

Geomorphosites of the Hérens valley: survey sheets

HERant001

Man carved stones

Localisation: Mayen Blanc, W of Mayens du Cotter (Evolène)	Coordinates: 605.343 / 107.212	Altitude: 1980 m
Type: PCT	Size: —	Property: COM (consortage de l'alpage de Cotter)

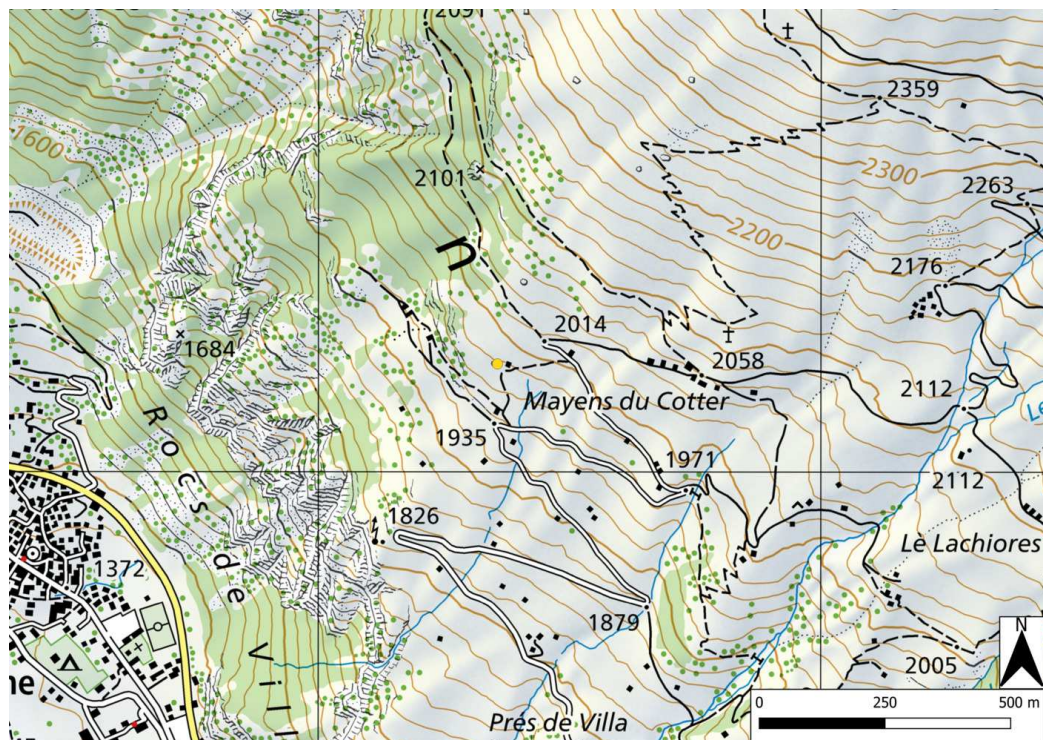



Figure A.1: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>The Pierre aux Immolés and the Mayen Blanc (ph S. Gille)</i></p>	

Description The geosite is located on the right hand side of the upper Val d'Hérens, just east of the village of Evolène. This side of the valley has the look of a vast and gentle slope facing south-west, with pastures and small pastoral settlements. The slope is overlooked by the high crest of the Sasseneire (3254 m) and the Pointe du Prélèt (2999 m).

The man carved stones ("*Pierre aux cupules*") are «traces of our prehistoric ancestors, [...] blocks on which cavities have been dug. They have several denominations (e.g. *pierres à écuelles*, *pierres à bassins*). The blocks can be allochthonous, of morainic or gravitational origin, or can be in-place rock outcrops. On their surface there are holes and cupels carved by man.

The carved stones of the Mayen Blanc are a dozen marble blocks which have been originated by rockfalls, and then have been shaped and polished by glacial action. In total they support about 200 cupels. The blocks are popularly known as *Pierres aux Immolés* ("stones of the immolates"), *Pierres aux Fées* ("fairy stones") or *Pierres des Mayens Blancs*. The toponyms derive from popular legends.

The site has importance for its vegetation, and is included in the inventory of prairies and dry pastures of national importance.

In Val d'Hérens there are several other sites of archaeological importance with traces of prehistoric populations, which have been described in a brochure (Beck & Pfeifer, 1999).

Morphogenesis The morphogenesis of this geosite is composed of three main phases. First, the blocks have been produced by rockfalls from the above slope. Then, they have been shaped, rounded and smoothed out by glacial action. Finally, man has carved cupels, signs and holes, part of the rock art of the region.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The blocks which form the geosite are well conserved, but the vicinity of the mountain pastures can be a source of degradation.	1
<i>Representativeness</i>	This geosite is quite representative of prehistoric carving on rocks, and of glacial polishing.	0.5
<i>Rareness</i>	In the study region there are a few other similar sites, but they are less well conserved. So the geosite is rare in this region.	0.75
<i>Paleogeographical value</i>	The blocks come from the slope above. There is not a particular paleogeographical value.	0.25
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Vegetation isn't that varied, it's composed mainly of dry prairies. The geosite doesn't have influence neither on the surrounding vegetation or the local fauna.	0
<i>Protected site</i>	Indirect protection coming from the inventory of prairies and dry pastures of national importance.	0.25
Ecological value	The site doesn't have any ecological influence, but it is indirectly under protection.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The geosite is hidden in the prairies. It can be observed only approaching it. Few view points are possible.	0.25
<i>Contrasts, vertical development, space structuration</i>	Very small contrast between the beige-brownish grey stones and the green or yellow pastures. No vertical development.	0
Aesthetic value	The stones are quite pretty to view once one has found them, but they lack contrast and vertical development.	0.25

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	Many legends circulate around the carved stones. Thus they have great symbolic importance in the region. The site is cited by Cardinaux (2005, 2006) as a sacred site of romand Switzerland.	0.75
<i>Historical importance</i>	Traces of prehistoric civilisation.	0.75
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	High cultural value at the symbolic and historical level.	0.75

Protection

Protection status Indirect protection coming from the inventory of prairies and dry pastures of national importance.

Degradation risk

<i>Fragility</i>	The main feature (i.e. cupels and holes) can be easily damaged or destroyed, thus affecting the integrity of the site and its scientific value.
<i>Natural vulnerability</i>	No short time scale natural vulnerability.
<i>Anthropogenic vulnerability</i>	Threats can come from the vicinity of pastures and from pastoral activity. The site can be easily damaged by visitors and vandals.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to Evolène, then 1h30' by hike. By car one can go up to the hamlet of Villa, then walk for about 45'. Hike is easy (T2).	0.75
<i>Security</i>	No risk.	1
<i>Site context</i>	Calm environment and relaxing landscape. Problems can arise with the presence of livestock with shepherd dogs.	0.5
<i>Tourism infrastructures</i>	No tourism infrastructures.	0
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	Flyer and brochure are available at the local tourism office.	0.75
<i>Education interest</i>	The site is easily readable by visitors.	1
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value is not that high. The site has more of a cultural and historical relevance, because of the traces of an ancient civilisation.

Use and management As of now, the site is only indirectly protected and is not used for geotourism. The site is quite fragile and vulnerable. Vulnerability may come from pastoral activity, or by vandalism; the latter is not that probable as long as the site is not well known or divulgated.

Management measures The site should be included in the inventory of archaeological sites in Valais. In the current situation no particular measure is needed.

References

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HERant002

Flanmayen anthropogenic terraces

Localisation: les Flanmayens (Evolène)	Coordinates: 602.600 / 108.000	Altitude: 1400 m – 1660 m
Type: AER	Size: 0.18 km ²	Property: PRI

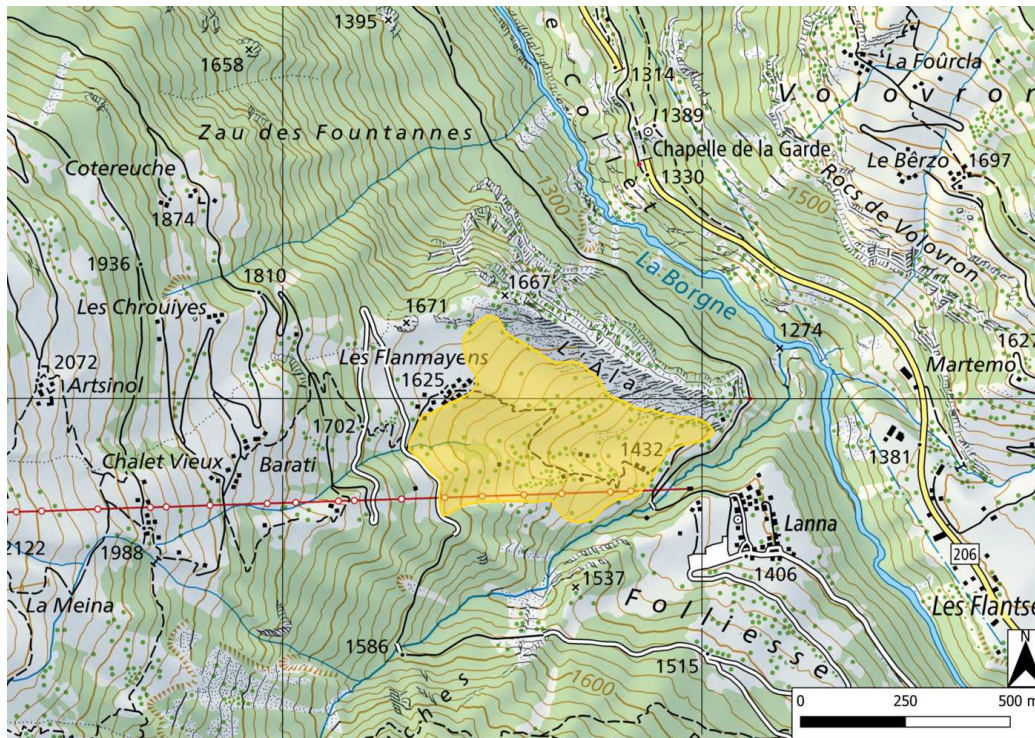


Figure A.2: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The terraced slope with the rock sill on the right hand side, and the village of Lanna (ph. Andrea Ferrando)



A view of the terraced slope (ph. Andrea Ferrando)

Description The site is located on the left (western) side of the upper Val d'Hérens, near the hamlet of Lanna, not far from Evolène, the main village of the valley. It consists of a south-east facing slope which has been terraced for agriculture. The terraces were built to obtain arable land on steep slopes, and they consist of loose earth withheld on the down side by dry stone walls. Terraces lessen soil erosion, and they increase the infiltration capacity of the soil.

The terraces of les Flanmayens were mainly used for the cultivation of rye and wheat, until the mid-20th century. After, their use for agriculture has stopped, and they were colonized by the flora typical of dry prairies. These terraces are still maintained by local people, and used for grazing.

The terraced slope goes from about 1400 to 1660 m in elevation. At its foot, there is the Merdechon stream, which goes into the Borgne river. On the top of the slope there is the rural centre of les Flanmayens.

On the eastern side, the terraced slope is abruptly bounded by a rock sill (l'Ala on the topographical map), shaped by glacial erosion. The rock sill then forms a vertical cliff, almost 200 meters high, which falls on the valley floor of the Borgne.

On the western side, the terraced slope is bounded by larch wood. The wooded slope is characterized by glacial deposits, which crop out in some

places with pyramid-like landforms

Morphogenesis The terraces of les Flanmayens have been built by man to obtain arable land, by moving the quaternary cover that was present on the slope and withholding it with dry stone walls. So, their morphogenesis is very easy to understand. On a side note, the site of les Flanmayens is very interesting even for the natural landforms which are present, which testimony a history of glacial and postglacial morphogenesis. Before the onset of anthropogenic action, the site has been shaped mainly by glacial action, and then fluvial erosion.

The rock sill of l'Ala, made up of very hard gneiss (Lirec formation, Cambrian), constituted an obstacle for the ancient Val d'Hérens glacier, that thus created a overdeepening hollow upstream, where the softer rocks of the Nappe du Tsaté crop out. Glacial action on the rock sill is evident because of the typical roches moutonnées on its top.

While on the rock sill the glacier eroded, on its western side it deposited sediments. Glacial deposits cover the slope on which the anthropogenic terraces have been built, and their thickness increases going further west. West of the terraces, glacial deposits crop out, and have been shaped by runoff erosion, forming a few earth pyramids.

With the retreat of the Val d'Hérens glacier, the overdeepening hollow hosted a lake. Glaciolacustrine deposits that testimony the presence of the Evolène lake are nowadays visible between Evolène and la Fauchère. From the sides of the valley, torrential activity formed the alluvial fans on which Lanna and les Flantses are located. This thick quaternary sedimentary cover is now deeply incised by the Borgne river and the Merdechon stream: the edge of the fluvial scarp which incises the fans is now 80 meters higher than the Borgne valley floor. Erosional activity of the Borgne has incised the rock sill, forming a deep gorge on its side.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	Terraces are well conserved, even if some of them are abandoned.	1
<i>Representativeness</i>	Good example of a terraced slope.	0.5
<i>Rareness</i>	The site is rare for the vertical development of the terraces, the aspect of the slope and the particular geomorphological context in which they have been built.	0.75
<i>Paleogeographical value</i>	No paleogeographical value for the terraces; quaternary deposits and landforms of the area testify to the existence of the ancient glacial Lake of Evolène.	0.5
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The terraces were cultivated for rye. Now that they are abandoned, they have been colonized by species typical of dry prairies and pastures.	1
<i>Protected site</i>	They're part of the Federal Inventory of Dry Prairies and Pastures (Object n° 7300).	1
Ecological value	High ecological value.	1

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	Many good view points are present along the cantonal road in the vicinities of Evolène, and on the road to Lanna. The site is crossed by a hiking trail which permits to observe it from near.	1
<i>Contrasts, vertical development, space structuration</i>	The site has quite a high contrast with the surrounding terrain, because of the presence of an evident rock sill on the eastern side and larch wood on the left. It has a vertical development of more than 200 meters. Even the space structuration gives it an intriguing look, because of the regular terraces limited on the right by the abrupt outcrop of the rock sill.	1
Aesthetic value	Aesthetic value is very high, both for the presence of many view points and for the look of the site itself.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance for the site itself, but the nearby hamlet of Lanna is one of the sacred places of romand Switzerland.	0.25
<i>Historical importance</i>	It's the best example of terraces for agriculture in the high part of the valley.	1
<i>Artistic and literary importance</i>	The main artistic and literary works are related to the nearby hamlet of Lanna and not to the Flanmayens terraces.	0.25
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Historical importance is high, but other cultural aspects are more related to nearby settlements.	0.75

Protection

Protection status The site is included in the Federal Inventory of Dry Prairies and Pastures (Object n° 7300).

Degradation risk

<i>Fragility</i>	The site is fragile, and very sensitive in case of abandon.
<i>Natural vulnerability</i>	Anthropogenic terraces are subject to degradation due to the action of gravity (e.g. earth flows, mudflows, stone falls in the dry stone walls) and runoff waters.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is negligible.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to Evolène, from which the terraces are already visible then about 1h on foot to the base of the terraced slope and 1h30' to les Flanmayens (T2). Alternatively, one can reach Lanna by car. From there, to reach the base of the terraced slopes it takes 10', while for les Flanmayens it takes 40'.	0.75
<i>Security</i>	No particular risk.	1
<i>Site context</i>	No particular perturbation is present.	1
<i>Tourism infrastructures</i>	The site is characterized by marked hiking paths and cableways open in the winter.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	The hiking path from Lanna to les Flanmayens and Artsinol is characterized by numerous panels. One of them, located in les Flanmayens, is about anthropogenic terraces.	0.75
<i>Education interest</i>	The landform is easily readable, and partly valorised.	1
Education	High educational value	0.75

Synthesis

Intrinsic value The site is very important for different points of view: scientific, ecological and cultural, mainly. It is easy to access and easy to comprehend.

Use and management The site is protected under the Federal Inventory of Dry Prairies and Pastures (Object n° 7300). It is crossed by a hiking path with dedicated panels. As of today, the terraces are not used for agriculture, but are still maintained and used as a pasture.

Management measures One important measure to take is to ensure the anthropogenic terraces are maintained and not totally abandoned, so they are not degraded by natural processes. In fact, abandoned terraces represent a main factor of geomorphological risk, because they constitute a huge source of loose material that can be easily moved by natural processes (e.g. debris flows).

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HERcom001

Tsarmine slope system

Localisation: eastern side of the Val d'Arolla between Satarma and the Grande Dent de Veisivi and Dent du Perroc (Evolène)	Coordinates: 602.600 / 108.000	Altitude: 1800 m – 3676 m
Type: AER	Size: 4.18 km ²	Property: -

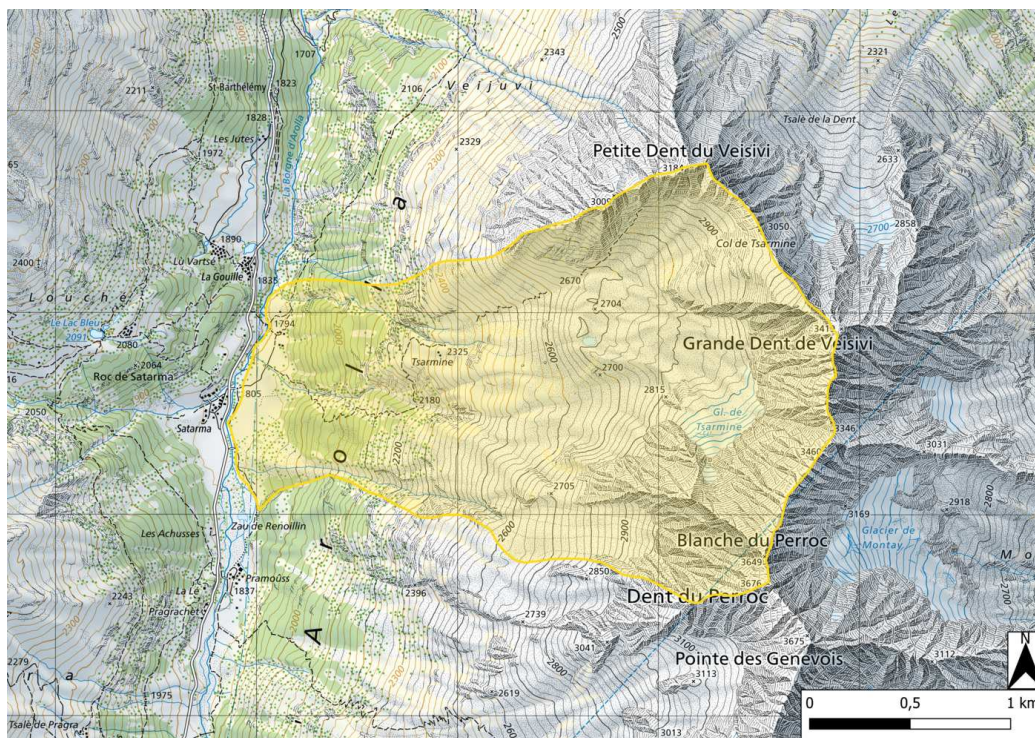


Figure A.3: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>View of the whole slope system of Tsarmine (ph. Andrea Ferrando)</i></p>	<p><i>The main torrential system coming down from the Dent du Perroc (ph. Andrea Ferrando)</i></p>
	
<p><i>The morainic wall of Tsarmine (ph. Andrea Ferrando)</i></p>	<p><i>The Tsarmine rock glacier, feeding a debris flow channel (ph. Andrea Ferrando)</i></p>

Description The site includes the slope of Tsarmine, located on the eastern side of the Arolla valley. The slope is surmounted by the summits of Petite Dent du Veisivi (3184 m), Grande Dent du Veisivi (3419 m) and Dent du Perroc (3676 m). The bottom of the slope, corresponding to the Borgne d’Arolla river, is located at about 1800 m asl. Along the slope, three small parallel subcatchments can be observed, along which the sediment trans-

fer occurs in different ways.

Morphogenesis Along the Tsarmine slope, the transfer of sediment occurs due to a combination of glacial, periglacial, gravity and fluvial processes (Reynard et al., 2012; Lambiel et al., 2016). Moving from north to south, laterally along the slope, three adjacent subsystems are observed in which sediment transfer occurs in three different ways.

The northernmost system (left on the photos in Figure 4.22) consists of a small debris-covered glacier (Tsarmine glacier) with a high latero-frontal moraine. The debris which covers the glacier derives mostly from rock falls from the overhanging rock walls. The latero-frontal moraine then feeds a torrential system, terminating on the valley floor with a small debris flow fan.

The middle system is, in the upper part, made by rock walls which feed a large scree slope. The scree is then moved by periglacial processes, the most notable being a large rock glacier, which in turn feeds another torrential system. The tongue of the rock glacier is cut because of gravitational phenomena. Also this torrential system is characterised by a debris flow fan at its foot.

The southernmost system consists of another torrential system, which is directly fed by the overhanging rock walls and scree slopes. It is the largest and most active torrential system of the three, as testified by the dimensions of the debris flow fan located at its foot. In addition, a large landslide body can be observed on the buttress between the middle and the southernmost system.

The landforms of Tsarmine (debris covered glaciers, moraines, rock glaciers, debris flow channels, rockslides, etc.) can be observed in many other locations in the Alps. The interest of the site lies not only in the landforms and processes themselves, but in the fact that it is rare to find places where the interaction between them is so clearly visible in a limited space.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is very representative of high mountain slope dynamics.	1
<i>Rareness</i>	High mountain slope systems are widespread in the region, but few of them have the diversity of landforms of the one in Tsarmine.	0.75
<i>Paleogeographical value</i>	The site has no paleogeographical value.	0
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Along the slope one can observe all the vegetational succession from the lowest to the highest elevation, passing through coniferous forests with larch to dry prairies and sparse vegetation. Pioneer vegetation is present on the debris flow channels and cones. Fauna is that typical of high mountain environments.	0.5
<i>Protected site</i>	The site is not protected.	0
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	There are lots of view points from the floor of the Val d'Arolla and from the western side of the valley, from the Lac Bleu to Arolla.	1
<i>Contrasts, vertical development, space structuration</i>	The slope has a very high and imposing vertical development, while the various elements (scree slopes, rock cliffs, debris flow channels and cones, moraines, glaciers etc.) combine in a very diverse structuration.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	Feeble historical importance due to the presence of mountain pastures and the ruined rural edifices of Tsarminé.	0.25
<i>Artistic and literary importance</i>	No artistic and literary importance.	0
<i>Geohistorical importance</i>	This slope system has been widely studied and it's taken as a case example for this type of geomorphological environment.	0.25
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	The natural vulnerability is related more to single landforms than to the geomorphological system itself.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is negligible.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to la Gouille. Satarma or Arolla. The site can be observed directly from the road, or taking the path from la Gouille to the Lac Bleu (40', T2). To access Tsarmine and the moraine of the Tsarmine glacier one can start from Satarma and then hike for 2h (the trail is not marked, T3).	1
<i>Security</i>	No particular risk.	1
<i>Site context</i>	No particular perturbation is present.	1
<i>Tourism infrastructures</i>	Road and marked hiking trails.	0.75
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities have been found.	0
<i>Education interest</i>	The geomorphological system is readable with mediation, but it has high education interest because of the visibility and diversity of landforms which are present.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The scientific value of the site is very high, as it's taken for a case example of high mountain geomorphological systems in scientific literature. The site has a very high aesthetical value. Ecological value is average, and the site is easily visible.

Use and management The site is not protected or managed in any way. While fragility and vulnerability of the site are low, it is very susceptible to climate change.

Management measures No particular management measure is required.

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HERflu001

Bramois alluvial fan

Localisation: Bramois (Sion)	Coordinates: 596.600 / 120.500	Altitude: 493 m – 515 m
Type: AER	Size: 6.14 ²	Property: PRI + COM

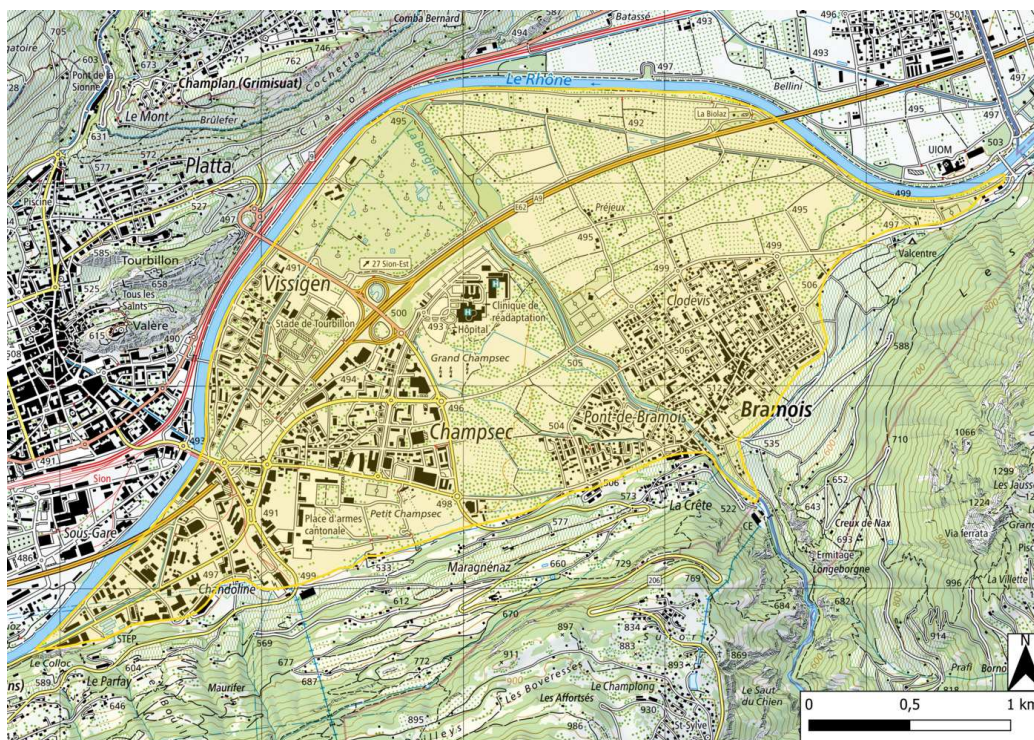


Figure A.4: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Bramois alluvial fan from the north (© Google Earth)



The outlet of the Val d'Hérens, with the village of Bramois and the alluvial fan, seen from Ayent (ph. Andrea Ferrando)

Description This geosite is one of the largest alluvial fans on the left bank of the Rhone river. It lies at the outlet of the Borgne river, covers an area of about 6 km² and is bounded to the north by the Rhone, which flows around it. The alluvial fans, made up of alluvial deposits, are very rich in mineral salts and therefore favour crop growth. This is why, throughout the Alpine valleys, these landforms were very quickly colonised by man, despite the high risk of flooding. The village of Bramois, one of the 101 Valais built sites of national importance (ISOS), was established on this fan.

Outside the village, the fan is largely devoted to agriculture. In here a specific watering system was produced: the "meunières". In Valais, these are found only here and in Martigny. This system, which is more or less similar to the network of bisses (irrigation channels), but which has the advantage of being laid out in clusters and thus covering the entire alluvial fan, irrigates the many crops grown in the region. The need for irrigation channels derives from the fact that the Rhone valley floor is very dry, so rainfall and snowmelt waters are not enough. This situation is even reflected in local place names, such as Champsec (which means "dry field").

The western part of the alluvial fan is occupied by the modern settlements of Champsec and Vissigen. Between the two, the highway exit of

Sion Est is located. The A9 highway crosses the alluvial fan from the southwest to the northeast. On the left bank of the Borgne river, next to Vissigen, there is a golf course.

Morphogenesis This geosite represents an alluvial deposit of the Borgne River, located at the mouth of the Val d'Hérens. It started forming between the end of the Ice Age (20.000 cal BP) and the Lateglacial (13.000 cal BP).

After a Lateglacial advance, the Hérens glacier retreated further up on the valley. The Borgne river, flowing down the already deglaciated lower stretch of the valley, transported the big quantities of sediment released by the glaciers. The sediment was then deposited at the mouth of the valley, thus slowly building the alluvial fan. A seismic reflection campaign carried out in the region shows that, from the surface to the bedrock, we first find 100 m of fluvio-glacial deposits, then 200 m of well-bedded glaciolacustrine deposits (clays) and finally 100 m of coarser glacial deposits (Besson et al., 1992).

In a completely natural setting, the alluvial fan is a deeply dynamical landform. The stream channels continuously migrate on its surface, and the alluvial fan itself continues to be built because of the occurrence of debris floods and debris flows. With the construction of the village of Bramois and all the related infrastructure, the natural dynamics of the alluvial fan have been completely altered. The Borgne river is now forced in an artificial channel, making it impossible for it to migrate. The artificial banks of the channel are built to prevent floods to reach the inhabited zones; thus, sediment deposition outside of the channel is no longer active (it could be in case of extreme events, but it would greatly damage the inhabited area).

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The alluvial fan is well conserved, but its natural dynamics have been completely altered by man.	0.5
<i>Representativeness</i>	The site is very representative of the fluvial landforms of the region.	1
<i>Rareness</i>	Alluvial fans are widespread in the Valais, but the Bramois fan is one of the largest.	0.5
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The alluvial deposits favour crops due to the presence of mineral salts. The fan is completely anthropised.	0.25
<i>Protected site</i>	The site is not protected.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	Due to its width, the fan is better viewed from afar: for example from the castles of Sion, from Grimisuat, Ayent or Nax. From Bramois itself the landform is not appreciable.	0.75
<i>Contrasts, vertical development, space structuration</i>	The contrasts are not that evident because the fan is covered by houses and infrastructures. Vertical development is low, as the fan has an almost flat surface.	0.25
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The village of Bramois is one of the built sites of national importance in Switzerland.	0.25
<i>Artistic and literary importance</i>	No artistic and literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	The natural vulnerability of an alluvial fan is very low.
<i>Anthropogenic vulnerability</i>	The site has been completely anthropised. Anthropogenic action has not destroyed the landform (it would be impossible due to its size), but it has completely altered its natural dynamics.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Bramois can be easily accessed by bus (from Sion) or by car. The site is better appreciated if seen from a distance, for example from Nax, Grimisuat, Ayent, all of them reachable by bus or car from Sion.	1
<i>Security</i>	No risk.	1
<i>Site context</i>	The traffic along the asphalt roads can disturb the visit.	0.75
<i>Tourism infrastructures</i>	Roads, villages, shops, restaurants.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are no interpretive facilities.	0
<i>Education interest</i>	The site is not easily visible of readable by a non-expert, but it is easily enhanceable.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value The intrinsic value of the site is average at best, mainly due to the high anthropogenic pressure being present.

Use and management The site is not protected. It's not fragile, nor vulnerable to natural processes. It has been completely anthropised, with the construction of a village (Bramois) and numerous other infrastructures. The landform has not been damaged, but its natural dynamics have been completely altered.

Management measures The site could be enhanced showing how humans interact with this kind of landforms: why they are often chosen as places to settle in, how anthropogenic actions affect their natural dynamics etc.

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HERflu002

Borgne gorge

Localisation: Along the Borgne stream from Bramois to Combioula (Sion / Vex / Mont-Noble / Saint-Martin / Hérémente)	Coordinates: 597.734 / 118.863	Altitude: 540 m – 869 m
Type: AER	Size: 1.00 km ²	Property: COM (Communes de Sion, Vex, Mont-Noble, Saint-Martin, Hérémente).

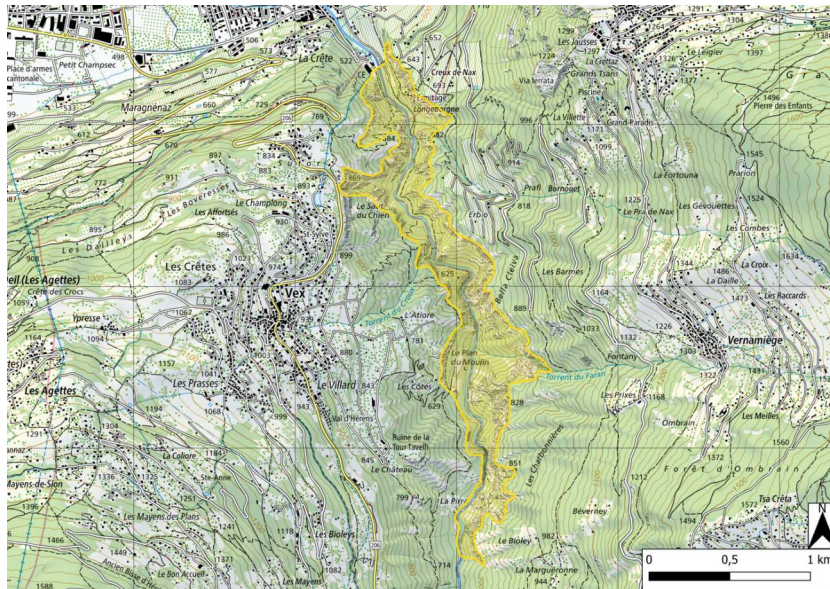


Figure A.5: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



Partial view of the gorge, with glacial deposits in the front (ph. Lucien Grangier)



The lower part of the gorge seen from the Hermitage de Longeborgne (ph. Andrea Ferrando)



The Hermitage de Longeborgne (ph. Andrea Ferrando)



Partial view of the gorge from upstream (ph. Andrea Ferrando)

Description This site includes one of the most beautiful connecting gorges on the left bank of the Rhône valley. It is majestic in its depth, vegetation and size. It begins near Les Bioleys and ends above the village of Bramois. The two slopes are fairly narrow downstream, while upstream they widen out.

From the geological point of view, the Borgne gorge is carved in hard Permian quartzites (Bruneggjoch Formation), which outcrop at a lower ele-

vation, in the lower part of the gorge, and more fractured Triassic dolomites and limestones (St-Triphon, Champcella and Clot de la Cime Formations), outcropping at higher elevations.

The rock faces reach over 150 metres high, while there are pebble and sandy fluvial deposits on the banks of the Borgne. This same river is left in an almost natural state, apart from a few dams and a very reduced flow due to the various reservoirs belonging to the EOS Grande-Dixence company. The vertiginous rock walls of this gorge are one of the most popular climbing sites in the Valais, and they provide an ideal playground for climbing enthusiasts.

The area is also home to a place of pilgrimage: the Hermitage of Longeborgne, founded in 1522. It is located on the eastern slope of the gorge and blends seamlessly into the landscape. Every year, large numbers of the faithful go there, and it is even said that in the past, barren women went there in the hope of being able to give birth later on. This place of meditation has of course been the inspiration for many writings and paintings. It is also on the list of cultural assets of regional importance, as is the hydro-electric power station above the village of Bramois.

The dense vegetation is reminiscent of a Mediterranean forest (pines, deciduous trees, moss).

Morphogenesis The region's glacial history is responsible for this landform. After the retreat of the Ice Age glaciers, the base level of the Val d'Hérens was higher than the valley floor of the Rhone. The ancient base level of the Val de Réchy can be located at an elevation about 850-1000 m, and it's testified by the glacial shoulder where the village of Vex has been built. The Rhone valley floor is located at about 500 m instead. To re-establish its equilibrium profile, the Borgne river evolved by regressive erosion, and formed a typical connection gorge.

The shaping of the fluvial gorge probably had already begun when the glacier covered the region, through the erosion caused by subglacial flows. In the process, the river cut into the slope to create a new equilibrium profile. Subsequently, this gorge was developed by man with various installa-

tions: hermitages, dams, hydroelectric power stations, etc.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	With the exception of hydroelectric infrastructure, the site is intact.	0.75
<i>Representativeness</i>	The site is very representative of the fluvial landforms of the region.	1
<i>Rareness</i>	Connection gorges are widespread in the area, but the Borgne gorge is one of the longest and deepest.	0.5
<i>Paleogeographical value</i>	Its paleogeographical relevance resides in the fact that its a testimony of the postglacial evolution of the area.	0.5
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Particular flora and fauna related to humid environments along the river, and to the particular microclimate of the gorge.	0.75
<i>Protected site</i>	The site is not protected.	0
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The gorge is very entrenched, so it hasn't particularly good view points – the best is probably at the Tour de Tavelli. One can observe it by going through it, but this way there are no comprehensive view points.	0.5
<i>Contrasts, vertical development, space structuration</i>	The particular environment contrast heavily with the surroundings. The gorge has also a very impressive vertical development.	1
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	On the eastern side of the gorge there is the Ermitage de Longeborgne.	1
<i>Historical importance</i>	The same hermitage has a great historical importance. Another historical feature is the Tour de Tavelli, located on the western side.	1
<i>Artistic and literary importance</i>	Its artistic and literary importance is related to the hermitage.	0.5
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	Due to the presence of several hydroelectric infrastructures, the site has an average economic importance.	0.5
Cultural value	High cultural value.	0.75

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	The rock walls, and especially the slopes with glacial deposits, are prone to degradation due to gravitational phenomena and runoff erosion. These processes are not expected to substantially affect the integrity of the whole site.
<i>Anthropogenic vulnerability</i>	Due to its large dimensions, the gorge has a very low anthropogenic vulnerability.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Bramois can be easily accessed by bus (from Sion) or by car. The gorge can then be accessed by various hiking trails. The view point at the Tour de Tavelli can be accessed in 15 minutes from Vex.	1
<i>Security</i>	Due to manoeuvres to the hydroelectric infrastructure, the Borgne water level can rise abruptly, so there could be risk of drowning by standing by the river banks.	0.75
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Roads, villages, shops, restaurants at Bramois and Vex.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are no interpretive facilities.	0
<i>Education interest</i>	The site is easily readable even without mediation.	1
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is average, with highest scores obtained by the aesthetic value and the cultural value, the latter because of the presence of a hermitage.

Use and management The site is not protected. It's not fragile, nor vulnerable to natural or anthropogenic processes. Its visit conditions are excellent, and the site is easily understandable, so its enhancement could be done at low cost.

Management measures No particular management measure is required.

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HERflu003

Lotrey fluvial terraces

Localisation: Evolène	Coordinates: 604.487 / 106.176	Altitude: 1330 m – 1400 m
Type: AER	Size: 0.48 km ²	Property: PRI

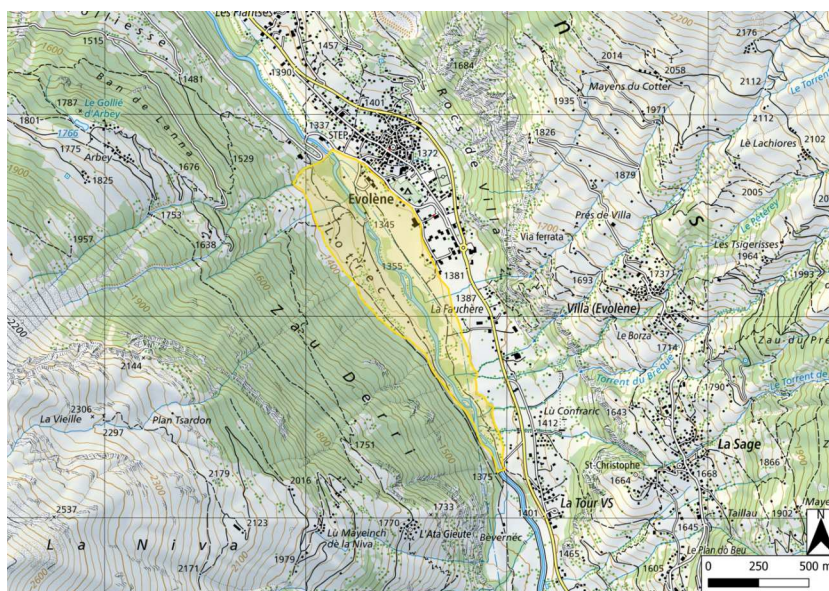


Figure A.6: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The fluvial terraces of Lotrey (Google Earth)



Panoramic view of Evolène (ph. Andrea Ferrando)

Description This geosite of fluvial origin comprises two very distinct parts: levels of fluvial terraces and an alluvial plain listed in the 1992 inventory of alluvial zones of national importance. In the following description, these two areas will be dealt with separately.

The alluvial plain of Lotrey has been formed by the Borgne river. In this stretch, the river is braided and contains vegetation (deciduous trees, fireweed, reeds) as well as a large number of fluvial bars and islets. A large number of trees, mainly deciduous, line the route. On the Lotrey alluvial plain, the river flows freely, but its flow is greatly reduced by the many reservoirs located upstream in the various valleys. The minimum flow is not always reached, and the river's biodiversity is thus weakened.

The second feature, the Lotrey river terraces, are easily identifiable in the Evolène landscape. Their integrity is good and no damage is visible. On either side of the river, three levels of terraces bear witness to the former levels of the Borgne. These are odd-numbered terraces, as the terraces facing each other are not at the same altitude. The highest level on the left bank is cut by ancient channels. All these terraces are covered with meadows. In the far north, on the left bank, the start of a ski lift is located on the last terrace level, along with a few isolated chalets. On the right bank, the highest terrace has been somewhat altered. This is where the school centre and some parking spaces are located. However, these alterations

are minor and the overall shape has been well preserved.

Morphogenesis The inactive fluvial terraces were formed at the end of the last ice age, when sediment supply to the Evolène area was far more intense than today (Baechler, 1992). They are therefore remnants of an ancient fluvio-glacial plain. With the change in water flow and sediment supply, the Borgne then cut across the ancient terraces, down to the present-day river bed.

However, even today, the Borgne meanders across the Lotrey area, forming a small alluvial zone. Vegetation has colonised some of the small islands, stabilising them. These are rarely flooded. In addition, the artificial water reservoirs belonging to EOS modify the flow of the Borgne quite considerably. The river often does not reach 20% of its natural flow. Yet this quantity has been enshrined in law in order to protect these areas of high biological and geomorphological potential, but which are very vulnerable.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The alluvial zone is well conserved, but the terraces are covered by buildings and infrastructures.	0.75
<i>Representativeness</i>	The representativeness of the site is not that high due to the terraces being poorly visible.	0.5
<i>Rareness</i>	Alluvial zones are common in the Val d'Hérens, while fluvial terraces are not that distributed.	0.75
<i>Paleogeographical value</i>	The presence of an alluvial zone and terraces can help to reconstruct the recent evolution of the valley.	0.5
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The vegetation is the one typical of alluvial zones.	0.5
<i>Protected site</i>	The site is protected under the Inventory of Alluvial Zones of National Relevance (Object n° 127).	1
Ecological value	High ecological value.	0.75

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The terraces are visible from small roads and pathways near the valley floor south of Evolène. The alluvial zone is also visible from many view points from higher slopes.	0.75
<i>Contrasts, vertical development, space structuration</i>	The presence of an alluvial plain contrasts with the surrounding steep mountain slopes. The terraces structure the space in a particular manner, shaping different levels in the gentle slopes around the active alluvial zone, but actually they are not that visible due to the presence of anthropic elements. Vertical development is very low.	0.25
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	There are ancient cottages on the left side of the Borgne. The presence of flat terrain due to the alluvial plain and terraces has permitted the development of Evolène, the main village of the upper Val d'Hérens.	0.75
<i>Artistic and literary importance</i>	No artistic and literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	The alluvial terraces are favourable for agriculture.	0.25
Cultural value	High cultural value.	0.75

Protection

Protection status The site is included in the Inventory of Alluvial Zones of National Relevance (Object n° 127).

Degradation risk

<i>Fragility</i>	The site is fragile because it's not too extended and the landforms are relict.
<i>Natural vulnerability</i>	The terraces can be affected by runoff processes, but the magnitude of these processes is not that relevant.
<i>Anthropogenic vulnerability</i>	The anthropogenic action is the main factor of degradation risk. The Lotrey terraces are located near the main village of the upper Val d'Hérens (Evolène), and they are already partially affected by the presence of buildings and infrastructure. Further construction can severely damage or degrade some of the landforms in the site. The flow and the sediment discharge of the Borgne river is altered by artificial catchments upstream, which are part of the Grande Dixence hydroelectric complex.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Bramois can be easily accessed by bus (from Sion) or by car. The gorge can then be accessed by various hiking trails. The view point at the Tour de Tavelli can be accessed in 15 minutes from Vex.	1
<i>Security</i>	No risk.	1
<i>Site context</i>	The traffic along the main road can disturb the visit.	0.75
<i>Tourism infrastructures</i>	Roads, footpaths, shops and hotels in Evolène.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are no interpretive facilities.	0
<i>Education interest</i>	The landform is easily recognisable, but its understanding requires mediation. The site is easily enhanceable.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The site has a high intrinsic value because of its high scientific, ecological and cultural interest.

Use and management The site is included in the Inventory of Alluvial Zones of National Relevance (Object n° 127). Its visit conditions are excellent. The main degradation risk factor is the expansion of human activities

(construction of new buildings or new roads) that could modify or destroy some of the fluvial terraces.

Management measures It should be made sure that human activities in the area don't affect substantially the fluvial terraces, maybe by highlighting some of them.

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HERflu004

Salay alluvial zone

Localisation: les Salays, Val de Ferpècle (Evolène)	Coordinates: 608.000 / 108.600	Altitude: 1730 m – 1790 m
Type: AER	Size: 0.15 km ²	Property: PRI (buffer zone of private properties) / PUB (alluvial zone property of the Evolène municipality)

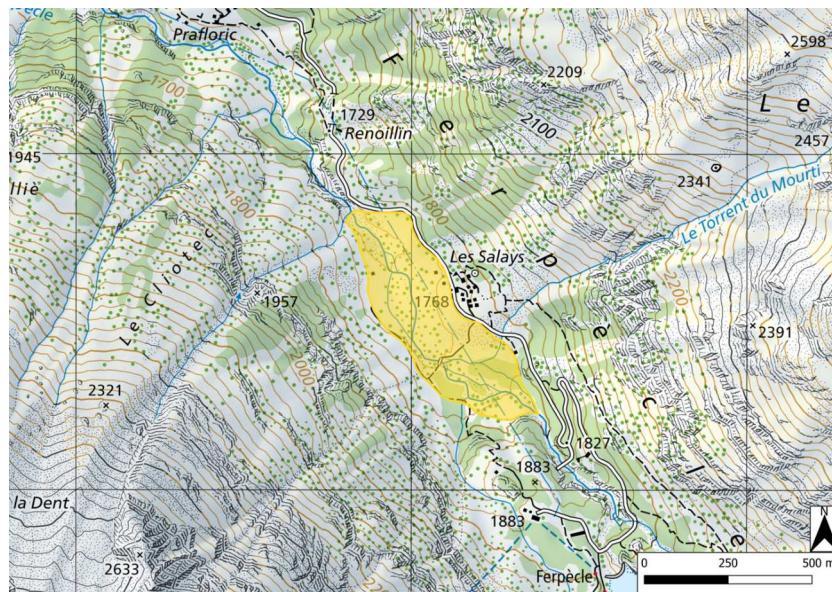


Figure A.7: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The alluvial zone as seen from the Mayens de Bréonna (ph. Lucien Grangier)



View of the alluvial zone of Salay from downstream (ph. Andrea Ferrando)

Description The site consists in a large alluvial zone located near the hamlet of les Salays, in the Ferpècle valley. In this stretch, the Borgne de Ferpècle river wanders freely between bars and islets, partly colonized by vegetation. The alluvial zone is what's left of the ancient proglacial margin of the Glacier de Ferpècle. The Little Ice Age moraines of this glacier are visible upstream of the alluvial zone. The vegetation is mainly made up of herbaceous or shrubby pioneer species.

Morphogenesis During the Eseggen stage (13000-10500 years ago) the Ferpècle and Mont Miné glaciers merged and covered with a large glacial tongue most of the Ferpècle valley. During that period, the locality called Salay was covered by ice. In the next millenia, the glacier experienced retreats and advances due to climate changes. During the glacial maximum of the Little Ice Age (XIX century), the glacial tongue arrived just upstream of Salay, and the present alluvial zone constituted the proglacial margin of the glacier. With the consequent retreat of the glacier, the Salay zone evolved from fluvioglacial sandur (a proglacial alluvial plain) to a frankly fluvial alluvial zone.

Nowadays, the fluvial processes are affected by human activity: upstream of the alluvial zone a dam has been built, as part of the Grande

Dixence hydroelectric complex. This has slightly modified the water flow of the Borgne de Ferpècle and the sedimentary supply to the alluvial zone. As of now, sediment comes mainly from some small tributaries (e.g. Torrent du Perroc, Torrent du Mourt) and smaller debris flow channels forming large fans.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The alluvial zone is apparently well conserved, but the presence of works for hydropower production upstream has completely altered its dynamics.	0.5
<i>Representativeness</i>	Very representative of postglacial morphogenesis.	1
<i>Rareness</i>	There are many of these alluvial zones in the study area.	0.25
<i>Paleogeographical value</i>	The site marks the position of the tongue of the Glacier de Ferpècle at the end of the Little Ice Age.	0.75
Scientific value	High scientific value due representativeness and paleogeographical value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Typical vegetation of alluvial zones, with a variety of the species that manage to colonize the fluvial bars. The fish fauna is scarce, mostly because of purges that killed fish. With the introduction of the minimum flow rates, the situation has become better.	0.5
<i>Protected site</i>	The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 130).	1
Ecological value	High ecological value.	0.75

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The alluvial zone of Salay is quite entrenched, so it's not well visible. To reach panoramic view points one must hike far from the site.	0.25
<i>Contrasts, vertical development, space structuration</i>	The site is not impressive. It contrasts with the surrounding stretches of the Borgne de Ferpecle, which are engorged, but the alluvial plain itself is not well visible. Vertical development is low. The presence of channels and bars is suggestive, but there are nicer examples in nearby localities.	0.25
Aesthetic value	Low aesthetic value.	0.25

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	There are photographs of the area from 1929 (fond Simmonot J.).	0.25
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 130).

Degradation risk

<i>Fragility</i>	The site is fragile.
<i>Natural vulnerability</i>	With climate change, the site is to be further colonized by vegetation. This will alter its geomorphological dynamics.
<i>Anthropogenic vulnerability</i>	This stretch of the Borgne de Ferpècle river is in fact very affected by anthropogenic activity. Upstream of the Salay alluvial zone there is a dam built to collect water for the Grande Dixence basin. Thus, the flow of the river is slightly less than it would be in natural conditions. The supply of sediment is also diminished.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to les Salays. The site is directly on the side of the road, and is crossed by a marked hiking trail.	0.75
<i>Security</i>	Risk may come from abrupt rises in the water flow due to discharges at the dam.	0.75
<i>Site context</i>	There is no particular perturbation.	1
<i>Tourism infrastructures</i>	Road and marked hiking trails.	0.25
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are panels focusing on the ecological features of the alluvial zone at the Ferpècle parking.	0.25
<i>Education interest</i>	The landform is not particularly well readable, also because it is not very well visible.	0.5
Education	Low educational value	0.25

Synthesis

Intrinsic value The site has a high scientific and ecological value, but it's not the best example of an alluvial zone in the Val d'Hérens.

Use and management The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 130). It suffers from the presence of a dam with water uptake, located upstream of the alluvial zone.

Management measures No particular management measure is required.

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HERflu006

Satarma alluvial zone

Localisation: between Satarma and Pramoûss (Evolène)	Coordinates: 603.850 / 099.200	Altitude: 1805 m – 1830 m
Type: AER	Size: 83,000 m ²	Property: PRI (buffer zone of private properties) / PUB (alluvial zone property of the Evolène municipality)

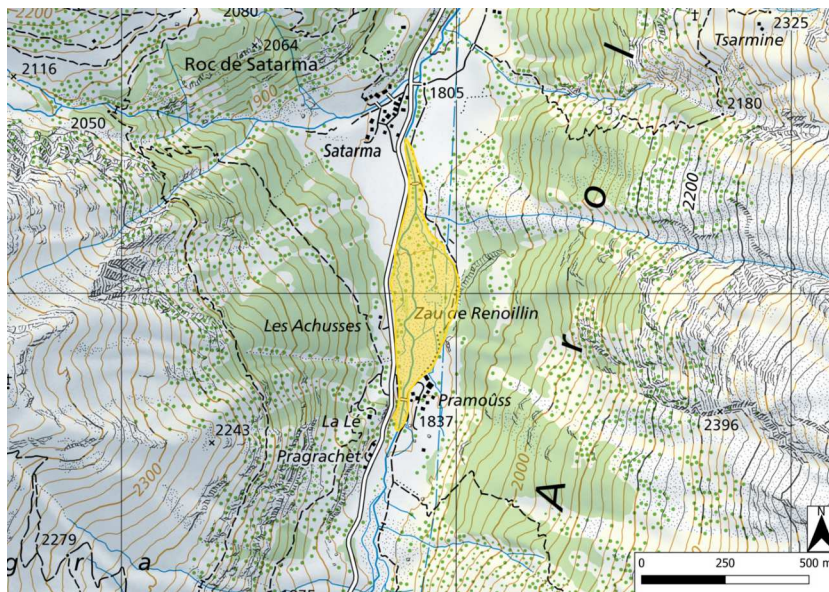


Figure A.8: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



View of the alluvial zone of Satarma from upstream (ph. Andrea Ferrando)



The alluvial zone as seen from downstream (ph. Andrea Ferrando)

Description The site consists in a large alluvial zone located between the hamlets of Pramoûss and Satarma, in the Val d’Arolla. Here the Borgne d’Arolla riverbed widens, and the river separates in several channels that flow between bars and islets. The alluvial zone is limited by artificial gravel embankments, in particular on the western side, where there is the road to Arolla, and on the south-eastern side, near the hamlet of Pramoûss. In the middle of the site there is a small artificial basin, contained in a gravel dam. The vegetation is mainly made up of herbaceous or shrubby pioneer species.

Morphogenesis The alluvial zone of Satarma was formed by deposition of fluvio-glacial, and then fluvial sediment, by the Borgne d’Arolla river. The deposition is favoured by two main factors: I) the presence of a wide and almost flat stretch of the valley; II) a large debris flow fan, coming from the right hand side of the valley, from the slopes of the Dent du Perroc, and the alluvial fan on which Satarma is built, act as natural dams downstream of the alluvial zone. As most alluvial plains of the Val d’Hérens, the site has evolved through the Holocene from proglacial sandur to a frankly fluvial plain. The alluvial plain naturally evolves, with fluvial channels moving and the continuous deposition and erosion of fluvial bars. It is often perturbed

by debris flows and floods.

The site is affected by human activity in several ways. First, it is bounded by artificial embankments, built to prevent floods from reaching the nearby road or the hamlets of Satarma and Pramoûss. The asphalt road itself is built on what originally was a marginal sector of the alluvial plain. Just upstream of the plain, the Borgne d'Arolla riverbed is artificially narrowed; the road to Pramoûss crosses the river with a small bridge. Finally, in the middle of the plain, sediment has been reworked to build a small dam that contains an artificial pond.

Human action affects the whole upper catchment of the Borgne d'Arolla. Water is taken in various localities to feed the Grande Dixence hydroelectric system. Due to this, the water flow of the Borgne d'Arolla is artificially controlled, and sediment supply to the river system has been altered. In some sectors, such as the Satarma alluvial plain, the riverbed of the Borgne d'Arolla has increased its height of more than 5 meters in 50 years. Due to that same activity, the Borgne d'Arolla is subjected to sudden discharge of water, that act as human-induced flows, and have a great impact on the morphodynamics of the valley and on its ecosystem.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The alluvial zone is well conserved, but slightly modified by human activity.	0.75
<i>Representativeness</i>	Very representative of alluvial zones in high mountain environment.	1
<i>Rareness</i>	There are many of these alluvial zones in the study area.	0.25
<i>Paleogeographical value</i>	The site marks one of the stages reached by the Arolla glacier.	0.5
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Typical vegetation of alluvial zones, with a variety of the species that manage to colonize the fluvial bars. The fish fauna is scarce, mostly because of purges that killed fish. With the introduction of the minimum flow rates, the situation has become better.	0.5
<i>Protected site</i>	The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 128).	1
Ecological value	High ecological value.	0.75

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The alluvial zone is well visible, both from the main road of the Val d'Arolla and from the other side of the river (from Pramoûss or from the path which goes from there to Satarma).	1
<i>Contrasts, vertical development, space structuration</i>	The site contrasts with the surrounding landscape because it's flat and for the wide gravelly river bed. It doesn't have vertical development. Space structuration is pleasing, with several small channels, fluvial bars and islets.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	Historical importance is connected to the hamlets of Satarma and Pramoûss, which contain testimonies of rural architecture.	0.25
<i>Artistic and literary importance</i>	A recent book (B. Barbeau, Les mayens de Satarma, 2003) talks about the area. There are photos from the first half of the XX century in which the alluvial plain can be seen.	0.25
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 128).

Degradation risk

<i>Fragility</i>	The site is fragile.
<i>Natural vulnerability</i>	With climate change, the site is to be further colonized by vegetation. This can alter its geomorphological dynamics.
<i>Anthropogenic vulnerability</i>	This stretch of the Borgne d'Arolla river is in fact very affected by anthropogenic activity: there are artificial enbankments that protect the nearby road and a small artificial basin in the middle of the alluvial plain. Furthermore, the Borgne d'Arolla has several water uptakes, part of the Grande Dixence hydroelectric system: that has modified the water flow of the river and the sediment supply to its alluvial zones. The Borgne d'Arolla is subjected to sudden discharge of water, that act as human-induced flows, and have a great impact on the morphodynamics of the valley and on its ecosystem.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to Satarma. The site is directly on the side of the road, and is crossed by a marked hiking trail, going from Satarma to Pramoûss.	1
<i>Security</i>	Danger may come from sudden discharge of water from the uptakes in the higher part of the Borgne d'Arolla catchment.	0.75
<i>Site context</i>	There is no particular perturbation.	1
<i>Tourism infrastructures</i>	Road and marked hiking trails.	0.25
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are panels focusing on the ecological features of the alluvial zone.	0.25
<i>Education interest</i>	The landform is easily readable and easy to enhance for geotourism.	0.75
Education	Average educational value	0.5

Synthesis

Intrinsic value The scientific value of the site is average, due to it being affected in various ways by human activities. Ecological value is high, and the site is easily accessible and visible.

Use and management The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 130). The Borgne d’Arolla river is constantly monitored due to the presence of water uptakes in the upper stream catchment.

Management measures No particular management measure is required. To enhance the site for geotourism, the site can be coupled with the proglacial margin of the Bas Glacier d’Arolla, and the differences between the two can be highlighted: in geomorphological context, in morphodynamics and in vegetation.

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HERflu007

La Lurette earth pyramids

Localisation: La Lurette (Saint-Martin)	Coordinates: 600.584 / 111.996	Altitude: 950 m – 1250 m
Type: AER	Size: 0.31 km ²	Property: PUB (Bourgeoisie de St-Martin)

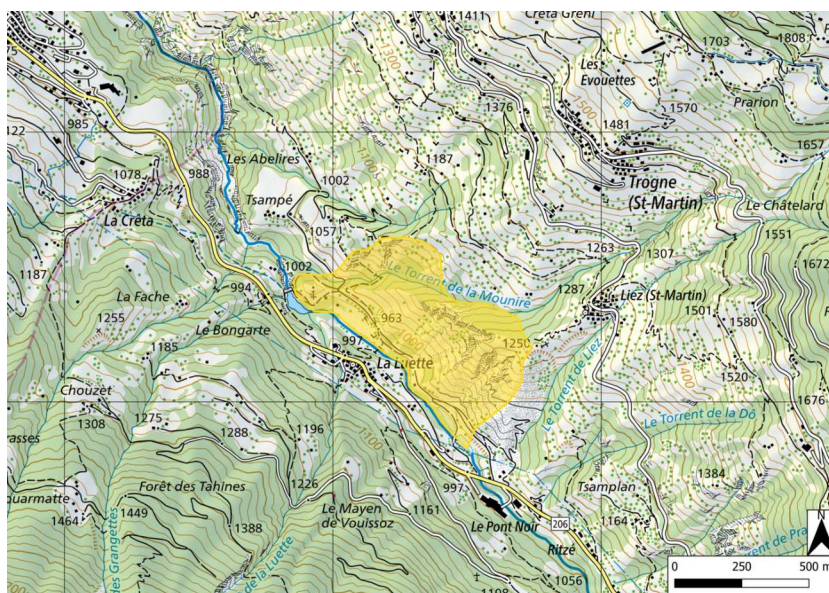






Figure A.9: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>The pyramids as seen from la Lurette (ph. Andrea Ferrando)</i></p>	<p><i>The southern sector of the site, characterised by badlands-like landforms (ph. Andrea Ferrando)</i></p>
	
<p><i>Incipient pyramid formation on the northern part of the site (ph. Andrea Ferrando)</i></p>	<p><i>Another view of the southern part of the site, with the active quarry (ph. Andrea Ferrando)</i></p>

Description The site is located on the right hand side of the Borgne river, in front of the village of la Lurette. It consists of a large outcrop of morainic deposits, which have been shaped by runoff processes in badlands and earth pyramids (or hoodoos).

The site is bounded by the Borgne river on the south-western side, flowing at about 950 m in elevation. On the south-east the outcrop terminates by the V-shaped incision of the Torrent de Liez, which forms a small debris flow fan at its confluence with the Borgne. North of the main morainic ridge, the deposit is incised by the Torrent de la Mounire; on the northern

flank of its small valley, the last badlands and incipient pyramids are seen. The top of the morainic deposit is located at an elevation of about 1250 m.

The southern part of the morainic deposit, by the Torrent de Liez, is exploited by a gravel quarry. Small dirt roads cut parts of the deposit, while the Borgne is characterised by two small artificial basins related to the quarry.

The slope facing the Borgne is deprived of vegetation, due to the high slope and its rapid evolution due to runoff erosion. On the other side, species typical of dry prairies are present. On the banks of the Borgne, broad-leaved trees are present (mainly birches).

Morphogenesis The morainic deposits of la Lurette were built by the Hérens glacier and constitute one of the most prominent Lateglacial features of the whole valley (Lambiel, 2021). Two main morainic ridges can be recognized, located on the two sides of the small valley of the Torrent de la Mounire. On the upper slope, smaller lateral morainic ridges have been recognised, probably deposited by a smaller glacier descending from the area of St-Martin.

The moraines of la Lurette rest on glaciolacustrine deposits, which are visible on the southern sector of the outcrop, near the quarry. These deposits document subsequent phases of retreat and advance of the ancient Hérens glacier (Fauchère, 1997; Sartori & Epard, 2011). North of the morainic ridges included in the geosite, fluvio-glacial deposits can be observed. They testify the presence of an ancient proglacial plain just outside the main frontal moraine of the Hérens glacier. As of now, they appear as flat terraces hanging on the valley floor of the Borgne, which is situated about 100 m below.

The glaciolacustrine and morainic deposits have then been shaped by runoff waters. The glaciolacustrine deposits, which are generally finer and more homogeneous, have been modeled in badlands-like landforms, with some small scale earth pyramids here and there. Moving north, one enters the glacial deposits, which are coarse and heterogeneous, comprising very large blocks. Here the main earth pyramids can be observed: they are 20-

40 meters high and quite thick. The formation of the pyramids is due to the presence of large blocks, which act like “cap rocks”, and protect from erosion the underlying finer sediment.

More recently, the quaternary deposits of la Lulette have been affected by human action. The southern side of the outcrop (mainly the part composed by glaciolacustrine deposits) has been artificially remodeled due to the presence of a quarry and the roads to access it.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The main pyramids are intact, but the southern sector of the outcrop is affected by quarrying activity.	0.5
<i>Representativeness</i>	The representativeness of the site is high but not exceptional because the pyramids have not the elegant shapes of other more well known sites.	0.75
<i>Rareness</i>	Landforms like these are not that rare in the study area, but their dimensions are noteworthy.	0.5
<i>Paleogeographical value</i>	This morainic deposit shows one of the stages reached by the glacier of the Val d'Hérens, thus they're important for reconstructing the glacial history of the region.	0.75
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	On the northern side the morainic deposits are colonized by the typical vegetation of dry prairies.	0.5
<i>Protected site</i>	The site is not protected.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The pyramids are very well visible from the cantonal road of the Val d'Hérens, near the village of la Lurette.	1
<i>Contrasts, vertical development, space structuration</i>	The colour and the shape of the pyramids contrast with the surrounding rural or woody landscape. The pyramids have high vertical development (some of them are 30-40 m high, and the morainic outcrop has a vertical development of almost 300 m), but they are quite stubby and thick, so they're not as impressive as the more notorious Euseigne pyramids.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic and literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	The gravel deposits of the site are exploited for quarrying.	0.5
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 128).

Degradation risk

<i>Fragility</i>	The site is fragile because the same geomorphological process that generated it (erosion by runoff waters) will slowly cause its degradation and destruction.
<i>Natural vulnerability</i>	The site is very dynamic even in a short time scale. Other than erosion by runoff waters, there are other active processes contributing to the evolution of the site – gravitational phenomena and fluvial erosion by the Borgne at the foot of the slope.
<i>Anthropogenic vulnerability</i>	Human activity is actually degrading the northern sector of the site, because of the presence of a gravel quarry, affecting both the morainic and fluvioglacial deposits on which pyramids and badlands are carved, and the nearby debris flow fan of the Torrent de Liez.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour all the year. The pyramids are visible from the bus stop in la Lurette and from the cantonal road in the vicinities.	1
<i>Security</i>	No risks are present, unless one climbs up the morainic deposits.	1
<i>Site context</i>	The presence of the quarry is the main perturbation in the area. In second place, there is the circulation on the cantonal road.	0.5
<i>Tourism infrastructures</i>	There is a hiking trail at the foot of the slope with the pyramids.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are no interpretive facilities.	0
<i>Education interest</i>	The site is easily readable, and its enhancement can be done with a reasonable investment.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value Even if they are not known or impressive as the Euseigne pyramids, the pyramids of la Lurette have a quite high intrinsic value.

Use and management Part of the site is used for quarrying activity. The main pyramids are outside of the quarry area and are not managed.

Management measures The site could be highlighted by panels similar to those present at the nearby Euseigne pyramids. The interaction between human exploitation (the gravel quarry) and natural processes can be highlighted.

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HERflu008

Euseigne earth pyramids

Localisation: Euseigne (Hérémente)	Coordinates: 598.327 / 113.583	Altitude: 720 m – 1040 m
Type: AER	Size: 0.22 km ²	Property: PUB (Commune d'Hérémente)

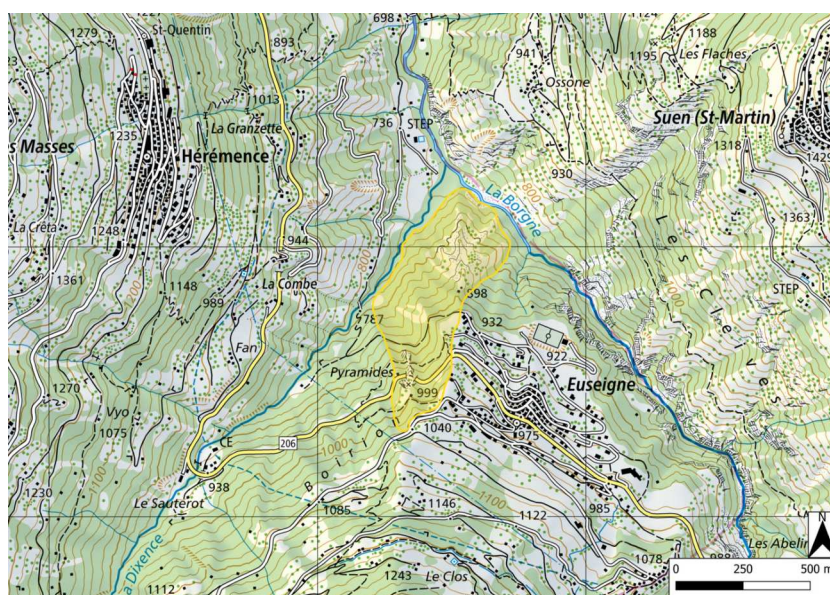


Figure A.10: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>The pyramids as seen from the north-west (ph. Andrea Ferrando)</i></p>	<p><i>The pyramids, with the old tunnel (ph. Andrea Ferrando)</i></p>
	
<p><i>Zoom on some of the pyramids (ph. Andrea Ferrando)</i></p>	<p><i>Incipient pyramid formation on the lower part of the geosite (ph. Andrea Ferrando)</i></p>

Description The Euseigne pyramids, located near the eponymous village in the lower Val d'Hérens (Hérémente municipality), are one of the best-known natural features of the Val d'Hérens and the Valais. They are a dozen "fairy chimneys" topped with boulders, 10-15 meters in height, carved in morainic deposits. Apart from the well-developed main pyramids, other pyramid-and-badlands-like landforms are visible at a lower elevation. The main road of the Val d'Hérens bypassed them with a tunnel – in 2023 the old tunnel was dismissed and a new one was built further away from the pyramids.

Morphogenesis The morainic deposits of Euseigne were left by the Dix glacier, flowing out of the Val d'Héremence. They constitute one of the most prominent Lateglacial features of the whole valley (Lambiel, 2021). Two main morainic ridges can be recognized, located on the two sides of the small valley of the Torrent de la Mounire. On the upper slope, smaller lateral morainic ridges have been recognised, probably deposited by a smaller glacier descending from the area of St-Martin.

During the Last Glacial Maximum, the Héremence glacier joined the Hérens glacier just downstream of the pyramids. Then in the Lateglacial there was a phase of glacial retreat, that left the lower Val d'Hérens completely deglaciated. In this time there formed an ancient "Hérens Lake", probably due to glacial damming of the lower Hérens valley by the main Rhone glacier. The presence of this lake is testified by glaciolacustrine deposits, which are found in several locations on the left side of the lower Val d'Hérens. These deposits show a 20° dip towards the Borgne.

The Euseigne moraine was deposited above some of these glaciolacustrine sediments, testifying a subsequent phase of advance of the Héremence glacier (Sartori & Epard, 2011).

Since the retreat of the glaciers, these moraine deposits have been subject to ambient weather conditions. The runoff action (rainfall, frost, etc.) slowly erode the moraine, which has very low permeability. Little by little, small trickles of water become concentrated and then narrow ravines are dug along the steep slopes, bypassing and isolating the largest resistant boulders. Thanks to their size and weight these boulders act as 'protective caps', compacting the underlying moraine, while the unprotected fine material unprotected fine material is carried away. These pyramids, always aligned in the direction of the steepest slope, continue to grow because of the lowering of the surrounding ground surface. At Euseigne, the pyramids reach a respectable height of 10 to 15 metres, and the protective caps visible at the top are several metres in diameter (weighing up to 20 tonnes). They are made of either gneiss or serpentinite, coming from the Val des Dix.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The geosite is affected by the passing of the cantonal road in a small tunnel (discontinued in 2023 with the construction of another tunnel). Some pyramids are missing the cap.	0.75
<i>Representativeness</i>	The site is very representative of runoff landforms on glacial deposits, and of earth pyramids in general.	1
<i>Rareness</i>	While earth pyramids are found in other locations in the Val d'Hérens, none are as well developed as the ones in Euseigne.	0.75
<i>Paleogeographical value</i>	The morainic deposits and the underlying fluvioglacial deposits of the pyramids allow to reconstruct the Quaternary history of the Val d'Hérens.	0.75
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1708) and in the Inventory of Swiss Geotopes (Object n° 53).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The pyramids are very well visible from the cantonal road of the Val d'Hérens, near the village of Euseigne.	1
<i>Contrasts, vertical development, space structuration</i>	The contrasts are great, both in the colours (the light beige of the pyramids against the green vegetated background, and the dark colour of the cap boulders) and in the shapes (the thin vertical pyramids against a gentle slope). The pyramids are up to 15 meters tall, and their height is enhanced by their thinness.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The pyramids are pointed out as natural curiosities for tourism since the XIX century.	0.5
<i>Artistic and literary importance</i>	There are lots of historical photos of the pyramids. They are mentioned in the book "les Mayens de Sion".	0.5
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	The pyramids are a tourist attraction (marked even on panels on the main highway of the Valais canton), thus they contribute to the tourism economy of the valley.	0.25
Cultural value	Average cultural value.	0.5

Protection

Protection status The site is included in the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1708) and in the Inventory of Swiss Geotopes (Object n° 53).

Degradation risk

<i>Fragility</i>	The site is fragile because the same geomorphological process that generated it (erosion by runoff waters) will slowly cause its degradation and destruction. For the same process, new pyramids-like landforms are developing in the lower part of the site.
<i>Natural vulnerability</i>	Other than its genetic process, the site is susceptible to gravitational processes. In fact, small landslides have greatly damaged one of the paths that allowed to visit the site. The pyramids can undergo degradation in case of earthquakes.
<i>Anthropogenic vulnerability</i>	The presence of the tunnel of a cantonal road has affected the Euseigne pyramids, and the ensuing vibrations could be an issue for the stability of the pyramids. In 2023 the cantonal road has been moved with the construction of another tunnel.
<i>Sensitivity to climate change</i>	The runoff erosion process can be enhanced by climate change – especially by the alternance of long dry periods and more intense and concentrated rain events.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour all the year. There is a dedicated bus stop, and the pyramids can be observed by taking a short walk along the old, dismissed cantonal road.	1
<i>Security</i>	No risks.	1
<i>Site context</i>	The traffic along the cantonal road can disturb the visit.	0.75
<i>Tourism infrastructures</i>	The old cantonal road is now entirely devoted to tourist that want to visit the geosite. The hiking path that crosses the pyramids is now closed due to landslides..	0.75
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There is a dedicated panel along the cantonal road, and plenty of depliants and publications.	1
<i>Education interest</i>	The site is readable with mediation, and easily understandable from the general public.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The Euseigne pyramids are among the most impressive and most well known earth pyramids in the whole Switzerland. Their intrinsic value is high.

Use and management The site is included in two Federal Inventories. Until 2023, the cantonal road crossed the pyramids, making for a curious context, but threatening the integrity of the site. The cantonal road was then moved. The site is both fragile and vulnerable. Visit conditions are excellent, and its educational value is high.

Management measures The site has already been successfully enhanced, and the main degradation risk factor (the cantonal road) has been moved.

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HERgla001

Vex glacial shoulder

Localisation: Vex	Coordinates: 597.200 / 118.240	Altitude: 780 m – 1083 m
Type: AER	Size: 0.94 km ²	Property: PRI-PUB

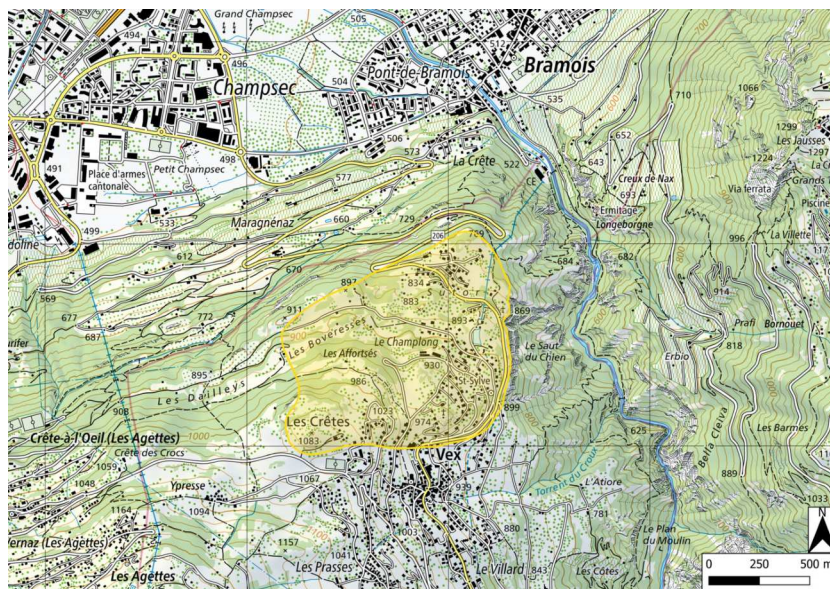
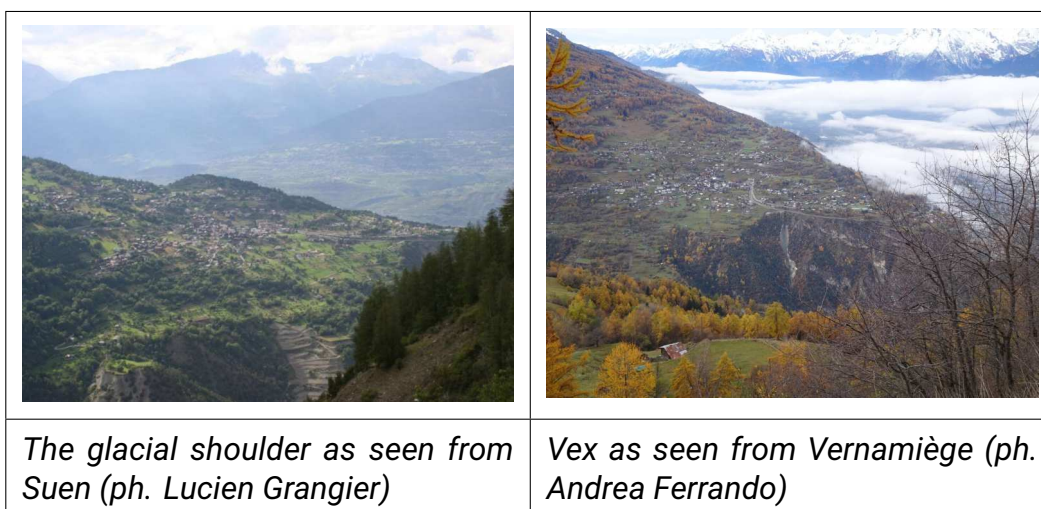


Figure A.11: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



Description The village of Vex, gateway to the Val d'Hérens, is located on an orographic shoulder. Overlooking the village of Bramois, this flat area bears witness to the action of the Rhône and Hérens glaciers. In addition to the village of Vex, this shoulder is home to the Saint-Gylve chapel, dating from the late 11th century and classified as a cultural asset of regional importance. Vex, situated at an altitude of 940 m, is ideally suited to agriculture, with its flat, south-facing slopes. For this reason, orchards and meadows characterise the landscape.

Morphogenesis This geosite of glacial origin bears witness to the passage of the Hérens glacier to this spot during the Würm and previous ice ages. There are three main phases in the formation of a shoulder. During the Last Glacial Maximum, the village of Vex was under a great thickness of ice. Then, during the Tardiglacial period, the Rhône glacier was no longer very extensive and no longer existed at the level of the village of Vex.

The retreat of the glaciers left a series of suspended side valleys – among them, the Val d'Hérens. As a result of regressive erosion, connecting gorges, such as the one crossed by the Borgne, became more pronounced. The glacial shoulder testifies for the ancient level of the suspended valley bottom. In more recent history, humans have taken advantage of the benefits of such a landform and settled there.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is well conserved even if it is anthropised.	1
<i>Representativeness</i>	It's a very good and visible example of a glacial shoulder.	1
<i>Rareness</i>	Glacial shoulders are widespread in the Alps and in the Rhone valley in particular, but the one in Vex is very large and pronounced.	0.25
<i>Paleogeographical value</i>	The site is a testimony of the position and size of glaciers during the last Ice Age.	0.75
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact due to very high anthropisation.	0
<i>Protected site</i>	The site is not protected.	0
Ecological value	No ecological value.	0

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	There are lots of points of views – the glacial shoulder is visible from almost every locality in the lower Val d'Hérens, and it's even recognisable from the Rhone valley floor and from the northern side of the Rhone valley.	1
<i>Contrasts, vertical development, space structuration</i>	The flattish top of the shoulder contrasts heavily with the rock walls and the gorges under it, and with the generally steep slopes above it.	0.5
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The flat top of the shoulder has made this geosite a preferential place for humans to settle – thus, the village of Vex was built. There's also a chapel dating from the XI century.	1
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	The flattish surfaces and the south-eastern aspect of some of them has made it possible to practice agriculture on it.	0.5
Cultural value	High cultural value.	0.75

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile, due to its dimension.
<i>Natural vulnerability</i>	The site is not vulnerable.
<i>Anthropogenic vulnerability</i>	Even if the site is totally anthropised, with a village and agricultural fields, the integrity of the landform has not been affected.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	More than a bus per hour to Vex. From the bus stop, one can take short hikes to the top of the glacial shoulder, called les Crêtes.	1
<i>Security</i>	No risks.	1
<i>Site context</i>	Car circulations along the roads in the village and on the whole shoulder can perturb the visit.	0.75
<i>Tourism infrastructures</i>	Marked hiking trails, roads, shops and hotels in Vex.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There is a didactic trail in Vex.	0.5
<i>Education interest</i>	The landform requires a mediation to be understood but it's easily visible.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value The site is well conserved and easily visible, and it has high cultural significance. This makes up for a generally high intrinsic value.

Use and management The site is not protected, and it's occupied by a village and other human activities (mainly agriculture). All this does not constitute a degradation risk factor, as the very wide landform is nor fragile nor vulnerable.

Management measures The didactic trail passing through Vex could be updated with more information about the geomorphology of the area.

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HERgla005

Mont Miné glacial system

Localisation: Glacier du Mont Miné, Ferpectle (Evolène)	Coordinates: 603.750 / 095.500	Altitude: 1880 m – 3825 m
Type: AER	Size: 13.09 km ²	Property: PRI (EOS Grande-Dixence) / PUB (Commune d'Evolène)

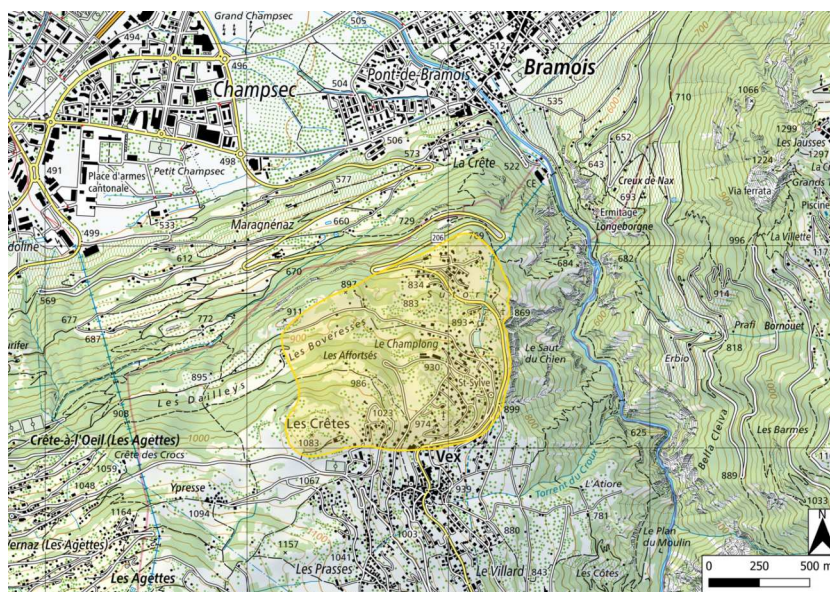


Figure A.12: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>The Glacier du Mont Miné as seen from the proglacial plain (ph. Andrea Ferrando)</i></p>	<p><i>The proglacial plain, with the Glacier du Mont Miné on the right and the Glacier de Ferpècle on the left (ph. Andrea Ferrando)</i></p>
	
<p><i>The proglacial plain of Ferpècle and the LIA moraine, deeply incised by gullies (ph. Andrea Ferrando)</i></p>	<p><i>Man-made structures in correspondence of the 1980s push moraine in Ferpècle (ph. Andrea Ferrando)</i></p>

Description The geomorphosite includes the whole extent of the Glacier du Mont Miné and its proglacial area, down to the LIA moraines.

The Glacier du Mont Miné is one of the two glaciers located at the head of the Val de Ferpècle, the other being the Glacier de Ferpècle. The glacier's accumulation zone is located between the Dents des Bouquetins (3838 m) and the Tête Blanche (3711 m). The glaciated north ridge of the Tête Blanche separates the head of the Glacier du Mont Miné from the head of the Glacier de Ferpècle. From the accumulation zone the glacier flows

north for about 4 km, until a rocky step at about 2800 m. Here the active part of the glacier terminates with a very high serac. At the bottom of the step, from about 2650 m to 2100 m, there is the lower tongue of the glacier. The lower tongue is completely separated from the upper active tongue – it is fed by serac falls and ice avalanches coming from the upper tongue. From the mouth of the glacier, a proglacial stream flows north, forming a large fluvioglacial fan and entering a large alluvial zone, in which it converges with the proglacial stream of the Glacier de Ferpècle.

The proglacial plain is located at about 1950 m, and it is dammed by a push moraine dating from the 1980s. The plain is fed by the Mont Miné stream and another stream coming from the Ferpècle glacier, located in the adjacent valley. Both streams form large fluvioglacial fans when entering the plain.

On the west side of the proglacial area, the steep LIA moraines are very well visible and affected by intense gullying and gravitational erosion. The east side is characterised by gentler terrain; here, multiple moraine ridges can be recognised, along with several outcrops of roches moutonnées. The LIA frontal moraine is not well preserved, and it is located at about 1800 m, on the edge of a rock sill. The Borgne de Ferpècle river crosses the sill in a deep fluvial gorge, then enters another alluvial zone in the vicinity of les Salays. This alluvial zone was the proglacial area in the LIA.

The lower part of the proglacial area has been slightly impacted by anthropogenic action. Some small weirs are present along the river just downstream of the proglacial plain. In the lower part of the site there is a dam, built to collect water for the Grande Dixence hydropower system – and, in the surroundings, there are excavation works covered by vegetation. Several structures have been built on the proglacial stream to remove glacial silt from its waters.

Morphogenesis The Mont Miné glacial system is a very complex geomorphological system, in which several active processes and landforms interact with each other and with older inherited landforms.

The Mont Miné glacier itself has a complex and interesting history. Both

the Mont Miné glacier and the Ferpècle glacier are currently in rapid retreat due to climate change - with the Ferpècle glacier retreating faster due to unfavourable topographic and aspect conditions. In the 19th century, at the height of the Little Ice Age, the Mont Miné merged with the Ferpècle glacier in a single glacier tongue. The maximum LIA extent of the glacier was reached in 1840. The LIA front moraine, poorly preserved, lies at about 1800 m of elevation, and the LIA proglacial area was located in the current alluvial zone of les Salays.

In the first half of the 20th century, a lake located at the confluence of the Mont Miné and Ferpècle glaciers, and dammed by the glacial tongues, caused several outburst floods (1942, 1943 and 1952). In the 1950s the two glaciers still merged into one single glacial tongue at the current proglacial plain (Mariétan, 1952; Bezinge & Kunz, 2001). The two glaciers splitted in 1957, and have been separate ever since (Bezinge, 2001). Because of the topographical context, the Mont Miné glacier is better protected from melting and therefore its ice-covered surface area (11 km² in 1973) is greater than that of the Ferpècle glacier (9.8 km² in 1973). However, the retreat of the glacier has uncovered typical glacial geomorphological features such as roches moutonnées, glacial potholes and morainic deposits.

The steady retreat has been interrupted only in the late 1980s, when the Mont Miné glacier advanced again in the proglacial plain, building a push moraine in the process (Bezinge & Kunz, 2001; Lambiel, 2021). The 1980s push moraine can still be observed at the lower margin of the main sandur in the proglacial area. The combination of the dam effect of the push moraine and the overdeepened hollow favoured the formation of a small lake, with a maximum depth of 16.7 metres and a volume of 30,000 m³ (Bezinge, 2001). In about 20 years the lake has been filled by fluvio-glacial deposits, forming the current sandur. Since then, the glacial tongue has retreated by about 800 meters.

The main current active process present in the upper part of the site (i.e. the active glacier) is still glacial activity, including glacier movement, melting of the debris-covered tongue, erosion, transport and deposition of sediments by the glacier. Downstream of the glacial tongue, fluvio-glacial

activity can be witnessed, i.e. transport and deposition of sediments in the alluvial zone. Gullyng and gravitational activity acts mainly on unconsolidated morainic deposits, such as the LIA moraines (Curry et al., 2005). Torrential activity and avalanches happen in the mountain sides, contributing to the sediment supply to the system.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is in perpetual change due to the retreat of the glacier, with more or less integer landforms. The integrity of the whole system in itself can be considered high. The proglacial area is affected by several man-made structures (roads, hydroelectric works, remodeled landforms).	0.75
<i>Representativeness</i>	It's very representative of the active glacial zones in the high alpine environment.	1
<i>Rareness</i>	Glaciers are not rare in the region, but the prominent glacial landforms and recent geomorphological evolution of the Ferpècle area have their own rareness.	0.5
<i>Paleogeographical value</i>	The various active and inherited landforms of the glacial system give important evidence of the recent geomorphological evolution of the region.	1
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	In the proglacial area of Ferpècle one can observe the whole evolution of vegetation from pioneer species to coniferous forest.	1
<i>Protected site</i>	The proglacial margin is included in the inventory of alluvial zones of national importance (OZA – Object n° 131). The protection perimeter established in the early 1990s does not take into account the lower end of the tongue of the Mont Miné glacier. As a result, a significant part of the current proglacial margin is not included in the inventory.	0.5
Ecological value	High ecological value.	0.75

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site can be seen by acceding to the Ferpècle area. View points from distance are present at Bréonna and at Bricola.	0.75
<i>Contrasts, vertical development, space structuration</i>	The white colour of the glacier contrasts with the rocky surrounding environment. The large alluvial zone of the proglacial margin contrasts with the very steep mountain slopes around. The very high LIA moraine, dissected by gullies and earth pyramids, add another element of interest to the landscape.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	This area is depicted in many paintings of the region since the XIX century and in photographs taken from 1899 to 1950. These works are also important for the reconstruction of the past surface of the glaciers. In 2022 the Glacier du Mont Miné has been the setting of performance art (Ablations: Mont Miné by Sarah Casey).	0.75
<i>Geohistorical importance</i>	From the end of the XIX century, this area has been an open-air laboratory for glaciology and geomorphology studies.	0.75
<i>Economic importance</i>	The Ferpècle area has a certain economic importance due to the fact that it contributes to the Grande Dixence hydropower system.	0.5
Cultural value	High cultural value.	0.75

Protection

Protection status The proglacial area is partly included in the inventory of alluvial zones of national importance (OZA – Object n° 131).

Degradation risk

<i>Fragility</i>	The site is not fragile, due to its dimension. Many of the elements of the geomorphological system are fragile – mostly inherited landforms such as the LIA moraines, and the glacier itself which is shrinking due to climate change.
<i>Natural vulnerability</i>	The LIA moraines are the most vulnerable to natural processes, such as runoff erosion, frost creep and gravitational processes, which are slowly dismantling them.
<i>Anthropogenic vulnerability</i>	The recently deglaciated areas are vulnerable because of their economic value, for example for hydropower production. In fact, the alluvial plain in the proglacial area has already been affected by works by the Grande Dixence SA, which have altered the flow of the Borgne and its sediment discharge.
<i>Sensitivity to climate change</i>	The main cause of the rapid evolution of the system is climate change, which is causing the glacier to retreat further up the slope. This has caused and will continue to cause a transition from active glacial landforms to inherited glacial landforms – and a shift in the heritage values of the site, which will depend less and less on the glacier itself and its dynamics, and more and more on postglacial processes (as argued by Bussard & Reynard (2023) for other glacial sites in the Swiss Alps). The evolution of the geomorphological system and its temporality have themselves a very high scientific value.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour in summer to Ferpèche, then a 1h walk up to the proglacial area.	0.75
<i>Security</i>	No risks.	1
<i>Site context</i>	No perturbation.	1
<i>Tourism infrastructures</i>	There are marked hiking trails and a restaurant near Ferpèche.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The site is well readable and understandable. Its valorisation could be done at low cost.	0.75
Education	Average educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is very high, mainly because of its scientific, ecological and cultural value.

Use and management The proglacial area is partly included in the inventory of alluvial zones of national importance (OZA – Object n° 131). Most of this area is managed and exploited for hydropower production – with the collecting of water for the Lac des Dix reservoir. Its visit conditions are good, and the educational value is high.

Management measures The current extent of the proglacial area should be included in the protected zone.

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HERgla006

Lac Bleu moraines

Localisation: Lac Bleu (Evolène)	Coordinates: 603.242 / 099.872	Altitude: 2060 m – 2120 m
Type: AER	Size: 44,000 m ²	Property: PRI

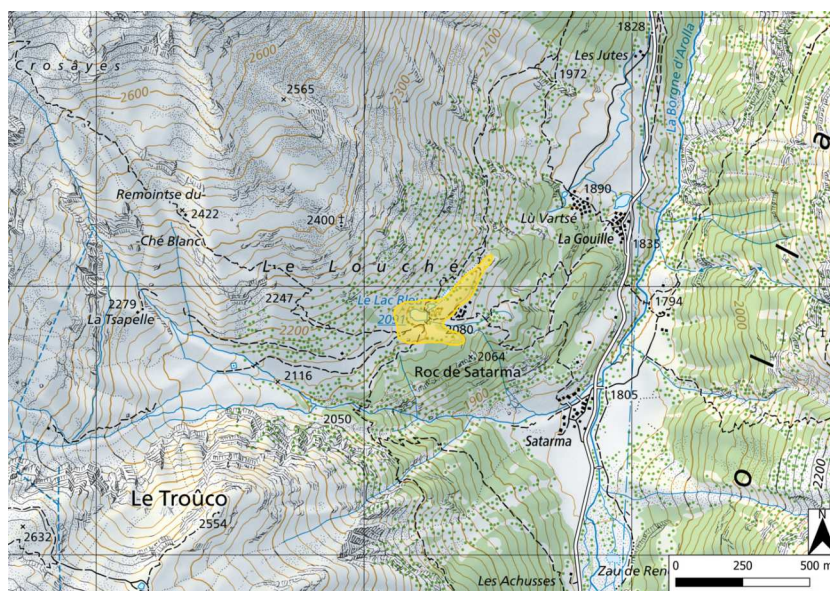


Figure A.13: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Lac Bleu with the moraine ridge on the valley side (ph. Andrea Ferrando)



Another view of the Lac Bleu. The degradation of the slopes due to trampling from hikers is visible (ph. Andrea Ferrando)

Description The Lac Bleu is a small natural lake located at 2091 m on the western side of the Val d'Arolla, near the small hamlet of la Gouille. The lake has an area of about 2600 m² and reaches the maximum depth of 4 m.

On the valley side, the lake is dammed by a morainic ridge, about 10 m high and 150 m long, with a SW-NE orientation. The lake has two outlets: one flows in a SE direction, while the other flows towards NE, following the trench between the morainic ridge and the slope. In that small valley another very small lake is found. Another moraine is present south of the lake.

Morphogenesis The moraines of Lac Bleu were formed in the Younger Dryas. They are the lateral moraines that marked the level reached by the glacier flowing from the Aiguilles Rouges d'Arolla. At the level of the Lac Bleu, the glacier of the Aiguilles Rouges joined the main Arolla glacier. In the millenia following the retreat of these glaciers, these moraines have been modeled by runoff, snow erosion and gravity, gaining a rounder and smoother shape.

The presence of a morainic ridge, together with an abundant spring, caused the formation of the Lac Bleu. The numerous trenches, subparallel

to the slope, at different elevations, could be indicators of very slow, deep-seated gravitational deformations.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The landforms are pretty much intact, but the soil cover all around the Lac Bleu is severely degraded by erosion and trampling.	0.5
<i>Representativeness</i>	The site is representative of the glacial landforms of the region.	0.75
<i>Rareness</i>	Relict moraines aren't rare in the Val d'Hérens.	0.5
<i>Paleogeographical value</i>	The site is important for the reconstruction of the glacial history of the valley.	1
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The lake hosts particular flora and fauna.	0.75
<i>Protected site</i>	The site is not protected.	0
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The moraines are easily visible from the lake and its surroundings.	1
<i>Contrasts, vertical development, space structuration</i>	The moraines are not imposing, but the scenery of the moraine ridges, the blue crystalline lake, the prairies and the larch woods make for a magnificent view.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The lake has a role in the development of tourism in the valley, being singled out as a hiking destination since the end of the XIX century.	0.5
<i>Artistic and literary importance</i>	The lake is pictured in several old black-and-white photos.	0.25
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The lake is fragile, as most small lakes are. The moraines are also fragile, being made of poorly consolidated material.
<i>Natural vulnerability</i>	No short term active processes are active at the site.
<i>Anthropogenic vulnerability</i>	The site is very vulnerable due to its high tourist frequentation. The trampling has already taken its toll on the slopes surrounding the lake and on the moraines, which are characterised by eroded and degraded soils.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to la Gouille, then about 40' of walking on a marked hiking trail (T2).	0.75
<i>Security</i>	No risks.	1
<i>Site context</i>	The context of the site is good, but the high frequentation can be considered a perturbation.	0.75
<i>Tourism infrastructures</i>	There are marked hiking trails. About 5' of walking before the lake there is a buvette.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	The site is cited in several hiking guides.	0.5
<i>Education interest</i>	The moraines are not that easily recognised by non-experts, so a mediation is required. The enhancement of the site could be done at low cost.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value The intrinsic value of the site is high, due to scientific interest, ecological importance and the very beautiful scenery.

Use and management The site is not protected, and it suffers from a very high (relatively speaking) touristic pressure.

Management measures Measures could be taken to reduce the degradation of the soil cover around the lake – for example by the interdiction to walk outside of the marked hiking trail and the picnic areas. For what concerns geotourism enhancement, a panel on the geomorphology of the site could be posed at the lake.

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HERgla008

Ferpècle glacial potholes

Localisation: Vallon de Ferpècle, south-west of Bricola (Evolène)	Coordinates: 609.470 / 099.135	Altitude: 2000 m – 2250 m
Type: AER	Size: 0.21 km ²	Property: PUB (Commune d'Evolène)

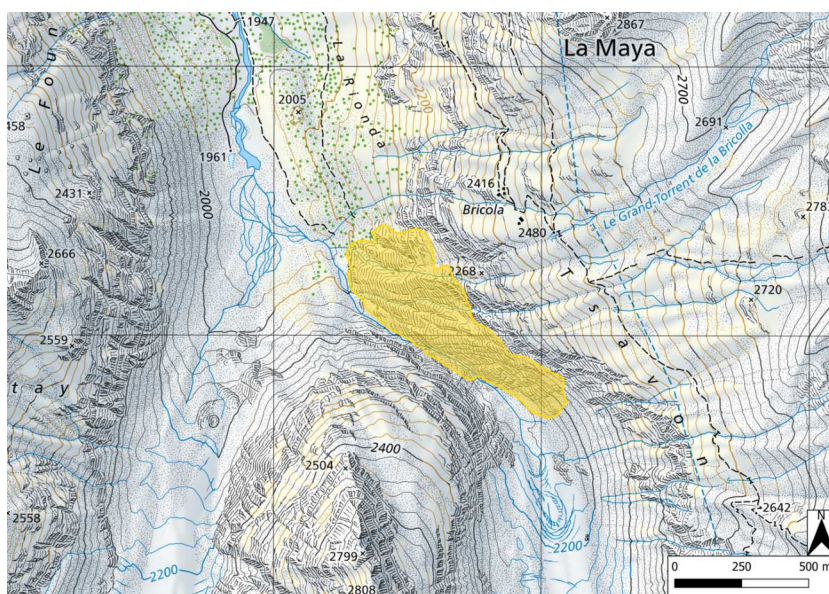



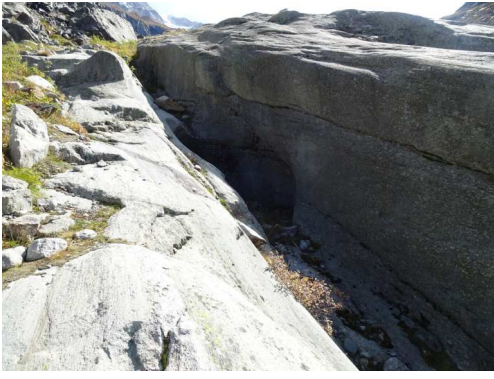


Figure A.14: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>View of the rocks modeled by glacial erosion (ph. Andrea Ferrando)</i></p>	<p><i>An inactive Nye channel (ph. Andrea Ferrando)</i></p>
	
<p><i>Glacial potholes still modeled by fluvial erosion (ph. Andrea Ferrando)</i></p>	<p><i>An inactive glacial pothole in a Nye channel (ph. Andrea Ferrando)</i></p>

Description The site is located in the upper part of the Ferpècle valley, just downstream of the tongue of the Ferpècle glacier. It consists of a large outcrop of rocks modeled by glacial and fluvio-glacial erosion, which occupies the right hand side of the outlet of the glacier, from the bottom of the valley at about 2000 m to an elevation of about 2250 m. For its large dimension and the variety of landforms that can be observed (roches moutonnées, Nye channels, fluvio-glacial potholes), it is one of the best example of this morphology in the entire Valais.

The site has the form of a large and rounded rocky shoulder, with its surface smoothed by glacial erosion. The surface of the shoulder is cut by several channels (Nye channels), which are up to 10 m deep; they are

very narrow and are characterised by vertical walls. Some of these channels contain fluvioglacial potholes, that is, rounded ponds entirely carved in the bedrock, sometimes filled with pebbles. While some channels are still modeled by small streams coming from the upstanding slopes, other are completely dry.

The bedrock is composed of very hard granodiorites (Pointe d'Otemma granodiorites, Permian).

Morphogenesis This geosite is one of the best examples of glacial erosion in the region, and was formed when the Ferpècle glacier still covered all the valley. Subglacial abrasion and plucking is responsible for the smoothed rock surfaces. Glacial striae and furrows can be recognised on the rock surfaces; they are originated by the abrasion of the sediment carried by the glacier, at the ice-bedrock interface.

Nye channels and potholes are formed by subglacial fluvial erosion. When the glacier still covered the region, its meltwaters flowed at the ice-bedrock interface, forming several streams. These streams flowed at high pressure, and could reach speed up to 200 km/h. Thus, they had high eroding capacity and could model the bedrock forming deep channels and ponds. As of now, with the glacier not present anymore in the site, the roches moutonnées are relict and subject to weathering. Some of the Nye channels and potholes are still modeled by fluvial erosion, because of small streams flowing through them; others have been filled by sediment. Some of them are dry instead.

At the foot of the outcrop, there is erosion by the proglacial stream of the Ferpècle glacier. Small gravitational phenomena can be recognised in a few portions of the site.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is quite representative of glacial potholes and roches moutonnées.	0.75
<i>Rareness</i>	Even if glacial landforms are widespread in the region, outcrops of roches moutonnées this large, with developed potholes, are not common.	0.75
<i>Paleogeographical value</i>	The site can be useful to reconstruct the circulation of waters under the ancient Ferpècle glacier.	0.25
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is not protected.	0
Ecological value	No ecological value.	0

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	Even if the outcrop is large, there are few good view points. Panoramic views can be had from the hiking trail to Bricola. To see the potholes one has to enter the outcrop, and its accessibility is not easy.	0.25
<i>Contrasts, vertical development, space structuration</i>	The large outcrop of smoothed rocks has a little bit of contrast with the surrounding landscape, and has a bit of vertical development. Potholes and Nye channels are impressive if seen up close.	0.75
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic and literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile, because of its large dimensions and of the hard bedrock.
<i>Natural vulnerability</i>	Gravitational phenomena (e.g. rock falls, debris flows) from the upper slopes can affect the upper parts of the geosite, but it would take a very large, catastrophic event, to have any real impact on its integrity.
<i>Anthropogenic vulnerability</i>	The site is quite remote, far away from human settlements and activities, so its anthropogenic vulnerability is null.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour in summer to Ferpècle, then a 1h – 1h50' depending on where one wants to go. To see the panoramic views one has to hike to Bricola – there is a marked hiking trail (T2). If one wants to enter the roches moutonnées and see the potholes, the hike is shorter but more difficult, as there is no marked trail and there are sections of easy scrambling (T4).	0.25
<i>Security</i>	The trail to Bricola is not dangerous. The visit to the potholes can pose orientation problems and can be very dangerous in case of rain.	0.5
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	No tourism infrastructures are present.	0
Visit conditions	Bad visit conditions	0.25

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	The potholes are cited in a guide by Pierre Kunz (1997).	0.5
<i>Education interest</i>	The landforms are readable with mediation, but their enhancement is difficult due to the visit conditions.	0.25
Education	Low educational value	0.25

Synthesis

Intrinsic value Despite a high scientific value, the site has no ecological or cultural importance and it's not easily accessible, so the intrinsic value is ultimately low.

Use and management The site is not protected nor managed.

Management measures No particular management measures are required. The site is too difficult to access to be easily enhanced for geotourism.

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HERgla009

Tsijiore Nouve glacial system

Localisation: Tsijiore Nouve, south-west of Arolla (Evolène)	Coordinates: 602.259 / 096.282	Altitude: 2133 m – 3791 m
Type: AER	Size: 3.83 km ²	Property: -

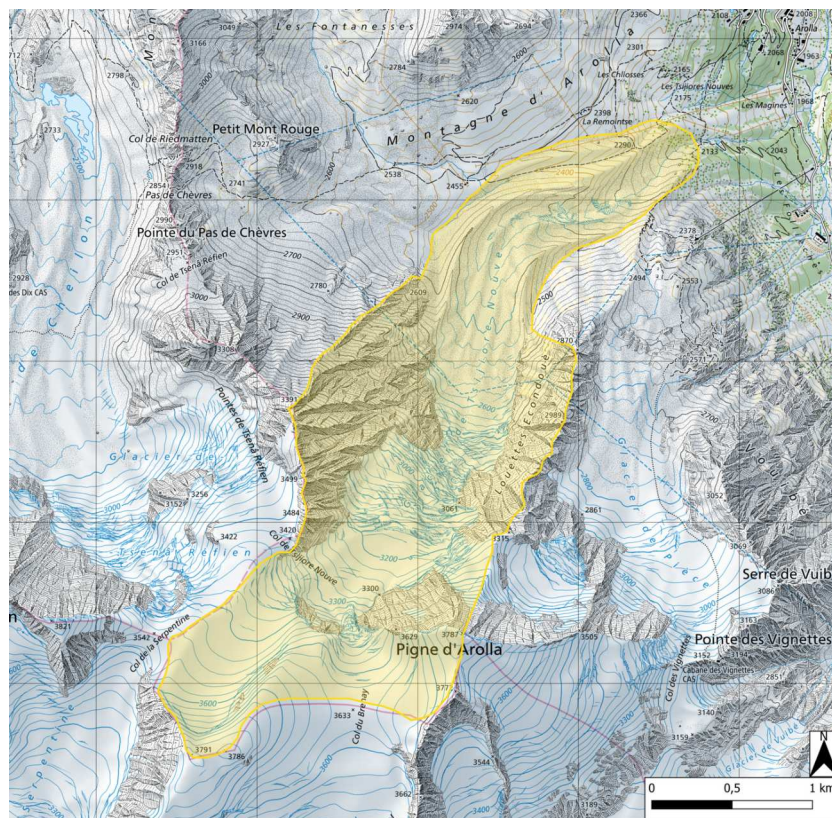


Figure A.15: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Tsijiore Nouve glacial complex seen from Tsarmine (ph. Mario Kummert)



The Pigne d'Arolla and the Tsijiore Nouve glacier (ph. Andrea Ferrando)



View of the Little Ice Age moraine, with a second internal ridge formed by gravitational collapse (ph. Andrea Ferrando)



Frost creep and gelifluction evidence on the outer side of the Little Ice Age moraine (ph. Andrea Ferrando)

Description The Tsijiore Nouve glacier is one of the most impressive of the Val d'Hérens. The accumulation zone is located between the Pigne d'Arolla (3787 m) and the Serpentine (3791 m). The glacier tongue then flows to the north: two separate tongues with seracs surpass a steep rock wall, then merge in a gentler area at about 3300 m in elevation. From 3200

m down to 2600 m the glacier tongue is again very steep, with numerous seracs and crevasses. From 2600 m downwards, the tongue has a gentler morphology, and it's largely covered by debris. The debris-covered glacier is present down to an elevation of about 2300 m.

At its lower end, The Tsijiore Nouve glacier built up an enormous moraine accumulation. Two main morainic ridges are recognisable, the oldest one dating to the Lateglacial, the other one dating to the Little Ice Age. The outer side of the left lateral moraines of the Tsijiore Nouve is affected by some infrastructure of the Arolla ski station. There are artificial water catchments that are part of the Grande Dixence hydroelectric complex.

Morphogenesis Due to the large amount of solid matter transported, this valley glacier built up an enormous moraine complex, particularly during the Little Ice Age. It is therefore one of the rare examples of a valley glacier with a raised moraine bed in Switzerland. The glacier tongue has many landforms associated with a debris-covered glacier.

The left lateral moraines are particularly interesting because of their double moraine structure, that represents two stages of glacial advance. The age of the inner moraine has been measured with radiocarbon dating, which showed that the deposit formed during the last 3000 years, and only a little part of it has been deposited during the Little Ice Age. The outer, more rounded moraine probably dates from the Egesen stadial of the Lateglacial.

One significant difference between them is their size. The most recent is twice the size of the other, probably because of accretion of material since the Lateglacial period. Between 2420 m and 2440 m, the historic moraine has three ridges, the innermost of which is the most recent. Two stages of the front part of the glacier are clearly visible at 2160 m for the oldest, and at 2220 m for a more recent stage. Their roots do not begin at the same altitude: the oldest is at 2440 metres, while the second is at 2540 metres. The historic moraine is covered by vegetation on the outer side. The inner side of the LIA moraine shows evident signs of gravitational collapse: there is an inner, lower ridge, that is separated by the main ridge

by a long trench. The developing of the gravitational process is evident by comparing historical aerial photos.

The outer side of the LIA moraine is affected by periglacial processes, mainly frost creep and gelifluction, which have produced several well developed terraces and lobes.

Several traces of earthworks are visible on their inner and outer flanks respectively. At 2280 metres, on the front of these two moraines (Lateglacial and historic), there are two landslide scarps caused by the construction of a road and the ski slope. In the upstream part, between these two moraines, two water catchments belonging to the EOS Grande Dixence company hold back water from the neighbouring streams. This stops them flowing and there is no water downstream. To force them into the catchments, the streams have been forced into concrete channels.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	Some changes to the terrain due to the development of the Arolla ski area in the front part of the moraine complex.	0.75
<i>Representativeness</i>	A fine example of a glacier with a large moraine accumulation from the Little Ice Age.	1
<i>Rareness</i>	It is one of the rare examples of a valley glacier with a raised moraine bed in Switzerland.	1
<i>Paleogeographical value</i>	The moraine complex allows to reconstruct the several phases of advance and retreat of the glacier in the Holocene. The moraines have been precisely dated.	1
Scientific value	Very high scientific value.	1

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Very sparse vegetation and typical fauna of the high alpine environment.	0.25
<i>Protected site</i>	The site is protected in the Inventory of Swiss Geotopes (Object n° 286).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible and recognisable even from afar. There are several points of view along the Montagne d'Arolla and in the Arolla valley.	0.75
<i>Contrasts, vertical development, space structuration</i>	The enormous morainic complex is very imposing. Other than that, the steep rock wall on which the glacier flows has a great vertical development.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	The geosite has been represented in several paintings.	0.25
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is protected in the Inventory of Swiss Geotopes (Object n° 286).

Degradation risk

<i>Fragility</i>	The site is fragile in all its elements: the glacier, and the morainic complex.
<i>Natural vulnerability</i>	The moraines are very vulnerable to natural processes, such as runoff erosion, frost creep and gravitational processes, which are evident on the inner side of the LIA moraine.
<i>Anthropogenic vulnerability</i>	The moraines, in particular the oldest ones, are vulnerable to modifications and works of the nearby ski area.
<i>Sensitivity to climate change</i>	The glacier is bound to retreat further up due to climate change. Probably, in the next future, the debris-covered part of the glacier will become detached from the main tongue.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to Arolla, then 1h30' on foot (T2) along the path that leads to the Col de Riedmatten.	0.5
<i>Security</i>	Risk of falling if one climbs up to the LIA moraine ridge. Otherwise, no risk.	0.75
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	There are marked hiking trails, while skilifts are active only during the winter season.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The site is very well readable and understandable. Its valorisation could be done at low cost.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is very high, mainly because of its scientific and aesthetic value. It is the only example of a glacier with a raised morainic bed in the region. The site has no ecological importance.

Use and management The site is protected in the Inventory of Swiss Geotopes (Object n° 286). Its visit conditions are good, and the educational value is high.

Management measures Further development of skilifts and tracks on the morainic deposits should be stopped, to prevent the erosion and degradation of the moraines themselves.

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HERgla010

Arolla glacial system

Localisation: Bas Glacier d'Arolla, Haut Glacier d'Arolla (Evolène)	Coordinates: 603.750 / 095.500	Altitude: 2370 m – 3870 m
Type: AER	Size: 12.91 km ²	Property: PRI (EOS Grande-Dixence) / PUB (Commune d'Evolène)

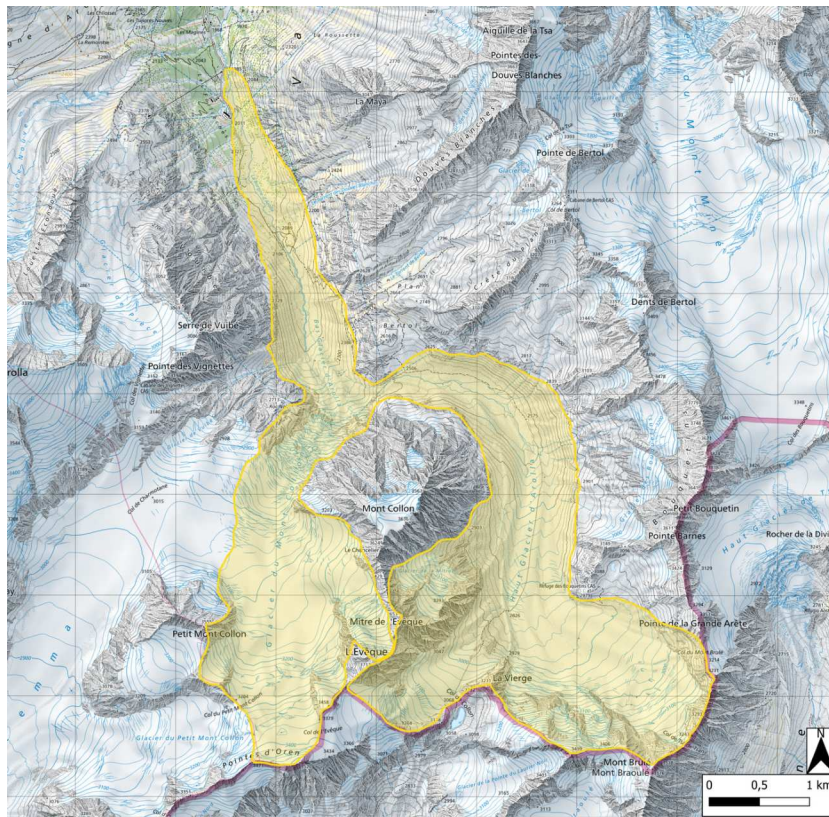


Figure A.16: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The proglacial margin of the Bas Glacier d'Arolla seen from the north-west (ph. Lucien Grangier)



The proglacial margin and the Bas Glacier d'Arolla on the right-hand side; on the left the valley of the Haut Glacier d'Arolla (ph. Andrea Ferrando)

Description The glacial system formed by the Bas and Haut Glaciers d'Arolla is one of the largest and most important of the Val d'Hérens. The two glaciers are located in the uppermost stretch of the Val d'Arolla, and they extend on the western and eastern foot of Mont Collon (3636 m) respectively. Until the 1930s-1940s the two glaciers converged in the main tongue of the Bas Glacier d'Arolla, while now, due to glacier retreat, they are separated. Nonetheless, they can be considered part of the same large geomorphological system.

The Haut Glacier d'Arolla is located on the eastern side of Mont Collon, and is one of the most studied glaciers of the Pennine Alps (see References – though they are only a few of the dozens of existing papers on this glacier). It is fed by two firn basins, one coming from the south-west, from the area between the Col de Collon (3068 m) and the Evêque (3716 m), and the other one located on the south-east, at the foot of Mont Brulé (3576 m). The main tongue originates at about 3000 m in elevation and reaches its proglacial margin at a little less than 2600 m. In all, the glacier is about 4 km long and 800 m wide at its max, but it is retreating at a rate of 25 m/y. The outlet stream runs across a large alluvial zone, and then is caught by one of the catchments of the Grande Dixence hydroelectric power plant.

Downstream of the water catchment there is a rock sill, and then a 100 m-high step, which connects the valley of the Haut Glacier d'Arolla to the one of the Bas Glacier.

The Bas Glacier d'Arolla originates from a large glacial cirque located between the Evêque and the Petit Mont Collon (3556 m). The upper stretch of the glacier, about 3 km long, is called Glacier du Mont Collon. This glacier then forms a huge icefall, extending from 3000 m to about 2500 m. At the foot of the icefall, the glacier tongue flowing downwards in the valley is the Bas Glacier d'Arolla proper. Other than the icefall, the Bas Glacier d'Arolla is also fed by snow and ice avalanches coming down from the slopes of the Mont Collon.

The glacier tongue is about 1 km long and 600 m wide. Between 1972 and 1990 the Bas Glacier advanced, but since then it has constantly retreating, and it could become soon disconnected from the icefall of the Glacier du Mont Collon, thus becoming only a large mass of dead ice.

The Bas Glacier d'Arolla left a vast fluvioglacial plain, which is now being exploited by EOS (Energie Ouest Suisse) Grande Dixence hydroelectric plant. We find infrastructures such as dykes and water intakes that reduce the flow of the watercourse and cause the bed to level slightly. The alluvial zone of the Borgne upstream of Arolla occupies the valley floor that was once covered by the Bas Glacier d'Arolla. The latter is retreating like most of the glaciers in the Alps. This alluvial zone is characterised by the strong presence of morainal sediments and a very low water flow. This is linked to hydroelectric power generation. The Borgne is fed by various tributaries from the adjacent slopes.

Most of these streams have temporary flows: they are active during snowmelt and heavy rainfall. The others are of minor importance because their water is drawn off by the EOS Grande Dixence works, which are present in several places. All the watercourses are thus captured at their outlets, resulting in very low residual flows in the main river. As a result, the fauna and flora specific to this type of environment, even if very small, are adversely affected, and the main sediment deposition area is around the glacier outlet. Very rarely does the water completely flood the extremities of this al-

luvial zone. This is why we find vegetation in these areas in the form of herbaceous and shrubby pioneer groups and alpine meadows (Bressoud, 1993). Despite all these different types of damage, this environment is under protection, and is one of the subjects of the inventory of alluvial zones of national importance.

Morphogenesis The Arolla glacier has been retreating since 1856, losing more than 1.6 kilometres in length. In the last fifteen years, it has lost around 300 metres. This is why the alluvial zone considered in this inventory is still very young and unstable. Erosive processes cause the bed to level out and the banks to be reshaped. As a result, there is still very little vegetation. Everything will evolve towards stabilisation, but for the time being, this area is still under the influence of the glacier and the sediments it releases. So the environment of this geotope is constantly changing.

Evidence of runoff erosion is visible on the LIA moraines of the two Arolla glaciers – earth pyramids, gullies and pseudo-badlands. These moraines are dissected by deep debris-flows channels. The main one is the Torrent de Bertol, which cuts across the LIA moraine of the Bas Glacier d’Arolla, then forming a debris flow fan on the proglacial margin.

The presence of artificial water catchments on the proglacial areas of both glaciers alters significantly the water flow and the sediment supply to the proglacial plains themselves. This has caused an acceleration of erosion, both in the proglacial plains and the lateral relict moraines.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is in perpetual change due to the retreat of the glacier. The proglacial margin is affected by construction works of the EOS Grande Dixence company.	0.75
<i>Representativeness</i>	It's very representative of the active glacial zones in the high alpine environment.	1
<i>Rareness</i>	Glaciers are not rare in the region.	0.25
<i>Paleogeographical value</i>	As with the other valley glaciers of the region, the various associated landforms can help to study its advances and retreats in past times.	1
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Very sparse vegetation in the proglacial area.	0.25
<i>Protected site</i>	The proglacial margin is included in the inventory of alluvial zones of national importance (OZA – Object n° 129).	0.75
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	There are several good view points in the upper Val d'Arolla. The proglacial margin can be seen from the surrounding slopes, and can be visited. The two glaciers are a bit more hidden in the upper reaches of the valley.	0.75
<i>Contrasts, vertical development, space structuration</i>	The white colour of the glacier contrasts with the rocky surrounding environment. The large alluvial zone of the proglacial margin contrasts with the very steep mountain slopes around.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	This area is depicted in several paintings of the region since the XIX century. These works are also important for the reconstruction of the past surface of the glaciers.	0.5
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Average cultural value.	0.5

Protection

Protection status The proglacial area is included in the inventory of alluvial zones of national importance (OZA – Object n° 129).

Degradation risk

<i>Fragility</i>	The site is fragile in many of its elements: the glacier, the alluvial zones and the moraines.
<i>Natural vulnerability</i>	The moraines are very vulnerable to natural processes, such as runoff erosion, frost creep and gravitational processes.
<i>Anthropogenic vulnerability</i>	The alluvial plain in the proglacial area has been affected by works by the Grande Dixence SA, which have altered the flow of the Borgne and its sediment discharge. The presence of these works also affects the lateral moraines of the glacier.
<i>Sensitivity to climate change</i>	The glaciers are bound to retreat further up due to climate change. In particular, the Haut Glacier d'Arolla is already disconnected from the Bas Glacier d'Arolla. Furthermore, the Bas Glacier d'Arolla is almost disconnected from its source zone (the Glacier du Mont Collon), and it's basically a large volume of dead ice. In general, there will be a continuous migration of the proglacial area further up the valley, along with the retreat of the glaciers.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to Arolla, then 30' on foot to the proglacial margin of the Bas Glacier d'Arolla. With a 1h hike one can reach the Notre Dame des Hauts d'Arolla.	0.75
<i>Security</i>	No risk.	1
<i>Site context</i>	Sonic perturbations due to the hydroelectric power plant.	0.75
<i>Tourism infrastructures</i>	There are marked hiking trails.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The site is very well readable and understandable. Its valorisation could be done at low cost.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is very high, mainly because of its scientific and aesthetic value.

Use and management The proglacial margin of the Bas Glacier is included in the inventory of alluvial zones of national importance (OZA – Object n° 129). Its visit conditions are good, while the educational value is high.

Management measures A solution needs to be found with EOS Grande Dixence to avoid destroying the left side moraine and the path that crosses it. The destruction of the moraine will also contribute to the raising of the bed of the Borgne.

References

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HERgla011

Mont Collon ice cap

Localisation: Mont Collon (Evolène)	Coordinates: 605.125 / 091.750	Altitude: 3400 - 3636 m
Type: AER	Size: 0.17 km ²	Property: PUB (Commune d'Evolène)

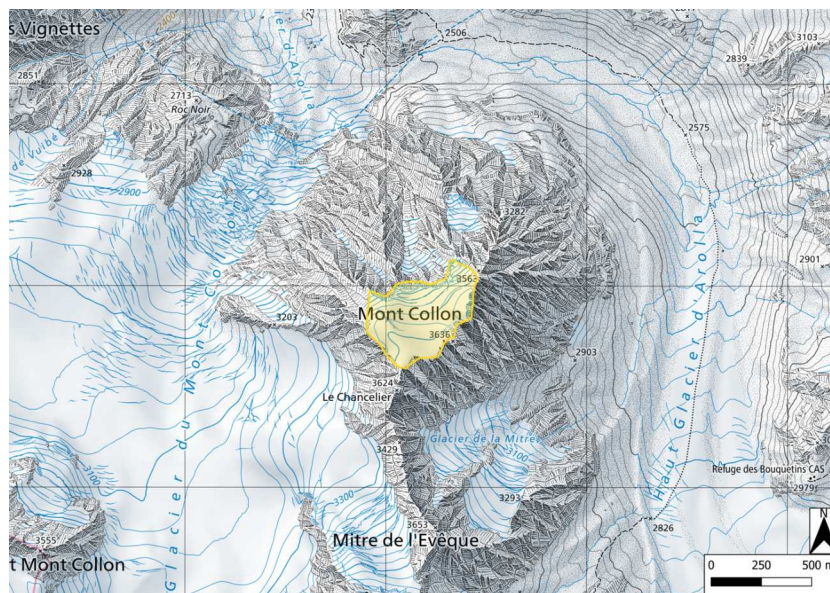


Figure A.17: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



*The Mont Collon as seen from Arolla
(ph. Andrea Ferrando)*



*The Mont Collon, and the Glacier du
Mont Collon on the right (ph. Andrea
Ferrando)*

Description The Mont Collon (3636 m) is a mountain located in the upper part of the Val d'Arolla. It rises between two glacial valleys: the valley on the eastern side hosts the Haut Glacier d'Arolla; the valley on the western side hosts the Glacier du Mont Collon, which has some diverging tongues, the main one of these being the Bas Glacier d'Arolla.

The mountain has a trapezoidal shape, with a flattish top hosting a little ice cap (not named in the Swisstopo map). This is one of the few ice caps of the region.

Morphogenesis The ice cap formation has been favoured by the flattish and large top of the mountain. It is delimited by high seracs, which are evident when looking at Mont Collon from Arolla.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	Good representation of a small ice cap.	0.75
<i>Rareness</i>	While glaciers are common in the area, ice caps are rare.	0.75
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is not protected.	0
Ecological value	No ecological value.	0

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible from Arolla and its surroundings.	0.5
<i>Contrasts, vertical development, space structuration</i>	The flat, white ice cap contrasts heavily with the steep and imposing rock shape of Mont Collon.	1
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	The site is depicted in paintings from the XIX century.	0.5
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Average cultural value.	0.5

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is fragile as all glaciers are, and even more due to it being quite small.
<i>Natural vulnerability</i>	No particular natural process is affecting the site.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is null.
<i>Sensitivity to climate change</i>	The glacier is susceptible to climate change. It will shrink, but, thanks to the high altitude, it is not bound to disappear very soon.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour all year long to Arolla. The mountain is already visible from the hamlet; to see it from nearer one can hike up to the hydroelectric power plant (20'). The access to the ice cap is only for alpinists (difficulty AD).	0.75
<i>Security</i>	No risk.	1
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Tourism infrastructures are present at Arolla.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The site is very well readable and understandable.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The scientific value is high, due it being one of the few examples of a ice cap in the region.

Use and management The site is not protected. Visit conditions are excellent, and the site could be easily enhanced. Being a glacier, it is very susceptible to climate change.

Management measures No particular measure is needed.

References

- Lambiel, C. (2020). Glacial and periglacial landscapes in the Hérens valley. In *Landscapes and Landforms of Switzerland* (pp. 263-275). Cham: Springer International Publishing.
- Lambiel, C., Maillard, B., Kummert, M., & Reynard, E. (2016). Geomorphology of the Hérens valley (Swiss Alps). *Journal of Maps*, 12(1), 160-172.
- Reynard, E., Perret, A., Bussard, J., Grangier, L., & Martin, S. (2016). Integrated approach for the inventory and management of geomorphological heritage at the regional scale. *Geoheritage*, 8, 43-60.

HERgla012

Vernamiège morainic ridge

Localisation: Lac de Vernamiège (Mont-Noble)	Coordinates: 600.742 / 117.945	Altitude: 1715 - 1750 m
Type: AER	Size: 45,000 m ²	Property: PUB (Commune de Mont-Noble)

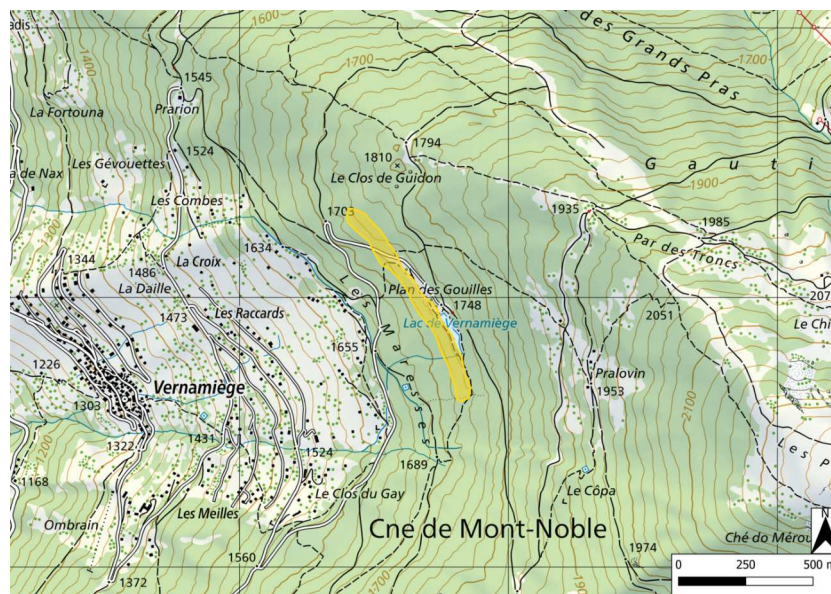


Figure A.18: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The hollow between the moraine ridge (on the left) and the slope (ph. Andrea Ferrando)



The Lac de Vernamiège, built by damming the small hollow between the moraine ridge (on the right) and the slope (ph. Andrea Ferrando)

Description The site is located on the slope above the village of Vernamiège, on the eastern side of the Val d'Hérens, at an elevation between 1715 m and 1750 m. It comprises a morainic ridge that is about 700 m long, even if it's not well visible or well conserved along its entire length – the part where the moraine is well recognisable is about 400 m long. The morainic ridge has a NW-SE direction, and it is sub-parallel to the slope. In between the ridge and the slope there is a small, almost flat hollow. Part of this hollow has been filled with a small artificial lake, known as Lac de Vernamiège or Lac des Gouilles. The area is immersed in dense fir and larch forest, and it's frequented by tourists and hikers.

Morphogenesis The morainic ridge of Vernamiège is one of the most ancient of the Val d'Hérens. They represent an early Lateglacial stadial of the Hérens glacier (Lambiel, 2021). The corresponding moraines on the other side of the Val d'Hérens are found near les Collons, at a similar elevation to those of Vernamiège. In the following millenia, the moraine has been affected by paraglacial phenomena, runoff erosion, which has given it a more rounded shape, and has been partially displaced by gravitational phenomena.

In recent times, the site has been strongly shaped by human action.

The Lac de Vernamiège has been realised by constructing two small earth dams, which clog the small hollow between the morainic ridge and the main slope.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The moraine is relict and thus not that well conserved. Furthermore, the site has been impacted by the construction of the Lac de Vernamiège.	0.5
<i>Representativeness</i>	It's a quite representative example of a relict moraine.	0.75
<i>Rareness</i>	While moraines aren't rare at all in the Val d'Hérens, only two locations are known for LGM moraines.	0.75
<i>Paleogeographical value</i>	The site allows to reconstruct the level reached by the Hérens glacier during the Last Glacial Maximum.	1
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The site is located in a larch and fir forest typical of these mountains. The lake hosts typical species of wetlands.	0.5
<i>Protected site</i>	The site is not protected.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is well visible by the area of the Lac de Vernamiège and its surroundings.	0.5
<i>Contrasts, vertical development, space structuration</i>	The site is not very well developed, but the moraine ridge and the hollow between it and the main slope add some contrast to it. There is also a small lake providing more contrast.	0.5
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is fragile, its main point of interest being a relict landform.
<i>Natural vulnerability</i>	No short time scale natural processes are present at the site.
<i>Anthropogenic vulnerability</i>	The site has been affected by the construction of a small artificial lake. Being very frequented, there is risk of erosion due to trampling on the moraine.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour all year long to Vernamiège, then 1h30' hike on a marked trail to Lac de Vernamiège. The small lake is reachable by car.	1
<i>Security</i>	No risk.	1
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Asphalt road and marked hiking trails.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There is a nature trails passing by the Lac de Vernamiège, and there is even a book about the trail (Pillet, 1998).	0.75
<i>Education interest</i>	The landform is understandable with mediation. Enhancement is possible at low cost.	0.5
Education	High educational value	0.75

Synthesis

Intrinsic value The scientific value is high, while ecological, cultural and aesthetic values are average at best.

Use and management The site is not protected. It has high education value and the visit conditions are excellent. There is a nature trail passing by the site, but panels don't concentrate on the moraine (but rather on the flora).

Management measures Given the high frequentation of the site, measures could be taken to reduce the trampling on the moraine crest. A panel could be posed to explain its morphogenesis to visitors.

References

- Lambiel, C. (2020). Glacial and periglacial landscapes in the Hérens valley. In *Landscapes and Landforms of Switzerland* (pp. 263-275). Cham: Springer International Publishing.
- Lambiel, C., Maillard, B., Kummert, M., & Reynard, E. (2016). Geomorphology of the Hérens valley (Swiss Alps). *Journal of Maps*, 12(1), 160-172.
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- Winistörfer, J. (1978). *Paléogéographie des stades glaciaires des vallées de la rive gauche du Rhône entre Viège et Aproz*. Sion : Fiorina & Burgener

HERgla013

Tour de Tavelli kame terrace

Localisation: Tour de Tavelli (Vex)	Coordinates: 597.722 / 116.939	Altitude: 680 m - 845 m
Type: AER	Size: 51,500 m ²	Property: PUB (Commune de Vex)

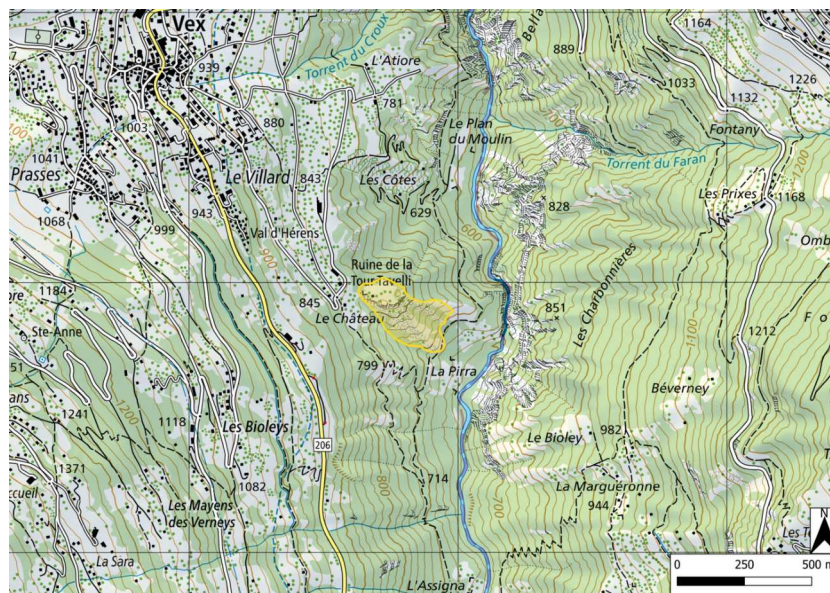


Figure A.19: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The kame terrace and the outcrops of glaciolacustrine deposits view from the south (ph. Andrea Ferrando)



The flat surface of the kame terrace (ph. Andrea Ferrando)

Description This geosite is located on the western side of the lower Val d'Hérens, about 1 km south-east of the village of Vex. The site consists of the small remnant of a larger kame terrace, which has been shaped by selective erosion as a small hill with a flat top. In this location there is one of the major outcrops of glaciolacustrine and fluvioglacial sediments in the lower Val d'Hérens.

On the flat top of the hill there are the remains of the Tour de Tavelli, a Medieval tower dating to the XII century.

Morphogenesis The Tour de Tavelli kame terraces is one of the most peculiar of the Val d'Hérens. It formed when the lower Val d'Hérens was still occupied by the eponymous glacier, which, during the Last Glacial Maximum, flowed north to merge with the main Rhone glacier.

In a subsequent phase, the Hérens glacier tongue terminated at Erbio, where some remnants of an ancient frontal moraine are found. During this phase, the lateral moraines of the Hérens glacier were located on both sides of the valley at 850 m – 950 m in elevation. Small lakes formed between the lateral moraines and the main valley slopes, and then they were filled by sediments.

The deposits which can be observed at the Tour de Tavelli are gravelly-

silty, and they originated in a small lacustrine delta. They are organised in foresets, inclined towards the Borgne river. On the right side of the lower Val d'Hérens, other kame terraces are found at Sevanne, Gréferic, Ossona and Tsampé (Sartori & Epard, 2011).

Subsequently, erosion due to runoff and fluvial processes has made abrupt the edges of the scarps of the kame terraces. Selective erosion reduced the surface of the Tour de Tavelli kame terrace, then isolating it as a small hill with a flat top. The valley floor then deepened due to fluvial erosion, with the formation of the gorge of the Borgne.

On the slopes that go down from the flat top to the valley floor, pseudo-badlands have developed due to runoff erosion. These landforms are also included in the perimeter of the geosite.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is a very good representation of a kame terrace.	0.75
<i>Rareness</i>	Outcrops of glaciolacustrine deposits are found in several locations of the Val d'Hérens, but they are often small and not that visible. Kame terraces are present along the two sides of the lower Val d'Hérens.	0.5
<i>Paleogeographical value</i>	The site has a high paleogeographical value as it allows the reconstruction of the Quaternary evolution of the valley.	1
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is not protected.	0
Ecological value	No ecological value.	0

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible from several locations in the lower Val d'Hérens. To observe the sediments it's better to access the site.	0.75
<i>Contrasts, vertical development, space structuration</i>	The pseudo-badlands that have developed in the glaciolacustrine sediments are well developed. The light grey colour of the sediments contrasts with the green vegetated slopes. The site is located on a small hill which emerges from the surrounding slope.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The small hill hosts the Tour de Tavelli, a tower dating to the XII century.	1
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	High cultural value.	0.75

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is fragile because it's built on poorly consolidated sediments.
<i>Natural vulnerability</i>	The sedimentary deposits will be slowly eroded by ongoing runoff and gravitational processes. These active processes are well visible on the slopes around the terrace.
<i>Anthropogenic vulnerability</i>	The anthropogenic vulnerability is very low.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	More than a bus per hour to Vex. It's better to stop at Vex, le Villard, and then go for a short hike to the Tour de Tavelli (20', T1).	1
<i>Security</i>	No risk.	1
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Asphalt road and marked hiking trails.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	The origin of these deposits are mentioned in several articles and pamphlets about the Medieval tower.	0.5
<i>Education interest</i>	The landform is understandable only with mediation. Enhancement is possible at low cost.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value The scientific value is high, and goes along with a high cultural value due to the presence of a Medieval tower on the top of the hill.

Use and management The site is not protected. It has an average education value, but the visit conditions are excellent. The Quaternary deposits at the site are both fragile and vulnerable to ongoing geomorphological processes.

Management measures No particular measure is needed.

References

- Lambiel, C. (2020). Glacial and periglacial landscapes in the Hérens valley. In *Landscapes and Landforms of Switzerland* (pp. 263-275). Cham: Springer International Publishing.
- Lambiel, C., Maillard, B., Kummert, M., & Reynard, E. (2016). Geomorphology of the Hérens valley (Swiss Alps). *Journal of Maps*, 12(1), 160-172.
- Sartori, M. & Epard, J.-L. (2011). Feuille 1306 Sion – Atlas géol. Suisse 1:25000, Notice expl. 130.
- Winistörfer, J. (1978). *Paléogéographie des stades glaciaires des vallées de la rive gauche du Rhône entre Viège et Aproz*. Sion : Fiorina & Burgener

HERgra001

Lanna block

Localisation: Ban de Lanna (Evolène)	Coordinates: 603.206 / 107.188	Altitude: 1540 m
Type: AER	Size: 500 m ²	Property: PUB (Commune de Evolène)

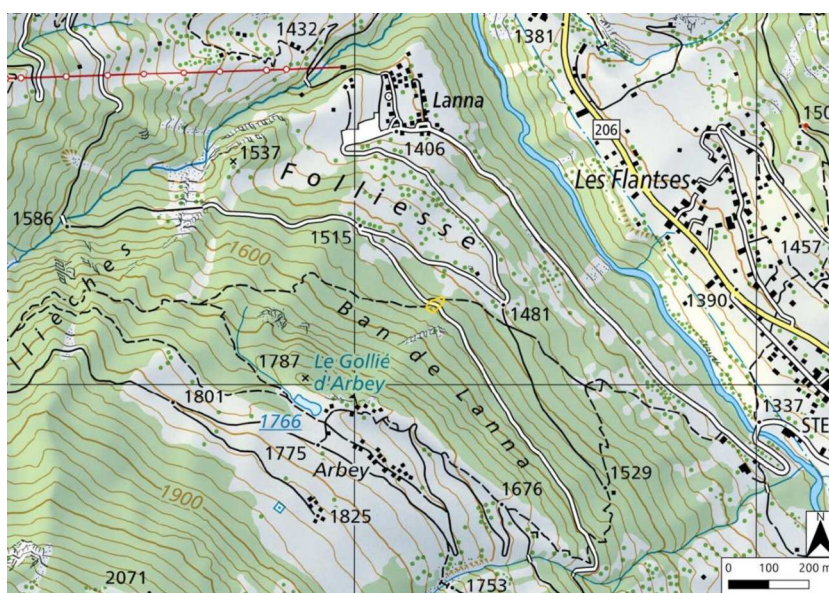
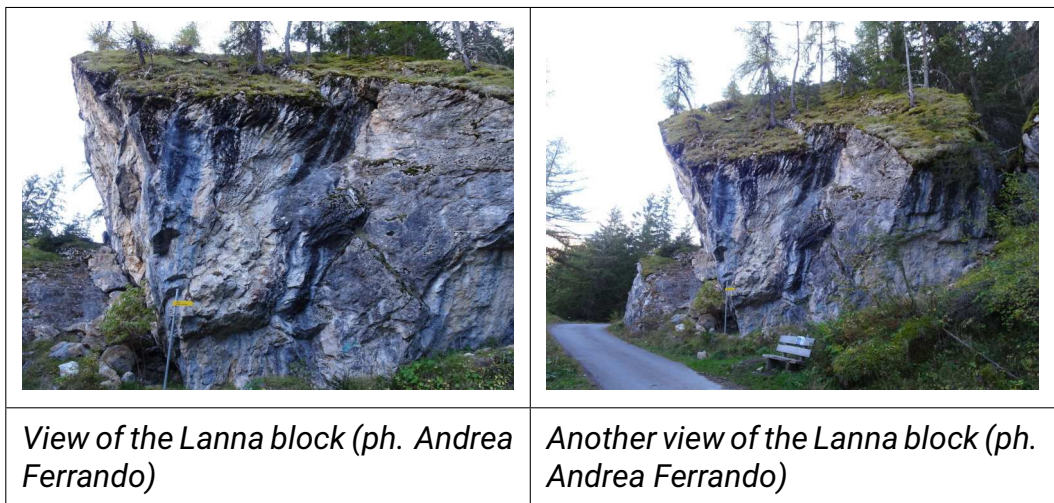


Figure A.20: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



Description This geosite is located about half a kilometre south of the hamlet of Lanna, at the base of the slope called Ban de Lanna. It consists of a great rock block, more than 10 m high, resulting from gravitational processes. The area is characterised also by other smaller blocks, partly covered by larch wood. Vegetation is also present on the large top of the block.

Morphogenesis The presence of the Lanna block and other smaller blocks around is due to rockfalls from cliffs located above. The whole slope is also affected by the presence of a DSGSD, of which the most evident indicator is the longitudinal trench in Arbey.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is not that representative.	0.5
<i>Rareness</i>	Rockfalls are widespread in the Hérens valley, but blocks this large are not that common.	0.5
<i>Paleogeographical value</i>	The site has no paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is not protected.	0
Ecological value	No ecological value.	0

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible only from the road which goes from Lanna to Arbey.	0.5
<i>Contrasts, vertical development, space structuration</i>	The block is very imposing, and the surrounding larch wood makes up for good contrast.	0.5
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is fragile because of its small dimensions.
<i>Natural vulnerability</i>	The site is not vulnerable.
<i>Anthropogenic vulnerability</i>	The block could be affected by road works.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	More than a bus per hour to Evolène. Then it's an easy walk to Lanna and then up towards Arbey (T1). Lanna can also be accessed by car, but from then one must continue on foot.	1
<i>Security</i>	No risk.	1
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Asphalt road and marked hiking trails.	1
Visit conditions	Excellent visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The landform is easily understandable. Enhancement is possible at low cost.	1
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value is average at best.

Use and management The site is not protected. It has high education value, and the visit conditions are excellent.

Management measures No particular measure is needed.

References

- Lambiel, C., Maillard, B., Kummert, M., & Reynard, E. (2016). Geomorphology of the Hérens valley (Swiss Alps). *Journal of Maps*, 12(1), 160-172.

- Marthaler, M., Girard, M., Meisser, N., Gouffon, Y. & Savary, J. (2020). Feuille 1327 Evolène. – Atlas géol.Suisse 1:25 000, Notice expl. 169.

HERkar001

Nax gypsum dolines

Localisation: (Mont-Noble)	Nax	Coordinates: 599.159 / 119.742	Altitude: 1150 m – 1280 m
Type: AER		Size: 0.22 km ²	Property: PRI

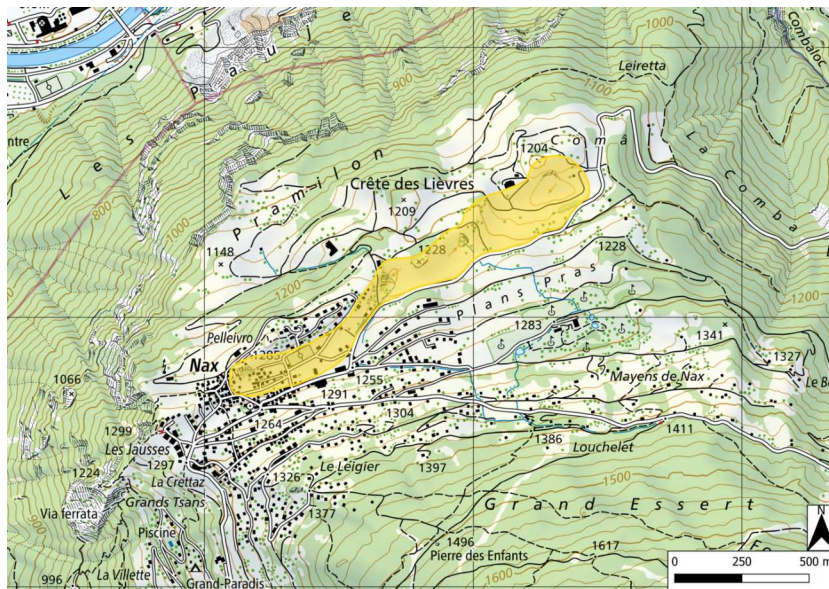
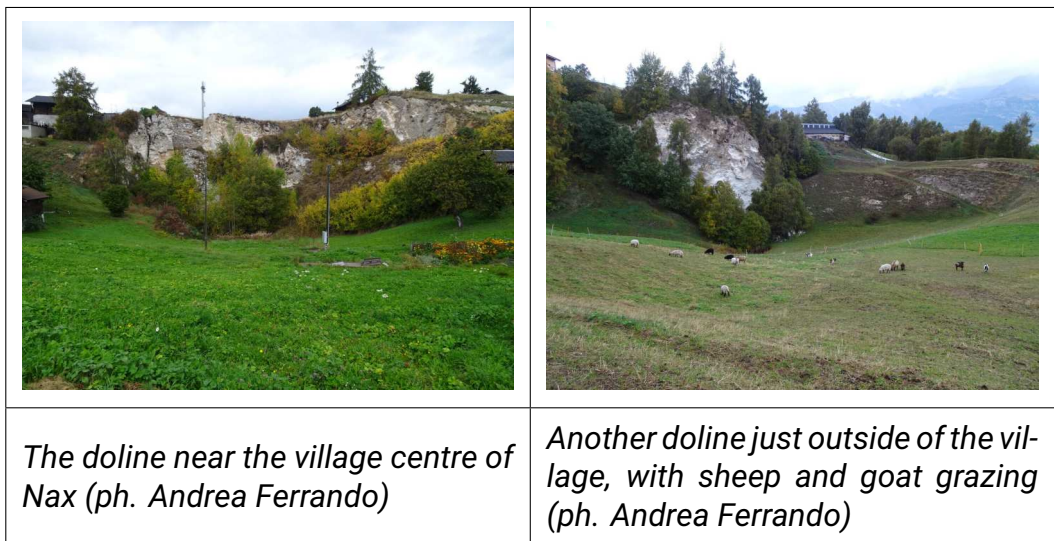


Figure A.21: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



Description The site is located in the village of Nax and in its immediate surroundings. It consists of five dolines, carved in gypsum, and arranged along a SW-NE trending fault.

One of the dolines is located right in the center of Nax, while the others are found at a few hundreds meters of distance, in rural areas around the village. They are 50-100 meters in diameter, and up to 10-15 meters deep. The dolines are funnel shaped and generally asymmetric: the northern flank is steep, often with vertical rock cliffs, while the southern flank is gentler, and is often used for grazing or agriculture. In the case of the doline in the centre of Nax, the geomorphological evolution of its vertical northern side can represent a problem for nearby houses. One of the dolines (Doline du Croux) is characterized by a small stream which disappears in a permanent sinkhole on its bottom. In that same doline a cave is located, with a depth of 20 meters. Other caves are located in the surrounding area, in the same gypsum outcrop: the most important of them is the Grotte de Nax, which is 200 meters long.

The water absorbed by the dolines comes out in the Marais de Poutafontana, located on the Rhone valley floor southwest of St-Leonard, at about 500 m of elevation.

Morphogenesis The site includes good examples of surface karst landforms developed on a gypsum outcrop. These landforms develop because of the action of runoff waters, charged in CO₂ from the atmosphere. The runoff waters cause the dissolution of gypsum, which is about 100 times faster than the dissolution of carbonate rocks (Salomon, 2006).

The dolines are carved in gypsum belonging to the Clôt de la Cime Formation (Carnian), and are aligned along a SW-NE oriented fault, that constitutes a much more erodible rock layer than the surroundings.

Supply of water is mainly given by snowmelt in the spring and rain in the summer and autumn. Only the Doline du Croux is permanently fed by a small stream.

The steep and rocky northern flanks of the dolines evolve not only by gypsum dissolution, but also by small rock falls.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is well conserved, even if houses and infrastructures are very near.	0.5
<i>Representativeness</i>	It's the most representative among the gypsum karst sites of the area.	0.75
<i>Rareness</i>	This kind of landforms is rarely found in the Val d'Hérens area.	1
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Broad-leaved trees, maybe alcalinophiles, are present at the bottom of the dolines.	0.5
<i>Protected site</i>	The site is not protected.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	One of the dolines is very well visible at the village centre of Nax. The others are well visible from roads and pathways just north-east of the village.	0.75
<i>Contrasts, vertical development, space structuration</i>	The main dolines are located on a gentle and undulating surface, so their depression has a strong contrast with the surrounding terrain. The contrast is also in the colours, with the white of the gypsum and the green of woods and pastures.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site has a low fragility. The processes that have created it will continue to shape it.
<i>Natural vulnerability</i>	Most of the dolines are characterized by rock scarps which evolve by rock falls and topplings, representing also a danger for nearby houses.
<i>Anthropogenic vulnerability</i>	Being at the heart of a village, anthropogenic activity is very near, and thus the site is vulnerable. The main cause of anthropogenic degradation is pollution: the waters that enter the dolines can be polluted, and the dolines can be come points of accumulation of garbage. Other than that, many dolines on the outskirts of the village are used for grazing and pasture. Because of that, degradation can be due to the strong presence of animals (overgrazing, accumulation of animal feces etc.).

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to Nax. From the bus stop, one has to walk from 10 to 30 minutes depending on how many dolines one wants to visit. Access is very easy (T1-T2).	1
<i>Security</i>	There's no risk if one observes the dolines from the surrounding roads and pathways. One should not enter the dolines, because of the danger of rockfalls and accidents, and because they are private property.	1
<i>Site context</i>	The site is very urbanized in the south-western part. In the north-eastern sector, it is notably shaped by rural activities.	0.75
<i>Tourism infrastructures</i>	No tourism infrastructures.	0
Visit conditions	Good visit conditions	1

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There is a website giving a brief explanation on the geomorphological process.	0.25
<i>Education interest</i>	The site is quite easily readable by visitors, with mediations.	1
Education	Average educational value	0.5

Synthesis

Intrinsic value The site has a quite high intrinsic value, because of both the scientific and aesthetic value. Visit conditions are excellent.

Use and management The site is not protected and is located right on the centre and the surroundings of a mountain village. One of the dolines is surrounded by houses, while the others are used for grazing and agriculture.

Management measures The main problem for the Nax dolines is the pollution of waters, both because of discharges from the houses and overgrazing in the nearby rural areas. Waters entering the dolines should be controlled. For promotion, an information panel could be posed somewhere around the edge of the doline in the centre of the village.

References

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HERkar002

A Vieille gypsum dolines

Localisation: Between Plan Levri and les Cliosses (Saint-Martin)	Coordinates: 605.157 / 110.682	Altitude: 2500 m – 2575 m
Type: AER	Size: 22,000 m ²	Property: PUB (Bourgeoisie de Saint-Martin)

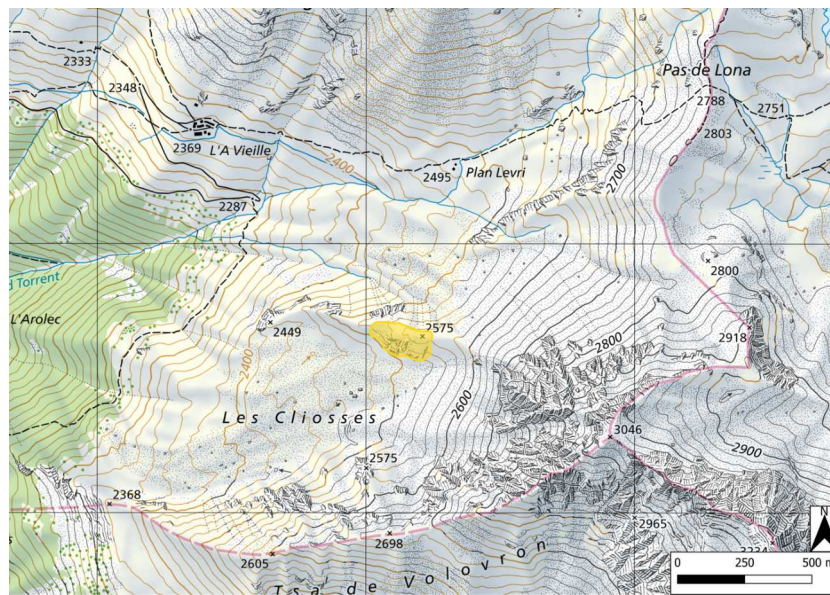

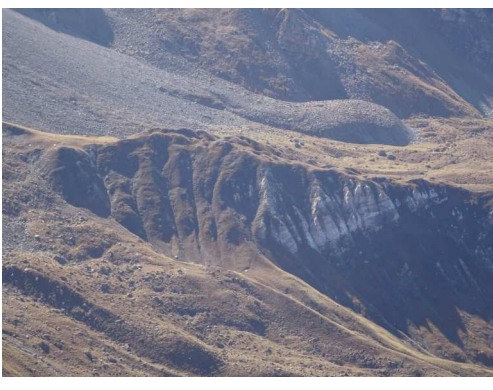


Figure A.22: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>The A Vieille dolines (ph. Lucien Grangier)</i></p>	<p><i>Panoramic view of the crest on which the dolines are located, taken from Pointe de la Tsevalire (ph. Andrea Ferrando)</i></p>

Description The geosite is located in the upper part of the Grand Torrent valley, on the eastern side of the upper Val d'Hérens. It consists in a succession of dolines that are found on the crest between the hollows of Plan Levri and les Cliosses. Each one of the hollows is occupied by large inactive rock glaciers.

The dolines are grouped on the top of the ridge, from about the 2520 m contour and the Point 2575 m marked on the Swisstopo map. Other dolines are found on the southern side of the crest. Most of them are less than 10 m in diameter and are about 1-2 m deep. On the northern side of the ridge, which is steeper than the southern side, one can observe small gypsum pyramids. On the bottom of the dolines, sparse vegetation can be observed. Some of them host thistles.

Morphogenesis The site includes good examples of surface karst landforms developed on a gypsum outcrop. These landforms develop because of the action of runoff waters, charged in CO₂ from the atmosphere. The runoff waters cause the dissolution of gypsum, which is about 100 times faster than the dissolution of carbonate rocks (Salomon, 2006).

The morphogenesis and evolution of the site can be assimilated to that

of a small “dôme écumoire” or “honeycomb karst” (Schoeneich & Imfield, 1997; Bollati et al., 2017). It can be summarized in two main phases: I) glacial retreat phase, with underground water flow in the gypsum rock mass and genesis of underground karst landforms; II) development of surface karst landforms, depending mainly on the steepness of the slope: on rounded ridges or plains there’s the formation of symmetric dolines and small pyramids; on gentle slopes asymmetric dolines develop, while on steeper slopes one has the formation of gullies, high pyramids and monoliths. On the A Vieille geosite one can observe symmetric dolines on the ridge crest, asymmetric dolines on the southern side, and pyramids and gullies on the northern side.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is well conserved.	1
<i>Representativeness</i>	The site is not the best example of this morphology in the region.	0.25
<i>Rareness</i>	This kind of landforms is rarely found in the Val d’Hérens area.	0.75
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Vegetation is not that varied, and it comprehends silicicous plants.	0.25
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	High ecological value.	0.75

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	Few easily accessible view points. To see the dolines, one must reach the site (which is not so accessible), or, alternatively, climb to the top of the nearby Pointe de la Tsevalire.	0.25
<i>Contrasts, vertical development, space structuration</i>	The site has a great contrast with the surrounding landscape.	0.75
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire).

Degradation risk

<i>Fragility</i>	The site is not fragile. The processes that have created it will continue to shape it.
<i>Natural vulnerability</i>	No other short term active processes are present at the site.
<i>Anthropogenic vulnerability</i>	On the present situation, the anthropogenic vulnerability of the site is almost null. The site is far from roads, settlements, human activities, and even from marked hiking trails.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Seven buses a day to Eison-la Crettaz, then about 3h of hiking. Alternatively, on car one can go up on the dirt road to A Vieille, until a parking space at about 2150 m in height. From there, 2h of hiking. Most of the hiking, up to Plan Levri (2495 m) is on a red-white marked trail, then one has to exit from the trail and wander to the geosite, which is about 600 m south. If the visitor hasn't the precise coordinates, the site is difficult to find. To access the view point on the Pointe de la Tsevalire (3025 m), one should continue from Plan Levri to Pas de Lona, then Cabane des Becs de Bosson and finally to the top of the mountain (4h from Eison-la Crettaz, difficulty: T3).	0.25
<i>Security</i>	Risk of losing orientation due to the absence of trails or signs.	0.25
<i>Site context</i>	No perturbation has been found.	1
<i>Tourism infrastructures</i>	No tourism infrastructures.	0
Visit conditions	Bad visit conditions	0.25

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The site is quite easily readable by visitors. Its enhancement is not that easy due to the low accessibility of the site.	0.5
Education	Low educational value	0.25

Synthesis

Intrinsic value The site has an average intrinsic value. Landforms are well conserved, interesting, rare and easily comprehensible by the general public, but the site is not easily accessible.

Use and management The site is indirectly protected and not managed. Its fragility and vulnerability are very low, while the enhancement could be difficult due to the distance from hiking trails and the absence of good view points.

Management measures No particular management measure is needed.

References

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HERorg002

Vouasson low marshes

Localisation: Vouasson (Evolène)	Coordinates: 600.902 / 106.387	Altitude: 2120 m - 2260 m
Type: AER	Size: 0.14 km ²	Property: COM (Consortage de l'alpage de Vouasson)

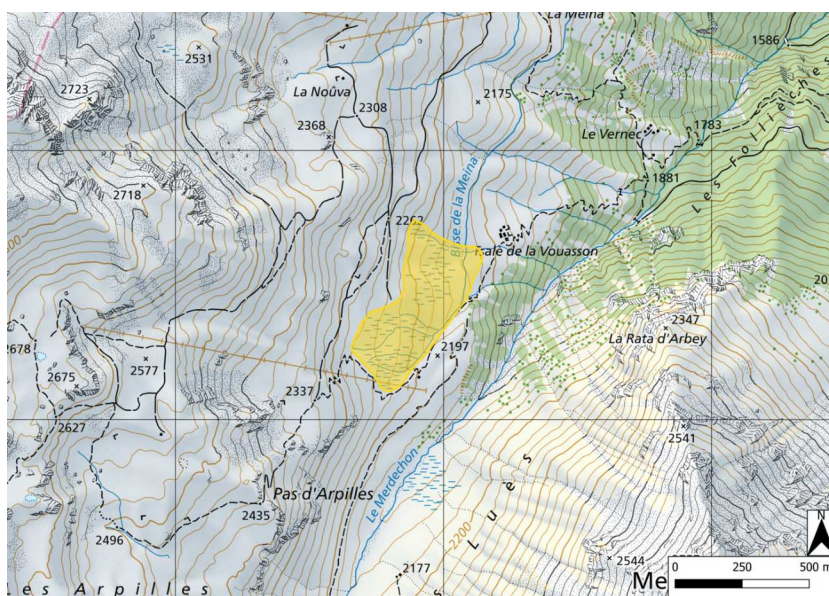




Figure A.23: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>A view of the marshes (ph. Andrea Ferrando)</i></p>	<p><i>Moraine of the Younger Dryas on the side of the marshes (ph. Andrea Ferrando)</i></p>

Description The marshes are located in the valley of the Merdechon, a left tributary of the Borgne. They are found at the eastern foot of the Pic d'Artsinol, in the vicinities of the rural settlement of Vouasson. Despite being protected in the Federal Inventory of Low Marshes of National Importance, the marshes are not easily identifiable. They are found on a rather steep slope, where there is abundance of water due to the presence of several springs. The water that runs through the marshes is collected by a small stream, which flows in a little valley delimited by a well conserved Younger Dryas moraine before joining the Merdechon. In the marshes, the vegetation consists mainly of sedges.

Morphogenesis The Vouasson marshes are very particular in the fact that they are not located in a flat area, or in a hollow or on the bottom of a valley, but rather on a quite steep slope. The formation of the marshes is due to the presence of a lot of springs in a small area; the water from these springs impregnate the soil, allowing the growth of flora typical of wetlands.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is well conserved.	1
<i>Representativeness</i>	The site is not that representative of this morphotype.	0.25
<i>Rareness</i>	Marshes located on a relatively steep slope are rare in the study area, and, for a fact, in the whole Alps.	1
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The site hosts the vegetation typical of marshes.	1
<i>Protected site</i>	The site is included in the Federal Inventory of Low Marshes of National Importance (Object n° 1815).	1
Ecological value	Very high ecological value.	1

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is surrounded by wide prairies and pastures, and it does not stand out among them. There are view points, but ultimately the site is difficult to view.	0.25
<i>Contrasts, vertical development, space structuration</i>	There is no contrast with the surrounding landscape if not for a stronger presence of water in the form of several small streams.	0.25
Aesthetic value	Low aesthetic value.	0.25

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is included in the Federal Inventory of Low Marshes of National Importance (Object n° 1815).

Degradation risk

<i>Fragility</i>	The site is fragile because of its small size and its features, and its ecosystem is very fragile.
<i>Natural vulnerability</i>	No short term active process is present at the site.
<i>Anthropogenic vulnerability</i>	The site could suffer from the presence of livestock, and is vulnerable to overgrazing. The landscape around the site is affected by the presence of the skilifts of the Evolène ski station.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to Evolène, then 3h long hike. By car one can reach the hamlet of Lanna and start the hike from there (2h). The hike is marked and easy but requires a bit of training (T3).	0.5
<i>Security</i>	Risk could come from bad weather conditions.	0.75
<i>Site context</i>	No perturbation has been found.	1
<i>Tourism infrastructures</i>	There are hiking trails and skilifts, the latter active only in the winter season.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The site is difficult to visualize and understand.	0
Education	No educational value	0

Synthesis

Intrinsic value The intrinsic value is high, due to average scientific value and very high ecological value.

Use and management The site is not protected, thanks to the inclusion in the Federal Inventory of Low Marshes of National Importance (Object n° 1453). Its potential for use for geotourism is very low, mainly because of its null educational value. The site has a low anthropogenic vulnerability mainly due to grazing, and it's affected by the presence of skilifts.

Management measures Being a marsh of national interest, it would be good to highlight the site and protect it with physical barriers (fences), to prevent its degradation by grazing activity.

References

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HERper001

A Vieille rock glacier

Localisation: Grand Torrent valley, south of Plan Levri (Saint-Martin)	Coordinates: 604.954 / 111.076	Altitude: 2180 m – 3046 m
Type: AER	Size: 0.64 km ²	Property: PUB (Bourgeoisie de St-Martin)

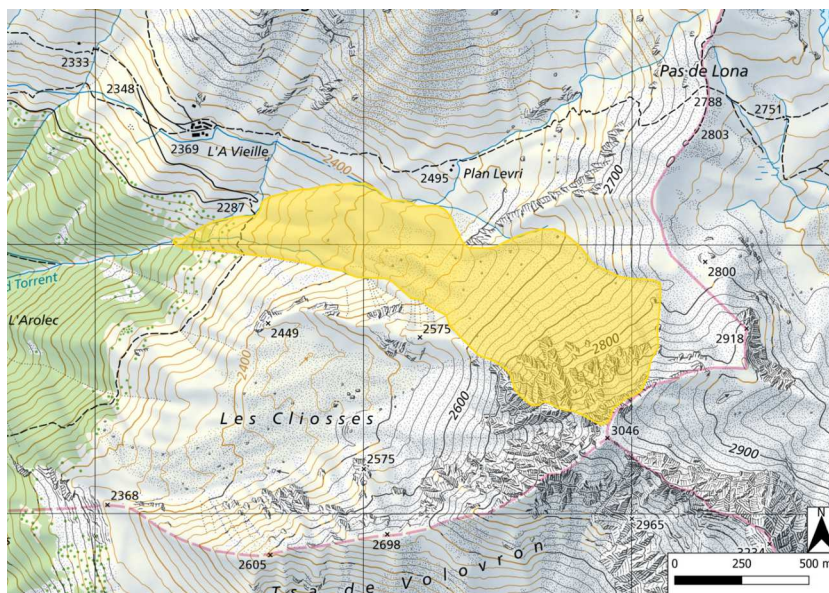


Figure A.24: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The A Vieille rock glacier as seen from the A Vieille cabins (ph. Lucien Grangier)



The lower part of the rock glacier (ph. Andrea Ferrando)

Description The geosite is located in the upper part of the Grand Torrent valley, on the eastern side of the Val d'Hérens. It consists of a large inactive rock glacier, one of the largest and most imposing in the region. The root zone of the rock glacier is located by the large scree slope at the foot of the north wall of the Sasseneire (3256 m). The tongue of the rock glacier begins at an elevation of about 2600 m. Coming from the southern side of the Grand Torrent valley, it extends along the valley floor for a little more than 1 km, down to an elevation of 2180 m. The Grand Torrent stream flows on the northern margin of the rock glacier, in a way confining it, and it's fed by waters coming from the rock glacier itself. The rock glacier has a maximum width of about 400 m in the median sector, but it shrinks to less than 100 m in the lower part of the tongue.

The rock glacier is composed from debris coming from the north wall of the Sasseneire: mainly Jurassic calcschists and marbles from the Tsaté Nappe. The area covered by the tongue of the rock glacier has a different bedrock, composed of Triassic gypsum and quartzites.

The A Vieille rock glacier is notable for the presence of well developed furrows, ridges, and thermokarst depressions. Its tongue is in fact very complex: in the lower sector it separates in two lobes, one of which terminates at 2300 m, while the other goes down to 2180 m. In the south-eastern

sector, a younger tongue can be recognized, partly overlapping the larger and older main tongue of the rock glacier. On the upper sector an abrupt, arch-shaped ridge can be seen, probably of morainic origin.

The main tongue of the rock glacier is covered by herbaceous vegetation, due to the glacier being inactive and to the alterability of calcschist, which permit the formation of soils.

Morphogenesis The A Vieille rock glacier formed thanks to the high availability of debris, due to the presence of large gravitational scree slopes at the northern foot of the Sasseneire. Because of interstitial ice, the debris started to flow, forming the main tongue of the rock glacier. The past movement of the tongue is testified by the well developed ridges and furrows, which highlight the flow of the material.

The formation of this landform probably occurred during the Bølling, which is a relatively warm period between the colder Older and Younger Dryas periods of the last Ice Age. High erosion rates caused a high availability of debris, which led to the formation of several rock glaciers on this side of the Val d'Hérens (another large inactive rock glacier is located nearby, at les Cliosses, and there is the Liapèy d'Enfer some kilometers further south).

During the Younger Dryas the rock glacier was partially covered by a little glacier, which left little latero-frontal moraines still visible today. During the subsequent warmer period the younger, south-western tongue of the rock glacier developed, partially overlapping the main one.

Nowadays, the rock glacier is inactive, and its lower portion is well below the lower limit of discontinuous permafrost in this region of the Alps (Lambiel, 2021). The melting of permafrost on the main tongue led to the formation of well visible thermokarst depressions. The main body of the rock glacier is still rich in waters, as there are numerous springs coming out from its borders.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is well conserved.	1
<i>Representativeness</i>	Very representative example of the periglacial landforms of the valley.	1
<i>Rareness</i>	Rock glaciers are common in the valley. But due to its dimensions and its lithology, this rock glacier can be considered rare.	0.75
<i>Paleogeographical value</i>	The presence of several tongues and morainic material allows the reconstruction of different colder and warmer periods during the last Ice Age.	0.75
Scientific value	Very high scientific value.	1

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The vegetation is that typical of high mountain prairies.	0.25
<i>Protected site</i>	Site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is very well visible from the trail going from l'A Vieille to the Pas de Lona.	0.75
<i>Contrasts, vertical development, space structuration</i>	The tongue of the rock glacier is very large, with ridges and furrows, with very particular thermokarst depressions on it. The high north wall of the Sasseneire, which overlies the root zone of the rock glacier, is very imposing.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	The rock glacier is inactive, and it's due to be modeled by other morphogenetic agents, such as runoff, nival erosion and gravity. On the northern side, the rock glacier is actively eroded by the Grand Torrent. None of these processes are expected to affect the integrity of the site in the short term.
<i>Anthropogenic vulnerability</i>	The site is far from human activities, so its anthropogenic vulnerability is very low.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Seven buses a day to Eison-la Crettaz, then about 2h45' of hiking. Alternatively, on car one can go up on the dirt road to A Vieille, until a parking space at about 2150 m in height. From there, 1h30' of hiking.	0.5
<i>Security</i>	Due to the moderately long hike, there is danger in case of bad weather.	0.75
<i>Site context</i>	No perturbation.	1
<i>Tourism infrastructures</i>	Hiking trails are present. In A Vieille there is a buvette.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The landform is easily visible, but to understand it a mediation is required. Enhancement is possible at low cost.	0.75
Education	Average educational value	0.5

Synthesis

Intrinsic value The intrinsic value of the site is very high, mainly because of its scientific and aesthetic value. The site has no ecological or cultural importance.

Use and management The site is not managed, but its visit conditions are good. Its fragility and vulnerability are very low.

Management measures No particular management measure is required. The site could be easily enhanced for geotourism by posing panels.

References

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HERper002

Liapey d'Enfer rock glacier

Localisation: Liapey d'Enfer, near the Remointse du Tsaté (Evolène)	Coordinates: 608.426 / 104.526	Altitude: 2280 m – 3020 m
Type: AER	Size: 1.05 km ²	Property: COM (Consortage de l'Alpage du Tsaté)

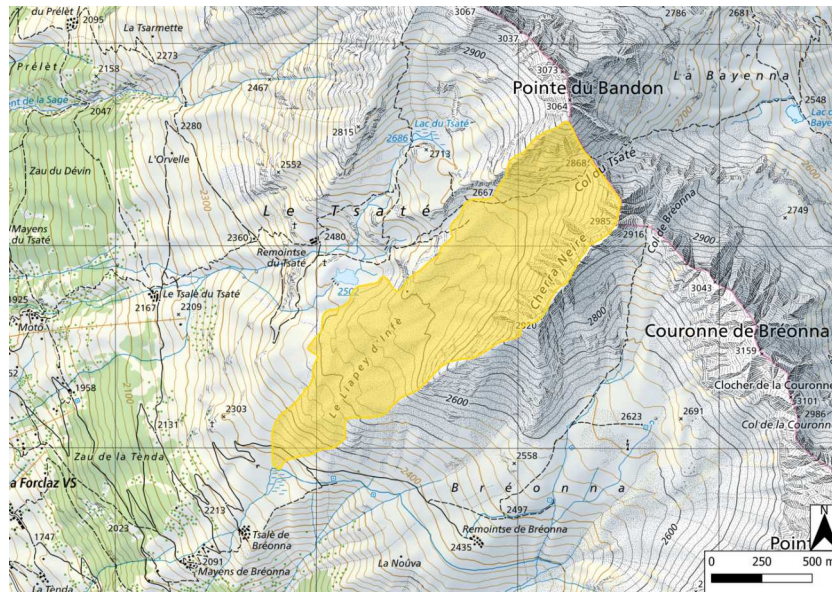


Figure A.25: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The upper part of the Liapey d'Enfer (ph. Andrea Ferrando)



The lower part of the rock glacier, near a small artificial lake (ph. Andrea Ferrando)

Description The site is located on the eastern side of the upper Val d'Hérens, above the village of la Forclaz. It consists of an enormous inactive rock glacier, which fills the entire valley descending from the Col du Tsaté to the Tsaté pastures. This little valley is bounded on the north by the Pointe du Bandon (3064 m) and on the south by the Cherra Neire ridge (2985 m).

The rock glacier is actually made of several coalescing tongues. In the lower part it separates in a number of diverging lobes, some of them flowing north towards the Lac Inférieur du Tsaté, some of them going southward. The main body of the rock glacier is inactive, but it is surmounted by smaller rock glaciers and pronival ramparts fed by debris at the foot of the Cherra Neire.

The rock glacier is made up almost exclusively by serpentinite blocks, coming from the slopes of the Cherra Neire. In the upper part one can find also calcschists and marbles, coming from the southern slopes of the Pointe du Bandon.

The toponym means literally "Hell's Scree" – the large stony ground without vegetation surely made an impression on the local folk, and could even be "hell" for the cattle that ventured out in it.

The rock glacier has not been colonized by vegetation, if one does not count lichens and sparse herbaceous flora. On the northern margin of it

there is a small private hut. The surrounding slopes are mainly characterized by pastures and dry prairies. Nearby there is a small artificial lake (the Lac Inférieur du Tsaté) and some rural cabins (Remointse du Tsaté). Several springs are present at the margins of the rock glacier.

Morphogenesis The Liapay d'Enfer rock glacier formed thanks to the high availability of debris, due to the presence of morainic deposits – as this valley was covered by a small glacier up to the Younger Dryas stage – and large gravitational scree slopes, especially on the southern side of the valley. The rock glacier was fed almost exclusively by debris coming from the Cherra Neire, as it is formed prevalently by serpentinites. Only in a small part in the upper sector of the rock glacier one can find debris coming from the other side of the valley (i.e. Pointe du Bandon).

Because of interstitial ice, the debris started to flow, forming the main body of the rock glacier. Unlike other rock glaciers, where the main tongue is easily recognisable, this is not the case with the Liapay d'Enfer – the body of the rock glacier is composed by several coalescing tongues and lobes. Separating one from another is a task all the more difficult now that the rock glacier is largely inactive, and flow structures such as ridges and furrows have partly collapsed.

Despite this, several stages of activity can be recognised, if only for the fact that the large inactive main body of the rock glacier is surmounted by a smaller tongue coming from the western sector of the Cherra Neire. This tongue is well defined and has still slopes, so it could still be active. Pronival ramparts are present all along the foot of the Cherra Neire. The Cherra Neire is affected by very active gravitational processes (mainly rock falls and topplings), induced by freeze and thaw cycles.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The geomorphosite is almost intact except for the lower part of the southern tongue, which has been cut by a dirt road.	0.75
<i>Representativeness</i>	Very representative example of the periglacial landforms of the valley.	1
<i>Rareness</i>	Rock glaciers are common in the valley. But due to its dimensions, its lithology, and its complexity, this rock glacier can be considered rare.	0.75
<i>Paleogeographical value</i>	The site has its importance in the reconstruction of glacial and postglacial evolution of the area.	0.75
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Very sparse vegetation is present, mainly pioneer species.	0.25
<i>Protected site</i>	The site is not protected.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The geosite is located on a hanging valley, so it's visible only approaching it. From the hiking trails in the Tsaté valley it is very well recognisable, but one has to ascend higher to be able to grasp the whole landform.	0.5
<i>Contrasts, vertical development, space structuration</i>	The dark colour of serpentinites contrast heavily with surrounding prairies. The dimensions of the landform are very impressive.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	There is mention of a dolmen and a menhir in the middle of the rock glacier. This testifies the impression that this site has made on the imaginary of the local folk, and it's reflected also in the toponym.	0.5
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	The rock glacier is inactive, and it's due to be modeled by other morpho-genetic agents, such as runoff, nival erosion and gravity. These processes are not expected to affect the integrity of the site in the short term.
<i>Anthropogenic vulnerability</i>	The anthropogenic vulnerability is low – the site has been affected by the construction of a dirt road, but arguably this hasn't compromised its integrity in a prominent way.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	One bus per hour the whole year long to la Forclaz, then 2h30' long hike (T3) along the path that goes to the Remointse de Tsaté and then to the Col du Tsaté.	0.5
<i>Security</i>	Due to the moderately long hike, there is danger in case of bad weather.	0.75
<i>Site context</i>	No perturbation.	1
<i>Tourism infrastructures</i>	Hiking trails are present.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The landform is easily visible, but to understand it a mediation is required. Enhancement is possible at low cost.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is high, mainly because of its scientific importance and aesthetic value. The site has no ecological value and has a feeble cultural importance.

Use and management The site is not managed, but its visit conditions are good, despite the long access. Its fragility and vulnerability are very low.

Management measures The construction of further dirt roads on the body of the rock glacier should be prevented. The site could be easily enhanced for geotourism by posing panels and realising a geological trail.

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HERper003

Tsena Réfien rock glacier

Localisation: Tsena Réfien, south-west of Arolla (Evolène)	Coordinates: 600.500 / 095.600	Altitude: 2490 m – 3391 m
Type: AER	Size: 0.87 km ²	Property: -

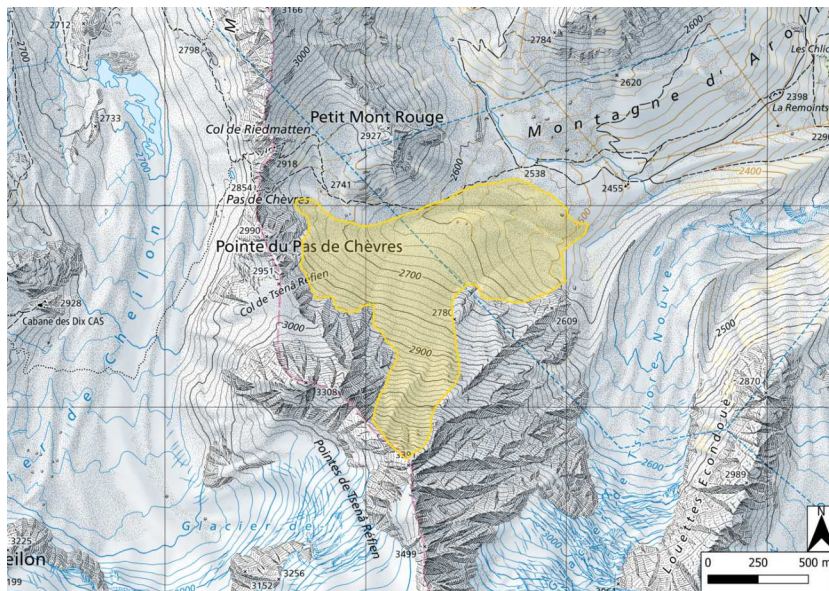


Figure A.26: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Tsena Réfien valley (ph. Andrea Ferrando)



Another view of the large scree slopes with an evident rock glacier tongue (ph. Andrea Ferrando)

Description The geosite is located in the upper part of the Tsena Réfien valley, on the western side of the Val d'Arolla. It's a complex geosite, consisting of a large inactive composite rock glacier, probably the largest of the Val d'Arolla, and its source zone, consisting of the northern rock wall of the Pointes de Tsena Réfien (3391 m) and the underlying active scree slopes.

The debris cones on the northern slopes of the Pointes de Tsena Réfien, composed by gneiss, reach the valley floor and some feed active and inactive rock glaciers at the foot of the slopes. The two largest scree cones are also avalanche paths, as it's testified by the snow remnants in the summer. Furthermore, the most easterly couloir contains a large debris flow. As you head westwards, the size of these scree slopes diminishes. One of them is topped by a landslide scarp. There is no vegetation in this environment.

The lower part of the geosite includes a large composite rock glacier with three identifiable main tongues. Two of them are located just at the foot of the scree slopes, while the third, largest one, occupies the valley floor down to about 2500 m in elevation. The two upper tongues are actively fed by the scree slopes, but their activity is uncertain, also because they are continually covered by debris falling from the overlying slopes. The uppermost one is probably active, as it may be shown by its steep front, but

it's partially covered by vegetation. The second tongue is probably inactive, and also colonised by vegetation. The lowermost third tongue is relict, and it has undergone partial collapse due to permafrost melting.

Morphogenesis In the Lateglacial Egesen stage, the glaciers of Tsijore Nouve and Tsena Réfien merged at about 2450 m of elevation, and the tongue resulting from the confluence of the two glaciers flowed down the valley in the direction of Arolla.

In the Little Ice Age probably there was still a very small glacier in the upper part of the Tsena Réfien valley, as it could be shown by historical photos. Today, there is no geomorphological evidence left of the presence of this small glacier, due to the high activity of the northern wall of the Pointes de Tsena Réfien, which continuously evolve by means of several different gravitational (rockfalls, debris flows etc.) and nival phenomena (snow-debris avalanches).

This has led to the formation of a large scree slope, which has been characterised as cold debris (Lambiel, 2006), where air circulation is present depending on the external air temperature. This process causes a high negative temperature anomaly on the soil.

The formation of the rock glacier happened when the entire area was over the lower limit of permafrost, and the debris could flow due to the presence of interstitial ice. The composite rock glacier formed in several steps, with the lower tongue being the most ancient, and the upper being the younger one. While the lower tongue is relict, and the mid one is probably inactive, the uppermost one shows signs of activity, and ice is present at its interior (Lambiel, 2006). In general, the lower part of the scree slopes, up to 2660 m in elevation, seems to show the presence of frozen debris. Then, going up on the slope, the pergelisol disappears, only to be found at higher elevations.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The geomorphosite is intact.	1
<i>Representativeness</i>	Very representative of periglacial and gravitational processes, which are among the main morphogenetic processes in the valley.	1
<i>Rareness</i>	Rock glaciers are common in the valley.	0.25
<i>Paleogeographical value</i>	This site allows to reconstruct the paleogeography of the Tsena Réfien valley.	0.5
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Very sparse vegetation typical of dynamic high mountain environments.	0.25
<i>Protected site</i>	The site is not protected.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible by hiking up in the Tsena Réfien valley, along the trail that goes to the Pas de Chévres and the Col de Riedmatten.	0.5
<i>Contrasts, vertical development, space structuration</i>	The northern wall of the Pointes de Tsena Réfien has a great vertical development. The large scree slopes have a high contrast with the lower part of the relict rock glacier, which is covered by prairies.	1
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	The site has played a role in the demonstration of the existence of air circulation in scree slopes (Lambiel, 2006).	0.25
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	The lower, relict part of the rock glacier is due to be modeled by runoff and nival erosion, but the processes will be very slow. The upper tongues will probably be damaged or even destroyed by high-activity gravitational processes occurring on the upper slopes.
<i>Anthropogenic vulnerability</i>	Its anthropogenic vulnerability is very low. The lower part of the relict rock glacier is partially affected by skilifts.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to Arolla, then 2h on foot (T2) along the path that leads to the Col de Riedmatten.	0.5
<i>Security</i>	Due to the long access, there is risk of accident in case of bad weather.	0.75
<i>Site context</i>	No perturbation.	1
<i>Tourism infrastructures</i>	There are marked hiking trails, while skilifts are active only during the winter season.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	Despite the presence of good view points, the rock glaciers are not easy to see, and to understand it a mediation is needed. The scree slopes are more easily readable.	0.25
Education	Low educational value	0.25

Synthesis

Intrinsic value The intrinsic value of the site is very high, mainly because of its scientific and aesthetic value. The site has no ecological or cultural importance.

Use and management The site is not managed. Its visit conditions are good, but the educational value is low due to the difficulty to see the rock glaciers by an unexperienced eye. The anthropogenic vulnerability is low, while the two upper rock glaciers will be probably affected by gravitational phenomena occurring on the overlying slopes.

Management measures No particular management measure is required. In case of enhancement, a panel could be posed on the hut of the skilifts.

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The western side of the Tour de Bonvin (ph. Andrea Ferrando)



The southern side of the Tour de Bonvin (ph. Andrea Ferrando)

Description The Tour de Bonvin (2443 m) is a rounded peak with a flat top, emerging from the northern buttress of Mont Noble, directly overlooking the Rhone valley. Its gentle slopes are characterised by large surfaces covered by blocks. Most of these deposits can be classified as block fields and block streams, that are landforms of periglacial origin – the Tour de Bonvin thus represents the site with the most widespread and well preserved block slopes in the Val d’Hérens and Val de Réchy region.

The deposits are rather scattered along the mountain sides, and are well visible from an elevation of about 2100 m – just above the limit of coniferous forests – to the summit of the peak. Such deposits are present also at lower elevations, but they are almost completely covered by vegetation, and as such they are not visible.

The deposits are lithologically analogous to the bedrock, that is composed by quartzites (Bruneggjoch Formation, Late Permian-Early Triassic). These rocks are very hard and resistant to erosion, and they tend to break in large squared blocks, so they favour the formation of block deposits like these.

Morphogenesis The main two landforms that can be observed on the Tour de Bonvin – block fields and block streams – are product of in situ alteration of rock outcrops by freeze-and-thaw processes. The alteration

first result in a blocky deposit, from which the finer material is carried away mainly by the action of runoff. If the block deposit lays on a flat (or gentle sloping) area, there is no flow, and a block field is formed. When the block deposit is found on a steep slope, the blocks tend to flow and accumulate along small valleys and furrows: these are block streams, which are usually elongated and narrow. On the lower slopes of the Tour de Bonvin, other landforms of periglacial origin can be observed, such a small protalus ramparts and rock glaciers. All of these periglacial landforms are now relict, as the Tour de Bonvin is below the lower limit of permafrost in the Alps.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The geomorphosite is intact.	1
<i>Representativeness</i>	The site comprehends very good examples of block streams and block fields.	1
<i>Rareness</i>	Extensive block slopes of periglacial origin are rare in the Val d'Hérens.	0.75
<i>Paleogeographical value</i>	The site helps to reconstruct the distribution of permafrost in past times.	0.25
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Typical vegetation of dry prairies in high mountain environment, with some larch and fir here and there. The block fields are populated by lichens.	0.25
<i>Protected site</i>	The site is not protected.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is well visible from the surrounding, and even from the main Rhone valley.	1
<i>Contrasts, vertical development, space structuration</i>	The gentle slopes covered by block fields and block streams make for a good contrast with the surrounding forests and meadows. The site is well developed vertically (more than 300 m from the foot to the top of the slopes), but the rounded shape of the Tour de Bonvin makes it less impressive than it could have been.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	With time the block slopes are bound to be covered by vegetation. It will be a long process, due to the hardness and low alterability of quartzites. The eventual growth of wood could be an issue in regards to the visibility of the site.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is low. The only human activity in the vicinities is the ski station of Mont-Noble. If the ski station is enlarged eastward, that could pose a danger to the periglacial landforms of the Tour de Bonvin.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour to Nax, then about 3h on foot (T3) to the Chalet Mont Noble, and then to the path that goes around the Tour de Bonvin (follow signs for l'Ar du Tsan). By car one can go up to le Chiesso, and from there it's only 1h on foot.	0.75
<i>Security</i>	There is some risk in case of bad weather conditions, especially if one exits from the marked hiking trails to enter the geosite proper.	0.75
<i>Site context</i>	No perturbation.	1
<i>Tourism infrastructures</i>	There are marked hiking trails, but they don't pass through the site. Skilifts are active only during the winter season.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The site requires a mediation to be understood, but it's rather accessible and easily enhanceable.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value The site has high scientific and aesthetic value, but not much of ecological and cultural value.

Use and management The site is not protected. Visit conditions are good, and the site could be enhanced at relatively low cost. The site is not fragile, but is bound to be covered by vegetation in current climate conditions, and that could be an issue for its visibility.

Management measures No particular measure is needed. Panels could be posed near the Chalet Mont Noble to explain the geomorphology of the site.

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HERstr001

la Maya

Localisation: la Maya, watershed between Val d'Hérens and Val de Réchy (Saint-Martin / Mont-Noble)	Coordinates: 604.104 / 113.395	Altitude: 2800 m – 2916 m
Type: AER	Size: 15,000 m ²	Property: -

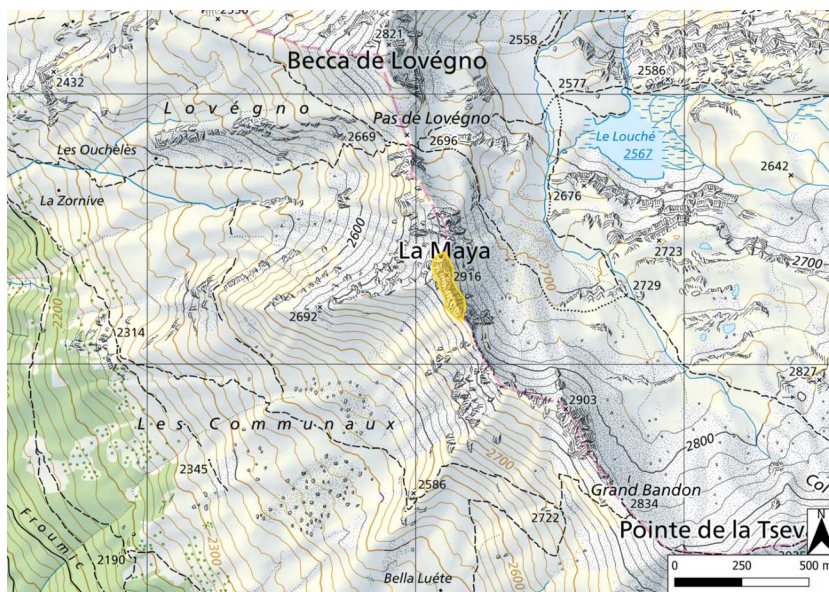


Figure A.28: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



La Maya as seen from the south-east (ph. Andrea Ferrando)



La Maya as seen from the Becca de Lovégno (ph. Andrea Ferrando)

Description The site includes la Maya (2916 m), a peak located on the watershed between the Val d'Hérens and the upper Val de Réchy. Despite not being among the highest peaks of the region, la Maya is very notable for its shape – it's a 100 meters high rock tower with vertical walls. The rock tower is asymmetric: if seen from the west or the east it has a rectangular shape, while if it's seen from the north or the south it appears thinner, with the shape of a finger.

La Maya is made of Late Cretaceous calcschists and marbles belonging to the Série Rousse formation of the Tsaté Nappe.

Morphogenesis The origin of the Maya rock tower is mainly due to selective erosion, that has isolated a slab of more resistant rocks. The rock tower is modeled by gravitational and freeze-and-thaw processes.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The geomorphosite is intact.	1
<i>Representativeness</i>	It is very representative of rock towers in the alpine environment.	1
<i>Rareness</i>	Structural landforms are widespread, but the shape of la Maya is rather unique.	0.25
<i>Paleogeographical value</i>	The site is important for the reconstruction of the geological history of the Alps, as it's formed by meta-sedimentary oceanic rocks (calcschists and marbles).	0.5
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact. Flora is very sparse and the fauna is that typical of the high alpine environment.	0
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The geosite is easily visible from several locations in the Val d'Hérens, in the Val de Réchy and even from the main Rhone valley. It is also very easily recognisable.	1
<i>Contrasts, vertical development, space structuration</i>	The rock tower of la Maya is imposing, due to it being 100 meters high and on the top of a high crest. Its regular shape and reddish-brown color are impressive.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	The rock tower will continue to be shaped by gravitational and freeze-and-thaw processes. The rise of the lower limit of permafrost may accelerate these processes, due to permafrost degradation.
<i>Anthropogenic vulnerability</i>	The anthropogenic vulnerability is nil.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	The site is well visible from many locations in the lower Val d'Hérens and the upper Val de Réchy. To reach the foot of the rock tower one must hike from Trogne (St-Martin) to Pas de Lovégno (3h30'). Several other longer trails are present, for example from Eison and Nax. The top of the Maya is accessible only by rock climbing.	0.5
<i>Security</i>	If one hikes to the slopes of the Maya, there is risk of accident due to bad weather.	0.75
<i>Site context</i>	High mountain environment without perturbations.	1
<i>Tourism infrastructures</i>	There are marked hiking trails.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The landform is easily visible and understandable.	0.75
Education	Average educational value	0.5

Synthesis

Intrinsic value The intrinsic value of the site is high, mainly because of its scientific importance and aesthetic value. The site has no ecological value and has a feeble cultural importance.

Use and management The site is indirectly protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and in one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona). Its visit conditions are good, despite the long access. Its fragility and vulnerability are negligible.

Management measures No particular measure is needed.

References

- Lambiel, C., Maillard, B., Kummert, M., & Reynard, E. (2016). Geomorphology of the Hérens valley (Swiss Alps). *Journal of Maps*, 12(1), 160-172.
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HERstr002

Pointe du Tsaté

Localisation: Pointe du Tsaté, watershed between Val d'Hérens and Val de Moiry (Evolène / Anniviers)	Coordinates: 608.523 / 106.350	Altitude: 2800 m – 3078 m
Type: AER	Size: 0.51 km ²	Property: PUB (Commune d'Evolène and Commune d'Anniviers)

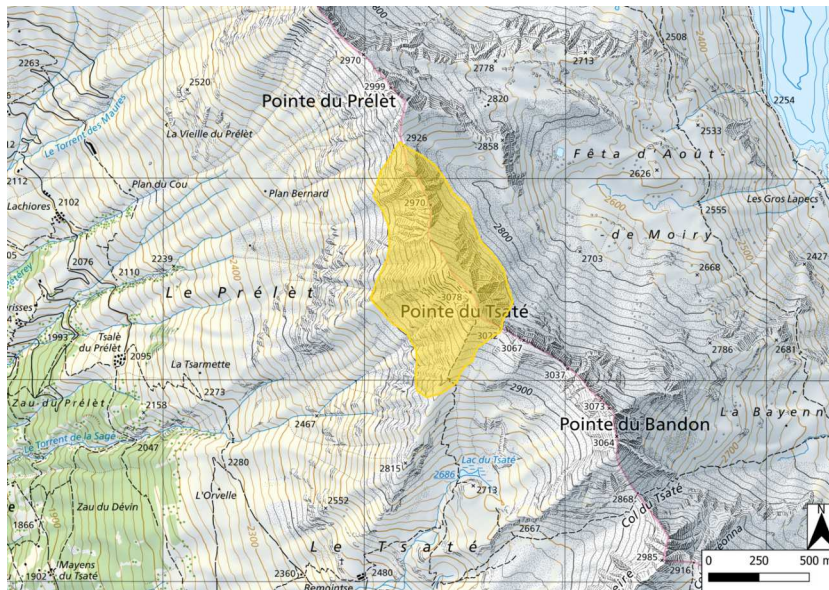


Figure A.29: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



*Pointe du Tsaté as seen from Lanna
(ph. Andrea Ferrando)*



*The summit ridge of Pointe du Tsaté
(ph. Andrea Ferrando)*

Description Pointe du Tsaté (3078 m) stands on the watershed between Val d'Hérens and Val d'Anniviers, both tributaries of the Rhone. It is an inconspicuous minor peak with a trapezoidal shape.

The slopes of the mountain are rather steep in the upper part. The southwestern flank, overlooking the Val d'Hérens, is scree-covered, furrowed by couloirs; to prevent debris flows along these couloirs, numerous rockfall barriers have been placed at the top. Rockfall barriers are clearly visible even from below. Further down, the slope becomes gentle and grazing, and finally becomes covered with larch trees down to the valley floor. The northeast slope descends to the Val de Moiry, a side branch of the Val d'Anniviers. It is a shorter, narrower flank, consisting of an insecure rock face and steep slopes of grass and stones.

The summit ridge, about 200 meters long, consists of boulders and slabs and is quite jagged. On the southern ridge are two stone cairns and some "Tibetan" flags. On the central ridge, about the same height, are a cairn of stones and the summit cross, which rests on a curious squared tower. The ridge ends with another small top, also surmounted by a large stone cairn.

From the geological point of view, the Pointe du Tsaté is important because it gives its name to a tectonic nappe. The Tsaté nappe is constituted by oceanic rocks, which originated in the Jurassic and Cretaceous in a

basin called the Ligurian-Piedmont Ocean. These rocks were then deformed during the Alpine orogeny, undergoing greenschist-facies metamorphism, and assuming their current position in the Alpine mountain chain.

From the bottom to the top, the Tsaté nappe is constituted by: I) Jurassic ophiolitic basement, made of serpentinites, metagabbros and metabasalts (or prasinites); II) Early Cretaceous (?) quartzites and quartz-schists, originating from metamorphism of cherts; III) Early to Late Cretaceous thick metasedimentary series called schistes lustrés – that is, alternances of calcschists, marbles and quartz-schists.

The top of Pointe du Tsaté is formed mainly by calcschists, with layers of metabasalts and metagabbros outcropping on the north ridge and the northern slopes.

Morphogenesis The origin of the Pointe du Tsaté is mainly due to selective erosion. The summit ridge is modeled by gravitational and freeze-and-thaw processes. Rockfall barriers have been posed to mitigate geomorphological risk on the western slope of the peak, as the Torrent de la Sage catchment is prone to debris flows that can affect the la Sage hamlet and the Hérens valley floor.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is affected by the construction of rockfall barriers.	0.75
<i>Representativeness</i>	It is very representative of structural ridges in the alpine environment.	1
<i>Rareness</i>	Structural landforms are widespread, and the Pointe du Tsaté doesn't have a striking profile that makes it recognisable.	0
<i>Paleogeographical value</i>	The site is important for the reconstruction of the geological history of the Alps, as it's formed by meta-sedimentary oceanic rocks (calcschists and marbles) and ophiolites.	0.75
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is not protected.	0
Ecological value	No ecological value.	0

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The geosite is easily visible from several locations in the Val d'Hérens and in the Val de Moiry.	1
<i>Contrasts, vertical development, space structuration</i>	The peak has a nice contrast of colours between the brownish debris and rock slopes on the top and the prairies and the woods at the foot of its slopes. Vertical development is high (about 1500 m from the floor of the Val d'Hérens to the top, and 700 m on the other side). Despite this, the peak doesn't stand out among the surrounding higher and more imposing mountains.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	On the mountain there is an archeological sacred site.	0.25
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	The peak has been incorporated in the movie "Au sud des Nuages" by Jean-François Amiguet.	0.25
<i>Geohistorical importance</i>	The peak gives its name to a tectonic nappe.	1
<i>Economic importance</i>	No economic importance.	0
Cultural value	Average cultural value.	0.5

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	The mountain peak is shaped by gravitational and freeze-and-thaw processes. These processes will not affect the integrity of the geosite.
<i>Anthropogenic vulnerability</i>	The western slope of the mountain has been affected by the construction of several rockfall barriers that – notwithstanding their usefulness – affect its integrity, aesthetic value and the site context.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	The site is well visible from many locations in the lower Val d'Hérens and the upper Val de Réchy. To reach its top one can hike from la Forclaz (4h, T3).	0.5
<i>Security</i>	If one hikes to the mountain top, there is danger in case of bad weather conditions.	0.75
<i>Site context</i>	The presence of rockfall barriers is one major perturbation.	0.5
<i>Tourism infrastructures</i>	There are marked hiking trails.	0.5
Visit conditions	Average visit conditions	0.5

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The landform is easily visible and understandable.	0.75
Education	Average educational value	0.5

Synthesis

Intrinsic value The intrinsic value of the site is high, mainly because of its scientific importance. The site has no ecological value and has a feeble cultural importance.

Use and management The site is not protected. On the top one of the sites of the Swiss Permafrost Monitoring Network (PERMOS) is located. The western slope is characterized by several rockfall barriers, that affect negatively the landscape.

Management measures The site is frequented by hikers, and would benefit from the presence of panels regarding the geology of the area. The site could be linked to the nearby standing Liapay d'Enfer rock glacier by means of a geological trail or something of the sort.

References

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- Marthaler, M., Girard, M., Meisser, N., Gouffon, Y. & Savary, J. (2020). Feuille 1327 Evolène. – Atlas géol.Suisse 1:25 000, Notice expl. 169.
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HERstr003

Dent Blanche

Localisation: Dent Blanche, watershed between Val d'Hérens, Val d'Anniviers and Matternal (Evolène / Anniviers / Zermatt)	Coordinates: 609.470 / 099.135	Altitude: 3000 m – 4357 m
Type: AER	Size: 2.51 km ²	Property: PUB (Commune d'Evolène, Commune d'Anniviers and Commune de Zermatt)

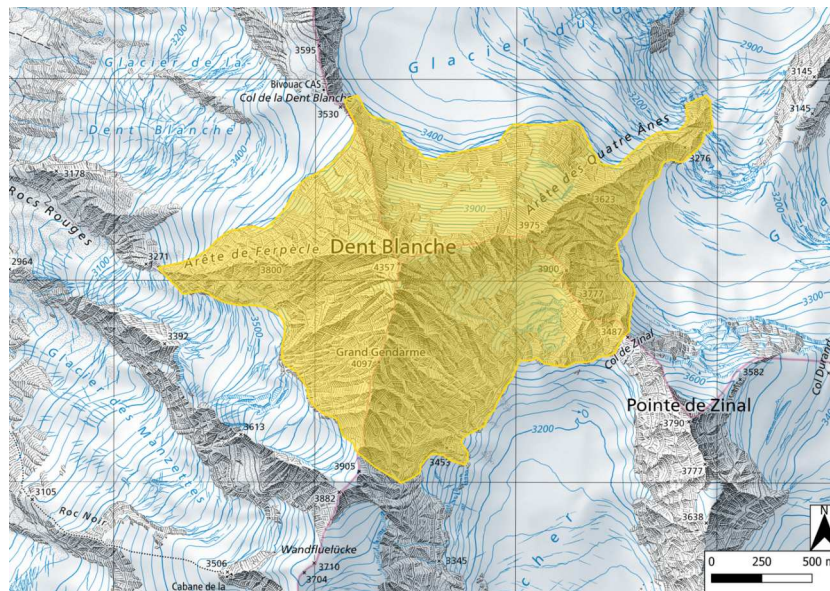


Figure A.30: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



Dent Blanche seen from Pic d'Artsinol (ph. Andrea Ferrando)



Dent Blanche seen from Pointe du Tsaté (ph. Andrea Ferrando)

Description The Dent Blanche (4357 m) is one of the most famous “4000s” of the Alps. Its imposing mass and its pyramidal shape make it the symbol of an entire region. While it is very well known among climbers, it carries also a geological importance. The Dent Blanche gives its name to a tectonic nappe belonging to the Austroalpine domain (that is, the paleo-African continent), that now is in the highest structural position in the Alpine orogen.

The Dent Blanche nappe is made of a complex crystalline continental basement, that comprises, from bottom to the top: I) Prepermian paraschists and paragneiss, with amphibolites and eclogites; II) Permian metagabbros and ultramaphites; III) Permian orthogneiss, metagranites and metadiorites. The Dent Blanche itself is made of the latter: the orthogneiss known as “Gneiss d’Arolla”.

Morphogenesis The Dent Blanche is a typical “horn”, modeled by glacial action at its foot and by gravitational and freeze-and-thaw processes at the upper rocky slopes.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	It's a very representative example of a high pyramidal mountain carved by glaciers.	1
<i>Rareness</i>	It's far from the only "horn" of the region but, together with the Matterhorn, it's the most recognisable and imposing.	0.75
<i>Paleogeographical value</i>	The site is important for the reconstruction of the geological history of the Alps, as it's formed continental crust rocks belonging to the paleo-African plate.	1
Scientific value	Very high scientific value.	1

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1707).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The geosite is easily visible from several locations in the Val d'Hérens, and in clear days from most of the surrounding valleys and mountains.	1
<i>Contrasts, vertical development, space structuration</i>	It's one of the most imposing peaks of the Alps, and it has a perfectly regular pyramidal shape. The peak is more than 4000 m in elevation, and the summit horn is about 1300 m high.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The peak has been frequented by alpinists since the XIX Century, so it has an importance for the development of tourism in the region.	0.5
<i>Artistic and literary importance</i>	The literary importance comes from the reports of the first climbing trips on the mountain. The Dent Blanche is one of the most represented peaks of the region in drawings and paintings, and it has even given its name to a movie ("les amants de la Dent Blanche" by Raymond Vouillamoz).	0.75
<i>Geohistorical importance</i>	The peak gives its name to a tectonic nappe.	1
<i>Economic importance</i>	No economic importance.	0
Cultural value	High cultural value.	0.75

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	The mountain peak is shaped by gravitational and freeze-and-thaw processes that could be exacerbated by climate change. These processes will not affect the integrity of the geosite, but could make its visit more dangerous, and the retreat of glaciers could impact its aesthetic qualities.
<i>Anthropogenic vulnerability</i>	The western slope of the mountain has been affected by the construction of several rockfall barriers that – notwithstanding their usefulness – affect its integrity, aesthetic value and the site context.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	The site is well visible from many locations in the Val d'Hérens and in the whole Valais canton. It is not necessary to access the summit horn to see and understand the geosite. To see it from near one can go by bus or by car to the upper Ferpècle valley, then hike up to Bricola (2h, T3).	1
<i>Security</i>	No risk	1
<i>Site context</i>	No perturbation.	1
<i>Tourism infrastructures</i>	There are marked hiking trails at the foot of the mountain, and an alpine refuge high up at 3500 m.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	The site is cited in a brochure by Pierre Kunz (1997).	0.75
<i>Education interest</i>	The landform is easily visible and understandable.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is very high – it has scientific, aesthetic and cultural importance.

Use and management The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1707). As one of the highest mountains of the Alps, the site is used mainly for alpinism and climbing.

Management measures No particular management measure is needed.

References

- Lambiel, C., Maillard, B., Kummert, M., & Reynard, E. (2016). Geomorphology of the Hérens valley (Swiss Alps). *Journal of Maps*, 12(1), 160-172.
- Manzotti, P., Balleve, M., Zucali, M., Robyr, M., & Engi, M. (2014). The tectonometamorphic evolution of the Sesia–Dent Blanche nappes (internal Western Alps): review and synthesis. *Swiss Journal of Geosciences*, 107(2), 309-336.
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HERstr004

Becs de Bosson rock towers

Localisation: Becs de Bosson (Mont Noble / Anniviers)	Coordinates: 605.439 / 112.878	Altitude: 2770 m – 2827 m
Type: AER	Size: 41,000 m ²	Property: PUB (Commune de Mont-Noble)

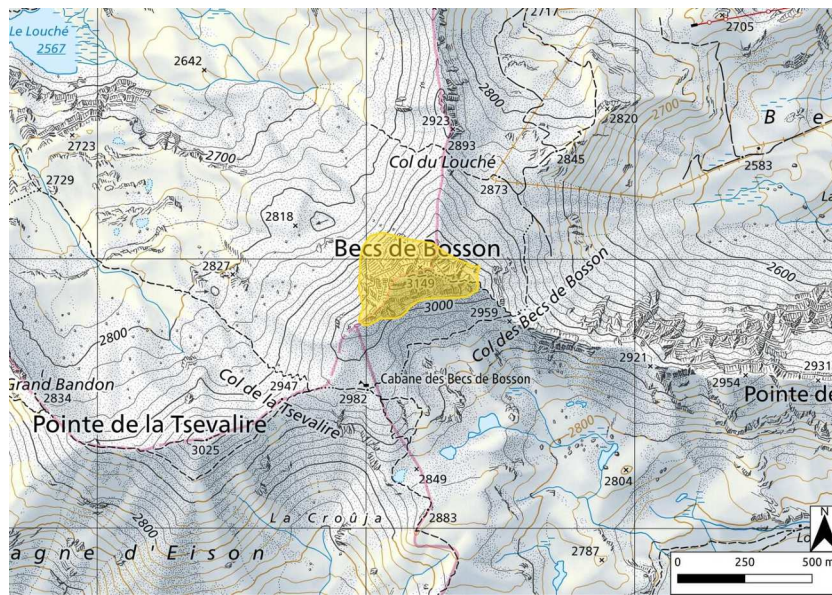


Figure A.31: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



*The Becs de Bosson from the south
(ph. Andrea Ferrando)*



*The Becs de Bosson as seen from
the Pointe de la Tsevalire (ph. An-
drea Ferrando)*

Description The Becs de Bosson (3149 m) are a mountain located at the orographic knot between the Val d'Hérens, the Val de Réchy and the Val d'Anniviers. It is notable for its turreted shape, rising abruptly from the gentler slopes between Pas de Lona on the south, Col de la Tsevalire on the west, Col des Becs de Bosson on the east and Col du Louché on the north.

The top of the mountain is made of two thin rock pillars that emerge from the summit pyramid. The eastern rock tower, named Grand Bec, is the highest at 3149 m. The western rock tower, called the Petit Bec, is a little lower (3148 m), and has a thinner and more broken appearance.

The curious shape of the Becs de Bosson is due to their geological nature, which makes it a site of geological – for the reconstruction of the orogenic history of the Alps – and geomorphological interest. On the Becs de Bosson, one can observe rocks belonging to two different tectonic nappes, one thrust over another. The lower part of the peak is made of rocks belonging to the Tsaté Nappe. They are Cretaceous metasedimentary rocks, which have formed on the bottom of an ancient ocean and then have undergone metamorphism during the Alpine orogeny. In particular, the gentle slopes at the foot of the summit pyramid are formed by calcschists (Série Grise formation), while the main bulk of the summit pyramid is made by

reddish marbles (Série Rousse formation), analogous to the one outcropping at la Maya.

Over the Série Rousse there is a thrust fault, over which rocks belonging to the Cimes Blanches Nappe are found. These are rocks formed on a continental margin. The summit rock towers are made of the Brèche Inférieure formation, that is, dolomitic, calcareous and even quartzitic breccias dating back to the Early Jurassic. These breccias can be easily recognised due to their whitish-light grey colour.

At the southern foot of the Becs de Bosson there is a refuge (Cabane des Becs de Bosson). The whole area is very frequented by hikers, thanks to some marked trails encircling the summit pyramid. Experienced hikers often climb the Petit Bec, which involves some easy scrambling, while the Grand Bec is only for rock climbers.

Morphogenesis The Becs de Bosson are one of the best example of selective erosion in the region, showcasing how different rocks are shaped differently in respect to the same geomorphological processes. The soft calcschists at the foot are modeled in gentle and rounded slopes. The reddish marbles are harder, more resistant to the erosion, and they have been shaped as a stocky asymmetrical rock pyramid. On the top of it rest the dolomitic breccias, which are also quite hard, but very fractured. The summit rock pillars thus have a slim, broken appearance. At the foot of the Grand Bec rock pillar, a small natural rock arch can be observed.

The slopes and the summit area of the Becs de Bosson are now shaped mainly by gravitational and freeze-and-thaw processes. On the southern foot one can observed some of the finest examples of patterned grounds in this area of the Alps. The northern rock wall of the Becs de Bosson is shaped mainly by rock falls and topplings – at the foot there is a large scree slope, which is the feeding area of a rock glacier.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is representative of structural landforms in the region.	1
<i>Rareness</i>	Structural landforms are widespread in the Val d'Hérens, but the peculiar geological context of the Becs de Bosson can be considered mildly rare.	0.25
<i>Paleogeographical value</i>	The site is important for the reconstruction of the geological history of the Alps, as it shows two different tectonic nappes one thrust on the other.	1
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The geosite is easily visible from several locations in the Val d'Hérens, in the Val de Réchy, the Val d'Anniviers and even from the main Rhone valley. It is easily recognisable.	1
<i>Contrasts, vertical development, space structuration</i>	The Becs de Bosson are imposing, due to their prominence and isolation. The two broken rock towers on the summit are impressive in their shape, and the alternation of rocks with different colours makes up for strong contrasts.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is included in the perimeter of Object n° 216 in the Inventory of Swiss Geotopes (Paysage périglaciaire du Haut Vallon de Réchy-Pas

de Lona).

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	The rock tower will continue to be shaped by gravitational and freeze-and-thaw processes. The rise of the lower limit of permafrost may accelerate these processes, due to permafrost degradation.
<i>Anthropogenic vulnerability</i>	No anthropogenic vulnerability.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	To access the foot of the rock towers one must hike up to the Cabane des Becs de Bosson. There is less than a bus per hour to Nax or Grimentz. Then 5h hike from Nax, or a 4h hike from Grimentz. The refuge is accessible from the A Vieille dirt road (there is a car park at about 2150 m) and then following the hiking trail to Pas de Lona, Col de la Tsevalire and the upper Val de Réchy (about 3h30'). In any case, trails are marked and not difficult (T3). It is more difficult to climb the rock towers: the Petit Bec involves a little bit of scrambling (T4) with fixed ropes, while the Grand Bec involves technical rock climbing (IV).	0.5
<i>Security</i>	Risk can be due to bad meteorological conditions.	0.5
<i>Site context</i>	Calm high mountain environment with no perturbations..	1
<i>Tourism infrastructures</i>	Hiking trails and mountain refuge.	0.75
Visit conditions	Average visit conditions	0.5

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are panels on the Val de Réchy. Some of them focus on the geo(morpho)logical setting of the valley.	0.25
<i>Education interest</i>	The site is quite easily readable by visitors.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is high, mainly because of its scientific importance and aesthetic value.

Use and management The site is indirectly protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and in one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona). Visit conditions are average, mainly due to long access to the foot of the mountain, and difficulty to access the rock pillars.

Management measures No particular measure is needed.

References

- Lambiel, C., Maillard, B., Kummert, M., & Reynard, E. (2016). Geomorphology of the Hérens valley (Swiss Alps). *Journal of Maps*, 12(1), 160-172.
- Marthaler, M., Sartori, M., Escher A. & Meisser N. (2008). Feuille 1307 Vissoie. - Atlas géol. Suisse 1:25 000, Notice expl. 122.

HRMant001

Prafleuri anthropogenic terraces

Localisation: Combe de Prafleuri, Hérémence	Coordinates: 594.000 / 103.000	Altitude: 2580 m – 2880 m
Type: AER	Size: 0.71 km ²	Property: PRI (Grande-Dixence SA)

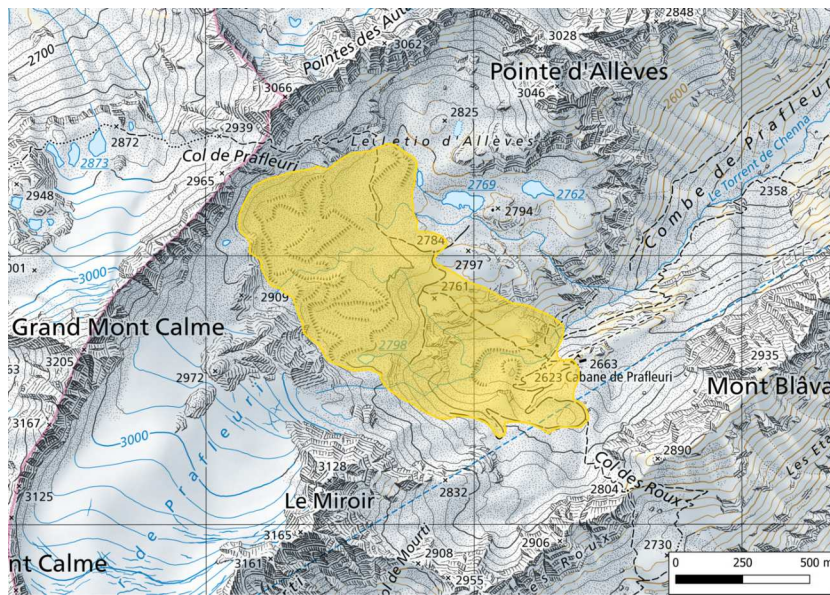


Figure A.32: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



View of the anthropogenic terraces from Mont Blava (ph. Andrea Ferrando)



View of another sector of the terraces (ph. Andrea Ferrando)

Description The site is located at the head of the valley called Combe de Prafleuri, which is a lateral valley of the Val d'Hérémence. On the north-western side, the site is bounded by the watershed between the Val d'Hérémence and the Val de Nendaz: the high crest encompasses the Grand Mont Calme (3205 m), the saddle of the Col de Prafleuri (2965 m) and the Pointe des Autans (3066 m). On the north, there is the glacial cirque of le Letio d'Allèves with several small lakes, dominated by the Pointe d'Allèves (3046 m), while on the southern side the Glacier de Prafleuri is located.

This valley hosts the remains of one of the biggest worksites of the Alps. The site was basically a very large quarry, from which stones were carved for the construction of the Grande Dixence dam, the highest in Europe, situated in the nearby Val des Dix. The quarry has been active from the 1940s to the 1960s, and has been abandoned since. Stones and blocs were taken mainly from the frontal morainic wall of the Glacier de Prafleuri. All of the moraine, deposited in the Little Ice Age, was used for the construction; at its place, nowadays one can observe several orders of anthropogenic terraces, walls and quarry tracks. On the southern side of the geosite, stones were quarried from a large, still active, rock glacier, descending from the Col de Mourti.

All the site is characterised by the remains of edifices, cableways and

other smaller structures, generally in concrete. The largest edifice, which hosted the quarrymen, has now become an alpine refuge, called Cabane de Prafleuri.

Morphogenesis Before the onset of anthropogenic activity in the 1940s, the highest part of the Combe de Prafleuri was a typical high alpine valley, shaped mainly by glacial, periglacial and gravitative processes. In the place of the quarry there was a high morainic wall deposited in the mid XIX century by the Glacier de Prafleuri. On the southern side, a large active rock glacier descends from the Col de Mourti to the crag where the Cabane de Prafleuri is located. Studies have been performed on this rock glacier (Delaloye et al., 2005), quantifying its movement in about 40 cm/y. North of the moraines there is the large cirque of the Letio d'Allèves: the upper rocky slopes of the cirque are broadsided by scree slopes. On the bottom of the cirque there are overdeepening hollows hosting small lakes. The largest of these lakes is fed by the outlet of the Glacier de Prafleuri, which forms an alluvial fan entering it.

Anthropogenic action has occurred from the 1940s to the 1960s, in an area of about 0.71 km², shaping what would become the largest high altitude quarry in Europe. Quarrying has mainly operated on the XIX-century moraine, removing almost all of it and reshaping the slopes with walls and terraces connected by dirt roads. The quarrying has affected also the lower tongue of the rock glacier of the Cabane de Prafleuri, disconnecting the terminal part of the rock glacier from its main body. At the time, it resulted in the exposition of one of the best section of the internal structure of a rock glacier (Fisch et al., 1977; Haeberli, 1992). The ballast was brought to the construction site of the dam by means of a 1600 m long tapis roulant placed in a tunnel.

The Torrent de Chenna crosses the quarry area, and has been partly regimanted. While crossing the anthropogenic terraces, the brook forms several small alluvial deposits made of fine material.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The traces of the old quarry are still well visible, and its landforms are well conserved.	1
<i>Representativeness</i>	Fortunately, this is the only occurrence of a quarry this large in the high mountain environment of the Val d'Hérens. The anthropogenic activities affect glacial and periglacial landforms, which are very representative of the geomorphology of the area.	0.5
<i>Rareness</i>	It's rare to find an anthropogenic geomorphosite this large in an high mountain environment, even outside of the study area.	1
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	No protection.	0
Ecological value	No ecological value.	0

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible from the hiking trails crossing the upper Combe de Prafleuri. The path to the Col de Prafleuri passes through the main portion of the quarry. To observe the geosite in its entirety, one must hike up the Col des Roux, and from there, to the summit of Mont Blâva, which is the best view point on the area.	0.5
<i>Contrasts, vertical development, space structuration</i>	The well-ordered and regular shapes of the anthropogenic terraces contrast strongly with the surrounding natural landscape. The site is developed in height, encompassing an altitude interval of about 300 meters, but it's not that imposing due to the vastness of the area.	0.5
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	Traces of one of the largest and most important worksites in the Alps for what concerns the XX century. The quarry is visible in an aerial photo taken in 1957 (courtesy of W. Friedli), that is the period when it was active.	1
<i>Artistic and literary importance</i>	The site has a certain importance, even if literature concerns mainly the construction of the Grande Dixence dam.	0.75
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	High cultural value.	0.75

Protection

Protection status No protection.

Degradation risk

<i>Fragility</i>	Generally, anthropogenic features left with no manutention are very fragile, but the site is very large, and that prevents the possibility of it being destroyed.
<i>Natural vulnerability</i>	The main cause of degradation of this geosite is due to the active natural processes of the area. The loose debris on which the terraces have been realised will be slowly reshaped mainly by runoff, gravity and the erosive action of the two streams crossing the area. On the southern sector, the active rock glacier will slowly cover some of the terraces built on it. However, these processes are not expected to significantly affect the integrity of the site in the short term.
<i>Anthropogenic vulnerability</i>	On the present situation, the anthropogenic vulnerability of the site is almost null. One danger can come if the society which has the property of the area decides to reshape the slope and cancel the traces of the quarry.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to the Chargeur bus stop, then 2h to 3h by hike, depending on the final destination of the hiker. The Chargeur can easily be reached by car. The Grande Dixence cable car, connecting the Chargeur to the top of the dam, permits to save 30-40 minutes of hiking time. Hiking to Cabane de Prafleuri or to the quarry is of medium difficulty (T3). Reaching Mont Blâva is more difficult (T3+).	0.5
<i>Security</i>	Risk can be due to bad meteorological conditions.	0.75
<i>Site context</i>	Calm high mountain environment with no perturbations.	1
<i>Tourism infrastructures</i>	Alpine refuge (Cabane de Prafleuri), marked hiking trails, cable car to abbreviate the hiking trail.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	The history of this place is shown in the guide of the "Sentier des Bouquetins" hiking trail, on panels along the trail itself and on the exposition at the foot of the Grande Dixence barrage.	1
<i>Education interest</i>	The site is easily readable by visitors.	1
Education	Very high educational value	1

Synthesis

Intrinsic value The intrinsic value is average, while the cultural and historical value is high, because of its connection with the construction of the Grande Dixence dam.

Use and management The site is not protected. Explanations on its history and geo(morpho)logical context are present along the nearby hiking

trails and on the expositions at the foot of the Grande Dixence dam.

Management measures No particular management measure is needed.

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HRMflu001

Écoulaies potholes

Localisation: La Barne, Val des Dix (Hérémente)	Coordinates: 595.962 / 101.301	Altitude: 2362 m – 2520 m (emerged); 2200 m – 2362 m (intermittently submerged)
Type: AER	Size: 58,900 m ²	Property: PRI (Grande-Dixence SA)

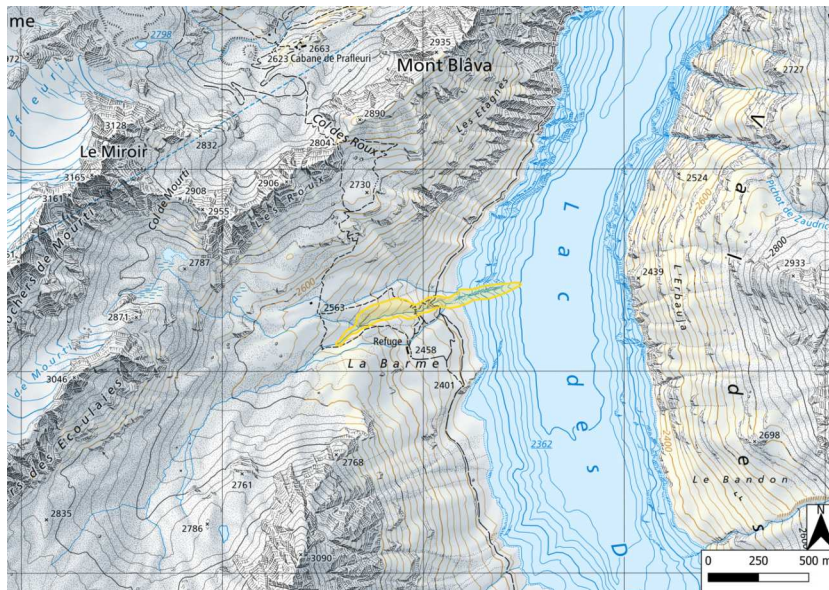


Figure A.33: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



Fluvial potholes along the Torrent d'Ecoulaies (ph. Andrea Ferrando)



Fluvial potholes along the Torrent d'Ecoulaies (ph. Andrea Ferrando)

Description The site is located on the western side of the Val des Dix, along the lateral Ecoulaies valley. The valley is surrounded by high mountain peaks: from the northern side, in counter-clockwise direction one has Mont Blâva (2935 m), la Rosablanc (3336 m), Lui des Chamois (3198 m), Pointe du Crêt (3322 m) and Rochers du Bouc (3315 m). The head of the main valley, dominated by the Pointe du Crêt, is occupied by the Ecoulaies glacier. On the north-western part there is a lateral valley which hosts the Glacier du Mourti. This glen is separated by the main valley by the Rochers d'Ecoulaies (3096 m).

The Torrent d'Ecoulaies flows out of the eponymous glacier and flows in north-east direction. The upper part of the stream is on morainic deposits. Then, at about 2520 m of elevation, the stream bed becomes set on rock – in particular calcschists and marbles belonging to the Série Grise Formation (Cretaceous). By entering the rock formation, the stream becomes engorged, forming a long series of small waterfalls and fluvial potholes. The gorge is never more than 10 m deep, and it's about 1 km long. The lower 200 meters of the gorge, from 2362 m in elevation, are submerged by the Lac des Dix reservoir. Depending on the level variations of the reservoir, more or less larger sections of the lower gorge can become emerged.

The emerged part of the gorge is crossed by two footbridges at respectively 2520 m and 2430 m. Another bridge is located at 2390 m, and is

routed by the dirt road that goes from the Grande Dixence dam to the southern end of the Lac des Dix.

Morphogenesis The gorge with fluvial potholes is a typical result of fluvial erosion on an uneven bedrock, made by soft calcschists and hard marbles. Potholes tend to form where the rock is more fractured and less resistant, while waterfalls form where there are sills of harder rocks. The gorge could even have originated as a subglacial Nye channel when the Ecoulaies valley was still completely covered by the eponymous glacier, before being modeled by frankly fluvial processes.

Before the construction of the Grande Dixence dam, the base level of the Torrent d'Ecoulaies was located at the bottom of the Val des Dix, which in this point is at about 2200 m. The Ecoulaies valley was a lateral hanging valley – the hanging valley step is located at about 2500 m, so there was a 300 m difference in height between this step and the floor of the Val des Dix. In this context, the Ecoulaies gorge evolved as a classic “connection gorge”, by regressive erosion. Alluvial and debris flow deposits were located at the base of the gorge, into the floor of the Val des Dix.

The construction of the dam and the filling of the reservoir have completely altered the natural dynamics of the Ecoulaies stream. The reservoir water level has become the new base level for the stream. Due to the fact that this water level is subject to continuous variations, depending on the season and the water influx, the base level of the stream constantly varies, and the erosion and deposition sectors of the Ecoulaies torrential system accordingly move up and down the stream itself.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The emerged part of the site is intact, while the other is submerged by the Lac des Dix. However, the very presence of the reservoir has completely altered the natural dynamics of the site.	0.5
<i>Representativeness</i>	It is representative of fluvial landforms of the region.	0.75
<i>Rareness</i>	Fluvial potholes are not that rare in the area.	0.5
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The ecological impact is scarce.	0.25
<i>Protected site</i>	No protection.	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible from the two or three marked hiking trails which cross the Torrent d'Ecoulaies.	0.5
<i>Contrasts, vertical development, space structuration</i>	The potholes and the gorge are impressive on their own, but they are not so imposing, or visible, in the context of the alpine landscape of the Val de Dix.	0.5
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The historical importance of the site is connected to the presence of the Lac des Dix and the Grande Dixence.	0.25
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	Low cultural value.	0.25

Protection

Protection status No protection.

Degradation risk

<i>Fragility</i>	The potholes are not fragile.
<i>Natural vulnerability</i>	The potholes could be affected by gravitational processes on the gorge walls. Debris flows along the Torrent d'Écoulaies could degrade some of them by filling them with sediment. These processes are not expected to significantly affect the integrity of the site, so the natural vulnerability is low.
<i>Anthropogenic vulnerability</i>	For what concerns the emerged part, anthropogenic vulnerability is low. The fact is that the construction of the Grande Dixence Dam and the Lac des Dix has completely altered the natural dynamics of the Écoulaies torrential system. Depending on the water level in the reservoir, the lower part of the fluvial gorge can become active and undergo erosion.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to the Chargeur bus stop, then 2h hike. The Chargeur can easily be reached by car. The Grande Dixence cable car, connecting the Chargeur to the top of the dam, permits to save 30-40 minutes of hiking time. To reach the potholes one has to follow signs for the Refuge de la Barmaz (T2).	0.75
<i>Security</i>	No risk.	1
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Hiking trails are present, and there is a refuge near the site. The "Sentier des Bouquetins" thematic trail passes nearby.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretative facilities are present.	0
<i>Education interest</i>	The site is easily readable, with mediation, but it's rather accessible and easily enhanceable.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The site's intrinsic value is average at best.

Use and management The site is not protected. Visit conditions are good, the site is easily accessible, and the site could be enhanced at relatively low cost.

Management measures No particular measure is needed.

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HRMgla001

Cheillon glacial system

Localisation: Glacier de Cheillon (Héré-mence)	Coordinates: 598.700 / 096.800	Altitude: 2370 m – 3870 m
Type: AER	Size: 6.88 km ²	Property: PRI (Grande-Dixence SA)

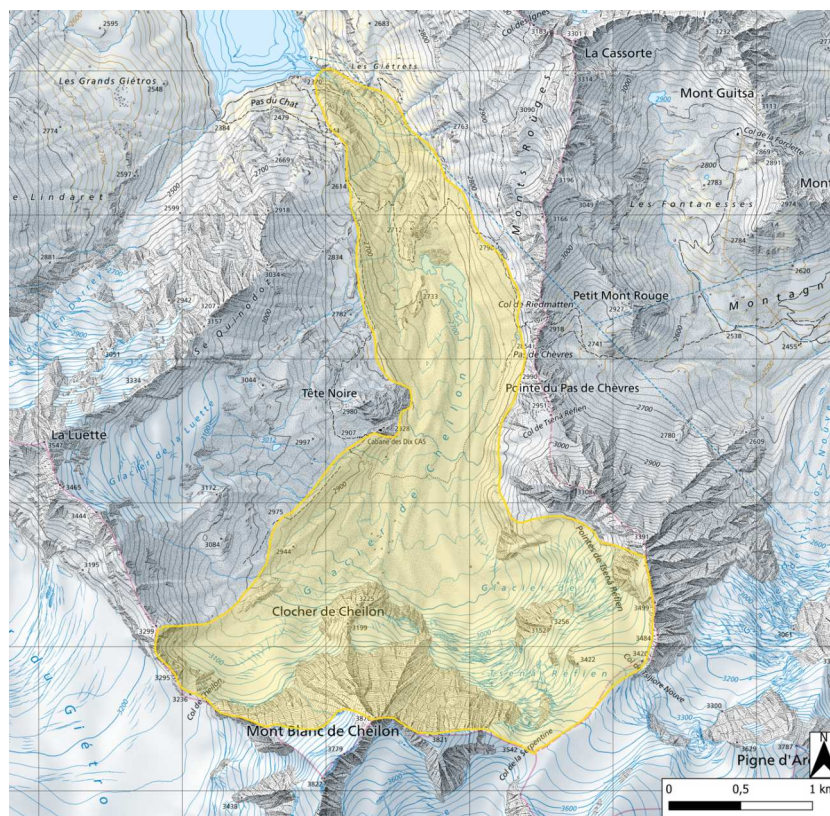


Figure A.34: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Cheillon glacier and the Lac des Dix (ph. Andrea Ferrando)



The Cheillon glacier and the Lac des Dix (ph. Andrea Ferrando)

Description The Cheillon glacier is located at the head of the Val des Dix. Its originates from the merging of two separate glaciers, at the northern foot of the Mont Blanc de Cheillon (3870 m). On the west, there is the Glacier de Cheillon proper, descending from the Col de Cheillon (3236 m), while on the east there is the Glacier de Tsenà Réfien, descending from the Col de Tsijiore Nouve (3420 m).

The two glaciers converge in a large, almost flat basin at an elevation of about 2800-2900 m. From there on, the main tongue flows down in a gentle valley for another 2.5 km, until the proglacial margin, situated at less than 2700 m. Much of the main glacier tongue is covered by debris.

The proglacial zone is large, and is listed in the inventory of alluvial zones of national importance since 2001. It is also part of the Dixence Federal District. In this area, all the glacial landforms such as roche moutonnée, verrous, moraines, are evident. The right-hand side of the glacier is more advanced than the other. On the other hand, the left side is curved due to the great thickness of the ice at this point. Downstream of the glacier, at the start of the sandur (proglacial plain), chunks of ice, like icebergs, break off from the glacier tongue. The sandur is crossed by braided streams and

ends in a fairly large alluvial zone. The most northerly section is no longer fed by the sandur, while heading south we come across a few eskers and drumlins. Further downstream the rocky escarpments on the two sides of the valley form a sort of rock sill. The rocks of the sill are smoothed, and represent fine examples of *roches moutonnées*. The proglacial stream crosses the sill with a small gorge, in which there is a long series of waterfalls and potholes. Along the sill, other inactive Nye channels with potholes can be seen.

At the foot of the sill there is another alluvial zone, which is what remains of a relict *sandur*. This represents the advance of the glacier around 1980. There appear to be remnants of dead ice. A second but much smaller lock is located downstream of this sandur zone. All these glacial gaps allow us to reconstruct the different stages of the glacier and its general direction. It must have formed an S shape in the landscape.

On either side of this area, most of which is still active today, moraines bear witness to the glacier's former passage. Moraines from the Little Ice Age are easy to spot. And there's one particularity worth noting. When we take the path leading to the Cabane des Dix, at an altitude of 2,620 m, an alluvial zone has formed behind the left lateral moraine, which acts as a dam.

The dominant colour in this landscape is grey, given that we are in a predominantly mineral environment. There is some vegetation, however, in the form of mosses in the northern part of the sandur.

Morphogenesis At the end of the Little Ice Age, the Cheilon glacier was still 5.3 km long (Hoelzle et al., 1999). Since then, it has begun a more or less constant retreat. As it retreated, it left more and more room for the proglacial margin, until a true alluvial zone was formed. Its sandur zone was always higher. In 1973, the glacier measured just 3.7 km and in 2000 3.3 km. Between 1924 and 2005, the glacier tongue lost just over 1 km in length (GLACIOLOGICAL REPORT (1881-2002)).

In this extremely fragile zone, active phenomena linked to the melting of the glacier can be observed every day. The whole environment is still

highly unstable and in perpetual motion. This is why the only vegetation to be found in the region is almost entirely moss, pioneer vegetation that appeared a few years ago. It is important to preserve such areas because they allow us to study the behaviour of several objects: the moraines, the glacier, the sandur and the vegetation. This environment is as interesting biologically (all stages of vegetation are visible) as it is geomorphologically and geologically (active processes).

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is in perpetual change due to the retreat of the glacier.	0.75
<i>Representativeness</i>	It's very representative of the active glacial zones in the high alpine environment.	1
<i>Rareness</i>	Glaciers are not rare in the region.	0.25
<i>Paleogeographical value</i>	As with the other valley glaciers of the region, the various associated landforms can help to study its advances and retreats in past times.	0.75
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Very sparse vegetation and typical fauna of the high alpine environment.	0.25
<i>Protected site</i>	The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 1170).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	There are several good view points in the upper Val des Dix.	0.75
<i>Contrasts, vertical development, space structuration</i>	The white colour of the glacier contrasts with the rocky surrounding environment. The different rock sills mark important ruptures in the landscape.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 1170).

Degradation risk

<i>Fragility</i>	The site is fragile in many of its elements: the glacier, the alluvial zones and the moraines. Other elements, such as the <i>roches moutonnées</i> , are not fragile.
<i>Natural vulnerability</i>	The moraines are very vulnerable to natural processes, such as runoff erosion, frost creep and gravitational processes. The glacier is bound to retreat further up due to climate change. So, there will be a continuous migration of the proglacial area further up the valley, along with the retreat of the glacier.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is null due to the remoteness of the site.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to the Chargeur bus stop, then 3h30' hike. The Chargeur can easily be reached by car. The Grande Dixence cable car, connecting the Chargeur to the top of the dam, permits to save 30-40 minutes of hiking time. To reach the glacier one has to hike up to the Cabane des Dix or the Pas des Chèvres (T3).	0.25
<i>Security</i>	There can be risk due to bad weather.	0.75
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Hiking trails and a refuge (Cabane des Dix)	0.75
Visit conditions	Average visit conditions	0.5

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretative facilities are present.	0
<i>Education interest</i>	The site is very well readable and understandable. Its valorisation could be done at low cost.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value of the site is very high, mainly because of its scientific and aesthetic value.

Use and management The site is included in the inventory of alluvial zones of national importance (OZA – Object n° 1170). Its visit conditions are average due to the long access, while the educational value is high.

Management measures No particular measure is needed.

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HRMcom001

Essertse peat bogs

Localisation: Essertse (Hérémece)	Coordinates: 594.537 / 111.300	Altitude: 2260 m – 2380 m
Type: AER	Size: 0.46 km ²	Property: COM (Consortage de l'alpage d'Essertse)

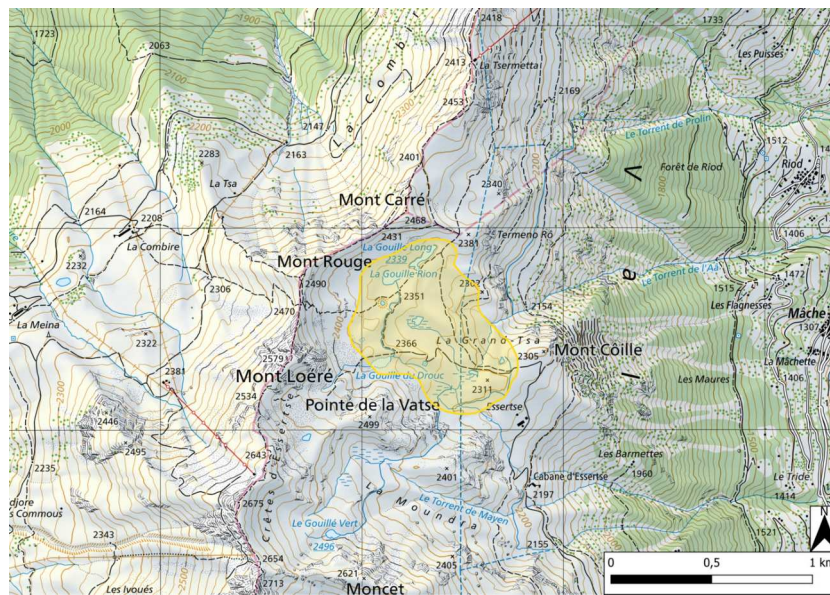


Figure A.35: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



*The terraced peat bog in Essertse
(ph. Andrea Ferrando)*



The Gouille Long and the Gouille Rond in Essertse (ph. Andrea Ferrando)

Description This geosite includes several levels of high marshes, located on a hanging hollow at 2300-2400 m on the western side of the Val d'Héremence. The hollow is rather large and flattish, and is bounded on the west by the watershed between the Héremence and Nendaz valleys, with the peaks of Mont Loéré (2579 m), Mont Rouge (2490 m) and Mont Carré (2468 m). On the south, the hollow is bordered by a secondary ridge which tops at the Pointe de la Vatsse (2499 m) and the Mont Côle (2305 m).

Most of the wetlands in Essertse are in the process of being filled in by sediments and organic matter, but this process is fairly slow, as in the case of Gouillé Rion (see photo above). Part of this geosite, the Grande Tsa, is a terraced peat bog. It is quite rare to find this in the Valais because of the continental climate. The majority of these landforms are found in humid regions, mainly in the Jura and the Pre-Alps. The Essertse peat bog is all the more special in that "it is found in extreme conditions and represents an altitude record for the Valais and probably for Switzerland". (Werner, 1994). This group of marshes forms one of the Cleuson-Dixence compensation biotopes. This area benefits from maintenance and renaturation work. In cultural terms, the Essertse mountain pasture, located below these terraces, is one of the cultural assets of regional importance. Generally speaking, the region has a fairly humid climate, with a relative

humidity of around 63% between November and April (Hoffer-Massard & Pivot, 2004).

From a geological point of view, this area is composed by rocks belonging to the Mont-Fort nappe, dissected and fractured by numerous faults. On the south, there are quartzschists and chlorite schists (Col de Chassoure Formation, Permian), while on the west and the north there are quartzites (Bruneggjoch Formation, Late Permian – Early Triassic). On the eastern side, by the two Gouilles, one finds gypsum and dolomites (St-Triphon Formation, Early-Middle Triassic). The Mont-Fort overthrusts the Siviez-Mischabel nappe, which constitutes all the lower part of the slope to the Hérémece valley floor (Ordovician gneiss and prasinites, Métailler Formation). While quartzites, quartzschists and gneiss are low-permeability rocks, gypsum and dolomites are more permeable, and they give way to small karst phenomena.

These wetlands encourage the development of a particular type of vegetation, adding to the richness of the Essertse region: "The vegetation is made up of floating sedge grass, the beaked sedge grouping, acid low marsh and high marsh". (Bressoud, 1993).

Morphogenesis The wetlands and peat bogs are located in a vast hanging hollow, which is a relict glacial cirque. Vegetated, partially dismantled morainic ridges are recognisable on the south-eastern side of the hollow. The Gouille Rond and Gouille Long formed in small dolines, located at the interface of permeable karst rocks (gypsum and dolomites) and impermeable rocks (quartzites).

While glacial processes are responsible for the general outlook of the area, the Essertse hollow has also been shaped by periglacial and nival processes. A relict rock glacier is present at the foot of Mont Loéré, while small relict block fields and block streams are located nearby. Well-developed snow moraines are visible just north of the two main Gouilles.

The whole area is rich in spring waters, probably due to the presence of several types of rocks with different properties in terms of permeability. This feature has not escaped the notice of mankind, who have built a

network of bisses (irrigation channels) here. In fact, anthropogenic action has shaped much of the wetland area. The two main Gouilles (Gouille Rond and Gouille Long) are fed by a small bisse, taking waters from the Gouille du Drouc – otherwise they would not have permanent water supply. The Gouille Rion is dammed on the eastern side, with a small earth dam which has partly been dismantled by erosion by the outlet of the lake. The Gouille du Drouc is artificial itself, as it's been realised with another small earth dam.

Various palynological studies have been undertaken in the region. In 1991, test pits and carbon-14 dating were carried out in the Gouillé Rion. The history of these marshes is as follows: around 13,000 BP, when the glaciers retreated from the region, a long period of erosion and readjustment of the post-glacial slopes deposited a lot of sedimentary material on which pioneer vegetation took root around 12,500-12,000 BP. A Scots pine forest then colonised the region until the appearance of larch and alder, which formed a vast forest reaching at least 2343 m between 9,500 and 3,600 BP. From 5,000 BP onwards, this forest began to thin out and its boundary gradually lowered until it was completely replaced by green alder bushes. It was not until around 1,700 BP that this forest vegetation gave way to meadows and pastures. This succession of vegetation allowed peat to form in a climate that was warmer and wetter than the present one. As the trees decomposed, they created the peat bogs we know today.

Nowadays there are signs of degradation in some spots of the site. The whole area is used for grazing by the alpage d'Essertse, and soil degradation due to overgrazing is visible here and there. The area is also very frequented by tourists, and this contributes to the degradation of soils. On the eastern side, the lower sill of the Essertse hollow is incised by a large gully which is evolving by headwards erosion – this gully feeds the Torrent de l'Aâ, which is one of the main active torrential systems on the western side of the Val d'Héremence.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is well conserved, but it shows signs of degradation due to pastoral activity and tourism.	0.75
<i>Representativeness</i>	This type of site is not very representative.	1
<i>Rareness</i>	This type of site – high marshes – is very rare in the region. Also, lakes forming in dolines and sinkholes are not frequent in this area.	1
<i>Paleogeographical value</i>	The peat bogs are of great importance for palinological reconstruction of past climates and environments.	1
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The presence of wetlands, small lakes and peat bogs makes this site very important for specialised flora and fauna.	1
<i>Protected site</i>	It is a compensation biotope for Cleuson-Dixence.	0.25
Ecological value	High ecological value.	0.75

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The geosite is only visible by ascending to the Essertse relict glacial cirque. View points are present on the ridge on the west of the cirque.	0.5
<i>Contrasts, vertical development, space structuration</i>	The flattish surface of the cirque contrasts with the surrounding steep slopes, while the several ponds, lakes and peat bogs add a great variety to the landscape.	0.75
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	The Alpage d'Essertse is among the cultural heritage of regional importance.	0.25
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	The site has a feeble economic importance due to it being exploited for grazing.	0.25
Cultural value	Low cultural value.	0.25

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is fragile as most wetlands and peat bogs are. Any perturbation can disrupt the equilibrium between biotic and abiotic components and lead to the degradation of the site.
<i>Natural vulnerability</i>	Some of the small lakes and ponds are bound to be filled by sediments, while some of the terraced peat bogs could be affected by runoff erosion. The integrity of the site is not endangered by these process.
<i>Anthropogenic vulnerability</i>	Overgrazing and tourist presence have led to the starting of soil degradation processes in some areas of the site.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	The site can be reached on foot by Thyon 2000 (1h) or by Praperot (3h), on the Val d'Hérémence floor. Both localities can be reached by bus.	0.75
<i>Security</i>	There can be risk due to bad weather.	0.75
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Hiking trails, and a refuge at 20' from the site (Cabane d'Essertse).	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are panels in site.	0.75
<i>Education interest</i>	The landforms require a mediation to be understood.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value Thanks to high scientific and ecological values, this site has a very high intrinsic value.

Use and management The site is not included in any inventory of protected areas, but there are some physical protections, mainly because of grazing. The site, and mainly its organic components (peat bogs), is fragile and vulnerable. The main risk factor is overgrazing and pressure by tourists, which have started to cause soil degradation.

Management measures It's important to make sure that cattles don't go into the proper wetlands. Tourism pressure can be reduced by prohibiting to leave the marked hiking trails and delimit dedicated areas for resting and picnics.

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HRMcom002

Bajin slope system

Localisation: catchment of Torrent de Bajin, western slope of Pic d'Artsinol (Hérémence)	Coordinates: 597.793 / 107.321	Altitude: 1558 m – 2997 m
Type: AER	Size: 4.18 km ²	Property: -

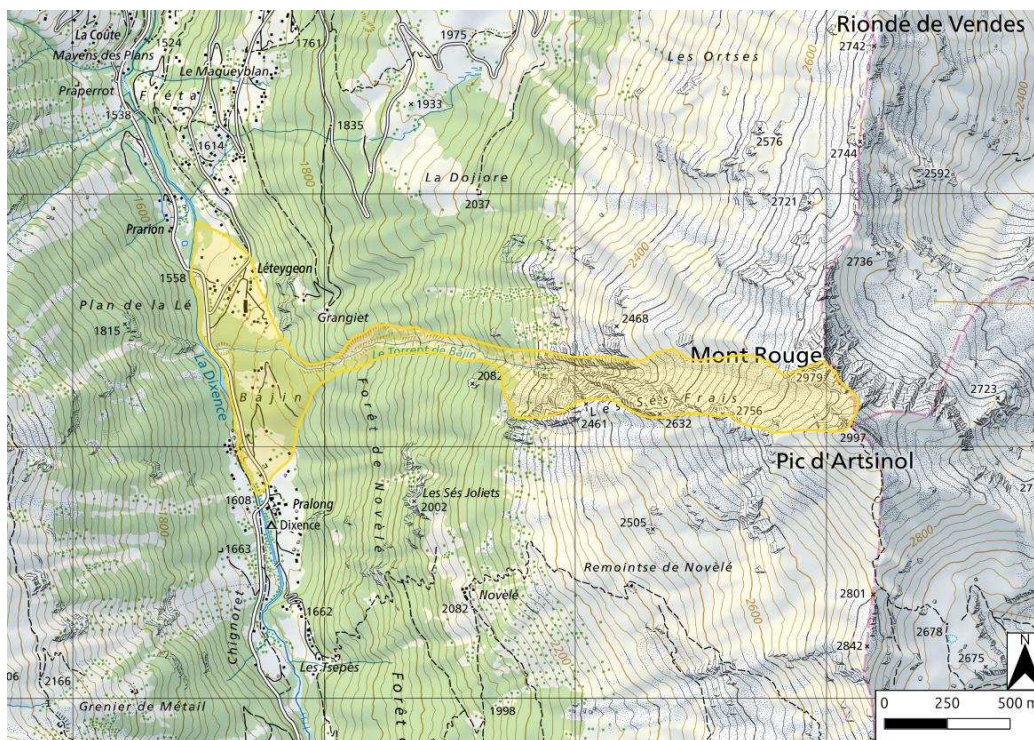


Figure A.36: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The head of the catchment of the Torrent de Bajin seen from Pic d'Artsinol (ph. Andrea Ferrando)



Pic d'Artsinol seen from Essertse (ph. Andrea Ferrando)

Description The site includes the catchment of the Torrent de Bajin, a small tributary of la Dixence river. The head of the catchment is located between Pic d'Artsinol (2997 m) and Mont Rouge (2979 m). From there, the small creek goes straight in W direction, down to the confluence with the Dixence at about 1550 m of elevation.

Morphogenesis The Torrent de Bajin catchment represent a slope system with interesting geomorphological dynamics. The upper rock scarps of Pic d'Artsinol and Mont Rouge feed the system with debris from rock falls. The head of the catchment is filled by a large active rock glacier, from which the creek flows out. The upper stretch of the creek flows on the bedrock, and is characterised by waterfalls and small gorges. The lower part of the creek flows on moraine deposits, and is characterized by a deeply eroded channel. The northern side of the channel shows evidences of gravitational collapse (trenches and double ridges), and intense runoff erosion. At the foot of the slope there is a large debris flow fan, partly constrained by topography. The lower part of the active channel of

the fan is characterised by concrete structures for the mitigation of geomorphological risk.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact except for the lower part of the debris flow fan.	0.75
<i>Representativeness</i>	The site is representative of torrential systems.	1
<i>Rareness</i>	High mountain slope systems are widespread in the region, but the interaction between different processes is notable.	0.5
<i>Paleogeographical value</i>	The site has no paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Along the slope one can observe all the vegetational succession from the lowest to the highest elevation, passing through coniferous forests with larch to dry prairies and sparse vegetation. Pioneer vegetation is present on the debris flow channels and cones. Fauna is that typical of high mountain environments.	0.5
<i>Protected site</i>	The site is not protected.	0
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is visible from the road from Hérémence to the Grande Dixence dam.	0.75
<i>Contrasts, vertical development, space structuration</i>	The slope has a very high and imposing vertical development, while the various elements (scree slopes, rock cliffs, the debris flow fan, and the rock glacier.) combine in a very pleasing way.	1
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic and literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	The natural vulnerability is related more to single landforms than to the geomorphological system itself.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is negligible.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to Pralong. The site is also reachable by car.	1
<i>Security</i>	No particular risk.	1
<i>Site context</i>	Traffic along the main road can disturb the visit.	0.5
<i>Tourism infrastructures</i>	Road and marked hiking trails.	0.75
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The geomorphological system is readable with mediation.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value The intrinsic value is from average to high in different respects.

Use and management The site is not protected or managed in any way. While fragility and vulnerability of the site are low, it is very susceptible to climate change.

Management measures No particular management measure is required.

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HRMper001

Allève rock glacier

Localisation: Combe d'Allève (Hérémece)	Coordinates: 594.550 / 104.550	Altitude: 2580 m – 3062 m
Type: AER	Size: 0.61 km ²	Property: -

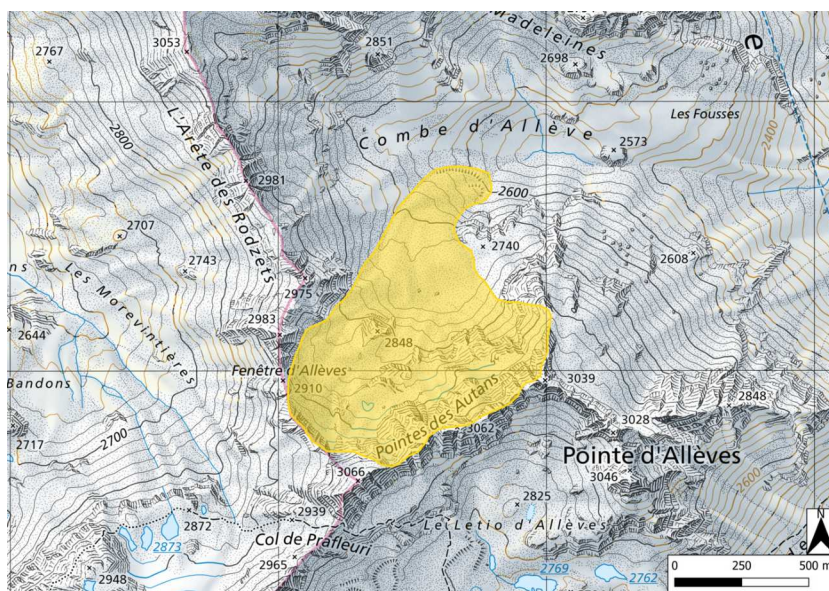
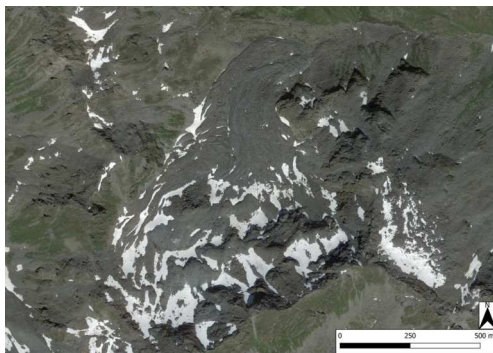


Figure A.37: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



Google Satellite view of the rock glacier.



The Allève rock glacier seen from Pic d'Artsinol. On the right hand side Mont Fort can be recognised (ph. Andrea Ferrando)

Description The geosite is located on the left side of the Val d'Hérémence, on a secondary valley called Combe d'Allève. The Combe d'Allève is a hanging valley, with its bottom step located at about 2500 m. It is surrounded by high mountain peaks, such as le Métailler (3213 m), l'Arête des Rodzets (2981 m) and the Pointes des Autans (3066 m and 3062 m). On the higher part of this small valley, several active rock glaciers and protalus ramparts are found. The geosite includes the largest one, situated on the southern side of the valley, at the foot of the Pointes des Autans.

The tongue of this rock glacier has a surface of about 24 ha, it's 600 m long. Its width varies from 400 m in the upper portion to 150 m at the lower front of the main tongue. It extends from 2750 m to 2580 m and it's characterised by several furrows formed because of its flow. On the eastern part they are longitudinal, while on the western part they are transversal. The lateral fronts are abrupt, and they rapidly evolve due to gravitational phenomena. The lower front is made up two easily recognisable lobes shaped by landslides; the slope of the lower front is about 40°, and fine material appears on it due to its rapid evolution. On the higher part of the rock glacier, two coalescing tongues can be recognised.

The rock glacier is fed by ancient moraines and by the large scree slope located on the northern side of the Pointes des Autans. The debris forms

because of gravitational processes and nivo-glacial action (some perennial snow fields and glacierets are still present on the slope, according to the Swiss topographical map, scale 1:25,000). For what concerns the bedrock, the feeding area is characterized by chlorite-albite schists and metagabbros belonging to the Métailler Formation (Cambrian – Early Ordovician), and these are the only lithologies found in the tongue of the rock glacier.

Morphogenesis The Combe d'Allève is a typical high alpine small valley, shaped by glacial and periglacial processes. During the last glacial maximum, a small glacier covered the valley. Its retreat probably started in the Lateglacial stage. As of now, there are only small remains of this glacier: small glacierets and snowfields on the northern side of the Pointes des Autans and on the south-eastern side of le Métailler.

The Allève glacier left great quantities of morainic material on the bottom of the valley. Because of the presence of interstitial ice, this material started to flow, forming the tongue of the rock glacier. The formation of the rock glacier is favoured also by the high elevation and the aspect of the slope, which is north-facing. The rock glacier is fed also by debris coming from the upstanding scree slopes.

The Allève rock glacier is active, as testified by geomorphological indicators: the absence of vegetation, the abrupt lateral and lower fronts, the presence of several furrows and ridges. The movement at the front was estimated to be up to 1 cm per day (Delaloye et al., 2005) due to the presence of an important quantity of interstitial ice.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The geomorphosite is intact.	1
<i>Representativeness</i>	Very representative example of an active rock glacier.	1
<i>Rareness</i>	Rock glaciers are common in the valley.	0
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The vegetation consists mainly of lichens. The fauna is rich, with marmots, ibexes, chamois and birds of prey.	0.5
<i>Protected site</i>	The site is not protected	0
Ecological value	Low ecological value.	0.25

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The rock glacier is situated on the bottom of a high valley, far from hiking trails. It can be seen from afar, from some of the peaks of the Val d'Hérémence (e.g. Pic d'Artsinol), but ultimately there are no good view points.	0
<i>Contrasts, vertical development, space structuration</i>	The tongue of the rock glacier is well developed and the head of the valley in which it is situated is imposing.	0.5
Aesthetic value	Low aesthetic value.	0.25

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	Periglacial landforms like this are very vulnerable to climate change. With rising temperatures, the permafrost zone is bound to get higher, causing some of the now-active rock glaciers to become inactive.
<i>Anthropogenic vulnerability</i>	The site is very remote, far from human activities and even from mountain hiking trails, so its anthropogenic vulnerability is very low.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour in the summer season to the Chargeur, at the base of the Grande Dixence dam. From there it takes another 2h30' of hiking, half of which is along the hiking trail that connects the Grande Dixence and Thyon 2000, and the other half is scrambling on rough terrain with no paths on it.	0
<i>Security</i>	Being remote and far from marked trails, there is very high danger of becoming lost, and danger of accidents.	0.25
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	No tourism infrastructures.	1
Visit conditions	Bad visit conditions	0.25

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretive facilities.	0
<i>Education interest</i>	The landform is visible but not easily readable by non-specialists.	0.25
Education	Low educational value	0.25

Synthesis

Intrinsic value The scientific value of the site is average: the rock glacier is intact and representative of the geomorphology of the valley, but it's not rare and the access is difficult.

Use and management The site is not managed.

Management measures No particular management measure is required. Given that the site is very remote, it can hardly be enhanced for geotourism.

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RECflu001

Réchy postglacial gorge

Localisation: Along the Rèche stream, between Réchy and les Moulins (Grône - Chalais)	Coordinates: 604.356 / 121.994	Altitude: 570 m - 900 m
Type: AER	Size: 75,500 m ²	Property: PUB (Communes de Chalais and Grône)

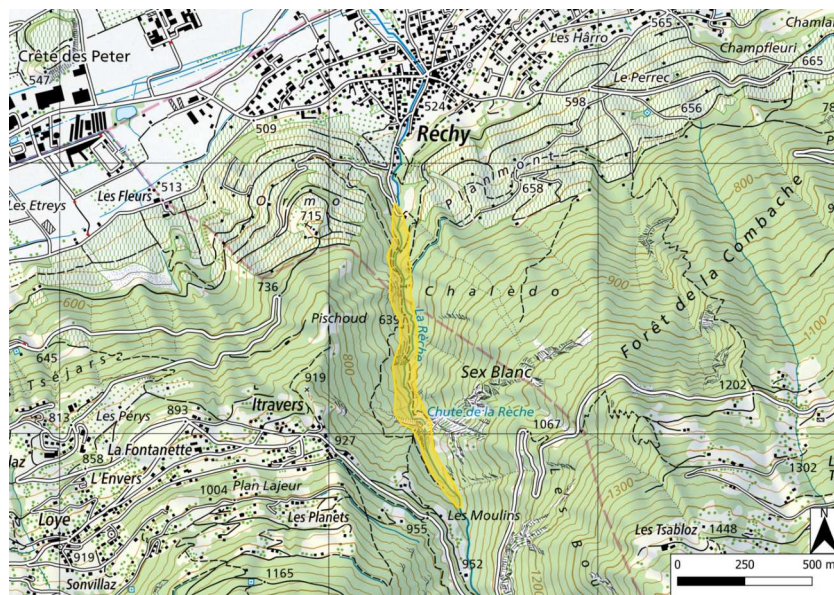


Figure A.38: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Rèche waterfall (ph. Charly Arbellay)



Panoramic view of the lower Val de Réchy. The gorge is visible on the center of the photo (ph. Andrea Ferrando)

Description The Rèche stream has its spring in the upper Val de Réchy, and then flows northward to the Rhone valley. Downstream of the locality called les Moulins, the stream enters a gorge and then falls from a 100-meters high cliff (the Sex Blanc), forming the waterfall called Chute de la Rèche. The stream then flows through a deep forested valley and then exits from the gorge by the village of Réchy; the village is built on the alluvial fan of the Rèche, which then joins the Rhone river.

Morphogenesis The site is a very typical example of the postglacial evolution of a hanging valley. After the retreat of the Ice Age glaciers, the base level of the Val de Réchy was higher than the valley floor of the Rhone. The ancient base level of the Val de Réchy can be located at an elevation about 900-950 m, and it's testified by the glacial shoulder where the village of Itravers has been built. The Rhone valley floor is located at about 500 m instead. To re-establish its equilibrium profile, the Rèche stream evolved by regressive erosion, and formed a typical connection gorge.

The particular morphology of the gorge is due to lithological factors. In the lower part, from Réchy to the base of the waterfall, the bedrock is made of Carboniferous schists and Permian paragneiss and micaschists.

All these rocks are very fractured and easily erodible, so the Rèche could deepen its valley.

At the base of the waterfall the geological map shows the presence of a fault, that puts in contact the Permian paragneiss with very hard Triassic dolomites. The dolomites form the high cliff where the waterfall is located. Being hard and resistant, the dolomites acted as a barrier in the respect of the regressive erosion, bringing to the formation of the high cliff of the Sex Blanc.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The geomorphosite is intact.	1
<i>Representativeness</i>	The site is very representative of a connection gorge, that is a typical postglacial landform in the area.	1
<i>Rareness</i>	This landform is not particularly rare in the study area.	0.5
<i>Paleogeographical value</i>	It testifies the postglacial evolution of the tributary valleys of the Rhone.	0.5
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The presence of a stream favours the development of particular flora and fauna.	0.5
<i>Protected site</i>	The site is not protected	0
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	There is only one good view point and it's currently inaccessible due to landslides. The surrounding area is covered by dense forests. On the contrary, the whole lower Val de Réchy can be seen from the opposite slope of the Rhone valley (Flantey, Ollon VS, Chermignon d'en Bas etc.).	0.25
<i>Contrasts, vertical development, space structuration</i>	The high dolomite cliff with the Rèche waterfall is very imposing, and it contrasts with the surrounding forested slopes.	0.75
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	Downstream of the waterfall, in the gorge, there is a coal mine that was active from 1858 to 1957. Upstream there is an ancient bisse (artificial canal) from the 17th century, and a mill.	0.75
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	The site had a past economic importance due to the presence of coal.	0.25
Cultural value	Average cultural value.	0.5

Protection

Protection status The site is not protected.

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	The site could be susceptible to floods by the Réche, and the gorge walls are very prone to landslides, especially downstream of the waterfall, where very fractured paragneiss and micaschists crop out. These processes don't represent a risk for the integrity of the site itself, but they are a risk factor for human infrastructure (i.e. the paths to visit the site).
<i>Anthropogenic vulnerability</i>	The site is near to the town of Réchy, and it has been affected by mining activity. Nevertheless, the anthropogenic impact has been modest, and the vulnerability is low.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Two buses per hour all year long to Réchy, then it's a 40' hike to the waterfall.	0.75
<i>Security</i>	The last stretch of the hiking trail to the waterfall is exposed to landslides.	0.5
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Hiking trails.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	Along the path to the waterfall there are panels about the waterfall itself and the coal mine.	0.5
<i>Education interest</i>	The landform is easily visible, but its understanding requires a mediation. The enhancement of the site is possible only if geomorphological risk along the access trail is reduced.	0.5
Education	Average educational value	0.5

Synthesis

Intrinsic value The intrinsic value is high, due to high scientific and ecological value, and a fair historical importance.

Use and management The site is not protected. Hiking trails with panels are present at the site, but the main one to access the Rèche waterfall is closed due to landslides. The educational value of the site is average, but visit conditions are bad due to geomorphological risk.

Management measures To ensure that visit conditions are improved, interventions must be made to reduce the geomorphological risk along the hiking trail to the gorge and the waterfall.

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RECgla001

Réchy relict glacial system

Localisation: Upper Val de Réchy (Mont-Noble)	Coordinates: 605.297 / 115.017	Altitude: 2183 - 3025 m
Type: AER	Size: 0.17 km ²	Property: PUB (Commune de Mont-Noble)

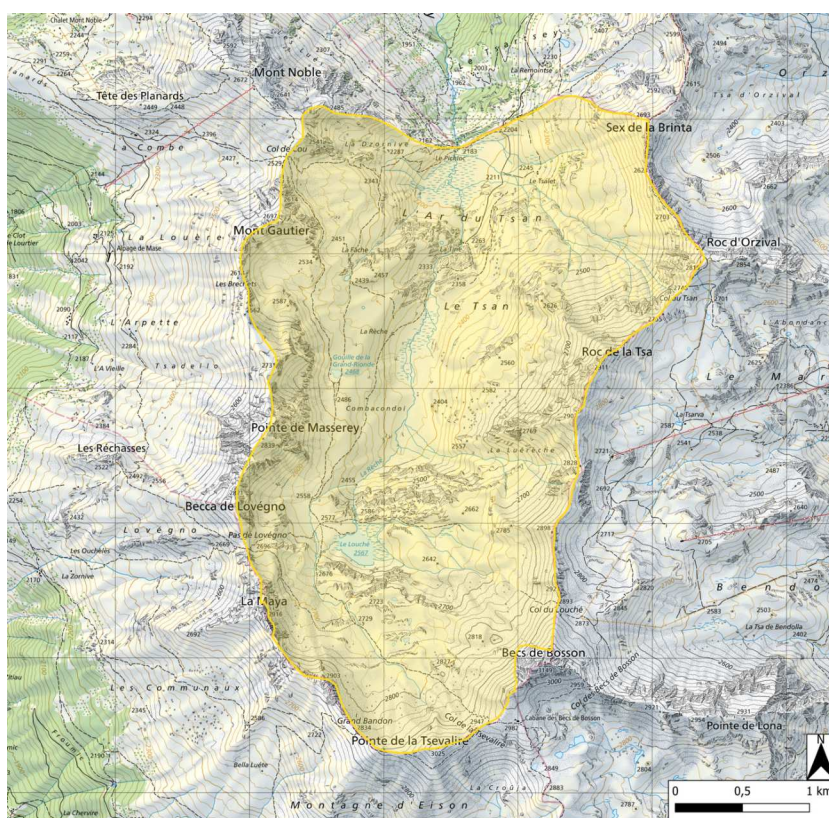


Figure A.39: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Louché glacial lake (ph. Andrea Ferrando)



The upper Val de Réchy, with alternating plains and rock steps; on the background the Becs de Bosson (ph. Andrea Ferrando)

Description The upper Val de Réchy extends from the Ar du Tsan hollow, at about 2200 m, to the valley head, dominated by the Becs de Bosson (3149 m) and Pointe de la Tsevalire (3025 m). On the western side runs the watershed between the Val de Réchy and the lower Val d'Hérens, with the peaks of la Maya (2916), Pointe de Masserey (2839 m), Mont Gautier (2697 m) and Mont Noble (2672 m). On the eastern side, the ridge separates the Val de Réchy from the Val d'Anniviers; the main peaks here are Roc de la Tsa (2911 m), Roc d'Orzival (2854 m) and la Brinta (2659 m).

This upper stretch of the Val de Réchy shows a very typical glacial morphology, with a "U"-shaped transversal profile, and a longitudinal profile made of alternating steep scarps and flattish areas; in the flattish areas and hollows, lakes and wetlands are present (le Louché, Ar du Tsan).

From the Col de Tsevalire, looking in the direction of Ar du Tsan, it is possible to recognise several rocky escarpments followed by successive flat areas and hollows. The first level runs from the pass to the top of the rocky escarpments, just over 100 m high, upstream of Lac de Louché. The latter was formed on a second flat area immediately preceding new escarp-

ments, also around 100 m high. This is the start of a narrow valley that runs for around 1.5 km before reaching the rocky escarpments overlooking the Ar du Tsan. The wetland is located on a hollow that precedes a larger step that marks the downstream limit of the upper Val de Réchy and from which a waterfall falls.

These escarpments, all cut by the Rèche from the Lac de Louché, have the same morphology. The rock in front of them appears smoothed and striated, while downstream of the escarpments the ground is covered with more or less coarse sediment or organic matter, as at the Ar du Tsan. Three alluvial fans have been identified: on the eastern side of Lac de Louché, on the eastern flank of the small valley downstream and on the eastern side of Ar du Tsan. Overall, from the centre of the Haut Vallon de Réchy to an altitude of around 2,600 m, the ground is covered with herbal vegetation, except where rock outcrops.

From a geological point of view, the Vallon de Réchy shows a significant section of the Grand St-Bernard nappe: frontal region with tectonics complicated by scales of Permo-Carboniferous rocks, Triassic limestone dolomites and gypsum; further south the crystalline core of Siviez-Mischabel, covered by the Permo-Triassic sedimentary rocks; on the highest summits there are overthrust elements of the schistes lustrées of the Combin area.

Morphogenesis These alternating flats and escarpments are in fact a succession of sills (escarpments) and overdeepening hollows sculpted by the glacier that occupied the entire valley during the last glaciation (Würm). The rock sills are present where the rock is harder, while the overdeepening hollows develop in more fractured or altered rocks (Tenthorey, 1993). As the glacier retreated during the late glacial period, it deposited both ground moraine and constructed moraine at the bottom and on the slopes of the valley. Below 2600 m, the morainic deposits have been colonised by vegetation, while higher up, in addition to deglaciation causing a readjustment of the slopes, periglacial processes have remobilised the moraine material (Tenthorey, 1993, Winistorfer, 1978).

Two phases of evolution can be observed in the hollows of the study area. Following the retreat of the glacier and the influx of meteoric and meltwater, the hollow fills with water and forms a lake, like the Louché lake. Over time, the sediments from the rivers that feed the lake eventually fill the lake completely, forming a marshy area such as Ar du Tsan. The hydrographic system, and the Rèche in particular, also contributed to transforming the site when the glacier retreated, either by incising the glacial deposits and the rock, for example the escarpments, or by encouraging the transport and deposition of sediments in the valley and creating alluvial fans which contributed or are contributing to filling in the glacial trough.

As of today, all the glacial landforms of the valley are relict. The site is being shaped mainly by periglacial and nival processes at the higher elevations (there are significant rock glaciers and patterned grounds), by gravitational processes (the valley sides are covered by scree slopes, debris cones etc.) and by runoff and fluvial erosion.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact, and the relict glacial morphology has not been substantially altered by subsequent processes.	1
<i>Representativeness</i>	The site is representative of a high mountain valley.	1
<i>Rareness</i>	This type of glacial morphology is slightly common in the region.	0.5
<i>Paleogeographical value</i>	The relict glacial landforms allow to reconstruct the recent evolution of the site.	1
Scientific value	High scientific value.	0.75

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Some glacial landforms, such as overdeepening hollows allow the formation of particular environments (the Louché lake, the wetland of the Ar du Tsan) that have a high ecological impact.	1
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	Very high ecological value.	1

Additional values

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site has lots of excellent view point, from the whole upper Val de Réchy and the surrounding ridges.	1
<i>Contrasts, vertical development, space structuration</i>	The alternation of plains and scarps, and the contrast between the green prairies and the greyish rocks are important. The Louché and the Ar du Tsan are other elements of contrast.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).

Degradation risk

<i>Fragility</i>	The site is not particularly fragile.
<i>Natural vulnerability</i>	A whole lot of geomorphological process act on the relict glacial landforms of the valley: periglacial, nival, runoff and fluvial, gravitational processes. But they aren't likely to substantially affect the integrity of the site, due to its very large area.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is null.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to Nax or Grimentz. Then 5h hike from Nax, or a 4h hike from Grimentz. Site is accessible from the A Vieille dirt road (there is a car park at about 2150 m) and then following the hiking trail to Pas de Lona, Col de la Tsevalire and the upper Val de Réchy (about 3h30'). In any case, trails are marked and not difficult (T3). The Val de Réchy is also accessible by Eison, by crossing the Pas de Lovégno.	0.5
<i>Security</i>	Risk can be due to bad meteorological conditions.	0.5
<i>Site context</i>	Calm high mountain environment with no perturbations.	1
<i>Tourism infrastructures</i>	Marked hiking trails.	0.5
Visit conditions	Average visit conditions	0.5

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are panels all around the Val de Réchy. Some of them focus on the geo(morpho)logical setting of the valley.	0.5
<i>Education interest</i>	The site is quite easily readable by visitors, with mediation. The very high variety of landforms and processes causes the Val de Réchy to have a very high education potential.	1
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value is very high, due to it being a site with scientific, ecological and aesthetic interest.

Use and management The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona). The site is not protected nor vulnerable, and has a high education potential, partially marred by the long access.

Management measures No particular measure is needed.

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RECgra001

Mont Gautier DSGSD trench

Localisation: Between les Brechets and Mont Gautier (Mont-Noble)	Coordinates: 603.980 / 115.941	Altitude: 2580 m – 2690 m
Type: AER	Size: 36,000 m ²	Property: PUB (Commune de Mont-Noble)

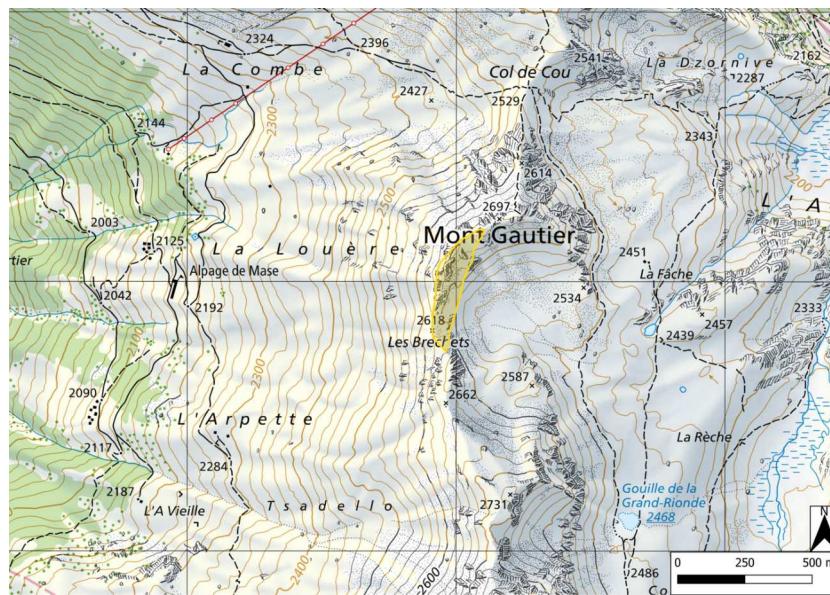


Figure A.40: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The trench as seen from the northern peak of Mont Gautier (ph. Andrea Ferrando)



Another view of the trench, with a solifluction lobe in it (ph. Andrea Ferrando)

Description The site is located on the watershed between the lower Val d'Hérens and the Val de Réchy, between the summit of Mont Gautier (2697 m) on the north and the pass of les Brechets (2618 m) to the south. It consists of a trench that causes a doubling of the ridge, and was formed because of a deep-seated gravitational slope deformation (DSGSD), also called sackung. The trench is 350 meters long; the distance between the two ridges is always less than 100 meters. The ridge on the west side is higher than the one on the east side, which elevates itself of only a few meters from the bottom of the trench.

Morphogenesis The presence of trenches within a doubling of a ridge is one of the typical geomorphological indicators of a DSGSD. In this case, a large volume of rocks is displaced towards the west (to the side of the Val d'Hérens). The displaced rock mass covers an area of about 2.5 km², and goes from the watershed between the Val d'Hérens and the Val de Réchy to the la Manna stream. It has a thickness of about 50 meters. The displacement is around 5 meters (Sartori & Epard, 2011).

The formation of the DSGSD is due to the geological context of this mountain slope. There are three main rock formation outcropping. From the bottom to the top of the slope there are: 1) Col de Choussure Formation

(early Permian), made by soft quartzschists and sericitoschists; II) Brunegjoch Formation (late Permian – early Triassic), made of hard quartzites and quartz-conglomerates; III) the Série Rousse (mid Cretaceous), made of reddish marbles. The first two formation belong to the Siviez-Mischabel nappe, while the third is part of the Tsaté nappe. Thus, there is also a thrust fault separating the two tectonic nappes.

The evolution of the DSGSD is best summarised as regressive destabilisation, induced by the geomechanical characteristics of the rock formations that compose the slope. The deformation started in the soft Col de Choussure Formation, and then it extended upwards, affecting the overlying quartzites and marbles. The red marbles outcropping on the ridge between les Brechets and Mont Gautier are also very fractured, and traction fissures probably related to the DSGSD can be observed all along the summit ridge of Mont Gautier.

The two slopes of the DSGSD trench are affected by periglacial processes, in particular frost creep and gelifluction. Small terraces and garlands can be observed all along the trench, while the southern part is filled by a well developed gelifluction lobe.

The western slope of the trench is characterised by very fractured rock walls. The occurrence of rock falls has created a small scree slope at the base of the rock walls.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is representative of the gravitational landforms of the region.	0.75
<i>Rareness</i>	DSGSD trenches this developed and visible are not that common.	0.75
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Typical vegetation of dry prairies in high mountain environment.	0.25
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is included in the perimeter of Object n° 216 in the Inventory of Swiss Geotopes (Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is only visible from la Brechette and Mont Gautier.	0.5
<i>Contrasts, vertical development, space structuration</i>	The double crest and the trench give a slight contrast with the otherwise sharp watershed between the Val de Réchy and the Val d'Hérens. It's more developed horizontally than vertically.	0.5
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).

Degradation risk

<i>Fragility</i>	The site is not fragile.
<i>Natural vulnerability</i>	No short term active process is active at the site.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is null due to the remoteness of the site.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	The site is accessible only with long hikes, partially out of marked trails. The shortest route would be to start from les Mayens des Praz (reachable by car) and then take the hiking trail to Col de Cou. At the col turn right towards le Louché, but then go out of the marked trail to reach les Brechets (3h30'; T4). From the Col de Cou one can climb up to Mont Gautier (T4+), from which the DSGSD trench is also visible.	0.25
<i>Security</i>	Risk of accident in case of bad weather, and also due to difficult terrain.	0.25
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	No infrastructure.	0
Visit conditions	Bad visit conditions	0.25

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretative facilities are present.	0
<i>Education interest</i>	The site requires a mediation to be understood, and it's not easy to enhance due to difficult access.	0.25
Education	Low educational value	0.25

Synthesis

Intrinsic value The site has an high scientific value, but not much of ecological, cultural or aesthetic value, making for an average intrinsic value overall.

Use and management The site is indirectly protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and in one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona). Visit conditions are average, mainly due to long and difficult access, that makes any kind of enhancement very difficult. The site is not fragile nor vulnerable.

Management measures No particular measure is needed.

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REckar001

Becs de Bosson gypsum dolines

Localisation: North of the Col de la Tsevalire (Mont-Noble)	Coordinates: 605.439 / 112.878	Altitude: 2770 m – 2827 m
Type: AER	Size: 41,000 m ²	Property: PUB (Commune de Mont-Noble)



Figure A.41: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The biggest doline of the site (ph. Andrea Ferrando)



Panoramic view of the dolines and the gypsum outcrops from the Pointe de la Tsevalire (ph. Andrea Ferrando)

Description The geosite is located in the upper part of the Val de Réchy, on the north-western side of the Becs de Bosson, at about 2800 m of altitude.

It comprises four dolines developed in an outcrop of gypsum and carnioles. The main one, located on the side of the hiking trail between le Louché and Col de la Tsevalire, is about 20 meters in diameter and has a depth of 6 meters. The other dolines are not that well developed, some of them are strongly asymmetric, but with evident absorption points for running waters. The gypsum outcrop is very well visible because of its white color, that contrasts with the brownish or greyish surrounding rocks.

Morphogenesis The site includes good examples of surface karst landforms developed on a gypsum outcrop. These landforms develop because of the action of runoff waters, charged in CO₂ from the atmosphere. The runoff waters cause the dissolution of gypsum, which is about 100 times faster than the dissolution of carbonate rocks (Salomon, 2006).

The dolines were formed in the base layer of the St-Triphon formation (Dorchaux member, Anisian), which is composed by white gypsum, partly substituted by carnioles (vacuolar breccias with elements of dolomites, metapelites and quartz).

Supply of water is mainly given by the melting of snow that accumulates on the dolines. In fact, nival erosion helps the dissolution process. Water absorbed by the dolines runs underground in east-south-east direction, and comes out in springs on the Anniviers valley (Cochand et al., 2009).

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	Karst processes are not representative of the geomorphology of the region, but are a little bit more diffused in the Val de Réchy and its surroundings.	0.5
<i>Rareness</i>	This kind of landforms is rarely found in the Val d'Hérens area.	1
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	High scientific value.	0.75

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	No ecological impact.	0
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is included in the perimeter of Object n° 216 in the Inventory of Swiss Geotopes (Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	There are good view points from the ridge between the Beccs de Bosson, the Col de la Tsevalire and the Pointe de la Tsevalire. The main doline is well visible from a marked hiking trail, while the others are visible with short deviations from it.	0.5
<i>Contrasts, vertical development, space structuration</i>	The site has a great contrast with the surrounding landscape. Vertical development is not that impressive.	0.5
Aesthetic value	Average aesthetic value.	0.5

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).

Degradation risk

<i>Fragility</i>	The site is fragile because it's a single landform in evolution.
<i>Natural vulnerability</i>	Some of the dolines on the eastern part of the geosite interact, and in fact are covered by talus scree and the Beccs de Bosson rock glacier. The sides of the main doline evolve because of rock falls, which are quite frequent due to the bad geomechanical characteristics of the gypsum.
<i>Anthropogenic vulnerability</i>	On the present situation, the anthropogenic vulnerability of the site is almost null. The site is far from roads, settlements and human activities.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to Nax or Grimentz. Then 5h hike from Nax, or a 4h hike from Grimentz. Site is accessible from the A Vieille dirt road (there is a car park at about 2150 m) and then following the hiking trail to Pas de Lona, Col de la Tsevalire and the upper Val de Réchy (about 3h30'). In any case, trails are marked and not difficult (T3).	0.5
<i>Security</i>	Risk can be due to bad meteorological conditions.	0.5
<i>Site context</i>	Calm high mountain environment with no perturbations.	1
<i>Tourism infrastructures</i>	Marked hiking trails.	0.5
Visit conditions	Average visit conditions	0.5

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are panels all around the Val de Réchy. Some of them focus on the geo(morpho)logical setting of the valley.	0.5
<i>Education interest</i>	The site is quite easily readable by visitors.	1
Education	High educational value	0.75

Synthesis

Intrinsic value The site has an average intrinsic value. Landforms are well conserved, rare and easily comprehensible by the general public. The only drawback is the low accessibility of the site, which can be visited only by trained hikers.

Use and management The site is indirectly protected. Panels are present on several spots of the Val de Réchy, with some of them focusing on the geomorphology of the area. Fragility and vulnerability of the site are low.

Management measures Since a marked hiking trail passes just on the side of the main doline, a specific panel could be posed in that spot. Other management measures are not needed.

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REckar002

Col du Tsan gypsum dolines

Localisation: Col du Tsan (Mont-Noble / Anniviers)	Coordinates: 607.070 / 115.658	Altitude: 2660 m – 2780 m
Type: AER	Size: 0.13 km ²	Property: PUB (Commune de Mont-Noble et de Anniviers)

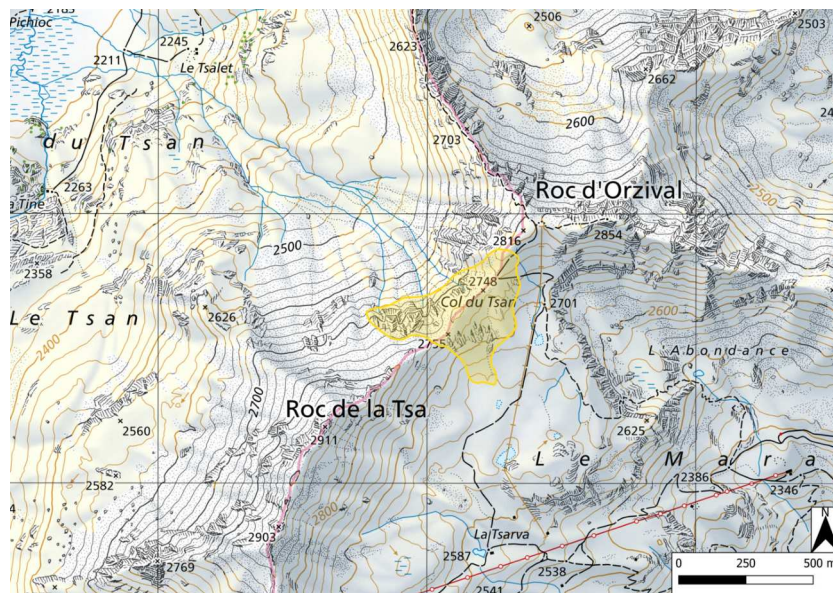


Figure A.42: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

	
<p><i>View of the Col du Tsan from the west; on the left the Roc d'Orzival (ph. Andrea Ferrando)</i></p>	<p><i>Zoom on the gypsum pyramids (ph. Andrea Ferrando)</i></p>

Description The Col du Tsan (2748 m) is located on the watershed between the upper Val de Réchy and the Val d'Anniviers. It stands between the Roc d'Orzival (2854 m) on the north and the Roc de la Tsa (2911 m) on the south. The mountain pass is characterised by asymmetrical slopes. The north-western slope, facing the Val de Réchy, is very steep, while the south-eastern slope, descending on the Val d'Anniviers, is rather gentle.

From the geological point of view, the area between the Col du Tsan and the Roc d'Orzival is made of rocks belonging to the Cimes Blanches nappe (Briançonnais domain, ancient continental margin): very deformed Triassic gypsum and dolomites, with interbedded lenses of calcschists. On the south, the Cimes Blanches nappe is overthrust by the Tsaté nappe, formed by Jurassic-Cretaceous oceanic rocks (metabasalts and calcschists). These rocks outcrop on the ridge that goes up to the Roc de la Tsa.

The gypsum that outcrops at the Col du Tsan is modeled in different landforms on the two sides of the mountain pass. On the steeper side, dissolution and runoff processes have formed rock pyramids and gullies, while on the gentler side gypsum dissolution resulted in the formation of dolines, some of which are filled by small ponds.

The western side of the Col du Tsan, with the gypsum pyramids, is included in the Federal Inventory of Landscapes, Sites and Natural Monu-

ments; the site is Object n° 1718 Val de Réchy-Sasseneire.

Morphogenesis The site includes examples of surface karst landforms developed on gypsum. These landforms develop because of the action of runoff waters, charged in CO₂ from the atmosphere. The runoff waters cause the dissolution of gypsum, which is about 100 times faster than the dissolution of carbonate rocks (Salomon, 2006).

The development of surface karst landforms depends mainly on the steepness of the slope: on rounded ridges or plains there's the formation of symmetric dolines and small pyramids; on gentle slopes asymmetric dolines develop, while on steeper slopes gullies, pyramids and monoliths are found. This situation is reflected on the two asymmetrical sides of the Col du Tsan.

The gypsum pyramids are still shaped by the erosion and dissolution by runoff waters and meltwaters. Gravitational processes are active on the outcrop, mainly rock falls and small debris flows, which result in debris cones at the foot of the slopes.

The southern part of the gypsum outcrop is partially covered by scree coming from the upper portion of the slopes of the Roc de la Tsa. This debris cover is affected also by periglacial processes, in particular frost creep and gelifluction, resulting in small terraces and lobes.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	Not the best examples of gypsum pyramids in the area, but solid.	0.5
<i>Rareness</i>	It's the only occurrence of gypsum pyramids developed on steep slopes in the Val d'Hérens and Val de Réchy area.	0.75
<i>Paleogeographical value</i>	No paleogeographical value.	0
Scientific value	Average scientific value.	0.5

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The vegetation is sparse. At the Col du Tsan the presence <i>Cerastium alpinum</i> , quite rare in the region, is reported.	0.5
<i>Protected site</i>	The site is partially protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	High ecological value.	0.75

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site is well visible from the surrounding areas. There are some good view points in the area between Ar du Tsan, Mont Gautier and Mont Noble.	0.75
<i>Contrasts, vertical development, space structuration</i>	The pyramids are well developed vertically, and the white colour of gypsum contrasts with the darker hues of the surrounding rocks. The pyramidal shapes are also quite impressive.	1
Aesthetic value	High aesthetic value.	0.75

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is partially protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).

Degradation risk

<i>Fragility</i>	The gypsum pyramids are fragile, as the karst and runoff processes that shaped them will cause their continuous evolution and destruction.
<i>Natural vulnerability</i>	Gravitational processes can affect the integrity of the pyramids.
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is low. Not far from the Col du Tsan there are skilifts and ski runs, but the pyramids are on a very steep slope, and that ensures them a sort of natural protection from anthropogenic pressure related to skiing.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	The shortest route is to start from Grimentz, reachable by bus or by car, then take the cable car to Bendolla (alternatively, 1h45' on foot). From Bendolla, another 1h30' long hike is required to arrive at the Col du Tsan (T3).	0.75
<i>Security</i>	There is some risk in case of bad weather conditions. High risk of falling if one descends from the Col du Tsan to the slope on where the pyramids are located.	0.75
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Hiking trails and skilifts.	0.5
Visit conditions	Good visit conditions	0.75

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	No interpretative facilities are present.	0
<i>Education interest</i>	The site is easily readable, with mediation, but it's rather accessible and easily enhanceable.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The site has high scientific, ecological and aesthetic value. Only the cultural value is null.

Use and management The site is partially protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).. Visit conditions are good, and the site could be enhanced at relatively low cost. The gypsum pyramids are quite fragile and vulnerable to natural processes. Human pressure is negligible.

Management measures No particular measure is needed. Panels could be posed near the Col du Tsan to explain the geomorphology of the site.

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RECgla002

Ar du Tsan peat bog

Localisation: l'Ar du Tsan, Val de Réchy (Mont-Noble)	Coordinates: 605.498 / 116.550	Altitude: 2184 m
Type: AER	Size: 0.16 km ²	Property: PUB (Commune de Mont-Noble)

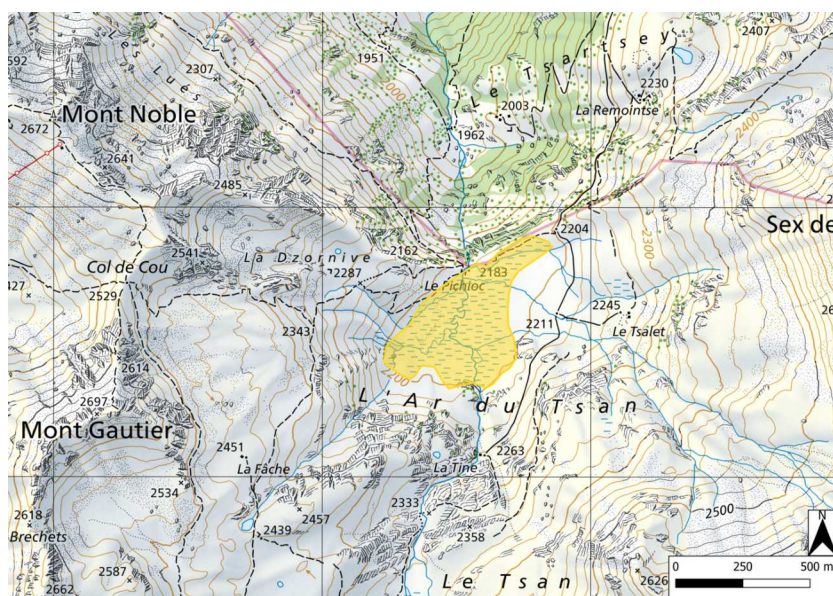


Figure A.43: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs



The Ar du Tsan wetland (ph. Andrea Ferrando)



Panoramic view of the Ar du Tsan, with active and inactive meanders (ph. Andrea Ferrando)

Description The Ar du Tsan is a large hollow located in the upper Val de Réchy, at an elevation of 2184 m. The flat bottom of the hollow hosts one of the most important wetlands of the area, its surface being 0.16 km². The hollow is surrounded by high mountain peaks, such as the Sex de la Brinta (2693 m) on the eastern side, and the Mont Gautier (2697 m) and the Mont Noble (2672 m) on the west.

The wetland is crossed by the Rèche stream, which forms a series of meanders. North of the wetland, there is a rocky sill, after which the Rèche forms a high waterfall, thus entering the lower sector of the valley. On the eastern side, the wetland is bounded by a large debris flow fan, largely covered by prairies, on which the Tsalet pasture is located. On the south, the Rèche enters the hollow by passing through another rock sill incised by a small gorge.

Morphogenesis The Ar du Tsan wetland has developed in an overdeepening hollow, which was originated because of the erosion of an ancient glacier. Glacial morphology is recognizable all along the upper Val de Réchy, which is characterised by an alternation of steps (often with rock sills) and flat sectors, in some cases overdeepened.

Following the retreat of the glacier, the Ar du Tsan was occupied by an

alpine lake, which was then filled by sediments. In the wetland, one can find alternating strata of humus, peat and fluvial gravelly and sandy deposits. At the same time, the rock sill that dams the hollow was incised by the Rèche stream. Part of the overdeepening hollow was filled by a large debris flow fan located on the eastern side. The fan is almost completely vegetated, but it shows signs of recent activity.

Because of the flatness of the wetland, the Rèche crosses it with a meandering pattern. Abandoned meanders can be recognised on the western bank of the active channel of the stream.

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is representative of filled up glacial lakes.	1
<i>Rareness</i>	A marsh this large and developed is rare in the study area.	1
<i>Paleogeographical value</i>	The marsh developed by the filling of an ancient glacial lake.	0.25
Scientific value	Very high scientific value.	1

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	Typical flora and fauna of high mountain wetlands.	1
<i>Protected site</i>	The site is included in the Federal Inventory of Low Marshes of National Importance (Object n° 1453).	1
Ecological value	Very high ecological value.	1

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The Ar du Tsan wetland is very well visible from the bottom of the valley and the surrounding slopes. View points are plenty and good.	1
<i>Contrasts, vertical development, space structuration</i>	The meanders of the Rèche contrast heavily with the green plain of the wetland. Besides, the flat bottom of the Ar du Tsan has a great contrast with the steep slopes of the Val du Réchy, and with the vertical cliff located just downstream of it.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is included in the Federal Inventory of Low Marshes of National Importance (Object n° 1453) and is in the perimeter of: the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire), and one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).

Degradation risk

<i>Fragility</i>	The site is fragile in the sense that it represent one stage of the filling of a mountain lake. The process of filling by sediments and colonisation by vegetation will continue until the wetland transforms into a prairie.
<i>Natural vulnerability</i>	The site could be susceptible to floods by the Réche and from debris flows coming from the sides. In fact, on the eastern side there is a large debris flow fan that is filling about half of the basin.
<i>Anthropogenic vulnerability</i>	Being very remote, the anthropogenic vulnerability of the site is negligible. A slight risk could only come from grazing activities, as there are pastures nearby.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than one bus per hour all year long to Nax, then it's a 5h hike (T3). By car one can go up to the Télé Mont-Noble station (then hike for 3h), or even take the dirt road to the Alpage de Bouzerou. From there, the hike is only 1h40' long. To reach panoramic view points the best option is to continue from the Ar du Tsan along the hiking trail to Col de Cou.	0.5
<i>Security</i>	The hike is quite long, so there is danger if weather conditions are bad.	0.75
<i>Site context</i>	No perturbation is present.	1
<i>Tourism infrastructures</i>	Hiking trails.	0.5
Visit conditions	Average visit conditions	0.5

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There is a panel located in the site, while other panels are present in several spots of the upper Val de Réchy, dealing with the geo(morpho)logical features of this place. There are also articles focusing on the wetland.	0.75
<i>Education interest</i>	The landform is well understandable with mediation. Enhancement is possible at low cost.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value Very high scientific, ecological and aesthetic values make up for a very high intrinsic value of the site.

Use and management The site is included in the Federal Inventory of Low Marshes of National Importance (Object n° 1453) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona). The use value is average, as the education value is high but the access is not that easy. Panels are present on the site and in several other spots of the upper Val de Réchy. Natural and anthropogenic vulnerability are very low, but the site is fragile, as it will continue to evolve from wetland to mountain prairie.

Management measures No particular measure is needed.

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RECper001

Periglacial system of the upper Val de Réchy

Localisation: Upper Val de Réchy (Mont-Noble / Saint-Martin).	Coordinates: 605.523 / 112.536	Altitude: 2640 m – 3149 m
Type: AER	Size: 1.97 km ²	Property: PUB (Commune de Mont Noble / Commune de Saint-Martin)

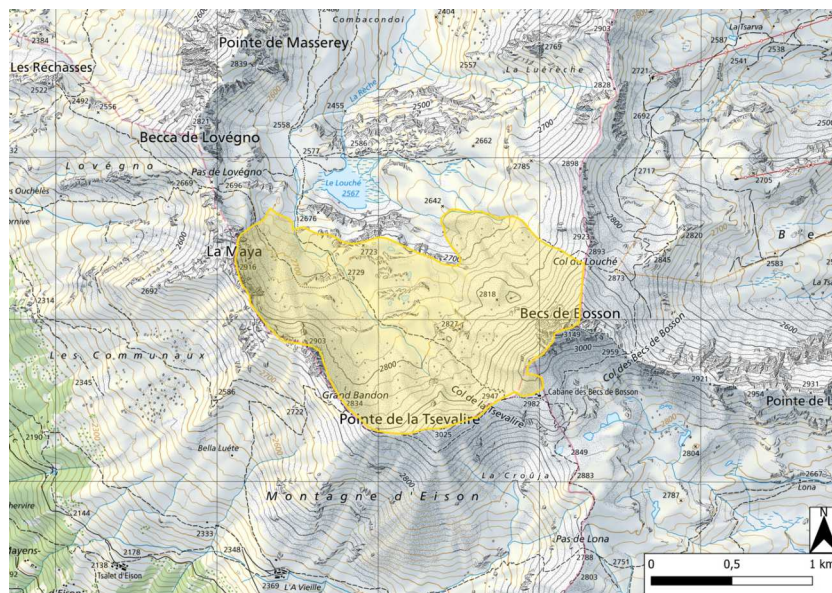


Figure A.44: Position and perimeter of the geosite. Base map: map.geo.admin.ch, ©Swisstopo

Photographs

<p><i>Patterned grounds and the Tsevalire rock glacier (ph. Andrea Ferrando)</i></p>	<p><i>The Becs de Bosson with their rock glacier (ph. Andrea Ferrando)</i></p>
<p><i>Polygonal grounds near the Cabane des Becs de Bosson (ph. Andrea Ferrando)</i></p>	<p><i>Gelifluction lobes and rock glaciers in the upper Val de Réchy (ph. Andrea Ferrando)</i></p>

Description The site includes a system of periglacial landforms located at the head of the upper Val de Réchy, on the northern side of the Pointe de la Tsevalire (3025 m) and the Becs de Bosson (3149 m). The upper part of the valley displays the full range of periglacial mountain landforms: rock glaciers, structured soils, sorted scree slopes, gelifluction lobes and push moraines. This site is particularly interesting because it has enabled us to describe the recent (Holocene) evolution of small high-mountain watersheds, marked by alternating glacial phases, with the presence of small cirque glaciers, and periglacial phases, during which detritus and periglacial processes dominate. At present, periglacial processes dominate, particu-

larly in the Becs-de-Bossons and Lona rock glacier complexes.

The two main rock glaciers are the Tsevalire rock glacier and the Becs de Bosson rock glacier, located on the northern side of the eponymous peaks. The Tsevalire rock glacier flows northwards from the north-western slopes of Pointe de la Tsevalire. It is 350 metres long and almost 150 metres wide. It is mainly composed of corneule, which gives it a beige-orange appearance, and calcschists.

The Becs de Bosson rock glacier is vast and has its roots at the foot of the Becs de Bosson, flowing north-westwards. The main lobe is almost 120 m wide, and a second, much smaller lobe is on the west side, where you can see numerous bulges perpendicular to the direction of flow. The surface of the rocky glacier, over 750 m long, is very chaotic, with numerous hollows and bulges. However, at the southern limit of the landform, straddling the rocky escarpment, a whole series of bulges can be seen, this time almost parallel to the direction of flow. It is one of the most studied rock glaciers in this region of the Western Alps.

The geosite includes various examples of patterned grounds (polygonal grounds, striped grounds). The main patterned grounds are located near the tongue of the Tsevalire rock glacier, and on the south-western shoulder of the Becs de Bosson, near the Cabane des Becs de Bosson.

Morphogenesis The wide array of landforms located at the head of the Val de Réchy is the result of periglacial processes, that is, processes related to the action of freeze-and-thaw processes and nival action. The active Tsevalire rock glacier, made up of corneule and calcschists, is thought to have its source in a moraine beneath the Pointe de la Tsevalire. Small rock faces that have now completely disappeared would have provided relatively little material for the moraine, explaining the relatively small size of the rock glacier (Tenthorey, 1993).

The Becs de Bosson rock glacier is made up of schist and limestone from the Becs de Bosson north wall. This site is actually a complex mixture of glacial and periglacial landforms. According to Tenthorey (1993) and Delaloye et al. (2003), the rock glacier already existed before the Little Ice

Age (1350 to 1850) and was partly covered by a glacier during this period. As the glacier developed, it reorganised the periglacial sediments, forming thrust moraines, which can be seen organised semi-parallel to the direction of flow, on the upper southern boundary of the landform and which would also have their equivalent on the northern boundary. The presence of this glacier would have contributed to the degradation of the permafrost upstream of the landform (Perruchoud, 2007). While the main lobe of the rock glacier is not very active, the presence of numerous bulges on the secondary lobe bears witness to its significant activity. The rebalancing of the slope of the thrust moraines towards the interior of the landform has also been observed (Perruchoud, 2007).

For what concerns the patterned grounds, their formation is due to granulometric sorting of the soil by the action of freeze-and-thaw. The calcschists and quartz phyllite marbles that make up the sector disintegrate easily under the effects of weathering (Lengeler, 1988), forming soils with a mixture of rock platelets and fine dust. At high altitude, in the discontinuous permafrost zone (>2600m), these wet soils are subjected to the action of freezing and thawing and, as a result of repeated increases and decreases in their volume, they become sorted. The swelling of the soil under the effect of frost allows the displacement of soil particles and the expulsion of stones (Veyret and Vigneau 2002). On a flat surface, the shapes most often encountered are polygonal soils, whereas on a slight slope, striated soils (in parallel bands) are more likely to be observed. These forms are common upstream of the Louché (Tenthorey, 1993).

Intrinsic value

Scientific value

Criteria	Assessment	Score
<i>Integrity</i>	The site is intact.	1
<i>Representativeness</i>	The site is very representative of the periglacial environment of high alpine valleys.	1
<i>Rareness</i>	Periglacial landforms are not rare per se in the Val d'Hérens and Val de Réchy, but the upper Val de Réchy has a very wide and diverse array of these landforms, so it can be considered rare.	0.75
<i>Paleogeographical value</i>	The complex morphology of the upper Val de Réchy can give insights on the Holocene evolution of the area, with its alternating glacial and periglacial periods.	1
Scientific value	Very high scientific value.	1

Additional values

Ecological value

Criteria	Assessment	Score
<i>Ecological impact</i>	The vegetation is sparse and typical of the high mountain environment.	0.25
<i>Protected site</i>	The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).	1
Ecological value	Average ecological value.	0.5

Aesthetic value

Criteria	Assessment	Score
<i>View points</i>	The site has lots of excellent view point, from the whole upper Val de Réchy and the surrounding ridges.	1
<i>Contrasts, vertical development, space structuration</i>	The alternation of plains and scarps, blocky deposits and finer grounds, and the contrast between the green prairies and the greyish rocks are important.	1
Aesthetic value	Very high aesthetic value.	1

Cultural value

Criteria	Assessment	Score
<i>Religious importance</i>	No religious importance.	0
<i>Historical importance</i>	No historical importance.	0
<i>Artistic and literary importance</i>	No artistic or literary importance.	0
<i>Geohistorical importance</i>	No geohistorical importance.	0
<i>Economic importance</i>	No economic importance.	0
Cultural value	No cultural value.	0

Protection

Protection status The site is included in the Federal Inventory of Low Marshes of National Importance (Object n° 1453) and is in the perimeter of: the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire), and one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona).

Degradation risk

<i>Fragility</i>	Given its dimensions, the site is not fragile.
<i>Natural vulnerability</i>	Periglacial landforms are prone to be affected by climate change, and especially by rising temperatures, which will cause the permafrost zone to rise up and up in elevation. Thus, many of them will become inactive in the next decades, and will be slowly dismantled by other active processes (mainly gravitational processes and runoff erosion).
<i>Anthropogenic vulnerability</i>	Anthropogenic vulnerability is null.

Promotion

Visit conditions

Criteria	Assessment	Score
<i>Accessibility</i>	Less than a bus per hour to Nax or Grimentz. Then 5h hike from Nax, or a 4h hike from Grimentz. Site is accessible from the A Vieille dirt road (there is a car park at about 2150 m) and then following the hiking trail to Pas de Lona, Col de la Tsevalire and the upper Val de Réchy (about 3h30'). In any case, trails are marked and not difficult (T3). The Val de Réchy is also accessible by Eison, by crossing the Pas de Lovégno.	0.5
<i>Security</i>	Risk can be due to bad meteorological conditions.	0.5
<i>Site context</i>	Calm high mountain environment with no perturbations.	1
<i>Tourism infrastructures</i>	Marked hiking trails, and a refuge (Cabane des Becs de Bosson).	0.75
Visit conditions	Average visit conditions	0.5

Education

Criteria	Assessment	Score
<i>Interpretive facilities</i>	There are panels all around the Val de Réchy. Some of them focus on the geo(morpho)logical setting of the valley.	0.5
<i>Education interest</i>	The main landforms (the two rock glaciers) are visible, but require a mediation to be recognised by non-experts. Other landforms, such as the patterned grounds, are less visible and require mediation to be seen and understood. The upper Val de Réchy has a great education interest because of the wide diversity of periglacial landforms located all in one place. In general, the periglacial environment, in the same way as the glacial environment, has a great potential in sensibilising the population on the issues of climate change on nature.	0.75
Education	High educational value	0.75

Synthesis

Intrinsic value The intrinsic value is very high, due to it being a site with scientific, ecological and aesthetic interest.

Use and management The site is protected under the Federal Inventory of Landscapes, Sites and Natural Monuments (Object n° 1718 Val de Réchy-Sasseneire) and is in the perimeter of one of the official Swiss Geotopes (Object n° 216 – Paysage périglaciaire du Haut Vallon de Réchy-Pas de Lona). The site is not protected nor vulnerable, and has a high education potential, partially marred by the long access.

Management measures No particular measure is needed.

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Degradation risk assessment

Sigle

In the table below the full result are given of the quantitative assessment of degradation risk, carried out with the methodology explained in Section 3.3.

ID	Name	Fragility					Natural vulnerability				Anthropogenic vulnerability					Protection					
		F ₁	F ₂	F ₃	F ₄	F ₅	Tot	NV ₁	NV ₂	NV ₃	Tot	AV ₁	AV ₂	AV ₃	AV ₄	AV ₅	Tot	PM ₁	PM ₂	PM ₃	Tot
H1	Man carved stones	4	4	4	4		4.0	1	1	1	1.0	2	3	2	1	4	2.4	4	4	4	4.0
H2	Flanmayens anthropogenic terraces	3	2	4	2	1	2.4	3	3	2	2.7	3	2	2	1	4	2.4	3	4	4	3.7
H3	Prafleuri anthropogenic terraces	3	2	4	4		3.3	2	4	3	3.0	1	1	2	1	1	1.2	3	4	4	3.7
H4	Nax gypsum dolines	3	2	3	2	1	2.2	2	2	4	2.7	3	2	4	1	4	2.8	2	4	4	3.3
H5	A Vieille gypsum dolines	3	3	3	2	1	2.4	2	2	2	2.0	3	1	2	1	1	1.6	4	4	2	3.3
H6	Becs de Bosson gypsum dolines	3	3	3	2	1	2.4	3	2	3	2.7	3	2	2	1	1	1.8	3	4	2	3.0
H7	Col du Tsan gypsum pyramids	3	3	3	2	3	2.8	3	3	2	2.7	1	1	2	2	4	2.0	4	4	3	3.7
H8	Tsarmine slope system	3	1	2	1	2	1.8	1	1	1	1.0	1	1	2	1	2	1.4	4	4	4	4.0
H9	Bajin slope system	3	2	2	1	1	1.8	2	1	1	1.3	1	1	2	1	1	1.2	4	4	4	4.0
H10	Bramois alluvial fan	3	1	4	3	1	2.4	1	1	1	1.0	2	1	4	4	4	3.0	4	4	4	4.0
H11	Borgne gorge	3	1	2	1	1	1.6	2	2	3	2.3	2	1	2	4	3	2.4	3	4	4	3.7
H12	Lotrey terraces	3	2	4	4		3.3	2	2	2	2.0	2	2	4	1	4	2.6	4	4	4	4.0
H13	Salay alluvial zone	3	2	4	3	1	2.6	2	2	2	2.0	2	2	3	1	2	2.0	3	4	2	3.0
H14	Satarma alluvial zone	3	2	4	3	2	2.8	2	2	2	2.0	2	2	4	1	4	2.6	3	4	2	3.0
H15	Lurette earth pyramids	3	2	4	2	4	3.0	3	1	1	1.7	3	4	4	1	4	3.2	3	4	4	3.7
H16	Euseigne earth pyramids	3	2	4	2	4	3.0	3	1	1	1.7	2	3	4	1	4	2.8	3	4	2	3.0
H17	Ecoulaies stream	3	2	2	2	2	2.2	3	2	2	2.3	2	2	2	1	1	1.6	3	4	4	3.7
H18	Rèche gorge	3	2	2	2	1	2.0	2	2	3	2.3	2	1	2	2	2	1.8	3	3	4	3.3
H19	Vex glacial shoulder	3	2	2	4		2.8	1	1	1	1.0	2	1	4	2	1	2.0	4	4	4	4.0
H20	Mont Miné glacial system	3	1	4	1	2	2.2	3	3	3	3.0	2	3	2	1	4	2.4	3	4	2	3.0
H21	Lac Bleu moraines	3	3	4	4		3.5	2	3	2	2.3	1	4	2	1	4	2.4	4	4	4	4.0
H22	Ferpècle glacial potholes	3	2	2	4		2.8	2	2	4	2.7	1	1	2	1	1	1.2	4	4	4	4.0
H23	Tsjiore Nouve glacial system	3	1	2	1	2	1.8	3	3	3	3.0	2	2	2	1	4	2.2	4	4	4	4.0
H24	Glaciers d'Arolla glacial system	3	1	2	1	2	1.8	3	3	3	3.0	2	2	2	1	2	1.8	4	4	4	4.0
H25	Mont Collon ice cap	3	2	2	3	2	2.4	3	3	3	3.0	1	1	1	1	1	1.0	4	4	4	4.0
H26	Vernamiège moraine	3	3	4	4		3.5	2	3	2	2.3	2	2	3	1	1	1.8	4	4	4	4.0
H27	Tour de Tavelli kame terrace	3	2	4	4		3.3	2	3	3	2.7	1	2	3	2	2	2.0	4	4	4	4.0
H28	Cheillon glacial system	3	1	2	1	2	1.8	3	3	3	3.0	2	2	2	1	1	1.6	4	4	4	4.0
H29	Réchy glacial valley	3	1	2	4		2.5	2	4	2	2.7	2	2	2	1	1	1.6	4	4	4	4.0
H30	Lanna block	4	4	2	4		2.5	1	1	1	1.0	1	1	3	1	1	1.4	4	4	4	4.0
H31	Mont Gautier DSGSD trench	3	3	3	3	1	2.6	2	2	2	2.0	1	1	1	1	1	1.0	4	4	3	3.7
H32	Vouasson peat bog	3	2	4	2	2	2.6	3	4	2	3.0	2	2	2	1	4	2.2	4	4	3	3.7
H33	Essertse peat bog	3	2	1	2	2	2.0	2	4	1	2.3	3	2	2	1	3	2.2	4	4	3	3.7
H34	Ar du Tsan peat bog	3	2	4	4		3.3	3	4	2	3.0	2	2	2	1	1	1.6	4	4	3	3.7
H35	A Vieille rock glacier	3	2	4	4		3.3	3	4	2	3.0	1	1	2	1	1	1.2	4	4	2	3.3
H36	Liapey d'Enfer rock glacier	3	1	4	4		3.0	2	4	2	2.7	1	1	2	1	1	1.2	4	4	4	4.0
H37	Tsena Réfien rock glacier	3	2	4	2	1	2.4	2	3	3	2.7	1	1	2	1	2	1.4	4	4	4	4.0
H38	Tour de Bonvin block slopes	3	2	4	4		3.3	1	1	1	1.0	1	1	2	1	2	1.4	4	4	4	4.0
H39	Allève rock glacier	3	2	4	1	1	2.2	2	3	3	2.7	1	1	1	1	1	1.0	4	4	4	4.0
H40	Réchy periglacial landscape	3	1	4	1	2	2.2	3	4	2	3.0	1	2	2	1	1	1.4	4	4	2	3.3
H41	la Maya	3	3	2	4		3.0	3	2	4	3.0	1	1	2	1	1	1.2	4	4	4	4.0

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<i>Continua dalla pagina precedente</i>																						
ID	Name	Fragility					Tot	Natural vulnerability				Tot	Anthropogenic vulnerability					Tot	Protection			Tot
		F ₁	F ₂	F ₃	F ₄	F ₅		NV ₁	NV ₂	NV ₃	AV ₁		AV ₂	AV ₃	AV ₄	AV ₅	PM ₁		PM ₂	PM ₃		
H42	Pointe du Tsaté	3	2	2	4		2.8	2	3	3	2.7	1	2	2	1	1	1.4	4	4	4	4.0	
H43	Dent Blanche	3	2	2	4		2.8	2	4	2	2.7	1	1	1	1	1	1.0	4	4	4	4.0	
H44	Becs de Bosson	3	2	2	4		2.8	2	4	2	2.7	1	1	1	1	1	1.0	4	4	4	4.0	
L1	Rio Torsero fossils	4	3	3			3.3	3	3	3	3.0	3	4	2	3	4	3.2	3	4	2	3.0	
L2	San Bernardino karst plateau	3	1	2	1	1	1.6	2	2	2	2.0	3	2	2	3	2	2.4	3	4	2	3.0	
L3	Pontinvrea asbestos	2	4	3			3.0	2	3	2	2.3	2	2	4	1	4	2.6	4	4	2	3.3	
L4	Marina Grande amphibolites	2	4	2			2.7	2	4	2	2.7	3	1	3	3	3	2.6	3	4	2	3.0	
L5	Mt. Ramaceto	2	1	2			1.7	1	2	2	1.7	2	1	2	1	1	1.4	3	4	2	3.0	
L6	Arma delle Manie	4	4	2	4		3.5	3	2	3	2.7	3	3	4	3	4	3.4	2	4	2	2.7	
L7	Arma della Pollera	3	4	2	1	1	2.2	3	2	3	2.7	3	2	2	3	1	2.2	4	4	2	3.3	
L8	Framura basalt coastal cliff	2	2	2			2.0	2	4	2	2.7	2	1	3	1	2	1.8	3	4	2	3.0	
L9	Baia dei Saraceni beach rock	4	4	4			4.0	4	4	2	3.3	2	3	3	3	3	2.8	4	4	2	3.3	
L10	Laione block streams	3	3	4	4		3.5	1	1	1	1.0	1	1	3	1	1	1.4	3	4	2	3.0	
L11	Pian del Fretto block field	3	3	4	4		3.5	1	1	1	1.0	1	1	2	1	1	1.2	3	4	2	3.0	
L12	Buco del Prete rock arch	4	4	2	3	4	3.4	4	2	4	3.3	1	1	1	3	2	1.6	3	4	2	3.0	
L13	Castel d'Appio badlands	3	2	3	2	1	2.2	1	1	1	1.1	2	1	1	3	3	2.0	4	4	2	3.3	
L14	Piana Crixia badlands	3	1	3	2	1	2.0	1	1	1	1.0	2	1	2	1	1	1.4	3	4	2	3.0	
L15	Capo Mortola limestones	1	3	2			2.0	2	4	2	2.7	3	3	2	2	1	2.2	4	3	2	3.0	
L16	Val Gargassa gorge	3	2	2	2	1	2.0	2	2	2	2.0	2	1	2	1	1	1.4	3	4	2	3.0	
L17	Loreto karst	3	3	2	2	1	2.2	1	1	1	1.0	2	2	2	1	1	1.6	3	4	2	3.0	
L18	Arroscia waterfalls	3	3	2	2	1	2.2	3	2	2	2.3	1	1	2	1	1	1.2	3	4	2	3.0	
L19	Tribogna slate quarry	2	4	2			2.7	3	2	4	3.0	2	1	4	1	4	2.4	4	4	2	3.3	
L20	Valle Lagorara jasper quarry	4	3	2	4		3.3	2	2	4	2.7	1	2	2	1	1	1.4	3	4	2	3.0	
L21	Iscioli quarry	2	2	2			2.0	3	2	4	3.0	3	1	3	1	4	2.4	4	1	2	2.3	
L22	Pietralavezzara quarry	2	3	2			2.3	3	2	4	3.0	3	1	4	3	4	3.0	4	4	2	3.3	
L23	Molana quarry	2	3	2			2.3	3	2	4	3.0	3	4	3	1	4	3.0	4	3	2	3.0	
L24	Verezzi old quarry	2	4	2			2.7	3	2	4	3.0	3	3	2	3	3	2.8	3	4	2	3.0	
L25	Bonassola quarry	2	3	2			2.3	3	2	4	3.0	3	1	3	1	4	2.4	4	4	2	3.3	
L26	Mt. Frontè glacial cirque	3	2	2	4		2.8	1	2	2	1.7	1	1	2	1	1	1.2	4	4	2	3.3	
L27	Sassello fossil corals	4	3	3			3.3	3	3	2	2.7	4	4	3	1	2	2.8	4	4	2	3.3	
L28	Prato della Cipolla DSGSD trench	3	2	2	3	1	2.2	1	2	2	1.7	1	1	3	1	4	2.0	1	4	2	2.3	
L29	Campo di Già dolines	3	2	3	3	1	2.4	2	2	2	2.0	1	2	3	3	1	2.0	3	4	2	3.0	
L30	Vara eclogites and rodingites	2	3	2			2.3	2	1	1	1.3	3	1	4	1	4	2.6	4	4	2	3.3	
L31	Rocca del Prete scarp	3	2	2	4		2.8	2	2	3	2.3	1	1	2	1	1	1.2	3	4	2	3.0	
L32	Malpasso coastal cliff	3	2	2	1	2	2.0	2	2	4	2.7	2	3	4	3	4	3.2	4	4	2	3.3	
L33	Loreto scarp	3	2	2	4		2.8	2	3	4	2.7	2	2	1	1	3	1.8	4	4	2	3.3	
L34	Realdo scarp	3	2	2	4		2.8	2	3	4	2.7	2	2	1	1	3	1.8	4	4	2	3.3	
L35	Portovenere coastal cliff	3	2	2	1	2	2.0	2	2	3	2.3	3	2	2	3	3	2.6	4	4	2	3.3	
L36	Ceriana tectonic window	2	1	2			1.7	1	1	1	1.0	1	1	4	1	1	1.6	4	4	2	3.3	
L37	Santa Giustina fossils	4	4	3			3.7	3	4	2	3.0	4	4	3	1	3	3.0	4	4	2	3.3	
L38	Martinetto gorges	3	3	2	2	2	2.4	2	2	3	2.3	2	2	3	1	4	2.4	4	4	2	3.3	

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		<i>Continua dalla pagina precedente</i>																			
ID	Name	Fragility					Natural vulnerability				Anthropogenic vulnerability					Protection					
		F ₁	F ₂	F ₃	F ₄	F ₅	Tot	NV ₁	NV ₂	NV ₃	Tot	AV ₁	AV ₂	AV ₃	AV ₄	AV ₅	Tot	PM ₁	PM ₂	PM ₃	Tot
L39	Carpi landslide	3	2	2	1	1	1.8	2	2	2	2.0	2	1	3	1	3	2.0	3	4	2	3.0
L40	Via Digione landslide	2	4	2	3	2	2.6	1	1	1	1.0	1	1	4	4	4	2.8	2	4	2	2.7
L41	Piana Crixia stone mushroom	4	4	3	3	4	3.6	3	2	4	3.0	1	2	3	1	3	2.0	2	4	2	2.7
L42	Cù du Mundu gorge	3	3	2	3	2	2.6	2	2	3	2.3	2	2	2	3	1	2.0	3	4	2	3.0
L43	Gola delle Fascette	3	2	2	1	2	2.0	2	2	2	2.0	3	2	2	1	2	2.0	3	4	2	3.0
L44	Arpaia cave	4	4	2	3	3	3.2	4	2	4	3.3	1	2	1	3	4	2.2	3	4	2	3.0
L45	Bergeggi cave	3	4	2	1	2	2.4	3	2	4	3.0	3	2	4	3	4	3.2	1	1	2	1.3
L46	Edera cave	4	4	2	4		3.5	3	2	4	3.0	2	4	2	3	4	3.0	4	4	2	3.3
L47	Balzi Rossi caves	3	4	2	4		3.3	2	2	4	2.7	4	3	3	3	4	3.4	1	2	2	1.7
L48	Borgio Verezzi caves	3	4	2	1	2	2.4	3	2	4	3.0	3	2	4	3	4	3.2	1	2	2	1.7
L49	Palmaria and Tino islands	3	1	2	1	1	1.6	2	1	4	2.3	3	3	4	3	4	3.4	3	4	2	3.0
L50	Agoraie lakes and ponds	3	2	4	2	1	2.4	3	4	2	3.0	2	4	2	1	1	2.0	1	1	2	1.3
L51	Bargone lake	3	3	2	3	1	2.4	2	2	2	2.0	1	3	2	2	1	1.8	2	4	2	2.7
L52	Val Ponci fluvial potholes	3	4	2	2	1	2.4	1	2	3	2.0	1	2	2	3	2	2.0	4	4	2	3.3
L53	Rio Baiardetta fluvial potholes	3	4	2	2	1	2.4	2	2	3	2.3	1	2	2	4	1	2.0	3	4	2	3.0
L54	Zanairin eclogite blocks	2	3	4			3.0	1	1	1	1.0	4	2	4	1	4	3.0	4	4	2	3.3
L55	Bevera entrenched meanders	3	2	2	1	1	1.8	1	2	2	1.7	1	1	2	1	1	1.2	3	4	2	3.3
L56	Gambatesa mine	2	3	2			2.3	3	2	4	3.0	4	2	4	1	4	3.0	1	2	2	1.7
L57	Libiola mine	2	2	2			2.0	3	2	4	3.0	4	3	3	3	4	3.4	4	4	2	3.3
L58	Monte Loreto mine	2	3	2			2.3	3	2	4	3.0	4	2	3	3	4	3.2	1	2	2	1.7
L59	Bric Gettina silver mine	2	3	2			2.3	4	2	4	3.3	4	3	2	1	2	2.4	3	4	2	3.0
L60	Lago delle Lame periglacial landforms	3	3	4	4		3.5	1	1	1	1.0	2	2	2	1	4	2.2	3	4	2	3.0
L61	Triora olistolites	2	2	2			2.0	1	2	2	1.7	1	1	2	1	1	1.2	4	4	2	3.3
L62	Mattarana olivines	4	4	2			3.3	1	1	1	1.1	3	2	3	1	4	2.6	4	4	2	3.3
L63	Mt. Pollone paleosol	4	4	4			4.0	3	3	2	2.7	1	4	2	2	4	2.6	4	4	2	3.3
L64	Celle Ligure plinthitic paleosol	4	4	4			4.0	4	3	4	3.7	1	4	4	3	4	3.2	4	4	2	3.3
L65	Pigna fault scarp	2	3	2	4		2.8	1	2	4	2.3	2	2	2	1	4	2.2	4	4	2	3.3
L66	Pria Burgheisa peridotites	4	4	2			3.3	1	1	1	1.0	2	2	2	1	1	1.6	4	4	2	3.3
L67	Val Graveglia fold	2	3	2			2.3	2	2	4	2.7	2	2	3	1	4	2.4	4	1	2	2.3
L68	Corniglia fold	2	3	2			2.3	1	4	4	3.0	1	1	1	1	4	1.6	4	4	2	3.3
L69	San Rocco coastal cliff	3	2	3	1	2	2.2	2	3	4	3.0	2	1	1	3	3	2.0	3	4	2	3.0
L70	Bergeggi dolomitic folds	2	3	2			2.3	2	2	3	2.3	2	1	4	3	4	2.8	4	4	2	3.3
L71	Pietre Strette conglomerates	2	4	2			2.3	1	1	1	1.0	1	1	2	3	1	1.6	3	4	2	3.0
L72	Mt. Castellaro pyroxenites	2	2	2			2.0	1	1	1	1.0	2	2	2	1	4	2.2	3	4	2	3.0
L73	Caresana polje	3	2	2	3	1	2.2	1	2	2	1.7	1	2	3	1	4	2.2	4	4	2	3.3
L74	Sestri Levante tombolo	3	2	4	1	1	2.2	2	1	2	1.7	2	2	4	3	4	3.0	4	4	2	3.3
L75	Pian d'Oneto DSGSD trench	3	2	2	3	1	2.2	1	2	2	1.7	1	1	4	1	1	1.6	3	4	2	3.0
L76	San Terenzo quartzites	2	3	2			2.3	2	2	2	2.0	2	2	3	3	4	2.8	3	4	2	3.0
L77	Rocca degli Uccelli scarp	3	2	2	3	2	2.4	3	2	4	3.0	2	2	2	3	4	2.6	4	4	2	3.3
L78	Praglia peridotites	2	3	2			2.3	1	1	1	1.0	2	2	4	2	1	2.2	4	4	2	3.3
L79	Bric dell'Oca rodingites	4	4	2			3.3	2	2	2	2.0	3	2	4	1	4	2.8	4	4	2	3.3

Continua nella pagina successiva

<i>Continua dalla pagina precedente</i>																						
ID	Name	Fragility					Tot	Natural vulnerability				Tot	Anthropogenic vulnerability					Tot	Protection			Tot
		F ₁	F ₂	F ₃	F ₄	F ₅		NV ₁	NV ₂	NV ₃	AV ₁		AV ₂	AV ₃	AV ₄	AV ₅	PM ₁		PM ₂	PM ₃		
L80	Roverino scarp	3	2	2	4		2.8	3	2	4	3.0	1	1	2	3	4	2.2	4	4	2	3.3	
L81	Nervi coastal cliff	3	2	2	1	2	2.0	2	2	4	2.7	2	2	2	4	4	2.8	3	4	2	3.0	
L82	Val Tanarello stratigraphic series	2	3	2			2.3	2	2	4	2.7	3	2	2	1	1	1.8	3	4	2	3.0	
L83	Punta Bianca metamorphic series	2	2	2			2.0	2	2	4	2.7	2	2	2	3	2	2.2	3	4	2	3.0	
L84	Lago dei Gulli peridotite spheroids	4	4	2			3.3	2	2	2	2.0	2	2	2	1	1	1.6	3	4	2	3.0	
L85	Pigna hydrothermal spring	4	4	3			3.7	2	2	2	2.0	3	3	4	1	4	3.0	3	4	2	3.0	
L86	Punta Chiappa speleothems	4	4	4	3	1	3.2	4	3	4	3.7	2	1	1	3	1	1.6	4	4	2	3.3	
L87	Riomaggiore coastal cliff	2	3	2			2.3	1	4	4	3.0	1	2	2	2	4	2.2	1	2	2	1.7	
L88	Basura cave	3	4	2	2	2	2.6	3	2	4	3.0	4	3	3	2	2	2.8	1	2	2	1.7	
L89	Arenzano marine terraces	3	2	4	4		3.3	1	1	1	1.0	1	1	4	3	4	2.6	4	4	2	3.3	
L90	Manie paleosol	4	3	4			3.7	3	2	3	2.7	1	4	4	3	4	3.2	4	4	2	3.3	
L91	Molassana red badlands	3	4	3	2	1	2.6	1	1	1	1.0	2	3	2	4	3	2.8	3	4	2	3.0	
L92	Castello della Pietra rock towers	3	3	2	4		3.0	3	2	3	2.7	1	2	2	1	1	1.4	3	2	2	2.3	
L93	Sciarborasca rock towers	3	4	2	4		3.3	3	2	3	2.7	2	2	2	3	2	2.2	3	4	2	3.0	
L94	Castell'Ermo rock towers	3	2	2	4		2.8	3	2	4	3.0	1	2	2	1	1	1.4	4	4	2	3.3	
L95	Rio Briga travertines	4	3	3			3.3	2	3	3	2.7	2	2	2	1	3	2.0	4	4	2	3.3	
L96	Tana dell'Orpe swallow hole	3	3	2	1	1	2.0	3	2	2	2.3	2	2	2	1	3	2.0	1	4	2	2.3	
L97	Bric Foresto fossils	4	3	3			3.3	2	3	2	2.3	3	3	2	1	2	2.2	4	4	2	3.3	
L98	San Giacomo slate quarries	2	3	2			2.3	3	2	4	3.0	4	1	2	2	2	2.2	1	1	2	1.3	
L99	Bussana Vecchia	3	1	3	4		2.8	2	2	2	2.0	1	1	4	4	4	2.8	4	4	2	3.3	

Geomorphological map of the Piana Crixia Natural Park

Geomorphology and geoheritage in the Piana Crixia Natural Park (Liguria, Italy)

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