**Magnetism on the Earth and on Mars.**

In January 2004 two Mars Exploration Rovers will land on Mars. The two Mars-cars are to drive around and analyse the surface of Mars with advanced instruments. Among these are 7 Danish magnets which are to collect particles of magnetic dust that are floating in the thin air. Cameras will take pictures of the collected Mars-dust. On the Earth the pictures will be analysed in order that the scientists can find out, how the surface-materials have been made. Has the red dust been made in water, or does the red colour have another explanation? Many factors indicate that there once was an ocean on Mars, and that the air was more dense. The question is, whether life did develop on Mars during that period. We would like to have an answer to that question.

On Bellahøj School the pupils in 7th grade will simultaneously analyse sand and ochre from the Earth for magnetic materials. In a vivarium will be placed a mill that blows the air towards a strong magnet wrapped up in a wooden block with foil. Through a tunnel the pupils are to sprinkle for instance sand down in front of the mill; thus the mill will raise the dust towards the magnet in the vivarium. The pupils have gathered the sand themselves in different places. The magnetic materials will now cling to the magnet and will be photographed for a report. Later on the pupils will compare their own photos with the photos from Mars.
Through the tunnel the sand for example is sprinkled down in front of the black mill.

The ring-shaped magnet is placed in the block under the foil.

Please notice the ring of magnetite above the magnet.

Starting the school year we’ll work on a course in magnetism in the physics classroom. In the planetarium on Bellahøj School we take a course in the Solar- System and Astronomy. The pupils will be instructed in the Solar System by means of a computer and a video projector. We’ll construct models of the solar system. The starry sky will be shown projected/shown on the ceiling by a globular projector.

This way the pupils will be motivated to do their own research, and I believe that some will look forward to seeing the results from Mars, as expectantly as they look forward to receiving their Christmas-gifts.

During the waiting time we’ll teach the pupils in building and operating LEGO Robolab. They are Lego-cars which the pupils have to programme themselves. Furthermore we’ll instruct them in the conditions of, how life can exist, and we’ll reflect on the possibilities of life on Mars, on the Jupiter-moon Europe or on an exoplanet around some other star than the Sun.

Our aim with the teaching project is to develop the interest and engagement with the pupils.

This projekt is inspired by ideas from Jens Martin Knudsen and Mars 2003 og Dansk Rumfart. Find more ideas here: www.mars2003.dk
The Plan:

1. What elements are attracted by a magnet?
2. On the magnet: Where is the strongest power?
3. Repellency and attraction between magnets.
4. Magnetic field-lines shown by ironchips.
5. Magnetizing of steel.
7. A compass on a needle.
8. A compass floating in water.
9. A floating magnet follows magnetic field-lines.
10. Terrestrial magnetism.
11. Sunspots.
12. Aurea borealis (Northern lights).
14. The Danish magnets on Pathfinder.
15. The Danish magnets on Mars Exploration Rovers.
16. Installation of magnetic sand, ochre, heated ochre etc.
17. Collecting sand and ochre, heating of ochre, analysis and photography of magnetic materials. Salten Skov
18. Comparison with photos from Mars of the collection.
20. Programming and playing with the cars.

Carsten Skovgård Andersen, Bellahøj Skole. www.bellahoj.dk :Stjernekammeret/Projekter
Procedure:

1. What elements are attracted by a magnet?

All the materials at our disposal will be tested to see if they are attracted by a magnet.

2. Which part of the magnet has the strongest power?

Let a small ironball roll along the magnet until it stops. That’s where the power is the strongest.

You can test what part of the magnet is able to lift the greatest number of nails. Test whether a magnet can attract a clip through a piece of paper, through a table top, through water, through a copper plate or through an iron plate.

3. Repellency and attraction between magnets.
Make tests with attraction and repellency between two magnets. One magnet you can have in your hand, while the other magnet either lies on the table, hangs in a thread, floats in a boat or turns around on a needle.

4. Magnetic field-lines shown by iron chips etc.
   Place a magnet under a piece of paper and sprinkle iron chips on the paper. Be careful that no iron chips get in contact with the magnet, as they are terribly difficult to pull off again.

The field-lines are closest, where the magnet is strongest, i.e. the poles. The north pole and the south pole attract each other.

The two north poles repel each other. Some field-lines are drawn into the nail.
The pupils can construct a complicated arrangement all by themselves with several magnets, nails, clips etc. Let the pupils get around and admire the fancy patterns.

Now it is a fascinating task to guess, how the magnets have been placed under the paper.

Take a photo of the pattern.

Pour the iron chips back from the paper by means of a tunnel. Place for instance two magnets under the paper and illustrate attraction and repellency by means of the iron chips.

A paper clip tied to the table with a thread is drawn towards a magnet so that it "flows" under the magnet. Through the space between the magnet and the clip are drawn different materials/objects, without the clip coming to a fall. At last try to drag iron through the space. What happens to the field lines and the clip?

The clip is bound in a sewing thread tied to the table. The clip is hanging in the air one centimeter below the magnet. An aluminium stick can be drawn through the space; the clip does not fall – But try with iron scissors.
Take a small compass – a magnetopobe – and guide it in the direction to which it points. Notice the curve it follows.

5. Magnetizing of steel.

A magnet is drawn with the same pole along a knitting needle or a saw blade. When the magnet reaches the end of the saw blade, it is lifted to the other end and this motion is repeated 10 times. This way you alter the saw blade or the knitting needle to become a magnet itself. You magnetize it. Test whether two magnetized saw blades are able to repel each other.
Test whether a magnetized saw blade is able to attract small nails.
Try to clip a magnetized saw blade. How many poles does each part have?


The magnetized saw blade is knocked against the table some times.
The magnetic saw blade is heated.

A magnetized saw blade is knocked against the table. Now try whether it has the same attraction to paper clips.
A magnetized saw blade is heated over a Bunsen-burner. Now test it’s magnetism.
A magnetized saw blade is drawn through a reel with alternating voltage. Now test it’s magnetism.
Transmit **direct current** through a reel. Now drag the magnetized saw blade through a reel with **alternating current**. What are the magnetic characteristics of the saw blade now? You'll discover that the saw blade has been magnetized so that it can lift small nails; also characteristics of the saw blade now? after the direct current has been cut off.

7. A compass on a needle. A compass needle is magnetized and put on a needle a long way from disturbing iron and magnets. Notice the direction of the compass.

![The magnetic saw blade is revolving on a needle.](image)

8. A compass floating in water.

A magnet floats on a piece of flamingo. Notice the direction.

![The magnetic saw blade float on a boat of flamingo.](image)

9. A sailing magnet follows magnetic field lines.
A magnetized knitting needle is placed in an upright position in a boat of flamingo.
Place one pole of a horseshoe-shaped magnet 5-10 cm from the boat; then place the other pole. Notice the sailing direction of the boat.

Use various/different magnets to steer the sailing magnets. Demonstrate the attraction as well as the repellency. Don’t place the horseshoe shaped magnet too close to the mast, as the mast will dominate and hinder the repellency. Play with the boats.

10. Terrestrial magnetism.

Talk about / explain the floating nucleus of the Earth, the magnetic poles of the Earth, the variation of the compass, the Ørsted Satellite.
Look it up on e.g. www.rummet.dk

11. Sunspots.

In the planetarium on Bellahøj School we can see photos of the Sun and of the sunspots. Films are shown about eruption on ESA’s CD-rom with Soho’s photos from the Sun.
It is explained, how the plasma follows the magnetic field lines on the Sun. The plasma undertakes slides in closed courses into the Sun and out again in a curve along the magnetic field lines and then again into the Sun. When these curves are broken the plasma is thrown out into space at a speed of for instance 2 million km per hour.


The photo above is from: Aurora Images.

Explain how the magnetism of the Earth guides the Sun-wind down towards the magnetic poles of the Earth.

The pupils can find many phantastic pictures of aurea borealis on the Internet. They can make a powerpoint-presentation of aurea borealis all by themselves and present it to the class or to the parents.
Aurea borealis photographed from the space shuttle Discovery in 1991

Polar light on Saturn

Nasa


About the conditions on Mars you are told: the size, gravitational acceleration, temperature, the atmospheric low pressure the pink sky, the polar cap, the dry ice, the wet ice, the traces of running water, the high volcanos, the red dust, the dust storms, the traces of life in a meteorite from Mars, etc. In the planetarium is furthermore demonstrated, where you can see Mars right now.

Experimental tests are being made about the distance and rotation of the planets.

Materials can be found on The Nine planets
http://seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html
- www.rummet.dk - www.tvcho.dk - www.rundetaarn.dk and www.dr.dk as weel as Nasa.

The pupils can make their own powerpoint presentation of Mars and other planets and show it to the class and the parents.


Reed on www.rummet.dk and www.planetcenter.dk
Magnetic particles got onto the Danish magnets on Pathfinder, when it was driving on Mars in 1997. The magnet to the right is the strongest and attracts most dust. There are 5 magnets on line, and each time you take a step to the left, you see a weaker magnet. By looking at the particles on the weaker magnets you can judge, how magnetic the dust on Mars is.

The photos are from

Mars/Mösbaur Group: Forskning/Mars
and www.rummet.dk

15. The Danish magnets on the Mars Exploration Rovers.
On each Rover are placed 7 magnets: at the foot of the camera mast 2 big magnets have been placed – each of them twice the width of a Danish five-kroner-piece. On the back of the Rover is a so-called vacuum cleaner magnet. It vacuums the air. Magnetic dust will cling to it – but in the middle only non-magnetic dust can stick. These 3 magnets measure the airborne dust.

On some grinding tools are placed 4 magnets that will catch the magnetic polishing dust, when the tools are examining the inner part of the rock material.

On board the Lander there is furthermore placed a drawing of a Lego-man, with magnets underneath. Measurements of the Mars-dust can be taken during the first couple of days after the landing (in app. half a million seconds.)

See the article in www.rummet.dk (the pictures have been taken from that article)

Furthermore Mössbauer-spectrometres have been placed on the Rovers to analyse the Mars surface. It is the first time a Mössbauer-spectrometer has been sent out into the space. The scientists expect a great deal from these analyses.

Also read about the magnets on the Rovers here (in English)

Follow the Mars Exploration Rovers on http://athena.cornell.edu

16. Installation of magnetic sand, ochre, heated ochre and soil from Salten Skov.

On the picture above is seen a test from the Ørsted Laboratory. To the right you see a ring of magnetic material of a soil-sample from Salten Skov.
In a vivarium is placed a fan (ventilator). For a motor we recommend number 260-21 from Model & Hobby, Frederiksborggade 23, 1360 Copenhagen K. Telephone no. 3314 3010. The cost of the motor is 89 Danish kr.

A current supply with 7 volt is needed. As a mill on the motor you can use a mill from a discarded CPU.

I found a fan with motor from a discarded computer. It has a motor that needs 12 volt direct current. This fan was for free.

A big ventilator could also be used.

The little ring is a neodymium-magnet from the Ørsted-Laboratory. The motor is no. 260-21

The discarded computer-fan for the current supply

A ventilator for 220 V

The magnet that has to catch the dust must be very strong. The Ørsted-Laboratory at the University of Copenhagen uses a little ring-shaped magnet of Neodyne-Iron-Boron = Nd$_2$ Fe$_{14}$B. It is incredibly strong. It can be glued together with foil, less than $\frac{1}{2}$ mm thick. Into a small wooden block is bored a hole that fits the magnet. Now place the magnet in the wooden block and fix the foil, so that it covers the top side of the block.

It is important that there is no space between the magnet and the foil. Either glue the magnet to the foil or be satisfied with boring the hole in the wooden block so short that the magnet is pressed against the foil all the time.

If magnetic material is raised up into the air, some of it will cling to the foil as a ring above the magnet. Before the next test/(experiment) the magnetic material is easily wiped off with a cloth. If the little magnet had not been wrapped in foil, it would have been impossible to get the dust off again.

A transparent lid is placed on the vivarium. Through a small hole in the lid you place a tunnel, so that
the materials can be sprinkled down in front of the mill. The magnet is placed in the vivarium with the foil-side upwards. That way the dust can get to the magnet, and a ring of magnetic materials can be formed above the ring shaped magnet. If you want to be absolutely perfect, you can create uniform wind conditions in all directions by letting the magnet stand on a small motor that rotates only a few times per minute.

N.B. The magnet is so strong that it can easily delete magnetic tapes, discs, credit cards etc. Keep it 5 cm from such things. Neither is it wise to place it close to a pacemaker.

The sand is sprinkled through the tunnel. The mill whirls it around in the vivarium. It’s seen that a ring of magnetite above the magnet has been formed. The magnet lies in a drilled hole in a wooden block, wrapped in 0,1 mm foil.


Pupils and teachers collect samples of sand in different places. Magnetite from the sand clings to the magnets during the analyses. The results are photographed and kept.

Ochre can be collected from the waterworks in Lejre or Slangerup. It is precipitated, when the water is oxidized. Ochre in flakes has to be crushed in a mortar and sifted. Be careful to collect ochre without sand, because sand will reduce the magnetism of the heated soil.

Examine a little ochre for possible magnetism.

In a paint shop you can buy a material under the name of ochre. But I am not certain that it is ochre, because the commercial names are not logical. Firms do easily call something ochre, although it really is goethit – also a good dye-stuff.
**Heating of ochre.** Now try to magnetize ochre through heating. Heat up a ceramic oven to **480 degrees Celsius.** According to the recipe, the ochre shall keep a temperature of **480** for **26 hours.**

If you’ve got time you can experiment at lower temperatures and longer hours to see, if that has got an effect.

When the ochre is cold, crush it in a mortar. Then test it for magnetism in the vivarium. Photograph the result for the report.

Heat up a little ochre to **900 degrees Celsius.** When it is cold test it for magnetism in the vivarium.

During a walk in Salten Skov by Silkeborg a walker noticed that the molehills were red. Samples of the soil were examined in the University, and it turned out that they contained magnetic particles of maghemite. If you can get hold of soil from Salten Skov by Silkeborg, it is open-and-shut to analyze it in the vivarium. Or perhaps you can examine red soil from the place, where you come from. Not all red soil is magnetic.

If pupils all over the country examine samples of soil, where they live, the results can be collected on a survey-map of magnetic species of soil. Incidentally maghemite is used for Memory in a computer. So if you can get hold of industrially produced maghemite, you can also examine that.

(Later on in the teacher’s guide, we’ll proceed with this point).
The sample of soil from Salten Skov is sprinkled down through the tunnel.

The red maghemite from Salten Skov clings to the magnet. The dark magnetite from some sand.

Here we will show you how much of each type of soil that hang on to the magnet:
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<tr>
<td>Ochre</td>
<td>Heated clean ochre</td>
<td>Heated ochre with sand</td>
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<tr>
<td>Salten Skov</td>
<td>Grib Skov</td>
<td>Sand from Due Odde</td>
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<tr>
<td>Sand from Nykøbing Sjælland</td>
<td>BASF, F-5238</td>
<td>Soil from Bellahøj</td>
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<tr>
<td>Lanzarote</td>
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18. Comparison with photos from Mars of the collection of magnetic materials.

The perspective is that it might be possible to find similarities in, how the minerals have been moulded. In particular we are interested in finding out whether the minerals have been moulded in water, and whether there are any signs of fossil life in the precipitated minerals.

The pictures are from [www.rummet.dk](http://www.rummet.dk), where you can read about the magnets on The Rovers


Also tell about the construction and the steering of the Mars-cars.

20. Programming and play with the cars.


**Extremofiles**

---- Micro-organisms in boiling water by the volcanos on the bottom of the sea.

On the bottom of the north-eastern part of the Pacific Ocean are volcanoes. 2.5 km below surface 15 m high chimneys release poisonous gasses. Because of the pressure the water may be 400 degrees C without boiling, but in the 121 degree C hot water nearby organisms live and thrive.

They are called archaea 121. They take in iron 2+ and produce magnetite with high purity. Scientists can find out if magnetite maybe have been produced by organisms by measuring its purity. If magnetite is found on Mars it will be interesting to measure its purity, if it exists. The scientists claim that the archaic bacteria on the bottom of the sea by the volcanoes is the most original form of life. One can speculate how the organisms can thrive at these high temperatures. Around the volcanoes are mussels as big as boots and other creatures that are 2 meters long.
---- Micro-organisms in the ice cap in Greenland.

---- Micro-organisms in the spring-stratum between salt- and fresh-water in caves.

Water

---- Water as a condition for life.

---- The pressure required for water to be flowing.

---- Measuring of ice on Mars.

---- The traces of river beds on Mars, i.e. flowing water on Mars in former times.

---- Crevices in the ice on the Jupiter-moon Europa: An ocean under the ice.

Meteorites

---- ALH84001,0

---- Could life have been brought to the Earth by a meteor?

---- Could life have come into existence on Mars first, and then have been brought from Mars to the Earth by a meteor?

The climate

---- The zone in a suitable distance from the Sun

---- Mercury

---- Venus: 480 degrees Celsius, carbon dioxide, no oceans, a pressure of 90 atmospheres.

---- The Earth: the oceans, precipitation of carbon dioxide, the plate-techtonit, oxygen.
---- Mars: Atmosphere, no plate-techtonic, temperature, pressure, water.

Exoplanets

---- The planets discovered in other solar systems are probably gas-giants.

Till now there are no telescopes that can show exoplanets, the size of the Earth. But it is likely that little planets also are found around other stars than the Sun.

Some conclusions (teacher’s guide, cursive).

1. What elements are attracted by a magnet?

Test all the materials at your disposal to see, if they are attracted by a magnet.

Iron, nickel and cobalt are attracted by a magnet.

2. Where on the magnet is the power the strongest?

Let a small iron ball roll along the magnet until it stops. That is where the power is the strongest. You can test what part of the magnet is able to lift the greatest number of nails.

The north pole and the south pole.

Try whether a magnet can attract a clip through a piece of paper – through a table top, through water, through a copper plate or through an iron plate.

The field lines pass unhindered through un-magnetic materials. But a magnetic material close by will alter the pattern of magnetic field lines in such a way that the power on the clip will be reduced to a greater or lesser extent. If convenient try to see the effect of an extensive/stretched iron plate and a short iron bar (of app. the same dimensions as the magnet and placed in continuation of the magnet).

3. Repellency and attraction between magnets.

Make tests with attraction and repellency between two magnets. One magnet you can have in your hand, while the other magnet either lies on the table, hangs in a thread, floats in a boat or turns around a needle.
Two identical poles repel each other. Two different poles attract each other. Both poles attract soft iron.

If you want to show that a steel bar is a permanent magnet, you have to show that one of its poles repels a pole on another magnet. If you only demonstrate attraction, then it is possible that one bar simply is of soft iron. Soft iron loses its magnetism, when the other magnets are removed. So a nail of soft iron is non-repellant when it lies alone.

4. Magnetic field lines shown by iron chips etc.

Place a magnet under a piece of paper and sprinkle iron chips on the paper. Be careful that no iron chips get in contact with the magnet, as they are terribly difficult to pull off again.

around and admire the fancy patterns. Now it is a fascinating task to guess, how the magnets have been placed under the paper. The pupils can construct a complicated arrangement all by themselves with several magnets, nails, clips etc. Let the class get ke a photo of the pattern.

Pour the iron chips back from the paper by means of a tunnel. Place two magnets under the paper and illustrate attraction and repellency by means of the iron chips. The iron chips settle along he field lines. Attraction and repellency are clearly illustrated.

A paper clip tied to the table with a thread is drawn towards a magnet, so that it “flows” under the magnet. Through the space between the magnet and the clip are drawn different materials/objects, without the clip coming to a fall. At last try to drag iron through the space. What happens to the field lines and the clip?

Materials of iron guide the field lines and that way they drag the field lines inside where they become more concentrated than outside. That is why the clip falls when iron scissors are drawn between the magnet and the clip. If instead you had drawn a short iron bar, a piece of a clip, the power in the hanging clip would have increased.

Take a small compass – a magnetoprobe – and guide it from the north pole in the direction it points. Notice the curve it follows. It follows the field lines from north to south.

5. Magnetizing of steel.

A magnet is drawn with the same pole along a knitting needle or a saw blade. When the magnet reaches the end of the saw blade it is lifted to the other end and this motion is repeated 10 times. This way you alter the saw blade or the knitting needle to become a magnet itself. You magnetize it.

Test whether two magnetized saw blades are able to repel each other. Test whether a magnetized saw blade is able to attract small nails.
Try whether you can magnetize a nail made of soft iron. Can the nail lift a small iron nail?

Try to clip a magnetized saw blade. How many poles does each part have?

_During the stroking the little magnets of the steel are turned in the same direction. That way a big magnet is produced. Even though the magnet is parted in two, both pieces will have a south pole as well as a north pole, because it still consists of small magnets._

_The steel in a saw blade can be magnetized so that the magnetism is preserved in a permanent magnet, because it is difficult for the little magnets to change at room temperatures._

_But in a nail of soft iron the little magnets can easily change, so they will lie pell-mell, and by that process they lose their magnetism again._

6. **De-magnetizing.**

A magnetized saw blade is knocked against the table. Now test whether it has the same attraction to paper clips.

By knocking the little magnets are being shaken together into a mess.

A magnetized saw blade is heated over a Bunsen-burner. Now test its magnetism.

_Heating makes the metal softer, so that the little magnets can turn around pell-mell._

Transmit **direct current** through a reel. You’ll discover that the saw blade has been magnetized so that it can lift small nails; also after the current has been cut off.

A magnetized saw blade is dragged through a reel with **alternating current**. Then test its magnetism. _This is the most effective way to de-magnetize._

7. **A compass on a needle.**

A compass needle is magnetized and put on a needle far away from disturbing iron and magnets. Notice the direction of the compass.

_The compass points north/south except for a small variation. The north pole points towards the magnetic south pole of the Earth, which is in the northern part of Canada. In Greenland the variation is bigger, because from Greenland there is a big difference between the direction to the magnetic south pole in Canada and to the geographical north pole._
8. A compass floating in water.

A magnet floats on a piece of flamingo. Notice the direction. It points north/south.

*When compasses became common on ships it was possible to cross the oceans directly instead of following the coasts. This step forward contributed perhaps to start the renascence.*

9. A sailing magnet follows magnetic field lines.

A magnetized knitting needle is placed in an upright position in a boat of flamingo. Place one pole of a horseshoe-shaped magnet 5-10 cm from the boat; then place the other pole. Notice the sailing direction of the boat.

Use various/different magnets to steer the sailing magnets. Demonstrate the attraction as well as the repellency. Don't place the horseshoe-shaped magnet too close to the mast, as the mast will dominate and hinder repellency. Play with the boats.

*The horseshoe-magnet influences mainly the topmost pole in the mast. The sailing direction follows the field lines the same way as the sun-wind is turned by the magnetic field of the Sun and the Earth. Aurea borealis arise because the magnetic field of the Earth carries the sun-wind down towards the magnetic south pole of the Earth in northern Canada. SOHO's pictures of the Sun show that the plasma is carried around in big curves by the magnetic field of the Sun. The pictures remind you of the field lines demonstrated with iron chips on a piece of paper above a magnet. On the Sun the plasma is carried out of the sun-spots in 100 km wide courses. The plasma is carried high up, and down into the Sun again. If the curves are broken by huge explosions, the plasma is thrown out into space as sun-winds. In the heat of the Sun the atoms are split in ions – the state is called plasma. It is the electric and magnetic characteristics of the plasma that makes it follow the curves of the magnetic fields.*

10. Terrestrial magnetism.

Talk about / explain the floating nucleus of the Earth, the magnetic poles of the Earth, the variation of the compass, the Ørsted Satellite.

Look it up on e.g. [www.rummet.dk](http://www.rummet.dk)

*Terrestrial magnetism is due to the currents in the floating iron nucleus, above the firm nucleus. 710.000 years ago the poles on the Earth changed position. This has happened many times during the geological history of the Earth. Magnetization-directions in lava in the Atlantic Ocean prove that. On the continental shelf lava hardens, if magnetization-lines settle in a direction determined by the actual magnetic field. Then each direction is represented by stripes of hardened lava on both sides of the shelf. The longer the period has lasted, the wider is the stripewith uniform magnetic orientation.*
That the magnetic field of the Earth even today is unstable we can deduce from the fact that the strength is swinging a great deal, and from the fact that the magnetic south pole moves about 50 km each year. The Danish satellite, Ørsted has carried out the most accurate measurements of the magnetic field of the Earth. Besides the floating nucleus the magnetic materials in the Earth’s crust also influence the magnetic field.

11. Sunspots.

In the planetarium on Bellahøj School we can see photos of the Sun and of the sunspots. Films are shown about eruption on ESA’s CD-rom with Soho’s photos from the Sun. It is explained, how the plasma follows the magnetic field lines on the Sun. The plasma undertakes slides in closed courses into the Sun and out again in a curve along the magnetic field lines and then again into the Sun. When these curves are broken the plasma is thrown out into space at a speed of for instance 2 million km per hour.

The number of sunspots had maximum in 2001. Five and a half years later it will have minimum and after 11 years, in 2012 again maximum. The climate on the Earth is influenced by this cycle. By maximum of sunspots the climate is warmer. Two Danish scientists believe that it is due to the fact that the sunwind by maximum is so powerful that it keeps particles from distant stars from hitting the Earth. But these, from far away coming cosmic particles, contribute to the formation of clouds in such a way that by sunspot-maximum fewer clouds are formed, and the Earth becomes warmer.

The sunwind follows the field lines because of its electric charge. The charges are due to the fact that the sun is so hot that the atoms are divided in plus and minus. This state is called plasma. The sunwind is plasma launched in tremendous explosions.


Explain how the magnetism of the Earth guides the Sun-wind down towards the magnetic poles of the Earth.

The pupils can find many phantastic pictures of aurea borealis on the Internet. They can make a powerpoint-presentation of aurea borealis all by themselves and present it to the class or to the parents.

The polar light is formed when the charged particles are led down with the magnetic field towards the northern or the southern part of the Earth. When the sun-particles hit the air-molecules at an elevation of more than 100 km, the air is charged with so much energy, that the air begins to emit light. Because of the atmospheric protection, human beings don’t get injured. But it does happen that high-voltage-lines fuse on account of the energy in the sunwind.

About the conditions on Mars you are told: the size, gravitational acceleration, temperature, the atmospheric low pressure the pink sky, the polar cap, the dry ice, the wet ice, the traces of running water, the high volcanos, the red dust, the dust storms, the traces of life in a meteorite from Mars, etc.
In the planetarium is furthermore demonstrated, where you can see Mars right now.

Experimental tests are being made about the distance and rotation of the planets.

Materials can be found on The Nine planets
http://seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html
- www.rummet.dk - www.tycho.dk - www.rundetaarn.dk and www.dr.dk as well as Nasa.

The pupils can make their own powerpoint presentation of Mars and other planets and show it to the class and the parents.

The atmospheric pressure on the Mars surface is only app. 1% of one atm. (or of our atmosphere). That is the reason why running water doesn’t exist. But water-ice has been detected. Distinct river-beds show that there has been running water on Mars at one time. During that period the Mars-atmosphere must have been denser.

Reed on www.rummet.dk and www.planetcenter.dk
Look at nr. 14 in the procedure

15. The Danish magnets on the Mars Exploration Rovers.
Reed on www.rummet.dk and www.planetcenter.dk

"Here are 7 magnets on each Rover and 3 magnets in a drawing of a Lego-man on the Lander. The 3 magnets catch the airborne dust: The Capture Magnet, the Filter Magnet and the Sweep Magnet.
The Capture magnet collects powerful as well as weak magnetic material. The Filter magnet collects only the powerful magnetic material. The Sweep magnet in the centre collects non-magnetic material (if such is found on Mars ...).
The magnets can be seen by both the panorama-camera, the microscope-camera and the element-spectrometer."
By studying the magnetic minerals in the red dust and in stones on Mars, we hope to detect, how the surface-materials on Mars have been formed. A crucial question is, whether running water has turned the surface of Mars red, or whether the red colour comes from other processes.

16. Installation of magnetic sand, ochre, heated ochre and soil from Salten Skov. Look at nr. 16 in the procedure

17. Collecting sand and ochre, heating of ochre, analysing and photographing. Look at nr. 17 in the procedure

The chemistry of ochre.

Iron is found both in oxydation step +2 and +3.
Iron in oxydation step +2 is called ferro or Fe^{++}.
Iron in oxydation step +3 is called ferri or Fe^{+++}.

On the Earth ferro from rocks is dissolved in water. Generally ferro is easily dissolved in water.

But in water ferro is oxidized into ferri, and ferri is hard to dissolve in water. It precipitates as ochre.

The waterworks take away the ochre and sell it to the paint industry, as ochre is a fine red dye. Even the Stone Age people painted with ochre.

Ochre is iron (3) hydroxyd with water-molecules bound to Fe(OH)_{3-n}(H_{2}O)_{n}.
It is unequal, how much H_{2}O = water that is bound in ochre.

In the history of the Earth ochre has been transformed.

By quick oxydation of ferro in water the end-product could be the reddish hematite = alfa-Fe_{2}O_{3} which is extremely faintly magnetic, or the yellowish goethite = alfa-FeOOH.

By a slow oxydation in water can be formed either the hard, dark Magnetite Fe_{3}O_{4}, which is very magnetic or lepedocrocite = gamma FeOOH. These can be turned into maghemite = gamma Fe_{2}O_{3}, which is very magnetic.

Because of its spinnel-structure, maghemite is written Fe_{2.67}O_{4}.

Ochre is non-magnetic. When heated a part of the ochre will be transformed into other materials i.e. the very magnetic maghemite.

We heat the ochre to a temperature of 480 degrees for 26 hours in a ceramic oven. In that way we get i.e. maghemite, which we can prove is very magnetic with the test in the “vivarium”
It is a project of its own to examine, how much heat is required to make maghemite. If sand is mixed into the ochre you will get less maghemite.

If you heat Maghemite to 900 degrees, it is transformed into hermatite, which is very little magnetic.

In the soil in Salten Skov we find the magnetic maghemite. We don’t know, how the ochre has been transformed into Maghemite precisely there. Maybe a forest fire has had the same effect as a ceramic oven. Perhaps the maghemite has been formed by bacteria that live on dissolved iron. It is a possibility that life has played a role in the evolution of magnetic materials.

The red dust on Mars is magnetic because of the contents of iron3links, but there could also be a little magnetite (a mixed iron-2-iron-3-connection) in the Mars-dust. That has been established by the Danish magnets on Pathfinder in 1997. It is important to find out, whether it has been formed in water. Has it become magnetic because of heating? Has life perhaps played a role? Have volcanoes heated the dust?

If titanium exist in the magnetic materials, you can say, that part of the formation of them has taken place outside water.

There are many questions to which the Mars-missions can give an answer in 2004.

Besides it is important to know more about the Mars-dust, because it would be a problem to make the instruments work on a manned Mars-Expedition during a dust-storm on Mars.

On the University of Århus there is a Mars-simulator. It has the same low pressure as Mars has. The same gas. The soil in the simulator is from Salten Skov by Silkeborg.

The whole idea with this teaching-project is to create an interest in the Mars-project and in Natural Science. The pupils make tests very similar to some of the tests on Mars.

By the analyses of earthly sand, little dark magnetic grains appear above the magnet. That is magnetite Fe$_3$O$_4$. It comes from the Scandinavian Rocks, but has been carried to us by the ice. And in many places you find it in the sand.

Magnetit eller magnetjernsten skrives mere nøjagtigt som Fe$^{2+}$Fe$^{3+}_2$O$_4$.

Læs mere på Mars/Mösbaur Group: Forskning/Mars og Marsgruppen, Center for Planetforskning.

18. Comparison with photos from Mars of the collection of magnetic materials.

The perspective is that it might be possible to find similarities in, how the minerals have been moulded. In particular we are interested in finding out whether the minerals have been moulded in
water, and whether there are
any signs of fossil life in the precipitated minerals.


    Also tell about the construction and the steering of the Mars-cars.

20. Programming and play with the cars.


    Look at 21 in the procedure

Pictures are from www.rumnet.dk.

De ni planeter - Mars/Mösbaur Group: Forskning/Mars

Nasa and Aurora Images

and own photographies

September 2003

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and http://ntserv.fys.ku.dk/mars/: Youth Lab www:planetcenter.gfy.ku.dk

Translation: Lone Gilbe
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500 ring magnets are sponsored by Siemens Flow Instruments. October 2003

**Study Magnetic soil:**

You can make experiments with magnetic soil from places where you live.

Mail results and photographs of your experiments, and I will put it in the world-map in this page:

http://www.bellahoj.dk/klasser/astronomi/map___kort.htm

Mars scientists investigate soil on Mars with magnets and spectrometers on Spirit and Opportunity to learn how soil and rocks on Mars were made. On the Earth some magnetic soil have been produced by bacteria, and some have been made in a chemical process. By studying magnetic soil you may also learn something about the development of life.

An invitation to you to participate:

1. Find some soil with particles that stick to a magnet. (Use a ringmagnet of noedynium-Iron-Boron. Put the magnet in a drilled hole in a peace of wood. Cover the magnet with thin aluminium.)
2. Dry the soil in an oven with 100 degrees C.
3. Measure how much weight percent of the soil that sticks to a magnet.
4. Photo the soil and the particles on the magnet.
5. Latitude/longitude of sample site.
6. Name of the area where the soil was collected.
7. Photo the location where the soil was collected.
8. Mail photos and text to ca@bellahoj.dk.
9. Send also some of the heated soil to me for possible testing at the University of Copenhagen. If you want to send soil over borders you must take away bacteria by heating it to 100 degrees Celcius.

Send to: Carsten Andersen, Bellahøj Skole
Svenskelejren 18
Dk-2700 Bellahøj
Denmark

Link to:
Rock Around the World

Mars scientists are asking students from around the world to help them understand the Red Planet. Send in a rock collected by you or your classroom from your region of the world, and the Mars Spaceflight Facility at Arizona State University will use a special tool like the one on the rovers (Mini-TES) to tell you what it's made of. Then everyone can compare their rocks to the ones found on Mars.

read more here: http://www.imagiverse.org/activities/schoolrocks/