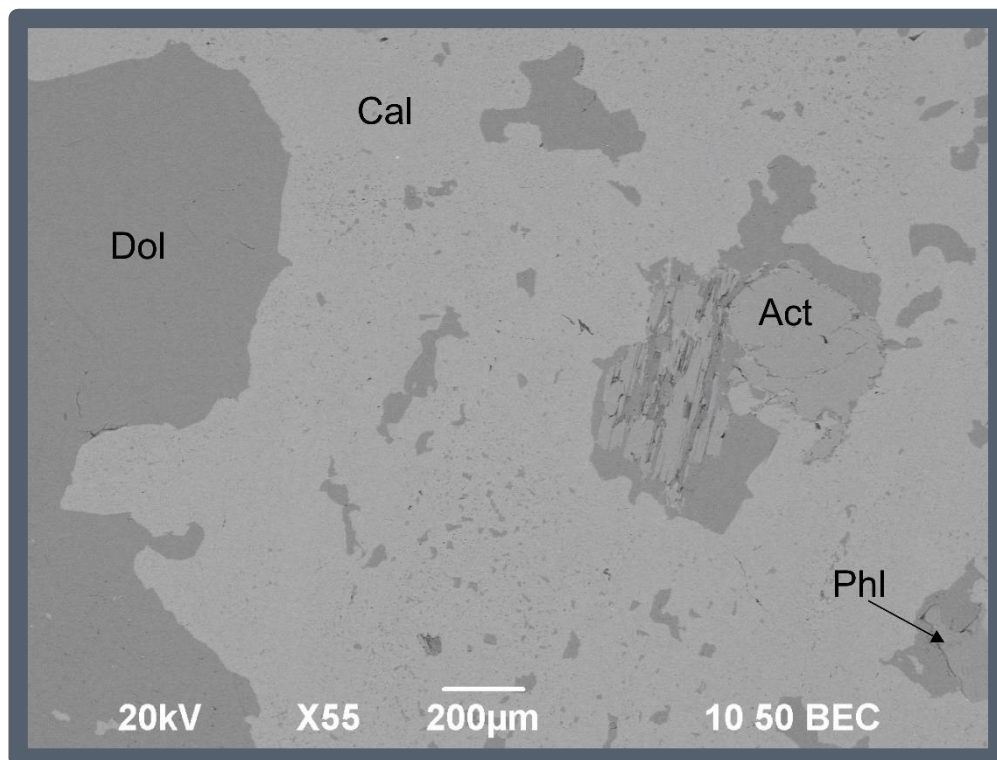
Petrography



Description: Granoblastic to mosaic texture with oriented growth of grains. Beside calcite and dolomite grains are also grains of mica, feldspar, quartz, hornblende, clinozoisite and pyrite. The figure is 2.5 mm in length. Photo: Mirka Trajanova. **Source of information:** Jarc, 2006



Description: SEM (BSE) image of polished Pohorje marble sample from location Roman quarry. The sample is composed of calcite (Cal), dolomite (Dol) and accessory minerals actinolite (Act), phlogopite (Phl) and pyrrhotite (Pyr). Photo: Miloš Miler. **Source of information:** Mašera, 2016.



Description: SEM (BSE) image of polished Pohorje marble sample from location Roman quarry. The image shows that the sample is composed mostly of calcite (Cal) and dolomite (Dol), with actinolite (Act) and phlogopite (Phl) as accessory minerals. Photo: Miloš Miler, **Source of information:** Mašera, 2016.

Mineral composition

If no accurate number, use MM=main minerals, SM = Subordinate minerals, AM=accessory minerals

Carbonate minerals (%)	Accessory minerals (quartz, aluminosilicate minerals, ferric oxides and sulphides)
>95% (mostly calcite with dolomitic lenses)	<5%

Source of information: Jarc et al., 2009

Physical properties

Apparent density (EN 1936) kg/m ³	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

Real density (EN 1936) kg/m ³	Total porosity (EN 1936) % vol	Water absorption coefficient by capillary (EN 1925) (g/m ² x s ^{0,5})	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	

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, cm ³ / 50cm ²	Method C - Amsler Abrasion Test, mm	Change in mass (increase: +; decrease: -), %	Breaking load, N	Thickness of the test specimens, mm

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		

Methods applied and source of information:

Chemical properties

Main elements

SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	TiO ₂ (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	MnO (%)	P ₂ O ₅ (%)	SO ₃ (%)	LOI (%)
2	1	1		4	54		1	1			43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
	3			1	1	4	
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
		12	4		2		1
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
	2					3	
Ag (ppm)	B (ppm)	Mo (ppm)	W (ppm)	Ga (ppm)	Ge (ppm)	Se (ppm)	Cs (ppm)
Tl (ppm)							

REE

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Gd (ppm)	Tb (ppm)
Dy (ppm)	Ho (ppm)	Er (ppm)	Tm (ppm)	Yb (ppm)	Lu (ppm)		

Methods applied and source of information: The geochemical analyses (mean values) was performed by ICP-ES (oxides) and ICP-MS (trace elements).
Jarc et al., 2010.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining book	https://ms.geo-zs.si/Nahajalisce/Podrobnosti/2237?culture=en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENVIČ, A., RAMOVŠ, A., SENEGAČNIK, A., VESEL, J., & VIŽINTIN, N. 1999. Slovenski naravni kamen. Ljubljana, Geological Survey of Slovenia, Slovenian National Building and Civil Engineering Institute, University of Ljubljana Geology department. 131 pg. JARC, S. 2006. Provenance of marble from some Slovenian archaeological sites, PhD Thesis, UL, NTF-OG, Ljubljana. JARC, S. & ZUPANCIC, N., 2009, A cathodoluminescence and petrographical study of marbles from Pohorje area in Slovenia, Chemie der Erde, 69, 75–80. HINTERLECHNER-RAVNIK, A. & TRAJANOVA, M. 2009. Metamorphic rocks. In: PLENIČAR, M. et al. (Eds.), The Geology of Slovenia. Geološki zavod Slovenije, 69-90. JARC, S., MANIATIS, Y., DOTSIKA, E., TAMBAKOPOULOS, D. & ZUPANCIC, N. 2010. Scientific characterization of the Pohorje marbles, Slovenia. Archaeometry. 52. 177 - 190. 10.1111/j.1475-4754.2009.00476.x. MAŠERA, T. 2016. SEM/EDS characterization of marble from some Slovenian deposits: diploma thesis. Ljubljana: Faculty of Natural Sciences and Engineering, 69 pg.	
Other publication		

Compiled by:	Geological Survey of Slovenia (GeoZS) www.geo-zs.si	Logo 
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