Climate, Volcanoes and Humans: hands-on for the classroom

Gina P. Correia | Giulia Realdon | Guillaume Coupechoux | Xavier Juan

EGU - GEFO

Geoscience Information for Teachers 2022 | 7th April 2022

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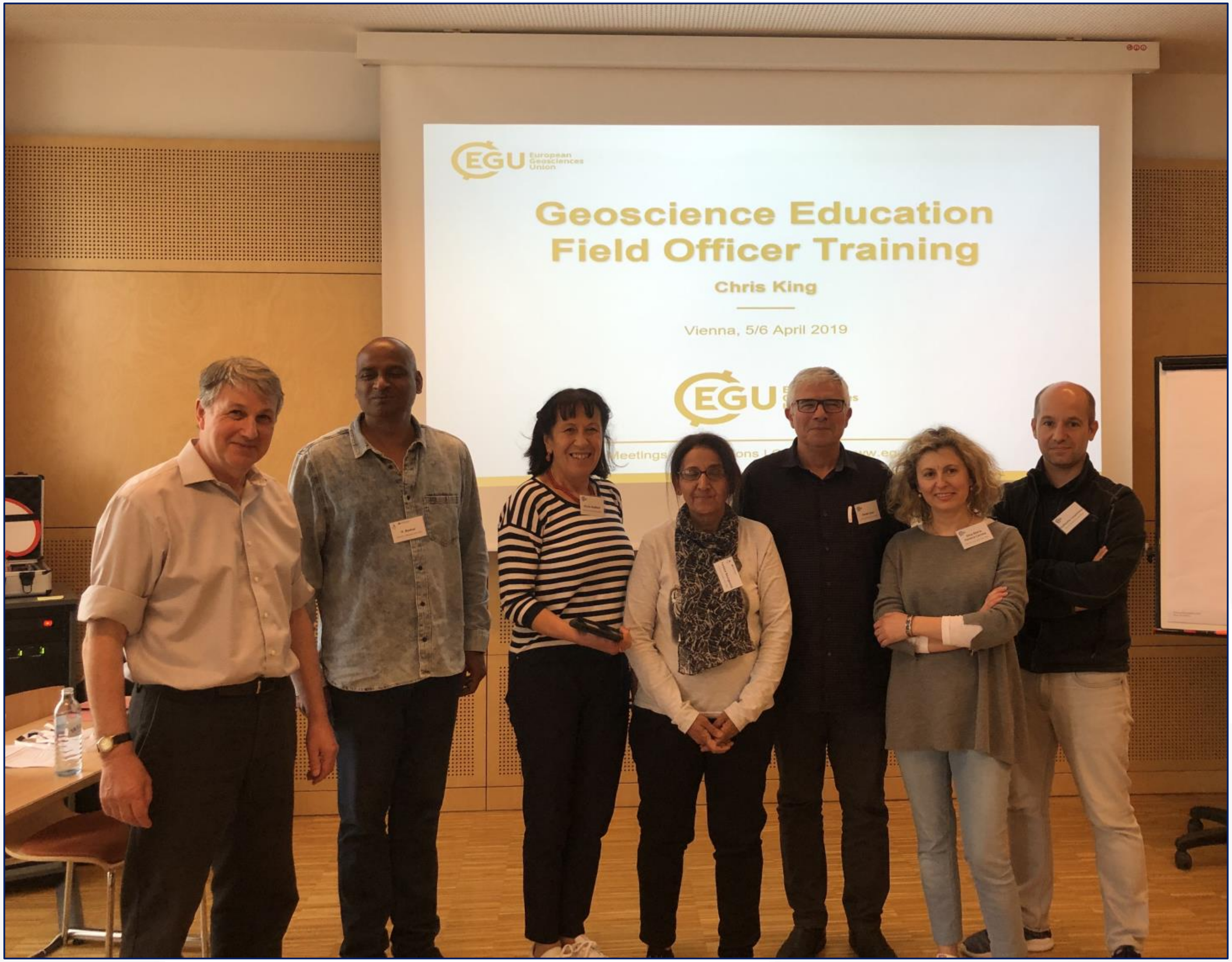

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Goal:

providing professional development for school teachers and future teachers, from primary to secondary schools, in teaching the elements of geoscience appropriate for their teaching curriculum, through interactive workshops.

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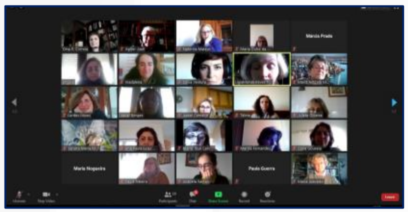
Since May 2019…



National workshops

Images: Gina P. Correia, Giulia Realdon

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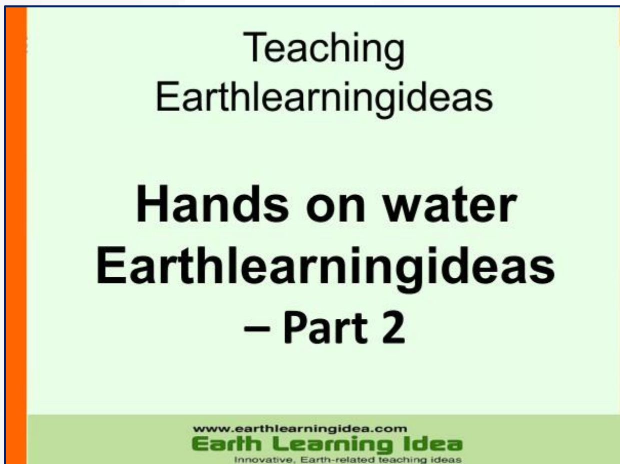
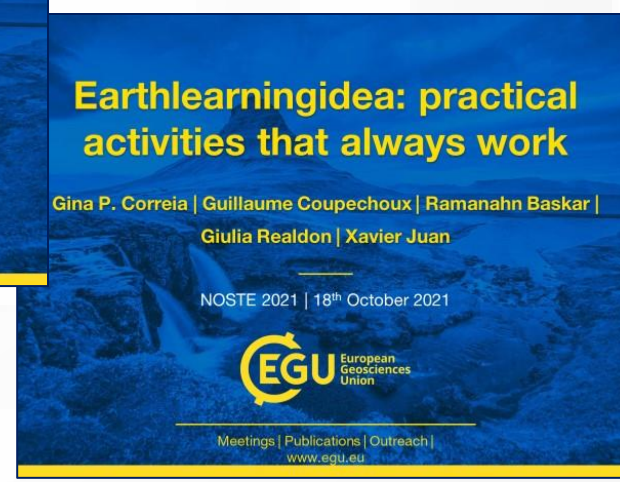
International workshops



vGeosciences Information for Teachers, 2021

International Earth Science Olympiads, 2021



NOSTE 2021, International Research Conference, Training Workshop and Biennial Convention

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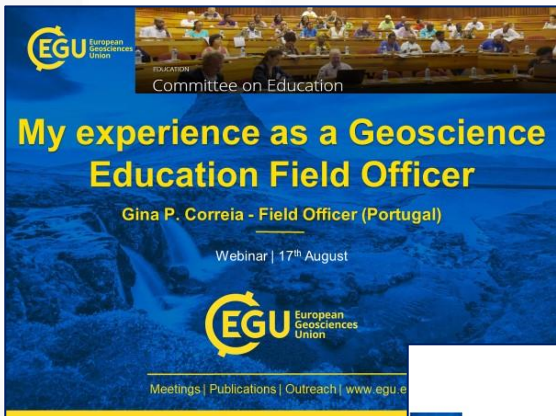
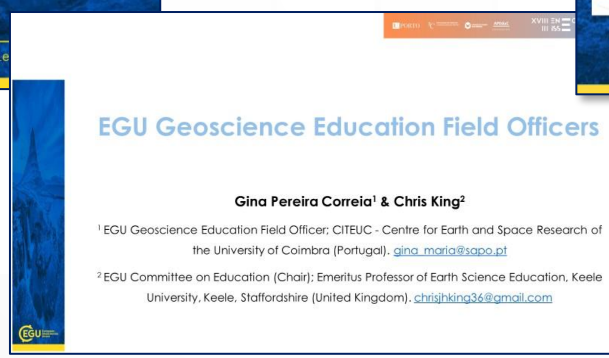
Conferences



EGU CoE Webinar, 2020



XVIII ENEC | III ISSE, 2020. Porto, Portugal

Le Geoscienze a Scuola, 2019. Parma, Italy

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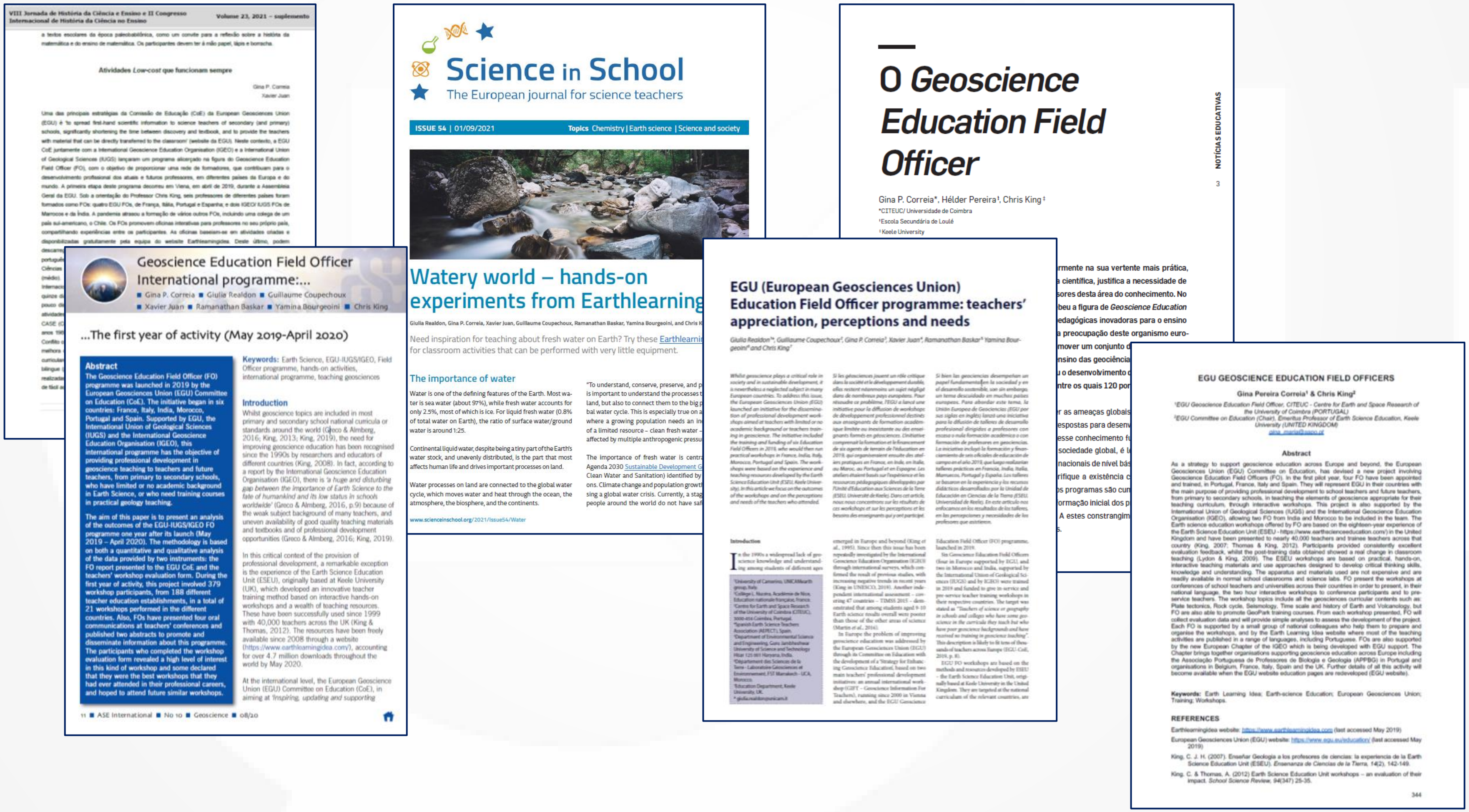
Since May 2019…

Publications



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At present…

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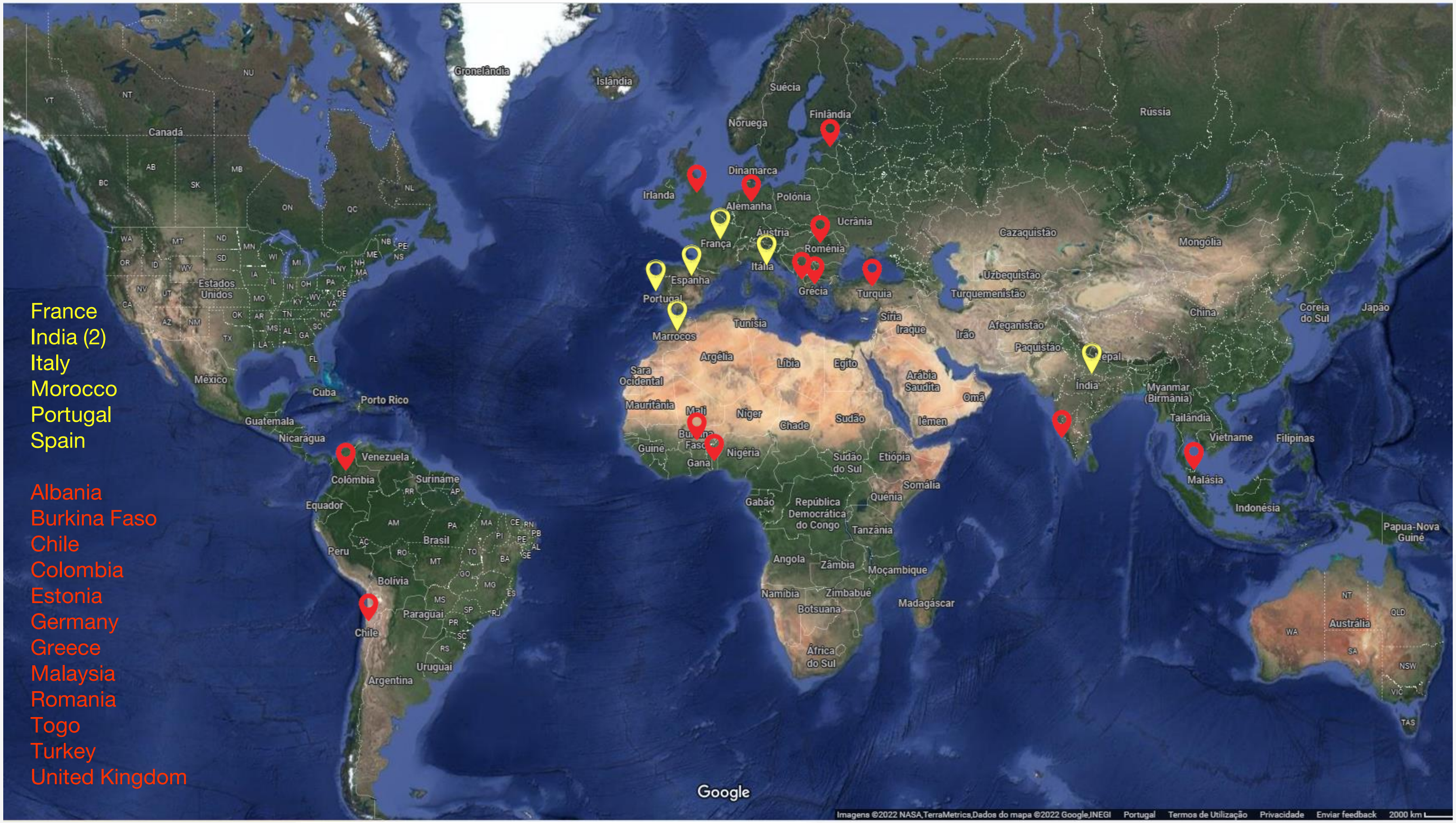
In the future…



France
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Germany
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Togo
Turkey
United Kingdom

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Workshops:

- Interactive;
- Hands-on;
- Activities: practical, simple and, overall time, speedy;
- Materials: inexpensive, easy to obtain/build and/or readily available in normal school classrooms and science labs.

Topics:

Plate tectonics | Rock cycle | Seismology | Time Scale and history of Earth | Volcanology | Hydrology and oceanography | Geopark training courses.

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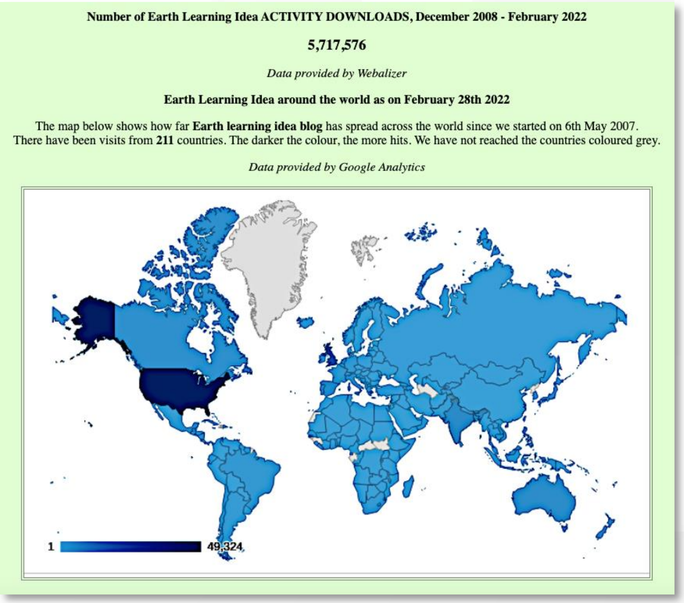

- 387 available activities
- Explanatory videos
- Translated into different languages
- 2008 to 2022 ⇨ > 5.700.000 downloads

http://www.earthlearningidea.com

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planetearth – Earth Sciences for Society

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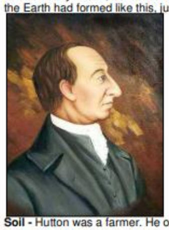
Geologists' Association – www.geologistsassociation.org.uk – 1858 – The Curry Fund

James Hutton – or 'Mr. Rock Cycle'?
Thinking towards the rock cycle, the Hutton way

James Hutton - Try thinking like James Hutton in the 1700s by asking these questions. Remember that, at that time, most people thought that the oldest rock on Earth was granite, which had crystallised from an early ocean, and all other rocks lay on top; the Earth had formed like this, just 6000 years ago.



James Hutton – the 'Founder of Modern Geology'.

Painting of James Hutton by Abner Lowe. This image is in the public domain because its copyright has expired.

Soil - Hutton was a farmer. He observed that soil was being eroded all the time but that a thick blanket of soil always remained. He asked himself 'Where does the new soil come from?' So - where does new soil come from?

A. *New soil is formed as decaying plants mix with weathered rock, helped by animals like worms in the soil – so it is a result of rock weathering.*

Sedimentary rocks - Hutton saw that beds of sedimentary rocks looked like the layers in modern sediments. He asked, 'Why do sedimentary rocks look like modern sediments?' So - why are sedimentary rocks similar to modern sediments?

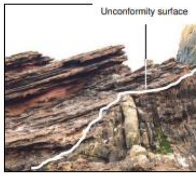
A. *Sedimentary rocks were modern sediments once, deposited long ago, before becoming hardened into rocks. This idea that ancient rocks were originally formed by processes active on Earth today, was later called, 'the principle of Uniformitarianism' – simply stated, 'the present is the key to the past'.*

Uplift - Hutton observed that while the land was being eroded all the time, it never went below sea level. He asked himself, 'Why is the Earth's surface never eroded below sea level?' So - why is this so?

A. *There must be some process that lifts bedrock up from time to time – that we now call uplift.*

At Hutton's time steam engines were being developed and showed that things expanded when they became hot. Hutten saw that some layers of rocks had been tilted upwards. He asked himself, 'Could the heating of deep layers of rocks cause rocks to be bent upwards and uplifted?' So - could this be so?

A. *It is possible that heating deep rocks could cause some uplift, but we now know that the main mechanism causing uplift is Plate Tectonics, which wasn't understood until the 1960s.*



'Hutton's Unconformity' at Siccar Point in Scotland.

The copyright on this image is owned by Anne Burgess and is licensed for reuse under the Creative Commons Attribution-ShareAlike 2.0 license.

Cycles - Hutton's fieldwork showed that where rocks were tilted upwards, they could be eroded and new sedimentary layers could be laid down on the top. He thought, 'Could there be more than one cycle of sediment being deposited, hardened into rock and then uplifted? So - can there be more than one cycle like this? If so, what is the cycle called?

A. *We now know that there can be many cycles of deposition, rock-formation and uplift – this is the sedimentary part of the 'the rock cycle'. The place where new sedimentary layers were deposited on top of older uplifted and eroded layers we now call an 'unconformity'.*

Granite - Although most people at the time thought granite had crystallised from an ancient sea, Hutton's fieldwork showed that it had once been molten. What clues might Hutten have found to show that granite was once molten magma?

A. *He found places where the granite had flowed into the surrounding rock, as dykes and veins.*

Time - Hutton asked himself, 'How long would it take for rocks to be cycled?' So - how long do you think it would take for old uplifted rocks to be eroded, new layers to be deposited, made into rocks and uplifted again?

A. *Hutton had no idea of the amount of time this must have taken, but when one of his friends realised what Hutton was saying, he wrote, 'The mind seemed to grow giddy by looking so far into the abyss of time' and Hutton himself wrote that the cycles had, 'no vestige of a beginning - no prospect of an end'. Now we know that a complete 'turn' of the rock cycle takes millions of years.*

Rock cycle - Which parts of the rock cycle had Hutton 'discovered' in his work?

A. *Hutton understood weathering and erosion, sediment deposition, how sedimentary and igneous (granite) rocks were formed, that rocks were uplifted, and that all this would take a lot of time – time that we now call 'geological time'.*

Hutton 'discovered' most of the rock cycle – maybe we should now call him, 'Mr. Rock Cycle'!

The back up

Title: James Hutton – or 'Mr. Rock Cycle'?

Subtitle: Thinking towards the rock cycle, the Hutton way.

Topic: A series of questions and answers that attempt to outline the possible thoughts of James Hutton as he developed his ideas in the context of what we now call the rock cycle.

Age range of pupils: 14 – 18 years

Time needed to complete activity: 15 mins

Pupil learning outcomes: Pupils can:
- describe and explain how Hutton's thinking may have developed towards the 'rock cycle' idea;
- show understanding of many of the processes and products of the rock cycle.

Context: Study of James Hutton's book '*Theory of the Earth*', published in 1788 shows that he had developed many of the ideas that we have now come to associate with the rock cycle. Hutton's work didn't become widely known until it was publicised by John Playfair in his book, '*Illustrations of the Huttonian Theory of the Earth*' published in 1802. After that, Hutton's ideas were widely used and developed, particularly by Charles Lyell in his three volume book, '*The Principles of Geology*' published between 1830 and 1833. Lyell's work, in turn, strongly influenced Charles Darwin as he developed his theory of evolution. For these reasons, Hutton is now widely regarded as 'the Founder of Modern Geology'. Hutton was a Scottish farmer and naturalist, who travelled widely and played a vital role in the development of scientific and other ideas in Scotland in the late 1700s (the time called 'the Scottish enlightenment')

Following up the activity:
Follow up the development of Hutton's thinking by following Darwin's thinking in the 'Darwin's 'big soil idea'' and 'Darwin's 'big coral atoll idea'' Earthlearningideas.
Try to make your own unconformity using the 'The Himalayas in 30 seconds!' activity, by removing the top of the folds and replacing them with horizontal layers of sand and flour.

Underlying principles:
- Rocks at the Earth's surface are weathered and then eroded to form sediment.
- Sediment is deposited in layers to form sedimentary sequences.
- Sedimentary sequences become sedimentary rocks.
- Granite is formed by slow crystallisation from magma.
- Rocks are uplifted by natural Earth processes; this allows the rock cycle to continue cycling.
- A full 'turn' of the rock cycle takes millions of years.

Thinking skill development:
'Thinking like Hutton' involves bridging between the current ideas of the pupils and the ways in which geologists may have thought in the past. By its nature, such a process also involves construction, cognitive conflict and metacognition.

Resource list:
- imaginative minds.

Useful links:
You can find more about James Hutton, how his thinking developed, and how important this was in the development of geology, by typing "James Hutton" into an internet search engine, like *Google*.

Source: Developed by Chris King of the Earthlearningidea Team.

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https://www.facebook.com/earthlearningidea

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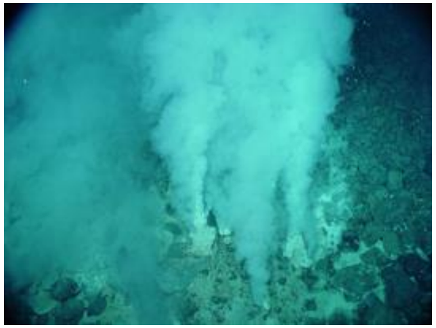
Why to use hands-on models and simulations to teach geosciences?

- Geosciences study phenomena rarely first-hand accessible:
  … too big … too slow
  … too far … sometimes dangerous!






Images: Dorian Wallender CC-BY, Thomei08 public domain, NOAA public domain, Etna Park

- They possibly remain theoretical concepts, far from experience, difficult to visualize, understand, remember, apply…
- The use of practical labs with low-cost materials can be a resource for teachers, especially when well equipped labs are not available

Workshop theoretical base: the CASE model

CASE - **C**ognitive **A**cceleration through **S**cience **E**ducation Programme

Earthlearningideas using the CASE approach to develop thinking skills

An Earthlearningidea workshop

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Climate, Volcanoes and Humans: hands-on for the classroom activities

- *See level in a plastic cup* - Eight ways to change the water level in a plastic cup – and global sea level.
- *Melting ice and sea level change 1 and 2 – ice caps* - Does sea level change when floating sea ice melts? And when ice caps melt?
- *Geobattleships* - Do earthquakes and volcanoes coincide?
- *See how they run* - Investigate why some lavas flow further and more quickly than others.
- *Volcano in the lab* - Modelling igneous processes in wax and sand.
- *The toilet roll of time* - Evolution of life
- *Interpret Earth temperatures from simulated deep-sea and ice cores* - Using sweets to simulate oxygen isotope ratios in cores.
- *The oxygen isotope sweet simulation* - Demonstrating how the oxygen isotope proxy records past Earth temperatures.

Retrieved from:
https://www.earthlearningidea.com/PDF/369_Global_sea_level.pdf

See level in a plastic cup - Eight ways to change the water level in a plastic cup – and global sea level.

Materials:

- a transparent plastic cup of water
- (optional) a source of ice and a marker pen

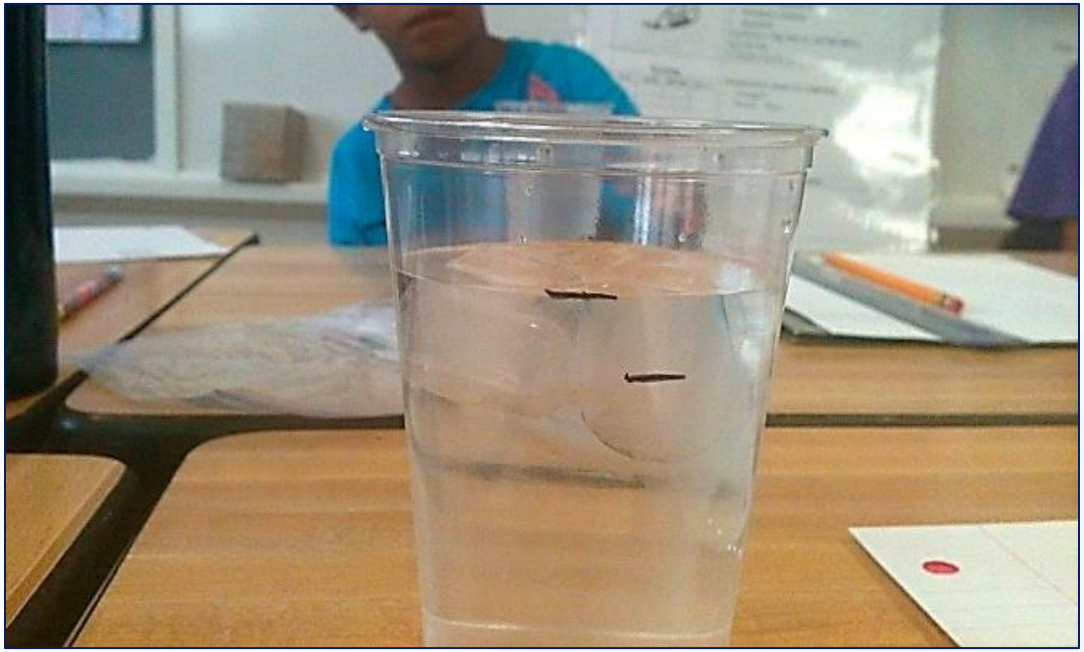


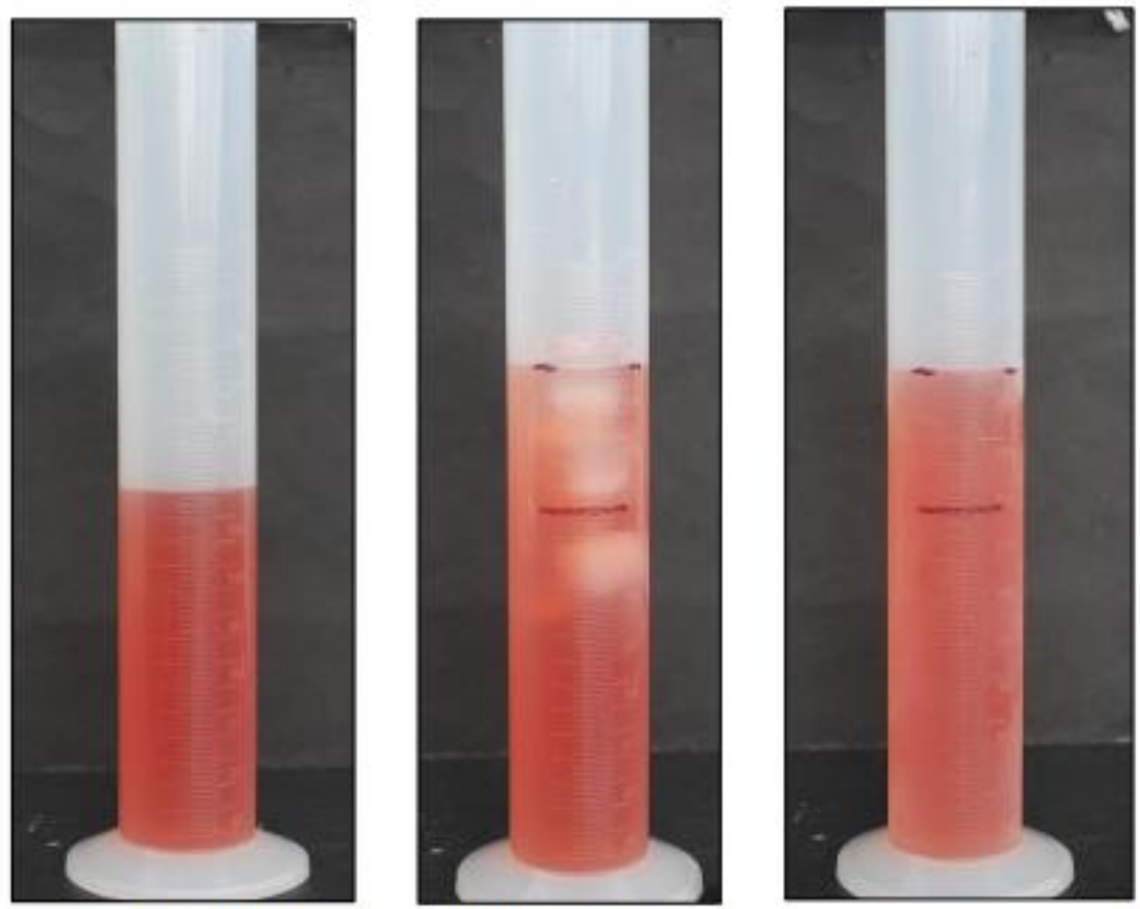
Image: Clinton Conrad

Retrieved from:
https://www.earthlearningidea.com/PDF/322_Melting_ice_sea_level_1.pdf

Melting ice and sea level change 1 – ice caps - Does sea level change when floating sea ice melt?

Materials:

- 500 ml measuring cylinder
- water
- crushed ice
- food colorant



1. 150 ml of coloured water 2. 210 ml after adding ice, 3. where the level remained after it had all melted

Images: Earthlearningidea

Retrieved from:
https://www.earthlearningidea.com/PDF/323_Melting_ice_sea_level_2.pdf

Melting ice and sea level change 2 – ice caps - Does sea level change when ice caps melt?

Materials:

- 500 ml transparent beaker or similar
- flat non-floating objects, e.g. 100g masses
- water
- ice cubes
- ruler

1. Coloured water up to about 280 ml.

2. Ice cubes added and water level marked.

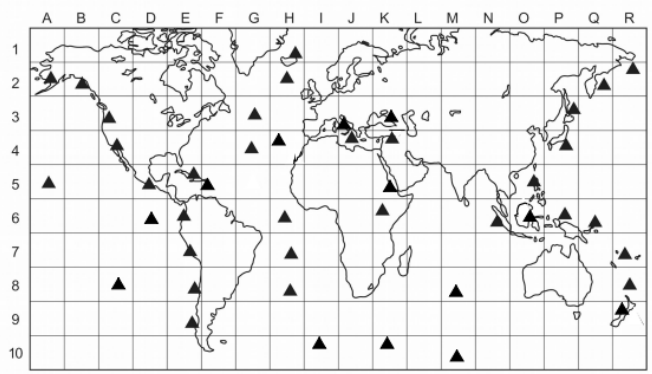
3. Water level rises to 450ml when all the ice has melted.

Retrieved from:
https://www.earthlearningidea.com/PDF/79_Geobattleships.pdf

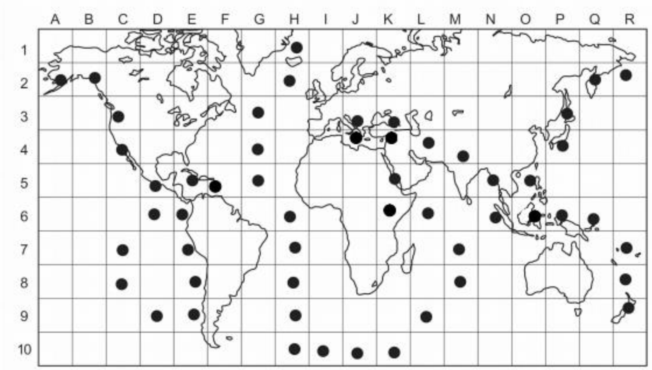
Geobattleships - Do earthquakes and volcanoes coincide?

Materials:

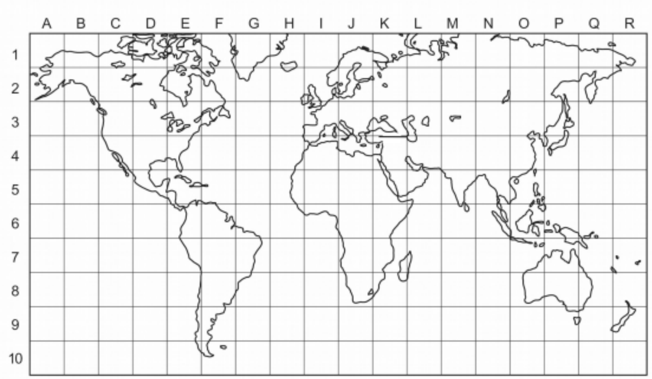
- sets of sheets for pairs of students, as supplied
- one student in each pair is handed a map of the distribution of volcanoes, with a blank map beneath
- the other student is handed a map of the distribution of earthquakes with a blank map beneath
- pencils



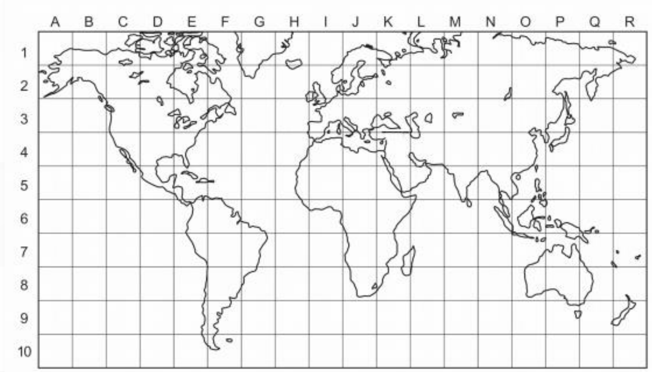
Main Volcanoes / Volcanic Activity



Main Earthquake Activity



Map for plotting Earthquake locations



Map for plotting Volcanoes / Volcanic activity locations

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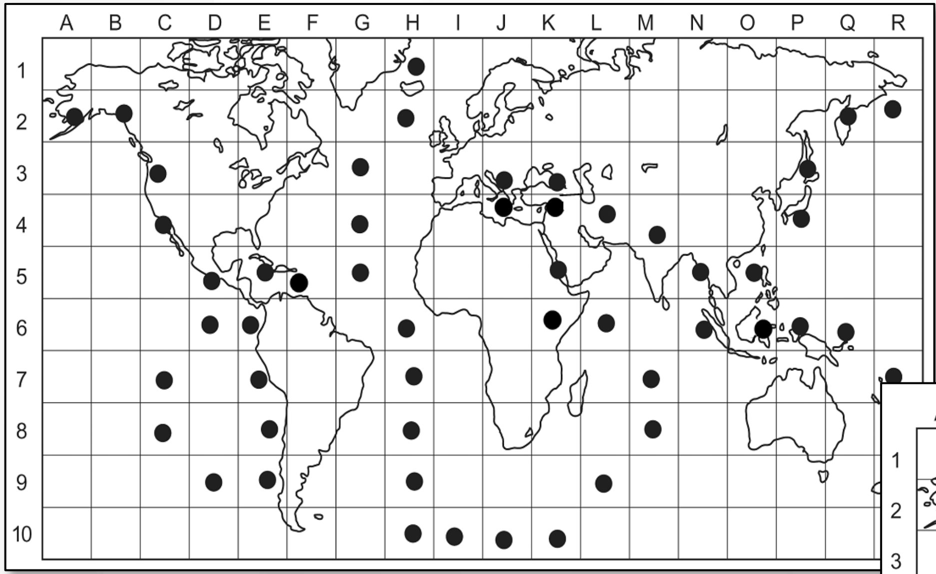
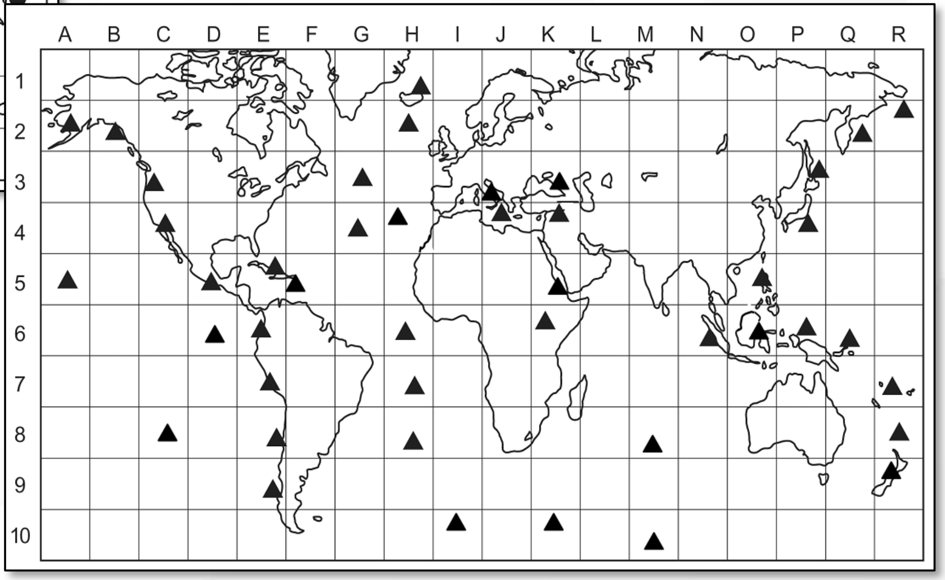
Geobattleships - Do earthquakes and volcanoes coincide?



- The players shoot in turns calling the coordinates
- … until a pattern emerges!



- Where are volcanoes and earthquakes?
- Where only earthquakes/only volcanoes?

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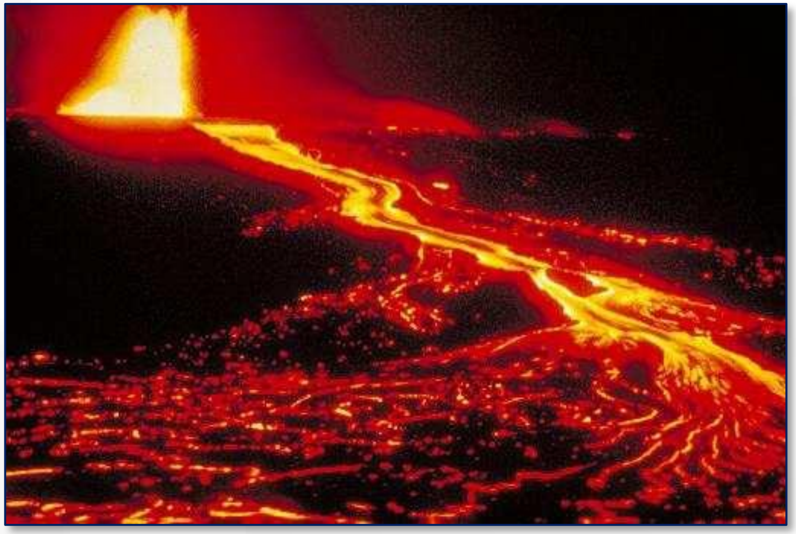
https://www.earthlearningidea.com/PDF/See_how_they_run.pdf

See how they run - Investigate why some lavas flow further and more quickly than others.



Images: Kilauea, USGS
and Mont St. Helens, Mike Doukas, public domain

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https://www.earthlearningidea.com/PDF/See_how_they_run.pdf
And
https://www.earthlearningidea.com/Video/Extrusion.html

See how they run - Investigate why some lavas flow further and more quickly than others.

Video: Giulia Realdon

Materials:

- three identical small clear plastic or glass containers with lids, such as empty drinks bottles (if in a laboratory, use boiling tubes).
- any harmless viscous liquid such as treacle, syrup or hair shampoo, whose viscosity is dependent upon temperature.
- a source of heat and a water bath (bowl of hot water) into which the containers can be immersed.
- a stop-clock or a smartphone
- a thermometer, if available.

Retrieved from:
https://www.earthlearningidea.com/PDF/See_how_they_run.pdf
And
https://www.earthlearningidea.com/Video/Extrusion.html

See how they run - Investigate why some lavas flow further and more quickly than others.

Video: Giulia Realdon

Materials:

- any harmless viscous liquid such as treacle, honey. syrup or hair shampoo, whose viscosity is dependent upon temperature
- a tile
- a stop-clock or a smartphone
- a small quantity of sugar or dry sand
- A few drops of water

Retrieved from:
https://www.earthlearningidea.com/PDF/89_Volcano_in_the_lab.pdf

Volcano in the lab - Modelling igneous processes in wax and sand.

Materials:

- 500ml glass beaker
- coloured candle wax
- washed sand
- cold water (preferably chilled in a fridge)
- a Bunsen or camping burner, tripod, gauze, heatproof mat, gas supply, matches
- eye protection, or safety screen

Image: Peter Kennet

Note: Although a wax 'eruption' may appear to be a dangerous activity, experience has shown that the worst that can usually happen is that the beaker cracks if it is heated too strongly, allowing some warm wax and water to trickle down.

Volcano in the lab - Modelling igneous processes in wax and sand.

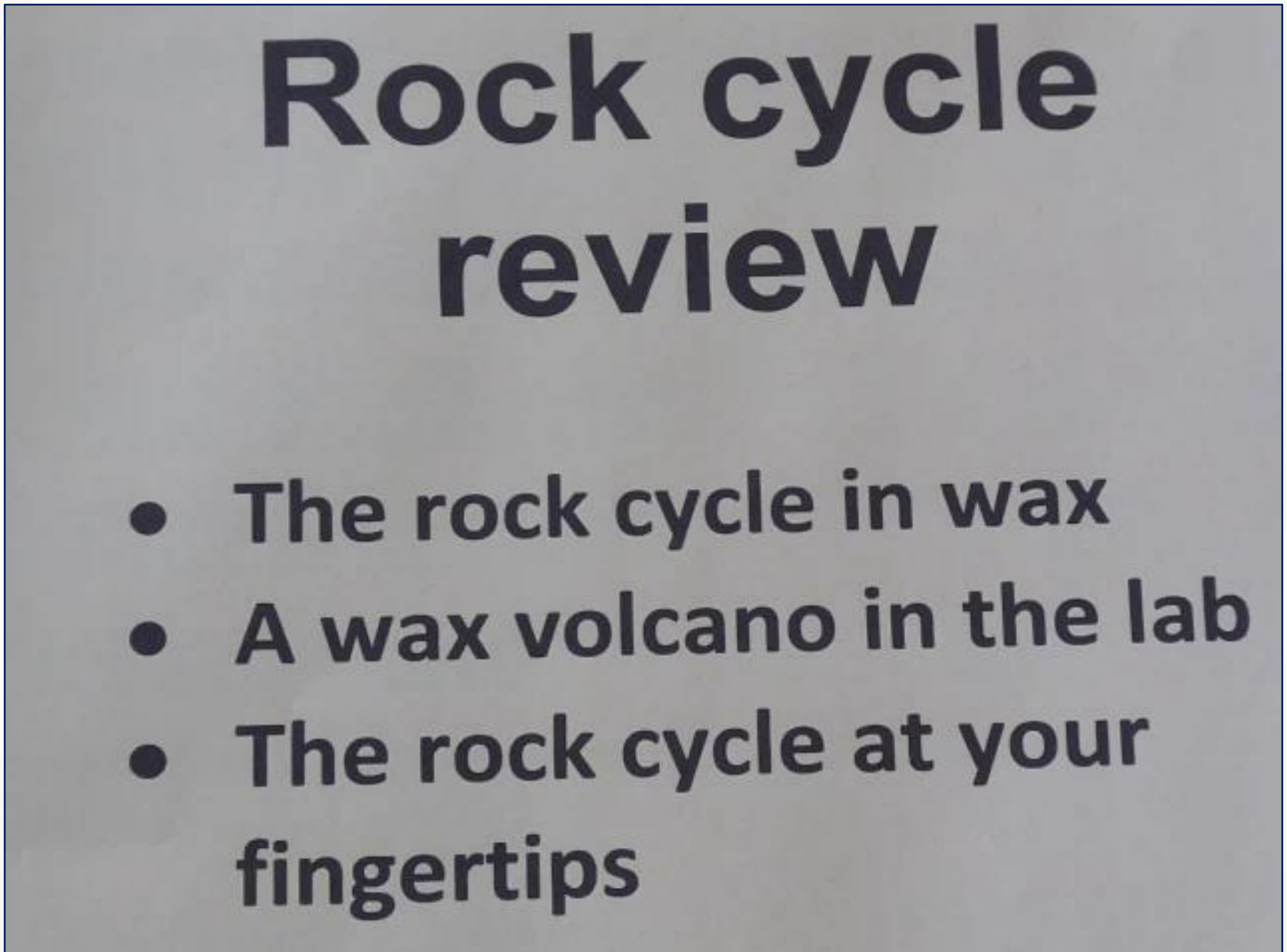
Before the burner is lit, ask the students to predict what will happen as the contents of the beaker heat up:

- Which will melt first - the wax or the sand?
- What will happen to the wax once it has melted?
- Why will it rise?
- Will any of the molten wax reach the top of the water?
- Will any of the molten wax set in the water?
- Will the molten wax convect round the beaker?

Then heat up the beaker and ask students to watch carefully throughout, from a safe distance or behind a safety screen

Retrieved from:
https://www.earthlearningidea.com/Video/RC_review2.html

Volcano in the lab - Modelling igneous processes in wax and sand.



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https://www.earthlearningidea.com/PDF/234_Toilet_roll_of_time.pdf

Evolution of life - *The toilet roll of time*

Materials:

- 46 sheets from a toilet roll
- the timeline marker sheet
- a felt-tipped pen
- scissors
- a means of attaching the timeline markers to the toilet roll (e.g., glue, staples)

Timeline

Event	Geological time (years ago)
Today – the future begins here	0 years
Oldest stone tools	3,300,000 years
India/Eurasia collision – Himalayan Mountains formed	50,000,000 years
K-Pg (K-T) mass extinction – dinosaurs became extinct	65,000,000 years
Early flowering plants	130,000,000 years
Beginning of the opening of the Atlantic Ocean	190,000,000 years
Early birds	160,000,000 years
Early mammals	220,000,000 years
The 'great dying' mass extinction	251,000,000 years
Supercontinent of Pangaea assembled	300,000,000 years
Early reptiles	315,000,000 years
Early amphibians	370,000,000 years
Early insects	400,000,000 years
Early land plants	430,000,000 years
Early fish	530,000,000 years
'Cambrian explosion – life with shells and other hard parts	545,000,000 years
Early multicelled organisms	2,000,000,000 years
Early organisms with cells containing nuclei (eukaryotes)	2,100,000,000 years
Build-up of free oxygen in atmosphere	2,700,000,000 years
Early bacteria and algae	3,500,000,000 years
Oldest known Earth rocks	4,000,000,000 years
Origin of the Earth – geological time begins here	4,567,000,000 years

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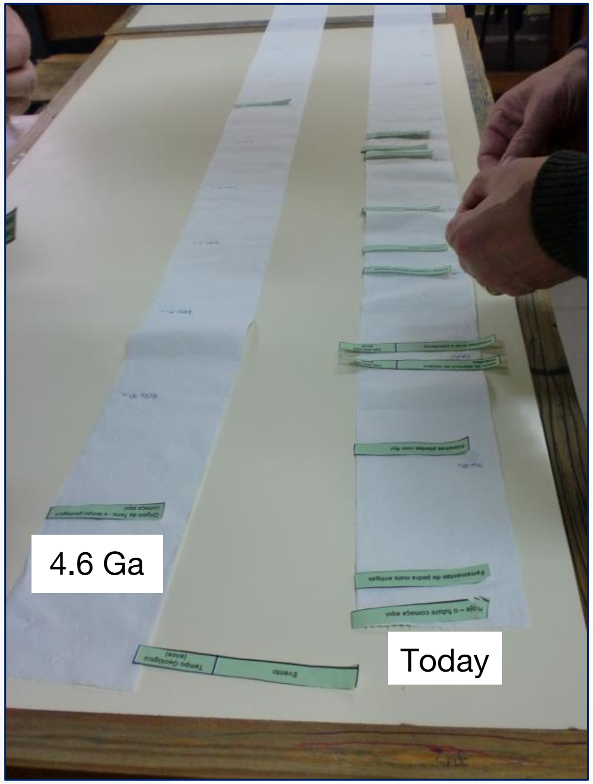
Evolution of life - *The toilet roll of time*



Each sheet can represent 100,000,000 years -

one hundred million years

Images: Gina P. Correia

Retrieved from:
http://www.earthlearningidea.com/Video/Evolution_60s.html

Evolution of life

Interpret Earth temperatures from simulated deep-sea and ice cores - Using sweets to simulate oxygen isotope ratios in cores.

Materials:

- A few bags of sweets that can be divided into different colours
- A stack of plastic stacking beakers
- Paper and scissors to cut paper disks

Retrieved from:
https://www.earthlearningidea.com/PDF/276_Oxygen_isotope_cores.pdf

Interpret Earth temperatures from simulated deep-sea and ice cores - Using sweets to simulate oxygen isotope ratios in cores.

Demonstration :

Sweets represent oxygen isotopes :

- Darker coloured sweets represent water with heavy oxygen - ^{18}O
- Paler-coloured sweets represent water with normal oxygen - ^{16}O

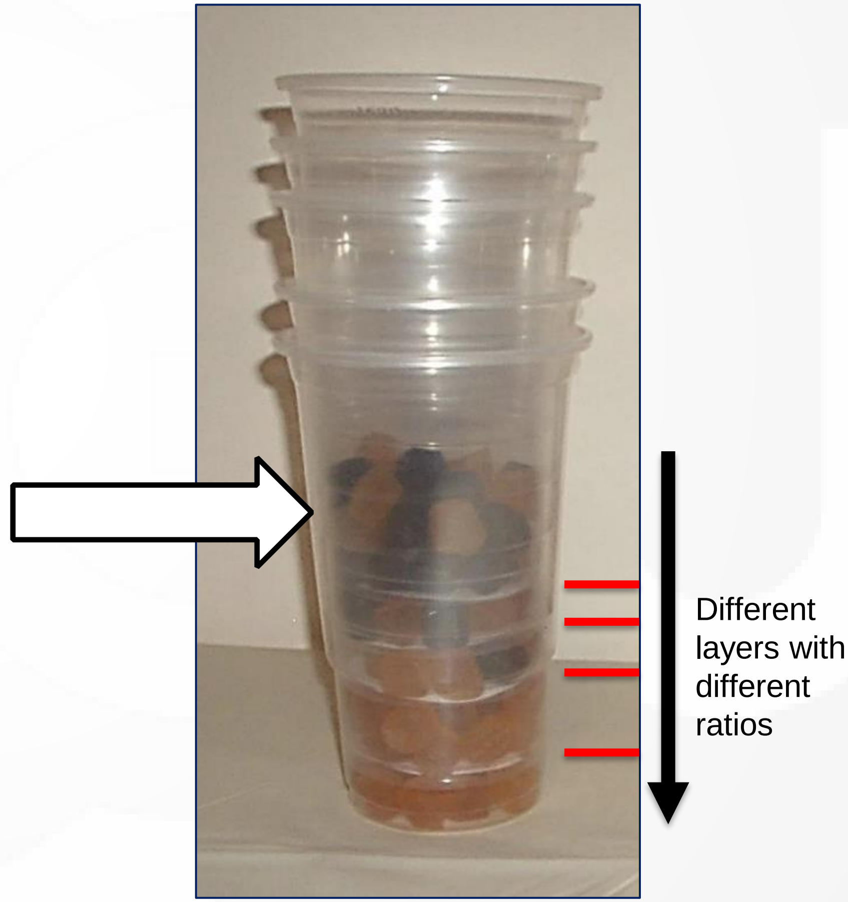


Image: Chris King

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Interpret Earth temperatures from simulated deep-sea and ice cores - Using sweets to simulate oxygen isotope ratios in cores.

Demonstration :

Some circular disks of paper put at the bottom of a set of stacking plastic beakers represent one layer in a core

The repetition of plastic beaker representes a « core » of different layers with different ratios

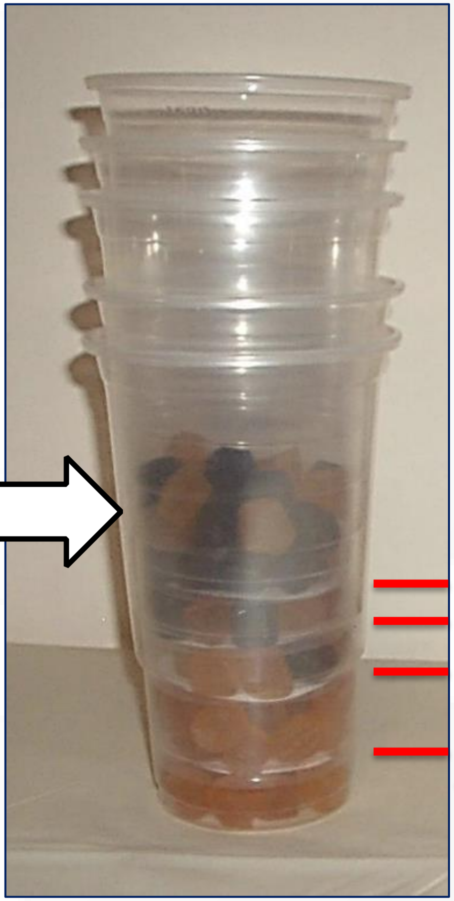

Image: Chris King

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Interpret Earth temperatures from simulated deep-sea and ice cores - Using sweets to simulate oxygen isotope ratios in cores.

Questions for the students :

Draw a graph of Earth temperature against core depth given that :

- If the core is a simulated ice core - the less ^{18}O it contains, the colder Earth's temperature will be, vice versa.
- If the core is a simulated deep-sea sediment core - the more ^{18}O it contains, the colder Earth's temperature will be, vice versa.

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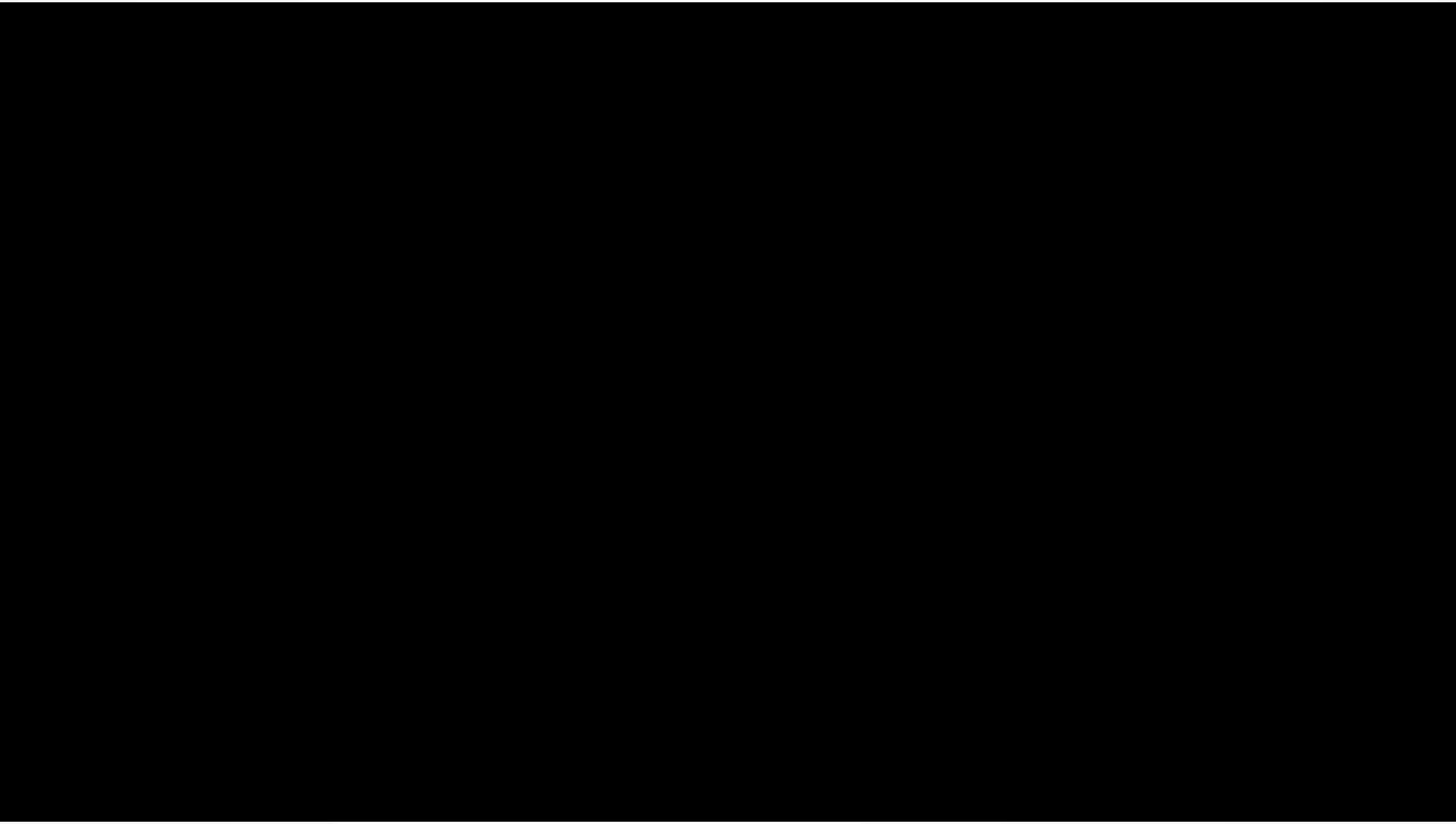
Interpret Earth temperatures from simulated deep-sea and ice cores - Using sweets to simulate oxygen isotope ratios in cores.

Time to experiment together !



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The oxygen isotope sweet simulation - Demonstrating how the oxygen isotope proxy records past Earth temperatures.

Materials:

- a few bags of sweets that can be divided into different colours
- 3 plastics containers
- a tray
- labels

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The oxygen isotope sweet simulation - Demonstrating how the oxygen isotope proxy records past Earth temperatures.

Demonstration :

Sweets represent oxygen isotopes :

- Darker coloured sweets represent water with heavy oxygen - ^{18}O
- Paler-coloured sweets represent water with normal oxygen - ^{16}O

Image: Chris King

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Demonstration :

Two possibilities :

- Warmer Earth during an interglacial
- Colder Earth during a glacial period

Image: Chris King

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Questions for the students :

- Why the density of a water molecule affects its rates of evaporation and condensation ?
- How in air masses moving from the tropic the $^{16}O/^{18}O$ proportion changes ?
- How the amount of change of rainfall which depends, in turn, on the temperature of the Earth at the time ?
- How ^{18}O proportions in ice core or in deep-sea core layers can indicate interglacial or glacial period ?

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Time to experiment together !

European Geosciences Union

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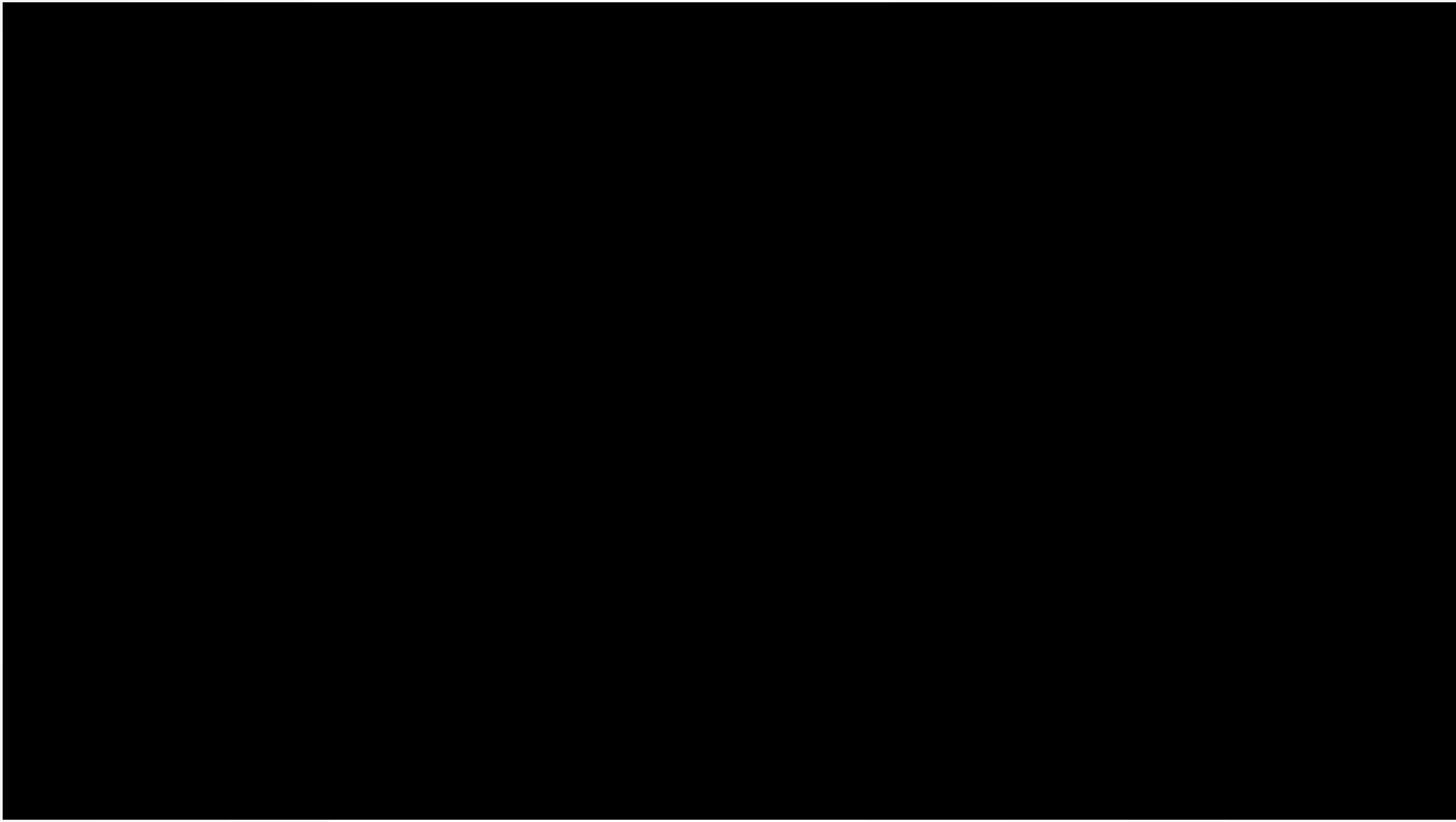

Evaluation form

https://forms.gle/6VTGsoy9WVFVNud56

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