Geoscience

SPE Seminar: Introduction to E&P
The Geological Society
30 November 2023

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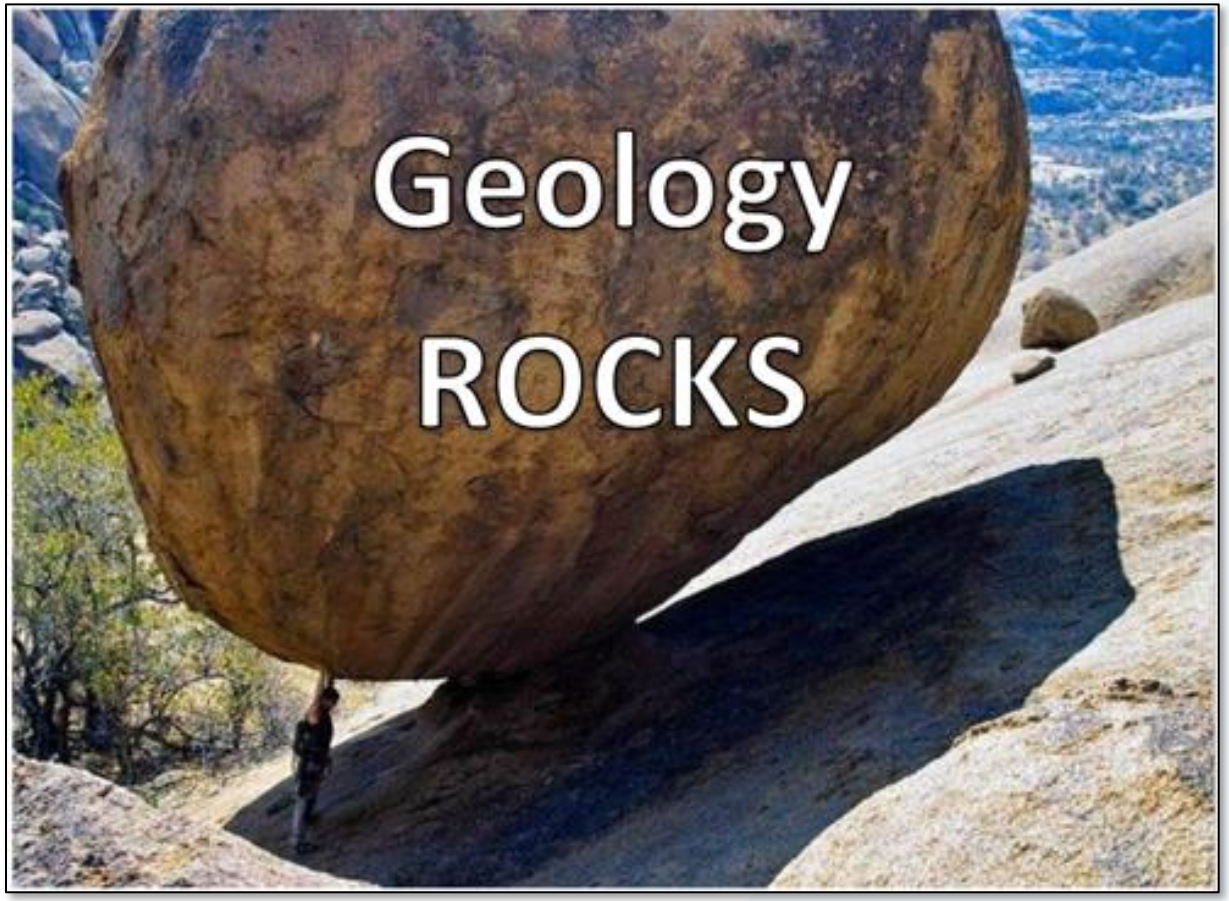
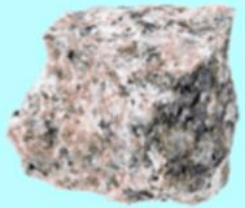
Contents



Types of Rocks

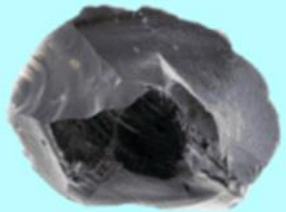
Igneous

- Forms from magma or lava solidification
- Hard, no layers



Granite

Intrusive
slow magma cooling



Obsidian

Extrusive
rapid lava cooling

Sedimentary

- Forms from sediment compaction
- Crumbly, layered

Sandstone

Clastic
compacted broken rocks

Limestone

Chemical
compacted dissolved minerals

Coal

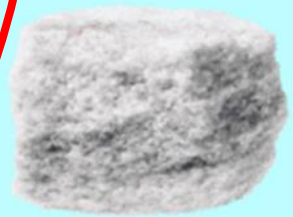
Organic
compacted biogenic matter

Metamorphic

- Forms by transformation of other rocks
- Relatively hard, may or may not have layers

Slate

Foliated
has layers



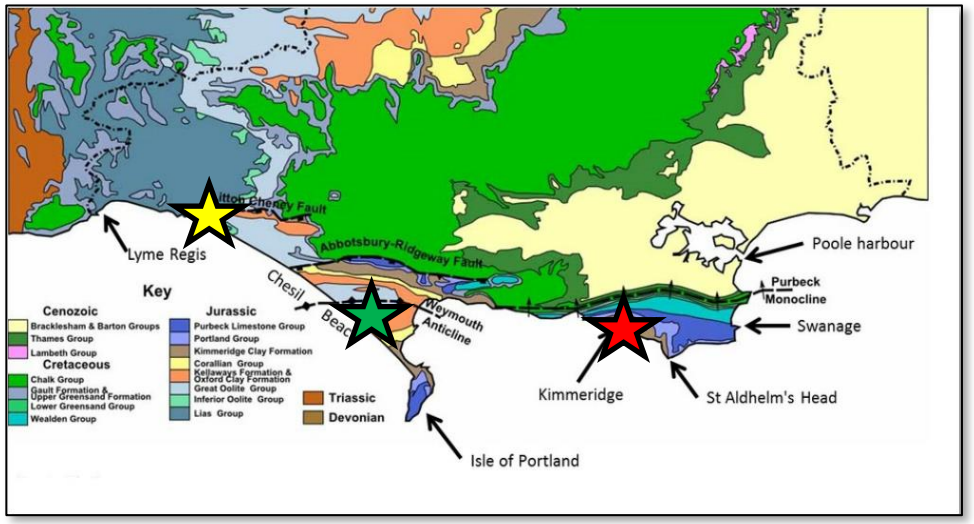
Marble

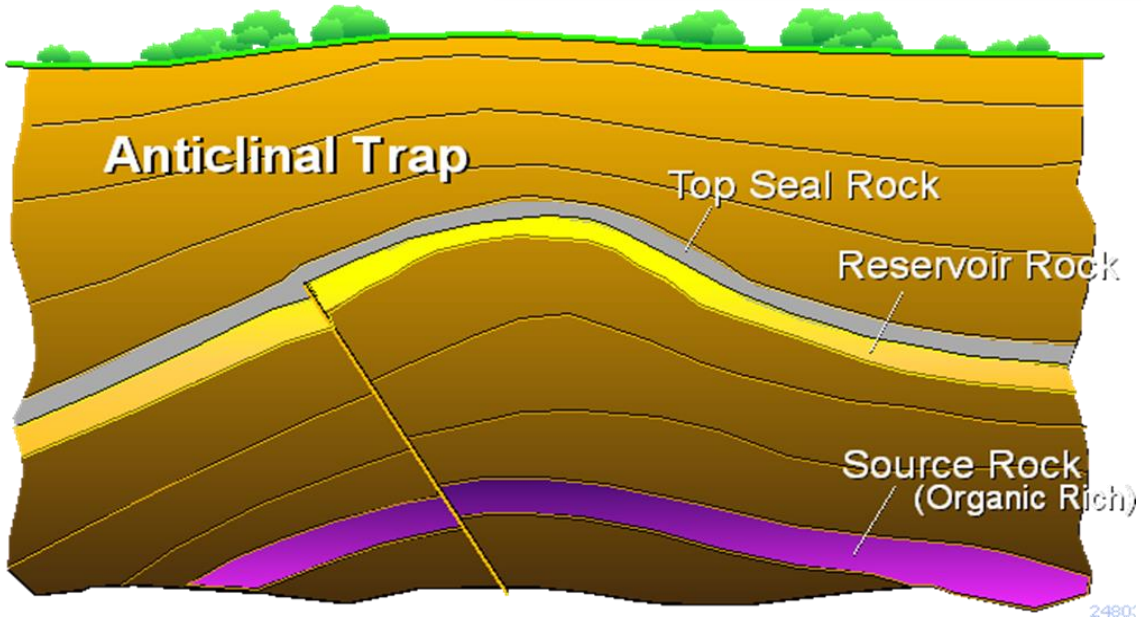
Non-Foliated
no layers

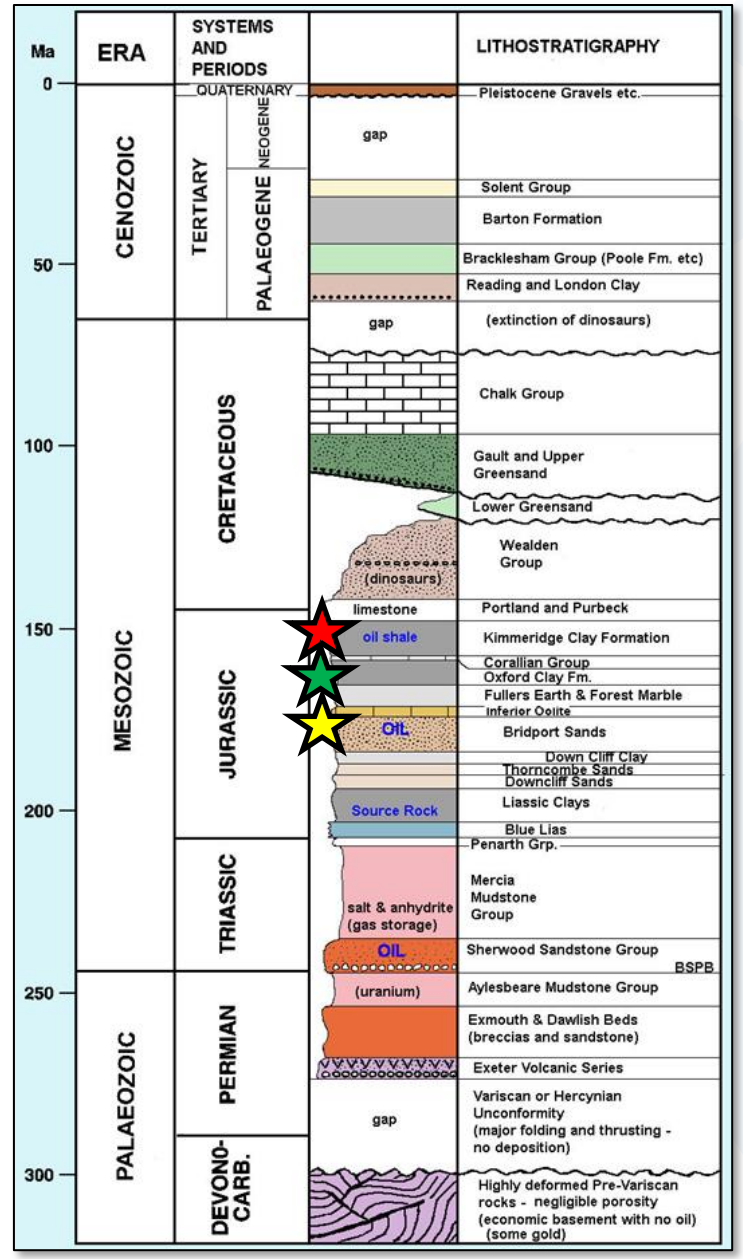
sciencenotes.org

Petroleum System

- Source Rock
- Reservoir Rock
- Seal / Cap Rock
- Trap







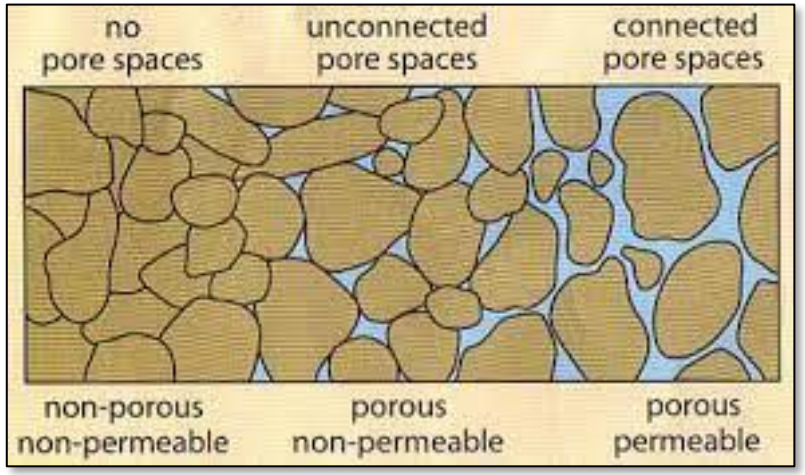
Source Rock

- Buried organic matter
- Anoxic conditions (lack of oxygen)
- Maturation through pressure & temperature
- Oil window: 60–120 °C, 2-4 km
- Gas window: 120–180 °C, 4-6 km

Photo: Ian West (https://wessexcoastgeology.soton.ac.uk/index.htm)

Reservoir Rock

- **Globally, nearly all reservoir rocks are either carbonates or sandstones**
- **Good porosity**
  - Storage of hydrocarbons
- **Good permeability**
  - Flow of hydrocarbons



Source: UC Denver

Photo: The Guardian online

West Bay – Bridport Sandstone

Photo: West Bay Photography

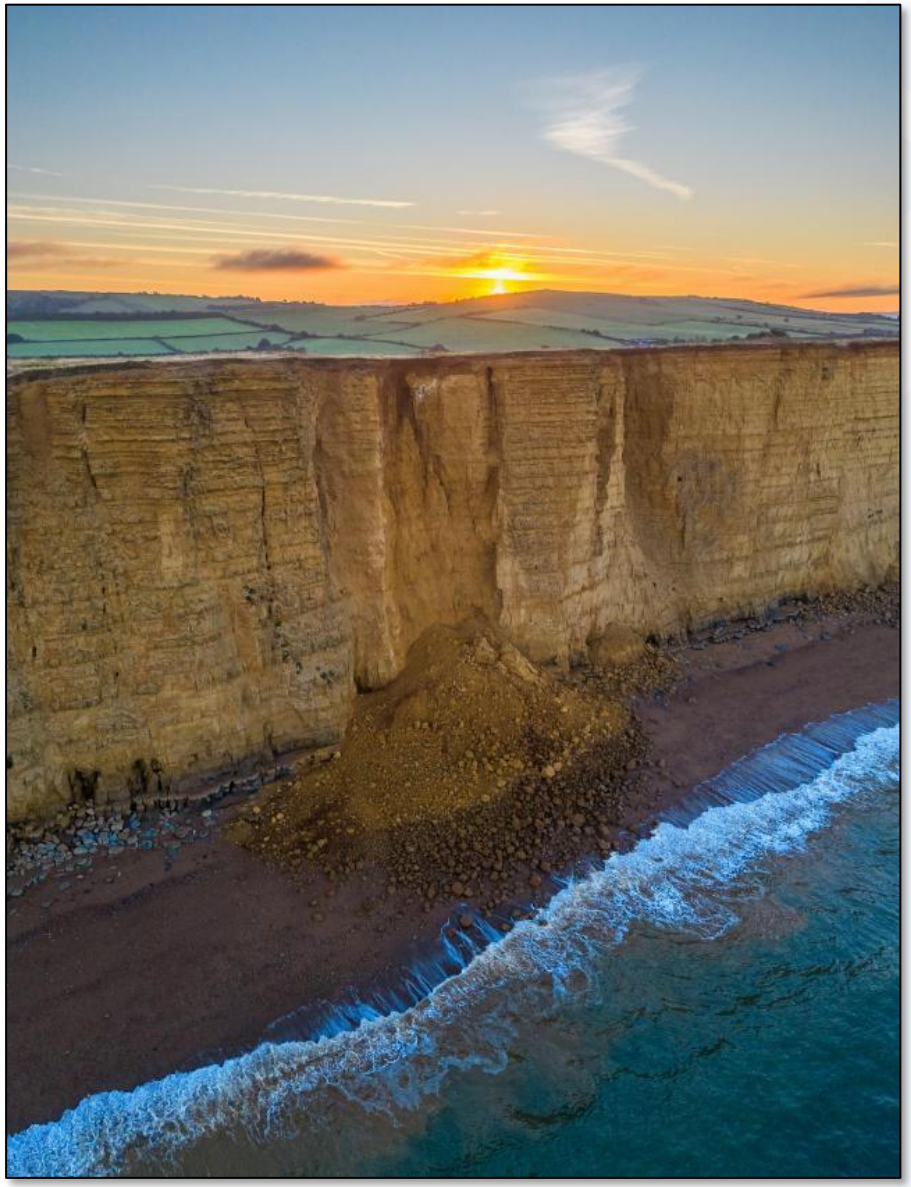


Photo: West Bay Photography

Seal Rock / Cap Rock

- Impermeable layer above the reservoir rock
- Typically composed of shale, chalks, clays, anhydrite or salt

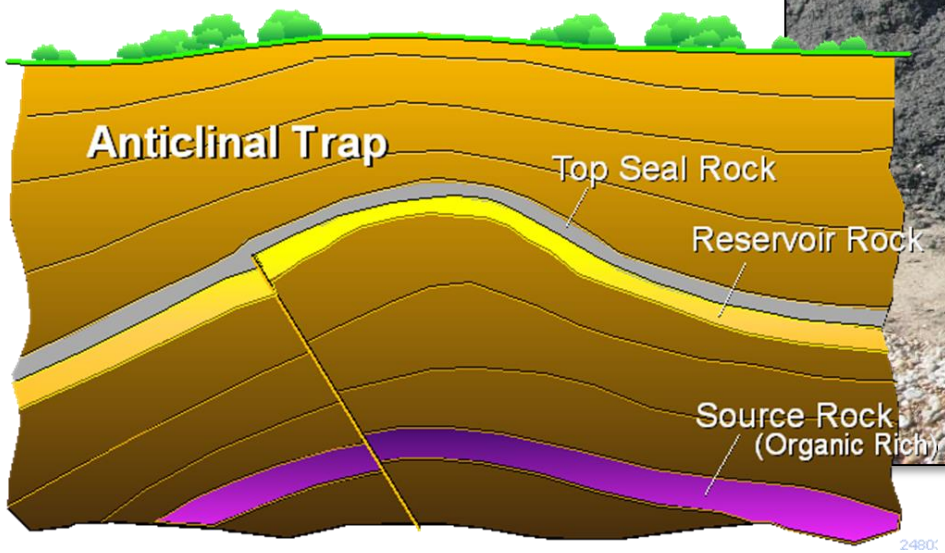
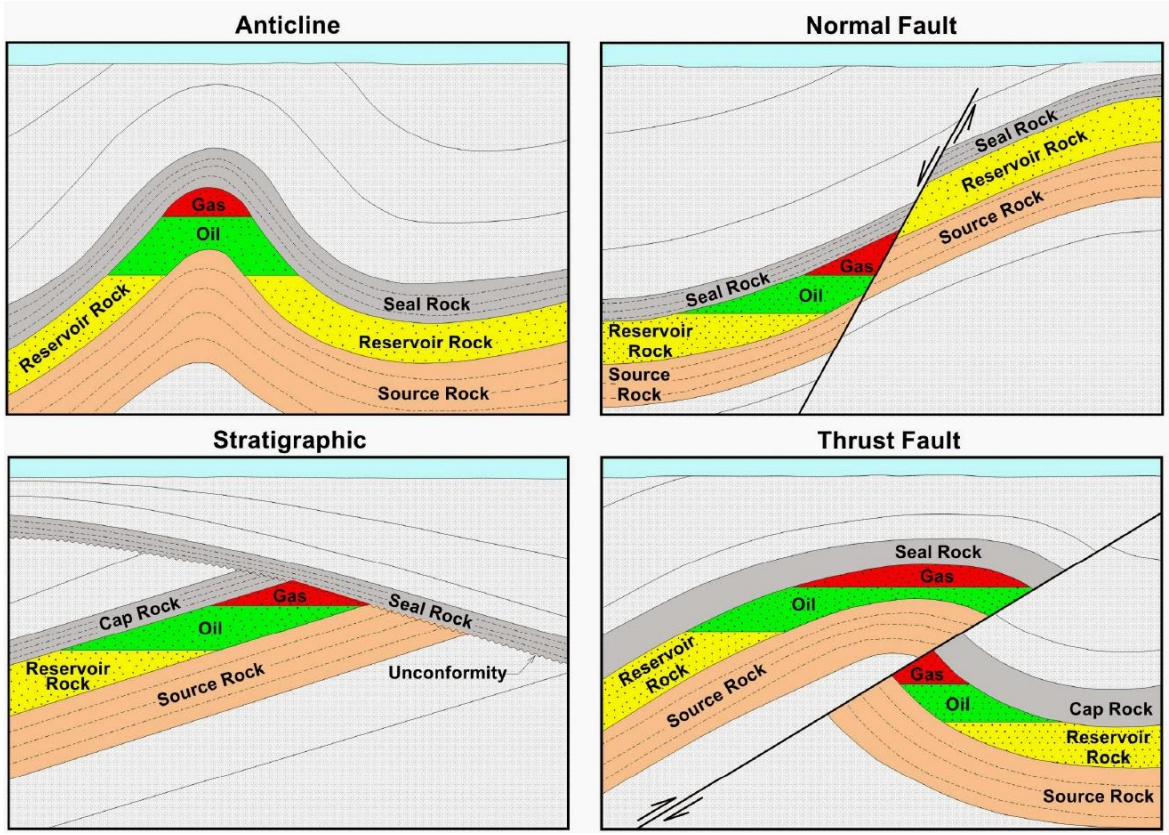


Photo: Ian West (https://wessexcoastgeology.soton.ac.uk/index.htm)

Trap

- Oil & gas less dense than water
- Structure required to retain/capture the hydrocarbons



GeologyIn (https://www.geologyin.com)

Photo: Ian Patterson (https://www.geography.org.uk)

Photo: Ian West (https://wessexcoastgeology.soton.ac.uk/index.htm)

Well Data

- Cuttings
- Core Data
- Logging Data

Cuttings at the rig site

Photo: Geodata & Drilling (www.geodatadrilling.com)

Photo: Geolotec (www.geolotec.com)

Geologist: *Is a person that studies geology*

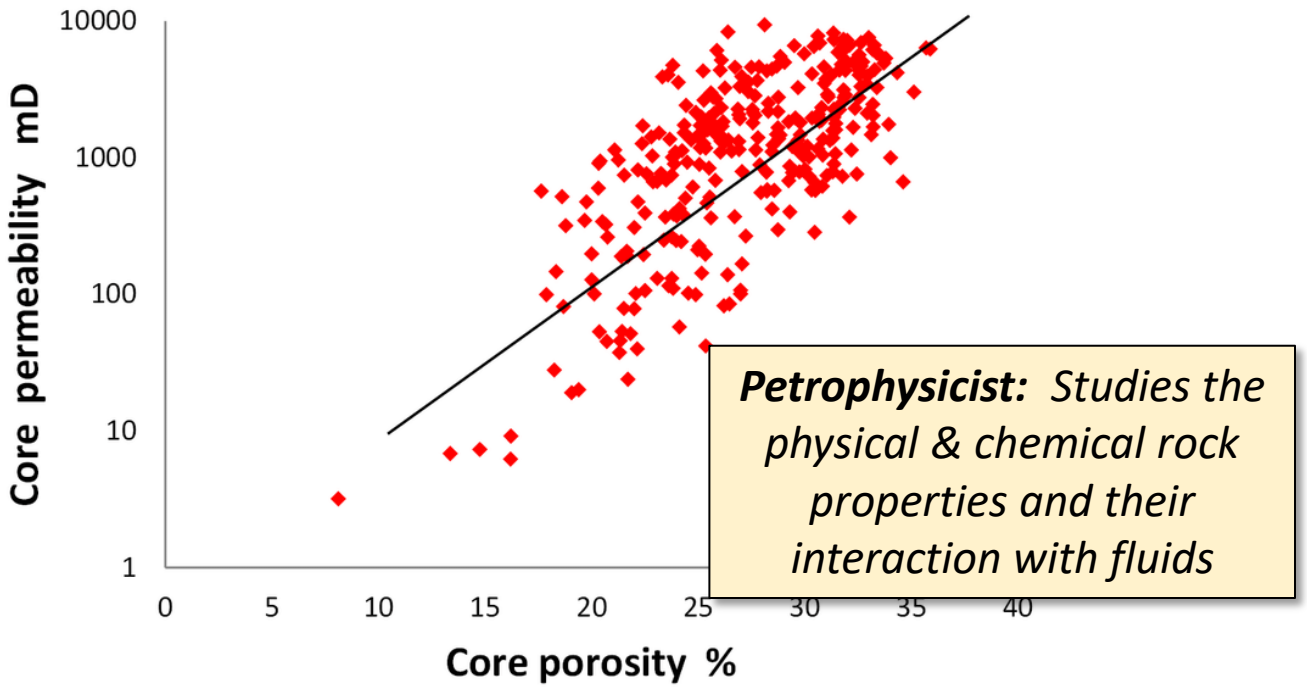
Core

Photo: West Michigan University

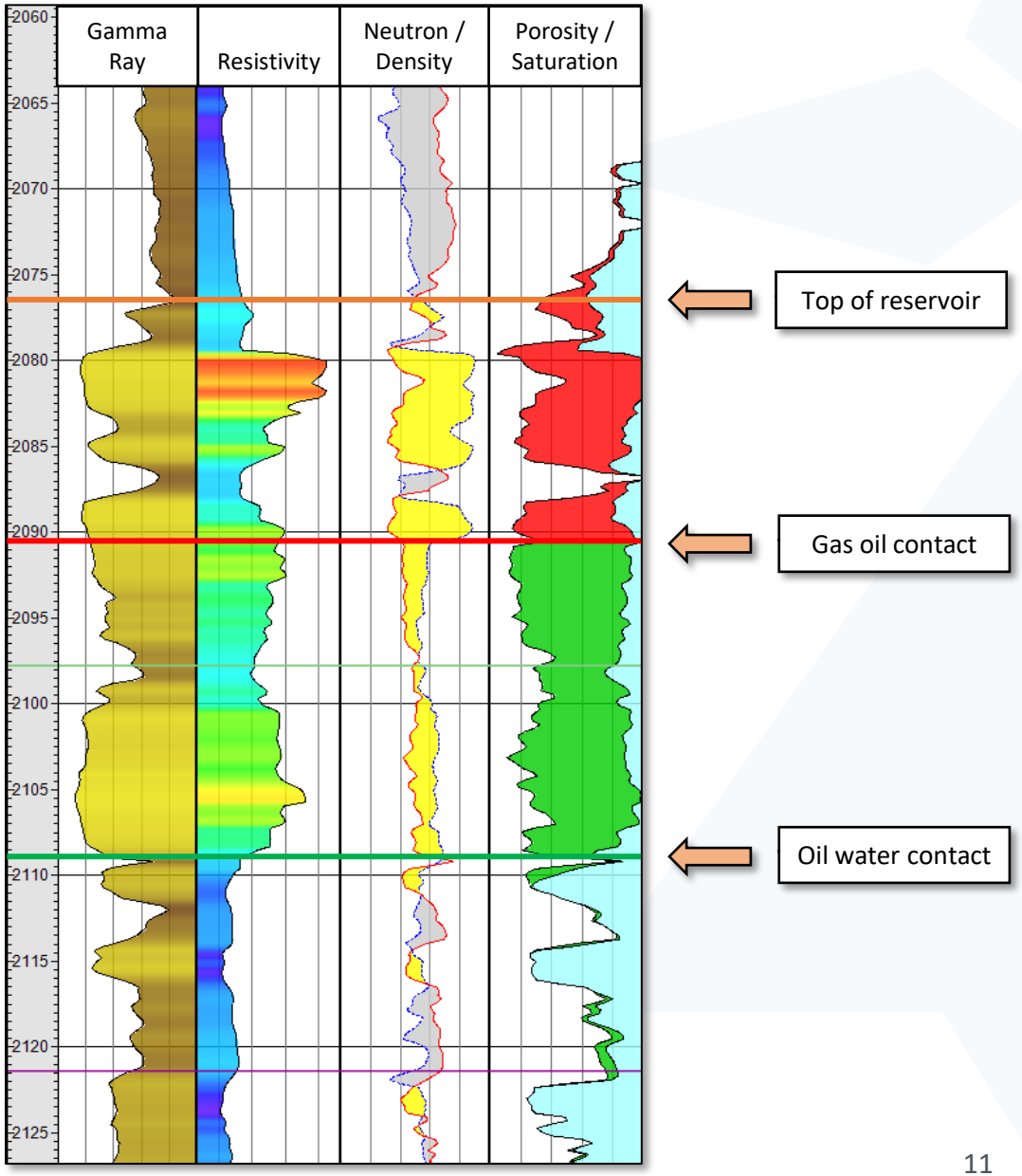
Logging Tools

Interpretation of Well Data

- **Petrophysicist analyses the acquired log data**
- **Core data integrated with log interpretation**
- **Results of well data analysis tell us:**
  - Depth of reservoir
  - Porosity
  - Saturation (ratio of hydrocarbons to water)
  - Reservoir thickness (gross & net)
  - Hydrocarbon type

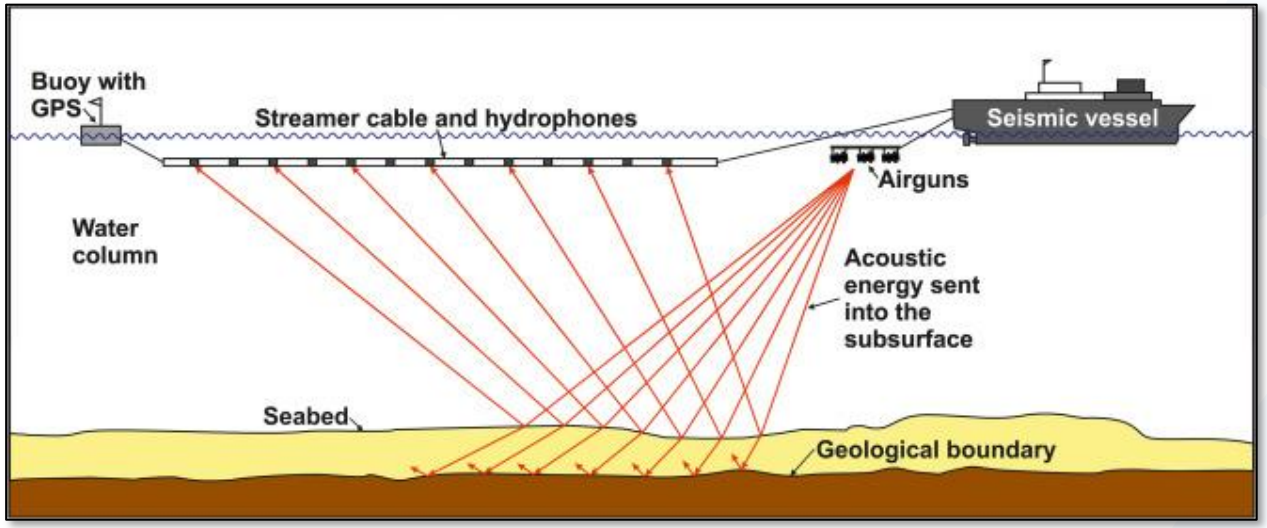


Petrophysicist: *Studies the physical & chemical rock properties and their interaction with fluids*

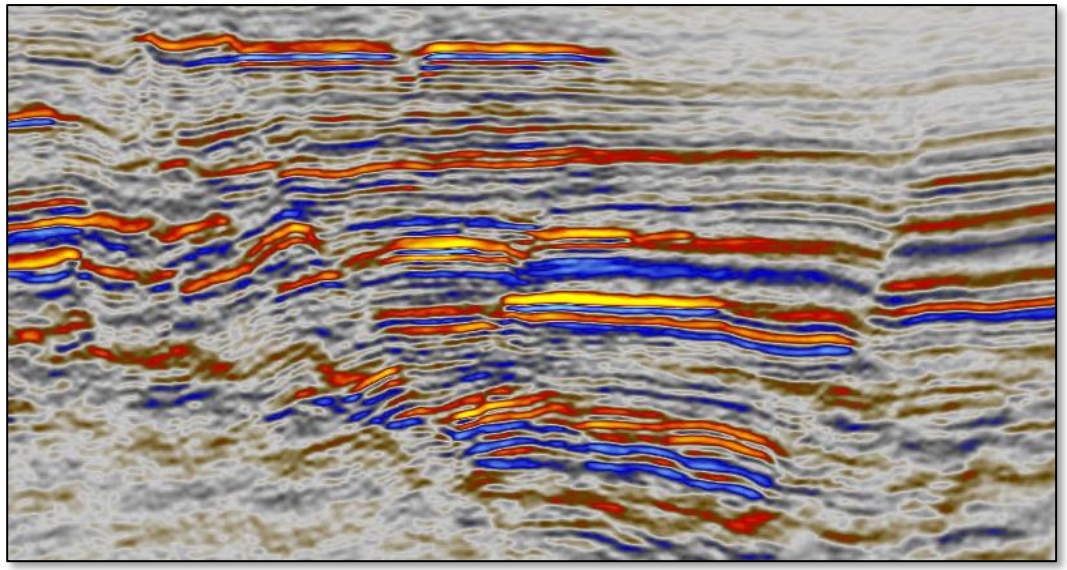


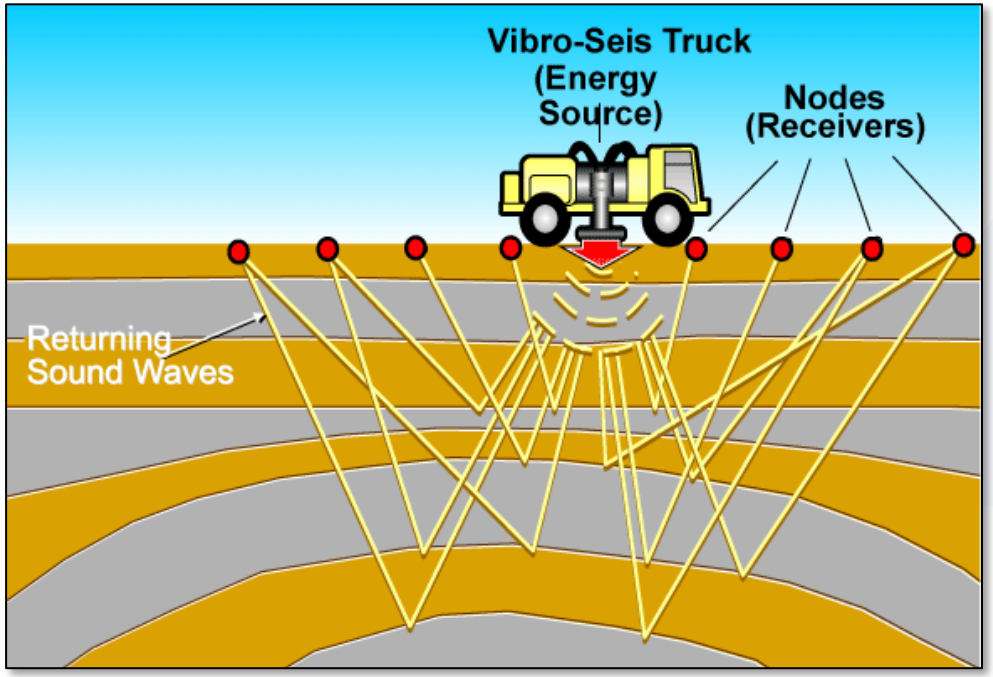
Seismic Data

- **Technique uses sound energy:**
  - Sound energy is transmitted into the earth with energy reflected back of rock layers
- **Seismic surveys can be undertaken onshore & offshore**
- **Extensive data processing undertaken to produce an image of the subsurface / rock layering**
- **Surveys undertaken as 2D profiles or 3D volumes**



Cox, D., et. al., 2020





GeoSiam (https://www.geosiamservices.com)

Seismic Surveys

- Seismic surveys undertaken onshore and offshore

Onshore: Vibroseis Truck

Offshore: Seismic Vessel

Onshore: Urban Acquisition

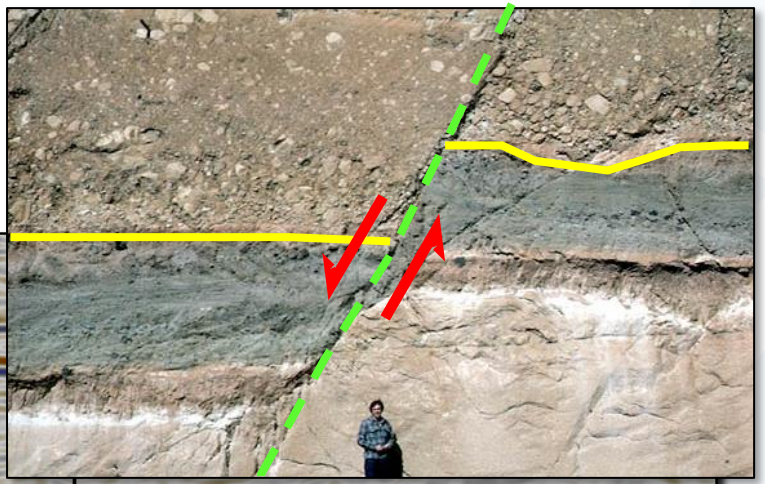
Signall Hill Petroleum

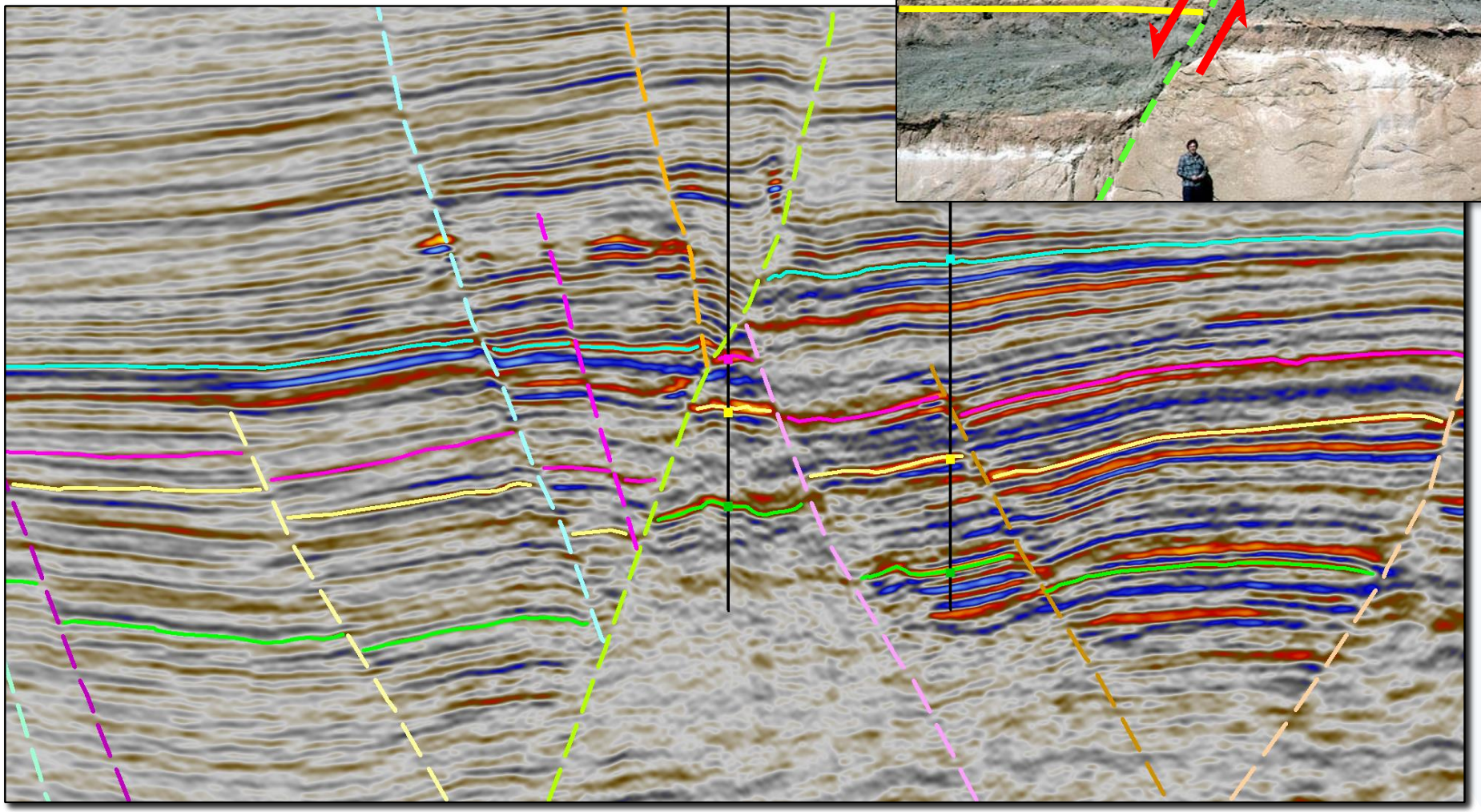
Seismic Interpretation

PERENCO

- **Well data guides interpretation (well-to-seismic tie)**
- **Interpret faults**
- **Interpret horizons**
  - Representing rock layer boundaries

Geophysicist: *Studies the physical properties of the earth*

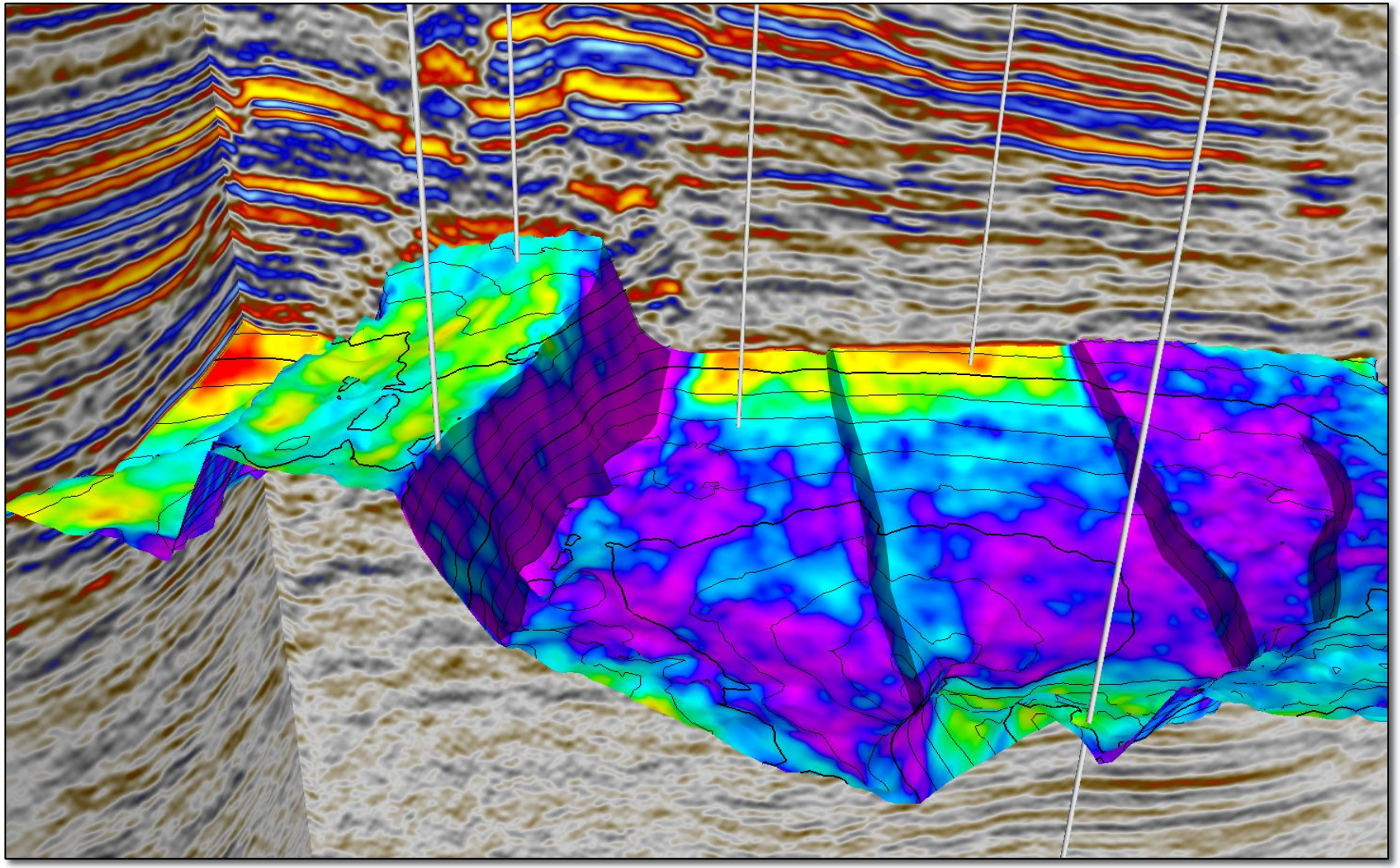




Seismic Interpretation

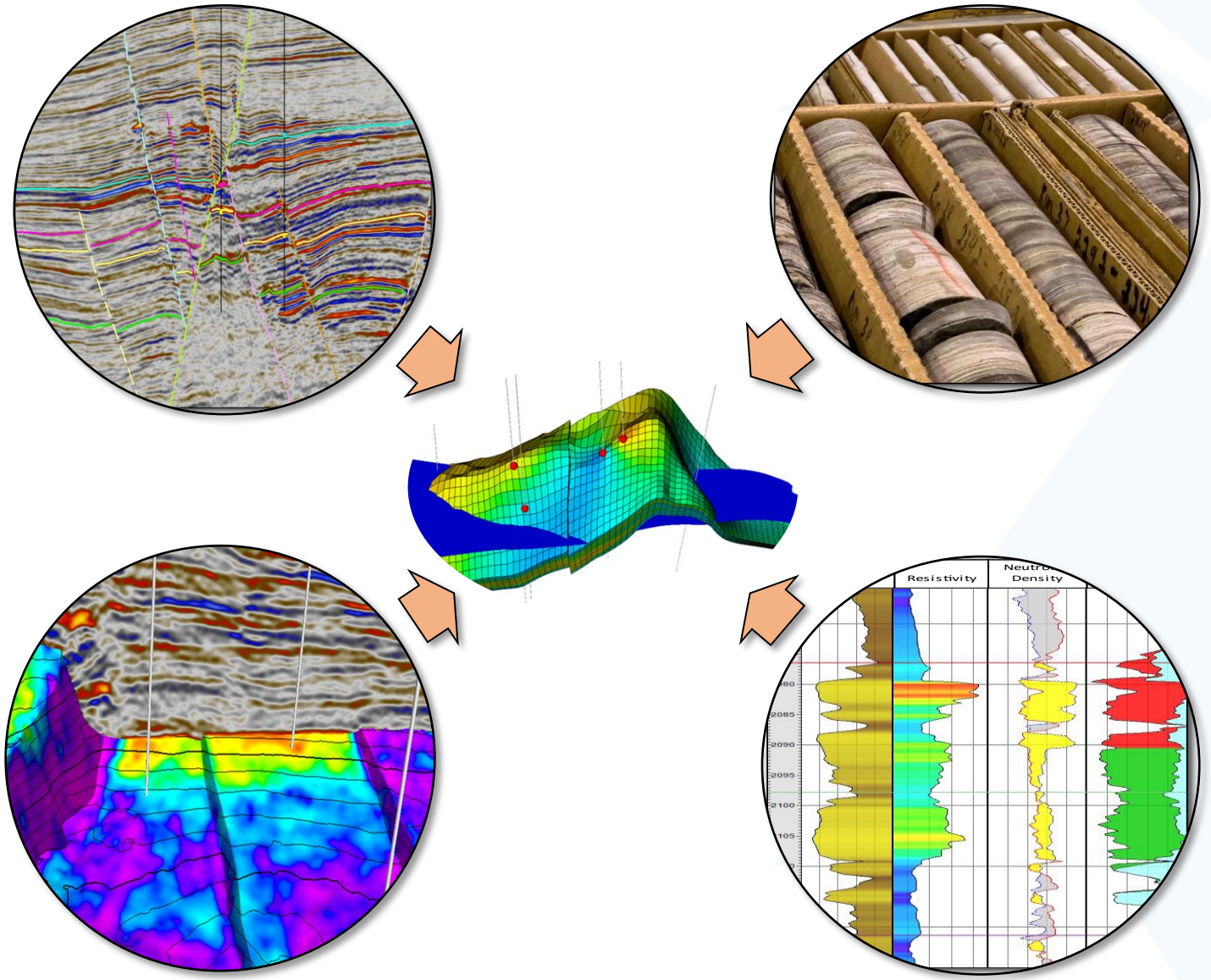
PERENCO

- **Make a structure map**
- **Project seismic attributes onto map**
- **Sound waves can be impacted by the fluid fill in the reservoir rock**
  - DHI (Direct Hydrocarbon Indicator)



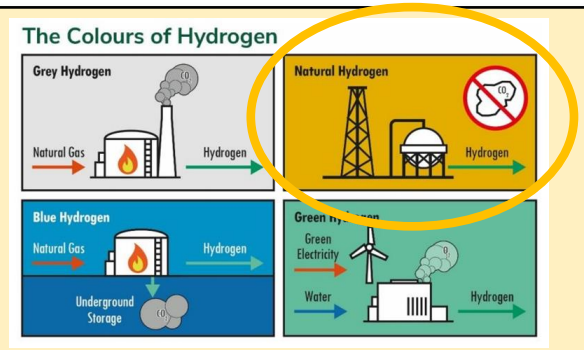
Petroleum System Evaluation

- **Integrate all geological & geophysical data and interpretations**
  - Petroleum system evaluated
- **Results in a subsurface model - Used for:**
  - Prospect size & risk
  - Field development
  - Well locations

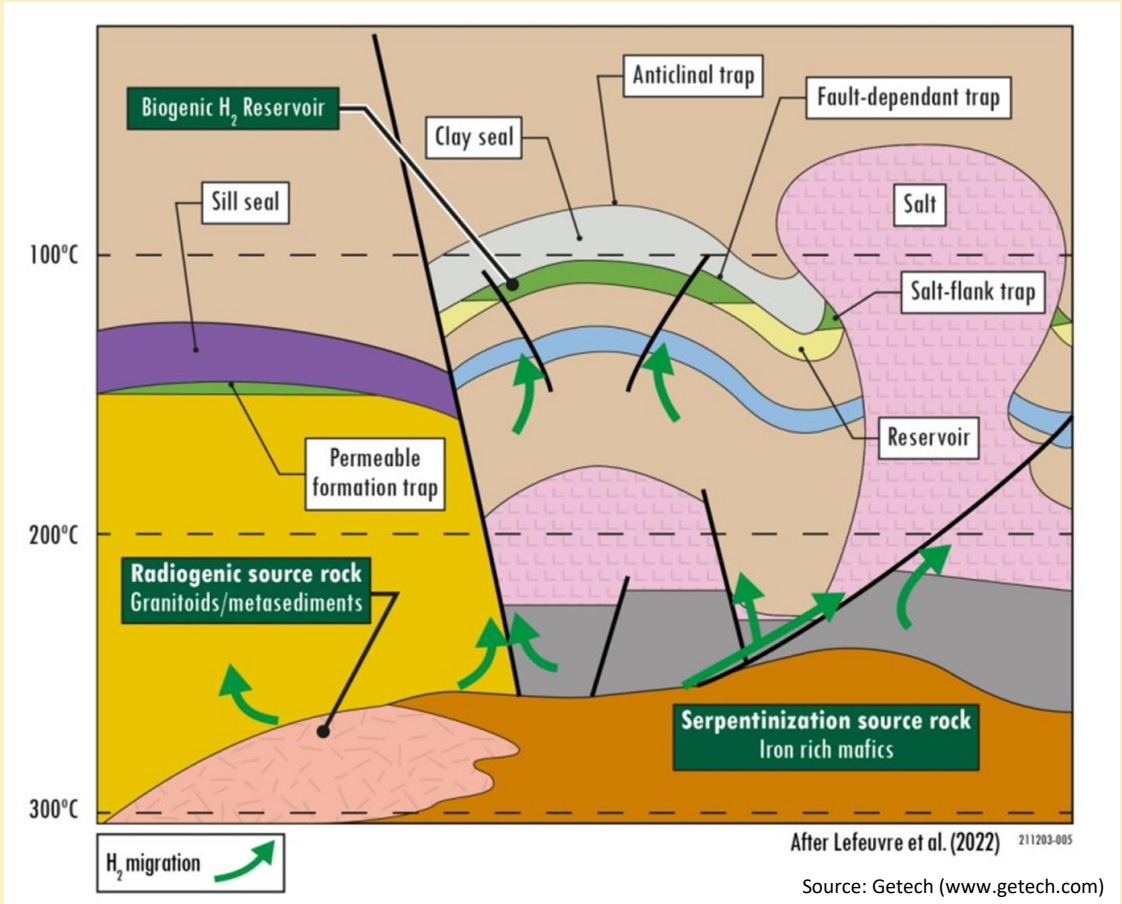


Geoscience in the Energy Transition

PERENCO

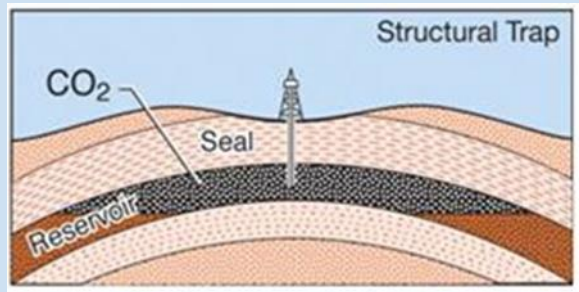


- **Natural Hydrogen / Gold Hydrogen**
  - Analogous to the petroleum system

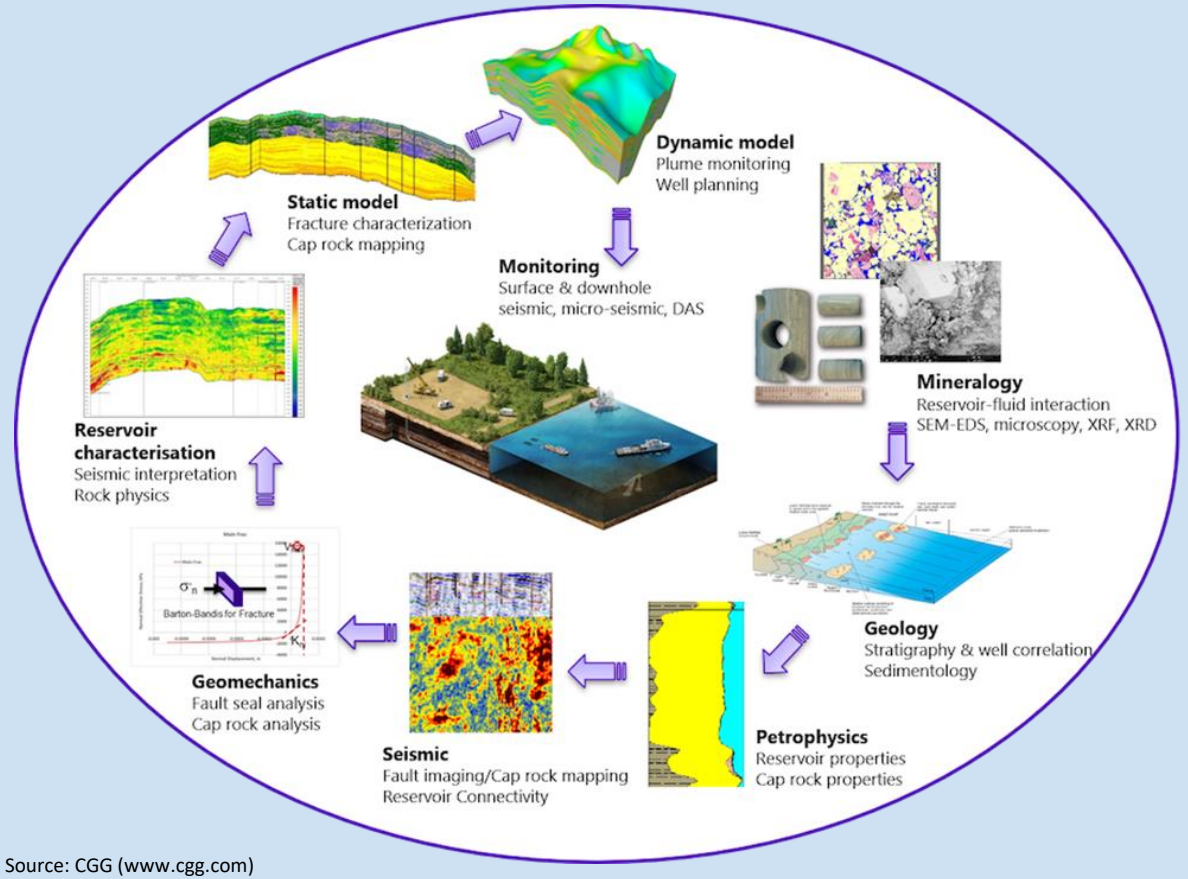


Source: Getech (www.getech.com)

- **CCS (Carbon Capture & Storage)**
  - Same geological & geophysical data, and interpretation & modelling techniques to the petroleum system evaluation



Source: National Energy Technology Laboratory (https://netl.doe.gov/)

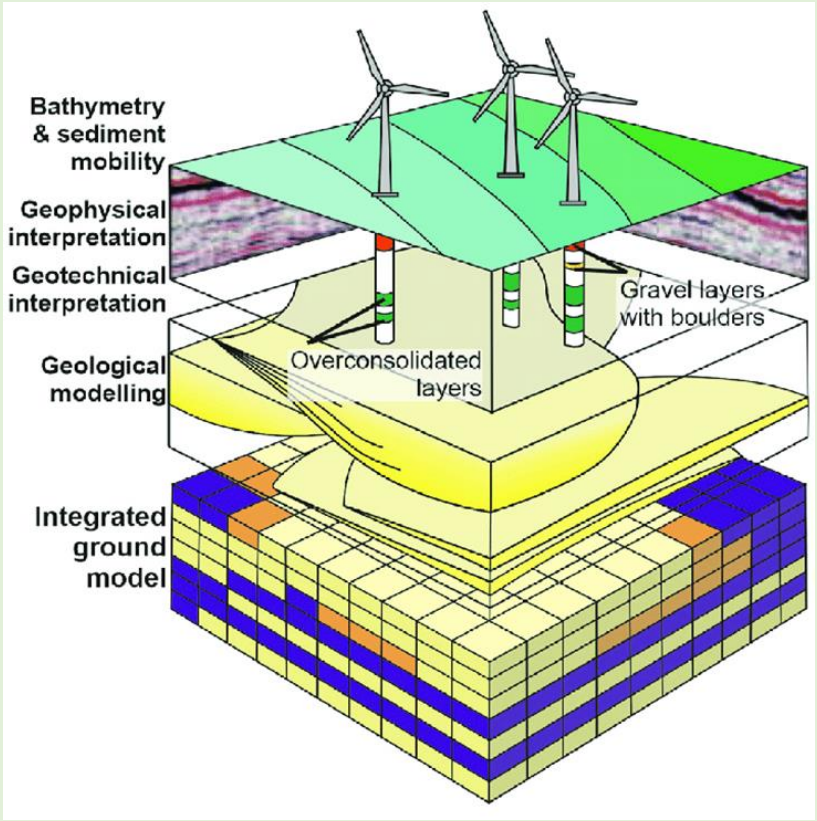


Source: CGG (www.cgg.com)

Geoscience in the Energy Transition

PERENCO

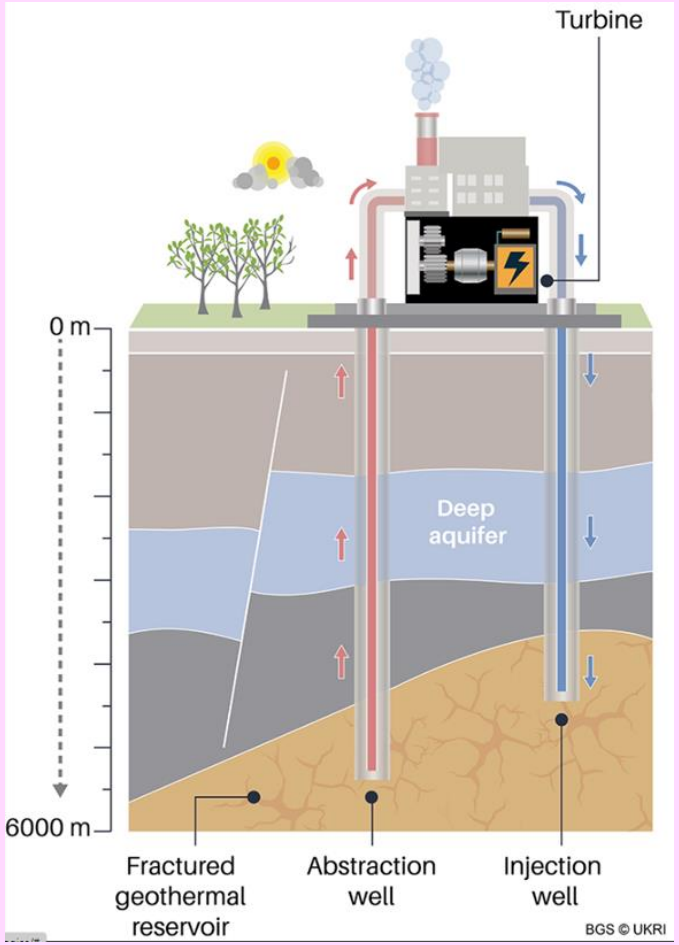
- **Wind Energy**
  - Same data types, interpretation methods as used to evaluate the petroleum system
  - Applied at a different scale and for a different purpose



Velenturf et al., 2021 (Geoscience Solutions for Sustainable Offshore Wind Development. Earth Sci. Syst. Soc. 1:10042

- **Geothermal Energy**
  - Understanding the geology key to the success of geothermal projects

Photo: Geograph (www.geography.org.uk)

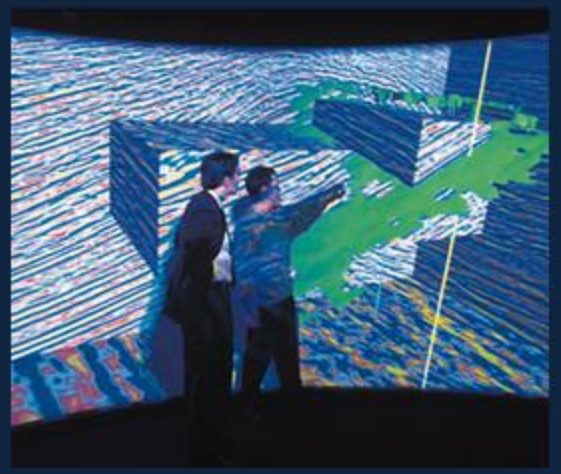


Source: BGS (www.bgs.ac.uk)

Geologist

What my friends think I do

What society thinks I do



What my boss thinks I do

What my spouse thinks I do

What I think I do

What I actually do