Kaustobiolity

LG II.

Rozložník: kap. 6
Dopita – Havlena – Pešek (1985)
Robb: kap. 5.4

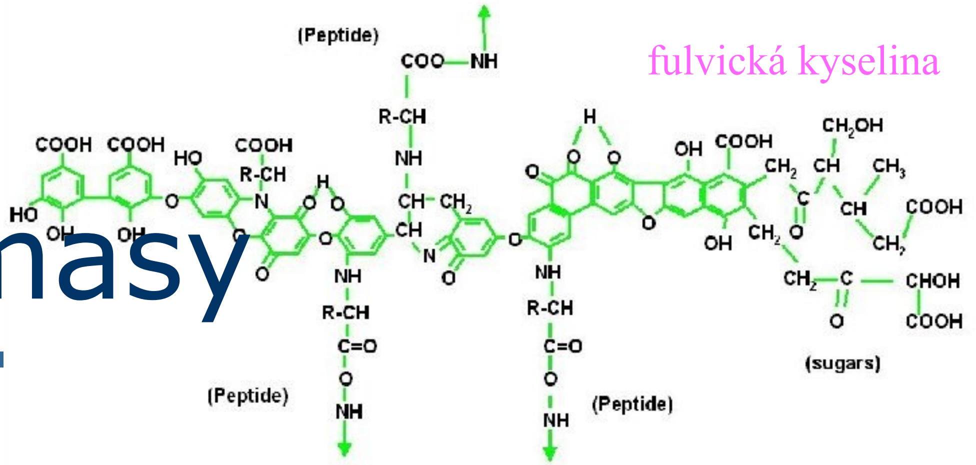
Kaustobiolity

- uhlí
- ropa, zemní plyn, bitumenové horniny
- hydráty CH_4

společné vlastnosti:

1. jednotný původ org. hmoty a prvkové složení: C, H, O, N
2. diagenetické a epigenetické procesy
3. pestré formy hmoty
4. vydávat tepelnou energii

Rozklad biomasy



fulvická kyselina

- tlení
- trouchnivění
- rašelinění → huminové látky
- hnití → hnilokal

- Změny kvality a kvantity – evoluce bioty

Základní chemická klasifikace org. hmoty zemské kůry

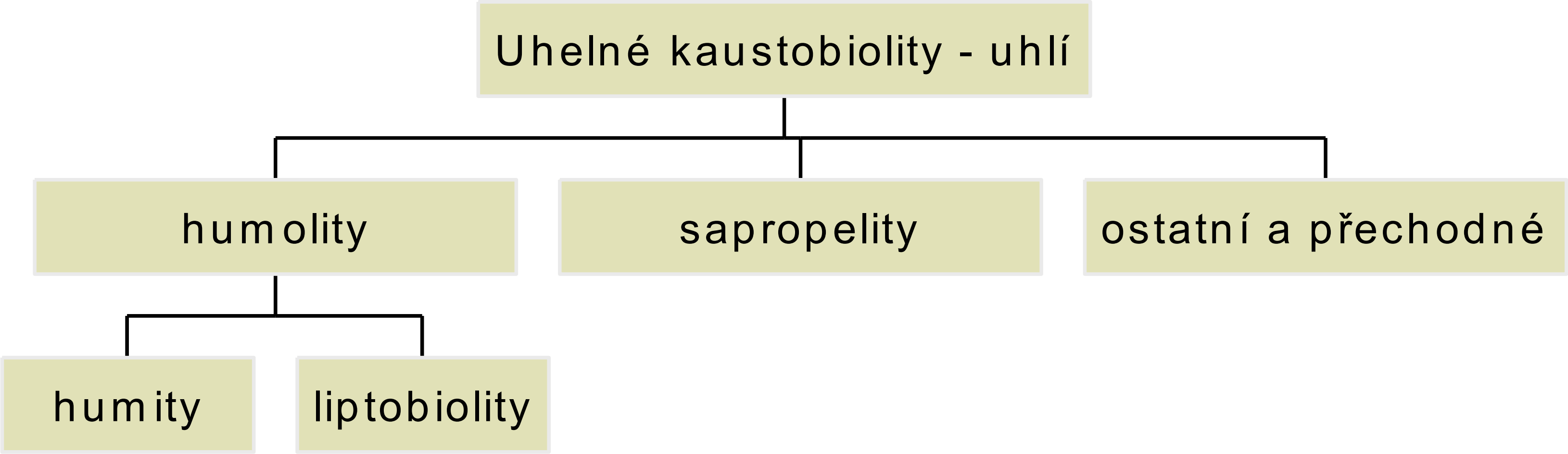
- bitumen
- huminové látky
- kerogen
- karboidy

Základní genetická klasifikace kaustobiolitů

vychází ze složení výchozích hmot a z procesů vzniku

- uhlí
- přírodní uhlovodíky

Uhlí



Uhelné kaustobiolity - uhlí

humolity

sapropelity

ostatní a přechodné

humity

liptobiolity

Přírodní uhlovodíky

- plynné, kapalné, tuhé

Prouhelňování (karbonifikace) a bituminace

procesy mají 2 fáze:

- biochemická fáze

suma procesů
- akumulace org.hmoty,
- rašelinění,
- hnití

- geochemická fáze

Geochemická fáze prouhelňování

anorganické faktory:
- T, P, čas, radioaktivita, pórovitost, …

míra prouhelnění:
- parametry makroskopické a laboratorní
- strukturní změny
- definice stádií prouhelňovacího procesu

odraznost organické hmoty

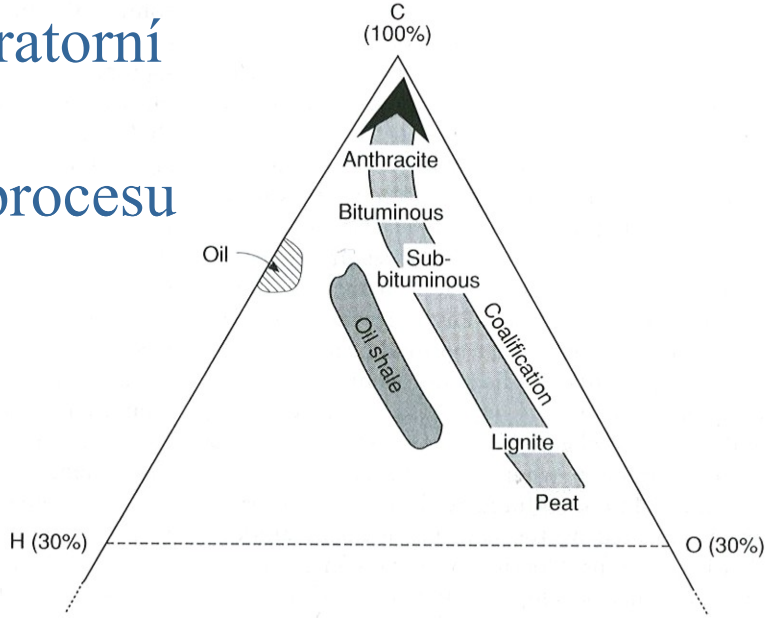


Figure 5.35 Ternary C–H–O plot showing the compositional trend accompanying coalification and the comparison between coals and oil and oil shale compositions (after Forsman and Hunt, 1958).

Geochemická fáze bituminace

- procesy
- měřítka bituminace
- teorie vzniku ropy

Vznik uhlovodíků

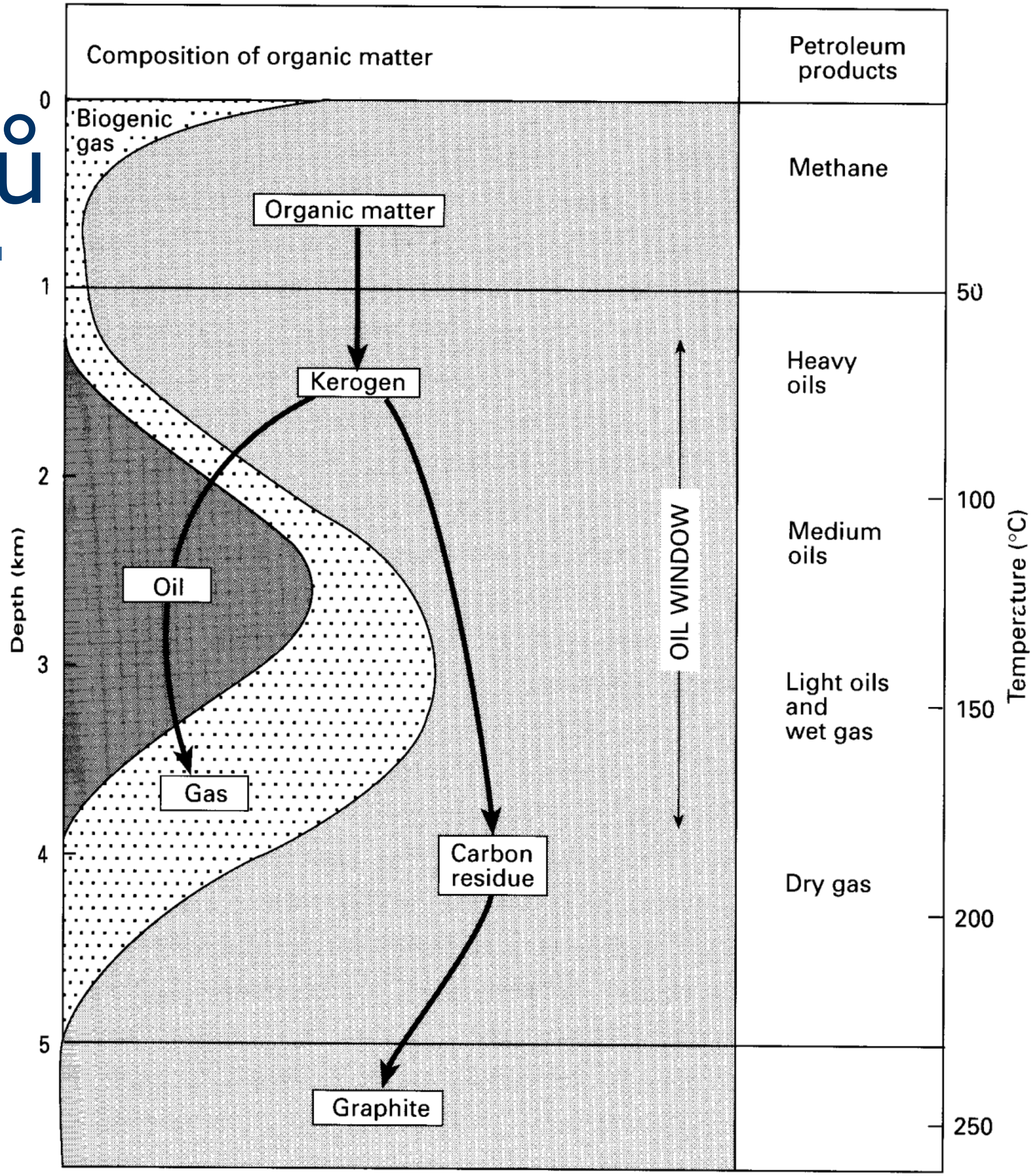


Fig. 25.5 Organic matter diagenesis showing the relationship between temperature, depth of burial and the petroleum products formed.

Geneze kerogenu

Fig. 25.6 The evolution paths of the three kerogen types during diagenesis.

Principal products of kerogen evolution

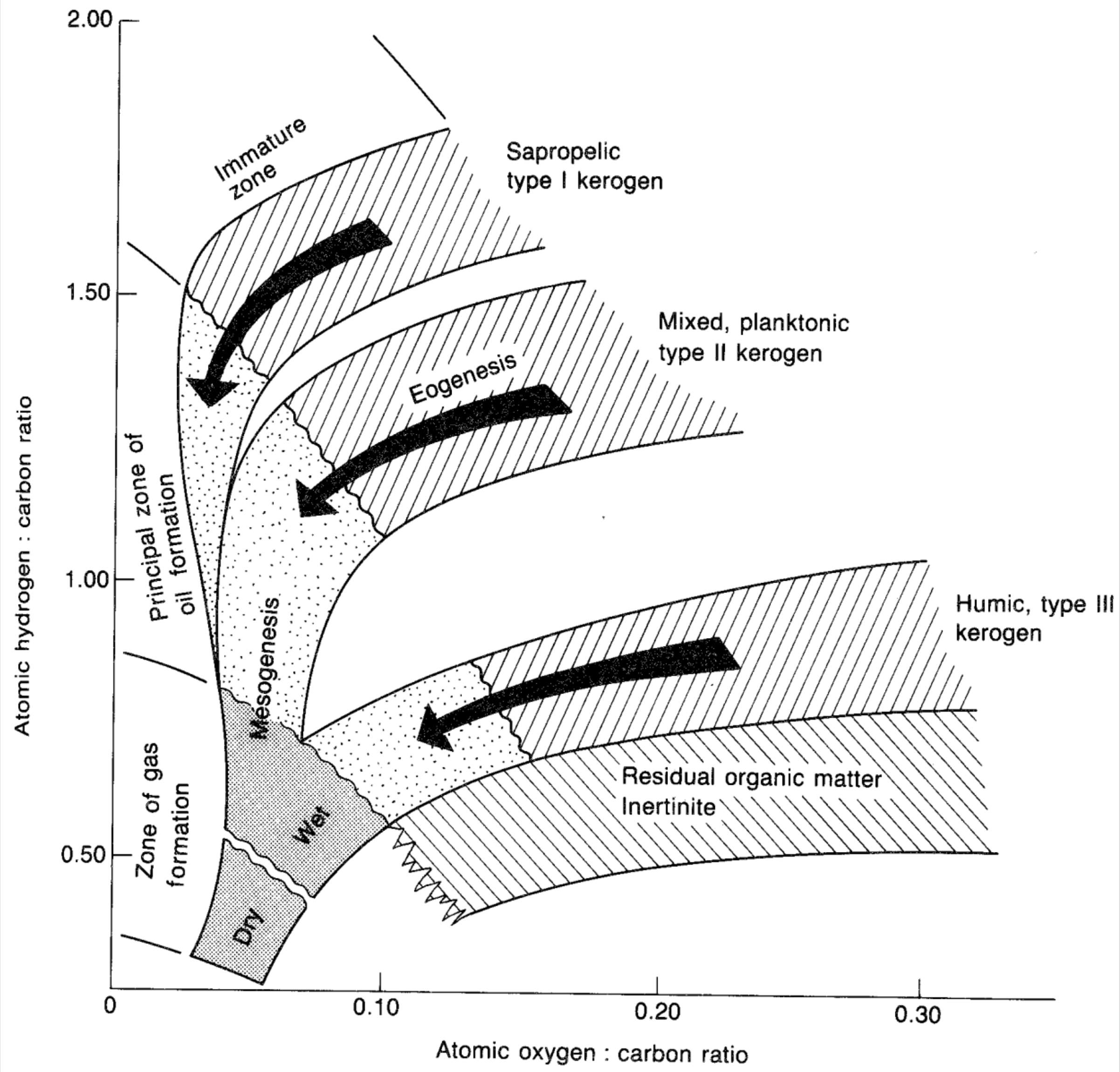
▨ CO_2, H_2O, biogenic CH_4, organic acids

⠿ Oil

▒ Gas

▧ Residual organic matter with no further potential for hydrocarbon generation

← Kerogen evolution paths



Ropa - oblasti

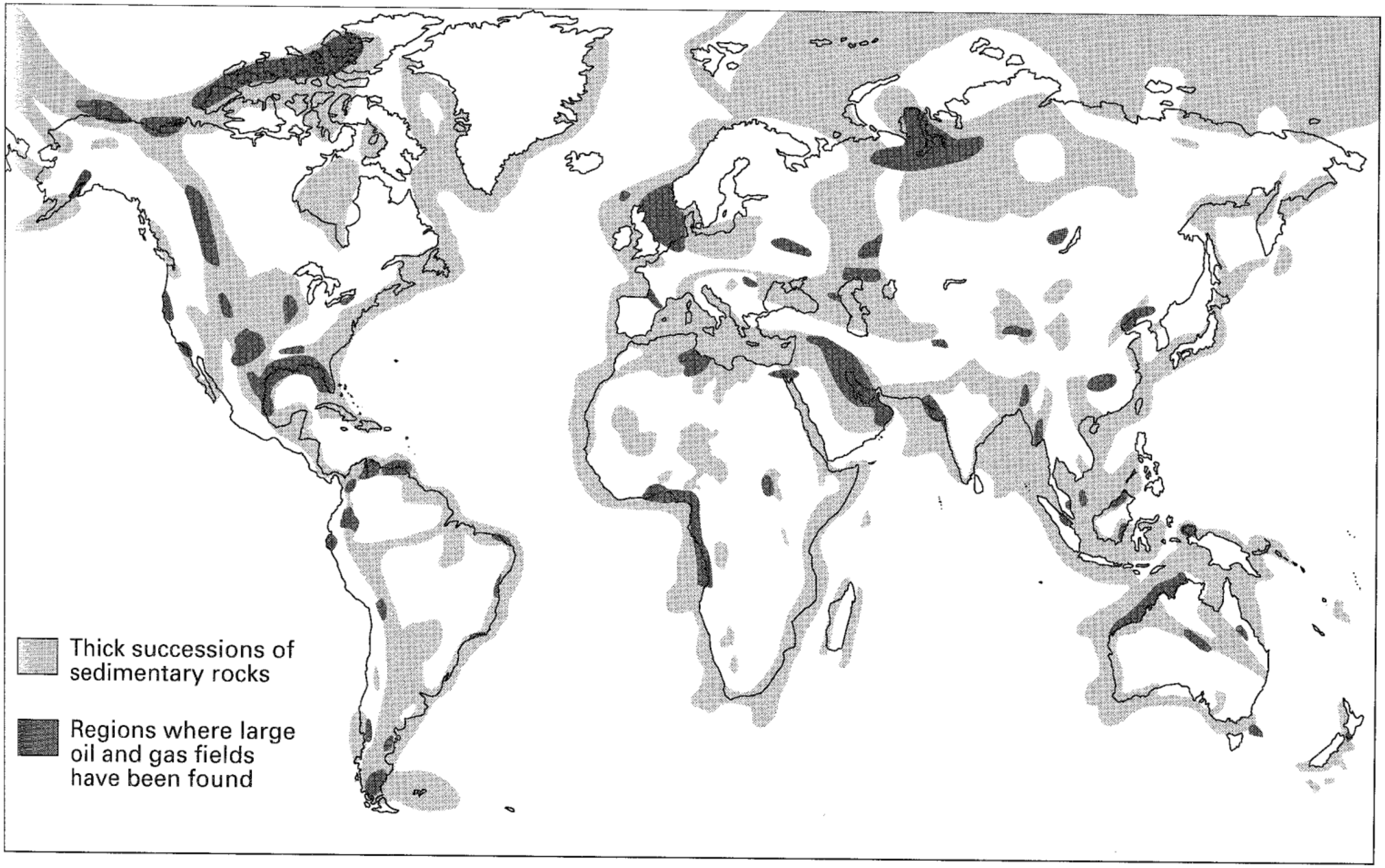


Fig. 25.1 Distribution of sedimentary basins that contain known or potential oil or gas accumulations and the main known oil and gas bearing regions of the world.

Vlastnosti kaustobiolitů - uhlí

fyzikální vlastnosti
chemické vlastnosti
technologicko-analytické parametry

petrologie uhlí:
petrologické makrosložky
(xylitická s., vláknitá s., lesklá s. atd.)
petr. mikrosložky, macerály
(huminit a vitrinit, liptinit, inertinit)

Jak se liší petrologické makrosložky hnědého a černého uhlí?

Dopita, Havlena, Pešek 1985: Ložiska fosilních paliv, kap. 2

Vlastnosti – přírodní uhlovodíky

- zemní plyn
- plynokondenzát
- ropa
- tuhé uhlovodíky
- naftoidy

°API = 141,5/D(v g/cm^3) – 131,5

hustota ropy

API gravity is a density scale calibrated so that density of water is 10 degrees API. Increasing API gravity = decreasing density

Condensate >55 API

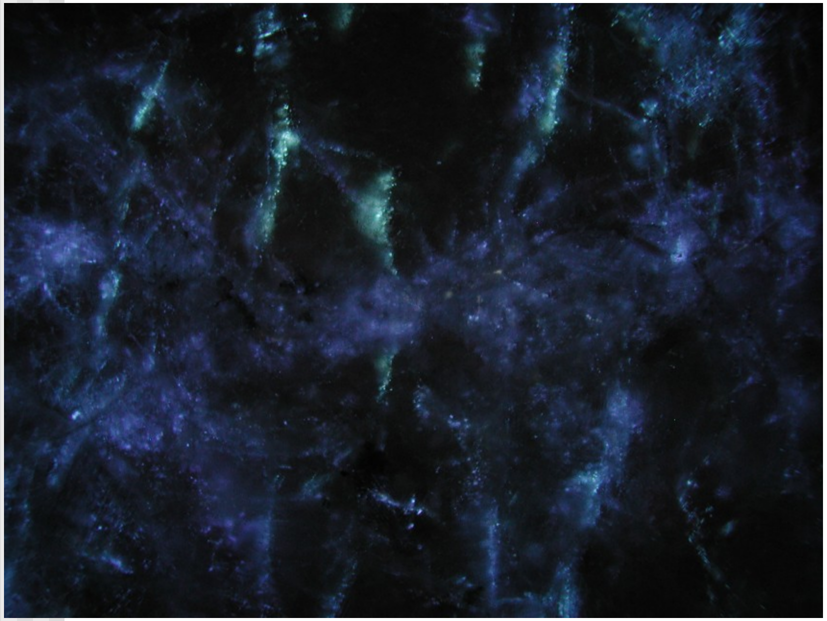
Light crude 31-55 API

Medium 22-31 API

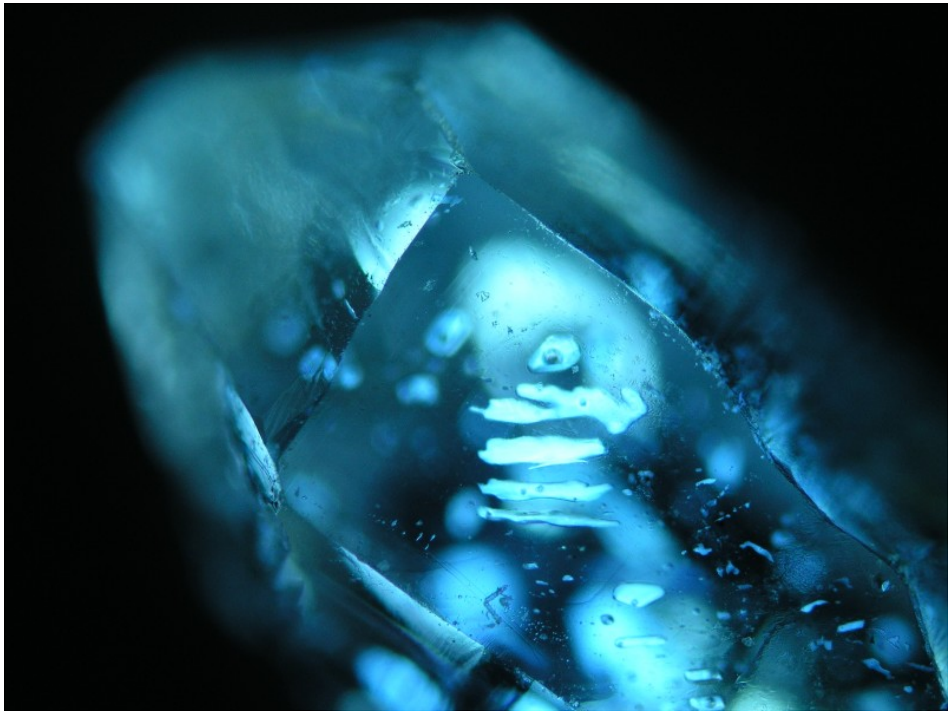
Heavy 22-10 API

Extra heavy <10 API

Fluorescence uhlovodíků



fluidní inkluze s uhlovodíky v kalcitu



fluidní inkluze s uhlovodíky v křemenu

Geologie ložisek uhlí

- pánev paralická a limnická
- sloj – lavice – proplástek
- souslojí - cyklus
- jalovina
- mořské patro
- tonstein (pyroklast.)
- brousek (pyroklast.+terigenní sed.)

Delta – akumulace, uhlonosné cykly

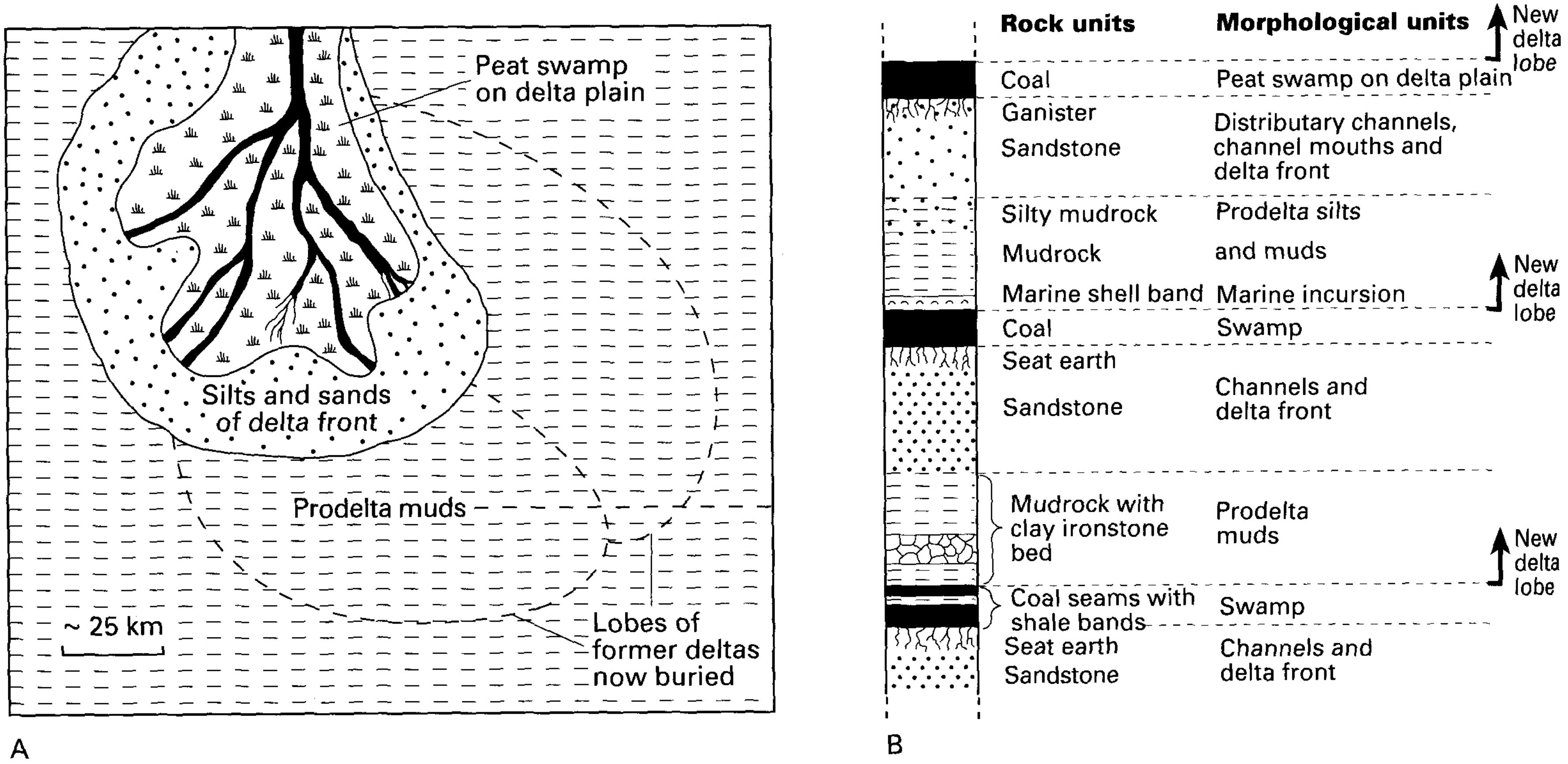


Fig. 24.4 (A) Three elongate delta lobes superposed upon each other with the three principal morphological units of the latest delta indicated. (B) A typical sequence of cyclothems. The positions of the approximate boundaries between the deposits of the three main morphological units of the delta are indicated with pecked lines.

Uhlí - oblasti

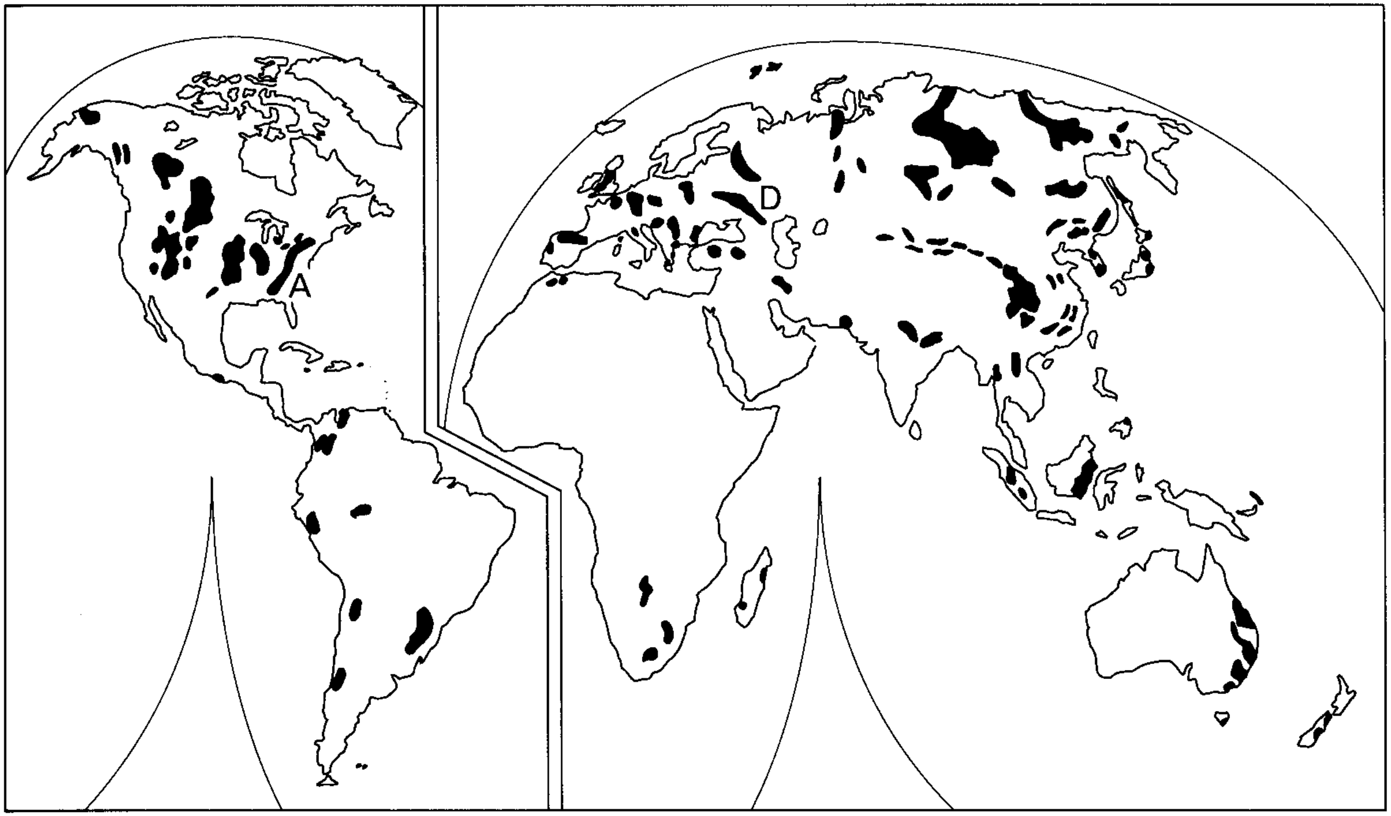
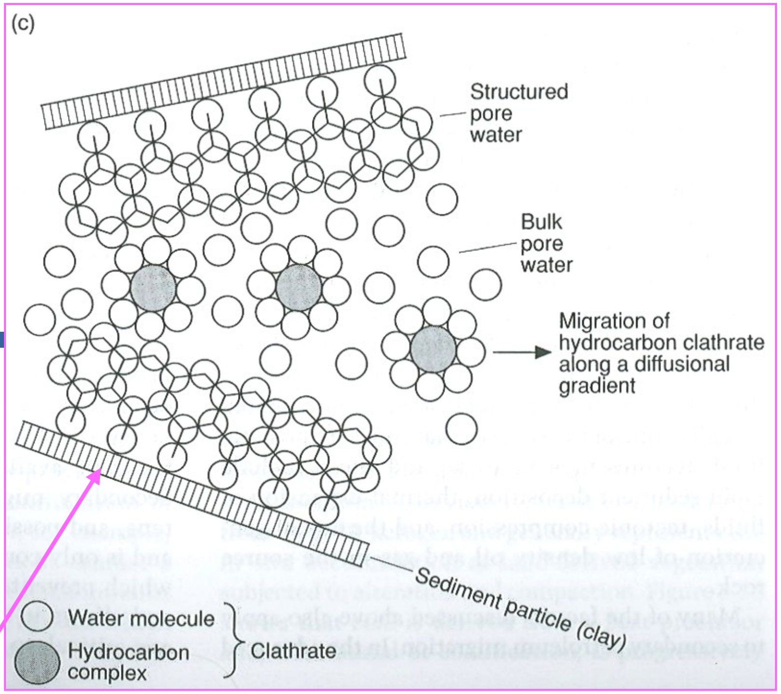


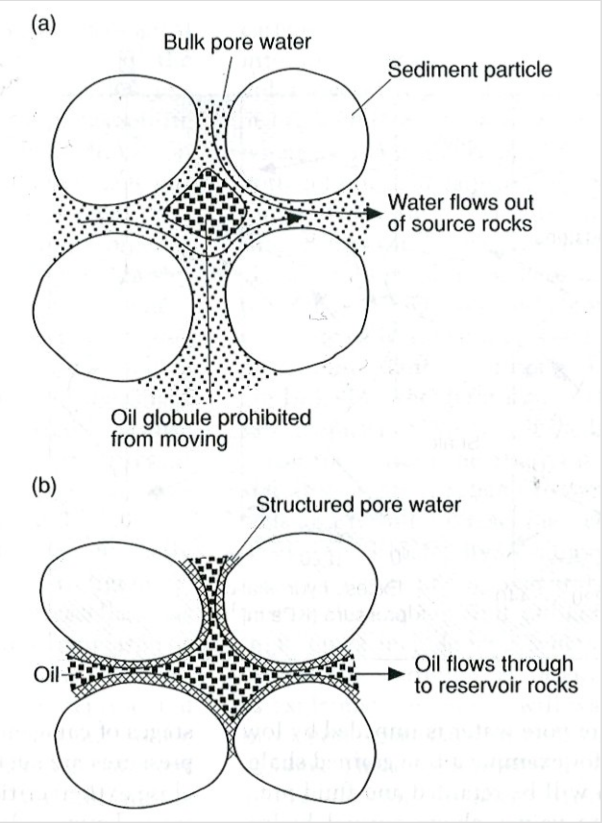
Fig. 24.2 World distribution of coalfields. A, Appalachian; D, Donets.

Geologie ložisek přírodních uhlovodíků

- ropomatečná hornina
- ložiskové pasti
- pórovitost
- propustnost
- migrace uhlovodíků (primární, sekundární), příčiny
- kolektory
- ložisková energie
- degradace lož. pastí

Migrace uhlovodíků





Effective porosity

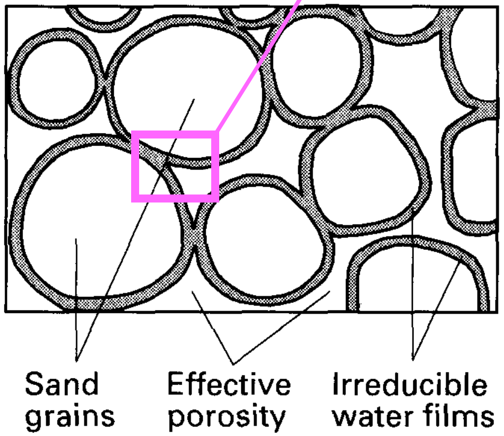
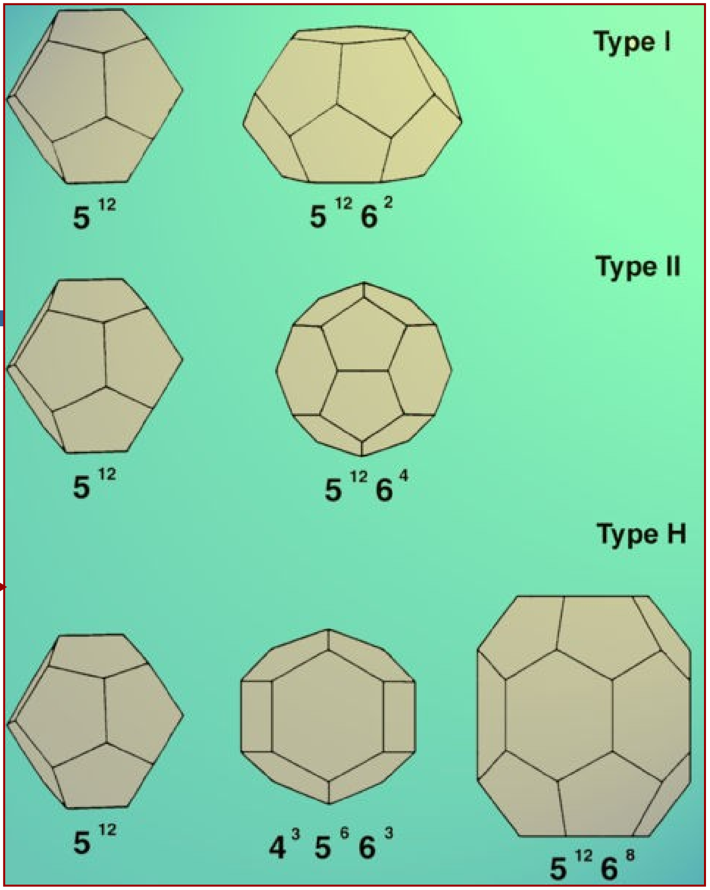


Fig. B.25.1

The grains of most waterlaid clastic rocks have a very thin film of water sticking to their grain surfaces. This water is held in place by strong interfacial tension and surface bonding and cannot be shifted. It therefore occupies some of the pore space and impedes the flow of hydrocarbons (Fig. B.25.1). The coarser the grain size the less is the surface area to which this water can adhere.

Klatráty

Clathrate hydrates (or *gas clathrates, gas hydrates, clathrates, hydrates* etc) were first documented in 1810 by Sir Humphrey Davy[1]; they are crystalline water based solids physically resembling ice, in which small non polar molecules (typically gases) are trapped inside "cages" of **hydrogen bonded water molecules**. Without the support of the trapped molecules, the lattice structure of hydrate clathrates would collapse into conventional ice crystal structure or liquid water. Most low molecular weight gases (including O_2, H_2, N_2, CO_2, CH_4, H_2S, Ar, Kr, and Xe), as well as some higher hydrocarbons and freons will form hydrates at suitable temperatures and pressures. Clathrate hydrates are not chemical compounds as the sequestered molecules are never bonded to the lattice. The formation and decomposition of clathrate hydrates are first order phase transitions, not chemical reactions.



Cages building the different gas hydrate structures.

Pasti

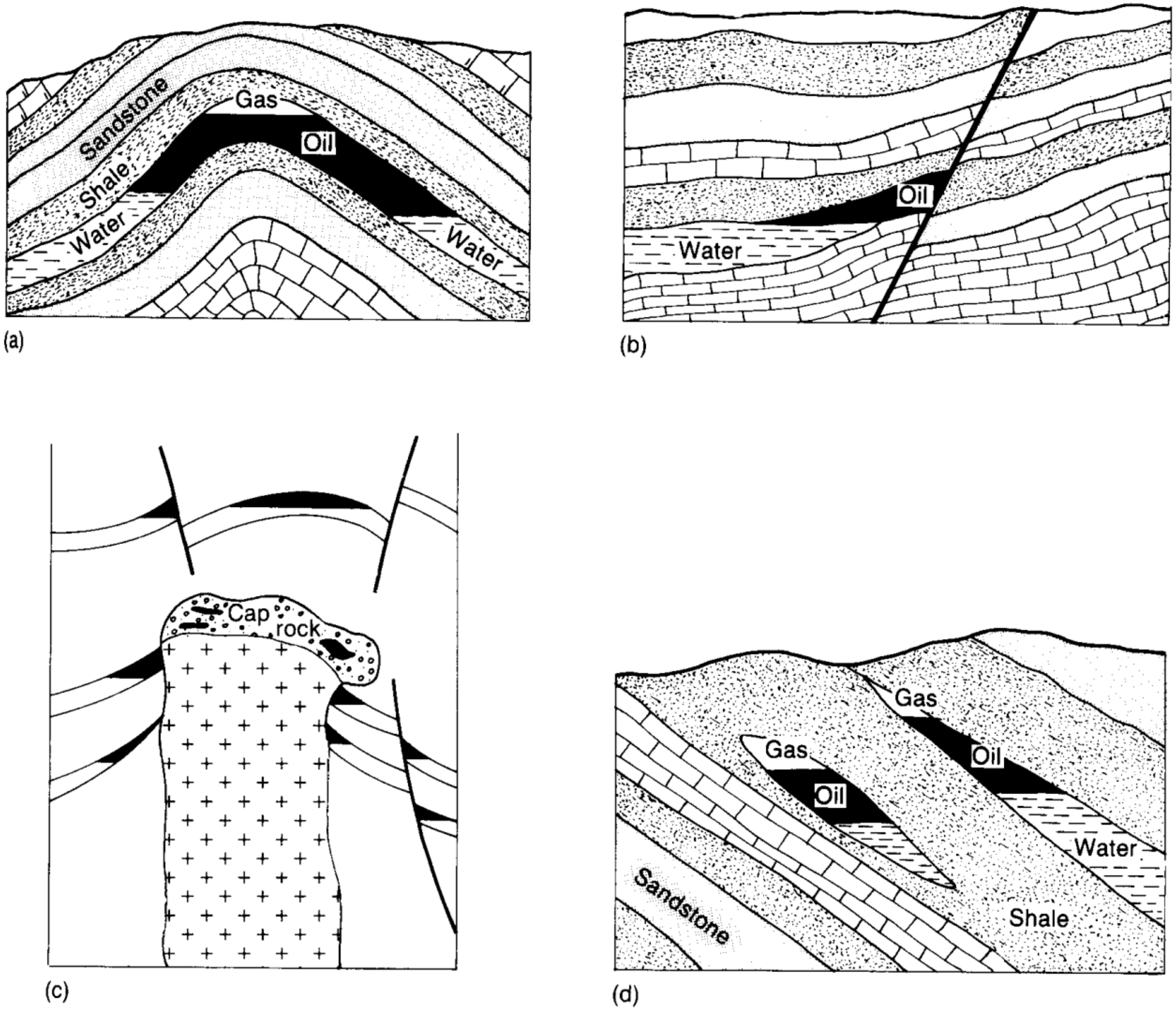


Fig. 25.8 Structural and stratigraphical oil traps. (a) Anticlinal trap developed in a sandstone reservoir in an open, asymmetrical fold. (b) Oil trapped by a fault seal. (c) Schematic diagram of salt dome traps, in supercap, cap rock and flank sandstones (abutting, fault sealed and pinch out). (d) Two types of stratigraphical traps. Right, sandstone wedge out; left, sandstone lens.

Pasti II.

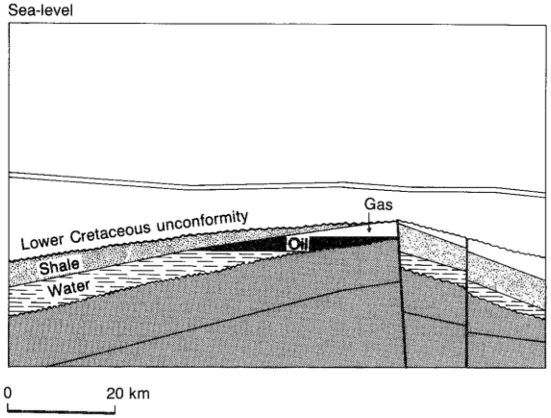


Fig. 25.10 Combination trap. A north–south section through the Prudhoe Bay Oilfield, Alaska.

Type of trap	Number of fields	Proportion of reserves (%)
Structural	132	78
Stratigraphical	44	13
Combination	24	9

Table 25.4 Classification of two hundred giant oilfield traps and percentage of oil contained in each class.

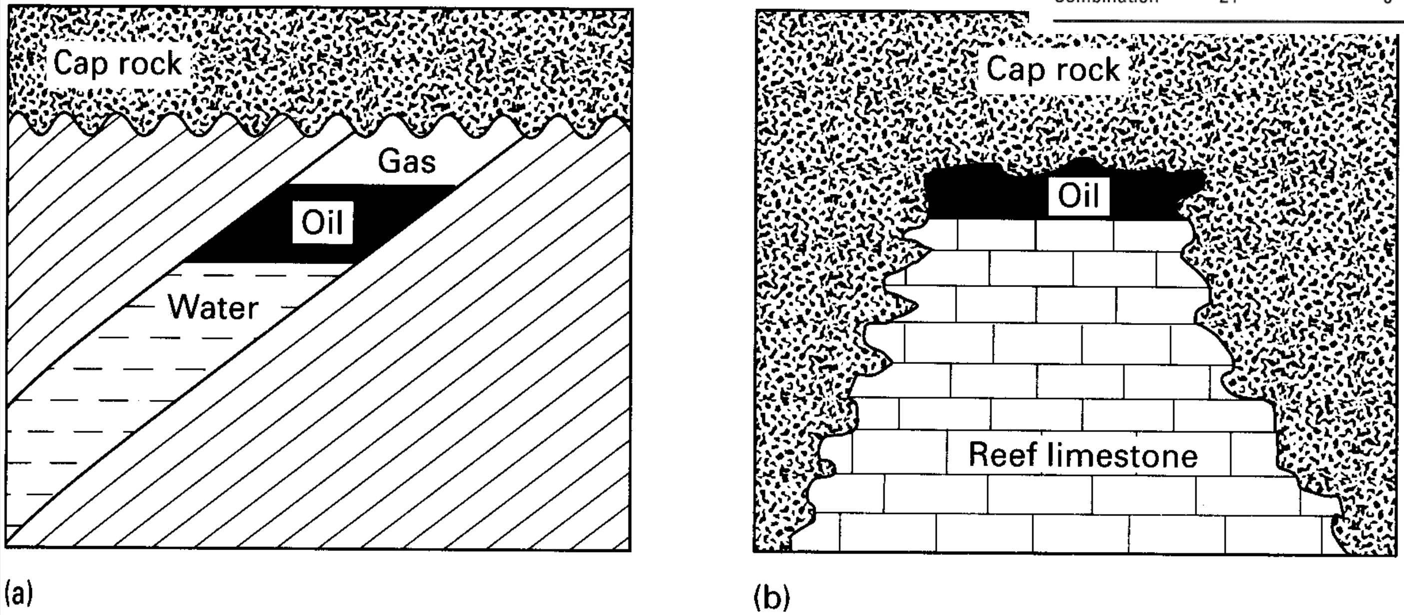
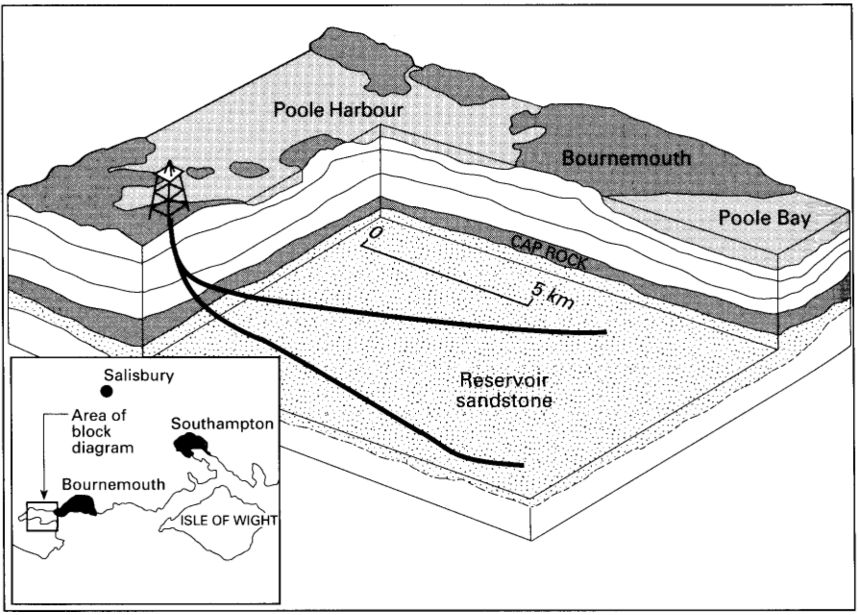


Fig. 25.9 (a) Unconformity trap. (b) Reef trap.

Ložiskový tlak a těžba



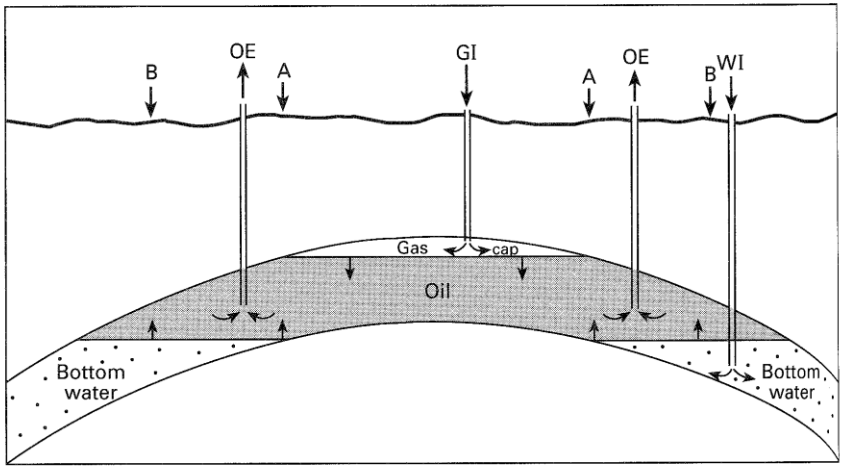
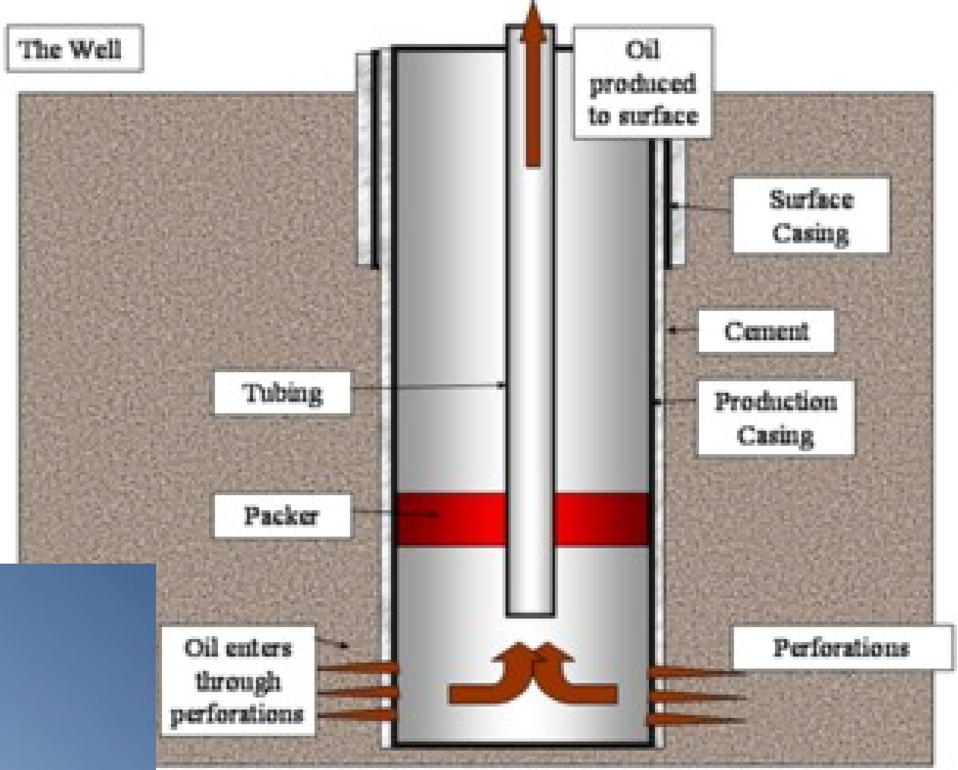


Fig. 25.11 An anticlinal trap from which oil is being drawn. The gas–oil and oil–water contacts will move during production so the producing wells must be drilled accordingly at sites OE. Wells at A would quickly go over to producing gas, whereas those at B would soon produce only water. The wells at OE would be expected to recover the last of the producible oil! OE, oil extraction wells; GI, a gas injection well; WI, a water injection well.

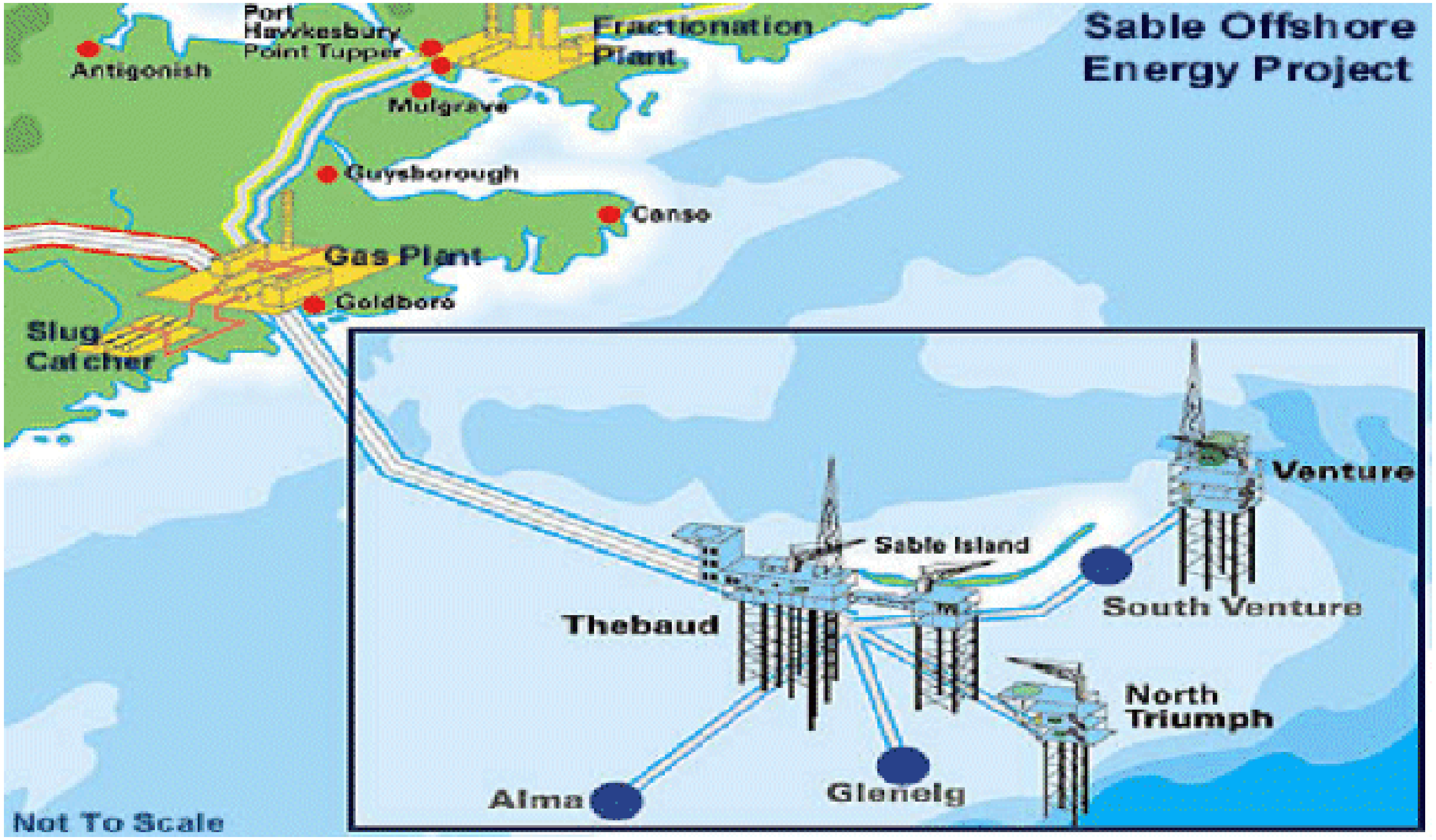
Ložiskový tlak

Těžba ropy



Texas

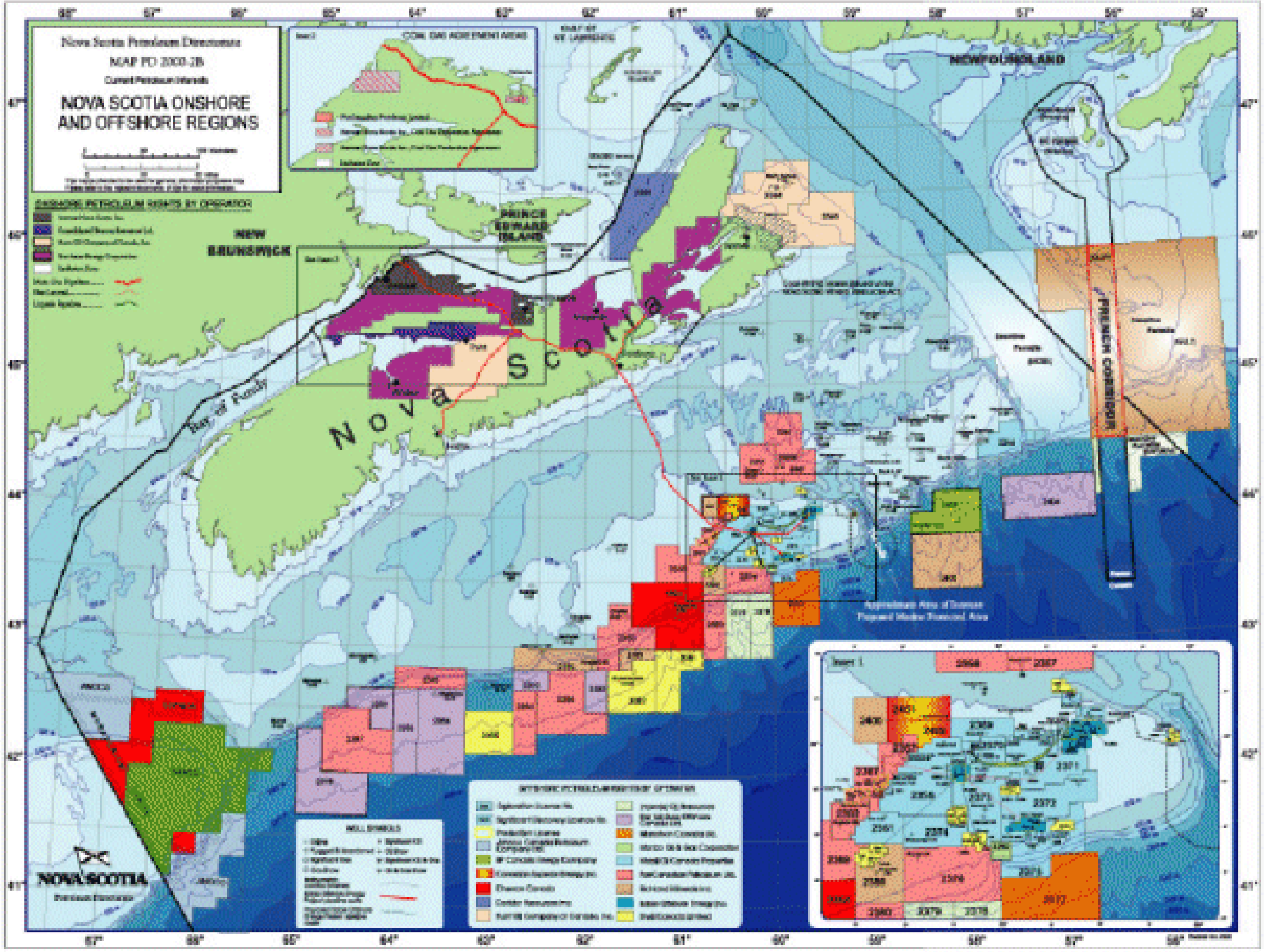
Průzkum a těžba na šelfech



Proč jsou uhlovodíky na šelfech?

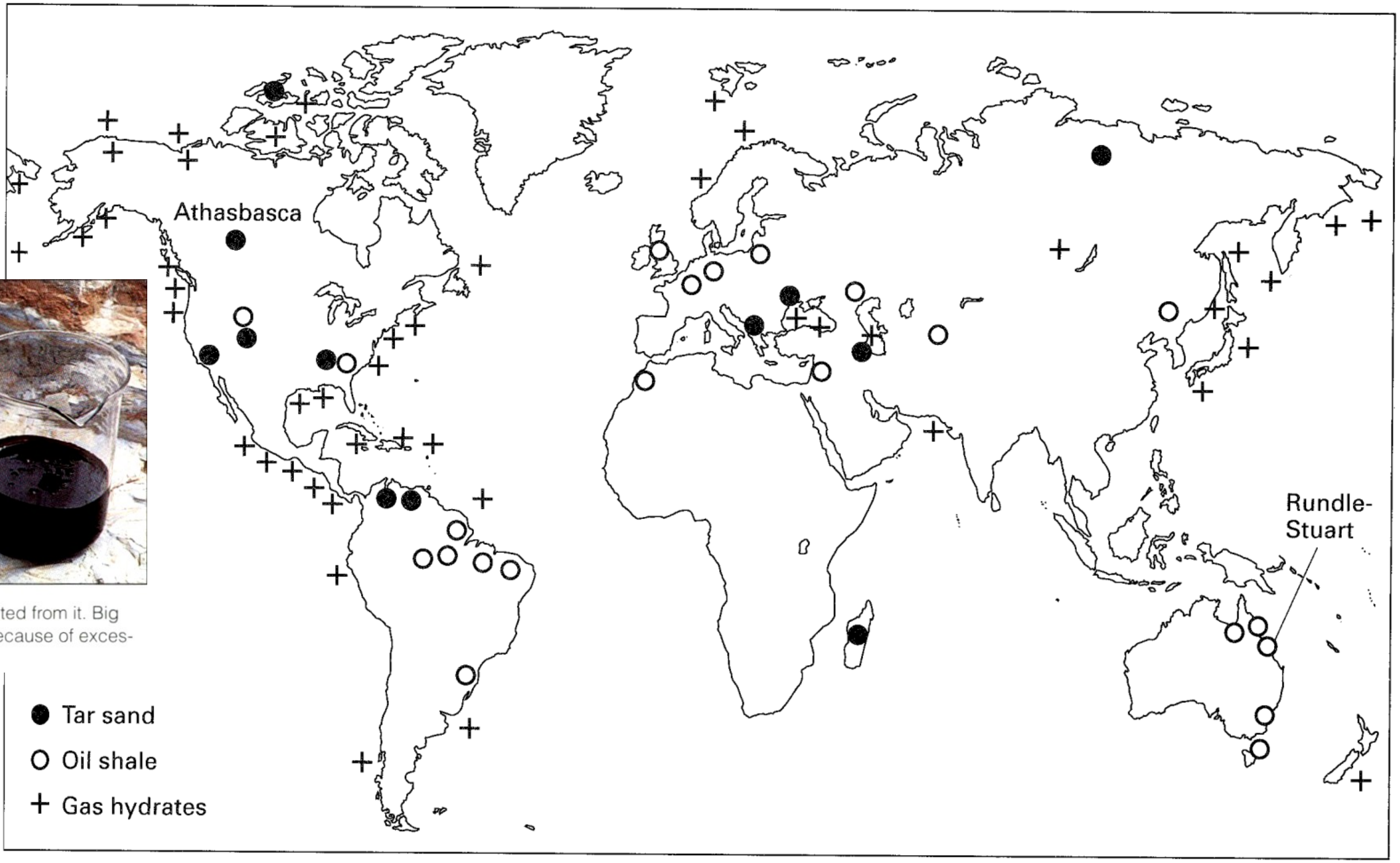
Geologie ložisek - průzkum

Artist concept of TDRS-H spacecraft on orbit.



Další zdroje uhlovodíků

Figure 19-7 Oil shale and the shale oil extracted from it. Big U.S. oil shale projects have been canceled because of excessive cost. (U.S. Department of Energy)



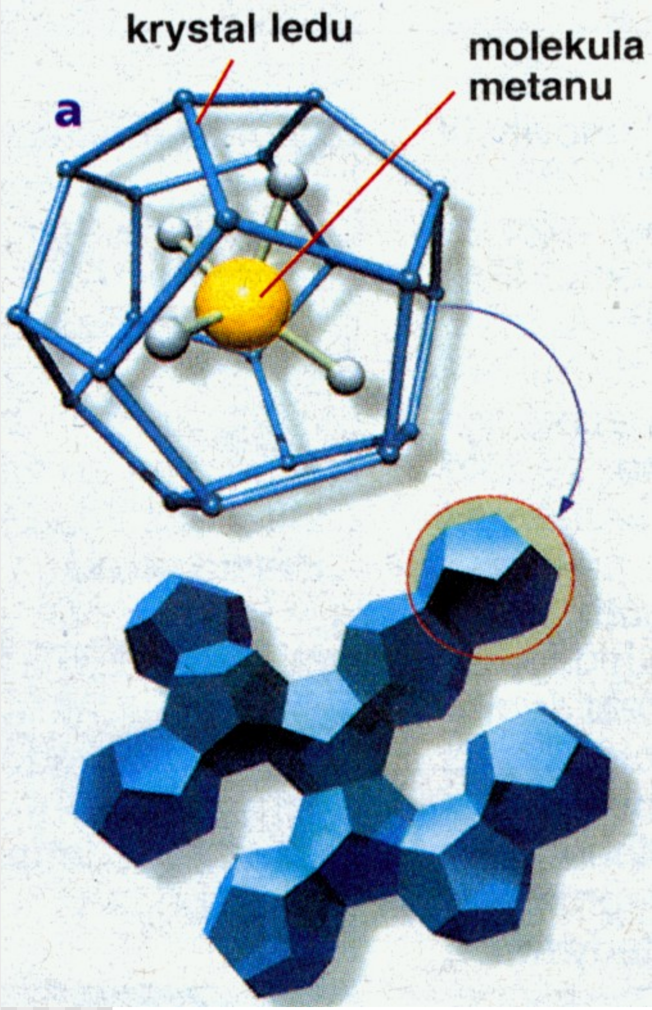
● Tar sand
○ Oil shale
+ Gas hydrates

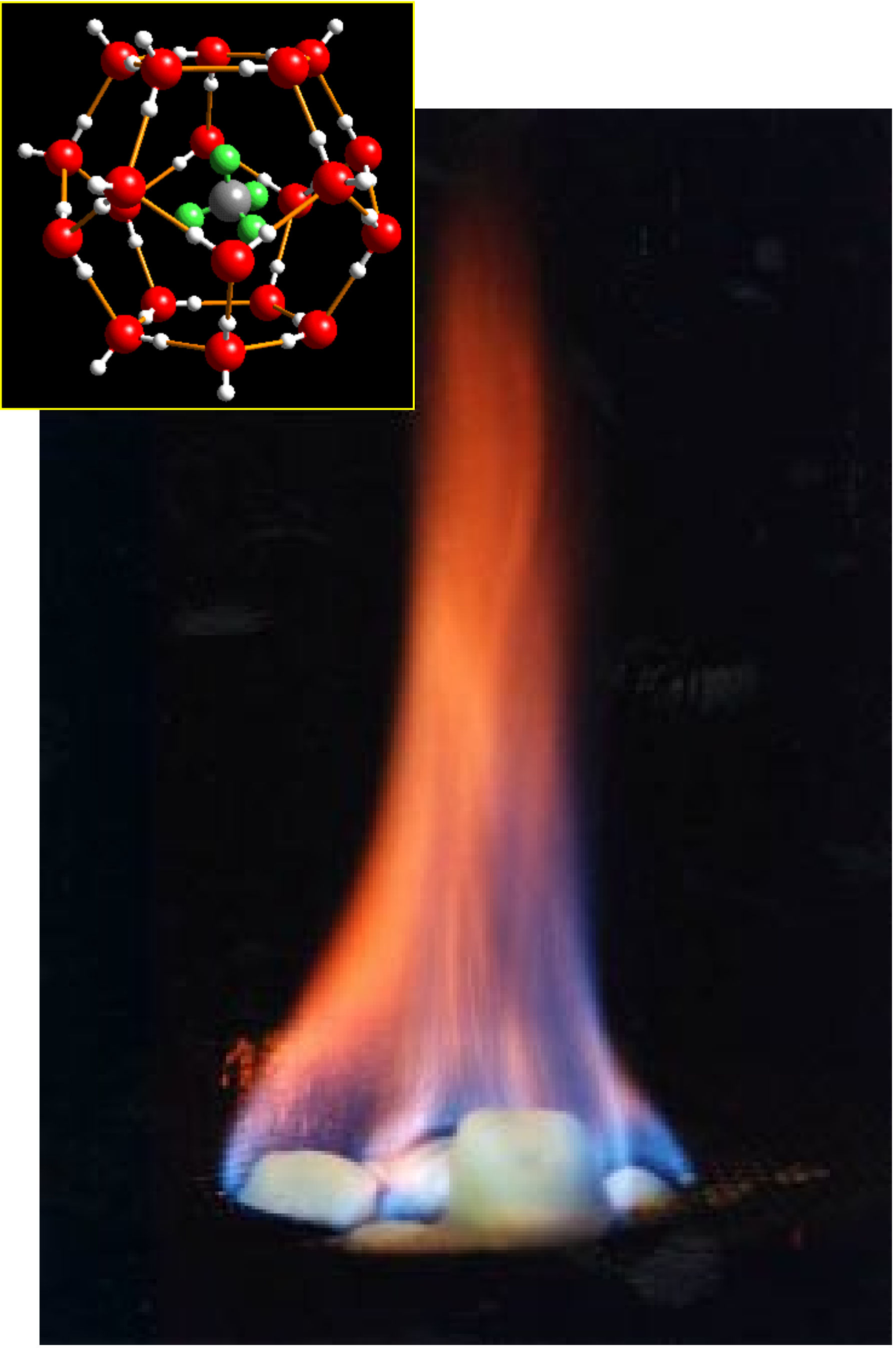
Fig. 25.13 World distribution of important tar sand and oil shale deposits, and the known occurrences of gas hydrates.

Oil sands

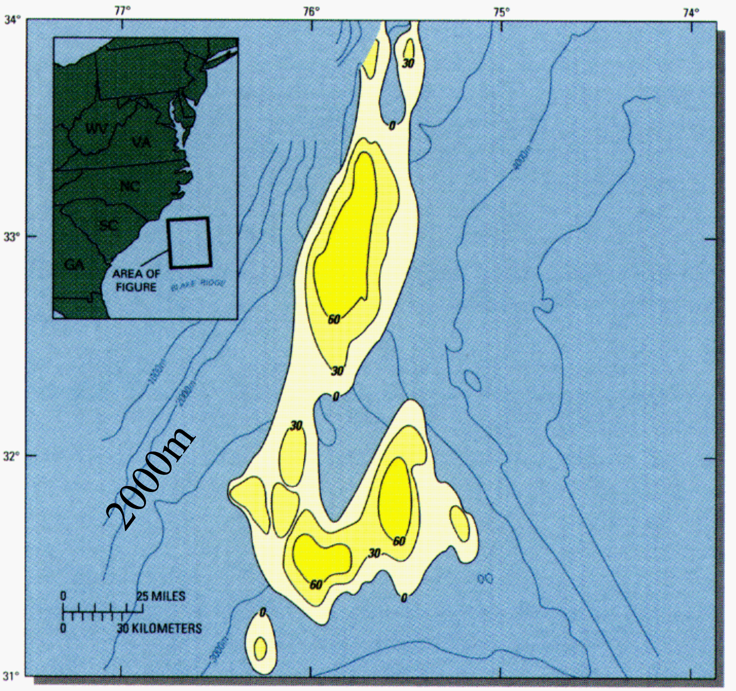

NORTHWEST TERRITORIES
Wood Buffalo National Park
Lake Athabasca
Clearwater River Provincial Park
Fort McMurray
Athabasca Oil Sands
Peace River Oil Sands
SASKATCHEWAN
Grande Prairie
ALBERTA
Cold Lake Oil Sands
Meadow Lake Provincial Park
Edmonton
Lloydminster
BRITISH COLUMBIA
Jasper National Park
Red Deer
Banff National Park
Calgary
Canada
United States
Medicine Hat
Lethbridge
MONTANA
NORTH
0
50
100
200
Kilometres

Hydráty CH_4





Rozšíření hydrátů metanu



Map showing location and inferred thickness (in meters) of hydrates within sediments in the high concentration area off North Carolina and South Carolina.

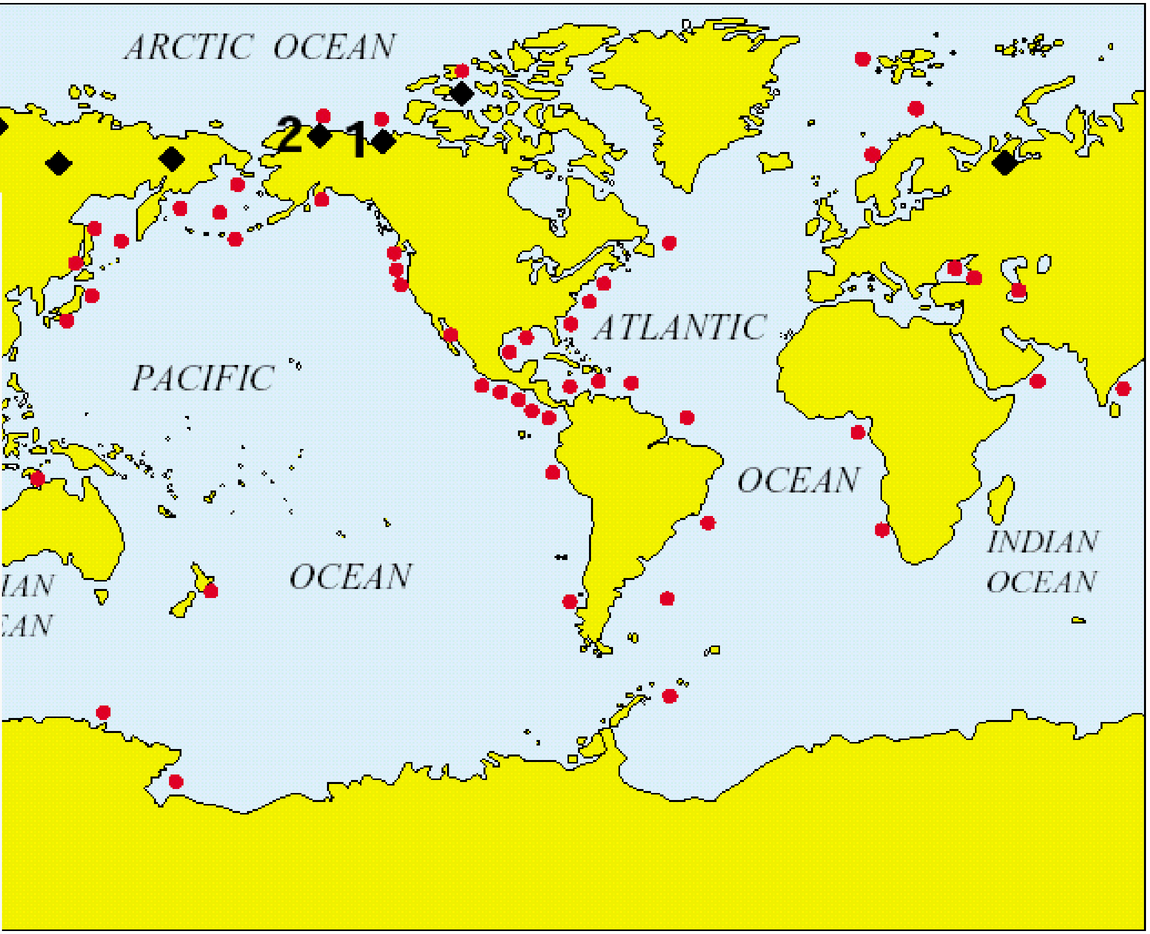
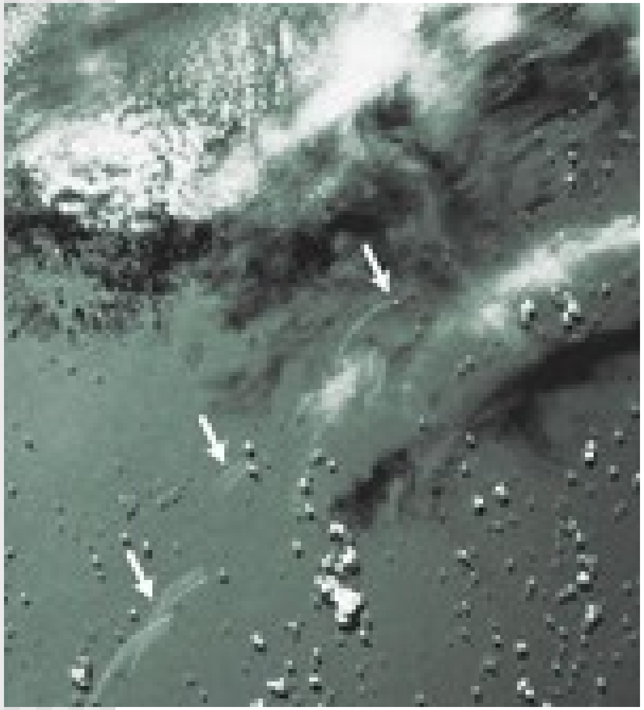


Figure 1. Known and inferred natural gas hydrate occurrences in marine (red circles) and permafrost (black diamonds) environments. Modified from K. A. Kvenvolden, U.S. Geological Survey (written commun., 1999). The USGS is studying hydrates at sites 1 (Mackenzie Delta, Canada) and 2 (North Slope, Alaska).

Uvolňování metanu

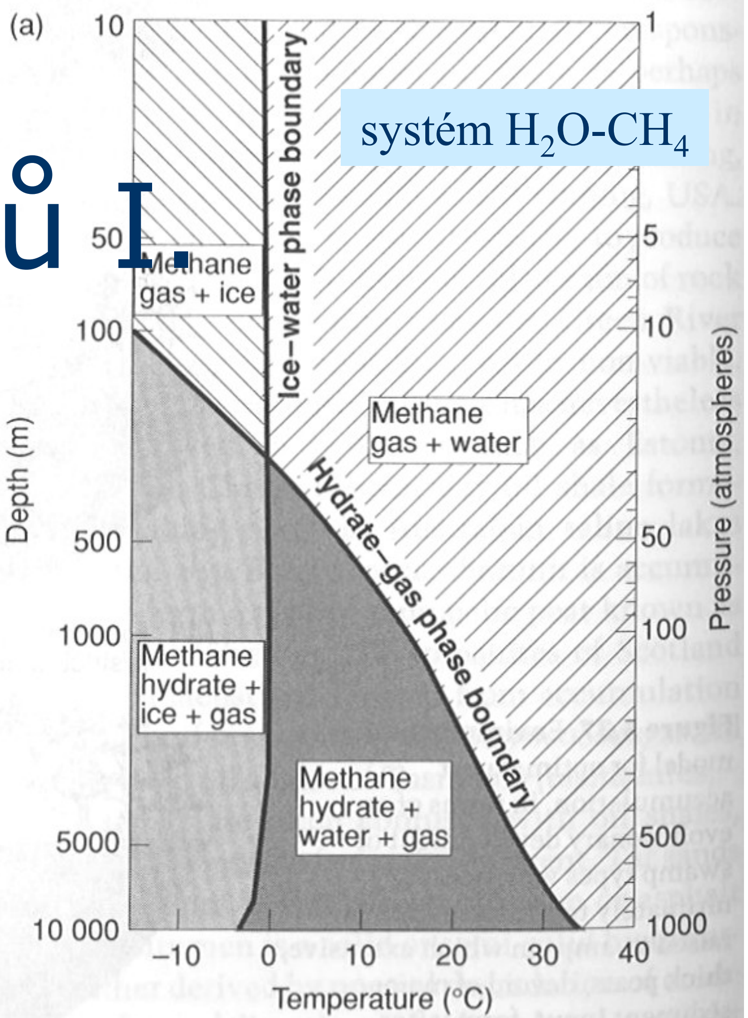


This colorized image of the ocean surface taken from the space shuttle makes the sea and clouds look like an artist's abstract dabs and brushstrokes. The bright streaks are oil slicks produced by hydrocarbons seeping naturally from seafloor vents.

Layers of gas hydrate in a subsea sediment sample.

Stabilita hydrátů I.

systém H_2O-CH_4



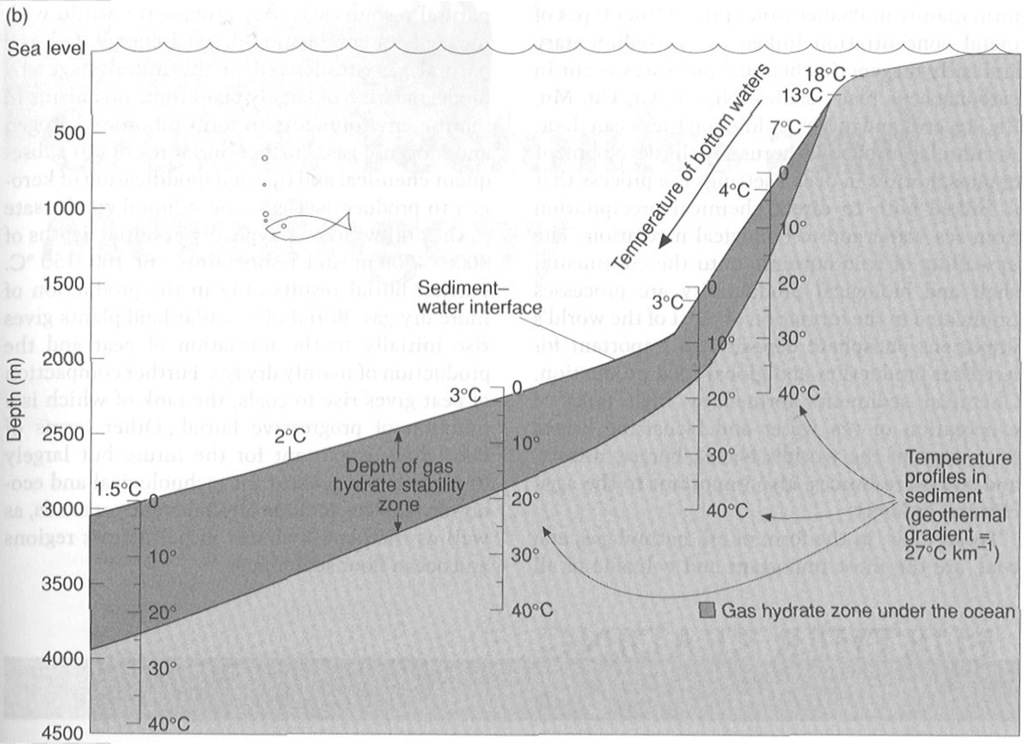
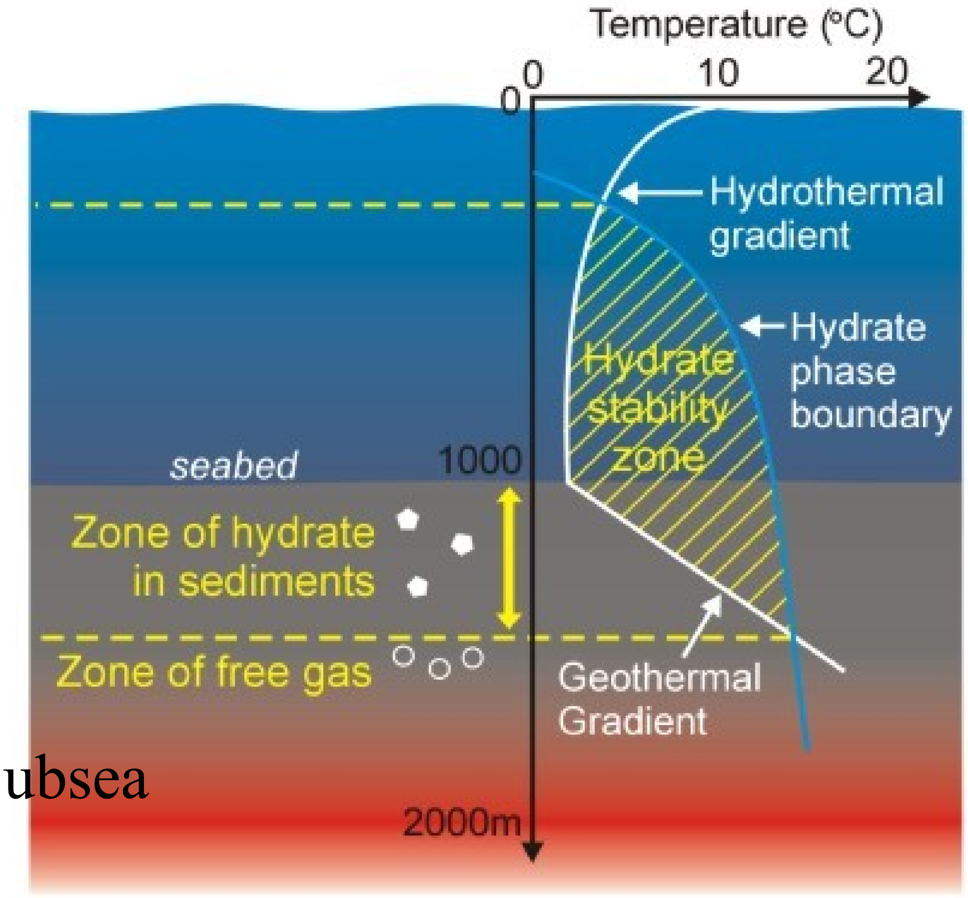


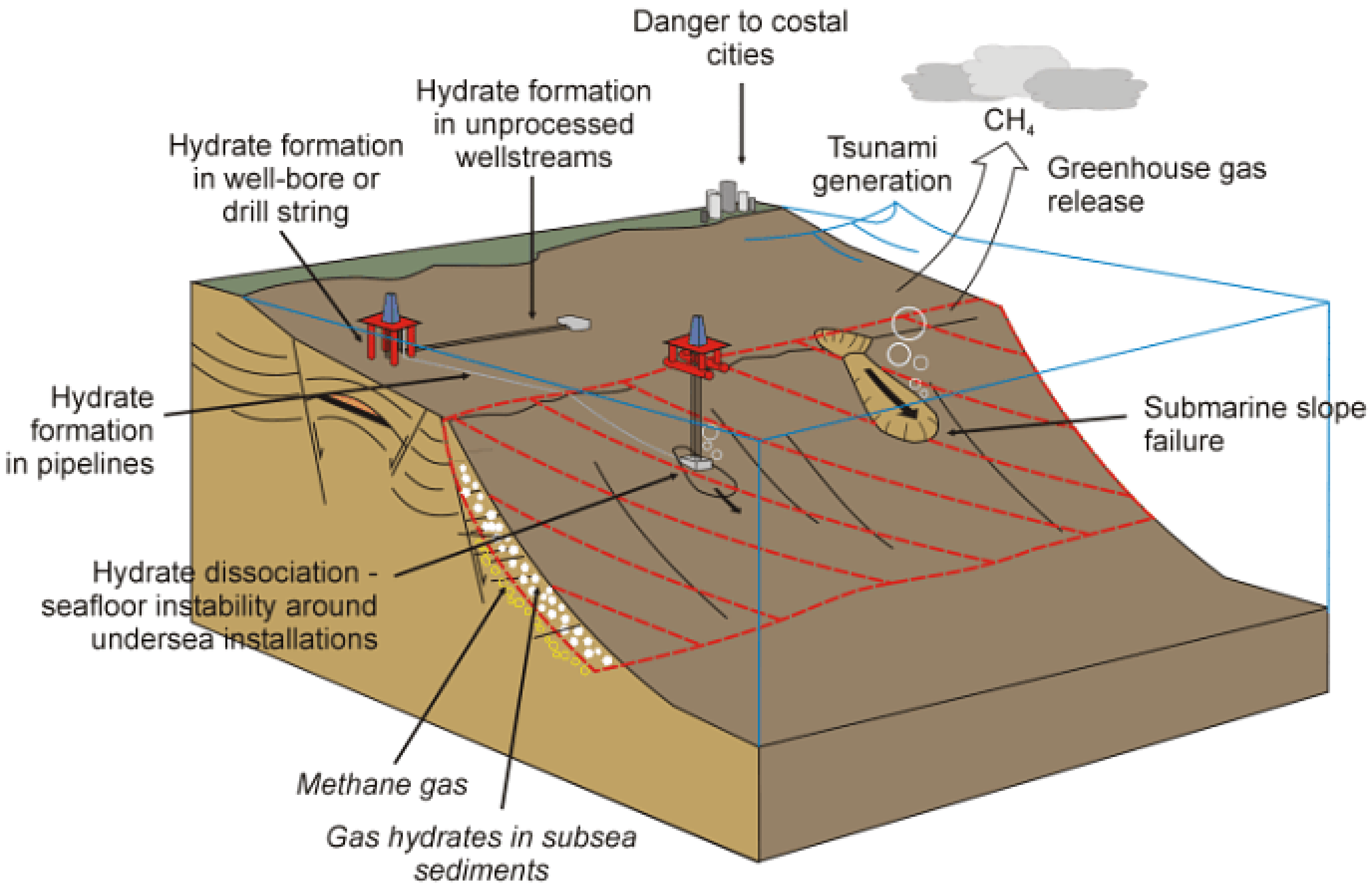
Figure 5.38 (a) Phase diagram illustrating the regions of gas hydrate stability under most natural conditions in the near-surface (after Kvenvolden and McMenamin, 1980). (b) Profile across a typical ocean–sediment interface in a continental margin setting, showing the progressive increase in the width of the gas hydrate stability zone in the ocean sediment with increasing depth of sea water (after Kvenvolden, 1988).

Stabilita hydrátů metanu II.

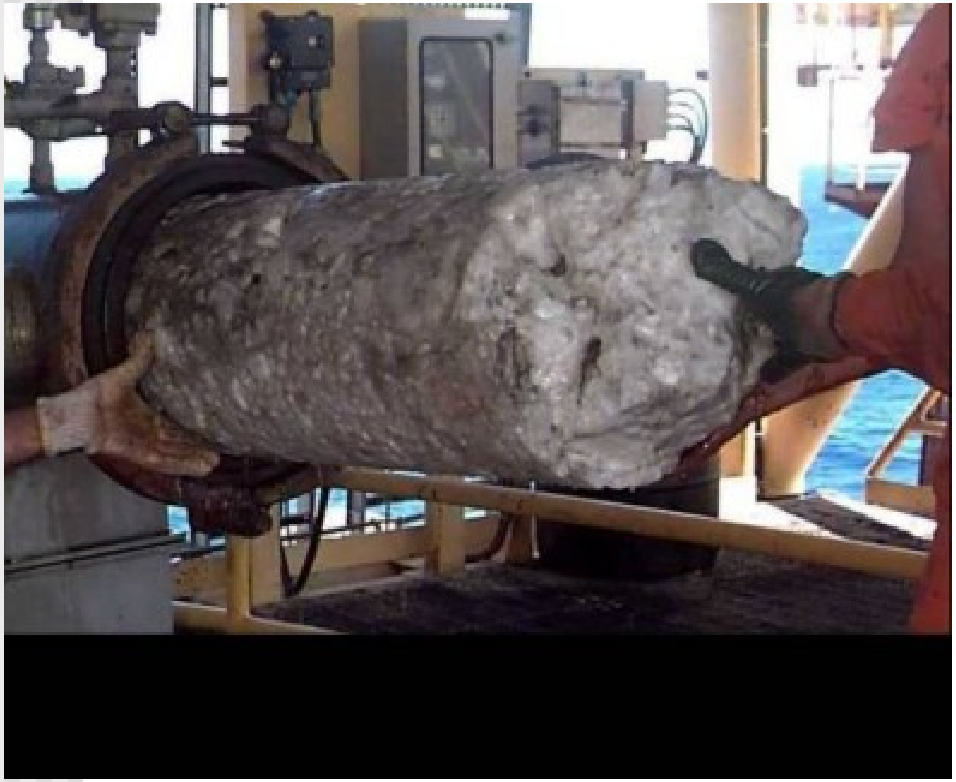


The Hydrate Stability Zone in Subsea Sediments

Rizika spjatá s existencí hydrátů CH_4



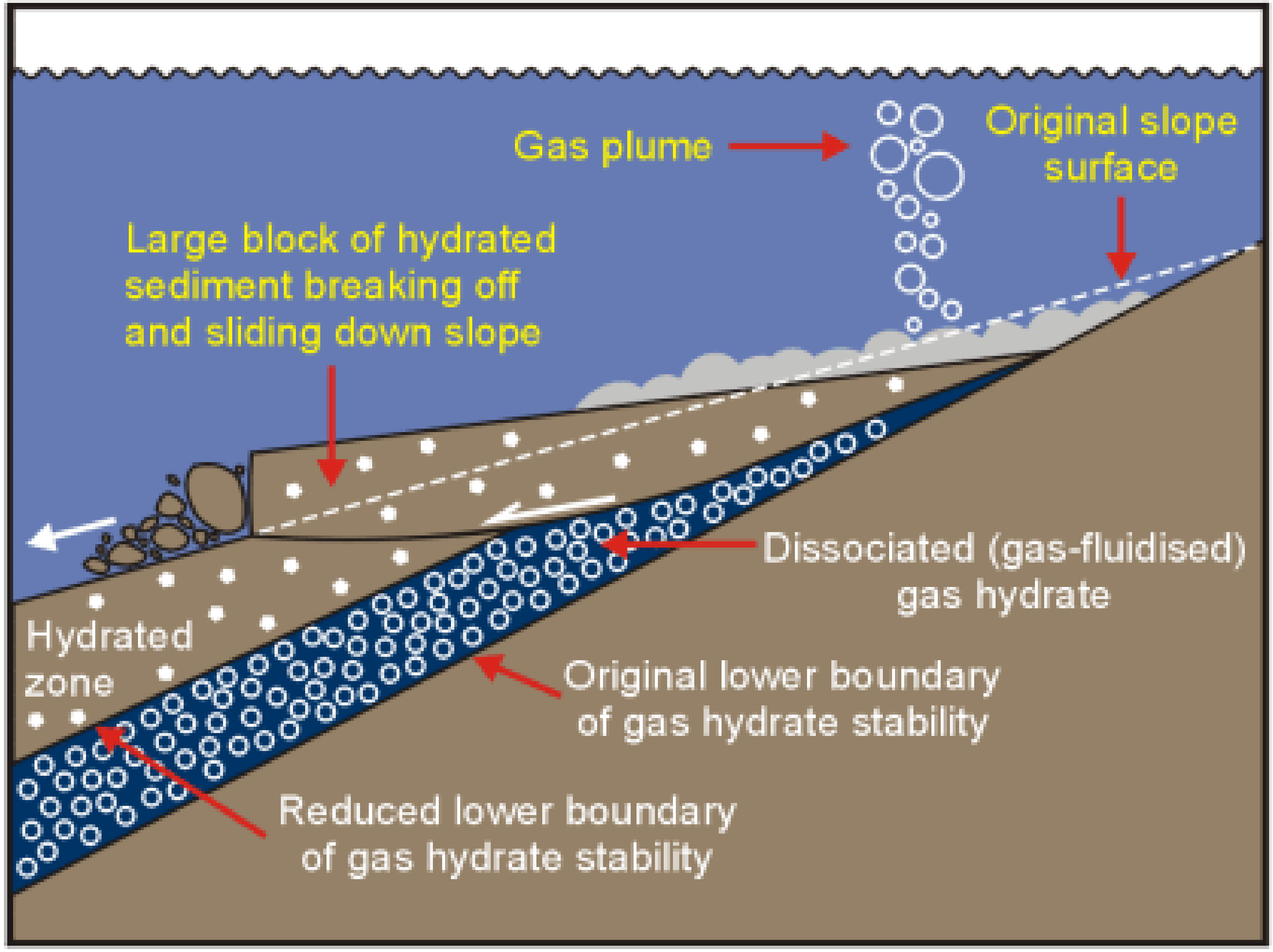
Hydráty metanu v potrubí



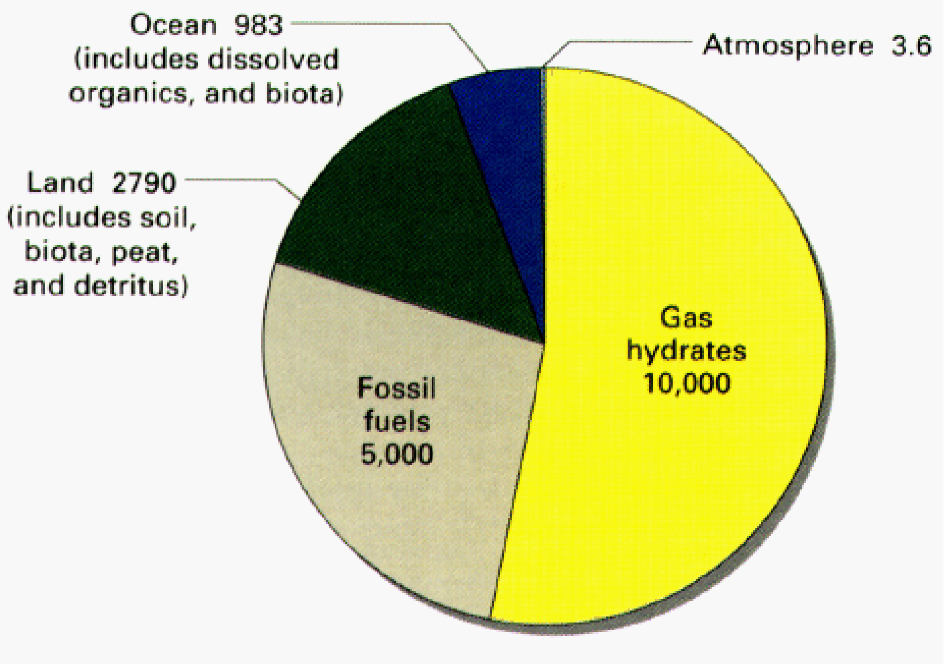
A large gas hydrate plug formed in a subsea hydrocarbon pipeline. Picture from Petrobras (Brazil).

Uvolňování metanu ze sedimentu

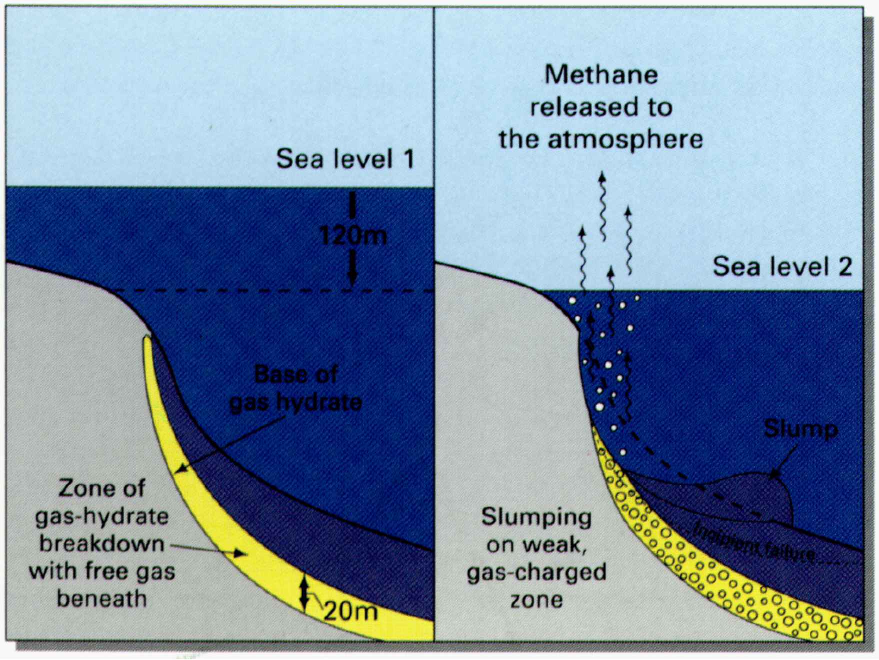
Potential scenario whereby dissociation of gas hydrates may give rise to subsea slope failure and massive methane gas release.

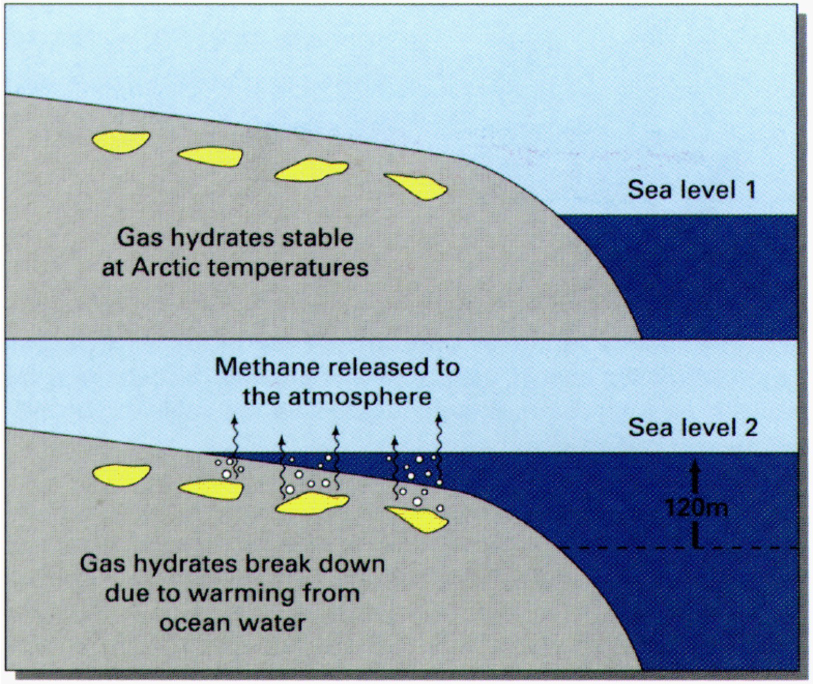


Význam



Distribution of organic carbon in Earth reservoirs (excluding dispersed carbon in rocks and sediments, which equals nearly 1,000 times this total amount). Numbers in gigatons (10^{15} tons) of carbon.





Sea-level rise causes relatively warm ocean water to cover cold Arctic strata. The resulting breakdown of stable gas hydrates within the sediment releases gas into the atmosphere.