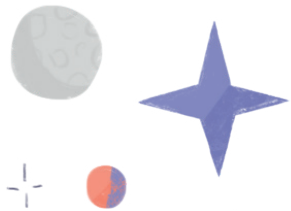
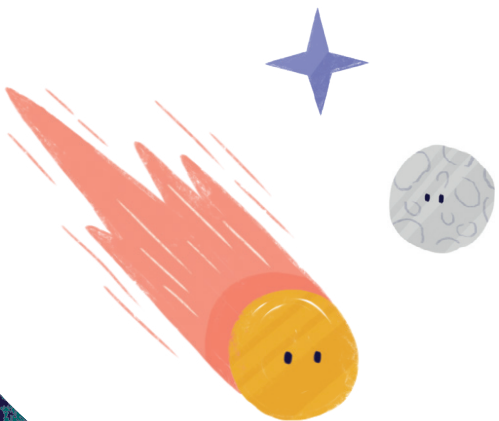
Moon Impact,
a geological story



EXHIBITION CHILDBOOK

6-12 years old



How old is our planet? How did it form? What is the difference between a moon and a planet? What is our Earth made of?

So many questions, one more important than the other. To answer them, we offer you an extraordinary journey through an exhibition.

An exhibition is a presentation that brings together objects, texts or images around a theme. Here, we propose you to travel through time and space, from the formation of the universe to the present day.

HURRY UP! WE HAVE A LONG WAY TO GO, SO LET'S GO!

Let's get to the heart of the matter. We are talking about geological history. But what is «geology»?

Geology is a science that studies what makes up the material structure of planets, like rocks and minerals. To follow the geological history is therefore to tell the story thanks to the clues that rocks leave us.

hi!

MY NAME IS VERA. I AM A FAMOUS ASTRONOMER.
I STUDY THE FUNCTIONING OF STARS AND GALAXIES IN SPACE.
WELCOME TO THE MOON IMPACT EXHIBITION! I WILL BE YOUR GUIDE FOR THIS ADVENTURE.
ARE YOU READY TO DISCOVER THE FANTASTIC HISTORY OF OUR PLANET?

let's go!

SOME TOOLS TO START THE VISIT:

YOU NEED A PEN OR PENCIL TO COMPLETE YOUR NOTEBOOK.

MINERAL

A solid substance formed naturally on Earth. It has a well-defined internal structure, where the atoms occupy regular positions. It is not made by plants or animals, it is an inorganic material. There are more than 5,000 different known minerals! Quartz, salt and ice are a few examples.

ROCK

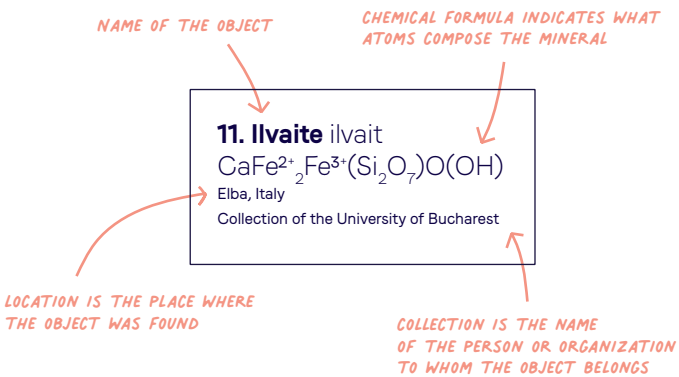
Natural solid material made by one or many different minerals. Based on how they form, rocks can be either igneous (like basalt or granite), metamorphic (like marble) or sedimentary (like shale and sandstone). The most common rocks on the surface of the Earth are the sedimentary rocks.

LABEL

It is the identity card of the objects in an exhibition. It allows us to give certain information about the object.

How to read it?

Here is an example of a label. They can have different shapes and contain more or less information. If you have any questions, do not hesitate to ask the museum staff for help.



Formation of the solar system

PLANETS, COMETS, MOONS...ALL SORTS OF FASCINATING OBJECTS! OUR SOLAR SYSTEM IS PRETTY AWESOME, BUT DO YOU KNOW HOW IT CAME TO BE?

Our solar system was born about **4.5 billion years ago inside a big molecular cloud that collapsed.** This cloud formed a swirling disk of dust and gas with a growing star in the middle: our Sun. Almost all the material in this disk was pulled inside the star and just a small part continued to rotate around it.

Remaining little particles came together with the help of gravity, forming bigger objects. They kept growing into small planets, which we call planetesimals. While they kept revolving around the star in their orbits, they kept accumulating material until there was not much left in the disk. That's when the planets became fully formed. Whatever small objects were left behind, formed the asteroids and comets of today.

The Sun provides a lot of heat and, because of that, the four planets closest to it are rocky and the four planets farthest to it are icy. The inner four planets are small and dense, and can be referred to as terrestrial. The outer four planets are very large and cold, so they are often called as giant planets.

FUN FACTS !

The Universe is still expanding! Scientists still don't know if the Universe has an end or not, but the visible Universe has about 93 billion light-years across (900 000 000 000 000 000 000 000 000 kilometers!).

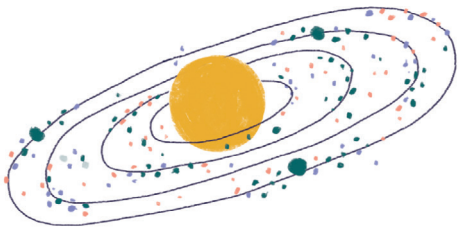
SCIENTISTS CONCLUDED THAT THE UNIVERSE STARTED WITH THE BIG BANG, ALMOST 14 BILLION YEARS AGO. IT WAS NOT ONLY THE BEGINNING OF SPACE, BUT ALSO THE BEGINNING OF TIME! 100 MILLION YEARS AFTER THE BIG BANG, THE STARS COULD BEGIN TO FORM AND THEY CONTINUE TO DO SO UNTIL TODAY. OUR SUN WAS FORMED ALMOST 5 BILLIONS YEARS AGO. IT IS AN ADOLESCENT STAR.

YOUR TURN TO PLAY!

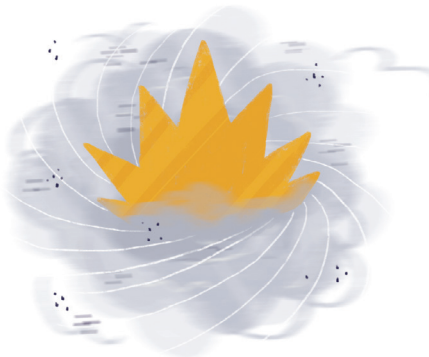
Resets the images in order. The goal is to put the four images of the formation of the solar system back in chronological order by numbering them from 1 to 4. Don't hesitate to use the notebook.

☐ Planets are fully formed

☐ Big molecular cloud



☐ Little particles come together forming planetesimals.



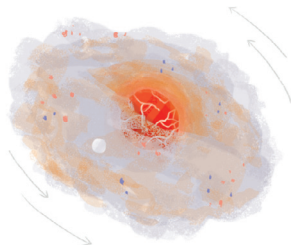
☐ Swirling disk of dust and gas

Solution:
1. Big molecular cloudP
2: Swirling disk
3: Planetesimals
4: lanets are fully formed

Formation of the moon

In the early stages of formation of our Solar System, a protoplanet called Theia, about the same size as Mars, approached the young Earth at very high speed.

They smashed into each other in a giant impact, where they both melted and vaporized, mixing everything together.



A different object formed from the impact, different from everything that we have known so far. It was made of lava and vapor, and had the shape of a donut, but with a big filling in the middle ... it is the Synestia!

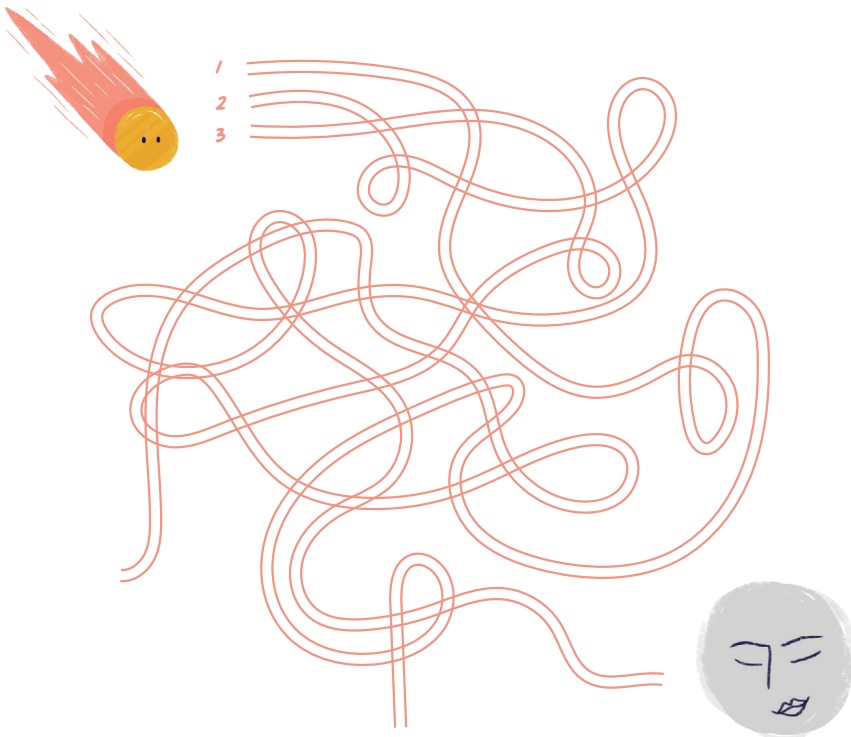
Lava droplets start to condense and to fall towards the middle onto the Earth. The Moon slowly forms in the outer parts of the Synestia. It eventually cools down and becomes what we know and love today.

WE CAN FIND ALMOST 200 MOONS THROUGHOUT OUR SOLAR SYSTEM. THEY ARE SMALL OBJECTS CAUGHT BY THE PLANET'S OR ASTEROID'S GRAVITY AND THEY ORBIT THEM JUST LIKE THE EARTH ORBITS THE SUN. MERCURY AND VENUS DON'T HAVE ANY MOONS BECAUSE THEY ARE TOO CLOSE TO THE SUN, WHICH WOULD STEAL THEM FROM THE PLANETS, BUT SATURN HAS ALMOST 82.

YOUR TURN TO PLAY!

Help Theia join the Proto Earth to make a giant impact.

Rule of the game: Find the right way to link Theia to the proto-earth and trace it with your pencil.



FUN FACTS !

Did you know that the dark side of the Moon is not dark? It receives as much light as any other part of the Moon, but it always faces away from the Earth! That's why we now call it the far-side of the Moon.

Solution : Path 2

Mineral evolution

The history of our Earth is marked by geological changes that influenced the development (or not) of organisms. And vice versa. The spiral is a chronological frieze not at scale, starting from the oldest in the center (the formation of our Earth) and ending at the most recent on the right (the present). Some key moments of the geological history of our planet are indicated on this frieze.

1 Gy = 1 Billion years ago = 1 000 000 000 years / **1 My** = 1 Million years ago = 1 000 000 years.

Most of the coal we have today comes from the huge forests of ferns that covered the Earth at the end of the Paleozoic. The supercontinent Pangea formed.

-541 My

The Paleozoic era is when life starts to leave the ocean and colonize the land. There are several explosions of life diversity alternating with several mass extinctions. Plants evolved from simple moss-like organisms to trees and forests. Animals diversified from sponges and trilobites to bony fish, reptiles and insects. Today, even the highest mountains of the Paleozoic are small and eroded.

After a global glaciation, the Earth became nice and warm again. Many weird creatures inhabited the Ediacaran sea ○.

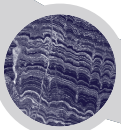
-4.567 Gy

The first minerals form in the molecular cloud before the solar system. These were diamonds ○.

After the Giant Impact the Earth was a huge ball of magma. When the magma colled the first rocks contained a lot of feldspars ○, like anorthite.

Stromatolites were colonies of algae that grew in many concentric layers.
New Minerals: aragonite ○, gypsum ○, halite ○.

Precambrian is the longest time period in Earth's history. It is subdivided into 3 parts: Hadean, Archean and Proterozoic. It was in the Hadean that the first rocks, the atmosphere, and the oceans formed. Most of the crust from that time was remolten later on and little is left.



Many ores with their beautiful shiny geodes formed at this time in large deposits. New minerals: copper ○, quartz ○, calcite ○.

Plenty of water circulated in the crust.
New minerals: micas ○.

Mass extinction: event where at least three quarters of animal and plant species disappear from the face of the Earth in a short period of geological time (less than a few million years).

The **Mesozoic** era is when the supercontinent Pangea broke apart. Africa and South America split and between them formed the Atlantic Ocean.

All the big mountains that we see today on the surface of the Earth, the Alps, the Himalayas, the Andes, as well as the majority of volcanoes, formed from the collision of continents that took place over the last 100 million years during **Neozoic**.

-252 My

-66 My

Dinosaurs spread all over the planet; first birds and mammals appeared. The corals that lived in the warm shallow seas built huge colonies, which transformed into many of the limestone mountains of today. Many of the buried animals and plants from this period transformed into oil. The end of the Mesozoic is marked by the fall of a huge meteorite, which brought the death of dinosaurs and ammonites. New Minerals: amber ○, oil ○, carbonates ○.

New rocks and minerals: chabasite ○, volcanic glass ○, stalactites ○.

DID YOU FIND THE MINERALS?

Look at the labels! When you find them, mark them in the little circles ○.
Which mineral is missing from the table?

Meteorites and comets continue to fall. They brought gold and water. When the crust cooled it started to cracked. Plate tectonics started.

Oldest mountains formed. New rocks: granites ○, metamorphic schists ○.

Precambrian

LOOKING INTO SEDIMENTARY ROCK LAYERS, WE FIND THAT THE OLDEST EVIDENCE OF LIFE IS FROM ABOUT 4 BILLIONS OF YEARS AGO! HOW DO WE KNOW THAT? FOSSIL RECORD! FOSSILS ARE THE REMAININGS OR THE TRACES LEFT BEHIND BY ANCIENT ORGANISMS. THEY HELP US UNDERSTAND HOW LIFE EVOLVED AND HOW THE ENVIRONMENT CHANGED OVER TIME. THE HARD PARTS, LIKE BONES AND TEETH AND TREE STEMS, ARE MORE EASILY PRESERVED, BUT IT IS ALSO POSSIBLE TO FIND PRINTS OF FEATHERS, SKIN AND LEAVES.

And today ?

OK, SO GEOLOGISTS STUDY ALL THE PAST HISTORY OF THE EARTH...BUT WHAT CAN THEY SAY ABOUT THE PRESENT?

The Earth is an amazing place with volcanoes, oceans, mountains and even weird places like geysers and caves. **Each of these places is made of different rocks and minerals, some that we may use daily in our lives**, sometimes without realizing it.

When you wake up in the morning and go brush your teeth, you're using the fluoride inside your toothpaste that comes from the mineral fluorite. Even our house itself! Bricks can be made of clay and tiles with slate. The aluminum we use in cans and in so many other utensils comes from bauxite. Light bulbs have tungsten, our electronic devices depend on tantalum, the glass comes from quartz, the batteries have lithium, our pencils have graphite...the list is long! **Even the water we drink is stored inside rocks** (we call them aquifers). We also use mostly fossil fuels to get around in our cars, but the derivatives of petroleum are also used in many other different products, like cosmetics, pharmaceuticals and plastics.

ENVIRONMENT

Unfortunately, the plastic that reaches the oceans and shorelines **is not biodegradable**, but it only breaks into smaller and smaller pieces. These microplastic particles can accumulate on the seafloor or can mix with the sand on the beaches. When they are heated, the plastic melts and glues everything together in a new rock-like material: the **plastiglomerate**. This material is already found in parts of Europe, North America and Indonesia. The plastiglomerate may be preserved in the geological record and mark the beginning of the Anthropocene, the new era of humans.

YOUR TURN TO PLAY!

One world is more environmentally friendly than the other.
Find the seven differences and help protect the planet.

THE MICROPLASTIC IN THE OCEAN CONCENTRATES A LOT OF CHEMICAL POLLUTANTS AND IT CAN BE INGESTED BY THE TINIEST ORGANISMS, LIKE THE PLANKTON. IT DAMAGES OUR WHOLE ECOSYSTEM, FROM BASE TO TOP. SOME ESTIMATES SAY THAT THERE ARE ALMOST 300 MILLION TONS OF PLASTIC IN THE OCEANS TODAY (AND 10 MILLION TONS MORE EVERY YEAR).
AROUND THE WORLD THERE ARE ACTIONS LIKE THE MANTA PROJECT, WHERE PEOPLE TRY TO CLEAN UP THE OCEANS AND RAISE AWARENESS OF THE DANGERS OF PLASTIC TO STOP THE POLLUTION. WE ALL CAN DO OUR PART TO HELP OUR PLANET!

Solution:
1 – turtle
2 – bird
3 – bottle
4 – trash can
5 – gourd
6 – bag
7 – boat

IT IS ALREADY THE END OF OUR ADVENTURE. YOU NOW KNOW SOME OF THE SECRETS OF OUR WORLD. DOESN'T IT MAKE YOU WANT TO LEARN MORE? SEE YOU SOON!

Moon Impact,
a geological story

http://expo-moonimpact.eu/

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Vera Rubin (1928 - 2016)

American astronomer, proved the existence of dark matter

set up by the Impact project team from the Laboratory of Geology of Lyon (CNRS / ENS de Lyon / Lyon1 University).

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