EUROLITHOS European Ornamental Stone Resources

EuroLithos Country Atlas
SLOVENIA

EuroLithos Atlas

Ornamental stone resources in Slovenia

Thematic focus: Slovenia

Responsible partner(s): Geological Survey of Slovenia (GeoZS)

Author(s): Snježana Miletić & Matevž Novak

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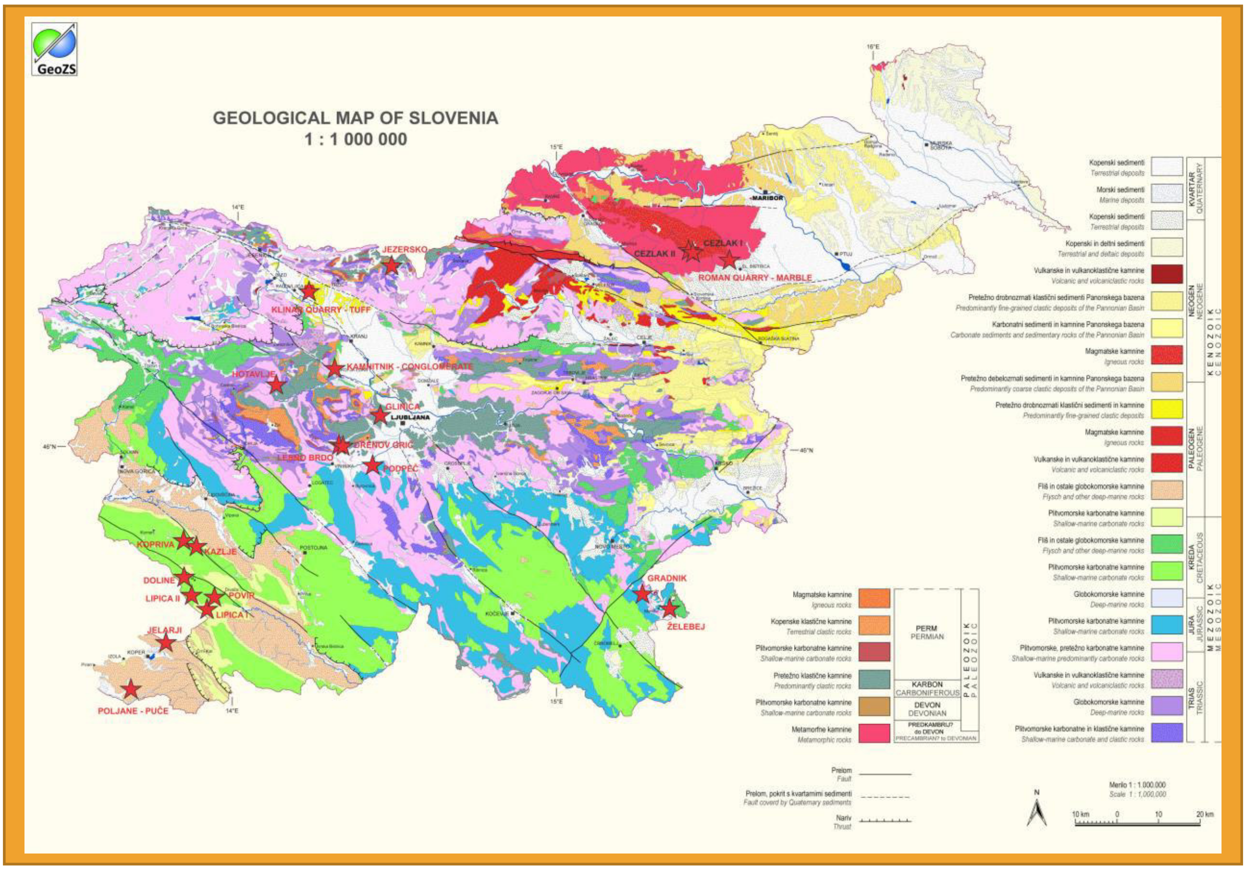
Geology of Slovenia

The territory of Slovenia spans the junction between four major Alpine structural units, each with an independent palaeographic and tectonic history: 1) the Dinarides, 2) the Southern Alps, 3) the Eastern Alps and 4) the Pannonian Basin. The present-day assemblage and geological structure of these structural units was mainly formed during the last 20 Ma, in Neogene. Tectonic processes related to the Alpine collision are still active. Paleographically, the structural units of Slovenia belong to the Adriatic continental microplate (Adria). Prior to the Mesozoic, the Adriatic fragment was attached to the African plate. Tertiary collision of Adria with Eurasia produced the Alpine orogenic chain and was the tectonic driving force that shaped the present-day structure of the Slovenian territory. The complex paleogeography of the Tethys Ocean domain and its margins that formerly existed between the African and Eurasian plate were largely obscured by subsequent subduction and collisional processes.

The lithologic composition of Slovenian territory is heterogeneous due to the complex geological past. Many deposits with variegated kinds of stone can be found in the area. Intensive tectonic activity and movement in the Earth's crust caused many fractures and faults in the rock beds. Consequently, it is very difficult to extract large stone slabs in the quarries. (Vrabec et al., 2009).



Simplified geological map of Slovenia with stars marking the main quarries (active and abandoned) of ornamental stones (Geological map of Slovenia 1:1 000 000, Bavec et al, 2013, https://egeologija.si/geonetwork/srv/slv/catalog.search#/metadata/ce9bd14b-5c46-4b20-8242-08c4b9b3b371)

Ornamental stone resources in Slovenia

In Slovenia, the types of stone are subdivided according to how it is used: ornamental (decorative) natural stone – stone for decoration and art, and building stone – stone used in building. The data on exploitation, production and use of ornamental and building stone are managed jointly under the term "natural stone".

The Karst region is one of the most interesting and promising areas with stone reserves of in Slovenia. Different types of limestones from Karst are used in building industry as well as in art. This region has been associated with the quarrying and manufacturing of stone for over two thousand years. The second interesting region of stone resource is the Pohorje range with granodiorite and various metamorphic rocks. Deposits of gray and variegated carbonaceous rocks and shales are known in central Slovenia. Calcareous tufa and breccia are known in the Karavanke mountains and sandstone is known at the coast. Deposits of different types of limestone can also be found in other regions. Important tuff deposits are located in a part of Gorenjska region and the Savinja valley.

The stone deposits depend on the geological composition of the regions. Characteristics of the regions are determined according to the geographical potential.

Nine territories of stone resources can be found in Slovenia and the following criteria was used for their determination: distribution of interesting and/or promising deposits of stones and potential of once abandoned quarries and deposits, which were reactivated and are still active today. Territories are also defined according to the tradition of stone quarrying.

Regions of stone deposits are:

- the coastal region which includes the Slovenian Adriatic coast and the Slovenian part of Istria,
- the Kras (Karst) area between the Brkini, the Vipava valley and the Italian border,
- Central Slovenia with foothills of the Alps, the margins of the Ljubljana basin, the Poljane valley, The Selce valley and the Idrija area,
- the Pohorje range between the rivers Drava, Mislinja and Dravinja, and the Drava River plain,
- the Karavanke mountains from Podkoren to Črna na Koroškem (Carinthia),
- Bela Krajina between the Kolpa river, the Gorjanci range and Kočevski Rog massif,
- the Tolmin area between the Šentvid plateau, the Julian Alps and the Italian border,
- the Dolenjska and Notranjska (Lower/Inner Carniola) karst from Nanos over the Bloke plateau and Suha Krajina to the Krško basin,
- the southern part of Slovenian Styria and the Posavje hills.

Slovenia is composed mostly of sedimentary rocks. The most common of them is limestone. Furthermore, some igneous and metamorphic rocks are exposed in the northern and central part of the country. All of them can be used as ornamental and building stones. On the other hand, certain soft rocks and the rocks with low adhesion from the north-eastern part of Slovenia cannot be used for this purpose.

Regarding the lithological varieties in Slovenia, the following types of rocks can be used as ornamental and building stones: granodiorite, gabbro, calcareous breccia, calcareous conglomerate, calcareous and quartz sandstone, clay shale, tuff, limestone, dolomitised limestone of various degrees of recrystallization, calcareous tufa, flowstone, mica schist and other types of schistose rocks, gneiss, marble, amphibolite, eclogite, serpentinite (Mirtič et al., 1999).

Ornamental stone production

Of all the above-mentioned promising rocks, only limestone, granodiorite, sandstone, and temporarily gabbro are actually quarried. The quarrying of variegated calcareous breccia, conglomerate, flowstone, marble, tuff, calcareous tufa and clay shales was abandoned during the last thirty years. Serpentinite, amphibolite and eclogite have not yet been quarried to a great extent. Various types of metamorphic rocks were once used in the Pohorje range for roof tiles and especially for wall and floor paving. Nowadays, mica schist is again used for roof tiles (Mirtič et al., 1999).

In the last five years, the production of "natural stone" in Slovenia decreased from more than 136,000 tonnes in 2014 to less than 97,000 tonnes in 2019 (see figure below).

GeoZS Geološki zavod Slovenije

PRODUCTION OF MINERAL COMMODITIES IN SLOVENIA (in metric tons)

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bentonite		140	130	130	160	104	135	168	98	143	199	232	182	147	113	99
Calcite		164.752	271.509	273.745	348.152	405.467	459.926	458.800	474.152	555.663	646.542	268.677	255.709	220.771	204.914	221.767
Kaolin																
Chalk																
Quartz sand		254.195	278.041	295.667	289.529	215.065	253.866	230.908	219.481	224.387	207.381	343.455	338.080	359.476	343.683	311.954
Tuff		95.126	88.013	90.319	109.949	58.062	39.401	24.639	23.732	19.171	8.872	9.116	8.840	9.144	8.633	9.133
Industrial dolomite		279.555	294.645	299.177	177.715	146.214	156.179	154.721	119.317	136.516	177.338	172.697	150.545	172.656	129.821	102.619
Chert		19.445	15.445	16.745	21.648	16.695	16.114	18.907	9.960	11.530	15.340	21.041	20.272	15.525	20.436	20.773
Ceramic clay		78.683	86.443	78.221	32.200	9.478	12.279	10.103	5.295	3.479	7.461	7.574		5.478	42.052	6.412
Industrial minerals and rocks		**891.896**	**1.034.226**	**1.054.004**	**979.353**	**851.085**	**937.900**	**898.246**	**852.035**	**950.889**	**1.063.133**	**822.792**	**773.628**	**783.197**	**749.652**	**672.757**
Brick clay		730.670	638.329	706.866	420.360	235.348	296.118	374.020	159.746	180.748	154.944	194.852	202.540	167.898	159.615	180.088
Natural stone	limestone	102.635	52.459	47.983	71.260	73.156	55.045	25.109	21.006	21.158	79.005	99.541	101.991	107.630	91.231	69.155
	tonalite	36.488	56.587	65.715	67.400	39.787	36.855	45.930	23.374	41.016	23.749	26.995	26.746	28.544	41.793	25.078
	other	29.741	24.392	27.124	21.959	21.573	19.724	11.896	11.526	8.332	9.917	9.790	7.690	6.151	3.615	2.660
Natural stone		168.864	133.438	140.822	160.619	134.516	111.624	82.935	55.906	70.506	112.671	136.326	136.427	142.325	136.639	96.893
Raw materials for lime		1.691.696	2.089.495	2.082.593	1.631.391	1.221.197	1.260.446	1.103.163	896.241	860.890	919.528	1.103.283	1.046.293	1.174.038	1.212.883	1.186.037
Raw materials for cement		1.306.889	1.324.803	1.489.625	1.684.258	1.188.493	982.653	883.573	952.758	1.138.560	1.325.907	1.190.807	1.149.065	1.318.832	1.405.518	1.551.728
Materials for construction industry		**3.898.119**	**4.186.065**	**4.419.906**	**3.896.628**	**2.779.554**	**2.650.841**	**2.443.691**	**2.064.651**	**2.250.704**	**2.513.050**	**2.625.268**	**2.534.325**	**2.803.093**	**2.914.655**	**3.014.746**
Crushed stone	limestone	5.926.378	7.242.777	7.134.305	7.541.043	6.284.804	5.773.480	4.034.597	3.264.404	2.813.266	3.060.104	3.486.409	3.164.109	3.824.938	4.757.905	4.557.967
	dolomite	6.197.589	6.712.996	6.909.947	7.291.259	7.175.362	6.143.336	5.440.918	4.223.692	4.127.357	4.901.721	4.427.094	4.280.306	4.808.753	5.516.316	4.984.010
	other	99.215	257.546	235.002	150.258	149.562	155.716	151.276	69.335	127.272	161.762	194.610	26.018	9.190	7.781	8.662
Crushed stone		12.223.182	14.213.319	14.279.254	14.982.560	13.609.728	12.072.532	9.626.791	7.557.431	7.067.895	8.123.587	8.108.113	7.470.433	8.642.881	10.282.002	9.550.639
Sand and gravel		3.750.707	6.871.519	8.549.960	4.506.076	3.001.291	2.422.771	1.899.770	1.707.455	2.143.013	2.799.006	2.943.870	1.833.732	2.047.403	1.810.666	1.437.101
Construction materials – aggregates		**15.973.889**	**21.084.838**	**22.829.214**	**19.488.636**	**16.611.019**	**14.495.303**	**11.526.561**	**9.264.886**	**9.210.908**	**10.922.593**	**11.051.983**	**9.304.165**	**10.690.284**	**12.092.668**	**10.987.740**
TOTAL		**20.763.904**	**26.305.129**	**28.303.124**	**24.364.617**	**20.241.658**	**18.084.044**	**14.868.498**	**12.181.572**	**12.412.501**	**14.498.776**	**14.500.043**	**12.612.118**	**14.276.574**	**15.756.975**	**14.675.243**
brown coal		594.456	587.912	483.417	488.828	510.769	419.466	435.800	314.262							
lignite		3.945.100	3.932.842	4.037.766	4.008.442	3.921.746	4.010.930	4.066.278	3.967.064	3.721.188	3.108.203	3.168.001	3.348.889	3.355.664	3.216.735	3.218.696
coal		4.539.556	4.520.754	4.521.183	4.497.270	4.432.515	4.430.396	4.502.078	4.281.326	3.721.188	3.108.203	3.168.001	3.348.889	3.355.664	3.216.735	3.218.696
oil		303	284	344	174	138	233	263	279	298	366	261	229	241	270	267
gas condensate		196	154	167	104	105	207	131	60	114	95	98	150	240	499	223
gas		4.913	3.751	3.078	2.348	2.317	6.006	2.095	1.454	2.698	2.463	3.109	4.331	7.554	14.423	6.225
oil and gas*		**5.412**	**4.189**	**3.589**	**2.626**	**2.560**	**6.446**	**2.489**	**1.793**	**3.110**	**2.924**	**3.468**	**4.710**	**8.035**	**15.192**	**6.715**
sea salt		803	1.624	3.029	535	2.924	59	4.291	5.684	3.360	0	2.191	2.417	2.335	2.018	1.437

Production of mineral commodities in Slovenia – production of "natural stone" is marked with a red rectangle (Source: Bulletin Mineral Resources in Slovenia, year 2020 (https://www.geo-zs.si/PDF/PeriodicnePublikacije/bilten_ms_eng/Bilten_2020.pdf)

Use of ornamental stone and heritage values

Use of stone in Slovenia has a long tradition. Our ancestors used all stone found in their vicinity. The oldest preserved products made from Slovenian stone are various stone tools from Early and Late Stone Ages. The oldest monuments are the Roman tombstones and inscribed stone which were found in north-eastern and central Slovenia. One such example is the Roman tombstone walled-in on the south part of St. Leonard's church in Spodnje Gameljne. It is reposited at the National Museum in Ljubljana. The Roman tombstone is made from Podutik limestone called "gliničan" which was commonly used during the Roman times. Romans also used it for building the city of Emona about two thousand years ago.

The necropolis made of Pohorje marble is one of the most important stone monuments in Slovenia. It is located in Šempeter in the Savinja valley, and it is a perfect case of stone manufacturing from the Roman age.

The Orpheus monument at Ptuj is also a Roman tombstone made of Pohorje marble, all in one piece. It is 5 m high and the largest known monolithic example in Central Europe.

Later on, stone marks such as contagious signs, crosses and chapels were built from stone as well. The oldest known sign is from the 14th century. The stone marks were used as direction indicators, boundary stones, monuments in cemeteries, etc.

Two periods are especially marked with the use of stone in Slovenia, baroque and mid-20th century. In baroque times, the finest statues, fountains and entrance portals were carved of stone, mostly by Venetian sculptors (Mirtič et al., 1999).

Just this year, in July, the selected works of architect Jože Plečnik were inscribed on the UNESCO World Heritage List. Between World War I and World War II his work carried in Ljubljana present an example of a human centred urban design that successively changed the identity of the city from a provincial city into the symbolic capital of the people of Slovenia. The architect Jože Plečnik contributed to this transformation with a series of public spaces (squares, parks, streets, promenades, bridges) and public institutions (national library, churches, markets, funerary complex) that were sensitively integrated into the pre-existing urban, natural and cultural context. This highly contextual and human-scale urbanistic approach, as well as Plečnik's distinctive architectural idiom, characterised also by the extensive use (and re-use) of stone stand apart from the other predominant modernist principles of his time.

With the discovery of the Portland cement in the beginning of 20th century, cheap concrete products supplement the stone. Today stone is still used for the same purposes as it was used in the past, although the import of stone is considerable, changing the Slovenian cultural landscape. This is especially inconvenient in the regions with a long tradition of use of stone. It is therefore important to preserve the use of the Slovenian autochthonous types of stones and its resources – quarries. Which stone will be used for certain purposes depends mainly on the appearance, manufacturing properties, proximity of the quarry, possibility of purchase, transport and price (Mirtič et al., 1999).

Descriptions of ornamental stone resources

Ornamental stone resources in Slovenia are described below in the order shown in Table 1.

Stone name	**Commodity**	**Lithology**
Apnenec Gradnik	limestone	limestone
Breča Želebej	sandstone	calcareous breccia
Čizlakit	granite	gabbro
Drenov grič	limestone	limestone
Gliniški apnenec	limestone	limestone
Hotavlje rdeči	limestone	limestone
Hotavlje roza	limestone	limestone
Hotavlje sivi	limestone	limestone
Kazlje	limestone	limestone
Kopriva	limestone	limestone
Lehnjak Jezersko	limestone	calcareous tufa

Lesno Brdo rdeči	limestone	limestone
Lesno Brdo sivi	limestone	limestone
Lipica fiorito	limestone	limestone
Lipica unito	limestone	limestone
Peračiški tuf	miscellaneous	andesite tuff (pietra verde)
Peščenjak (Jelarji)	sandstone	lithic greywacke
Peščenjak (Poljane-Puče)	sandstone	lithic greywacke
Podpeški apnenec	limestone	limestone
Pohorski marmor	marble	marble
Repen (Doline)	limestone	limestone
Repen (Povir)	limestone	limestone
Škofjeloški konglomerat	sandstone	conglomerate (calcareous)
Tonalit (Cezlak)	granite	granodiorite
Tonalit (Josipdol)	granite	granodiorite

Apnenec Gradnik

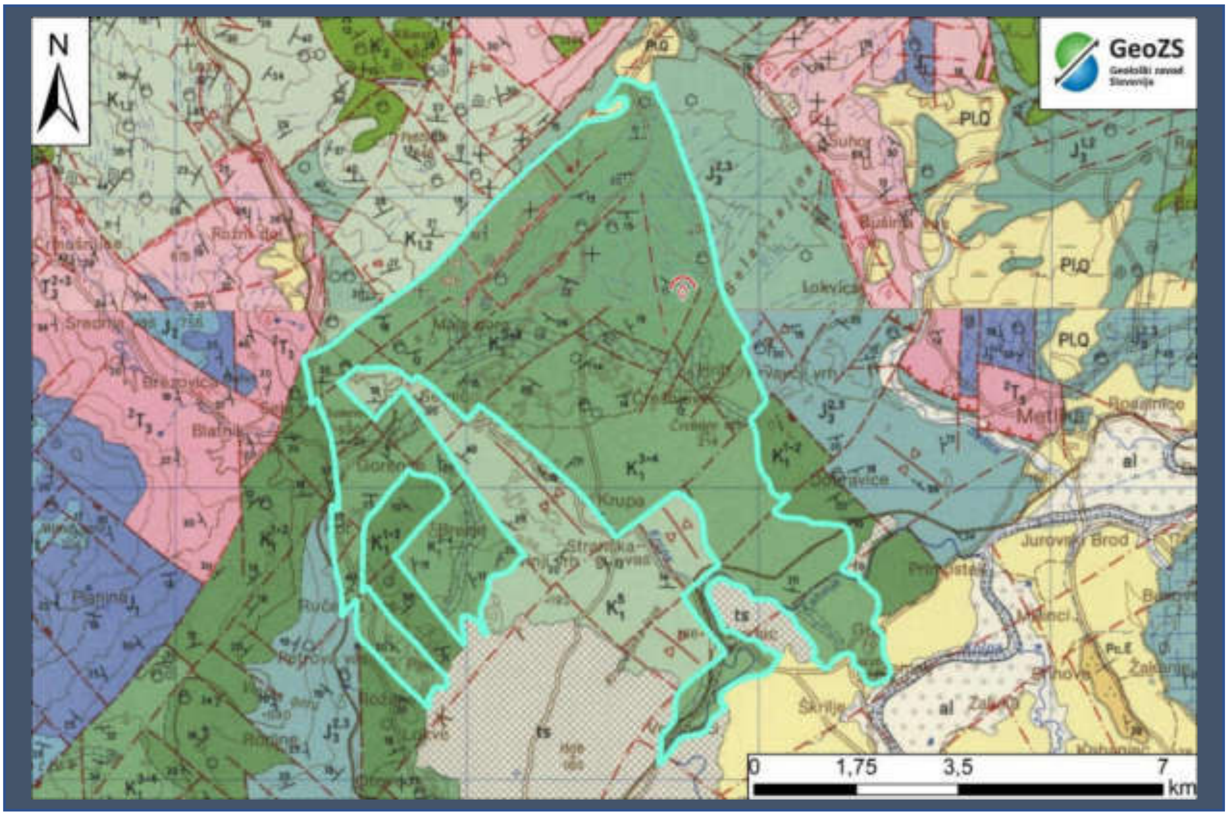
Gradnik limestone

5 cm

Short description: Light-grey to brownish-gray, dense limestone with rare sparry calcite vuges and recrystallised fossils. Structure is homogeneous to pseudo-breccia. The image displays a rough surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	grey	Slovenia	Bela krajina province (Dolenjska (traditional province))	Metlika	Gradnik, Semič

Geological setting



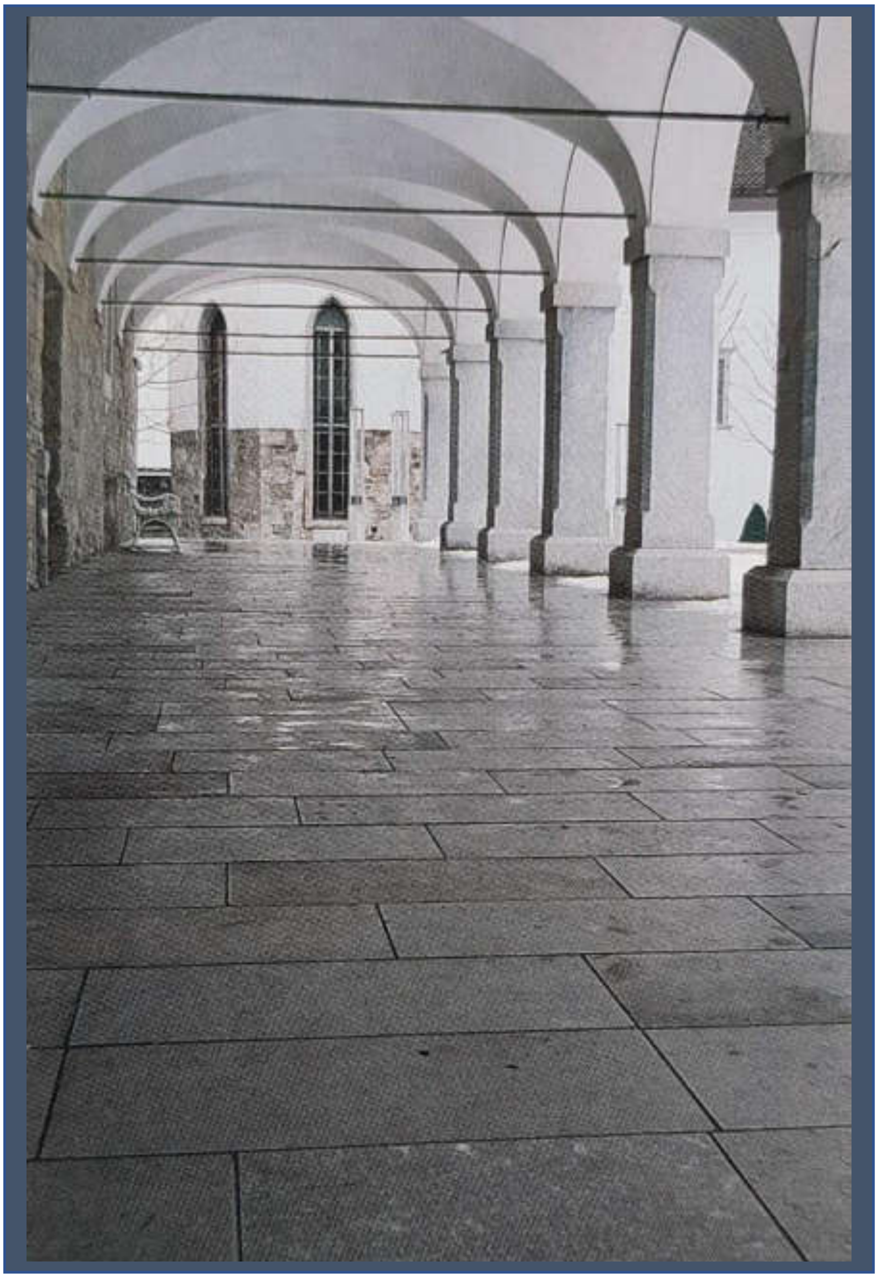
Geology: Thick-bedded shallow-marine limestone with lateral transitions to dolomite in a fault-bounded tectonic block. Productive horizon is approximately 36 metres thick.

Production: No. Small abandoned quarry at the village Gradnik near Semič in SE Slovenia, mostly used by local people.

Geological age: Early Cretaceous (Barremian-Aptian) (129-115 million years)	
Geological unit: Barremian-Aptian limestones of External Dinarides.	

Application, use and heritage

Description: Used locally as building stone, for flooring and cladding.



Courtyard of Ljubljana Caste is partly paved with Gradnik limestone. Photo from Mirtič et al., 1999.

Petrography

Photomicrograph, thin section or other

Description: Biomicrite to intra-/pel-/onco- or dismicrite with recrystallized fragments of fossils, intraclasts and pellets in micrite, some layers contain also oncoids. In places bioturbation and desiccation pores filled with sparite, calcitic veins and stylolites.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)		
98	**in traces**	**in traces**	**in traces**	**in traces**		

Source of information: Mirtič et al., 1999.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	0,2	55	-	-	-	-	-	up to 43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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.	
Other publication		

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Breča Želebej

Želebej Breccia

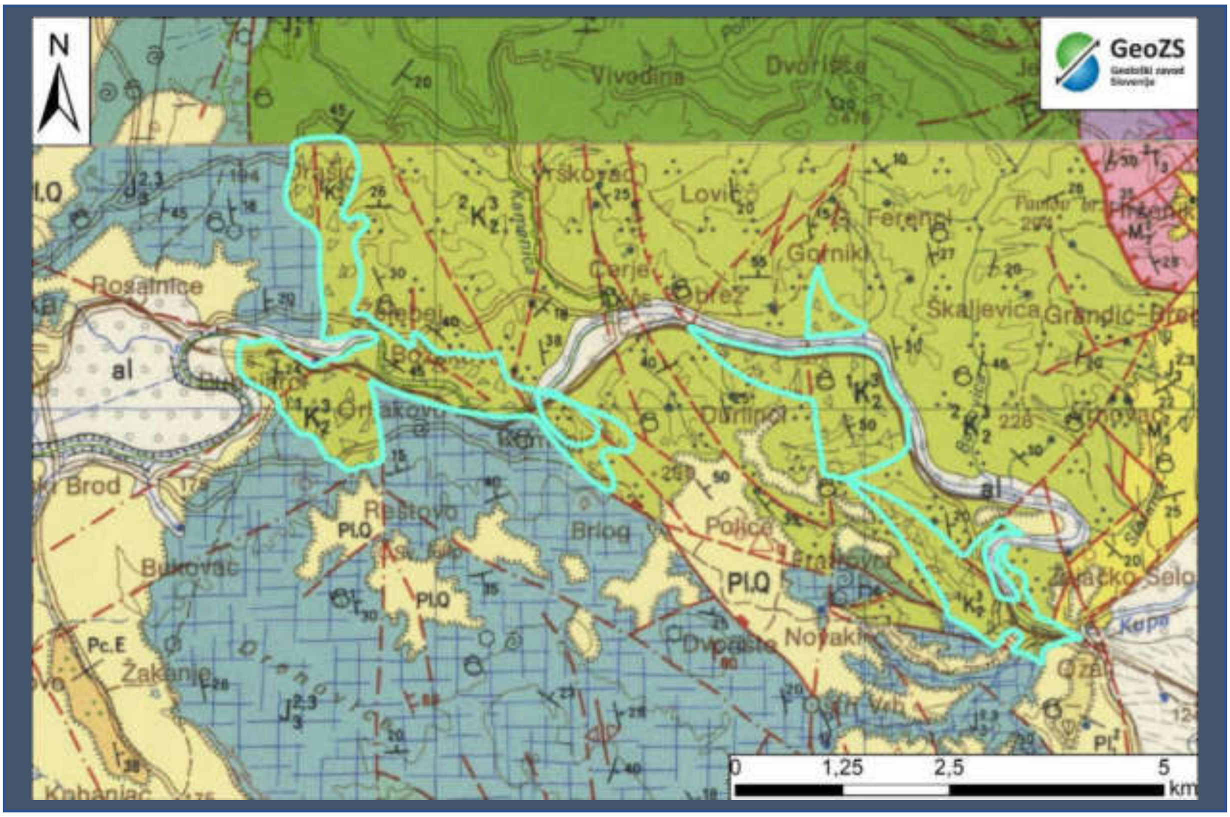
Želebejska breča

5 cm

Short description: Light grey to olive grey coarse grained calcareous breccia. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
sandstone	Calcareous breccia	grey	Slovenia	Bela Krajina province/Dolenjska (traditional province)	Metlika	Želebej pri Metliki

Geological setting



Geology: The geological unit represents the basal coarse-grained breccia horizon of Upper Cretaceous flysch, deposited in the deep-marine Slovenian Basin.

Production: No. Abandoned quarry at Želebej near Metlika.

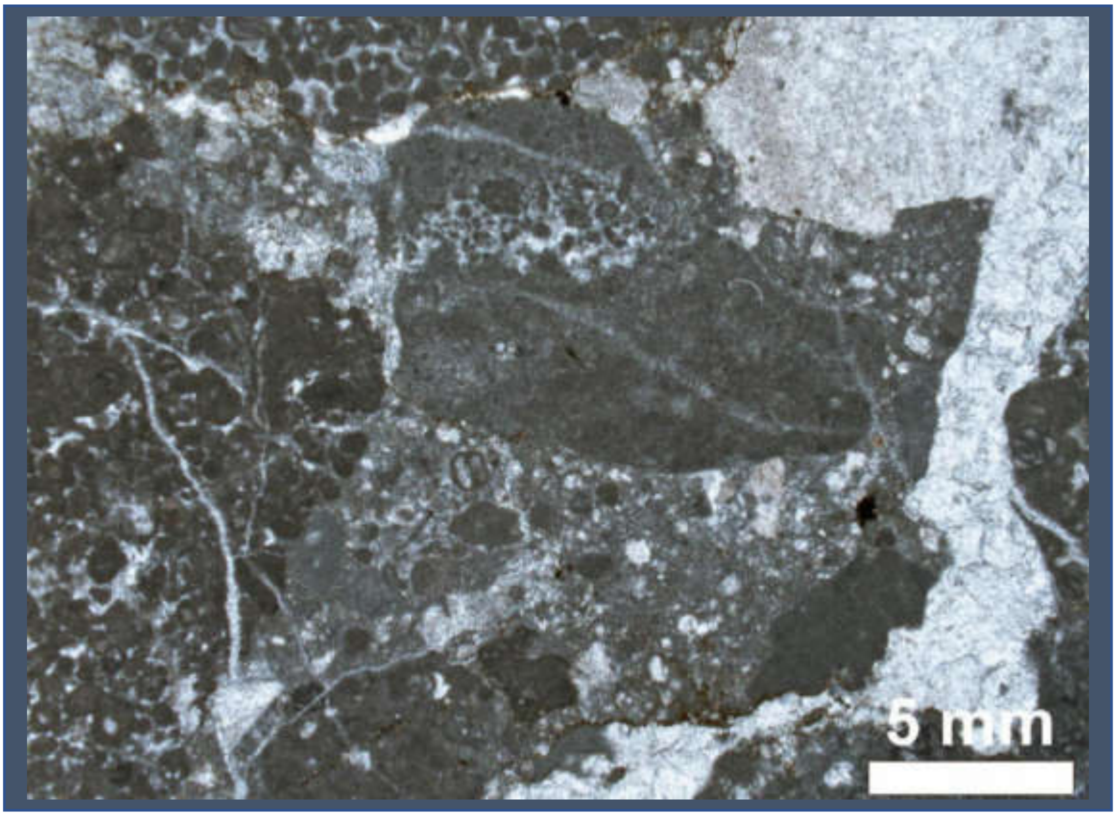
Geological age: Late Cretaceous, Coniacian–Maastrichtian (89.3–65.5 million years)
Geological unit: Upper Cretaceous flysch of Internal Dinarides

Application, use and heritage

Description: Internal (parts with clay matrix) and external use. Fasade and wall cladding, indoor floors, stairs and pavements.

Renovated staircase of the Church of the Holy Spirit (1487) in Črnomelj is made of Želebej breccia.

Petrography



Description: Medium to coarse grained calcareous breccia composed of clasts of different kinds of limestones and fossil remains (rudists, formaninifera, algae, ostracods, echinoderms) in calcareous matrix.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999.

Mineral composition

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

Calcite (%)	Clay minerals (%)	Pyrite (%)	Quartz (%)	Limonite minerals (%)	Organic matter (%)
94-98	**up to few %**	**up to few %**	**up to few %**	**up to few %**	**up to few %**

Source of information: Mirtič et al., 1999.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

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., MLADENOVIČ, 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.	
Other publication		

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Drenov grič

Drenov grič limestone

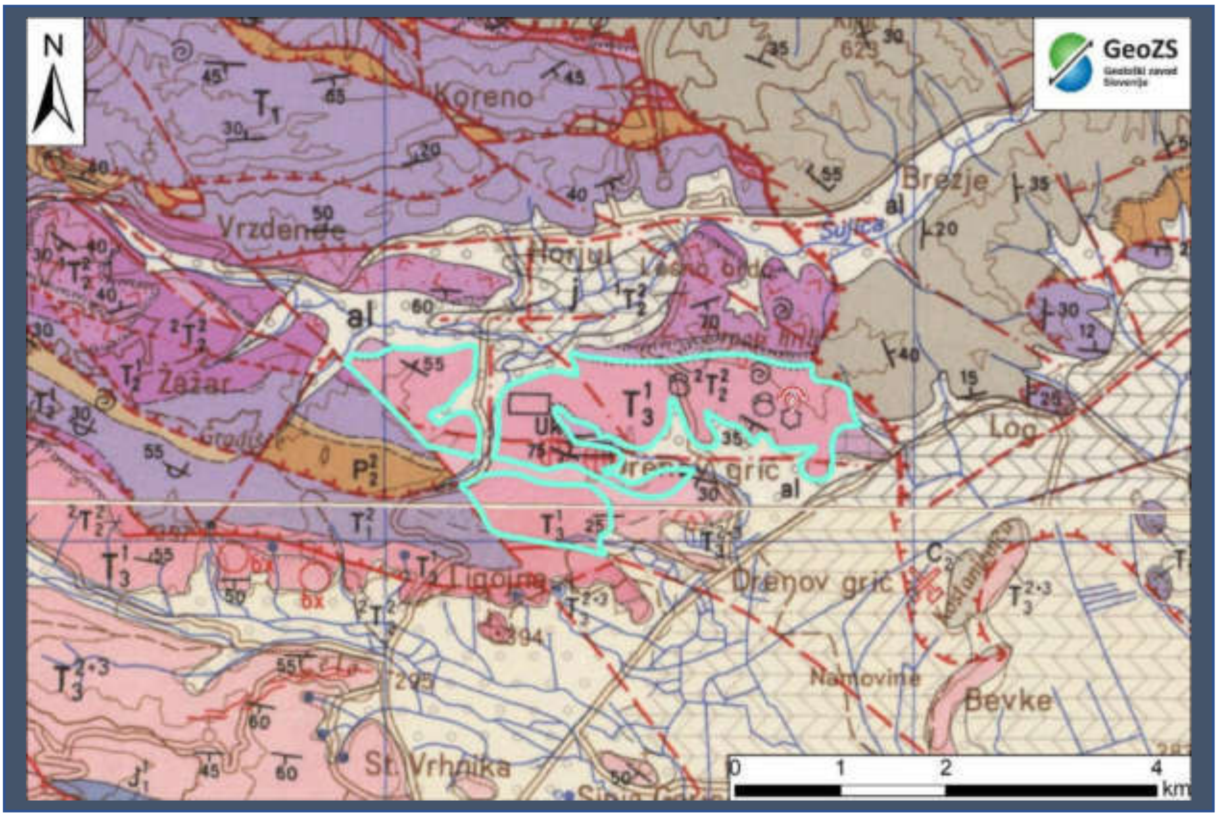
Apnenec Drenovega griča

10 cm

Short description: Well-stratified black micritic limestone with numerous white calcite veins and fossil remains of mainly bivalves and marlstone intercalations. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	black	Slovenia	Notranjska (traditional province)	Vrhnika	Drenov grič

Geological setting



Geology: Bedded to thin-bedded limestone with intercalations of shaley marlstone and claystone. Diverse marine and brackish fauna and with most common bivalve species *Trigonodus carniolicus* and *Myophoria kefersteini*, gastropods, ostracods and foraminifera suggest depositeion in a shallow-marine lagoon on the Dinaric carbonate platform. Three layers of coal (anthracite) were also found among the limestone beds.

Production: Kucler quarry near Drenov Grič was the largest extraction site. Together with several smaller ones it is now abandoned. It is designated as natural monument. Drenov grič limestone is no longer quarried.

Geological age: Upper Triassic (Carnian) (225 million years)
Geological unit: Carnian Raibl beds of the Outer Dinarides geotectonic unit.

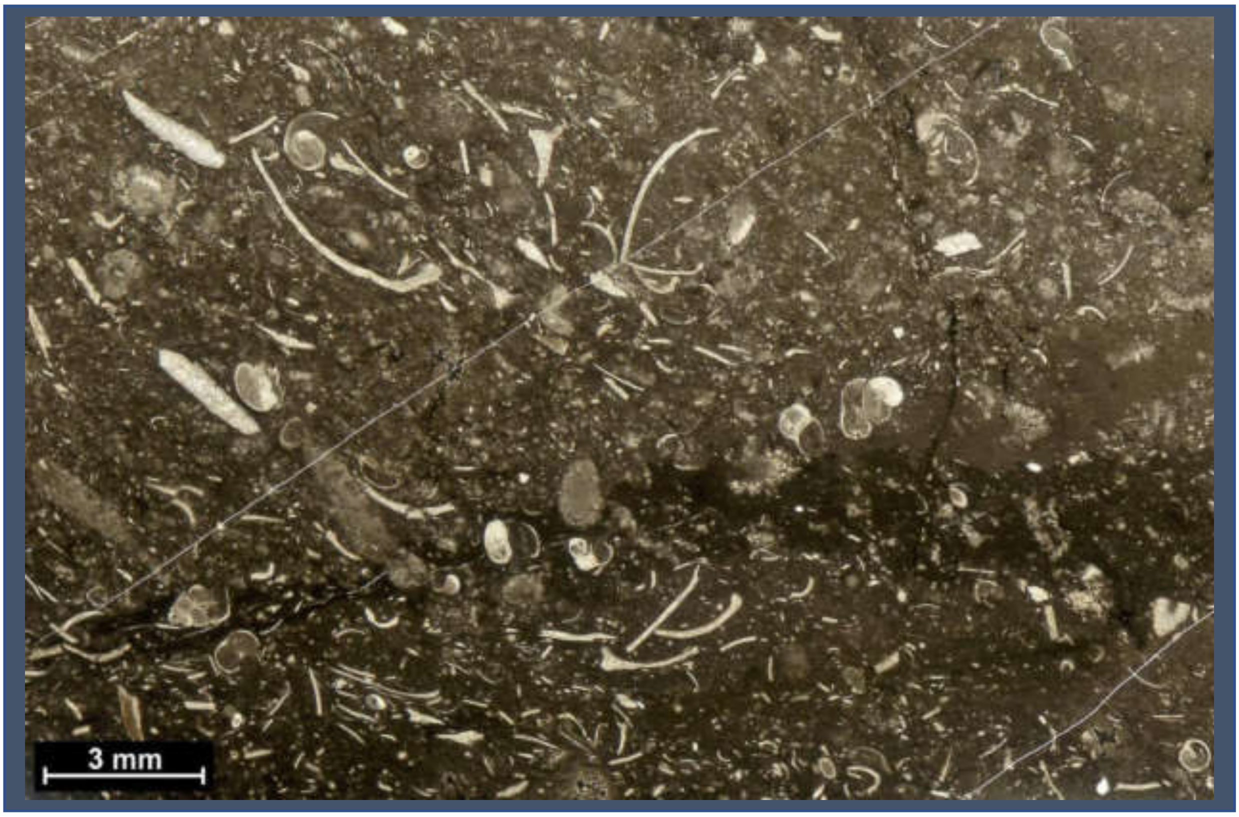
Application, use and heritage

Description: Due to its uniform black colour, invigorated by white calcite veins and individual remains of shells it has been very appreciated and often used as ornamental stones for portals, columns, slabs, tombstones, and other ornaments. It played a major role in the Slovenian art and architecture, mainly during the Baroque period.

Two stone giants at the portal to the entrance of Ljubljana's s Seminary Palace (1714).

Entrance portal of St. Jacob's Church in Ljubljana and Moorish king sculpture in one of the altars from early 18th century (photo of the sculpture: Miran Kambič, photo library of the Department of Art History, Faculty of Arts, University of Ljubljana).

Petrography



Description: Calcite is the main component, with dolomite, quartz, illite/muscovite and pyrite. Pyrite occurs frequently as framboidal pyrite concentrated in veins filled with phyllosilicates and around fossil fragments, although in some areas isometric grains of pyrite also occur. Some fossil fragments of bivalves, gastropods and ostracods are also present. Very rich in carbonaceous and bituminous organic matter.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999, Ramovš, 2000; Kramar et al., 2011; Kramar et al., 2019

Mineral composition

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

Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)
Mineral n (%)						

Source of information:

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

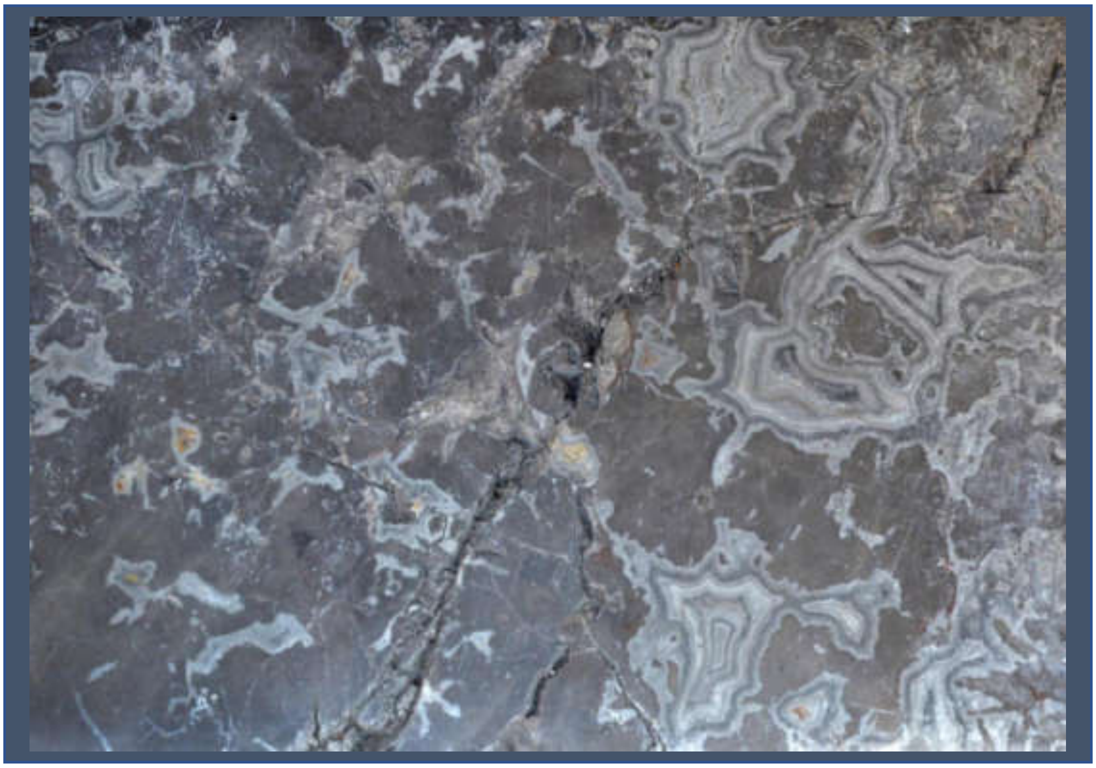
Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Non-commercial directory		
Commercial directory		
Scientific publication	JELEN, B. 1990: The Karnian bivalves (Mollusca) from Lesno Brdo, Slovenia, NW Yugoslavia and their paleobiological significance. Geologija, 31/32, 11-127. http://www.geologija-revija.si/dokument.aspx?id=889 MIRTIČ, B., MLADENOVIČ, 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. RAMOVŠ, A. 2000. Podpeški in črni ter pisani lesnobrdski apnenec skozi čas. Ljubljana, Mineral. 115 pp. KRAMAR, S., MIRTIČ, B., KNÖLLER, K & ROGAN-ŠMUC, N. 2011. Weathering of the black limestone of historical monuments (Ljubljana, Slovenia): Oxygen and sulfur isotope composition of sulfate salts. Applied Geochemistry, Volume 26, 9–10, 1632-1638. KRAMAR, S., ŽBONA, K. I., BEDJANIČ, M., MLADENOVIČ, A. & ROŽIČ, B. 2019: Drenov Grič black limestone : a heritage stone from Slovenia. In: HANNIBAL, J. T., DOLENEC, S., COOPER, B. J. (eds.), Global heritage stone : worldwide examples of heritage stones. 1st ed. London: The Geological Society Special Publications no. 486, 1-14, https://sp.lyellcollection.org/content/early/2019/10/03/SP486-2017-188	
Other publication		

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

Gliniški apnenec

Glinice limestone

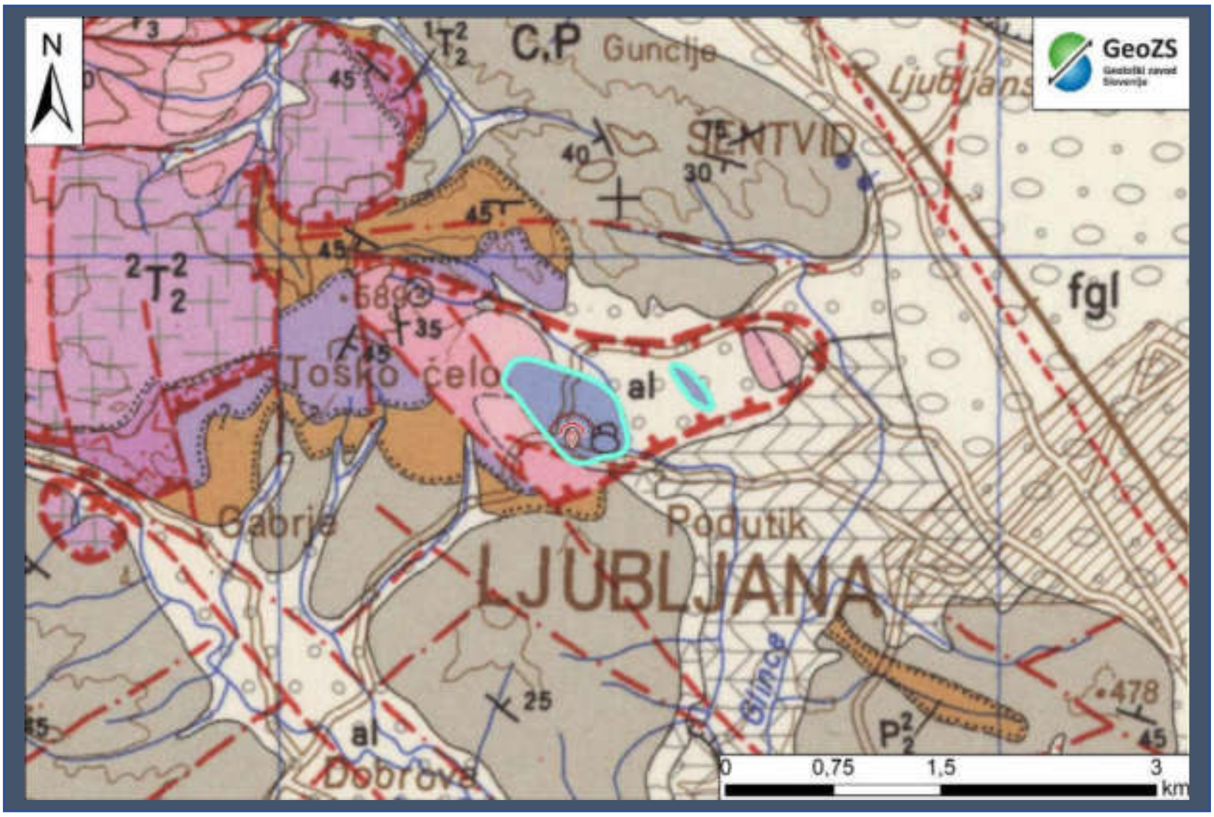


10 cm

Short description: Grey or dark grey, fine-grained, micritic or ooid limestone with numerous white and red calcite veins, with numerous fissures and corrosion vuges. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	grey	Slovenia	Notranjska (traditional province)	Brezovica	Glinice, Podutik

Geological setting



Geology: A shallow-marine thick-bedded limestone formed on the Dinaric carbonate platform. It is exposed in a fault-bounded block at the village of Glinice, which has given the stone-mason's name to the limestone.

Production: Abandoned quarry in Glinice, near Podutik (W Ljubljana).

Geological age: Lower Jurassic (Lower Lias)	
Geological unit: Outer Dinarides – middle Lower Jurassic limestone and dolomite	

Application, use and heritage

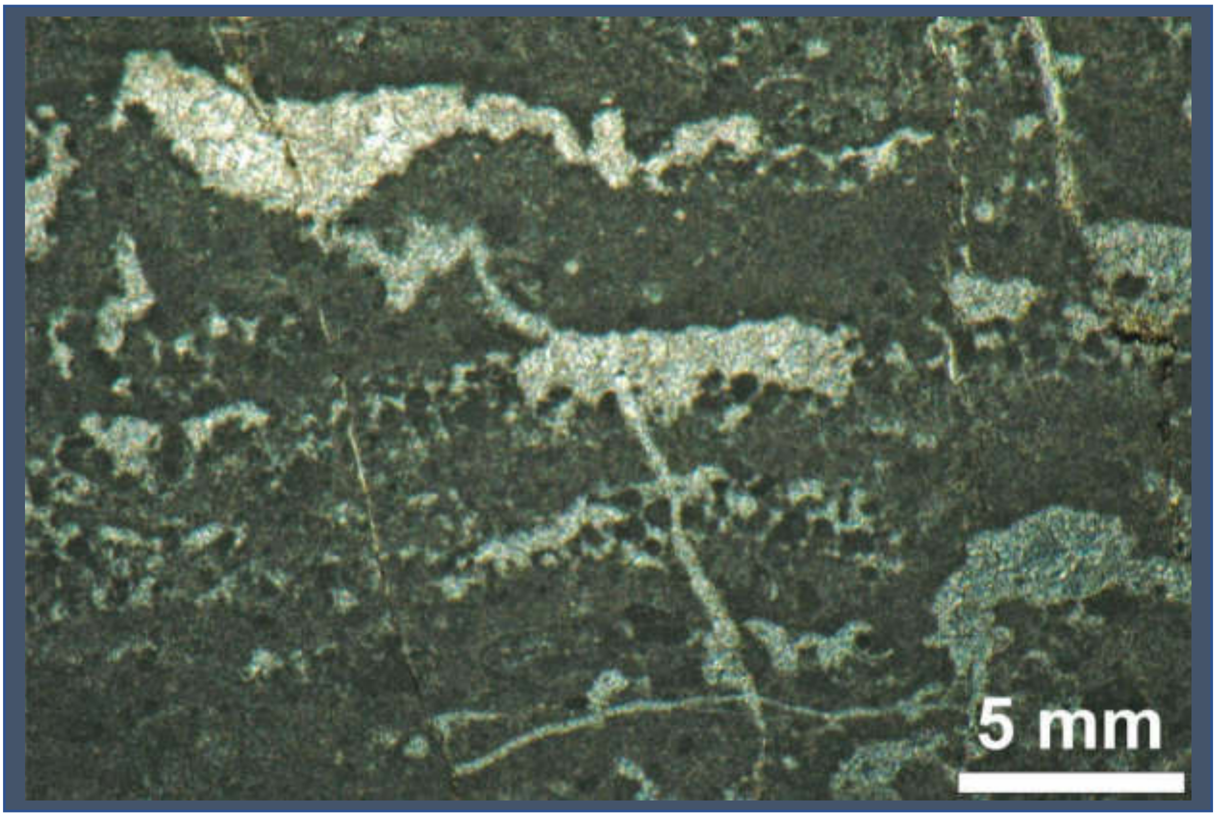
Description: This grey micritic limestone with interbeds of oolitic and oncolytic limestone is used as decorative and building stone mainly in Ljubljana. The quarry near Podutik had been active from Roman times.

The large entrance portal of the Souvan house (1827) is made of Glinice limestone. Both ribbed pillars exhibit typical cockade texture.

The central Špital bridge made of Glinice limestone dates back to 1842. Arch. Jože Plečnik added the left and right concrete bridges in the years 1929–31 to make one of the most recognizable sites of Ljubljana.

An old fountain carved from Glinice limestone.

Petrography



Description: Micritic and algal biomicritic limestones prevail, interrupted by interbeds of oosparitic limestones. Photo: R. Brajkovič

Source of information: Geological Survey of Slovenia, Ramovš, 1990; Novak, 2003.

Mineral composition

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

Mineral 1 (%)	Mineral 2 (%)	Mineral 3 (%)	Mineral 4 (%)	Mineral 5 (%)	Mineral 6 (%)	Mineral 7 (%)

Source of information:

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	RAMOVŠ, A. 1990. Gliničan od Emone do danes. Geološki zbornik 9, 171 pp. MIRTIČ, B., MLADENOVIČ, 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. NOVAK, M. 2003. Zgornjetriasne in spodnjejurske plasti na območju Podutika pri Ljubljani. Geologija, 46/1, 65-74.	
Other publication		

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EUROLITHOS European Ornamental Stone Resources

GeoERA RAW MATERIALS

Hotavlje rdeči

Red Hotavlje limestone

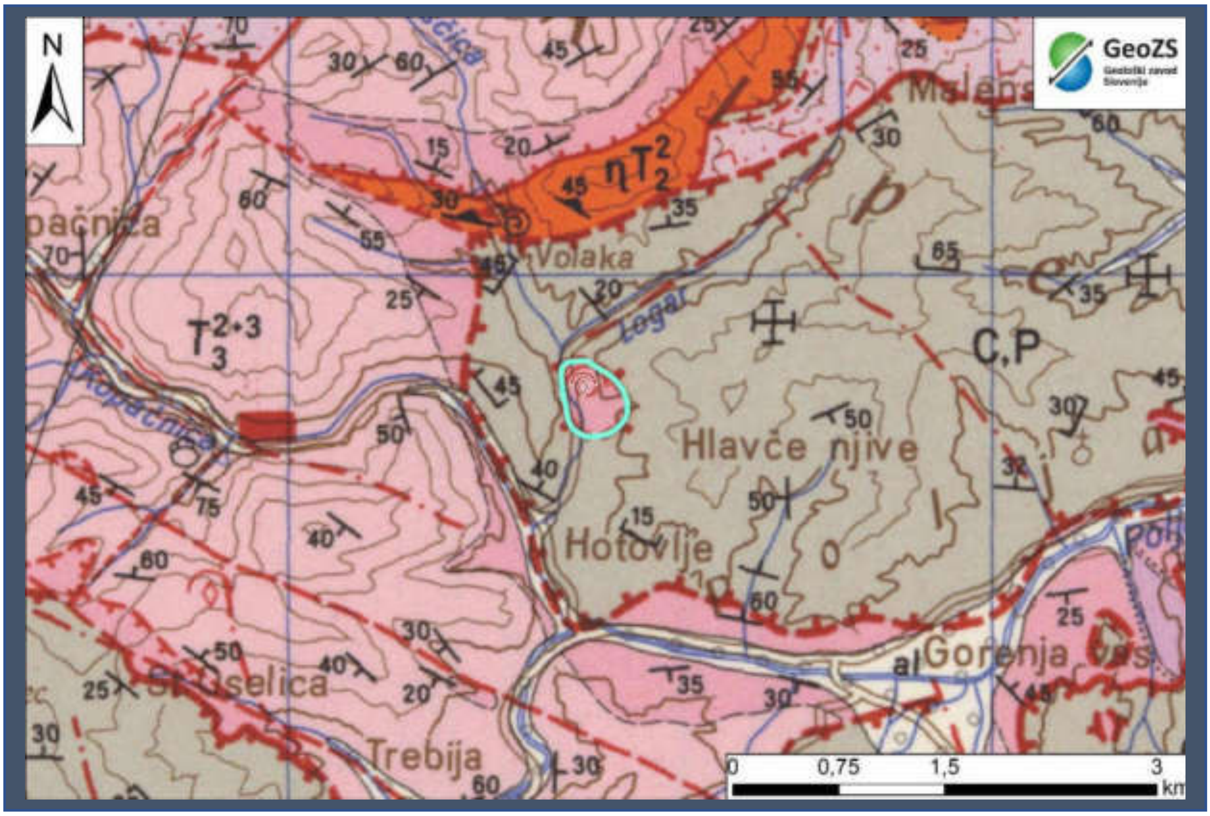
Rdeči hotaveljski marmor

20 cm

Short description: Heterogeneous, variegated limestone with color transitions from greyish-pink, pink, red to purple. Characteristic are frequent veins filled with reddish shale, greenish tuff and claystone, and yellowish calcite. Larger nests are filled with lumps of bright calcite or yellowish to purple dolomite crystals. Images display polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	multicoloured, red	Slovenia	Gorenjska (traditional province)	Gorenja vas - Poljane	Hotavlje

Geological setting



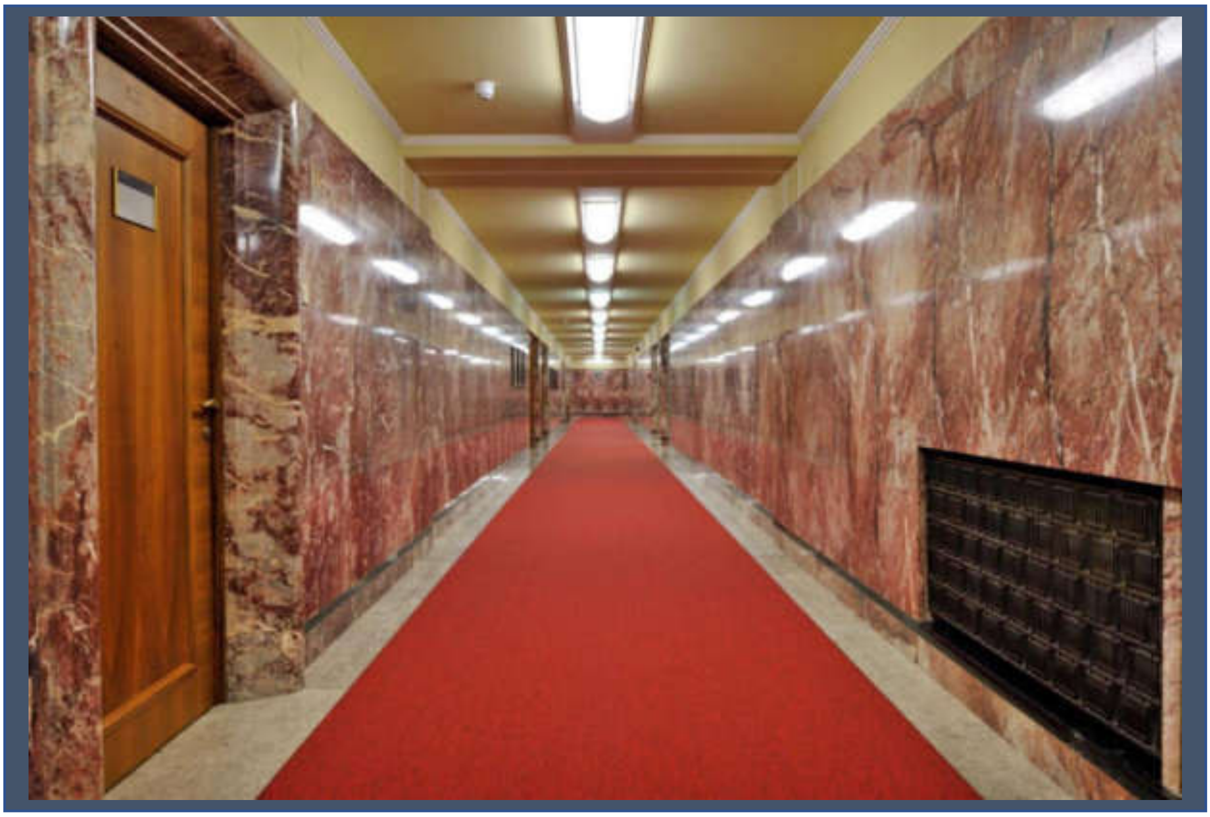
Geology: Non-bedded, massive limestone with remains of shallow-marine organisms (cyanobacteria, algae, sponges, corals and sea urchins) formed in reef setting in the Tethys ocean. The colour is due to karstification of the exposed surface and filling with red weathering residue (terra rossa) and tuff.
Hotavlje limestone belongs to the same geological unit as grey and red Lesno Brdo limestone, but with higher degree of recrystallization).

Production: Active, concessionaire MARMOR Hotavlje, exploitation site Hotavlje, mining right to exploitation of natural stone - limestone. Nowadays exploited in the underground galleries of a modernized quarry.

Geological age: Late Triassic (early Carnian, Cordevolian substage) (237-235 million years)	
Geological unit: Cordevolian limestone of Outer Dinarides	

Application, use and heritage

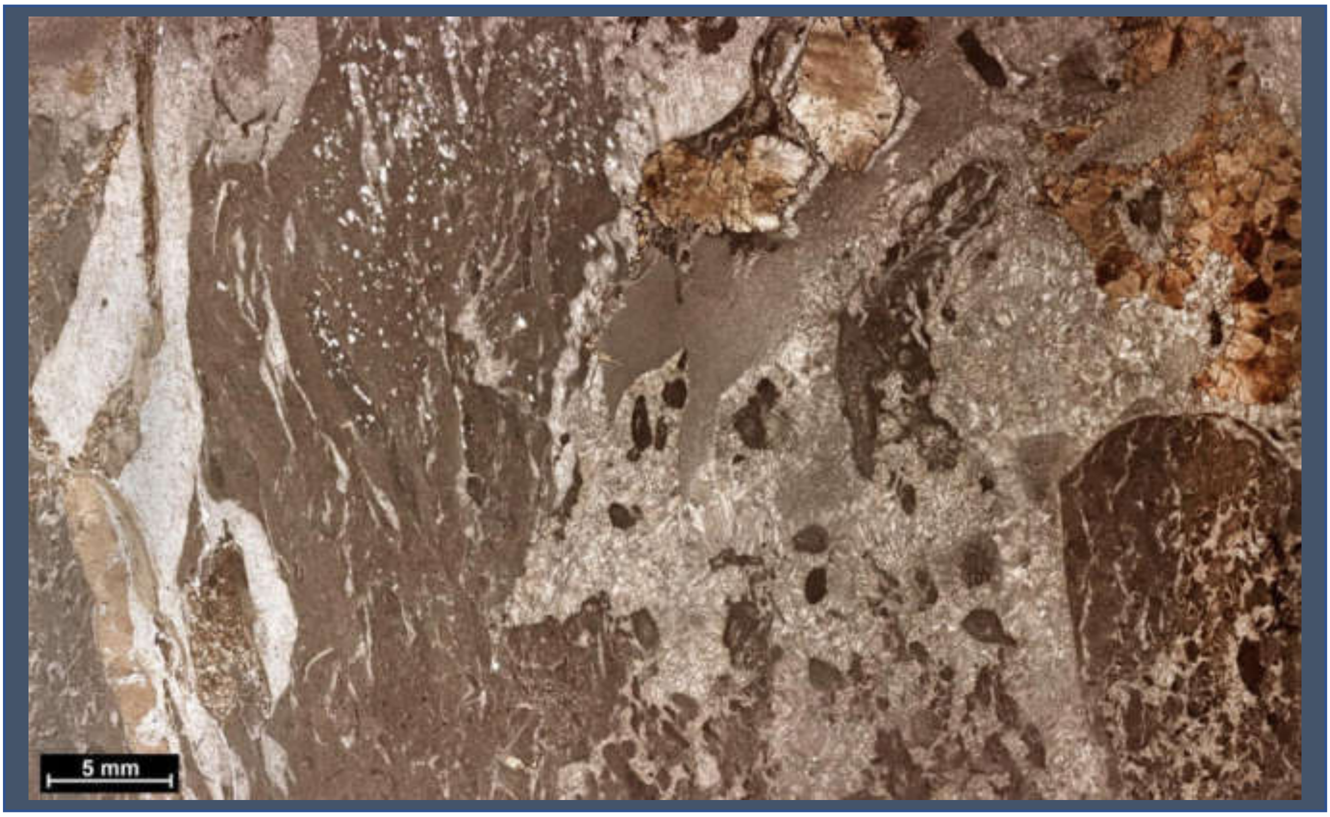
Description: The stones nice colour, high shine of polished surface and a very attractive appearance make the Hotavlje limestone a highly appreciated natural stone at home and abroad. Use: ornamental and building stone (polished, without inclusions)



Interior decoration of the hall in the 1st floor of the Slovenian Parliament building with large Red Hotavlje limestone panels. Photo: Miran Kambič

Door portals of the Exhibition Hall in the National and University Library (1941) in Ljubljana and entrance of the Prešeren Theatre (1950) in Kranj decorated with Red Hotavlje limestone.

Petrography



Description: Intrabiomikrosparite - mostly calcite grains in microsparite, Fe-oxides and hidroxides give red, rose and yellow color, green from tuffs. Many veins and lenses of white and yellow sparite calcite, and red, rose, green or white accumulations of dolomite, often partly or completely calcified. Veins filled with red and green marlstone, many fossil remains of algae, sponges, corals, gastropods, also intraclasts and pellets, some stylolites.

Source of information: Geological Survey of Slovenia, Ramovš, 1995; Mirtič et al., 1999.

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)	Heamatite (%)	Pyrite (%)
98	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**

Albite (%)
in traces

Source of information: Ramovš, 1995; Mirtič et al., 1999.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	up to 3	52-55	-	-	-	-	-	up to 43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

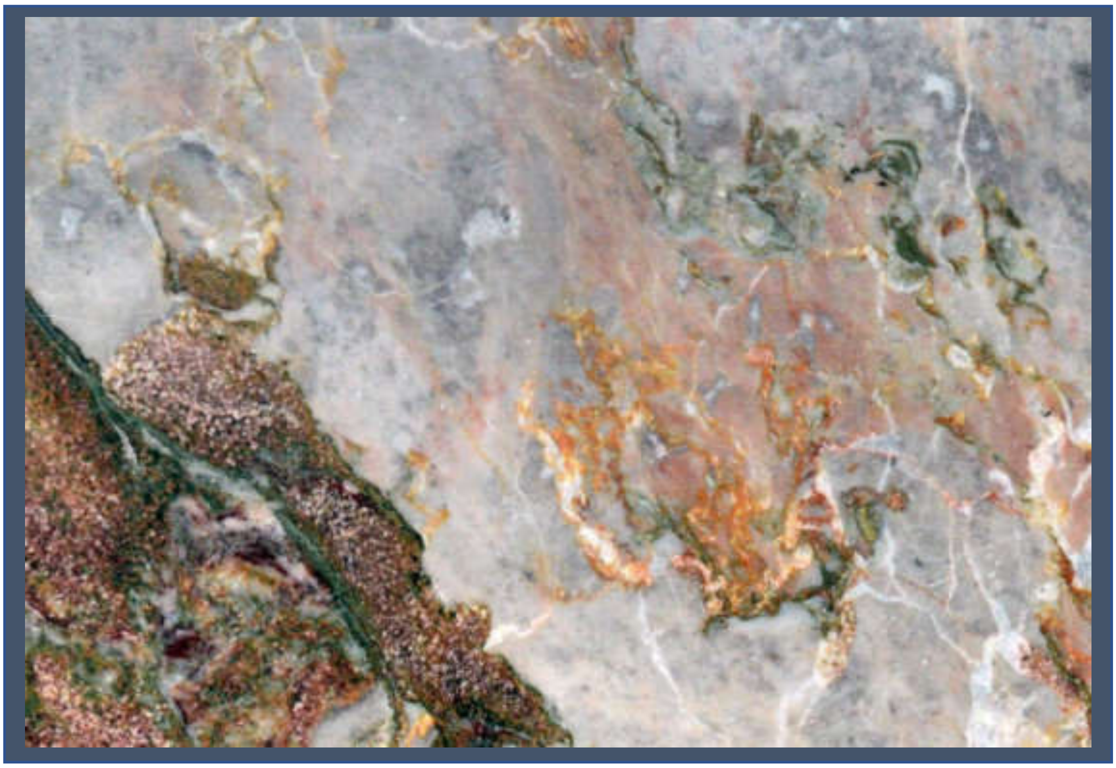
Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	RAMOVŠ, A. 1995. Hotaveljčan skozi čas. (Der Hotavlje-Kalke durch die Zeit). Marmor Hotavlje, Kranj, 128 pp., Ljubljana. MIRTIČ, B., MLADENOVIČ, 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.	
Other publication		

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

Hotavlje roza

Rose Hotavlje limestone

Rožnati hotaveljski marmor

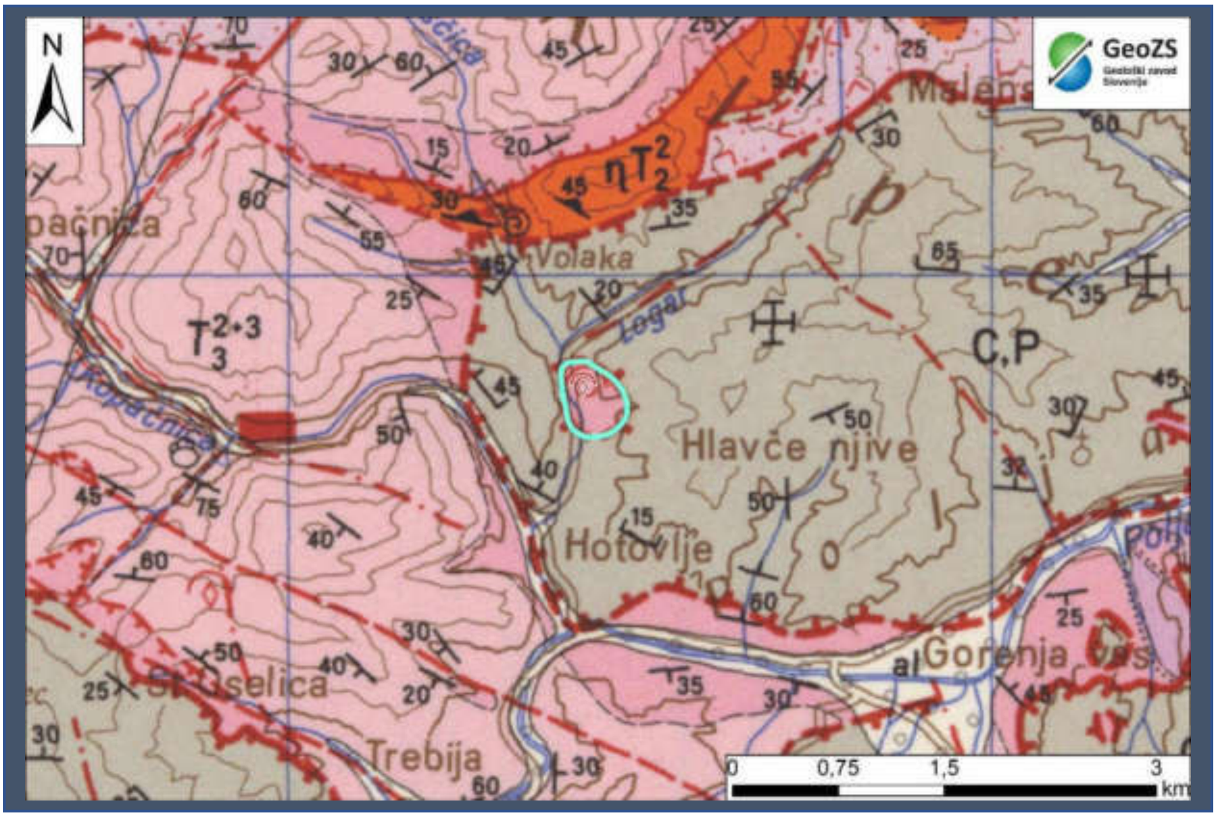


4 cm

Short description: Heterogeneous, variegated limestone with color transitions from grey, grayish-pink, pink to red. Characteristic are frequent veins filled with reddish shale, greenish tuff and claystone, and yellowish calcite. Larger nests are filled with lumps of bright calcite or yellowish to purple dolomite crystals. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	multicoloured, pink	Slovenia	Gorenjska (traditional province)	Gorenja vas - Poljane	Hotavlje

Geological setting



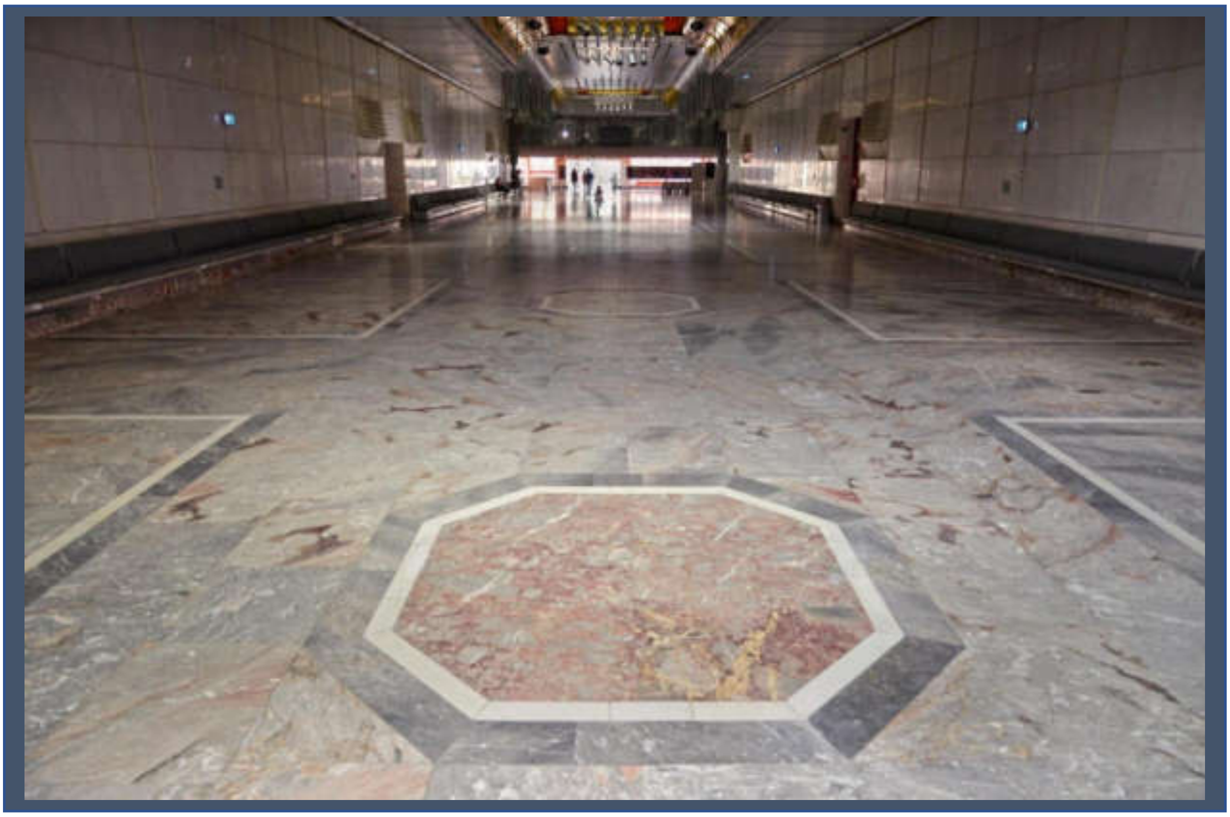
Geology: Non-bedded, massive limestone with remains of shallow-marine organisms (cyanobacteria, algae, sponges, corals and sea urchins) formed in reef setting in the Tethys ocean. The colour is due to karstification of the exposed surface and filling with red weathering residue (terra rossa) and tuff. Hotavlje limestone belongs to the same geological unit as grey and red Lesno Brdo limestone, but with higher degree of recrystallization).

Production: Active, concessionaire MARMOR Hotavlje, exploitation site Hotavlje, mining right to exploitation of natural stone - limestone. Nowadays exploited in the underground galleries of a modernized quarry.

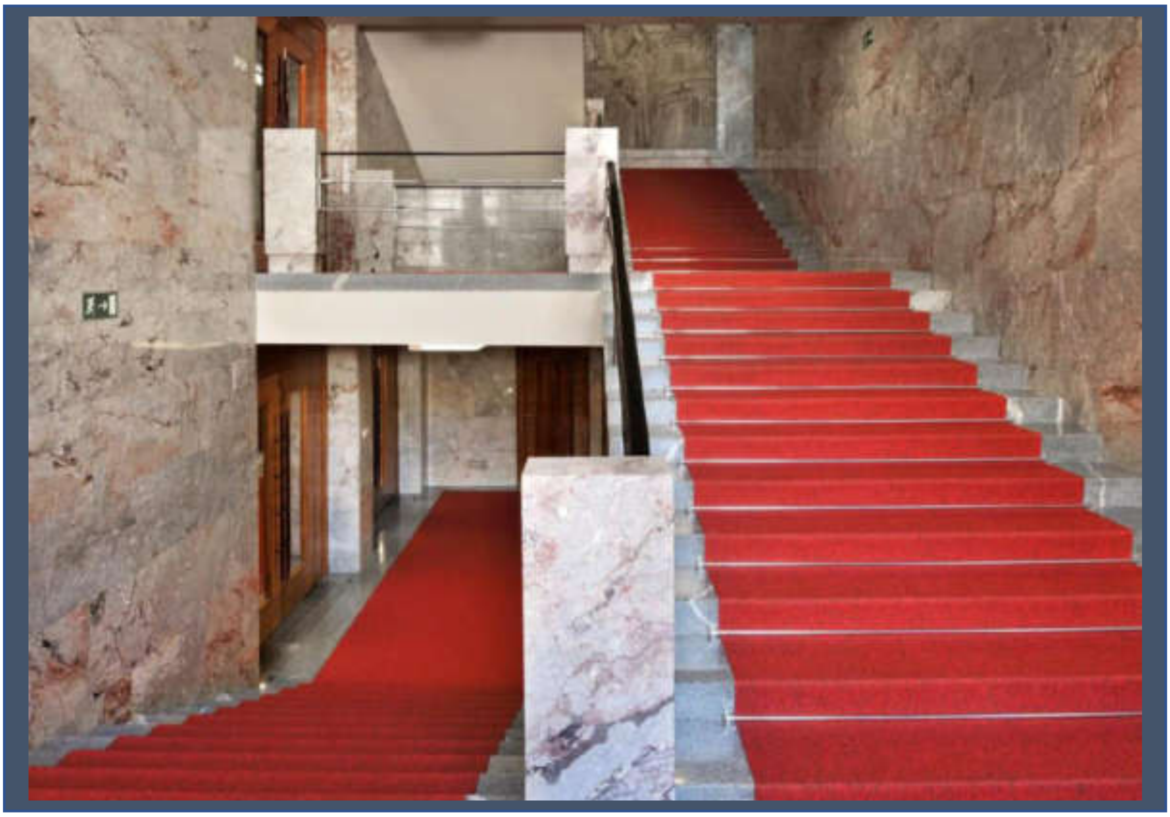
Geological age: Late Triassic (early Carnian, Cordevolian substage) (237-235 million years)
Geological unit: Cordevolian limestone of Outer Dinarides

Application, use and heritage

Description: The stones nice colour, high shine of polished surface and a very attractive appearance make the Hotavlje limestone a highly appreciated natural stone at home and abroad.
Use: ornamental and building stone (polished, without inclusions)



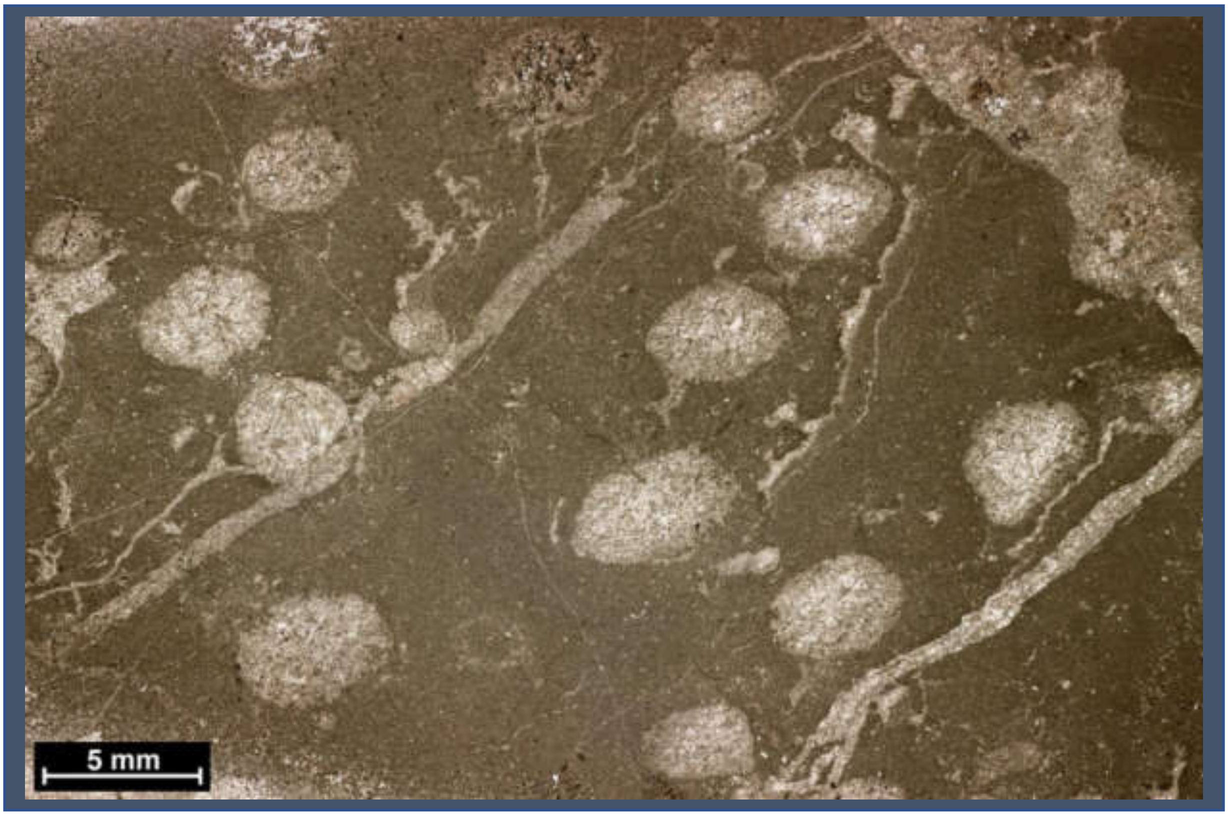
In the interior of the Cankar Cultural Centre (1983) in Ljubljana, as many as 2000 m^2 of surface is covered with panels of rose and grey Hotavlje limestone.



Staircase of the Slovenian Parliament building decorated with Rose Hotavlje limestone. Photo: Miran Kambič

A pillar in the Constitutional Court of the Republic of Slovenia building (1927) and four large porches at the entrance to the New Žale Central Cemetery (1988) in Ljubljana.

Petrography



Description: Intrabiomikrosparite - mostly calcite grains in microsparite, Fe-oxides and hydroxides give red, rose and yellow color, green from tuffs. Many veins and lenses of white and yellow sparite calcite, and red, rose, green or white accumulations of dolomite, often partly or completely calcified. Veins filled with red and green marlstone, many fossil remains of algae, sponges, corals, gastropods, also intraclasts and pellets, some stylolites.

Source of information: Geological Survey of Slovenia, Ramovš, 1995; Mirtič et al., 1999.

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)	Heamatite (%)	Pyrite (%)
98	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**

Albite (%)
in traces

Source of information: Ramovš, 1995; Mirtič et al., 1999.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	up to 3	52-55	-	-	-	-	-	up to 43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	RAMOVŠ, A. 1995. Hotaveljčan skozi čas. (Der Hotavlje-Kalke durch die Zeit). Marmor Hotavlje, Kranj, 128 pp., Ljubljana. MIRTIČ, B., MLADENOVIČ, 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.	
Other publication		

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

Hotavlje sivi

Grey Hotavlje limestone

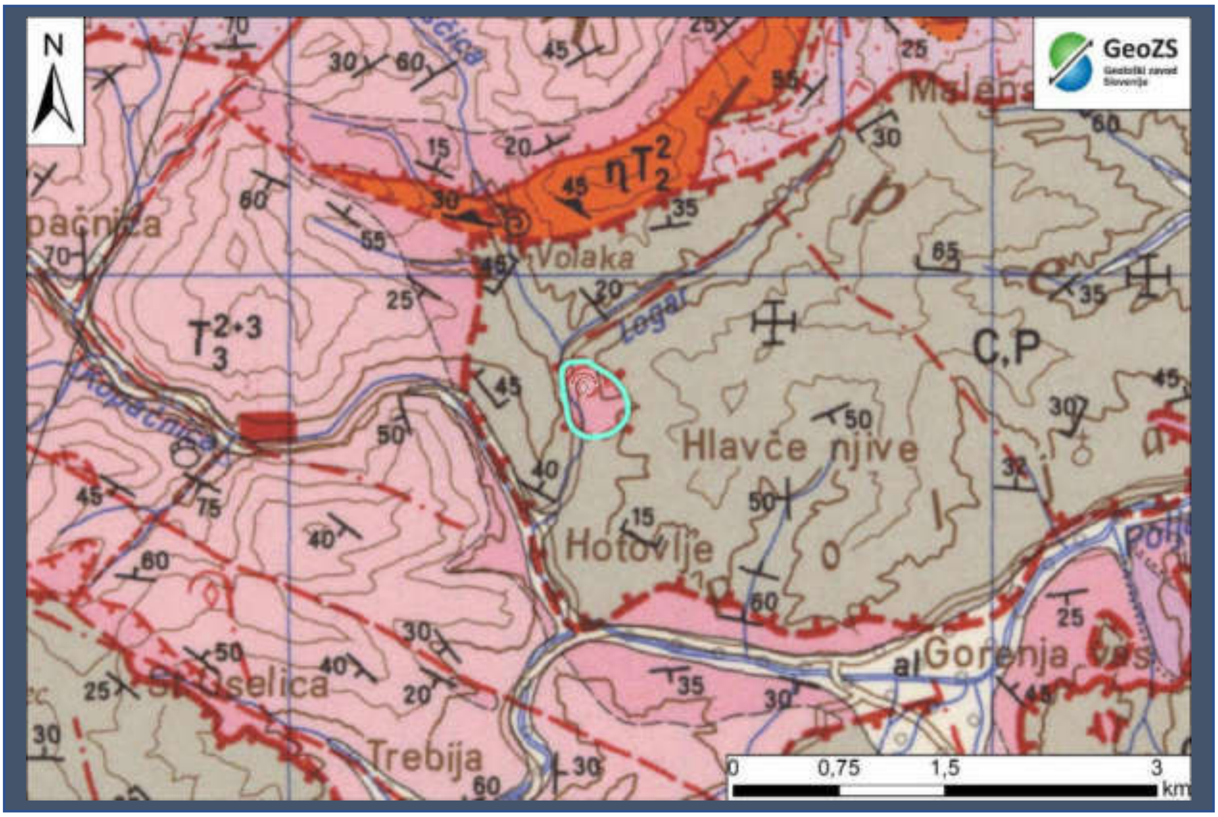
Sivi hotaveljski marmor

5 cm

Short description: Heterogeneous, variegated limestone with color transitions from light-grey and dark-grey to pinkish-grey. Characteristic are frequent veins filled with yellowish calcite. Larger nests are filled with lumps of bright calcite or yellowish dolomite crystals. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	multicoloured, grey	Slovenia	Gorenjska (traditional province)	Gorenja vas - Poljane	Hotavlje

Geological setting



Geology: Non-bedded, massive limestone with remains of shallow-marine organisms (cyanobacteria, algae, sponges, corals and sea urchins) formed in reef setting in the Tethys ocean.
Hotavlje limestone belongs to the same geological unit as grey and red Lesno Brdo limestone, but with higher degree of recrystallization).

Production: Active, concessionaire MARMOR Hotavlje, exploitation site Hotavlje, mining right to exploitation of natural stone - limestone. Nowadays exploited in the underground galleries of a modernized quarry.

Geological age: Late Triassic (early Carnian, Cordevolian substage) (237-235 million years)
Geological unit: Cordevolian limestone of Outer Dinarides

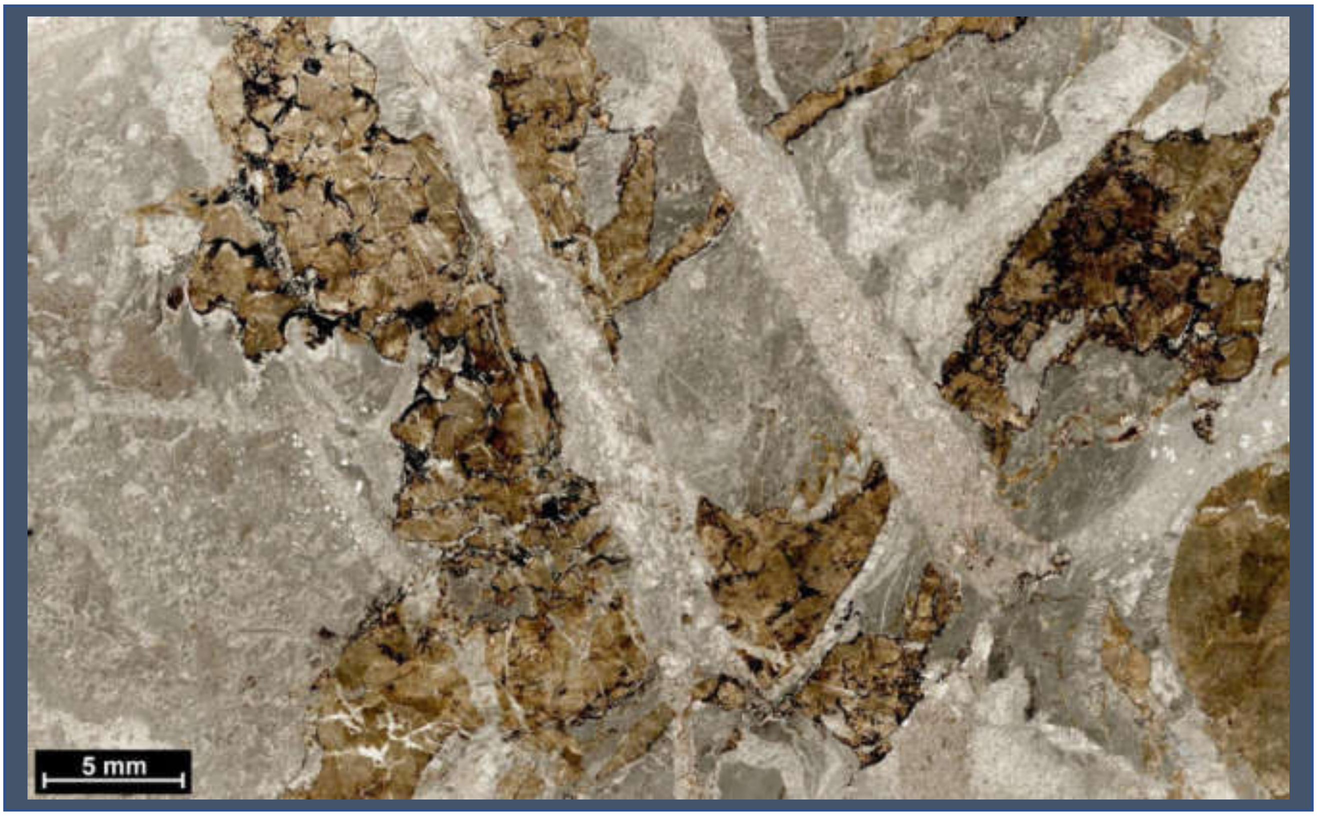
Application, use and heritage

Description: The stones nice colour, high shine of polished surface and a very attractive appearance make the Hotavlje limestone a highly appreciated natural stone at home and abroad. Use: ornamental and building stone (polished, without inclusions)

Baroque Fountain of the Three Carniolan Rivers by Francesco Robba (1751) in Ljubljana. The bowl of the fountain, the stairs and the columns are renovated using the Grey Hotavlje limestone.

A house from 1619 in Ljubljana renovated with Grey Hotavlje limestone.

Petrography



Description: Intrabiomikrosparite - mostly calcite grains in microsparite, Fe-oxides and hidroxides give red, rose and yellow color, green from tuffs. Many veins and lenses of white and yellow sparite calcite, and red, rose, green or white accumulations of dolomite, often partly or completely calcified. Many fossil remains of algae, sponges, corals, gastropods, also intraclasts and pellets, some stylolites.

Source of information: Geological Survey of Slovenia, Ramovš, 1995; Mirtič et al., 1999.

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)	Heamatite (%)	Pyrite (%)
98	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**

Albite (%)
in traces

Source of information: Ramovš, 1995; Mirtič et al., 1999.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	up to 3	52-55	-	-	-	-	-	up to 43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

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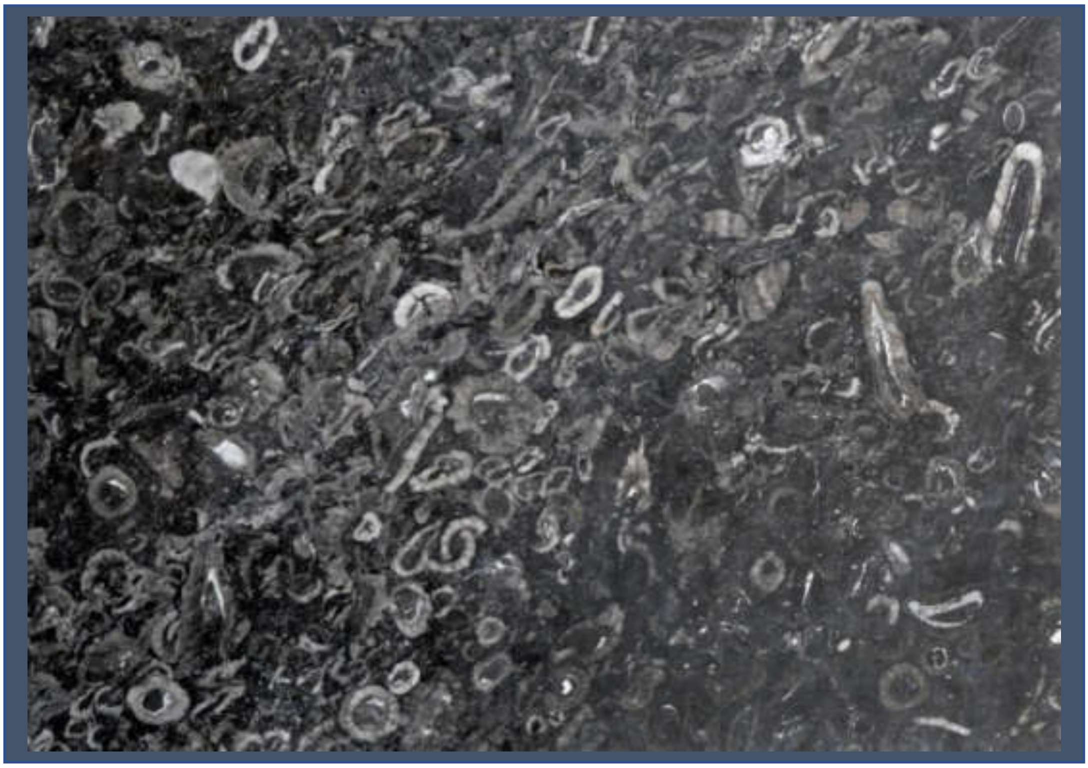
Commercial directory		
Scientific publication	RAMOVŠ, A. 1995. Hotaveljčan skozi čas. (Der Hotavlje-Kalke durch die Zeit). Marmor Hotavlje, Kranj, 128 pp., Ljubljana. MIRTIČ, B., MLADENOVIČ, A., RAMOVŠ, A., SENEGAČNIK, A., VESEL, J., & VIŽINTIN, N. 1999. Slovenski naravni kamen. Ljubljana, Geological Survey of Slovenia, Slovenian National Building and Civil Engineering Institute, University of Ljubljana Geology department. 131 pg.	
Other publication		

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

Kazlje

Kazlje limestone

Lipica fiorito nero

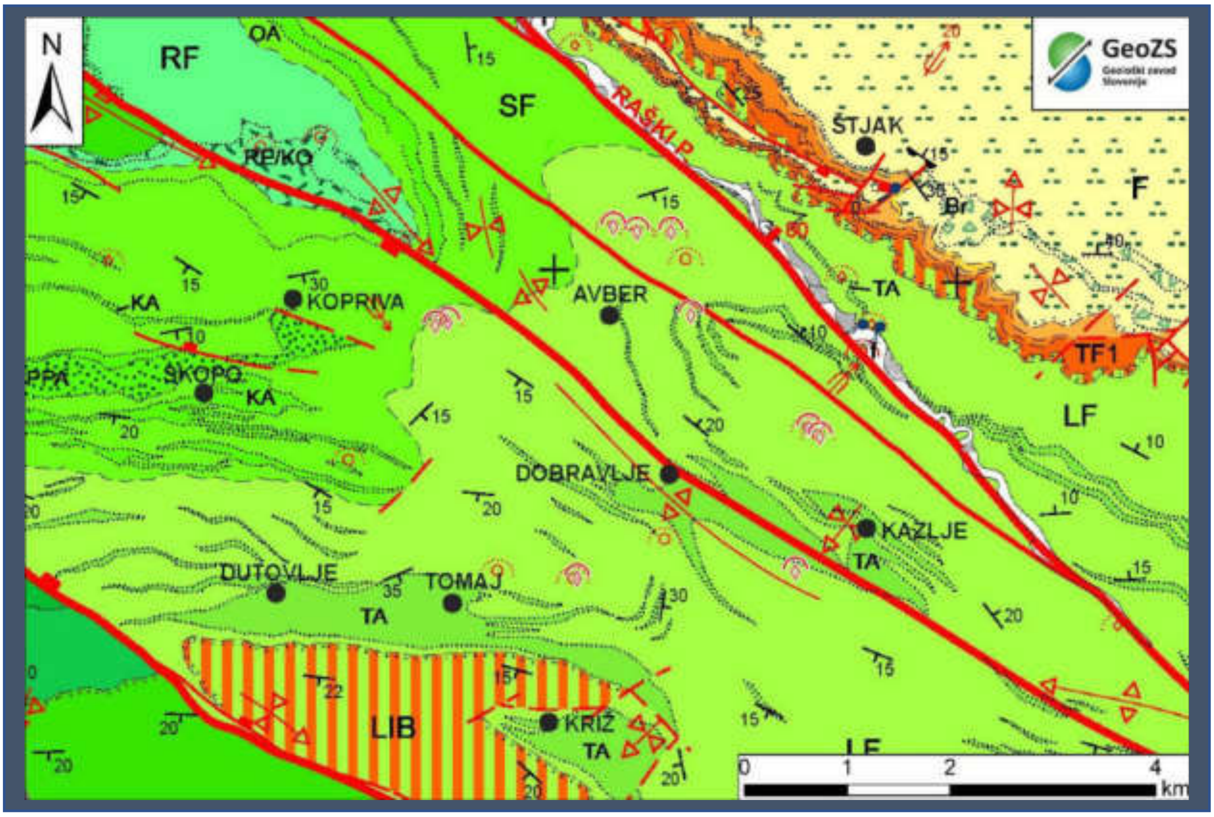


10 cm

Short description: Dark-grey to black fine-grained, stratified limestone with light-coloured fossils remains (mostly rudist shells) of different sizes and degrees of fragmentation. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	dark-grey	Slovenia	Primorska (traditional province)	Sežana	Kazlje

Geological setting



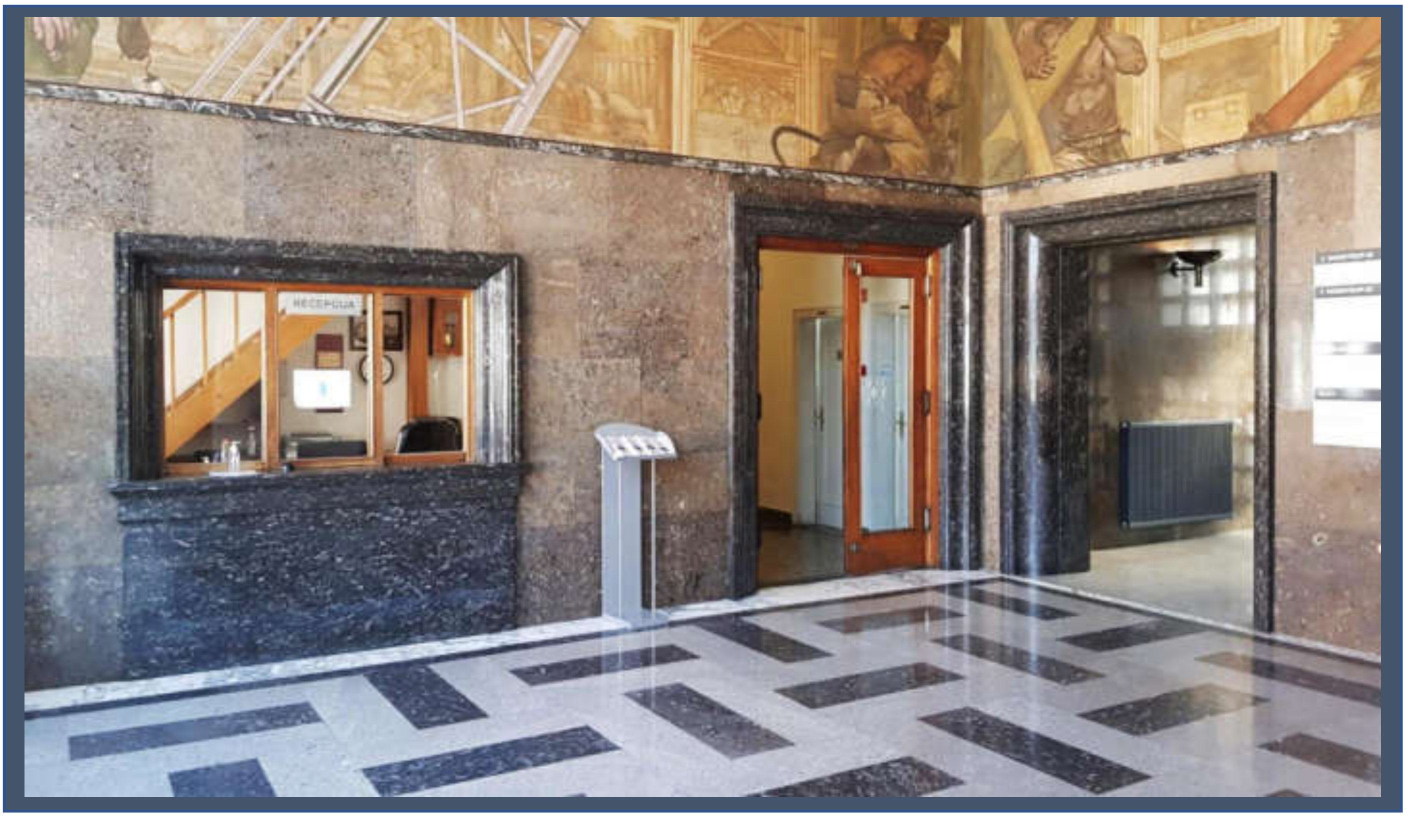
Geology: Kazlje limestone of the Lipica Formation (LF) formed on the Adriatic-Dinaric Carbonate Platform in closed lagoon and its edges with rudist bivalves and a lot of finely dispersed organic matter giving the dark colour. The economically productive lens-shaped unit in Kras region, Trieste-Komen plateau, SW Slovenia is max. 41 m thick.

Production: Active, concessionaire MARMOR Sežana, d.d., exploitation site Kazlje, mining right to exploitation of natural stone - limestone.

Geological age: Late Cretaceous (late Santonian) (85 million years)
Geological unit: Lipica formation (Upper Aurisina fm. in Italy) of Outer Dinarides

Application, use and heritage

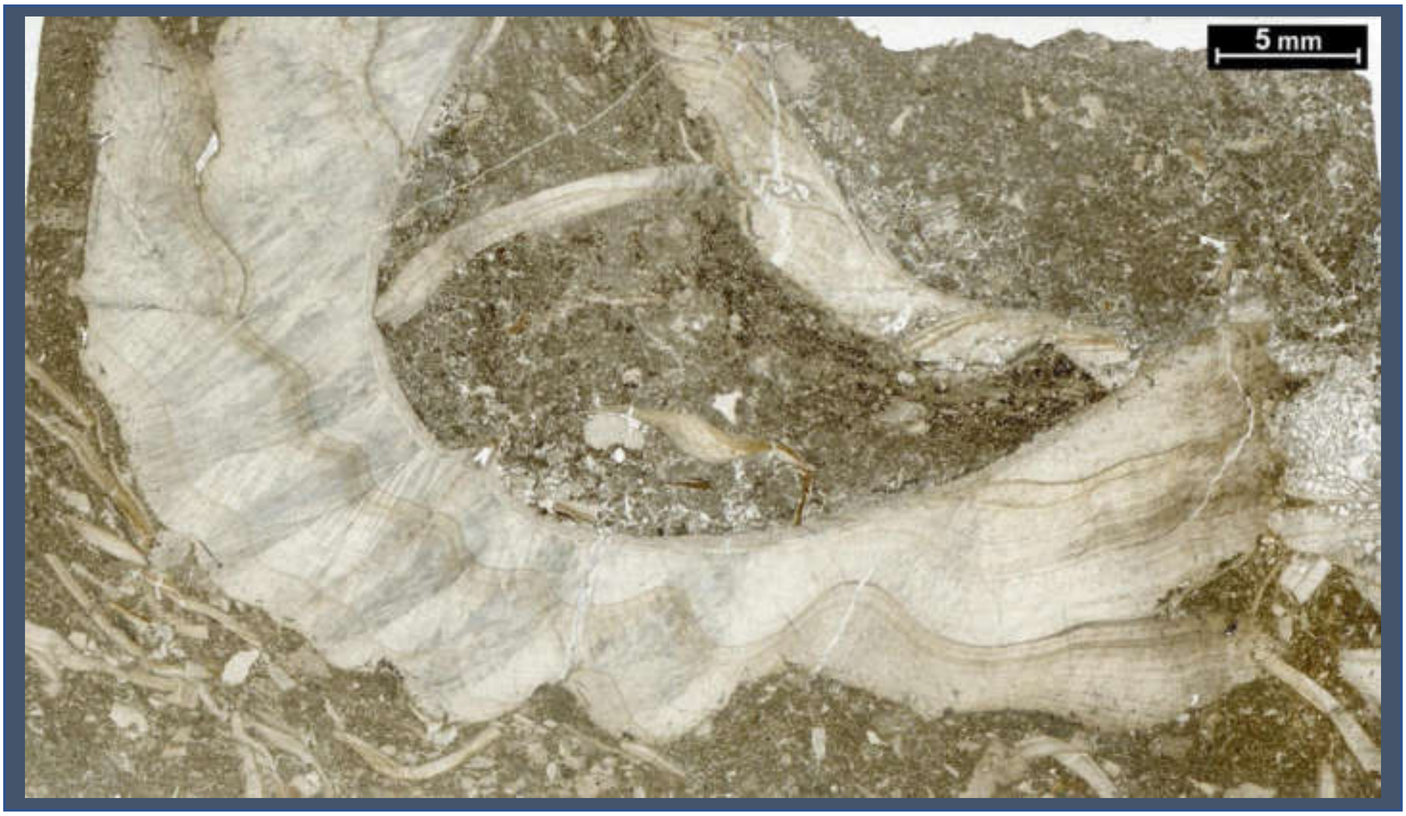
Description: Due to the rarity, good properties and decorative value of this limestone it is mostly used as a boutique stone for smaller decorative elements in churches (altars, pillars, statues) and in noble buildings. Owing to its white calcitic mollusc valves, the stone was named “biserni” (“pearly”) (Mirtič et al., 1999).



The dark floor and wall panels and door frames in the lobby of Montanistika building (1937) in Ljubljana are made of Kazlje limestone.

Altar pillar made of Kazlje limestone in St. Elija Parish Church (1823) in village Kopriva in the Kras region.

Petrography



Description: Bioclastic limestone with rudist shells od different degrees of fragmentation in micritic matrix.

Source of information: Geological Survey of Slovenia, Vesel et al., 1975; Cavin et al., 2000; Pleničar, 2009; Jurkovšek et al., 2013.

Mineral composition

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

Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)
Mineral n (%)						

Source of information:

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Non-commercial directory		
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. VESEL, J., ŠKERLJ, J., ČEBULJ, A. & GRIMŠIČAR, A. 1975. Nahajališča okrasnega kamna v Sloveniji. / Freestone quarried in Slovenia. Geologija, 15, 243-258. CAVIN, L., JURKOVŠEK, B., KOLAR JURKOVŠEK, T. 2000. Stratigrafsko zaporedje zgornjekrednih ribjih združb Krasa (Slovenia). Geologija 43/2, 165-195 http://www.geologija-revija.si/dokument.aspx?id=724 PLENIČAR, M. 2009. Kreda - Cretaceous. In: Geology of Slovenia (Ed: Pleničar, Ogorelec and Novak). Geological Survey of Slovenia, Ljubljana, 612 pg. JURKOVŠEK, B., CVETKO TEŠOVIĆ, B., KOLAR-JURKOVŠEK, T. 2013. Geologija Krasa = Geology of Kras. Ljubljana: Geološki zavod Slovenije, 205 pp. JEŽ, J. et al. 2015. Platy limestone – geological definition and its use as a mineral commodity. Project RoofOfRpock Final report for the project area in Slovenia. Geological Survey of Slovenia, 122 pp. (https://roofofrock.geo-zs.si/Publication/pages/platy-limestone/supplements/appendix-2-2.pdf)	
Other publication		

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

Kopriva

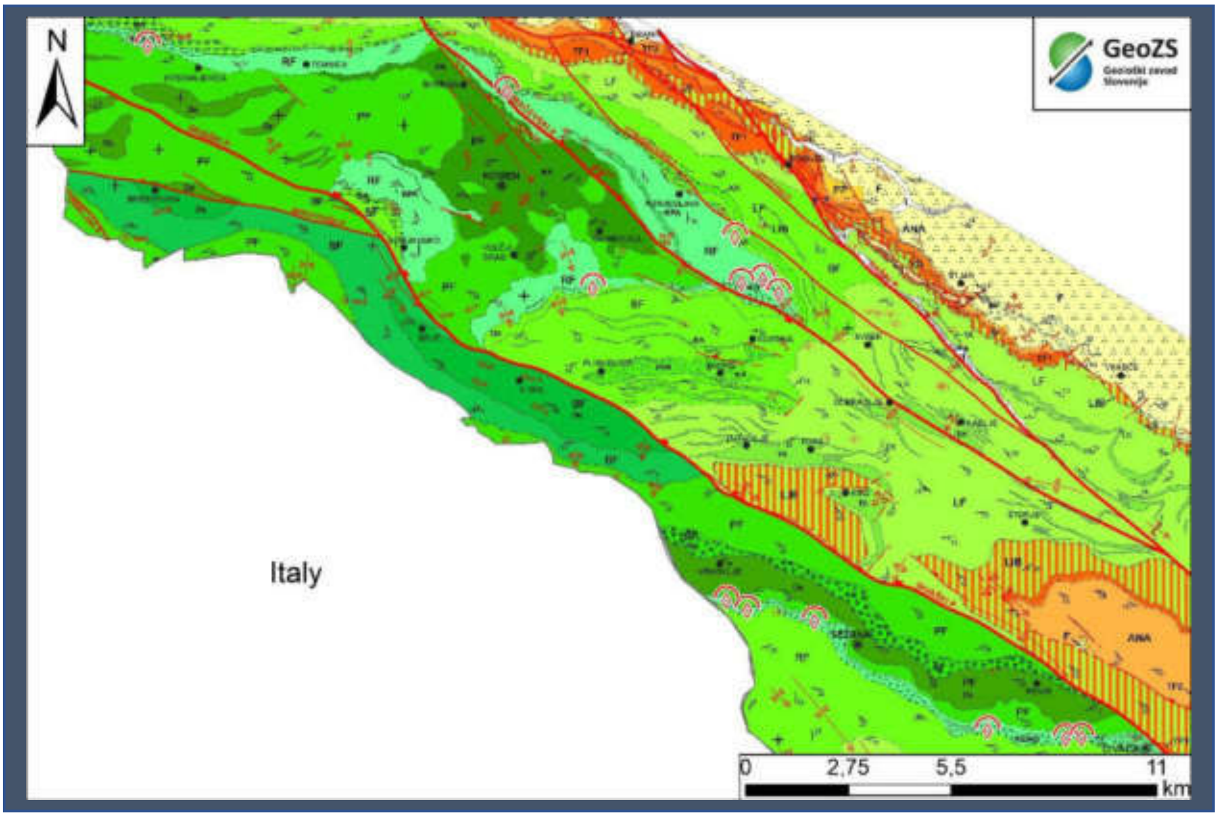
Kopriva limestone

5 cm

Short description: Light-grey massive limestone with evenly distributed dark-grey broken and rounded mollusc fragments (mainly rudists). The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	light-grey	Slovenia	Primortska (traditional province)	Sežana	Pliskovica, Kopriva

Geological setting



Geology: Beds of Turonian Limestones on the Dinaric Carbonate Platform. Kopriva member of Repen Formation (KO/RF) was formed in a high-energy environment on the Adriatic-Dinaric Carbonate Platform where shells were crushed.

Production: Active, concessionaire MARMOR Sežana, d.d., exploitation site Kopriva, mining right to exploitation of natural stone - limestone. Kopriva limestone gradually passes laterally and vertically into Repen type limestone, in which the fossil shells are better preserved.

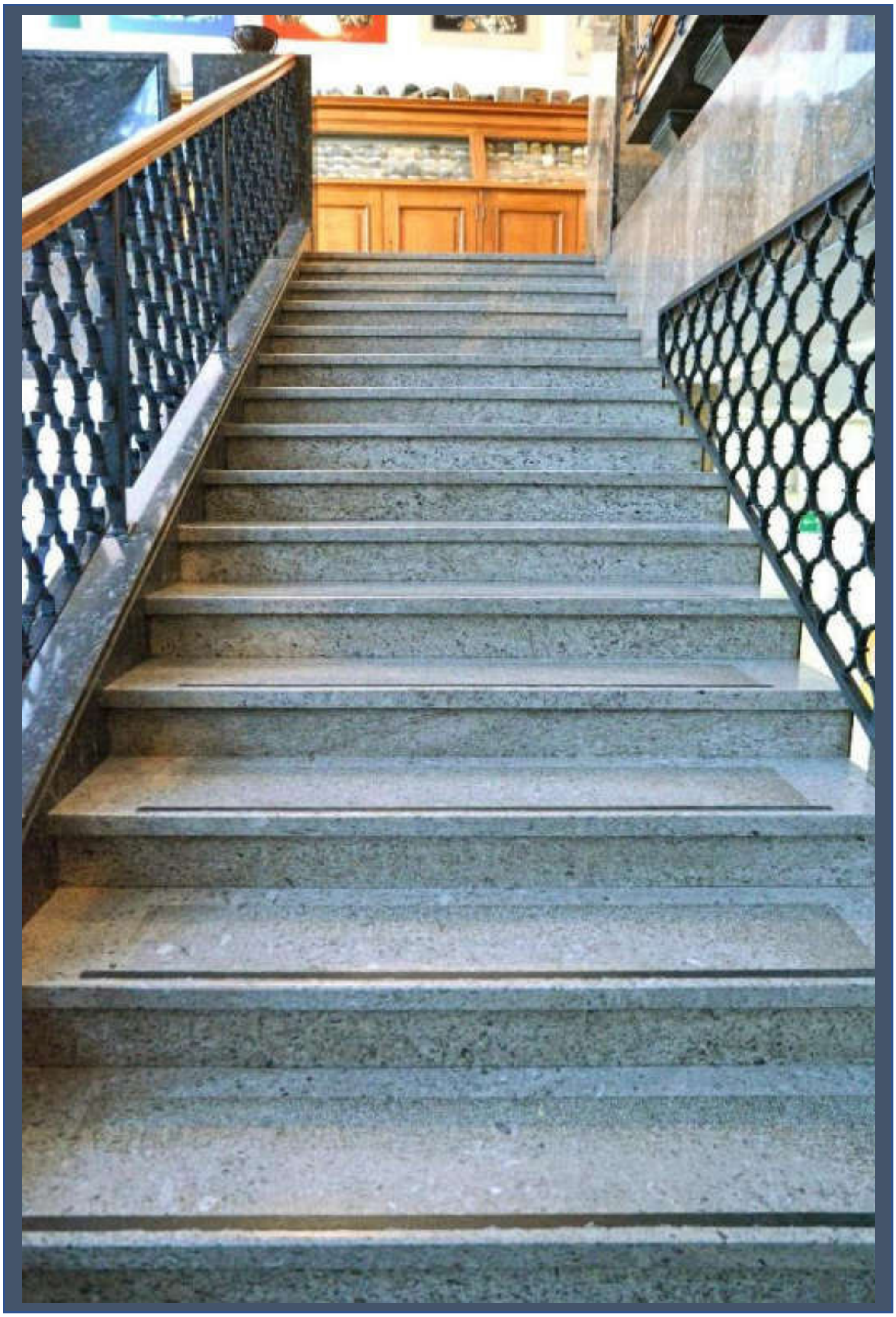
Geological age: Late Cretaceous (Cenomanian-Turonian) (95-90 million years)
Geological unit: – Kopriva member of Repen formation of Outer Dinarides

Application, use and heritage

Description:
Lenticular bodies of the Kopriva limestone were long quarried in the Kras area as a highly valued natural stone.

St. Elija Parish Church (1823) in village Kopriva in the Kras region is mostly built from Kopriva limestone.

Some of the decorative elements made of Kopriva limestone in St. Elija Parish Church in Kopriva.



Stairs in the Montanistika building (1937) in Ljubljana are paved with light-grey Kopriva limestone.

Petrography

Description: Massive biosparite with fragmented mollusc shells (mostly rudists, pachidonts and gastropods), foraminifera and other microfosils.

Source of information: Geological Survey of Slovenia, Vesel et al., 1975; Pleničar, 2009; Jurkovšek et al., 2013, Jež et al., 2015.

Mineral composition

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

Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)
Mineral n (%)						

Source of information:

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Non-commercial directory		
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. VESEL, J., ŠKERLJ, J., ČEBULJ, A. & GRIMŠIČAR, A. 1975. Nahajališča okrasnega kamna v Sloveniji. / Freestone quarried in Slovenia. Geologija, 15, 243-258. VESEL, J. 1979. Repen stone. Geologija 22/1, 117-126; PLENIČAR, M. 2009. Kreda - Cretaceous. In: Geology of Slovenia (Ed: Pleničar, Ogorelec and Novak). Geological Survey of Slovenia, Ljubljana, 612 pg. JURKOVŠEK, B., CVETKO TEŠOVIĆ, B., KOLAR-JURKOVŠEK, T. 2013. Geologija Krasa = Geology of Kras. Ljubljana: Geološki zavod Slovenije, 205 pp. JEŽ, J. et al. 2015. Platy limestone – geological definition and its use as a mineral commodity. Project RoofOfRpock Final report for the project area in Slovenia. Geological Survey of Slovenia, 122 pp. (https://roofofrock.geo-zs.si/Publication/pages/platy-limestone/supplements/appendix-2-2.pdf)	
Other publication		

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

Lehnjak Jezersko

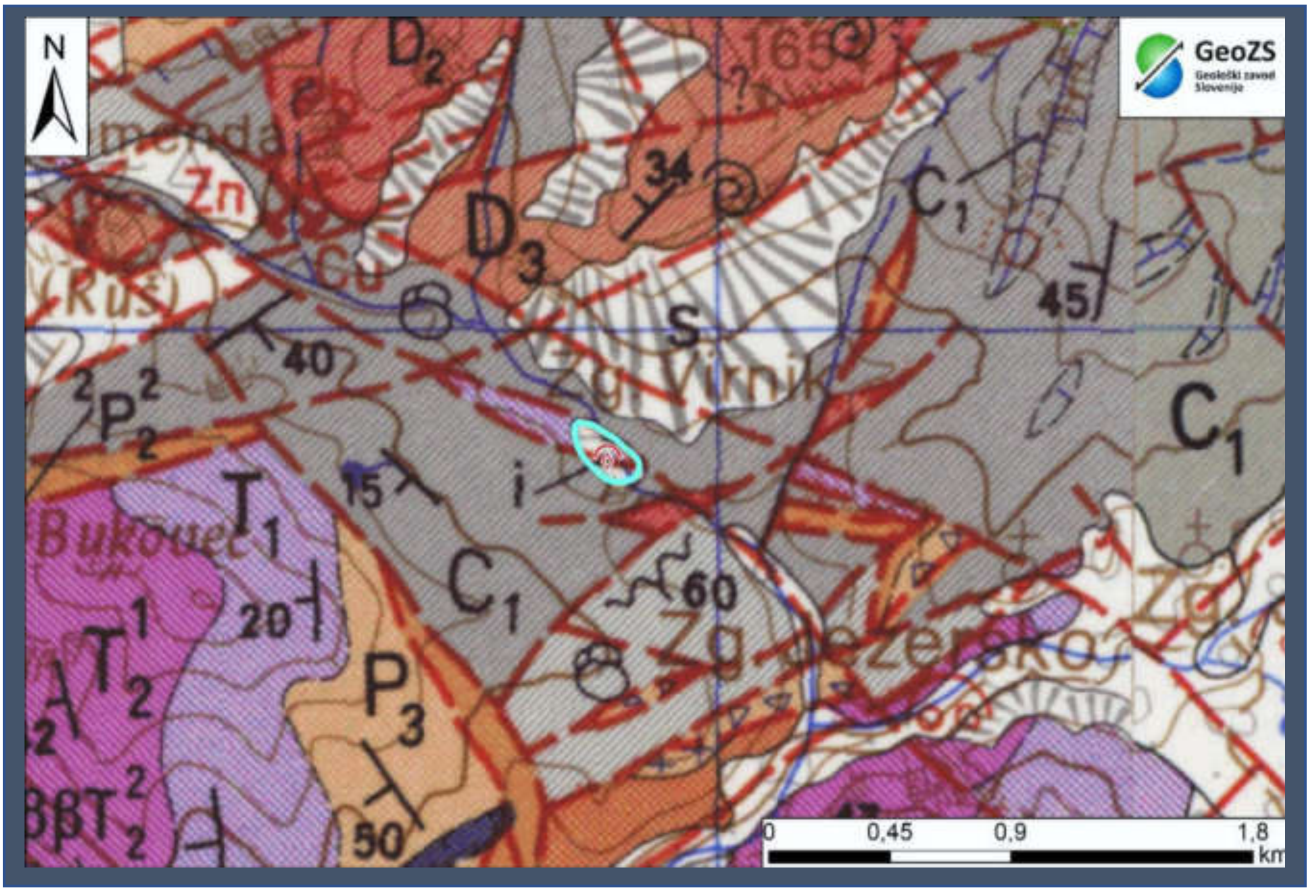
Jezersko travertine

5 cm

Short description: Heterogeneous, porous appearance, characterized by pitted holes and troughs in its surface, color changes within different shades of yellow.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	calcareous tufa	beige	Slovenia	Gorenjska (traditional province)	Jezersko	Zgornje Jezersko

Geological setting



Geology: Localized deposit of about 4 ha on the left bank of the Kokra river near Jezersko. Deposited over the Carboniferous black shale and limestone breccia with spring water. Its thickness does not exceed 20 m.

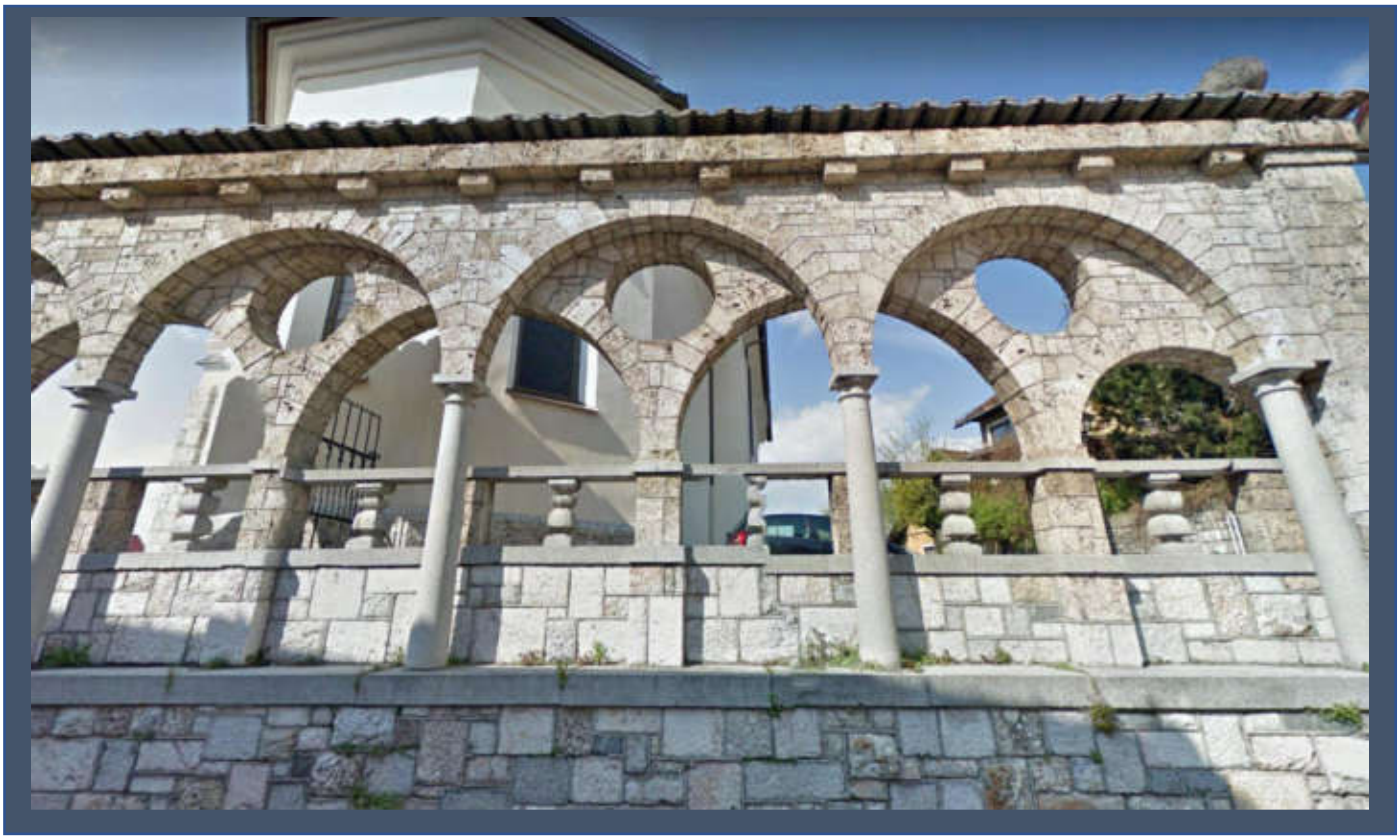
Production: No (abandoned). Excavation started in 1950. Larger-scale extraction from 1970 to 2004. Exported mainly to Switzerland and Germany. In 2004, the Spodnje Jezersko tufa deposits have been designated a valuable geological natural asset and a special landscape feature.

Geological age: Quaternary, Holocene (last 10,000 years)
Geological unit: Quaternary calcareous tufa deposit in the Southern Karavanke Mountains.

Application, use and heritage

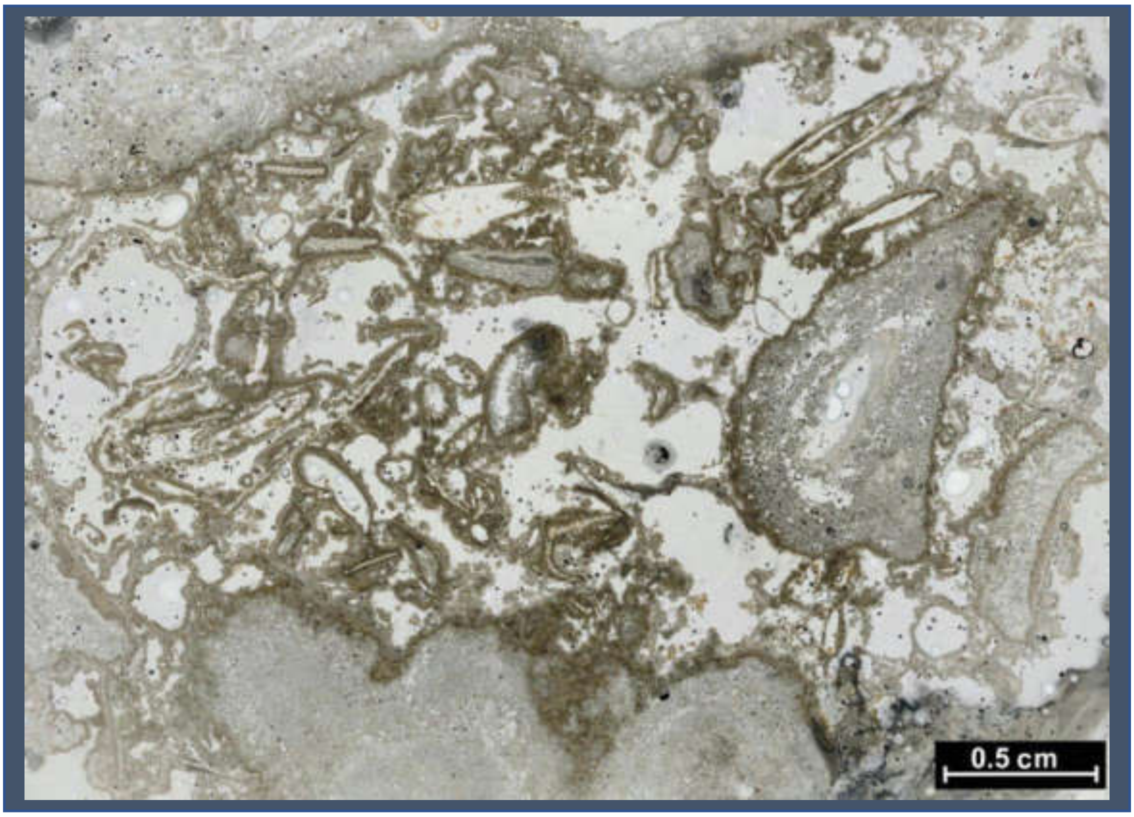
Description: Soft for processing and thus suitable only for load-bearing claddings. The quality depends on size and distribution of holes – lower quality of stone with uneven sizes and distribution of holes and extent of caverns (up to few meters). This ornamental stone was used for cladding different buildings in Gorenjska traditional province and in Ljubljana (for example façade entrance of the central pharmacy on the Prešeren square).

Entrance façade of the Ljubljana Central Pharmacy (1896).



Jezersko travertine in Plečnik's Arcade (1954) in Kranj.

Petrography



Description: Granular texture, porous (granular porosity 10-15%) calcite with fossil remains of different plants, moss and gastropods. Contains small amounts of quartz, muscovite, albite and magnetite.

Source of information: Geological Survey of Slovenia, Mirtič et al.; 1999, Šubic, 2011.

Mineral composition

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

Calcite (%)	Dolomite (%)	Limonite minerals (%)
96-98	**in traces**	**in traces**

Source of information: Mirtič et al., 1999.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
Other oxides less than 1%					54	Other oxides less than 1%					up to 42

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
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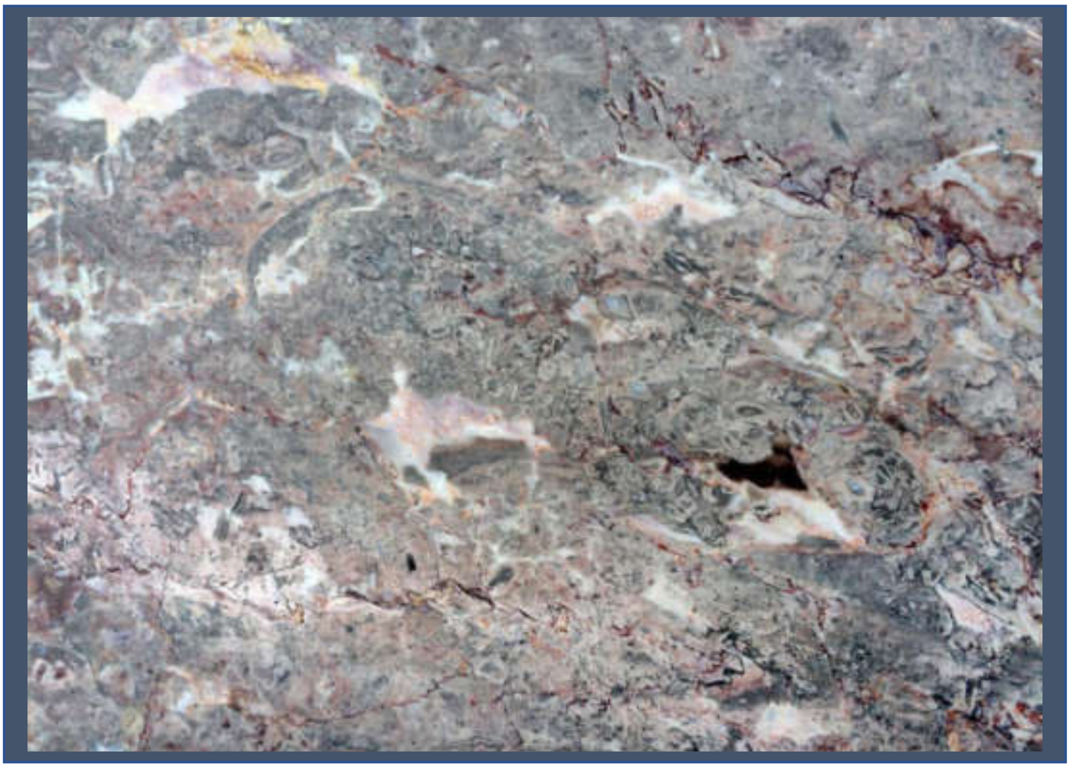
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, A., RAMOVŠ, A., SENEGAČNIK, A., VESEL, J., & VIŽINTIN, N. 1999. Slovenski naravni kamen. Ljubljana, Geological Survey of Slovenia, Slovenian National Building and Civil Engineering Institute, University of Ljubljana Geology department. 131 pg. ŠUBIC, T. 2011. The Spodnje Jezersko natural asset – its tufa deposits and conservation. Varstvo narave 25, 121-131. VESEL, J., ŠKERLJ, J., ČEBULJ, A. & GRIMŠIČAR, A. 1975. Nahajališča okrasnega kamna v Sloveniji. / Freestone quarried in Slovenia. Geologija, št. 15. URN:NBN:SI:DOC-DTOS3JGZfrom http://www.dlib.si	
Other publication		

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

Lesno Brdo rdeči

Red Lesno Brdo limestone

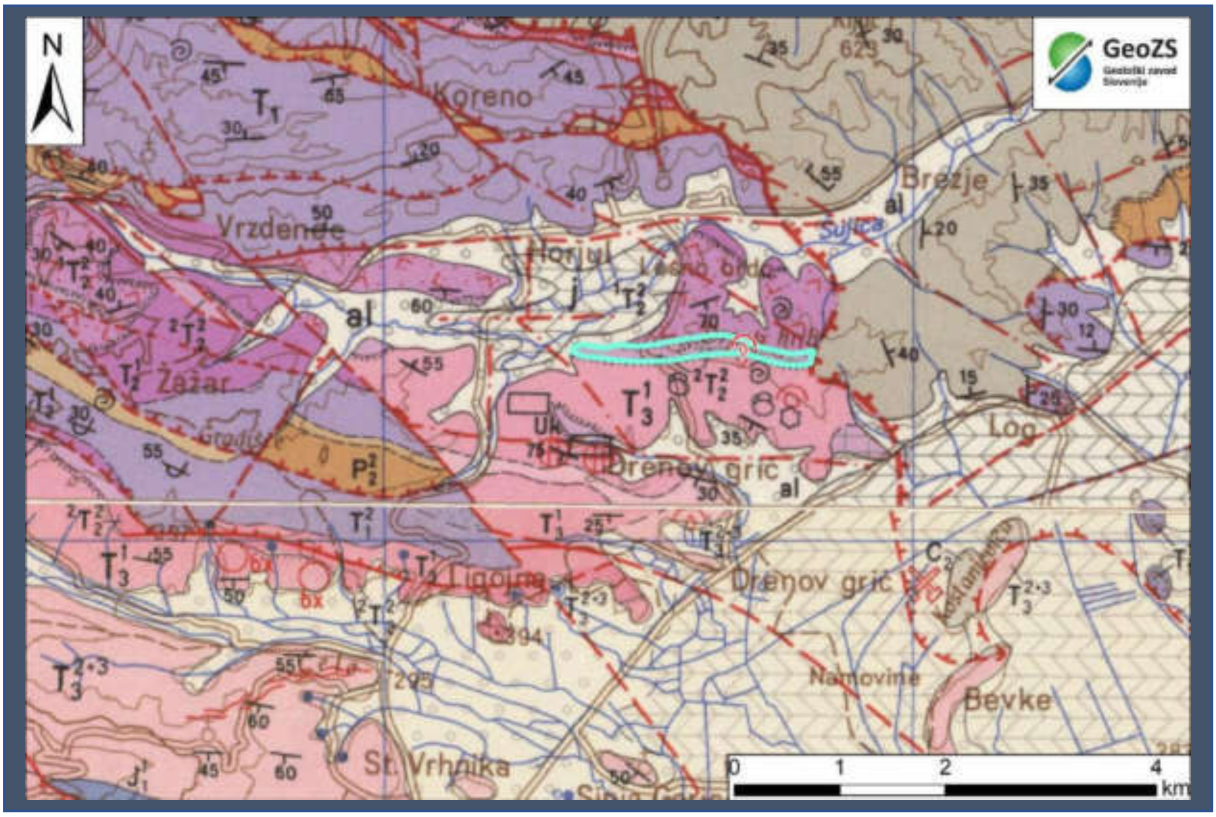


5 cm

Short description: Heterogeneous, variegated limestone with color transitions from grey and pinkish-grey to pink. Characteristic are frequent veins filled with reddish shale and claystone, and yellowish calcite. Larger nests are filled with lumps of bright calcite or yellowish dolomite crystals. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	multicoloured, pink	Slovenia	Notranjska (traditional province)	Vrhnika	Lesno Brdo

Geological setting



Geology: Non-bedded, massive limestone with remains of shallow-marine organisms (cyanobacteria, algae, sponges, corals and sea urchins) formed in reef setting in the Tethys ocean. Lesno Brdo limestone belongs to the same geological unit as pink and red Hotavlje limestone, but with lower degree of recrystallization). The productive horizon lies on clastic sediments and ends with Upper Triassic (Julian, Tuvalian) thin-bedded black limestone and variegated clastic sediments.

Production: Active, concessionaire MINERAL, obdelava naravnega kamna, d.o.o., exploitation site Lesno Brdo, mining right to exploitation of natural stone - limestone.

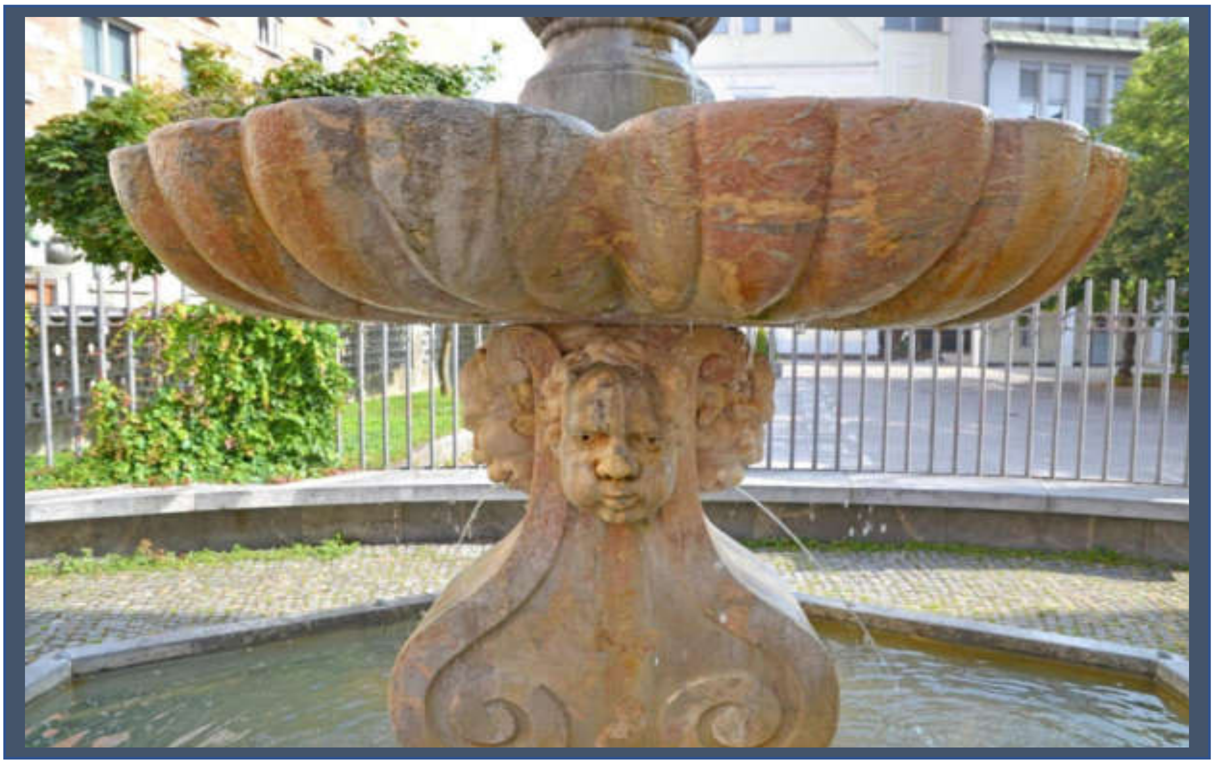
Geological age: Late Triassic (early Carnian, Cordevolian substage) (237-235 million years)
Geological unit: Cordevolian limestone of Outer Dinarides

Application, use and heritage

Description: The stones nice colour, high shine of polished surface and a very attractive appearance make the Lesno Brdo limestone a highly appreciated natural stone at home and abroad. Use: ornamental (internal and external) and building stone.

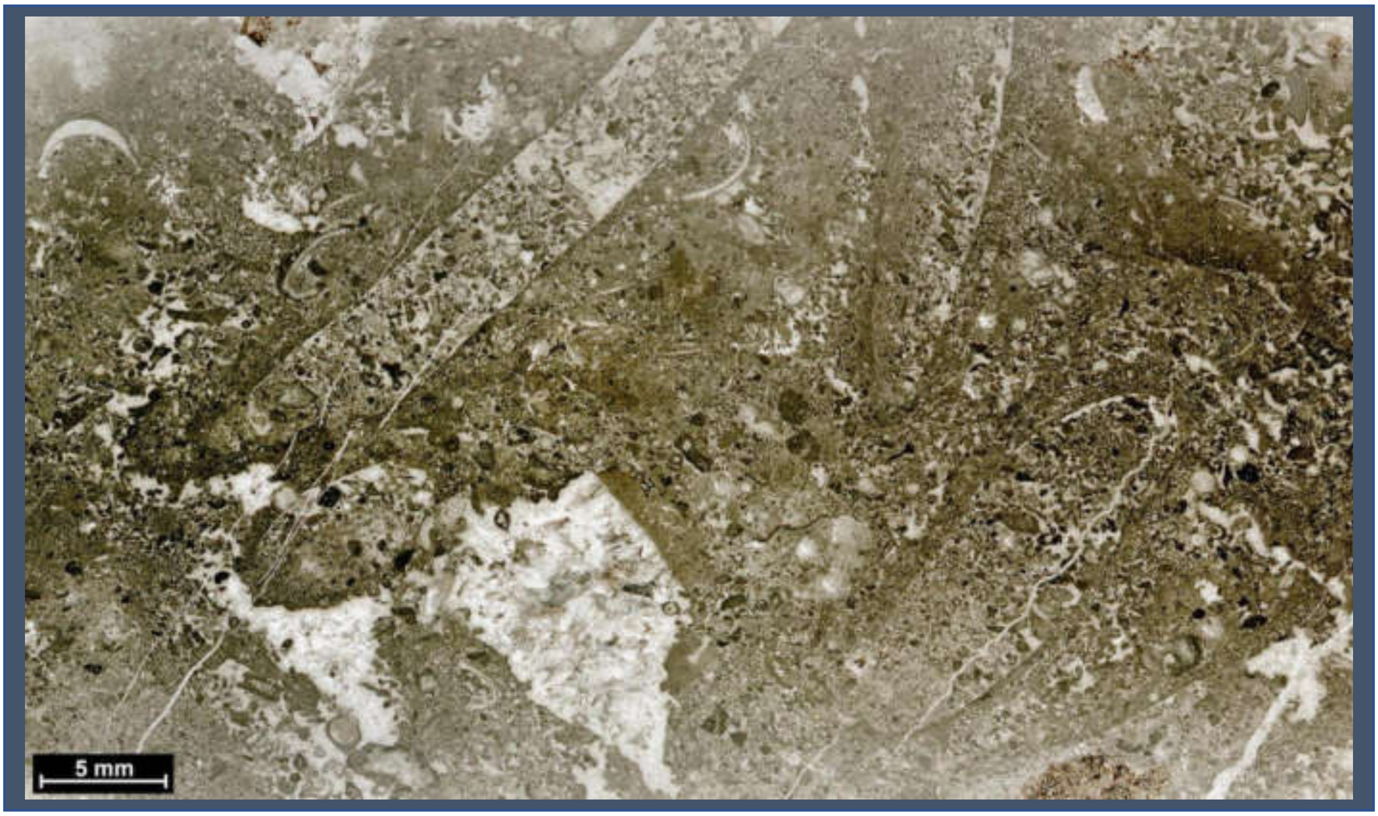
The renovated column of baroque Fountain of the Three Carniolan Rivers by Francesco Robba (1751) in Ljubljana is carved from Red Lesno Brdo limestone monolite. Renovated Plague Column (1890) in Ljubljana.

Narcissus Fountain by Francesco Robba in Ljubljana.



The bowl and its base with figures of the renovated Fountain of Neptune (1678) in Ljubljana are made of Red Lesno Brdo limestone.

Petrography



Description: Intrabiomicrosparite - mostly calcite grains in microsparite, Fe-oxides and hidroxides give red, rose and yellow color, green from tuffs. Many veins and lenses of white and yellow sparite calcite, and red, rose, green or white accumulations of dolomite, often partly or complitely calcitised. Veins filled with red and green marlstone, many fossil remains of algae, sponges, corals, gastropods, also intraclasts and pelets, some stylolites.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999; Ramovš, 2000.

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)	Pyrite (%)	Albite (%)
98	**in traces**	**in traces**	**in traces**	**in traces**	**In traces**	**In traces**

Source of information: Mirtič et al., 1999; Kramar et al., 2010.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	up to 1,5	52-55	-	-	-	-	-	up to 43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
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Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. RAMOVŠ, A. 2000. Podpeški in črni ter pisani lesnobrdski apnenec skozi čas. Ljubljana, Mineral. 115 pp. KRAMAR, S., MLADENOVIČ, A., UROŠEVIČ, M., MAUKO PRANJIĆ, A., PRISTACZ, H., MIRTIČ, B. 2010. Deterioration of Lesno Brdo limestone on monuments (Ljubljana, Slovenia). RMZ - Materials and geoenvironment : periodical for mining, metallurgy and geology, 57/1, 53-73.	
Other publication		

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

Lesno Brdo sivi

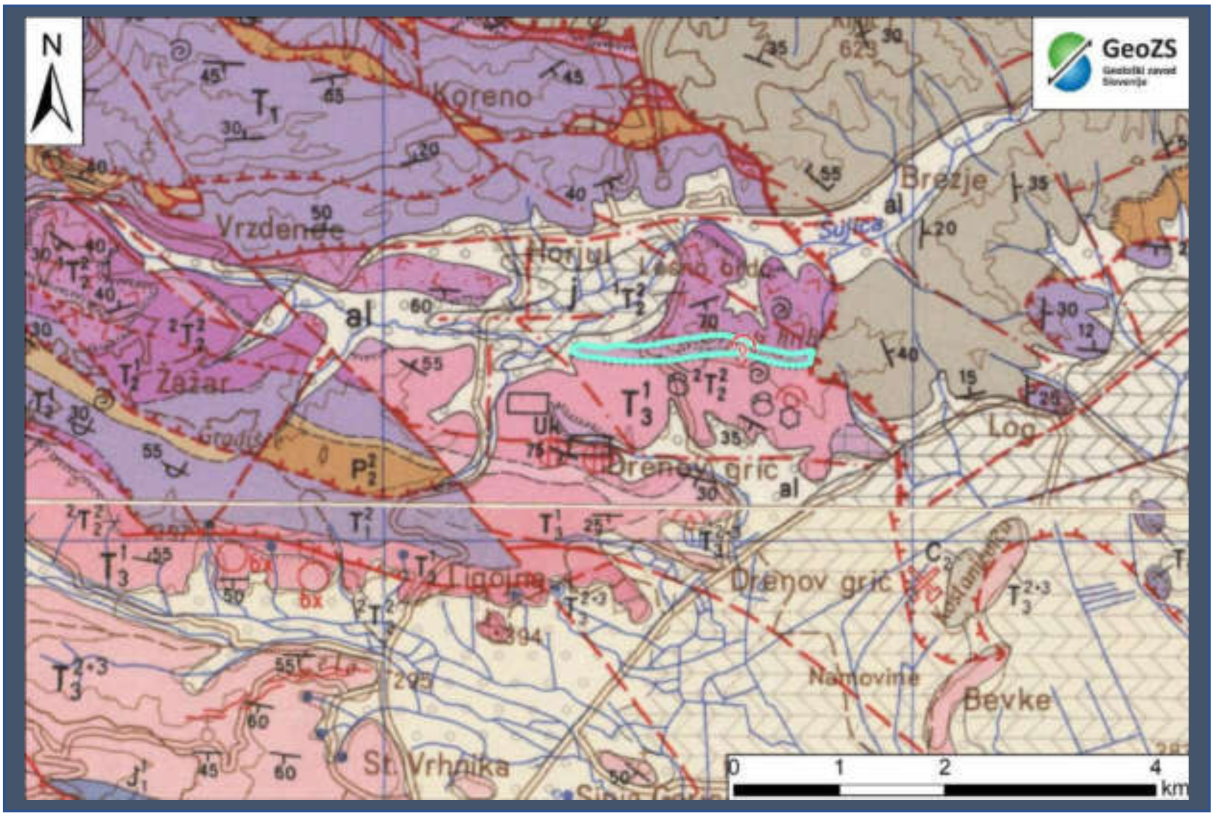
Grey Lesno Brdo limestone

4 cm

Short description: Heterogeneous, variegated limestone with color transitions from dark-grey and light-grey to pinkish-grey. Characteristic are frequent veins filled with yellowish calcite. Larger nests are filled with lumps of bright calcite or yellowish dolomite crystals. The image displays a polished surface.

Commodity (vocabulary)	**Lithology (vocabulary)**	**Typical colour (code list)**	**Place of origin**			
			Country	**County / District / Province**	**Municipality / Community**	**Place/town / Village**
limestone	limestone	multicoloured, grey	Slovenia	Notranjska (traditional province)	Vrhnika	Lesno Brdo

Geological setting



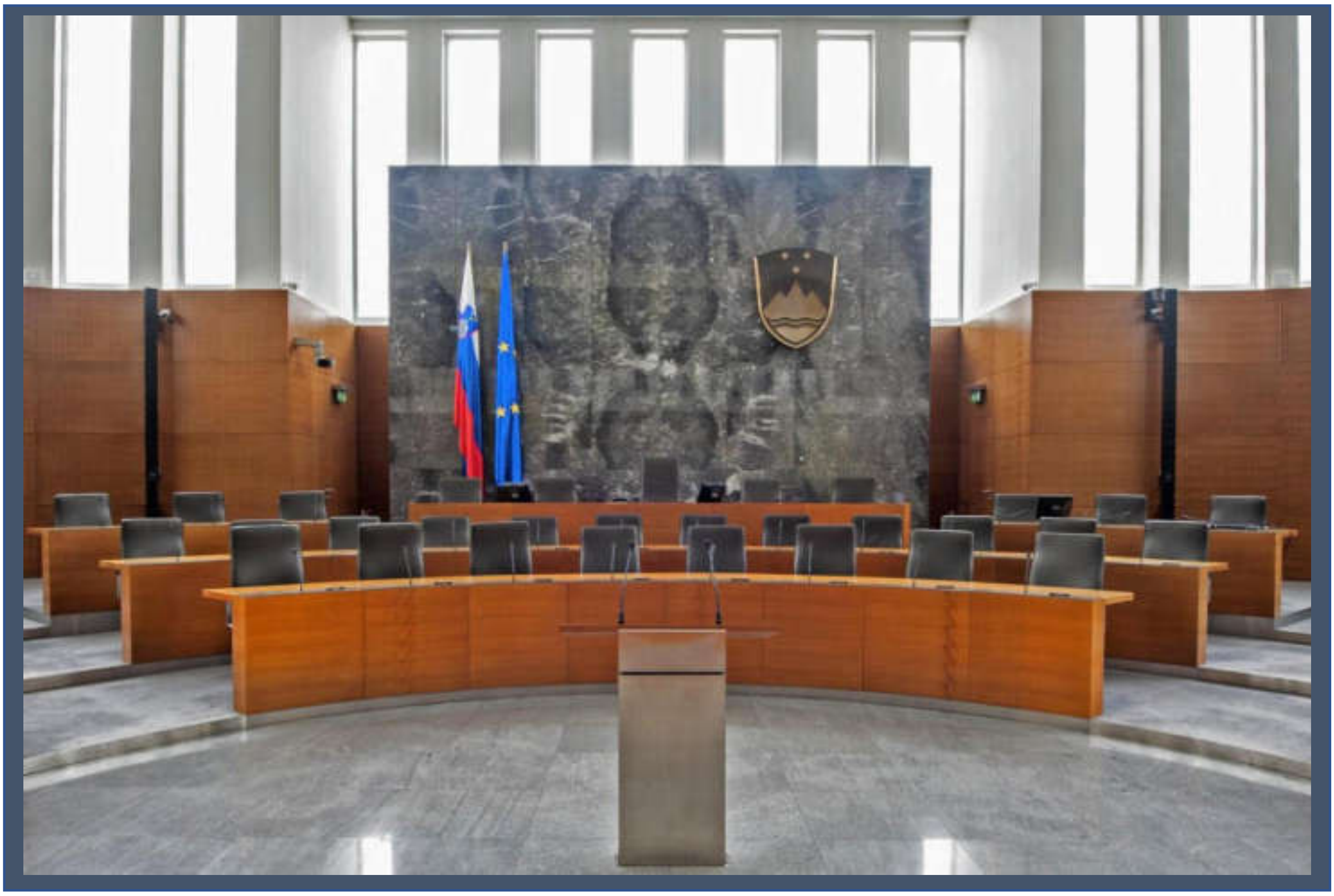
Geology: Non-bedded, massive limestone with remains of shallow-marine organisms (cyanobacteria, algae, sponges, corals and sea urchins) formed in reef setting in the Tethys ocean. Lesno Brdo limestone belongs to the same geological unit as pink and red Hotavlje limestone, but with lower degree of recrystallization). The productive horizon lies on clastic sediments and ends with Upper Triassic (Julian, Tuvalian) thin-bedded black limestone and variegated clastic sediments.

Production: Active, concessionaire MINERAL, obdelava naravnega kamna, d.o.o., exploitation site Lesno Brdo, mining right to exploitation of natural stone - limestone.

Geological age: Late Triassic (early Carnian, Cordevolian substage) (237-235 million years)
Geological unit: Cordevolian limestone of Outer Dinarides

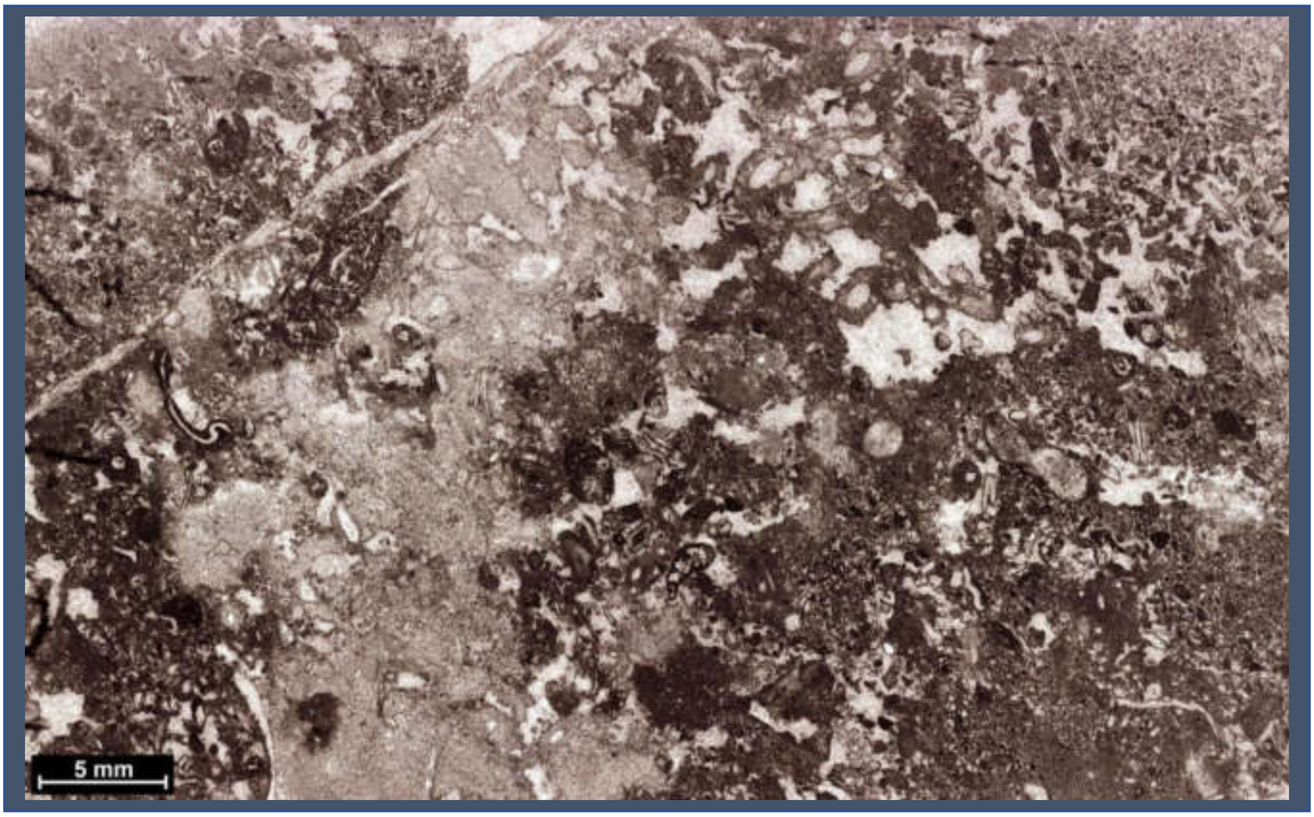
Application, use and heritage

Description: The stone´s nice colour, high shine of polished surface and a very attractive appearance make the Lesno Brdo limestone a highly appreciated natural stone at home and abroad. Use: ornamental (internal and external) and building stone.



The Great Hall of the Slovenian Parliament building in Ljubljana with large Grey Lesno Brdo limestone panels. Photo: Miran Kambič

Petrography



Description: Intrabiomikrosparite - mostly calcite grains in microsparite, Fe-oxides and hidroxides give red, rose and yellow color, green from tuffs. Many veins and lenses of white and yellow sparite calcite, and red, rose, green or white accumulations of dolomite, often partly calcified. Many fossil remains of algae, sponges, corals, gastropods, also intraclasts and pellets, some stylolites.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999; Ramovš, 2000.

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)	Pyrite (%)	Albite (%)
98	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**

Source of information: Mirtič et al., 1999; Kramar et al., 2010.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	up to 1,5	52-55	-	-	-	-	-	up to 43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

EUROLITHOS European Ornamental Stone Resources

GeoERA Raw Materials

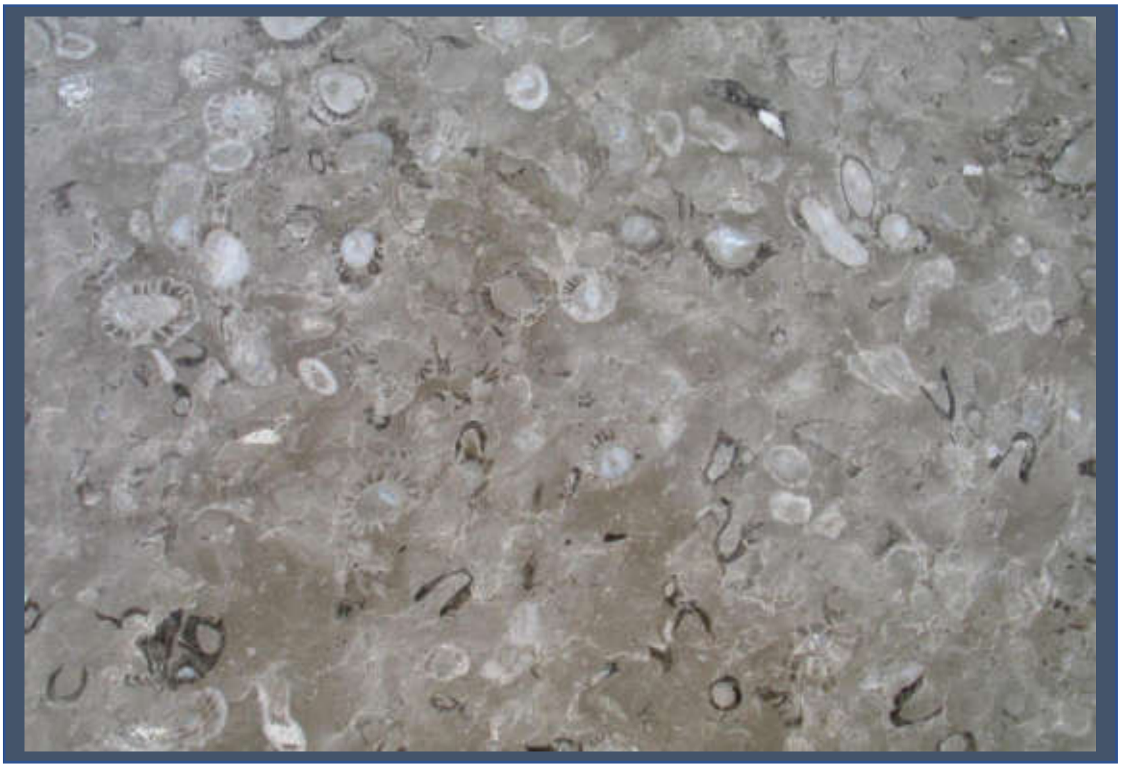
Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. RAMOVŠ, A. 2000. Podpeški in črni ter pisani lesnobrdski apnenec skozi čas. Ljubljana, Mineral. 115 pp. KRAMAR, S., MLADENOVIČ, A., UROŠEVIČ, M., MAUKO PRANJIĆ, A., PRISTACZ, H., MIRTIČ, B. 2010. Deterioration of Lesno Brdo limestone on monuments (Ljubljana, Slovenia). RMZ - Materials and geoenvironment : periodical for mining, metallurgy and geology, 57/1, 53-73.	
Other publication		

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

Lipica fiorito

Rožasti lipiški apnenec

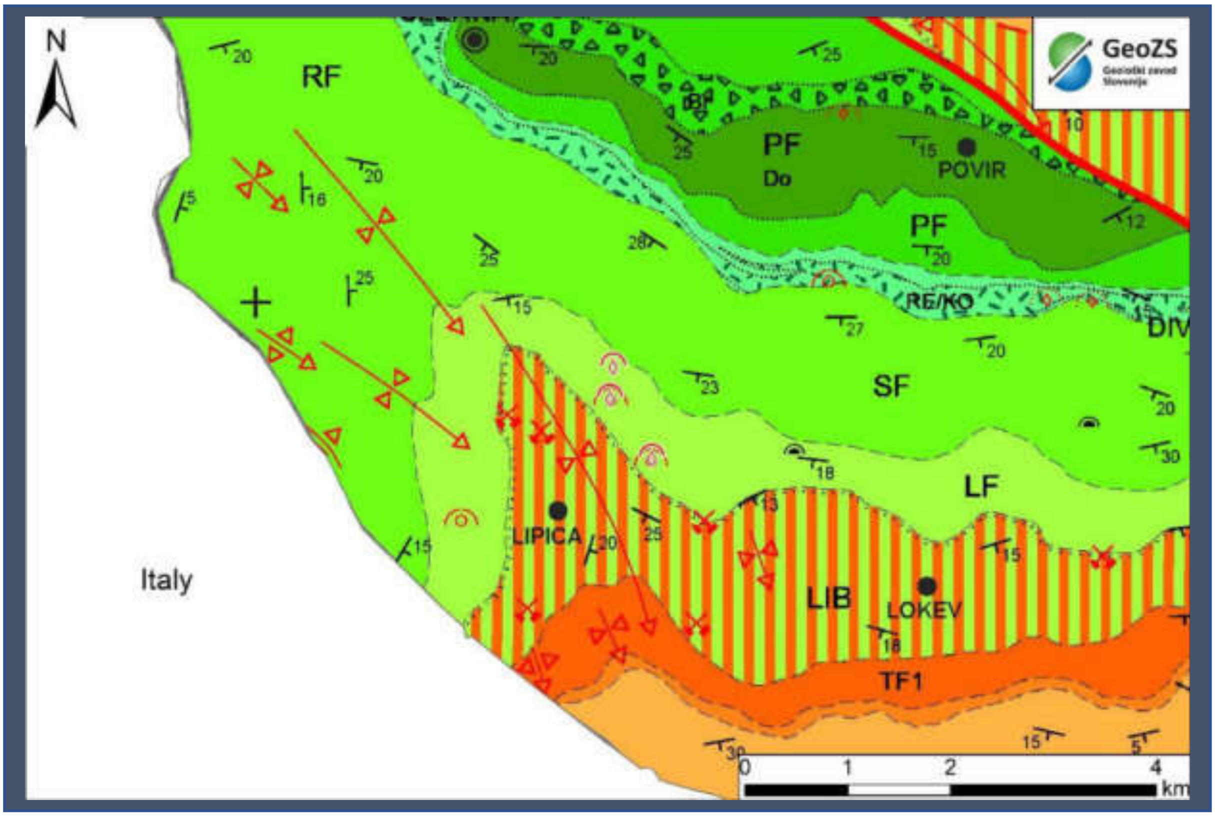


10 cm

Short description: Grey to light-grey fine-grained, stratified limestone with fossils remains (rudist shells) of different sizes and degrees of fragmentation. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	light-grey	Slovenia	Primorska (traditional province)	Sežana	Lipica

Geological setting



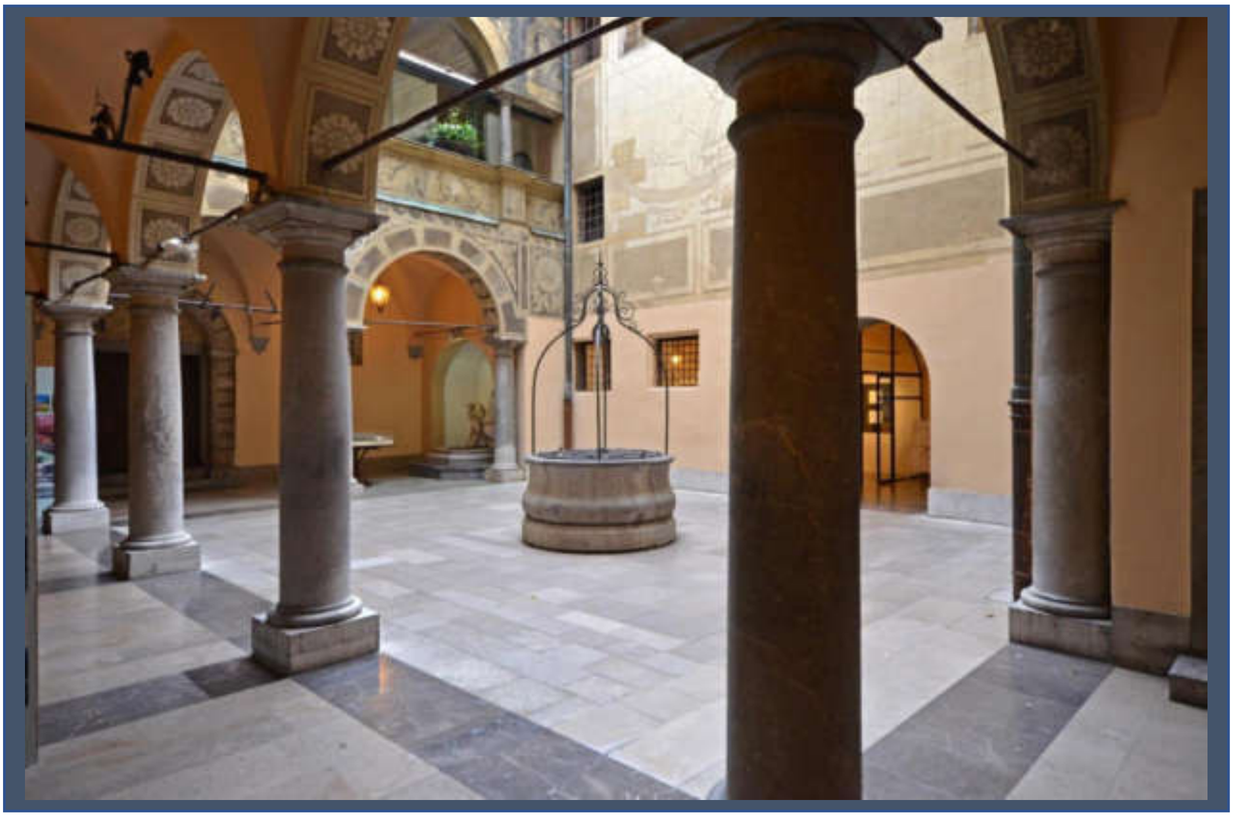
Geology: Rocks of the Lipica Formation (LF) were formed in the immediate vicinity of thickets of rudist bivalves in the shallow marine Adriatic-Dinaric Carbonate Platform and marginal areas of the Tethys Ocean during the Late Cretaceous period. The economically most promising part of the Lipica Formation lies in the north limb of the Lipica Syncline with an axis slightly plunging towards the southeast (Kras region, Trieste-Komen plateau, SW Slovenia).

Production: Active, concessionaire MARMOR Sežana, exploitation site Lipica I, mining right to extraction of natural stone - limestone. Lipica Fiorito (Italian for rose) type with flower-like cross-sections of whole rudist shells gradually passes into Lipica Unito (Italian for uniform) type of homogeneous, fine- or coarse-grained limestone with fragmented fossils of only a few millimetres.

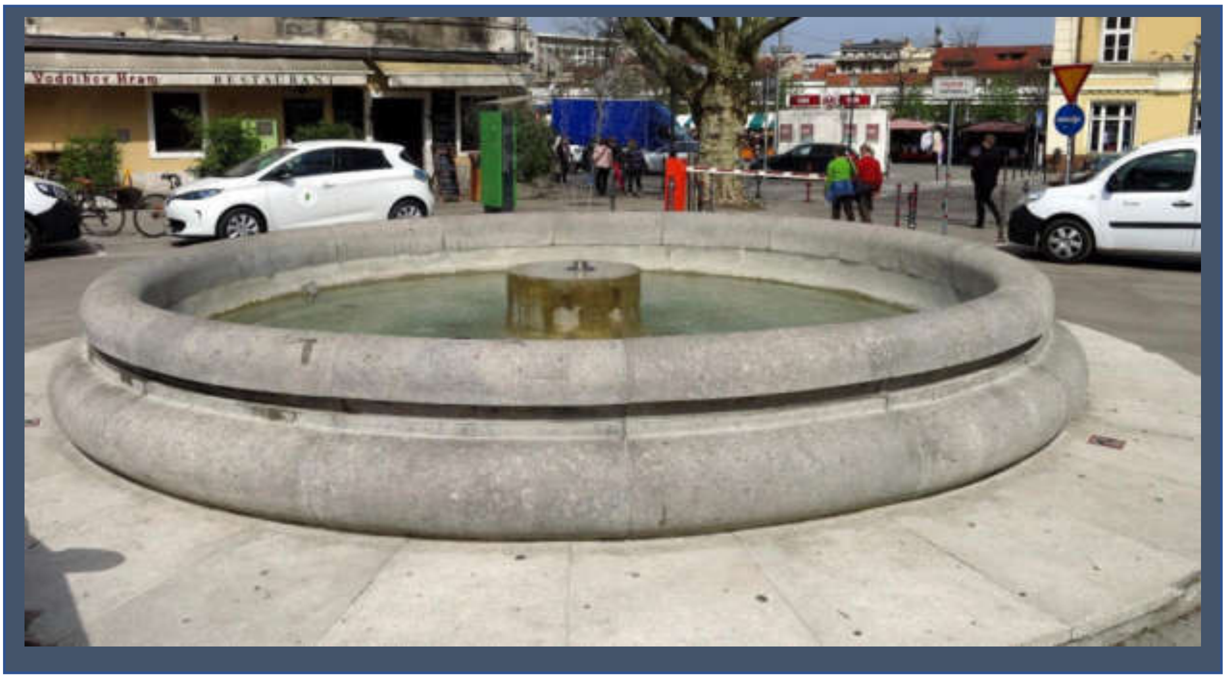
Geological age: Late Cretaceous (–late Santonian) (85 million years)
Geological unit: Lipica Formation (Upper Aurisina Fm. in Italy) of Outer Dinarides

Application, use and heritage

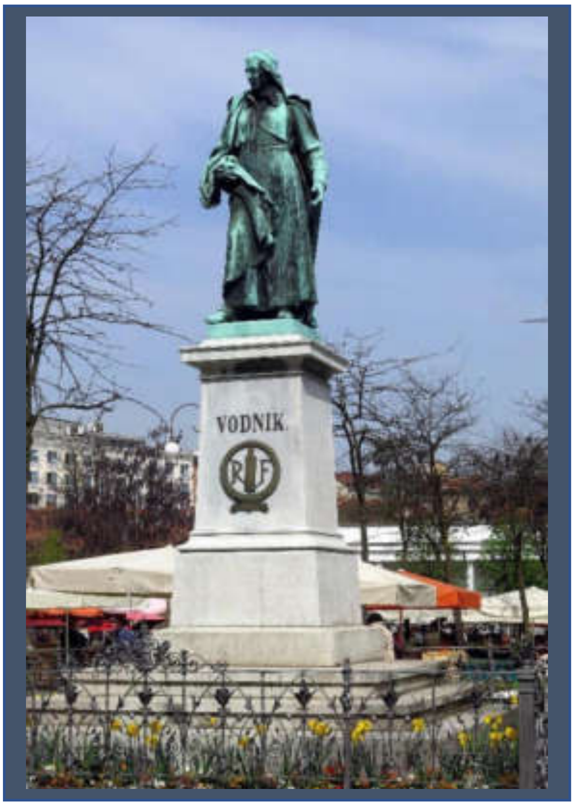
Description: Dimension (ornamental) stone, polished for internal use, unpolished for pavements (sidewalks). Architectural elements, fountains, benches, tables, stoneware etc.



Central atrium of the Ljubljana Town Hall (1718) is paved with light-coloured Lipica fiorito limestone.



Large fountain in Ljubljana city centre is made of Lipica fiorito limestone blocks.



The pedestal of the Slovenian poet Valentin Vodnik statue (1889) in Ljubljana is made of Lipica fiorito limestone blocks.

Petrography

Description: Fine-grained, fossiliferous limestone. In homogenous matrix numerous rudists of different sizes, dark and oriented parallel to bedding. Recrystallized biomicritic texture of micrite with microgranular fossil fragments filling out the spaces between bigger fossil remains. Besides rudists, limestone often contains foraminifers, sponges, hydrozoans, echinoderms and gastropods.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999; Jurkovšek et al., 2013.

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)
99,5	**in traces**	**in traces**	**in traces**	**in traces**

Source of information: Mirtič et al., 1999.

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**

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	0,8	55	-	-	-	-	-	43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. JURKOVŠEK, B., CVETKO TEŠOVIĆ, B., KOLAR-JURKOVŠEK, T. 2013. Geologija Krasa = Geology of Kras. Ljubljana: Geološki zavod Slovenije, 205 pp. JEŽ, J. et al. 2015. Platy limestone – geological definition and its use as a mineral commodity. Project RoofOfRpock Final report for the project area in Slovenia. Geological Survey of Slovenia, 122 pp. (https://roofofrock.geo-zs.si/Publication/pages/platy-limestone/supplements/appendix-2-2.pdf)	
Other publication		

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

Lipica unito

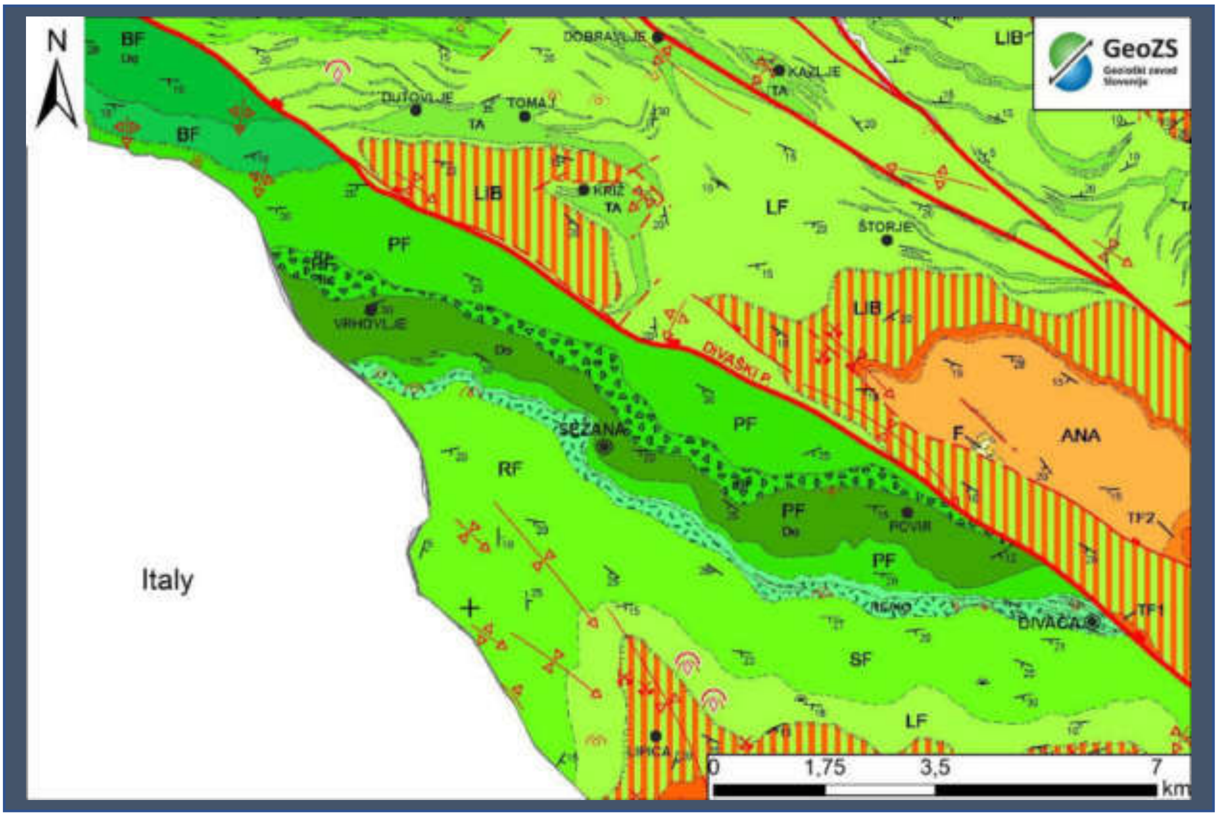
Enotni lipiški apnenec

5 cm

Short description: Light-gray stratified homogeneous compact coarse-grained limestone with small bioclasts (fine-grained limestone breccia of organic origin). The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	light-grey	Slovenia	Primorska (traditional province)	Sežana	Lipica

Geological setting



Geology: Rocks of the Lipica Formation (LF) were formed in the immediate vicinity of thickets of rudist bivalves in the shallow marine Adriatic-Dinaric Carbonate Platform and marginal areas of the Tethys Ocean during the Late Cretaceous period. The economically most promising part of the Lipica Formation lies in the north limb of the Lipica Syncline with an axis slightly plunging towards the southeast (Kras region, Trieste-Komen plateau, SW Slovenia).

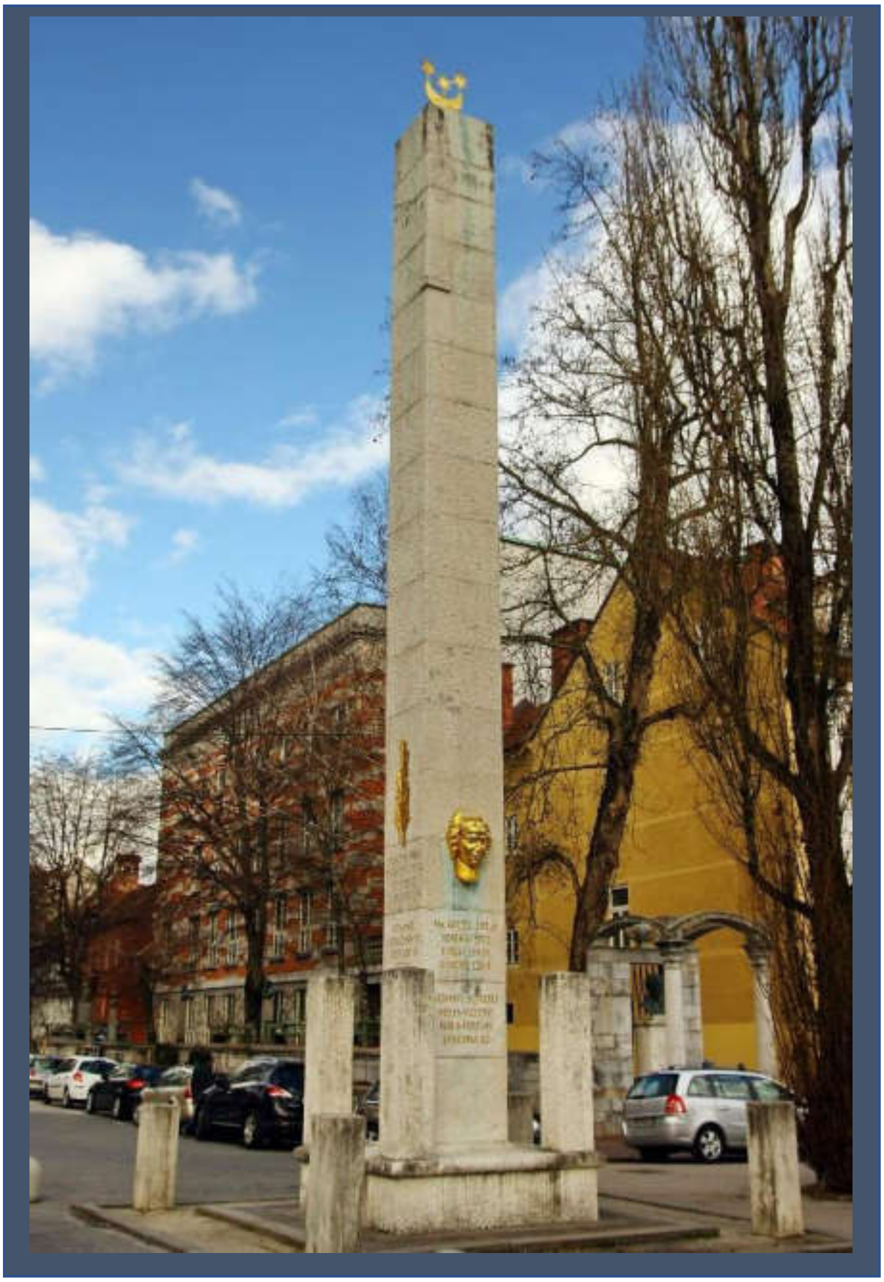
Production: Active, concessionaire MARMOR Sežana, exploitation site Lipica II, mining right to extraction of natural stone - limestone. Lipica Unito (Italian for uniform) type of homogeneous, fine- or coarse-grained limestone with fragmented fossils of only a few millimetres gradually passes into Lipica Fiorito (Italian for rose) type with flower-like cross-sections of whole rudist shells.

Geological age: Late Cretaceous (–late Santonian) (85 million years)

Geological unit: Lipica Formation (Upper Aurisina Fm. in Italy) of Outer Dinarides

Application, use and heritage

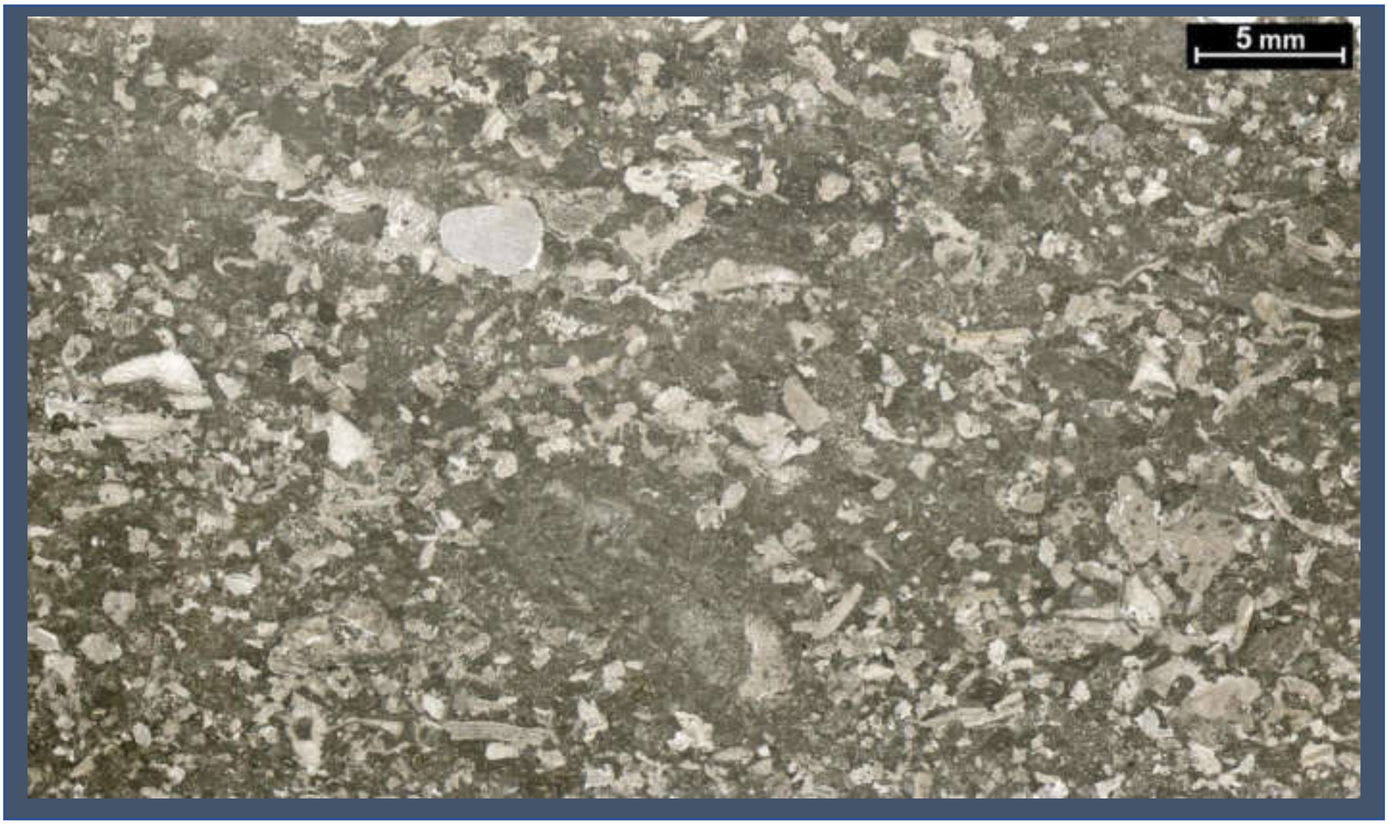
Description:
Dimension (ornamental) stone, polished for internal use, unpolished for pavements (sidewalks). Architectural elements, fountains, benches, tables, stoneware, sculptures etc. Organic matter and clay (dark parts) have negative effect on the stone value. Used in architectural projects abroad, e.g. Almas Tower, Dubai (UAE)



Napoleon's Illyria Pillar (1929) at the French Revolution Square in Ljubljana is built of light-coloured Lipica unito limestone blocks.

5,000 m2 of interior flooring in Almas Tower (2010) in Dubai (UAE) and external panels of Institute of Pediatric Research Città della Speranza (2011) in Italy are made of Lipica unito limestone. Photos courtesy of Marmor Se

Petrography



Description: Recrystallized biomicritic texture with microgranular skeletal fragments filling the space between bigger (up to 2 mm) fossil remains. In places dark areas of organic matter. Fine-grained, fossiliferous limestone. In homogenous matrix numerous rudists of different sizes, dark and oriented parallel to bedding. Besides rudists, limestone often contains foraminifers, sponges, hydrozoans, echinoderms and gastropods.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999; Jurkovšek et al., 2013.

Mineral composition

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

Calcite (%)	Dolomite (%)	Clay minerals (%)	Quartz (%)	Limonite minerals (%)
99,5	**in traces**	**in traces**	**in traces**	**in traces**

Source of information: Mirtič et al., 1999.

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	0,8	55	-	-	-	-	-	43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. JURKOVŠEK, B., CVETKO TEŠOVIĆ, B., KOLAR-JURKOVŠEK, T. 2013. Geologija Krasa = Geology of Kras. Ljubljana: Geološki zavod Slovenije, 205 pp.	
Other publication		

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

Peračiški tuf

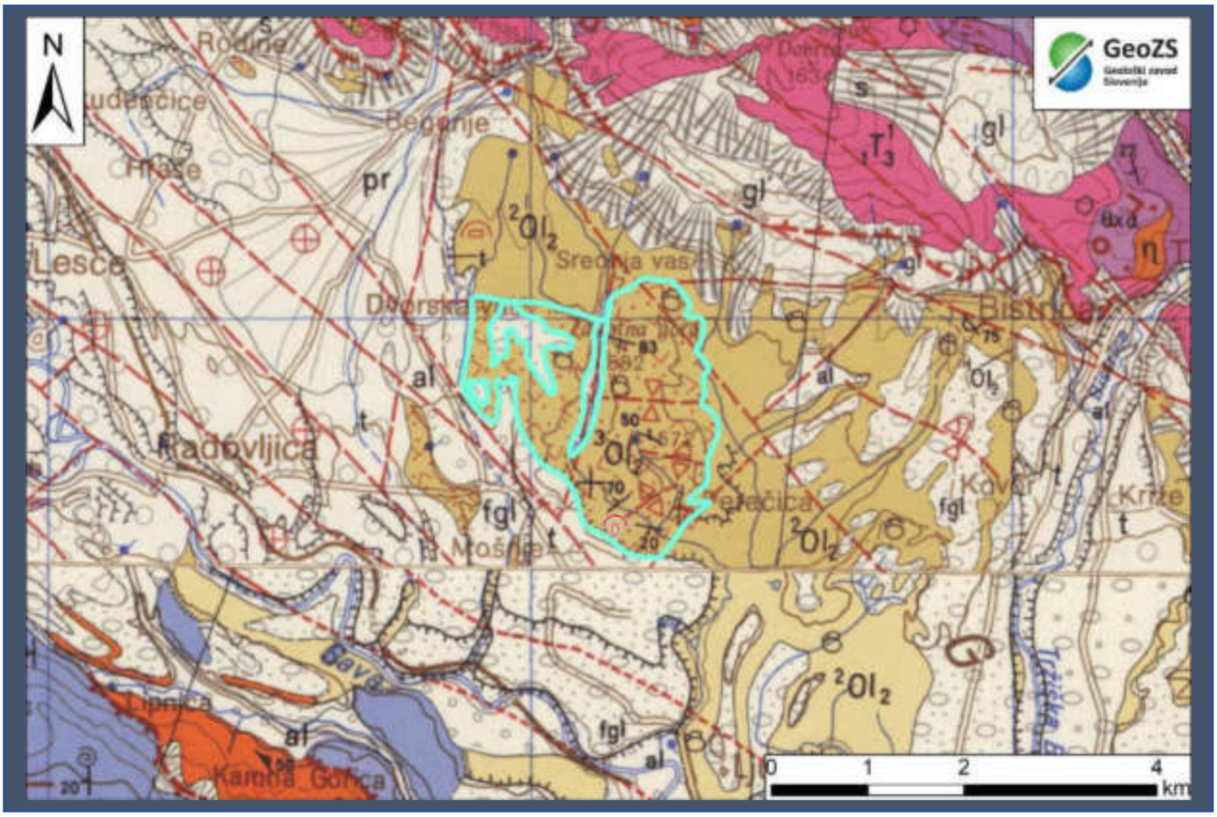
Peračica tuff

4 cm

Short description: Soft andesitic tuff of green color, in places brown due to carbonatization, easily weathered. It occurs in lapilli-, coarse- and fine-grained varieties. The image shows rough surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
miscellaneous	andesite tuff (pietra verde)	green	Slovenia	Gorenjska (traditional province)	Radovljica	Radovljica

Geological setting



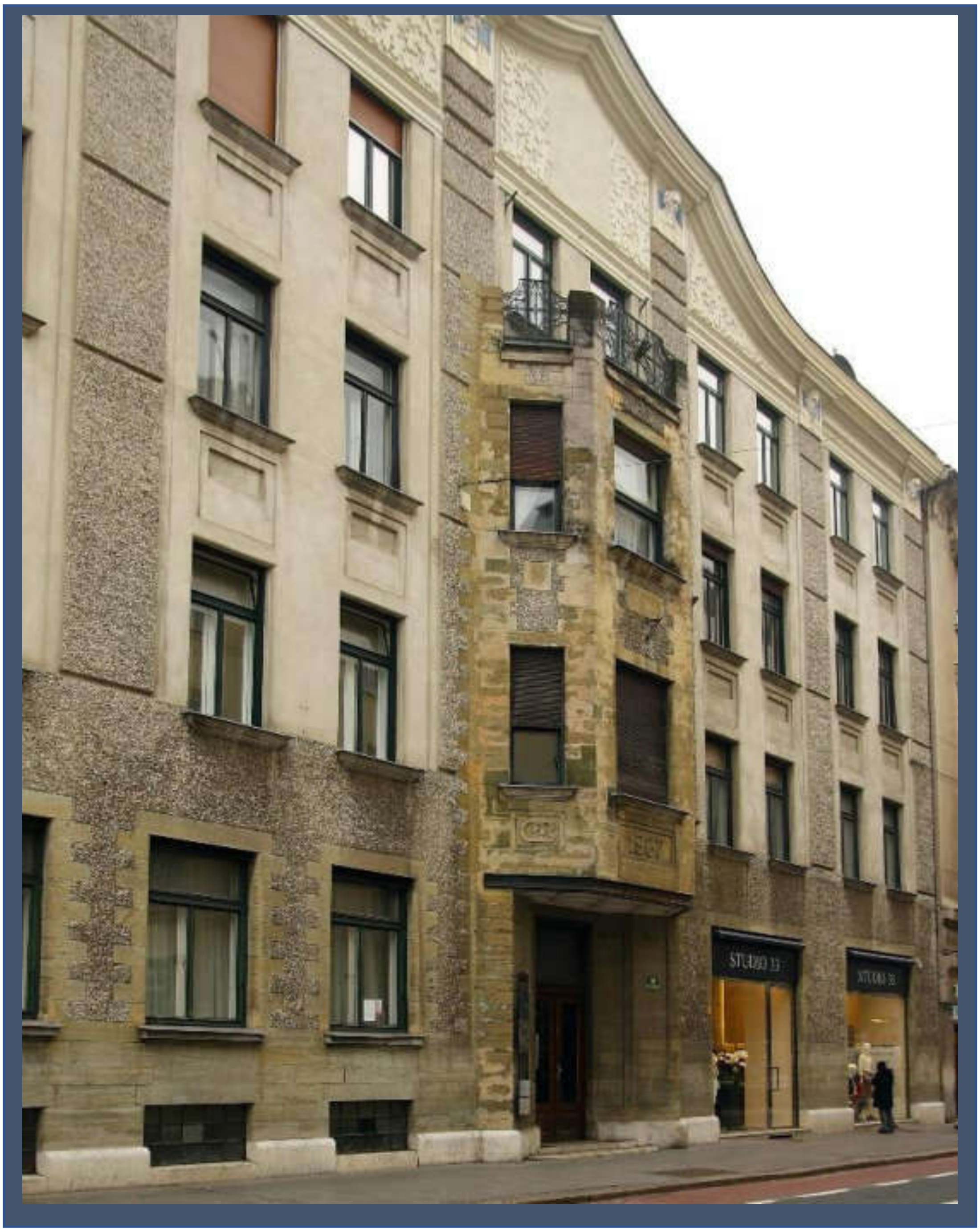
Geology: Pyroclastic andesitic tuff is part of the Oligocene Smrekovec volcanic complex.

Production: No (abandoned quarries: Bogataj, Klinar and Pernuš quarry).

Geological age: Oligocene (25 million years)
Geological unit: Smrekovec volcanic complex of the Pannonian basin geotectonic unit.

Application, use and heritage

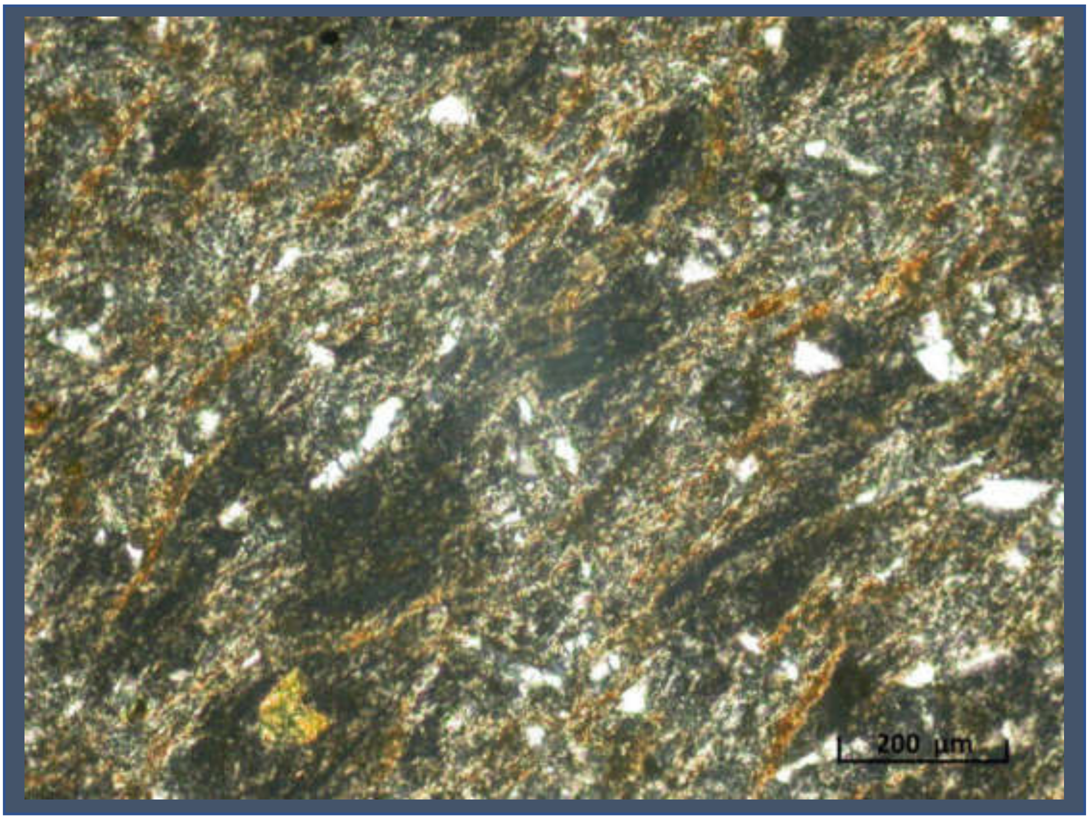
Description: Due to the softness of the rock and its colour, tuff was exploited from the Roman times and especially in the 16th century. It is named Peračica tuff after quarries in the valley of Peračica creek near Brezje. It strongly characterises the architecture of the Gorenjska area where it is used mostly for architectural elements, tombstones, portals.



The cladding on the ground floor and the oriel above the entrance of the Neo-Baroque Bamberg house (1907) in Ljubljana are made of green andesitic Peračica tuff.

Country house in Zgornja Besnica with entrance portal, window frames and benches made of Peračica tuff.

Petrography



Description: The rock contains plagioclases, pyroxene, quartz, zeolites, micas and analcime. Green color is from chlorite which substitutes primary biotite. Both, the fine-grained and coarser-grained lapilli tuff occurs. The rock on the figure is intensively llimonitised. Photo: Mateja Košir

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999, Kralj, P. 2009, Košir, 2011.

Mineral composition

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

Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)

Source of information:

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

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	

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		

Source of information:

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. KRALJ, P. 2009. Tertiary volcanic formations. In: PLENIČAR, M. et al. (Eds.), The Geology of Slovenia. Geološki zavod Slovenije, 503-514. KOŠIR, M. 2011. Izvor piroklastičnih kamnin z arheološkega najdišča Mošnje : diplomsko delo = Provenance of pyroclastic rocks from archaeological site Mošnje Diploma thesis. University of Ljubljana, Faculty of Natural Sciences and Engineering, Ljubljana, 74 pg.	
Other publication		

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

Peščenjak

Jelarji sandstone

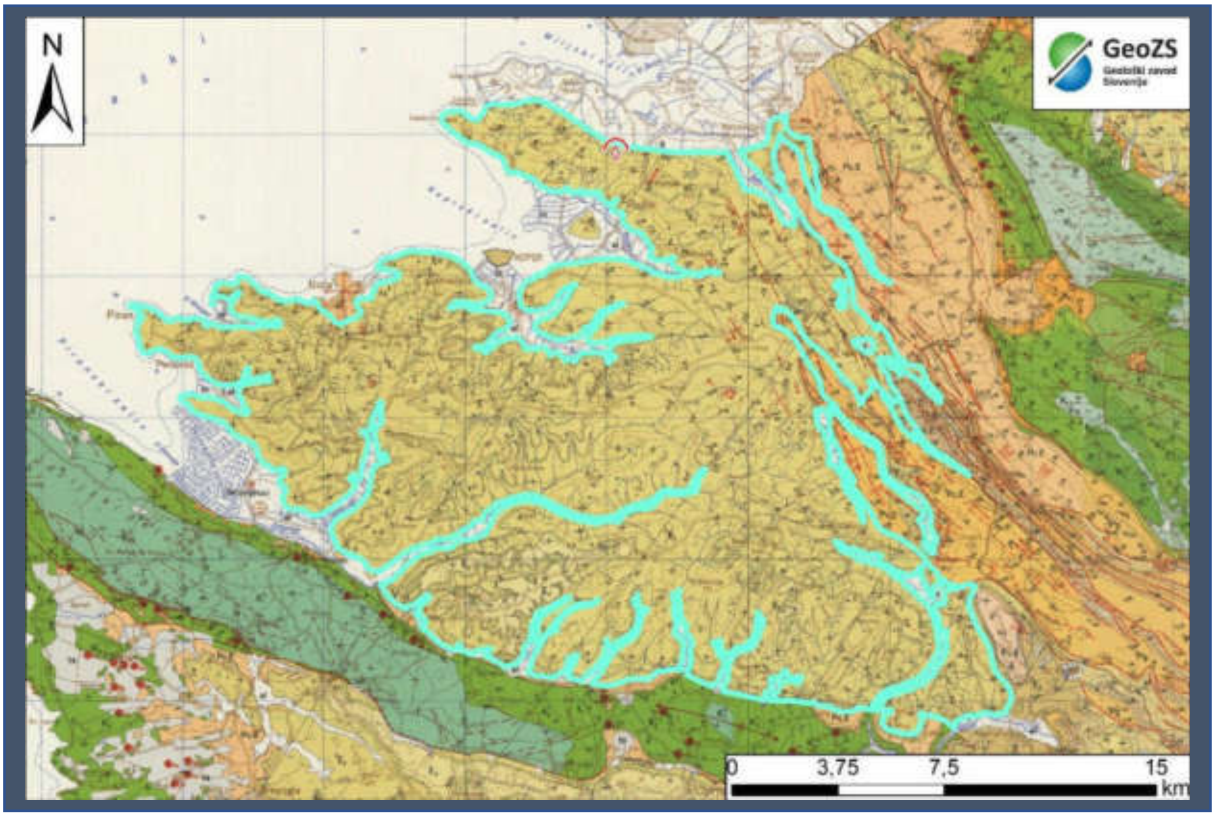
Peščenjak Jelarji

5 cm

Short description: Grey to brownish and bluish-grey thick-bedded uniformly fine-grained sandstone. The image displays a rough surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
sandstone	Lithic graywacke	grey	Slovenia	Primorska (traditional province)	Koper	Jelarji

Geological setting



Geology: Beds of greywacke type sandstone, alternating with marlstone, are integral parts of the Paleogene flysch sequence of the Paleogene Adriatic Carbonate Platform.

Production: No. Abandoned quarry Elerji (formerly named Jelarji) at Sečovlje (N Istria).

Geological age: Middle Eocene, late Lutetian (41 million years)
Geological unit: Eocene flysch of Adria Microplate

Application, use and heritage

Description: Due to easy excavation and cutting it has been used for centuries and is nowadays adorning most old Istrian city centers and squares, while also being known abroad. Owing to its frost resistance it is appropriate for covering internal and external surfaces. It is mostly used for external surfaces, such as pavements, walls, steps, window sills, door frames, building blocks, and cladding.

Tartini Square in Piran on the N Istrian coast is paved with Jelarji sandstone. Photo: Grega Pirc

Walkway along Breg embankment of Ljubljanica river in Ljubljana is paved with Jelarji sandstone.

Private residence in Puče in Slovenia Istria built with blocks of Jelarji sandstone.

Petrography

Description: Sandstone with mostly limestone and monocrystal quartz grains, some lithic grains of volcanic and metamorphic rocks, siltstones and chert, with sparite calcite cement.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999.

Mineral composition

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

Calcite (%)	Quartz (%)	Dolomite (%)	Feldspars (%)	Mica (glauconite) (%)	Pyrite (%)	Organic matter (%)
15-35 (lim. grains) + 15 (matrix)	**25-40 (monocrystals), 5-10 (mycrocrystals)**	**few %**	**few %**	**few %**	**few %**	**few %**

Source of information: Mirtič et al., 1999.

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

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	

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		

Source of information:

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
24-40	10-18	1-3	-	0,8-1,2	26-30	-	-	-	-	-	30

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: JUS B.H 360 to 369
Mirtič et al., 1999.

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., MLADENOVIČ, 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. RUDA 3 trade and engineering website: https://www.ruda3.si/en	
Other publication		

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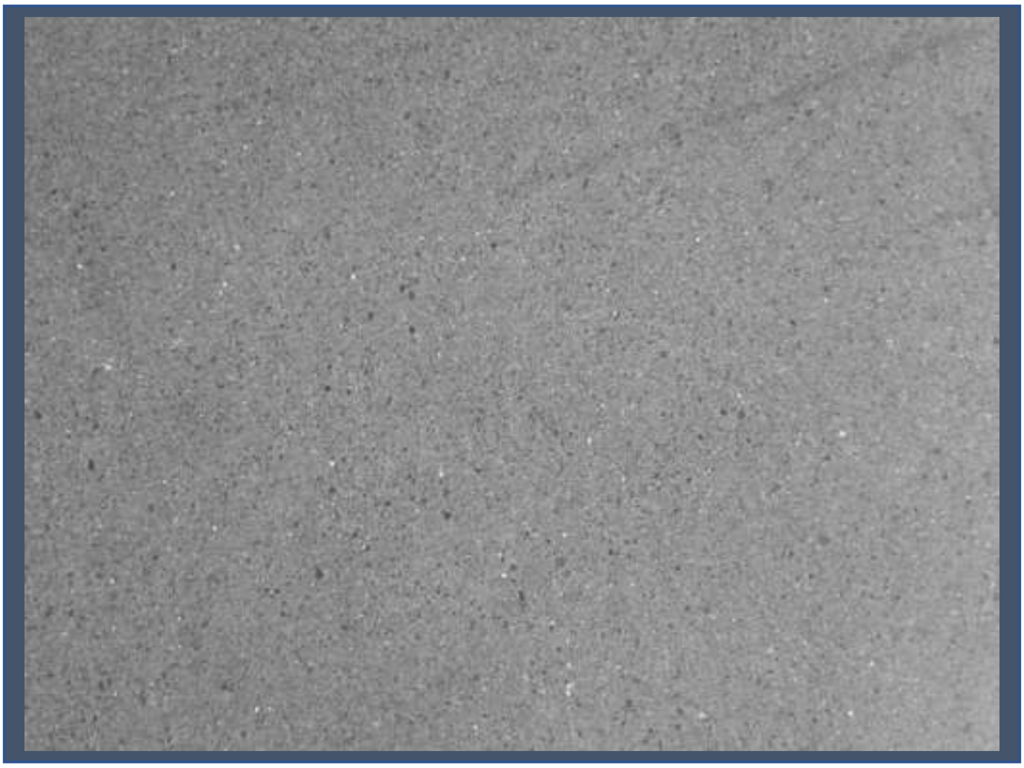
Peščenjak

Poljane-Puče sandstone

Peščenjak Poljane-Puče

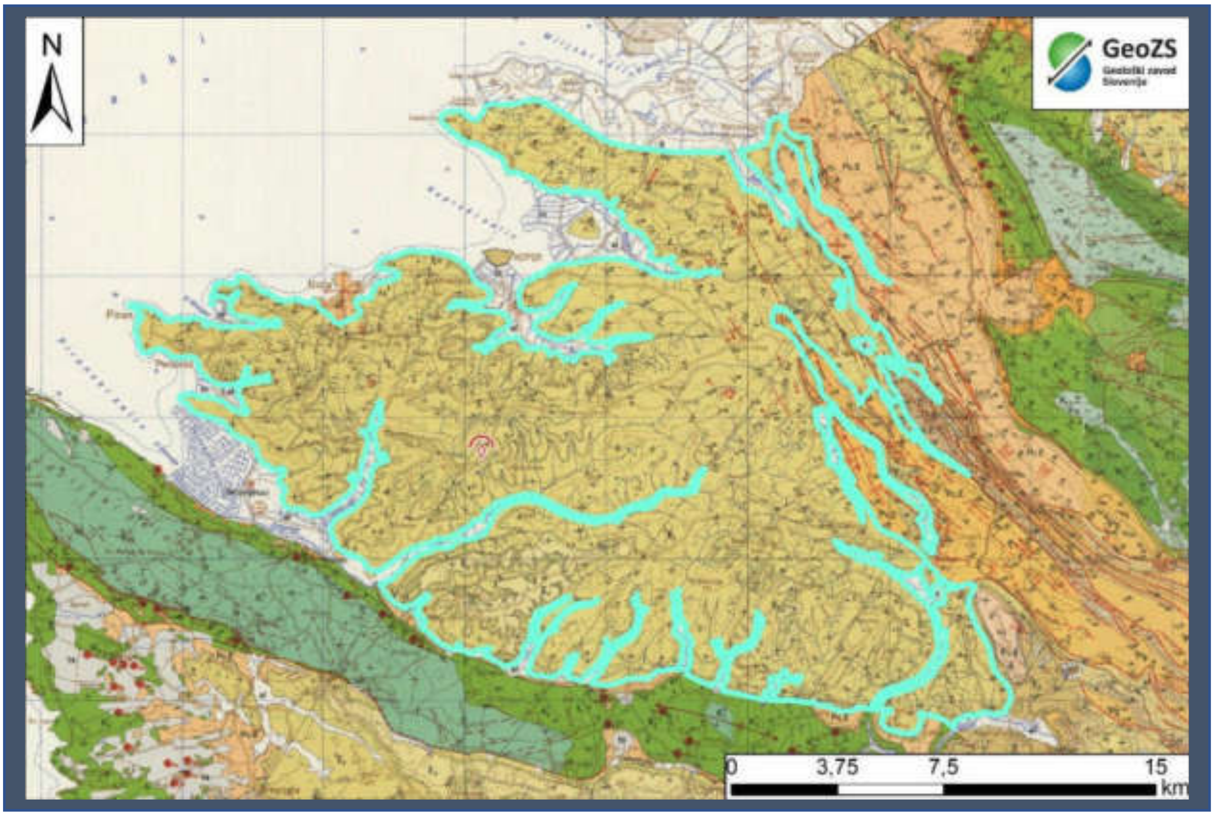


4 cm

Short description: Gray to brownish thick bedded uniformly fine-grained flysch sandstone.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
sandstone	Lithic graywacke	grey	Slovenia	Primorska (traditional province)	Koper	Poljane-Puče, Sečovlje

Geological setting



Geology: Coastal Dinaric flysch - Beds of greywacke type sandstone, alternating with marlstone, are integral parts of the Paleogene flysch sequence of the Paleogene Adriatic Carbonate Platform.

Production: No (abandoned quarries)

Geological age: Tertiary (Eocene)
Geological unit: Eocene flysch of Adria Microplate

Application, use and heritage

For photographs of use see ***Peščenjak (Elerji)***

Description: The sandstone is used for pavements, building and cladding.

Petrography

For microphotograph see ***Peščenjak (Elerji)***

Description: Sandstone with mostly limestone and monocrystal quartz grains, some lithic grains of volcanic and metamorphic rocks, siltstones and shert, with sparitic calcitic cement.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999.

Mineral composition

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

Calcite (%)	Quartz (%)	Dolomite (%)	Feldspars (%)	Mica (glauconite) (%)	Pyrite (%)	Organic matter (%)
25-40 (lim. grains) + 15 (matrix)	**25-35 (monocrystals), 8-10 (mycrocrystals)**	**few %**	**few %**	**few %**	**few %**	**few %**
Lithic grains of volcanic, metamor. rocks and aleurite (%)						
10-20%						

Source of information: Mirtič et al., 1999.

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

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	

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		

Source of information:

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
30	10	1	-	0,8-4	25-35	-	-	-	-	-	30

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: JUS B.H 360 to 369
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
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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., MLADENOVIČ, 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.	
Other publication		

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Podpeški apnenec

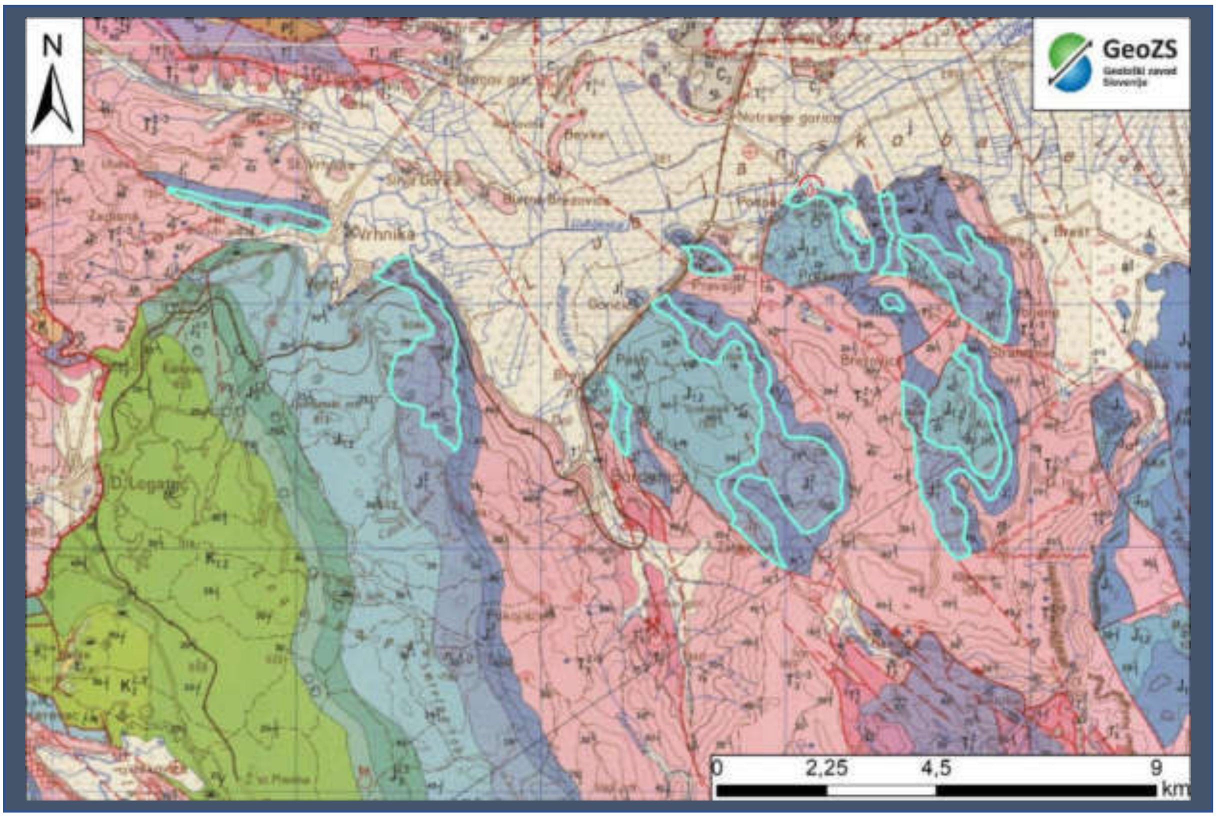
Podpeč limestone

20 cm

Short description: Dark grey or black limestone of high decorative appearance due to the contrasting white colour of its fossil remains of large lithiotid shells. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	dark-grey	Slovenia	Notranjska (traditional province)	Brezovica	Podpeč

Geological setting



Geology: Palaeogeographically the Lithiotis Horizon is situated within the shallow-water lagoonal facies of the Dinaric Carbonate Platform. The Podpeč limestone is interstratified within ooidal limestones.

Production: No. Abandoned quarry at northern foothill of Mount Krim (Sv. Ana).

Geological age: Lower Jurassic (Pliensbachian) (190-180 million years)
Geological unit: Outer Dinarides – middle Lower Jurassic limestone and dolomite, Lithiotis Horizon

Application, use and heritage

Description: Designated GHSR in 2017 (Kramar et al., 2015), natural monument since 1991, geological monument of national importance since 2004. Historic use is more than 50 years, with quarrying during the Roman time, as well as in 17th and 20th centuries.

Podpeč limestone has been utilized as cut building blocks, slabs for interior use, sculpting stone and for monuments.

The internationally renowned Slovenian architect Jože Plečnik (1872-1957) used Podpeč limestone in various buildings – some of them are the Central Stadium in Ljubljana, the faculty of Natural Sciences and Technology of the University of Ljubljana, the National and University Library (1937-1941), many altars and churches…

Podpeč limestone with fossil shells in remains of ancient Roman Emona (present-day Ljubljana).

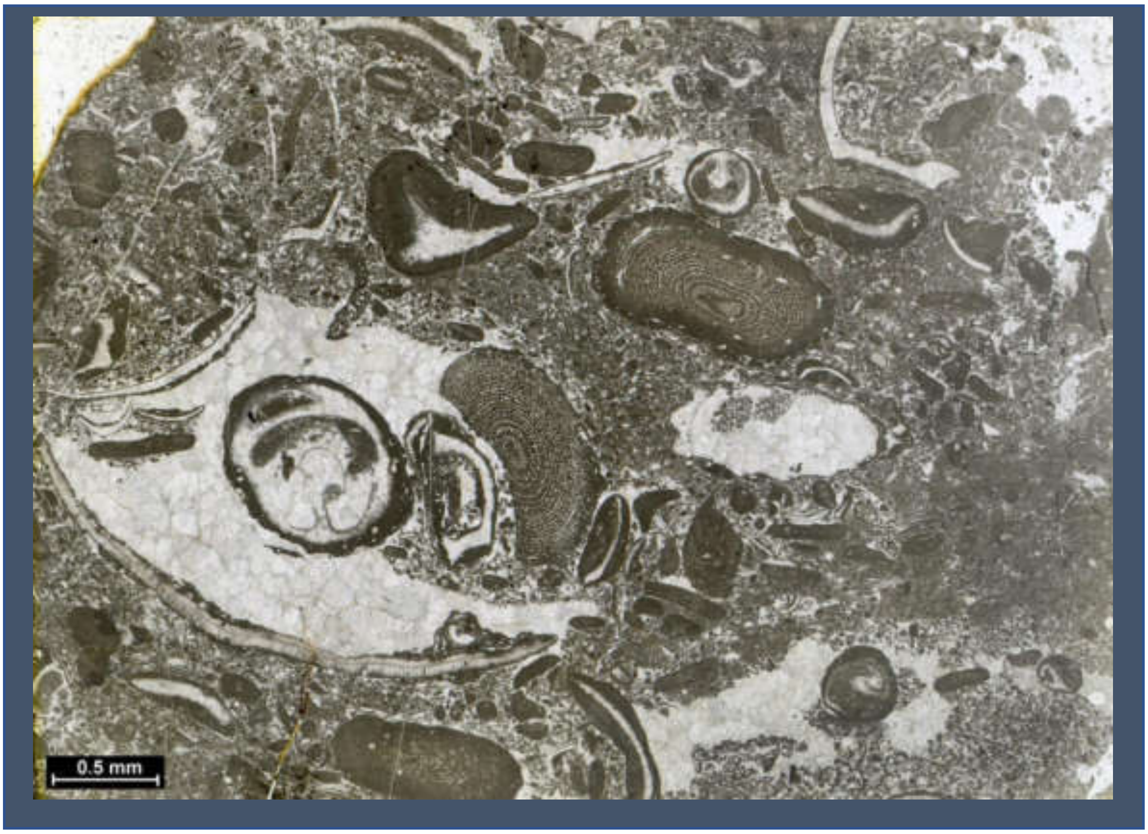
Podpeč limestone blocks in the Plečnik's National and University Library in Ljubljana

Colonnade staircase of the National and University Library in Ljubljana.

Ursuline Church of the Holy Trinity in Ljubljana.

Plečnik's Church St. Michael (1940) in Črna vas.

Petrography



Description: Calcite, with the limestone being black in colour due to the presence of organic matter, and white in colour due to the pure low-Mg-calcite (sparite) fossil bivalves (*Lithiotis*, *Cochlearites* and *Lithioperna* are characteristic). Some shells are dolomitized. Quartz also occurs as terrigenous grains.

Podpeč limestone occurs in many varieties. Besides the most typical micrite limestone with lithiotids, dark grey micrite with brachiopods, and brownish oncolite and oolite with gastropods and foraminifer *Orbitopsella* are most common. Upper images display a polished surface.

Source of information: Geological Survey of Slovenia, Buser & Debeljak, 1996; Kramar et al., 2015.

Mineral composition

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

Calcite (%)	Dolomite (%)	Organic matter (%)	Quartz (%)
pure low-Mg-calcite (sparite)	**some shells are dolomitized**		**terrigenous grains of quartz**

Source of information: Kramar et al., 2015.

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
2.71-2.73	0.9-1.2	0.13-0.30	Dry: 160-190	-

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
	-	-	Dry: 14-18

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
-			0.01-0.1 % by mass	-	-

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		
-	-	-	-	-

Source of information: Kramar et al., 2015.

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	-	-	-	-	-	-	-	43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Kramar et al., 2015.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	BUSER, S. & DEBELJAK, I. 1996. Lower Jurassic beds with bivalves in south Slovenia. Geologija, 37-38. 23-62. http://www.geologija-revija.si/dokument.aspx?id=835 MIRTIČ, B., MLADENOVIČ, 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. RAMOVŠ, A. 2000. Podpeški in črni ter pisani lesnobrdski apnenec skozi čas. Mineral, Ljubljana. 1-115. KRAMAR, S., BEDJANIČ, M., MIRTIČ, B., MLADENOVIĆ, A., ROŽIČ, B., SKABERNE, D., GUTMAN LEVSTIK, M., ZUPANCIC, N. & COOPER, B. 2015. Podpeč limestone: A heritage stone from Slovenia. Geological Society Special Publication. 407. 219-231. 10.1144/SP407.2.	
Other publication		

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

Pohorski marmor

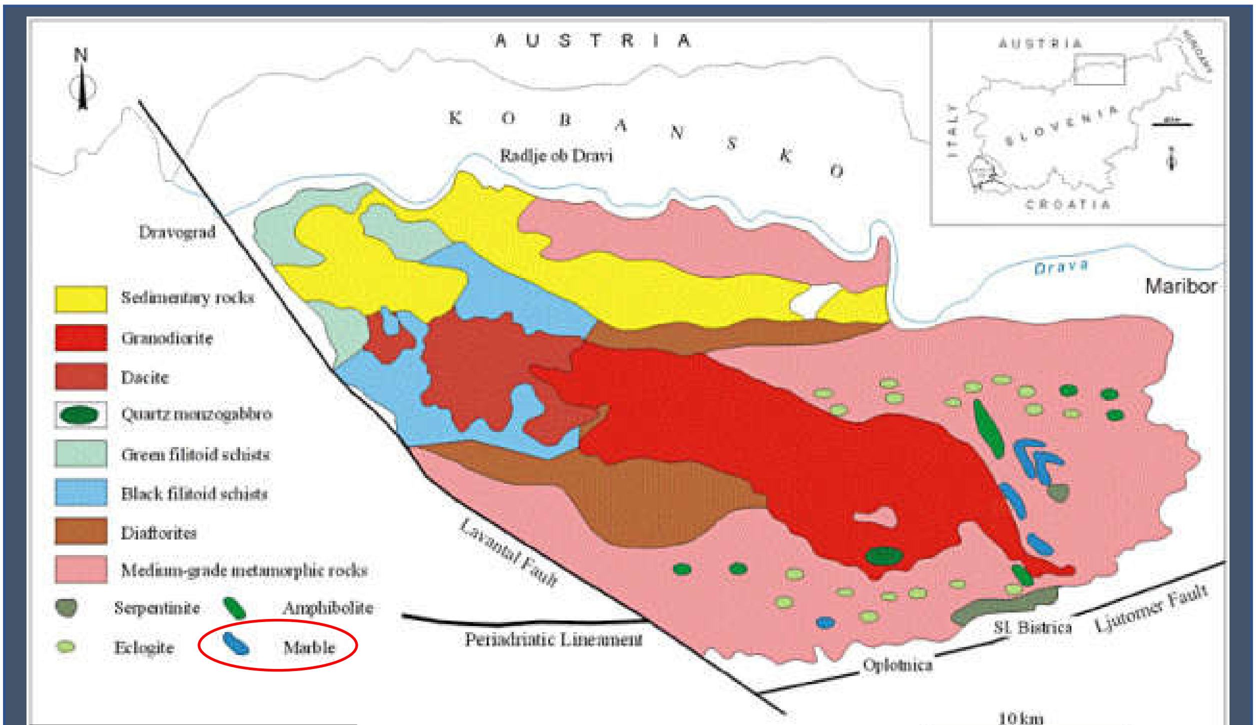
Pohorje marble

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



Modified after Jarc et al., 2010.

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.

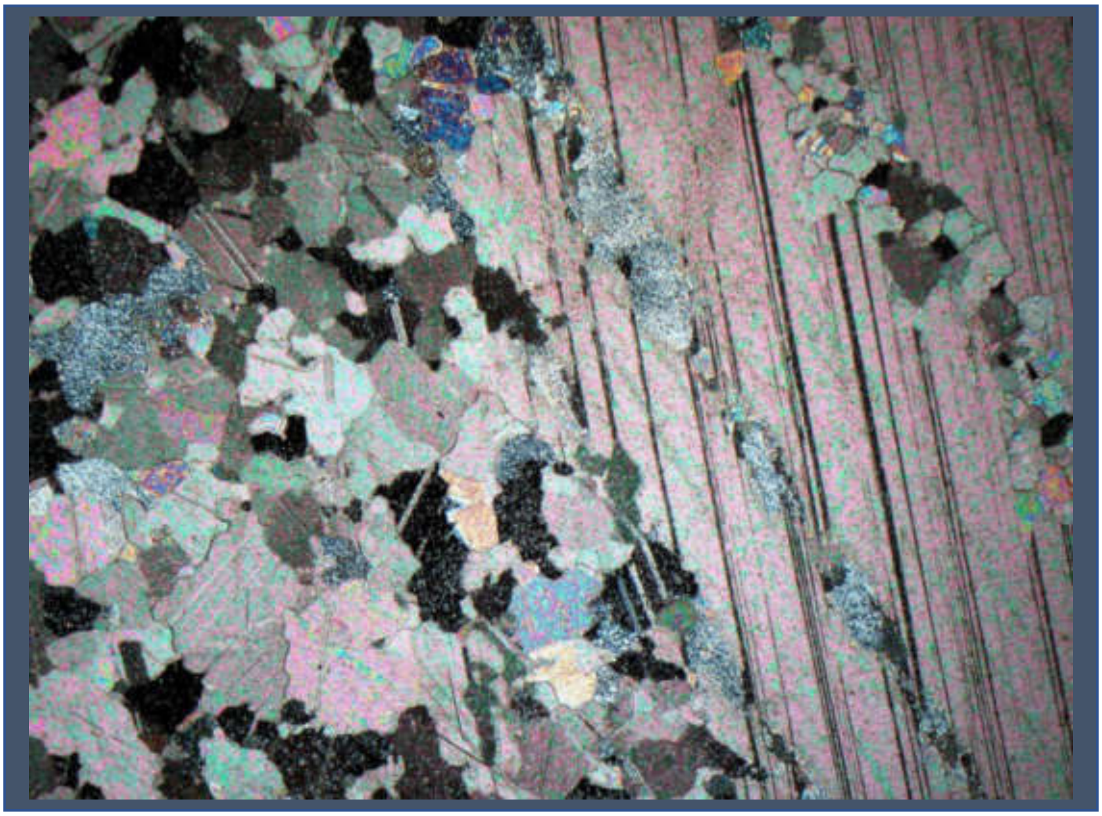
Geological age: Cretaceous
Geological unit: Pohorje series of Austroalpine nappe, Eastern Alps

Application, use and heritage

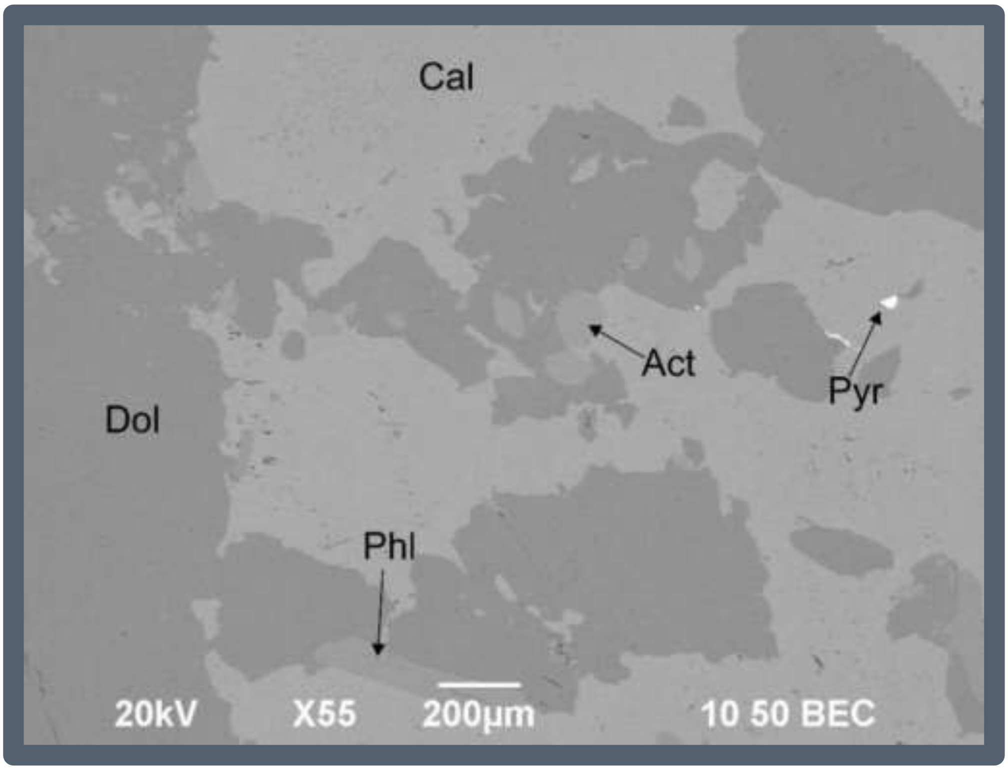
Description: Pohorje marble is used from Roman times mainly as ornamental stone for tombstones and monuments.

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.

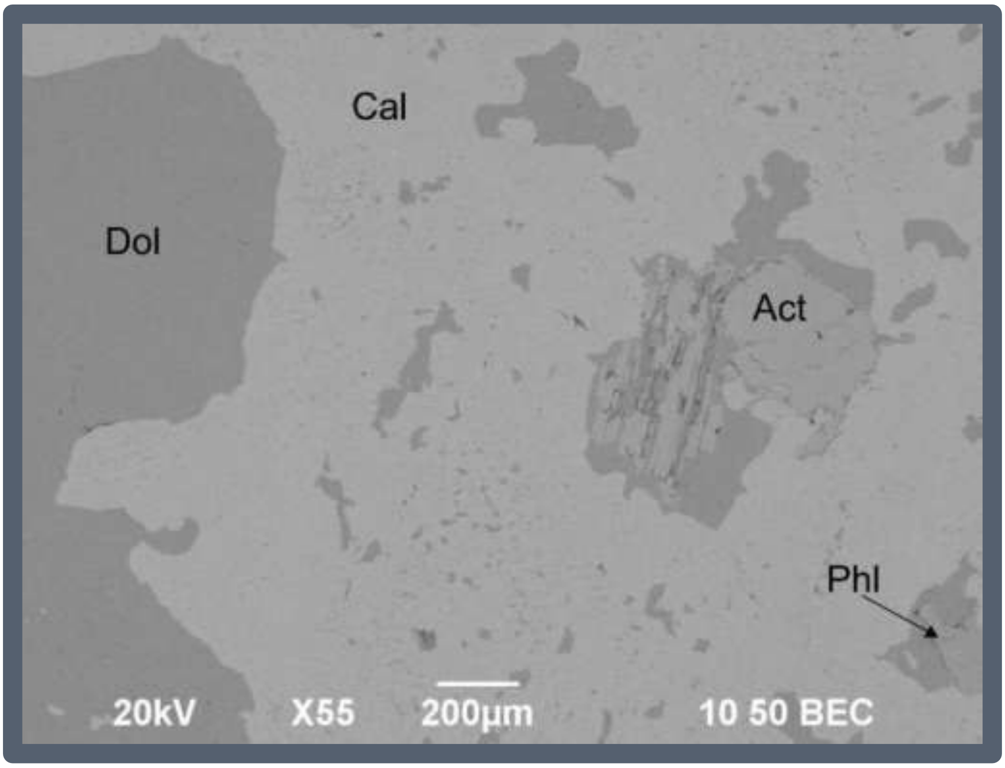
Petrography



Description: Granoblastic to mosaic texture with oriented growth of grains. Beside calcite and dolomite grains are also grains of mica, feldspar, quartz, hornblende, clinozoisit 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 pyrhotite (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 (%)	Accesory minerals (quartz, aluminosilicate minerals, ferric oxides and sulphides)
>95% (moslly calcite with dolomitic lenses)	**<5%**

Source of information: Jarc et al., 2009

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_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., MLADENOVIČ, 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

Repen

Repen limestone

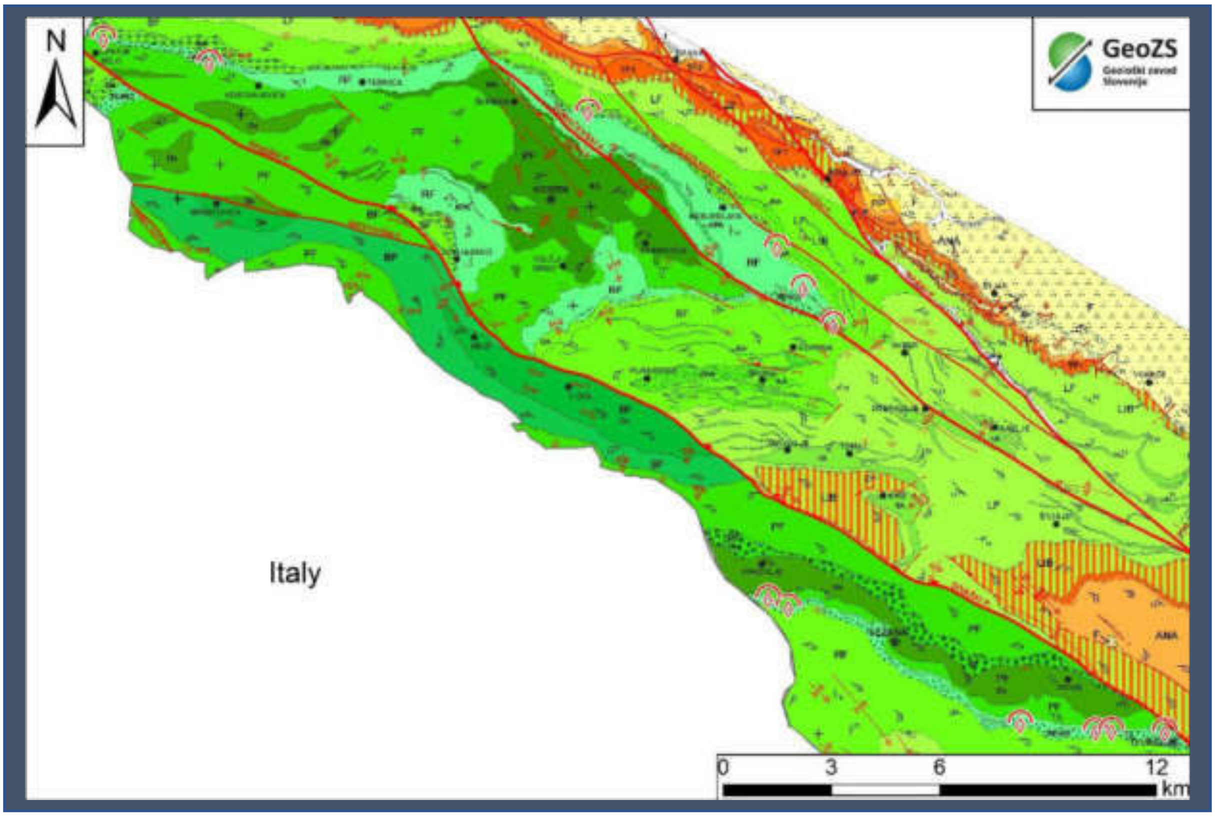
Repenski apnenec

5 cm

Short description: Stratified to massive, light-grey and grey fine-grained (micritic) limestone with large well-preserved rudist and chondrodont shells. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	light-grey	Slovenia	Primorska (traditional province)	Sežana	Vrhovlje, Doline

Geological setting



Geology: Rocks of Repen Formation (RF) were formed in a calm deep-sea environment on the submerged Adriatic-Dinaric Carbonate Platform into which larger shells were flooded from the shallower coastal parts and reefs. Thickness of the economically most promising horizon in Kras Region (Trieste-Komen plateau, SW Slovenia) is variable and reaches up to 30 m, with inclination of 0-20°.

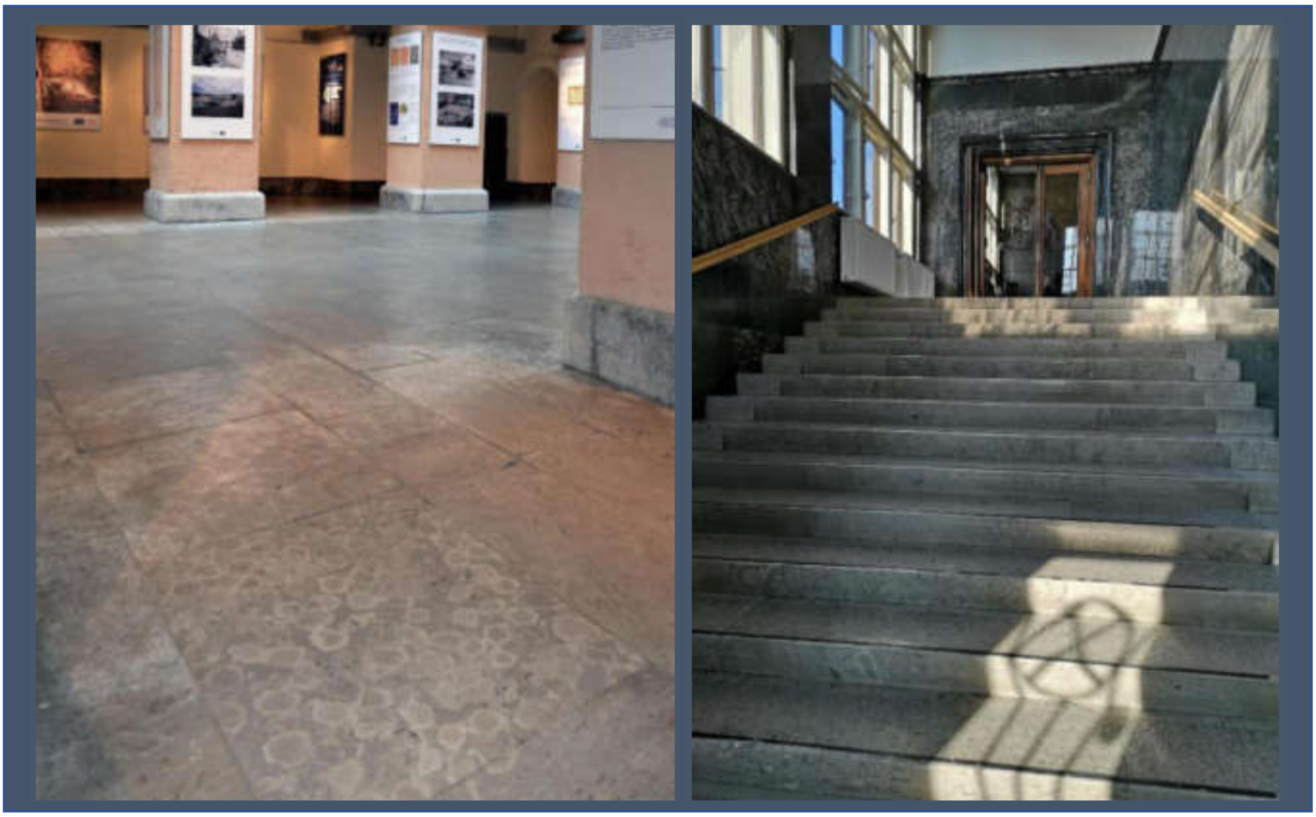
Production: Active, concessionaire MARMOR Sežana, exploration site Doline - repen, concession for extraction of natural stone. Repen limestone gradually passes laterally and vertically into Kopriva type limestone, in which the fossil shells are fragmented giving it a more homogeneous structure.

Geological age: Late Cretaceous (–Cenomanian-Turonian) (95-90 million years)
Geological unit: Repen member of Repen formation of Outer Dinarides

Application, use and heritage

Description: This Repen limestone is very interesting for ornamental stone industry due to soft bright colour, good mechanic properties, beautiful fossil remains of chondrodonts and caprinides, and proximity to processing plants and tradition.

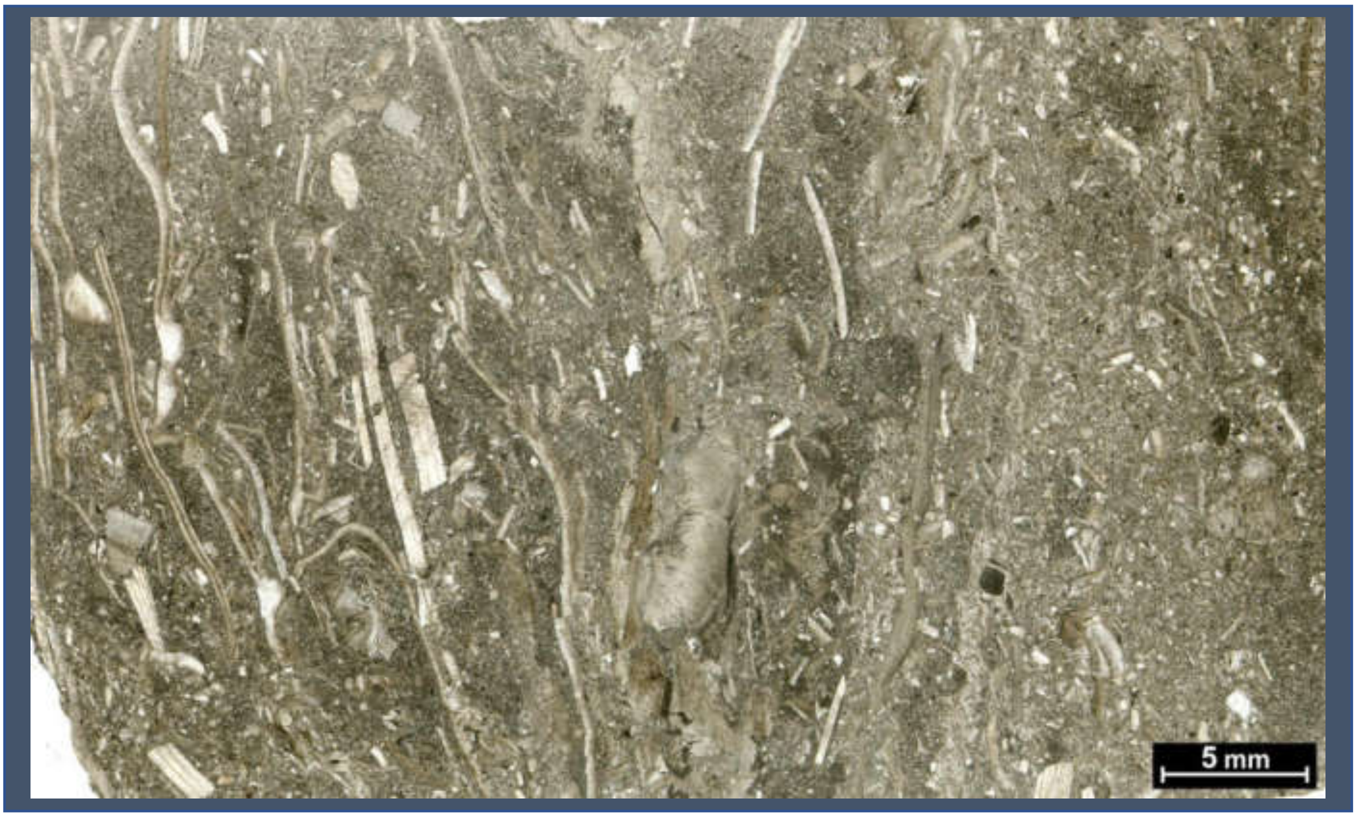
Many stone houses and fountains in the Kras region, like these ones in Štanjel, are built with Repen limestone.



The floor in the Historic Atrium of the Ljubljana Town Hall (1718) and the stairs in Montanistika building (1937) in Ljubljana are paved with light-grey Repen limestone with numerous cross sections of very large rudist shells.

Bevk Square in Nova Gorica city centre renovated with 7,000 m^2 of Repen limestone in 2014.

Petrography



Description: Biomicrite to biosparite with large rudist shells and finer fragments of bivalves, echinoderms, algae and pelagic fossils in recrystallized micrite.

Source of information: Geological Survey of Slovenia, Vesel et al., 1975; Vesel, 1979; Mirtič et al., 1999, Jurkovšek et al., 2013.

Mineral composition

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

Calcite (%)	Dolomite (%)	Organic matter (%)	Clay minerals (%)
99	**in traces**	**in traces**	**in traces**

Source of information: Mirtič et al., 1999.

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

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	

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		

Source of information:

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	up to 0,5	55	-	-	-	-	-	43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method. Mirtič et al., 1999.

Sources of more information

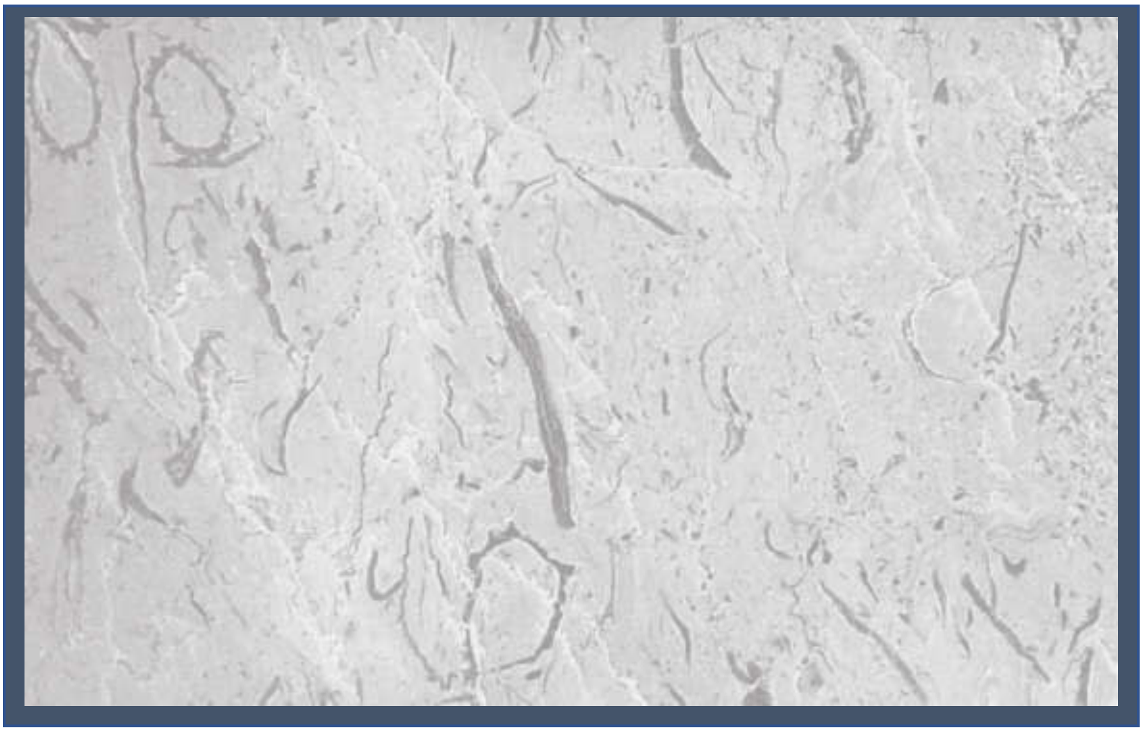
Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	VESEL, J., ŠKERLJ, J., ČEBULJ, A. & GRIMŠIČAR, A. 1975. Nahajališča okrasnega kamna v Sloveniji. / Freestone quarried in Slovenia. Geologija, št. 15. URN:NBN:SI:DOC-DTOS3JGZfrom http://www.dlib.si VESEL, J. 1979. Repen stone. Geologija, 22/1, 117-126. MIRTIČ, B., MLADENOVIČ, 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. JURKOVŠEK, B., CVETKO TEŠOVIĆ, B., KOLAR-JURKOVŠEK, T. 2013. Geologija Krasa = Geology of Kras. Ljubljana: Geološki zavod Slovenije, 205 pp.	
Other publication		

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

Repen

Repen limestone

Repenski apnenec

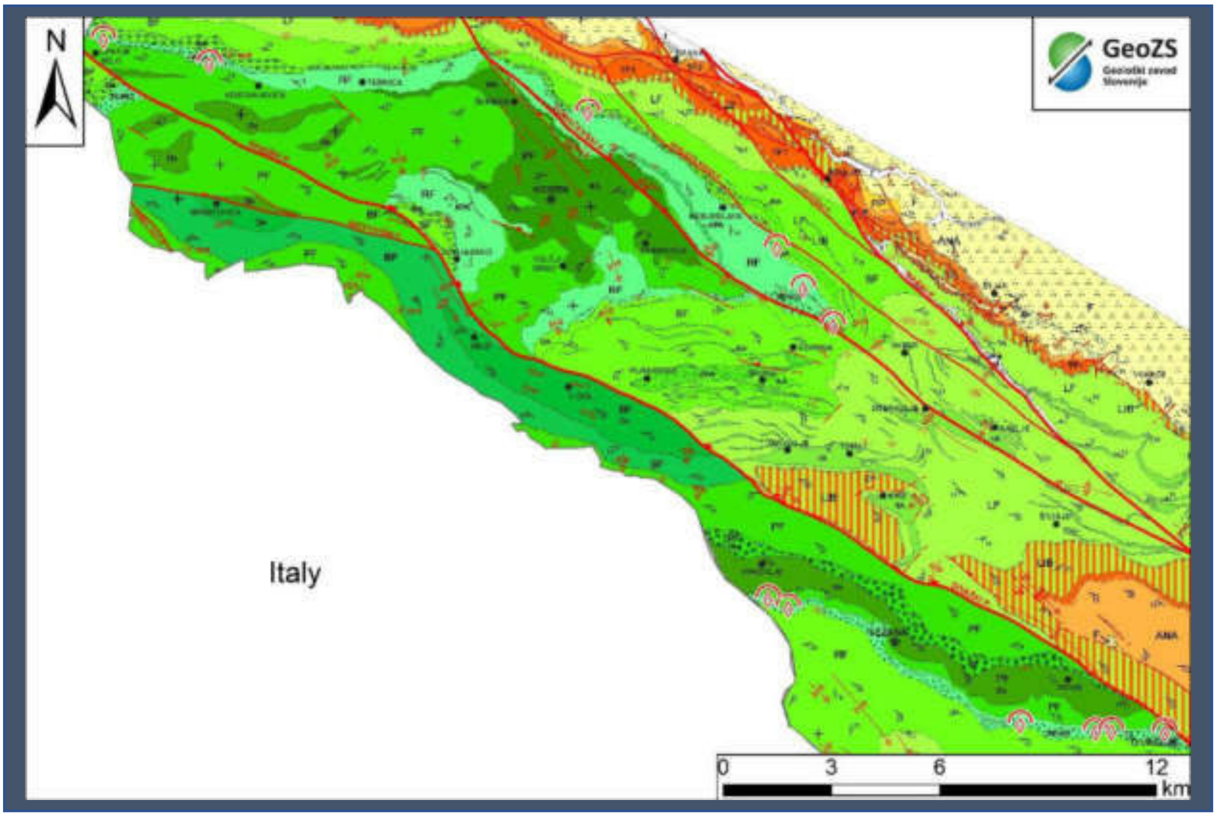


4 cm

Short description: Stratified, light grey and grey limestone with preserved rudist fossils, rounded and oval intersections of few centimeters. Sampled by: Andreja Senegačnik

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
limestone	limestone	light-grey	Slovenia	Primorska (traditional province)	Sežana	Povir

Geological setting



Geology: Repen horizon of the Cretaceous Karst limestones (The Karst Region, SW Slovenia). This Upper Cretaceous horizon is consists of few types of limestone. Beds of Repen limestone near Povir are discontinuous, in elongated lenticular forms.

Production: Active, concessionaire KAMNOSEŠTVO TAVČAR, pridobivanje in obdelava kamna d.o.o., exploitation site Debela Griža pri Povirju, mining right to exploitation of natural stone - limestone.

Geological age: Upper Cretaceous (K2 - Turonian)
Geological unit: Kraški apnenci - Repenski horizont

Application, use and heritage

Description: This Repen limestone is very interesting for ornamental stone industry due to soft bright colour, good mechanic properties, beautiful fossil remains of chondrodonts and caprinides, and proximity to processing plants and tradition. (Sample by; Andreja Senegačnik)

Petrography

For photomicrograph see ***Repen (Doline).***

Description: Biomicrite to biosparite with fragments of bivalves, echinoderms and other fossils in recrystallized micrite.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999.

Mineral composition

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

Calcite (%)	Clay minerals (%)
99	**in traces**

Source of information: Mirtič et al., 1999

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

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	

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		

Source of information:

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
-	-	-	-	0,8	55	-	-	-	-	-	43

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: Guidelines of the Lime Industry and the JUS B.H 360 to 369 standards are used for the chemical analysis of carbonate rocks. Chemical composition of certain limestones is determined by complexometric analysis (for CaO and MgO) according to G. Mueller´s method.
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publication	MIRTIČ, B., MLADENOVIČ, 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. VESEL, J., ŠKERLJ, J., ČEBULJ, A. & GRIMŠIČAR, A. 1975. Nahajališča okrasnega kamna v Sloveniji. / Freestone quarried in Slovenia. Geologija, 15, 243-258. URN:NBN:SI:DOC-DTOS3JGZfrom http://www.dlib.si	
Other publication		

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

Tonalit

Pohorje tonalite

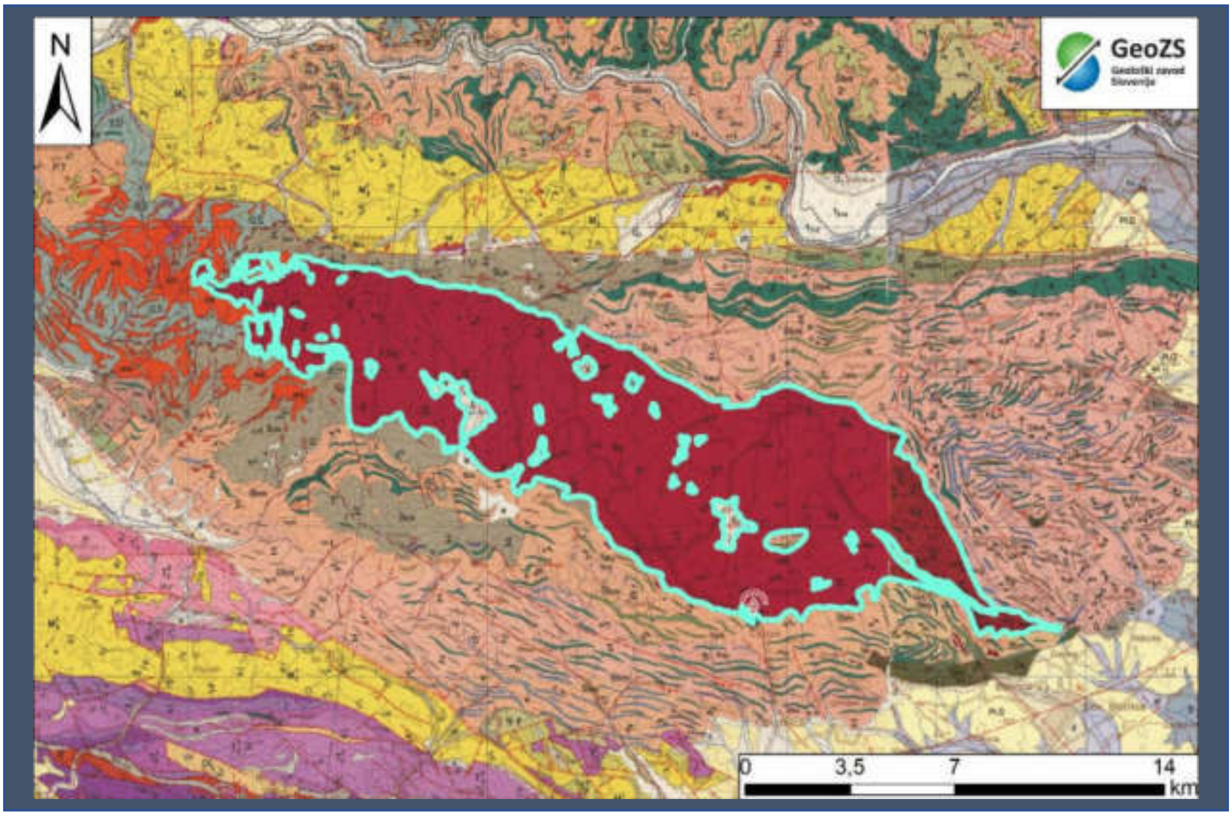
Pohorski granodiorit

3 cm

Short description: The rock is light gray to gray, sometimes with bluish tint. It contains mafic inclusions and streaky schliren. Structure is usually oriented. Granodiorite is crosscut by white aplite-pegmatite veins up to about 40 cm thick. The image displays a polished surface.

Commodity (vocabulary)	**Lithology (vocabulary)**	**Typical colour (code list)**	**Place of origin**			
			Country	**County / District / Province**	**Municipality / Community**	**Place/town / Village**
granite	granodiorite	gray	Slovenia	Štajerska (traditional province)	Oplotnica	Cezlak, Oplotnica

Geological setting



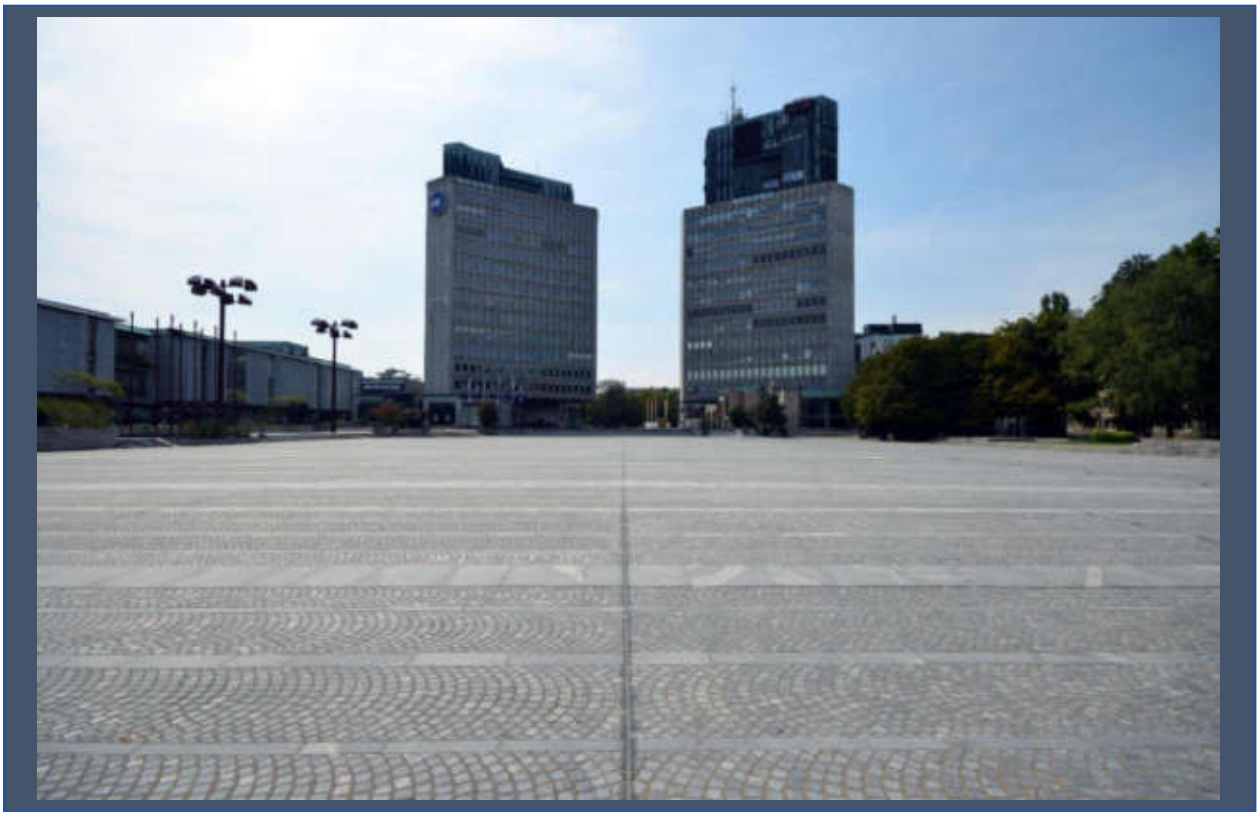
Geology: Granodiorite forms central part of the Pohorje massive , a tectonic block belonging to the Austroalpine units of the Eastern Alps. Central part of the block is intruded by the Early Miocene medium-grained grey granodiorite, but locally also tonalite is present. The genesis of granodiorite is connected to Neogene magmatism and tectonics which was intensive in this area.	

Production: Active, concessionaire MINERAL, quarry Cezlak I at Oplotnica, concession for extraction of natural stone.	

Geological age: Miocene (16-19 million years)	
Geological unit: Pohorje igneous complex	

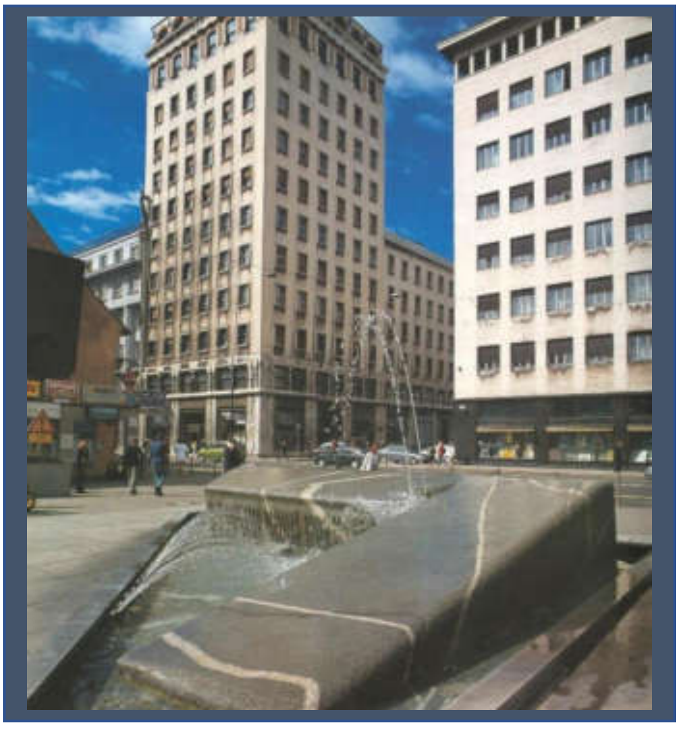
Application, use and heritage

Description: The rock in Cezlak attracted interest of people already in the 19th century, when local farmer started small extraction in 1891. Bigger production started in 1910 under the ownership of Windischgrätz when the first investigations were carried out. Mainly paving cubes and blocks for construction of bridges were produced. After World War II, the production and the market were growing. Granodiorite is very appreciated stone in Slovenia due to its durability and decorative white veins. Numerous architectural details are made of granodiorite, and some important buildings decorated: the Slovenian Parliament, the Republic Square business complex, the Faculty of Law of the University of Ljubljana, many post-war stone sculptures etc. Granodiorite is also exported, mostly to Austria, Germany and Switzerland. .



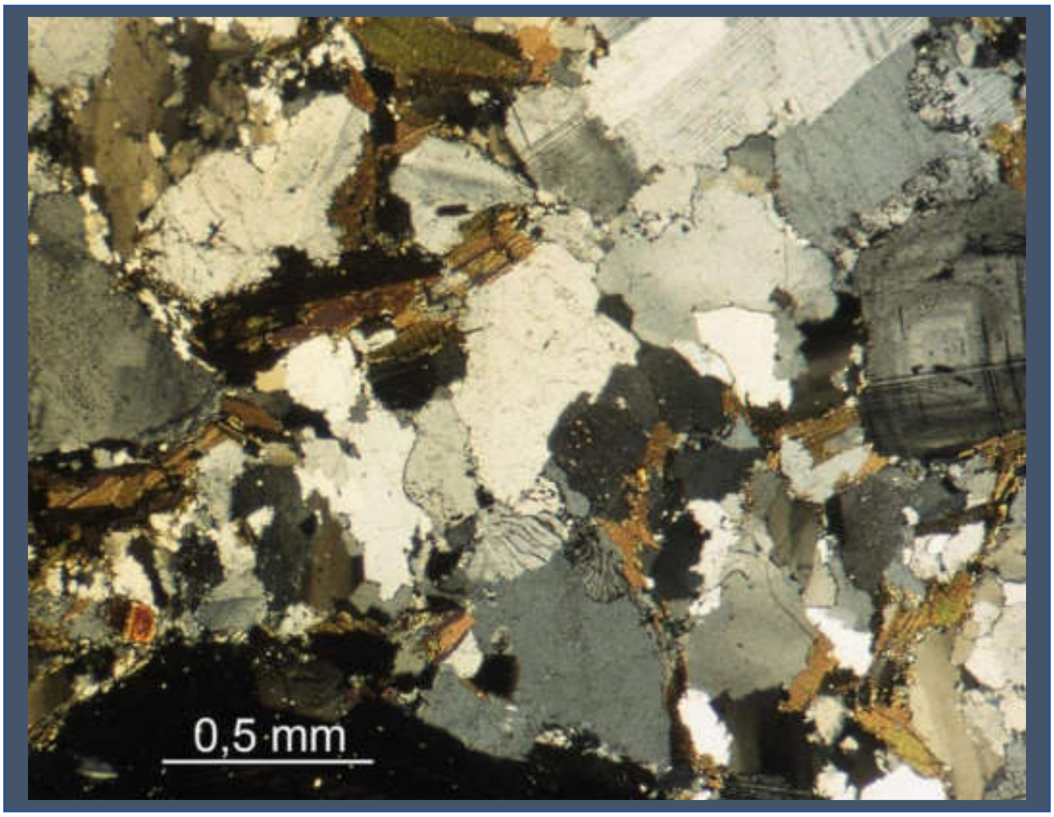
The Republic Square in Ljubljana. Facades of both towers are lined with panels, and the square's surface is paved with granodiorite bricks and tiles.

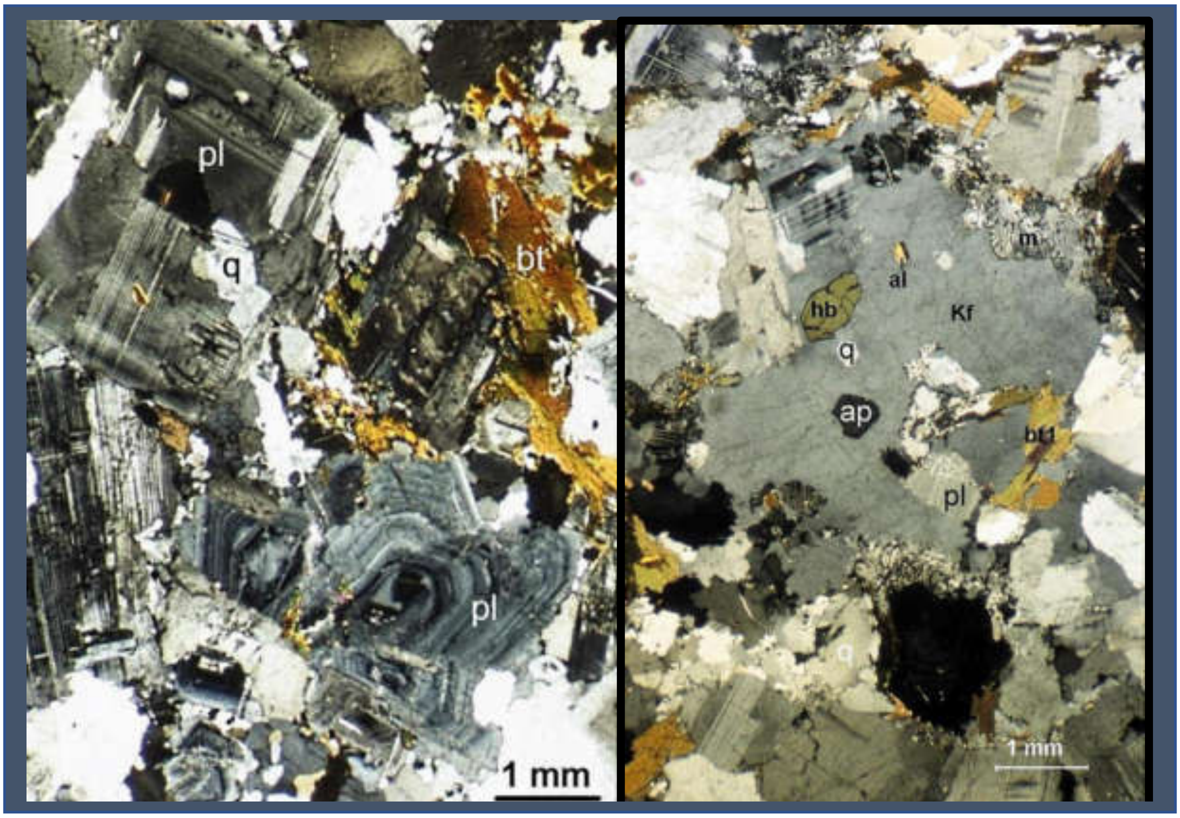
The Čopova street in Ljubljana paved with Pohorje granodiorite with decorative aplite-pegmatite veins.



The Mobitel Fountain in Ljubljana is made of two monolithic blocks of granodiorite, the largest ones ever extracted in Cezlak I quarry.

Petrography





Description:
Upper figure: Medium-grained hipidiomorphic granular texture of white plagioclase and K-feldspar, grayish quartz, brown biotite and hornblende. Accessory orthite, apatite, zircon, titanite, opaque minerals (pyrite, magnetite). Local alterations yield secondary chlorite, calcite, part of epidote and sericite. Aplite-pegmatite veins are composed of K-feldspar, plagioclase, quartz, and sparsely contain white mica, opaque minerals and tiny garnets.
Figure lower left: Granodiorite with older lamellar (pl) and younger zoned plagioclases (pl), corroded biotite (bt) and strained quartz (q). × nicols.
Figure lower right: Tonalite to granodiorite transition. Metasomatic K-feldspar (Kf) grain with myrmekitic reaction rim (m) toward plagioclases, including plagioclase (pl), biotite (bt), quartz (q), hornblende (hb), apatite (ap) and alunite (al). × nicols.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999; Trajanova et al., 2009; Kramar et al., 2016.

Mineral composition

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

Plagioclase (%)	Quartz (%)	Biotite (%)	K-feldspar (%)	Hornblende (%)	Orhtite (%)	Apatite (%)
30-40	**20-30**	**10-15**	**5-10**	**1**	**In traces**	**In traces**
Zircon (%)	Titanite (%)	Pyrite (%)	Magnetite (%)	Calcite (%)	Epidot (%)	Allanite
In traces	**In traces**	**In traces**	**In traces**	**In traces**	**In traces**	**In traces**

Source of information: Faninger, 1973; Zupančič, 1994a; Zupančič, 1994b; Zupančič, 1996; Mirtič et al., 1999; Trajanova et al., 2008; Trajanova et al., 2009; Trajanova et al., 2013

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
69	19	1-2	-	-	5	-	-	-	-	-	-

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: JUS B.H 360 to 369
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publications	FANINGER, E. 1973. Pohorske magmatske kamnine. Geologija 16, 271-315. ZUPANČIČ, N. 1994a. Petrografske značilnosti in klasifikacija pohorskih magmatskih kamnin. Rud. met. zb. 41, 101-112. ZUPANČIČ, N. 1994b. Geokemične značilnosti in nastanek pohorskih magmatskih kamnin. Rud. met. zb. 41, 113-128. ZUPANČIČ, N. 1996. Minerali pohorskega magmatskega masiva. Geologija 37, 271-295. MIRTIČ, B., MLADENOVIČ, 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. TRAJANOVA, M., PÉCSKAY, Z. and ITAYA, T. 2008. K-Ar geochronology and petrography of the Miocene Pohorje Mountains batholith, Slovenia. Geologica Carpathica 59/3, 247-260. TRAJANOVA, M., ZUPANČIČ, N., DOBNIKAR, M. 2009. Terciarni magmatizem = Tertiary magmatism. In: PLENIČAR, M. et al. (eds.), Geologija Slovenije = The geology of Slovenia. Ljubljana: Geološki zavod Slovenije. TRAJANOVA, M. 2013: Starost pohorskega magmatizma; nov pogled na nastanek pohorskega tektonskega bloka (Age of the Pohorje magmatism; new view on the origin of the Pohorje tectonic block). PhD thesis. 183 pp., Ljubljana. KRAMAR, S., TRAJANOVA, M., DOLENEC, M., GUTMAN, M., BEDJANIČ, M. & MLADENOVIČ, A. 2016. Heritage Stone 7. Pohorje Granodiorite – One of the Most Significant Slovenian Natural Stones. Geoscience Canada, 43, 79-88.	
Other publication		

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

Tonalit

Tonalite

Pohorski granodiorit

4 cm

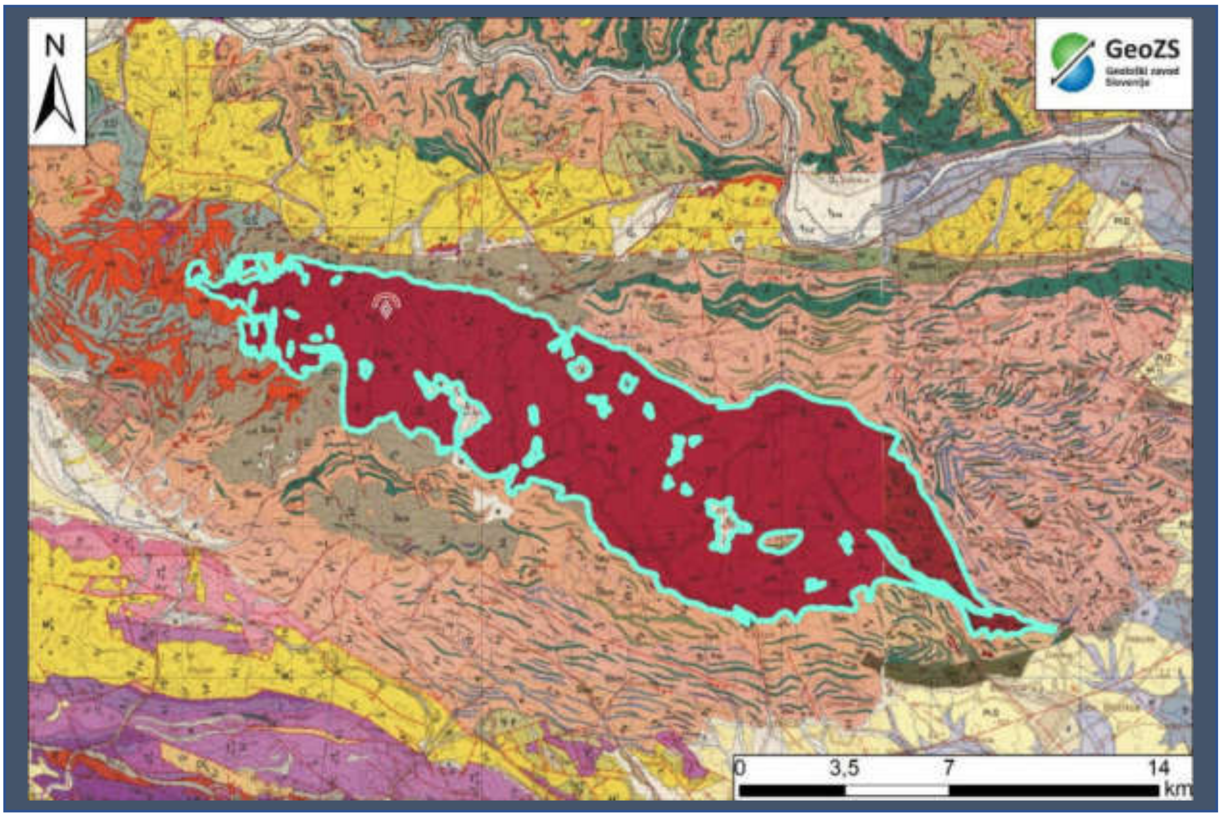
Short description: The rock belongs to the same pluton as Cezlak. The main difference between the two is that this rock is finer grained, which can be seen from the scale's comparison inserted in the microscopic image. Oriented structure of the rock is locally pronounced, reflecting on the mafic inclusions as well. No schlieren were noticed in this quarry, and aplite-pegmatite veins are very infrequent and thin, reaching the most a few centimeters. Sampled by: Andreja Senegačnik

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
granite	granodiorite	gray	Slovenia	Štajerska (traditional province)	Ribnica na Pohorju	Josipdol

EUROLITHOS

GeoERA

Geological setting



Geology: Granodiorite forms central part of the Pohorje massive and outcrops on its northern side. The genesis of granodiorite is connected to Tertiary magmatism and tectonics which was intensive in this area. The rock belongs to the same pluton as Cezlak.

Production: No (abandoned quarry near Josipdol).

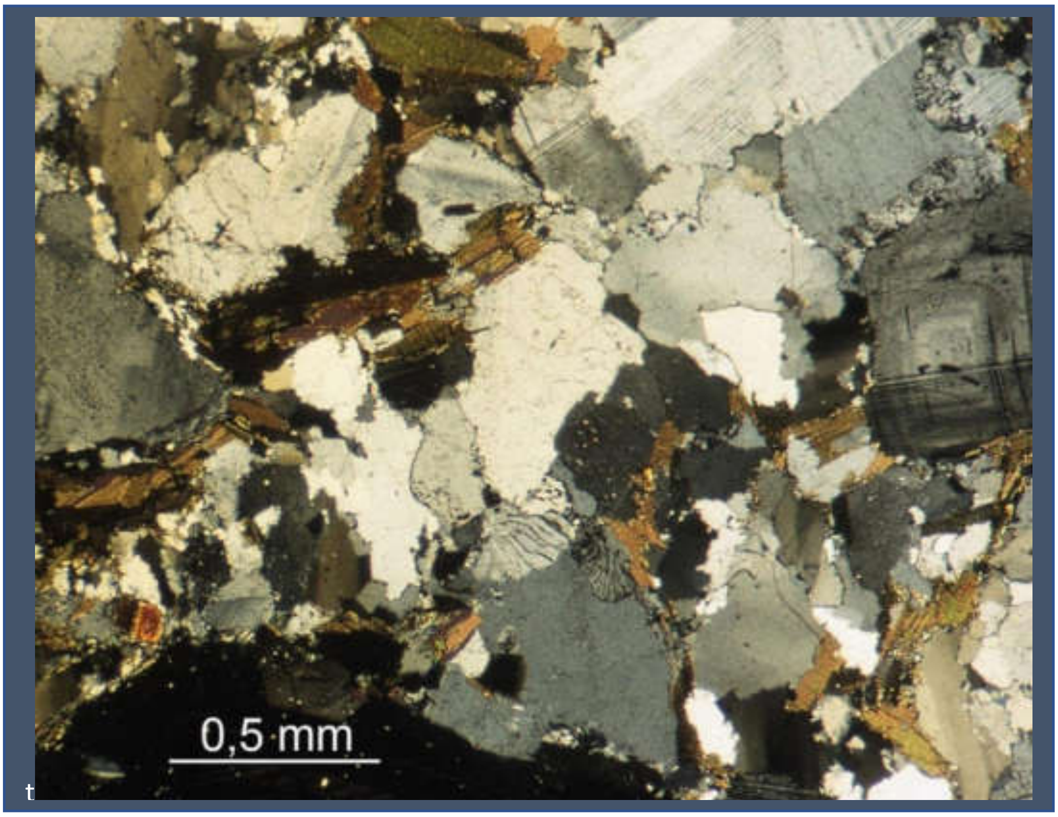
Geological age: Tertiary (Mc)
Geological unit: Tertiary magmatic complex

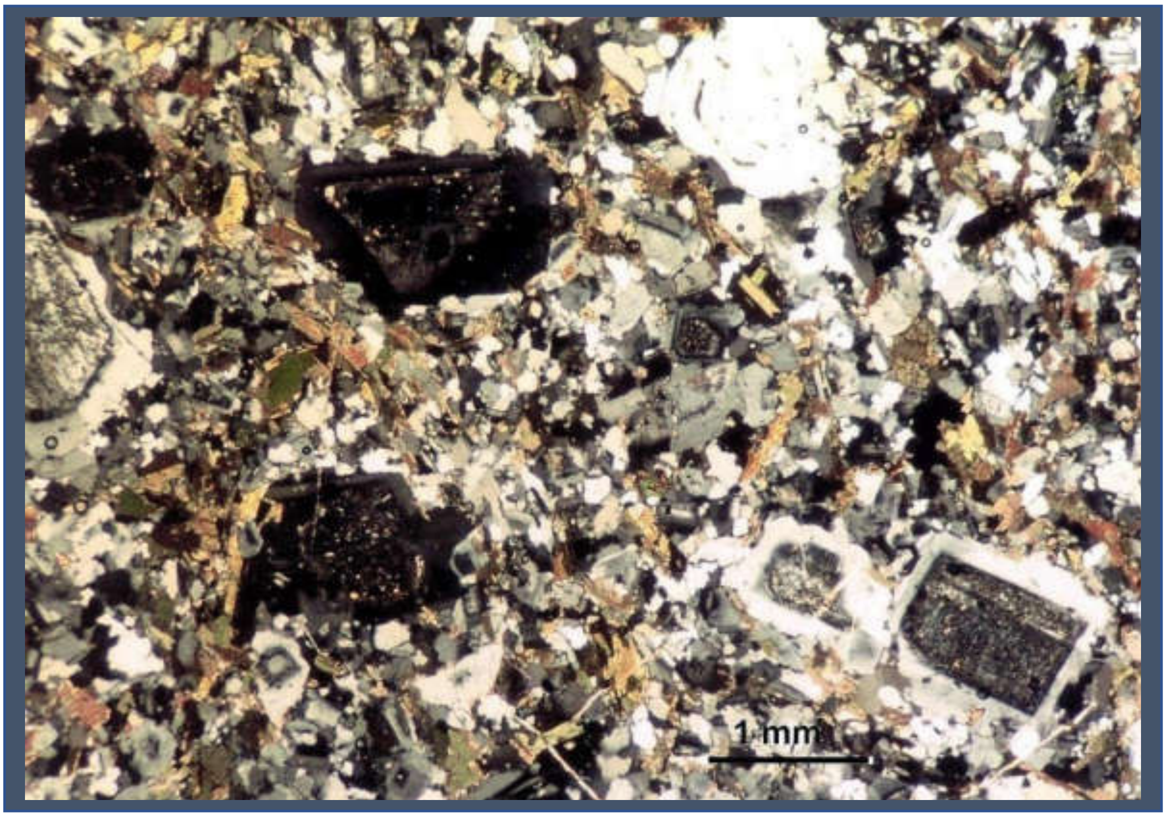
Application, use and heritage

Picture showing example of fuse; it is possible to have several examples

Description: Granodiorite is very appreciated stone in Slovenia due to its durability and decorative white veins. It adorns many famous buildings, paved squares, streets and carved many post-war stone sculptures.

Petrography





Description: The rock has fine to medium grained hipidiomorphic to xenomorphic texture. It consists of the same minerals as the Cezlak granodiorite. Their quantity varies slightly. Locally, heterogranular texture is noticed. Porphyritic granodiorite with partly altered cores of the zoned plagioclase phenocrysts with epitaxial rims. × nicols; Hudi Kot near Josipdol.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999. Trajanova et al., 2009.

Mineral composition

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

Plagioclase (%)	Quartz (%)	Biotite (%)	K-feldspar (%)	Hornblende (%)	Orhtite (%)	Apatite (%)
30-40	**20-30**	**10-15**	**5-10**	**1**	**in traces**	**in traces**
Zircon (%)	Titanite (%)	Pyrite (%)	Magnetite (%)	Calcite (%)	Epidot (%)	Allanite
in traces	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**

Source of information: Faninger, 1973; Zupančič, 1994a; Zupančič, 1994b; Zupančič, 1996; Mirtič et al., 1999; Trajanova et al., 2008; Trajanova et al., 2009; Trajanova et al., 2013

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
69	19	1-2	-	-	5	-	-	-	-	-	-

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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: JUS B.H 360 to 369
Mirtič et al., 1999.

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publications	FANINGER, E. 1973. Pohorske magmatske kamnine. Geologija 16, 271-315. ZUPANČIČ, N. 1994a. Petrografske značilnosti in klasifikacija pohorskih magmatskih kamnin. Rud. met. zb. 41, 101-112. ZUPANČIČ, N. 1994b. Geokemične značilnosti in nastanek pohorskih magmatskih kamnin. Rud. met. zb. 41, 113-128. ZUPANČIČ, N. 1996. Minerali pohorskega magmatskega masiva. Geologija 37, 271-295. MIRTIČ, B., MLADENOVIČ, 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. TRAJANOVA, M., PÉCSKAY, Z. and ITAYA, T. 2008. K-Ar geochronology and petrography of the Miocene Pohorje Mountains batholith, Slovenia. Geologica Carpathica 59/3, 247-260. TRAJANOVA, M., ZUPANČIČ, N., DOBNIKAR, M. 2009. Terciarni magmatizem = Tertiary magmatism. In: PLENIČAR, M. et al. (eds.), Geologija Slovenije = The geology of Slovenia. Ljubljana: Geološki zavod Slovenije. TRAJANOVA, M. 2013: Starost pohorskega magmatizma; nov pogled na nastanek pohorskega tektonskega bloka (Age of the Pohorje magmatism; new view on the origin of the Pohorje tectonic block). PhD thesis. 183 pp., Ljubljana.	
Other publication		

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

Čizlakit

Cezlakite

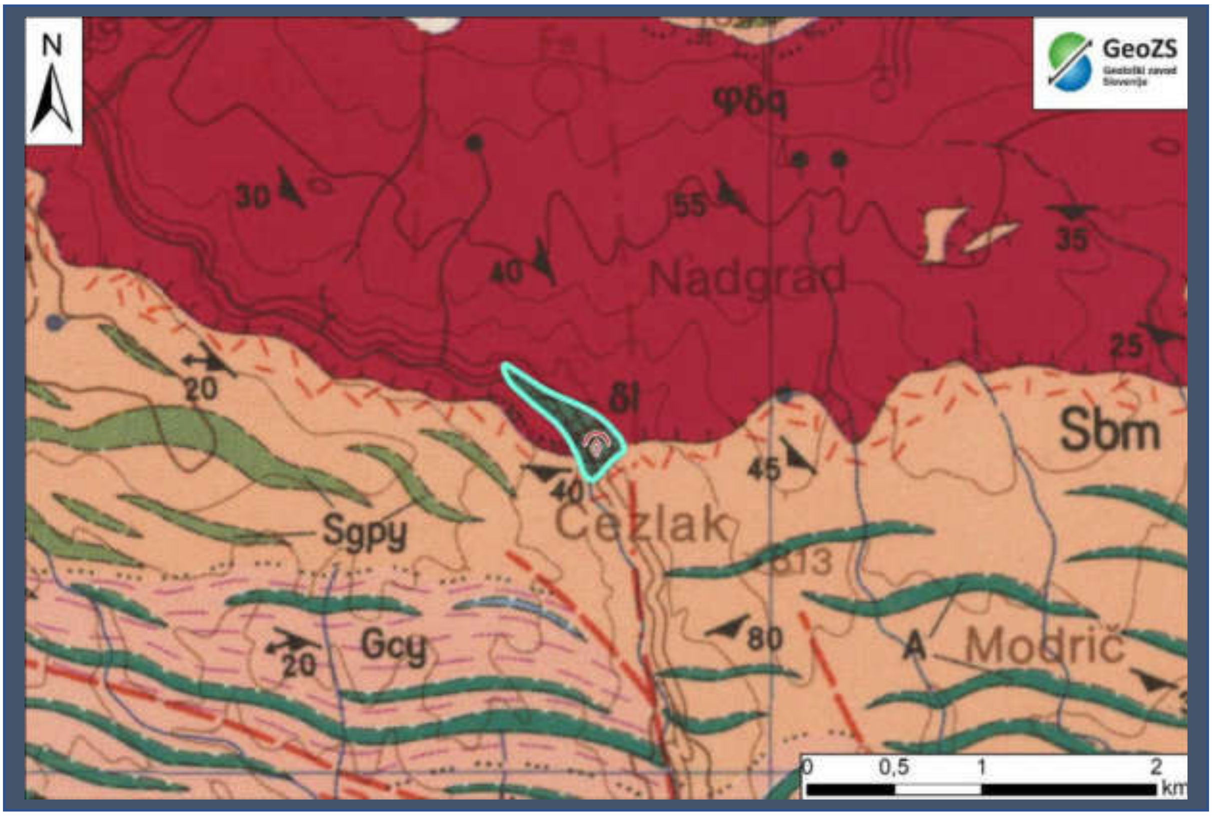
Kremenov diorit

5 cm

Short description: Green coarse-grained mafic intrusive igneous rock - gabbro with light green augite, dark grey hornblende, white plagioclases, greyish quartz, and decorative white aplite-pegmatite veins. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
granite	gabbro	green	Slovenia	Štajerska (traditional province)	Oplotnica	Cezlak, Oplotnica

Geological setting



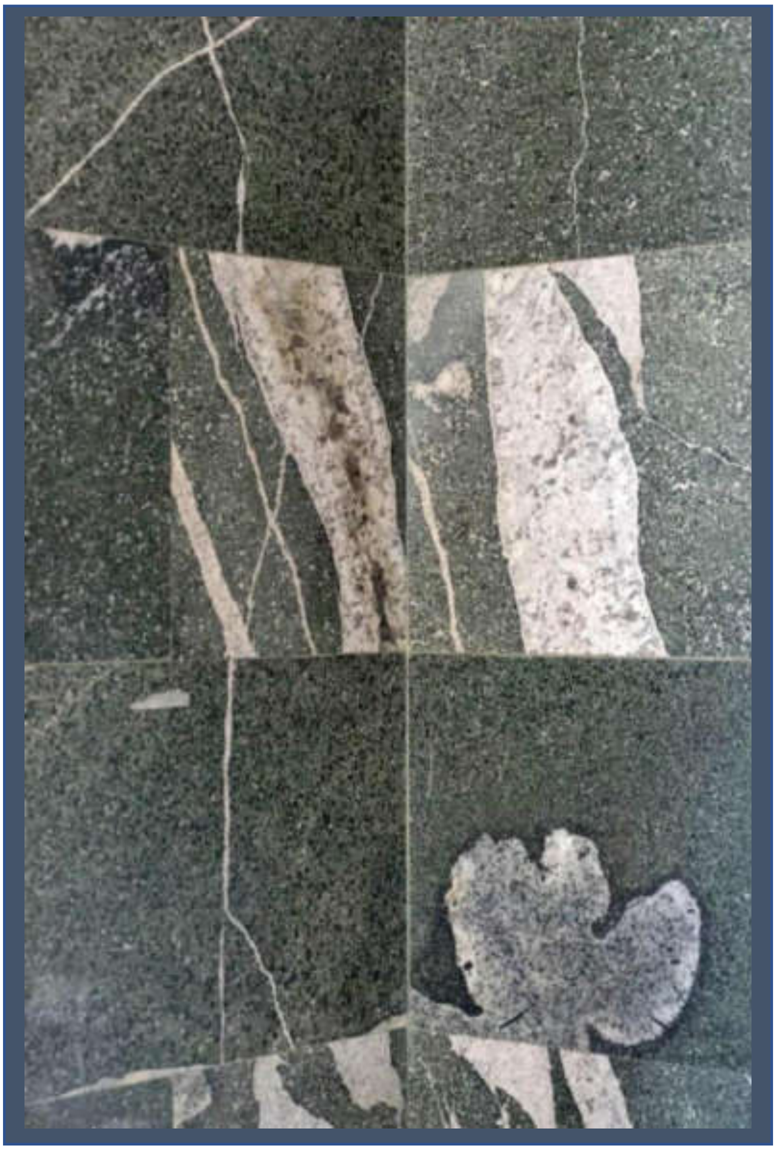
Geology: Lenticular inclusion of dark green gabbro in the grey granodiorite of the Pohorje igneous complex.

Production: No. Limited reserves in Cezlak II Quarry, the only place where this rock is found in Slovenia. Both, the rock and the quarry are protected as natural monuments.

Geological age: Miocene (20-16 million years)
Geological unit: Pohorje igneous complex

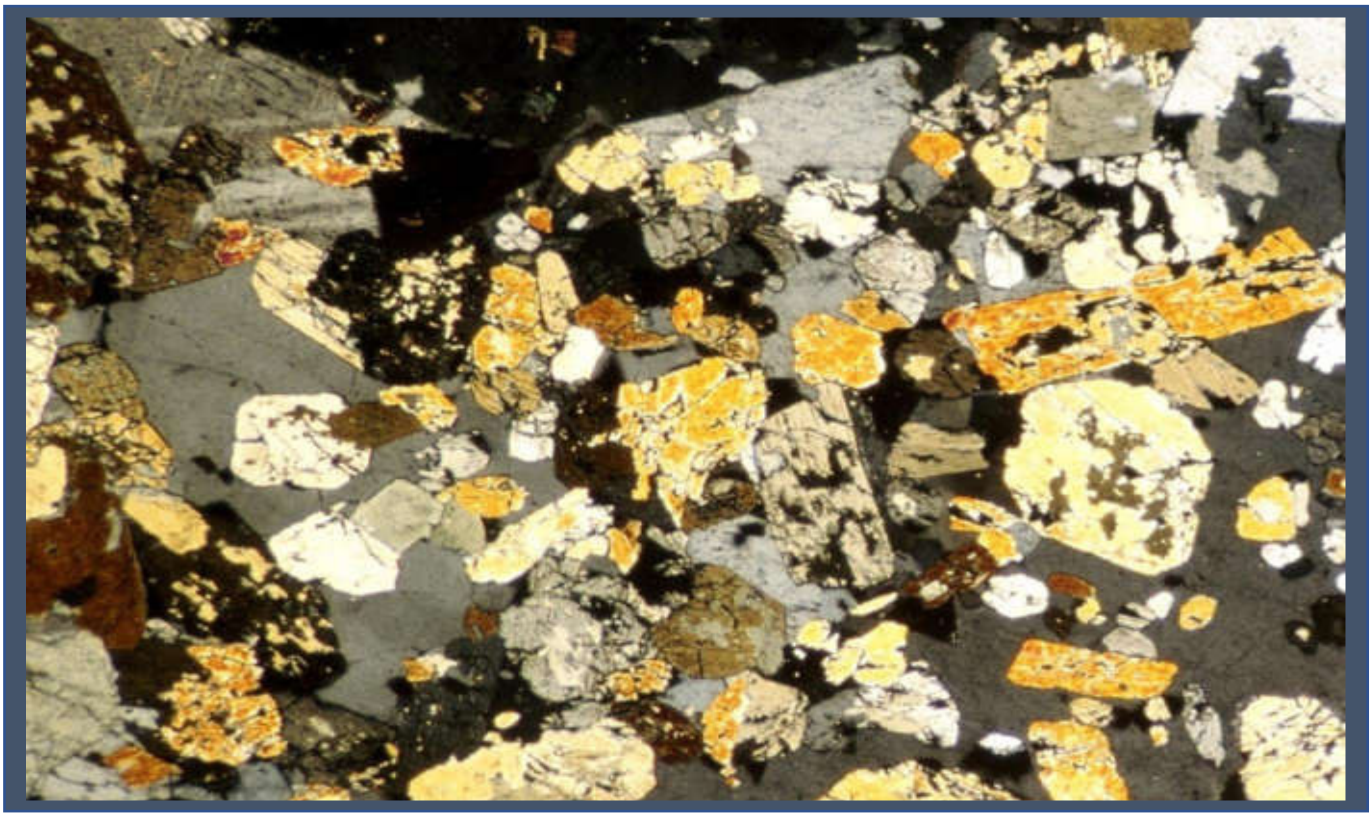
Application, use and heritage

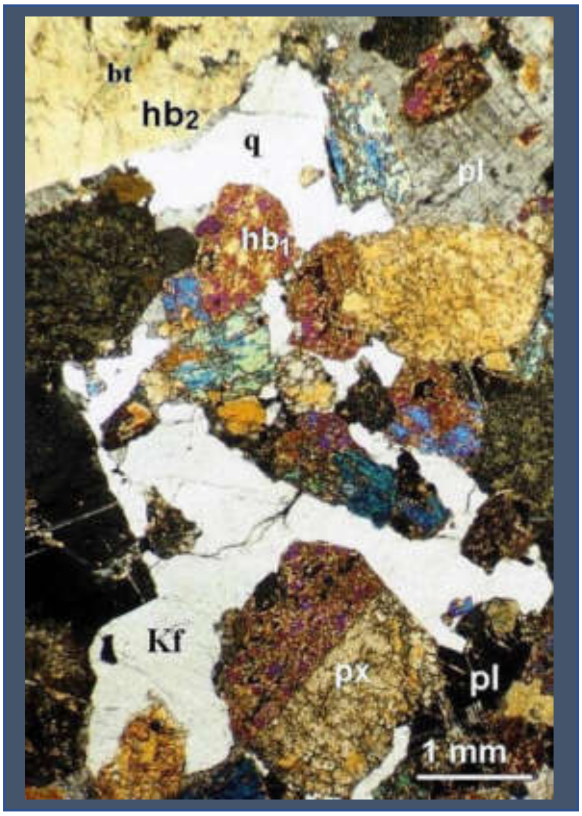
Description: Slovenian Parliament building (1917) in Ljubljana with green cezlakite panels under windows.



Description: Interior decoration with cezlakite in the Montanistika building (1937), the seat of the Department of Geology of the Faculty of Natural Sciences and Engineering in Ljubljana.
This sort of gabbro is very rare and thus valuable. Internal use, polished for floors and walls.

Petrography





Description: Hipidiomorphic, coarse-grained rock with augite, hornblende, plagioclases, quartz, and aplite-pegmatite veins from feldspars and quartz.
Relics of pyroxene (px) in older hornblende (hb1). Secondary hornblende (hb2) replaces. K-feldspar (Kf) replaces plagioclase (pl), while quartz (q) replaces both. × nicols.

Source of information: Geological Survey of Slovenia, Mirtič et al., 1999; Trajanova et al., 2009.

Mineral composition

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

Augit (%)	Hornblende (%)	Plagioclase (%)	Quartz (%)	Pyyrite (%)	Titanit (%)	Opaque minerals (%)
26-65	**10-65**	**5-25**	**1-5**	**in traces**	**in traces**	**in traces**
Zircon (%)	Apatit (%)	Biotite (%)	Calcite (%)	Chlorite (%)	Epidote (%)	
in traces	**in traces**	**in traces**	**in traces**	**in traces**	**in traces**	

Source of information: Faninger, 1973; Zupančič, 1994a; Zupančič, 1994b; Zupančič, 1996; Mirtič et al., 1999; Trajanova et al., 2008; Trajanova et al., 2009; Trajanova et al., 2013

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory	Geological Survey of Slovenia: Mining Registry Book	https://www.ms.geo-zs.si/en-GB
Commercial directory		
Scientific publications	FANINGER, E. 1973. Pohorske magmatske kamnine. Geologija 16, 271-315. ZUPANČIČ, N. 1994a. Petrografske značilnosti in klasifikacija pohorskih magmatskih kamnin. Rud. met. zb. 41, 101-112. ZUPANČIČ, N. 1994b. Geokemične značilnosti in nastanek pohorskih magmatskih kamnin. Rud. met. zb. 41, 113-128. ZUPANČIČ, N. 1996. Minerali pohorskega magmatskega masiva. Geologija 37, 271-295. MIRTIČ, B., MLADENOVIČ, 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. TRAJANOVA, M., PÉCSKAY, Z. and ITAYA, T. 2008. K-Ar geochronology and petrography of the Miocene Pohorje Mountains batholith, Slovenia. Geologica Carpathica 59/3, 247-260. TRAJANOVA, M., ZUPANČIČ, N., DOBNIKAR, M. 2009. Terciarni magmatizem = Tertiary magmatism. In: PLENIČAR, M. et al. (eds.), Geologija Slovenije = The geology of Slovenia. Ljubljana: Geološki zavod Slovenije. TRAJANOVA, M. 2013: Starost pohorskega magmatizma; nov pogled na nastanek pohorskega tektonskega bloka (Age of the Pohorje magmatism; new view on the origin of the Pohorje tectonic block). PhD thesis. 183 pp., Ljubljana.	
Other publication		

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Škofjeloški konglomerat

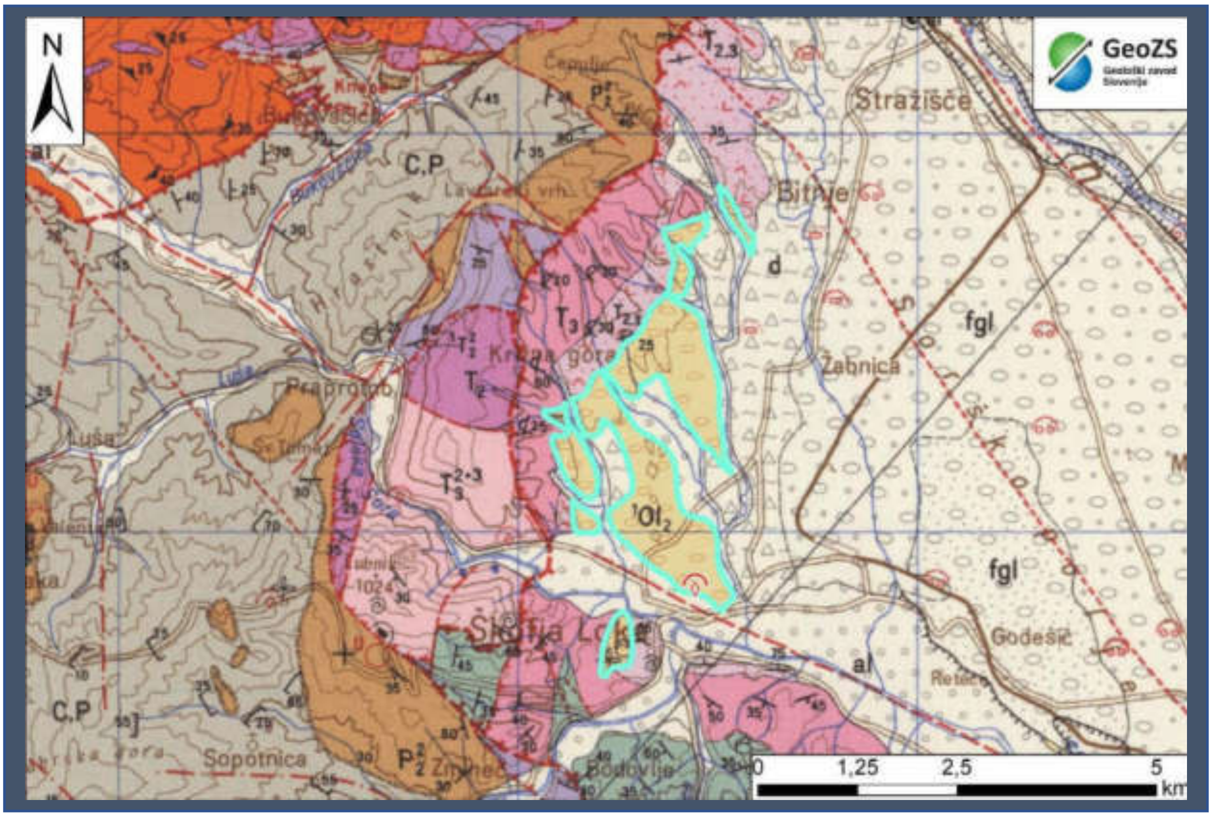
Škofja Loka conglomerate

5 cm

Short description: Medium to coarse grained reddish and yellowish calcareous conglomerate. The image displays a rough surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
sandstone	Conglomerate (calcareous)	multicoloured	Slovenia	Gorenjska (traditional province)	Škofja Loka	Kamnitnik, Škofja Loka

Geological setting



Geology: Basal unit of the subsiding Oligocene intercontinental Pannonian Sea, a part of Paratethys Ocean. The unit consists of different braided river channel and sand bars deposits. Typical coarse-grained conglomerate with well-rounded pebbles alternate with conglomeratic breccia composed of a mixture of differently sized and poorly rounded pebbles, fine-grained conglomerate and thinner cross-laminated sandstone layers.

Production: No (abandoned quarries Kamnitinik-1, Kamnitnik-2)

Geological age: Early Oligocene
Geological unit: Škofja Loka conglomerate of the Pannonian Basin.

Application, use and heritage

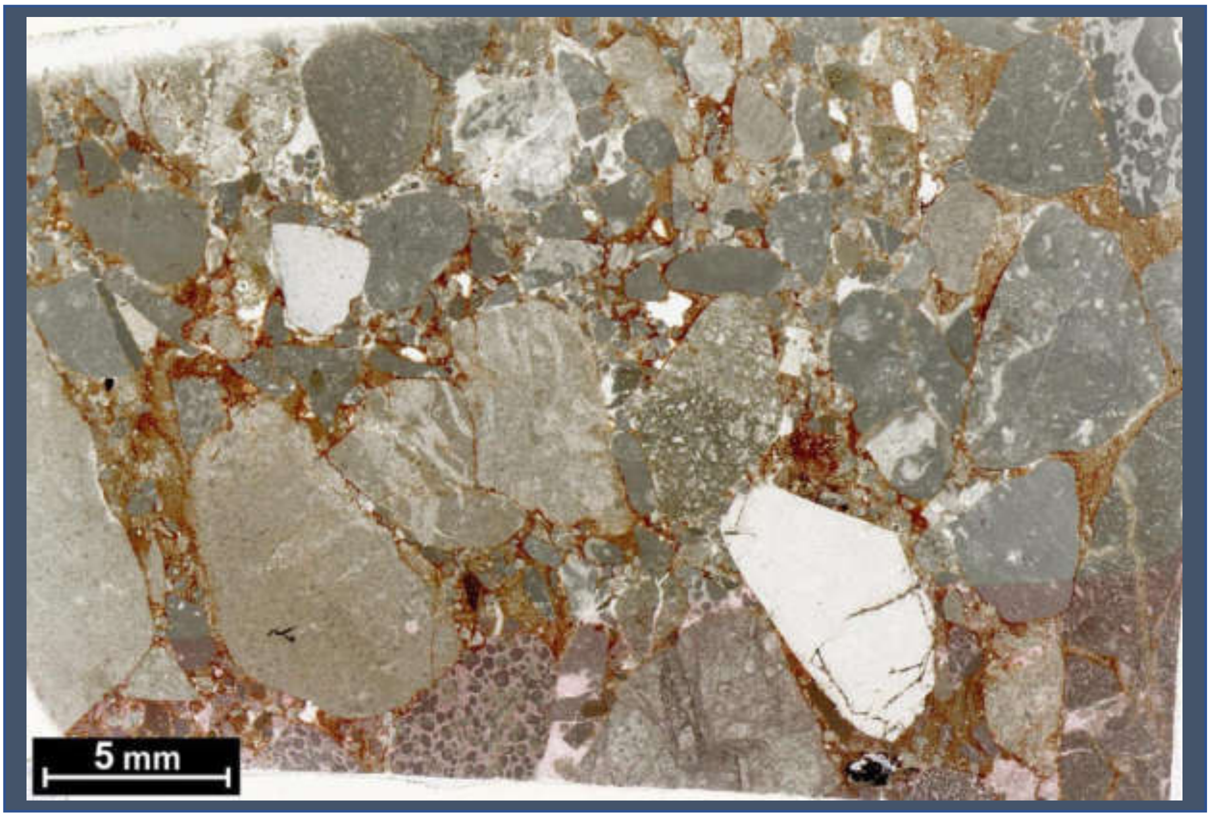
Description: Known from Roman times in columns. Used mainly locally as building stone for houses, portals, window frames, fences, and bridges.

Entrance portal of the baroque building from 1710 in Ljubljana made of Škofja Loka conglomerate.

Škofja Loka conglomerate preserved as decorative architectural elements in renovated buildings in Ljubljana.

The portico at the main southern gate of the Roman wall in Ljubljana is decorated with Škofja Loka conglomerate. The pillars are not ancient, but rather added by Plečnik.

Petrography



Description: Conglomerate consists of different types of carbonate and rare chert pebbles, strongly cemented by brick-red sandy-silt matrix. Most common pebbles are grey ooid limestone and light grey dolomite of Jurassic age, dark grey and black Early Cretaceous limestone, red-brown Late Cretaceous limestone, and shale. Less common pebbles are pink Early Triassic ooid limestone.

Source of information: Ramovš, 1968; Vesel et al., 1975.

Mineral composition

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

Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)	Mineral n (%)

Source of information:

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

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	

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_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
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:

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., MLADENOVIČ, 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. VESEL, J., ŠKERLJ, J., ČEBULJ, A. & GRIMŠIČAR, A. 1975. Nahajališča okrasnega kamna v Sloveniji. / Freestone quarried in Slovenia. Geologija 15. RAMOVŠ, A. 1968. Škofjeloški konglomerat, njegova sestava, fosilni ostanki in geološka zgodovina. Loški razgledi, 15, 164-179.	
Other publication		

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