Earth Learning Ideaの歴史

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History of Earth Learning Idea

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Abstract

This paper introduces the history of "Earth Leaning Idea" published in every 1-2 week (s) since 2017. The aim of ELI is " To develop an internet-based support network for teacher trainers and teachers of Earth science and geography across the globe, by providing educational resources that will promote interactive teaching and the development of investigational and thinking skills". Translation of ELI contents and distribution system of hands-on experiments equipment will contribute to foster science literacy for citizenship.

Keywords：Earth Learning Idea, Geoscience Education, hands-on experiment

1. はじめに

全世界的な気候変動や環境問題、エネルギー資源問題や自然災害など、現在の社会が直面する様々な課題について、正しく理解し、行動をとるためには、科学リテラシー・科学教育、特に地学分野の教育は重要である。日本の初等中等教育における地学分野の教育は、小学校の「太陽と地面の様子」（第３学年）、「雨水の行方と地面の様子」（第４学年）、「天気の様子」（第４学年）、「月と星」（第４学年）、「流れる水の動きと土地の変化」（第５学年）、天気の変化」（第５学年）、「土地のつくりと変化」（第６学年）、「月と太陽」（第６学年）、中学校の「身近な地形や地層、岩石の観察」（第１学年）、「地層の重なりと過去の様子」（第１学年）、「火山と地震」（第１学年）、「自然の恵みと火山災害・地震災害」（第１学年）、「気象観測」（第２学年）、「天気の変化」（第２学年）、「日本の気象」（第２学年）、「自然の恵

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みと気象災害」（第２学年）、「天体の動きと地球の自転・公転」（第３学年）、「太陽系と恒星」（第３学年）と続く（文部科学省, 2009）。高等学校では、平成21年３月の学習指導要領改訂以降、「地学基礎」（２単位）および「地学」（４単位）が設置されている。ただし、教科書需要数から推測した地学基礎および地学の履修率は、それぞれ約26%、約１%と極端に低い（吉田・高木, 2020）。また、地学および地学基礎の開設率が低いことは、地学系教員数の減少にも直結している（藤林ほか, 2010）。小学校現場で文系の教員が多いことと、中学校・高等学校での地学系教員数の減少は、教育現場で地学を専門としない教員が地学分野の教育を受け持つことになり、教員の苦手意識も合わせて、生徒たちが環境問題を考える時に欠かせない地学分野の学習がなおざりになる恐れがある。

Earth Learning Idea（ELI）は、２週間に１度の頻度でインターネット上に無償で公開されている、地球科学における様々な現象などを理解するためのハンズオン教材である（Earth Learning Idea, online：index.html）。一般的な理科室や身近にあるものを使って実践できるアイデアが解説と共にまとめられている。英国では、地学分野の教員が参加する学会組織（Earth Science Teachers' Association：ESTA）があり、年に１回の集会を開催している。ここでは、通常の口頭発表・ポスター発表のほかに、「Bring and Share（B&S）」と呼ばれるセッションが毎回設けられている。B&Sは、壇上で簡単なアナログ実験や教材・教具を実演して紹介する取り組みである。学会発表よりも堅苦しくなく、教員がアイデアを広く披露し、参加者からのフィードバックと改善にもつながる。ここで発表されたアイデアから、ELIに掲載されたものも多く存在する。

本論では、学校教育現場で広く活用することができるELIの歴史とこれまでに公開されたコンテンツ、日本語翻訳版を解説する。

2. Earth Learning Ideaの歴史

ELIは、2007年の当初から、クリス・キング（Chris King）、ピーター・ケネット（Peter Kennett）、エリザベス・デイボン（Elizabeth Devon）の３名が中心となって開発が進められてきた。英国キール大学名誉教授のクリス・キング氏は、ブリストル大学で地質学の学士、リード大学で堆積学の修士号を取得後、英国・キール大学（Keele University）で教育学のトレーニング（Postgraduate Certificate in Education：PGCE）を受け、19年間に渡って英国の公立学校（state school）で地学・地理を教えた。その後、キール大学で地学を教え、1999年から2016年まではキール大学の地球科学教育ユニット（Earth Science Education Unit）のディレクターを務めた（Fig. 1）。この間、国際地質科学連合・地球科学教育小委員会（IUGS-COGE）の副会長、国際地学教育組織（IGEO）の役員、英国地球科学教員組織（Earth Science Teachers' Association：ESTA）の会長を歴任している。残念ながら、2022年２月に逝去された。ピーター・ケネット、エリザベス・デボン両氏も、大学で地質学の学位を取得したあと、長く公立学校で地学を教えていた経験を持つ。ケネット氏は、ESTAの創立メンバーでもある。

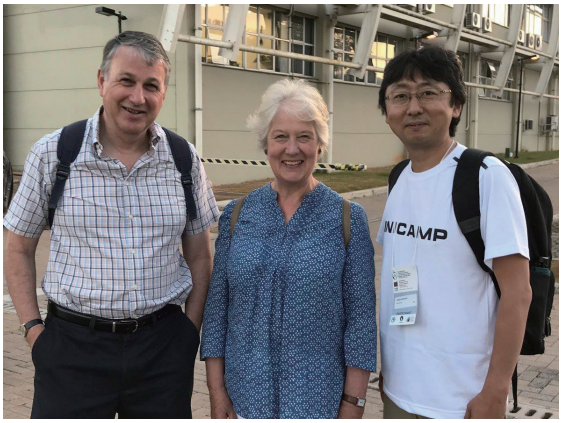


Fig. 1　クリス・キング氏（左）

キール大学の地球科学教育ユニット（Earth Science Education Unit：ESEU）は、英国のKey Stage 1〜4（5歳〜16歳までの義務教育課程）の教員に、地球科学の継続教育（Continuing and Professional Development：CPD）を実施している。民間企業からの資金援助を受け、実質的に無償で学校に提供されている。学校側は標準的な実験器具、コピー代、ファシリテーターの旅費のみを負担する。トレーニングを受けたファシリテーターが移動式の科学キットを持参し、半日〜1日程度のモジュール化されたELIの教材コンテンツを使ってワークショップを行う。

ELIの初回の投稿は、2018年の国際惑星地球年に先立って、2007年5月に公開された。以降、2007年9月から12月から月に1度、2008年1月からは1〜2週に1度の頻度で公開が続けられている。

2023年12月までに合計で429本以上の教材がアップロードされており、2008年12月から2023年11月までの総ダウンロード数は、6,517,737回である。ダウンロードが多い国は、米国・英国・インド・豪州・カナダ・スペインなどである。

4. 世界各国のELI

インターネット上に無償で公開されるELIのコンテンツは、世界各国の協力者によって翻訳・公開がされている（Table 1）。日本語への翻訳は、渡来めぐみ先生（茗渓学園中学校高等学校）と澤口（東洋大学）がボランティアで協力をして行なっており、以下のサイトで公開されている（日本語版ELI, online：index.php）。

Table 1 翻訳された言語とコンテンツ数

	翻訳されている言語	コンテンツ数
1	スペイン語	297
2	カタルーニャ語	287
3	ノルウェー語	96
4	イタリア語	88
5	ドイツ語	150
6	ポルトガル語	354
7	ポーランド語	33
8	日本語	102
9	韓国語	9
10	タミル語	1

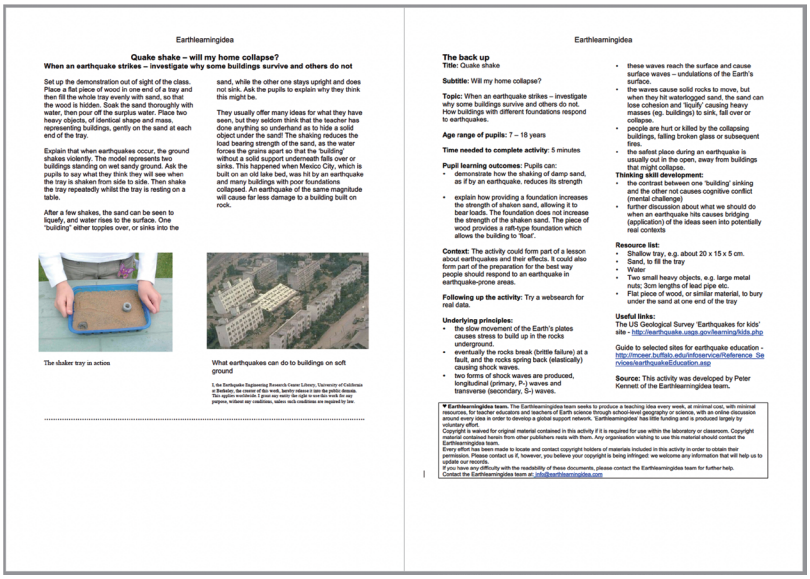
※英語オリジナル版は429本が公開されている。
（2023年12月現在）

5. ELI教材とリスト

1つの教材は、2枚程度のPDFファイルからなり、その中には指導の要領として、題名、副題、概要、対象年齢、必要な時間、達成目標、発展的な学習、用意するもの、役立つリンク、などが記載されている（Figs. 2, 3）。

ELIは、ウェブサイトからダウンロードができるが、（1）キーワード検索、（2）カテゴリー別リスト索引、（3）アルファベット順リスト索引、の3つの方法でコンテンツを選び出すことができる。いくつかのELIには、発展的な追加コンテンツ（Extension）や動画ビデオなどが利用できる。

全てのELI教材は、10個のカテゴリーと、合計で57個のサブカテゴリに分類がされている（Table 2）。1つのELI教材は、それぞれ1～3個のカテゴリーに分類されている。



Earthlearningidea

Quake shake – will my home collapse?

When an earthquake strikes – investigate why some buildings survive and others do not

Set up the demonstration out of sight of the class. Place a flat piece of wood in one end of a tray and then fill the whole tray evenly with sand, so that the wood is hidden. Soak the sand thoroughly with water, then pour off the surplus water. Place two heavy objects, of identical shape and mass, representing buildings, gently on the sand at each end of the tray.

Explain that when earthquakes occur, the ground shakes violently. The model represents two buildings standing on wet sandy ground. Ask the pupils to say what they think they will see when the tray is shaken from side to side. Then shake the tray repeatedly whilst the tray is resting on a table.

After a few shakes, the sand can be seen to liquefy, and water rises to the surface. One "building" either topples over, or sinks into the sand, while the other one stays upright and does not sink. Ask the pupils to explain why they think this might be.

They usually offer many ideas for what they have seen, but they seldom think that the teacher has done anything so underhand as to hide a solid object under the sand! The shaking reduces the load bearing strength of the sand, as the water forces the grains apart so that the 'building' without a solid support underneath falls over or sinks. This happened when Mexico City, which is built on an old lake bed, was hit by an earthquake and many buildings with poor foundations collapsed. An earthquake of the same magnitude will cause far less damage to a building built on rock.

The shaker tray in action

What earthquakes can do to buildings on soft ground

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Earthlearningidea

The back up

Title: Quake shake

Subtitle: Will my home collapse?

Topic: When an earthquake strikes – investigate why some buildings survive and others do not. How buildings with different foundations respond to earthquakes.

Age range of pupils: 7 – 18 years

Time needed to complete activity: 5 minutes

Pupil learning outcomes: Pupils can:

- demonstrate how the shaking of damp sand, as if by an earthquake, reduces its strength
- explain how providing a foundation increases the strength of shaken sand, allowing it to bear loads. The foundation does not increase the strength of the shaken sand. The piece of wood provides a raft-type foundation which allows the building to 'float'.

Context: The activity could form part of a lesson about earthquakes and their effects. It could also form part of the preparation for the best way people should respond to an earthquake in earthquake-prone areas.

Following up the activity: Try a webesearch for real data.

Underlying principles:

- the slow movement of the Earth's plates causes stress to build up in the rocks underground.
- eventually the rocks break (brittle failure) at a fault, and the rocks spring back (elastically) causing shock waves.
- two forms of shock waves are produced, longitudinal (primary, P-) waves and transverse (secondary, S-) waves.
- these waves reach the surface and cause surface waves – undulations of the Earth's surface.
- the waves cause solid rocks to move, but when they hit waterlogged sand, the sand can lose cohesion and 'liquify' causing heavy masses (eg. buildings) to sink, fall over or collapse.
- people are hurt or killed by the collapsing buildings, falling broken glass or subsequent fires.
- the safest place during an earthquake is usually out in the open, away from buildings that might collapse.

Thinking skill development:

- the contrast between one 'building' sinking and the other not causes cognitive conflict (mental challenge)
- further discussion about what we should do when an earthquake hits causes bridging (application) of the ideas seen into potentially real contexts

Resource list:

- Shallow tray, e.g. about 20 x 15 x 5 cm.
- Sand, to fill the tray
- Water
- Two small heavy objects, e.g. large metal nuts; 3cm lengths of lead pipe etc.
- Flat piece of wood, or similar material, to bury under the sand at one end of the tray

Useful links:

The US Geological Survey 'Earthquakes for kids' site - http://earthquake.usgs.gov/learning/kids.php

Guide to selected sites for earthquake education - http://mceer.buffalo.edu/infoservice/Reference_Services/earthquakeEducation.asp

Source: This activity was developed by Peter Kennett of the Earthlearningidea team.

Fig. 2　ELI教材のイメージ

Earthlearningidea

地震のゆれ－私の家はこわれる？

地震が来た時，なぜある家は崩れないのかを調べてみよう。

教室の外で実験の準備をします。トレイの端に平らな木片を置き，砂をトレイいっぱいに均等に入れて，木片が隠れるようにします。水をトレイからあふれるまで十分に注ぎます。全く同じ形・重さの2つの重たい物体をビルに見立てて，トレイの砂の上に静かに置きます。

地震が発生して地盤が激しく揺さぶられた時を説明してみましょう。このモデルは湿った砂の上に立つ2つのビルを表しています。トレイを左右に揺すったら何が起きると思うかを生徒に聞いてみましょう。それでは，トレイをテーブルの上におきながら，トレイを揺すってみましょう。

数回揺すると，砂は液状化したように見えます。一方のビルは倒れるか，砂の中に沈んでいきます。もう1つのビルは真っ直ぐに立ったままでいます。理由を生徒に説明させてみましょう。

たくさんのアイデアが出されると思いますが，教師が砂に下に硬い物質を隠していたと考える生徒はかないものです。振動は砂の荷重強度を減少させるので，水が砂の粒子をバラバラにし，下にあった硬い支えを失ったビルは倒れるかのようにしまうのです。古い湖底層の上に立つメキシコシティで地震が発生した際には，貧弱な基礎しか持たない多くのビルが倒壊しました。同じマグニチュードの地震が起きたとしても，沼地の上に立ったビルでは被害は少ないでしょう。

実験中のトレイ

柔らかい地面の上に立つ建物に地震が引き起こす影響

Earthlearningidea

指導の要領

題名： 地震のゆれ

副題： 私の家は壊れる？

概要：地震が来た時，なぜある家は崩れないのかを調べてみよう。異なる基礎を持つ建物が地震でどうなるか

対象年齢： 7 – 18 歳

必要な時間： 5 分

生徒の学習成果：生徒は次のことができるようになる。

- 湿った砂を地面のように揺すると強度が減少することを実演できる。

- 基礎を準備することで砂の強度が増し，荷重に耐えることができるようになることを説明できる。基礎は揺すった砂の強度を高めてはいない。木片がイカダのような基礎の役割を果たし，ビルがその上に浮いている。

コンテキスト： この活動は，地震とその影響の授業の一部として構成できる。地震の起こりやすい地域において，人々が地震にどのように対応すべきかの準備の一部としても構成できる。

発展的な学習： 実際のデータをウェブで調べてみる。

土台となる基礎概念

- 地球表層のプレートのゆっくりした運動が地下の岩石に応力を生じる。
- その結果，岩石は脆弱に応って破壊され（脆性破断），岩石は反動で戻り（弾性的），地震波が発生する。
- 2つの種類の地震波が発生する。縦方向の波（P 波）と横方向の波（S 波）
- これらの地震波が地表に到達し，表面波を生ずる地表のうねり
- 地震波は固体の岩石を動かすが，水浸しの砂に到達すると，砂は液状化を失い，重たい物体（建物など）を沈ませ，倒壊・崩壊させる"液状化"が起きる。
- 人々は倒壊した建物や壊れた窓ガラス，引き続く家事などによって怪我をしたりとくなることがある。
- 地震が発生した時に安全な場所は，倒壊する可能性のある建物から離れた野外である。

思考力の発展：

- 一方の建物が沈んで，もう一方が沈まないという対比が認知的葛藤を生じる（知的な疑問）
- 地震が発生した時に何をすべきかを実に議論し，出されたアイデアを現実世界に橋渡し（応用）してみよう。

用意するもの：

- 浅いトレイ 20 x 15 x 5 cm.
- トレイを満たす量の砂
- 水
- 2つの重たい物体。例えば，大きな金属製ナット，3cm 長の鉛パイプなど
- トレイの一方の砂の下に埋める平らな木片かそれに似た物

役立つリンク：

The US Geological Survey 'Earthquakes for kids' site - http://earthquake.usgs.gov/learning/kids.php

Guide to selected sites for earthquake education - http://mceer.buffalo.edu/infoservice/Reference_Services/earthquakeEducation.asp

原典：このアクティビティは，ELIチームの Peter Kennett が開発した。

Fig. 3　日本語版ELI教材のイメージ

Table 2 ELIのカテゴリー分類

ID	カテゴリー	カテゴリー（日本語）	ID	カテゴリー	カテゴリー（日本語）
1	**Earth as a System**	**システムとしての地球**	**6**	**Investigating the Earth**	**地球を調べる**
1-1	Atmosphere	大気	6-1	Fieldwork	野外調査
1-2	Carbon cycle	炭素循環	6-2	Geophysics	地球物理学
1-3	Nitrogen cycle	窒素循環	6-3	Magnetism	磁気
1-4	Rock Cycle	岩石循環	6-4	Mapwork	地質図
1-5	Water cycle	水循環	6-5	Oceanography	海洋学
2	**Earth Energy/Processes**	**地球のエネルギー／プロセス**	**7**	**Geological Time**	**地質学的タイムスケール**
2-1	Deformation, folding and faulting	変形・褶曲・断層	7-1	Dating the Earth	年代測定
2-2	Geophysics	地球物理学	7-2	Stratigraphy and Sequences	地質・層序
2-3	Igneous processes	火成作用	7-3	Visualising deep time	過去の可視化
2-4	isostasy	アイソスタシー	**8**	**Natural Hazards**	**自然災害**
2-5	Metamorphic processes	変成作用	8-1	Catastrophic processes	壊滅的なプロセス
2-6	Plate tectonics	プレートテクトニクス	8-2	Earthquakes	地震
2-7	Sedimentary processes	堆積作用	8-3	Floods	洪水
2-8	Sedimentary structures	堆積構造	8-4	Landslides	地すべり
3	**Earth in Space**	**宇宙の中の地球**	8-5	Local hazards	地域災害
3-1	Astronomy	天文学	8-6	Sink holes	陥没
3-2	Earth- seasons . . .	地球の四季	8-7	Tsunamis	津波
3-3	Earth's Moon	地球の月	8-8	Volcanoes	火山
3-4	Eclipses - solar and lunar	日食・月食	**9**	**Resources and Environment**	**資源と環境**
3-5	Planets	惑星	9-1	Climate change 'net zero' emissions	気候変動　排出物ネットゼロ
4	**Earth Materials**	**地球を構成する物質**	9-2	Climate change - general	気候変動　一般
4-1	Earth's structure	地球の内部構造	9-3	Environment	環境
4-2	Engineering & industrial geology	地質工学	9-4	Power sources	エネルギー源
4-3	Forensic geoscience	犯人探し	9-5	Resources	資源
4-4	Minerals	鉱物	**10**	**CROSS-CATEGORY TOPICS**	**カテゴリー横断的トピック**
4-5	Soils	土壌	10-1	Cross-curricular ELIs	教科横断的ELI
4-6	Rocks	岩石	10-2	Early years	地質時代
5	**Evolution of Life**	**生命の進化**	10-3	Great scientists	偉大な科学者
5-1	Evolution of life	生命の進化	10-4	Maths in ELIs	ELIで使われる数学
5-2	Fossils (other than dinosaurs)	化石（恐竜を除く）	10-5	UK exams	英国の例
5-3	Dinosaurs	恐竜	10-6	Visual Impairment	視覚障害者のための教材
5-4	Adaptation to environment	環境適応	10-7	Holiday geology	休日の地質学
5-5	Preservation	保存			

Table 3　2023年までに公開されたELIリスト（カテゴリー別）

Cat_No.	ID	Title(subtitle)
1. Earth as a System		
1-1 Atmosphere		
1-1	25	High flow, low flow?: atmosphere and ocean in a tank (Hot, cold and particle-filled density currents as they flow in the atmosphere and ocean)
1-1	103	Earth's atmosphere - step by step evolution (Using a physical model to show the development of our current atmosphere)
1-1	167	Changing state - transforming water (Practical activities to change the state of water; solid, liquid, gas)
1-1	288	Atmosphere and ocean in a lunchbox(A model for all pupils – of hot, cold and cloudy density currents)
1-1	310	Is the greenhouse effect happening outside today?(A classroom discussion to consolidate understanding about the greenhouse effect)
1-2 Carbon cycle		
1-2	39	Carbon goes round and round and round (Make your own carbon cycle)
1-2	55	Carbon cycle through the window (How much evidence of the carbon cycle can you see through the window?)
1-2	213	Tag' a carbon atom - and explore the carbon cycle(A thought experiment to investigate carbon cycle processes)
1-3 Nitrogen cycle		
1-3	335	'Tagging' nitrogen atoms – to explore the nitrogen cycle(A thought experiment to investigate nitrogen cycle processes)
1-4 Rock Cycle		
1-4	10	Rock cycle in wax (Using a candle to demonstrate the rock cycle processes)
1-4	52	Rock cycle through the window (The rock cycle processes you might be able to see - and those you can't)
1-4	93	James Hutton - or 'Mr. Rock Cycle'? (ELI+) (Thinking towards the rock cycle, the Hutton way)
1-4	219	Sand on a sill(What will happn to a sand grain left on a window sill? - a rock cycle discussion)
1-4	253	Laying out the rock cycle: product and process(Sorting out the rock cycle products – and then adding the processes)
1-4	272	Not misunderstanding the rock cycle(Addressing common misconceptions about the rock cycle)
1-4	274	The rock cycle at your fingertips(Modelling the rock cycle with your fingers)
1-4	316	From 'Rock detective' to 'Laying out the rock cycle'(Investigate rocks to sort them into groups, add them to the rock cycle and name them)
1-4	317	The deep rock cycle explained by plate tectonics: lithification(A model showing how plate tectonics can explain sediments becoming sedimentary rocks)
1-4	318	The deep rock cycle explained by plate tectonics: deformation and metamorphism(A model showing how plate tectonics can explain metamorphism and rock-deformation)
1-5 Water cycle		
1-5	54	From rain to spring: water from the ground (Demonstrating how water flows through the ground - and how it can be used and polluted)
1-5	67	'Water, water everywhere but not a drop to drink' (Investigating how to get clean water from dirty 'pond' water)
1-5	70	Watery world of underground chemistry (ELI+) (Using pH to link the atmosphere, hydrosphere, biosphere and lithosphere together)
1-5	139	Well, well, well! (Making a working model of a well)
1-5	144	Water - a matter of taste or a taste of matter? (Is all water the same?)
1-5	168	Mini-world water cycle (A water cycle demonstration model in a box)
1-5	171	Water cycle world (A discussion activity on the natural water transformations on Earth)
1-5	173	'Tagging' water molecules - to explore the water cycle (ELI+) (A thought experiment to investigate the water cycle)
1-5	174	Cycling water and heat in the lab - and the globe (ELI+) (Demonstrating the water cycle, latent heat and global energy transfer)
1-5	204	Watery world game (ELI Early years) (Climb through the watery world but watch out for snakes!)
1-5	383	Limestone springs – the wells of Wells(Modelling the underground flow of water through limestone passages to springs)
1-5	417	Make your own aquifer – 1 with sponges(A clean way to demonstrate water in pores in rocks)
1-5	418	Make your own aquifer – 2 The London Basin(Model the aquifers in the London Basin with sponges)
2 Earth Energy/Processes		
2-1 Deformation, folding and faulting		
2-1	9	Himalayas in 30 seconds! (Making a miniature fold mountain range in an empty box)
2-1	16	Valley in 30 seconds - pulling rocks apart (Investigating faulting in an empty box)

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2-6	84	Model a spreading ocean floor offset by transform faults (A model of the transform fault 'steps' in oceanic ridges and their magnetic stripes)
2-6	85	Continental jigsaw puzzle (ELI+) (Can you reassemble a supercontinent from a 'jigsaw puzzle'?)
2-6	86	Mantle plume in a beaker (ELI+) (Modelling processes at a constructive (divergent) plate margin)
2-6	87	Plate riding (ELI+) (Role-play plate-surfing to ask: 'How is the plate you live on moving now?')
2-6	88	Plate tectonics through the window (ELI+) (What might you see through a window or porthole at an active plate margin?)
2-6	91	Wegener's 'Continental drift' meets Wilson's 'Plate tectonics' (ELI+) (How Wegener's continental drift evidence matches up with evidence for plate tectonics)
2-6	198	Continental split - the opening of the Atlantic Ocean (Modelling how the continents moved, from Pangaea to today)
2-6	208	Hotspots (ELI+) (Modelling the movement of a plate across the globe)
2-6	216	Did the continents move for you?(Plotting the movement of continents using apparent polar wandering curves)
2-6	217	What drives the plates?(Using a pupil model to demonstrate that slab pull is the main plate-driving force)
2-6	250	The Earth time jigsaw puzzle(Plot the moving continents, from the past to the future)
2-6	278	Plate margins and movement by hand(Modelling plate margins and plate movement with your hands)
2-6	293	The heat is on(Modelling the movement of heat from the Earth's core outwards)
2-6	302	Faults in a Mars™ Bar(Pulling apart a Mars™ Bar to model a divergent plate margin)
2-6	326	'All models are wrong' – but some are really wrong: plate-driving mechanisms(Many textbook diagrams of plate-driving forces have arrows in the wrong places)
2-6	328	Which is the fastest spreading oceanic ridge?(A map-based activity to find the most active oceanic spreading ridge)
2-6	333	UPDATE: Follow the Joides Resolution research ship at sea()
2-6	333	UPDATE: Recent research in plate tectonics()
2-6	334	What do the top and bottom of a tectonic plate look like?(Questions to test understanding of plate tectonic processes)
2-6	338	Melting and boiling – the influence of pressure(How does a reduction in pressure lower melting and boiling points?)
2-6	347	What drives the plates? The evidence(Examine the evidence for the different plate tectonic driving mechanisms)
2-6	348	What drives the plates? In slab pull, what is it that pulls?(Understanding how slab pull works through examining the data)
2-6	349	What drives the plates? Modelling slab pull(Modelling and discussing the slab pull plate-driving mechanism in the classroom)
2-6	353	Marie Tharp: 'The valley will be coming up soon'. Bruce Heezen: 'What valley?'('A woman scientist in a man's world' – what was it like?)
2-6	355	Wandering continents(What evidence enables us to reconstruct the ancient supercontinent of Pangaea?)
2-6	359	Mars™ margins – diverged, converged and transformed(Modelling plate margins with a Mars™ Bar – apart, together and side by side)
2-6	408	Hands on magnetic stripes(Demonstrating how oceanic ridge magnetic stripes form with several pair of hands)
2-7 Sedimentary processes		
2-7	13	Mighty river in a small gutter (Sediments on the move)
2-7	21	Rock, rattle and roll (Investigating the resistance of rocks to erosion by shaking in a plastic container)
2-7	46	Weathering - rocks breaking up and breaking down (Matching pictures and descriptions of weathered rocks with the processes of weathering that formed them)
2-7	60	Grinding and gouging (How moving ice can grind away rocks)
2-7	61	Dust bowl (Investigating wind erosion)
2-7	66	Sandcastles and slopes (What makes sandcastles and slopes collapse?)
2-7	71	Cracking apart (ELI+) (Simulating the weathering or rocks in a desert environment)
2-7	73	Changing coastlines (Investigating how wave erosion, transportation and deposition can change the shapes of coastlines)
2-7	104	Evidence from the deep freeze (Photographs of glacial and periglacial landscapes)
2-7	117	Danger - quicksands! (Why do some rocks give way when it rains hard?)
2-7	180	Ice power (ELI+) (Freezing water in a syringe to measure expansion)
2-7	207	Teacher - 'What's the difference between weathering and erosion?' (Addressing common misconceptions about weathering and erosion)
2-7	210	Falling slopes(Modelling how rock cliffs and slopes can collapse)
2-7	212	Shell shake - survival of the toughest (Why is the fossil record incomplete?)
2-7	215	Karstic scenery - in 60 seconds(Modelling the chemical weathering of limestone)

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2-7	230	Rolling, hopping floating and invisibly moving along(Investigating how sediment is transported by water)
2-7	258	Ice-thickness from scratch: visualising past processes by calculation(Modelling glacial striation-formation by calculation – thinking through the assumptions)
2-7	259	A bucket for a pothole: visualising past processes by calculation(Modelling river pothole-formation by calculation – thinking through the assumptions)
2-7	260	Investigating small-scale sedimentary processes AND modelling mighty rivers(The 'Mighty River in a small gutter' Earthlearningidea activity used at different scales)
2-7	283	From river sediment to stripey rocks(Modelling the build up of different layers of sediment as seen in sedimentary rocks)
2-7	312	When are soft rocks tough, and hard rocks weak?(A discussion about the toughness/resistance of rocks in different places)
2-7	320	The LegoTM method of showing weathering, erosion, transportation and deposition(Using LegoTM bricks to demonstrate sedimentary processes)
2-7	337	Breaking up – classroom freeze-thaw weathering(Showing how freezing and thawing can break porous rocks in the classroom)
2-7	345	How can storms affect erosion rates?(Predict what will happen to a landscape if it is affected by a storm)
2-7	363	How many sand grains are there in a bucket – or on a beach?(Planning activities to estimate the number of sand grains in a bucket – or on a beach)
2-7	375	Making waves: a storm in a teacup?(Three ways to make waves in a container of water: wind, earthquake and impact)
2-7	392	'A world in a grain of sand'(What can a grain of sand tell us about its past?)
2-7	403	Speeding up nature to trap carbon dioxide(The potential role of enhanced weathering and carbonation in mitigating climate change)
2-7	409	Coastal erosion(What controls the form of a coastline and the steepness of its cliffs?)
2-7	122	Fluids, friction and failure (How can unseen fluids affect the movement along faults and glacier beds?)
2-8 Sedimentary structures		
2-8	11	Sand ripple marks in a washbowl (How asymmetrical ripple marks form in sand)
2-8	12	Sand ripple marks in a tank (How symmetrical ripple marks form in sand)
2-8	47	Cracking the clues (Making your own cracking clues to the Earth's past)
2-8	177	Sedimentary structures - graded bedding (Make your own graded bed - one depositional event, but with coarse to fine sediment)
2-8	179	Sedimentary structures - sole marks (Evidence from the base of a sedimentary bed)
2-8	181	Sedimentary structures - imbrication (Which way did the river flow?)
2-8	184	Sedimentary structures - load casts (Interpreting odd bumps on the bases of beds)
2-8	194	Sedimentary structures - cross-bedding and 'way-up' (Using cross bedding to determine the way-up of a bed of sedimentary rock)
2-8	195	Sedimentary structures - cross-bedding and ancient currents (Using cross bedding to find the directions of ancient currents)
2-8	235	What was it like to be there? - clues in sediment which bring an environment to life(Bringing a depositional environment to life using evidence from sedimentary structures)
2-8	282	Modelling by hand 'when the youngest rock is not on top'(Illustrating how rock sequences can have older rocks on top of younger ones)
2-8	287	Modelling unconformity – by hand(Using your hands to demonstrate how unconformities form)
2-8	294	Right way up or upside down? - modelling anti- and synforms by hand(Use your hands to show how the beds in folds can be the right way up or inverted)
2-8	327	Beach, river, dune, mountain, plain – what layers might be preserved here?(A discussion on what evidence might be preserved in rocks from different environments)
2-8	329	How do sedimentary beds form? – and why can we see them?(Demonstrating how the beds in sedimentary rocks are deposited)
2-8	330	Sedimentary structures – make your own cross-bedding(Classroom activities to make and explain how cross-bedding forms)
2-8	341	Which sedimentary structures can you make?(Making sedimentary structures in the classroom using simple apparatus and materials)
2-8	358	What would it feel like to wriggle your toes on an ancient bedding plane as the sediment was being deposited?(Clues from the present day about the origin of sedimentary rocks)
2-8	372	Picturing puzzle structures(Visualise and draw sedimentary structures from a verbal description)
2-8	382	Picturing trace fossils and other strange shapes(Visualise and draw trace fossils and sedimentary structures from a verbal description)

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3 Earth in Space		
3-1 Astronomy		
3-1	427	Demonstrate the apparent rotation of the sky with an astronomical umbrella(Using a simple model to show the difference in the appearance of the night sky seen from Earth or from space)
3-2 Earth- seasons . . .		
3-2	169	Screaming roller coaster (How fast am I travelling (due to Earth's spin and Earth's orbit)?)
3-2	191	Hor or not? (Investigating how latitude affects the amount of solar radiation received)
3-2	192	Earth on Earth (Using a globe in the sunshine to show how day/night and the seasons work)
3-2	193	Seasons: the effect of our tilted Earth (An indoor demonstration explaining the changing seasons)
3-2	299	The Earth and Milankovitch cycles – by hand(Modelling the Earth's squashed orbit, tilt and wobble using your hands)
3-3 Earth's Moon		
3-3	68	Craters on the Moon (Why are the Moon's craters such different shapes and sizes?)
3-4 Eclipses - solar and lunar		
3-4	56	Why does the Sun disappear? (Demonstrate what happens when the Moon hides the Sun)
3-4	154	Jaffa moon (Modelling the phases of the Moon using Jaffa CakesTM)
3-4	158	Polystyrene moon (Visualising the phases of the Moon using a ball on a stick)
3-4	160	Lollipop moon (Modelling the phases of the Moon with a ball, lollipops and a bright light)
3-4	162	Eclipse the lollipop (Modelling eclipses of the Moon and the Sun with a ball, lollipops and a bright light)
3-4	356	What would an eclipse look like from the moon?(From the moon, what would the Earth look like during a) a solar, b) a lunar eclipse on Earth?)
3-5 Planets		
3-5	92	Playground planets (Modelling the relative sizes of the planets and their distances from the Sun)
4 Earth Materials		
4-1 Earth's structure		
4-1	59	From an orange to the whole Earth (Using an orange to model different densities of the Earth's layers)
4-1	74	From clay balls to the structure of the Earth (ELI+) (A discussion of how physics can be used to probe Earth's structure)
4-1	78	Bouncing, bending, breaking (ELI+) (Modelling the properties of the Earth's mantle)
4-1	147	Core activity (ELI+) (Piecing together evidence for the composition of the Earth's core)
4-1	196	Journey to the centre of the Earth - on a toilet roll (Just how thin is the crust we live on?)
4-1	243	Boring chocolate!(What can boreholes tell us about the Earth?)
4-1	423	Shadowlands(Simulating the effect of the Earth's core on earthquake waves)
4-2 Engineering & industrial geology		
4-2	151	Testing rocks 1 - bouncing back (Testing the strength of rocks)
4-2	156	Smelter on a stick (ELI+) (Smelting iron ore to iron on a gas burner)
4-2	157	Testing rocks 2 - 'Splat!' (A simple way of testing the plasticity of clay)
4-2	159	Testing rocks 3 - that shrinking feeling (Investigating shrinkage in clay as it dries out)
4-2	269	Recipe for the perfect fracking fluid(Make your own fluid to fracture hydraulically (frack) methane-bearing shale)
4-2	279	Make and use your own Plaster of Paris(Investigate a large-scale industrial process in a boiling tube)
4-2	313	What is it made of?(Relate each mineral or rock to the everyday object containing it.)
4-3 Forensic geoscience		
4-3	72	Innocent until proven guilty (ELI+) (Using forensic geoscience to solve the crime)
4-4 Minerals		
4-4	29	Salt of the Earth (Who can make the biggest salt crystal?)
4-4	30	Eureka! - detecting ore the Archimedes way (Measuring density using a stick, string, a ruler, a bucket and a bottle of water)
4-4	48	Rocks to eat? (How we get the elements we need to stay healthy)
4-4	108	What am I made of? (ELI+) (A comparison between the chemistry of the human body and the rest of the Earth)
4-4	131	Identifying minerals - use your sense(s)! (Minerals in the dark: identifying minerals when the lights fail)
4-4	133	Jigging (Using density to separate different materials)
4-4	164	Gold prospectors (Panning for 'gold' in river sediment)
4-4	165	Mineral expert 1 (Beginning to identify minerals - introducing colour, habit, lustre, cleavage)

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4-4	170	Mineral expert 3 (ELI+) (The mineral foundations of everyday life)
4-4	172	Mineral expert 4 - Recycle your mobile phone (Why should I recycle my mobile (cell) phone?)
4-4	248	'I'm pure calcium carbonate' – the calcium carbonate question(A discussion focussed on common misconceptions about calcium carbonate)
4-4	314	Mineral or not?(Discussion about what is a mineral and what is not)
4-4	412	Picturing Minerals -1(Visualise and draw minerals from a verbal description)
4-4	413	Picturing Minerals -2(Visualise and draw minerals from a verbal description)
4-4	416	Essential Minerals for the Green Revolution – 1 Lithium(An element which is pulling more than its weight in the world)
4-4	420	Essential Minerals for the Green Revolution – 2 Copper(An element for which the demand is increasing rapidly)
4-4	421	Essential Minerals for the Green Revolution – 3 Rare Earth Elements(Vital components in modern technology)
4-4	424	Essential Minerals for the Green Revolution – 4 Graphite(From a pencil to the electric car!)
4-4	100	'Crystallisation' in a pudding dish (Simulating the formation and growth of crystal lattices)
4-5 Soils		
4-5	8	Why does soil get washed away? (Investigating why some farmers lose their soil through erosion whilst others do not)
4-5	22	Permeability of soil - 'The great soil race' (Investigating the properties of different soils by pouring water on them)
4-5	58	Darwin's 'big soil idea' (Can you work out how Charles Darwin 'discovered' how soil formed?)
4-5	152	Make your own soil (Investigating the type and origin of the ingredients of soil)
4-5	153	Soil doughnuts (Sorting out soils)
4-5	161	Soil layers puzzle (Make your own soil profile and investigate others)
4-5	271	Is there life in this soil sample?(Questions to consolidate pupil understanding of soil-formation)
4-5	332	Where on Earth is no soil found?(A 'deep question' discussion about soil-formation)
4-5	410	The soil water shake test(Investigate the components of soil)
4-6 Rocks		
4-6	4	Rock detective - rocky clues to the past (Investigating your local rocks to find out how they formed)
4-6	5	Modelling for rocks: what's hidden inside - and why? (Investigating the permeability of rocks and how they let water, oil and gas flow through)
4-6	7	What was it like to be there - in the rocky world? (Bringing the formation of solid rock to life - by imagining yourself there when it formed)
4-6	27	Make your own rock (Investigating how loose sediment may be stuck together to form a 'rock')
4-6	31	Space within - the porosity of rocks (Investigating the amount of pore space between the 'grains' of a model 'rock')
4-6	97	Geological postcards 1 - granite and chalk (Picture postcard puzzles)
4-6	98	Geological postcards 2 - sandstone and limestone (Picture postcard puzzles)
4-6	134	Building Stones 1 - a resource for several Earthlearningidea activities (Use a key to identify many different attractive-looking rocks)
4-6	135	Will my gravestone last? (Testing scientific ideas in a graveyard)
4-6	137	Building Stones 2 - Igneous rocks (What are the differences between igneous rocks commonly used as building stones?)
4-6	140	Building Stones 3 - Sedimentary rocks (How do the sedimentary rocks used for building stones differ?)
4-6	143	Building Stones 4 - Metamorphic rocks (What are the differences between metamorphic rocks commonly used as building stones?)
4-6	163	Rocks from the big screen (Indoor preparation for outdoor field work, using a picture and specimens)
4-6	178	'Rockery 1' - rock game (Model different characteristics of rocks - with your pupils)
4-6	182	'Rockery 2' - rock cycle game (Model the stages of the rock cycle - with your pupils)
4-6	211	Roadstone - which rock?(Investigating the best rock type for the wearing course of roads)
4-6	239	Design your own rocky play-park(Telling the stories of rocks for everyone)
4-6	247	Does my rock hold water and will water flow through it?(Investigating the differences between porosity and permeability)
4-6	249	Rock around your school(Investigating the building materials around your school and in your area)
4-6	303	Rock grain cut out(How can you tell which grains come from which rock?)
4-6	344	A rock is a time capsule – a message from the past(Bringing to life the extraordinary stories of ordinary rocks)
4-6	394	Picturing igneous rocks – 1(Visualise and draw igneous rocks from a verbal description)
4-6	396	Picturing igneous rocks – 2(Visualise and draw igneous rocks from a verbal description)
4-6	398	Picturing metamorphic rocks(Visualise and draw metamorphic rocks from a verbal description)

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5 Evolution of Life		
5-1 Evolution of life		
5-1	32	Time-line in your own backyard (Hang pictures of the important events in the history of life on a string time-line)
5-1	132	Sorting out the evolution of evolution headlines (ELI+) (Lay out your own timeline of how the theory of evolution developed)
5-1	200	How many Great Great Great Great Grandparents? (Finding out how we inherit our characteristics)
5-1	201	How many Beany Beetles? - the evolution game (Investigating evolution by adaptation and natural selection)
5-1	234	Toilet roll of time (Make a geological timeline to take home)
5-1	280	The pattern of continents/oceans versus the pattern of life on Earth(How can the link between continental patterns and life on Earth be explained?)
5-1	426	Scary scorpions(Make your own scorpion and imagine how it lived)
5-2 Fossils (other than dinosaurs)		
5-2	28	Fossil or not? (Discussion about what is a fossil and what is not)
5-2	37	What was it like to be there? - bringing a fossil to life (A series of questions to bring fossils, and the environments in which they lived, to life)
5-2	50	How could I become fossilised? (Thinking through fossilisation in the context of me or you)
5-2	65	Trail-making(Making your own "fossil" animal trails)
5-2	115	Mary Anning - Mother of Palaeontology ("A woman in a man's world")
5-2	119	Curious creatures (Using fossil and modern evidence to work out the lifestyles of extinct animals)
5-2	142	Who ate the ammonite? (A Jurassic food web - from fossil evidence)
5-2	176	Running the fossilisation film backwards (Bringing a fossil 'back to life')
5-2	186	Trace fossils - burrows or borings (What evidence do living organisms leave behind in rocks?)
5-2	202	Fossilise! (ELI Early years) (A game showing how fossils form and survive)
5-2	264	The ups and downs of ammonites(How did ammonites adjust their position in the sea?)
5-2	425	Picturing Fossils -1(Visualise and draw fossils from a verbal description)
5-2	212	Shell shake - survival of the toughest (Why is the fossil record incomplete?)
5-2	382	Picturing trace fossils and other strange shapes(Visualise and draw trace fossils and sedimentary structures from a verbal description)
5-3 Dinosaurs		
5-3	6	Dig up the dinosaur (Become a fossil hunter and dig up a dinosaur)
5-3	14	Meeting of the dinosaurs - 100 million years ago (The evidence given by dinosaur footprints)
5-3	17	How to weigh a dinosaur (Using a dinosaur footprint impression to estimate how heavy the animal was)
5-3	23	Dinosaur in the yard (Was Iguanodon strolling in the sun, or fleeing in fear?)
5-3	35	Dinosaur death - did it die or was it killed? (Was this a Cretaceous crime scene? using rock and fossil forensic evidence to find out)
5-3	360	Extinction mystery(What did kill the dinosaurs?)
5-3	362	Let's weigh that dinosaur!(How can a plastic model reveal the mass of an actual dinosaur?)
5-4 Adaptation to environment		
5-4	44	Space survival: how could we survive a year in a dome? (Pupils plan to survive for a year in a sealed dome in a desert)
5-4	146	Fifty million years into the future (Investigating how animals become adapted to their environments)
5-4	183	Sea shell survival (How are common sea shells adapted to their habitats?)
5-5 Preservation		
6 Investigating the Earth		
6-1 Fieldwork		
6-1	26	Earth science out-of-doors: preserving the evidence (What evidence of the present times might we find in a million years from now?)
6-1	136	Do-it-yourself dip and strike model (with DIY clinometer) (ELI+) (Using a model to measure and understand dip, dip direction, strike and apparent dip)
6-1	187	Fieldwork: Applying 'the present is the key to the past' (An outdoor activity to apply the present to the past - using Earth science-thinking in reverse)
6-1	188	Fieldwork: Envronmental evaluation (Developing a strategy for evaluating the environment)
6-1	203	Fieldwork: 'All powerful' strategy (Discussing geological histories in imaginative ways)

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6-1	220	Fieldwork: Questions for any rock face - Planning for fieldwork(Preparing your pupils before setting out to "ask questions for any rock face")
6-1	221	Fieldwork: Questions for any rock face 1: weathering (What questions about weathering might be asked at any rock exposure?)
6-1	222	Fieldwork: Questions for any rock face 2: erosion (What questions about erosion might be asked at any rock exposure?)
6-1	223	Fieldwork: Interactive re-creation (Activities using simple transportable apparatus to simulate features in the field)
6-1	226	Fieldwork: Questions for any rock face 3: soil (What questions about soil might be asked at any rock exposure?)
6-1	227	Fieldwork: Questions for any rock face 4: rock group (sedimentary or igneous) (What questions about the type of rock might be asked at any rock exposure?)
6-1	229	Fieldwork: Questions for any rock face 5: sedimentary grains (What questions about sedimentary grains might be asked at any rock exposure?)
6-1	231	Fieldwork: Questions for any rock face 6: fossils (What questions about fossils might be asked at any rock exposure?)
6-1	232	Fieldwork: Questions for any rock face 7: tilted or folded rocks (What questions about tilted or folded rocks might be asked at any rock exposure?)
6-1	233	Fieldwork: Questions for any rock face 8: faults (What questions about faults might be asked at any rock exposure?)
6-1	237	Questions for any rock face 9: metamorphic rock(What questions about metamorphism might be asked at any metamorphic rock exposure?)
6-1	238	Questions for any rock face 10: sequencing(What questions about sequencing geological events might be asked at any rock exposure?)
6-1	240	Questions for any rock face 11: tectonic plates(What questions about relationships to tectonic plates might be asked at any rock exposure?)
6-1	242	Questions for any rock face 12: potential of the quarry or cutting(What questions about the potential of the site might be asked at any rock exposure?)
6-1	244	Questions for any rock face 13: quarry economics(What questions about potential for quarry re-opening might be asked at any rock exposure?)
6-1	245	Questions for any rock face 14: recording(What questions about recording geological data might be asked at any rock exposure?)
6-1	246	Fieldwork: the view from the site(Using the view of the local area to tune yourself into the local geology)
6-1	257	The 'What makes a good educational experience' approach to planning fieldwork(Thinking through the fieldwork strategies that are most likely to inform and inspire)
6-1	263	Now and then – spotting the difference(How did the conditions differ between today and when the rock was formed?)
6-1	292	The 'What could hurt you here?' approach to field safety(Teaching how to keep safe during fieldwork and other outdoor activities)
6-1	297	View to the future – and the past(Using a viewpoint or overview educationally)
6-1	306	Urban fieldwork – the stories from materials, colours, lines and shapes(Find out the stories told by materials used in building and for decoration)
6-1	321	'Recreating' the rocks seen in the field – step by step(Simulating a dipping sedimentary rock sequence through a sequence of Earthlearningideas)
6-2 Geophysics		
6-2	96	Electrical ground probing (Measuring the electrical resistance of the ground to find buried objects)
6-2	189	Under pressure (ELI+) (Calculating the intense pressure underground)
6-2	190	Water pressure - underground (ELI+) (Demonstrating how hydrostatic pressure increases with depth)
6-2	270	Modelling remote sensing geophysics(Using a mock gravimeter and magnetometer set up in the classroom)
6-3 Magnetism		
6-3	75	Magnetic Earth (ELI+) (Modelling the magnetic field of the Earth)
6-3	80	Frozen magnetism (ELI+) (Preserving evidence of a past magnetic field in wax)
6-3	197	Why won't my compass work on the other side of the Equator? (ELI+) (Understanding the three-dimensional magnetic field of the Earth)
6-3	209	Human magnets! (ELI+) (Modelling ancient and modern magnetic fields, using your pupils)
6-3	290	Recipe for a magnetic Earth and a magnetic detector(Using a stress ball and small magnet, with a needle and thread to model magnetic Earth)
6-3	81	Magnetic stripes (ELI+) (Modelling the symmetrical magnetic pattern of the rocks of the sea floor)
6-3	408	Hands on magnetic stripes(Demonstrating how oceanic ridge magnetic stripes form with several pair of hands)

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6-4 Mapwork		
6-4	101	Geological mapwork from scratch 1: a conical hill (ELI+) (Draw your own cross sections - of increasing difficulty)
6-4	102	Geological mapwork from scratch 2: valley with simple geology (ELI+) (Draw your own cross sections and 3D geological model)
6-4	105	Geological mapwork from scratch 3: valley with dipping geology (ELI+) (Draw your own cross sections and 3D geological model)
6-4	106	Geological mapwork from models 1: plain with simple geology (ELI+) (Draw and make your own 3D models of the geology of a flat region)
6-4	107	Geological mapwork from models 2: cuesta with simple geology (ELI+) (Draw and make your own 3D models of the geology of a cuesta)
6-4	111	Geological mapwork from models 3: valley with horizontal floor (ELI+) (Draw and make your own 3D models of the geology of a valley with a horizontal floor)
6-4	113	Geological mapwork from models 4: sloping ridge and valley (ELI+) (Draw and make your own 3D models of the geology of a sloping ridge/valley area)
6-4	116	Geological mapwork from models 5: folded geology on block models (ELI+) (Draw and make your own 3D models of areas with folded rocks)
6-4	123	Geological mapwork from models 6: plain with faults in the direction of dip (ELI+) (Draw and make your own 3D models of the geology of a flat region with faulted rocks)
6-4	124	Geological mapwork from models 7: plain with faults parallel to the outcrops of the beds (ELI+) (Draw and make your own 3D models of the geology of a flat region with faulted rocks)
6-4	125	Geological mapwork from models 8: plain with different types of fault (ELI+) (Draw and make your own 3D models of the geology of a flat region with faulted rocks)
6-4	129	Opengeoscience 1: igneous intrusions and lavas (Opening geological maps to the world)
6-4	130	Opengeoscience 2: tilted and folded rocks (Opening geological maps to the world)
6-4	138	Geological mapwork: using surface geology to make a geological map (ELI+) (Match the photos to a map to see how a geological map works)
6-4	311	The sliced Jelly Babies™ approach to understanding 3D geological maps(Use Jelly Babies™ cut at the dip angle to highlight structures on geological maps)
6-4	419	Teaching geology to students with visual impairment (VI)(Modifying block models to teach map-work to students who cannot see)
6-5 Oceanography		
6-5	315	Exploring current flows through straits(Testing the L. F. Marsili model of Bosphorus currents (1680))
6-5	340	Lost at sea – the amazing journeys of rubber ducks around the world(Studying ocean currents following the Friendly Floatees ocean spill)
6-5	350	Measuring the depths of seas and oceans: How is it done?(A simple demonstration of how we measure sea floor depths and relief)
6-5	351	Modelling seafloor mapping(How to simulate an echo-sounder study of seafloor topography)
6-5	352	Sounding the Pacific Ocean(An echo sounder traverse of the eastern Pacific)
6-5	369	Sea level in a plastic cup(Eight ways to change the water level in a plastic cup – and global sea level)
6-5	353	Marie Tharp: 'The valley will be coming up soon'. Bruce Heezen: 'What valley?'('A woman scientist in a man's world' – what was it like?)
6-5	25	High flow, low flow?: atmosphere and ocean in a tank (Hot, cold and particle-filled density currents as they flow in the atmosphere and ocean)
6-5	288	Atmosphere and ocean in a lunchbox(A model for all pupils – of hot, cold and cloudy density currents)
7 Geological Time		
7-1 Dating the Earth		
7-1	141	Working out the age of the Earth - moving backwards as time moved forwards (Link up your own timeline of how scientists worked out the age of the Earth)
7-1	295	Dating the Earth – before the discovery of radioactivity(Charles Lyell and Mount Etna, 1828)
7-1	366	But how old is it?(Investigating radioactive dating of rocks and minerals)
7-2 Stratigraphy and Sequences		
7-2	20	Laying down the principles (Sequencing the events that form rocks through applying stratigraphic principles)
7-2	40	What is the geological history? (Sequencing events to reveal a history using simple stratigraphic principles)
7-2	41	Where shall we drill for oil? (Sorting out the sequence - oil prospect)

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7-2	261	Filling the gap – picturing the unconformity 'abyss of time'?(Working out what happened during unconformity time gaps)
7-2	307	What happened when?: sorting out sequences using stratigraphical concepts(Are the age-based stratigraphical concepts principles or laws? – and how do you use them?)
7-2	339	What might be the marker for the 'golden spike' at the end of the Anthropocene?(How is geological time subdivided and what are likely future human impacts on the Earth?)
7-2	389	Walther's law of sedimentation – teaching it the LegoTM way(How does a relative rise in sea level affect a vertical sequence of sediments?)
7-2	411	Walther's law of sedimentation – teaching it the LegoTM way Part 2:(How does a relative fall in sea level affect a vertical sequence of sediments?)
7-3 Visualising deep time		
7-3	149	How many for a million? (How many sheets of graph paper for 1 million, or 100 million, or 1000 million squares?)
7-3	150	How long does it take? (Sorting out Earth events according to the time they take)
7-3	286	Back in time "Alligators spotted in London"(Retrieving and communicating information)
7-3	404	The origin of the Earth – at arm's length(The age of the Earth – with a good stretch of imagination)
7-3	234	Toilet roll of time (Make a geological timeline to take home)
7-3	344	A rock is a time capsule – a message from the past(Bringing to life the extraordinary stories of ordinary rocks)
8 Natural Hazards		
8-1 Catastrophic processes		
8-1	309	If a sedimentary bed were laid down outside now – what would it be like?(A discussion of beds and catastrophic processes)
8-1	357	What catastrophic natural processes affected your region in the geological past?(Use the evidence in your local region to interpret dramatic geological events)
8-2 Earthquakes		
8-2	1	Quake shake - will my home collapse? (When an earthquake strikes - investigate why some buildings survive and others do not)
8-2	18	Earthquake through the window - what would you see, what would you feel? (Asking pupils to picture for themselves what an earthquake through the window might look like)
8-2	19	Surviving an earthquake (Learn the earthquake drill and increase your chances of survival)
8-2	49	Earthquake prediction - when will the earthquake strike? (Modelling the build-up of stress and sudden release in the Earth that creates earthquakes)
8-2	76	Waves in the Earth 1 - the slinky simulation (ELI+) (Using a long spring to find out how earthquake waves travel through the Earth)
8-2	77	Waves in the Earth 2 - Human molecules (ELI+) (Pupils are pushed around to demonstrate the properties of seismic waves)
8-2	112	Shaken but not stirred? (How earthquakes affect buildings)
8-2	121	Merry waves - all year round (ELI+) (Modelling how the energy of seismic waves is transmitted)
8-2	266	An earthquake in your classroom(A classroom earthquake intensity scale)
8-2	273	Jelly/biscuit modelling of how earthquake waves amplify and devastate(Demonstrating how seismic shaking depends on local geology)
8-2	281	Earthquakes in art(Developing a scientific report based on evidence in historic paintings)
8-2	300	Spaghetti quakes(Why are big earthquakes so much more destructive than small ones?)
8-2	304	The slinky seismic waves demo(Using slinkies to show how earthquakes produce P-, S- and surface waves)
8-2	79	Geobattleships (ELI+) (Do earthquakes and volcanoes coincide?)
8-2	415	Slip-sliding away(How does monitoring fault creep help to forecast earthquakes?)
8-2	423	Shadowlands(Simulating the effect of the Earth's core on earthquake waves)
8-3 Floods		
8-3	34	Flood through the window - what would you see, how would you feel? (Pupils picture for themselves what a major flood through the window might look like)
8-3	62	Dam burst danger (Modelling the collapse of a natural dam in the mountains - and the disaster that might follow)
8-4 Landslides		
8-4	15	Landslide through the window - what would you see, what would you feel? (Asking pupils to picture for themselves what a landslide through the window might look like)
8-4	406	Landslide danger – and climate change(Case studies of how landslides work and the likely effects of climate change)
8-4	117	Danger - quicksands! (Why do some rocks give way when it rains hard?)
8-4	210	Falling slopes(Modelling how rock cliffs and slopes can collapse)

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8-5 Local hazards		
8-5	354	Which natural hazards could damage the area where you live?(How safe is your home area?)
8-6 Sink holes		
8-6	185	Sink hole! (Demonstrate sink hole processes in action)
8-7 Tsunamis		
8-7	3	Tsunami through the window - what would you see, what would you feel? (Asking pupils to picture for themselves what a tsunami through the window might look like)
8-7	45	Tsunami (What controls the speed of a tsunami wave?)
8-7	254	Tsunami alert! Run for the hills or stay by the sea?(Why does one type of earthquake produce a tsunami, whilst another does not?)
8-8 Volcanoes		
8-8	2	When will it blow? - predicting eruptions (How a simple tiltmeter can demonstrate the bulging of a volcano before eruption)
8-8	33	Blow up your own volcano! (Demonstrate the importance of gases in volcanic eruptions)
8-8	42	Eruption through the window (How could an eruption transform your view?- lava, ash, lahar or something worse)
8-8	90	Party time for volcanoes! (ELI+) (How much force does it take to set off a party popper "volcano"?)
8-8	110	Take a 'Chance' on the volcano erupting (ELI+) (How hazardous is the volcano?)
8-8	114	Krakatoa - The balloon goes up at Krakatoa (Using a tank and balloon to simulate the huge tsunamis caused by the eruption of Krakatoa)
8-8	126	Bubble-mania (The bubbling clues to magma viscosity and eruptions)
8-8	284	Best classroom eruption?(Which type of classroom eruption best shows how volcanoes erupt?)
8-8	79	Geobattleships (ELI+) (Do earthquakes and volcanoes coincide?)
9 Resources and Environment		
9-1 Climate change 'net zero' emissions		
9-1	364	How will the 'net-zero' target affect your local area?(Assessing the local impact of the government's 'net-zero' targets for carbon emissions)
9-1	365	Capturing carbon? (Update of 27th October 2021)(Can we capture and store carbon from burning fuel, cement- and steel-making? Should we?)
9-1	367	Blue Hydrogen – the fuel of the future?(Could "blue" hydrogen be produced and used here?)
9-1	368	Harnessing the power of the Sun(Could solar farms be used in your area?)
9-1	370	Tidal energy(Can the tides be harnessed to produce green energy?)
9-1	371	How will rising sea level affect our coastlines?(… and what can be done to adapt to rising sea levels?)
9-1	373	Heat from the Earth(Investigating ground source heat pumps)
9-1	374	Green hydrogen used to even out renewable energy supplies?(Could 'green hydrogen' be the solution to the efficient use of renewable energy?)
9-1	376	Energy from burning waste(Where does all my non-recyclable waste go?)
9-1	377	Hydrogen of many colours(The situation regarding hydrogen in the UK, October 2021)
9-1	378	Energy from buried waste:(Landfill gas)
9-1	379	Small-scale hydroelectric power schemes(Investigating opportunities for micro-hydro)
9-1	380	A new use for old coal mines(A potential source of energy from beneath our feet)
9-1	381	Let's plant some trees(Investigating the importance of trees to our planet)
9-1	384	Nuclear waste disposal (Investigating geological disposal facilities (GDFs))
9-1	385	Deep geothermal power from 'hot dry rocks': an option in your area?(A discussion of potential for extracting 'hot dry rocks' geothermal energy locally)
9-1	387	Harnessing the power of waves(Investigating the development of wave power)
9-1	388	Storing gas underground: What can we store? How can we do it? How will it help?(A discussion on gas power sources that can be stored and the storage conditions needed)
9-1	390	The future for global agriculture(The adaptation of agriculture to climate change)
9-1	391	Nuclear batteries - the future?(Investigating advances in battery technology)
9-1	393	Farming the wind – through onshore and offshore windfarms(A discussion on the local and national potential of developing wind energy sources)
9-1	395	Liquid biofuels - keeping our wheels turning into the future(Investigating fuels produced from biomass)

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9-1	397	Inland flooding: a Sheffield case study(How should we respond to the increased risk of inland flooding as temperatures rise?)
9-1	399	Matching supply and demand using stored water(Pumped storage hydroelectric schemes – just-in-time power)
9-1	400	How do I choose the best insulation?(Investigating enhanced insulation for buildings)
9-1	402	Electric vehicles - the way to go?(Investigating the advantages and disadvantage of Evs)
9-1	405	Nuclear power - harnessing the energy of the atom(Investigating the use of nuclear power now and in the future)
9-1	403	Speeding up nature to trap carbon dioxide(The potential role of enhanced weathering and carbonation in mitigating climate change)
9-1	406	Landslide danger – and climate change(Case studies of how landslides work and the likely effects of climate change)
9-2 Climate change - general		
9-2	275	The oxygen isotope sweet simulation(Demonstrating how the oxygen isotope proxy records past Earth temperatures)
9-2	276	Interpret Earth temperatures from simulated deep-sea and ice cores(Using sweets to simulate oxygen isotope ratios in cores)
9-2	285	How can the ice core evidence for climate change be explained?(An educational opportunity for discussing evidence, hypotheses and possible responses)
9-2	301	Modelling tipping points – by hands(Demonstrating tipping points in the Earth's system with the hands of three people)
9-2	305	What could we measure to find out if climate change is happening here?(What climate change indicators could be measured in our own backyard or school grounds?)
9-2	322	Melting ice and sea level change 1 – sea ice(Does sea level change when floating sea ice melts?)
9-2	323	Melting ice and sea level change 2 – ice caps(Does sea level change when ice caps melt?)
9-2	324	Climate on arrival(If you suddenly arrived somewhere – what would tell you what the climate was like?)
9-3 Environment		
9-3	53	Environmental detective (Imagining how the evidence of modern environments could become preserved)
9-3	127	Take it or leave it? - the geoconservation debate (When is collecting wrong, and when is it right? - try to decide for yourself)
9-3	199	Why is the Dead Sea dead? (Measuring salinity)
9-3	218	So, you want to conserve a geodiversity site (What could you do if you wanted to conserve a geoscience site?)
9-3	319	Finding the Earth in the UN Sustainable Development Goals(Map for yourself the areas where Earth studies are linked to the UN SDGs)
9-3	325	What colour was the world in the past?(Using rock evidence and 'the present is the key to the past' to colour the geological world)
9-3	331	Playground continents(A palaeogeography in your school yard)
9-3	386	The fishing game: beware of overfishing(A game showing how fish stocks should be managed sustainably)
9-3	188	Fieldwork: Envronmental evaluation (Developing a strategy for evaluating the environment)
9-4 Power sources		
9-4	57	Power through the window (Which power source might be built in the view you can see from your window?)
9-4	95	Rock power: geothermal power simulations (ELI+) (Modelling geothermal power sources - renewable or not?)
9-4	175	Which power source? - solving the crisis in Kiama (ELI+) (Searching for all the power sources that could be developed in a mythical country)
9-4	228	Where does offshore oil come from? (An activity to dispel misconceptions about the source of oil)
9-4	343	What is/are the least bad option(s) for plugging the future global energy gap?(A discussion on the least-damaging ways to meet world energy needs in the future)
9-4	346	Future power: predicting the mix of future power source contributions(Extrapolating from the last 50 years of power use to realistically predict the next 50 years)
9-4	367	Blue Hydrogen – the fuel of the future?(Could "blue" hydrogen be produced and used here?)
9-4	368	Harnessing the power of the Sun(Could solar farms be used in your area?)
9-4	370	Tidal energy(Can the tides be harnessed to produce green energy?)
9-4	373	Heat from the Earth(Investigating ground source heat pumps)
9-4	374	Green hydrogen used to even out renewable energy supplies?(Could 'green hydrogen' be the solution to the efficient use of renewable energy?)
9-4	376	Energy from burning waste(Where does all my non-recyclable waste go?)
9-4	377	Hydrogen of many colours(The situation regarding hydrogen in the UK, October 2021)
9-4	378	Energy from buried waste:(Landfill gas)

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9-4	379	Small-scale hydroelectric power schemes(Investigating opportunities for micro-hydro)
9-4	380	A new use for old coal mines(A potential source of energy from beneath our feet)
9-4	385	Deep geothermal power from 'hot dry rocks': an option in your area?(A discussion of potential for extracting 'hot dry rocks' geothermal energy locally)
9-5 Resources		
9-5	24	Trapped! Why can't oil and gas escape from their underground prison? (Demonstrate how oil and gas can be trapped in reservoir rocks beneath the surface)
9-5	36	Quarry through the window - what would you see, what would you not see? (Asking pupils to 'picture' what a 'quarry through the window" might look like)
9-5	64	Make your own oil and gas reservoir (Demonstrating how oil and water flow through permeable rocks)
9-5	69	Riches in the river (Investigating how valuable ores may become concentrated on river beds)
9-5	164	Gold prospectors (Panning for 'gold' in river sediment)
9-5	41	Where shall we drill for oil? (Sorting out the sequence - oil prospect)
9-5	128	Hydrothermal mineralisation - interactive (ELI+) ('The rock with the hole' hydrothermal mineralisation demo)
10 CROSS-CATEGORY TOPICS		
10-1 Cross-curricular ELIs		
10-1	267	Geo-art: paintings to sculptures inspired by all things 'geo'Create your own geo-artwork()
10-1	268	Geo-literature: poems and stories inspired by all things 'geo'(Create your own geo-poem or story)
10-1	308	Rocks music(Create your own geo-instrument)
10-1	336	Geo-music - music inspired by all things 'geo'(Create your own geo-music)
10-1	281	Earthquakes in art(Developing a scientific report based on evidence in historic paintings)
10-1	286	Back in time "Alligators spotted in London"(Retrieving and communicating information)
10-2 Early years		
10-2	155	Found in the ground: sorted! (An introduction to classification using things 'found in the ground')
10-2	224	Pirates and buried treasure(Grouping and sorting a variety of objects)
10-2	225	Sensory treasure hunt(Using senses to match objects with similar propeties)
10-2	236	Rock Explorers(Putting rocks into families)
10-2	241	Rock builder(Simulating the formation of fossiliferous sedimentary rocks)
10-2	6	Dig up the dinosaur (Become a fossil hunter and dig up a dinosaur)
10-2	27	Make your own rock (Investigating how loose sediment may be stuck together to form a 'rock')
10-2	28	Fossil or not? (Discussion about what is a fossil and what is not)
10-2	152	Make your own soil (Investigating the type and origin of the ingredients of soil)
10-2	167	Changing state - transforming water (Practical activities to change the state of water; solid, liquid, gas)
10-2	202	Fossilise! (ELI Early years) (A game showing how fossils form and survive)
10-2	204	Watery world game (ELI Early years) (Climb through the watery world but watch out for snakes!)
10-2	249	Rock around your school(Investigating the building materials around your school and in your area)
10-2	320	The LegoTM method of showing weathering, erosion, transportation and deposition(Using LegoTM bricks to demonstrate sedimentary processes)
10-2	392	'A world in a grain of sand'(What can a grain of sand tell us about its past?)
10-2	410	The soil water shake test(Investigate the components of soil)
10-2	426	Scary scorpions(Make your own scorpion and imagine how it lived)
10-2	164	Gold prospectors (Panning for 'gold' in river sediment)
10-3 Great scientists		
10-3	63	Darwin's 'big coral atoll idea' (Try thinking like Darwin did to solve the coral atoll mystery)
10-3	109	William Smith - 'The Father of English Geology' (ELI+) (Thinking like William Smith)
10-3	58	Darwin's 'big soil idea' (Can you work out how Charles Darwin 'discovered' how soil formed?)
10-3	91	Wegener's 'Continental drift' meets Wilson's 'Plate tectonics' (ELI+) (How Wegener's continental drift evidence matches up with evidence for plate tectonics)
10-3	93	James Hutton - or 'Mr. Rock Cycle'? (ELI+) (Thinking towards the rock cycle, the Hutton way)

Table 3　続き

10-3	115	Mary Anning - Mother of Palaeontology ("A woman in a man's world")
10-3	295	Dating the Earth – before the discovery of radioactivity(Charles Lyell and Mount Etna, 1828)
10-3	353	Marie Tharp: 'The valley will be coming up soon'. Bruce Heezen: 'What valley?'('A woman scientist in a man's world' – what was it like?)
10-4 Maths in ELIs		
10-4	258	Ice-thickness from scratch: visualising past processes by calculation(Modelling glacial striation-formation by calculation – thinking through the assumptions)
10-4	259	A bucket for a pothole: visualising past processes by calculation(Modelling river pothole-formation by calculation – thinking through the assumptions)
10-4	363	How many sand grains are there in a bucket – or on a beach?(Planning activities to estimate the number of sand grains in a bucket – or on a beach)
10-5 UK exams		
10-6 Visual Impairment		
10-6	419	Teaching geology to students with visual impairment (VI)(Modifying block models to teach map-work to students who cannot see)
10-7 Holiday geology		
10-7	277	Earthlearningidea bauble quiz(Fun for all the family – and your class)
	214	Weathering limestone - with my own breath!(A classroom demonstration of how limestone is weathered)

6. まとめ

ELI教材は、教育目的で利用される場合は著作権が放棄され、誰でも自由に利用することができる。充分な実験器具が準備できないような環境でも実施ができること目指しているので、開発当初からインドなどの学校でトライアルが実施されてきた。欧州地球科学連合（European Geoscience Union：EGU）の教育小委員会（Education Committee：EC）では、４月にウィーンで開催される例会の際に“教師のための地球科学情報”ワークショップ（Geosciences Information for Teachers：GIFT）を開催しており、ここでもELIが活用されている。

藤林ほか（2010）が、「生徒が科学的な思考を働かせて地学的事象を理解し，またアナログ実験等を通して地学的事象を身近にとらえられるよう、教授法を工夫していくことが必要 」と指摘するように、ELIを全国の小中学校・高等学校の授業で活用することが期待される。アメリカ合衆国アラスカ州フェアバンクノーススター学校区では、サイエンスキットと呼ばれる教材を図書館で一括管理し、各学校に配布されており、これを参考に北海道地域でも、教材・教具の共有システムの試みが始まっている（境, 2022）。今後は、ELI教材の翻訳作業に加え、こうした支援体制の確立を進めることで、地学教育を通じた科学リテラシーの向上を目指す。

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