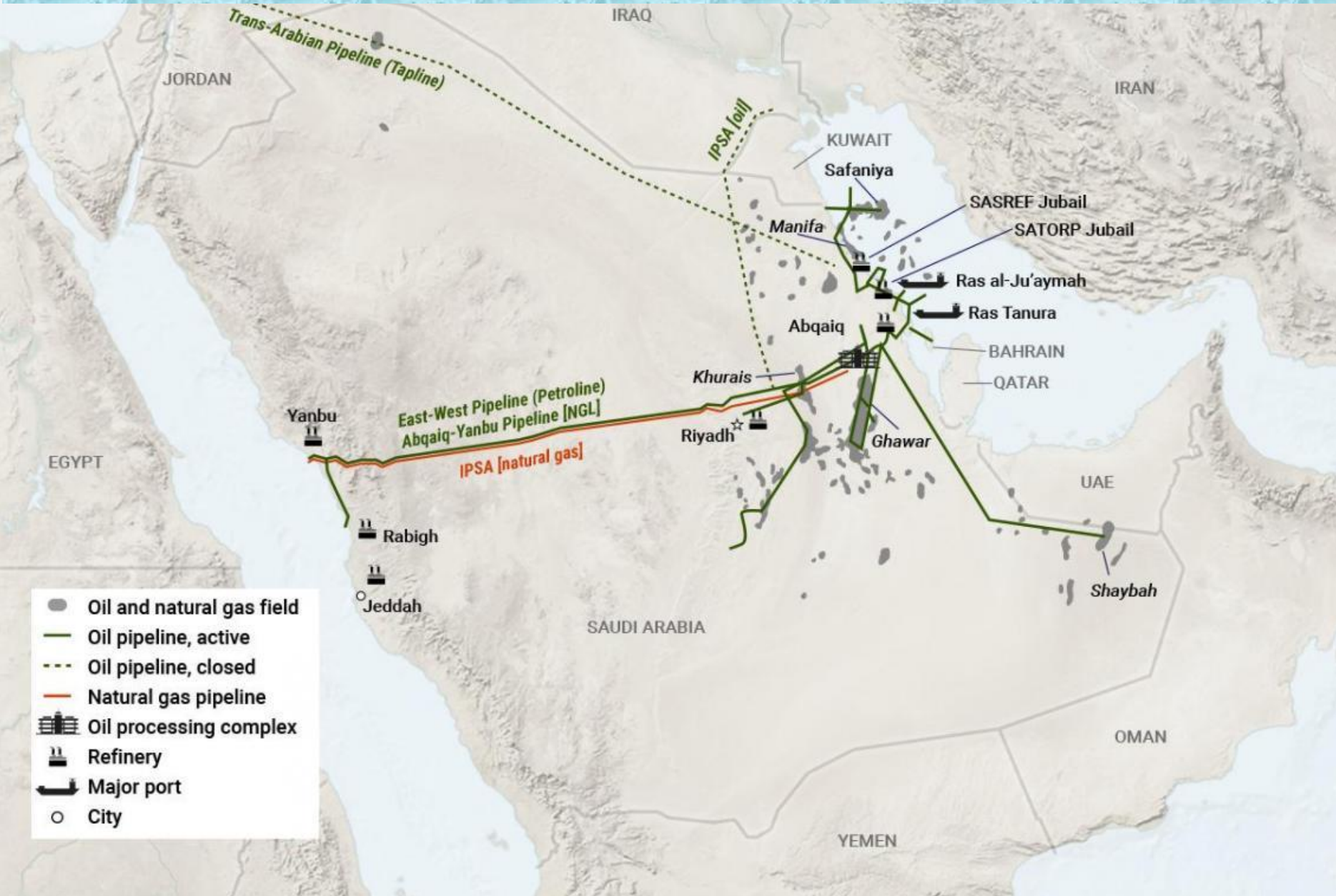


Petroleum Geology (Geo 452)



□ **Student Learning Objectives:**

- Petroleum system elements
- Petroleum system processes
- Origin of Petroleum
- Source Rock Analysis
- Reservoir Properties
- Identify Hydrocarbon Traps
- Sedimentary Rocks and Petroleum Systems
- Sedimentary Basins and Petroleum Systems
- Petroleum Exploration

□ Petroleum Geology

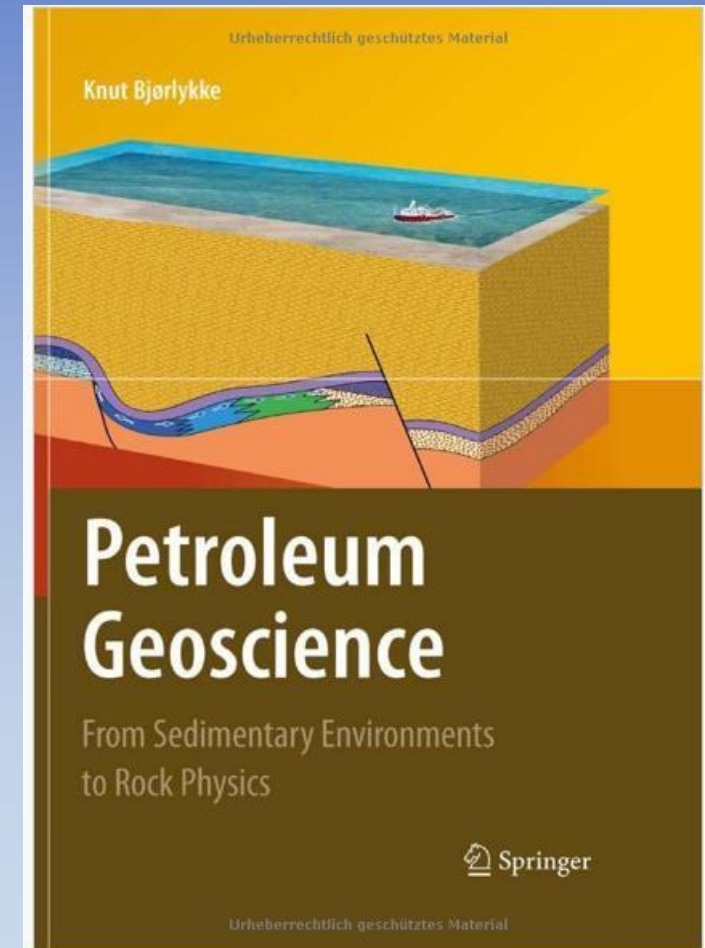
- Petroleum geology is not a well-defined academic subject. It includes many different aspects of the Earth sciences which are used in petroleum exploration and production.
- Petroleum geoscience is geology and geophysics applied to petroleum exploration and production
- Petroleum Geology is an application of geology (study of Earth, materials and processes) to the exploration and production of oil and natural gas
- It is difficult to know where to start when teaching petroleum geology because nearly all the different disciplines build on each other.
- The energy which we release when burning petroleum is therefore stored solar energy.

□ Petrophysics

- Petrophysics is the study of rock properties and rock interactions with fluids (gases, liquid hydrocarbons, and aqueous solutions).

□ Petroleum Geology

- Petroleum Geoscience: From Sedimentary Environments to Rock Physics (Knut Bjørlykke, 2010)



Petroleum Geology (Geo 452)

□ Course topics:

- Introduction
 - ❖ Course objectives, course plan, grading system.
 - ❖ Definition and scope of petroleum geology
- Historical Overview of Petroleum Production and Exploration
- Origin of petroleum
- The petroleum system and Processes
 - ❖ Source rocks
 - ❖ Generation and Migration of hydrocarbons
 - ❖ source rock evaluation
 - ❖ Maturation and measures of maturity
 - ❖ Types of source rocks
 - ❖ Types of organic matter (kerogen types)
 - ❖ Thermal maturity of organic matter
 - ❖ Petroleum Reservoirs
 - ❖ Reservoir Properties
 - ❖ Hydrocarbon Traps
- Sedimentary Rocks and Petroleum Systems
- Sedimentary Basins and Petroleum Systems
- Petroleum Exploration

□ Petroleum geology and other sciences

➤ Sedimentary geology

- forms one of the main foundations of petroleum geology.
- location of different facies in the sedimentary basins,
- from that the likely presence of source rocks with a high content of organic matter, reservoir rocks and cap rocks.
- The distribution and geometry of potential sandstones or carbonate reservoirs sequence stratigraphy
- The biostratigraphic correlation of strata encountered in exploration wells is achieved by micropalaeontology

➤ Sedimentary environments (sedimentary facies)

- Determine the distribution of reservoir rocks and their primary composition.
- Diagenetic processes determine the porosity, permeability and other physical properties such as velocity, in both sandstone and limestone reservoirs.

➤ Organic geochemistry

- which includes the study of organic matter in sediments and its transformation into hydrocarbons, has become another vital part of petroleum geology.

□ Petroleum geology and other sciences

➤ Tectonics and structural geology

- Provide an understanding of the subsidence, folding and uplift responsible for the creation and dynamic history of a basin. The timing of the folding and faulting that forms structural traps is very important in relation to the migration of hydrocarbons.

➤ Seismic methods

- have become the main tool for mapping sedimentary facies, stratigraphy, sequence stratigraphy and tectonic development.

➤ Geophysical measurements

- may include gravimetry and magnetometry; electromagnetic methods that were used mostly in ore exploration have also been applied to oil exploration

Geophysical well-logging methods

- Practical petroleum geology is not only based on many different geological and geophysical disciplines.
- A good background in basic chemistry, physics, mathematics and computing is also required, particularly for different types of basin modelling.

□ Historical Overview of Petroleum Production and Exploration

➤ Early History

- Liquid oil and semi-solid asphalt derived from natural outcrops and seepages
- Hand excavation in pits, collection from seeps and drainage at Earth's surface
- E.g. La Brea Tar Pits of Southern California
- 200-400 B.C. Greeks used petroleum compounds to water proof ships and for medicine
- 1600-1800 A.D. Europeans used petroleum products for manufacturing, water proofing and fuel
Pitch, oil, tar, brine water
- Refined and separated through boiling and heating
- 1800's refineries developed for fuel products
- Paraffin wax
- Liquid paraffin (kerosene, coal oil)
- Replaced whale oil for lamps and lighting

□ Historical Overview of Petroleum Production and Exploration

➤ Modern History

- 1859 First successful / commercial oil well drill
- Cable tool techniques
- Simple impact / chisel drilling
- Oil Creek, Pennsylvania (Titusville) “Colonel Drakes Well”

➤ Early 1900's

- Advances in drilling and exploration techniques
- Exploration of anticlines
- Stratigraphic occurrence, paleo shorelines, diagenesis
- Advanced drilling techniques
- 2. Advances in petroleum refinement and processing
 - a. Lighter density derivatives (light gases, petrol, gasoline, diesel fuel)
- 3. 1920's birth of the modern petroleum industry
 - British Petroleum, Shell (Dutch)
 - Esso (Exxon), Gulf Oil, Texaco, Mobil, Socal (Chevron)
 - Middle East and South American petroleum exploration
 - Arabian-American Oil Company (ARAMCO)

□ Historical Overview of Petroleum Production and Exploration

➤ Modern History

❖ Mid-1900's / 1960's

- 1. Organization of Petroleum Exporting Countries (OPEC)
 - a. Iraq, Iran, Kuwait, Saudi Arabia, Venezuela + North African Countries added in
- 2. Advances in exploration techniques
 - a. Geophysics, geochemistry, remote sensing
 - Gravity/magnetic surveys
 - Seismic reflection
 - Advanced drilling technology, enhanced recovery (e.g. Hydraulic fracturing)

❖ 2000's

- 3-D Seismic, GIS/GPS technology, offshore-deep water drilling
- Enhanced recovery ("fracking"), thermal processing (oil shale)
- Major Oil Producers
 - a. OPEC Countries, U.S., China, Russia, Brazil, Malaysia

Historical Overview of Petroleum Production and Exploration

➤ First Modern Oil Well, USA

- The first successful oil well was completed by Edwin Drake (right) on August 27, 1859, near Titusville, Pennsylvania. The oil-bearing reservoir rock was encountered at a depth of 21 meters (69 feet). (Photo by CORBIS/Bettman)



■ Typical Percussion Cable Rig



■ Baku, Azerbaijan, 1890's Pumping oil into a "reservoir lake"!

