GEOSCIENCE FOR LEAVING CERTIFICATE GEOGRAPHY

Continuing Professional Development Course 2023

EXPLORING NATURAL RESOURCES MODULE PLAN

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iCRAG
SFI RESEARCH CENTRE IN APPLIED GEOSCIENCES

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Suirbhéireacht Gheolaíochta
Ireland | Éireann

An Roinn Comhshaoil, Aeráide agus Cumarsáide
Department of the Environment, Climate and Communications

Geoscience for Leaving Certificate Geography Teachers CPD programme

About the Geoscience for Leaving Certificate Geography Teachers CPD programme

Geoscience is vital for our sustainable future, and geography is the key gateway to geoscience for most students. The Geoscience for Leaving Certificate Geography Teachers CPD programme has been developed by iCRAG (the Science Foundation Ireland Centre for Research in Applied Geosciences) and Geological Survey Ireland to create an opportunity for teachers and geoscience professionals to come together to increase the awareness of geoscience within the Leaving Certificate geography curriculum.

During the CPD course, teachers and geoscience professionals from both research and industry are paired together to co-create curriculum facing resources that are freely available for use. Over the course of six evening sessions, teachers learn more about the cutting-edge geoscience being undertaken by their partnered geoscientists, before working together to develop a curriculum-facing resource using their interests, teaching expertise and the knowledge of the geoscientist. In 2023, the resources produced have included lesson plans and module plans, and the accompanying teacher notes and slides/field booklets for each resource.

The resources link the most recent advances in geoscience to the geography curriculum in a way that is both understandable and relevant. The resources are freely available to be used for classes anywhere in the world. We hope that you and your students enjoy using them.

This resource

This resource has been developed by Teresa Sullivan, a geography teacher at St. Oliver Post Primary, Co Meath and iCRAG geoscientists Farimah Fattahi Masrour and Markus Pracht, and Ronan McCool from Geological Survey Ireland. The resource is a deep dive into the contentious topic of exploring natural resources, in particular geology, quarries and bogs. Included in this resource pack is a full lesson plan and associated teacher notes, and a PowerPoint of slides. It is suitable for Transition Year and Leaving Certificate Students.

Sincerely,

Elspeth Sinclair, Fergus McAuliffe, Siobhán Power
Programme Managers – Geoscience for Leaving Certificate Geography Teachers

Geological Survey Ireland, a division of the Department of Environment, Climate and Communications, has been mapping Ireland since 1845. They continue to map the Irish land and marine territories, as well as mineral and groundwater resources. They have responsibility for actions in the current Climate Action Plan including monitoring coastal change, the Just Transition in the midland counties, and providing data for de-risking offshore renewable energy. Irish geoscience research, particularly as it contributes to the development of government policy, is an important part of their work and they fund and co-fund many research projects, including some of the iCRAG research work. Their data and maps are freely available to all at www.gsi.ie.

iCRAG is the Research Ireland Centre for Applied Geosciences hosted by University College Dublin.
We are a team of researchers creating solutions for a sustainable society.
We develop innovative science and technologies to better understand the Earth's past, present, and future and how people are connected to it.
We drive research in areas that are critical to society and the economy, including:
• Sustainable discovery of energy resources and raw materials required for decarbonisation.
• Securing and protecting groundwater and marine resources.
• Protecting society from Earth's hazards such as flooding and landslides.
The iCRAG Research Ireland Centre for Applied Geosciences hosted by UCD, comprises 150 researchers across ten universities and institutions. iCRAG is funded by Research Ireland, Geological Survey Ireland and industry partners.
Further information is available at: www.icrag-centre.org

Disclaimer: Every effort has been made to ensure that the information in this book is accurate. Data, links, and maps are accurate as of January 2024. The publishers cannot accept responsibility for any consequences arising from the use of this resource. The publishers are in no way liable or responsible for any injury or loss to any person using this resource.

Module plan: Exploring Natural Resources

Contents

Module plan:

Links to curriculum

Core Unit 1: Patterns and Processes in the Physical Environment

1.2 The tectonic cycle:
Rocks are continually formed, modified, destroyed and reconstituted as part of the rock cycle. They are formed and modified by endogenic forces; they are destroyed by exogenic forces of erosion on exposure to weather and climate; they are reconstituted by the deposition of sediments.
The Human interaction with the rock cycle: mining, extraction of building materials.

Core Unit 2: Regional Geography

2.2 The dynamics of regions:
The study of regions show how economic, human and physical processes interact in a particular area (two contrasting Irish regions: - physical processes – economic processes).

Elective Unit 4: Patterns and Processes in Economic Activities

4.5 Environmental impact:
Economic activities have an environmental impact.

Specific Teaching objectives

- To give students an understanding of the geological time scale.
- To give students an understanding of geological principles.
- To give students an understanding of the processes of folding and faulting.
- To give student an understanding of peatlands and quarrying in Ireland.

Learning Outcomes

Students should be able to:

- Revise the rock cycle, examine rock samples and locate them on a geological map of Ireland.
- Study geological time, naming the eras and major geological events that impacted on Irish geology.
- Interpret geological principles from cross sections and date them youngest to oldest.
- Examine the forces of folding and faulting through modelling activities.
- Identify and locate peatlands in Ireland.
- Practice using and interpreting Google maps, ArcGIS and Scoilnet maps (OS map and aerial photographs).
- Investigate quarry output types and processes at work in the quarry system.
- Evaluate the impact of peatland decommissioning.
- Synthesis learning about quarries and peatlands and determine their interaction and impacts on the economy, society and the environment.

Keywords and definitions

Geology	Geology is the study of the Earth. It looks at how the Earth formed, its structure and composition, and the type of processes acting on it.
Eras	The Geologic Time Scale is divided into four main eras.
Igneous	Forms when magma cools and solidifies.
Sedimentary	Form when small particles called sediments build up layer upon layer and pressure caused them to compress and cement together over time.
Metamorphic	Rocks that have been changed due to heat and pressure.
Processes	Geological events.
Chronological	The sequence of events.
Superposition	States that layers of rock are laid down one on top of another (superimposed). The oldest rock strata will be on the bottom and they youngest at the top.
Horizontality	Originally sediments are deposited horizontally forming layers of sedimentary strata. Later in time the strata may become tilted or folded by tectonic plate movements.
Cross-cutting	A geological feature that cuts across or disrupts another feature must be younger than the feature that is disrupted.
Disconformity	A type of unconformity where there has been a lack of erosion or deposition between two parallel sedimentary strata.
Unconformity	An interruption in the series of the Earth's rocks layers.
Faulting	Rocks breaking.
Quaternary	The Quaternary Period covers geological history for the last 2.6 million years up to the present day.
Carboniferous	The Carboniferous was 300 million years ago and during the Carboniferous, peat forming conditions also existed where plant matter accumulated in low-oxygen acidic water.
Seismic	Refers to vibrations caused by movement of rocks.
Blasting	A number of electrical charges are used to detonate explosives that breaks up into smaller pieces.
Crushing	Rocks or larger aggregates are crushed to produce smaller particles for construction or other uses.
Screening	Separating raw materials into products of different specific grades (sizes).
Greenwashing	Washing removes impurities such as dust, mud, contaminants, and other particles from aggregate (rock).
Carbon sink	Stores more Carbon than it releases.
Sequestration	The process of removing carbon from the air.
Restoration	To restore a functioning peatland habitat.
Regeneration	To repair a peatland habitat.

Linkage and Integration

Linkages

- English: Oral discussion, debating, memory maps, note taking.
- Art - Modelling folds and faults.
- STEM – physics of deformation forces, chemistry of metamorphism, biological decomposition and carbon sink.
- Engineering – Quarry processes.
- History – chronology and timelines, social changes.
- Mathematics – calculation, graphical interpretation.
- SPHE – collaboration, interaction.

Differentiation

- Adapt the resource to suit different levels of ability through teaching style, tasks and expectations. In a general sense considering the expectations at higher and ordinary level from the leaving certificate syllabus will provide a guide as to the level of depth and understanding of concepts and complexity of skills expected.
- All students benefit from scaffolded resources and including pair and group work activities such as think-pair-share, higher and lower order questions, visual displays, animations, peer assessment and silent debates enhance the engagement opportunities and improve learning outcomes. In the mixed ability classroom extension tasks for exceptionally abled students should be embedded.
- The use of assistive technology or immersive reader give students greater access to the learning and specifically engineering groupwork matching students of stronger and weaker abilities encourages peer teaching and helps in accomplishing tasks.

Approaches to teaching and learning

Resources

- Computer / Laptop
- Teacher PowerPoint presentation
- Teacher resource booklet
- Student resource booklet
- Mini whiteboards
- Geological Map of Ireland
- Rock Samples
- Internet activated devices for ArcGIS, Google Maps and Scoilnet Maps activities
- Exam Papers or www.examinations.ie
- Stationery
- Playdough

Student learning activities and methodologies

- Retrieval practice
- Collaborative learning- pair and group work
- Active learning
- Oral questioning
- Teacher Based Instruction

- Student lead Inquiry
- Peer assessment
- Think-Pair-Share
- Digital activities - navigate and practice using the tools on Scoilnet maps
- Interact with ArcGIS and the Geological Survey of Ireland websites
- Silent debate
- Interact with video clips
- Sketching and labelling

Assess student learning

- Oral questioning: cold calling and targeted.
- Evaluation of retrieval knowledge.
- Participation in group activities.
- Peer assessment of activities.
- Formative feedback on activities.
- Summative feedback on completed resource booklet.

Further development of resource

- Participate in ArcGIS student training and set up an account, to create your own Story Maps.
- Create a geographical investigation regarding local economic activities.
- Create linkages to geological timescale and the formation of rock types across Ireland.
- Go on fieldtrips and collaborate with local primary economic activities.
- Match the resource to the Geographical Investigation at Leaving Certificate.

Teacher Notes

Exploring Natural Resources; Geology, The Quarry & The Bog

Learning Activities and Detailed Instructions

Aimed at senior cycle students, either as a Transition Year Module, or adapted as a series of Leaving Certificate topics. The activities could be transferred to Junior Cycle for CBA2 "My Local Geography".

There are six lessons carried out over single and double periods, each in sequence, and you are guided through using the PowerPoint, which matches with the activities on the student resource booklet.

Lesson One – Geology

Success Criteria	Revise the rock cycle: categories and processes. Examine a geological map of Ireland. Identify the geological eras in chronological order. Match the geological eras to major geological events. Explore local county geology; naming rocks, geological origin and activity that lead to their formation.
Learning Activities	Retrieval activities using the mini whiteboards: – For the rock cycle match the letters on the diagram to the keywords in the table. Swap the whiteboard with your neighbour and discuss the answers. – Repeat for the second rock cycle this time matching the process to the rock category. Compare results with your neighbour. – Complete the student booklet showing the rock cycle and table. Circulate around the room to check for understanding. Students use the whiteboards to complete their booklet. Discuss and demonstrate the geology map of Ireland, using the link below for great definition https://www.geoschol.com/ireland.html. Introduce the idea of geological time, eras and periods, show students the video on geological time. https://www.youtube.com/watch?v=XMjkO72KVjE Direct students to the geological timescale of Ireland and to colour in the map in their student booklet. Exit ticket questions.
Homework	Explore national geology – follow the QR code in their booklet. Follow the instructions to complete the summary of notes on their counties geological record. https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0
Assessment	Formative feedback / Check for understanding: Higher and lower order questioning on retrieval activities. Teacher observation of learning activities. Homework task.

Lesson Two – Geological Principles

Success Criteria	Recognise superposition, original horizontality and cross cutting relationships on a diagram and photograph. Interpret geological cross sections using geological principles. Practice application of geological principles on a worksheet. Create your own cross-sectional area for interpretation by your partner.
Learning Activities	Retrieval activities using the mini whiteboards: – 2 minutes to order the geological periods – youngest to oldest, using their notes order the numbers only. Check for understanding. Discuss and explain the geological principles, follow along in student workbook and annotate diagrams. Practice together the example on the board. Individually try to chronologically date the digital example at https://cimss.ssec.wisc.edu/sage/geology/lesson1/activity4.htm Students compare answers and then complete the worksheet with four examples together. Exit Task and summary
Homework	Create your own cross section to share and complete with your partner to see if they can interpret it. Use five letters A, B, C, D, E
Assessment	Formative feedback / Check for understanding: Higher and lower order questioning on retrieval activities. Teacher observation of learning activities. Homework task.

Lesson Three – Folding & Faulting

Success Criteria	Make four models of different crustal deformations arising from stress on the Earth's crust paired with erosion over time. Follow the instructions in your resource booklet. Make four models of different crustal deformations arising from stress on the Earth's crust paired with erosion over time. In your groups (3) assign rotating roles: one reader, one sculptor, one observer, (all sketching). Observe the forces of compression in the formation of folds and faults. Sketch the images on your resource booklet.
Learning Activities	Modified instructions from https://www.jpl.nasa.gov/edu/teach/activity/modeling-crustal-folds/ For each model, take at least three colors of playdough and form them into thin rectangles, roughly 0.5-1 cm thick and 5-6 cm wide. Stack each of the colored layers on top of each other and trim or square off the edges to form a uniform block. • Syncline and Anticline: Take your block and apply pressure evenly from the sides to create a uniform wave. Trim a thin, 1 centimeter layer off the top of your block horizontally to represent erosion, which exposes hidden layers in the rock. Draw your block in the space on the next slide. • Plunging Synclines and Anticlines: Cut another centimeter off your block, this time vertically from the top to the bottom at an angle, shaving off the forward-facing side of your model. Notice that the newly exposed layers are no longer on the same plane. Because you cut at an angle, there's a plunge in the block where the rock is exposed at different angles. Draw this perspective of your block. • Asymmetrical Folds: With a fresh block with your playdough. Compress your layers from the sides as before, but this time, make the folds lean more to one side. As before, "erode" away the top centimeter horizontally with your knife. How does this block differ from steps 1 and 2 above? How could you tell from looking at the top of your block that there was an asymmetrical fold hidden beneath. • Faults: Lastly, cut your block in half from top to bottom at an angle of your choice. Reattach the two sides with one side sliding lower than the other. You've just simulated a type of earthquake! As before, use your knife to "erode" the top centimeter of the block. Draw your block below. From your observations, what does erosion tell us about the presence of faults?
Homework	Label diagrams
Assessment	Formative feedback / Check for understanding: Teacher observation of learning activities. Homework task.

Lesson Four (likely a double class) – Peat

Success Criteria	Watch the videos and observe the peat landscapes, answer all questions on the resource booklet Differentiate between raised and blanket bogs and locate them in parts of Ireland Sketch the different types of peatlands in Ireland. Using ArcGIS examine local quaternary sediments and detail in your resource booklet. Using Google Maps name a local bog and give its coordinates
Learning Activities	• Retrieval Practice – Brain Dump • On your mini-whiteboard you have 60 seconds to write everything you know about peat. Swap the whiteboard with your neighbor, read their ideas and write one new piece of information on their board, swap board another two times before the board goes back to the owner. The owner reads through the new suggestions. • Discuss what peat is, pass around a sample of wet and dried out peat. • Formation of peat video https://www.youtube.com/watch?v=kYqygTcO-YQ – answer questions on the resource booklet. • Revisit the geological timescale and date peat deposits, recap on the law of superposition by asking higher and lower order questions. • Analyse the formation landscapes of blanket and raised peat and draw annotated sketches into the resource booklet. • Optional – link in with the formation of coal • Visit the quaternary sediments on ArcGIS and zoom into the local area – complete the resource booklet https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228
Homework	Visit Google Maps and research a local peatland https://www.google.com/maps/@53.7253164,-7.3440571,7587m/data=!3m1!1e3?entry=ttu Name a local bog, provide coordinates, identify from a satellite image.
Assessment	Formative feedback / Check for understanding: Teacher observation of learning activities. Higher and lower order questions. Homework task.

Lesson Five – Lets Rock

Success Criteria	Examine the appearance and location of Irish rock samples. Complete rock sample worksheet
Learning Activities	Lay out the large geological map in the centre of each group, there should be at least 6 people per group with 2 rocks from each category. Each student must collect a different rock sample from the top of the classroom and note the name. In rotation each student identifies, describes, and locates their rock on the geological map. Students remain engaged documenting the details in their resource booklet. When unsure group members can research the answers using their notes and resource booklet. When complete students can return to take at least two more samples from any category.
Homework	Create a digital collage for the appearance of all rocks listed in the resource booklet.
Assessment	Formative feedback / Check for understanding: Higher and lower order questioning on retrieval activities. Teacher observation of learning activities. Homework task.

Lesson Six (likely a double class) – Quarrying

Success Criteria	Recognise the geological principles on a quarry face and label on a diagram. Identify the rock from the ARCGIS map and then explore the Active Quarries layer. Sketch the different types of a quarry and complete the research table. Identify and describe quarry processes. Explore the DIAS Seismic maps of quarry blast magnitude. Practice screening (sieving) the graded materials and measure the long axis with a callipers. Using scoilnetmaps practice the swipe and spotlight tool. Draw a labelled sketch map of a local quarry. In pairs discuss and document the social, environmental and economic impacts of quarries.
Learning Activities	Retrieval Practice – True / False Quarrying activity Introduce and recap on quarries and geological principles – recognize the principles from the images – invite students to the white board to identify what they see and to label the photograph. Active Quarries in Ireland activity, follow the link and complete the resource booklet. https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228 Visually go through the processes found in a quarry from the PowerPoint, annotate the drone photograph and label. Visit the https://www.insn.ie/events/ Map of seismic activity from around the world picked up on local seismographs. Download the Vibrations and Seismic App and get students to jump up to replicate the shaking and observe the Instrumental Intensity Scale. Complete the quarry processes description in the resource booklet. Explore local quarries on https://maps.scoilnet.ie/OSiMaps/EsriVer17/index.html demonstrate how to use the swipe and spotlight tool. Students find a local quarry and using the aerial photograph tool, take a screenshot / download a pdf of the area. In the resource booklet draw and label a sketch map of the aerial photograph. In pairs complete the mind map template considering the positive and negative impacts of quarrying, reference case studies (local and national), statistics etc. Optional extension activity – sieving the material from a sample into different grades.
Homework	Any of the activities could be assigned as homework from this lesson.
Assessment	Formative feedback / Check for understanding: Higher and lower order questioning on retrieval activities. Teacher observation of learning activities. Homework task.

Lesson Seven (multiple classes) – Excavation to Restoration of Peatlands

Success Criteria	Identify historical extraction methods used in bogs, from old photographs. Sequentially list out the extraction methods used by Bord na Mona to harvest the bog. Take notes about decommissioning in the bog. Interpretate the location of wind farms in Ireland are determine why they are strategically located. Watch a video and answer questions about the relationship between quarrying and peatland decommissioning. Watch a video and answer questions about the carbon farming. Form an argument about peatland decommissioning using evidence to support your opinion, Participate in a walking debate. Observe and detail observations of a peatland area timelapse from Google Earth and the Sentinel Satellite. Using Scoilnet maps practice the swipe and spotlight tool for local boglands. In pairs discuss and document the social, environmental and economic impacts of quarries.
Learning Activities	Retrieval Activity – draw a diagram of a raised and blanket bog from memory, compare to previously completed diagrams in student resource booklet. Discuss historical extraction and the rebranding of Bord na Mona. Students list ways in which decommissioned bogs are being used. Introduce the concept of greenwashing. Ask students to summarise carbon sequestering from the presentation, following a think pair share activity. Visit Google Maps for Irish windfarms https://www.google.com/maps/search/wind+farms+ireland/@53.4184135,-6.7952356,7.77z?entry=ttu With an extension activity to visit to a Bord na Mona case study at https://www.bordnamona.ie/bord-na-mona-submit-planning-application-for-proposed-windfarm-in-co-longford/ Analyse the installation process of a wind turbine and its environmental, economic, and social impacts. Watch and answer questions on Derrinlough windfarm https://youtu.be/BLF8cVlv3Wo?si=kTb5saNgRpcsbRGV Optional extension activity: read Brendan Wyse FG Councilor's opinion on the solar farm. https://brendanwyse.ie/2020/08/08/solar-farm-on-timahoe-north-bog/ Discussion and retrieval on renewable energies as a use for cutaway bogs. Watch the segment on carbon farming from the RTE series Heated 16:06 (minutes) and answer the questions on the student resource booklet. Follow with discussion and viability for Irish farmers. Debate the different points of views using the pros and cons (whiteboards here to document opinions) https://www.rte.ie/player/series/heated/10002421-00-0000?epguid=IP10002422-01-0001 Walking debate "should bogs be decommissioned". Complete the mindmap of Peatland Restoration Interactions & Impacts.
Homework	Peatland Restoration – Bring the Bog Back episode. Bogs: Timelapse from Google Earth https://earthengine.google.com/timelapse/ for Kilmurrays, Derryarkin, Offaly, watch the timelapse from 1984-2022 Click on the map to identify place names (top right-hand corner).

	Describe with evidence how the site of the bog has changed over time (pause if you need to).
Assessment	Assess the work in resource booklet offering formative feedback.

Lesson Eight – Scaffolded Essays

Success Criteria	Complete two scaffolded essays (from LC exams www.examinations.ie)
Learning Activities	Essay: Human Interaction with the Rock Cycle - Quarrying Essay: Environmental Impacts of Economic Activities - Peatlands
Assessment	Correct submitted essays with formative feedback and group feedback. Circulate around the room checking for understanding and offering feedback.

Extra Resources / Sources

https://www.curriculumonline.ie/Senior-Cycle/Senior-Cycle-Subjects/Geography/
https://www.sciencefacts.net/rock-cycle.html
https://www.geoschol.com/ireland.html
https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0
https://cimss.ssec.wisc.edu/sage/geology/lesson1/activity4.htm
https://www.jpl.nasa.gov/edu/teach/activity/modeling-crustal-folds/
https://www.bordnamona.ie/
https://www.bnmpcas.ie/
https://www.tcd.ie/Geology/about/information-schools.php (rock samples)
https://www.insn.ie/events/

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