Geoscience practical activities on natural hazards in a rapidly changing world

Candan Kafali | Dragos Tataru | Fotios Danaskos | Gina P. Correia | Giulia Realdon | Inga Zaitseva-Pärnaste | Pete Loader | Sylke Hlawatsch | Xavier Juan

EGU - GEFO

Geoscience Information for Teachers | Vienna 25th April 2023

EGU and the birth of GEFO Programme

- Among the different STEM subjects, **geosciences are probably the most neglected**, both in school curricula and in the teaching practices of many countries.

- 2019 - **EGU** launched a programme with the objective to promote geoscience education in Europe and beyond, creating a first group of teacher trainers, the **Geoscience Education Field Officers (GEFO)** in 6 countries (France, India, Italy, Morocco, Portugal, and Spain) with the support of the International Union of Geological Sciences (**IUGS**) and the International Geoscience Education Organisation (**IGEO**).

1st GEFOs' trainee (Vienna, 2019)

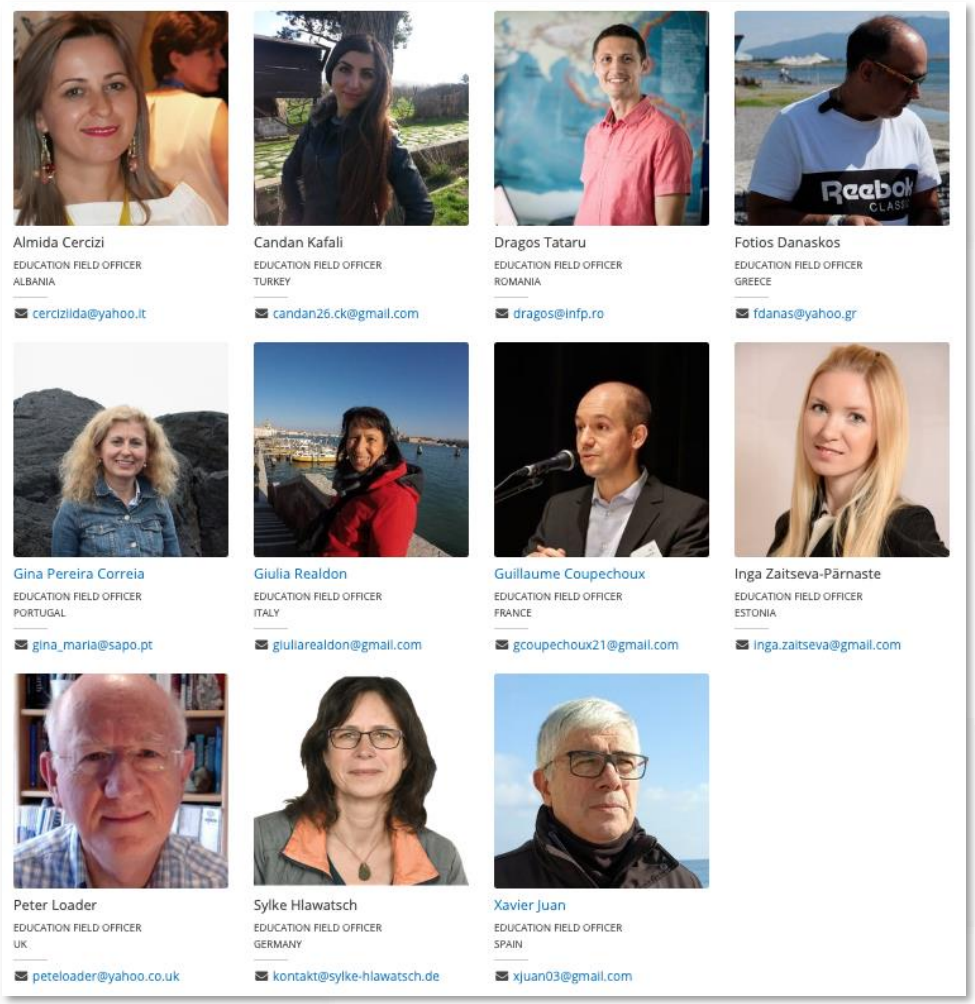
New GEFOs' trainee (Barcelona, 2022)

- 2020/2022 - Due to its success, a second call was open and **13 new GEFO** were appointed to represent Albania, Burkina Faso, Chile, Colombia, Estonia, Germany, Greece, India, Malaysia, Romania, Togo, Turkey, and the United Kingdom.

21 Geoscience Education Field Officers in the world
EGU + IUGS-COGE

Image: Google Earth, Gina P. Correia

EGU Geoscience Education Field Officers



https://www.egu.eu/education/field-officers/

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.

EGU Geoscience Education Field Officers

- GEFOs offer face to face and online workshops at national and international level.

Images: Candan Kafali, Fotios Danaskos, Gina P. Correia, Giulia Realdon, Pete Loader

EGU Geoscience Education Field Officers

Workshops:

- Interactive
- Hands-on
- Activities: practical, simple, requiring max. one teaching time
- 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 | Earth in space | Natural hazards | Geopark training courses

Images: examples of workshop materials, Chris King, ESEU

EGU Geoscience Education Field Officers

- GEFOs promote geosciences teaching by presenting GEFO programme in National and international Conferences and magazines.

Conferences

EGU CoE Webinar, 2020

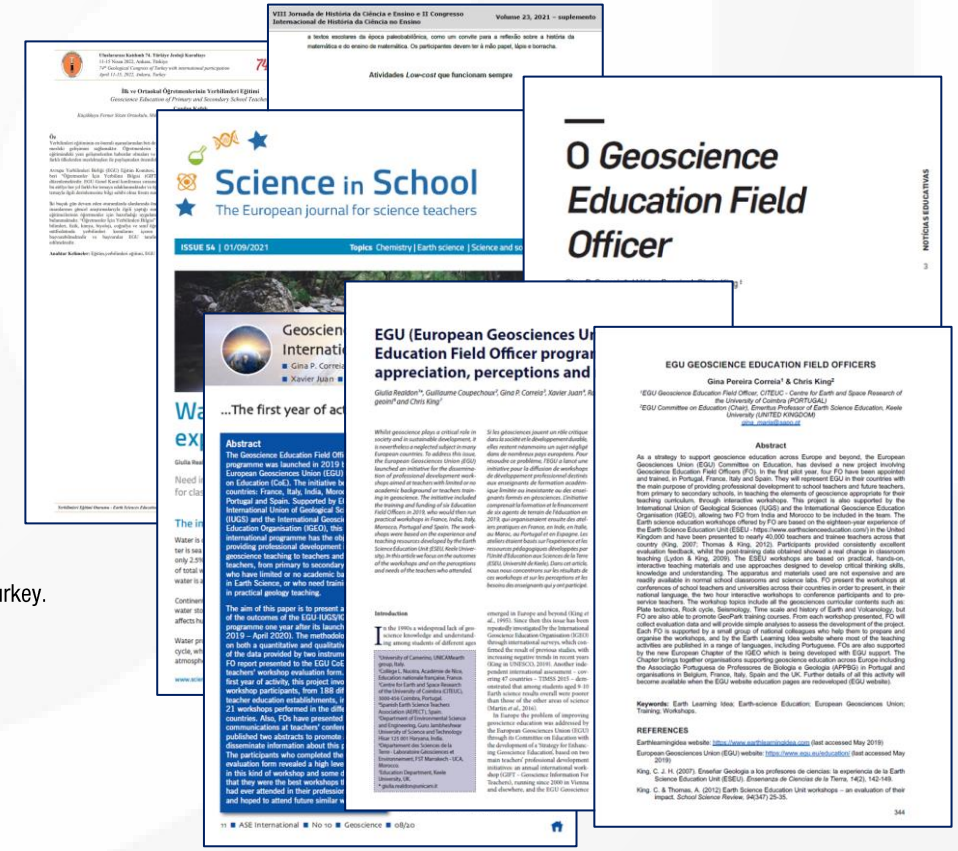
XVIII ENEC I III ISSE, 2020.
Porto, Portugal

Le Geoscienze a Scuola, 2019.
Parma, Italy

GeoMinköln, 2022. Germany

74th Geological Congress of Turkey.
2022, Ankara, Turkey

Publications



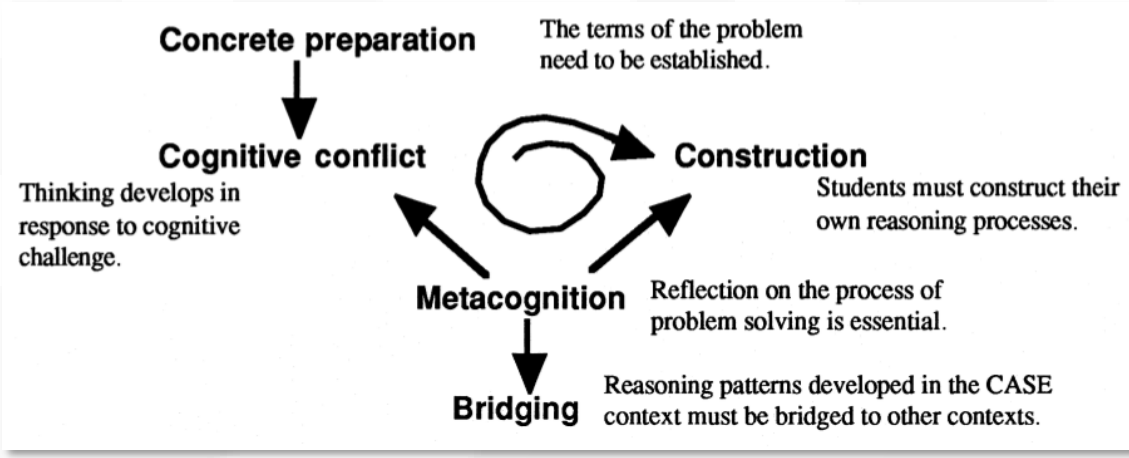
Workshop theoretical base: the CASE model

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

- Aimed at the development of cognitive skills **through** science teaching
- Based on the work of educational psychologists Piaget and Vygotsky
- Successfully tested in the '90 in UK and used worldwide

The five pillars of CASE methodology

1. **Concrete preparation**: preparing the ground, ensuring familiarity with the apparatus, the terminology, and the problem being addressed.
2. **Construction**: collecting data and detecting patterns in the data.
3. **Cognitive conflict**: when new data does not fit the expected pattern, challenging students' previous knowledge.
4. **Metacognition**: reflecting on one's own thinking, verbally or on paper.
5. **Bridging**: applying this new understanding to new contexts and to the real world.



Images:Center for Language Education, HKUST, P. Adey 1999

Geoscience Education Field Officers: the activities repository

Earth Learning Idea : 15 years on and still going strong!

The ELI team - Chris King, Peter Kennett, Elizabeth Devon, Pete Loader.

The EARTHLEARNINGIDEA ("ELI") concept was born in 2007 following a failed bid by the International Geoscience Education Organisation (IGEO) to present Earth science teaching workshops, to teachers in developing countries during the 2008 International Year of Planet Earth. Masterminded by the late Professor Chris King and two colleagues on a volunteer basis, the initial plan was to publish a new activity every week for the year on a specially designated website. Each activity presented an Earth science topic using an interactive, inquiry-based approach to educate and motivate pupils, whilst developing their thinking and investigative skills.

Secondary age (11-18 yrs) activities

SCAN ME

SCAN ME

There are now over 400 activities, many with accompanying teaching videos (based on the CASE model), and extension ideas. All are FREE to download with a new topic published every two weeks. Most are aimed at teachers and teacher trainers in developing countries and so use simple apparatus that might be available in classrooms with few resources, whilst focusing on fairly simple ideas. They are designed to cover the geoscience curricula of Primary to Upper Secondary education.

Primary/Junior age (5-11 yrs) activities

SCAN ME

Innovative, Earth-related teaching ideas website

SCAN ME

ESTA Earth Science Teachers' Association

www.earthlearningidea.com

Earth Learning Idea

Innovative, Earth-related teaching ideas

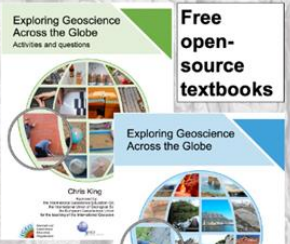
EGU European Geosciences Union

ELI PAGES | CHILDREN'S FUN | RESOURCES | TRANSLATIONS | ELI IN THE WORLD

Brickquake Video

SCAN ME

The ELI Blog



Free open-source textbooks

SCAN ME

New in 2023

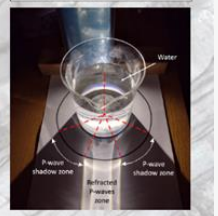
Our website now includes videos of many of our activities in action

Natural Hazard ELIs

Future Earthlearningidea activities

Critical minerals series

Earthquake Shadow Zones



The Earthlearningidea in Feb 2023 :

- ELIs in English are currently being published at one per fortnight; over 400 English activities have so far been published
- ELI PDF, videos and PowerPoint files have been downloaded more than 6.2 million times
- ELI has been accessed in most countries and more than 12,500 cities globally
- ELIs have been translated into 10 other languages: Spanish, Catalan, Norwegian, Italian, German, Portuguese, Polish, Japanese, South Korean
- ELIs have been used as the basis of teacher training education workshops in many countries

Mining and the Green Revolution

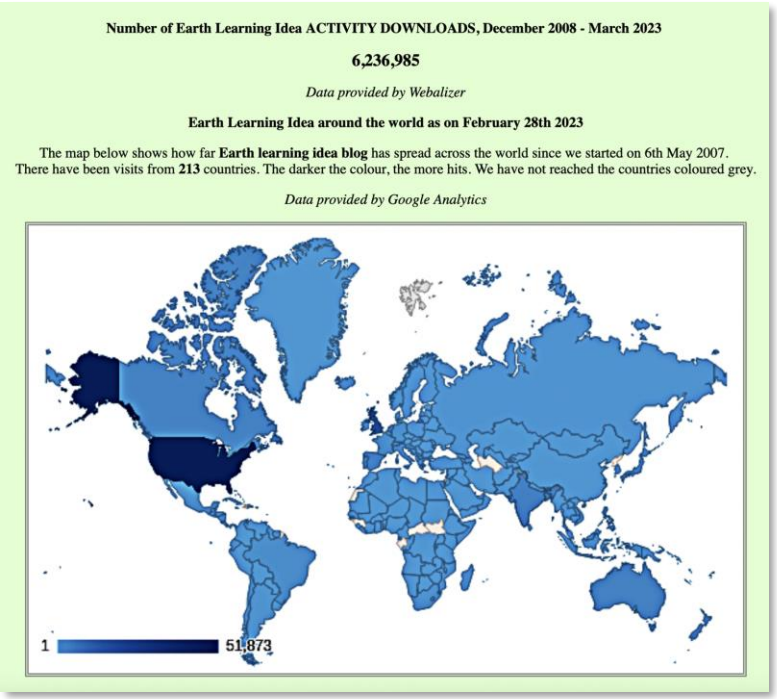
Contact details

Web: www.earthlearningidea.com

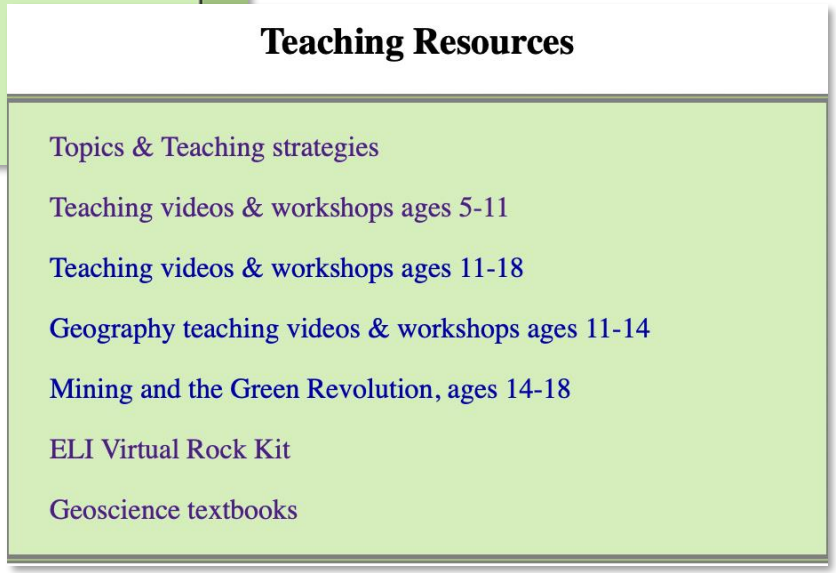
Follow us on Twitter: @ELI_Earth

E-mail: pete@Earthlearningidea.com

Geoscience Education Field Officers: the activities repository



http://www.earthlearningidea.com



- > 400 available activities
- Explanatory videos
- Translated into different languages
- 2008 to 2023 ⟹ over 6 million downloads

Geoscience Education Field Officers: the activities repository

ESTA Earth Science Teachers' Association
earth-science-teachers.uk

www.earthlearningidea.com

Earth Learning Idea

Innovative, Earth-related teaching ideas

European Geosciences Union

Shaken but not stirred?
How earthquakes affect buildings

Make up a model as shown in either of the two photographs, depending on what materials you have to hand.

Photo 1: Model 'buildings' of different heights, using helium-filled balloons (*Photo: Peter Kennett*)

Photo 2: Blutak™ 'buildings', secured to a wooden base by more Blutak™. The middle 'building' is swaying as the base is moved backwards and forwards on the table top. (*Photo: Peter Kennett*)

Show the model to the pupils and ask them to say which of the three structures will sway the most when the base is shaken forwards and backwards several times on the bench. Most pupils will say that the tallest structure will sway the most, but this is not always the case. The amount of movement at the top of each column depends upon the frequency with which the base is moved – a high frequency will cause the shortest structure to sway the most, while a lower frequency causes the tallest structure to sway the most. With practice you can find the right frequency to get any of the buildings to sway the most – so that the pupils' predictions are wrong each time!

Ask the pupils to suggest what relevance this demonstration has in the real world. Most will suggest that the model is showing what happens to buildings when they are affected by an earthquake. No doubt, pupils will relate their observations to images seen on T.V., filmed during a recent earthquake.

Damaged buildings in the Port-au-Prince neighbourhood of Bel-Air, after the 2010 Haiti earthquake. The tall block remains standing amid the ruins of lower, less well-constructed buildings.

Show pupils the animated cartoon on the website below, to help them to relate the model aid to a high rise building. Ask them what may not be correct about the cartoon (*Tall buildings are not necessarily the ones to collapse in an earthquake, if they have been properly constructed*).
http://upload.wikimedia.org/wikipedia/commons/b/b4/Bldg_1sss.gif

The back up

Title: Shaken but not stirred?

Subtitle: How earthquakes affect buildings

Topic: A teacher-led demonstration of the relationship between the frequency of the shaking of the 'ground' and the movement of model 'buildings' of various heights.

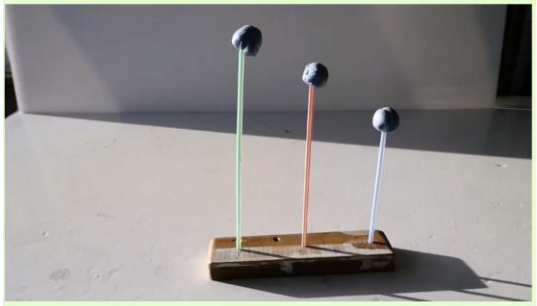
Age range of pupils: 14 – 18 years

Time needed to complete activity: 10 minutes

Shaken but not stirred? How earthquakes affect buildings

ELI activity: Shaken but not stirred? How earthquakes affect buildings

Video demonstrations



Shaken but not stirred? How earthquakes affect buildings

ELI activity: Shaken but not stirred? How earthquakes affect buildings

Pupil learning outcomes: Pupils can:

- observe the movement of a structure when its base is shaken;
- establish a visual relationship between the height of a structure and the frequency with which it is shaken;
- relate their observations to the damage caused by an earthquake in a built-up area.

Context: The activity can be used to help students to explore the effects of earthquakes in densely populated areas, and to dispel misconceptions about the relative safety of high rise buildings in seismically active regions.

Following up the activity:
Pupils could:

- look for a relationship between the height of structures and the frequency of vibration by timing the movement to and fro of the base and using a range of heights for their 'buildings'; *In the model shown in Photo 2, the 21cm tall structure swayed at 1.7 shakes (cycles) per second: the 17cm structure at 3.1 cycles per second and the 13 cm structure at 4.0 cycles per second.*
- investigate other materials in place of the ones shown in the photographs, using 'stalks' of different rigidity, and with different masses on top of their structures;
- carry out a web search for images of buildings which have survived/been destroyed by the same earthquake and suggest reasons for their findings;
- carry out a web search for various engineering solutions in the design of earthquake-resistant buildings.

Underlying principles:

- All buildings have a natural frequency of vibration. They shake in response to the ground being shaken by the passage of seismic waves, generated by an earthquake.
- When the natural frequency of vibration is the same as the frequency of the seismic waves, the building is said to resonate, and it is at this point that the building sways the most and so is most liable to be damaged.
- Tall buildings are not necessarily the ones at most risk from earthquake damage.
- Engineering solutions depend on calculating the natural frequency of the building and on knowing the normal range of frequencies of the relevant types of seismic waves, before designing strengthening measures etc.
- Existing buildings can sometimes be made more earthquake resistant by adding extra struts, or flexible joints. This is termed retrofitting.

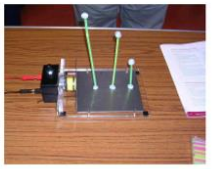
Thinking skill development:
Students usually experience a cognitive conflict at the start of the activity, when the structure which they had expected to move the most does not always do so. Explaining why they were wrong involves metacognition. Linking the model to real earthquakes is a relatively simple bridging skill.

Resource list:

- a model of three 'high rise buildings', made up before the lesson. Photograph 1 shows three helium-filled balloons on 'party sticks' cut to different lengths, fixed to holes drilled in a block of wood. Photograph 2 shows three drinking straws with blobs of Blutak™ of similar mass, fixed to a wooden base with more Blutak™.

Useful links: See below. Also see the Earthlearningidea activities: '*Quake shake – will my home collapse?*', '*Surviving an earthquake*', and '*Earthquake through the window – what would you see, what would you feel?*'

Source: Based on an idea by Peter Loader, in 'Teaching Earth Sciences', Vol. 36 No. 1 2011. A more sophisticated method, using an electrically operated shaker table, is given in 'Innovations in Practical Work: Seismology', 2007, Gatsby Science Enhancement Programme, ISBN: 978-1-901351-72-9.



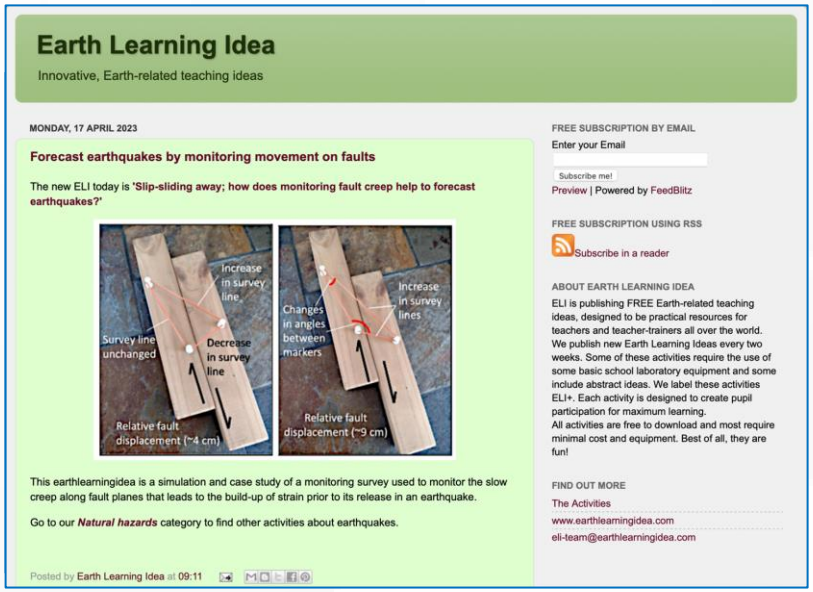
Model 'buildings' using an electrically operated shaker table, from the SEP kit. (*Photo: Peter Kennett*)

Details of publications and equipment, including a working seismograph, capable of recording real earthquakes, are given on the website:
http://www.sep.org.uk

Geoscience Education Field Officers: the activities repository in social media

https://www.facebook.com/earthlearningidea

https://twitter.com/ELI_Earth



- a new Blog update every Monday
- a new activity posted every 2 weeks
- New videos uploaded all the time.

http://earthlearningidea.blogspot.com/

Geoscience practical activities on natural hazards in a rapidly changing world

In this workshop we are presenting a few **examples of practical labs**:

- addressing some topics **included in the Geosciences curriculum** for different age groups;
- useful for **understanding the functioning** of our planet and its **most common natural hazards**;
- requiring students to **apply their new learning** to the other situations and **to real phenomena happening on the Earth**;
- fostering **students' awareness and positive attitudes** towards the protection and sustainable management of our planet.

Image: NOAA, permitted use

Geoscience practical activities on natural hazards in a rapidly changing world

The workshops we are presenting today address:

- **Earthquakes**
  - Shaken but not stirred? How earthquakes affect buildings
  - Quake shake: will my home collapse when an earthquake strikes? investigate why some buildings survive and others do not
  - Spaghetti quakes Why are big earthquakes so much more destructive than small ones?
  - Earthquake prediction - when will the earthquake strike? Modelling the build-up of stress and sudden release in the Earth that creates earthquakes
- **Tsunamis**
  - Tsunami! What controls the speed of a tsunami wave?
- **Landslides**
  - Failing slopes - Modelling how rock cliffs and slopes can collapse
  - Sandcastles and slopes - What makes sandcastles and slopes collapse?
- **Lava flows**
  - Extrusion - See how they run

Shaken but not stirred? How earthquakes affect buildings

https://www.earthlearningidea.com/PDF/112_Shaken_not_stirred.pdf

What causes buildings to collapse in an earthquake?

Possible causes

- Magnitude of earthquake
- Distance from epicentre
- Earthquake depth
- Level of economic development
- Building design
- Building standards
- Corruption
- Ground conditions

Gölcük Mosque, Turkey

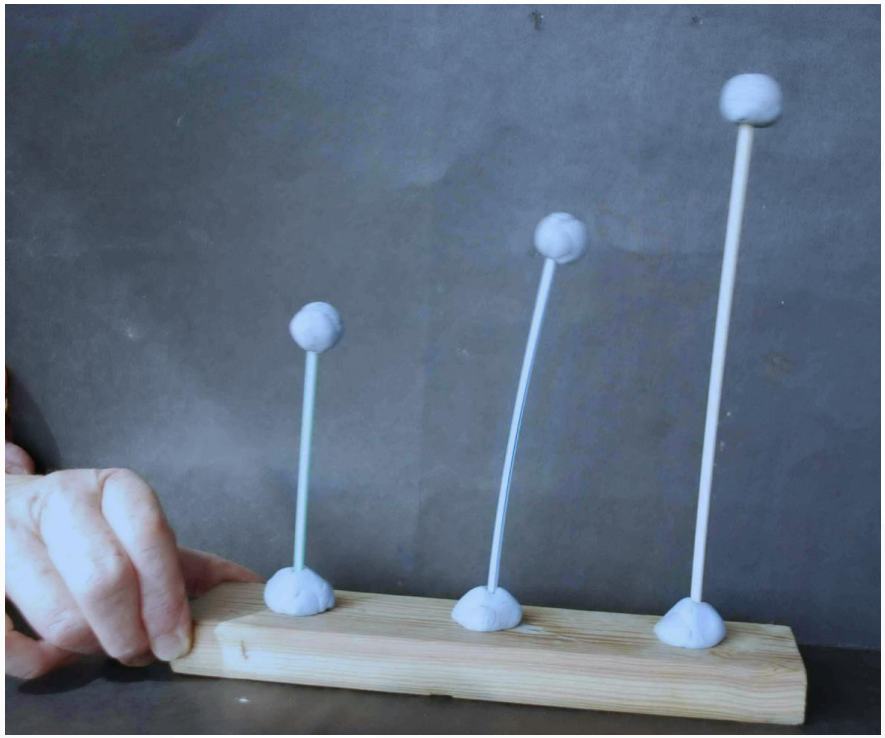
Izmit earthquake Turkey (7.4 mag) 17th August 1999

Images: Peter Kennett, Earthlearningidea and
Enric Marti - Associated Press (New York Times) August 20 1999

Shaken but not stirred? How earthquakes affect buildings

https://www.earthlearningidea.com/PDF/112_Shaken_not_stirred.pdf

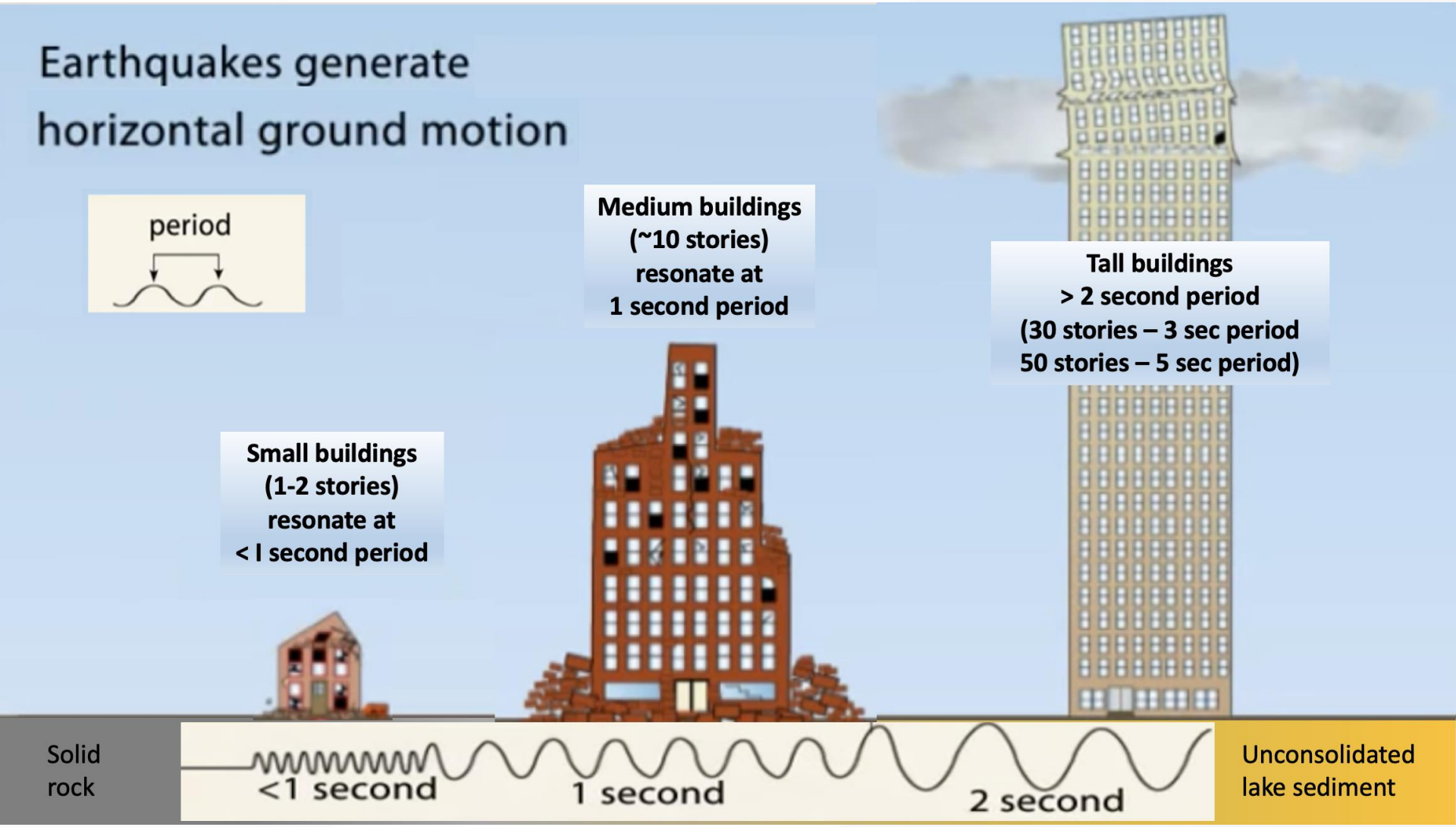
RESONANCE



Photos by Peter Kennett - EarthlearningIdea and Marcello Casal Jr/AB, licensed under the Creative Commons Attribution 2.5 Brazil licence

Shaken but not stirred? How earthquakes affect buildings

https://www.earthlearningidea.com/PDF/112_Shaken_not_stirred.pdf



Quake shake: will my home collapse when an earthquake strikes? investigate why some buildings survive and others do not

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

Images: Earthlearningidea and
Earthquake Engineering Research Center Library, University of California at Berkeley, permitted use

Earthquake prediction - when will the earthquake strike? Modelling the build-up of stress and sudden release in the Earth that creates earthquakes

https://www.earthlearningidea.com/PDF/49_Earthquake_prediction.pdf

Images: Peter Kennett, Earthlearningidea

Spaghetti quakes Why are big earthquakes so much more destructive than small ones?

https://www.earthlearningidea.com/PDF/300_Spaghetti_quake.pdf

Image: Peter Kennett, Earthlearningidea

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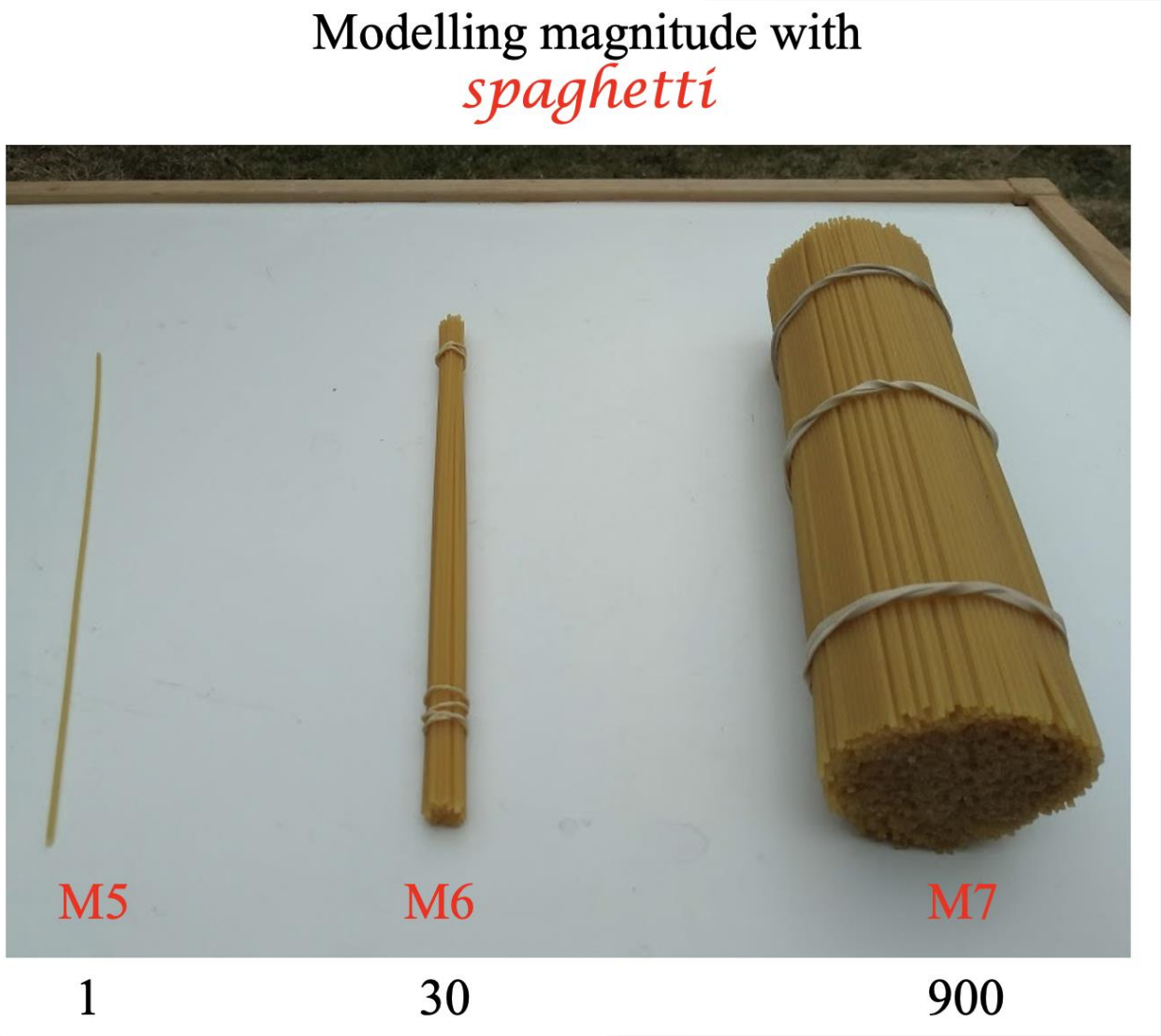

Image: Pete Loader, Earthlearningidea

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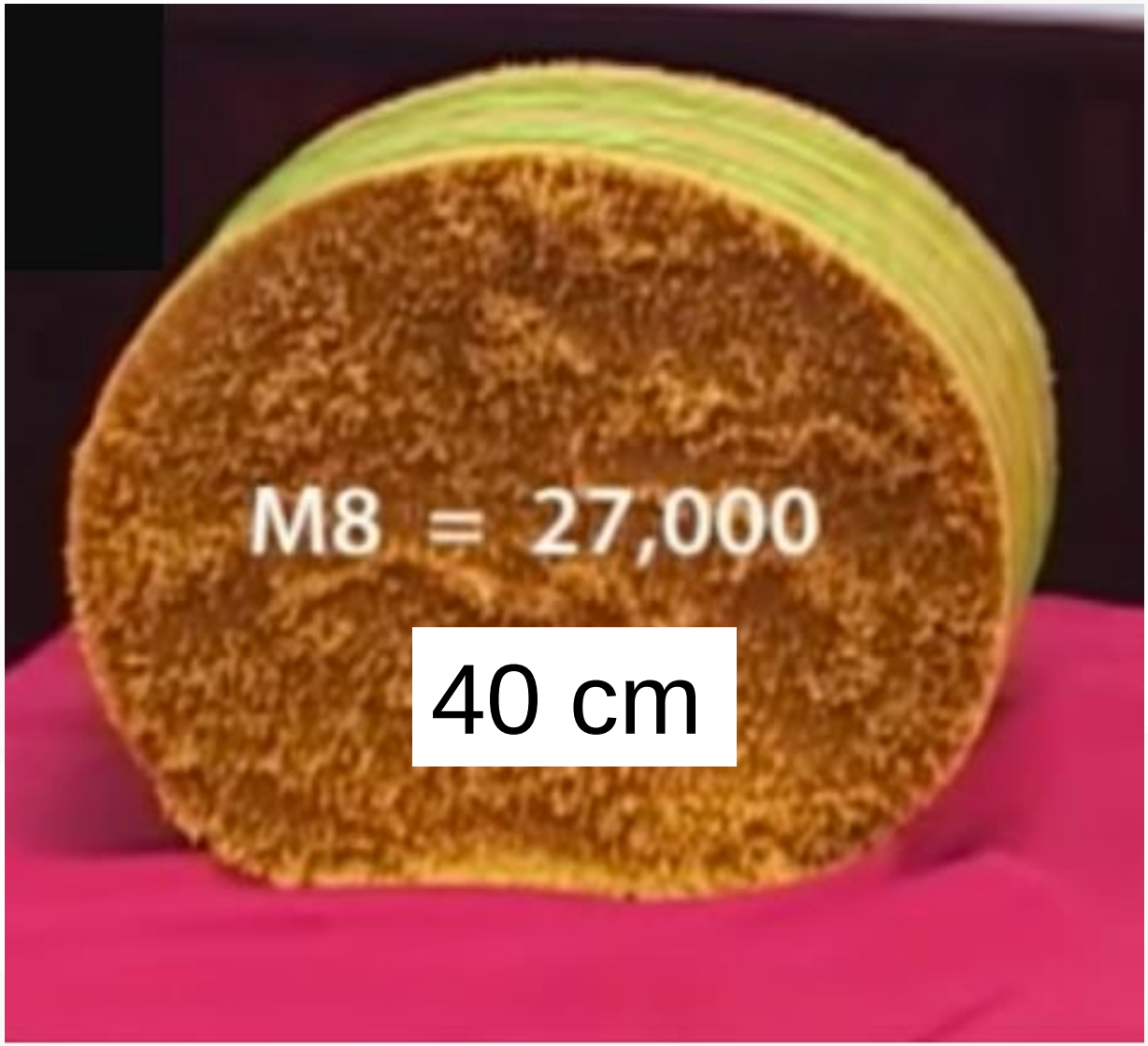

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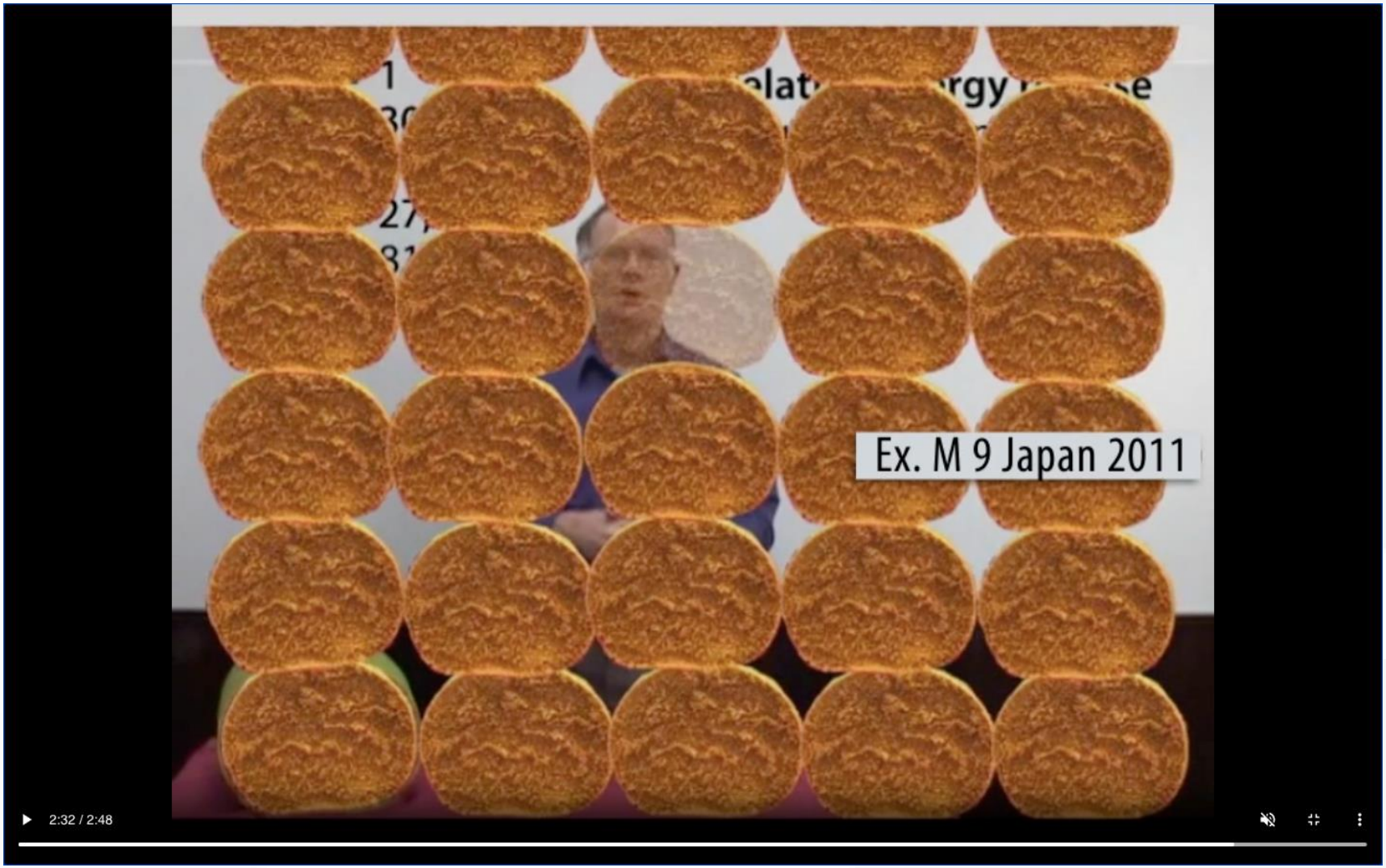


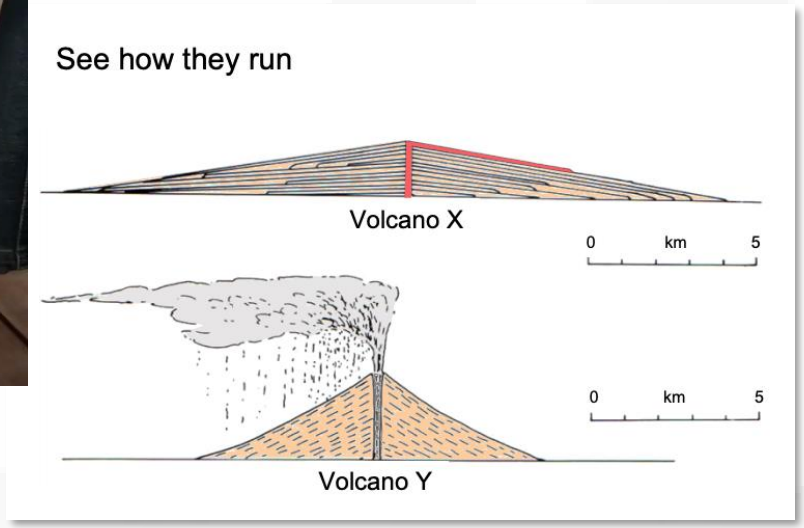
Tsunami! What controls the speed of a tsunami wave?

https://www.earthlearningidea.com/PDF/45_Tsunami_demo_final.pdf

Images: Peter Kennett, Earthlearningidea and
David Rydevi: skylark292@gmail.com, public domain

Extrusion - See how they run

https://www.earthlearningidea.com/Video/Extrusion.html



Images: Giulia Realdon, diagram: Earthlearningidea

Failing slopes - Modelling how rock cliffs and slopes can collapse

https://www.earthlearningidea.com/PDF/210_Slope_failure.pdf

Images: Earthlearningidea and
Gattoarturo - Opera propria, CC BY-SA 3.0,
https://commons.wikimedia.org/w/index.php?curid=19454117

A tribute to Professor Chris King

(1949 – 2022)

GEFOs run this workshop in the memory and honor of Professor Chris King.

He was a guide and an inspiration not only for us but for many generations of Geoscience teachers across the world.

Images: Giulia Realdon, Xavier Juan

Bring EGU workshops to your area!

- This and **other workshops** are also available **free of charge** (funded, up to a certain number, by EGU) in your area
- **How?**

  Identify topics of interest and possible dates
- **Write to the GEFO in your country** (see next slide) to check availability
- Collect at least 10-15 registrations
- Provide a suitable classroom for the activity (projector, microphone, if needed, water, other depending on activity required)

Contacts to request EGU or IUGS-IGEO GEFO for teachers' workshops

Country	Name	e-mail
Albania	Almida Cerciziida	cerciziida@yahoo.it
Estonia	Inga Zaitseva-Pärnaste	inga.zaitseva@gmail.com
France	Guillaume Coupechoux	gcoupechoux21@gmail.com
Germany	Sylke Hlawatsch	kontakt@sylke-hlawatsch.de
Greece	Fotios Danaskos	fdanas@yahoo.gr
Italy	Giulia Realdon	giuliarealdon@gmail.com
Portugal	Gina P. Correia	gina_maria@sapo.pt
Romania	Dragos Tataru	dragos@infp.ro
Spain	Xavier Juan	xjuan03@gmail.com
Turkey	Candan Kafali	candan26.ck@gmail.com
United Kingdom	Pete Loader	pete@earthlearningidea.com
Burkina Faso	Seydou Sogoba	Seydousogoba21@gmail.com
Chile	María Jesús Bravo Perez	majesus.bravop@gmail.com
Colombia	Carlos Echeverría Barajas	carlos.echeverria@uptc.edu.co
India (North)	R. Baskar	rbaskar@ignou.ac.in
India (South)	Venkatraman Hegde	vshegde2009@yahoo.com
Malaysia	Jasmi Hafiz Bin Abdul Aziz	jasmihafiz@um.edu.my
Morocco	Yamina Bourgeoini	bourgeoini@gmail.com
Togo	Pauline Yawoa da Costa	dzycosta@yahoo.fr

Don’t forget to fill in the evaluation form

- Go to: https://forms.gle/2CR2QYyFK6tbXdTBA
- Or frame the QR code:

In memory of Chris King
1949 - 2022

Sandcastles and slopes - What makes sandcastles and slopes collapse?

https://www.earthlearningidea.com/PDF/66_Sandcastles.pdf

Images: Peter Kennett, Earthlearningidea

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