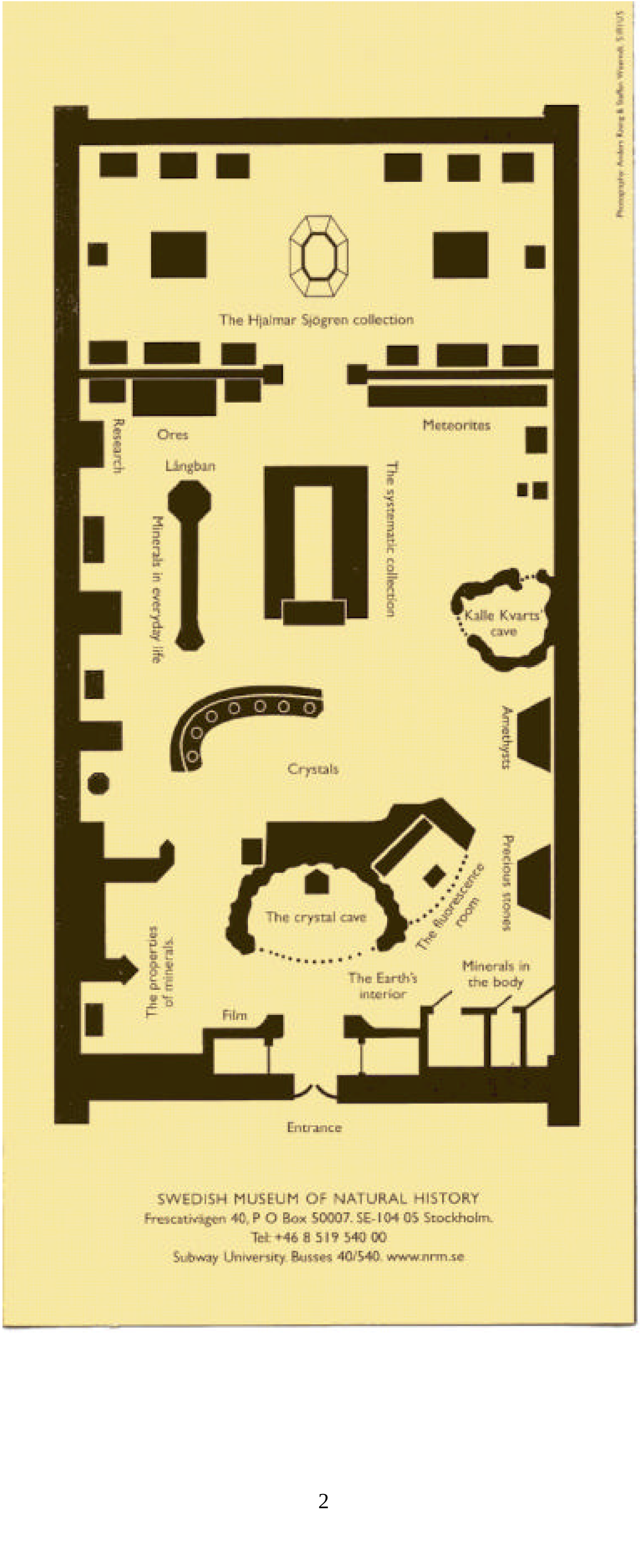
Naturhistoriska riksmuseet

AN EXHIBITION ABOUT MINERALS

TREASURES FROM THE EARTH´S INTERIOR

Photo: Anders Rising

The Swedish museum of natural history


The Hjalmar Sjögren collection
Research
Ores
Meteorites
Långban
The systematic collection
Minerals in everyday life
Kalle Kvarts' cave
Amethysts
Crystals
Precious stones
The fluorescence room
The crystal cave
The properties of minerals.
Minerals in the body
The Earth's interior
Film
Entrance
SWEDISH MUSEUM OF NATURAL HISTORY
Frescativägen 40, P O Box 50007. SE-104 05 Stockholm.
Tel: +46 8 519 540 00
Subway University. Busses 40/540. www.nrm.se

Contents

Mica Photo: Staffan Waerndt

- Minerals are the “building blocks“ of rocks.
- Minerals consist of one or more elements.
- Minerals are always formed by geological processes.
- Minerals normally occur in solid form.
- About 4000 minerals have been identified.
- “Mineral“ comes from Medieval Latin‘s minera, which means mine.

Wulfenite Photo: Anders Rising

Are there minerals in the earth‘s interior?

A rock consists of one or more minerals, which can be formed by the crystallization of molten rock. This can occur on the earth‘s surface, but also deep in its interior. Pressure and heat rise rapidly with increasing depth, and a mineral can be transformed into another type if it is transported between various depths by slow geological processes.

Innermost core
Solid alloys of iron and nickel

Lower mantle
Olivine and pyroxene transformed to new phases by high pressure and temperature

Earth‘s crust
Silicate minerals such as quartz, feldspar and mica predominate

Outer core
Liquid of iron and nickel

Upper mantle
Olivine, pyroxene

Can you see the minerals in this block of granite?

Granite is among the most common rocks in Sweden.
It is a so-called magmatic rock, having been formed at great depths and crys tallized on its way up toward the earth‘s surface.
Granite contains the minerals quartz, feldspar and mica.

Do I have minerals in my body?

Vitamins and minerals

Your body must have certain vitamins and “minerals” in order to function properly. Iron is an essential ingredient of blood, for example. You usually get all the “minerals” you need from the food you eat. The minerals displayed in this exhibit normally occur in solid form and have geological origins. Thus, “minerals”, i.e. mineral nutrients, are not true minerals.

Metals in your body

The body of a person who weighs 75 kilograms contains the following metals in the quantities indicated:

Magnesium 35 g
Iron 4 g
Zinc 2 g
Copper 0.1 g
Manganese 0.02 g
Chromium 0.006 g
Molybdenum 0.005 g

These metals are dissolved into ions and are not minerals.

Do you drink minerals?

Today, many people gladly pay for “mineral water“. But does it contain minerals? The liquid on sale is actually spring water with a salt content of 0.5 per litre. The salts consist of metals such as calcium, sodium and magnesium, which have dissolved in water.

Tooth enamel – hard as the mineral apatite

Tooth enamel is the hardest substance in the body. Its chemical composition is largely identical to that of the mineral, apatite. But since the enamel has been formed in our bodies, it is not classified as a mineral. Apatite has a hardness rating of 6 on the 10-point Mohs´ scale.

Painful stones

Kidney stones consist of salts that have precipitated in the form of crystals. They are not minerals-- but plenty hard, and very painful when they pass through the urinary tract. Gallstones are built up from organic substances contained in bile. If you visit the adjacent toilets, you will find several examples of the body‘s “mineral formations“.

The properties of minerals

Perhaps you think that many minerals look the same. One way to identify an unfamiliar mineral is to test it for such properties as hardness, lustre and magnetism.
Such traits may also determine the uses to which a mineral can be put.

Hard as a rock

There is great variation in the hardness of minerals.
A diamond, the hardest mineral on earth, is several thousand times harder than talc, for example.
A harder mineral can make a scratch in a softer one, a fact which provides the basis of the Mohs´ Hardness Scale.

Can you identify these minerals?
Quartz is the hardest, followed by feldspar and then calcite, the softest of these three.

More on hardness

Hardness refers to the ability of a substance to resist abrasion, scratches and other effects of external forces.
The degree of hardness depends on the strength and orientation of the material's chemical bonds.

In the early 1800s, mineralogist Friedrich Mohs compared the hardness of several common minerals and devised a 10-point scale based on their resistance to scratching by each other and by various objects.

A mineral with certain hardness can scratch all softer minerals.
The hardness of an unfamiliar mineral can be determined by trying to scratch it with common objects of known hardness. There is a much greater difference on the 10-point scale between corundum (9) and diamond (10) compared with talc (1) and gypsum (2).

The Mohs´ Hardness Scale is still used today for the identification of minerals.

Minerals with power to attract

Magnetite and pyrrholite are common minerals that are so strongly magnetic that they react to a simple hand-magnet, and can thus be easily identified.

How is iron affected by magnetism?
Spin the container and move it to the side.

More on magnetism

Magnetism manifests itself in the attraction of magnetized materials to magnets and magnetic fields. This phenomenon is caused by the uniform alignment of electrons in motion. A magnetic field is a space through which magnetic or electric currents are flowing.

Many minerals react if they are placed within a magnetic field, which may attract or repel certain objects.

There are many different kinds of magnetic minerals, characterized by coordination of electronic motions; as the electrons revolve around the atomic nucleus, and as they rotate on their own axes.
A magnetic field arises when the electrons in material move in the same direction, strengthening the effect of their individual magnetic properties.

The electrons in non-magnetic materials are not organized in this way. Their motions are not co-ordinated. As a result, the sum of their magnetic forces is nil.
In nearly all magnetic minerals, it is the presence of iron, which accounts for their magnetism.

Cubes, rods and thin layers

Minerals can cleave into a variety of shapes. Sometimes there are weaker bonds in certain directions, along which the material may readily break into pieces.
These "cleavage patterns" vary between minerals, which can break down into such diverse forms as cubes, rods and thin layers.
The tendency to split is a characteristic trait of many minerals.
Cleavage occurs where the bonds between atoms are weakest, usually where the distance between atoms is greatest.

Colour and Streak

If you draw a mineral across unglazed porcelain, such as that of an ordinary house fuse, the pulverized mineral forms a streak of colour, which sometimes differs, from the mineral's normal colour.
This is one method that can be used to identify minerals.

Test the colour streaks formed by some minerals. With the help of those colours, you can probably figure out which minerals you have tested.

Small can weigh more than large

The ratio between mass and volume is called density. It is a property, which varies greatly between minerals. Gold is one of the earth's heaviest minerals, which is utilized when panning for gold.
The heavy grains of gold settle to the bottom of the pan.

The scales show that the little chunk of galena weighs more than the larger piece of borax.

Ores often have a high density.
- Which is the sample of iron ore?

Shiny as metal?

Some of the light that strikes the surface of a mineral is reflected. We perceive the reflected light as the material's sheen or lustre, which varies greatly between different minerals.

Try aiming the light at various minerals. Describe the lustre: Does it look like metal, glass, diamond or a greasy surface?

More on lustre

The proportion of reflected light depends on the ability to reflect light and on the characteristics of the mineral surface

For shiny materials such as metal, glass and diamonds, it is primarily their ability to refract light that accounts for their lustre. For other types of material, surface characteristics are more important.

Metallic lustre
Opaque minerals that absorb a lot of light have a metallic lustre.
Examples include most sulphides and many oxides.

Vitreous lustre
Seventy percent of all minerals have a lustre that resembles common glass. One example is feldspar.

Adamantine lustre
Highly reflective minerals such as diamond and sphalerite have this kind of lustre.

Greasy lustre
The surfaces of these minerals look as though are covered with grease or fat. This can be seen on the fracture surfaces of quartz.

Dull surface
Light spreads over the surfaces of these minerals so that they appear not to have any lustre, as in the case of pitchblende, an oxide of uranium.

A rainbow of mineral colours

The splendour of the mineral kingdom is magnificent, with all the colours of the rainbow represented. Colour can be an important aid to identification, but some minerals occur in a wide range of colours.

More on colour

There are many processes that influence the colour of translucent materials. While passing through a mineral, light can be absorbed by the electrons of certain elements; it can also be scattered or absorbed by structural defects, or by inclusions of water or other minerals.

The most common source of colour in many minerals is the presence of metals such as iron, chromium, manganese, nickel and cobalt. When light passes through a mineral, it is partly absorbed by the metal atoms‘ electrons as they shift from one energy level to another. The remaining wavelengths, those which are not absorbed, emerge to give the mineral the colour that we see.

It is different with opaque minerals, i.e. those through which light cannot pass. A large portion of the light that strikes the surface is reflected immediately.
A small portion interacts with atoms in the outer surface of the material before it is ejected.
In this process, some of the light loses energy. It is the wavelength of the light that is reflected which determines the colour of opaque minerals.

Colourful quartz

Quartz is an example of a mineral that can occur in a variety of colours.
The varieties have names like amethyst, rose quartz, citrine and smoky quartz.

Rose quartz Photo: Staffan Waerndt

Minerals - essential to art

There are still artists today who mix their own oil paints using pigments from the mineral kingdom.

Zinc and titanium oxides can be used for shades of white. Natural greens can be painted with compounds of chromium or copper, while the colours of the sea can be derived from various minerals containing cobalt. Cadmium sulphide and cadmium oxide have long been used for red and yellow colours. Iron oxide is used to produce shades of brown.

Light through minerals

When light passes through a translucent mineral, its speed is reduced. The extent of the reduction can be specified as a refractive index.

With many minerals, the speed of light may vary depending on the path it takes through the crystal structure. This trait can function like a fingerprint for purposes of identification.

More on light

Light travels fastest in vacuum.

The relationship between the speed of light in vacuum and its speed in a substance is called its refractive index.

For many minerals, the size of the refraction ratio is related to direction. Light that falls on such a substance is divided into two components, two separate rays.

The two rays are affected in different ways as they pass through the mineral. For some wavelengths, the two rays may be out of phase when they emerge from the mineral, while other wavelengths may be in phase.

Since specific phase shifts are characteristic of certain minerals, they can be used for identification. This is done with a microscope fitted with a polarizing filter, which makes it possible to observe the “interference spectrum“ associated with each phase shift.

Are you seeing double?

Calcite is a birefractive mineral, meaning that it refracts light in two directions.
A text read through a bit of calcite appears double.

In the same way, a laser beam that passes through calcite emerges as two separate rays.

Radiant minerals

Some minerals are naturally radioactive due to the presence of such elements as uranium and thorium.

Radioactive minerals can be used as indicators for determining the age of rocks.

More on radioactivity

A radioactive mineral may consist largely of the active element such as uraninite, an oxide of uranium.
Uraninite is an economically important ore, since the energy it contains can be used to drive nuclear power plants.

Some minerals that contain low concentrations of radioactive elements are used to determine the age of rocks. They function as a sort of geological clock, based on the knowledge that the radioactive substance is converted to more stable forms of another element at a specific rate.

Zircon is such a mineral. When it is formed, it takes up small amounts of uranium, but no lead.

Over time, the radioactive uranium “decays“ to lead at a specific rate. By measuring the relative proportions of uranium and lead isotopes in a mineral sample, it is possible to calculate how long ago it was formed.

A glow in the dark

Fluorescence is a phenomenon by which minerals can be self-illuminating if they are exposed to ultraviolet light.
This is because they contain substances that generate

More on fluorescence

Many minerals produce beautiful fluorescent colours when they are lit with ultraviolet light. The colour and the intensity of the fluorescence may vary. Calcite, for example, can glow red, orange, white, blue or green.

All forms of light contain energy. When electrons of certain elements absorb ultraviolet light, they acquire sufficient energy to shift to a higher energy level.
But this is not a stable condition, and the electrons eventually “fall“ back to their original energy levels.

In so doing, they release excess energy, which in some cases gives rise to the light phenomenon known as fluorescence.

A phosphorescent mineral continues to glow after the UV light is removed. Luminescence is the joint term for fluorescence and phosphorescence.

Crystals

Crystals like ice

2000 years ago, the Greeks believed that rock crystals consisted of water, which had frozen so hard that it could not melt. Their word for ice, “krystallos”, was applied to the crystals of quartz. In this beautiful form, they are called rock crystals.

Feel the small quartz crystals - but be careful

The crystals are hexagonal and the surfaces are completely smooth. Like all other matter, they are built up of atoms.
Crystals grow slowly, as their atoms accumulate layer by layer.
The smooth surface you feel is the final layers of atoms that was added before the crystal stopped growing.

If you break off a piece of crystal, the next visitor may be cut by the remnant.
- Buy a crystal in the museum shop, instead!

Nature as designer

Crystals that have plenty of time to grow can become very large.
This is a natural crystal of the common mineral, quartz.
Feel the smooth surface. How many faces does this rock crystal have?
As you can see, some of the surfaces are not completely flat:
- Nature is not perfect.

Do you dare to taste the halite crystals?

The mineral halite is easy to recognize by its taste. But identifying minerals by taste is not a very common method.

- Hold your hand in the opening while you turn the crank clockwise.

You probably have some halite back home in the kitchen. But you call it…

The seven crystal classes

Nearly all minerals can form into crystals. The orderly form of crystals is often a notable feature of a mineral‘s appearance. The external form is a result of the organized manner in which the atoms of the mineral are arranged.

There are seven crystal classes, each with its own characteristic symmetry. All crystal-forming minerals fall into one of the seven categories. Here you can see examples and models of each type.

Cubic crystals
The cube and the octahedron are typical shapes in this category, which includes the most regular forms and the highest degree of symmetry.

Tetragonal crystals
Four-sided prisms and pyramids are typical tetragonal crystal shapes.

Hexagonal crystals
Six-sided prisms, pyramids and bipyramids are typical hexagonal crystal shapes.

Trigonal crystals
This is a variation of the hexagonal type, but with a three-fold symmetry.

Orthorhombic crystals
Box-like and tabular crystal shapes are common in this category.

Monoclinic crystals
Oblique prisms are common monoclinic shapes.

Triclinic crystals
Triclinic crystals are the least symmetrical of the seven types.

Is it possible to see the atoms of crystals?

The three-dimensional pattern formed by the atoms of a crystal is called a crystal structure.
With an electron microscope it is possible to produce images, which reveal the structure. It is difficult to see individual atoms, but their pattern is clearly visible.
It is the particular arrangement of atoms, which determines the mineral's properties. This photo shows the structure of tourmaline as revealed by a transmission electron microscope.

Crystal formation

Minerals are usually formed by crystallization from a melt, or precipitation from a solution. In these experiments, crystals have formed from salt solutions. But since they have not formed naturally, they are not minerals.

Fantastic shapes

The inner structure provides the basis for the visible shape of a crystal.
Many minerals can assume various shapes, depending on surrounding conditions.
It is fascinating to see how many different shapes are formed by nature in the mineral kingdom.

Precious stones

Beautiful, rare and valuable— perhaps that is how we think of precious stones.
They have also been said to possess magic powers: Many are the tales and myths in which precious stones play important parts.

Minerals that are so rare and beautiful that they are regarded as attractive in jewellery are usually called precious stones.
Their hardness and exceptional ability to refract light are also desirable features.

Ruby — said to give the bearer a rich love life

Amethyst — an amulet against drunkenness

Emerald — the jewel of happy marriages

Sapphire — symbol of purity and fidelity

Aquamarine — the jewel of seafarers

Diamond — symbol of eternal love

Colourful names

Only some twenty minerals are frequently used as gemstones. But there are various names for the same mineral in different colours.

Ruby is the name given to red corundum of gemstone quality. But the same mineral in other colours, including blue, yellow and neutral, is called sapphire. An emerald is beryl that has been coloured deep green by natural forces; other variants of beryl are aquamarine and the yellowish heliodor. Other important gemstones are the minerals chrysoberyl, opal, topaz, tourmaline and zircon.

Most gemstone minerals can now be manufactured artificially. But synthetic gems are not nearly as valuable as the natural varieties.

Quartz in jewellery

The most beautiful specimens of the mineral quartz have long been used as gemstones.
The colourless and transparent varieties are called rock crystal. Other varieties include yellow citrine, violet amethyst and rose quartz.

Rock crystal Photo: Anders Rising

Diamond is the hardest mineral on earth

The graphite in a “lead“ pencil is made of the same element as these diamonds—carbon.
While graphite is one of the softest minerals, diamond is the hardest material that is known. Diamonds are formed under enormous pressure in the Earth‘s hot interior.

Increasing the lustre

Gemstones must be cut, ground and polished in order to shape them into jewellery, while at the same time intensifying their beauty.

Minerals in everyday life

- Graphite is used for lubrication, among other things. But its most well known use is in pencils.
- Cryolite is used together with the rock bauxite to produce the metal aluminium.
- Calcite is an important ingredient of cement and paper. It is also used as a polishing agent in toothpaste.
- Quartz is used in the manufacture of glass. It is also a source of silicon, which is essential in electronic components used by modern information technology.
- Sulphur is used in the manufacture of rubber products, including car tyres.
- From magnetite comes iron, which is used in large steel constructions as well as in many common objects.
- Corundum is one of the hardest minerals on Earth, and for that reason is frequently used as an abrasive.
- Copper, a highly conductive metal, can be extracted from chalcopyrite.
- The flake-formed micas are flexible and resistant to weathering, properties that come to good use in roofing paper.
- The iron-containing pigments in the familiar red paint from the old Falun mine are extracted from the mineral pyrite.
- Lead from galena is used in such applications as fishing sinkers and car batteries, and as an ingredient of crystal glass.
- Kaolinite is used in the manufacture of coated paper.
- Halite is pure sodium chloride, commonly known as table salt.
- Feldspar is an important component of glass and china.

Sulphur Photo: Anders Rising

Ores

Where are the economically most important mineral and metal resources located?
The map shows a selection of the largest deposits.

All that glitters is not gold...

Ores and precious stones are not evenly distributed around the globe. The map shows the locations of the largest deposits that are currently being worked.

"Ore" is the term applied to any material from which it is profitable to extract minerals or metals. This means, for example, that the concentration of gold in gold ore is much lower than the concentration of iron in iron ore.
Below, you can see a selection of Swedish ores.

Minerals are important for Sweden

As long ago as 500 years before the birth of Christ, Nordic tribes began to make iron from ores found in lakes and bogs. But iron did not come into common use until it was discovered how to make iron from ores found in rocks.

The apatite iron ores in Kiruna and Malmberget are by far the largest deposits of iron ore in Sweden.
They consist of the iron oxides, magnetite and hematite, and are the only iron deposits that are mined today.

Ores and minerals have been of great economic significance for Sweden in the past, and they remain so today. Sweden is among the largest European producers of iron, silver, lead, gold, copper and zinc.

Sweden is also a world leader in the recycling of metals. Although metal deposits are continually being formed anew, it is a slow process that occurs on a geological time-scale. Minerals must therefore be treated by everyone as non-renewable sources of metals.

Meteorites

When the sky falls

Meteorites are rare. They usually burn up in the atmosphere. Those that reach the Earth have a thin black fusion crust formed by frictional heating in the atmosphere.

Meteorites vary in size and composition. The most common are stony meteorites. More unusual are irons, composed of iron-nickel metal.
There are other combinations, as well— silicate minerals set in metal, for example.

Stony meteorites are most common

Stony meteorites consist dominantly of silicates like olivine, pyroxene and feldspar. These minerals often occur in the form of spherical droplets called chondrules. Stony meteorites containing chondrules are called chondrites.
They are older than the Earth, whose age has been established as over four billion years. In carbonaceous chondrites there are small quantities of organic substances.
Achondrites, which lack chondrules, vary in appearance and are uncommon.

Iron meteorites— once more precious than gold

The largest meteorites yet discovered are irons. The iron-nickel metal has slowly cooled into large crystals that become visible when etched. In prehistoric times, before humans had learnt to make iron from ore, iron from meteorites was more precious than gold.

Stony-iron meteorites

The beautiful pallasites with olivine crystals set in metal belong to the category of stone-iron meteorites. That is also true of mesosiderites, which consist of welded fragments of iron and stone, formed by collisions in space.

Achondrites

The achondrites comprise several kinds of unusual stony meteorites without chondrules. These meteorites, whose appearances and origins vary greatly, crystallized from molten rock at an early stage of their histories.
Some have very unusual origins— the planet Mars, and the Moon.

Tektites

When large meteorites strike the Earth, lumps of molten bedrock can be blown out through the atmosphere, and return to Earth as glassy objects, call tektites.

Fossil meteorites — only in Sweden!

This fossil stony meteorite has a terrestrial age of 475 million years. It occurs in a slab of limestone from Brunflo in the region of Jämtland.
The original minerals of the meteorite have been replaced by minerals formed on Earth, but its chondrule structure is well preserved.
It is even possible to see the fossil remains of an octopus beside the meteorite.

Dozens of fossil meteorites have been found at various locations on Earth, all of them in Sweden. They are embedded in limestone deposited in an ancient sea.

Tons of iron meteorites on Greenland

This polished slab has been cut from a large iron meteorite called Cape York. In northeastern Greenland, iron meteorites are scattered over an area of 10 000 square kilometres. A total of 56 tons of meteoric iron has been found to date.

The Inuit of former times knew of this resource, and worked the iron into knives and arrowheads.

Touch an iron meteorite!

Meteorites are the oldest material you can ever touch. This iron meteorite is older than the Earth: it is 4.6 billion years old!

When the rain of iron meteorites named Sikhote-Alin fell over Siberia on 12 February 1947, more than one hundred impact craters were formed, the largest being 28 metres in diameter.
Meteoric iron amounting to 27 tons was collected.

Iron meteorite from Siberia Photo: S. Waerndt

Meteorite from the Moon

The craters of the Moon have been formed by meteorite impacts. When the meteorites are large, fragments of the Moon can be cast into space and some of that material may fall to Earth. Comparisons with material collected by the Apollo expeditions show that this meteorite came from the Moon. Such meteorites have only been found in the Sahara and the Antarctic.

Meteorite from Mars

Meteorites from Mars are much younger than other meteorites. Their source is indicated by small amounts of trapped gas, which is identical in composition with the atmosphere of Mars.

The solar system's stone-crusher

Most meteorites come from the asteroid belt between Mars and Jupiter. They are formed when celestial objects collide, become fragmented and thrown into Earth-crossing orbits.

Chondrites, the most common type of stony meteorites, come from smaller objects that have not been melted. Large celestial objects, on the other hand, have melted at an early stage of their histories. This resulted in an inner core of metal, surrounded by a stony mantle. Iron meteorites come from the metal cores, while achondrites represent the melted stony material.

Biggest and smallest

The largest meteorites yet discovered are irons because they are not as brittle as stone meteorites.

The record is held by the meteorite Hoba in Namibia - a giant of sixty tons. Another giant is the meteorite named Cape York from Greenland, a slab of which can be seen here. The smallest meteorite that has ever been collected consisted of one gram of black dust from a carbonaceous chondrite that exploded high up in the atmosphere.

Low risk of being hit

About five meteorites are recovered from falls every year worldwide. Thus, the risk of being hit by one is exceedingly small. There are no reliable reports of humans being struck dead by meteorites - only one case resulting in a bruise. However, a dog was killed in Egypt when Nahkla, one of the rare meteorites from Mars, fell to Earth in 1911.

Dinosaur killer?

The most well-known meteorite impact in the history of the Earth occurred 65 million years ago at the Yucatan Peninsula in Mexico. It is believed to have caused the extinction of the dinosaurs. A closer example is provided by the Lake Siljan, which is part of the largest impact structure in Europe. It was formed by a meteorite that struck some 365 million years ago, coinciding with the extinction of many species.

Hessle — a famous Swedish meteorite

The stony meteorite named Hessle exploded in the atmosphere on New Year's Day of 1869, resulting in a meteorite shower over the region of Uppland, which was seen by worshippers leaving church. The black meteorites were easy to find in the white snow.

The Strunz Classification System

The German mineralogist Hugo Strunz devised a classification of minerals based on ten classes:

1. Elements
2. Sulfides and sulfosalts
3. Halides
4. Oxides and hydroxides
5. Carbonates
6. Borates
7. Sulfates, chromates, molybdates, wolframates
8. Phosphates, arsenates, vanadates
9. Silicates
10. Organic compounds

This section of the exhibition includes some 600 minerals classified according to the Strunz system.

Pull the specimen cases carefully, and close them when you are done. The labels indicate the name of the mineral, its chemical composition, where the specimen was found and the catalogue number.

Långban — a mine rich in minerals

Långban is a mining village within the district of Filipstad, located in the western region of Värmland. It is known for the remarkable richness of its mineral deposits, and has long been a source of iron and manganese ores.

Some 270 different minerals have been found at Långban.
Of these, about seventy were previously unknown and are therefore classified as "type minerals", which means that their original descriptions are based on the Långban deposit.
This is probably a world record for type minerals at a single location.
The mineral richness of the area is due to the unusually high concentrations of metals such as lead, manganese, antimony and arsenic in rocks that are poor in silicon.

Formation of minerals at Långban

Scientists believe that the Långban deposits were formed in connection with volcanic activity. They were left on the floor of an ancient shallow sea, and may have been associated with a volcanic arc.

The sediments on the seafloor consisted of carbonates that were eventually transformed into the dolomite marble in which the ore is now embedded]. The sediments also contained volcanic deposits, including ash and lava.

The heat from a volcano radiates to the surrounding area, and this can cause water to circulate. Further away from the volcano, cold seawater infiltrates the bedrock, where it warms up and dissolves various elements contained in the sediments.

When the water solution reaches more or less vertical fissures, it moves upward to the seafloor again. When it comes in contact with cold seawater, the elements settle out to form minerals: An ore has been formed.

At Långban, this process of enrichment accounts for the presence of such metals as antimony (Sb), arsenic (As), barium (Ba), iron (Fe) lead (Pb) and manganese (Mn).

Subsequent geological events, such as deformation, have influenced the mineralogical features of the area, as it exists today.
Many of Långban's rare minerals are deposited in fissures.

Smoky quartz

Smoky quartz is a fairly common variety of the mineral quartz. It gets its name from the “smoky“ colour, which can range from brown to black.

Smoky quartz Photo: Anders Rising

Quartz can become as dark as this specimen if it contains low levels of aluminium and is exposed to natural radiation over a long period of time.

This specimen consists of a single, large crystal.

Pyrite and chalcopyrite

Pyrite is a very common mineral. Among its identifying characteristics are the colour and the metallic lustre.
Pyrite is used in the production of sulphuric acid, and sometimes contains small inclusions of gold.

These pyrite crystals are joined to a large piece of chalcopyrite.

Gypsum

Gypsum is a colourless mineral, which is not very hard. It can be formed by the crystallization of saline solutions, for example in marine bays, and also when desert groundwater evaporates.

When gypsum is heated, the water bound to its crystals evaporates. This leads to the formation of another mineral, anhydrite.

Calcite

Calcite is a mineral with distinct cleavage. It is birefractive, which can be seen if a transparent sample is placed over a written text - the text is then seen as a double image.

Calcite is an economically important mineral with many technological applications, for example in fertilizers, paper-manufacturing processes and mortar.

Amethyst – a violet quartz

Quartz crystals can grow in a rock cavity called a druse. Here are two halves of a druse from Brazil, a country with large deposits of amethyst. Calcite appears as white crystals grown on the amethyst.

Welcome to Sjögren's mineral collection

Professor Hjalmar Sjögren accumulated one of the world's most remarkable private collections of minerals, which he donated to the museum on becoming the head of its mineralogy department in 1901.

Professor Sjögren collected minerals from all over the world and ordered the custom-built cabinets in which the collection is still kept today. It contains around 7000 samples from more than sixty countries.

Hjalmar Sjögren

Mineral Research at the Swedish Museum of Natural History

The Department of Mineralogy at the Swedish Museum of Natural History was established in 1841. It houses the country's largest mineral collection and is a national centre for mineralogical research.

The research is conducted within several different areas of mineralogy and related disciplines. In addition to the extensive collection, the resources of the department include laboratories and analytical instruments. The main focus is on the properties of minerals, the conditions under which they are formed, and their various geological and cultural roles.

The research is financially supported by the Swedish research Council, Geological Survey of Sweden and the European Community.

Treasures from the earth's interior is produced by
The Swedish museum of natural history (NRM) 2001-2002

Translate: Al Burke