ENGLISH

GROTTONEUM

SAALFELDER FEENGROTTEN

VISITOR GUIDE

A MUSEUM TO DISCOVER

WELCOME TO THE GROTTONEUM

Discover – Wonder – Taking part

For all of you, who want to know more about the beginning of the Saalfelder Feengrotten, here it is: The sensational experience museum within the Feengrotten Park. Visit the Grottoneum and dive into the lively genesis of the today's show-grottos.

You don't find dusty showcases and big wall charts in vain. The slogan for the Grottoneum is: LISTEN, READ, TOUCH and SMELL and get on the track of thrilling questions. Miners from the Middle Ages, precious minerals, and gigantic scorpions from the Silurian sea are waiting for you to discover the subterranean world.

Find out how the miners inflamed the light in the mine and brought in fresh air at that time. Let the molecules dance and align the colourful minerals of the Feengrotten. Visit the grotto-cinema and experience the secrets of the Feengrotten.

These and many more stations are waiting for you within the Grottoneum – a treasure moment for the whole family.

For more information about the Grottoneum, the show-mine Saalfelder Feengrotten, the Feenweltchen and the gastronomic opportunities take a look at our homepage www.feengrotten.de.

Station 22: Fascination minerals

The world of the Feengrotten is a fascinating natural wonder. Countless dripstones and sinter surfaces grow in more than 100 colours.

About 50 different minerals have been detected so far. The crystals from which a mineral is, are some microscopic. Only with a lot of magnification reveals their unique variety of shapes and colours.

Station 21: Treasury of the Feengrotten

In the realm of treasures

Quartz **SiO2**

Chemical elements: **Silicon, Oxygen**

Until the Middle age all the crystals are called quartz. Today the quartz is the title for a very form- and colourful mineral. The most of them are grey-white and sometimes reddish coloured. The quartz crystals can reach an edge length up to 1 cm in hollows below ground. A special form is the sceptre quartz. In this kind on top of the crystal grows a second quartz crystal.

Aragonite **Ca(CO3)**

Chemical elements: Calcium, Carbon, Oxygen

In the long tunnel of the Feengrotten you can see many Aragonites. The mineral consists of colourless and sometimes white crystals which have a limp form. On some places the Aragonite covers several square metres of the rocks with less millimetre strength in the Feengrotten. It's used as a jewellery stone very often. They are referred as Mexican, Californian or Turkish Onyx.

Brochantite **Cu4(OH)6(SO4)**

Chemical elements: **Copper, Sulphur, Oxygen, Hydrogen**

Brochantite is the only proven copper sulphate in the Feengrotten so far. It comes through the weathering of the coppery ores. The turquoise-colored mineral formed as a sinter-like crust on the rocks. Some of the surfaces glisten like pearl Brochantits, some are vitreous in different shades.

At high magnification, bar-like crystals are visible to the spear-shaped end faces. Also, needle-like crystals, globes and nodules are formed.

OVERVIEW

Welcome in the GROTTONEUM

Hard work deep in the mountain

Already 400 years ago we had active mining for alum slate in the present Feengrotten. It looks like that they searched for precious metal and didn't expect to discover another natural resource, the black alum slate. In the dark narrowness of the mountain the miners definitely needed light and fresh air.

How the miner got light

During the Stone and Bronze Age the pine chip was the first light. It's a part of resinous wood, which they used with fire to glow. During ancient times they made oil lamps out of clay. The lamps were filled with suet.

During the Middle Age they developed lamps, the same as the ones used in the former mine "Jeremias Glück". Mostly opened or closed frog lamps made of clay, brass or iron. Furthermore they used suet for fuel, but also colza oil, which was won from the seed of "Rübsen", a similar plant to rape.

There was a strong hook at each mine lamp and the miners attached the light to the clothes when they dug. Now their hands were free for working in the tunnel.

Gale-force winds at the mine?

Is there good or bad weather in the mine? Yes, indeed! Fresh air – good weather – needs the miner for breathing and the glowing of his lamp. Used air was called dull or bad weather. Toxic and explosive gases were very dangerous and had to get out of the mine quickly.

To get fresh air into the mine it was necessary to have two vents on the earth's surface. They had to be connected below ground. Besides the tunnel entrances – the so-called mouth holes – they used also the vertical tunnels for fresh air supply. As you know from home when you change the air in the room the temperature- and air pressure difference is responsible for the draught. You can also feel it below ground: it pulls.

To find out if there is enough fresh air below ground they often took canary birds or mice or other small animals into the mine. If the animal was very calm and didn't move in his cage, they know that they had to bring in fresh air very fast.

Station 21: Treasury of the Feengrotten

In the realm of treasures

Diadochite and Destinezit

$Fe_2^{3+}(PO_4)(SO_4)(OH)\cdot 5H_2O$ / $Fe_2^{3+}(PO_4)(SO_4)(OH)\cdot 6H_2O$

Chemical elements: Iron, Phosphor, Oxygen, Sulphur, Hydrogen

On the chemical way the both minerals have the same composition. But from the mineralogical way there are differences. While the Diadochite is amorphous, that means it doesn't show any crystal structure, the Destinezit forms crystals and connects an additional water molecule. He is also stabile outside the mine atmosphere thereby. The Diadochite dries up shortly and moulders into powder.

Barite $BaSO_4$

Chemical elements: Barium, Sulphur, Oxygen

Barite is a very seldom Feengrotten-Mineral and comes by a size from 3 x 2 cm. His colours reach from yellow to white to colourless. In the period of origin the mineral shows a transparent shine, which will become dull through the weathering process. In the Feengrotten the Barite is bound to particular little disorders. These are cracks and displacements of the rocks. Nowadays Baryt is used in the industry in many ways, for example as filler in the paper production.

Apatite $Ca_5(PO_4)_3F$

Chemical elements: Calcium, Fluorine, Phosphor, Oxygen

Apatite is the main part of the phosphorite-nodules in the Feengrotten. Mostly you can find him globular or ovoid with a diameter of 1 – 7 cm. Apatit was built on the bottom of the silurian sea more than 440 million years ago. The nodules are deep black through to the organic carbon. Even today the mineral is used for the production of fertilizer.

Station 20: Curing water from the mountain

To promote health

In the 2nd century the greek doctor Galenos said: “The waters must be designed, like the stratum where they flow through.” Also the different layers of rock in the Feengrotten produced several waters: high mineralized (for curative water) and a lot lighter mineralized ones which were traded as mineral water.

In the search of the source-place, a little group of brave men went below ground in the year 1910. It didn’t exist anymore plans from the former mine. The entrances were forfeited and filled with debris. The only entrance was a hundred meter tunnel. At great risk and troubles they got inside the former mine. Totally unexpected they found the present source grottos and the place of origin from the sources below ground. Chemical analyses proved the high medical value of the waters. That’s why they wanted to open a health spa. But the beauty of the grottos induced the founder of the show-mine, Adolf Mützelburg, to open the wonder of nature for the public. The first visitor of the Feengrotten came to see it on the 31.05.1914.

Besides the operating of the show-mine they filled up high mineralized waters from 1928 to 1964 called “Saalfelder Heilquellen” and sold in whole Germany. The unique Phosphor-Arsenic-Iron-Sulphate-Sources were used for several therapies of suffering from gout, gall and nerves. It was also used against anemia and metabolic complications.

In the year 1964 the Wismut began to search for uranium on the Feengrotten land and also made deep drilling. They didn’t fill up the holes of the drills the right way. That’s why the healing spring flowed off in other layers of rock and couldn’t get hold anymore.

The light mineralized, neutral and low-enriched basic deep waters were sold on the open market between 1933 and 2005 as mineral water “Gralsquelle”. The great demand soon was more than a spring discharge so that they made an additional deep drilling in 1939. Today you find the GROTTONEUM in the former bottling-rooms. Here you can taste the original mineral water with his typical iron flavour.

Station 02: Survival underground

Gale-force winds at the mine?

It happened a lot that there were accidents and disasters underground caused from the bad weather conditions during the Middle Age. So they made many experiments to find out new things to avoid that. The bellows was used to suck the bad air out of the mountain and to blow in fresh air. This tool was made by hand, horses or water power either way.

Come on and try it yourself!

Station 04: Treasures of the mountain

What did the miners search below ground?

Copper, gold and silver are the first metals, which are known from the human race. In search of those mineral deposits the humans reached inside the soil in old Egypt and Mesopotamia.

The search for the treasures of the mountain already started above ground. In former mining was the locating of the searched sedimentary rocks on the earth's surface, so-called cutting out, a very important evidence of the mineral ores which were looked for. They mostly found such cutting outs at mountain slopes. Later they could see what kind of mineral ores are in the ground, because of certain plants' growth.

During the Bronze Age there were some traces of former mining in the area of Saalfeld. People, who lived around the river Saale extracted copper ores from 2200 – 1200 BC. From the Middle Age through to Thirty Years' War [1618-1648] they primarily mined silver ores. Until the late 19th Century they extracted the mineral ores cobalt, copper and iron. They also mined the barite for paper production and colouring earth for painting the house facades. Even today the Maxhütte Unterwellenborn (near Saalfeld) produces iron ore out of unrefined iron in miner's fashion smelting.

Station 18: The Ochre of the Feengrotten

Colour pigments and healthful sludge?

During the 19th century the mining of alum slate stopped in whole Europe. Also the mine "Jeremias Glück" was closed and was buried in oblivion. Only the ochre sludge flowed out of the mouth hole – an opening in the mountain.

Ochre is from bright yellow to yellow brown natural colour pigment and since way back it was used as a colourant. The variety of ochre connections within the nature is nearly vast – but which colour is meant knows nearly every person yet. The ochre is a natural weathering product of iron ores and feldspar with a high concentration of hydrous iron oxides considered chemically.

After the closing in 1855, August Wohlfarth, a businessman from Saalfeld, bought the former mine. Because of the accumulation of the water in the mine inside the long tunnel he gained iron ochre. However it happened without any touch or knowledge of the basic mine workings. Mr. Wohlfarth let produce earth colours for painting house fronts in his "Saalfelder Farbenfabrik" (paint factory) from the dried ochre sludge. He went on with the ochre production until 1909 with modest success. The produced amount was unprofitable to go on with further colour production. So the ochre preparation stopped. That was the final end for winning solid materials in the mine "Jeremias Glück".

In spite of that the leaked ochre sludge found a medical use for the inhabitants from Saalfeld. Since the last century the healthful sludge was used to abate pain such as rheumatism.

Station 17a: White crystals from black stone?

Picture legend

Picture 1:

The broken alum slate and a big amount of wood were piled up on a grillage and set on fire. It was a complicated burning process with a huge oxygenation capacity. Nevertheless it needed to burn slowly and so the stillman had a huge responsibility.

Picture 2:

After the complete burning of the grillage the left part was moistened and released for the natural decomposition.

Picture 3:

Later on this bulk was leached with water in huge wood tubs. Just after this step the alum formed.

The lye was collected and brought to the boiling house for further processing.

Picture 4:

In the boiling house the lye was steamed over the open fire in big boiling pans made of lead. The cooking was repeated very often so that the concentration of the alum was raised in the lye.

Picture 5:

For cooling down they hung up the bars and laces in the hot lye. The white alum crystals were growing on them. They were stored and transported inside of clay pots or wooden pots.

Station 05: Come along with hammer and chisel!

Constant knocking wears the stone

The tools of mining are called “Gezähe”. Although those tools were very easy during centuries, the miner worked very effective. The drift of the tunnel – the expansion of the mine – were made with hammer and chisel. The miner in “Jeremias Glück” drifted the tunnel between 3 and 10 cm per working shift.

The famous symbols of mining are hammer and chisel. If you have seen a tunnel made from them, you can imagine the incredible work which has done with these simple tools.

For the winning they held the chisel on a wooden handle and placed it on the stone. The other hand kept the hammer and struck a blow upon the chisel. The miner took 15 chisels per shift below ground. He held them onto yoke. They sharpened the chisels after the working shift in the smithy. As a lucky charm he left a used chisel and his hammer down there after end of work.

For softer stones they have used a wedge axe which is similar to a pick axe. But to do a work like this you need enough space for swinging the tool.

Station 06: Hewers and mine surveyors

Who planned the construction of the mine?

A mine is a complex subterranean structure. All the aisles – the length of the tour – and the ups and downs on the different levels – the floors – seem to be confusing at the first view. But it was necessary to conduct an exact measurement and calculation below ground so that the winning can be successful.

The miner followed the way of the lodes and stratifications to the requested sedimentary rocks.

The hewer did a very important job. He was able to tell which rock is valuable and which is useless. To show the hewer the right way for mining the mine surveyor has to measure the mine construction. He wrote down new lodes in a sketch for fissures, a kind of subterranean map.

The work of the mine surveyor is the same as the ones of a measurement engineer nowadays. He decided about above and below ground borders of the owner's property to avoid problems with the neighbourhood. Already in the Middle Age the mine surveyor was an officer. He had to confirm under oath and his records were legal character like documents.

For the measurement below ground the mine surveyor used a compass, goniometer,plumb, surveyor's chain and a limb.

The assessment of value was made with the limb. It showed how steep or even the mountain has to become.

The magnetical North Pole was found out with the compass and the mine surveyor decided in which way the route will go. He hung up the compass on a tight string to do that. The result became inexact, if there where parts of iron in that area. That's why they produced the tools for the mine surveyors and mine lamps without iron.

The so-called "hour" hung up on the ceiling so that the hewer stuck to the right way in the mine. For that they used three strings in a row and at the end there was a plumb. The strings had to be in a row with a mark behind the next rock.

Station 17: Roasting and Boiling

White crystals from black stone?

The winning of the alum slate started around 1550 in the Saalfeld area. Unfortunately the age-old, enormous significance of the alum advised in oblivion by today. The process of the production of these fascinating crystals from black stone was very intensive and brought almost no profit.

Already in the ancient they used alum as a timber preservative. Also the Romans estimated it as a helping excipient for colouring their red capes, the roman toga. As recently as 100 years ago you could found alum in almost every home and handicraft business.

For the paper production the alum was absolutely essential. Since the Middle Ages the tawers used it the most. With the help of alum they made the goat- and sheepskin durable and smooth. But it was also important for the healing of skin- and bowel diseases. Over centuries they used it as a hemostatic medicine.

The alum ranks among the minerals, which is rare in the nature in clean form. Before the mining started in the Middle Age, they obtained the alum slate from the alum stone, the so-called alunite. You only found it in the Orient, in Egypt and Byzantium. After the Turkish conquest in 1455 the Europeans were cut off the deposits and the alum was getting expensive. Some years later they finally found the alum in Europe: in Tofal (Italy), then Papal States. The pope had the absolute monopoly of the alum until 1510. He detected the unique value and determined that the alum could only be acquired by the popes. The purchase of "unchristian" alum was strictly prohibited and it was proclaimed an anathema on that. That's why the popes got rich quick.

A very important discovery was the quarrying of alum from black- or alum slate. The miners won the alum in a different levels process consisting of burning, leaching and crystallizing. The yield often was modest and many alum factories closed shortly after a few years.

Station 14: Lively stones?

How fast grows a dripstone?

While dripstones of chalkstone grow very slow, the process in the Feengrotten goes much faster.

Mostly know are dripstones in chalkstone caves. The chalkstone gets separate through the subterranean running water which contains carbon dioxide. When the water drops down then the chalkstone is “painting” the ceiling of the caves with tiny crystals out of calcium carbonate. Now the growing of the dripstone starts.

This process is taking very long in human measure: in more than 100 years a dripstone grows only 8-15 mm. A ONE meter dripstone takes more than 10.000 years and during drought the growing ends.

There are some chalkstones in the Feengrotten. But they are very seldom, because the sour and sourest waters prevent the chalkstone sedimentation. The most dripstones of the Feengrotten consist of the soft material Diadochit. They grow up to 3 cm per year compared to the chalkstone cave it would be 300 years.

Station 16: From the mountain to the grotto

Make the discovery of the hidden world and listen to the words of the researcher here.

Station 07: Water inrush

Rain underground?

Water soaks in each mine, sometimes plenty of it. If you don’t get it out, then the water collects below ground and the mine “drowns”. The command and using of the water is very important for the running of the mine and life of the miners then and now.

The soaking water is coming from several sources. A part is coming from the precipitations which infiltrates from the soil into the mine. After a few weeks of heavy rain or melting of snow you can watch a rain-affected drop activity in the Feengrotten.

Another part of the water is coming from the groundwater which infiltrates from to mining of water-bearing rocks. If there is a suddenly overflow in the mine caused by groundwater then it is called water inrush.

In the former mining the water was taken out of the mine per water menials with pots, cans, buckets and tankards. After the 14th century they used sophisticated machines which were operated from the humans or horses. Later they made use of the water power.

To drain the water along the natural slope of the mountain they dug a so-called earth tunnel. Through the tunnel the water got out of the mine. The earth tunnel is still working this way and his water drains into the Arnsgereuther creek close to here.

Station 08: Weary routes

Stones on the way into daylight

To talk in the language of the miners: „driving“ means walking below ground. That’s why the miner drives even when he is walking. After he found the desired ore and hewed it from the rock he had to carry it into daylight.

From the begin of the mining the miners used the so-called “Fahrung” as stairs, “driving trees” – boles with smashed in steps and ladders – titled “Fahrten” to get over the floor level differences inside the mountain much better.

Besides the mine drainage the transportation of the rocks was the most difficult technological task.

Already at the beginning of the 12th century they used a winch for that. Above a horizontal bole they tightened a wooden tray at a hanging rope, so that they could wind this one up and down. The winch was operated by a winch servant. He was responsible for the transportation of the ores from the low to the next higher level. A part of the rocks was carried above ground with drawing sheets or a tubular leatherbag – a “Bulge” by the mine boy.

Later the miners used treadwheels (chart) to get out the rocks faster of the mountain. In large mines were operated by water power sweeper wheels for use.

Station 12 a: Molecule-table

Pyrite **FeS2**

Chemical elements: **Iron, Phospor**

Pyrite occurs in rocks of the Feengrotten are very common. The iron contained in the forms by weathering brown, yellow and ochre tones. Because of its colour resembles gold is also known as fool's gold.

Pyrite, also known as fool's gold or iron pyrites, was established already in the bottom mud of the silurian sea before 440 million years. The gold-coloured, hard mineral forms individual crystals in a surprisingly regular cubes form. In the rock of the Feengrotten he is usually dispersed and may contain small amounts of gold or silver. Rarely enrichments in lump form or as accompanying material can be observed in the crystal.

Volborthit **Cu32+V25+O7(OH)2•2H2O**

Chemical elements: **Copper, Oxygen, Vanadium, Hydrogen**

Volborthit is a mineral that appears mainly in green and yellow colours. On the rocks of the Feengrotten are formed only by the elements vanadium ores.

Volborthit consists of tiny crystals which form spherical or pustular aggregates with a diameter of up to 2 millimeters. The colours range from yellow-green to apple green to lemon yellow, orange or cream-coloured. Volborthit is a rare mineral. More remarkable is that it has been discovered in the Feengrotten in several places and demonstrated.

Station 12 a: Molecule-table

Apatite **Ca5(PO4)3F**

Chemical elements: Calcium, Fluorine, Phosphor, Oxygen

You can find the mineral Apatite in so-called phosphorite-nodules in the Feengrotten. It emerged from the shells, bones and shells million years old marine creatures.

Apatite comes in many color variations: white, yellow, green, blue, pink, purple and brown. In the Feengrotten the mineral is finely distributed only as a major component of phosphorite-nodules. They consist mostly of a black base and can reach a diameter of 1-7 centimeters. A related mineral, the hydroxyapatite is also an important building block for the construction of the bone.

Diadochite **Fe23+(PO4)(SO4)(OH)•5H2O**

Chemical elements: Iron, Phosphor, Oxygen, Sulphur, Hydrogen

Diadochite is a rare mineral, but is in the Feengrotten in large amounts. On the black rock of the alum slate it forms bright vivid contrasts.

Diadochite occurs only at very few places in the world and is therefore a feature of the Feengrotten.

It can be found in many places underground and the main part of the dripstones. Diadochite is not a mineral in the rock, but is only due to oxidation processes of other minerals such as pyrite and phosphorus compounds formed. The mineral is white and soft yellow to brown colours, and is sometimes also called the mountain of butter.

Dypingit **Mg5(CO3)4(OH)2•5H2O**

Chemical elements: Magnesium, Carbon, Oxygen, Hydrogen

Dypingit is still not well known and very rare in the Feengrotten. Under certain circumstances, it emits cold light after being illuminated with UV light.

Dypingit is extremely rare in the Feengrotten occurring mineral and was only discovered a few decades ago. Under the microscope, is seen that it occurs in a round ball-like shape and has a snow-white colour. Most of these balls have a diameter of only about one millimeter. Rarely are large areas of rock covered with dense Dypingit.

Station 09: The Dripstone Empire

The soft stone?

The dripstones of the Feengrotten are extremely filigree and breakable. Just one touch and it destroys the fine beauty. Here you can gaze it very close, because you only can see it from far below ground.

The size of the stalactite is only limited by the own weight. If he gets too heavy and too tall, then it breaks off the ceiling. Much thicker and more stable than the slender stalactite is the stalagmite, which grows from the ground. It becomes a dripstone column: a stalagnate.

A little saying helps you to remind the dripstones:

“Stalactites are hanging down, but stalagmites are standing up”.

Station 10: Mineral-Zoom

Here you can take a look at the selected minerals of the Feengrotten. If you turn the wheel you can see them on different zoom level.

Station 11: The abandoned mine

The growth of the dripstones are hiding

In the abandoned hollows a colourful dripstone and seepages scenery formed along the ceiling and the walls of the old mine.

Her name “Feengrotten” as the “most colourful show-grotto of the world” referred on the variety of the minerals in the rocks. The nature got free hand after the last miner was gone, so that the subterranean world was alive. Many chemical reactions were responsible for the formation of this unique miracle of wonder inside the mountain and they still are.

Water and oxygen sunk in the opened mines; different weathering processes took place. This procedure caused the formation of sulphurous acid. It separates iron, phosphates and other minerals from the rock. These solutes also started new chemical connections. That’s how the mineral Diadochit formed. The main part from the dripstones of the Feengrotten formed to countless stalactites and also towered many stalagmites.

Station 12: Dances of the molecules

Welcome to the colour-laboratory of nature

The colourfulness of the Feengrotten belonged to the different composition of the minerals. Inside the dripping water there are many chemical elements and minerals which are waiting for a connection of them.

On this molecule-table you can puzzle your own mineral. Pull out a part from the water cloud and follow the matching elements and molecules. If you put them together the right way then you see further information and pictures of the mineral you’ve made.

Let’s start the colour-puzzle!