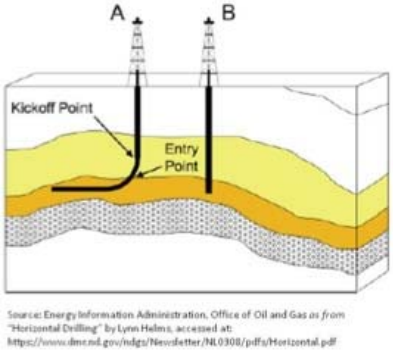
Overview of Petroleum Exploration Methods

I. Drilling Techniques
   a. Cable Tool Drilling – percussion drilling, natural borehole fracturing
      https://www.youtube.com/watch?v=H6N0x8BnOKE
   b. Rotary Drilling
      i. Air Rotary
      ii. Mud Rotary – rotary bit drilling
      https://www.youtube.com/watch?v=FyZtV57eR8g

   c. Directional Drilling
      i. vertical drilling
      ii. horizontal drilling

      Horizontal drilling is a **drilling** process in which the well is turned **horizontally** at depth. It is normally used to extract energy from a source that itself runs **horizontally**, such as a layer of shale rock. **Horizontal drilling** is a common was of extracting gas from the Marcellus Shale Formation.



Source: Energy Information Administration, Office of Oil and Gas *as from* "Horizontal Drilling" by Lynn Helms, accessed at: https://www.dmr.nd.gov/ndgs/Newsletter/NL0308/pdfs/Horizontal.pdf

II. Borehole Geophysics ("wireline geophysics")
   Overview of Wireline Operations (2 min)
   https://www.youtube.com/watch?v=VGh9vRFggF8
   What is well logging?
   https://www.youtube.com/watch?v=1RJY4hCiWC4

   a. Physical Logs
      i. Caliper Logging

      A **caliper log** is a well logging tool that provides a continuous measurement of the size and shape of a borehole along its depth[1] and is commonly used in hydrocarbon exploration when drilling wells. The measurements that are recorded can be an important indicator of cave ins or shale swelling in the borehole, which can affect the results of other well logs.

      ii. Temperature Logging
      iii. Pressure Logging

   b. Electric Logs
      i. SP logging - spontaneous potential

      The **spontaneous potential log**, commonly called the **self potential log** or **SP log**, is a passive measurement taken by oil industry well loggers to characterise rock formation properties. The log works by measuring small electric potentials (measured in millivolts) between depths in the borehole and a grounded electrode at the surface. Conductive bore hole fluids are necessary to create a SP response, so the SP log cannot be used in nonconductive drilling muds (e.g. oil-based mud) or air filled holes.[1]

ii. Resistivity Logging

Resistivity logging is a method of well **logging** that works by characterizing the rock or sediment in a borehole by measuring its electrical **resistivity**. **Resistivity** is a fundamental material property which represents how strongly a material opposes the flow of electric current.

c. Radioactivity Logs

i. Natural Gamma Ray Logging

Gamma ray logging is a method of measuring naturally occurring gamma radiation to characterize the rock or sediment in a borehole or drill hole. It is a wireline logging method used in mining, mineral exploration, water-well drilling, for formation evaluation in oil and gas well drilling and for other related purposes.[1] Different types of rock emit different amounts and different spectra of natural gamma radiation. In particular, shales usually emit more gamma rays than other sedimentary rocks, such as sandstone, gypsum, salt, coal, dolomite, or limestone because radioactive potassium is a common component in their clay content, and because the cation exchange capacity of clay causes them to absorb uranium and thorium. This difference in radioactivity between shales and sandstones/carbonate rocks allows the gamma tool to distinguish between shales and non-shales.

ii. Neutron Logging

iii. Density Logging

SP and Gamma Ray Logs
https://www.youtube.com/watch?v=VeWJ9chFjo8&list=PLUoci1lKZF8K9mEg22FBW4jibNbY59y7z

d. Sonic (Acoustic) Logs

e. Combination Logs

f. Dip Meter Logs

dipmeter log A down-hole geophysical log designed to measure the dip and dip direction of dipping surfaces in a borehole. The logging tool consists of four resistivity logging devices set at 90° to one another, and held against the side of the borehole (see RESISTIVITY LOG; and RESISTIVITY METHODS). When wound back to the surface they respond instantly to layers of differing electrical resistivity (e.g. a clay horizon or porous sands) associated with the bedding, while dipping beds produce a response with a time delay related to the dip of the horizon. Computer processing of the data yields a tadpole plot of dips and dip directions in the well.

g. Borehole Imaging

Well-Log Interpretation
https://www.youtube.com/watch?v=mZ4v-YI541Q

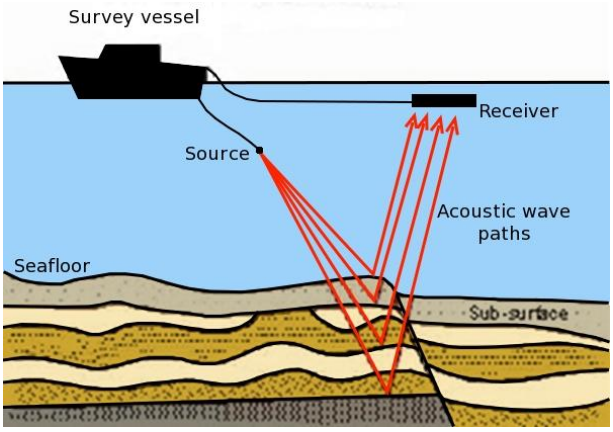
III. Surface Geophysics

a. Gravity Surveying

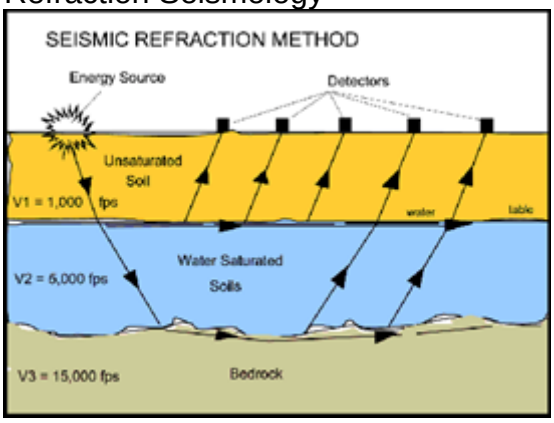
b. Magnetic Surveying

c. Seismic Surveying
    i. Reflection Seismology

Youtube (2 min) https://www.youtube.com/watch?v=H6FPfGe9lIo



ii. Refraction Seismology



IV. Remote Sensing
    a. Conventional Aerial vs. Satellite Imaging
    b. Visual Remote Sensing
    c. Radar and Lidar
    d. Multispectral Scanning

V. Subsurface Geologic Mapping

    a. Geological Cross Sections
        i. Well Log Correlation
        ii. Stratigraphic Analysis

    b. Geological Mapping
        i. Facies Maps
        ii. Isopach Maps
        iii. Structure Contour Maps
    c. Seismic Modelling
        i. Seismic Facies Analysis
        ii. Seismic Sequence Analysis
        iii. 3-D Seismic Modelling