UNCONVENTIONAL HYDROCARBONS

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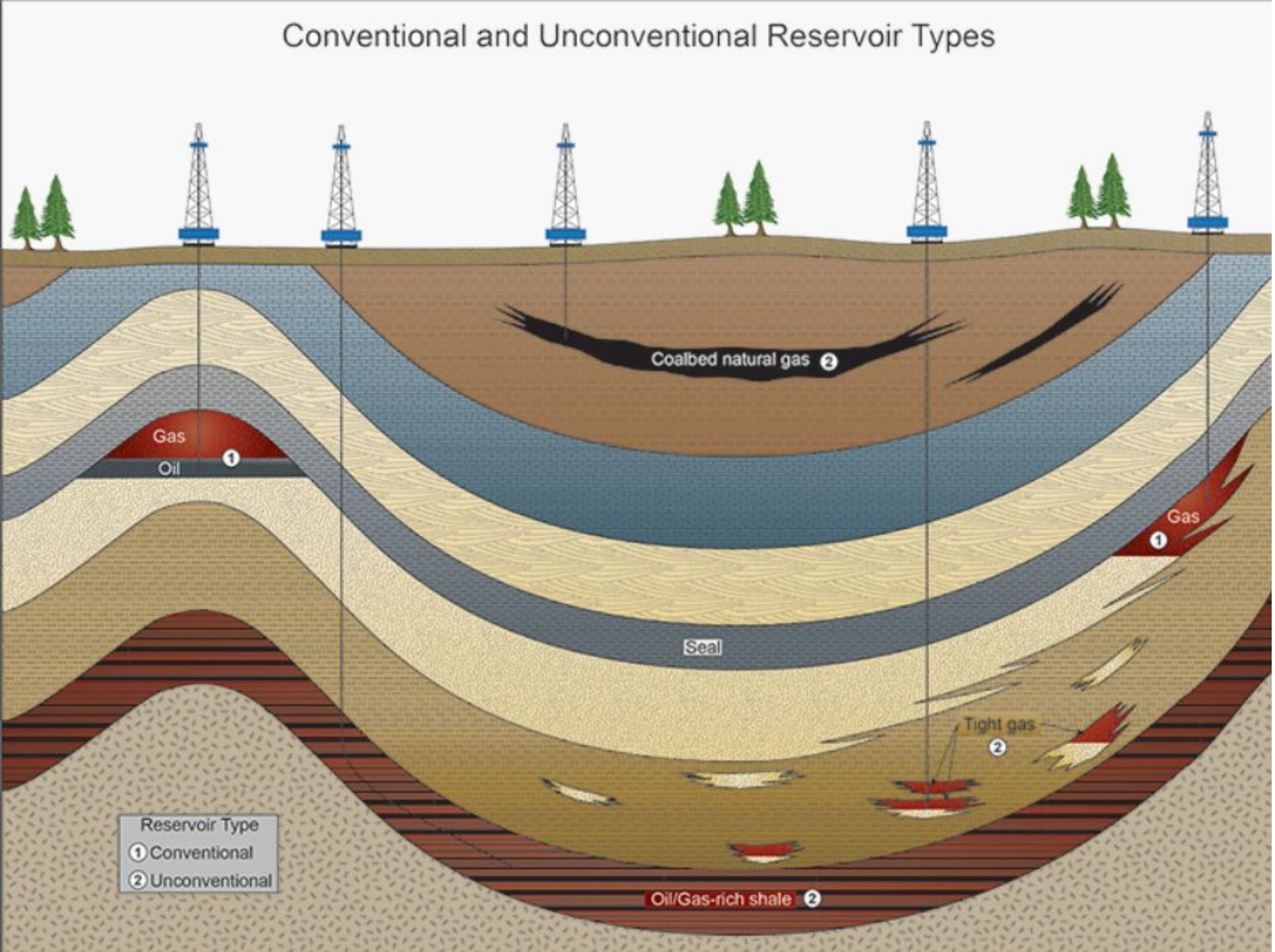
Conventional and unconventional

Conventional and unconventional oil and gas resources are defined by ease of development, cost, and recovery techniques. Conventional oil and gas resources are generally produced by vertical wells that target high porosity and permeability reservoir rocks and spatially defined hydrocarbon pools. Unconventional oil and gas resources are typically more challenging to extract due to being distributed throughout the pore spaces of very low porosity and permeability reservoir rocks.



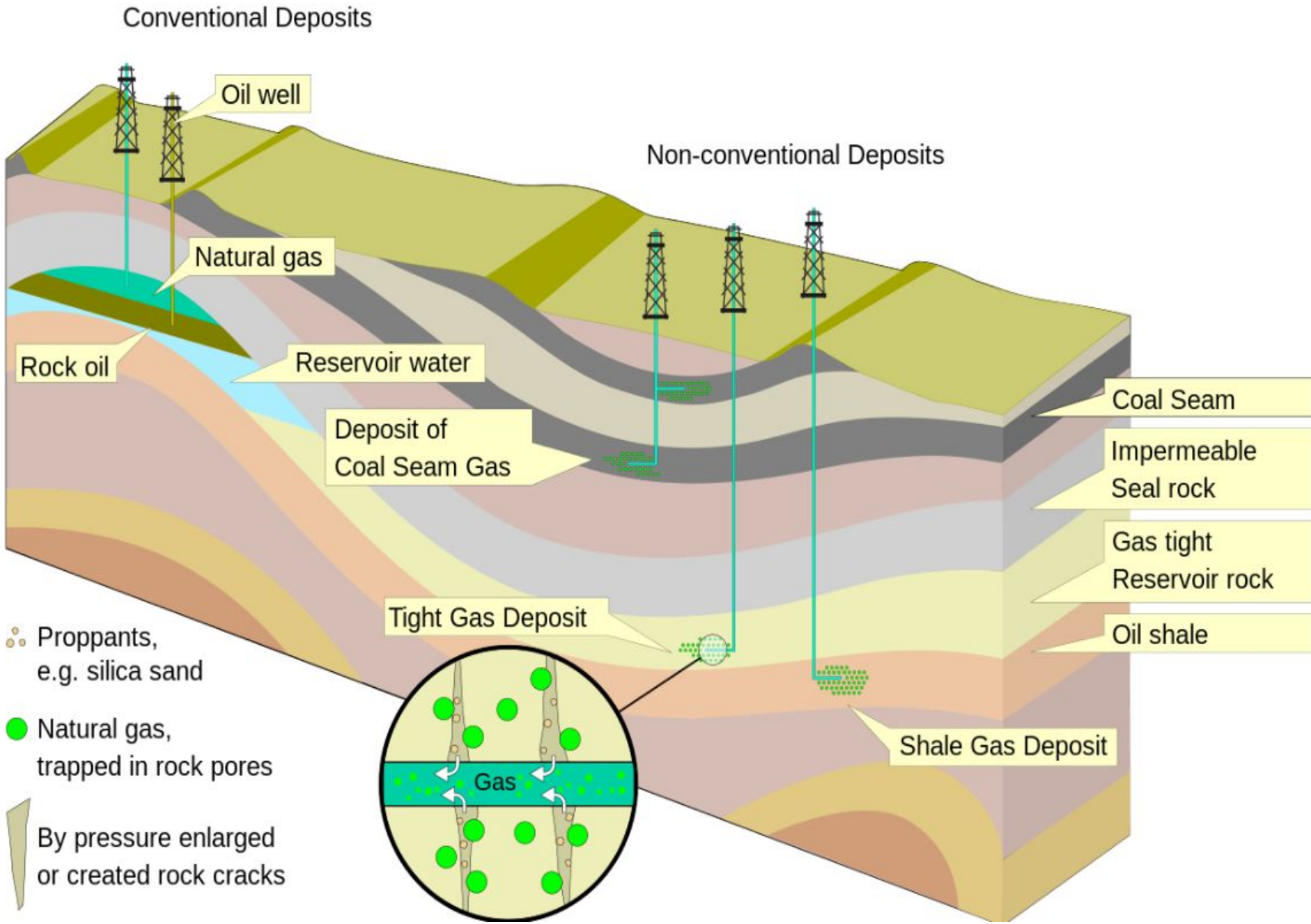
Unconventional hydrocarbon includes:

- Shale gas and oil
- Tight gas and oil
- Heavy oil and tar sand
- Clathrates (gas hydrates)
- Coal bed methane (CBM)

Because of technological advancements such as horizontal drilling and hydraulic fracturing, these previously uneconomical resources are the focus of new oil and gas exploration and development. In general, exploration geologists and engineers attempt to locate hydrocarbon reservoirs that will be productive and profitable.

Shale gas

Shale gas is natural gas locked in shale formations. In these reservoirs, the shale is both the source and the reservoir rock.

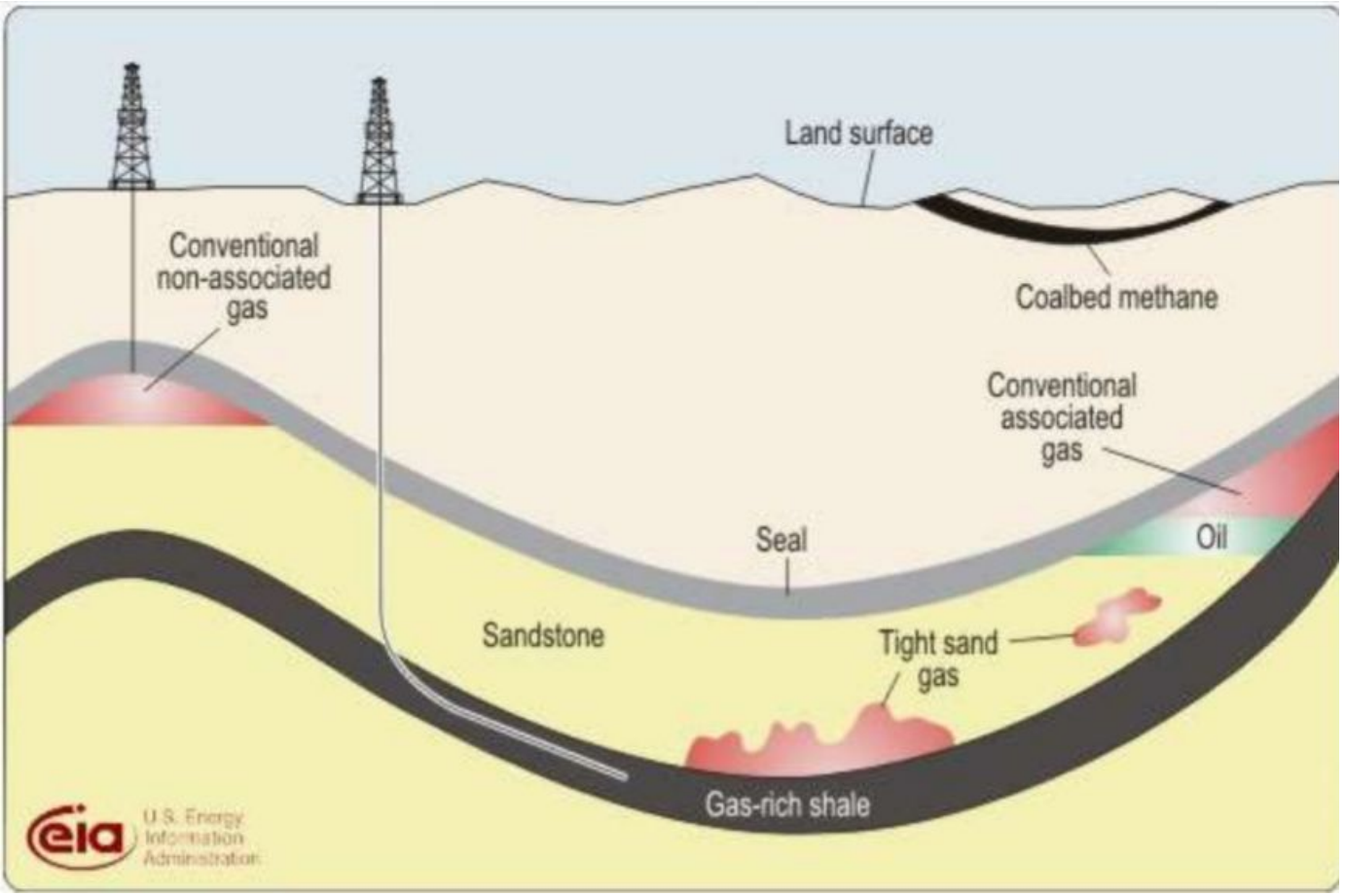


- The gas remaining in these shale is present in very small pores and may also be partly adsorbed on remaining organic matter or its residue (coke) and on clay minerals.
- The shales have been uplifted and may therefore have small extensional fractures, but they must be hydro fractured by water injection to increase the permeability.

Shale oil is oil locked in shales and associated tight siltstones or carbonates, all of which have low permeability and porosity. (*should not be confused with oil shale*)

Tight gas and oil reservoirs contain natural gas and oil trapped in the pores of siltstones and sandstones with very low permeability (<0.1 millidarcy) and very low porosity (<10%).

Extraction

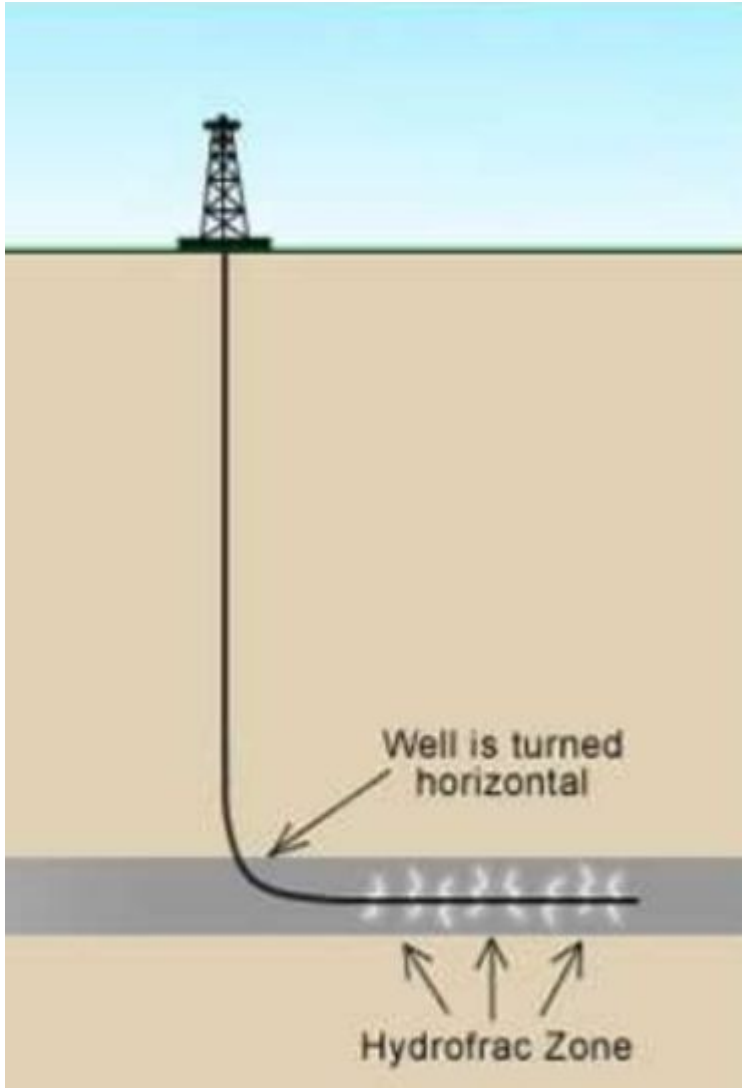


- The gas deposits are usually found in rocks that have low permeability, ruling out the possibility of regular drilling.
- The most commonly used method is called fracking (hydraulic fracturing).
- As opposed to vertical drilling for traditional gas, in this case horizontal drilling is carried out.

TWO MAJOR DRILLING TECHNIQUES ARE USED TO PRODUCE SHALE GAS

Horizontal Drilling

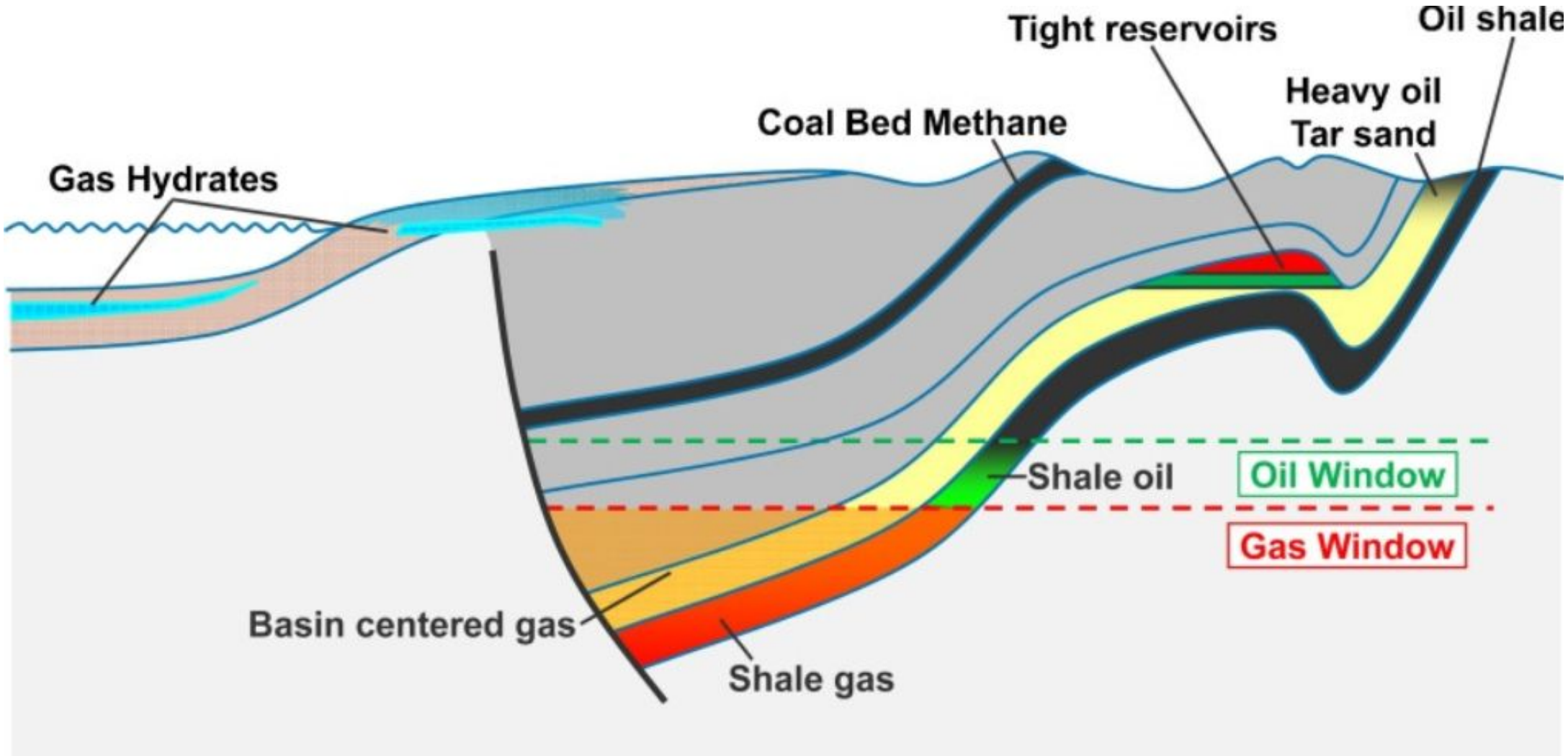
Horizontal drilling is used to provide greater access to the gas trapped deep in the producing formation. First, a vertical well is drilled to the targeted rock formation. At the desired depth, the drill bit is turned to bore a well that stretches through the reservoir horizontally, exposing the well to more of the producing shale.



Hydraulic Fracturing

It is a technique in which water, chemicals, and sand are pumped into the well to unlock the hydrocarbons trapped in shale formations by opening cracks (fractures) in the rock and allowing natural gas to flow from the shale into the well. When used in conjunction with horizontal drilling, hydraulic fracturing enables gas producers to extract shale gas at reasonable cost.

HEAVY OIL AND TAR SAND



Oil sands, **tar sands**, **crude bitumen**, or more technically **bituminous sands**, are either loose sands or partially consolidated sandstone containing a naturally occurring mixture of sand, clay, and water, saturated with a dense and extremely viscous form of petroleum technically referred to as bitumen (or colloquially as tar due to its superficially similar appearance). The oil sands have long been referred to as *tar sands*; however, industry groups dispute this name due to its negative environmental associations.

INTRODUCTION

- Known for a long time and was easy to exploit for use in small quantities.
- In southern California oil was mined from the early 1860s to the 1890s because the heavy oil would not flow to the wells.
- Tar sands are sandstone reservoirs which have been filled with oil at shallow depth <2 km (<70-80 C) so that the oil has become biodegraded. Reservoir rocks which have been buried more deeply and then uplifted before the oil migration may be sterilized at higher temperatures and are less likely to be biodegraded.

Natural bitumen deposits are reported in many countries, but in particular are found in extremely large quantities in Canada. Other large reserves are located in Kazakhstan, Russia, and Venezuela. The estimated worldwide deposits of oil are more than 2 trillion barrels (320 billion cubic meters).

- Tar sand contains asphaltic oil rich in asphaltenes and resins. It has a high content of aromatics and naphthenes compared to paraffins, and a high content of nitrogen, sulphur and oxygen (NSO).
- Most of the hydrocarbon molecules have more than 60 carbon atoms and the boiling point and viscosity are therefore very high.
- The viscosity of the biodegraded oil is very high and the oil must be heated so that the viscosity is reduced before it can be produced by drilling wells.

Tar sandstone

METHODS OF EXTRACTION

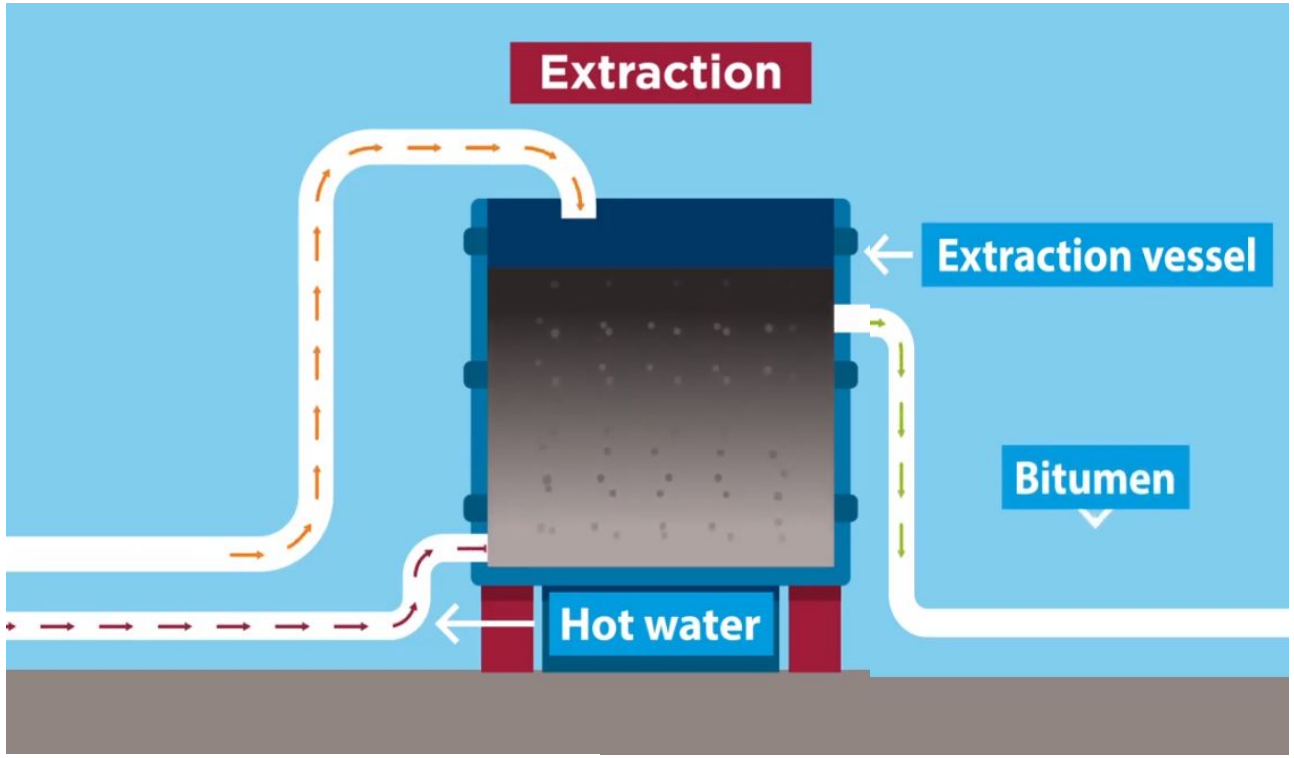
Shallow reserves, which make up about 20 percent of oil sands, are recovered through **surface mining (ex-situ)**, which is mining through open pits.

The process of surface mining differs a bit from company to company but generally includes conditioning, separation and froth treatment.

Conditioning (подготовка) starts the process of separating sand and bitumen and breaks apart any large pieces of oil sands. The oil sand is mixed with warm water -- called a **slurry** -- and transported by pipeline to an extraction facility. Here, the slurry is put through a **separation** process where sand sinks to the bottom and impure bitumen froth rises to the top.

The froth is steamed, deaerated and diluted with naphtha to remove any lingering solids and promote flow. Diluted bitumen is processed in **inclined plate settlers** (**IPS**) and **centrifuges** -- both methods further clean the bitumen.

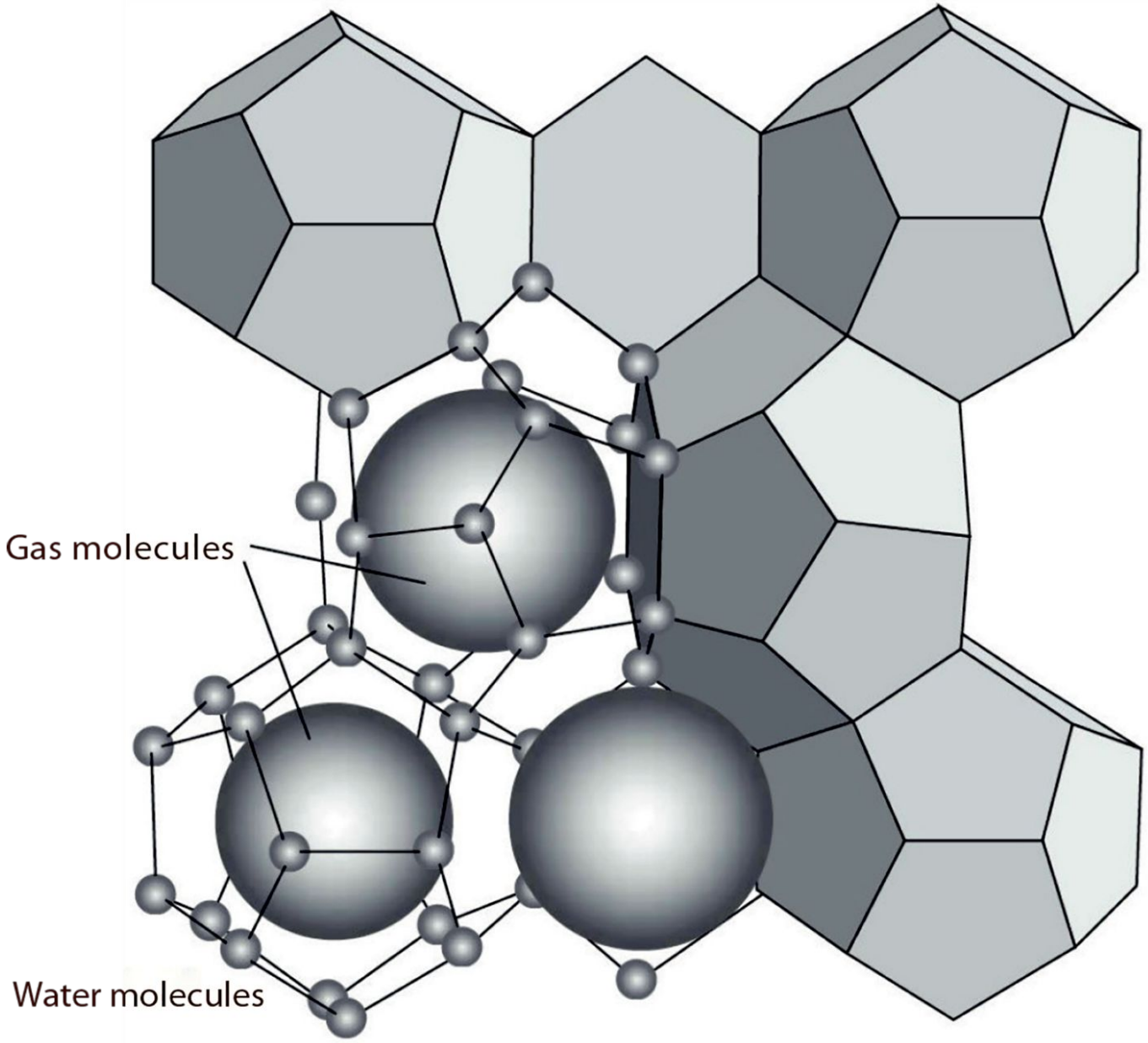
And after all that, extraction is finished.



Deeply deposited bitumen reserves aren't reachable through open-pit digging and are recovered using **in situ** techniques, the most successful known as SAG-D. **SAG-D** is **steam-assisted gravity drainage**, a method that involves injecting steam into wells within the oil sand. The intense temperature and pressure separate the bitumen and water from the sand, and the bitumen -- rendered soft with the heat -- surfaces while the sand stays put. Other in situ techniques include **toe to heel air injection** (**THAI**), a relatively new process that combines both vertical and horizontal air injections into underground wells, and a **vapor extraction process** (**VAPEX**), similar to SAG-D but with a solvent injections instead of steam.


GAS HYDRATES

Gas Hydrates are compounds where methane (CH4) molecules are trapped within the crystal lattice structure of ice. They occur in permafrost, on submarine continental slopes and in deep ocean floor sediment.



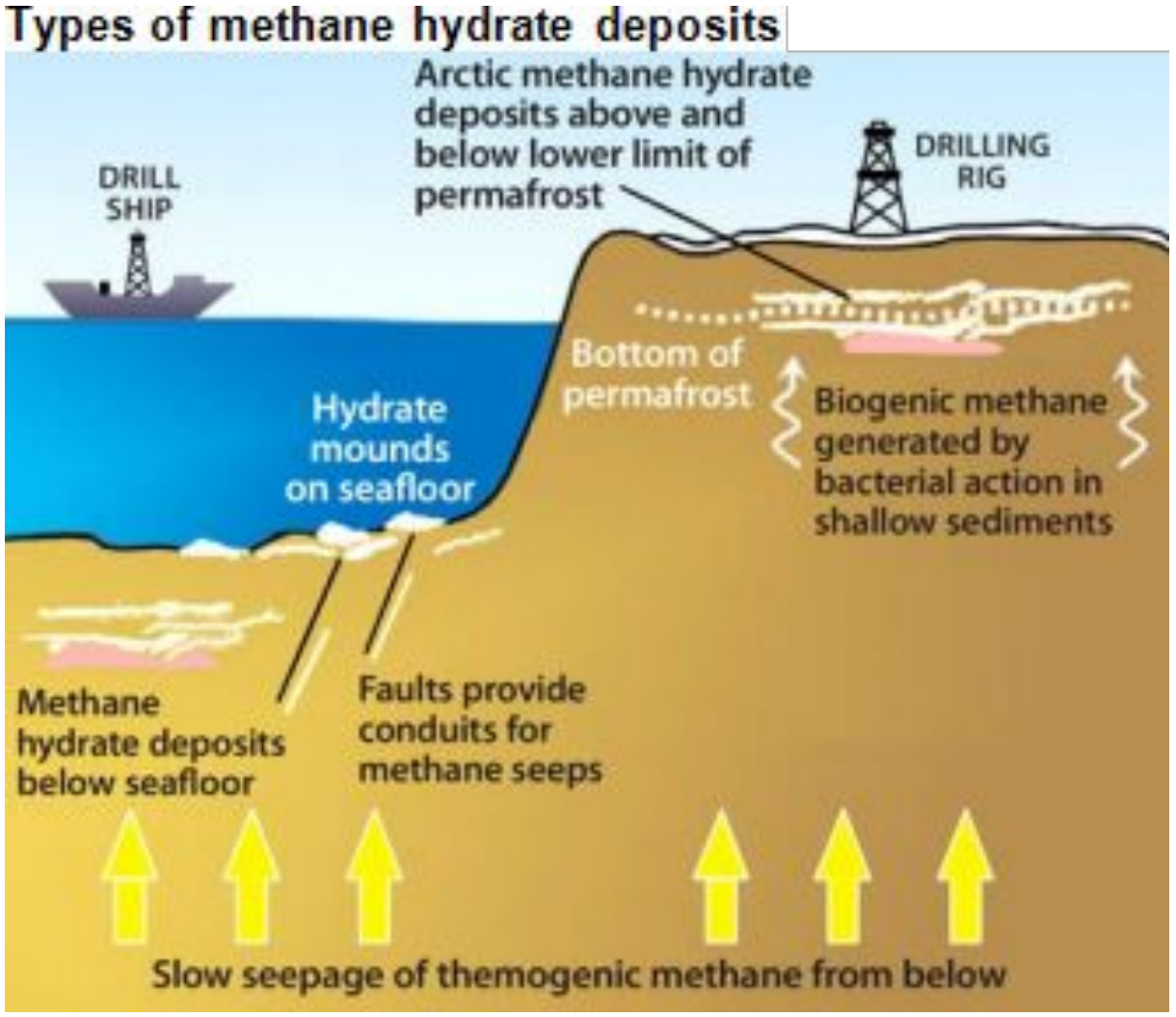
Gas hydrates, or methane hydrates, are created when methane is frozen in the molecular structure of ice. They are classified as clathrates, compounds formed by the inclusion of one molecule within cavities in the crystal lattice of another. A unique property of clathrates is the absence of chemical bonding, which makes it possible to separate them relatively easily. When methane hydrates are warmed or depressurized, it will revert back to water and natural gas.

- It is stable at high pressures and low temperatures.
- When gas hydrates dissolve (melt) one volume of gas hydrate produces 160 volumes of gas.

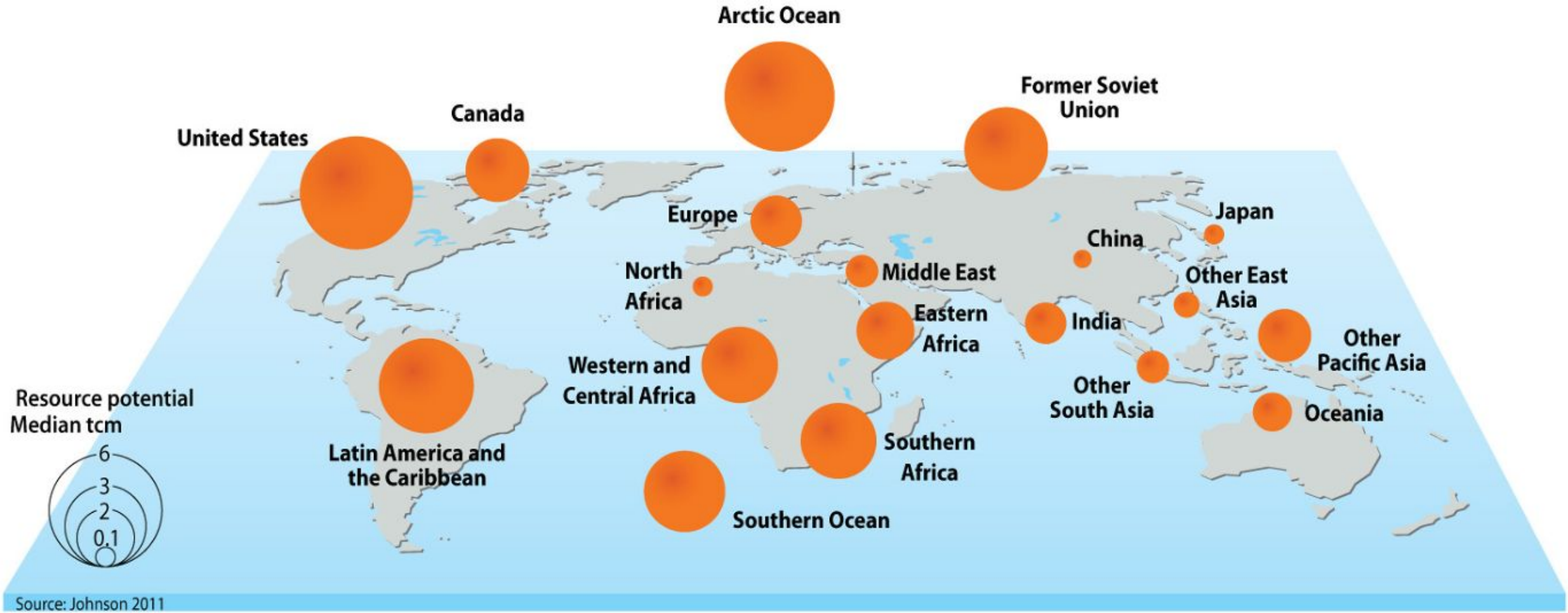
- The source of the methane is mostly biogenic, from organic rich sediments, but gas hydrates may also fill the pores in sand beds.
- During the glaciations gas hydrates were more widespread than now and occurred also beneath the seafloor in basins like the North Sea.
- Gas hydrates are potentially a very important source of gas.

Hydrate deposits generally occur in two types of settings: on submarine continental slopes and in deep ocean floor sediment where temperature and pressure conditions are suitable for their formation.

The majority of the gas hydrates supply is found over 1,600 feet below the sea's surface. Methane that forms hydrate can be both biogenic (created by biological activity in sediments) and thermogenic (created by geological processes deeper within the earth).



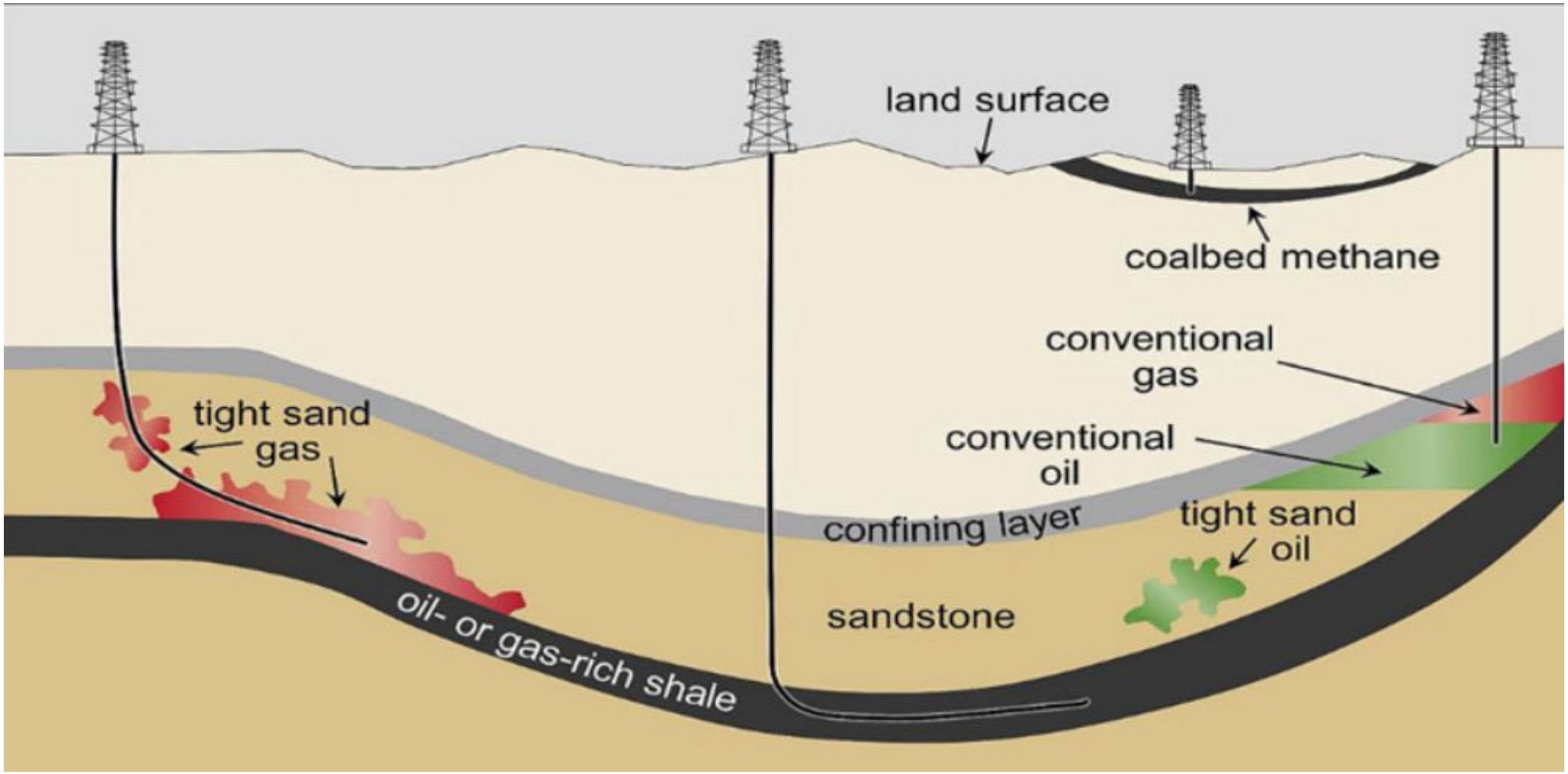
Gas hydrates resource potential by global regions



Hydrates can be recovered in the following ways:

- Heating the hydrates using hot water, steam, electromagnetic radiation (such as microwaves) or electricity. These methods would raise the temperature so that the hydrates would melt, releasing the natural gas.
- Lowering the pressure of the hydrates. Lowering the pressure would also cause the hydrates to melt, releasing the natural gas.
- Injecting chemical inhibitors. Inhibitors prevent hydrates from forming or cause hydrates that have formed to “melt.”

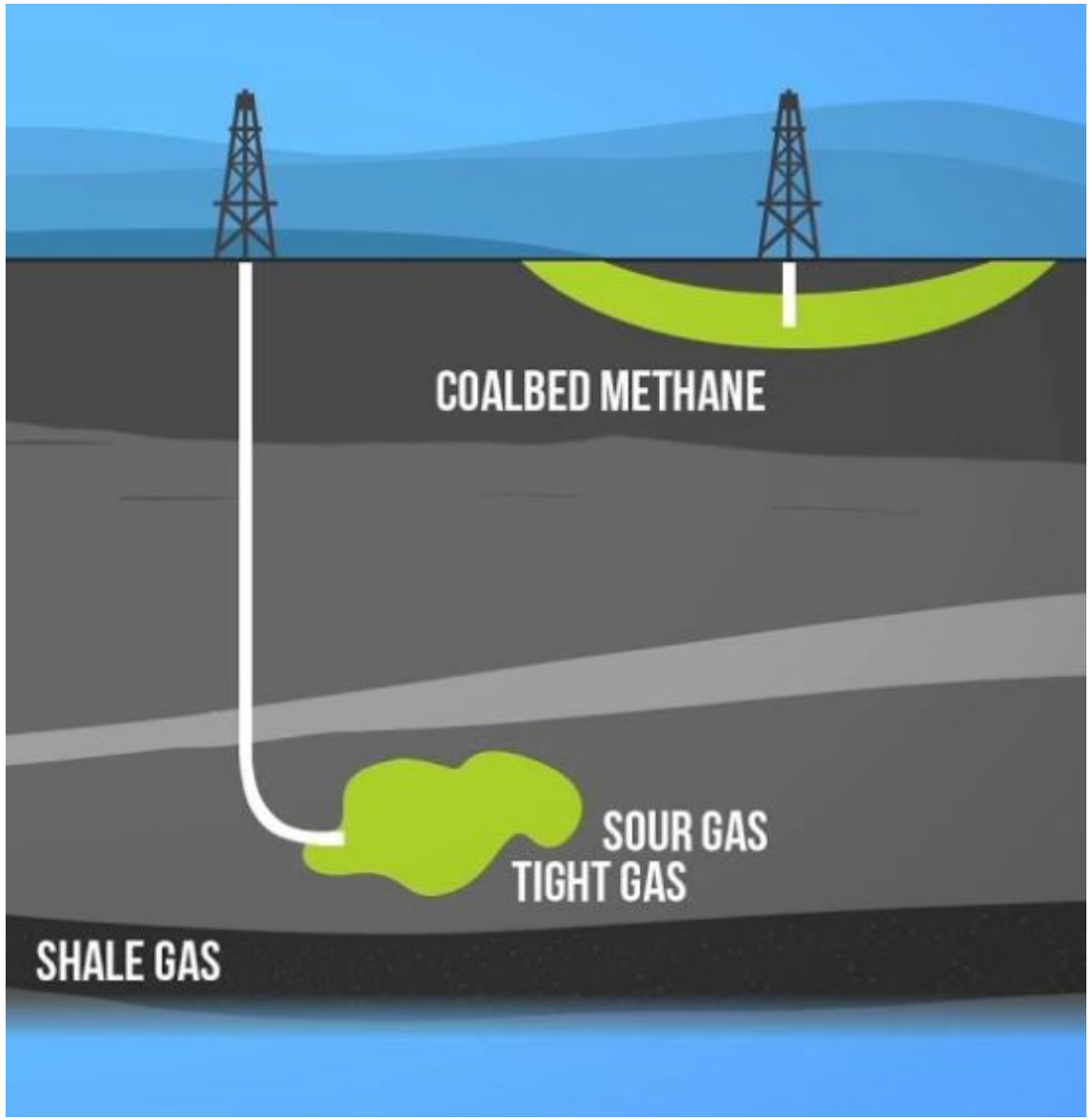
COALBED METHANE



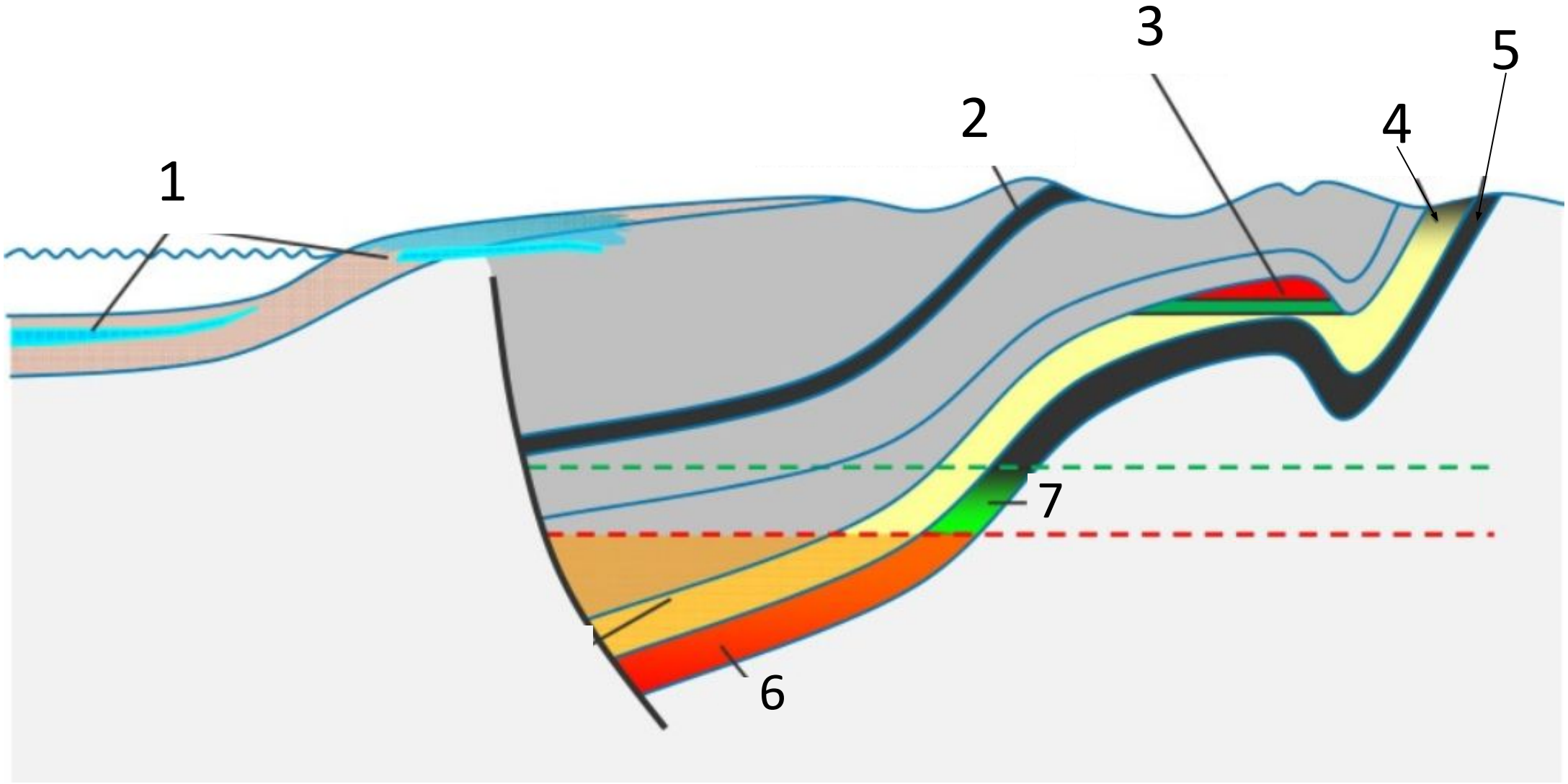
Coalbed natural gas (CBNG)

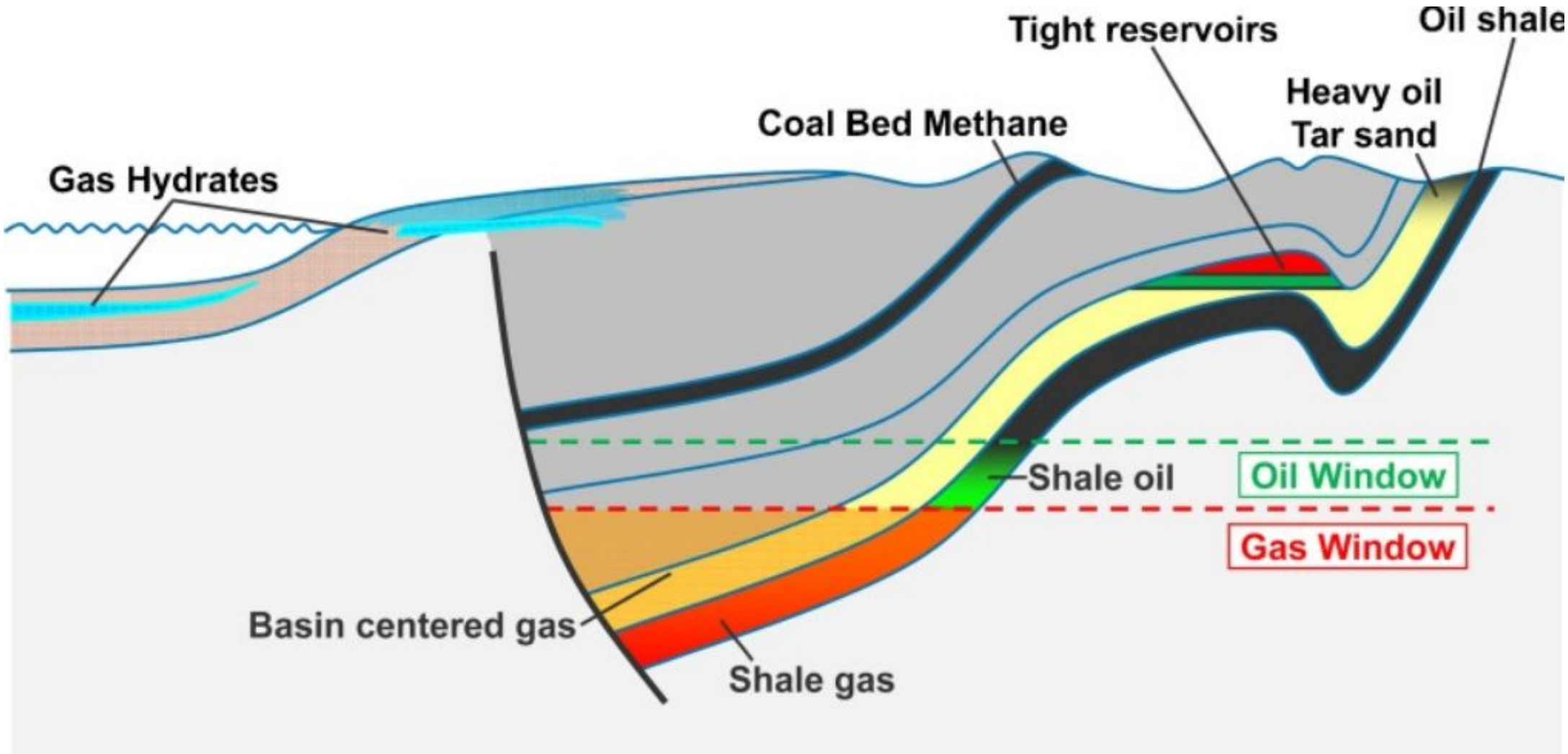
- **Coalbed methane** (**CBM** or **coal-bed methane**), **coalbed gas**, **coal seam gas** (**CSG**), or **coal-mine methane** (**CMM**) is a form of natural gas extracted from coal beds. In recent decades it has become an important source of energy in United States, Canada, Australia, and other countries.
- CBM is formed during the process of coalification, the transformation of plant material into coal. It is considered a valuable energy resource with reserves and production having grown nearly every year since 1989. Varied methods of recovery make CBM a stable source of energy.

CBM can be recovered from underground coal before, during, or after mining operations. It can also be extracted from “unminable” coal seams that are relatively deep, thin or of poor or inconsistent quality. Vertical and horizontal wells are used to develop CBM resources. Extraction requires drilling wells into the coal seams and removing water contained in the seam to reduce hydrostatic pressure and release absorbed (and free) gas out of the coal.



Name all the unconventional hydrocarbons




Tight reservoirs
Oil shale
Heavy oil
Tar sand
Coal Bed Methane
Gas Hydrates
Shale oil
Oil Window
Gas Window
Basin centered gas
Shale gas