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Rock shelters in Slovenian Istria as a potential for the development of geotourism in the region

Spodmoli v Slovenski Istri kot potencial za razvoj geoturizma v regiji

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Abstract

Geotourism is a special form of tourism which focuses on visiting geological and geomorphological sites. In the article we discuss the basic terms regarding geotourism, geodiversity and geoconservation, and then present the main features of rock shelters, i.e. landforms whose formation has not yet been elucidated. In our opinion rock shelters in Slovenian Istria have a potential to become sites for geotourism. We evaluated the geotourism potential of five rock shelter locations: Veli Badin, Štrkljevica, Mišja peč, Stena and Kavčič. The results of the evaluation show that three of the chosen rock shelter locations have a potential to develop as geotourist sites. Research confirmed our assumptions that the lack of scientific knowledge about rock shelters is a weakness from the geotourist point of view. Beside more detailed research on rock shelters, other activities, e.g. management of the sites, creating tourist activities, information material etc. are also needed if we want rock shelters to become geotourist sites in the future.

Izvleček

Geoturizem je posebna oblika turizma, ki se osredotoča na obiskovanje geoloških in geomorfoloških naravnih znamenitosti. V članku najprej predstavimo glavne pojme, ki se tičejo geoturizma, geodiverzitete in ohranjanja geo-dediščine, nato pa se osredotočimo na spodmole – reliefne oblike, katerih nastanek zaenkrat še ni pojasnjen. Po našem mnenju imajo spodmoli v Slovenski Istri potencial, da se razvijejo kot geoturistične znamenitosti. Ovrednotili smo geoturistični potencial petih lokacij spodmolov: Veli Badin, Štrkljevica, Mišja peč, Stena in Kavčič. Rezultati ocenjevanja so pokazali, da imajo tri lokacije potencial, da se razvijejo kot geoturistične znamenitosti. Z raziskavo smo potrdili naše domneve, da je z geoturističnega vidika pomanjkanje znanja o spodmolih slabost. Poleg bolj poglobljenih raziskav o spodmolih bodo potrebne tudi druge aktivnosti, npr. upravljanje z lokacijami, nudenje turističnih aktivnosti, izdelava informacijskega materiala o spodmolih itd., če želimo, da spodmoli v prihodnosti postanejo lokacije geoturističnega obiska.

Introduction

The most impressive landforms (caves, canyons, waterfalls etc.) will always be attractive to visitors. As well as being part of geodiversity (variety within abiotic nature), some of them can carry different values in humans' point of view: scientific, cultural, aesthetic, ecological, economic, educational etc. Some of them are, because of their importance, recognized as a natural heritage and consequently protected for future generations. These so-called geosites and geomorphosites can play an important role in the development of geotourism in the areas where they are located. Geotourism, with its focus on geological heritage, is a special form of tourism and by following the concept of sustainable tourism it encourages synergy between conservation of geological heritage and tourism development, which brings satisfaction to both tourists and the local community. Its goals are raising people's interest in geoscience by visiting geosites and geomorphosites and learning on the field as well as enhancing further research in the field of geology and geomorphology.

Slovenian Istria is known for being a region where rock shelters (or abris) occur. These are shallow cave-like openings, formed mostly in the lower parts of rock faces/cliffs. So far little is known about rock shelter formation, but our opinion is that they are interesting landforms and can be attractive to tourists. With the aim to figure out which rock shelter locations have the highest potential for the development of geotourism we decided to evaluate five locations: Veli Badin, Štrkljevica, Mišja Peč, Stena and Kavčič. The selection of these sites was based on their official recognition as valuable natural features (Official Gazette RS, 2010), and our knowledge of these locations from the field (all are part of ongoing research of rock shelter morphogenesis). The evaluation of their geotourist potential was made according to a method proposed by Kubalíková (2013). Results showed that three of the chosen rock shelter locations have a potential for geotourist development. The evaluation also revealed the fact that with the intent to increase geotourist potential, more detailed research on these landforms should be made, as scientific and educational values of the sites are the basis for geotourism development.

Geodiversity, geoheritage and geoconservation

In order to understand the concept of geotourism we should first discuss three terms which in principle represent the basis of this special type of tourism: geodiversity, geoheritage and geoconservation.

Geodiversity is a variety within abiotic nature, a diversity of geological (rocks, minerals, fossils), geomorphological (landforms, processes) and soil features, "including their assemblages, relationships, properties, interpretations and systems" (Gray, 2004; Erhartič, 2007). Seen from a man's point of view, geodiversity has different values (Gray, 2004; Reynard, 2004; Kubalíková, 2013):

a) intrinsic/scientific value (independent of human evaluation; for understanding the history of the Earth);
b) cultural, historical, archaeological, spiritual, religious values;
c) aesthetic value (very important for geotourist activities);
d) ecological value (flora and fauna depend on particular geomorphological and geological conditions)
e) economic/functional value (use of mineral resources, geoheritage, geotourist potential and activities);
f) research/educational value (for understanding the origin of life and landforms, evolution of the landscape and climate and paleogeographical reconstructions).

Scientific and partly ecological value can be regarded as objective values and all the other as subjective values (dependent of the culture, education, social level…of the assessor) (Reynard & Panizza, 2005).

With the aim to minimize negative impacts on natural features considered to carry special values for humans, some parts of abiotic nature are protected as natural heritage. Natural heritage is described as a part of nature "which the society of a particular place and time accepts as a value" (Skoberne & Peterlin, 1988, as cited in Erhartič, 2010). The definition also covers the abiotic part of natural heritage, i.e. geoheritage, which represents geosites and geomorphosites. The act of "protecting geosites and geomorphosites from damage, deterioration or loss through the implementation of protection and management measures" (Hose, 2012, p. 16) is geoconservation. With geoconservation the most valuable parts of the geodiversity are preserved for the future generations.

In Slovenian documents about nature conservation the term "valuable natural feature" (Official Gazette RS, 2014) is used instead of the term natural heritage. According to the Decree on the categories of valuable natural features (Official Gazette RS, 2003) valuable natural features are of different categories: geomorphological valuable natural feature, subsurface geomorphological valuable natural feature, geological valuable natural feature, hydrological valuable natural feature, botanical valuable natural feature, zoological valuable natural feature, ecosystemic valuable natural feature, dendrological valuable natural feature, designed landscape, valuable landscape and also minerals and fossils. Parts of nature are officially recognized as valuable natural features because of following characteristics: extraordinary, typical, complexly bound, preserved, rare, scientifically or historically important parts of nature (Official Gazette RS, 2003). In our case we are interested in geological valuable natural features – geosites, and geomorphological valuable natural features – geomorphosites. Geosites according to the Decree on the categories of valuable natural features represent mineral and fossil deposit locations and different types of geological features: tectonic, mineralogical, petrological, paleontological, stratigraphical, glacial, hydrogeological and sedimentological. Minerals and fossils are a special category of valuable natural features. Geomorphosites, which can be single objects or wider landscapes (Reynard & Panizza, 2005), according to the same Decree represent two types of landforms: surface landforms (karstic, glacial, fluvial-denudational, polygenetic and coastal landforms) and subsurface landforms (caves and shafts). The main difference between geosites and geomorphosites is that geosites can be found also in urban environments, for example mines and quarries (Dowling, 2011). Another difference between the two types of sites is in the assessment of their values. Geosites were in the past assessed only through the aspect of their scientific value, while methods for geomorphosites evaluation always included other values, for example aesthetic, cultural and economic. But scientific value is always the basis of evaluation for geotourist purposes as well (Reynard 2005; Kubalíková, 2013).

Geotourism, geotourists and geoparks

The term geotourism is a coinage of two words – "geological" and "tourism". The first part of the word refers to geological and geomorphological sites, the second to tourist visits, planning, management and infrastructure (accommodation, transport) (Dowling, 2011). As it can be seen from the term itself, geotourism is a form of "special interest tourism" (Hose, 2012, p. 8) or niche tourism (Hose, 2005) with a single focus of interest, and is as such close to other types of special interest tourism, for example ecotourism and cultural tourism. In the same way as ecotourism focuses on biotic environment (flora and fauna) and the basis of cultural tourism is the contact with different cultures, geotourism focuses on abiotic environment: forms (landforms, rock outcrops, rock types, sediments, soils, crystals) and processes (erosion, glaciation, volcanism etc.) (Dowling, 2011).

Geotourism is actually quite a new global phenomenon (Dowling, 2008), but it has a widespread potential, because it can develop on a small or large scale and in natural or urban environments (Dowling, 2011). The beginnings of its development were in the late 1980s with accelerating loss of mines and quarries, some geological exposures (road side exposures) and geomorphosites (hard coastal defenses) in the UK (Hose, 2012). Its purpose was primarily to "promote and possibly fund geoconservation, especially for mines and quarries" (Hose, 2012, p. 7). It was recognized as a special form of tourism in the early 1990s by Hose, a geologist who made the first modern geotourism definition, which was "the promotion and explanation to a non-specialist audience of the geologic features and/or significance of a delimited area by either a fixed facility and/or populist publication" (Hose, 1994, p. 2, as cited in Hose, 2012). The same author later redefined his definition and in 2012 (p. 11) again made a new definition of geotourism: "The provision" of interpretative and service facilities for geosites and geomorphosites and their encompassing topography, together with their associated in situ and ex situ artefacts, to constituency-build for their conservation by generating appreciation, learning and research by and for current and future generations." Although "HOSE" is an authority in the field of geotourism, in the years after his first definition of geotourism many authors tried to make their own definition. Dowling and Newsome for example defined geotourism as "…a form of natural area tourism that specifically focuses on geology and landscape. It promotes tourism to geosites and the conservation of geo-diversity and an understanding of earth sciences through appreciation and learning. This is achieved through independent visits to geological features, use of geo-trails and viewpoints, guided tours, geo-activities and patronage of geosite visitor centres." (Dowling & Newsome, 2010, as cited in Dowling, 2011, p. 1). Their definition includes the term geodiversity which refers to geological and geomorphological natural features, but the basic focus of geotourism is according to them only on geosites. A solely geological component of geotourism is also found in the definitions of some other authors, for example Slomka & Kicinska-Swiderska (2004), Sadry (2009) and Amrikazemi (2010). But on the other hand even broader definitions of geotourism exist, for example from National Geographic, which includes not only geoheritage and its conservation, but also culture and history of the regions (Internet 1).

Just as there is no unified definition of geotourism, there is no such definition of a visitor – a geotourist. Geosites and geomorphosites are not visited only by specialists from the geoscientific field, but also by other people who admire natural features. Grant (2010, as cited in Dowling, 2011) describes two sorts of geotourists:

- visitors, who can be unaware, aware or interested in geological tourism
- geotourists, who are geo-amateurs, geo-specialists and geo-experts.

According to his definition everyone is a potential geotourist, the difference is only in the knowledge about the geo- and geomorphosites. And by good management of the sites, even people who have little knowledge of Earth processes and forms, can get interested in this topic and understand the need of protection and conservation of natural heritage. Which is all in all one of the basic goals of geotourism.

The point of geotourism is not only in admiring geoheritage but also in establishing a tourist product and promoting it. This entrepreneurial part of geotourism involves different actions: planning and management of the sites, transportation, accommodation and trained team (guides), which are usually operated by local communities. These actions consequently enhance people's interest in visiting geosites and geomorphosites. The development of geotourism is a result of cooperation between nature conservation authorities, educational institutions, local community and investors (Dowling, 2011). Ideally expectations of all the cooperating sides meet and geotourism can consequently fund geoconservation (Martini, 2000). As geotourism tries to follow the concept of sustainable tourism it encourages synergy between conservation of geoheritage and touristic development, which brings satisfaction to both tourists and the local community. One of the best examples of sustainable geotourism development are geoparks. A geopark is "a nationally protected area containing number of geological heritage sites of particular importance, rarity or aesthetic appeal (UNESCO, 2009). Geoparks can act as an alternative to UNESCO World Heritage Site (Hose, 2012). These areas represent a combination of geoconservation, geo-education and tourism, which brings economic benefit to local people. For a geotourist experience geoparks offer tourists different activities (visiting information centres and museums, hiking on geotrails, organized guided tours and school excursions, seminars etc.) and information material (maps, educational material, leaflets, etc.) (Dowling, 2011). In Slovenia we have two geoparks which are both on the list of European Geoparks Network (EGN), therefore on the list of Global Geoparks Network (GGN) and by that under the auspices of UNESCO. These are Idrija Geopark and Geopark Karavanke/Karawanken (Slovenian-Austrian cooperation) (Internet 2 & 3), and they can act as a good example for any potential geotourist actions in other parts of the country.

Characteristics of rock shelters in Slovenian Istria

Rock shelters (or abris) are shallow cave-like openings, formed mostly in the lower parts of rock faces/cliffs. In the past they attracted people's attention as potential housing, shelters from the weather and storage places, now they are more interesting as objects of scientific research and tourist visits. In Slovenian Istria rock shelters occur in two areas: Kraški rob (Karst edge) and Dragonja river valley. Kraški rob, where most of the rock shelters can be found, represents an area of specific landscape from source of Timavo river in Italy to Mt. Učka and Raša bay at eastern coast of (Croatian) Istria (Placer, 2007). In our case we are interested in part of this area between villages Osp and Socerb at Slovenian-Italian border and villages Sočerga and Rakitovec at Slovenian-Croatian border. This part of Kraški rob covers an area of approximately 17 km in length and from 2 to 15 km in width (Placer, 2007). The formation of Kraški rob is related to geological events which had a great impact on the area on a larger scale. Kraški rob represents a contact belt between Adriatic-Apulian foreland and External Dinarides. The overthrusting of External Dinarides in the end of Eocene and in the beginning of Oligocene, followed by the underthrusting of the Adriatic-Apulian foreland underneath External Dinarides in the Middle Miocene resulted in a specific landscape, a series of geomorphological steps, where Eocene alveoline-numulite limestones, more resistant to weathering, are thrust on less resistant Eocene flysch (Placer, 2007; 2008). Kraški rob as a landscape thus represents a combination of steep limestone rock faces and more gently sloping flysch slopes (Natek, Repe & Stepišnik, 2012). Elevation of limestone rock faces in the area varies between 750 m above sea level (e.g. at Kavčič) to 50 m above sea level (e.g. at Osp). The area is also a contact between continental and coastal part of Slovenia and a climate border. Kraški rob is therefore unique in Slovenia by its geomorphological, geological, and biological characteristics (rock faces are habitats of special flora and fauna) and is as such officially recognized as valuable natural feature (Official Gazette RS, 2010; Internet 4). The same is with limestone rock faces, where rock shelters occur – they were already recognized among nature conservation authorities as a part of natural heritage (Official Gazette RS, 2010). The other rock shelter location, a limestone hill Stena, is in Dragonja river valley. The elevation of this site is lower than of those at Kraški rob – approximately 30 m above sea level. According to Placer (2007) this location is not a part of subthrusting belt. It represents the western part of Buje anticline (Pleničar et al., 1973), from which it is separated by the river bed of Dragonja. Alveoline-numulite limestones are in contact with flysch and with alluvial sediments of Dragonja (Fuks, 2010). This location was like in the case of Kraški rob recognized as a part of natural heritage (Official Gazette RS, 2010).

In the Slovenian literature we can find definitions, which describe rock shelters as small horizontal caves (for example Stepišnik, 2011), but in case of Slovenian Istria these landforms are shallow caverns, which have more or less disctinctive overhangs and roofs, but they are not caves. In research paper about Kraški rob (Natek et al., 1993) authors named different phenomena from this area as rock shelters. Among them were large caverns (e.g. rock shelters at Veli Badin, for sizes see Table 1), which partly resemble cave entrances, but in the paper there are examples of describing overhangs on limestone-flysch contacts as rock shelters. Placer et al. (2011) defined three types of rock shelters in Slovenian Istria: corrosion-freeze thaw type (e.g. caverns of Veli Badin), structural-tectonic type (overhang that represents a small thrust) and litologic-facial type (overhang, which is a result of differential weathering on a limestone-flysch contact). We are interested in first type (corrosion-freeze thaw rock shelters), as shapes of these landforms are the closest to description in definition of rock shelters (cave-like openings in rock faces), and not in other two types. The reason is that for now no agreement exist, if we can regard these two types of overhangs as rock shelters or not.

Rock shelters in Slovenian Istria vary in size and shape. But their form in crossection can be in general described as following: at the bottom their shape traverses from short slope of 30-40 degrees to subhorizontal bench, which continues to a concave, hollow part of rock shelters. The hollow part is covered with a roof, which can be straight or slighty sloping. In transitional part from the concave part of rock shelters to vertical slope above them, they have a slightly convex shape (Kunaver & Ogrin, 1992). In the walls and roofs of rock shelters at most of the locations in Slovenian Istria calcareous formations (tufas), which resemble shape of speleothems, can be found.

Rock shelters similar to these in Slovenian Istria occur at various locations on Earth. They can be found just across the border in Croatian Istria, for example in Mirna river valley and close to Buzet. They occur in Velebit Mountains (Croatia) close to Ravni Dabar and Baške Oštarije and on rock faces of Kornati islands (Croatia). We spotted them north from Shiraz in Iran, on the coast of lake Van in Turkey, and near town Perissa in Santorini, Greece. According to the literature rock shelters of such shapes can be also found near Eyzes-de-Tayac at river Vezere (France), at Mesa Verde (Cliff Palace) in southwestern Colorado (USA) (Kunaver, 2007), in northwestern Sahara (Smith, 1978), and in the Golden Gate Reserve, South Africa (Mol & Viles, 2010; 2011), if we cite just some of the examples. As rock shelters can be found in different rock types (limestone, marble, sandstone etc.) and climate types (coastal, desert, mountain climates etc.), it is difficult to link their formation to only one factor or process. There is a possibility that different processes are involved in their formation, but as the final shape of rock shelters is similar, they can be for now regarded as convergent landforms.

Slovenian researchers, whose main focus was on rock shelters in Slovenian Istria and not on rock shelters from other locations, through years discussed different possible causes of their formation:

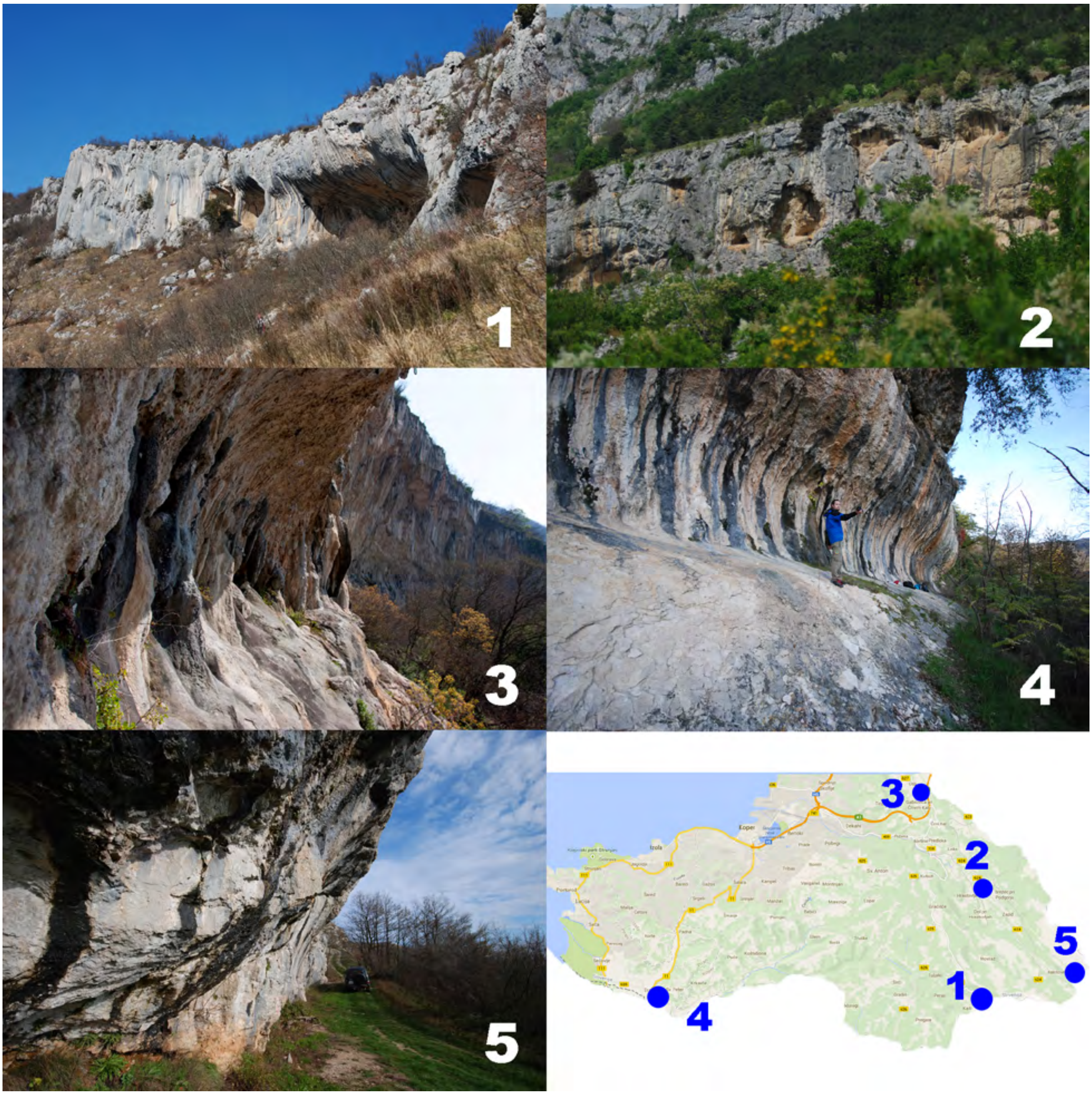

Fig. 1. Rock shelter locations, chosen for evaluation of geotourist potential: 1 – Veli Badin, 2 – Štrkljevica, 3 – Mišja peč, 4 – Stena, 5 – Kavčič, and their position on the map showing the major part of Slovenian Istria. Author of the photos 1–5 (2012–2014): L. Ozis. Source of the map: Google maps, 2014.

Sl. 1. Lokacije spodmolov, ki so bile izbrane za ocenjevanje geoturističnega potenciala: 1 – Veli Badin, 2 – Štrkljevica, 3 – Mišja peč, 4 – Stena, 5 – Kavčič, in njihov položaj na zemljevidu, ki prikazuje večji del Slovenske Istre.

- combination of mechanical weathering, corrosion and denudation, probably in the time of Würm glaciation (Habić et al., 1983);
- combination of tectonically crushed limestones on limestone-flysch contact and exfoliation due to microclimatic conditions (high temperatures of rock faces in all seasons – result of SW-S-SE exposition of rock faces) (Kunaver & Ogrin, 1992; Ogrin, 1995);
- combination of selective weathering of limestones on limestone-flysch contact and microclimatic conditions (Kunaver & Ogrin, 1993);
- combination of mechanical weathering, denudation and corrosion; possible lithological differences among limestone layers (Natek et al., 1993);
- influence of lithological and tectonic features of limestones, intensive mechanical weathering on a bedding plane, partly exfoliation; impact of colder climatic conditions in the past (Grmovšek, 2001);
- river erosion and unroofed caves (Gogala, 2007);
- selective weathering (mechanical and chemical) and denudation of limestones on limestone-flysch contact; climatically exposed rock faces (Kunaver, 2007);
- combination of different factors: lithological and tectonic features, temperatures, corrosion and probably biological influence; ”corrosion-freeze thaw” rock shelters (Placer et al., 2011).

Table 1. The chosen rock shelter locations for evaluation of geotourist potential.

Tabela 1. Izbrane lokacije spodmolov za vrednotenje njihovega geoturističnega potenciala.

Name of valuable natural feature	*Category of valuable natural feature*	*Brief description*	*Range of importance (and consequent protection)*
Veli Badin – Krog	geomorphological, geological, botanical, ecosystemic	limestone scale with picturesque rock shelters, natural bridge, kamenitzas, representative thermophilic vegetation, nesting place and habitat of endangered bird species sizes of rock shelters: - the largest rock shelters: 20-25 m in width, 10-13 m in height and 10-15 m in depth; - smaller rock shelters: 5-10 m in width, 3-5 m in height and 1-5 m in depth	national
Štrkljevica – rock face	geomorphological & subsurface geomorphological, botanical, zoological	rock face of Kraški rob (Karst edge) between villages Podpeč and Zanigrad with rock shelters, cave and three occasional waterfalls, habitat of rare and endangered animal species sizes of rock shelters: due to protection of the rock face we did not measure sizes of rock shelters	national
Mišja peč – rock shelter	geomorphological	rock shelter in limestone rock face of collapsed cave Mišja peč size of rock shelter: w = 15,5 m, h = 5 m, d = 3 m	local
Stena	geomorphological, geological, botanical, ecosystemic	limestone rock face in Dragonja river valley, site of Mediterranean flora sizes of rock shelters: rock shelters are shallow, but longer in width, for example: w= 20 m, h = 3,5 m, d = 1,2 m	national
Kavčič – rock faces	geomorphological, geological, botanical	rock faces of Kavčič, thrust contact of limestone over flysch, east from village Rakitovec size of rock shelter: w = 28 m, h = 7 m, d = 3,5 m	local

Source: Official Gazette RS, 2010

As we can see many assumptions of their formation exist, but none of them has been proven yet. Their formation is obviously complex, a result of an interaction of many factors and processes. Our ongoing research on rock shelters led to the following new insights about these landforms:

a) they occur on the contact of two limestone layers, and not at limestone-flysch contact;
b) the influence of tectonic factors is important, at least in some cases, e.g. folded limestone layers at location Veli Badin (Štefančič, 2012);
c) rock shelters are not unroofed caves – numerous calcareous formations on their roofs and walls are tufas and not speleothems (Ozis & Šmuc, 2014), as many previous authors except for Placer et al. (2011) thought;

but nevertheless many questions regarding their formation remain unanswered for now. Although little is known about rock shelters in Slovenian Istria they are in our opinion still interesting landforms and can be promoted in the field of geotourism.

Method for evaluation of geotourist potential of rock shelters

With the aim to estimate the geotourist potential of rock shelters in Slovenian Istria, we decided to evaluate rock shelters from five different parts of the region: Veli Badin, Štrkljevica, Mišja peč, Stena and Kavčič. Rock shelter locations and their position in Slovenian Istria are presented in Figure 1. All the chosen examples are according to the document Rules on the designation and protection of valuable natural features officially recognized as valuable natural features (Official Gazette RS, 2010). Rock shelters are in this document in most cases listed as being a part of protected rock faces, but also as individual examples of natural heritage. These five examples were chosen because they have already been recognized as geoheritage, and we know them well from our field work (ongoing research on morphogenesis of rock shelters in Slovenian Istria). Descriptions of rock shelter locations in Table 1 are from the same document. To these short descriptions we added information about rock shelter sizes. Numbers present the largest sizes measured of width (w), depth (d) and height (h) of hollow part of rock shelters.

Table 2. Method for geosite and geomorphosite assessment for geotourism purposes.

Tabela 2. Metoda za ovredotenje geološko in geomorfološko zanimivih območij za namene turizma.

Scientific and intrinsic values	
Integrity	0 - totally destroyed site
	0.5 - disturbed site, but with visible abiotic features
	1 - site without any destruction
rarity (number of similar sites)	0 - more than 5 sites
	0.5 - 2-5 similar sites
	1 - the only site within the area of interest
diversity (number of different partial features and processes within the geosite or geomorphosite)	0 - only one visible feature/process
	0.5 - 2-4 visible features/processes
	1 - more than 5 visible features/processes
scientific knowledge	0 - unknown site
	0.5 - scientific papers on national level
	1 - high knowledge of the site, monographic studies about the site
Educational values	
representativeness and visibility/clarity of the features/ processes	0 - low representativeness/clarity of the form and process
	0.5 - medium representativeness, especially for scientists
	1 - high representativeness of the form and process, also for the laic public
exemplarity, pedagogical use	0 - very low exemplarity and pedagogical use of the form and process
	0.5 - existing exemplarity, but with limited pedagogical use
	1 - high exemplarity and high potential for pedagogical use, geodidactics and geotourism
existing educational products	0 - no products
	0.5 - leaflets, maps, web pages
	1 - info panel, information at the site

actual use of a site for educational purposes (excursions, guided tours)	0 – no educative use of the site
	0.5 – site as a part of specialized excursions (students),
	1 – guided tours for public
Economic values	
accessibility	0 – more than 1000 m from the parking place
	0.5 – less than 1000 m from the parking place
	1 – less than 1000 m from the stop of public transport
presence of tourist infrastructure	0 – more than 10 km from the site existing tourist facilities
	0.5 – 5 – 10 km tourist facilities
	1 – less than 5 km tourist facilities
local products	0 – no local products related to a site
	0.5 – some products
	1 – emblematic site for some local products
Conservation values	
actual threats and risks	0 – high both natural and atrophic risks
	0.5 – existing risks that can disturb the site
	1 – low risks and almost no threats
potential threats and risks	0 – high both natural and atrophic risks
	0.5 – existing risks that can disturb the site
	1 – low risks and almost no threats
current status of a site	0 – continuing destruction of the site
	0.5 – the site destroyed, but now with management measures to avoid the destruction
	1 – no destruction
legislative protection	0 – no legislative protection
	0.5 – existing proposal for legislative protection
	1 – existing legislative protection (Natural monument, Natural reservation...)
Added values	
cultural values: presence of historical/ archaeological/ religious aspects related to the site	0 – no cultural features
	0.5 – existing cultural features but without strong relation to abiotic features
	1 – existing cultural features with strong relations to abiotic features
ecological values	0 – not important
	0.5 – existing influence but not so important
	1 – important influence of the geomorphologic feature on the ecological feature
Aesthetic values	
number of colours*	0 – one colour
	0.25 – 2-3 colours
	0.5 – more than 3 colours
structure of the space*	0 – only one pattern
	0.25 – two or three patterns clearly distinguishable
	0.5 – more than 3 patterns
viewpoints	0 – no viewpoints
	0.25 – 1-2 viewpoints
	0.5 – 3 and more viewpoints

Source: KUBALÍKOVÁ, 2013

*values difficult to describe

In the literature we can find numerous methods for assessing natural features as potential geoheritage, but there are only a few methods for evaluation of geotourist potential of the sites. Kubalíková (2013) compared a number of methods for assessing geotourist potential of geosites and geomorphosites. Similar research did Erhartič (2010), but the difference between the two authors is that Erhartič (2010) tried to find the best examples for evaluation of geoheritage and not of geotourist potential. Kubalíková (2013) found out that methods are usually made on the same principle, the differences between them are in the authors' decision of which value they regard as more important. Scientific value is always basic in evaluations, followed by assessment of added values. According to Kubalíková (2013), methods for geotourist purposes should consider the following criteria of evaluation:

a) intrinsic/scientific values (diversity, importance of the natural feature, scientific knowledge of the site)
b) pedagogical potential and exemplarity (the site itself and availability of the supporting products – maps, trails, information centres, panels etc.)
c) accessibility and visibility of the site, accompanied by the presence of tourist infrastructure (accommodation, shops, restaurants, local products etc.)
d) threats and risks – current protection of the site
e) added values (aesthetic, cultural, historic, ecological etc.)

As Kubalíková (2013) actually concluded the previous knowledge of assessment for geotouristic purposes, we decided to use the method she proposed for our evaluation of the five rock shelter locations. The method is presented in Table 2. With this method sites are evaluated by most criteria with numerical values from 0 (the lowest value) to 1 (the highest value), except for the criteria of "aesthetic values" where the range of values is between 0 (lowest value) and 0.5 (highest value). The sites evaluated with highest values (1 or in the case of aesthetic values 0.5) in all the criteria reach the evaluation of 18.5 units.

In our case we joined two conservation values: "potential threats and risks" and "actual threats and risks", into one value, so the highest evaluation the sites could reach is 17.5 units and not 18.5 units as in case of Kubalíková (2013). At some criteria we could not attribute only one numerical value to sites, so we decided to evaluate them in range, for example 0 – 0.5, or 0.5 – 1. (Maybe creating a numerical value in between, for example 0.25 or 0.75, would be a better option.) Consequently, the geotourist potential of each site is not presented as one number, but as a range between the highest and lowest sum of numerical values. With the aim of a better representation and comparison of the results, we decided to calculate the average sums of geotourist potential for all the chosen locations.

Results

The results of the evaluation of geotourist potential of five rock shelter locations in Slovenian Istria are presented in Table 3.

As we can see the locations Štrkljevica and Veli Badin are closer to the highest value (17.5 units) than other locations, but the evaluation results of all the locations are overall close to each other. Kubalíková (2013) does not propose any guidelines for further explanation of numerical data calculated with her method, so we first wanted to figure out which locations are above and which below the average value (17.5 / 2 = 8.75 units). According to this calculation the locations Veli Badin, Štrkljevica, Stena and Mišja peč have geotourist potential that is above the average value and the location Kavčič the one below the average value. Because the evaluation results of all five locations are close, we decided to make another comparison of the results. We calculated the average value of the results (52.875 / 5 = 10.575 units). In this case the locations Veli Badin, Štrkljevica and Stena are above the average value, but the location Mišja peč has a geotourist potential below the average value, the same as the location Kavčič (see Table 3). This comparison more accurately shows the actual geotourist potential of the chosen five locations, as Mišja peč has a higher potential as a recreational site (climbing) than as a geotourist site. A more detailed explanation of the results according to each of the criteria for geotourist potential is thus:

Scientific and intrinsic values

a) Integrity: all the locations except Mišja peč were given the highest value (1) to be the sites without any destruction. Rock shelter Mišja peč is a part of a climbing area, so some impacts of human actions are present, but the site is not destroyed. Štrkljevica also used to be a hiking (via ferrata) and climbing area but due to the protection of Eurasian eagle-owl (Bubo Bubo) habitat (PZS, 2004; Mihelič, 2006), nature conservation authorities in 2003 closed the location for recreational use. Now is possible to observe the rock face from a viewpoint in village Zanigrad, or hike on a path below the rock face. A similar thing happened at Veli Badin where a part of the hiking path was closed for visitors (PZS, 2004). Nevertheless some hikers still use the closed paths at both locations (Internet 7 & 8).
b) Rarity: Although rock shelters are a common landform in the Slovenian Istria, we gave the location Veli Badin the highest value (1) as rock shelters at this location are the largest (see sizes in Table 1) and the most recognisable examples of such landforms in Slovenian Istria. Other locations were given the value 0-0.5, because more than 5 similar sites in the region exist, but in case of Slovenia, rock shelters occur mainly in Slovenian Istria, and are not typical for other parts of the country.

c) Diversity (number of different processes within the site): All rock shelter locations were given the value 0.5. Because morphogenesis of the rock shelters is still unknown, it is difficult to claim how many processes are involved in their formation, but most likely there are more than one.
d) Scientific knowledge: All the locations except Kavčič were evaluated the same (0.5). Some publications about rock shelters in Slovenia exist, but many questions about these landforms are still unanswered. In case of location Kavčič specific publications do not exist, it is included in the descriptions of Kraški rob.

Educational values

a) Representativeness/clarity of the features/processes: All locations were given the value 0 – 0.5, because formation processes of rock shelters are still uncertain.
b) Exemplarity, pedagogical use: As being almost an unknown landform (this statement regards to rock shelter types that are typical for Slovenian Istria, and not to other types of these landforms, which formation is already known), these rock shelters have a great potential for pedagogical use in the future (value 1).
c) Existing educational products: Locations Veli Badin and Štrkljevica were given the value 0.5 – 1, because info panels are present on sites. In case of other locations pieces of information exist, but are of different kind: Mišja peč – climbing information (Internet 9), Stena – TV documentary about river Dragonja (Internet 10), Kavčič – information for hikers (Internet 11).
d) Actual use of a site for educational purposes: All sites except Kavčič are part of specialized excursions (students, different geosocieties - GMDS and DŠG (Internet 5 & 6)). Kavčič is visited by hikers and mountain bikers.

Economic values

a) Accessibility: Mišja peč and Stena were given the highest value (1), because they are close to stops of public transport, Veli Badin and Štrkljevica are close to parking space for cars, but Kavčič can only be reached by 4×4 vehicle and in that case parking is on the spot (Internet 17 & 18). The method of Kubalíková (2013) does not go into details in case of quality of the roads, so we have to add some comments on that issue. Mišja peč and Stena would still have the best accessibility, but in case of Veli Badin and Štrkljevica the quality of the roads can be quite problematic. One way to reach Veli Badin is a combination of regional and macadam roads, but the visitor should in that case cross the international border with Croatia. The other option is a local road on the other side of the hill which is in a very bad condition – half macadam, half "asphalt". Road to the village Zanigrad, where there is a view point for Štrkljevica, is also in a bad condition (half macadam, half "asphalt"), and the macadam road which runs below Štrkljevica can be accessed only by 4×4 vehicle. The road to Kavčič is also in a bad condition and the only option to reach the location by car is again with 4×4 vehicle. If we took the above facts into account, the results for this criteria would be quite different.
b) Presence of tourist infrastructure: Štrkljevica and Stena are close to tourist facilities (tourist information centre/point, restaurant, accommodation – villages Hrastovlje and Dragonja), Mišja peč is close to facilities (village Osp), but the tourist information point is in the more distant village Črni Kal. In case of Veli Badin and Kavčič tourist facilities are 5-10 km away from the location (Gračišče and Zazid). Although there are options for overnight accommodation near Veli Badin (Sočerga, Smokvica), village Gračišče is the main tourist centre of the area (Internet 12–16).
c) Local products: No local products related to site are found on any of the locations.

Conservation values

a) Actual threats and risks: All the locations except Mišja peč (climbing area) were evaluated to have the highest value (1), i.e. low risks and almost no threats. At locations Veli Badin and Stena some climbing bolts are present in rock face, but they are not assessed as potential threat. Veli Badin is like Štrkljevica under protection as a site of bird species habitat, so no special intervention on the site is allowed without the permission of nature conservation authorities.
b) Current status of the site: Again all the locations except Mišja peč were given the highest value (1) – no destruction.
c) Legislative protection: All the evaluated sites are officially recognized as valuable natural features and included in the corresponding legislative protection.

Added values

a) Cultural values: presence of historical/archaeological/religious aspects related to the site: Only Štrkljevica fulfils the criteria of cultural values. In one part of the rock face are ruins of a ”castle”, which was actually a village fortress (Internet 8).
b) Ecological values: All of the locations were evaluated as geomorphological features which are also important habitats of fauna and (or) flora. Kraški rob is a climatic border, biodiversity is consequently high in this area. Stena as being a habitat for the Mediterranean flora and rare fauna was in 1990 declared a natural monument of Municipality of Piran (Turk, 2012).

Table 3. Evaluation of geotourist potential of five rock shelter locations in Slovenian Istria.
Tabela 3. Ocena geoturističnega potenciala petih lokacij s spodmoli v Slovenski Istri.

<table>
<tr><th rowspan="2">Criteria of geotourist potential assessment</th><th colspan="5">Rock shelter locations</th></tr>
<tr><th>1) Veli Badin</th><th>Štrkljevica</th><th>Mišja peč</th><th>Stena</th><th>Kavčič</th></tr>
<tr><td colspan="6">Scientific and intrinsic values</td></tr>
<tr><td>integrity</td><td>1</td><td>1</td><td>0.5</td><td>1</td><td>1</td></tr>
<tr><td>rarity (number of similar sites)</td><td>1</td><td colspan="4">0 – 0.5</td></tr>
<tr><td>diversity (number of different processes within the geosite or geomorphosite)</td><td colspan="5">0.5</td></tr>
<tr><td>scientific knowledge</td><td colspan="4">0.5</td><td>0</td></tr>
<tr><td colspan="6">Educational values</td></tr>
<tr><td>representativeness and visibility/ clarity of the features/ processes</td><td colspan="5">0 – 0.5</td></tr>
<tr><td>exemplarity, pedagogical use</td><td colspan="5">1</td></tr>
<tr><td>existing educational products</td><td>0.5 – 1</td><td>0.5 – 1</td><td>0 – 0.5</td><td>0 – 0.5</td><td>0 – 0.5</td></tr>
<tr><td>actual use of a site for educational purposes (excursions, guided tours)*</td><td colspan="4">0.5</td><td>0</td></tr>
<tr><td colspan="6">Economic values</td></tr>
<tr><td>accessibility**</td><td>0.5</td><td>0.5</td><td>1</td><td>1</td><td>0 – 0.5</td></tr>
<tr><td>presence of tourist infrastructure**</td><td>0.5</td><td>1</td><td>0.5 – 1</td><td>1</td><td>0.5</td></tr>
<tr><td>local products</td><td colspan="5">0</td></tr>
<tr><td colspan="6">Conservation values</td></tr>
<tr><td>actual threats and risks & potential threats and risks</td><td>1</td><td>1</td><td>0.5</td><td>1</td><td>1</td></tr>
<tr><td>current status of a site</td><td>1</td><td>1</td><td>0.5</td><td>1</td><td>1</td></tr>
<tr><td>legislative protection</td><td colspan="5">1</td></tr>
<tr><td colspan="6">Added values</td></tr>
<tr><td>cultural values: presence of historical/ archaeological/religious aspects related to the site***</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>ecological values</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="6">Aesthetic values</td></tr>
<tr><td>number of colours</td><td colspan="5">0.25</td></tr>
<tr><td>structure of the space</td><td>0.5</td><td>0.25</td><td>0 – 0.25</td><td>0</td><td>0</td></tr>
<tr><td>viewpoints</td><td>0.5</td><td>0.5</td><td>0.25</td><td>0.25</td><td>0.25</td></tr>
<tr><td>Geotourist potential (sum)</td><td>11.25 – 12.25</td><td>11.5 – 13.5</td><td>8 – 10.25</td><td>10 – 11.5</td><td>7.5 – 9.75</td></tr>
<tr><td>Geotourist potential (average sum)</td><td>11.75</td><td>12.5</td><td>9.25</td><td>10.75</td><td>8.625</td></tr>
</table>

*sources: Internet 5, 6, 11
**sources: Internet 12–18
***source: Internet 8

Aesthetic values

a) Number of colors: All of the locations were given the value 0.25 (2-3 colors). Colour combination is in all the examples of rock shelters grey limestone walls with different colours of tintenstriche (algae, lichen, mosses).
b) Structure of the space: The highest value (0.5) was given to the location Veli Badin, where different shapes of rock shelters dependent on tectonic structure of the site can be found. In case of Stena and Kavčič, rock shelters are of only one shape.
c) Viewpoints: Again the highest value was given to Veli Badin, which has more than 3 viewpoints, the same as Štrkljevica. Other locations were "given 0.25 points (1-2 viewpoints).

Discussion

As we expected, the results of Kavčič and Mišja peč were lower than the results of the other three locations. Although Kavčič is used for recreational purposes (hiking, mountain biking), it is a location distant from tourist facilities and is not so important regarding other values - scientific, educational and aesthetic. Mišja peč is a popular location for recreational use (climbing). Being popular as a climbing site is a fact which reduces other values (e.g. conservational), but it can be used as an example of informing the public about other rock shelters in the area. Stena has a good potential from the point of accessibility of touristic facilities, it is also an important ecological site, but the problem is that it is quite unknown, especially in the field of geosciences. We did not expect the results of Veli Badin and Štrkljevica to be so close and that Štrkljevica would even have a slightly higher tourist potential than Veli Badin. Although Veli Badin is the site with the largest rock shelters in the region (and can be thus regarded as one of the most beautiful locations – a subjective description), its problem is its remoteness from touristic facilities. The advantages of Štrkljevica compared to Veli Badin are closeness to tourist facilities (village Hrastovlje) and a cultural component (ruins of a village fortress) which is also important as one of the added values. Nevertheless both locations were evaluated to have the highest geotourist potential in the area and can be developed in the geotourist aspect. But we must not forget that the evaluation was made only with one method (Kubalíková, 2013) and that using another method could give us different results. We could also get different results by adding new values within each of the evaluation criteria (in our case "quality of the roads" can be added) or joining values within criteria in the same evaluation method.

Conclusions

Geotourism is a special form of tourism which focuses on visiting geosites and geomorphosites and thus learning about landforms and processes. One of its goals is raising people's interest in geoscience and also enhancing further research in this field. The importance of scientific research for geotourism development has been shown in case of our research. In our opinion, rock shelters in Slovenian Istria are interesting landforms which could in the future attract attention of potential geotourists to this region. We evaluated the geotourist potential of five rock shelter locations which are already recognized as part of Slovenian natural heritage (Official Gazette RS, 2010). Three of the chosen rock shelter locations - Veli Badin, Štrkljevica and Stena - have a potential to develop as geotourist sites. They have different values which are considered important for geotourism and have some tourist infrastructure already present on sites or at least close by. The research confirmed our assumptions that the lack of scientific knowledge on rock shelters (and consequent lack of their educational potential) is a weakness from the geotourist point of view. As scientific value of the sites is a basis for further geotourism development, our aim in the future is to fill the void in the geoscientific knowledge on rock shelters. Our research can thus act as an example that geotourism development is always interrelated with geoscientific knowledge.

Although scientific values of rock shelters are basic for geotourism development, there are still some actions needed to transform rock shelters into geotourist sites. These actions, which also the local community should be involved in, include the management of the sites, transportation, accessibility and accommodation improvement, the creating of tourist activities (e.g. geo-tours), information material (maps, leaflets, e-contents…) and promotion of the sites (e.g. creating an informational website, publishing popular articles about rock shelters, along with photographs of these landforms etc.). Only with such actions rock shelters can be recognized not only as natural heritage but also as geosites and geomorphosites which could attract geotourists to Slovenian Istria.

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