

# 32nd IGC Conference 2011

## Guide for the Post-Conference Excursion

18 – 20 July 2011

Interlaken – Grimsel – **Binntal** – **Zermatt** - Bern



The Matterhorn as seen from the Klein\_Matterhorn (3883 m) at sunrise with realgar crystals from Lengenbach and a group of rock crystals, Binntal, Switzerland.

© original photos from Mathias Zehring (background) and Fritz Dreier (realgar) and André Gorsatt (quartz).

## Programme:

Monday 18<sup>th</sup> July 2011:

- Handegg and Gelmersee,
- Grimselpass and the hydroelectric power station
- Ernen, a traditional Swiss village in the Canton of Valais
- Binnental, the valley of rare minerals

Hotel Ofenhorn in Binn (Valais)

Tuesday 19<sup>th</sup> July 2011:

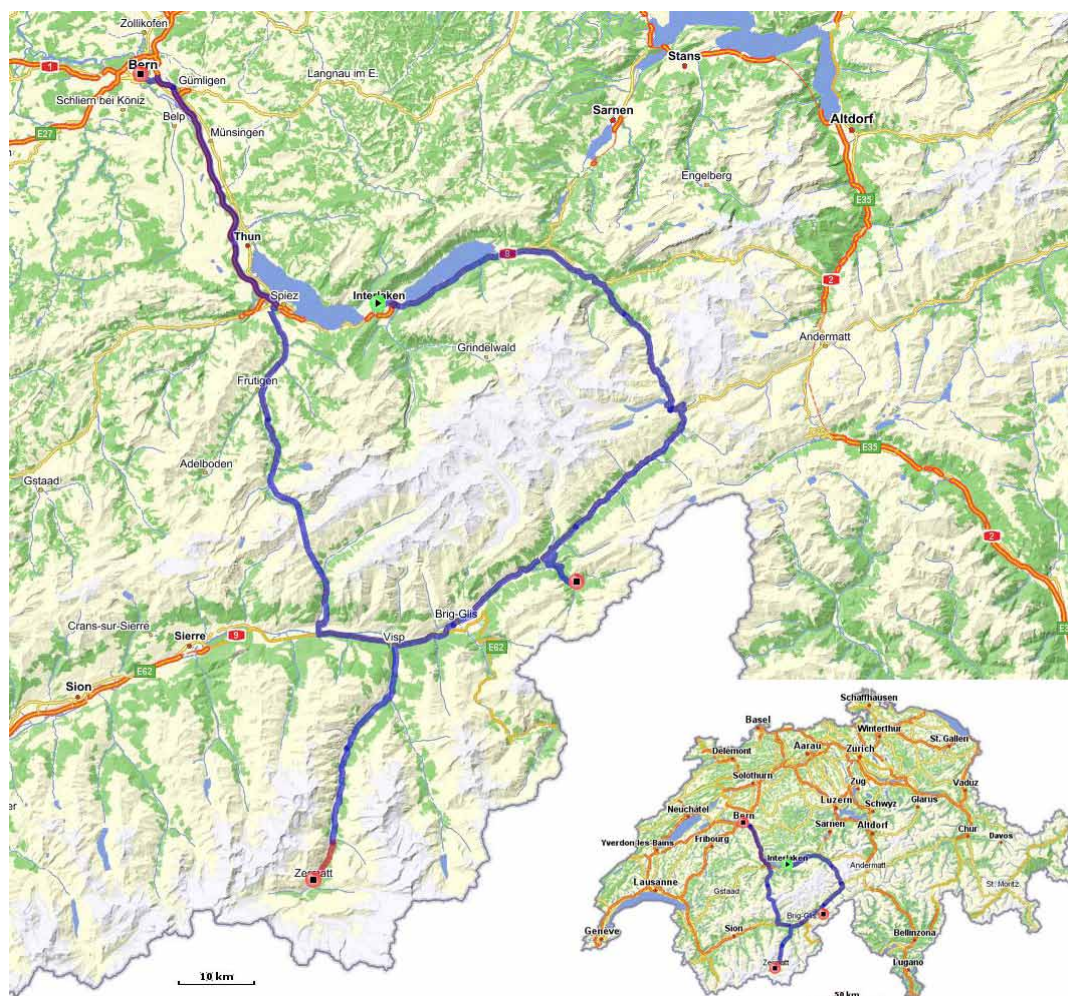
- Lengenbach, the mineral quarry of rare sulfosalt minerals
- Visit of the mineral museum in Binn
- Arrival in Zermatt

Hotel Bristol in Zermatt (Valais)

Wednesday 20<sup>th</sup> July 2011:

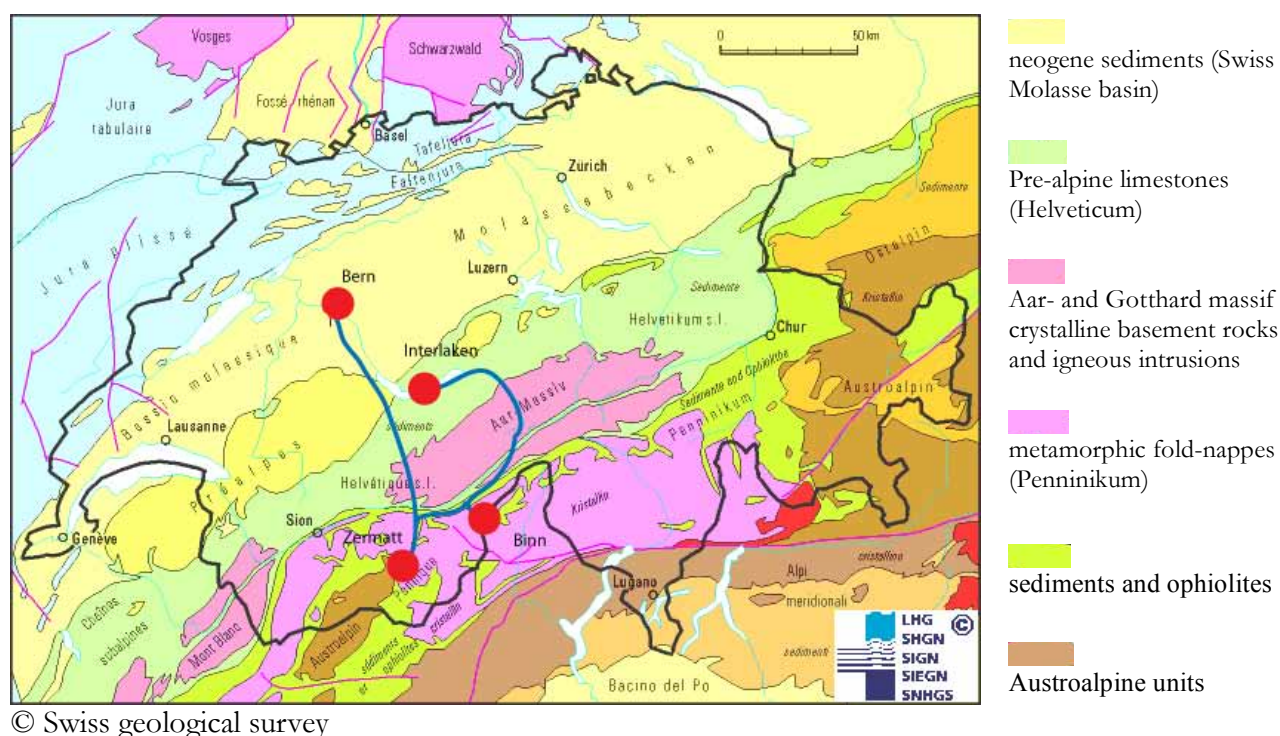
- The collision of Africa with Europe: Geological promenade near the Matterhorn
- Return to Bern

## The maps:





## Geological overview:



During the Post-Conference field trip, we will cross again several geological units, all affected by Alpine metamorphism from diagenesis around Bern up to amphibolite facies in the Valais.

In Interlaken, we start in deformed Prealpine limestones (so-called “Helveticum”) that were deposited in a shallow marine basin in the Mesozoic (235-65 ma). In the Grimsel region, we are in the Aar-massif, which consists of Paleozoic basement rocks that were deformed and metamorphosed during the Variscan orogeny in the late Paleozoic. Younger Mesozoic sediments were eroded from this basement as a thrust fault brought the basement to the surface during the Alpine orogeny. The lithologies of the basement rocks are mainly gneisses, schists and amphibolites. These were in some places intruded by Permian granites (Aare granite). During a late phase in the Alpine orogeny in the Tertiary the Aarmassif was uplifted, forming a large elongated dome structure. The overlying limestones of the Helvetic nappes now have a very high dip angle, forming a ridge that appears at the Eiger and south of the Jungfrau mountain.

The Goms valley (Valais) south of the Grimsel is mainly characterised by Mesozoic sediments, deformed and affected by the Tertiary Alpine regional metamorphism. The small Binn valley is located at the front of the piled Penninic fold-nappes. The most important unit in the Binn valley is the Monte Leone unit. It consists of strongly deformed and metamorphosed pre-Alpine (Paleozoic and Precambrian) magmatic rocks with their Mesozoic para-autochthonous sediment cover.

Finally, in Zermatt we can observe the whole tectonic sequence of the Alps. Starting from crystalline Penninic fold-nappes, which represent the former southern margin of the European plate, we arrive at the top (Matterhorn) in the overlying Austroalpine crystalline unit (“African” plate) as a spectacular relic of the Tertiary continent/continent collision (Africa vs. Europe). This collision resulted in the Alpine orogeny.



## Grimsel region:

The Grimsel is a rugged mountainous region, mainly consisting of igneous rocks and is the source of the Aare river. With the Finsteraarhorn peak, 4274 m (14'000 feet) dominating the spectacular scenery, the Grimsel region is characterised and shaped by many glaciers and lakes.



The Grimsel lake (water reservoir for hydro-electric power plant), and the Unteraar glacier with the snowy Oberaarhorn, Finsteraarhorn and Lauteraarhorn peaks in the background. © M.S. Krzemnicki



The glaciers have shaped and polished the rocks, resulting in an Eldorado for free-climbers and mountaineers nowadays.

© Robert Bösch for  
Mammut Inc.



## The lake Gelmersee



The lake Gelmersee is a reservoir with a usable volume of 13 million m<sup>3</sup>. It is located on a height of 1850 m in the Grimsel region and can be reached with the thrilling Gelmerbahn cable car from the Grimselpass road at Handegg. This cable car is the steepest funicular in Europe with a slope up to 106 % !

The milky green colour of the lakes and rivers in the Grimsel are due to very fine and dispersed silt which is produced by the continuous abrasion of the rocks by glaciers.



Trail around the lake Gelmersee. © Ruschi, Flickr.com

For the adventurous gemmologists, there will be a trail around the Gelmersee lake through the wild rocks and steep granite walls.



Smoky quartz intergrowth ("Gwindel") from the Gelmerhorn region. © Norbert Burgener



## The Goms: The upper valley of the Rhone river in the Canton of Valais

The source of the Rhone river, one of Europe's main rivers, is located East to the Grimselpass. The Goms valley is a high valley following the general striking direction of the sedimentary rocks interlayered between the crystalline Aar-massif in the North and the gneissic Penninic units in the South.



The Goms valley with the village Obergesteln, In the background the Galenstock peak and the source of the Rhone river. Viewing direction is Northeast. © M.S. Krzemnicki

The Goms has still preserved its original and historic charm with small villages of wooden chalets in the typical style of the so-called "Walser" population. The Walser were an alemannic ethnic group, who populated large parts of the Swiss Alps during the Middle Ages. They built their villages typically clustered together in spots which were found to be safe from avalanches and rock slides.



These typical small wooden chalets were built to storage food and hay. To prevent that a clever mouse climbs into the wooden chalet, they are built on piles, each with a round rock plate as a barrier.

We will visit the village Ernen, which was an important market place in former times for a local tour.

### The Binntal valley:

The Binntal valley is a hidden valley close to the Italian border. It is known world-wide for its minerals, but is also known for its flora with many rare plants and flowers.



View into the Binntal valley with the Schinhorn peaks (gneissic rocks) and the Geisspfad pass (serpentinite as a relic of a former ocean crust) on the right. © M.S. Krzemnicki



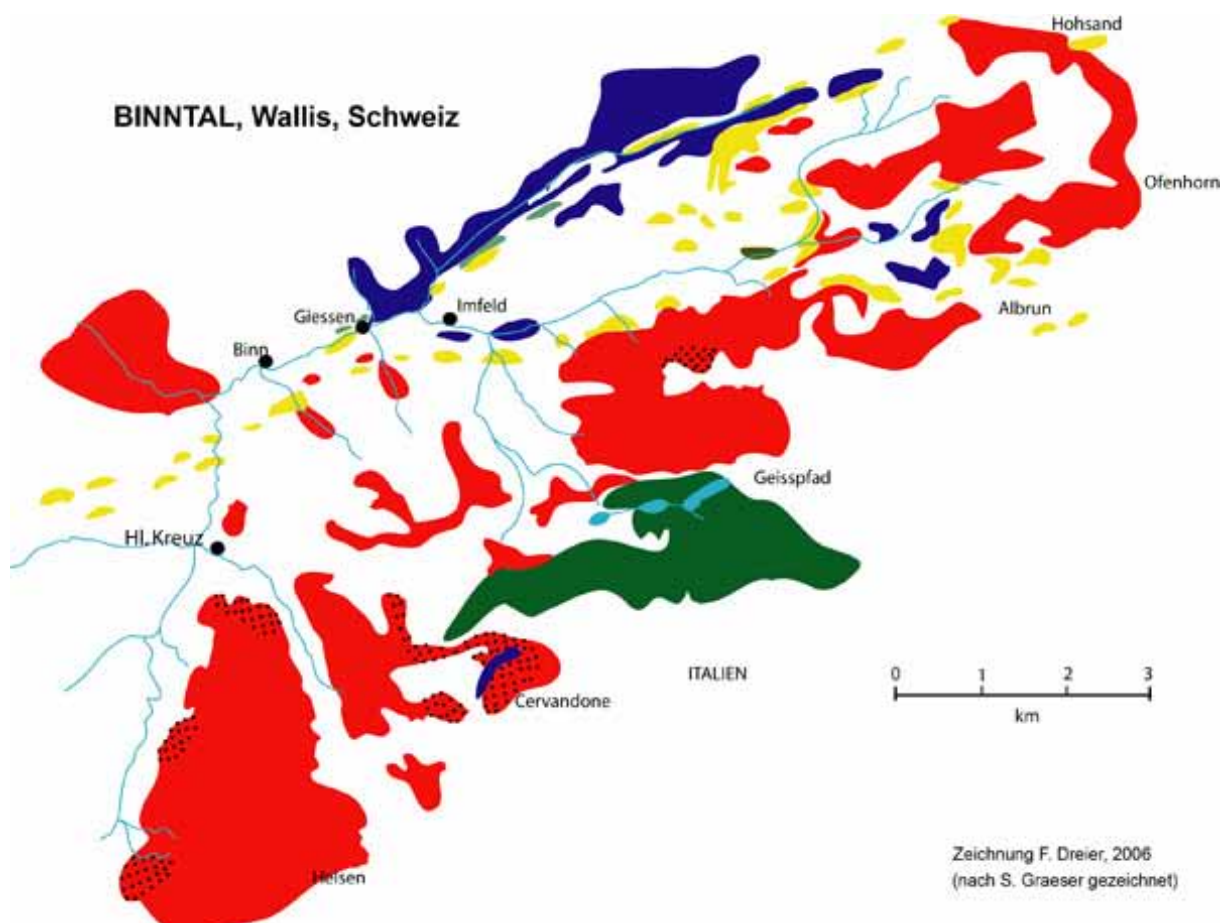
View from the Eggerhorn (Binntal) across the Goms valley back into the Aar massif with the Aletschhorn 4195 m and the Wannenhorn 3906 m. © M.S. Krzemnicki





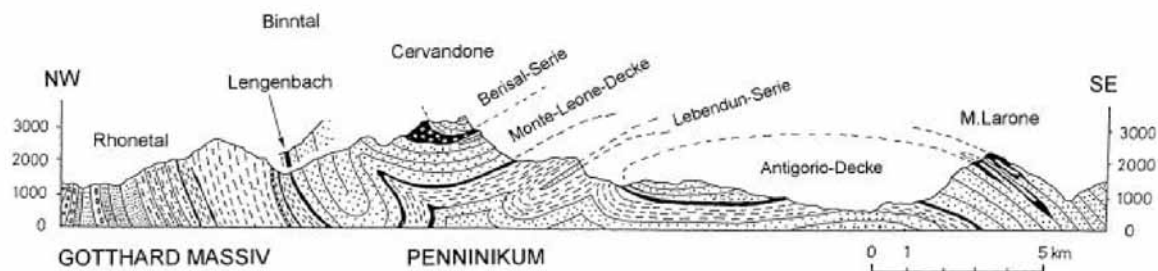
The Breithorn, at the lower end of the Binntal and close to the village Binn. This mountain is mainly formed by Grisons slates. These mica-rich metasediments are soft which explains the rounded shape of this mountain.

© M.S. Krzemnicki

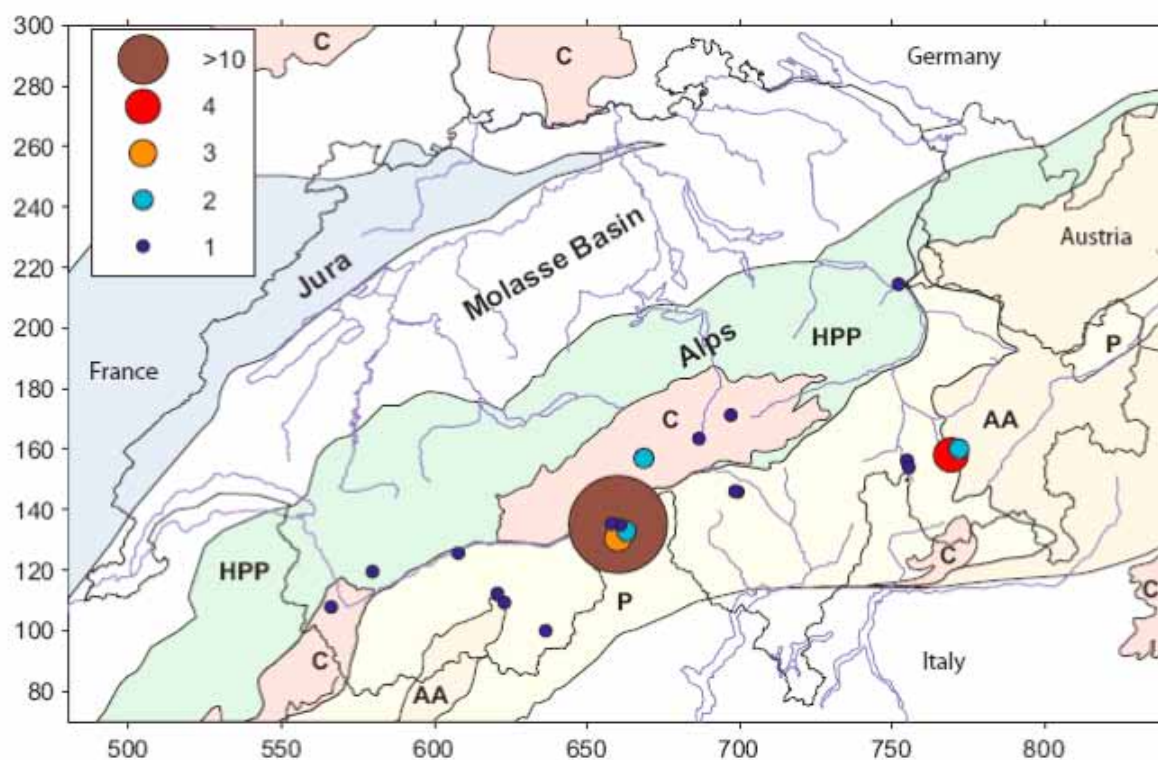


Schematic geological map of the Binntal, showing in red the main gneissic body of the Monte Leone fold-nappe. The para-autochthonous Triassic marbles are marked in yellow and the adjacent Mesozoic Grisons slates are dark blue. At the border to Italy in the south of the Binntal we find a larger serpentinite body, interlayered into the gneissic Monte Leone fold nappe.. © F. Dreier, after S. Graeser.





Geological cross section through the Binntal showing the folded Monte Leone unit with the underlying Antigorio unit and the overlying Berisal series, all belonging to the Penninic fold-nappes. Indicated is the position of the Lengenbach quarry in the Triassic marble.

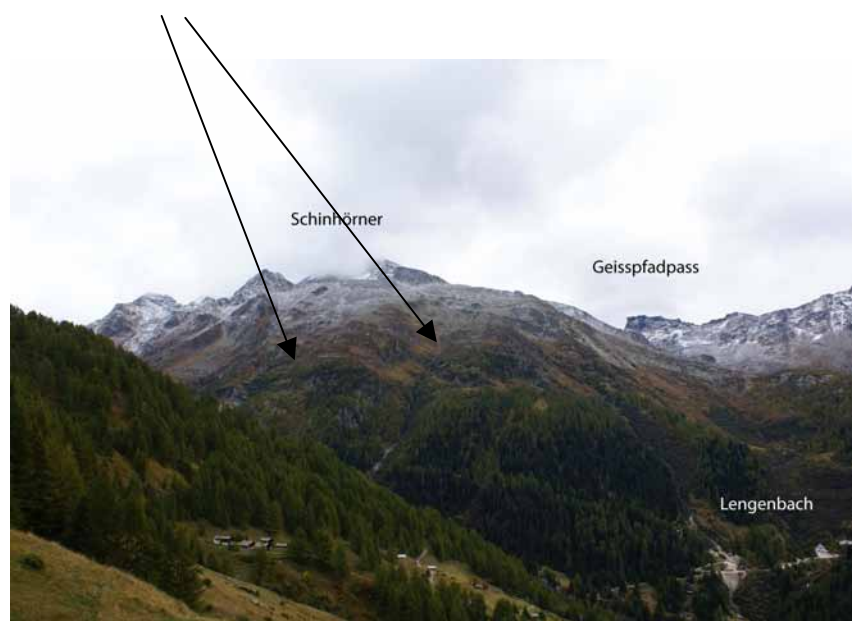


Regional distribution of type-minerals (minerals found for the first time worldwide at a site). The large brown circle represent the Lengenbach dolomite marble quarry, in which numerous rare and unique arsenic sulfides have been discovered. The light blue, dark blue and orange circles represent other localities in the Binntal, which mostly produced rare and new arsenite minerals. © P. Roth

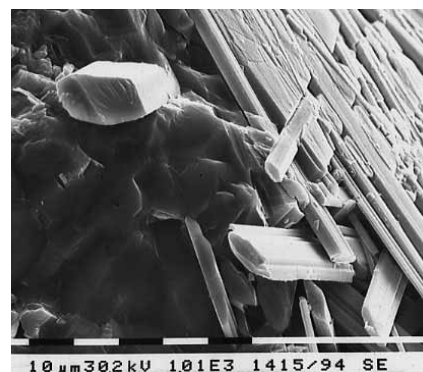
We can separate four main lithologies in the Binntal (i.e. gneisses, dolomite marble, Grisons slates interlayered with some amphibolites, and a large serpentinite complex) which all have been overprinted by the Alpine metamorphism, and leading to a great number of outstanding mineral specimens. Due to tectonic contacts and intense hydrothermal activity, all lithologies are more or less rich in minerals, but all with very specific paragenetic characteristics. Genetically we can differentiate between hydrothermal formations in clefts and fissures and mineral formation in small druses created by solution processes in the dolomite marble. Furthermore we find many rock-forming minerals formed due to metamorphic reactions during Alpine orogeny, but also relictic minerals of Pre-Alpine formation, such as aquamarine and molybdenite in metamorphically overprinted pegmatitic dykes.

### To highlight some of the important findings and minerals:

**Lärcheltini zone:** World famous locality for excellent anatase crystals of complex habit. Many specimens are nowadays on display in museum collections all over the world. Apart from anatase, there are magnetite, hematite, rutile, but also rare minerals such as monazite, asbecasite, fetiasite, graeserite and even some specks of gold.



Lärcheltini zone (in gneiss) and Lengenbach quarry (dolomite marble) in the Binntal. © M.S. Krzemnicki



Anatase on quartz and two barrel-shaped anatase crystals, both from Lärcheltini. © T. Schüpbach and Joachim Peter.  
SEM micrograph of graeserite, a rare As-oxide found as clusters of metallic fine needles at the type-locality Lärcheltini zone. © Foto & coll.: M.S. Krzemnicki

**Pizzo Cervandone / Wanniglacier:** This zone in the gneisses of the Monte Leone unit is famous for outstanding arsenic-oxides (arsenites) and REE-bearing minerals. It is the type locality of a number of new minerals such as cafarsite, asbecasite, chernovite etc., which mostly until now are only known from this locality.



Cafarsite crystals and aquamarine with anatase from Wanniglacier, Binnental. © Thomas Schüpbach

**Lengnabach quarry:** This is by far the most famous mineral locality in Switzerland. So far, 29 new minerals have been discovered in the marbles at Lengnabach. Most of these minerals are rare sulfosalts (*Me-As-sulfides*). The quarry has been worked since the 18<sup>th</sup> century.

The Lengnabach has provided many spectacular mineral specimens, which are very beautiful as they are found in small druses in a white powdery dolomite marble. Apart from many metallic sulfosalts, there are still nowadays plenty of golden pyrites, and some honey-coloured sphalerites and vivid red realgar crystals found in the mine.



Binnite (= tennantite) with some pyrites in a small druse in the dolomite marble from Lengnabach.  
© Mathias Reinhardt.



# MINERALS FROM THE LENGENBACH QUARRY

## Sulfides, sulfosalts:

acanthite	Ag <sub>2</sub> S
arsenopyrite	FeAsS
*baumhauerite	Pb <sub>12</sub> As <sub>16</sub> S <sub>36</sub>
*baumhauerite-2a	Pb <sub>11</sub> Ag <sub>7</sub> As <sub>17.2</sub> Sb <sub>4</sub> S <sub>36</sub>
bernardite	Tl(As,Sb) <sub>5</sub> S <sub>8</sub>
bornite	Cu <sub>5</sub> FeS <sub>4</sub>
chalcopyrite	CuFeS <sub>2</sub>
*dalnegroite	Tl <sub>4</sub> Pb <sub>2</sub> (As,Sb) <sub>20</sub> S <sub>34</sub>
*du frénoysite	Pb <sub>2</sub> As <sub>2</sub> S <sub>5</sub>
*edenharterite	TlPbAs <sub>3</sub> S <sub>6</sub>
enargite	Cu <sub>3</sub> AsS <sub>4</sub>
*ernigglite	Tl <sub>2</sub> SnAs <sub>2</sub> S <sub>6</sub>
galena	PbS
greigite	Fe <sup>2+</sup> Fe <sup>3+</sup> <sub>2</sub> S <sub>4</sub>
*hatchite	PbTlAgAs <sub>2</sub> S <sub>5</sub>
*hutchinsonite	TlPbAs <sub>5</sub> S <sub>9</sub>
*imhofite	Tl <sub>3</sub> As <sub>7.67</sub> S <sub>13</sub>
*jentschite	TlPbAs <sub>2</sub> SbS <sub>6</sub>
*jordanite	Pb <sub>14</sub> As <sub>6</sub> S <sub>23</sub>
*lengenbachite	Pb <sub>6</sub> (Ag,Cu) <sub>2</sub> As <sub>4</sub> S <sub>13</sub>
*liveingite	Pb <sub>9</sub> As <sub>13</sub> S <sub>28</sub>
lorandite	TlAsS <sub>2</sub>
mackinawite (?)	(Fe,Ni) <sub>9</sub> S <sub>8</sub>
marcasite	FeS <sub>2</sub>
*marrite	PbAgAsS <sub>3</sub>
molybdenite-3R	MoS <sub>2</sub>
*nowackite	Cu <sub>6</sub> Zn <sub>3</sub> As <sub>4</sub> S <sub>12</sub>
orpiment	As <sub>2</sub> S <sub>3</sub>
pararealgar	AsS
pearceite	(Ag,Cu) <sub>16</sub> (As,Sb) <sub>2</sub> S <sub>11</sub>
proustite	Ag <sub>3</sub> AsS <sub>3</sub>
*gabrielite	Tl <sub>2</sub> CuAg <sub>2</sub> As <sub>3</sub> S <sub>7</sub>
pyrargyrite	Ag <sub>3</sub> SbS <sub>3</sub>
pyrrhotite	Fe <sub>1-x</sub> S
pyrite	FeS <sub>2</sub>
*quadratite	AgCdAsS <sub>3</sub>
*rathite	(Pb,Tl) <sub>3</sub> As <sub>5</sub> S <sub>10</sub>
*"rathite-140"	Pb <sub>6</sub> As <sub>10</sub> S <sub>21</sub>
realgar	AsS
routhierite	TlCu(Hg,Zn,Fe) <sub>12</sub> As <sub>4</sub> S <sub>13</sub>
*sartorite	PbAs <sub>2</sub> S <sub>4</sub>
*seligmannite	PbCuAsS <sub>3</sub>
*sicherite <sup>1)</sup>	TlAg <sub>2</sub> (As,Sb) <sub>3</sub> S <sub>6</sub>
*sinnerite	Cu <sub>6</sub> As <sub>4</sub> S <sub>9</sub>
*smithite	AgAsS <sub>2</sub>
smythite	Fe <sub>13</sub> S <sub>16</sub>
sphalerite	ZnS
*stalderite	TlCu(Zn,Fe,Hg) <sub>2</sub> As <sub>2</sub> S <sub>6</sub>
stephanite	Ag <sub>5</sub> SbS <sub>4</sub>
tennantite	(Cu,Ag,Fe,Zn) <sub>12</sub> As <sub>4</sub> S <sub>13</sub>
tetrahedrite	(Cu,Ag,Fe,Zn) <sub>12</sub> (Sb,As) <sub>4</sub> S <sub>13</sub>
*trechmannite	AgAsS <sub>2</sub>
*fibrous sulfosalt	Pb-As-S
*wallisite	TlPbCuAs <sub>2</sub> S <sub>5</sub>
wurtzite-2H, -4H	ZnS
xanthoconite	Ag <sub>3</sub> AsS <sub>3</sub>

## Elements:

arsenic  
arsenolamprite  
gold  
graphite  
silver

## Halides

fluorite  
halite

## Oxides

anatase  
arsenolite  
brannerite  
coulsonite  
goethite  
lepidocrocite  
magnetite  
nolanite  
quartz  
rutile  
uraninite

## Carbonates

aragonite  
calcite  
cerussite  
dolomite  
hydrozincite  
magnesite  
malachite

## Sulfates, molybdates

anglesite  
barite  
osarizawaite (?)  
wulfenite

## Phosphates, arsenates:

apatite  
gorceixite  
goyazite  
mimetite  
\*struvite-(K)  
\*"köttigite-Ca"

## Silicates:

orthoclase (var. adularia)  
albite  
biotite  
dickite  
hemimorphite  
\*hyalophane  
kaolinite  
montmorillonite  
muscovite, and var.  
fuchsite  
barian mica ("oel-  
lacherit")  
paragonite  
phlogopite  
scapolite  
thorogummite  
tourmalines  
dravite  
uvite  
beryl

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\* = type locality Lengenbach (29)

<sup>1)</sup> Graeser et al. 2001

→ 2-3 unknown minerals under investigation

TOTAL<sub>Lengenbach</sub> = 112 species

TOTAL<sub>Sulfides, etc.</sub> = 57 species



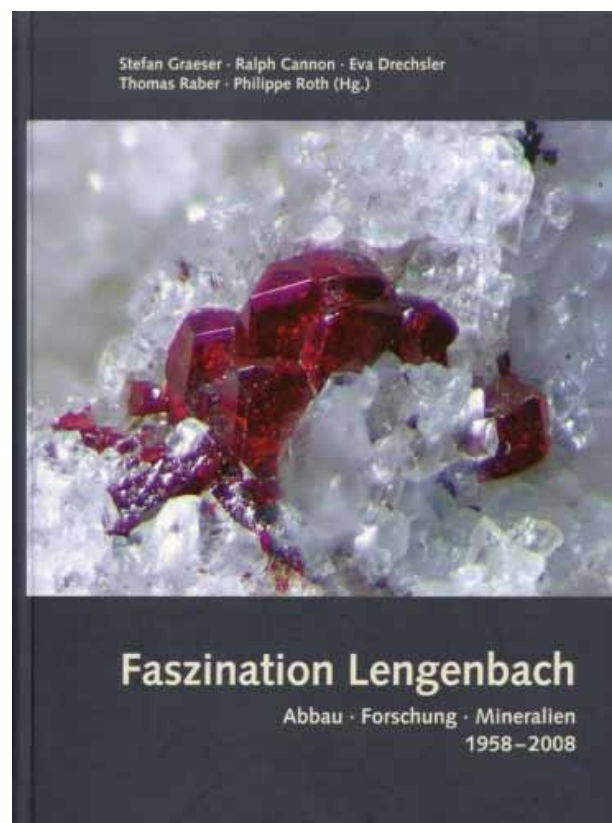
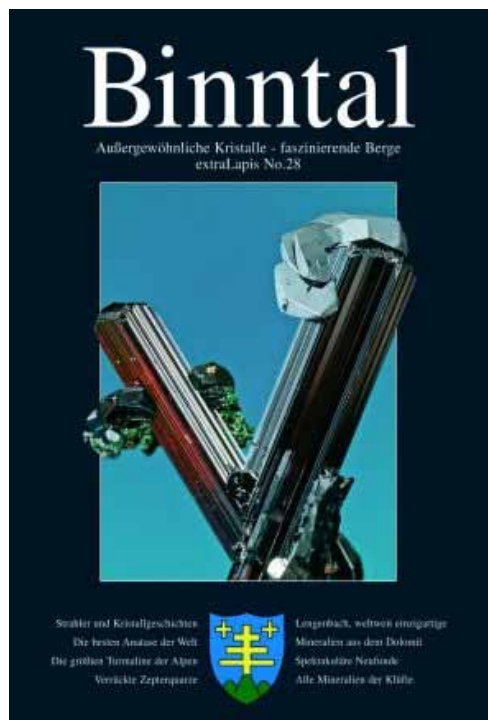
Smithite and Lengenbachite. © Thomas Schüpbach



Hutchinsonite from Lengenbach. © Thomas Schüpbach



Marrite and Xanthokon from Lengenbach. © Stephan Wolfsried



Time for a Swiss Schnaps....

