

Geoheritage popularisation and cartographic visualisation in the Tsanfleuron-Sanetsch area (Valais, Switzerland)

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1. Introduction

This paper presents the underlying concepts developed by the Institute of Geography of the University of Lausanne (Switzerland) for a popularisation project of the geoheritage in the Tsanfleuron-Sanetsch area (Valais, Switzerland). Due to its wide scientific interest, the local geoheritage is of great value (Reynard, 2008). The article details the complementary links existing between the different parts of a geotourist project – databases, educational panels, educational material and geotourist map – developed for popularising the geoheritage value of the area. Each element of the project is briefly presented. Special focus is set on mapping questions: how cartographic design and information structure can be set in order to facilitate map's use and comprehension. In this way, the Tsanfleuron-Sanetsch map is presented as an applied example of the guiding principles proposed by Coratza and Regolini-Bissig (2009).

2. Geoheritage in the Tsanfleuron-Sanetsch area

2.1 Access and location

The area of Tsanfleuron is part of Les Diablerets mountain massif (Fig. 1). There are two main entrance points linked by hiking trails. In the west, the cable car Glacier 3000 leads from Pillon pass to an alpine restaurant (Fig. 3, point 2) and to the ski fields on Tsanfleuron Glacier. In the east, the Sanetsch pass (Fig. 3, point 5) is accessible by car from Sion. From the pass, tourists mainly go for a walk on the *lapiés* of Tsanfleuron (karstic area, Fig. 2) situated in front of the glacier. On this part, tourist facilities can also be found: hut and hotel. Many other hiking trails link the Tsanfleuron area to its surroundings: Derborence, Savièse, Gsteig, Pillon (Fig. 3). The tourist area covers more than 50 km² between the Sanetsch pass in the east and the glacier in the west.

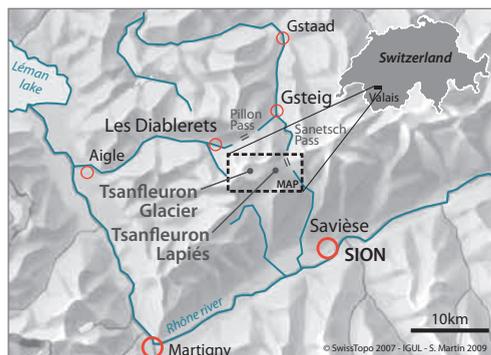


Fig. 1 Situation map.

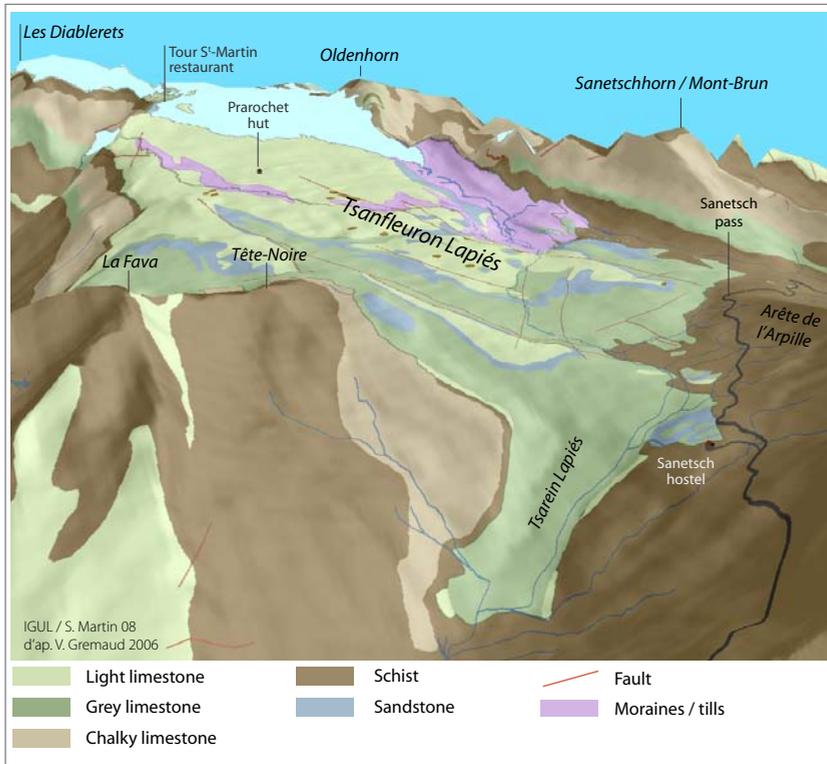


Fig. 2 Geological 3D map of Tsanfleuron-Sanetsch area (simplified from Gremaud and Nessi, 2006).

2.2 Geoheritage

With 9 km², the karstic area is one of the largest in Switzerland (Reynard, 2008). It covers a wide plateau pending to the northeast and belonging to the Diablerets and Mont-Gond nappes, part of the Helvetic domain. The Tsanfleuron lapiés are mainly formed in Eocene and Cretaceous (Urgonian) limestones (Fig. 2). The limits between the two nappes and other structural fractures could influence the karstic erosion and the groundwater flows (Gremaud, 2008). Although the main part of water flows eastward to the Glarey source (Morge river valley), the Tsanfleuron karstic area also supplies several surrounding springs (Savoy et al., 2008).

The karstic area was also extensively studied (Corbel, 1957; Maire, 1976; Tóth, 2006, 2008). Apart from carbonate crusts, many other karstic forms can be observed: wide range of karren forms, dolines and other glacio-karstic landforms like *Schichttreppenkarst* or *roches moutonnées* karren. Morphological differences between the upper and lower part of the *lapiés* were identified by Maire (1976): downhill the Little Ice Age (LIA) moraines, the karstic landforms are various and

sharp, whereas above this limit, the landscape is mostly affected by glacial processes (Fig. 3, 4).

Tsanfleuron Glacier is a rather thin plateau glacier. Therefore, it has retreated fast during the last century. At its LIA maximum, around 1850, the glacier left large moraines crossing the present *lapiés*. A small tongue extends the glacier on its eastern part. The glacier has been widely studied: e.g. basal ice layers formation (Tison & Lorrain, 1987; Hubbard & Sharp, 1995; Hubbard et al., 2000) and relation between glacier and limestone bedrock with precipitation of carbonate crusts (Hallet et al., 1978; Souchez and Lemmens, 1985). Moreover, from October to May, the glacier is used for skiing from Glacier 3000 cable car station (Fig. 3, point 2).

The historical rockfalls of Derborence, in the near surroundings of Tsanfleuron, were also taken into account in the popularisation project. Indeed, rockfall deposits are visible from the Tour St-Martin (Fig. 3, point 3). As this event is linked with local legends on Les Diablerets mountain (*diable* means devil) and also became the subject of a novel (C.-F. Ramuz, *Derborence*, 1934), it contributes to the cultural value (Reynard, 2005) of the area. Furthermore, the Sanetsch pass has some importance as a language frontier and watershed limit (Rhone and Rhine river catchment areas).

3. The geotourist project

A first attempt was made a few years ago to popularise the rich natural features of the Tsanfleuron area (Collectif, 1995; Reynard, 2004). A geotourist trail was proposed on the karstic area with a leaflet describing natural features and processes (including glacier) and some tourist information. However, this popularisation project was not well communicated to a large public (Reynard, 2008).

In 2008, on the request of the municipality of Savièse (Valais, Switzerland), the University of Lausanne developed additional geotourist products on the whole area (Tsanfleuron *lapiés* and glacier, Fig. 1): educational panels, material for school children and a geotourist map. This project partly meets the popularisation plan proposed by Reynard (2006).

3.1 Databases

The first step was to collect existing information on the area. Separate databases were created for each type of data: bibliography (EndNote), pictures (MS Access) and geodata (ESRI ArcGIS). The three databases should be able to interact one with another and allow wider interactivity in data handling.

3.2 Educational panels

The main part of the project was to develop material for education panels. They had to present the whole diversity of the geoheritage. As the panels were put only near buildings, their number – five – and location were limited. Visitors' specificities added some constraints. Firstly, the text was written in three languages (French, English and German). This leads to a considerable use of schemes, pictures and maps to communicate. Secondly, as the majority of tourists stay in only one part of the area – glacier or *lapiés* – information had to be sorted and sometimes repeated (Table 1).

Location	Tourist facilities	Theme 1	Theme 2
1. Sanetsch pass	car park, bus stop	Introduction (context)	Karst
2. Sanetsch hostel	catering, lodging bus stop	Same as panel 1	Same as panel 1
3. Prarochet hut	catering, lodging	Karst	Glacier
4. Tour St-Martin	catering Snow Bus stop	Geology	Derborence rock falls
5. Scex Rouge	catering, ski lifts Snow Bus stop, cable car station	Introduction (context)	Glacier

Table 1 Description of the educational panels (Tsanfleuron-Sanetsch area; for location, see Fig. 3).

3.3 Material for school children

According to the municipality of Savièse, the geotourist project should also be aimed at the local population. Thus, it was a way to inform the population on the value of the landscape and natural features and raise environmental awareness. With the same intention, many illustrations created for the panels were adapted to school use. They became the base material of a slide show presenting in a simple way the main geomorphologic processes (karstic and glacial). A new chapter was added, presenting the danger of human misuse of the natural area: soil destruction and water pollution. Both the slide show and individual pictures were set on a CD distributed to the teachers in the commune.

3.4 Geotourist map

In addition to the educational panels, a map was designed to inform tourists on hiking trails and other facilities: restaurants, hostels, transportation. Moreover, additional educational information was developed for the back of the map. We chose to focus on the glacial and karstic processes, with more detailed information than on the panels. The links between the map (front side) and educational information (back side) were preserved by the use of a colour code and pictograms for each theme (Fig. 3 and 4). These links also allow the interaction on the field with educational panels.

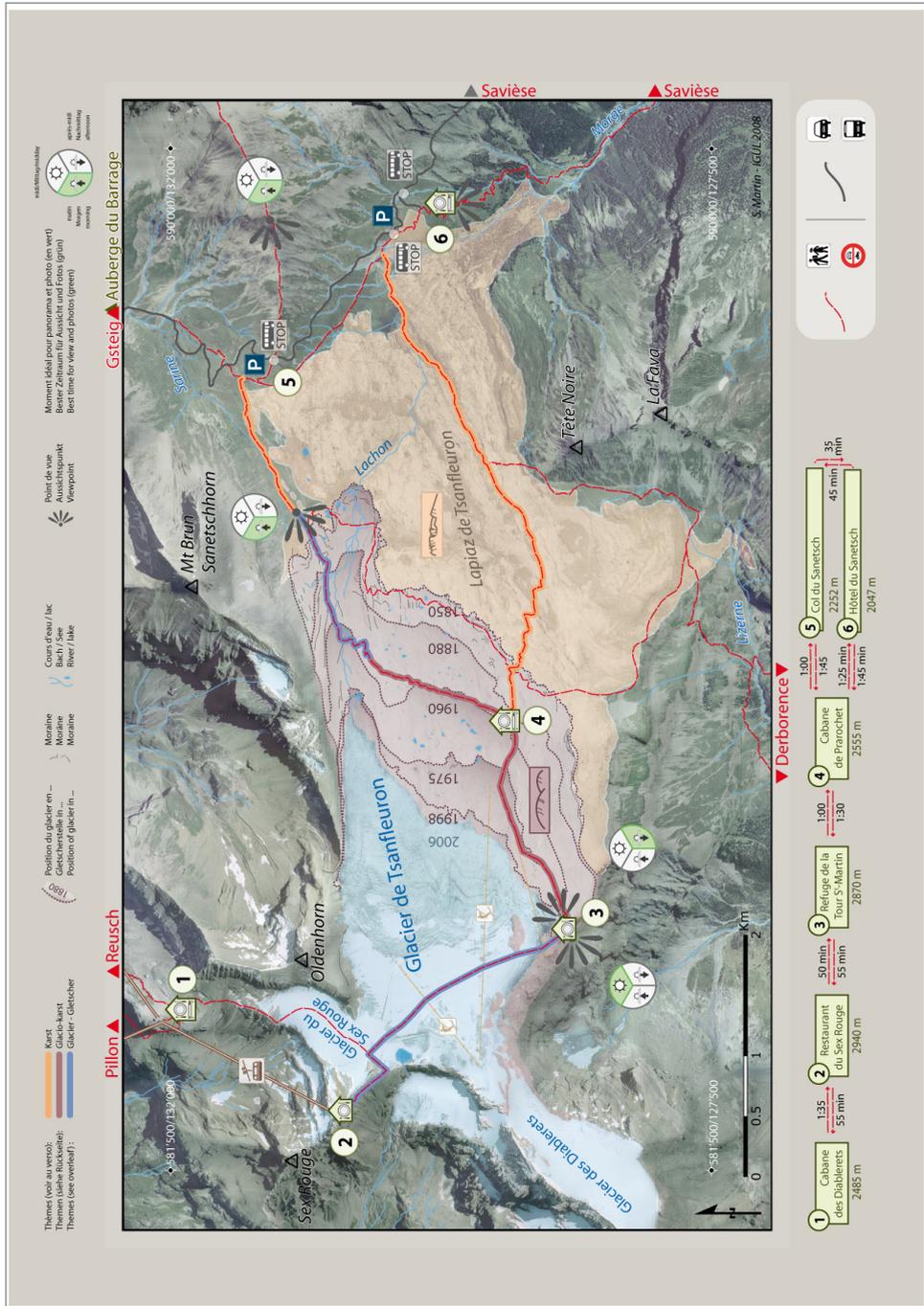


Fig. 3 Geotourist map of Tsanfleuron-Sanetsch area (front side).

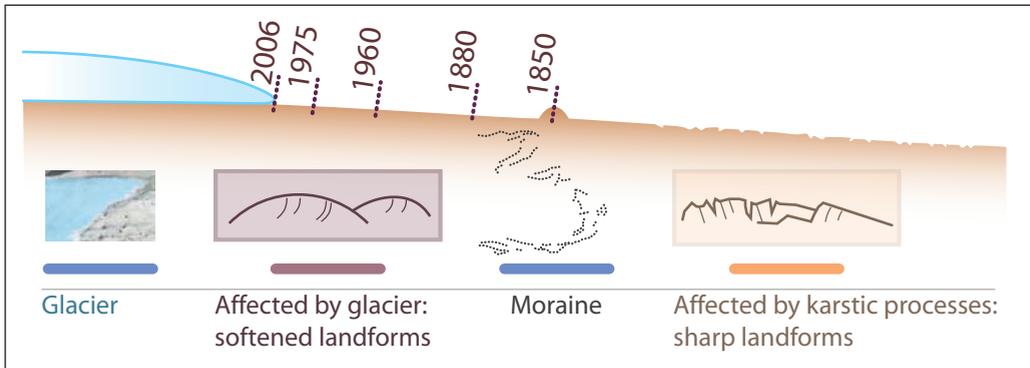


Fig. 4 Scheme of the three morphologic areas linking both sides of the map.

4. Mapping the geoheritage

4.1 Methodology

The Tsanfleuron-Sanetsch map is addressed to non-specialists, according to the categories of Carton et al. (2005). Its main purpose is to orientate people, but the map should also give information on local geoheritage (landforms and processes). The mapping process raised several questions, particularly on the map's design and sorting of content. The guiding principles for mapping geomorphosites proposed by Coratza & Regolini-Bissig (2009) were used as methodological basis (Table 2), in addition to more general cartographic methods (MacEachren, 1994; Bailey et al., 2007; Slocum et al., 2009).

Identifying the future users of the map and its main purposes are essential steps of the process, as they influence all other aspects of the map. Furthermore, the choices made during the mapping process must be coherent with the defined framework (Martin & Reynard, 2009).

Map components	Guiding questions	Guiding principles for the map of Sanetsch-Tsanfleuron
1. Users	Who is the intended audience?	a. upper part (glacier): tourists (mainly foreigners) come for a one-day trip, but generally remain on the glacier. b. lower part (Sanetsch pass, karstic area): local people, hikers and families coming for a one-day trip. c. whole area: hikers going through the <i>lapiés</i> of Tsanfleuron.
2. Purpose	What is the purpose of the map?	Category of “promotion maps” (Bissig, 2008) with particular aims: orientation, basic tourist information and educational elements. It should help the users to understand the main geomorphological components of the landscape (see Theme).
3. Theme	What is going to be revealed with the map?	Focus on the interaction of glacial and karstic processes that have shaped the landscape.
4. Level	Which complexity of information is desired / required?	According to the diversity of users, the map should allow two levels of complexity: general information (visual) and more detailed, but still popularised, information (textual).
5. Scale	What is the area to be covered?	The area covers the trails between main access points (Sanetsch pass and Glacier 3'000 station) and the places of interest (whole <i>lapiés</i> and glacier of Tsanfleuron).
6. Dimensionality	How to show the morphology of the mapped area?	Orthophoto whose relief is shown by a superimposed hillshaded layer (based on a 25m DEM).
7. Design	How to produce maps that look good and are easy to understand?	Adapted to users and purpose; information sorted by themes and complexity levels; links between levels and media (see also Martin & Reynard, 2009).
8. Form and size	For what purpose and in which context is the map going to be used?	Available on the spot, the map should be used as a guide, to consult on the way, in complement to a topographic map but also in interaction with educational boards visible in the field.

Table 2 Guiding principles (according to Coratza and Regolini-Bissig, 2009) adopted for the geotourist map of Tsanfleuron-Sanetsch.

4.2 Educational content

Educational content should not overload the map (Coratza & Regolini-Bissig, 2009), as this must firstly orientate the users. We chose to focus on three themes: (1) glacial dynamics and landforms, (2) karstic processes and landforms and (3) the relation between both processes and associated landforms. The map shows the areas where each theme prevails, above and below Little Ice Age moraines (Fig. 3, 4; according to Maire (1976). The only other educational elements displayed on the map are the historical extensions of the glacier from 1850 until today, based on topographical maps analysis.

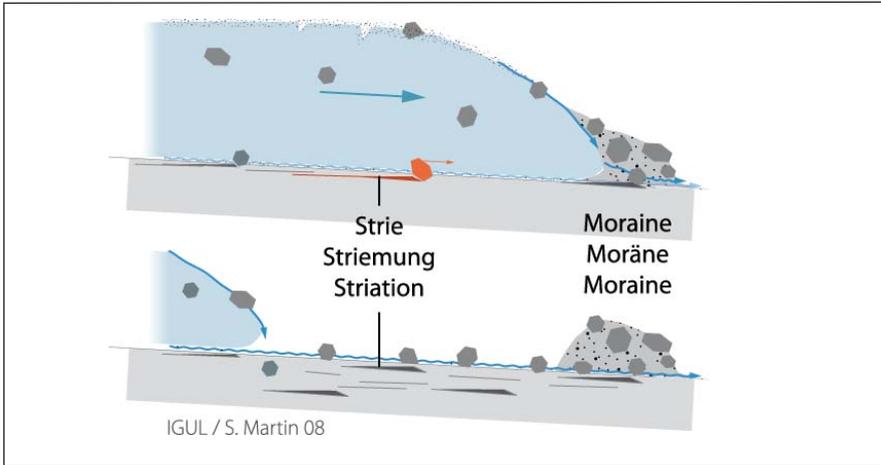


Fig. 5 Example of scheme (glacial striation).

On the back, information is organised according to the three themes (Fig. 4). Texts, explanatory schemes (Fig. 5) and annotated pictures (Fig. 6) help the user to understand the landforms he sees on the field (with help of the map) and complete the information displayed by educational panels. The use of various media (map, schemes, text), multiple scales (general context, processes and forms) and strong links between them (colour, pictograms, text) allow multi-level reading. This is the key point when being aimed at non-specialist and heterogeneous users.



Fig. 6 Example of annotated picture (moraines).

4.3 Background layer

In order to facilitate orientation, the background layer represents the terrain. It is also a means to increase the attractiveness of the map. To keep the map readable, background with a heavy visual load – such as topographical maps or aerial photographs – should be avoided. Patterson (2002) recommends using a background representing the terrain as “real” as possible: remove lines, rasterize all vector items, modulate tones and texturize areas (forests, rocks...). For the Tsanfleuron-Sanetsch map, we first chose to use a hillshaded layer with hypsometric tinting (Fig. 7, left). However, the last version uses a hillshaded orthophoto (Fig. 7, right). Relief is harder to understand, but – according to the majority – the map looks better in this way. To bring out important information and pictograms, the thematic areas cover partly the underlying orthophoto (Fig. 3).

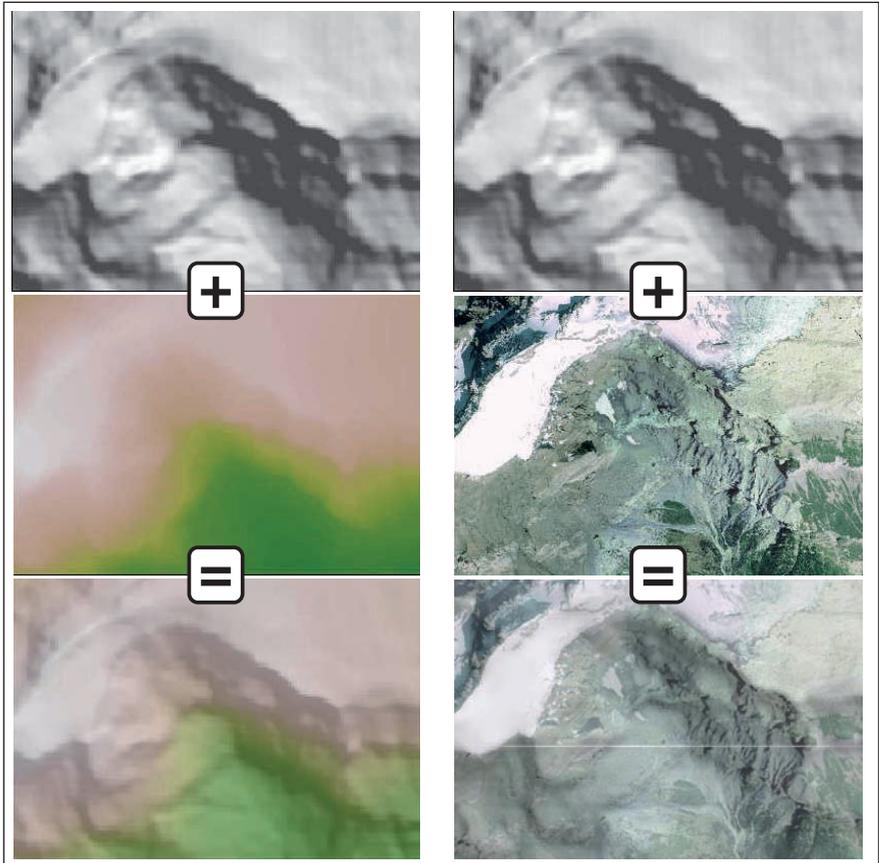


Fig. 7 Hillshaded background layer with hypsometric tinting (left) and orthophoto (right).

4.4 Information layers

As the geotourist map meets several purposes, numerous types of information are to be displayed (Table 3). However, only useful information must first be selected in order to keep the map simple and attractive. Both questions “what to put on the map” and “what to omit” should be resolved by keeping in mind the chosen purposes and the user needs (Martin & Reynard, 2009). It is also essential to differentiate the categories of information by the use of visual variables (Bertin, 1967; MacEachren, 1994). In this way, the map allows the user to find easily what he is looking for.

Purpose	Information	Geometry	Representation
Orientation	location	point	pictogram; coordinates, names
	routes and direction	line	linear sign (3 types)
	landscape	surface	hillshaded orthophoto (Fig. 7)
View	viewpoint	point	oriented pictogram, (Fig. 8b)
	view direction	line/angle	
	best time for view (photo)	---	pictogram (3 types) (Fig. 8a)
Geoheritage	(geo)site	point/line/surf	linear sign (moraines)
	thematic trail	line	3 colours
	thematic area	surface	3 colours
Basic tourist information	transportation	point/line	pictogram (4 types), linear sign
	catering, lodging	point	pictogram (2 types)
	time of walk	---	text (arrow)

Table 3 Categories of information displayed on the Tsanfleuron-Sanetsch map and their representation.

Orientation

The map should inform the user on his current position, on his destination(s) and on the general aspects of the surrounding landscape. In fact, it is a tool for building an indirect experience of space (Golledge & Stimson, 1997; Bailey et al., 2007). Orientation is also important for understanding spatial interactions and phenomena such as glacier retreat.

There are two main categories of tourists visiting the Tsanfleuron-Sanetsch area (Table 2): people staying in one part of the area (on the glacier around the cable car station or on the *lapiés* between Sanetsch pass and Prarochet Hut) and hikers crossing the area. These normally already have a topographic map. The geotourist map is, therefore, used as a complement. To allow interaction between both kinds of maps, we chose to keep a few similar place names (glaciers, summits), northward orientation and coordinate points. Tourists staying in one part do not need a precise map, as the path network is well indicated in the field. For them, we kept only visible or useful items: ski lifts, hydrographical network, pathways and tourist facilities (Fig. 3).

View

Viewpoints on aesthetic panoramas are tourist attractions. But looking on the landscape can also be a way to understand natural processes and landforms. Several views are displayed on the educational panels and on the back of the map with annotations and schemes. Each viewpoint selected for the map refers to these pictures and offers a look on a specific theme (glacier, rockfalls, *lapiés*, all parts of the area).

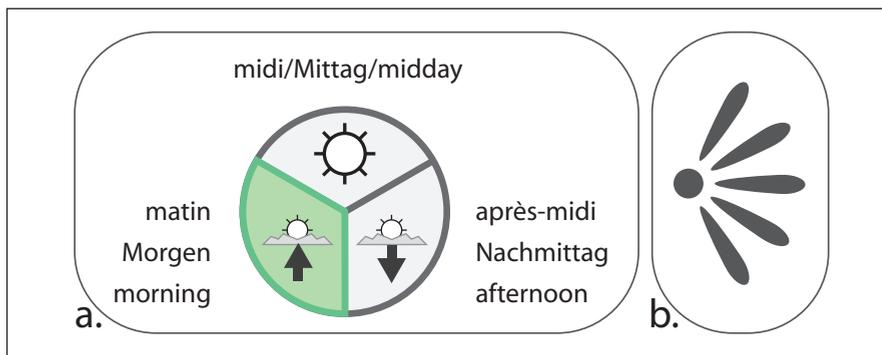


Fig. 8 a) Best time for view pictogram; b) Viewpoint pictogram.

Along with directional viewpoints, a pictogram informs the user on the best time to see the landscape or to take a picture from this point (Fig. 8a). This idea was proposed at a regional scale by Carton et al. (2005).

Geoheritage

Although the geotourist map of Tsanfleuron-Sanetsch area deals with geomorphological features, it is not a geomorphosite map. Apart from moraines, no landform is represented on the map. Only morphologically similar areas are displayed (Fig. 3). The map is, therefore, used as an interface to access and organise the educational information on the back and give a general view of the landscape and spatial distribution of phenomena.

The two main types of morphology are symbolised on the map with pictograms. One represents striated (or a little karstified) *roches moutonnées* whereas the other shows sharp karren with sinkholes (Fig. 4). Along with the explanation on the back, the user can, therefore, recognise the interesting landforms on the field, whatever the way he follows.

Basic tourist information

As it is a mountain area, there are only a few tourist facilities. There was, therefore, no need to select them. All what could be useful to plan a short trip while being already on the spot was kept on the map: time of the walk between two points, destinations outside of the map's boundaries, transportation (bus stops, cable cars, car parks), hostels, restaurants (Fig. 3). However, as the map will not be reprinted each year, changeable information (timetables, price lists) was rejected. Pictograms were made explicit in order to reduce textual information and legend. It is all the more important since the map's users speak different languages.

On the back side, additional information is given on two themes. Firstly, people interested in learning more about local geoheritage are given information about the educational panels and the educational brochure (Reynard, 2004). Secondly, hikers are made aware of the dangers in mountain area and the importance of preserving the environment (rubbish, dogs, use of vehicles). Therefore, the map participates in both of the geoheritage popularisation's main goals: protection and tourist promotion (Reynard, 2008).

5. Conclusion and perspectives

Considering a geotourist project as a whole permits us to increase communication effectiveness. However, it implies clearly sorting the information between the different media and keeping strong visual and thematic links between them.

Furthermore, project design – especially the map – should be coherent with a pre-defined framework. In this way, the guiding principles proposed by Coratza & Regolini-Bissig (2009) help taking each element into account. The first questions should, therefore, be: who are the users, what are the purpose(s) and, then, what is the theme? This basic framework influences information complexity and sorting (different levels) and general design of panels, figures and map.

A geotourist map (and other complementary media) can be considered as a user interface, linking to thematic information. But the map should also be a simplified representation of landscape that allows links between observed reality and scientific explanation to be made. Special effort should, therefore, be made to visualise more effectively natural landscape and features.

Spatial and informational interaction may be a key to manage complex information content and increase map effectiveness. Moreover, this could solve the recurrent problem of users heterogeneity by widening the multi-level reading possibilities. Thus, people who do not like reading maps could also comprehend "their" geoheritage.

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