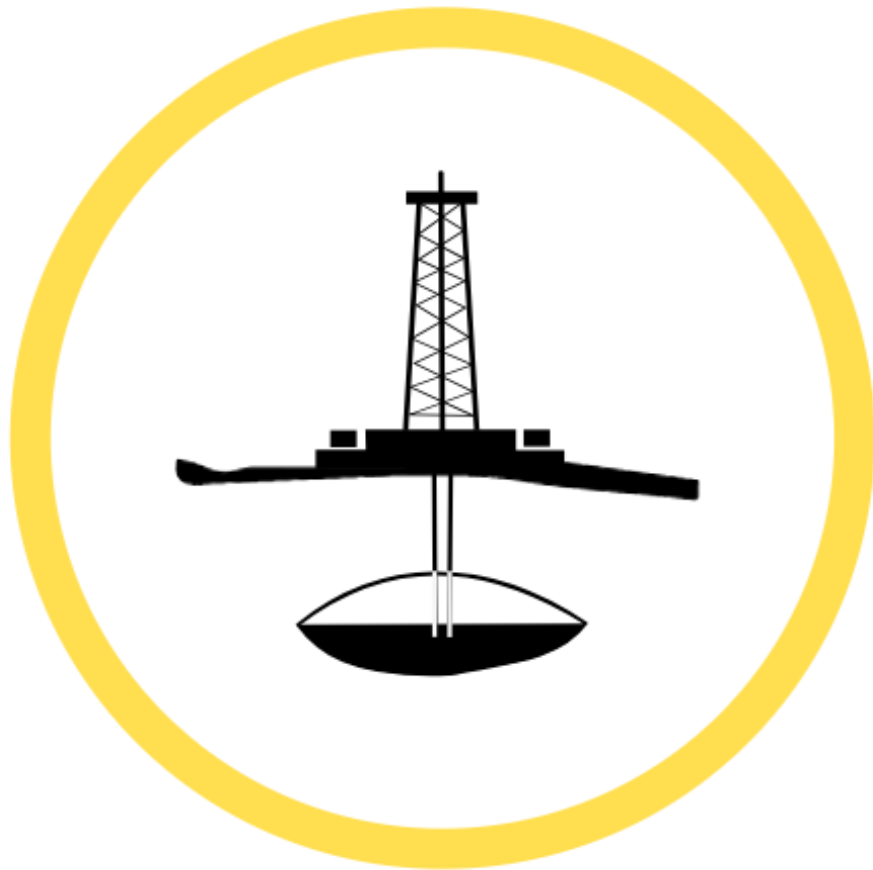
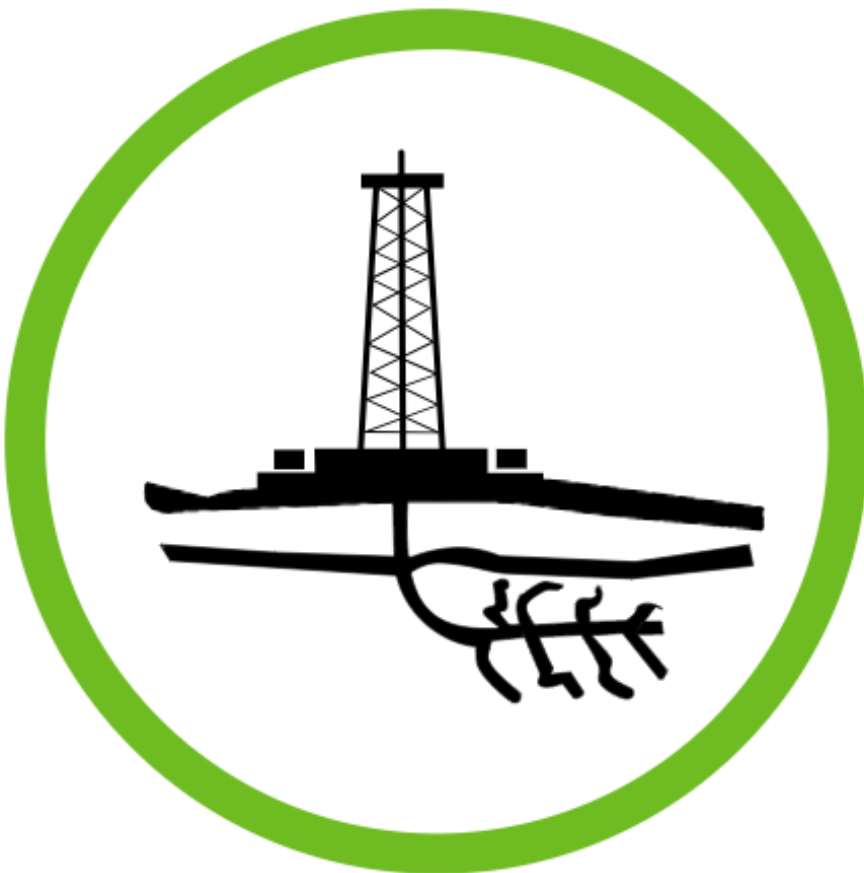


Conventional Hydrocarbon Extraction -



is the extraction of hydrocarbon resources (typically light crude oil and / or gas) from naturally porous and/or permeable geological reservoirs using **natural fluid pressure or standard pumping technologies.**

Unconventional Hydrocarbon Extraction -



is the extraction of hydrocarbons not using standard techniques. Methods include 1) **hydraulic fracturing** to improve reservoir permeability and the release of tightly held gas and

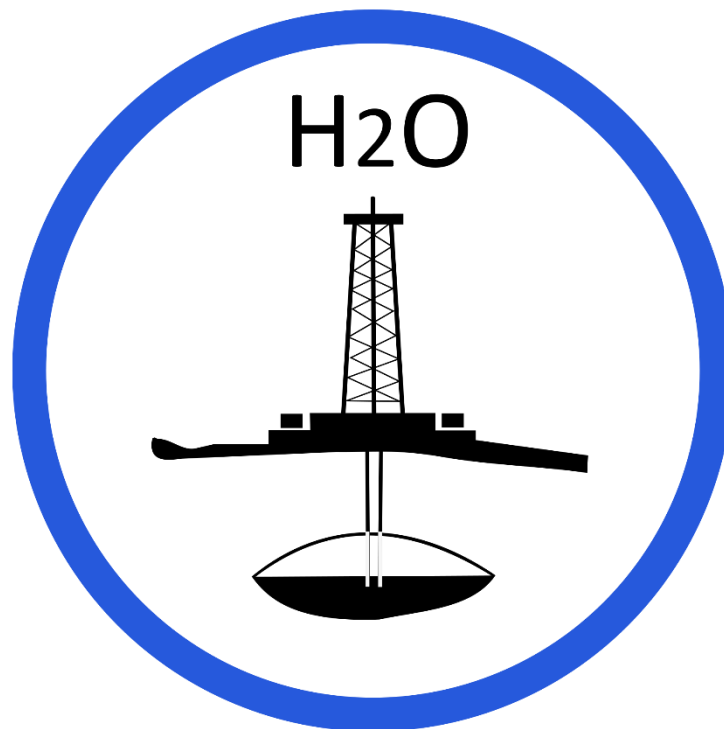
2) the **heating of a geological reservoir** to reduce the viscosity of heavy/ super heavy oils and bitumen.

Underground Mining -



the extraction of raw materials
(rocks and/or minerals) from
the ground.

Wastewater injection -



the injection and disposal of liquid waste/ wastewater (typically from oil and gas exploitation) deep into the ground.

Geothermal Energy Production -



the generation of heat and/or electricity from the extraction of natural heat stored in the Earth. For energy/ electricity production, steam or hot water from the ground is brought to the surface to drive power station turbines.

Reservoir Impoundment -



is the process of filling a water reservoir.

Underground Gas Storage -



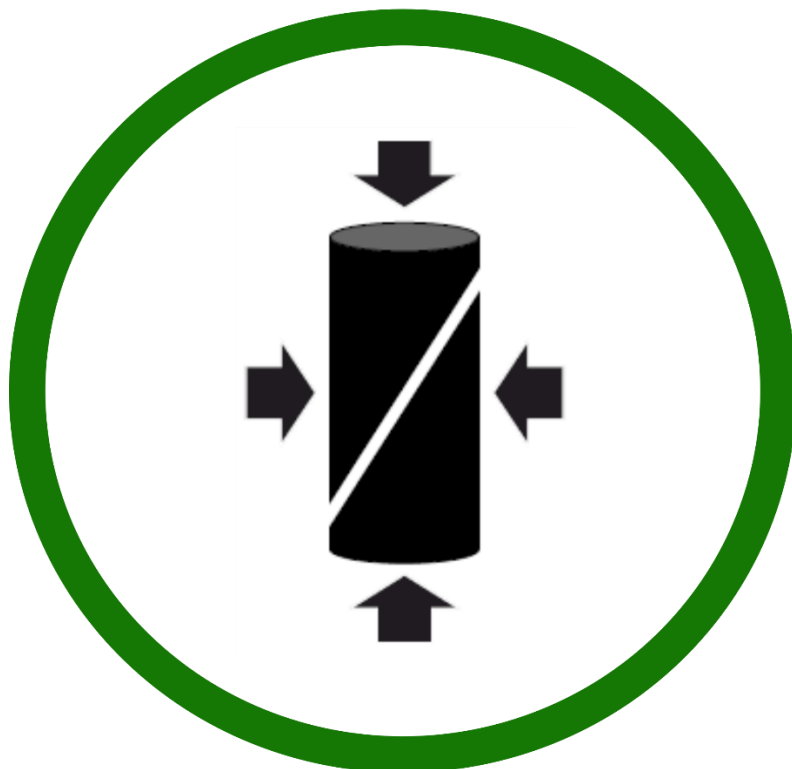
is the below ground storage of gas (e.g. natural methane or hydrogen) in rock formations such as depleted gas fields, aquifers or salt caverns.

CO² Sequestration -



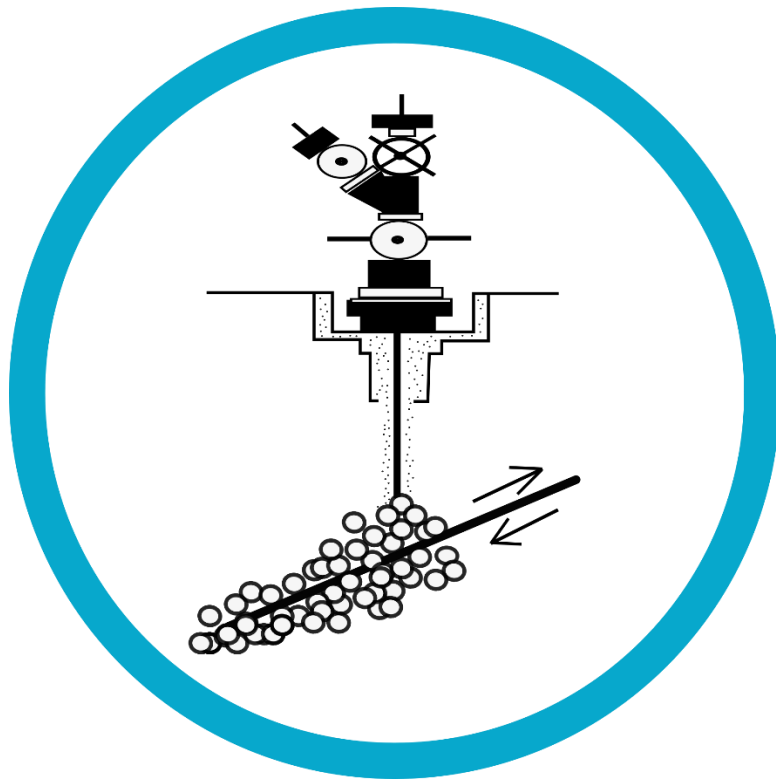
is the capture and long-term storage of carbon dioxide (e.g. underground) to mitigate or defer global warming.

Laboratory Experiment -



is the testing of geological materials in a controlled environment to give insight and quantitative information on physical processes.

Fluid Injection -



is the injection of fluids, typically water or carbon dioxide, into underground rock formations.

Anthropogenic Seismicity Sources Matching Game

1. Cut along the dashed lines to separate the graphics from the terms and definitions.
2. Mix up separated pieces and arrange them face down on a groupwork table.
3. Ask students in pairs or groups to match the terms with a definition and associated graphic.
4. At the end of the exercise one student can be given the correct answers to mark the matches out of 10 and give hints to help correct the remaining incorrect matches.
5. This activity can also be done competitively by being scored and/ or timed.

Intended Learning Objectives-

- Players become familiar with some of the sectors/ industry processes and technologies that can trigger or induce earthquakes (anthropogenic seismicity sources).
- Players learn georesource exploitation methods and terminology.
- The game provides an introduction to, and understanding of the graphics utilised in the EPISODES Platform Research Infrastructure for Anthropogenic Seismicity - <https://episodesplatform.eu/> and can be played alone or before completing the student worksheets in the educational outreach learning package 'Earthquakes caused by humans'.
- **Acknowledgements**
 - This educational outreach material was produced for and part funded by –
 - The European Plate Observing system ([EPOS](#)), Thematic Core Service for Anthropogenic Hazards - [Consortium - TCS AH \(ah-epos.eu\)](#) Section for Promotion & Dissemination and
 - The British Geophysical Association (BGA) Outreach Initiative - [Outreach | The British Geophysical Association \(geophysics.org.uk\)](#)

For queries &/or feedback on this worksheet please get in contact with the author - [Glenda Jones - Keele University](#)



Glossary –

Anthropogenic Seismicity	earthquakes/ tremors/seismic events related to human activity
Carbon Capture & Storage / CO2 sequestration	the process involved in carbon dioxide capture and long-term storage of either atmospheric carbon dioxide or carbon dioxide created by industrial processes to mitigate or defer global warming
Conventional hydrocarbon extraction	extraction of hydrocarbon resources (typically light crude oil and / or gas) from naturally porous and/or permeable geological reservoirs using natural fluid pressure or standard pumping technologies
Episode	grouped dataset comprised of geoscientific and time-correlated industry data
Georesources	economically usable energy, space and raw materials of value from above or below Earth's surface
Geothermal energy production	technology using thermal energy generated and stored in the Earth for heat and/or electricity production
Hydraulic fracturing	fracturing of rock by high pressure fluid injection (most commonly done to release tightly held oil or gas)
Hydrocarbon	hydrogen & carbon compound (e.g. coal, natural gas, crude oil)
Mining	the extraction of raw materials (rock and/or minerals) from underground or above ground (opencast)

Permeable/ permeability	term describing a material that allows the passing of liquids or gas
Porous/porosity	term describing a material with pores/voids/holes (e.g. to hold a gas or liquid)
Reservoir	place where fluids or gas collect (e.g. water dam or sub-surface oil field)
Reservoir impoundment	process of filling a water reservoir
Unconventional Hydrocarbon Extraction	extraction of hydrocarbons not using standard techniques. Methods include hydraulic fracturing (reservoir stimulation) techniques to improve reservoir permeability, and heating of the geological reservoir to reduce the viscosity of heavy, super heavy oils and bitumens.
Underground gas storage	technology of gas storage in sub-surface rock formations
Viscous/viscosity	term describing a material (typically a fluid) that resists flow due to internal friction (in a thick/sticky state)
Wastewater injection	injection of waste fluids into rockmass (typically from hydraulic fracturing operations)