The Karst Region of Slovenia: A Potential Global Heritage Stone Province

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Sabina Kramar, Breda Mirtič, Ana Mladenović, Mojca Bedjanič, Boštjan Rožič, and Andrej Šmuc

Abstract
The Karst (Kras) region of Slovenia is one of the world's most interesting areas of natural stone reserves. The region is mainly composed of Cretaceous shallow-water limestone, with the most common type currently excavated being the rudist limestone of the Lipica Formation, which date to the Santonian to Campanian times. The Karst region has been associated with the quarrying and processing of stone for over two thousand years, i.e. since the Roman period. The exploitation and international recognition of the Karst region provide abundant support for its nomination as a Global Heritage Stone Province.

Keywords
Karst region • Cretaceous limestone • Rudist limestone • Stone province

43.1 Introduction

This contribution nominates the Karst region of Slovenia, one of world's most interesting areas of natural stone reserves, for international recognition as a "Global Heritage Stone Province" (GHSP). This GHSP nomination is based on the fact that the Karst region has played a significant role in human history and culture. Our nomination follows the Terms of Reference accepted by the IUGS Heritage Stone Task Group (HSTG) and published in Global Heritage Stone Circular 6 (www.globalheritagestone.org), which include the following definition: "A Global Heritage Stone Province (GHSP) is a designated area, where two or more Global Heritage Stone Resources (GHSRs) are associated in close geographic proximity and by their common geology".

S. Kramar (✉) · A. Mladenović
Slovenian National Building and Civil Engineering Institute, Dimičeva 12, 1000, Ljubljana, Slovenia
e-mail: sabina.kramar@zag.si

B. Mirtič · B. Rožič · A. Šmuc
Faculty of Natural Sciences and Engineering, Department of Geology, University of Ljubljana, Privoz 11, 1000, Ljubljana, Slovenia

M. Bedjanič
Institute of the Republic of Slovenia for Nature Conservation, Maribor Regional Unit, Pobreška Cesta 20a, 2000, Maribor, Slovenia

43.2 Global Heritage Stone Province Recognition

43.2.1 Formal Name

Karst or Kras.

43.2.2 Origin of Name

The word karst (or kras in Slovene) originates from the ancient word for stone—"ka(r)a/gs(r)s"—that provided the region with its name in Roman times: Carusaud, Karusad, Carsus. Over time, the word slowly changed into Kras (Slovene), Karst (German) and Carso (Italian). Nowadays the word KRAS has two different meanings in Slovene: on the one hand it refers to a specific geographic area, while on the other it is also the name of a specific type of landform. In terms of the former meaning, the Kras is a limestone plateau located on the northernmost part of the Adriatic Coast, above the Gulf of Trieste (Fig. 43.1). In terms of the latter meaning,

G. Lollino et al. (eds.), *Engineering Geology for Society and Territory – Volume 5*,
DOI: 10.1007/978-3-319-09048-1_43,

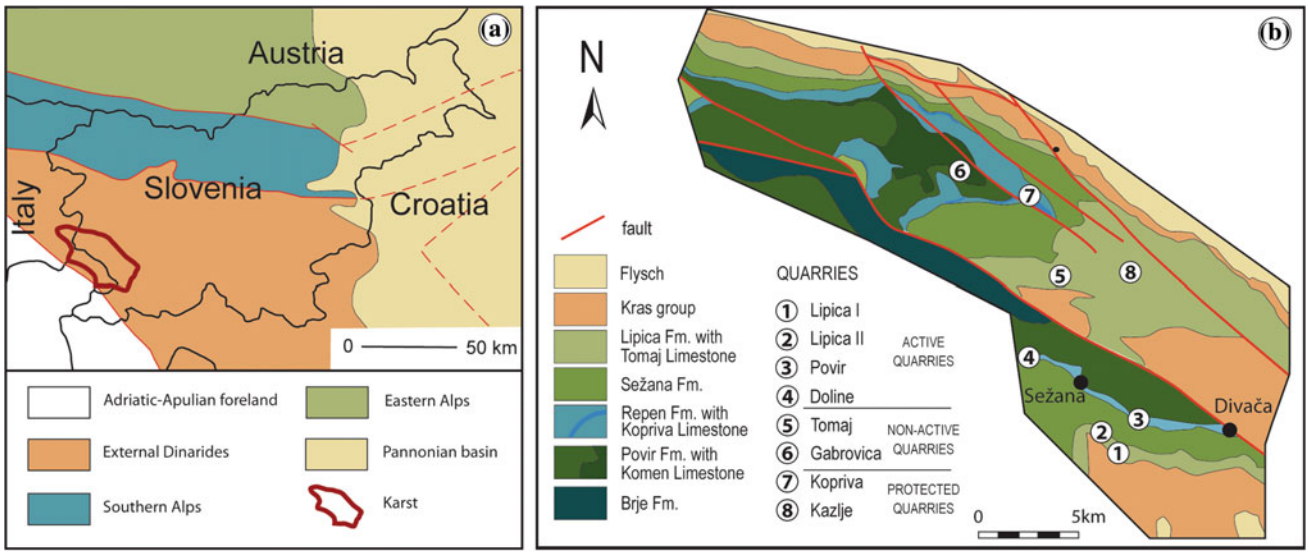

Fig. 43.1 **a** Macrotectonic subdivision of Slovenia [modified from Placer (1999)]; **b** Geological map of the Slovenian Karst [compiled from Jurkovšek et al. (1996) and Jurkovšek (2010)] showing the locations of selected quarries

the word kras refers to a type of terrain comprising a distinctive assemblage of landforms and hydrology arising from a combination of high rock solubility and well developed secondary porosity, where unique superficial and underground features developed and where underground water drainage predominates.

43.2.3 Other Names

No other names.

43.2.4 Area of Occurrence

The 450 45′ parallel runs through the middle of the Karst region, with the 140 00′ meridian east crossing it east of Divača, the region's main city. Although not very high (from 200 to 500 m a.s.l.), the Kras plateau is well-defined; to the SW it rises over the Gulf of Trieste, to the N it is surrounded by the alluvial Soča plain and the Vipava valley, while the SE border is defined by the Brkini Hills and the Reka River valley.

43.2.5 List of Constituent "Global Heritage Stone Resource" Designations Included Within This Designated Province

Natural stone types from the Karst region have been excavated from the following three formations or members:

The Repen Formation (Repen and Kopriva limestones)
The Lipica Formation (Lipica Fiorito, Lipica Unito)
The Tomaj Limestone (dark, laminated limestone within the Lipica Formation)

43.2.6 List of Other Known Constituent Heritage Stone Types, not Otherwise Designated, with an Assessment of International/National/Regional Status that Are also Located Within This Designated Province

In the Karst region, the Kopriva, Lipica and Kazlje quarries are declared as geological monuments of national importance. In addition, Kopriva quarry is officially protected as a natural monument.

43.2.7 Geological Setting

The Karst region is a part of the Adriatic-Dinaric microplate and structurally belongs to the larger tectonic unit of the External Dinarids, more specifically the Komen thrust sheet. During the Mesozoic the area formed part of a southern Tethyan passive margin and belonged to the Dinaric Carbonate Platform (mainly limestones), while during the Palaeogene it represents a transition to the foreland basin (foraminiferal limestones and flysch deposits).

43.2.8 Unifying Geological Characteristics Within This Province

The main characteristic of the Karst region is that it is composed mainly of Cretaceous shallow-water limestones of the Dinaric Carbonate Platform, with only minor occurrences of Palaeocene flysch deposits. This feature also characterises the region as a special type of landform with an almost total absence of surface water drainage and numerous surface karst features. Natural stone types have been excavated from three different formations or members in the Karst region: the Repen Formation (Repen and Kopriva limestones), the Lipica Formation (Lipica Fiorito, Lipica Unito) and the Tomaj Limestone (dark, laminated limestone within the Lipica Formation). The most common type of rock currently excavated is the rudist limestone of the Lipica Formation which date to the Santonian to Campanian times. Limestones of this formation are mainly represented by a light grey, thick-bedded to massive LIPICA limestone rich in (largely fragmented) rudists. Rudist shells can be either relatively well preserved (such as in Lipica Fiorito quarried limestone) or almost completely disintegrated and intensively endolitised (Lipica Unito quarried limestone). Other fossils present include echinoderms, benthic foraminifera and bryozoans. The limestones were deposited in hydrodynamically high-energy subtidal environments of a carbonate platform.

43.2.9 Natural Variation of Geology Within This Province

Although the Kras is composed solely of limestones of the Dinaric Carbonate Platform, this succession dates almost entirely to the Cretaceous. During this time the platform was subject to sea-level changes, tectonic movements and evolutionary changes of varying magnitudes. The rocks of the various formations thus range from supratidal limestones with developed palaeokarstic features, subtidal limestones with different biota, to episodic deeper-water facies. However, the majority of the facies used as natural stones are represented by subtidal limestones containing numerous rudist shells belonging to the Lipica Formation.

43.2.10 Vulnerability

Although a large number of quarries are documented in the region, many are currently inactive. Slovenian Karst quarries are distributed across five different horizons, located from NW to SE in the following order: the first zone is represented by the Nabrežina horizon, a light grey rudist limestone (Lipica Fm.; quarries: Lipica I and II (Fig. 43.2a, b), Lokve); this is followed by the "Repen" horizon comprised of a grey and light olive grey rudist limestone (Povir and Repen Fm. (Fig. 43.2c); quarries: Lisično I and II, Vitez, Polževo, Vrhovlje, Doline and Povir); the third horizon is characterised by light, dark grey or black rudist limestones (Repen, Sežana and Lipica Fm.; quarries near Pliskovica, Kopriva, Gabrovica, Kamna Gorica, Brje, Tomaj, Kazlje (Fig. 43.2d) and Avber); the fourth horizon contains grey limestones (Povir Fm., non-active quarries near Škrbina, Kobjeglava, Komen and Lipa), and finally the fifth horizon is represented by repetitions of Repen limestone (Repen Fm.; quarries: Kostanjevica-Puja, Temnica, and Opatje Selo I and II).

There are four currently active quarries in the Karst region. At the Lipica I and Lipica II quarries the extraction of Lipica Unito and Lipica Fiorito natural stone is carried out, using both open-cut and underground methods (Fig. 43.3). In terms of size, the Lipica I quarry is one of the largest natural stone quarries in Slovenia. The natural stone extracted from the Doline and Povir quarries is a type of Repen limestone and is also quarried in neighbouring Italy. Repen natural stone, which is considered the most valuable of all types on Karst, is increasingly popular for its appearance and quality. All lithotypes are characterised by high density (2,640–2,692 kg/m^3), low water absorption (0.2–0.8 %m/m) and low open porosity (1.8–4.1 %); consequently they also exhibit high frost and salt resistance as well as high compressive (108–306 MPa) and flexural (6–19 MPa) strength (Mirtič et al. 1999). As such they are considered the highest quality calcareous natural stones in Slovenia.

43.2.11 Historical Use and Geographical Area of Utilization

There is no doubt that stonecutting was already a well-established activity in the Karst region over 2000 years ago (Fatur et al. 2000). Limestone from Karst (today a part of Slovenia and easternmost Italy, see Fig. 43.1) was used by the Romans in several towns, including Aquileia, Trieste and Ljubljana (Brecelj et al. 1989; Frangipane 2010). Karst limestones were commonly employed in Venice until the 13th century, especially for fountain sculptures or ornaments on buildings and churches, with Istrian limestones prevailing thereafter. In his seminal 17th century work The Glory of the Duchy of Carniola, Valvasor (nobleman, scientist, polymath and fellow of the Royal Society in London, which also introduced the word karst to European scholars) mentioned the export of large blocks of Karst limestones to Venice and other destinations. The construction of the Trieste-Vienna railway, completed in 1857, resulted in an increase in stonecutting workshops in Italian Aurisina, as well as the

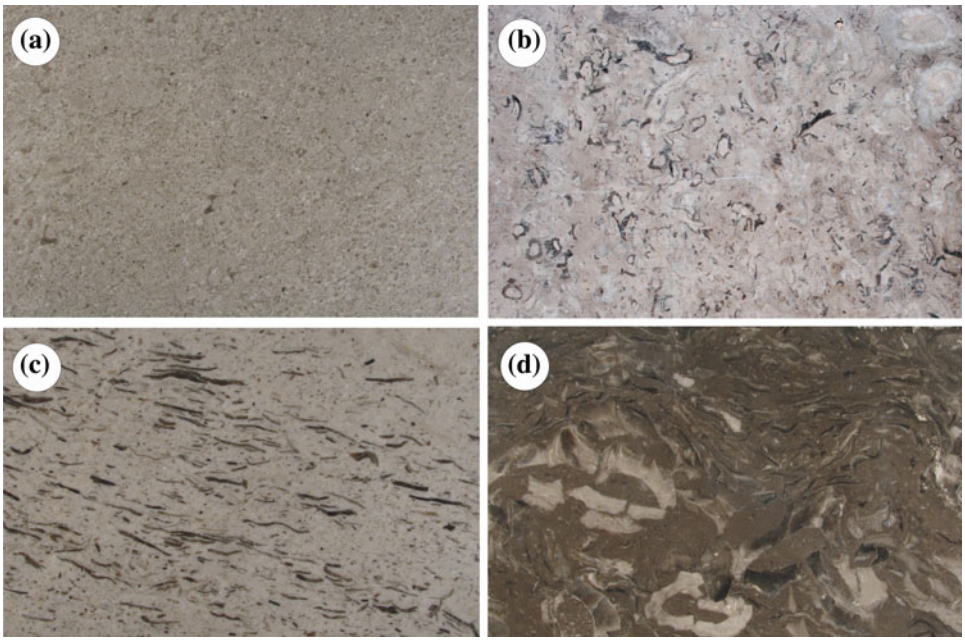

Fig. 43.2 Characteristic lithotypes of Karst limestones; **a** Lipica unito (photo length 11 cm), **b** Lipica fiorito (photo length 30 cm, photo by Jasmina Rijavec), **c** Repen limestone (photo length 11 cm), **d** Kazlje limestone (photo length 11 cm)

Fig. 43.3 South portal face wall with the entrance into Lipica II quarry underground galleries (Kortnik 2012)

opening of other Karst quarries. Stone blocks from these quarries were transported throughout the Austro-Hungarian Empire and were used in important buildings such as the opera houses in Budapest and Graz, Prague railway station and the Viennese Parliament building. Trieste international port also enabled transportation of stones to even more distant destinations, including Hamburg and even Egypt and America (Brecelj et al. 1989; Frangipane 2010; Premrl 2012). Between the mid-19th century and the mid-20th century, Karst limestones were used in the construction of several important buildings in Trieste (Brecelj et al. 1989), while during the last century Karst natural stones were used by the internationally renowned Slovenian architect Jože Plečnik (Prelovšek 1987). In villages, castles and churches in the vicinity of the Karst region, Karst natural stones have been employed to construct many typical stone-built

architectural features such as wells, portals, corbels, baptismal fonts and shrines (Klementič et al. 1987). Grey laminated limestones known as Komen "shale" have also been used as roof decking (Mirtič et al. 1999).

43.2.12 Construction

Karst natural stones are most commonly used in the construction of façade cladding, pavements, window sills, staircases, indoor flooring and wall cladding, but are also widely appreciated by sculptors (Fatur et al. 2000). Karst limestones currently adorn house façades, streets, squares and buildings in both the Karst region (Hotel Favory in Lipica) and other parts of Slovenia (RTV Koper, Casino Perla in Nova Gorica, Hotel Kempinski Palace in Portorož), as well as in neighbouring Istria (Croatia), Italy, Austria, Hungary, many other European Countries (tall building in Sarajevo), Russia (Hotel in Toljatija) and the Far East. New markets have recently opened up in the Middle and Far East, the Arabian Peninsula and the USA.

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