

# Geological tour of Ljubljana

## FIELDTRIP E

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### Introduction

This guided tour is intended to help you learn about the cultural history of a Middle-European city, as written in natural (building and ornamental) stone. It will showcase the City of Ljubljana as a small open-space geological museum. Natural stone is here presented as a window between natural and cultural heritage. Its great variety enables the study of its geological features (rock type, fossils, structures) and technical properties. On the other hand, it documents Ljubljana's interesting history from the Antiquity through modern times. Here we learn about the most important touristic landmarks of Ljubljana through the types of stone used and the quarries where they originate.

The highlight of the tour is the stone-built cultural monuments designed by the renowned architect Jože Plečnik (1872–1957). Very few cities in Europe are marked in such a degree by the architecture and urbanistic solutions of a single architect. Jože Plečnik valued natural stone greatly and used it in his most monumental works in Ljubljana. Moreover, his post-World War II work is a good example of the sustainable re-use of natural stone as a building material and as ornamental architectural element. All of these considerations led to the inscribing of “The works of Jože Plečnik in Ljubljana – Human Centred Urban Design” on the UNESCO World Heritage List in 2021. Here, the architectural heritage of Jože Plečnik is presented from a different angle, adding another dimension of understanding and appreciation of his opus.

### A short history of Ljubljana and the use of natural stone

The Ljubljana region was already settled by pile dwellers before 2,000 BC. Excavations have shown that the quartz sandstone rubble was occasionally used to construct the earliest Late Bronze Age settlement (10<sup>th</sup>–9<sup>th</sup> c. BCE), but also appeared in later Early and Late Iron Age settlements in foundations, drywalls, and retaining walls. The source of this building material should certainly be sought in the quarry (or quarries) located in the immediate vicinity of these settlements, somewhere on the southern slopes of Ljubljana Castle Hill (Djurić and Rižnar, 2016).

The first settlers to use large quantities of stone for building were the Romans. The first Roman settlement was a military stronghold called Colonia Iulia Emona, built in the 1<sup>st</sup> century AD. It was protected with a wall, whose remains are best seen today along Mirje. The Romans had already opened most of the quarries in the surroundings of the Ljubljana Basin, which were excavated long after World War II. They had quarried Upper Carboniferous quartz sandstone and conglomerate on the southern slopes of the Ljubljana Castle Hill. They had found high quality Lower Jurassic Podpeč Limestone on the southern margins of the Ljubljana Moor (see this Guidebook, Field Trip D) and Glinice Limestone on the northern outskirts of Ljubljana at Podutik, which could also have been sources of lime the Romans used in construction (Ramovš, 1990, 2000). Traces of the Roman transport of heavy products from either the Podutik or Podpeč quarries have not been preserved. However, several hypotheses been made regarding that part of the production cycle in the past. As for the Podpeč Quarry, it has always been – and still is – believed that its products were mainly transported along the Ljubljanica River. It is also supposed that the course of the river was altered in length by roughly 6 km, from Podpeč towards Vrhnika, to flow in the immediate vicinity of the quarry for purposes of easier transport. Today, this supposition is widely accepted, despite its rather shaky grounds (Djurić and Rižnar, 2016). There were also white to yellowish varieties of detritic Neogene limestone, which came from a number of sources in the vicinity of Moravče and was probably only used later, in the 3<sup>rd</sup> century. The limited use of Peračica Tuff for construction purposes has not yet been determined chronologically, while the colourful, mostly calcareous Škofja Loka Conglomerate was used for architectural elements in Late Antiquity. As for interregional rocks, the use of Cretaceous Aurisina Limestone from Italy has been proven, at least for the earliest period of the Roman colony, while white Eastern Alpine marbles were used in the period for the construction of the defensive walls of Emona (from Gummern) and later for funerary monuments and architectural elements (from Pohorje). Mediterranean marbles have only been documented as floor and wall veneers (Djurić and Rižnar, 2016).

In the 6<sup>th</sup> century, Roman Emona was destroyed by the barbaric invasions of the Huns. All of the inhabitants left, and the town sank into oblivion. The name Ljubljana was first mentioned in the mid-12<sup>th</sup> century. In 1335, the town passed into the hands of the Habsburgs and became an important stronghold on the way to the sea, and in the hinterland on the border to-

ward the Ottoman Empire. In 1461, the diocese of Ljubljana was established, and the church of St. Nicholas became the cathedral. Medieval Ljubljana evolved around three squares: first around the square of Stari trg, then around the square of Mestni trg, and around Novi trg square on the other side of the Ljubljanica River. Houses in medieval times were largely constructed of wood, and stone was only used for the walls, independently surrounding all three parts. The medieval walls on Vegova Street were built atop roughly the exact site of the former Roman wall; however, Emona was located to the west, and medieval Ljubljana to the east of the wall. Until 1484, when the City Hall was built on the same site it occupies today, the medieval town centre was at Tranča, next to the Cobblers' Bridge (Spanžel et al., 2020).

In 1511, a major earthquake (the Idrija Earthquake, estimated M6.8, X EMS), struck Ljubljana and caused a great deal of damage all over Carniola. During the restoration process, narrow medieval houses were linked, and roof ridges were oriented parallel to the street.

In the 17<sup>th</sup> and 18<sup>th</sup> centuries stone buildings began to replace the wooden ones. What proved more defining were the religious conflicts that arose when the triumphant Counter-Reformation introduced the Baroque. For the Jesuits, who came to Ljubljana in 1597 and decisively contributed to the defeat of the Reformation, both Gothic and Renaissance architecture were unacceptable. Only Baroque churches, with their magnificence and ceremonial grandeur, had the power to inspire in rituals of worship. Baroque art was therefore more than simply a matter of taste; it was a symbol of affiliation with the Roman Catholic church. The Baroque reached its peak at the beginning of the 18<sup>th</sup> century when, also on the initiative of the Academia Operosorum Labaciensis (1693–1701), some prominent Italian artists, mainly from the neighbouring Venetian Republic, came to work in Ljubljana: architect Andrea Pozzo and sculptors Francesco Robba and Jacopo Contieri, to name but a few. Houses were raised with a third floor and dressed in luxurious Baroque façades. Interiors were decorated with arcaded courtyards and staircases. They also renovated or built most of the churches in the Baroque style, including the cathedral, as well as the new town hall (Spanžel et al., 2020). This period proved a major milestone in terms of the use of stone in Ljubljana. The dark Upper Triassic limestone quarried on the slopes of Lesno Brdo/Drenov Grič (west of Ljubljana) was very popular in Ljubljana and vicinity from the end of the 17<sup>th</sup> century onwards (Ramovš, 2000). Lesno Brdo limestone is distinguished by its uniform black colour, which is animated by numerous white calcite veins. It formed in the shallow lagoon environment in the Late Triassic (Carnian) and it often contains numerous fossils, especially bivalve shells. Interlayers of the softer black marlstone are less resistant to weathering and give way to decomposition. The entrance portal to the Seminary Palace with its two stone giants is one of the finest Baroque portals in Ljubljana.

In addition to the black Lesno Brdo Limestone, variegated, red, pink, and grey limestone are also still quarried near Lesno Brdo. This type of limestone is slightly older than black limestone and formed during the same age and in a shallow reef environment, much like Hotavlje Limestone, as described later.

The end of the 18<sup>th</sup> century brought the Age of Enlightenment, a period that rediscovered antiquity, among other things. In terms of architecture, it marked the emergence of Classicism, which returned to the models of Greek antiquity. In Ljubljana, they started to pull down the wall that had halted expansion of the town.

After Napoleon's wars with the Austrian monarchy, Ljubljana was occupied by the French, and for a short period (1809–1813) became the capital of the Illyrian Provinces. While this was not an important period in terms of architecture it had far-reaching implications for Slovenian national awareness, as it was the first time ever that the Slovenian language was taught in higher schools. For this reason, Napoleon has never been seen as an oppressive occupier, and the inhabitants of Ljubljana even erected a monument in his honour. The four years of the Illyrian Provinces represented the only break in the Habsburg regime, which lasted a whole 579 years, from 1335 to 1918 (Spanžel et al., 2020).

After Napoleon's defeat the town rose from anonymity once again. In 1821 it hosted the congress of the Holy Alliance, an association of triumphant states striving to maintain the monarchic system. For this occasion, the site of the abandoned Capuchin monastery was transformed into Congress Square, which served to host public events and parades. This was a period marked by the first attempts at a systematic designing of the town. Biedermeier, a reflection of the simple and comfortable style of the Viennese middle class, dominated in art.

In 1848, a railway was built from Vienna to Ljubljana, and in 1857 it was extended south to the port of Trieste. The train was a symbol of a new era based on industrialization. It triggered an accelerated development of cities and posed new challenges for architecture. Work was now divided between architect and engineer. The latter designed a frame that the architect-artist adorned with an appropriate façade. Classical architectural elements gradually embraced neo-Renaissance, neo-Romanesque, and neo-Gothic elements. During this fertile period, a number of important institutions were built in Ljubljana: the Provincial Museum, the National Hall, the Philharmonic Hall, and the Palace of the Provincial Government (Spanžel et al., 2020).

The 1895, a hugely destructive earthquake ("the Big Ljubljana Earthquake", M6.1, VIII–IX EMS) proved a turning point in Ljubljana's development. Some ten percent of the city's buildings were severely damaged or destroyed. The whole of the monarchy assisted in the rebuilding effort, and what had started as utter destruction became an opportunity for new development. A young architect, Maks Fabiani, who at the time

worked for Professor Otto Wagner at the Vienna Academy, took the initiative to propose an urban design plan. It was Fabiani who introduced the Viennese Secession style, closely related to Art Nouveau, to Ljubljana. During this period of national awakening, when Slovenians were establishing their own cultural institutions in parallel to the existing German ones, the choice of architectural style became a sign of nationality (Spanžel et al., 2020). In the mere first 14 years after the earthquake, more than 400 buildings were built and more than 600 were renovated. Most of Ljubljana's bridges, monuments, parks, and main buildings date back to the post-earthquake development. Already two years after the earthquake, the first Austro-Hungarian seismological observatory was established in the basement of the Realka High School on Vegova Street in Ljubljana.

The post-earthquake (1895) renovation allowed Ljubljana to develop from its earlier provincial appearance into a modern European city. After the dissolution of the Austro-Hungarian Monarchy the city became the capital of Slovenia – and the people's capital; and was looking for its own architectural identity, which was to be shaped by architect Jože Plečnik. He was certainly one of the most talented of Otto Wagner's students. Prior to World War I, he had already designed several buildings in Vienna, the most important being the Zacherl House (1905). The Vienna Academy had even proposed Plečnik as Wagner's successor, but for political reasons the proposal was not approved. In 1911, Plečnik moved to Prague to teach at the college of arts and crafts, and in 1920 was appointed by President Masaryk as chief architect for the restoration of Hradčany with Prague Castle, which was to be transformed into a symbol of the new, democratic state. Despite this prestigious position, Plečnik returned to Ljubljana in 1921 when he was offered the post of professor at the newly founded school of architecture. It was in Ljubljana that he wanted to see his vision of the nation's capital come to life. He respected the qualities of the old quarter of Ljubljana, the natural, architectural, and historic characteristics with their intangible aspects, which he emphasised with both small and large interventions. He interpreted anew a series of public spaces (squares, parks, streets, promenades, bridges) and public institutions (national library, churches, markets, funerary complex), which he sensitively integrated into the pre-existing urban, natural, and cultural context and which contributed to the city's new identity. The dialogue between the architect and the town developed to the extent that today Ljubljana is known as "Plečnik's Ljubljana" (Spanžel et al., 2020).

It can be said that the most iconic Plečnik's building in Ljubljana, the National and University Library, is his monument to Podpeč Limestone. He used it in the façade, the entrance lobby, the staircase colonnade and the large lobby. The exterior is made of this lagoonal limestone, most of it without the typical lithitoid bivalves. On the polished interior surfaces,

however, their white cross sections are beautiful adornments to the otherwise deep, dark stone. Plečnik, as well as some other architects, used this stone in many other prominent buildings, such as in the Parliament building, Nebotičnik (Ljubljana Skyscraper), the Montanistika building, City Hall, etc. (Kramar et al., 2014).

One of the most appreciated decorative stones in Ljubljana was, and still is, the Upper Triassic Hotavlje Limestone. This reef limestone is characterized by its non-homogeneous texture and richly varied colour, which ranges from dark grey to grey and pink, to scarlet red. The colours are further enriched by veins of reddish claystone and green tuff. Larger nests are filled with bright calcite, tiny grains of pyrite, and yellow or purple rhombohedral dolomite crystals, which formed during diagenesis. Its larger-scale quarrying begun after WW II; however, the first stone-cutters' products from this limestone are documented from the early 18<sup>th</sup> century (Ramovš, 1995). Today, this limestone is still being excavated in the underground galleries of a large modern quarry. In the interior of the Cankarjev dom, the largest culture and congress centre in Slovenia, as many as 2000 m<sup>2</sup> of surface is covered with panels of Hotavlje Limestone.

Some of the most widely used stones in modern Ljubljana are various "karst stones", the common name for light-grey limestones of Cretaceous age with cross sections of rudist bivalves. They come from the quarries of Aurisina/Nabrežina near Trieste, Lipica, Dolina, and Kazlje in Slovenian Kras, and Rasotica on the Croatian island of Brač. In Lipica in Kras, two different grey limestones are quarried; they are called "uniform" (Lipica unito) and "rosy" (Lipica fiorito) limestone. In Lipica unito, rudist bivalves are finely crushed and give the impression of a unified grainy rock, while in Lipica fiorito, the cross sections of whole rudists resemble flower petals. The Repen and Kopriva limestones from the Dolina quarry are very fine grained and considered the highest quality calcareous natural stones in Slovenia (Mirtič et al., 1999). The Karst limestones were used in the construction of several important buildings and monuments in many other European Countries, and around the world. Nowadays, they are most commonly used in the construction of façade cladding, pavements, staircases, indoor and outdoor flooring and wall cladding, and are also held in high esteem by sculptors.

We tore the stone from our mountains, our hands formed and smoothed it: saxa loquuntur (rocks speak). – Arch. Jože Plečnik, 1926

We welcome you to learn more about the natural stones of Ljubljana from the booklet A geological tour of Ljubljana: natural stone in cultural monuments. Available as a PDF at:

[www.ljubljana.si/assets/Uploads/Geoloski-sprehod-po-Ljubljani-ANG.pdf](http://www.ljubljana.si/assets/Uploads/Geoloski-sprehod-po-Ljubljani-ANG.pdf)

EON	ERA	PERIOD	EPOCH	AGE (million years)	SLOVENIAN NATURAL STONE	FOREIGN NATURAL STONE	
PHANEROZOIC	CENOZOIC	QUATERNARY	HOLOCENE	0.01	Jezerško calcareous tufa		
			PLEISTOCENE	2.6	Quaternary conglomerate		
		NEOGENE	PLIOCENE	5.3	Moravče sandstone Pohorje granodiorite Pohorje cizlakite	Lithothamnian limestone, CRO	
			MIOCENE	23			
		PALEOGENE		OLIGOCENE	34	Peračica tuff Škofja Loka conglomerate	Nummulitic limestone, CRO
				EOCENE	56	Istrian flysch sandstone	
				PALEOCENE	66		
		MESOZOIC	CRETACEOUS	UPPER	101	Lipica limestone Repen and Kopriva lms.	Aurisina limestone, IT and Rasotica limestone, CRO
				LOWER	145		
	JURASSIC		UPPER	163	Podpeč limestone Glinice limestone Škofja Loka platy limestone	Carrara marble, IT	
			MIDDLE	174			
			LOWER	201			
	TRIASSIC		UPPER	237	Black Lesno Brdo limestone Variegated Lesno Brdo lms. and Hotavlje limestone	Jablanica gabbro, BIH	
			MIDDLE	247			
			LOWER	252			
	PALEOZOIC		PERMIAN	UPPER	260	Tarvis breccia	Bolzano quartz porphyry, IT Baveno granite, IT(?)
				MIDDLE	272		
				LOWER	299		
			CARBONIFEROUS	UPPER	323	Carboniferous sandstone, conglomerate and claystone	
		LOWER		359			
		DEVONIAN		419			
	SILURIAN		443				
	ORDOVICIAN		485				
	CAMBRIAN		541				
	PRECAMBRIAN	PROTEROZOIC			2500	Pohorje marble	Prilep marble, MAC
		ARCHEAN			4000		

Figure: List of Slovenian and foreign natural stones used in Ljubljana with their stratigraphic position (Novak, 2016)

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